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Tooele Army Depot North Area

Final Remedial Investigation Report for Operable Units 4-10

Volume I

February 1994

Rust Environment and Infrastructure
Grand Junction, Colorado 81506

Prepared for

U.S. Army Environmental Center
Aberdeen Proving Ground Maryland 21010-5401
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This report presents the results of previous investigations as well as current RI results for 17 sites within seven operable units at Tooele Army Depot—North Area. It contains a general introduction, site background, a description of methodologies used including quality assurance procedures, followed by a section on each operable unit that describes the investigation performed, nature and extent of contamination, contaminant fate and transport, risk assessment results for human health and the environment, and conclusions and recommendations. Field logs, photographs, survey results, and supportive analytical data are presented in appendices. The report includes three volumes with Volume I being the RI Report and Volumes II and III including the appendices.

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EXECUTIVE SUMMARY

Tooele Army Depot North Area (TEAD-N) is a National Priorities List (NPL) site under the Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA). As such, a Remedial Investigation/Feasibility Study (RI/FS) must be performed. There are 7 operable units containing 17 sites at TEAD-N that are under CERCLA. Rust Environment and Infrastructure (Rust E&I, formerly SEC Donohue, Inc.), under a U.S Army Environmental Center (USAEC, formerly U.S. Army Toxic and Hazardous Materials Agency (USATHAMA)) contract (Contract No. DAAA15-90-D-0007, Task Order 0003), was tasked with conducting the RI/FS for TEAD-N. The operable units (OUs) and associated sites investigated are shown in Table ES-1.

Table ES-1. Operable Units and Sites at TEAD-N

Operable Unit	Site No.	Site Name
4	31	Former Transformer Boxing Area
	32	PCB Spill Site
	35	Wastewater Spreading Area
5	17*	Former Transformer Storage Area
	33*	PCB Storage Building 659
6	9*	Drummed Radioactive Waste Area
	18*	Radioactive Waste Storage Building
7	5*	Pole Transformer PCB Spill
8	6	Old Burn Area
	7	Chemical Range
	13	Tire Disposal Area
	22	Building 1303 Washout Pond
	23	Bomb and Shell Reconditioning Building
	36	Old Burn Staging Area
9	8	Small Arms Firing Range
	40	AED Test Range
10	41*	Box Elder Wash Drum Site

*Sites not scheduled for additional field investigations because they do not require further characterization.

The RI/FS was conducted in accordance with the requirements of a Federal Facilities Agreement (FFA) between EPA Region VIII, State of Utah Department of Environmental

Quality, and Tooele Army Depot. The FFA establishes the appropriate regulatory requirements and schedule for completing the RI/FS.

The main objectives of the RI portion of the RI/FS were to investigate the nature and extent of contaminant releases within each operable unit and to assess the potential risk to human health and the environment posed by these releases. Although there have been several previous environmental investigations conducted at TEAD-N, little previous information exists for the 17 sites investigated as a part of this RI. On the basis of a review of previous investigation data, facility records, historical photographs, and a site walkover, work plans were prepared and an RI field investigation program was implemented. In some cases, the proposed field investigation activities were designed to fill data gaps and, for others, the activities were designed as a first look at whether contaminant releases have occurred as a result of previous operations conducted at TEAD-N and whether these releases have had or may have an adverse impact on human health or the environment. The activities conducted under the current RI were not designed to fully characterize the extent of contamination.

Field activities conducted during the RI included the following:

- Surface and subsurface unexploded ordnance (UXO) surveys
- Geophysical surveys
- Surface soil sampling and analysis
- Test pit characterization and sampling and analysis
- Surface water sampling and analysis
- Radiological surveys
- Site walkover surveys
- Background soil sampling
- Ecological survey

This RI report presents the results of these activities and summarizes the results of previous investigations. The data presented in this report will be used in the completion of the FS where various remedial-action alternatives will be screened, analyzed, and recommended for each of the seven operable units. The data were also screened and evaluated on a site-by-site basis to allow the completion of a risk characterization for each individual site. The results of the risk characterization were evaluated against regulatory risk-based standards to determine if current conditions at a site pose a significant risk to human health or the environment. Overall, the methodology used for the risk assessment is health protective, which means that the true risks from the site are unlikely to be higher than the derived estimates, and are most likely lower.

Where the extent of contamination has been defined, exposure pathways are complete and the risk assessment thoroughly characterizes any adverse health effects in a conservative manner. However, this report presents recommendations for further investigations of 11 sites where sufficient data are not available to adequately assess risk to human health and the environment

or to adequately complete the analysis of remedial-action alternatives. The 11 sites for which additional field investigations have been identified and scheduled are presented in Table ES-2.

Table ES-2. The Eleven Sites Scheduled for Additional Field Investigations at TEAD-N

Operable Unit	Site No.	Site Name
4	31	Former Transformer Boxing Area
	32	PCB Spill Site
	35	Wastewater Spreading Area
8	6	Old Burn Area
	7	Chemical Range
	13	Tire Disposal Area
	22	Building 1303 Washout Pond
	23	Bomb and Shell Reconditioning Building
	36	Old Burn Staging Area
9	8	Small Arms Firing Range
	40	AED Test Range

For these sites, the assessment of contamination has not been fully defined. Additional data needs have been identified and are currently being addressed; as such, the evaluation of adverse health effects derived for each of these sites could be an underestimate of the health risk actually associated with the site. This is reflected in the Baseline Risk Assessment where data deficiencies have led to incomplete exposure pathways for some sites. There are inconsistencies in the risk assessment analysis performed for the sites with additional data needs. These inconsistencies will be rectified in an addendum to this report following the collection of additional data.

Ecological risk assessments evaluate the likelihood that adverse ecological effects will occur, either directly or indirectly, as a result of stressors related to human activity. On a facility-wide basis, these models indicate that the potential does exist for contaminants to directly affect populations at upper trophic levels (i.e., raptors and large mammals). This potential exists through indirect pathways as well, mainly from the bioaccumulation of contaminants in plants and small mammals that are foraged or fed upon by members of higher trophic levels. A profile of these contaminants and their chemical, physical, and biological characteristics is presented in Appendix H, Toxicity Profiles.

At TEAD-N, the stressors to the environment are chemical contaminants that, while they affect each individual site in varying degrees of ecological intensity, must be evaluated on a

facility-wide basis because of the relatively small size of the sites. Potential receptor pathways have been modeled for key sites and conclusions have been made that assess the ecological impacts and risks of contaminants entering the food chain. Alterations to the trophic structure and ecological process of each individual site or of the entire TEAD-N facility cannot be evaluated until further data are collected and, because of this, recovery times from exposure to contaminants cannot be derived or predicted. In order to fully assess the ecological risk to the ecosystem at TEAD-N, biological sampling and analysis have been identified and scheduled. Results of this additional investigation will be described in a forthcoming TEAD-N ecological report.

The following summarizes the findings of this RI for each operable unit at TEAD-N.

OPERABLE UNIT 4

OU 4 consists of three sites located in the southeastern part of TEAD-N: the Former Transformer Boxing Area (Site 31), the PCB Spill Site (Site 32), and the Wastewater Spreading Area (Site 35).

Former Transformer Boxing Area (Site 31)

The Former Transformer Boxing Site consists of Open Storage Lot 680, which is located east of the Former Transformer Storage Area (Site 17). This lot was used for short-term storage of transformers that were once stored at Site 17. There were no reported spills or releases of PCB-contaminated oils at this site. There was also no visual evidence of spills or releases on the surface of the graveled lot.

Because of the lack of evidence of contaminant releases at this site, no RI sampling and analysis activities were conducted at Site 31. However, because of the potential for PCB release from past undetected oil spills, Site 31 soil will be sampled and analyzed for PCBs to evaluate risk to human health and the environment.

PCB Spill Site (Site 32)

The PCB Spill Site is the location of a spill of PCB-contaminated oil on Open Storage Lot 665D, which resulted from the puncture of two electrical transformers. The spill occurred on an unpaved ground surface. Cleanup of the oil-contaminated soils was conducted shortly after the spill, and the soils that were removed along with some of the oil were placed in 55-gallon drums. TEAD collected composite soil samples to verify the cleanup of the soils. The composite samples indicated that low levels of residual PCBs were still present in the site soils. However, because of the low concentrations, further sampling of the site did not appear to be warranted. Rust E&I did not perform additional sampling at this site.

A preliminary baseline risk assessment performed utilizing the existing PCB data indicated carcinogenic risk estimates could be in the 1E-06 range. The risk assessment only considered incidental soil ingestion and dermal contact exposure pathways for potential exposure to

carcinogens. Chronic, noncarcinogenic health effects and the inhalation pathway for carcinogenic health effects were not evaluated.

Because of residual uncertainties with the earlier data and the calculated risks within the EPA target range, it has been determined that additional samples and analyses are needed to more fully characterize the site. Thirty-one soil samples at 0-, 5-, and 20-foot depths are scheduled to be taken and analyzed for PCBs. The additional data will be used to estimate carcinogenic and chronic, noncarcinogenic health effects associated with the site.

Wastewater Spreading Area (Site 35)

Site 35 consists of an area where wastewater was discharged from a former residential area in the southeastern portion of TEAD-N. The Environmental Photographic Interpretation Center (EPIC) performed a review of historical aerial photographs ranging from 1953 to 1981. Site 35 was identified as a potential source of contamination from 1953 and 1959 photographs that indicated the presence of liquids in ditches, trenches, a ravine, and a spreading area below the ravine.

Rust E&I collected soil samples from the ditches, ravine, and spreading area to determine if contaminant releases occurred during the period of activity for the early 1950s to mid 1960s. The area is currently vegetated, and the ditches are in some cases barely discernable. There was no evidence in 1992 of any recent activity in the Site 35 area. Soil samples taken during the RI contained few detectable concentrations of contaminants at Site 35. However, alpha and gamma chlordane were both present at 10 $\mu g/g$ in one of the samples collected. The total extent of chlordane contamination could not be defined because of the location of the sample that contained the chlordane. The anions, chloride, sulfate, and phosphate were also detected in concentrations exceeding background in approximately half of the samples collected. Metals detected above background levels included iron, lead, and zinc. Iron and zinc were only detected above background concentrations in one sample. Lead was detected in three surface soil samples but not in subsurface soil samples.

The baseline risk assessment conducted for Site 35 shows that carcinogenic risks associated with potential exposure pathways using various exposure scenarios (on-site worker, construction worker, installation school student/employee, installation resident, off-site resident, and future on-site resident) were all within or lower than the EPA target range of 1E-04 to 1E-06 for residual risk. Chronic, noncarcinogenic risk estimates for Site 35 were below the EPA goal for a residual hazard index of 1 or less with the exception of the future on-site resident scenario for reasonable maximum exposure (RME) levels. This scenario showed a hazard index of 1E+00.

Since the source and extent of chlordane contamination was not defined by the Remedial Investigation, it has been concluded that additional sampling is required. This will address the possibility that higher concentrations of chlordane exist at Site 35. To determine if any migration of soil contaminants to groundwater may have occurred, Water Well 1 (WW-1) will be sampled.

OPERABLE UNIT 5

OU 5 is made up of two sites, both of which are related to potential PCB contamination through the storage of electrical transformers containing oils contaminated with PCBs. These sites are the Former Transformer Storage Area (Site 17) and the PCB Storage Building 659 (Site 33). Of the two sites, actual releases of PCBs were confirmed at Site 17. The following paragraphs describe the findings of the RI for each of the two sites.

Former Transformer Storage Area (Site 17)

The Former Transformer Storage Area (Site 17) refers to Open Storage Lot No. 675B in the northern portion of the Maintenance Area of TEAD-N. This graveled lot was used for long-term storage of electrical transformers and capacitors prior to 1979. In 1979, all of the transformers were removed from the lot. Following removal of the transformers, composite surface-soil samples were collected and analyzed for PCBs. The results showed that low concentrations of PCBs were present in the soils of Site 17. Using conservative parameters, a value of 0.5 ppm PCB was calculated to be the maximum present in Site 17 soils. This value is well below the 1.0 ppm action level established by the EPA above which action should be considered for potential residential land use.

It was determined, after further review of the existing data, that no further sampling of the site soils was required. A baseline risk assessment was performed utilizing existing PCB data and conservative assumptions in order to evaluate risks associated with this site. All carcinogenic risks were below the EPA target range of 1E-04 to 1E-06 for residual risk with the exception of the current on-site worker (RME case only) and the future on-site resident. These latter risks are within the EPA target range and are considered to be protective of human health. Chronic, noncarcinogenic risk estimates for Site 17 were below the EPA goal for a residual hazard index of 1 or less for both the average exposure and RME case.

From the previous investigation data and the baseline risk assessment, it is recommended that no additional investigations are warranted at this site.

PCB Storage Building 659 (Site 33)

The PCB Storage Facility began receiving transformers in 1979 when the transformers at Site 17 were moved to Building 659 for long-term storage. The facility is a Toxic Substances Control Act (TSCA)-permitted facility for the storage of PCB-contaminated transformers. The building has a concrete floor, perimeter berm, and diversion structures at the entrance areas to contain any spills. The facility appeared to be in good condition and well maintained at the time of the RI field investigation. There was no evidence of contamination at this site. Further, there is no evidence to indicate that PCB-contaminated wastes caused by operations at Site 33 have ever been released to the environment.

Because Building 659 is a TSCA-permitted facility that is monitored and well maintained, no investigations were conducted during the RI at Site 33. If this facility were to be transferred to the public in the future, part of the transfer process would include additional investigations to ensure the lack of risk to human health and the environment.

OPERABLE UNIT 6

OU 6 consists of two sites where releases of radioactive contaminants were suspected to have occurred. This includes the Drummed Radioactive Waste Area (Site 9) and the Radioactive Waste Storage Building (Site 18). No previous investigations have been conducted at these sites. The following paragraphs briefly describe Sites 9 and 18.

Drummed Radioactive Waste Area (Site 9)

Site 9 consists of two areas that were previously identified as having been used for the storage of one or more 55-gallon drums containing low-level radioactive waste. The exact location where the materials may have been stored had never been determined. No investigations were previously conducted at Site 9. Although radioactive releases were possible, no releases had been reported.

During the RI, Rust E&I conducted a surface radiation survey across the two suspect areas of drum storage to determine if a release of radioactive materials had occurred. The first small area was scanned over its entire surface with no elevated levels of radioactivity being detected. The second larger area was gridded and each grid line was scanned for radiation. Again, no areas of concern for radioactivity were detected during the survey.

As a result of the radiation surveys, it was determined that no further investigation of this site is warranted.

Radioactive Waste Storage Building (Site 18)

The Radioactive Waste Storage Building (Site 18) is located on the northern end of Building 659, which also houses transformers (Site 33). This radioactive storage portion of the building is walled off and locked. The storage area is a Nuclear Regulatory Commission (NRC)-licensed facility for the storage of radioactive materials. Low-level radioactive materials are stored in this area. Access to the materials is controlled, and periodic monitoring of the facility for releases of radioactive materials is performed.

No previous investigations have been conducted for this facility. During a site visit in 1992, Rust E&I concluded that further investigations at this facility were not warranted. Since this facility is an active licensed facility that is locked, well maintained, and monitored, it appears that no further investigations are required under the RI.

OPERABLE UNIT 7

OU 7 consists of the Pole Transformer PCB Spill (Site 5). RI investigations were performed at this site. The following paragraphs describe the results of the RI for Site 5.

Pole Transformer PCB Spill (Site 5)

The Pole Transformer PCB Spill (Site 5) is the site of a pole-mounted electrical transformer that caught on fire and resulted in a spill of PCB-contaminated oil to the surrounding soils. The contaminated soils were excavated and placed in 55-gallon drums for off-site disposal. No soil samples were collected from the excavation to verify that the cleanup was complete. However, a composite sample of the drummed soils was collected and analyzed for PCBs. The results showed that the composite concentration of PCBs (3.45 $\mu g/g$) was lower than the TSCA limit of 10 parts per million (ppm) for soils.

During the current RI, surface- and subsurface-soil samples were collected along the perimeter of the excavation, and a subsurface soil sample was collected in the center of the excavation to determine if residual PCB contamination is present in the soils and, if present, whether the contaminants pose a risk to human health and the environment. Results of the sampling and analysis indicate that low levels of PCBs and polychlorinated dibenzofurans and dibenzodioxins are present in the soils in and adjacent to the excavation.

Results of the baseline risk assessment indicate that carcinogenic risks associated with Site 5 are within or below the EPA target range for residual risk. The highest risk associated with this site was estimated to be 4E-05 for the hypothetical, future on-site resident for RME. Chronic, noncarcinogenic risk estimates were below the EPA goal for a residual hazard index of 1 or less for all scenarios evaluated. Although low concentrations of contaminants exist, it appears that no further investigation of the site is warranted.

OPERABLE UNIT 8

OU 8 is made up of six sites generally located in the southwestern section of TEAD-N. It contains the Old Burn Area (Site 6), the Chemical Range (Site 7), Tire Disposal Area (Site 13), Building 1303 Washout Pond (Site 22), the Bomb and Shell Reconditioning Building (Site 23), and the Old Burn Staging Area (Site 36). All of these sites have been scheduled for additional investigation.

Old Burn Area (Site 6)

The Old Burn Area (Site 6) is located in the south-central portion of TEAD-N and consists of a gently sloping grassy area with a bermed revetment located in the eastern portion of the site. The area was used for the testing of munitions and was also used for the burning of wooden boxes and crates on the surface and in shallow trenches. A review of EPIC aerial photographs shows that various trenching activities occurred from the 1950s to the 1970s. All of the former trenches and disturbed areas have been filled, graded, and vegetated since use of the area for testing was discontinued.

Weston (1990) conducted geophysical surveys over a portion of the Old Burn Area to further define the locations of former trenches that were observed in the aerial photographs. The geophysical surveys identified several target areas. Because of safety concerns, Weston conducted a drilling program of four soil borings adjacent to but not in former trenches as

defined by the geophysical surveys and aerial photographs. The borings were drilled to a depth of 50 feet and soils were collected. The results from these samples indicated that there were no explosives or site-related inorganic contaminants in site soils.

A geophysical survey was conducted during the current RI across the entire Site 6 area to verify and further define target areas identified during the previous investigation and to investigate other areas to the south of the previous survey that are shown as trenched and disturbed areas on historical photographs. The detailed survey successfully identified several areas of potential buried materials. Three of the target areas defined by the geophysical survey were selected for test pit excavation and sampling. A fourth test pit was excavated and sampled in an area identified on the basis of visual observations. In addition, two exploratory pits were excavated but not sampled in a geophysical target area in the southwestern portion of the site.

One test pit was located within the revetment area of the site where several trenches were shown on historical photographs and were verified by the geophysical survey. A variety of munitions-related debris was encountered in this test pit. Soil samples collected contained high levels of a variety of metals. A test pit located just to the northwest of the revetment was found to contain metal banding obtained from the burning of boxes and crates in the area. Soil samples collected from this test pit also contained elevated concentrations of several metals. A third test pit to the south of the revetment contained only explosives at a depth of 1 foot. A fourth test pit located in the western portion of the site contained explosive contaminants to a depth of 7.5 feet. Soil samples collected below the depth of buried materials generally contained background concentrations of analytes, indicating that vertical migration of contaminants has not occurred. The horizontal extent of contamination was not defined for any of the contaminated areas.

Several shallow drainage areas (gullies) were sampled on the northern side of the site to determine if contaminants are migrating off-site via the surface-water pathway. These drainages were found to be intercepted by a manmade drainage ditch, which carries runoff to the northwestern corner of the site where the ditch exits via a culvert under the access road. Nearly all of the gully soil/sediment samples contained explosive contaminants and elevated metals. A sample location taken in the ditch as it exits the site, however, contained no contaminants above background concentrations, indicating that no off-site migration of contaminants is occurring via the surface-water pathway.

Results of the baseline risk assessment for Site 6 indicate that risks to human health and the environment are below the EPA target range for residual contamination with the exception of reasonable maximum exposure (RME) noncarcinogenic risk for the construction worker scenario and the RME carcinogenic risk for the future on-site resident scenario. However, potential health risks associated with the elevated lead concentrations detected at Site 6 were not evaluated. Because of the toxicological effects of lead, risks need to be evaluated using blood lead levels.

Additional investigation of the trenches within the revetment area of Site 6 appears to be warranted because of the variety of materials found and the high concentrations of contaminants identified in the subsurface soils at this site. The extent of contamination needs

to be defined so human health and environmental risks can be fully characterized. Ten additional test pits are planned to be excavated and sampled as well as comprehensive surface soil sampling performed to fully characterize the area. These soil samples will be analyzed for explosives and metals.

Chemical Range (Site 7)

Prior to 1991, two open trenches were present at the Chemical Range (Site 7) where debris from explosives testing in the area was disposed of. These trenches reportedly contained various items associated with the testing of flares, smoke grenades, smoke pots, riot control munitions, and other related munitions testing. Weston (1990), because of safety concerns, did not sample within the open trenches nor drill adjacent to the trenches. Surface-soil samples were collected from the bermed soils adjacent to the trenches. Results indicated the presence of several metals in concentrations above background. Weston also conducted a geophysical survey in the area and determined that a third area of waste disposal may be present.

At the time of the RI field investigation activities in 1992, the previously open trenches had been filled and the surface graded. To verify previous geophysical results and to determine the location of the previous trenches, Rust E&I conducted a geophysical survey across Site 7. Three target areas were identified, and test pits were excavated in each target area to determine the nature of the materials buried in the trenches and to collect surface- and subsurface-soil samples for analysis. The target area identified previously by Weston (1990) and again by Rust E&I in 1992 was excavated, but no buried debris was found to be present. The source of the geophysical anomaly is currently unknown. Soil samples collected from the test pit for this target area contained no contaminants of concern. The second test pit was excavated within one of the former open trenches and was found to contain a variety of metal debris. Soil samples from this pit, however, were found to contain only elevated concentrations of chloride and sulfate. The third test pit, located in the edge of one of the former trenches, contained no metal debris or contaminants on the basis of the soil samples collected. Surface-soil samples collected during the RI contained no contaminants of concern. Results of the Weston sampling could not be confirmed since the soils that were previously sampled appear to have been used to backfill the trenches. It is also suspected that clean soils may have been used to complete the filling and grading of the former trenches.

Because of the uncertainty of data results to date and because information has risen subsequent to the RI which indicates additional possible contamination, it has been determined that additional sampling is needed to more fully characterize this site. This comprehensive sampling includes 15 new test pits and numerous surface soil samples that will be analyzed for metals and explosives.

Tire Disposal Area (Site 13)

A large pit that resulted from former gravel mining operations had been used for the disposal of thousands of tires from TEAD-N vehicles. No previous investigations were conducted at this site. On the basis of a review of literature concerning the stability of tires in the environment, it was determined that additional studies were not warranted at Site 13. As part

of the RI, however, a site walkover was conducted to look for evidence of the disposal of other types of waste in the former gravel pit. No other types of waste were observed, and no evidence of spills or releases was found.

Subsequent to the RI, the tires were removed to an off-site location for re-use. As part of the RI Phase II field investigation, soil samples will be collected at this site.

Building 1303 Washout Pond (Site 22)

The Building 1303 Washout Pond consists of Building 1303, which was used for the sawing of munitions, and a contaminated area, which resulted from washdown operations. Washdown water from the washing of floors at Building 1303 crossed a concrete pad to a shallow ditch, depression (pond), and an open spreading area.

The RI at Site 22 consisted of the collection of 10 surface-soil samples in the area suspected to have received washdown water. A sample collected adjacent to the concrete pad was found to contain explosive contaminants and metals. An area of surface staining was observed during the RI adjacent to the gravel bypass road where the washdown water ran in a shallow ditch prior to entering the ponding area. A sample collected within this stained area contained high levels of explosives and metals. Samples collected from the ponding area contained explosives but only background concentrations of metals. An explosive contaminant was detected in only one of the remaining samples collected to the east and northeast of the ponding area.

Results of the baseline risk assessment indicate that there are carcinogenic and chronic, noncarcinogenic risks to human health and the environment associated with Site 22. The estimates of risk, however, were biased by the sample collected in the small area of surface staining. The primary risk would be to the on-site worker, construction worker, and future on-site resident through exposure to explosives and metals.

It has been determined that further investigation is needed in the area between Building 1303 and the ponding area in order to define the horizontal and vertical extent of contamination. This will be accomplished through the drilling of soil borings to a depth of 10 feet and then sampling for explosives and metals. Additional surface soil samples will be taken and also analyzed for explosives and metals. Risks to human health and the environment will be re-calculated and assessed utilizing the new data.

Bomb and Shell Reconditioning Building (Site 23)

Located in the western portion of TEAD-N, the Bomb and Shell Reconditioning Building (Building 1245) was used for conducting bomb reconditioning, including primarily sandblasting and painting. Floor drains in the building discharged liquids from washdown operations to two ditches north of the site. During the RI, other areas of surface staining were observed in soils adjacent to the building and paved areas. These stained areas, the ditches, and the discharge areas for the ditches were sampled during the RI.

Samples collected along the perimeter of the building and the paved area primarily contained metals and anions, although semi-volatile compounds were detected in one of the surface-soil samples near Building 1343 (boiler building). Sediment collected in the ditches and discharge areas contained metals, anions, and low levels of PCBs. Surface water collected during discharge to one of the ditches contained elevated metals and anions.

Results of the baseline risk assessment show that carcinogenic risks to human health are within or lower than the EPA target range for residual risk except for the future on-site resident scenario at the RME level. This scenario shows a risk of 1.12E-04, just above the EPA target range. Chronic, noncarcinogenic risk estimates are below the EPA goal for a residual hazard index of 1 or less for all scenarios evaluated.

It has been determined that further investigation of the site is needed. The extent of contamination resulting from wastewater discharge will be better defined through soil sampling downstream from the discharge area north of the site. Additional surface-soil samples are scheduled in order to define the horizontal extent of contamination along the perimeter of the paved area of the site. In the drainage ditches, underneath the pavement, and in the unpaved area, a number of soil borings are scheduled to determine the vertical extent of contamination. All of these soil samples will be analyzed for semi-volatile organics and metals.

Old Burn Staging Area (Site 36)

The Old Burn Staging Area (Site 36) consists of a small gravel pit located just north of the Old Burn Area (Site 6). The pit was used for the storage of materials to be burned at Site 6. EPIC photographs show dark areas within the floor of the gravel pit. These areas were interpreted as areas of standing liquid. It was also believed that trenching may have occurred in the bottom of the pit. Rust E&I conducted a geophysical survey in the pit to determine if buried materials were present. There were no target areas identified by the survey. However, during the RI, it was observed that several dark stained areas are present in the pit as a result of surface burning. Therefore, only surface-soil samples were collected within the pit. These samples contained elevated concentrations of barium, chromium, copper, iron, lead, silver, and zinc.

During the site visit by Rust E&I at Site 36 in 1991, it was noted that several burn areas were present to the north of the pit. A geophysical survey was conducted in this area to determine if there were trenches or pits associated with this burning activity. No target areas were identified by the survey. Surface samples were collected from this area but only one of the samples was found to contain elevated concentrations of metals.

The results of the baseline risk assessment indicate that noncarcinogenic risks associated with Site 36 are below the EPA goal for a residual hazard except for the RME construction worker scenario. The risk assessment did not fully evaluate potential health risks associated with the site due to the limited data available.

Additional investigation of the former burn areas in the gravel pit is required and scheduled to determine the vertical and horizontal extent of contamination. On the basis of the geophysical

survey, it appears that there are no areas of buried materials. Therefore, six shallow soil borings are scheduled. Samples from these borings will be analyzed for metals, and the additional data will be used to evaluate potential health risks associated with Site 36.

OPERABLE UNIT 9

OU 9 consists of two test ranges in the northwestern section of TEAD-N: The Small Arms Firing Range (Site 8) and the AED Test Range (Site 40). Both of these sites have been scheduled for additional investigation.

Small Arms Firing Range (Site 8)

Located along the western boundary of TEAD-N, the Small Arms Firing Range (Site 8) has been used for training military personnel in the use of small firearms. Bermed areas behind the targets at the site were selected for metals analysis. During the RI, four locations were sampled using a composite sampling approach.

Target Analyte List (TAL) metals analysis indicate that only lead exceeds background concentrations in berm soils. Toxicity Characteristic Leaching Procedure (TCLP) results indicate that there are leachable concentrations of barium, cadmium, lead, and mercury. However, only lead exceeds regulatory limits for TCLP.

No risk assessment calculations have been performed for this site. Fifty additional surface and subsurface soil samples are scheduled to determine actual metal concentrations; this will also determine the extent of lead contamination and size fraction of the lead contaminants. This information will be utilized to assess risk to human health and the environment and reported in an RI Report Addendum.

AED Test Range (Site 40)

The AED Test Range is a testing facility that has been used extensively over the years for the testing of munitions, bombs, and rocket engines. Activities included a deactivation furnace (foundation of building remains), a drop tower, several testing revetments, and an area of bomb detonation as evidenced by craters. The site is still used occasionally for testing activities.

RI field activities included UXO surveying, geophysical surveying of each revetment area, surface-soil sampling adjacent to the building foundation and in revetments, and surface and subsurface sampling of the test pits. Geophysical surveys were conducted in each of the areas within revetments. Results of these surveys showed possible buried pits or trenches containing metal debris in four of the revetments. One revetment contained abundant munitions debris, the top of a 55-gallon drum, and a heavy metal casing. Samples from this test pit contained elevated concentrations of explosives and metals. Buried materials and subsurface contamination were not encountered in the remaining three test pits completed at the site. Several of the surface-soil samples contained detectable concentrations of explosives and elevated metals. The extent of contamination was not determined. Because of the

variety of testing activities conducted at this site, it is suspected that contaminants may be different for each test area.

The baseline risk assessment shows that estimated carcinogenic risks to human health are below the EPA target range for residual risk for all scenarios except the on-site worker and future on-site resident cases at the RME levels. These scenarios show carcinogenic risks between 2E-06 and 5E-06. Chronic, noncarcinogenic risk estimates were below the EPA goal for a hazard index of 1 or less for all scenarios evaluated. On the basis of the RI, it appears that the presence of UXO may present the greatest risk for this site.

To delineate the extent of contamination and further characterize the site, 180 additional soil samples are scheduled to be taken and analyzed for metals and explosives. Results from these analyses will be used to re-calculate risks to human health and the environment. Results of this further assessment will be reported in an RI Report Addendum.

OPERABLE UNIT 10

Box Elder Wash Drum Site (Site 41)

A total of 21 drums are present in the channel of Box Elder Wash. The source of the drums and the date of the dumping are unknown. The drums contain what appears to be tar. Previous investigation of the drum contents included sampling of four of the exposed and open drums. Results from the previous sampling showed the presence of several semi-volatile organic compounds, barium, and mercury.

RI investigations at the drum site included geophysical surveying to locate potential buried drums, hand excavation and inventory of all drums in the wash, collection of samples from eight drums, collection of surface and subsurface soils from hand-augered borings adjacent to the drums, collection of surface soils downstream from the drum site, and collection of a sample from a surface tar spill above the drum site.

Drum samples contained numerous metals, volatile organic compounds, and anions. In addition, two explosives (HMX and nitrobenzene) were detected at low concentrations. HMX was present at 1.8 μg/g and nitrobenzene ranged from 1.15 μg/g to 2.49 μg/g. The drum samples were also analyzed for TCLP metals. Results showed metal concentrations did not exceed EPA regulatory levels.

Samples taken from subsurface soils contained no detectable concentrations of contaminants. Pyrene was detected at 0.99 μg/g in one surface soil sample, and nickel was detected at 48 μg/g in the sample from the surface tar spill. All other surface soil samples contained no evidence of contamination.

Results of the baseline risk assessment for Site 41 soils (assuming removal of the drums and stained soils) indicate that carcinogenic and chronic, noncarcinogenic risks to human health are below EPA target levels for all scenarios.

It is recommended that the drums and stained soil in and above Box Elder Wash be removed. Once removed, no further investigation of this site is warranted.

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

Rust Environment and Infrastructure (Rust E&I, formerly SEC Donohue, Inc.) has been contracted by the U.S. Army Environmental Center (USAEC, formerly the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA)), under Contract No. DAAA15-90-D-0007, to conduct a Remedial Investigation/Feasibility Study (RI/FS) for 17 sites located within 7 Operable Units (OUs) at Tooele Army Depot North Area (TEAD-N), Utah. The RI/FS is being conducted in accordance with the requirements of a Federal Facilities Agreement (FFA) between the U.S. Environmental Protection Agency (EPA) Region VIII, State of Utah Department of Environmental Quality (UDEQ), and Tooele Army Depot (TEAD). Under this agreement, all work performed is to be consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the Resource Conservation and Recovery Act (RCRA), and applicable state law.

The main objectives of the RI portion of the RI/FS are to investigate the nature and extent of contaminant releases within each OU and to assess the potential risk to human health and the environment posed by these releases. To provide the information and data required to meet these objectives, Rust E&I initially reviewed results of previous environmental investigations at TEAD-N and, on the basis of this review, prepared RI Work Plans that identified data-quality objectives, data gaps, data-collection strategies, and methods and procedures required to further characterize each OU. From these work plans, Rust E&I conducted the field-investigation phase of the RI in May through July of 1992 at TEAD-N and completed subsequent sample analysis and data-evaluation activities. Figure 1-1 shows the work process for completing the RI/FS for TEAD-N.

The purpose of this report is to summarize the scope of the RI, to summarize previous investigations conducted at each OU, to present and evaluate the data collected, and to provide subsequent conclusions and recommendations. Included are the results of a Baseline Risk Assessment, which provides an evaluation of the potential threat to human health and the environment in the absence of any remedial action for contamination associated with an OU. The RI report also provides the basis for an FS, which utilizes all available site data for the development, screening, and detailed analysis of remedial alternatives for each OU. These alternatives will be selected on the basis of their ability to eliminate or reduce potential risk to human health and the environment to within acceptable regulatory and/or risk-based levels.

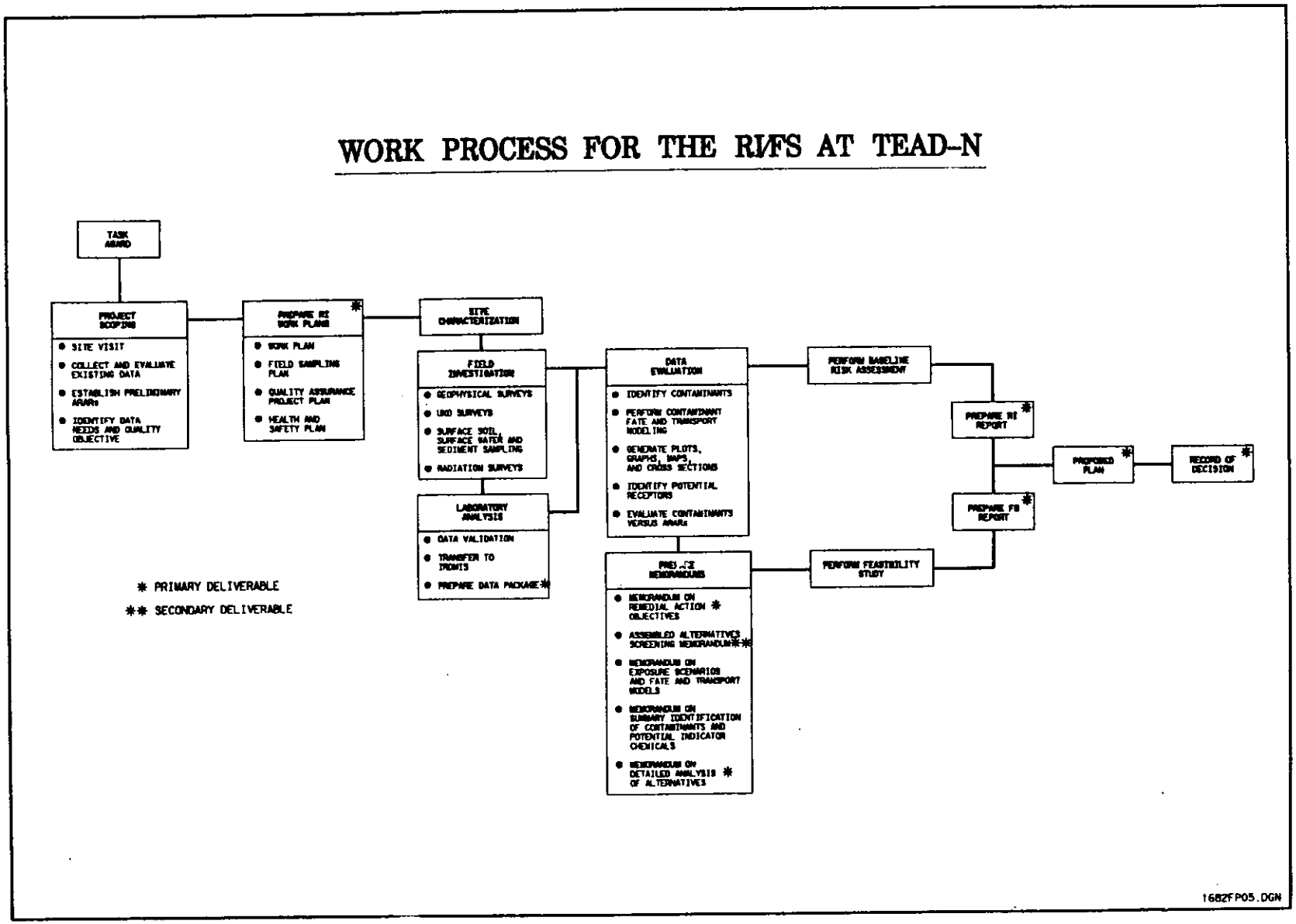


Figure 1-1. Work Process Diagram for the RI/FS at TEAD-N

1.2 INSTALLATION BACKGROUND

1.2.1 Installation Description

TEAD-N occupies approximately 24,732 acres of the Tooele Valley, in Tooele County, Utah. The facility is located just west of the city of Tooele, Utah, approximately 35 miles southwest of Salt Lake City (Figure 1-2). It is bounded to the south by the Stockton Bar and South Mountain, to the north by Grantsville (approximately 2 miles away) and the Great Salt Lake, to the east by Tooele and the Oquirrh Mountains, and to the west by the Stansbury Mountains. Stockton has a population of 426, Grantsville a population of about 4,500, and the city of Tooele a population of 13,887. Tooele County has a total population of 26,601.

Tooele Valley is predominantly undeveloped with the exception of Grantsville, Tooele, and scattered residential development north of Tooele. Except for Tooele, lands immediately adjacent to TEAD-N are undeveloped. Properties to the north of the facility are used for livestock grazing and limited cultivation, and properties to the west and south are used for rangeland grazing. Properties to the east include residential development immediately adjacent to TEAD-N.

The major missions of TEAD-N include the maintenance, renovation, and storage of wheeled vehicles, and the reception, storage, issuance, maintenance, and disposal of munitions. Developed features at TEAD-N include igloos, magazines, administrative buildings, an industrial maintenance area, military and civilian housing, roads, hardstands for vehicle storage, and other allied infrastructure. Although not included as part of this RI, a second area of Tooele Army Depot, designated the South Area (TEAD-S), is located approximately 17 miles to the south of TEAD-N. TEAD-S has served primarily as a facility for the storage and maintenance of bulk chemical agents and chemical weapons.

1.2.2 Site History

TEAD-N was established as the Tooele Ordnance Depot on April 7, 1942, by the U.S. Army Ordnance Department. It was redesignated as TEAD-N in August of 1962. At that time, a second facility, TEAD-S (formerly the Deseret Chemical Warfare Depot) became part of the Tooele Army Depot although the two facilities are located approximately 17 miles apart.

During World War II, TEAD was a back-up depot for the Stockton Ordnance Depot and Benicia Arsenal, both located in California. It stored vehicles, small arms, and other equipment for export.

Currently, TEAD is one of the major ammunition storage and equipment maintenance installations in the U.S., supporting other Army installations throughout the western U.S. However, the installation has been recommended for closure by the Base Realignment and Closure Commission.

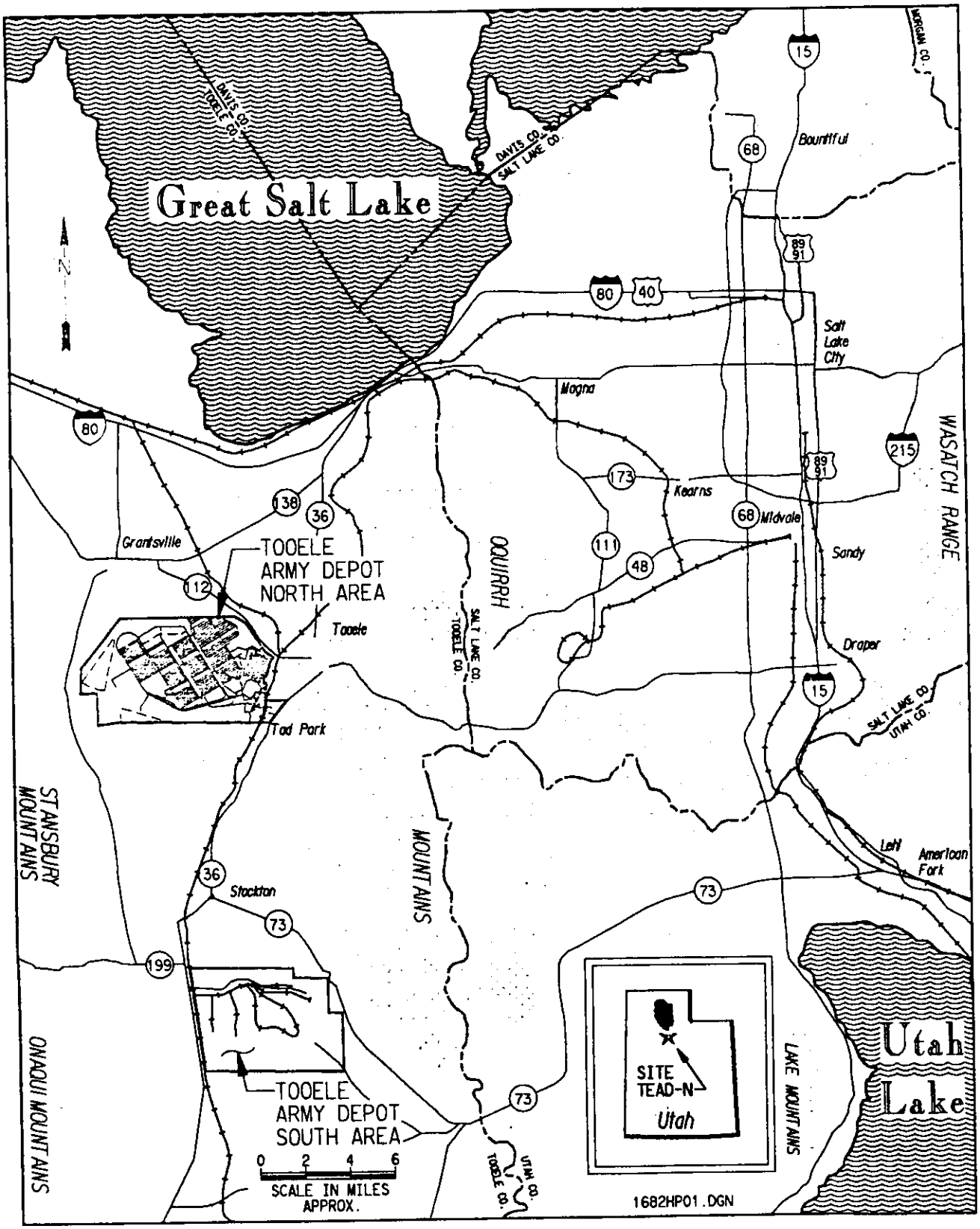


Figure 1-2. Location Map of Tooele, Utah, and Vicinity

As a result of continuous operations since 1942, a variety of known and potential waste and spill sites have been identified at TEAD-N. Environmental evaluation of these sites began in the late 1970s and continues through the present.

1.2.3 Operable Unit Descriptions

This RI covers the 17 sites contained in Operable Units 4, 5, 6, 7, 8, 9, and 10 at TEAD-N, all of which are listed in Table 1-1 and shown in Figure 1-3.

OU 4 consists of three sites in the southeastern part of TEAD-N: the Former Transformer Boxing Area (Site 31), the PCB Spill Site (Site 32), and the Wastewater Spreading Area (Site 35). Site 31 is an open area where transformers were temporarily located for preparation for shipment. Site 32 is the location of a previous transformer oil spill. Site 35 is an area where wastewater from an on-site housing area was allowed to discharge and which contains two unlined ditches leading to a ravine and a spreading area. Sites 31 and 32 are shown in Figure 1-4, and Site 35 is shown in Figure 1-5.

OU 5 consists of two sites in the eastern portion of TEAD-N: the Former Transformer Storage Area (Site 17) and the PCB Storage Building 659 (Site 33). Site 17 was formerly used for the storage and handling of transformers. Site 33 is currently used for the storage of transformers and is operated under a Toxic Substances Control Act (TSCA) permit. Sites 17 and 33 are shown in Figure 1-6.

OU 6 consists of two sites in the eastern portion of TEAD-N: the Drummed Radioactive Waste Area (Site 9) and the Radioactive Waste Storage Area (Site 18). Site 9 consists of the areas where one or more 55-gallon drums of low-level radioactive waste were possibly stored from approximately 1960 to 1978. Site 9 is shown in Figure 1-7. Site 18 is a Nuclear Regulatory Commission (NRC)-licensed facility for the storage of radioactive materials and is located in the northeastern corner of Building 659 (Figure 1-8). Potential contaminants at these sites are radioactive isotopes.

OU 7 consists of a single site in the south-central portion of TEAD-N: the Pole Transformer PCB Spill Site (Site 5). This site is the location of a PCB spill that occurred when a transformer was damaged during a utility-pole fire (Figure 1-9).

OU 8 consists of six sites in the southwestern portion of TEAD-N: The Old Burn Area (Site 6), the Chemical Range (Site 7), the Tire Disposal Area (Site 13), the Building 1303 Washout Pond (Site 22), the Bomb and Shell Reconditioning Building (Site 23), and the Old Burn Staging Area (Site 36). Site 6 (Figure 1-10) is an area that was used for the testing of munitions, fuses, and propellants and the burning of crates and boxes. Site 7 consists of two covered trenches that were used for the testing and disposal of munitions (Figure 1-11). Site 13 was a disposal site for tire carcasses from TEAD-N vehicles (Figure 1-12). Site 22 reportedly received washdown water from Building 1303, where sawing of munitions was conducted (Figure 1-13). Site 23, Building 1345, was used for performing external work on large munitions (Figure 1-14). Site 36 is a former gravel pit that was used for the staging of materials to be burned or disposed of at Site 6 (see Figure 1-10).

Table 1-1. The 17 Sites Within 7 Operable Units at Tooele Army Depot-North Area

Operable Unit	Site No.	Site Name
4	31	Former Transformer Boxing Area
	32	PCB Spill Site
	35	Wastewater Spreading Area
5	17*	Former Transformer Storage Area
	33*	PCB Storage Building 659
6	9*	Drummed Radioactive Waste Area
	18*	Radioactive Waste Storage Building
7	5*	Pole Transformer PCB Spill
8	6	Old Burn Area
	7	Chemical Range
	13	Tire Disposal Area
	22	Building 1303 Washout Pond
	23	Bomb and Shell Reconditioning Building
	36	Old Burn Staging Area
9	8	Small Arms Firing Range
	40	AED Test Range
10	41*	Box Elder Wash Drum Site

*Sites not scheduled for additional field investigation because they do not require further characterization.

OU 9 consists of two sites in the western-most portion of TEAD-N: the Small Arms Firing Range (Site 8) and the AED Test Range (Site 40). Site 8 has been used for training in the use of small arms (Figure 1-15). Site 40 was used for the testing of munitions and rocket engines, and for testing of the former Building 1236 Deactivation Furnace, which now consists of the foundation and three walls (Figure 1-16).

OU 10 (Figure 1-17) consists of the Box Elder Wash Drum Site (Site 41) in the north-central portion of TEAD-N. The site contains a total of 21 drums in the Box Elder Wash streambed, which carries intermittent runoff from the southwestern corner of TEAD-N, north through the Igloo Storage Area, and across the north-central TEAD-N boundary.

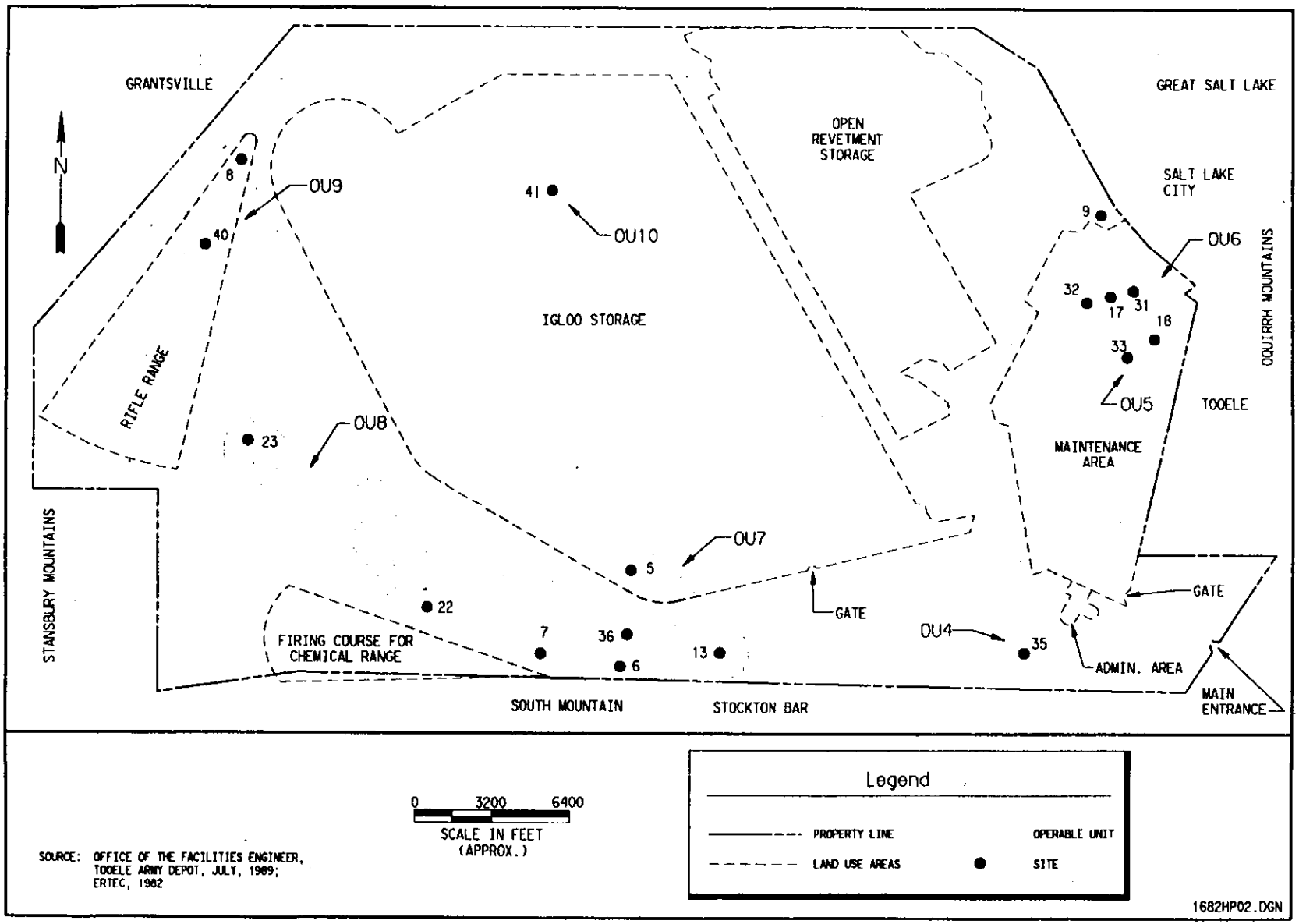


Figure 1-3. Location of Operable Units/Sites at TEAD-N

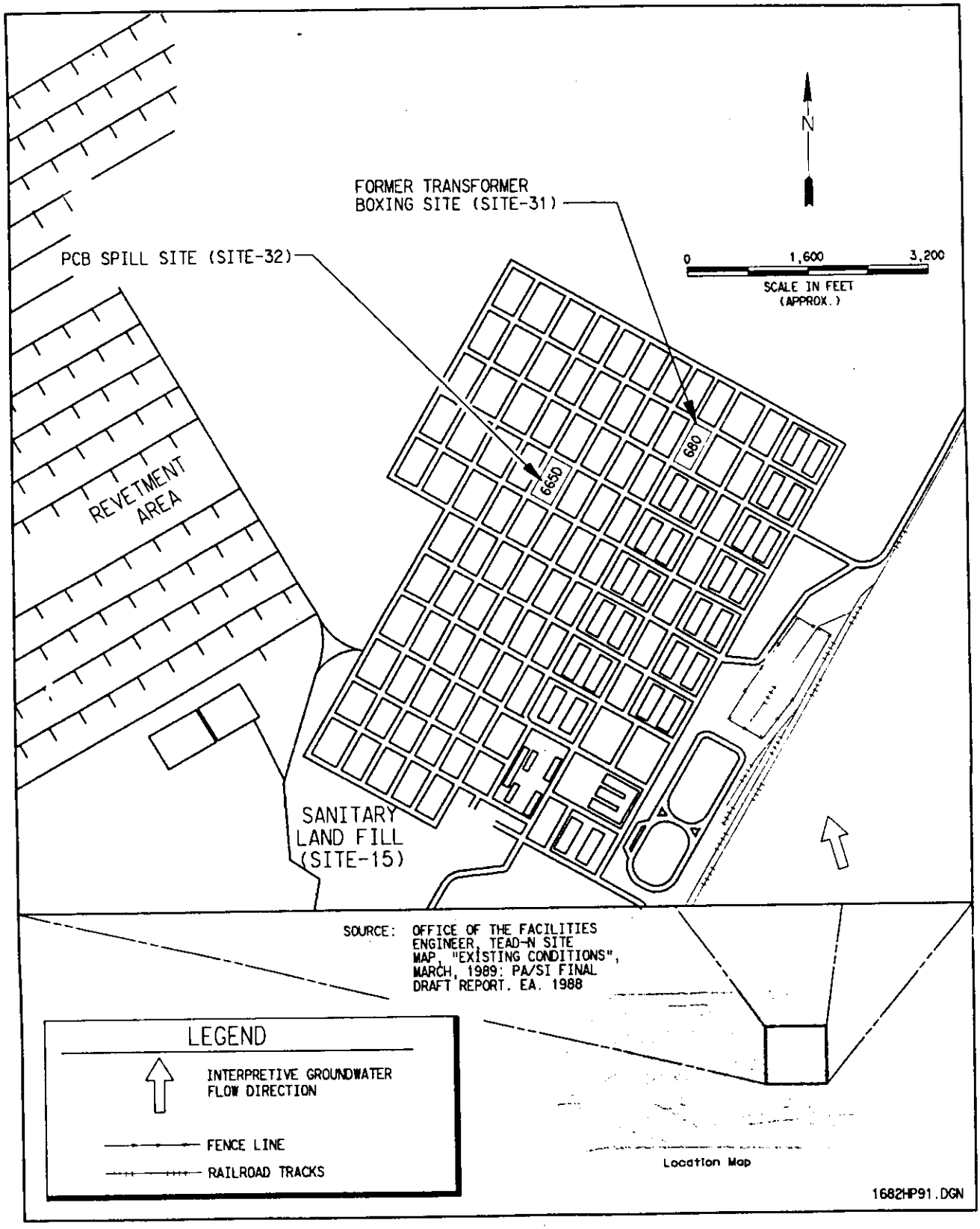


Figure 1-4. Location Map for the Former Transformer Boxing Area (Site 31) and the PCB Spill Site (Site 32)

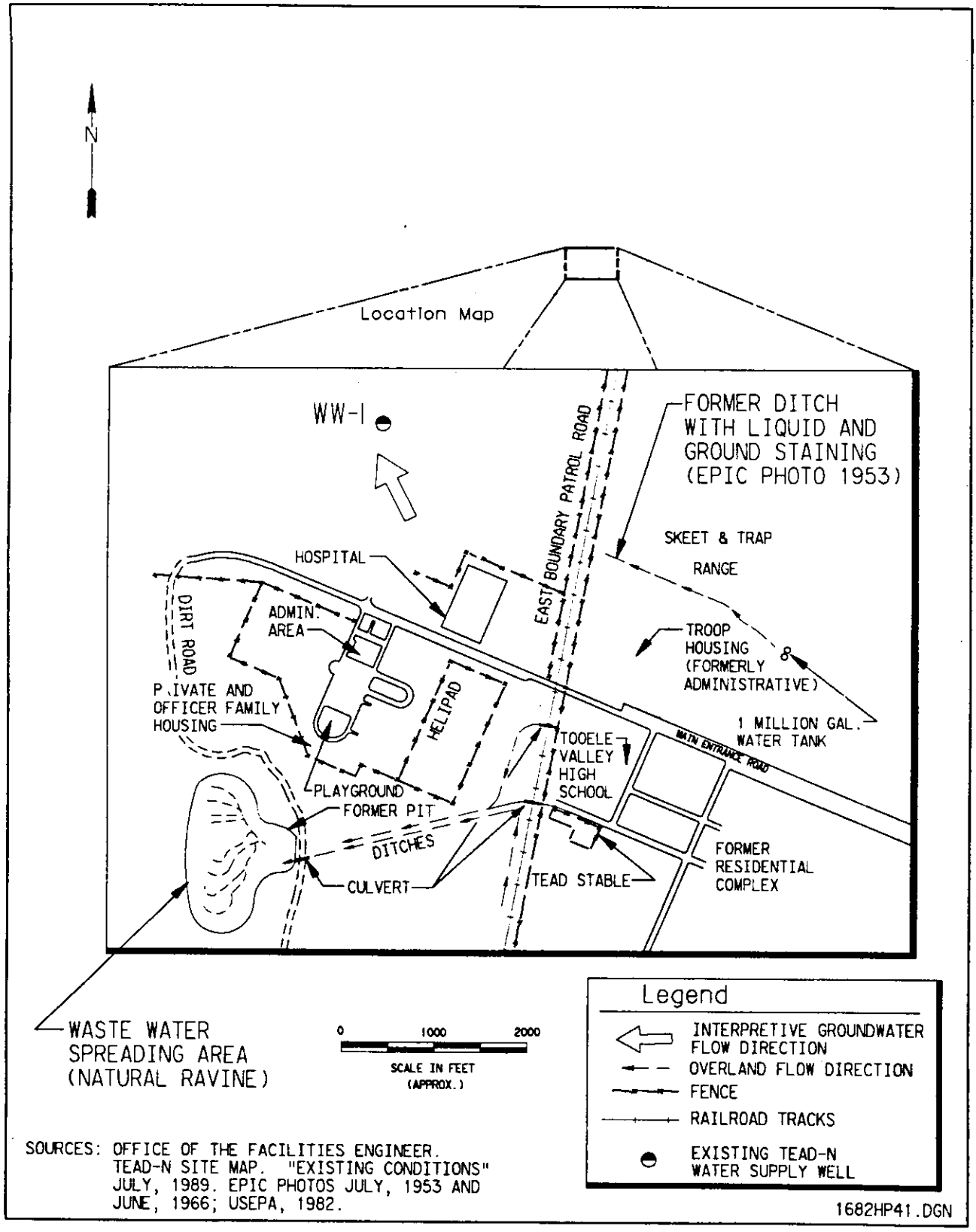


Figure 1-5. Location Map for the Wastewater Spreading Area (Site 35)

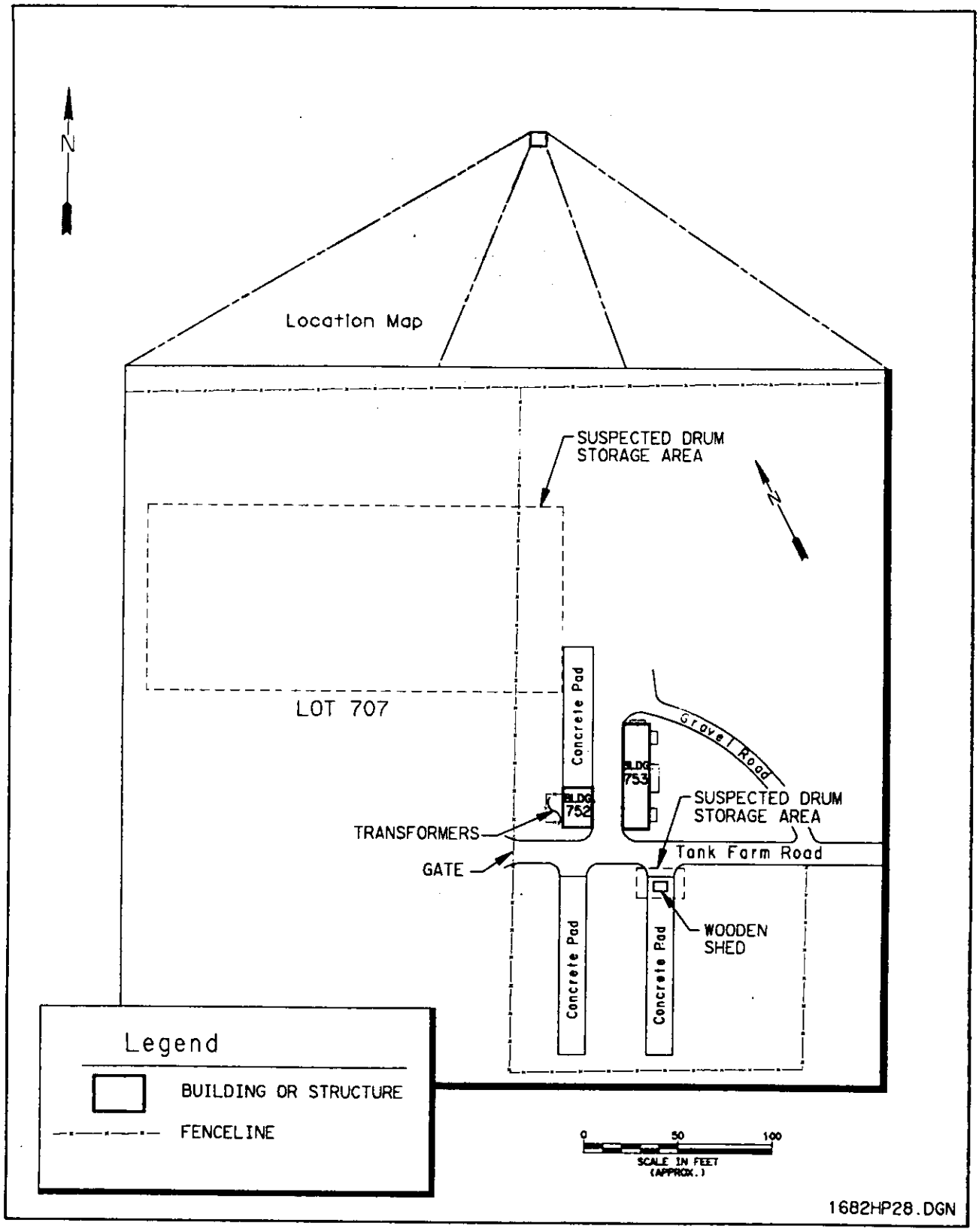


Figure 1-7. Location Map for the Drummed Radioactive Waste Storage Area (Site 9)

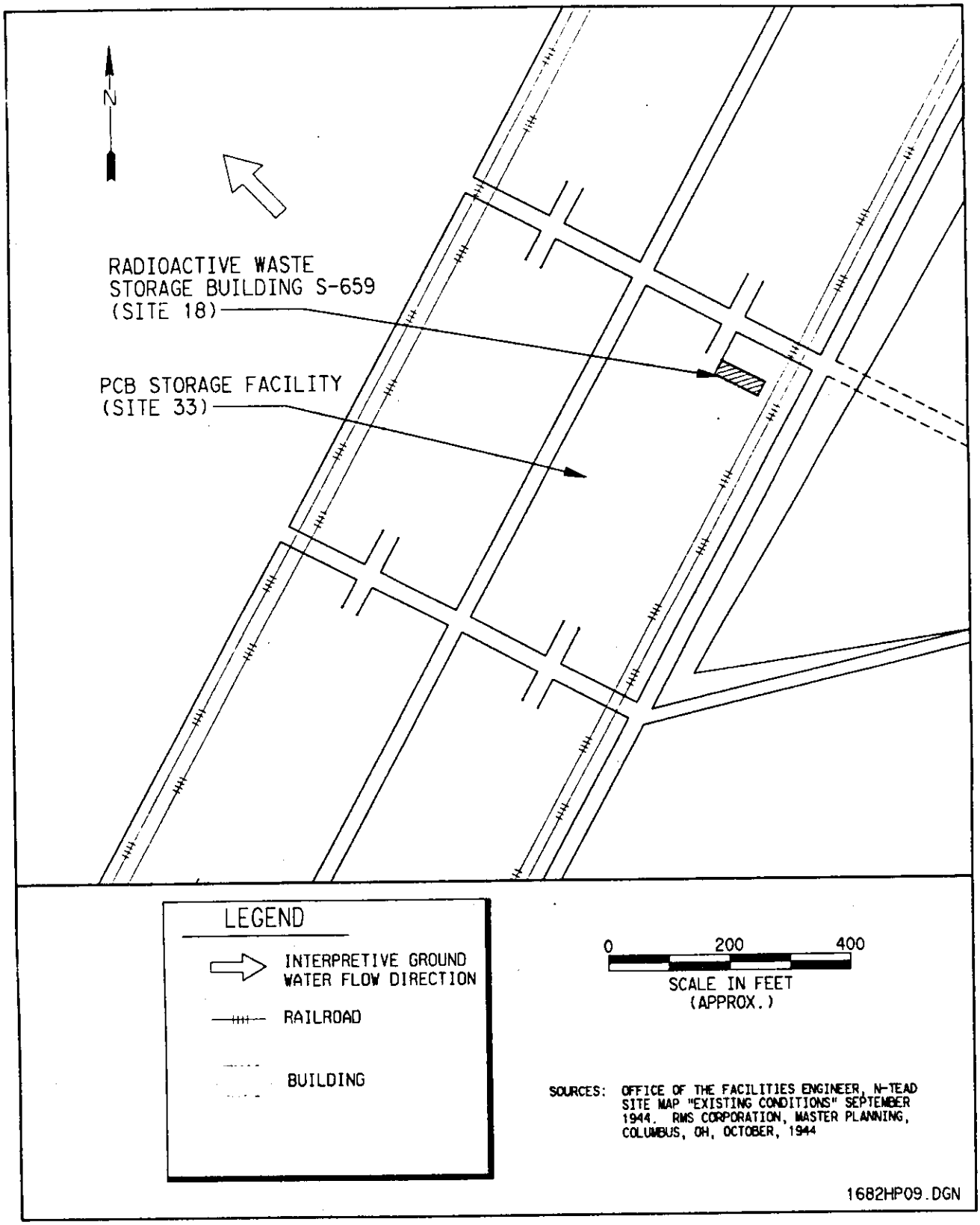


Figure 1-8. Location Map for the Radioactive Waste Storage Building (Site 18)

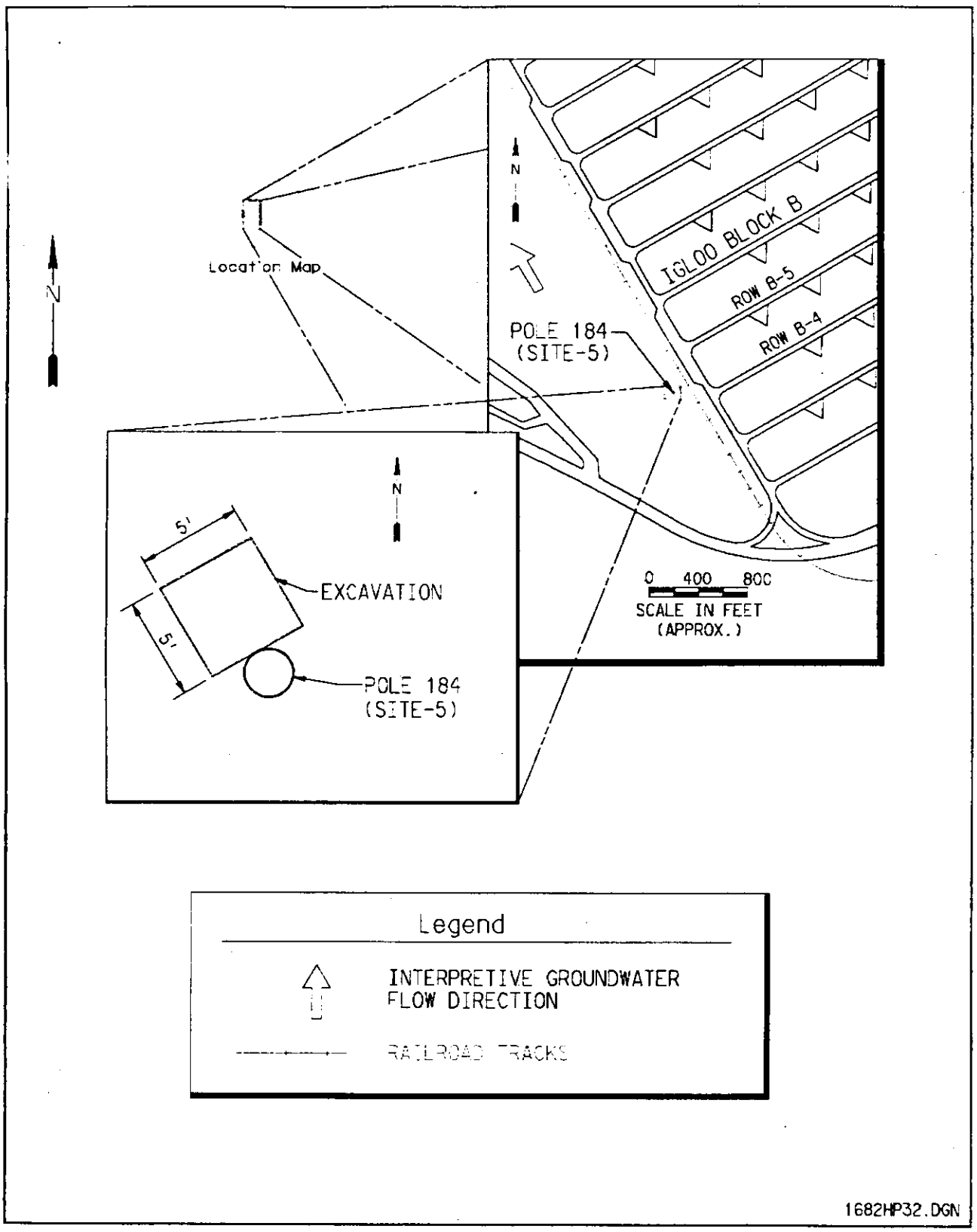


Figure 1-9. Location Map for the Pole Transformer PCB Spill (Site 5)

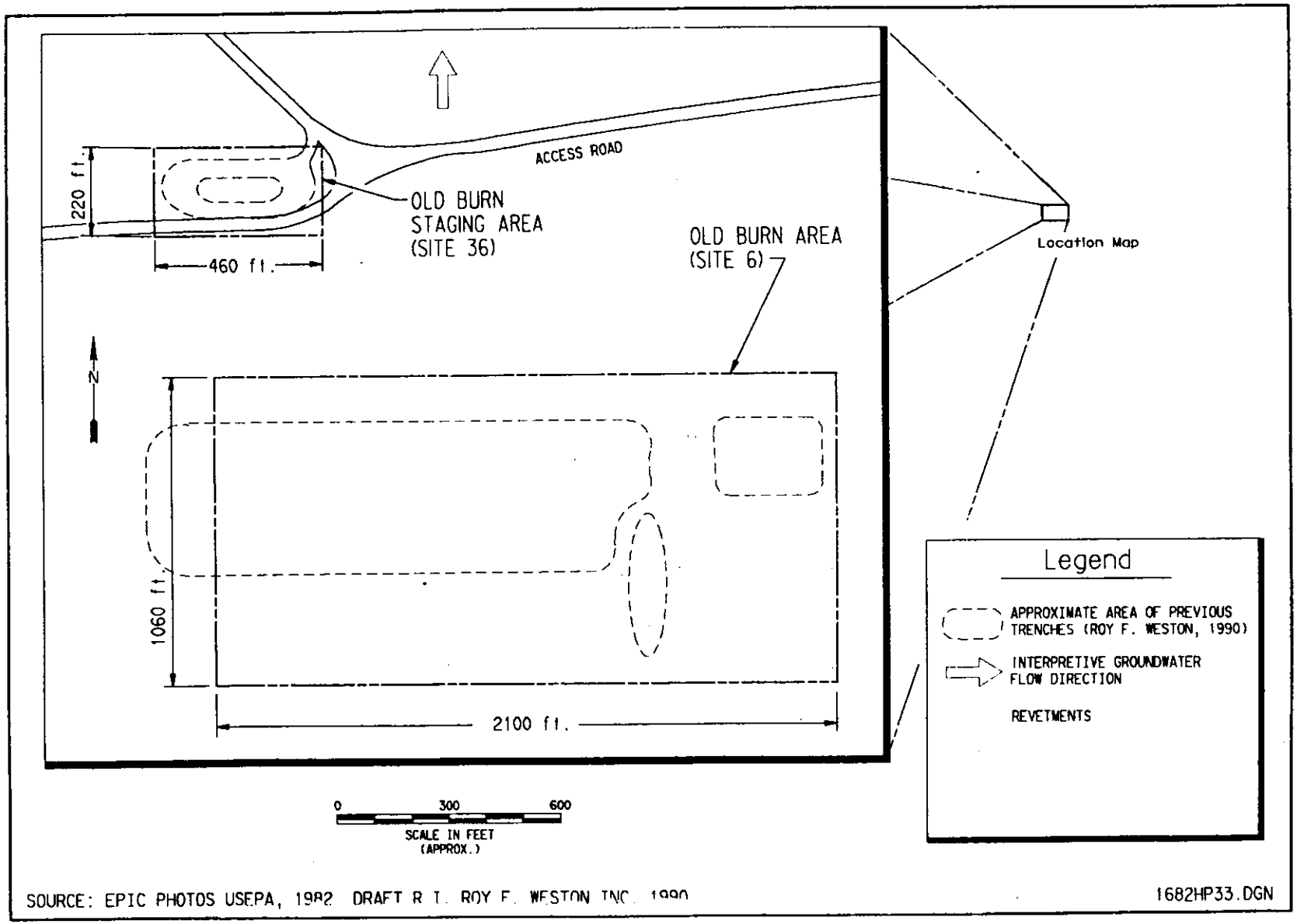


Figure 1-10. Location Map for the Old Burn Area (Site 6) and the Old Burn Staging Area (Site 36)

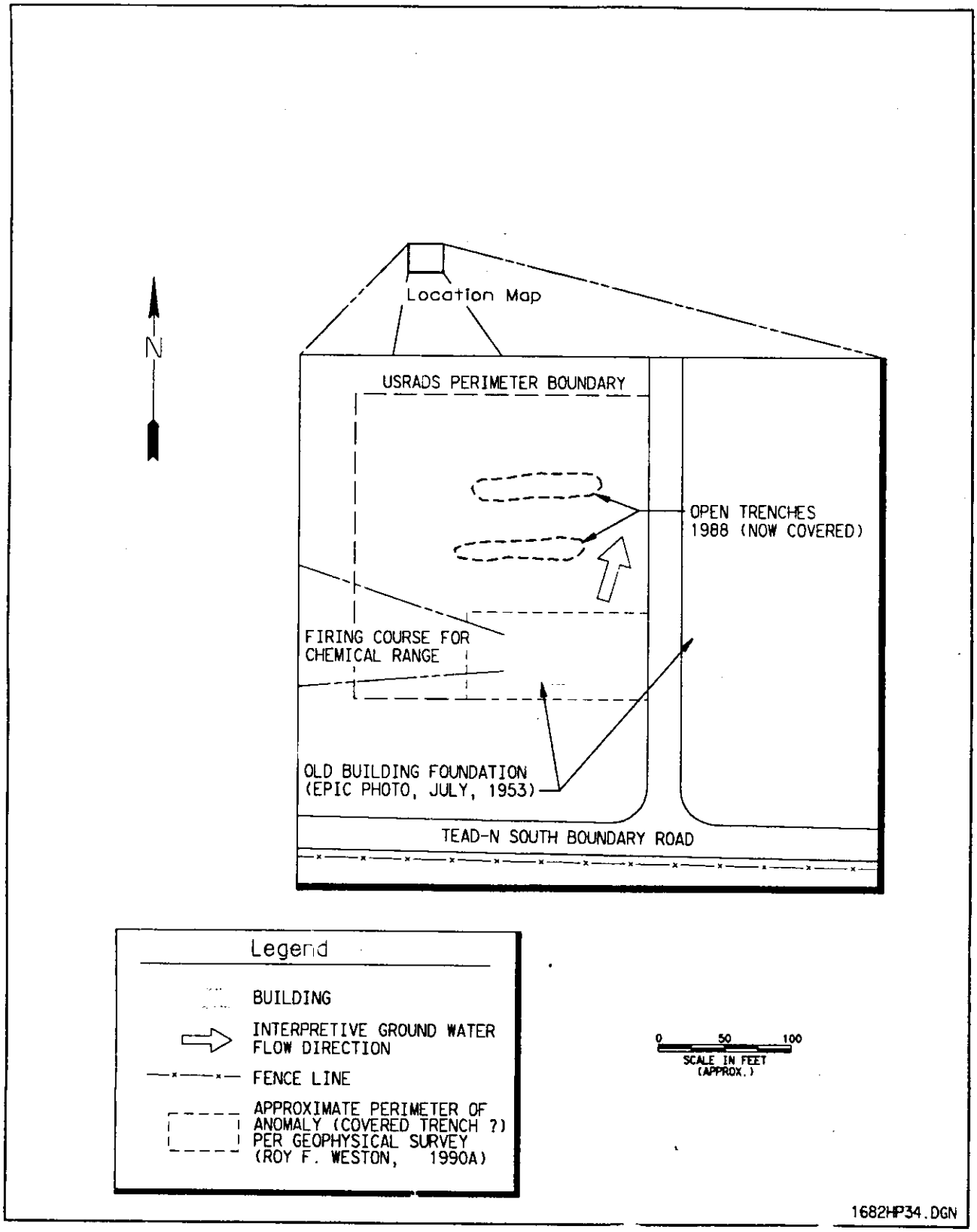


Figure 1-11. Location Map for the Chemical Range (Site 7)

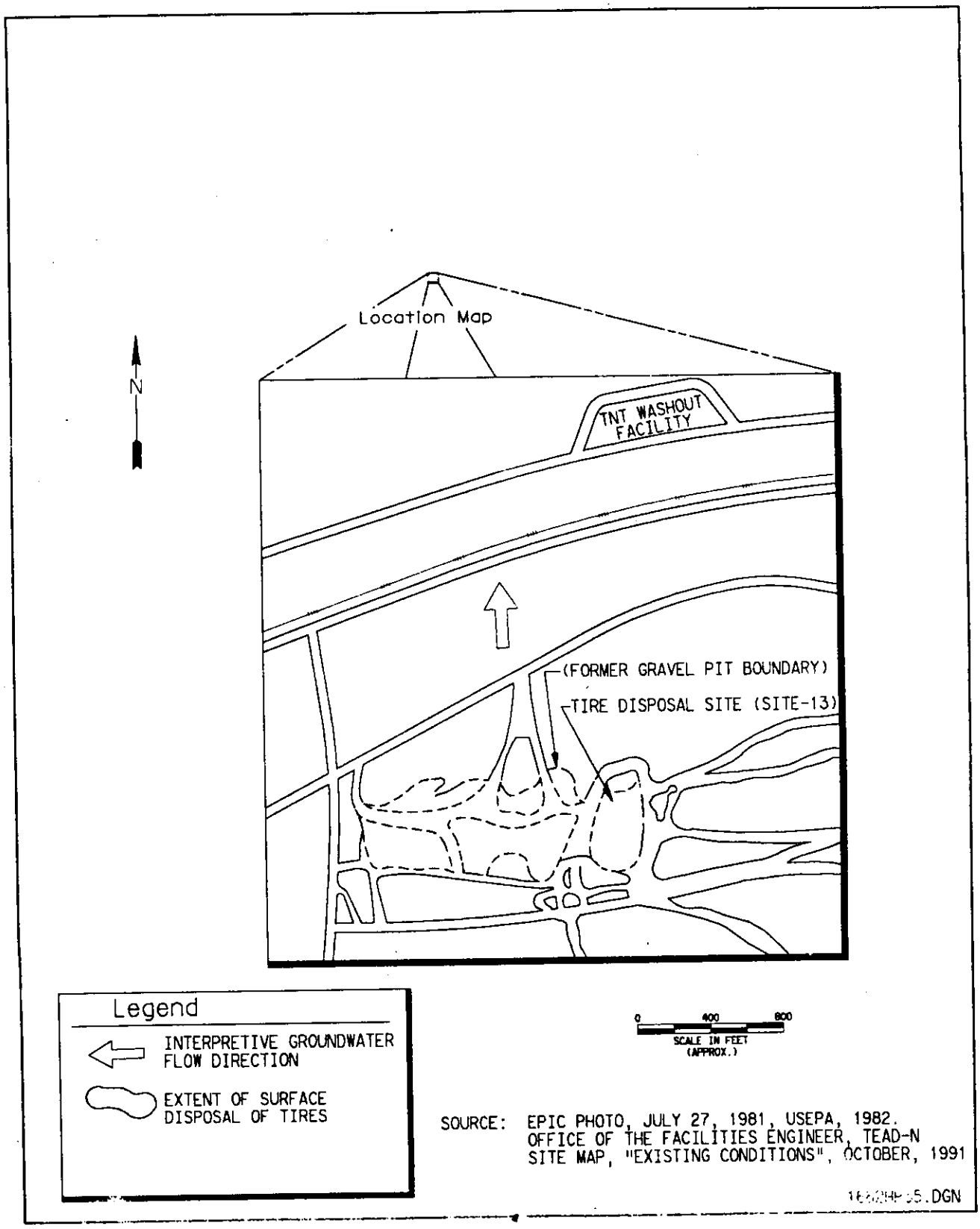


Figure 1-12. Location Map for the Tire Disposal Area (Site 13)

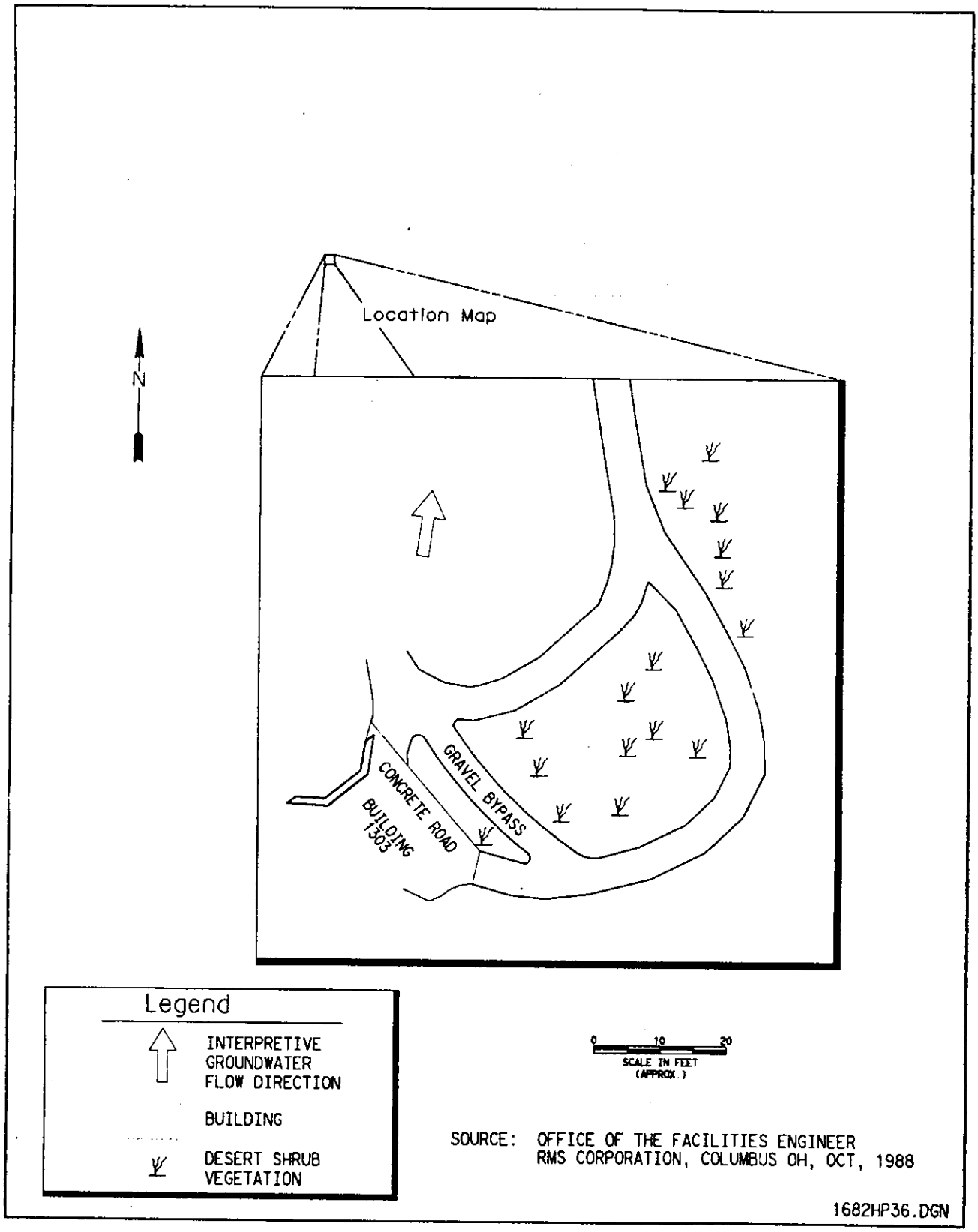


Figure 1-13. Location Map for the Building 1303 Washout Pond (Site 22)

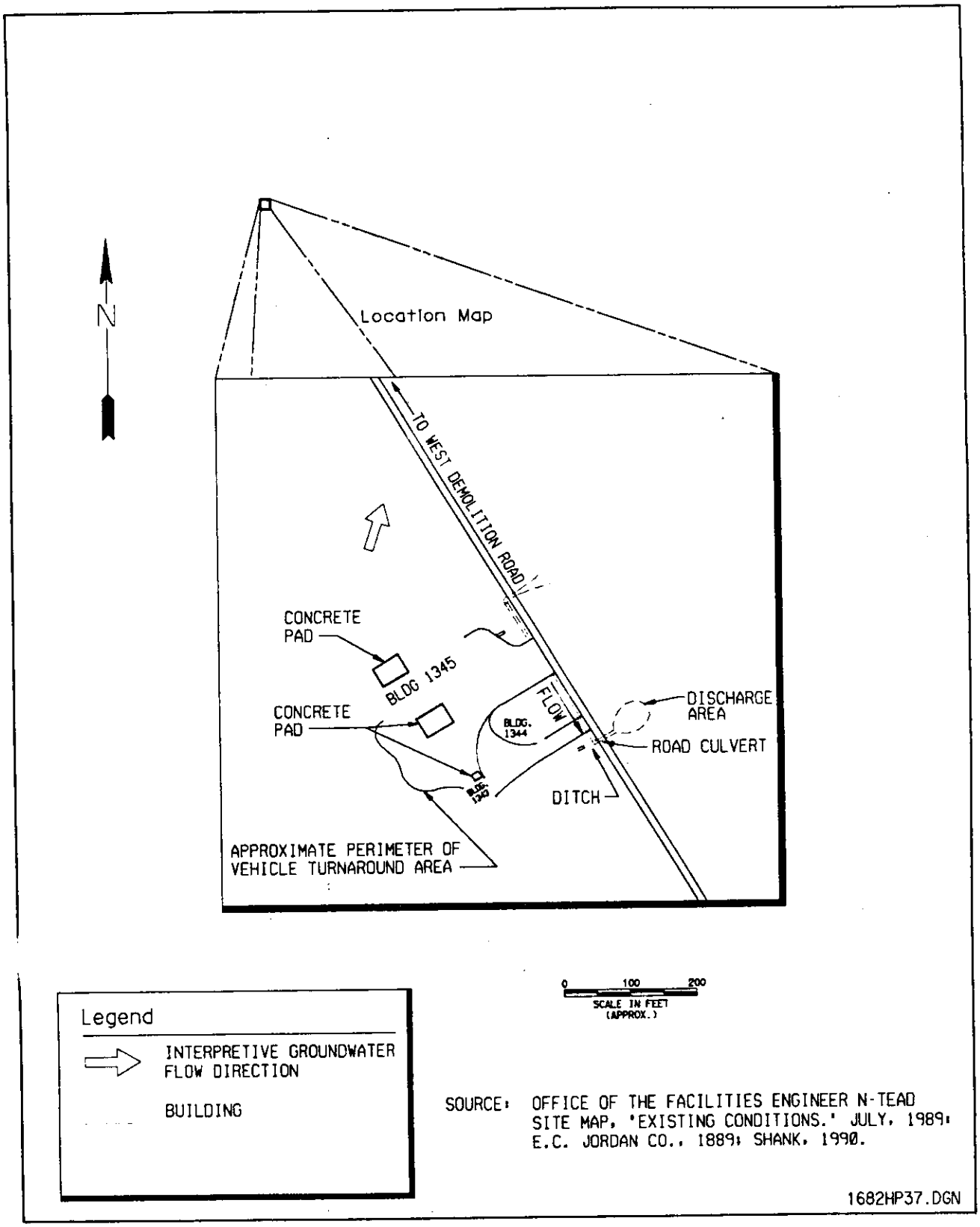


Figure 1-14. Location Map for the Bomb and Shell Reconditioning Building 1345 (Site 23)

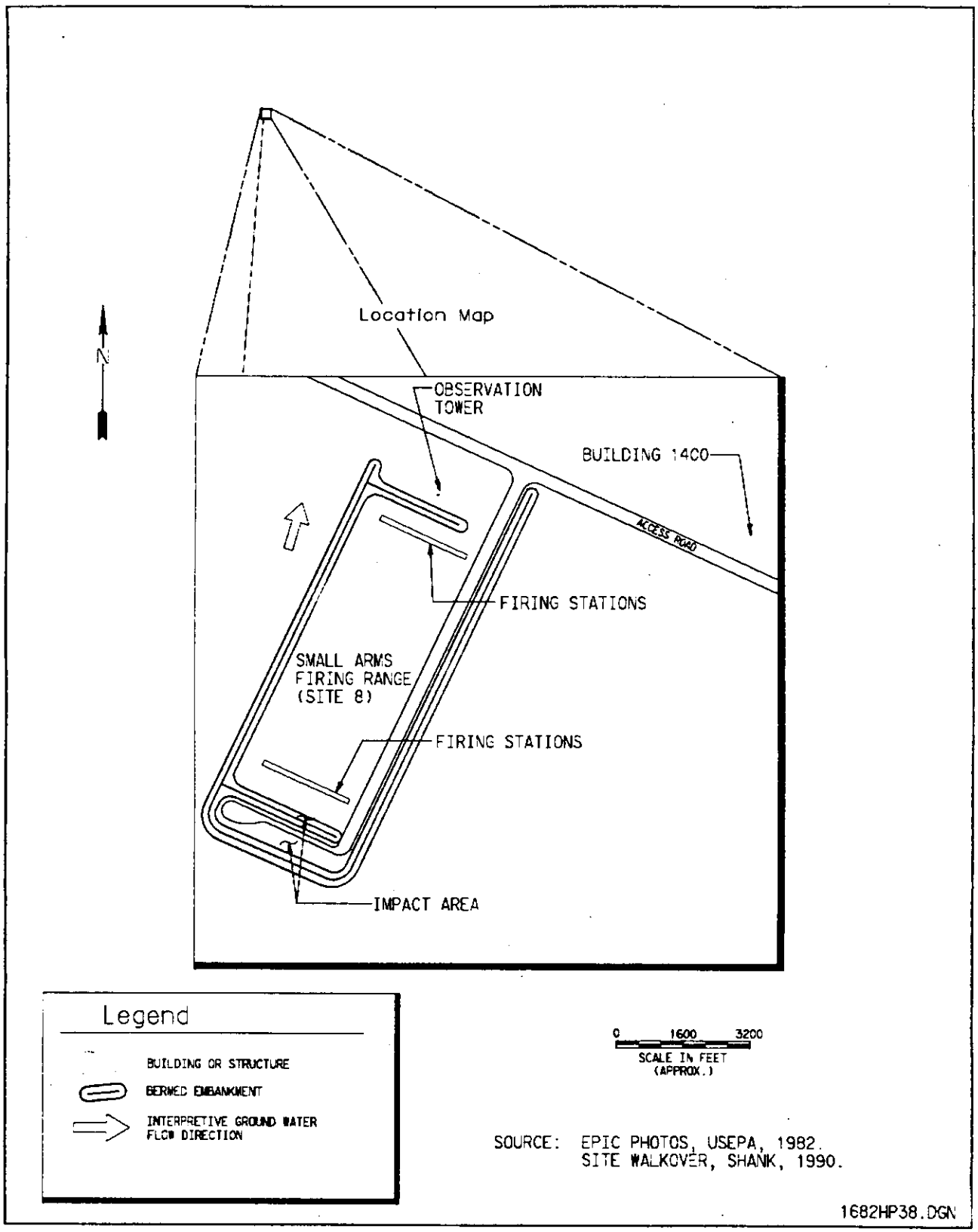


Figure 1-15. Location Map for the Small Arms Firing Range (Site 8)

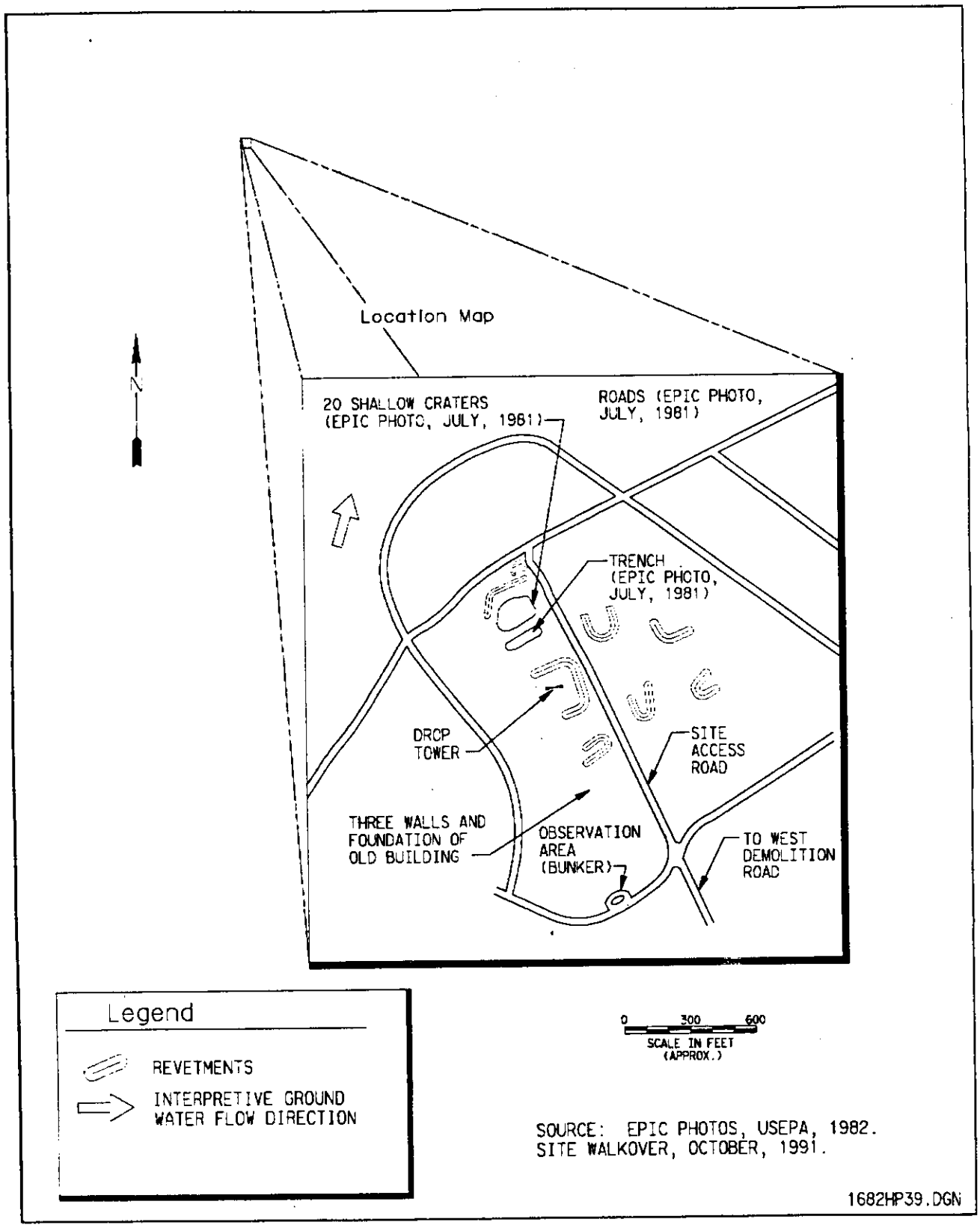


Figure 1-16. Location Map for the AED Test Range (Site 40)

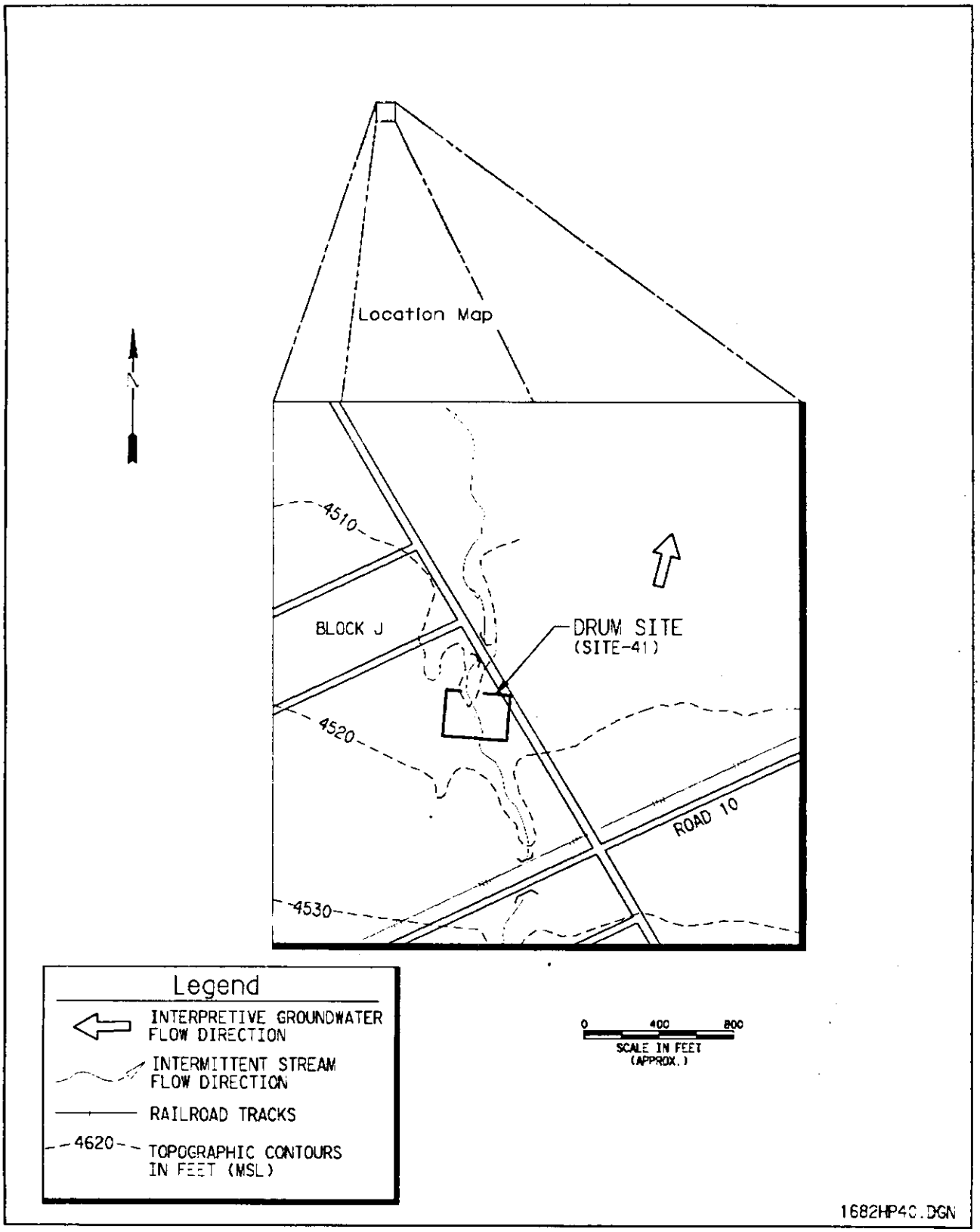


Figure 1-17. Location Map for the Box Elder Wash Drum Site (Site 41)

1.2.4 Previous Investigations

Table 1-2 provides a summary of previous investigations at TEAD-N from 1979 to the present. These projects ranged from general environmental surveys of the entire area to RIs and preliminary risk assessments. The 17 sites characterized during the RI are in various stages of environmental evaluation. Most of the previous investigations provided recommendations for further work. The RI field investigation conducted by Rust E&I was designed primarily to fill data gaps left from previous investigations. However, some of the 17 sites had no data collected prior to the current RI. For these sites, the data collected during the RI were designed to confirm the presence or absence of contaminant releases to environmental pathways rather than to define the extent of contamination. Specific results of previous investigations are provided in following sections of this report. Previous investigation results have been incorporated into discussions of the nature and extent of contamination, contaminant fate and transport, and risk to human health and the environment.

1.3 REGULATORY BACKGROUND

A variety of environmental investigations have been conducted at TEAD-N from 1979 to the present. In 1987, under contract to the EPA, the NUS Corporation published a Final Interim RCRA Facility Assessment for TEAD-N (NUS,1987), which identified 28 Solid Waste Management Units (SWMUs). These SWMUs were suspected or known to have released contaminants into the environment. Subsequent investigations resulted in the identification of an additional 18 SWMUs, which resulted in a total of 46 potential hazardous waste sites at TEAD-N.

On October 2, 1984, the EPA proposed TEAD-N for inclusion on the National Priorities List (NPL). The facility was listed on the NPL on October 1, 1990. As a result, the EPA, State of Utah, and TEAD entered into an FFA on September 16, 1991. In this agreement, 17 of the 46 SWMUs were redesignated as CERCLA sites contained within 7 OUs. The remaining 29 SWMUs are covered under a RCRA Corrective Action Permit (CAP), which was issued to TEAD by the State of Utah on January 7, 1991. Under the CAP, the SWMUs were divided into 9 known releases SWMUs and 20 suspected releases SWMUs. As a result of the FFA and CAP, work plans prepared by another contractor, E.C. Jordan Co. (E.C. Jordan, 1990a and 1990b), required reformatting and revision to reflect the new division of the previously identified 46 SWMUs. In 1991, Rust E&I prepared and submitted draft work plans for an RI/FS for the 17 CERCLA sites at TEAD-N. Field investigation activities were completed in the summer of 1992 on the basis of these plans and verbal approval from the EPA and State of Utah.

Guidelines for the remediation of hazardous constituents released from federal facilities are provided in Section 120 of CERCLA. Essentially, all guidelines, rules, regulations, and criteria carried out under CERCLA apply to federal facilities. In that context, environmental studies and remediation activities to be conducted at TEAD-N are governed by CERCLA under the review and approval of the EPA Region VIII and the State of Utah (the Division of Environmental Response and Remediation). The FFA specifies the responsibilities of each

Table 1-2. Summary of Previous Investigations at TEAD-N from 1979 to the Present

Report Issue Date	Investigation Title (Study Lead)	Objective	Scope	Conclusions and/or Recommendations	Identified Data Needs
December 1979	Environmental Assessment of Tooele Army Depot, Report No. 141. (for USATHAMA)	Assess environmental quality of TEAD with regard to use, storage, treatment, and disposal of hazardous materials and define any possible public health concern.	Conducted a records review to identify major source areas.	The potential for chemical migration exists at both TEAD-N and TEAD-S. Major chemicals of concern: chemical agents, plating rinse waters, and explosive residues.	None
June 1982	Installation Environmental Assessment (Inland Pacific Engineering Co. under USACE)	Define TEAD activities and their potential environmental impact.	Described TEAD activities, facilities, and the surrounding environment. Conducted inventory indigenous flora and fauna at TEAD-N.	Summary of environmental, human, and economic impact in the event of closure and/or clean-up.	None
1982 - 1985	Investigation at the Open Burning/Open Detonation Areas (AEHA)	Evaluate potential for environmental contamination at OB/OD areas at army depots nationwide with respect to federal regulations. Determine which areas should be used for continued OB/OD operations.	Established the potential for soil, surface-water, groundwater, and surface-soil contamination via records review and limited sampling of potential source media.	Soil study indicated no remedial action necessary. No OB/OD Areas closed as a result of study. Metals of concern are PB, CD, and BA.	Full hydrogeological evaluation needed to assess public health risk of 246TNT, RDX, and HMX in groundwater.
1982	Exploratory Environmental Contamination Assessment Report (ERTEC)	Identify potential source areas at both TEAD-N and TEAD-S.	Phase I: used existing data to identify SWMUs of concern. Phase II: installed monitoring wells, performed geophysical surveys, and sampled/analyzed soil, sediment, and GW/SW at SWMUs with greatest contamination potential.	Minimal contamination and migration in all media. The IWL plume was identified (ZN, CL, F, PO4, NA 12DCLE, T12DCE, TRCLE, and 246TNT). Plume migration path is toward TEAD-S-N Supply Well No. 2. Estimated time to reach northern boundary of TEAD-N: 55 years from 1982.	The vertical and horizontal distribution of chemicals in the IWL plume and potential risk to public health need to be assessed.
May 1983	Analysis of Existing Facilities/Environmental Assessment Report (TEAD Facilities Engineering)	Identify and summarize activities and/or missions associated with TEAD and perform an environmental assessment of these activities.	Described major activities, cultural elements, and environmental characteristics surrounding TEAD.	No conclusion or recommendations for further study were presented.	None
January 1985	Monitoring Activity and Waste Disposal Review and Evaluation (CH2M Hill)	Determine adequacy of Phase I and II investigations (ERTEC) and determine if adequate information is available to support an FS.	Reviewed all available data to determine existence of data gaps.	Data deficiencies identified in the Ertec Phase II report. Sample/analyze all existing monitoring and water supply wells on a semiannual basis. Sample/analyze Well No. 1 and have results reviewed by medical community to determine possible health risks due to chemicals in groundwater.	Geologic, chemical, and hydrologic conditions throughout TEAD must be evaluated. Install two wells north of TNT Washout Facility.

Table 1-2. Summary of Previous Investigations at TEAD-N from 1979 to the Present (continued)

Report Issue Date	Investigation Title (Study Lead)	Objective	Scope	Conclusions and/or Recommendations	Identified Data Needs
March 1985	A study of Environmental Balance (Department of the Army)	Describe the environmental management program at TEAD.	Developed ecological profile of TEAD as well as present TEAD's goals with respect to air, water, solid waste, radiation, and hazardous materials management.	Further environmental controls are necessary at TEAD to prevent chemical releases.	None
March 1985	Performance of Remedial Response Activities at Uncontrolled Hazardous Waste Sites - Final Plan (CDM)	Review documents developed for or by the DOD and make recommendations regarding documents' completeness.	Discussed technical support and potential approaches to site remediation.	A guide to implementing alternative remedial actions at TEAD.	None
1985	Interim Groundwater Quality Assessment Report (Woodward-Clyde)	Assess the distribution of chemicals in groundwater in the vicinity of the unlined IWL and connecting ditches.	Sampled/analyzed lagoon liquid, lagoon sludge, and soils surrounding the lagoon and ditches. Sampled/analyzed existing monitoring wells and water supply wells in the vicinity of the IWL.	Contamination of groundwater downgradient of IWL. Identified sources include surface water, sludge, and soil containing various VOCs, semi-VOCs, and metals. VOCs only detected in groundwater.	Interim monitoring of existing and proposed wells to further characterize the distribution of chemicals in groundwater.
November 1985	Analytical/Environmental Assessment Report (TEAD Facilities Engineering)	Summarize conclusions of previous studies and assess potential environmental impact due to future development plan.	Updated site maps and study existing land use to determine accuracy of existing Preservation Plan. Collected and analyzed new data including interviews with security, traffic control, and health services personnel.	No currently proposed project at TEAD presents long-term or irreversible negative impacts on the Tooele Valley environment.	None
January 1986	Industrial Wastewater Lagoon and Ditches - Groundwater Quality Assessment Report, Corrective Action Plan, and Record of Decision (JMM)	Define the extent and magnitude of groundwater contamination associated with the IWL.	Phase I characterized geologic conditions and groundwater flow (31 piezometers). Phase II determined the distribution of chemicals in groundwater (25 monitoring wells). Phase III evaluated remedial alternatives.	TRCLE was the predominant chemical. Highest concentrations were found adjacent to the wastewater ditches south of the IWL. Remediation would occur at the northern end of the TEAD-N using extraction wells, an air stripper, and injection wells. Estimated time for remediation: 30 years.	Additional monitoring wells needed to further characterize groundwater quality.
March 1986	Engineering Report for Closure of the Industrial Wastewater Lagoon (JMM)	Assess feasible alternatives for closing the IWL with respect to cost, effectiveness, and regulatory compliance and develop necessary engineering analyses for closure.	Provided a description of the distribution of source chemicals, discussed available treatment processes, and recommended a closure approach.	The report concluded that for source soils and sludges at the IWL: (1) removal and off-site disposal, or (2) removal to new, on-site disposal facility were most feasible remedial alternatives.	None

Table 1-2. Summary of Previous Investigations at TEAD-N from 1979 to the Present (continued)

Report Issue Date	Investigation Title (Study Lead)	Objective	Scope	Conclusions and/or Recommendations	Identified Data Needs
July 1986	Environmental Photographic Interpretation Center Report (USEPA and EPIC)	Identify possible areas of hazardous wastes and identify corrective actions and/or necessary investigations.	Acquired archival black and white aerial photographs for approximately 5-year intervals between 1940 and 1981.	Black and white enlargements of seven significant areas were provided.	None
August 1987	Draft Interim RCRA Facility Assessment (NUS)	Evaluate releases of hazardous wastes and identify corrective actions and/or necessary investigations.	Reviewed existing USEPA files (desktop survey) to verify characteristics of SWMUs and identify additional SWMUs.	Continued and first-time sampling at several SWMUs; including IWL, X-Ray Lagoon Pole Transformer PCB Spill Site, TNT Washout Facility, Pesticide/Herbicide Handling and Storage Building, Sewage Lagoons, Sanitary Landfill, and Battery Pit.	Continued sampling at investigated SWMUs. Missing historical data and radiological survey needed.
May 1988	Groundwater Quality Assessment Engineering Report (JMM)	Additional characterization of groundwater quality in IWL areas.	Installed 12 monitoring wells and continued sampling/analysis of 19 existing wells for VOCs, selected metals, and major cations and anions.	Major VOCs (TRCLE, 111TCA, and CCL4) detected in TEAD-N monitoring wells. Major cations and anions, however, were found to increase in concentration with depth and distance along groundwater flow lines.	Six additional monitoring wells are needed to evaluate the distribution of chemicals in unmonitored zones (250-450 feet BGS).
1988	Preliminary Assessment/Site Investigation Report (EA)	Identify TEAD-N SWMUs that present a known or potential threat to public health or the environment.	Reviewed existing databases for potential source information. Conducted an on-site inspection. Installed 5 monitoring wells and 4 lysimeters and sampled/analyzed existing monitoring wells, surface soil, and/or sediment for explosives, metals, VOCs, and semi-VOCs.	Explosives detected in soils and sediments at the TNT Washout Facility. Recommendations include: TEAD-N should discontinue or relocate the laundry facility or install an impermeable liner beneath the pond and inspect the liner at the X-Ray Lagoon.	Necessary monitoring wells: TNT Washout Facility, Drum Storage Areas, Chemical Range, Old Burn Area, and X-Ray Lagoon. Soil borings at TNT Washout Facility.
1990	Final Remedial Investigation Report (WESTON)	Summarize previous investigations. Review data collected and previous conclusions. Identify and investigate data gaps for the TNT Washout Facility, Chemical Range, Old Burn Area, Sanitary Landfill, and Drum Storage Areas.	Reviewed existing data and implemented an extensive field program consisting of 30 boreholes for soil characterization and 28 monitoring wells. Performed an extensive geophysical survey. Analyzed groundwater, soil samples for VOCs, semi-VOCs, metals, explosives, and major cations and anions.	Contamination assessment indicated low concentrations of explosives in shallow soils surrounding the TNT Washout Facility. VOCs C6H6, 12DCE, TRCLE were detected in groundwater at the Sanitary Landfill. Surface-soil/groundwater contamination at the Drum Storage Areas was limited. Surface-soil samples from the Chemical Range and the Old Burn Area exhibited low concentrations of metals.	Additional monitoring wells are required to characterize the perched groundwater zone at the TNT Washout Facility and between the Sanitary Landfill and Sewage Lagoons. Continued sampling of existing wells recommended.

Table 1-2. Summary of Previous Investigations at TEAD-N from 1979 to the Present (continued)

Report Issue Date	Investigation Title (Study Lead)	Objective	Scope	Conclusions and/or Recommendations	Identified Data Needs
1991	Groundwater Quality Assessment for Tooele Army Depot Tooele, Utah (ESE)	Provide additional data regarding groundwater elevations and provide analytical data for the Groundwater Quality Assessment of the IWL for corrective actions evaluation.	Collect groundwater elevation measurements from 140 existing piezometers and monitoring wells, and collect and analyze groundwater samples for VOCs from 26 existing monitoring wells.	Conditions at TEAD are very similar to results from previous investigations. Groundwater flowgradient is in a north to northwest direction. The contaminants detected during this investigation and the TRCLE plume position are similar to results of the 1988 (JMM) and 1990 (Weston) investigations.	None
1991	RCRA RFI Phase I Summary Report for Known Release Units (ASI)	Summarize information regarding SWMUs with known releases at TEAD-N.	Consisted of a files search, review, and data evaluation.	Evaluated proposed sampling and analysis program by E. C. Jordan and retained appropriate recommendations. Additional recommendations were made by ASI on the basis of the data review.	All nine known releases SWMUs require additional data collection.
1992	Final Preliminary Baseline Risk Assessment for Tooele Army Depot - North Area (Rust E&I)	Conduct a preliminary assessment of risk to human health from contaminants identified from previous investigations.	Review existing data, develop contaminants of concern, identify exposure pathways, potentially exposed populations, and calculate associated risk to human health.	Document provides a preliminary baseline. Additional risk assessments will be required on a site-by-site basis as data become available. Preliminary results indicate highest risk to be related to hypothetical future on-site residents.	Specific data gaps were identified. Investigations are currently being conducted to fill these data gaps (JMM and Rust E&I).

agency for the study and cleanup of waste sites at TEAD-N. Also included in the FFA is a schedule for the completion of each major phase of the RI/FS with specific deliverable dates for primary documents (e.g., work plans, RI Report, and FS Report) and secondary documents (e.g., Assembled Alternatives Screening Memorandum).

A list of the primary Applicable or Relevant and Appropriate Requirements (ARARs) for TEAD-N is presented in Table 1-3. Generally, these ARARs represent federal requirements except in those areas where state requirements are more stringent than the federal requirements. Oak Ridge National Laboratory under contract to USAEC, prepared both location-specific and chemical-specific ARARs for TEAD-N. These documents, although in draft form, have been included as Appendix A. In addition to CERCLA or state requirements, there are also USAEC and Department of Defense (DOD) requirements that must be met (i.e., regulations governing UXO).

1.4 REPORT ORGANIZATION

The organization of this report generally follows the suggested format provided in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988). In addition, the report is organized to fulfill USAEC requirements for reporting geotechnical and analytical results (USATHAMA, 1987 and USATHAMA, 1990).

Section 2.0 describes the physical characteristics of TEAD-N, including the physiography, climate, demographics and land use, geology, hydrogeology, background water quality, soils, vegetation, and wildlife. Section 3.0 discusses the procedures that were used during the RI to select sample locations, conduct the field investigation, select contaminants of concern, evaluate fate and transport characteristics, and to assess risk to human health and the environment.

Sections 4.0 through 10.0 present the RI results for OUs 4 through 10, respectively. These sections present the following information for each of the 17 sites: (1) site characteristics; (2) a description of previous investigations and RI activities; (3) the nature and extent of contamination, including the vertical and horizontal extent of contamination as identified by the previous investigations and the current RI; (4) contaminants of concern; (5) fate and transport characteristics for the contaminants of concern; (6) potential exposure pathways; (7) Baseline Risk Assessment where appropriate; (8) ecological risk assessment; (9) conclusions; and (10) recommendations.

Section 11.0 summarizes the conclusions and recommendations from the preceding sections. This includes a discussion of the adequacy and limitations of the data presented in the RI, identified data gaps, and recommendations for further investigations. Section 12.0 presents the references cited in the RI, and Section 13.0 provides a glossary of acronyms and abbreviations used throughout the RI. Several appendices are provided in Volumes II and III that summarize field, analytical, and computer modeling methods and corresponding results for the 17 sites at TEAD-N.

Table 1-3. Primary ARARs for TEAD-N

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
SAFE DRINKING WATER ACT	42 U.S.C. 300f et seq.			
National Primary Drinking Water Regulations	40 C.F.R. Part 141	Establishes health-based standards for public water systems (maximum contaminant levels (MCLs)).	Applicable - Chemical Specific	No evidence exists for contamination of surface water or groundwater at TEAD-N
National Secondary Drinking Water Regulations	40 C.F.R. Part 143	Establishes welfare-based standards for public water systems (Secondary maximum contaminant levels).	Applicable - Chemical Specific	No evidence exists for contamination of surface water or groundwater at TEAD-N
CLEAN AIR ACT	42 U.S.C. 7401			
National Primary and Secondary Ambient Air Quality Standards	40 C.F.R. Part 50	Establishes primary and secondary standards for six pollutants to protect public health and welfare.	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations
SOLID WASTE DISPOSAL ACT				
Land Disposal Restrictions	40 C.F.R. Part 268	Identifies hazardous wastes that are restricted from land disposal and describes those circumstances under which an otherwise prohibited waste may be land disposed.	Applicable - Chemical Specific, Action Specific	May apply depending on final remedial alternatives selection
Underground Injection Control Program	40 C.F.R. Parts 144-147	Provides for protection of underground sources of drinking water.	Relevant and Appropriate - Chemical Specific, Action Specific	No underground injections will take place under proposed remedial alternatives

Table 1-3. Primary ARARs for TEAD-N (continued)

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
TOXIC SUBSTANCES CONTROL ACT (TSCA)	15 U.S.C. 2601 et seq.			
(PCB) Storage and Disposal	40 C.F.R. Part 761 Subpart D	Requirements for storage and disposal of PCBs including incineration	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations
PCB Waste Disposal Records and Reports	40 C.F.R. 761 Subpart K	Requirements for PCB waste disposal records and reports	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations
PCB Spill Cleanup Policy	40 C.F.R. Part 761 Subpart G	Criteria for determining adequacy of PCB spill cleanup	Applicable - Chemical Specific, Action Specific	Proposed remedial actions will be in compliance with regulations
EPA GUIDANCE ON REMEDIAL ACTIONS FOR SUPERFUND SITES WITH PCB CONTAMINATION	OSWER Directive No. 9355.4-01 (EPA/540/G-90 007) August 1990	Recommends approach for evaluation and remediation of PCB contaminated sites and suggests PCB cleanup goals	To Be Considered - Chemical Specific	PCB guidance will apply for some remedial alternatives
CLEAN WATER ACT	33 U.S.C. 1251-1376			
National Pollutant Discharge Elimination System (NPDES)	40 C.F.R. Parts 122 and 125, and 230-231	Requires permits for discharge of NPDES pollutants from any point source into waters of the United States.	Relevant and Appropriate - Chemical Specific, Location Specific	Proposed remedial actions will not involve point source discharges into U.S. waters
Effluent Guidelines and Standards for the Point Source Category	40 C.F.R. Part 414	Requires specific effluent characteristics for discharge under NPDES permits.	Relevant and Appropriate - Chemical Specific, Location Specific	Proposed remedial actions will be in compliance with regulations

Table 1-3. Primary ARARs for TEAD-N (continued)

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
General Pretreatment Regulation for Existing and New Sources of Pollution	40 C.F.R. Part 403	Sets standards to control pollutants that pass through or interfere with treatment processes in public treatment works or that may contaminate sewage sludge.	Relevant and Appropriate - Chemical Specific	Proposed remedial actions will be in compliance with regulations
Water Quality Standards	40 C.F.R. Part 131	Sets criteria for water quality based on toxicity to human health.	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations
Ambient Water Quality Criteria	40 C.F.R. Part 131 Subpart D	Sets criteria for ambient water quality based on toxicity to aquatic organisms.	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations
UTAH WATER QUALITY ACT	19-5-101	Groundwater Protection R317-6.	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations
UTAH SOLID WASTE MANAGEMENT ACT	19-6-501	Standards for Cleanup R315-101.	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations
UTAH SOLID AND HAZARDOUS WASTE ACT	19-6-101	Permitting and Management requirements R315-1 through R315-101; Standards for cleanup R315-101.	Applicable - Chemical Specific, Action Specific	Proposed remedial actions will be in compliance with regulations
UTAH SAFE DRINKING WATER ACT	19-4-101	Water Quality (MCLs) R309-103.	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations

Table 1-3. Primary ARARs for TEAD-N (continued)

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
GENERAL	10 C.F.R. Part 20	Establishes permissible levels of radiation in unrestricted areas and waste disposal requirements.	Relevant and Appropriate - Chemical Specific, Location Specific	No evidence exists for radioactive contamination at TEAD-N
SOLID WASTE DISPOSAL ACT				
Groundwater Protection	40 C.F.R. 264.90 - 264.101	Establishes standards for pollutants that will, or are likely to, enter into groundwater.	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations
UTAH GROUNDWATER PROTECTION RULES	Utah Administrative Code R317-6	Establishes standards for protection of groundwater quality	Applicable - Chemical Specific	Proposed remedial actions will be in compliance with regulations
PROTECTION OF BALD AND GOLDEN EAGLES	16 U.S.C. 668-668d	Protects identified species.	Applicable - Location Specific	Proposed remedial actions will be in compliance with regulations
PROTECTION OF MIGRATING GAME AND INSECTIVOROUS BIRD	16 U.S.C. 701-718h	Protects identified species.	Applicable - Location Specific	Proposed remedial actions will be in compliance with regulations
NATIONAL HISTORIC PRESERVATION ACT	49 U.S.C. 470 40 C.F.R. 6301(b) 36 C.F.R. Part 800	Establishes standards for designating and maintaining structures of historical importance.	Applicable - Location Specific	Proposed remedial actions will be in compliance with regulations

Table 1-3. Primary ARARs for TEAD-N (continued)

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
ENDANGERED SPECIES ACT	U.S.C. 1531 50 C.F.R. Parts 200 and 402	Requires action to conserve endangered species within critical habitats upon which endangered species depend (includes consultation with the U.S. Department of the Interior).	Applicable - Location Specific	Proposed remedial actions will be in compliance with regulations
ARCHEOLOGICAL AND HISTORICAL PRESERVATION	16 U.S.C. 469 40 C.F.R. 6301(c)	Establishes procedures to provide preservation of historical and archeological data which might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	Applicable - Location Specific	Proposed remedial actions will be in compliance with regulations
HISTORIC SITES, BUILDINGS AND ANTIQUITIES ACT	16 U.S.C. 461-467 40 C.F.R. 6301(a)	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	Applicable - Location Specific	Proposed remedial actions will be in compliance with regulations
FISH AND WILDLIFE COORDINATION ACT	166 U.S.C. 661-666	Requires consultation when a federal department or agency proposes or authorizes any modification of any stream or other water body, and adequate provision for protection of fish and wildlife resources.	Applicable - Location Specific, Action Specific	Proposed remedial actions will not affect any stream or water body at TEAD-N; no lakes or perennial streams exist at the site.

Table 1-3. Primary ARARs for TEAD-N (continued)

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
ENDANGERED AND THREATENED WILDLIFE AND PLANTS (1992)	50 C.F.R. 17.11 and 17.12	List of endangered and threatened plants and wildlife.	Applicable - Location Specific	Proposed remedial actions will be in compliance with regulations
AMERICAN INDIAN RELIGIOUS FREEDOM ACT	42 U.S.C. 1996 43 C.F.R. 7	Protection of sites or artifacts associated with current Indian or other traditional, religious practices, rites, or ceremonies	Applicable - Location Specific	Proposed remedial actions will be in compliance with regulations
SOLID WASTE DISPOSAL ACT				
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 C.F.R. Part 257	Establishes criteria for use in which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment, and thereby constitute prohibited open dumps.	Relevant and Appropriate - Location Specific, Chemical Specific	Remedial alternatives which address soil removal would require disposal in an approved hazardous waste landfill
Standards Applicable to Generators of Hazardous Waste	40 C.F.R Part 262	Establishes standards for generators of hazardous waste.	Relevant and Appropriate - Action Specific, Location Specific	Proposed remedial actions will be in compliance with regulations

Table 1-3. Primary ARARs for TEAD-N (continued)

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
Standards Applicable to Transporters of Hazardous Waste	40 C.F.R.Part 263	Establishes standards that apply to transporters of hazardous waste within the U.S. if the transportation requires a manifest under 40 C.F.R. Part 262.	Relevant and Appropriate - Action Specific	Would apply to offsite treatment and/or disposal of soil
Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal (TSD) Facilities	40 C.F.R. Part 264	Establishes minimum national standards, which define the acceptable management of hazardous wastes for owners and operators of facilities that treat, store, or dispose.	Relevant and Appropriate - Action Specific	Proposed remedial actions will be in compliance with regulations. Includes Subpart 0-standards for incinerators.
SOLID WASTE DISPOSAL ACT				
Use and Management of Containers	Subpart I	Provides standards for the condition, compatibility, management, inspection, containment, and closure for containers used in hazardous waste related activities.	Relevant and Appropriate - Action Specific	Potential exists for these regulations to apply for some remedial alternatives
Waste Piles	Subpart L	Provides containment, design closure, and post-closure care requirements for facilities that treat or store hazardous wastes in piles.	Relevant and Appropriate - Action Specific	Potential exists for these regulations to apply for some remedial alternatives

Table 1-3. Primary ARARs for TEAD-N (continued)

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
MIGRATION BIRD TREATY ACT OF 1918	16 U.S.C. 703	Prohibits the taking, capture; killing, and processing of any migratory bird, their parts, or eggs.	Applicable - Action Specific	Proposed remedial actions will be in compliance with regulations
CLEAN WATER ACT	33 U.S.C. 1251-1376			
Dredge or Fill Requirements	40 C.F.R. Parts 230-231	Requires discharges to address impact of discharge or dredge or fill material on the aquatic ecosystem.	Relevant and Appropriate - Action Specific	Proposed remedial actions will not involve dredge and fill of soil; possibly grading, backfill, and/or excavation and approved landfill disposal
USAEC GUIDELINES AND POLICIES:				
Department of the Army Ammunition and Explosives Safety Documents	USAT CESP 385-02	UXO safety guidelines for explosives and ammunition.	Applicable - Action Specific	Proposed remedial actions will be in compliance with regulations
Department of the Army Ammunition of Explosives Safety Standards	AR 385-64	UXO safety guidelines for for explosives and ammunition.	Applicable - Action Specific	Proposed remedial actions will be in compliance with regulations
Department of Defense Explosives Safety Board Directives	#6055.9	UXO safety guidelines for explosives and ammunition.	Applicable - Action Specific	Proposed remedial actions will be in compliance with regulations

Table 1-3. Primary ARARs for TEAD-N (continued)

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
UTAH AIR CONSERVATION ACT	19-2-101	Fugitive Dust Control R307-1-3.1.8(A) R307-1-4.5.2(B) Particulates Emissions R301-1-3.2.	Applicable - Action Specific	Proposed remedial actions will be in compliance with regulations
GENERAL				
	RCRA Section 3020	Regulates reinjection of hazardous wastes during remediation.	Relevant and Appropriate - Action Specific	Remedial actions do not involve reinjection of hazardous wastes
	29 C.F.R 1910.120	OSHA Worker Safety.	Applicable - Action Specific	Where appropriate, proposed remedial actions will be in compliance with regulations
	29 C.F.R. 1926 Subpart P	Excavation.	Applicable - Action Specific	Remedial actions which include excavations will be in compliance with regulations
	40 C.F.R. 190	Regulates cleanup of radioactively contaminated sites.	Relevant and Appropriate- Action Specific, Location Specific	No evidence exists for radioactive contamination at TEAD-N
	40 C.F.R 440	Regulates discharges of radionuclides to surface waters.	Relevant and Appropriate-Action Specific	No evidence exists for radioactive contamination at TEAD-N
HAZARDOUS MATERIALS TRANSPORTATION ACT	49 C.F.R. Parts 107, 171-177	Regulates transportation of hazardous materials.	Applicable - Action Specific	Will apply to remediation alternatives which specify off-site treatment and/or disposal

Table 1-3. Primary ARARs for TEAD-N (continued)

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate	Comments
UTAH WASTE TIRE RECYCLING ACT	Title 26 Ch. 32A	Regulates how to store used tires.	Relevant and Appropriate - Action Specific	Tires from OU 8 Site 13 were previously removed from the site
UTAH USED TIRE MANAGEMENT AMENDMENT (1993)	House Bill 213	Amendment to Title 26, Ch. 32A.	Relevant and Appropriate - Action Specific	Tires from OU 8 Site 13 were previously removed from the site

2.0 PHYSICAL CHARACTERISTICS OF THE TEAD-N AREA

2.1 PHYSIOGRAPHY

TEAD-N is located in the Great Salt Lake Basin, a large interior drainage basin within the Basin and Range Physiographic Province. The Basin and Range Province is characterized by large fault blocks that trend approximately north and south, and form a series of interior basins bounded by fault-block mountain ranges.

The Tooele Valley, which is a topographic expression of a northward-plunging structural basin, is bounded by the north-trending Stansbury and Oquirrh Mountains, which rise from the valley floor at elevations ranging from 5,000 feet to over 10,000 feet. Topography of the valley floor is shaped by coalescing alluvial fans formed by erosional debris washed from the adjacent mountains. The valley is floored with ancestral Lake Bonneville sediments. The topography at TEAD-N is characterized by a gently rolling surface intersected by a series of shallow gullies that drain the facility. The average topographic gradient in the northern portion of the site is approximately 70 feet per mile, increasing to about 150 feet per mile at the southern boundary.

2.2 CLIMATE

The Tooele Valley climate ranges from arid to semi-arid. Average annual precipitation at Tooele is approximately 17 inches. At Grantsville, which is 2 miles north of TEAD-N, the average annual precipitation is approximately 11 inches. The greatest amount of precipitation occurs in the mountains surrounding the valley, where the average is more than 40 inches per year. The normal mean annual air temperature at Tooele is approximately 51°F although the area is characterized by hot, dry summers and cold winters.

2.3 DEMOGRAPHICS AND LAND USE

With the exception of Tooele (population of 13,887), Grantsville (population of 4,500), Stockton (population of 426) (Bureau of Census, 1990), residents of the on-site housing, and a scattered population living outside of these towns, the area surrounding TEAD-N is largely undeveloped. The city of Tooele contains properties immediately to the east of the TEAD-N boundary. To the north of TEAD-N, properties are used primarily for pasture and cultivation and, to the west and south, for rangeland grazing. The southeastern portion of TEAD-N is bounded by State Highway 36. On the eastern side of TEAD-N, there is a right-of-way for the Union Pacific Railroad. Tooele Municipal Airport and scattered residential homes are located east of this railroad right-of-way. The facility is bounded on the north by State Highway 112. North of Highway 112 is the Tooele County Landfill, a construction company, and undeveloped land. The city of Grantsville is located approximately 2 miles north of the northwestern corner of TEAD-N. There is some recent residential development that abuts the northeastern boundary of TEAD-N. There is on-site housing for both civilians and military families in the Administrative Area of TEAD-N. There are 30 military personnel and 62 dependents currently living in on-base housing. Also located at TEAD-N is

the Tooele Alternative High School. It has 42 full-time and 100 part-time students. Additional on-site land use was previously described in Section 1.2 in terms of the types of activities conducted at TEAD-N.

The population of Tooele County has grown slightly with a total of 26,601 in 1990 compared with 26,033 in 1980 (for an approximate 2-percent increase). The city of Tooele, however, has shown a slight decrease from 14,375 in 1980 to 13,887 in 1990 (for an approximate 3-percent decrease). Much of the fluctuation in population in the Tooele Valley is related to changes in both mining and military activities. Agriculture and ranching in the area are generally stable and do not account for major fluctuations in the population. With the exception of both areas of TEAD and Kennecott Copper, industrial employers in the Tooele Valley are light manufacturing, industrial processing, and warehousing companies.

Water supply wells at TEAD-N (Figure 2-1) are used intermittently for industrial use and for irrigation of landscaped areas at TEAD-N. According to TEAD personnel, groundwater from the supply wells is treated to meet regulatory maximum contaminant limits (MCLs) to allow for water consumption. Primarily during the summer months, several supply wells located off site are used for irrigation and livestock watering. The town of Grantsville obtains drinking water from three community water wells (Wells 1, 2, and 3), which are located downgradient of the TEAD-N site. The city of Tooele obtains drinking water from supply wells located cross-gradient of TEAD-N, from an upgradient well, and from a surface-water source (reservoir). Previous estimates indicate that TEAD-N uses only 4 percent of the water used within the Tooele Valley. Of this water, it was estimated that 17 percent was for domestic use and the remaining 83 percent was for industrial use (Weston, 1990). Most of the industrial water is treated prior to discharge back into the hydrologic system.

2.4 GEOLOGY

TEAD-N lies near the eastern edge of the Basin and Range Structural Province, which is characterized by fault-block mountain ranges and intervening sedimentary basins. In eastern Tooele County, the crest lines of the mountain ranges trend north-south; this is roughly parallel to the front of the Wasatch Range, which forms the eastern margin of the province. Bedrock in the mountain ranges bordering the Tooele Valley has been extensively folded and faulted.

Tooele Valley is characterized by gravelly bajadas sloping toward and grading to a sandy and silty valley bottom. The valley floor consists of a thick sequence of unconsolidated basin-fill alluvial sediments of Tertiary and Quaternary age. The basin fill consists of an older sequence of moderately consolidated sands, gravels, silts, and clays of the Salt Lake Group (upper Tertiary) overlain by deposits of unconsolidated sand, gravel, silt, and clay (Quaternary). Although the thicknesses of basin fill vary throughout the structural basin, depths to Paleozoic bedrock at TEAD-N range from 0 (outcrops in the northeastern corner) to more than 2,000 feet in the south-central portion of the facility. Depth to bedrock is shown in Figure 2-2.

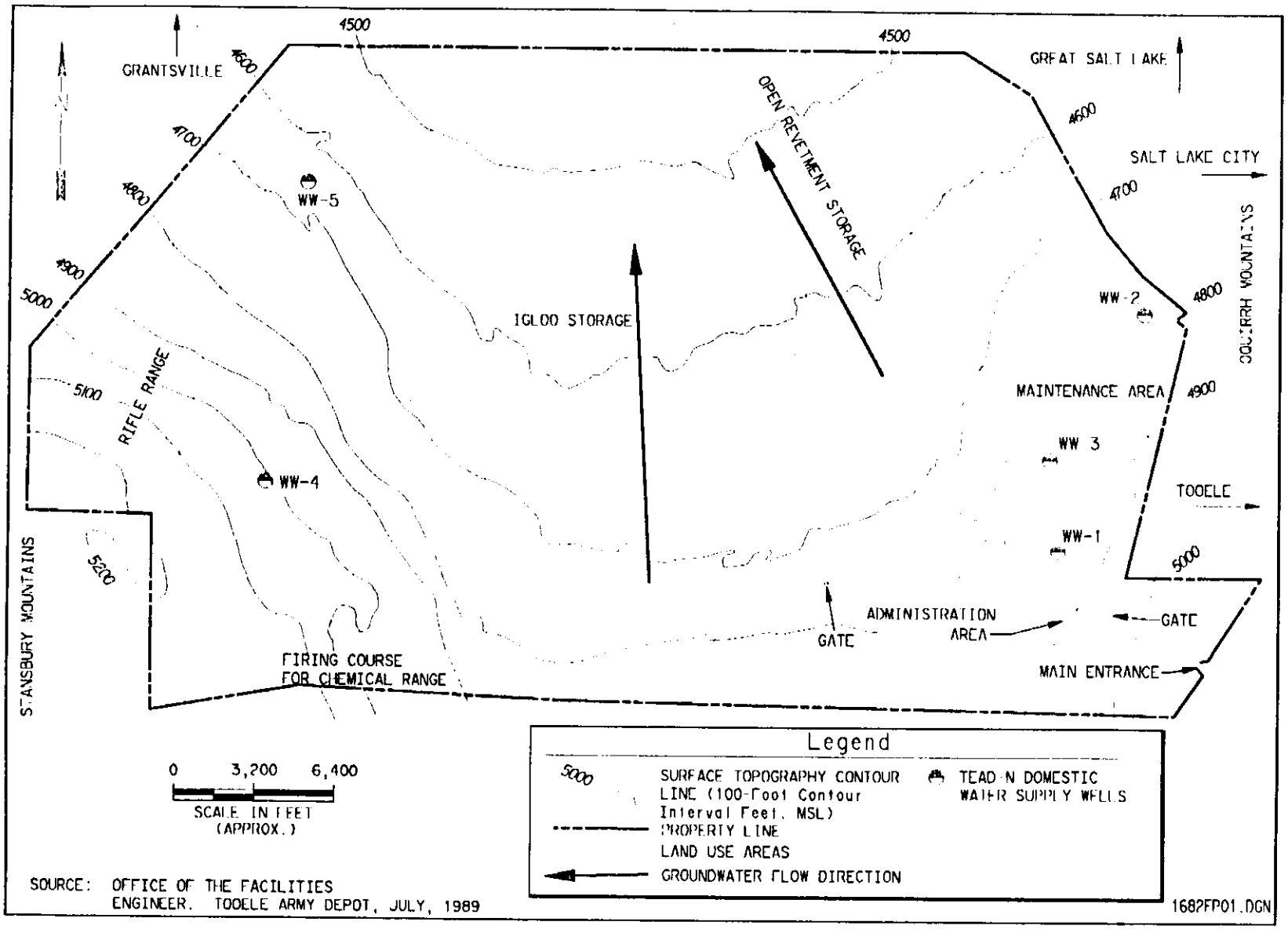


Figure 2-1. Location of Water Supply Wells at TEAD-N

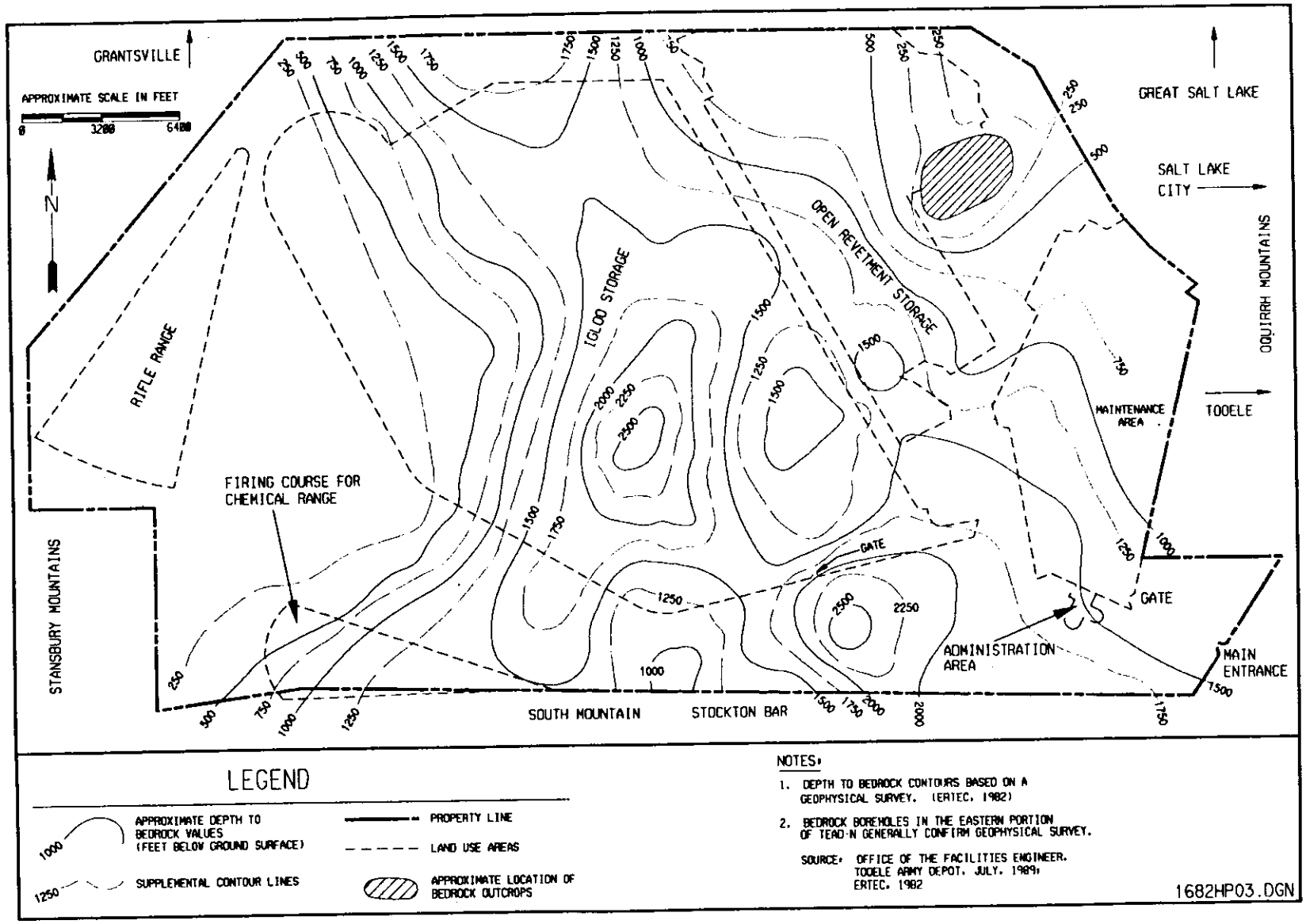


Figure 2-2. Depth to Bedrock Contour Map

Bedrock beneath the unconsolidated sediments of Tooele Valley consists of alternating quartzite and limestone beds similar to the late Paleozoic rocks found in the mountains to the east, south, and west. Borehole and geophysical data indicate that bedrock in the area of TEAD-N occurs as a topographically high and elongated block, oriented northeast to southwest, and with deeper suballuvial flanks extending to the southwest and southeast. Bedrock consists of fine-grained, blue-gray, and black limestone with calcite-filled veins and fine-grained-to-granular white, red, and brown quartzite.

2.5 SOILS

Soils in desert and semi-arid areas are categorized in three ways. The lithosols, which generally occur on slopes, ridges, and plateaus, are actively eroding "young" soils that are slightly altered examples of the parent material. The regosols, which are not found at TEAD-N, are undeveloped soils that occur in actively shifting dunes. Mature desert soils, the aridosols, make up most of the soil composition at TEAD-N. These aridosols are defined on the basis of their layers with the upper layer containing little organic matter and the lower layers consisting of clays, silts, and fine sandy materials (MacMahon, 1990).

Soils that develop in semi-arid climates generally are deep, well drained, moderately permeable, and alkaline. In addition, these soils have a moderate water-erosion potential and a slight wind-erosion potential. Hydraulic conductivities of the soil in the TEAD-N area range from 1×10^{-2} to 1×10^{-4} centimeters per second (JMM, 1992).

Figure 2-3 shows the different soil types found in the vicinity of the TEAD-N facility. These soils, which developed in alluvial deposits or lacustrine sediments, consist primarily of gravelly loam, loam, or fine sand. The U.S. Soil Conservation Service (SCS) has identified eight primary soil series that are found at this location: the Abela, Berent, Hiko Peak, Birdow, Medburn, Taylorsflat, Doyce, and Manessa. Additionally, two miscellaneous types were identified, Borrow Pits and Disturbed Area.

2.5.1 Environmental Setting

Parent material is the material from which a soil is formed through a variety of physical and chemical processes. The type of parent material greatly influences the type of soils that develop. The soils of TEAD-N are derived primarily from alluvium and lacustrine deposits.

Climate influences soil development and productivity in several important ways, such as the accumulation of organic matter in the surface layer; the translocation and chemical breakdown of soluble salts, minerals, and sediments; and the formation of distinct soil horizons. Average annual precipitation in this region ranges from about 11 to 17 inches per year, with about half occurring as winter snowfall. Flash flooding may occur in the valley primarily as a result of summer thunderstorms. Approximately 40 inches of precipitation fall in the mountains surrounding Tooele Valley.

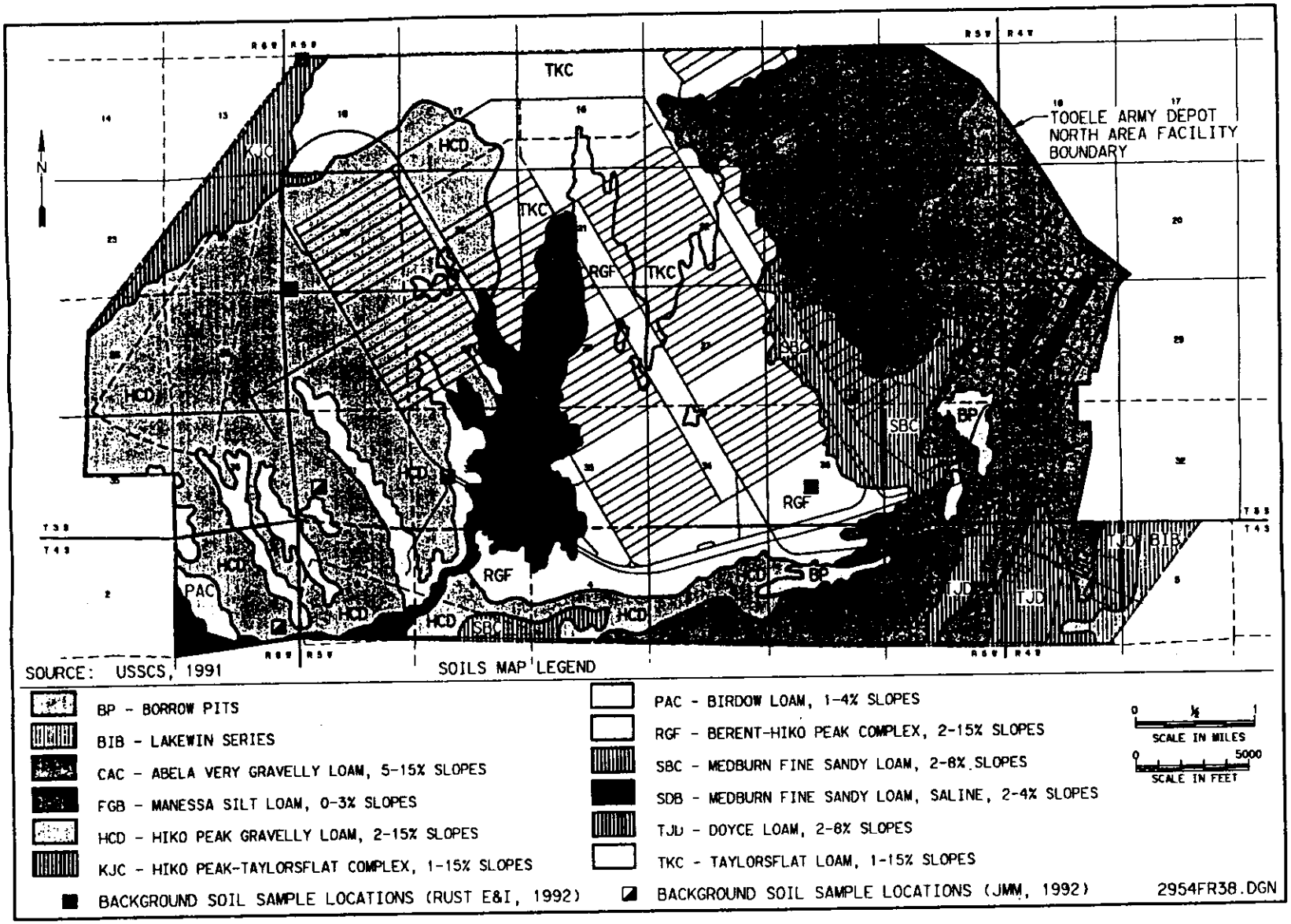


Figure 2-3. Soil Type Map for TEAD-N

Furthermore, because of the low precipitation, soil productivity within this region is low and concretionary layers may form (SCS, Unpublished 1992), resulting in decreased vegetative cover. This, in turn, reduces the amount of organic matter in the soil, which decreases water-holding capacity. Additionally, because of the low precipitation, the translocation of salts, minerals, and clays, and the resulting formation of soil horizons are limited. With a deficiency of water, dry soils do not develop strong diagnostic horizons (identification layering) except for salt crusts or concretionary layers. During dry periods, water can be drawn through the soil by capillary action and evaporate either in the soil profile or at the ground surface. Layers of caliche (a layer of calcium hardpan) or other evaporite salts may accumulate in desert soils in this manner. The long-term effects of cattle grazing (soil compaction and gravel cover alternation) are readily visible and add to the low soil productivity (Orodho, 1990).

Soil crusting also affects soil productivity. It reduces infiltration rates, thereby limiting both the depth to which salts are leached and the depth to which roots can penetrate. Many of the soils in this area are susceptible to forming a surface crust. The sparse vegetative cover exposes more soil to raindrop impact. Raindrop impact tends to compact the soil surface and break down the soil-surface structure into a massive condition. This reduces the amount of large pore space available for infiltration. The high sodium content of many soils in the region disperses soil particles, which results in a naturally poor soil-surface structure.

The natural erosion rates of soils within the region are high. This is caused by low vegetative cover, soil crusting, low organic matter content, and easily eroded parent materials. Additionally, the dispersal property of sodium makes soil particles more easily detached by wind and water.

Topographic relief significantly affects soil development in terms of its drainage, elevation, aeration, aspect, steepness of slope, and susceptibility to erosion. Generally, steep south-facing and west-facing slopes are warmer and drier than north-facing and east-facing slopes. The result is that snow and moisture accumulate to a greater extent on the cooler, north-facing and east-facing slopes; the vegetative composition is more dense, thereby accumulating more organic matter.

2.5.2 Soil Survey Results

2.5.2.1 *Mapping Unit Descriptions*

The soil types identified on the TEAD-N facility are identified in Table 2-1, along with the approximate number of acres and percentage each occupies within the facility area. Table 2-1 also provides the general characteristics of the surface soils of the TEAD-N investigation area. These characteristics include the mapping unit, soil type, origin of the soil, general location of the soil in the landscape, the texture, depth, pH, permeability, and infiltration rate (JMM, 1992).

Table 2-1. General Characteristics of Surface Soil of TEAD-N Investigation Area

Mapping Unit	Soil Type	Origin	General Location	Characteristics				
				Texture	Depth (feet bgs)	Soil pH	Permeability	Infiltration Rate (cm/sec)
Abela Included in this unit are Borvant and Birdow soils.	Abela	Developed in alluvium derived primarily from limestone and quartzite.	Alluvial fans on 1 to 8 percent slopes at elevations of 4600 to 6000 feet above MSL.	Gravelly loam (GM-GC; SC-SM)	0 to 0.8	7.9 to 8.4	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam (GC-GM)	0 to 1.7	7.9 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam to extremely gravelly sandy loam (GM-GC; GP-GM)	1.7 to 5	8.5 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
	Borvant	Developed in alluvium derived predominantly from limestone.	Shallow soil over a carbonate cemented hardpan on fan terraces on short or medium length, convex, 2 to 15 percent slopes at elevations of 5200 to 6500 feet above MSL.	Gravelly loam (GM-GC, SC-SM)	0 to 0.5	7.4 to 9.0	Moderate	$4.2x10^{-4}$ to $1.4x10^{-3}$
				Very gravelly loam (GM-GC)	0.5 to 1.5	7.9 to 9.0	Moderate	$4.2x10^{-4}$ to $1.4x10^{-3}$
				Indurated	1.5	--------	--------	--------
Berent-Hiko Peak Complex. Included in this unit are Amtoft, Medburn, Sprager, Taylorsflat, Duneland, and Rock Outcrop soils.	Berent	Eolian sands derived from mixed rock types.	Hummocky vegetated sand dunes and fan terraces up to 30 percent slopes at elevations of 4500 to 5800 feet above MSL.	Loamy fine sand (SM)	0 to 0.5	7.4 to 8.4	Rapid	$4.2x10^{-3}$ to $1.4x10^{-2}$
				Fine sand (SM)	0.5 to 5	7.9 to 9.0	Rapid	greater than $1.4x10^{-2}$
	Hiko Peak	Developed in alluvium from mixed rock types.	Alluvial fan terraces on medium length, convex, 2 to 15 percent slopes at elevations of 4400 to 6000 feet above MSL.	Gravelly loam (GM-GC)	0 to 0.5	7.9 to 8.4	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam (GM-GC)	0.5 to 1	7.9 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam (GM-GC)	1 to 5	8.5 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
	Amtoft	Developed in alluvium derived from mixed rock types.	Rock outcrops on 30 to 70 percent slopes.	Very cobbly loam (GM-GC)	0 to 1	7.9 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Extremely cobbly loam (GM-GC; GP-GC)	1 to 1.5	7.9 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Unweathered bedrock	1.5	--------	--------	--------
	Spager	Developed in alluvium derived from limestone	Alluvial fan terraces on 2 to 15 percent slopes at elevations of 5200 to 6200 feet above MSL.	Gravelly loam (GM-GC; SC-SM)	0 to 0.5	7.4 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam, very gravelly fine sandy loam (GM-GC)	0.5 to 2	greater than 8.4	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Indurated	2	---	---	---

Table 2-1. General Characteristics of Surface Soil of TEAD-N Investigation Area (continued)

Mapping Unit	Soil Type	Origin	General Location	Characteristics				
				Texture	Depth (feet bgs)	Soil pH	Permeability	Infiltration Rate (cm/sec)
	Taylorsflat	Alluvium and lacustrine sediments derived from mixed rock types.	Lake terraces and alluvial fan terraces on medium length, linear to convex, 1 to 5 percent slopes at elevations of 5000 to 6000 feet above MSL.	Loam (CL-ML) Loam (CL-ML) Loam (CL-ML)	0 to 0.5 0.5 to 1.0 1.0 to 5	7.9 to 8.4 7.9 to 8.4 8.5 to 9.0	Mod. slow Mod. slow Mod. slow	$4.2x10^{-4}$ to $1.4x10^{-3}$ $1.4x10^{-4}$ to $1.4x10^{-3}$ $1.4x10^{-4}$ to $1.4x10^{-3}$
	Duneland	Sand; derived from mixed rock types.	Ridges and intervening troughs made of fine sand sized particles on lake plains and low lake terraces.	Sand (SM-SW)	NA	NA	NA	NA
	Rock outcrop	Dependent on the type of bedrock.	Exposures of barren bedrock that occur mainly on escarpments or ridges. Slopes range from 30 to 60 percent.	NA	NA	NA	NA	NA
Medburn. Included in this unit are Hiko Peak and Taylorsflat soils.	Medburn	Developed in alluvium and lacustrine sediments, derived predominantly from sedimentary rocks.	Lake terraces and alluvial fan terraces on short or medium length, convex or linear, 2 to 8 percent slopes at elevations of 4500 to 5800 feet above MSL.	Fine sandy loam (SM; SC-SM) Fine sandy loam (SM; SC-SM) Fine sandy loam (SM; SC-SM)	0 to 0.5 0.5 to 3.5 3.5 to 5	7.9 to 8.4 7.9 to 9.0 8.5 to 9.0	Mod. rapid Mod. rapid Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$ $1.4x10^{-3}$ to $4.2x10^{-3}$ $1.4x10^{-3}$ to $4.2x10^{-3}$
Birdow. Included in this unit are Erda and Lakewin soils.	Birdow	Developed in alluvium derived predominantly from limestone and quartzite.	Flood plains, stream terraces, and alluvial fans on long, linear, or slightly concave 1 to 4 percent slopes at elevations from 4250 to 6200 feet above MSL.	Loam (CL-ML) Loam (CL-ML)	0 to 2.3 2.3 to 5	7.4 to 8.4 7.9 to 9.0	Moderate Moderate	$4.2x10^{-4}$ to $1.4x10^{-3}$ $4.2x10^{-4}$ to $1.4x10^{-3}$
	Erda	Developed in alluvium and lacustrine sediments derived from mixed rock types.	Alluvial fan terraces and lake terraces on 1 to 5 percent slopes at elevations of 4250 to 6000 feet above MSL.	Silt loam (CL-ML) Silt loam (CL-ML) Silt loam, silty clay loam (CL-ML)	0 to 1 1 to 3 3 to 5	7.4 to 8.4 7.9 to 9.0 7.9 to 9.0	Mod. slow Mod. slow Mod. slow	$1.4x10^{-4}$ to $4.2x10^{-4}$ $1.4x10^{-4}$ to $4.2x10^{-4}$ $1.4x10^{-4}$ to $4.2x10^{-4}$

Source: Taken from JMM, 1992.

2.5.2.2 *Soils of the TEAD-N Facility Area*

The soils of the TEAD-N site are similar in origin and character to those of the region. These soils of the TEAD-N facility area are primarily derived from alluvium and lacustrine deposits of mixed rock sources (SCS, Unpublished 1992; Weston, 1989). Additionally, some of the soils on the site formed in alluvium derived dominantly from limestone and quartzite. The two surficial soil types are (1) lake bed sediments with low to moderate permeability and (2) colluvium and alluvium deposits with moderate to high permeability.

The soils of the facility and adjacent areas are developing under cool and arid conditions, and are rather weakly developed overall. Because the facility area receives little precipitation (11 to 17 inches on average) and because about half of the precipitation falls during the summer months when the moisture is used by plants, very little moisture ultimately passes through the soil profile. The air temperature averages 75 °F in July and 28 °F in January; the average freeze-free period is 120 to 160 days (SCS, Unpublished 1992). These relatively cool, year-around temperature conditions also limit the development of soils.

Specifically, within the northeastern portion of the TEAD-N facility area, the soils are primarily classified as Manessa silt loam and Abela very gravelly loam. The southeastern portion of the TEAD-N facility area is a mix of soils, including the Abela very gravelly loam, borrow pits (disturbed), and Doyce loam mapping units. The north-central portion of the site is largely dominated by the Taylorsflat loam mapping unit, and in the south-central area of the site, the soils are dominated by the Berent-Hiko Peak Complex. The western portion of the facility area is comprised largely of soils from the Hiko Peak gravelly loam, with fingers of Berent-Hiko Peak Complex and Hiko Peak-Taylorsflat Complex, and Birdow loam mapping units. The soils map (see Figure 2-3) shows each soil-mapping unit identified within the area.

The soils on the TEAD-N area are predominantly (approximately 47 percent) Hiko Peak and Berent-Hiko Peak soils. The Abela, Taylorsflat, and Manessa soils comprise approximately 15, 11, and 10 percent of the area, respectively. The remaining seven mapping units comprise the last 17 percent of the TEAD-N facility.

2.6 HYDROGEOLOGY

Groundwater conditions vary throughout the Tooele Valley with unconfined, confined, and artesian conditions being encountered. Groundwater depth ranges from less than 10 feet in northern Tooele Valley to greater than 700 feet below ground surface (bgs) along the southwestern edge of TEAD-N.

Regionally, groundwater originates at recharge areas along the basin margins, moves toward the northwest beneath Tooele Valley, and ascends to discharge areas in the central and northern parts of the valley. Recharge zones along the valley margins extending into the basin are characterized by downward vertical gradients. Major discharge areas exist north of TEAD-N in the Tooele Valley (e.g., Six-Mile Spring and Fishing Creek Spring).

Piezometers and monitoring wells installed near the northern TEAD-N boundary indicate upward vertical gradients in that area.

Groundwater in Tooele Valley is found in the alluvial valley fill deposits and, to a lesser extent, in underlying bedrock. The alluvial aquifer is composed primarily of gravels, with major interbedded zones composed of varying amounts of sands, silts, and clays. On an areal basis, the alluvial aquifer ranges in thickness from 0 (i.e., from bedrock outcrops) to 2,500 feet bgs near the southern boundary of TEAD-N (Everitt and Kaliser, 1980). Horizontal hydraulic conductivity of the alluvial aquifer is approximately 200 feet per day (ft/d) with a vertical hydraulic conductivity of approximately 30 ft/d. Calculated groundwater velocities range from about 4 feet per year to greater than 9,800 feet per year, using an estimated porosity of 0.25 (JMM, 1988). Average calculated vertical groundwater-seepage rates range from less than 1 foot per year to 200 feet per year (Jordan, 1990a).

Groundwater-flow direction at TEAD-N is from the southeast to the northwest. The potentiometric surface is relatively flat across TEAD-N with a hydraulic gradient of approximately 0.007. Groundwater-flow direction is altered to some extent in the IWL Area where the alluvial aquifer encounters the fault-block bedrock ridge.

The bedrock aquifer, consisting primarily of low permeability quartzite and limestone, occurs beneath a relatively small area in the eastern portion of TEAD-N. The remainder of TEAD-N and Tooele Valley is directly underlain by the alluvial aquifer.

Although permeability of the bedrock is very low, strong evidence suggests extensive fracturing in the bedrock, which allows considerable groundwater flow. Highly fractured or weathered bedrock will exhibit the highest hydraulic conductivities. With the exception of the IWL area, there is little site-specific bedrock-aquifer information for TEAD-N. Hydraulic conductivity of the fractured quartzite bedrock is estimated at 268 ft/d. Where the bedrock was shown to contain clay-filled fractures, hydraulic conductivity is estimated to be 0.2 ft/d. Hydraulic gradients for the bedrock aquifer located in the vicinity of the bedrock block range from 0.02 to 0.09. Horizontal velocity of groundwater movement in the bedrock ranges from less than 10 feet per year to about 5,500 feet per year, based on an estimated porosity of 0.03 (Jordan, 1990a).

Seventy-nine monitoring wells were installed at TEAD-N in conjunction with a Groundwater Quality Assessment at the IWL (JMM, 1988). Locations of these wells and other existing monitoring and water-supply wells are shown in Figure 2-4. A groundwater contour map for TEAD-N is shown in Figure 2-5. This map was generated on the basis of groundwater-elevation data obtained in June 1992.

Groundwater levels have been measured at TEAD-N since about 1982. Hydrogeologic data indicate that water levels rose in response to record-high rainfalls in Utah between 1982 and 1984. Water levels have gradually declined since then because of normal to below-normal precipitation rates.

Previous reports also show localized moist zones (sometimes referred to as a perched water table) beneath some sites (i.e., TNT Washout Facility and the Sanitary Landfill SWMUs) at

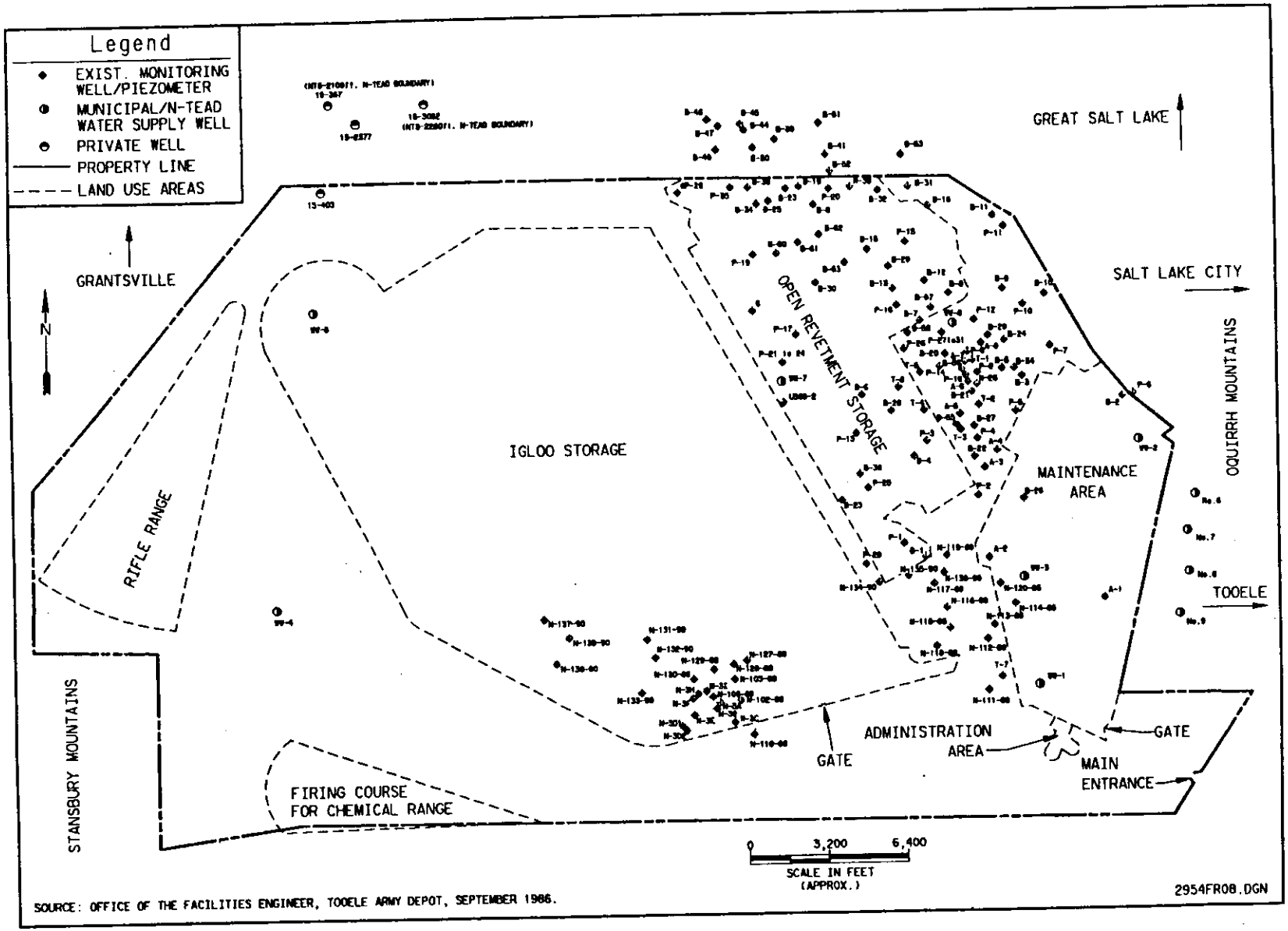


Figure 2-4. Location Map of Existing Monitoring and Water Supply Wells

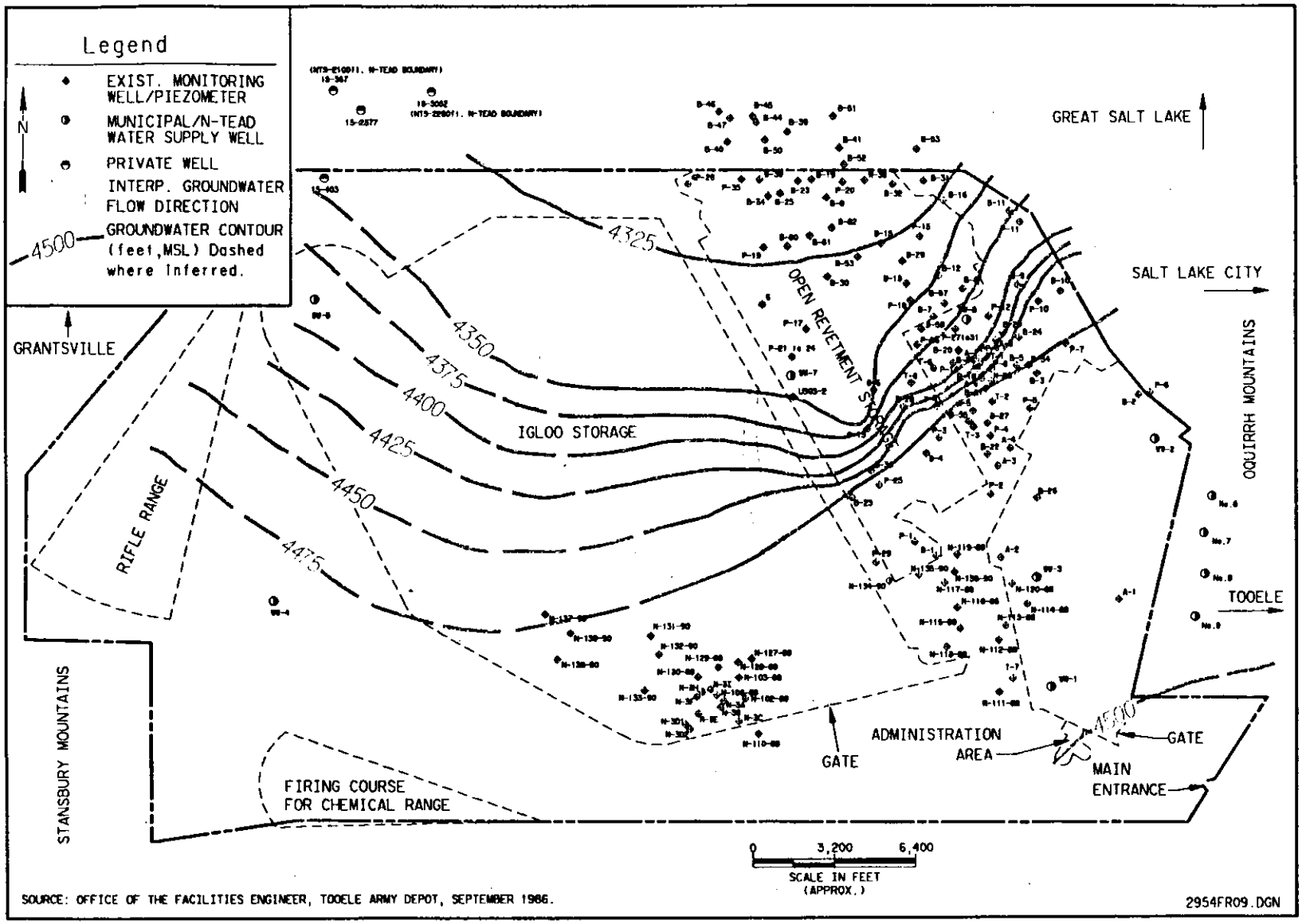


Figure 2-5. Groundwater Contour Map for TEAD-N

TEAD-N. In areas where investigative work occurred, these moist zones were first encountered from approximately 17 to 180 feet bgs. Varied depths of these zones across TEAD-N indicate the possibility of numerous vertically spaced, localized, moist zones. Previous reports indicate that groundwater perched along these zones eventually will reach the regional alluvial aquifer (Jordan, 1990a).

During rare periods of heavy rain or rapid melting of mountain snowpack, surface water may occur at TEAD-N in Box Elder Wash and South Willow Creek, both of which cross TEAD-N near its western boundaries (see Figure 2-6).

2.7 BACKGROUND SOIL AND GROUNDWATER CHARACTERISTICS

Knowledge of background geochemical conditions is necessary to assess the presence or absence of contamination in field sampling results. For this RI, background conditions in soil and groundwater were assessed from an understanding of contaminant releases at the site and field sampling. With the exception of contaminants identified in blanks, detections of organic analytes above certified reporting limits (CRLs) in soil samples were considered indicative of contamination. To evaluate background conditions of inorganic analytes in soils at TEAD-N, soil samples were collected from 10 locations considered to be free from contamination releases. Results were statistically summarized and background levels were assessed for each analyte. Based on these statistical background concentrations, detections in field samples were evaluated in Sections 4 through 10 of this report to determine if detections of inorganics represented contamination resulting from site activities.

Since large depths to groundwater are exhibited at TEAD-N and preliminary contaminant transport modeling (see Section 3.4.3) indicates minimal impact to groundwater from surface contamination, no groundwater samples were collected as part of this RI. Therefore, background groundwater conditions were not statistically evaluated as part of this investigation. However, since groundwater quality is important to the conceptual understanding of the site, a brief summary of groundwater conditions is provided in Section 2.7.2.

2.7.1 Background Soils

Background soil samples were collected under two concurrent investigative programs from 10 locations across TEAD-N during 1992. A total of 20 soil samples were collected (including one field duplicate) from locations inferred to be free from contamination based on historical release information. Sampling locations are presented in Figure 2-7. As part of the TEAD-N Phase I Suspected Releases RFI (JMM, 1993), six background locations were sampled. As part of the RI for OUs 4 through 10, four background locations were sampled.

At each location, except SB-BK-004 and SB-BK-006, two background soil samples were collected: one from the surface and one from either the 2- or 3-foot sample interval. At SB-

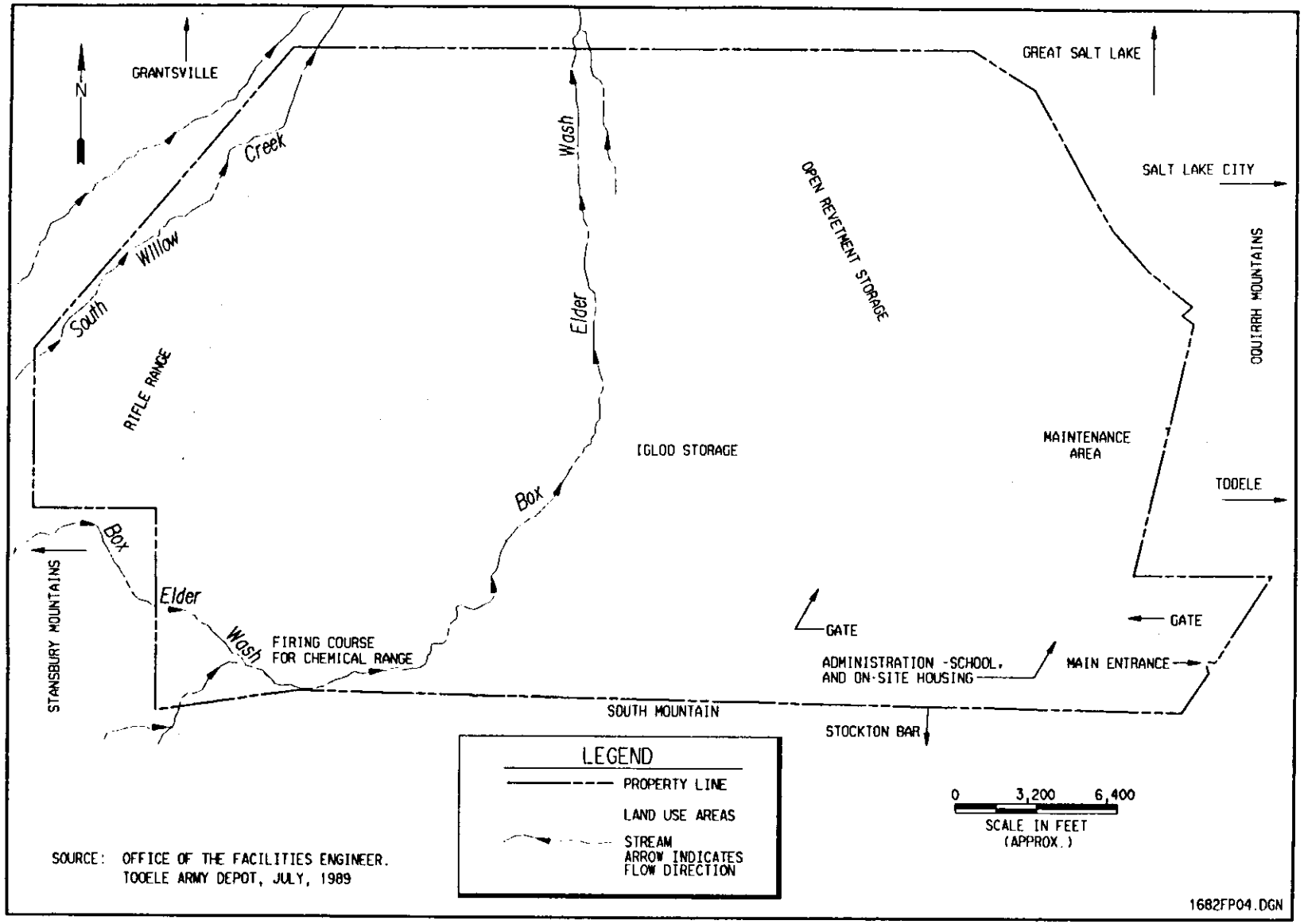


Figure 2-6. Surface Water Drainages at TEAD-N

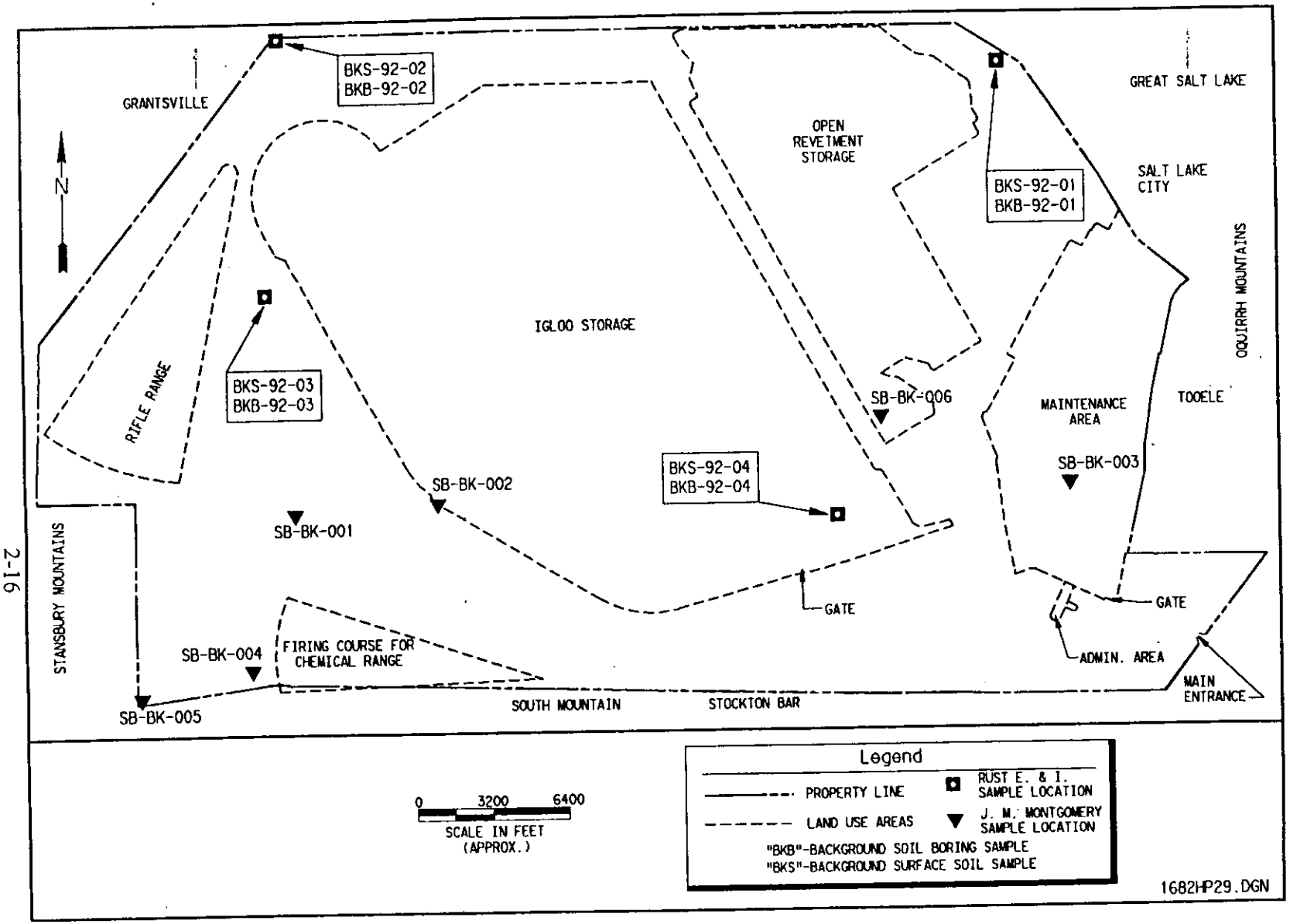


Figure 2-7. Background Soil Sample Locations for TEAD-N

BK-004, a background soil sample and a field duplicate were collected at the surface, and one background soil sample was collected from the 3-foot interval. At SB-BK-006, one background soil sample was collected from a depth of 10 feet only. All background soil samples were analyzed for metals, anions, and pH. Results of background soil sampling analyses are presented in Appendix F.

Detections of inorganic analytes were statistically evaluated to calculate upper bound background concentrations for each particular analyte. In general, the upper bound of the background concentrations were calculated as the tolerance limit containing 95 percent of the population with a probability (confidence) of 0.95 (EPA, 1989). For each analyte, the reported detections were tabulated and general population characteristics, such as the frequency and range of detections, arithmetic mean concentration, and standard deviation, were summarized to provide preliminary statistical information for the calculation of upper bound background concentrations. These summary statistics and calculated upper bound background concentrations are presented in Table 2-2.

Upper bound background concentrations presented in Table 2-2 were calculated using the following conditions. For analytes that were not detected above CRLs in any samples, the CRL was presented as the background concentration. For analytes with detection frequencies up to 15 percent, the highest concentration detected was presented as the background concentration, since statistical methods are not appropriate for such small populations. For analytes with detection frequencies greater than 15 percent, a test for normality was performed and an upper bound background concentration was calculated as the tolerance limit. For normal populations, the tolerance limit was calculated as the sum of the mean concentration and one standard deviation times a tolerance factor based on the number of samples in the population.

For this statistical approach, reported nondetections were assigned a value equal to one-half the CRL. The resulting population of concentrations was tested for normality by evaluating the coefficient of variation and/or performing a Kolmogorov-Smirnov test. Based on the results of these tests, all populations were approximately normal and upper bound tolerance levels calculated. However, for arsenic and lead, anomalously high values within the population of detected concentrations were identified as outlier values and were discarded prior to the test for normality.

For arsenic, three of the highest detections reported were associated with samples for which matrix interferences made accurate reporting impossible. For lead, the highest value reported was approximately twice the next highest value and occurred in the same sample (BKS-92-03) as the highest value reported for zinc. Since concentrations of these analytes were much lower in the soil sample from the 3-foot interval, it was suspected that surface contamination may be present in the surface sample from this location. The highest zinc value could not be identified as an outlier based on established statistical procedures and normality testing. However, the highest reported value for lead was identified as an outlier and discarded prior to statistical analysis.

Table 2-2. Summary of Results and Upper Bound Background Concentrations for Soils

Analyte	Detection Frequency	Low Concentration (µg/g)	High Concentration (µg/g)	*Arithmetic Mean(x) (µg/g)	Standard Deviation (µg/g)	**Upper Bound Background (µg/g)
Metals:						
Silver (Ag)	10/19	<0.384	0.660	0.267	0.200	0.749
Aluminum (Al)	19/19	2280	32000	11500	8360	31700
Arsenic (As)	12/16	<48.0	63.2	22.5	21.2	76.0
Barium (Ba)	19/19	36.7	270	117	66.2	277
Beryllium (Be)	9/19	<0.078	1.46	0.566	0.561	1.92
Calcium (Ca)	19/19	2580	170000	40400	37400	131000
Cadmium (Cd)	2/18	<0.424	0.847	N/A	N/A	0.847
Cobalt (Co)	11/19	<1.42	6.94	2.50	1.99	7.32
Chromium (Cr)	18/19	<4.05	19.1	11.5	4.67	22.8
Copper (Cu)	18/19	<1.95	29.0	11.7	6.84	28.2
Iron (Fe)	19/19	3400	26000	11300	5840	25400
Mercury (Hg)	1/18	<0.026	0.037	N/A	N/A	0.037
Potassium (K)	19/19	541	8200	3270	2330	8920
Magnesium (Mg)	19/19	1330	35600	9030	7810	28000
Manganese (Mn)	19/19	59.0	660	334	187	787
Sodium (Na)	11/11	189	1790	507	474	1840
Nickel (Ni)	11/19	<2.46	17.4	6.52	5.28	19.3
Lead (Pb)	18/18	0.786	62.0	19.0	17.4	63.4
Antimony (Sb)	1/18	<3.42	15.0	N/A	N/A	15.0
Selenium (Se)	0/10	<0.25	N/A	N/A	N/A	0.250
Thallium (Tl)	2/18	<6.62	11.7	N/A	N/A	11.7
Vanadium (V)	18/19	<1.34	28.0	16.0	7.05	33.1
Zinc (Zn)	18/19	<7.96	210	58.4	45.8	169
Anions:						
Bromide (Br)	0/8	<8.83	N/A	N/A	N/A	8.83
Chloride (Cl)	4/19	<6.05	470	53.5	117	336
Cyanide (CYN)	0/15	<0.92	N/A	N/A	N/A	0.92
Fluoride (F)	0/8	<19.2	N/A	N/A	N/A	19.2
Total Nitrate/Nitrite (NIT)	8/11	<0.600	2.15	1.06	0.660	2.92
Nitrite (NO2)	0/8	<3.16	N/A	N/A	N/A	3.16
Nitrate (NO3)	2/8	<3.36	9.45	N/A	N/A	9.45
Phosphate (PO4)	0/8	<5.00	N/A	N/A	N/A	5.00
Sulfate (SO4)	2/18	<14.4	466	N/A	N/A	466
Total Phosphate (TP04)	10/10	130	560	316	125	681
Other:						
pH	11/11	5.91	9.76	8.02	1.27	11.6

*Arithmetic mean of detections above Certified Reporting Limit (CRL) and values of 1/2 CRL for results reported below CRL values .

**Upper Bound Background Concentration (UBBC) determined as follows: for detection frequency = 0, UBBC = Certified Reporting Limit; for 0 < detection frequency <15%, UBBC = Highest detection; for detection frequency >15%, UBBC = Tolerance Limit (TL); where TL=x + ks: x = Arithmetic Mean; s = Standard deviation; and k = tolerance factor for one-sided normal tolerance with probability (confidence) at 0.95 (US EPA, 1989a).

2.7.2 Background Groundwater

Data collected from the groundwater sampling of wells in the northeastern portion of the facility have identified three types of groundwater encountered in this vicinity. These groundwater types are characterized by the concentrations of four ionic species (i.e., calcium, sodium, sulfate, and bicarbonate) that each contains. These three types of groundwater are referred to as Type 1, Type 2, and Type 3 (JMM, 1988).

Type 1 groundwater represents precipitation and snow melt from the surrounding mountain ranges (i.e., the Oquirrh Mountains to the east and the Stansbury Mountains to the west) that recharge the alluvial aquifer. Typically, this water contains no dominant cations with a high concentration of bicarbonate. The monitoring wells and the TEAD water-supply wells along the western side of the site intercept this type of groundwater before it acquires high concentrations of other ions (especially chloride and sulfate) in the aquifer (JMM, 1988).

In the northern, southern, and central portions of the site, Type 2 groundwater is encountered. Type 2 water represents Type 1 water with additional anions (i.e., higher concentrations of all major ions with the exception of bicarbonate) and additional cations dissolved from the alluvium from mixing with more saline groundwater contained in the bedrock aquifer (JMM, 1988).

Type 3 groundwater comprises the geothermal water intercepted by deep and intermediate wells installed in the alluvial aquifer beneath the off-depot area north of TEAD. This groundwater is characterized by the highest concentrations of sodium and chloride in TEAD-N groundwater, and moderate concentrations of calcium, sulfate, and bicarbonate (JMM, 1988).

2.8 VEGETATION

The vegetation mapping units located on the TEAD-N facility area are based upon the SCS soil survey and range site types for Tooele County (SCS, Unpublished 1992). A plant species list was developed for the area. These and other data sources were utilized to coordinate data and information for this report. The vegetation map, presented as Figure 2-8, identifies vegetation mapping units discussed in this report.

A total of seven range site types were identified within the TEAD-N facility area. These range sites are: (1) Semidesert Sand (Utah Juniper), (2) Semidesert Gravelly Loam (Wyoming Big Sagebrush), (3) Semidesert Loam (Wyoming Big Sagebrush), (4) Semidesert Alkali Loam (Black Greasewood), (5) Upland Stony Loam (Pinyon-Utah Juniper), (6) Loamy Bottom (Basin Wildrye), and (7) Upland Loam (Mountain Big Sagebrush). Two range site complexes were also identified based upon soil type complexes. Each range site type is described in the following subsections and includes information on dominant plant species and soils.

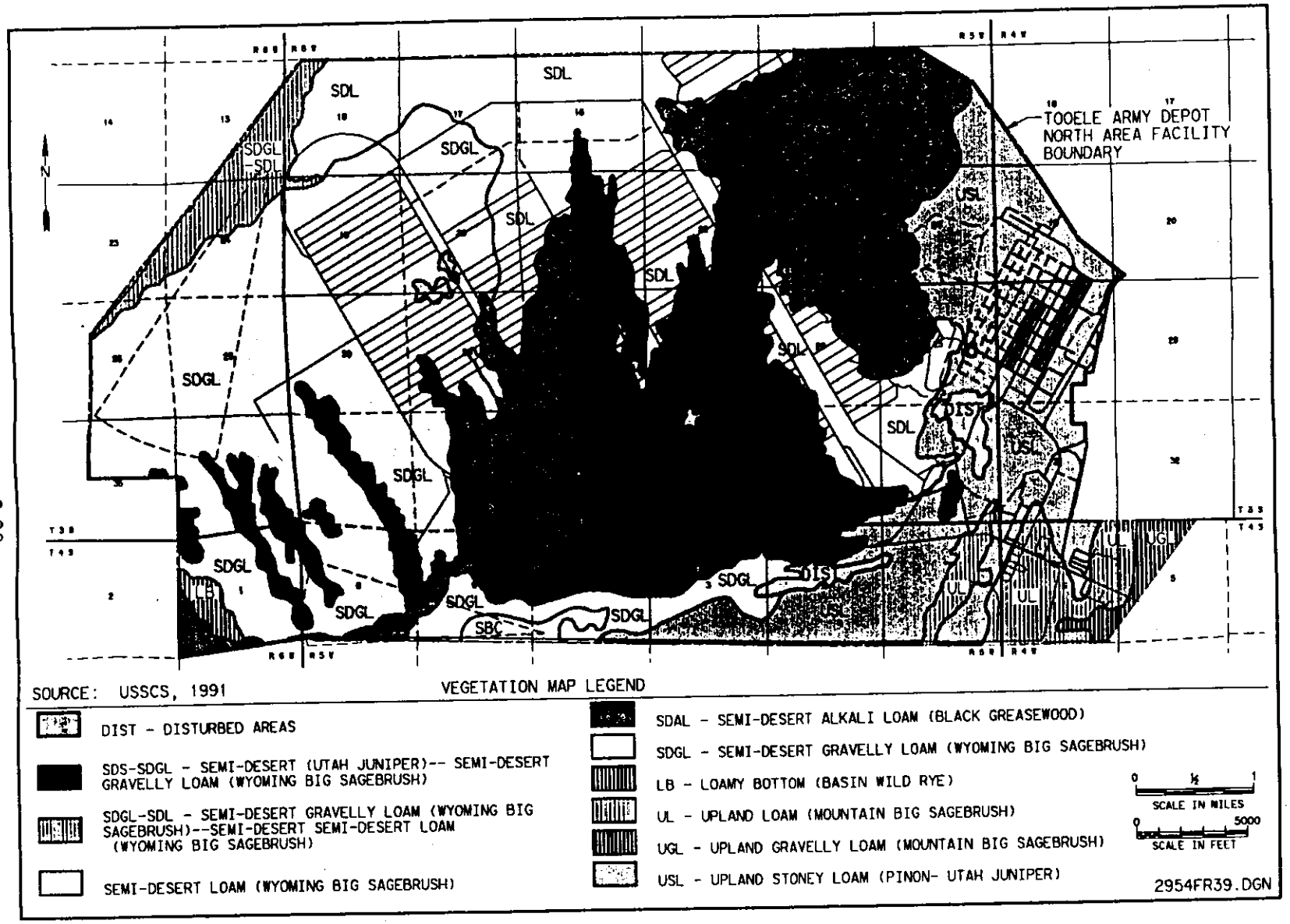


Figure 2-8. Vegetation Map for TEAD-N

2.8.1 Regional Vegetation

The climate of a region profoundly influences soil and vegetation development. The Tooele Valley region is classified as a cold desert, dominated by sagebrush and saltbush plant species. Soil and plant-community development are, to a great extent, a function of precipitation and temperature (Welsh et al., 1987). The amount of precipitation available during the growing season is a primary factor in determining the type of species present, number of individuals, and the general productivity of the vegetation and soils of the area. In addition to adapting to low precipitation and high evaporation rates, plants in this area have adapted to a moderately eroded soil, and some have adapted to alkaline and saline soils. The valley bottoms within the TEAD-N region are typically filled with the erosional deposits from surrounding mountain ranges and are frequently occupied in part by saline pans, salt flats, or fresh to saline lakes or ponds (Welsh et al., 1987).

Distribution of plant species tends to be correlated with the geology and soils present on a site (Welsh et al., 1987). The geology of this area consists primarily of lacustrine and sedimentary material of mixed rock origins (SCS, Unpublished 1992). Welsh and others (1987) noted that the plant communities that may occur on TEAD-N include Salt Desert Shrub, Riparian Communities, Cool Desert Shrub, and Juniper-Pinyon.

Vegetation types have been previously identified on the TEAD-N area. These four types range from moist and more productive to drier and less productive--the Upland Loam, Foothill, Sandy Hills, and Desert Bench. The Upland Loam is a sagebrush/grass vegetation type, dominated by sagebrush and other shrubs; and a variety of grasses, including wheatgrasses, bluegrass, needle-and-threadgrass, and a variety of forb species. The Foothill vegetation type is primarily a grassland vegetation type, dominated by a variety of grass species including wheatgrass, bluegrass, needle-and-threadgrass, and Indian ricegrass, as well as a number of forbs including sweet vetch, balsam root, yarrow, and snakeweed. The Sandy Hills vegetation type is an upland savannah with scattered juniper trees. Although pinyon can exist in this community, they are not present on this specific site. The following species are important: Indian ricegrass, sand dropseed, needle-and-threadgrass, sagebrush, and ephedra. Finally, the Desert Bench type, is a dry vegetation type, dominated by shadscale, winterfat, greasewood, grey molly's alkali sacaton, spiked wheatgrass, western wheatgrass, Indian ricegrass, bud sage, and salt sage.

2.8.2 Survey Results of Range Site Types

The range site types identified on the TEAD-N facility area are identified in Table 2-3. Included are the approximate number of acres they cover and percentage of area each occupies within the facility area. Additionally, the general plant/soil relationships for the site area are also shown in this table. Figure 2-8 (page 2-20), Vegetation Map, shows the distribution of range site types within the facility area. The following descriptions for the range site types address general species composition and abundance based upon SCS evaluations (SCS, Unpublished 1992). Plant species are identified by their common name within each range site description; the scientific names for plant species are identified in Table 2-4.

Table 2-3. Range Site Types for TEAD-N

Range Site Type	Soil Type	Acres	Percentage
Semidesert Sand (Utah Juniper)--Semidesert Gravelly Loam (Wyoming Big Sagebrush)	Berent-Hiko Peak Complex	5,070	20
Semidesert Gravelly Loam (Wyoming Big Sagebrush)--Semidesert Loam (Wyoming Big Sagebrush)	Hiko Peak-Taylorsflat Complex, 1 to 15 percent slopes	480	2
Semidesert Loam (Wyoming Big Sagebrush)	Taylorsflat loam, 1 to 5 percent slopes Medburn fine sandy loam, 2 to 8 percent slopes	3,724	15
Semidesert Gravelly Loam (Wyoming Big Sagebrush)	Hiko Peak gravelly loam, 2 to 15 percent slopes	6,350	26
Semidesert Alkali Loam (Black Greasewood)	Manassa silt loam, 0 to 3 percent slopes Medburn fine sandy loam, saline, 2 to 4 percent slopes	3,942	15
Upland Stony Loam (Pinyon-Utah Juniper)	Abela very gravelly loam, 5 to 15 percent slopes	3,759	15
Loamy Bottom (Basin Wildrye)	Birdow loam, 1 to 4 percent slopes	100	1
Upland Loam (Mountain Big Sagebrush)	Doyce loam, 2 to 8 percent slopes	697	3

Semidesert Sand (Utah Juniper)--Semidesert Gravelly Loam (Wyoming Big Sagebrush). This range site complex occurs on the Berent-Hiko Peak, 2 to 15 percent slopes, soils complex. The Semidesert Sand range site type occurs on the Berent soil; the Semidesert Loam range site type occurs on the Hiko Peak soil. The vegetation that occurs on the Hiko Peak soil is discussed under the Semidesert Gravelly Loam range site type.

On the Berent soils, the present vegetation is Utah Juniper, Wyoming big sagebrush, needle-and-threadgrass, and cheatgrass. The potential plant community on this soil is an overstory of Utah juniper with about 30 percent cover. The understory vegetation is about 45 percent perennials and also includes Indian ricegrass, fourwing saltbush, sand dropseed, scarlet globemallow, bud sagebrush, and spiny hopsage.

Table 2-4. Plant Species Potentially at TEAD-N

Latin Name	Common Name	Observed at TEAD-N
SHRUBS AND SUBSHRUBS		
FAMILY ANACARDIACEAE	SUMAC	
Rhus aromatica	Squaw Berry	x
FAMILY ACERACEAE		
Acer negundo	Boxelder	x
FAMILY ASTERACEAE	COMPOSITE	
Artemisia nova	Black Sagebrush	x
Artemisia spinescens	Bud Sagebrush	x
Artemisia tridentata	Wyoming Big Sagebrush	x
Chrysothamnus nauseosus	Tall Rabbitbrush	x
Chrysothamnus viscidiflorus	Viscid Rabbitbrush	
Tetradymia glabrata	Littleleaf Horsebrush	
Tetradymia spinosa	Spiny Horsebrush	
FAMILY CAPRIFOLIACEAE	HONEYSUCKLE	
Sambucus caerulea	Blue Elder	x
FAMILY CHENOPODIACEAE	GOOSEFOOT FAMILY	
Atriplex canesceus	Four-wing Saltbrush	x
Atriplex confertifolia	Shadscale	
Atriplex falcata	Sickle Saltbush	x
Atriplex gardneri	Gardner Saltbush	
Atriplex rosea	Tumbling Saltweed	
Atriplex tridentata	Trident Saltbush	x
Sarcobatus vermiculatus	Black Greasewood	x
FAMILY ELAEAGNUS	OLEASTER	
Elaeagnus angustifolia	Russian Olive	x
FAMILY EPHEDRACEAE	JOINT FIR	
Ephedra viridis	Mormon Tea	x
FAMILY PINACEAE		
Juniperus osteosperma	Utah Juniper	x
FAMILY ROSACEAE	ROSE	
Coleogyne remosissima	Blackbrush	
Prunus virginiana ssp. melanocarpa	Chokecherry	
Purshia mexicana var. stansburiana	Cliff-rose	
Purshia tridentata	Antelope Bitterbrush	x
FAMILY SALICACEAE	WILLOW	
Populus sargentii	Plains Cottonwood	x

Table 2-4. Plant Species Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY SALICACEAE (cont.)		
Salix exigua	Coyote Willow	x
FAMILY TAMARICACEAE	TAMARISK	
Tamarix chineusis	Tamarisk	x
FAMILY ULMACEAE	ELM	
Ulmus pumila	Chinese Elm	x
CACTI		
FAMILY CACTACEAE	CACTUS	
Opuutia polyacantha	Plains Prickly Pear	x
FORBS		
FAMILY AGROSTIDEAE	REDTOP	
Sporobolos cryptandrus	Sand Dropseed	x
FAMILY ASCLEPIADACEAE	MILKWEED	
Asclepias speciosa	Showy Milkweed	x
FAMILY ASTERACEAE	COMPOSITE	
Antennaria microphylla	Rosy Pussytoes	
Chaenactis douglasii	Dusty Miller	x
Chaenactis stevioides	Pincushion	
Cirsium arvense	Canadian Thistle	x
Cirsium neomexicanum	New Mexican Thistle	x
Cirsium vulgare	Bull Thistle	x
Crepis acuminata	Tapertip Hawksbeard	
Crepis occidentalis	American Hawksbeard	
Erigeron divergens	Spreading Fleabane	x
Erigeron engelmannii	Engelmann Daisy	x
Erigeron flagellaris	Trailing Daisy	
Grindelia squarrosa var. serrulata	Curlycup Gumweed	x
Haplopappus acaulis	Stemless Goldenweed	
Helianthus annuus	Common Sunflower	x
Lactuca serriola	Prickly Wild Lettuce	x
Senecio spartoides var. multicapitatus	Broom Groundsel	
Tragopogon dubius ssp. major	Yellow Goatsbeard	x
FAMILY BORAGINACEAE	BORAGE	
Cryptantha humilis	Cryptantha	x
Cryptantha micrantha	Purpleroot	x
Cynoglossum officinale	Hound's Tongue	

Table 2-4. Plant Species Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY CHENOPODIACEAE	GOOSEFOOT	
Allenrolfea spp.	Pickleweed	
Chenopodium album	Pigweed	x
Eurotia lanata	Winterfat	x
Kochia americana	Green Molly	x
Kochia scoparia	Gray Molly	x
Salsola iberica	Russian Thistle	x
Suaeda occidentalis	Western Seepweed	x
FAMILY COMPOSITAE	SUNFLOWER	
Arctium minus	Burdock	x
Balsamorhiza hookeri	Hooker's Balsamroot	x
Chrysothomnus viscidiflorus	Sticky-flowered Rabbitbrush	x
Gutierrezia sarothrae	Broom Snakeweed	x
Leucelene ericoides	Heath Aster	x
Lygodesmia grandiflora	Rush Pink	x
Machaeranthere canesceus	Hoary Aster	x
Salvia dorrii	Desert Sage	x
Tetradymia canesceus	Littleleaf Horsebrush	x
Tragopogon dubius	Western Yellow Goatsbeard	x
Xonothocephalum sarothrae	Snakeweed	x
FAMILY CONVOLVULACEAE	BINDWEED	
Convolvulus arvensis	Creeping-Jenny (Bindweed)	x
FAMILY CRUCIFERAE	MUSTARD	
Capsella bursa-pastoris	Shepard's Purse	x
Cardaria draba	Whitetop (Peppergrass)	x
Camelima microcarpa	False Flax	x
Chorispora tenella	Purple Mustard	x
Conringia orientalis	Hare's Ear	
Descurainia pinnata	Pinnate Tansymustard	x
Descurainia sophia	Flixweed Tansymustard	x
Erysimum aperum	Wallflower	
Hutchinsia procumbens	Slenderweed	
Lepidium densiflorum	Prairie Peppergrass	
Lepidium montanum	Peppergrass	x
Lepidium perfoliatum	Clasping Peppergrass	x
Lesquerella occidentalis	Western Bladderpod	
Sisymbrium altissimum	Jim Hill Mustard	
Sisymbrium officiale	Hedge Mustard	x
Stanleya pinnata	Prince's Plume	x
Thelypodiopsis vermicularis	Thelypody	
Thelypodium sagittatum	Arrowleaf Thelypody	

Table 2-4. Plant Species Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY EUPHORIBIACEAE	SPURGE	
Euphorbia glyptosperma	Euphorb	x
FAMILY FABACEAE	PEA	
Astragulus bekwithii	Beckwith Milkvetch	
Astragulus calycosus	Torrey Milkvetch	
Astragalus cibarius	Browse Milkvetch	x
Astragalus convallarius	Timber Milkvetch	
Astragalus speciosa	Showy Milkvetch	
Astragalus utahensis	Utah Milkvetch	
Lathyrus brachycalyx	Shortcalyx Peavine	
Lupiunus brevicoulis	Shortstem Lupine	x
Lupinus caudatus	Spurred Lupine	
Melilotus alba	White Sweetclover	x
Melilotus officinalis	Yellow Sweetclover	x
FAMILY GENTIANACEAE	FILAREE	
Erodium cicutarium	Cutleaf Filaree (Storksbill)	x
FAMILY LABIATAE	CATNIP	
Nepeta cataria	Catnip	
FAMILY LEGUMINOCAE	LEGUMES	
Medicago satiua	Alfalfa	x
FAMILY LILLIACEAE	LILLY	
Allium acuminatum	Pointed Wild Onion	x
Allium nevadense	Onion	x
Calochortus nuttallii	Mariposa (Sego Lily)	x
Zigadeuus paniculatus	Death Camus	x
FAMILY LOASACEAE	BLAZINGSTAR	
Acrolasia albicaulis	Acrolasia	
Mentzelia albicaulis	Whitestem Blazingstar	
FAMILY MALVACEAE	GLOBEMALLOW	
Sphaeralcea coccinea ssp. dissecta	Scarlet Globemallow	x
Sphaeralcea grossulariifolia	Gooseberryleaf Globemallow	
FAMILY ONAGRACEAE	EVENING PRIMEROSE	
Oenothera caespitosa	Morning Lily	
Oenothera pallida	Evening Primrose	

Table 2-4. Plant Species Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY POLEMONIACEAE	PHLOX	
Gilia aggregata	Scarlet Gilia	
Gilia leptomeria	Gilia	x
Phlox hoodii ssp. canescens	Hood Phlox	
Phlox longifolia	Longleaf Phlox	
FAMILY POLYGONACEAE		
Eriogonum ovalifolium var. nevadensis	Wild Buckwheat	
Erigonum unbellatum	Sulfur Buckwheat	
Rumex crispus	Curly Dock	x
FAMILY RANUNCULACEAE	BUTTERCUP	
Ranunculus testiculatus	Bur Buttercup	x
FAMILY SCROPHULARIACEAE	FIGWORT	
Castilleja chromosa	Paintbrush	x
Penstemon linarioides ssp. coloradoensis	Creeping Penstemon	
Verbascum thapsus	Mullein	
Verbascum vergatum	Wand Mullein	
Veronica biloba	Bilobed Speedwell	
FAMILY TYPHACEAE	CATTAIL	
Typha augustifolia	Narrowleaf Cattail	x
Typha latifolia	Common Cattail	x
FAMILY VERBENACEAE	VERBENA	
Verbena bracteata	Vervain	x
GRAMINOIDS		
FAMILY HORDEAE	BARLEY	
Elymus smithii	Smith's Wild Rye	x
Hordeum jubatum	Wild Barley	x
FAMILY JUNCACEAE	SEDGE	
Juncus arcticus ssp. vallicola	Artic Rush	
FAMILY POACEAE (GRAMINEAE)	GRASS	
Agropyron cristatum ssp. desertorum	Crested Wheatgrass	x
Agropyron smithii	Western Wheatgrass	
Alopecurus pratensis	Meadow Foxtail	x
Aristida purpurea	Three-awn	x
Bouteloua gracilis	Blue Gramagrass	x
Bromus tectorum	Cheatgrass	x
Distichlis stricta	Inland Saltgrass	

Table 2-4. Plant Species Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY POACEAE (GRAMINEAE) (Cont.)		
Elymus cinerus	Basin Wildrye	
Elymus elongatus	Tall Wheatgrass	x
Elymus elymoides	Squirreltail	x
Elymus spicatus	Bluebunch Wheatgrass	
Hilaria jamesii	Galleta Grass	
Phragmites communis	Common Reed	
Poa bulbosa	Bulbous Bluegrass	x
Poa compressa	Canada Bluegrass	
Poa fendleriana	Muttongrass	
Poa secunda	Sandberg Bluegrass	x
Puccinellia spp.	Alkaligrass	
Sitanion hystrix	Bottlebrush Squirreltail	
Spartina gracilis	Alkali Cordgrass	
Sporobolus airoides	Alkali Sacaton	x
Stipa comata	Needle-and-Threadgrass	x
Stipa hymenoides	Indian Ricegrass	x

Semidesert Gravelly Loam (Wyoming Big Sagebrush)--Semidesert Loam (Wyoming Big Sagebrush). These range site types occur on the soils Hiko Peak-Taylorsflat Complex, 1 to 15 percent slopes. The vegetation that occurs on the Hiko Peak soil is described under the Semidesert Gravelly Loam (Wyoming Big Sagebrush). The vegetation that occurs on the Taylorsflat soil is described under the Semidesert Loam (Wyoming Big Sagebrush).

Semidesert Loam (Wyoming Big Sagebrush). This range site type occurs on two soils on the TEAD-N area: Taylorsflat loam, 1 to 5 percent slopes, and on the Medburn fine sandy loam, 2 to 8 percent slopes. The present vegetation in most areas is Wyoming big sagebrush, Indian ricegrass, and cheatgrass (SCS, Unpublished 1992). The potential plant community on this range site type is about 50 percent perennial grasses, 15 percent forbs, and 35 percent shrubs. Important plant species include bluebunch wheatgrass, Wyoming big sagebrush, Indian ricegrass, bottlebrush squirreltail, needle-and-threadgrass, scarlet globemallow, penstemon, Hood phlox, and Douglas rabbitbrush (SCS, Unpublished 1992).

Semidesert Alkali Loam (Black Greasewood). This range site type occurs primarily on the soil Manassa silt loam, 0 to 3 percent slopes and on the Medburn fine sandy loam saline, 2 to 4 percent slopes. The present vegetation is usually cheatgrass, crested wheatgrass, Wyoming big sagebrush, and bluebunch wheatgrass. The potential plant community on this range site is about 30 percent perennial grasses, 15 percent forbs, and 55 percent shrubs. Other important plant species include black greasewood, bottlebrush squirreltail, and Indian ricegrass.

Upland Stony Loam (Pinyon-Utah Juniper). This range site type occurs primarily on the soil Abela very gravelly loam, 5 to 15 percent slopes. The present vegetation is usually

bluebunch wheatgrass, cheatgrass, mountain big sagebrush, Utah juniper, and yellowbrush. The potential plant community on this range site is an overstory of pinyon and Utah juniper with about 50 percent canopy cover. The understory vegetation is about 45 percent perennial grasses, 5 percent forbs, and 50 percent shrubs. Important plant species also include black sagebrush, bluegrass, and antelope bitterbrush.

Semidesert Loam Gravelly (Wyoming Big Sagebrush). This range site type occurs on the soil Hiko Peak gravelly loam, 2 to 15 percent slopes. The present vegetation is Wyoming big sagebrush, Douglas rabbitbrush, Indian ricegrass, and cheatgrass. The potential plant community is about 45 percent perennial grasses, 15 percent forbs, and 40 percent shrubs. Important plant species include Wyoming big sagebrush, bluebunch wheatgrass, Indian ricegrass, bottlebrush squirreltail, Nevada bluegrass, Hood phlox, rosy pussytoes, shadscale, and Douglas rabbitbrush.

Loamy Bottom (Basin Wildrye). This range site type occurs on the soil Birdow loam, 1 to 4 percent slopes. The present vegetation in most areas is basin big sagebrush, bluebunch wheatgrass, rabbitbrush, and basin wildrye (SCS, Unpublished 1992). The potential plant community is about 70 percent perennial grasses, 10 percent forbs, and 20 percent shrubs. Important plant species are basin wildrye, basin big sagebrush, western wheatgrass, Nevada bluegrass, tapertip hawksbeard, and rubber rabbitbrush.

Upland Loam (Mountain Big Sagebrush). This range site type occurs on the soil Doyce loam, 2 to 8 percent slopes. The present vegetation in most areas is mountain big sagebrush, rabbitbrush, bluebunch wheatgrass, antelope bitterbrush, and some Utah juniper. The potential plant community is about 60 percent perennial grasses, 10 percent forbs, and 30 percent shrubs. Important plant species also include Indian ricegrass and bluegrass.

Disturbed. This mapping unit includes a variety of soil and vegetation types which reflect disturbances resulting from human activities. This mapping unit includes the Borrow Pits soil mapping units (see Section 2.5), as well as other areas of the facility which have been disturbed. The soil textures in these areas vary, but they may contain toxic chemicals or metals that adversely affect plant growth. Much of this type supports less than 10 percent vegetative cover, and has no agricultural value. Some of the Borrow Pit areas, however, may have some value for wildlife habitat or industrial use. Floral composition varies, but species are generally weedy invaders, such as cheatgrass, Indian ricegrass, and rabbitbrush.

2.8.3 Flora Composition

A list of plant species observed and probable for the facility area is presented in Table 2-4 (MacMahon, 1990) (McPherson, 1979). A total of 81 species in more than 30 families have been identified within the facility area. Vegetation type and number are shown in Table 2-5.

An endangered species survey for flora has been conducted on the TEAD-N site but no observations of endangered or sensitive species have been recorded. However, because of

Table 2-5. Vegetation Type and Number at TEAD-N

	Identified	Probable	Total
Trees	7	0	7
Shrubs	12	8	20
Forbs	49	50	99
Cactus	1	0	1
Grasses	12	14	26
Total	81	72	153

the types of vegetation communities present on the site, or because of sightings in adjacent areas, the following federally listed species could possibly occur on the site: clay phacelia (Phacelia argillacea), cryptantha (Crypantha compacta), desert milkvetch (Astragalus desereticus), pohl milkvetch (Astragalus lentiginous ssp. pohlii), Ute lady's tresses (Spiranthes diluvialis), deep creek stickseed (Hackelia ibapensis), and basin fishhook cactus (Sclerocactus pubispinus). Only the clay phacelia is listed as endangered; all of the other species are listed as Category II species.

2.8.4 Vegetation of the Facility Area

Generally, the vegetation composition and range site types of the TEAD-N facility are quite similar to the regional vegetation. Additionally, the facility area reflects site-specific conditions such as slope, moisture condition, aspect, and soils of the area, as well as the facility's history and its human activities. The vegetation within the TEAD-N facility area is influenced by the arid/semi-arid climate. Drought-resistant and drought-tolerant species are typically associated with shadscale/big sagebrush habitat. The associated species vary, but one or both dominant species are usually present.

A total of eight range site types were identified within the TEAD-N facility; two range site complexes were also identified. The Semidesert Gravelly Loam (Wyoming Big Sagebrush) range site is the most prevalent type, occupying approximately 26 percent of the area. A majority of the facility area (approximately 78 percent) is dominated by Wyoming Big Sagebrush, and/or Pinyon-Juniper vegetation, and its associated species. Black Greasewood and its associated species are also important, occupying approximately 15 percent of the area. About 3 percent of the area is dominated by Mountain Big Sagebrush, and about 1 percent of the area is occupied by Basin Wildrye. Disturbed areas (borrow pits) occupy about 2 percent of the area.

2.9 WILDLIFE

A general wildlife survey of the TEAD-N facility area was conducted. The purpose of this investigation was to collect and summarize information concerning the wildlife resources of

the TEAD-N facility area. Specifically, the purposes of this survey were to (1) develop a wildlife species list for the TEAD-N facility area and (2) identify and qualitatively describe the status, physical characteristics, behavior, and general diet requirements as background for the risk assessment.

2.9.1 Regional Wildlife Information

The Basin and Range Physiographic Province is a semi-arid, cold desert region characterized by low precipitation, low relative humidity, daily and seasonal temperature extremes, and moderate to high winds. The summers are typified by hot, dry, sunny days, and cool nights; the winters are generally cold and snowy. The average annual precipitation is about 17 inches. The normal mean annual air temperature is approximately 51°F, with monthly average temperatures ranging from a high of 75°F in July to a low of 28°F in January. There are an average of 120 to 160 frost-free days.

The Tooele Valley region is dominated by sagebrush and saltbrush plant species. Within the TEAD-N facility area, the vegetation is relatively uniform; typical sagebrush-grass communities are interspersed with saltbush vegetation communities.

The extant plant species and vegetation communities as well as the climate in the Tooele Valley have affected the available forage and accessible animal niches. The animals in this region have adapted to these environmental factors by specializing as hibernators, estivators, and diurnal or nocturnal species. The region is inhabited by a wide variety of animal species, ranging from mammals to protozoans. These species may occur as permanent residents, temporary or seasonal residents, or on a migratory basis.

Historically, several wildlife species were known to occur within the Tooele Valley region, including the bison, grizzly bear, elk, black bear, and mountain sheep. Reintroduction efforts in the mountainous areas surrounding TEAD-N have been undertaken for the mountain sheep and elk; similar efforts have targeted pronghorn antelope for the valley region.

2.9.2 Threatened and Endangered Species

There are 15 endangered, candidate, or sensitive wildlife species either known to occur or that potentially occur on the TEAD-N facility. Eleven of these are protected by the Endangered Species Act of 1973, Section 668-668d.

Nine endangered, candidate, or sensitive bird species have been either identified in the region, or observed on the TEAD-N facility area. Of these species, the bald eagle and the peregrine falcon are endangered species; all of the others are Federal Candidate Species (Category II). The golden eagle, which is protected under the Eagle Protection Act, has also been observed on the TEAD-N facility area. These protected species include the bald eagle (Haliaeetus leucocephalus spp. alascanus), the American peregrine falcon (Falco peregrinus anatum), the ferruginous hawk (Buteo regalis), the western snowy plover (Charadrius alexandrinus nivosus), the white-faced ibis (Plegadischihi), Swainson's hawk (Buteo

swainsoni), western yellow-billed cuckoo (Coccyzus americanus occidentalis), mountain plover (Charadrius montanus), and the golden eagle (Aquila chrysaetos).

Additionally, two federal candidate mammalian species–the skull valley pocket gopher (Thomomys umbrinus robustus) and the spotted bat (Euderma maculata)–may also occur on the site. Four Utah State sensitive species occur on the site either as permanent or seasonal residents, or they may potentially occur on the site. These species include the mule deer (Odocoileus hemionus), pronghorn antelope (Antilocapra americana), sage grouse (Centrocercus urophasianus), and chukar (Alectoris chukar). Each of these is discussed in Section 2.9.3 below.

2.9.3 Wildlife Species at TEAD-N

Approximately 127 species have been identified in the near vicinity of the TEAD-N facility area. Of these, 58 species were mammals and 63 were birds (Table 2-6). Additionally, 6 reptiles were also identified. No fish or amphibians were identified. Table 2-7 identifies the observed or potential wildlife species for the TEAD-N area. Wildlife species noted were observed by Rust E&I personnel during the field investigation. Other listed species were compiled from references (Burt 1980, Peterson 1990, Stebbins 1985).

Information regarding each general category of wildlife, (i.e., raptors, passerine birds, large mammals, small mammals, and reptiles) is presented below. Certain wildlife species have been discussed in greater detail because of their protected status (e.g., endangered, sensitive).

Table 2-6. Wildlife Type and Number at TEAD-N

		Identified	Probable	Total
Mammals				
	Small	56	18	74
	Large	2	3	5
Birds		55	70	125
Raptors		8	7	15
Reptiles		6	10	16
Total		127	108	235

Table 2-7. Mammals, Birds, and Reptiles Potentially at TEAD-N

Latin Name	Common Name	Observed at TEAD-N
MAMMALS		
ORDER CHIROPTERA		
FAMILY MOLOSSIDAE	FREETAIL BATS	
Tadirida brasiliensis	Mexican Freetail Bat	
FAMILY SORICIDAE	SHREW	
Sorex cinereus	Masked Shrew	
Sorex merriami	Merriam Shrew	X
Sorex obscurus	Dusky Shrew	X
Sorex palustris	Norther (Water Shrew)	
Sorex vagrans	Vagrant Shrew	X
FAMILY VESPERTILIONIDAE	PLAINNOSE BATS	
Eptericus fuscus	Big Brown Bat	X
Euderma maculata	Spotted Bat	X
Lasionycteris notcivagaus	Silver-haired Bat	X
Lasiurus cinereus	Hoary Bat	X
Myotis californicus	California Myotis	X
Myotis evotis	Long-eared Myotis	X
Myotis Lucifugus	Little Brown Myotis	X
Myotis subulatus	Small-footed Myotis	X
Myotis thysanodes	Fringed Myotis	X
Myotis velifer	Cave Myotis	X
Myotis volaus	Long-legged Myotis	X
Pipistrellus hesperus	Western Pipistrel	X
Plecotus townsendii	Western Big-eared Bat	
ORDER LAGOMORPHA		
FAMILY LEPORIDAE	RABBIT AND HARES	
Lepus americanus	Snowshoe Hare	
Lepus californicus	Black-Tailed Jackrabbit	X
Lepus townsendi	Whitetail Jackrabbit	
Sylvilagus audubonii	Desert Cottontail	X
Sylvilagus Idahoeusis	Pygmy Rabbit	
Sylviliagus nuttallii	Nuttalls Cottontail	X
ORDER RODENTIA		
FAMILY SCIURIDAE	SQUIRRELS	
Ammospermophilus leucurus	Whitetail Antelope Squirrel	X
Eutamias dorsalis	Cliff Chipmunk	X
Eutamias minimus	Least Chipmunk	X
Eutamias umbrinus	Uinta Chipmunk	X
Marmota flaviventris	Yellow-Bellied Marmot	

Table 2-7. Mammals, Birds, and Reptiles Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY SCIURIDAE (continued)	SQUIRRELS	
Citellus lateralis	Golden-Mantled Ground Squirrel	X
Citellus townsendii	Townsend's Ground Squirrel	X
Citellus variegatus	Rock Squirrel	X
Tamiasciurus hudsonicus	Red Squirrel	X
FAMILY GEOMYIDAE	POCKET GOPHERS	
Thomomys bottae	Valley Pocket Gopher	X
Thomomys talpoides	Northern Pocket Gopher	X
Thomomys umbrinus robustus	Skull Valley Pocket Gopher	
FAMILY HETEROMYIDAE	POCKET MICE AND KANGAROO RATS	
Dipodomys microps	Great Basin Kangaroo Rat	X
Dipodomys ordii	Ord's Kangaroo Rat	X
Microdipodops megacephalus	Dark Kangaroo Mouse	X
Perognathus longimembris	Little Pocket Mouse	X
Perognathus formosus	Great-Basin Pocket Mouse	X
Peromyscus truei	Pinyon Mouse	X
FAMILY CRICETIDAE	NEW WORLD RATS, MICE, AND VOLES	
Clethrionomys gapperi	Boreal Redback Vole	X
Lagurus curtatus	Sagebrush Vole	X
Microtus longicaudus	Long-Tailed Vole	X
Microtus Moutanus	Mountain Vole	X
Microtus pennsylvanicus	Meadow Vole	X
Neotoma cinerea	Bushy-Tailed Woodrat	X
Neotoma lepida	Desert Woodrat	X
Onychomys leucogaster	Northern Grasshopper Mouse	X
Peromyscus boylei	Brush Mouse	X
Peromyscus crinitus	Canyon Mouse	
Peromyscus maniculatus	Deer Mouse	X
Peromyscus truei	Pinyon Mouse	X
Phenacomys intermedius	Mountain Phenacomys	X
Reithrodontomys megalotis	Western Harvest Mouse	X
FAMILY OCHOTONIDAE	PIKAS	
Ocbotona princeps	Pika	
FAMILY MURIDAE	OLD WORLD RATS AND MICE	
Mus musculus	House Mouse	X
Rattus norvegicus	Norway Rat	
FAMILY ZAPODIDAE	JUMPING MICE	
Zapus princeps	Western Jumping Mouse	X

Table 2-7. Mammals, Birds, and Reptiles Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY ERETHIZONTIDAE	NEW WORLD PORCUPINES	
Erethizon dorsatum	Porcupine	X
ORDER CARNIVORA		
FAMILY CANIDAE	WOLVES, FOXES, AND THE COYOTE	
Canis latrans	Coyote	X
Vulpes vulpes	Red Fox	
FAMILY PROCYONIDAE	RACCOON, RINGTAIL, AND COATI	
Bassariscus astutus	Ringtail	
FAMILY MUSTELIDAE	WEASELS, SKUNKS, BADGERS, and OTTERS	
Martes americana	Marten	
Mephitis mephitis	Striped Skunk	X
Mustela erminea	Short Tailed Weasel	X
Mustela frenata	Long-Tailed Weasel	X
Mustela vison	Mink	
Spilogale putorius	Spotted Skunk	X
Taxidea taxus	Badger	X
FAMILY FELIDAE	CATS	
Felis concolor	Mountain Lion	
Felis rufus	Bobcat	
ORDER ARTIODACTYLA		
FAMILY ANTILOCAPRIDAE		
Antilocapra americana	Pronghorn Antelope	X
FAMILY BOVIDAE		
Oreamnos americanus	Mountain Goat	
Ovis canadensis	Bighorn Sheep	
FAMILY CERVIDAE	DEER	
Cervus canadeusis	Elk	
Odocoileus hemionus	Mule Deer	X
AVES		
ORDER APODIFORMES		
FAMILY APODIDAE	SWIFTS	
Aeronautes saxatalis	White-Throated Swift	X
FAMILY TROCHILIDAE	HUMMINGBIRDS	
Archilochus alexandri	Black-chinned Hummingbird	
Selasphorus platycercus	Broad-Tailed Hummingbird	X
Selasphorus rufus	Rufous Hummingbird	

Table 2-7. Mammals, Birds, and Reptiles Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
ORDER CAPRIMULGIFORMES		
FAMILY CAPRIMULGIDAE	NIGHTJARS	
Chordeiles minor	Common Nighthawk	X
Phalaenoptilus nuttallii	Common Poorwill	
ORDER CHARADRIIFORMES		
FAMILY CHARADRIIDAE	PLOVERS	
Charadrius alexandrinus	Western Snowy Plover	X
Charadrius mountanus	Mountain Plover	
Charadrius vociferus	Killdeer	X
FAMILY SCOLOPACIDEA	SANDPIPERS AND PHALAROPES	
Numenius americanus	Long-billed Curlew	
Gallinago gallinago	Common Snipe	
ORDER CICONIFORMES		
FAMILY ARDEIDAE	HERONS AND BITTERNS	
Ardea herodias	Great Blue Heron	
Egretta thula	Snowy Egret	
FAMILY THRESKIORNITHIDAE	IBISES AND SPOONBILLS	
Bataurus leutiginosus	American Bittern	
Nyoticorax nycticopax	Black-Crowned Night Heron	
Plegadis chihi	White-Faced Ibis	
ORDER COLUMBIFORMES		
FAMILY COLUMBIDAE	PIGEONS	
Zenaida macroura	Mourning Dove	X
ORDER CUCULIFORMES		
FAMILY CUCULIDAE	CUCKOOS, ROADRUNNERS AND ANIS	
Coccyzus americanus	Yellow-Billed Cuckoo	
ORDER FALCONIFORMES		
FAMILY ACCIPITRIDAE	HAWKS	
Accipiter cooperii	Cooper's Hawk	
Accipiter gentilis	Northern Gosshawk	
Accipiter striatus	Sharp-Shinned Hawk	
Aquila chrysaetos	Golden Eagle	X
Buteo jamaicensis	Red-tailed Hawk	X
Buteo lagopus	Rough-legged Hawk	X
Buteo regalis	Ferruginous Hawk	X
Buteo swainsoni	Swainson's Hawk	
Curcus cyaneus	Marsh Hawk (Northern Harrier)	
Haliaeetus leucocephalus	Bald Eagle	X

Table 2-7. Mammals, Birds, and Reptiles Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY CATHARTIDAE	VULTURES	
Cathartes aura	Turkey Vulture	X
FAMILY FALCONIDAE	FALCONS	
Falco colunbarius	Merlin	
Falco mexicanus	Prairie Falcon	X
Falco peregrinus	Peregrine Falcon	X
Falco sparverius	American Vestrel	
ORDER GALLIFOMES		
FAMILY PHASIANIDAE	FOWL-LIKE BIRDS	
Alectoris chukar	Chukar	
Dendragapus obscurus	Blue Grouse	
Phasianus colchicus	Ring-Necked Pheasant	
Centrocercus urophasianus	Sage Grouse	
Dendragapus obscurus	Blue Grouse	
ORDER PASSERIFORMES		
FAMILY AEGITHALAIDAE	BUSHTITS	
Psaltriparus minimum	Bushtit	
FAMILY ALAUDIDAE	LARKS	
Eremophila alpestris	Horned Lark	X
FAMILY BOMBYCILLIDAE	WAXWINGS	
Bombycilla cedrorum	Cedar Waxwing	
Bombycilla garrulus	Bohemian Waxwing	
FAMILY CERTHIDAE	CREEPERS	
Certhia americana	Brown Creeper	
FAMILY CORVIDAE	CROWS	
Aphelocoma coerulescens	Scrub Jay	
Corvus brachyrhynchos	American Crow	X
Corvus corax	Common Raven	X
Cyanocitta stelleri	Stellar's Jay	
Gymnorhinus cyanocephalus	Pinyon Jay	X
Nucifraga columbiana	Clark's Nutcracker	
Pica nuttalli	Yellow-Billed Magpie	
Pica pica	Black-Billed Magpie	X
FAMILY EMBERIZIDAE	GROSBEAKS AND SPARROWS	
Amphispiza belli	Sage Sparrow	
Amphispiza bilineata	Black-Throated Sparrow	
Chondestes grammacus	Lark Sparrow	
Junco hyemalis	Dark-Eyed Junco	X
Junco hyemalis caniceps	Gray-Headed Junco	

Table 2-7. Mammals, Birds, and Reptiles Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY EMBERIZIDAE (continued)	GROSBEAKS AND SPARROWS	
Junco hyemalis oreganus	Oregon Junco	
Melospiza lincolnii	Lincoln's Sparrow	
Melospiza melodia	Song Sparrow	
Passerculus sandwichensis	Savannah Sparrow	X
Passerina amoena	Lazuli Bunting	X
Pheucticus melanocephalus	Black-headed Grosbeak	X
Pipilo chlorurus	Green-Tailed Towhee	X
Pipilo erythrophthalmus	Rufous-Sided Towhee	
Pooecetes gramineus	Vesper Sparrow	X
Spinus tristis	American Goldfinch	
Spizella arborea	American Tree Sparrow	
Spizella breweri	Brewer's Sparrow	
Spizella passerina	Chipping Sparrow	X
Zonotrichia leucophrys	White-Crowned Sparrow	
FAMILY FRINGILLIDAE	FINCHES	
Leucosticte arcloa	Rosy Finch	
Carpodacus cassinii	Cassin's Finch	
Carpodacus mexicanus	House Finch	X
Loxia curvirostra	Red Crossbill	
Coccothraustes vespertina	Evening Grosbeak	
Carduelis fristis	American Goldfinch	
Carduelis pinus	Pine Siskin	X
FAMILY HIRUNDINIDAE	SWALLOWS	
Hirundo pyrrhonata	Cliff Swallow	
Hirundo rustica	Barn Swallow	X
Stelgidopteryx serripennis	Northern Rough-Winged Swallow	X
Tachycineta bicolor	Tree Swallow	
Tachycineta thalassina	Violet-Green Swallow	
FAMILY ICTERIDAE	ORIOLES	
Agelaius phoeniceus	Red-Winged Blackbird	X
Euphagus cyanocephalus	Brewer's Blackbird	X
Molothrus ater	Brown-Headed Cowbird	X
Sturnella neglecta	Western Meadowlark	X
Xanthocephalus xanthocephalus	Yellow-Headed Blackbird	X
FAMILY LANIIDAE	SHRIKES	
Lanius excubitor	Northern Shrike	
Lanius ludovicianus	Loggerhead Shrike	X
FAMILY MIMIDAE	MOCKINGBIRDS AND THRASHES	
Mimus polyglottos	Northern Mockingbird	
Oreoscoptes montanus	Sage Thrasher	

Table 2-7. Mammals, Birds, and Reptiles Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY MUSCICAPIDAE	THRUSHES, SOLITAIRES, BLUEBIRDS, KINGLETS AND GNATCATCHERS	
Turdus migratorius	American Robin	X
FAMILY PARIDAE	CHICKADEES AND TITMICE	
Catharus guttatus	Hermit Thrush	
Myadestes townsendi	Townsend Solitaire	
Parus atricapillus	Black-Capped Chickadee	X
Parus gambeli	Mountain Chickadee	
Polioptila caerulea	Blue-Gray Gnatcatchers	
Regulus calendula	Ruby-Crowned Kinglet	X
Regulus satrapa	Golden-Crowned Kinglet	X
Sialia currucoides	Mountain Bluebird	X
FAMILY PARULIDAE	WOOD WARBLER	
Dendroica caerulescens	Black-Throated Warbler	
Dendroica coronata	Yellow-Rumped Warbler	X
Dendroica petechia	Yellow Warbler	X
Geothlypis trichas	Common Yellowthroat	X
Icteria vireus	Yellow-Breasted Chat	X
Oporornis tolmiei	Mac Gillivrays Warbler	X
Vermivora celata	Orange-Crowned Warbler	
Vermivora virginiae	Virginia Warbler	
FAMILY PASSERIDAE	WEAVER FINCHES	
Passer domesticus	House Sparrow	X
FAMILY SITTIDAE	NUTHATCHES	
Sitta canadensis	Red-Breasted Nuthatch	
Sitta carolinensis	White-Breasted Nuthatch	
FAMILY STURNIDAE	STARLINGS	
Sturnus vulgaris	European Starling	X
FAMILY SYLVIIDAE	OLD WORLD WARBLERS	
Regulus satrapa	Golden-Crowned Kinglet	
FAMILY THRAUPIDAE	TANAGERS	
Piranga ludoviciana	Western Tanager	
FAMILY TROGLODYTIDAE	WRENS	
Catherpes mexicanus	Canyon Wren	
Cistothorus palustris	Marsh Wren	
Salpinctes obsoletus	Rock Wren	X
Troglodytes aedon	House Wren	X
Troglodytes troglodytes	Winter Wren	

Table 2-7. Mammals, Birds, and Reptiles Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
FAMILY TYRANNIDAE	TYRANT FLYCATCHERS	
Contopus borealis	Olive-sided Flycatcher	
Contopus sordidulus	Western Wood-Pewee	X
Empidonax hammondii	Hammond Flycatcher	
Empidonax oberholseri	Dusky Flycatcher	
Empidonax occidentalis	Western Flycatcher	X
Myiarchus cinerascens	Ash-Throated Flycatcher	
Syaornis saya	Say's Phoebe	X
Tyrannus verticalis	Western Kingbird	X
FAMILY VIREONIDAE	VIREOS	
Vireo gilvus	Warbling Vireo	X
Vireo solitarius	Solitary Vireo	
ORDER PICIFORMES		
FAMILY PICIDAE	WOODPECKERS	
Colaptes auratus	Northern Flicker	X
Colaptes auratus	Red-Shafted Flicker	
Picoides pubesceus	Downy Woodpecker	X
Picoides willosus	Hairy Woodpecker	X
Sphyrapicus nuchalis	Red-Naped Sapsucker	
ORDER STRIGIFORMES		
FAMILY STRIGIDAE	OWLS	
Asio flammeus	Short-Eared Owl	X
Asio otus	Long-eared Owl	X
Bubo virginianus	Great Horned Owl	X
Athene cunicularia	Burrowing Owl	X
Otus kennicotti	Western Screech-Owl	
Tyto alba	Barn Owl	X
REPTILIA		
ORDER SQUAMATA		
SUBORDER LACERTILIA	LIZARDS	
FAMILY IGUANIDAE	IGUANID	
Cryptophytus collaris	Collared Lizard	X
Gambelia wislizenii	Long-nosed Leopard Lizard	
Sceloporus graciosus	Sagebrush Lizard	
Uta stansburiana	Side-Blotched Lizard	X
Phrynosoma platyrhinos	Desert Horned Lizard	
FAMILY SCINCIDAE		
Eumeces skiltonianus	Great Basin Skink	X
FAMILY TEIIDAE	WHIPTAILS AND RACE-RUNNERS	
Cnemidophorus tigris	Western Whiptail	X

Table 2-7. Mammals, Birds, and Reptiles Potentially at TEAD-N (continued)

Latin Name	Common Name	Observed at TEAD-N
SUBORDER SERPENTES	SNAKES	
FAMILY COLUBRIDAE	COLUBRID SNAKE FAMILY	
Coluber coustrictor	Western Yellow-bellied Racer	
Hypsiglena torquata	Night Snake	
Masticophis taeniatus	Striped Whipsnake	
Pituophis melanoleucus deserticola	Great Basin Gopher Snake	X
Thamnophis elegans	Wandering Garter Snake	
FAMILY VIPERIDAE	PIT VIPERS	
Crotalus viridis lotusus	Great Basin Rattlesnake	X
ORDER SALIENTIA		
FAMILY BUFONIDAE	TRUE TOADS	
Bufo woodhousei	Western Woodhouse Toad	
FAMILY PELOBATIDAE	SPADEFOOT TOADS	
Scaphiopus intermentanus	Great Basin Spadefoot	
FAMILY RANIDAE	TRUE FROGS	
Rana pipieus	Northern Leopard Frog	

2.9.3.1 *Raptors*

Raptors return to central Utah between mid-February and early April, depending upon weather conditions. Early in the breeding season, raptors will return to their traditional nest sites or construct new ones in the area. Eggs are usually laid during March or April. Nest occupation continues until the chicks are fledged which, depending on the species and when nesting activities begin, occurs from early June to mid-August. Ferruginous hawks fledge at about 41 days of age; golden eagles fledge at about 64 days (Pendleton, et al., 1987).

Raptors are of special concern in all areas of the United States where development activities may destroy nesting sites (which are mainly in tree canopies) or key foraging sites, or where an increase in the number of people in an area may disturb nesting activities and cause nest abandonment. Raptors such as the ferruginous hawk and the golden eagle search for and feed from the air. Activity in the general locale of their foraging will tend to discourage these species from staying in the area. Because raptor species vary considerably in their tolerance to human activities, many Federal and State regulations and guidelines require that raptor nesting surveys be conducted for a minimum of 2 miles from all proposed development activities that might impact the birds. These species are of special concern because the potential contaminants identified at the facility bioaccumulate in species at the top of the food chain. Because these are birds of prey and many are on the threatened and endangered list, they should be considered as "keystone predators" (Levin, 1984). If this wildlife is

jeopardized, other endpoints (such as overpopulation of other species) in an ecological community would be affected.

Bald Eagle. The bald eagle, Haliaeetus leucocephalus spp. alascanus, was listed as an endangered species in 1978 by the U.S. Fish and Wildlife Service. The bald eagle inhabits most of Utah, including the TEAD-N facility area, and its habitat in the area is considered critical.

The bald eagle has commercial value in the black market because of its highly prized feathers and other parts. It is not considered a threat to agricultural interests in general. The bald eagle does not breed in the TEAD-N vicinity, but is considered a winter resident in the Tooele Valley. The eagles arrive each year in late November, with the adults arriving before juveniles. Bald eagles usually winter where the weather conditions are mild and food can be found during the entire winter. The Tooele Valley provides both moderate weather and sufficient quantities of food and has been a wintering area for bald eagles since the early 1960s. As raptors, bald eagles are classified as tertiary consumers and carnivores. The diet of the bald eagle consists largely of fish (especially salmon), birds, and small mammals (especially rabbits) during the breeding season (Ehrlich et al., 1988). During the remainder of the year, bald eagles consume rabbits, waterfowl and seabirds, carrion, and, occasionally, other vertebrates (Bortolotti, 1988). Carrion that the bald eagle consumes includes winter-kills of sheep, rabbits, and mule deer, as well as hunter-kills of mule deer, pronghorn antelope, and rabbit. The primary food sources for bald eagles of the Tooele Valley are black-tailed jackrabbits and desert cottontails. Other animals of the area that could be consumed opportunistically include coyote, kit fox, great basin gopher snake, great basin rattlesnake, long-tailed weasel, long-tailed pocket mouse, and Ord's kangaroo rat. The bald eagle's method of foraging primarily entails high patrols, with low patrols and swoops also being utilized.

Bald eagle behavior varies from season to season. During the spring when they nest, bald eagles do not socialize with other eagles or tolerate human disturbances near nesting sites. They generally roost singularly, or sometimes with a mate, in or near the nest tree. Hunting is conducted from the nest tree to the water, shoreline, or other hunting or scavenging area. During the winter, bald eagles become more tolerant of disturbances from both man and other animals. They may socialize with other eagles and have communal roosts. Additionally, they may hunt cooperatively in small groups of two or three birds when food is scarce.

The Utah Division of Wildlife Resources conducts an annual census of eagles in Rush Valley and Ophir Canyon, which are in close proximity to TEAD-N. The 1991 standardized-count totals conducted by the regional offices were as follows: a total of 1,204 eagles in Utah, 310 eagles (approximately 25 percent of the states total) in the central region, and 100 eagles in Ophir Creek Canyon. As many as 50 to 60 individuals roost in Ophir Canyon and spend the day hunting in Rush Valley.

Peregrine Falcon. Though once common across the United States, the peregrine falcon (Falco perigrenus) population declined significantly since the 1940s; it was listed as an endangered species in 1969. This population decline was linked largely to eggshell thinning resulting from the use of DDT, other pesticides, and PCBs (Ehrlich et al., 1988). Aggressive

intervention by groups such as The Peregrine Fund, and the discontinued use of DDT have resulted in increased peregrine falcon populations; breeding pairs are being introduced to parts of their former range. This species has been observed in the southeastern portion of Utah, in the northwestern portion of the state, and south of Salt Lake City. Peregrine falcons have been observed in the TEAD-N facility area.

Usually preferring open country and cliffs, peregrine falcons appear to be highly adaptable with regard to habitat. These birds will breed in open habitats from tundra to savanna, and from seacoasts to high mountains (Ehrlich et al. 1988). They will also breed in open forests. Despite the fact that many breeding pairs have been successfully introduced into cities where they nest on infrastructure and feed on pigeons, peregrine falcons are sensitive to human interference at nesting sites. Their nests are typically well rounded scrapes in accumulated debris on cliff ledges, or sometimes within trees, and are occasionally lined with grass (Ehrlich et al., 1988).

The peregrine falcon swoops or flies fast after a wide variety of birds, especially doves and pigeons, and participates in cooperative hunting, usually hunting in pairs (Ellis et al., 1993). They will also consume shorebirds, waterfowl, and passerine birds (Ehrlich et al., 1988).

Ferruginous Hawks. The ferruginous hawk (*Buteo regalis*), which occurs within the TEAD-N facility area, is a wildlife species of special concern. The status of this hawk throughout its range is generally unknown, but its total population is believed to be relatively small when compared with golden eagles, prairie falcons, northern harriers, or other Buteos. The U.S. Fish and Wildlife Service presently classifies the ferruginous hawk as a Category II Species. Ferruginous hawk populations are known to fluctuate considerably over a period of years. The reason for this probably relates to changes in prey populations (e.g., cottontails, jackrabbits, ground squirrels, and prairie dogs) (Davis et al., 1993). Additionally, the ferruginous hawk is considered to have the greatest sensitivity to human disturbances of any raptor species nesting in the TEAD-N area. They will sometimes abandon their nests after only one or two direct human disturbances within 50 yards of it (Call, 1987). Ferruginous hawks are especially sensitive to disturbances during the courtship and egg-laying period. It should be also noted, however, that individual birds apparently vary considerably in their sensitivity to human activities and to the type of activity. For these reasons, raptor biologists are particularly concerned about land use, resource developments, or human disturbances within a 1/2-to-1 mile range of any active ferruginous hawk nest.

The diet of ferruginous hawks is almost exclusively small mammals, especially ground squirrels, cottontails, and jackrabbits. They will also consume birds, reptiles (snakes, lizards), and large insects (Ehrlich et al., 1988).

These hawks nest in a variety of locations: 20 to 40 feet high in a tree; along cliff faces; on the ground, bank, butte, or slope; and on man-made structures such as water towers. Their nests are large, platform structures composed of heavy sticks, twigs, cow dung, bones, and rubbish. They are lined with a grass, inner bark strips, roots, etc., and occasionally with green leaves. Ferruginous hawks frequently return to previous nesting areas, and may repair and reuse old nests (Ehrlich et al., 1988).

Swainson's Hawk. The Swainson's hawk (Buteo swainsoni) is a summer breeding resident of the TEAD-N area. The habitat includes savanna, plains, prairies, desert, woodland, and cultivated lands with scattered trees and dry meadows.

This species returns every year, renovating the same nest about 50 percent of the time or using abandoned nests of other birds (Ehrlich et al., 1988). Its nest is most often constructed of twigs in a tree about 20 to 30 feet from the ground, but it may also nest on a cliff or occasionally on the ground. The nest itself is constructed of large sticks, twigs, brambles, grass, etc. and it is lined and occasionally layered with inner bark, fresh leaves, flower clusters, down, and feathers. This species is particularly sensitive to disturbances during breeding and may abandon a nest after even minor disturbances (Ehrlich et al., 1988).

Swainson's hawks typically prefer small mammals–anything from shrews to ground squirrels, but most often rodents. Its diet may also include rabbits, lizards, snakes, frogs, toads, and birds (mostly fledglings). This hawk will occasionally feed heavily or subsist on small vertebrates and large insects, particularly locusts, grasshoppers, and crickets. This hawk is characterized by a high altitude patrol when in pursuit of its prey, although it may also use a low coursing flight. This species may also use low observation perches, or may even stand by a rodent hole waiting for its prey to emerge (Ehrlich et al., 1988).

Golden Eagle. Golden eagles (Aquila chrysaetos) are abundant all year around on TEAD-N. They range throughout the western U.S., Canada, and Alaska (Peterson, 1987) and are protected by the Migratory Bird Act and the Eagle Protection Act.

Golden eagles are a large (3 to 3.5 feet high, with a wing span of 76 to 92 inches), dark-brown/golden-colored bird. Golden eagles are territorial and will aggressively defend a 5-square-mile area during nesting activities. Golden eagles tend to nest along cliff or canyon walls, although they may utilize trees, constructing their nest 10 to 100 feet plus high. The platform nests are constructed of sticks interwoven with brush, leaves, etc., and are lined with fine materials. Golden eagles frequently construct 2 to 3 nests (or more), utilizing them alternatively, year after year.

During the breeding season, golden eagles feed primarily on small mammals, birds, jackrabbits, reptiles, and insects. They also will include other prey in their diets when mammals are scarce and, during these times, frequently scavenge carrion (Ehrlich et al., 1988). These eagles also hunt in pairs similar to the peregrine falcon (Ellis et al., 1993).

Golden eagles are relatively tolerant of human-related disturbances, as long as the adult birds are undisturbed for sufficient periods of time to feed their young. Adults will generally leave the nest when anyone is observed approaching them and may leave the nest even when the intruder is several hundred yards away. These raptors will remain away from the nest until the intruders leave the area.

2.9.3.2 *Passerine and Other Birds*

Based upon observances within the facility and surrounding area, 55 passerine species were observed. The species found within the TEAD-N facility area are typical of those found in this region and make up the majority of birds located at the facility. These birds act as a food source for many of the other avian species such as the raptors, as well as some mammals, which can lead to increased bioaccumulation of contaminants in species at the upper trophic levels of the TEAD-N ecosystem.

Western Snowy Plover. The western snowy plover (Charadrius alexandrinus) is currently listed as a Category II candidate species.

The habitat of this species is usually wetlands, but it may also use mudflats, which have standing water during the migration season. The snowy plover uses the TEAD-N area as alternate nesting habitat during high water periods of the Great Salt Lake.

This species typically nests on beaches or on bare alkaline mudflats; it may also nest, however, on the sand margins of rivers, lakes, and ponds. The male snowy plover typically builds a scrape-type ground nest which is marked with twigs and other debris, and it is usually lined with bits of concealing ornaments. Nests are usually built amid grass tufts, and the male often makes one to two extra scrapes. Typically, three buff-colored eggs, with black marks, are laid in the nest.

The die of this species consists primarily of insects during the breeding season; however, some aquatic invertebrates are also taken during this time. Additionally, worms, crustaceans, mollusks, and fish may be consumed. Ground gleaning and probing are the primary foraging techniques (Ehrlich et al., 1988).

White-faced Ibis. White-faced ibis (Plegadis chihi) is currently listed as a Category II candidate species. The preferred habitat of this species is wetlands, but it may also use mudflats which have standing water during the migration season. Like the snowy plover, the white-faced ibis uses the TEAD-N area as alternate nesting habitat during high water periods of the Great Salt Lake.

Nesting usually occurs in largely freshwater habitats including marshes, swamps, ponds, and rivers. Nests are typically built on the ground; however, they may also nest in aquatic vegetation, shrubs, or low trees. The nests themselves are deeply cupped platforms of coarse emergent vegetation and sticks which are lined with finer materials (Ehrlich et al., 1988).

The diet of the white-faced ibis consists primarily of aquatic invertebrates (especially crayfish), insects, earthworms, fish, small vertebrates, and occasionally aquatic vegetation. In Utah, grasshoppers and frogs are the main constituents of its diet. The foraging method is dominantly probing and ground gleaning (Ehrlich et al., 1988).

Western Yellow-billed Cuckoo. The western yellow-billed cuckoo (Coccyzus americanus spp. occidentalis) inhabits open woodland, especially with dense undergrowth, parks, riparian woodlands, and stream thickets, particularly those with willows.

Nesting takes place in shrubby vegetation, usually about 4 to 8 feet off of the ground (Ehrlich et al., 1988). The nest consists of unkempt twigs, lined with rootlets, and dried leaves, and is rimmed with pine needles and other vegetative materials. This cuckoo is occasionally brood parasitic upon the black-billed cuckoo, but rarely upon other birds. This brood parasitism often coincides with outbreaks of cyclical insect populations (e.g., cicadas, tent caterpillars), which leads to an overabundance of prey (Ehrlich et al., 1988).

The primary constituent of this species' diet is insects, especially hairy caterpillars. Sometimes the yellow-billed cuckoo also consumes a few bird eggs, frogs, lizards, berries, and fruit. The young are primarily fed regurgitated insects. The foraging technique is dominantly foliage gleaning, which includes not only foliage but occasionally branches (but never from the ground). Some foraging may be done while hovering, which includes taking insects or berries from plants. Some hawking (i.e., sallying from a perch on short flights to capture insects) may also take place (Ehrlich et al., 1988)).

Mountain Plover. The mountain plover (Charadrius montanus) is a rare migrant to the TEAD-N area. Its habitat is at moderate elevations, especially on shortgrass prairies. It will occasionally utilize dry fields and grassy deserts during migration (Ehrlich et al., 1988).

The plover builds its nest on flat ground between hummocks (Ehrlich et al.,1988). Nests are occasionally located amid cacti or scattered shrubs and often near old cow pats. The nest itself consists of a scrape, which is lined with cow manure chips, rootlets, and/or grass. The first egg of a clutch is frequently laid in the bare scrape, with the lining being added during incubation (Ehrlich et al., 1988).

The diet of the mountain plover consists largely of insects, especially grasshoppers, crickets, beetles, and flies. The foraging technique consists of ground gleaning (Ehrlich et al., 1988).

Sage Grouse. The sage grouse (Centrocercus urophasianus) is an exclusive resident of sagebrush communities, living, eating, breeding, and nesting under the cover of both short and tall sagebrush. The sage grouse is a State of Utah sensitive species, owing largely to widespread efforts to eradicate sagebrush in favor of agricultural and grazing land. The use of herbicides in the eradication of sagebrush has also likely impacted this species. This species is only locally migratory during the winter (Ehrlich et al., 1988).

Within the sagebrush community, wet meadows or green areas are required by broods for insect foraging. The sage grouse conceals its nest under sagebrush, in a shallow depression slightly lined with grass and sage leaves. The eggs are marked and are generally 6 to 9 eggs per clutch (Ehrlich et al., 1988).

During the breeding season, the diet of the sage grouse includes insects since this species lacks the muscular gizzard, which limits its diet to relatively soft foods. During the spring and summer of the year, the diet includes flowers and buds from forbs. During the fall and winter months, the sage grouse diet consists almost exclusively of sagebrush leaves. Foraging techniques include foliage browsing and ground gleaning (Ehrlich et al., 1988).

Chukar. The chukar (Alectoris chukar) habitat includes rocky, grassy, arid mountain slopes, riparian brush, and open desert. This species is usually found near water, and studies indicate that they require drinking water except when succulent forage is available (Ehrlich et al. 1988). This game bird species is categorized as a Utah sensitive species.

Nest scrapes are concealed amid rocks or brush in shallow depressions that are lined with dried grass, feathers, and other materials. It is important to avoid disturbance of breeding grounds (Ehrlich et al., 1988).

The chukar diet consists primarily of seeds, leaves, insects (especially grasshoppers), and fruit. Cheatgrass and Russian thistle are also important constituents of their diet (Ehrlich et al., 1988).

2.9.3.3 *Large Mammals*

Pronghorn Antelope. The pronghorn antelope (Antilocapra americana) once populated all parts of Utah, except the highest elevations and densely forested areas. Throughout the 1800s, the species was almost eradicated from Utah because of over-hunting, grazing competition with sheep and cattle, and fencing of the open range. The first legislation to protect the antelope population was written in 1898. Since 1945, controlled hunting by permit is used as a population-management tool.

Antelope prefer wide-open, flat, or rolling terrain, particularly in the upland prairies and semiarid plains where sagebrush and grasses dominate the vegetation (Martin et al., 1951). Their habitat is somewhat varied, with the vegetation dominated by a high density of grasses, forbs, and shrubs.

Classified as primary consumers and herbivores, antelope utilize grasses, forbs, and shrubs throughout the year. However, during the winter, antelope must have shrubs of sufficient nutritional quality and availability to serve as forage. During the winter, pronghorn rely heavily on selected browse species to provide them nutrition and maintain their health. These browse species are primarily Wyoming big sagebrush, basin big sagebrush, bud sagebrush, greasewood, Douglas rabbitbrush, curlleaf mountain mahogany, serviceberry, spiny hopsage, and rubber rabbitbrush. Of these species, Sundstrom and others (1973) noted that antelope utilize big sagebrush–particularly Wyoming big sagebrush–as the most important winter browse species. Pronghorn compete very little with grazing sheep or cattle. Although antelope prefer the same forage species as sheep, sheep will usually out compete antelope, resulting in the loss of antelope from that range.

In addition to quality forage, another important environmental factor that antelope require is available water. Irwin and others (1984) noted that while antelope commonly use snow during the winter months, they tend to concentrate near flowing water. Irwin further noted that habitats located a long distance from available water were unused by antelope.

Pronghorn antelope are adapted to open range and are not readily able to jump obstacles, such as fences. Common three-strand barb wire fences are frequently fatal to animals, and

many animals become entangled in these range fences and die. Antelope are more likely to go under a fence than over it and, while TEAD-N is surrounded by a high chain-link fence, pronghorn antelope have been observed going under the fence in order to browse off the base.

The pronghorn antelope population has commercial value. The pronghorn hunting industry affects the Utah economy because (1) local landowners receive money for permits to hunt on private land, (2) hunting-license fees collected by the state support range and wildlife management programs in the Utah Department of Wildlife Resources (UDWR), (3) sales of hunting equipment and supplies support local economies, and (4) hunting attracts out-of-state hunters.

Utah estimated its pronghorn population at approximately 10,000 animals in 1983. Currently, there are 190 pronghorn established in Rush Valley (which is just south of Tooele Valley), up from 118 in 1989. A total of 35 bucks, 105 does, and 50 fawns were counted in the preseason survey. There was a ratio of 48 fawns to 100 does in the population and a ratio of 33 bucks to 100 does. Five hunting permits for bucks were issued in 1989 and 1990.

Mule Deer. The Mule Deer (Odocoileus hemionus) is a year-round resident of TEAD-N. These deer are characterized by large "mule like" ears, black tails, and white-rumps. The males are larger than the females and weigh 110 to 475 pounds; females weigh from 70 to 160 pounds (MacMahon, 1990).

Mule deer habitat varies considerably from mountains to desert plateaus. Generally, this species prefers open, broken country and avoids heavy forests. Mule deer are known to inhabit woody riparian, shrubland, juniper woodland, and aspen woodlands. These deer range throughout the western U.S. and southwestern Canada, migrating seasonally to avoid heavy snow and to find adequate food. That is, they frequently spend the hot summer months at higher elevations, returning to the foothills and valleys during the winter. Mule deer wintering areas are extremely important to survival and are often located at lower elevations in juniper, big sagebrush, and riparian habitat types.

The mule deer is classified as a primary consumer and herbivore. During the winter months, mule deer browse available trees and shrubs, particularly mountain mahogany, cliffrose, bitterbrush, poplar, pine, willows, aspen, juniper, and sagebrush. In the summer, they forage primarily on herbaceous plants, including a variety of grasses (e.g., needle-and-threadgrass, grammagrass, wheatgrass, bluegrass), and forbs (e.g., paintbrush, knotweed; Martin et al., 1951).

2.9.3.4 *Bats*

Spotted Bat. The spotted bat (Euderma maculata) is a rare and little-known species, which has been identified in early records from the Tooele area. This species is currently listed as a Federal Candidate (Category II) species. The spotted bat prefers arid, open, or scrub country habitat.

Most of the bats in the United States are insectivorous. The insects eaten most commonly include various kinds of flies, moths, flying ants, caddisflies, mosquitoes, and ground beetles (Martin et al., 1951). A total of 12 species of bats have been reported near TEAD-N.

2.9.3.5 *Small Mammals*

Three species of shrews have been observed on or near the facility area, including Merriam shrew, vagrant shrew, and the water shrew. Twenty-nine rodent species have been observed within the TEAD-N facility area. Of these, 8 species are squirrels and chipmunks, 2 gophers, 5 pocket mice and kangaroo rats, and 14 rats, mice, or jumping mice. Rabbits and hares are common inhabitants on the facility area, and three species have been identified, including the desert cottontail, Nuttalls cottontail, and the black-tailed jackrabbit. Additionally, five species of Mustelidae have been observed, including two weasel species, two skunk species, and one badger.

Skull Valley Pocket Gopher. This gopher (Thomomys umbrinus spp. robustus) is a little-known subspecies. Additionally, little is known about its habitat or other biological requirements. The type of location for this species is Orr's Ranch in Skull Valley.

The diet of pocket gophers is entirely vegetarian, and consists largely of roots, rootstocks, bulbs, and tubers. Seeds, nuts, as well as some surface vegetation may be consumed if it is available near the burrow opening. Food is sometimes stored in underground caches for future use. Pocket gophers apparently consume almost any vegetative material that grows in the vicinity of their burrow. These gophers sometimes come aboveground to forage, but often pull plants down through the surface soil into the burrow system (Martin et al., 1951).

3.0 SITE ASSESSMENT METHODOLOGY

This section discusses the procedures that were used to select sample locations, to conduct the field investigation, and to assess risk.

3.1 SAMPLING METHODOLOGY

Sampling identification used consistently throughout this report is as follows:

ARP	AED Test Range-Test Pit
ARS	AED Test Range-Surface Soil
BEB	Box Elder Wash Drum Site-Subsurface Soil
BER	Box Elder Wash Drum Site-Drum
BES	Box Elder Wash Drum Site-Surface Soil
BKB	Background-Subsurface Soil
BKS	Background-Surface Soil
BRD	Bomb and Shell Reconditioning Building-Sediment
BRS	Bomb and Shell Reconditioning Building-Surface Soil
BRW	Bomb and Shell Reconditioning Building-Surface Water
BWS	Building 1303 Washout Pond-Surface Soil
CRS	Chemical Range-Surface Soil
CRT	Chemical Range Trench
OBP	Old Burn Area-Test Pit
OBS	Old Burn Area-Surface Soil
OSS	Old Burn Staging Area-Surface Soil
PPS	Pole Transformer PCB Spill-Surface Soil
PPT	Pole Transformer PCB Spill-Subsurface Soil
SAS	Small Arms Firing Range-Surface Soil
WSB	Wastewater Spreading Area-Subsurface Soil
WSS	Wastewater Spreading Area-Surface Soil

Characterization of spills, discharges, other releases, and source areas were approached in a systematic manner by E.C. Jordan Co. (E.C. Jordan, December 1990) in their preparation of draft SI and RI Work Plans for TEAD-N. Rust E&I retained the methodologies recommended by E.C. Jordan. The following sections describe the three statistical techniques that were used to determine the measurement and sampling and analysis requirements for each site requiring further investigations at TEAD-N. The three techniques are:

- Areal Approach
- Spill Approach
- Pit/Trench/Discharge Approach

3.1.1 Areal Approach

An areal approach is applicable to sites where no specific information concerning the location of a release is available. Although the constituents are usually known or expected, chemicals could be detected at any concentration and at any location. The goal of the areal approach is threefold: (1) locate a release, (2) estimate spill/release area dimensions, and (3) estimate concentration of the released chemicals. To achieve this goal, the site is sampled using a grid. Samples are collected from a specified number of grid blocks and analyzed as discrete samples or composited to reduce sample numbers and analytical costs. Grid spacing is based on (1) size of the site, (2) preliminary estimate of the release quantity, (3) desired probability of detecting the release, and (4) cost.

The areal approach was used to initially characterize the Small Arms Firing Range (Site 8). Based on the results of the initial survey, additional sampling is planned.

The areal sampling/surveying approach was applied at the Drummed Radioactive Waste Storage Area (Site 9), where the area of the potential release is large and limited predominantly by the site boundaries. A radiological survey was performed at this site according to the spatial-sampling technique described in the EPA guidance for site inspections (EPA, 1987). Figure 3-1 presents the tables used to select the grid size and number of sample points. The selection process considers the following four factors:

<u>Area of Interest (A_i)</u> is a total site area where a potential release may have occurred.

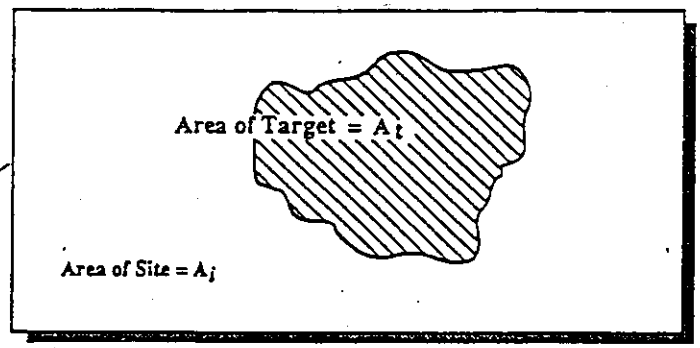
<u>Area of Target (A_t)</u> is the minimum size of a spill requiring detection, based on a probable spill event and physical site conditions. For example, if one 55-gallon drum of liquid is spilled in highly permeable soils, the target area is likely to be small. By specifying the minimum area of the target, spill-detection efforts can be focused on spills large enough to be potentially hazardous (e.g., a 1-square-foot spill area is probably not worth locating).

<u>Probability of Detection</u> is the probability that a spill of the specified minimum size (A_t) will be detected (i.e., given that a spill of size A_t exists, the sampling grid will detect it with a probability of p). USAEC specifies using 80 to 90 percent probability of detection (i.e., p equals 0.80 to 0.90) (USATHAMA, 1990).

<u>Grid Spacing</u> is the distance between rectangular grid lines. Grid spacing is based on a selected A_i, A_t, probability of detection, and practical site considerations such as cost. When estimating spatial distributions, it is usually best if data are collected on a central-aligned or triangular grid system to ensure that all areas of interest are represented (Gilbert, 1987). For TEAD-N, a central-aligned grid system was chosen (i.e., samples are collected from the center of a rectangular grid block). A closer grid spacing is used to increase the probability of detecting A_t, thereby improving the definition of the spill area.

Because instrumented radiological surveying is essentially a continuous process, the sampling coverage was limited only by the presence of equipment on the site. It is estimated that 90 percent of the site was surveyed.

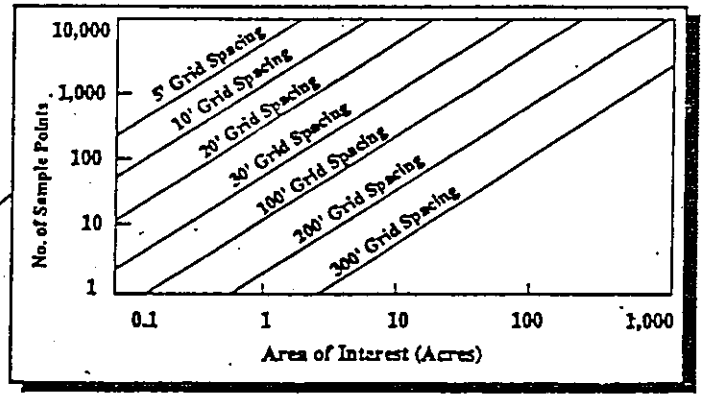
Illustrates Area of Interest (A_i) to Target (A_t) Ratio



Number of Sample Points Required for Various Ai/At Ratios and Probability of Detection

Probability of Detection	Ai/At = 10	Ai/At = 100	Ai/At = 1000
	Number of Sample Points		
100	16	160	1600
96	13	130	1300
90	10	100	1000
75	8	80	800
50	5	50	500
40	4	40	400
30	3	30	300

Approximate Sample Point Spacing



Source: USEPA, 1987. "Expanded Site Inspection (ESI) Transitional Guidance for FY 1988". OSWER Directive 9345.1-02; Office of Emergency and Remedial Response; October 1987.

Figure 3-1. Areal Sampling Approach

3.1.2 Spill Approach

A spill approach was used at sites where the site history and/or aerial photographs indicate specific disposal areas, discharge locations, or designated operational areas. The goal of the spill approach is to define site dimensions (i.e., spill or disposal areas) and estimate chemical concentration. This information is systematically found by employing grid sampling; however, because the approximate location of the spill is known, a more closely spaced grid can focus on particular areas within the sites. Grid sampling for this type of release is then based on the following:

- Size of potential or expected spill area, based on existing information
- Estimate of spill volume
- Desired probability of detecting the released chemicals
- Cost

This approach was applied at two sites: the Pole Transformer PCB Spill (Site 5) and the Building 1303 Washout Pond (Site 22). At these two sites, information exists that indicates either a spill or a release occurred in a particular area of the site. Existing data were used to define A_i and to position the grid over the potential release area. In addition, previous sample locations for Site 5 were included in the grid to help define the distribution of spilled/released chemicals.

Because of the small area of Site 5, it is believed that areal sampling coverage was essentially complete. Site 22, however, will require additional sampling to define the extent of contamination.

3.1.3 Pit/Trench/Discharge Approach

Many of the RI sites have pits, trenches, or other contained areas where wastes were disposed of, stored, and/or later covered. Also included in this approach are those sites where a liquid or airborne dust was discharged at a known point location. This approach applied to seven RI sites: the Wastewater Spreading Area (Site 35), the Old Burn Area (Site 6), the Chemical Range (Site 7), the Old Burn Staging Area (Site 36), the Bomb and Shell Reconditioning Building (Site 23), the AED Test Range (Site 40), and the Box Elder Wash Drum Site (Site 41). Because dimensions of these types of releases are confined to a known pit, trench, lagoon area, or discharge point or area, the sampling goal is to determine whether the source and media in direct contact with the source (i.e., soils underlying the source) contain chemicals significantly above background concentrations or regulatory limits. In this case, the sampling strategy is to collect a sufficient number of samples to evaluate the concentration distribution. Sampling schemes for the seven RI sites mentioned above were developed using this approach.

The sampling plan for Site 41 is believed to have adequately defined the extent of drum and soil contamination. However, the other six sites will require additional sampling to characterize the contamination type and pattern.

Characterization of trenches, pits, and discharge areas included direct sampling of the potential source areas. Because these areas are relatively small, they are regarded as homogeneous in nature, and sampling is focused on the source areas. Data generated from sampling homogeneous areas were used to establish the mean source concentration in a trench/pit/discharge area, without collecting an excessive number of samples. A minimum of four samples were collected from each pit, trench, or discharge point or area in order to evaluate the normality of the analytical results. The mean chemical concentration of the pit/trench/discharge area was then calculated.

In order to assess the significance of mean chemical concentration data for the pit/trench/discharge areas, a comparison between these data and background data was conducted. As part of TEAD-N-wide sampling efforts, Rust E&I and James M. Montgomery, Inc., each collected surface-soil samples and subsurface-soil samples from four background soil types and analyzed the samples to determine the mean chemical background concentration for inorganics and anions. For chemicals where background concentrations were zero (e.g., volatile organic compounds (VOCs) and semi-volatile organic compounds (semi-VOCs)), a test of proportions was used to assess whether site sample concentrations were significantly above background (EPA, 1989). For chemicals that were naturally occurring at detectable concentrations in background soils (e.g., metals and anions), an analysis of variance was used to determine significance of site sample concentrations (EPA, 1989).

3.2 GENERAL FIELD INVESTIGATION PROCEDURES

3.2.1 Unexploded Ordnance Clearing

Six of the eleven sites where fieldwork was conducted potentially contain unexploded ordnance (UXO) and/or reactive soils as a result of past or current activities. These sites are:

- Old Burn Area, Site 6, may contain UXO especially in buried trenches.
- Old Burn Staging Area, Site 36, may contain UXO in pit area.
- Chemical Range, Site 7, may contain UXO in buried trenches.
- Building 1303 Washout Pond, Site 22, may contain reactive soils.
- Bomb and Shell Reconditioning Building, Site 23, may contain reactive soils.
- AED Test Range, Site 40, may contain UXO in all areas of the test range.

Prior to, during, and after UXO clearance activities, UXO personnel adhered to certain conditions that comply with the *U.S. Army Series 60 Manual* for handling ordnance items and followed current USAEC Safety Office guidance (USATHAMA, 1987b). The following conditions were required for the UXO personnel:

- Detailed Standard Operating Procedures (SOPs) were provided for all UXO procedures.

- Equipment to communicate with off-site emergency-response personnel was present at the site (i.e., cellular and/or radio telephones).

- UXO operations were conducted only during daylight hours.

- UXO operations ceased during thunder/lightning storms or other severe weather.

- UXO operations were conducted with a minimum of two UXO subcontractor personnel, who were equally qualified and knowledgeable of UXO.

- Arrangements were made prior to initiation of fieldwork with the geographically responsible military Explosive Ordnance Disposal (EOD) unit and TEAD-N personnel for the safe disposal of UXO. Safe disposal was performed by military EOD or installation personnel, not contractor UXO personnel.

- Prior to conducting field geophysical survey activities at the Old Burn Area, Old Burn Staging Area, Chemical Range, or AED Test Range, UXO personnel assessed these sites to determine if variable time fuses and other items that might render unsafe work conditions were potentially present.

- UXO personnel located, identified, recovered/removed, and consolidated discovered ordnance or energetic items from test pits via surface clearance or sweeping procedures, except for items known or thought to contain chemical agents or ordnance that could not be safely removed.

- The location, date, and time of UXO encountered were recorded.

- UXO that could not be safely removed for safe disposal was marked, and the military EOD unit or TEAD-N personnel was notified.

- Ordnance items determined to be expended were disposed of as nonhazardous waste.

- UXO and/or energetic materials that were safe to move were staged at a properly located holding area, on-site, pending disposal.

- UXO personnel had stop-work authority at sites with potential UXO and/or shock-sensitive soils.

The UXO personnel supported performance of the following specific field activities: site access, clearance of grid areas for geophysical surveys, and clearance of surface- and subsurface-sampling locations. To ensure safe and clear access through an area where the

potential for UXO exists, a clearance team of two UXO personnel conducted a visual sweep of the proposed route, and cleared and marked a 10-foot-wide path. They maintained a line of sight with each other and communicated with other field crew members at all times. When UXO was encountered, it was marked and identified, and a route was cleared around the hazard. An alternate route out of the UXO area was also cleared.

3.2.2 Geophysical Surveys

Geophysical surveys were conducted at the Old Burn Area (Site 6), the Old Burn Staging Area (Site 36), the Chemical Range (Site 7), and the AED Test Range (Site 40) to assist in locating and mapping individual areas where trenching may have occurred and/or where potentially hazardous materials may have been buried. The technique used at TEAD-N was magnetometry combined with an Ultrasonic Ranging and Data System (USRADS) that allowed real-time monitoring of the geophysical results. The magnetometer surveys were conducted to help determine the location and extent of subsurface features. The USRADS survey was chosen, in part, because it is a passive survey, which is desirable in areas where there is potential for inadvertent detonation of UXO.

A more complete description of the procedures used to complete the geophysical surveys is presented in Appendix B.

3.2.2.1 *Grid Establishment*

Following the surface sweep of the area for UXO, the geophysical team established grid lines using a measuring tape, compass, and line-of-sight techniques. From a permanent, known location (i.e., bench mark and fence line), the team established corner points for the area to be surveyed using laths and high visibility flagging. Grid lines between these corner points were established using a measuring tape and line-of-sight. High visibility flagging and laths were placed at the appropriate grid spacing. Map coordinates were calculated for the corner points, and measurements were referenced to these points. Grids were oriented north-south and east-west.

3.2.2.2 *Magnetometry*

An EM-31 Ground Conductivity Meter was used for all geophysical surveying conducted during the RI at TEAD-N, which included the Old Burn Area, the Old Burn Staging Area, the Chemical Range, and the AED Test Range. The EM-31 measures an induced magnetic field for measurement of ground conductivity. The EM-31, combined with USRADs, was considered the best method for rapid characterization of sites containing buried trenches. Survey grids to be used at the sites varied according to the size of the area, but generally were at 20-by-20-foot or 50-by-50-foot spacings. The grids were laid out by first establishing a baseline through the central portion of the survey area using a compass and measuring tape. The baseline was a straight line with survey stakes placed a minimum of every 100 feet along its length. Using the baseline as a reference, the remainder of the survey grid was

established (at a minimum of 100 feet by 100 feet). The grid stakes were labeled in accordance with an alphanumeric grid system. When utilizing the USRADS, any magnetic anomalies encountered in the four survey areas were better defined using more closely spaced measurements in a crisscross fashion across the originally identified anomaly.

The methods and results of the geophysical surveys are more fully described in Appendix B.

3.2.3 Test-Pit Excavation

Test pits were excavated in areas likely to contain UXO. The following steps were taken while excavation activities were being performed:

1. UXO clearing of the test-pit site was completed prior to the start of any work at the site.

2. The center point of the test-pit site was established using a tape measure and compass from a known permanent location in order to establish a coordinate location.

3. The test pit was excavated in several depth increments after the surface area was cleared.

4. After each increment, the sampler and UXO personnel visually inspected the pit to decide if conditions were appropriate for sampling. The depth increments were determined on the basis of the UXO depth-of-clearance capabilities.

5. The backhoe operator closely monitored the excavation while digging and stopped excavation when:

   - Any drums, UXO, or other potential waste containers were encountered.
   - Distinct changes of materials were encountered.
   - When UXO personnel directed the operator to cease digging.

6. The test pit was sampled with soil from the center portion of the backhoe bucket. No personnel were allowed in the test pit for sampling activities.

7. The depth of the test pits varied according to the original depth of former trenches or pits. Test pits were generally terminated at the base of fill/top of original soil surface. Test pits generally did not exceed 10 feet in depth.

8. Following sampling, the test pit was properly backfilled with stockpiled material and natural local soil (as required). The surface was graded and restored to its original condition following the test-pit excavation.

3.2.4 Soil Sampling

Prior to sampling, the immediate sampling area was cleared of debris and litter. In areas where UXO was suspected, the immediate area was cleared by UXO personnel. When the location was not cleared of UXO, the UXO personnel selected another location as close to the original location as was practical. Stainless-steel spoons or a hand-operated barrel auger was used to penetrate surface and near-surface soil to the desired depth in order to obtain samples for chemical analysis. Depths for surface samples were generally 0 to 6 inches. The sampling equipment consisted of either large stainless-steel spoons or a stainless-steel auger bit attached to a stainless-steel rod and a "T" handle. The auger bit was used to bore a hole to the desired depth and was then withdrawn. The barrel portion of the auger bit holds the soil cuttings and eliminates contact with the sidewall of the boring, which minimizes the potential of contaminating the soil from other parts of the hole. The auger was used mainly in areas where soil samples were to be collected at intervals greater than 6 inches but less than 5 feet.

If stainless-steel spoons were used, the spoons would transfer sample material directly to the sample bottle (in the case of samples for VOCs) or to a stainless-steel mixing pan. For samples collected by auger barrel, a stainless-steel spoon and/or knife was used to remove the sample from the auger barrel. The material was then placed in a stainless-steel tray for thorough mixing prior to bottling. Sample material to be analyzed for volatile organics, however, was bottled immediately "as-is" upon removal from the auger barrel to avoid loss of volatiles. The sample material removed was also immediately scanned with a photoionization detector (PID) and visually inspected by UXO personnel to aid in decisions concerning sample packaging, handling, shipping, and personal-protection requirements. Following sample collection, the sampling equipment was cleaned using USAEC-specified decontamination procedures.

Equipment and supplies used for sampling with stainless-steel spoons or a barrel auger included:

- Barrel auger (3-inch-diameter and stainless-steel)
- Stainless-steel spoons
- Stainless-steel knife or putty knife
- Disposable latex surgical gloves and/or nitrile gloves
- Stainless-steel sample tray
- Tape measure
- Chain-of-Sample-Custody forms
- Cooler with ice or Blue Ice (or equivalent)
- Sample bottles
- Decontamination supplies (e.g., pans, brushes, sprayers, distilled water)
- Waste containers
- PID

3.2.5 Test-Pit Soil Sampling

The pits were sampled from the ground surface to avoid unsafe sampling conditions associated with entering trenches or pits. The sampler directed the backhoe operator to remove material from the selected depth or location within the test pit. The bucket was then brought to the surface and moved away from the test pit. The sampler approached the bucket and monitored its contents with the PID and recorded the reading on the test-pit log. UXO personnel also examined the contents of the bucket for characteristic signs of explosive materials. The sample was collected from several locations near the center of the bucket and placed in a stainless-steel mixing pan where the sample was homogenized (using a stainless-steel cutter and spoon) prior to bottling. For samples to be analyzed for volatile organics, however, the sample was immediately placed in the appropriate container "as-is" and sealed to avoid volatile loss. The sample material was placed in the bottles using a stainless-steel spoon.

Test pits were logged by the site geologist as they were being excavated (see Appendix C). This logging included a sketch of the pit location, profile sketch showing materials encountered, pit depth, and the location of all samples collected from the pit. The test-pit logs also contained any pertinent measurement data (e.g., PID readings), UXO information, or observations that could affect the quality or evaluation of the resulting data.

3.2.6 Sediment and Surface-Water Sampling

Since the streambeds, ditches, and gullies at most of the sites at TEAD-N are intermittent and normally dry, the procedures used for the collection of surface soils were also used for the collection of dry sediments. Surface-water samples were collected from only one site, the Bomb and Shell Reconditioning Building (Site 23).

The sampling location was established on a site map and was marked in the field using flagging and a 4-foot wooden stake. The stake was labelled with the sample identification (ID) number. Both surface water and sediment were collected at the Bomb and Shell Reconditioning Building site. During the time of sediment sampling, there was no water present because operations at the main building were down at the time. The water sample was collected approximately 1 week later when water was being discharged from the building. The water was collected by:

- Immersing the sample-collection bottle below the surface of the water with the opening pointed upstream to avoid collecting floating debris and to minimize trapped air bubbles in the case of samples for volatile organics. The containers were triple rinsed just downstream of the sample point to minimize disturbance of the water to be sampled and then filled with no headspace (for VOCs) or with minimal headspace.

- Measuring field parameters, including PID readings over headspace, temperature, pH, and specific conductance.

- Completing the appropriate surface-water data records.

The sediment samples, since they were collected from a shallow ditch, were collected with a stainless-steel spoon, using the same technique described for collecting surface-soil samples.

3.2.7 Radiological Surveys

A survey of the two former storage areas at the Drummed Radioactive Waste Area (Site 9) was conducted using a hand-held portable radiation meter capable of detecting alpha, beta, and gamma radiation. The instrument consisted of a meter with a probe mounted on an extension handle to allow close surveying of the ground surface. The survey was conducted in the following manner:

- Survey grids were established at the two sites using pin flags and a measuring tape. The first site (North Survey Area) covered an area approximately 100 feet by 220 feet and was subdivided into five survey lanes, which were 20 feet wide. The second site (South Survey Area), comprising an area 30 feet by 30 feet, was covered 100 percent by a walking survey.

- A team of two conducted the surveys: one operated the survey instrument, and the other recorded readings taken at specific grid locations. The survey was conducted by walking along the grid lanes and slowly swinging the detector in a 30-degree arc just above the ground surface without touching the surface. An instrument operational check was performed prior to the start of the survey using radioactive check sources of known activity with which to calibrate the instrument. Other instrument checks were performed according to manufacturer's recommendations. A background reading was established for the area and subsequent readings were compared to that background.

- Although two surveys were planned (one for beta/gamma and one for alpha), only the beta/gamma survey was required since no elevated radiation was encountered. Also, the alpha decay energies for all isotopes that possibly could have been stored on site were high enough to be detected by the instrument used.

3.2.8 Drum Sampling

Drum samples were collected from the Box Elder Wash Drum Site (Site 41). The drums were filled with a hard tarry solid waste. All or part of some drums were exposed at ground surface, and waste within the drums was exposed through openings in the drums. Eight drums were sampled: four being drums that had been sampled in a previous investigation and four previously unopened and unsampled drums. This sampling was conducted as follows:

- The steep bank of the wash was sloped using a backhoe to prevent caving of the bank on workers prior to entering the drum site in the bottom of the wash.

- Partially exposed or buried drums were carefully hand excavated prior to sampling and the condition, any markings, and the type of opening for each drum were noted and recorded.

Each drum was also given an ID number, which was painted on the barrel for future reference to corresponding analytical data. Photographs showing the location of each drum are presented in Appendix D. The drum ID, the sample ID, drum location, and drum description were also entered into a field logbook.

- Previously unopened drums were opened by removing the bung using nonsparking tools.

- A PID and a combustible gas/oxygen meter were used to monitor the breathing zone at each drum site prior to and during opening and sampling of the drum.

- Samples were collected from the exposed wastes using stainless-steel spoons and a stainless-steel corer. The sample collected was scanned with a PID prior to bottling, and the measurements were recorded. No liquids were found to be present.

3.2.9 Decontamination Procedures

Decontamination of excavation and sampling equipment is critical to prevent cross-contamination. Larger equipment, such as the backhoe, was steam cleaned, and other equipment, such as spoons and pans, were washed and rinsed following USAEC-approved decontamination procedures.

Prior to the start of field sampling activities, a source of clean water for decontamination was located in water supply well WW-3 and was sampled to ensure that the water used was free from contaminants. The sample was analyzed for TCL inorganics, TCL VOCs, TCL semi-VOCs, TCL pesticides/PCBs, anions, petroleum hydrocarbons, and explosives. The sample data were submitted to USAEC prior to the start of sampling activities. References to "USATHAMA-approved water" relate to the WW-3 well water source that was found not to contain elevated concentrations of the above specified analytes.

A decontamination pad was established for the cleaning of the backhoe. The backhoe was cleaned prior to the start of test-pit-excavation activities using high-pressure water and a high-pressure steam rinse. Solvents and detergents were not used. Decontamination wastes were collected in the pit and allowed to evaporate. No liquid wastes had to be containerized because of the rapid evaporation experienced at TEAD-N. Following completion of the field activities, the plastic and sludge from the decontamination pit were placed in drums for proper disposal. The pit was then filled with the berm materials surrounding the pit, and the surface was graded.

Small sampling equipment and supplies (e.g., hand auger barrels, spoons, knives, and pans) were decontaminated on-site using decontamination pans with USAEC-approved water for washing and distilled water for a final rinse. Loose material was removed prior to washing using a brush. Following the clean-water wash and distilled-water rinse, the equipment was allowed to air dry before use. All decontamination wastes were containerized and properly disposed of.

Monitoring equipment that could not be immersed in water was cleaned using damp disposable paper wipes and was dried using dry disposable paper wipes. Internal workings of the equipment were cleaned according to procedures recommended by the manufacturer. When possible, protective coverings were used to protect the instrument's outer surface from contamination.

Sample containers were wiped off with clean disposable wipes and then placed in Ziploc™-type plastic bags to prevent contamination of the sample shipping container and other samples during shipment.

3.2.10 Control and Disposal of Contaminated Wastes

A minimal amount of potentially contaminated waste requiring disposal was generated during the RI field investigation at TEAD-N. The small amount of generated waste was handled in the following manner:

- Disposable personal protective equipment, which was potentially contaminated, was placed in plastic bags, tagged, and labelled with the date, location, contents, and suspected contaminants. The bags were then placed in DOT-approved drums pending laboratory analysis of samples collected from the location where the personal protective equipment was used. If the data from samples indicated that no contamination was present, the bags were disposed of in the on-site sanitary landfill. Where contamination was present in samples from the location, the drum was appropriately labelled and stored for later classification and disposal.

- Decontamination wastes were placed in DOT-approved 55-gallon drums and properly labelled with the date, location, and suspected contaminants. Samples were collected from each drum and were analyzed for suspected contaminants and RCRA Waste Characteristics. Disposal of the wastes was dependent upon the results of the analyses and tests.

- Soil wastes from the excavation of test pits were field screened using a PID and visually inspected for evidence of contamination. These soil wastes were used to backfill the pit. Clean soil was used to backfill the pit as necessary in order to restore the location to its original state before excavation.

All waste containers were transported to a storage area as directed by TEAD-N personnel. Responsibility of waste disposal was with the facility. Rust E&I is in the process of providing the facility with analytical data to support disposal decisions.

3.2.11 Summary of Deviations from Planned RI Field Activities

Table 3-1 presents a summary of actual RI field investigation activities performed versus the proposed field activities as described in the RI/FS Work Plans for TEAD-N. Note that sites have been re-assigned within OUs subsequent to approval of the work plans (e.g., Site 6 has been re-assigned from OU 7 to OU 8, etc.).

N-nitrosodimethylamine, benzidine, and aniline were not in the scope of work for the Phase I remedial investigation, and thus were not analyzed. While these priority pollutants are known or suspected carcinogens, and thus could pose a risk if present, it is unlikely that they are present at Sites 41, 17 or 5. The contaminants of concern at Site 5 are PCBs and dioxins/furans. The contaminant of concern for Site 17 is PCB. As concerns Site 41, benzidine and aniline are associated with the manufacture of dyes, and N-nitrosodimethylamine is mainly associated with food products. If any of these compounds were present in the tar inside the drums at Site 41, it is unlikely that there would have been soil contamination resulting from the release of any of these three pollutants. These compounds would be present, if at all, in low concentrations and very little of the tar would have leaked from the drums. Sites 9, 18, and 33 did not require laboratory analysis of soils samples. The other 11 sites will have further investigation and, where sampling for organics is performed, these compounds will be included in the analyte list.

3.3 SELECTION PROCESS FOR THE CONTAMINANTS OF CONCERN

The selection process for the contaminants of concern included a screening process that compares the concentration of analytes detected in samples from each site against established background concentrations (for metals and anions only) and the CRL for organic compounds. The one-tailed test of significance suggested by the EPA to compare mean concentrations for chemicals present at the site with background values (EPA 1989b) was not used in this application because it is more appropriate for sites having homogeneous contamination and a larger number of background samples. One-sided normal tolerance intervals with a 95 percent confidence would result in the mean plus "more than 2" standard deviations of the background data (EPA 1989c) being established as the screening criteria. Mean plus 2 standard deviations was used instead, resulting in a more conservative approach. Inorganics that were detected in soil samples from a site at levels below the background concentration for the reported soils at TEAD-N were not considered to be contaminants of concern. In addition, organic analytes that were in site sample analyses at levels below the CRL were not considered to be contaminants of concern. The screening methodology for common laboratory contaminants recommended by the EPA (1989) was utilized. This included removal of a lab contaminant if the reported concentration was less than 10 times the amount detected in the corresponding quality control (QC) blank sample. Contaminants that were removed by this process included acetone, methylene chloride, methyl ethyl ketone, and the

Table 3-1. Summary of RI Field Investigation Activities at TEAD-N

Media Type	Field Surveys Planned	Field Surveys Performed	Samples Planned	Samples Sampled	Change Rationale
Operable Unit 4					
Waste Water Spreading Area/Site 35					
-Stained areas surface samples (SS).			2	1	Only one stained area was located during the site sample location staking tour with Rust E&I, USAEC, and regulatory agency representatives. The second proposed sample location was consequently deleted.
-Surface samples from ditches (SS).			4	3	One sample was deleted during the site sample location staking tour with Rust E&I, USAEC, and the regulatory agency representatives.
-Surface samples from wash (SS).			2	2	No change, collected as planned.
-Subsurface samples from 4 soil borings (SB).			9	9	There were 3 borings scheduled for the Wastewater spreading area. The additional boring was drilled in an attempt to collect samples from the targeted sampling zone. This attempt was unsuccessful due to the presence of subsurface dense cobble gravels encountered above the target depths. The two borings drilled on the western side of the spreading area also encountered the previously mentioned gravels, and they were only successful to 30-inch depths. The total number of samples remained the same, however, with the addition of the extra boring.
Operable Unit 6					
Drummed Radioactive Waste Storage Area/Site 9					
-Ionizing radiation survey.	1	1			Beta/gamma radiation survey performed at this site. Since no beta or gamma radiation was detected, an Alpha scan was not performed.

Table 3-1. Summary of RI Field Investigation Activities at TEAD-N (continued)

Media Type	Field Surveys Planned	Field Surveys Performed	Samples Planned	Samples Sampled	Change Rationale
Operable Unit 7					
PCB Pole Spill/Site 5					
-Surface grab samples (SS).			4	4	No change. Collected as planned.
-Soil-boring samples (SB).			5	5	No change. Collected as planned.
Operable Unit 8					
Old Burn Area/Site 6					
-Geophysical (USRADS) survey.	1	1			No change except GPR survey not required.
-Surface-soil samples from test pit locations (SS).			4	4	NOTE: Two extra observation test pits were excavated at this site on the basis of the USRADS survey. No visible contamination was observed and consequently no samples were collected for analysis.
-Subsurface-soil samples from test pits (SB).			16	16	No change. Collected as planned.
-Surface-soil samples from site's old drainage gullies (SS).			4	5	One surface sample at the drainage gullies from the burn site was added during the Rust E&I, USAEC, and the regulating agency representatives site sample station staking tour.
Old Burn Staging Area/Site 36					
-Geophysical (USRADS) survey.	1	1			No change except GPR survey was not required.
-Surface-soil samples from test pit locations (SS).			1	0	This sample (OSS-92-1) was deleted on the basis of the geophysical survey information that indicated no subsurface debris was present at this location.

Table 3-1. Summary of RI Field Investigation Activities at TEAD-N (continued)

Media Type	Field Surveys Planned	Field Surveys Performed	Samples Planned	Samples Sampled	Change Rationale
-Subsurface-soil samples from test pits (SB).			4	0	This test pit and its associated samples were deleted on the basis of the geophysical survey information, that indicated no subsurface debris was present at this location. The samples that were deleted included OSP-92-(01thru04).
-Surface-soil samples from the site's existing gravel pit (SS).			4	5	One sample (OSS-92-13) was added to the pit perimeter sample pattern to better cover the area of concern within the pit itself. This sample was added during the Rust E&I, USAEC, and the regulatory agency representatives site sample location staking tour.
-Surface-soil samples collected north of gravel pit (SS).			4	4	The sample sites for the area north of the pit were repositioned to better define the area within the USRADS geophysical survey. The sample stations were placed on the basis of surface disturbances within the survey perimeter. These samples were OSS-92-(09THRU12).
Chemical Range/Site 7					
-Geophysical (USRADS) survey.	1	1			No change. Survey completed as proposed.
-Surface-soil samples from test pit locations (SS).			3	3	No change. Collected as planned.
-Subsurface-soil samples from test pits (SB).			12	12	NOTE: On the basis of observed surface disturbances in the region to the northwest of the USRADS survey perimeter, one observation pit was excavated. No observable contamination was noted, and consequently no samples were collected for analysis.
Building 1303 Washout Pond/Site 22					
-Surface-soil grab samples (SS).			10	10	These samples were relocated from E.C. Jordan work plans during the site staking tour with Rust E&I and USAEC representatives.

Table 3-1. Summary of RI Field Investigation Activities at TEAD-N (continued)

Media Type	Field Surveys Planned	Field Surveys Performed	Samples Planned	Samples Sampled	Change Rationale
Bomb and Shell Reconditioning Building/Site 23					
-Surface soils collected from building discharge areas (SS).			2	2	No change. Collected as planned.
-Surface soils collected from stained soils (SS).			6	7	The Sample BRS-92-09 was added to the sampling program during the site sample location staking tour with REI, USAEC, and the regulatory agency representatives.
-Surface sediments (soils) collected from building discharge ditches (SD).			2	2	No change. Collected as planned.
Outfall water collected from building discharge ditches (SW).			2	1	Sample BRW-92-02 was deleted from the sampling program because no water was present at the sample station during the collection period.
Operable Unit 9					
Small Arms Firing Range/Site 8			2	2	No change. Samples collected as planned.
-Composite surface-soil samples (SS). -Surface-soil grab samples (SS).			0	2	Two additional surface samples were added to this sample site during the Rust E&I, USAEC, and regulatory agency site sample location staking tour prior to the field sampling program. The added sample numbers are SAS-92-03 and SAS-92-05. NOTE: This site was resampled and analyzed for total metals on December 29, 1992. The original sampling plan inadvertently only specified TCLP analysis.

Table 3-1. Summary of RI Field Investigation Activities at TEAD-N (continued)

Media Type	Field Surveys Planned	Field Surveys Performed	Samples Planned	Samples Sampled	Change Rationale
AED Test Range/Site 40					
-Geophysical (USRADS) survey.	1				NOTE: The survey and test pit at the former trench area were not required as the trench was open during Rust E&I's site visit, and no debris or other observable contaminants were noted. USRADS surveys were conducted in all revetments. On the basis of the results, four test pits were located in the revetments numbered 2, 4, 5, and 6 of the USRADS map numbering system. These pits were numbered AED #1, AED #2, AED #3, and AED #4 respectively.
-Surface-soil samples from test pit locations (SS).			5	4	The test pit at the former trench area was not excavated, as the trench was open during Rust E&I's site visit, and no debris or other observable contaminants were noted. The surface sample assigned to this pit was deleted.
-Subsurface-soil samples from test pits (SB).			5	5	The subsurface sample from the deleted test pit (previously explained) was deleted. One sample (AED-92-402) was added to test pit AED #4 to analyze stained soils and debris that were observed during pit excavation.
-Surface-soil samples collected from perimeter of old building (SS).			4	4	No change. Collected as planned.
-Surface-soil sample collected from revetments (SS).			6	3	The surface samples from revetments AED #2, AED #4, AED #5, and AED #6 were deleted because surface samples had already been collected for these revetments in conjunction with the test pits that were excavated at these locations. The remaining revetments, along with the area where previously bomb craters had been located, were sampled by grab samples. The collected samples were ARS-92-R21 for revetment AED #1, ARS-92-R31 for revetment AED #3, and ARS-92-R61 for the old bomb crater area.

Table 3-1. Summary of RI Field Investigation Activities at TEAD-N (continued)

Media Type	Field Surveys		Samples		Change Rationale
	Planned	Performed	Planned	Sampled	
Operable Unit 10					
Box Elder Wash Drum Site/Site 41					
-Drummed waste (DS).			8	8	No change. Collected as planned.
-Drummed waste aqueous (DSW).			4	0	Deleted: No aqueous materials were present in the sampled drums.
-Surrounding surface soil at drum site (SS).			4	4	No change. Collected as planned.
-Soil borings at drum site (SB).			4	4	Boring samples were numbered in the field as they had not been previously numbered. These subsurface samples were collected at the same location as were the surrounding surface-soil samples. They were numbered BEB-92-01, BEB-92-02, BEB-92-03, and BEB-92-04, and they correspond to the surface samples BE5-92-01, BES-92-02, BE5-92-03, and BES-92-04, respectively.
-Surface soil sampled in wash (SS).			5	5	Four downstream soil samples were collected. The fifth sample was moved to the ridge of the wash where a tar spill had been observed during the site sample staking tour with Rust E&I, USAEC, and regulatory agency representatives.
Installation-Wide Investigation					
Background Soil Sampling Analysis					
-Surface-soil grab samples (SS).			4	4	No change. Collected as planned.
-Soil-boring samples (SB).			4	4	No change. Collected as planned.

phthalates. Contaminants not considered common laboratory contaminants were removed if the reported concentration was less than 5 times the amount detected in the corresponding QC blank sample; contaminants that were screened by this process included 1,4-dichlorobenzene, chrysene, nitrate, phosphate, and sulfate. Contaminants screened by the above procedures are discussed individually for each site in Section 4 through 10.

The toxicity and mobility of compounds that were detected at a site should be considered during the selection process for contaminants of concern. However, for the OUs at TEAD-N, the number of detected compounds that survived the initial screening at each site was small (less than 30), so all of the compounds were included as contaminants of concern and were considered during the human health and environmental risk assessment (Baseline Risk Assessment) that was completed for the OUs as part of this RI Report. The Baseline Risk Assessment for the OUs considered the cumulative effects of human exposure to the contaminants of concern for each site, using toxicity data that are available from the EPA. Toxicity data are not available for synergistic or antagonistic effects.

Tables of contaminants of concern for specific media at each site, for which laboratory analytical data are available, are presented in the RI results section for each site. For most sites, only soil data are available. For some sites, there are no analytical data and, hence, no tables of contaminants of concern.

The tables also include, for each contaminant at each site, the range of detected concentrations and a representative value. The representative value is the 95 percent upper confidence limit on the arithmetic mean concentration. For sites at which a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as a concentration value for the non-detects in computing the representative value.

3.3.1 Chemical Data Analysis

All samples collected for this RI were analyzed using USATHAMA or EPA analytical methodologies as prescribed in the Field Sampling Plan (FSP) for the TEAD-N RI for Operable Units 4 through 10 (CNES, 1992) and the USAEC Quality Assurance Program (QAP) (USATHAMA, 1990). Table 3-2 presents a list of USAEC-certified and EPA equivalent analytical methods used for this RI. USAEC certified methods were used for all analyses except for the dioxins/furans.

Most soil and all drum samples were analyzed by A.D. Little located in Cambridge, Massachusetts, within the period from June to September 1992. Soil samples collected in December 1992 were analyzed by DataChem, Inc., located in Salt Lake City, Utah. Water supply sampling was performed to certify that the on-site water used during environmental programs was free of contamination. Sampling of the water supply was conducted under the concurrent TEAD-N Suspected Release Phase I RFI (JMM, 1993) and was analyzed by Environmental Science and Engineering, Inc., located in Gainesville, Florida. Based on the analytical results, USATHAMA approved the water supply on June 26, 1992, for a period of 6 months.

Table 3-2. Summary of Reference Methods Used for RI Field Sampling

Analyte/Analyte Group	USATHAMA Method Soil	USATHAMA Method Aqueous	USEPA Method Equivalent Soil	USEPA Method Equivalent Aqueous	Method Description
Priority Pollutant Volatile Organic Compounds (VOCs)	LM16	UM33	8240	8240	GC/MS[a]
Priority Pollutant Base/Neutral/Acid Extractables (semi-VOCs)	LM15	UM16	8270	8270	GC/MS
Explosives	LW26	UW26	NA[b]	NA	HPLC[c]
Dioxins/Furans	NA	NA	8280	8280	GC/MS
Organochlorine Pesticides	LH16	UH16	8080	8080	GC/ECD[d]
Target Analyte List Metals					
Standard ICP Metals[e]	JS15	SS16	6010	200.7	ICP[f]
Arsenic	JS15/JD13	SS16/SD24	7060	206.2	GFAA[g]
Lead	JS15	SS16	6010	239.2	ICP/GFAA
Mercury	JB03	SB03	7471	245.1	Cold Vapor AA[h]
Selenium	JS15	SS16/SD24	7740	270.2	GFAA
Thallium	JS15	SS16	6010	279.2	ICP/GFAA
TCLP Metals	JS15/JD13	SS16/SD24	200.7	245.1	ICP/Cold Vapor AA
Anions					
Sulfate, Chloride	KT04	TT08	300.1	300.1	IC[i]
Nitrite Plus Nitrate	KT04	TT08	Modified	353.2	Technicon
Phosphates	KT04	TT08	353.2	365.1	Technicon
Total Cyanide	KY07	TY12	Modified 365.1 9010	335.3	Colorimetric

[a]GC/MS=Gas chromatography/mass spectroscopy.
[b]NA=Not applicable.
[c]HPLC=High pressure liquid chromatography.
[d]GC/ECD=Gas chromatography/electron capture detection.
[e]Standard ICP metals include: Aluminum, Antimony, Barium, Beryllium, Cadmium, Calcium, Total Chromium, Cobalt, Copper, Iron, Magnesium, Manganese, Nickel, Potassium, Sodium, Vanadium, Zinc.
[f]ICP=Inductively coupled plasma.
[g]GFAA=Graphite furnace atomic absorption.
[h]AA=Atomic absorption.
[i]IC=Ion chromatography.

Soil and drum sample analyses performed for this RI included VOCs, semi-VOCs, nitroaromatic compounds (explosives), pesticides, dioxin/furans, PCBs, Target Analyte List (TAL) metals, and anions. Some soil samples were subjected to Toxicity Characteristic Leaching Procedure (TCLP) for metals at specific OUs. The particular suite of analyses to which samples were subjected was based on historical information for the specific OU investigated. The FSP outlines the rationale and proposed sampling plan for each OU investigated. Historical information on potential contamination present at each OU and analytical results from sampling performed for this RI are presented by OU in Sections 4 through 10. Database listings of the raw data for each OU and the associated chemical quality control data are included as Appendices F and G, respectively.

3.3.2 Chemical Data Quality Assurance/Quality Control

Analytical sample results obtained for this RI are compared to background conditions (Section 2.7), previous sampling results, and OU histories in Sections 4 through 10 of this report. These comparisons allow identification and/or confirmation of contamination at the OUs and are used in the selection of contaminants of concern. The contaminants of concern are then used in the ecological and human health risk assessment to determine if any adverse effects are associated with the OUs. Prior to comparison to background or OU-specific conditions, analytical data were subjected to quality assurance/quality control (QA/QC) protocols specified by the USAEC QAP (USATHAMA, 1990). This program is focused on ensuring precision, accuracy, representativeness, comparability, and completeness in the reported data. A flow chart detailing the data validation procedures performed by IRDMIS is presented in Figure 3-2. Further information regarding IRDMIS data analysis protocols can be found in the IRDMIS User's Manual. The following sections describe these QA/QC protocols and how results relate to the quality of data used in this RI.

3.3.2.1 *Laboratory Quality Assurance/Quality Control*

USAEC Laboratory QA/QC procedures, as described in the QAP, consist of creation and analyses of method blanks, laboratory quality control spikes, and matrix spike/matrix spike duplicates (MS/MSDs). These samples were analyzed with the actual field samples to evaluate the quality of the resulting analytical data. A discussion of the laboratory QC procedures used to evaluate the analytical data generated for this RI is presented below.

3.3.2.1.1 ***Method Blanks.*** For each chemical analysis conducted by the laboratory, method blanks were included in the sample lots to identify contamination that may have been introduced during sample preparation or analysis. Analytes detected above CRLs in the method blank were used to delineate actual site contamination from potential laboratory contamination. Method blank data were compared with results from samples with which the blanks were associated. For common laboratory contaminants (i.e., acetone, methyl ethyl ketone, methylene chloride, toluene, and the phthalate esters), sample results were considered valid only if the concentration in the sample exceeded 10 times the amount detected in the corresponding method blank (EPA, 1989). For analytes not considered to be common

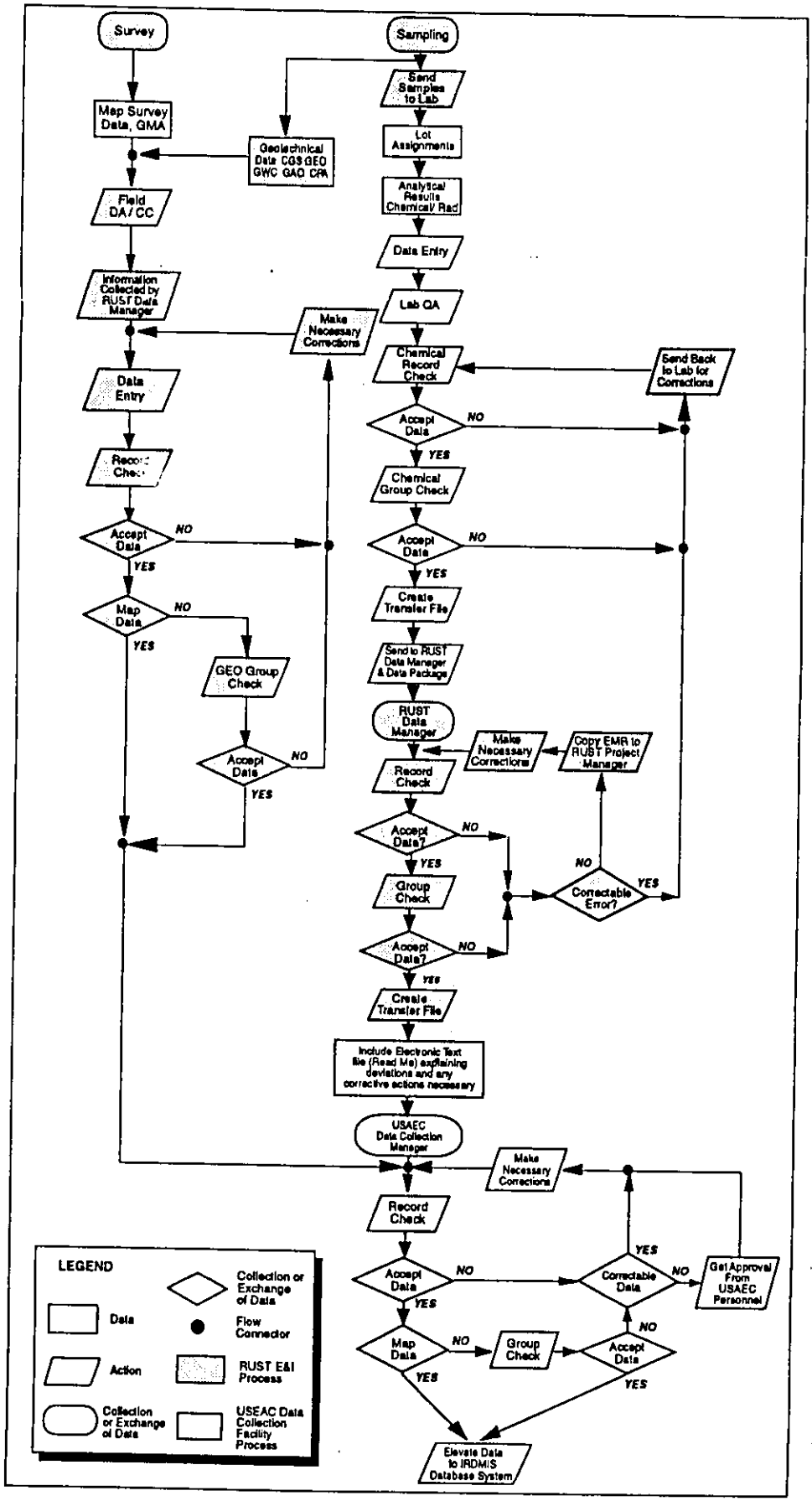


Figure 3-2. Flow Chart for Data Validation Within IRDMIS

laboratory contaminants, sample results were considered valid only if the concentration in the sample exceeded 5 times the amount detected in the corresponding method blank (EPA, 1989). Table 3-3 presents organic compounds detected in method blanks that were used to evaluate the sampling results for this RI.

Common laboratory contaminants detected above CRLs in the method blanks were acetone (0.0083 to 0.014 μg/g), methylene chloride (0.007 to 0.075 μg/g), and butylbenzyl phthalate (0.09 to 0.26 μg/g). Detections of these contaminants in the corresponding field samples were considered laboratory artifacts unless the reported concentration exceeded 10 times the method blank concentration. Contaminants, other than common laboratory contaminants, that were detected in method blanks were 1,4-dichlorobenzene (0.00045 to 0.00059 μg/g), chrysene (0.270 μg/g), 4-methylphenol (0.046 μg/g), dioxins (1.9E-07 to 4.1E-06 μg/g), furans (4.7E-07 to 7.4E-07 μg/g), and numerous unknown compounds (0.1 to 5.0 μg/g). These compounds, with the exception of the unknowns, were used to screen field samples according to the "5-times rule." The unknown compounds could not be matched using USAEC's chemical response database.

In addition to being detected in the method blanks, octachlorodibenzodioxin was detected (5.4E-04 to 4.0E-03 μg/L) in the rinse blanks. This indicates that some degree of laboratory contamination may have occurred in lots ZUN, ZUT, ZUI, and ZUU.

3.3.2.1.2 ***Laboratory Quality Control (QC) Spikes.*** To verify method performance and provide information on analytical method accuracy and precision, the laboratory was required to analyze laboratory quality control spike samples (QC spikes). Three QC spikes were required for each analytical batch: one spiked at twice the concentration of the lower CRL for the method and the other two samples spiked at 10 times the concentration of the lower CRL for the method. Field samples were bracketed by the QC spikes during the actual analysis run; low spike analyzed initially, followed by the field samples, and then analysis of the two high spikes. The spike recovery data were plotted on "control charts" to determine if resulting recoveries were within acceptance tolerance ranges as set by USAEC. The "control charts" were also used to record results from the evaluation of method specific holding times.

3.3.2.1.3. ***Matrix Spike/Matrix Spike Duplicates.*** Matrix spike/matrix spike duplicates (MS/MSDs) were analyzed in conjunction with blanks and replicates to provide quality control for the analytical methods used. The MS/MSDs were used to provide information regarding sample matrix effects and the capability of different methods to efficiently extract analytes of interest. MS/MSDs were analyzed with every analytical batch. The MS/MSDs are actual field samples split three ways: one control sample and two duplicate samples. The control sample is analyzed, and the result is used to establish the amount of analyte actually present in the field sample. This concentration can then be used to subtract from the concentration obtained for the spiked samples to establish a percent recovery for that particular analyte in that matrix. In addition, the relative percent difference (RPD) for the two spikes can also be estimated. These two factors, the percent recovery and the RPD, are used to assess the precision of the analytical method.

Table 3-3. Summary of Analytes Detected in Soil Method Blanks

Analyte	Analyte Code	Reported Value µg/g	Lot Designation	Sites Affected*
Volatile Organic Compounds				
Acetone	ACET	0.0120	VJS	35
Acetone	ACET	0.0130	VJU	41
Acetone	ACET	0.0140	VJV	41
Acetone	ACET	0.0100	VKF	6, 35
Acetone	ACET	0.0083	VKK	23
Methylene Chloride	CH2CL2	0.0075	VJS	35
Methylene Chloride	CH2CL2	0.0059	VJU	41
Methylene Chloride	CH2CL2	0.0065	VJV	41
Methylene Chloride	CH2CL2	0.0070	VKF	6, 35
Methylene Chloride	CH2CL2	0.0076	VKK	23
Methylene Chloride	CH2CL2	0.0084	VKL	41
Methylene Chloride	CH2CL2	0.0140	VKM	41
Semi-volatile Organic Compounds				
Butylbenzyl phthalate	BBZP	0.090	SKD	6, 36
Butylbenzyl phthalate	BBZP	0.260	SKN	
Chrysene	CHRY	0.270	SJU	
1,4-Dichlorobenzene	14DCLB	0.00054	VJS	
1,4-Dichlorobenzene	14DCLB	0.00045	VKF	
1,4-Dichlorobenzene	14DCLB	0.00050	VKK	
1,4-Dichlorobenzene	14DCLB	0.00059	VKL	41
1,4-Dichlorobenzene	14DCLB	0.00046	VKM	
Dioxins/Furans				
Heptachlorodibenzodioxin, total	THPCDD	0.0000019	ZUH	5
Heptachlorodibenzodioxin, total	THPCDD	0.0000041	ZUT	
Hexachlorodibenzofuran, total	THCDF	0.0000006	ZUT	
Octachlorodibenzodioxin	OCDD	0.0000346	ZUH	5
Octachlorodibenzodioxin	OCDD	0.0000408	ZUT	

Table 3-3. Summary of Analytes Detected in Soil Method Blanks (continued)

Analyte	Analyte Code	Reported Value µg/g	Lot Designation	Sites Affected*
Dioxins/Furans (cont.)				
Pentachlorodibenzofuran, total	TPOCDF	0.0000005	ZUT	
2,3,7,8-Tetrachlorodibenzofuran	TCDF	0.0000005	ZUT	
Tetrachlorodibenzofuran, total	TTCDF	0.0000007	ZUT	
Pesticides				
2,2-Bis(para-chlorophenyl)-1,1,1-trichloroethane	PPDDT	0.121	CDX	5
Heptachlor	HPCL	0.00186	CDX	
Metals				
Boron	B	7.34	YYD	8
Chromium	CR	1.70	YYD	8
Lead	PB	0.679	YYA	8
Vanadium	V	2.54	YYD	8
Zinc	ZN	2.93	YYD	8
Anions				
Bromide	BR	16.60	IHR	
Nitrate	NO3	2.67	IHK	6, 7
Nitrate	NO3	2.82	IHL	36
Nitrate	NO3	4.65	IHR	41
Nitrate	NO3	3.43	IHV	
Phosphate	PO4	9.56	IHR	41
Phosphate	PO4	10.60	IHS	23, 41
Phosphate	PO4	7.28	IHV	
Phosphate	PO4	5.69	IHX	

*If no entry, the QC data does not affect the analytical results for any site.

Note.—The following analytes will not be considered in soil method blank samples due to high background concentrations: aluminum, barium, calcium, chloride, iron, magnesium, manganese, potassium, sodium, and sulfate.

Each EPA analytical method has established ranges of performance, and laboratories under contract to EPA are required to continually evaluate method-specific results of MS/MSDs to determine precision and accuracy criteria for utilized methods. Based on these results, laboratory and method-specific performance characteristics can be compared to EPA method performance criteria. This approach is also utilized by USAEC for establishing upper and lower control chart limits.

Percent recovery values outside of established method-specific ranges may indicate matrix interference effects. For instance, when more than 100 percent of an analyte is recovered it is generally assumed that the sample matrix is contributing to the reported analyte concentration. Similarly, if percent recoveries are significantly less than 100 percent, the sample matrix may be influencing the analyte extraction process. Relative percent differences also provide information regarding possible matrix interference effects during analyses. If RPDs are outside of statistically significant ranges, then variability in sample results can be attributed to variability in the matrix or the capability of a method to extract a particular analyte from that matrix.

Under the IRDMIS system, the standard matrix control charts for each lot of data are reviewed by the USAEC Chemistry Branch. There are 26 data lots for soil samples collected at Sites 5 and 41. Twenty-three of the lots were reviewed by the Chemistry Branch and found to be acceptable. For Site 41 soil samples, Lot SKN was not reviewed for semi-VOCs. There are no data available to judge the quality because of dilutions during analysis. Therefore, the semi-VOC analyses in this lot are considered questionable. Sample BES-92-09 is the only sample affected.

All data for Site 5 were contained in two lots, CDX and ZUH. Lot ZUH was not reviewed by the Chemistry Branch because dioxin/furan analysis is not a USAEC performance demonstrated method. The analyses were performed by a subcontract lab, Triangle Laboratory, and Arthur D. Little reviewed the QC data which were provided in the data package. It was found that all samples were prepared and run within holding times. All standards were found to show adequate recoveries. The PCB data for Site 5 should be considered questionable. Lot CDX was extracted or concentrated in the incorrect solvent (i.e., methylene chloride instead of hexane/acetone). Samples were sent back for solvent exchange and re-analysis. The daily calibrations standard and spike data were out of control because of matrix effects, so the samples were acid cleaned and analyzed for a third time, 10 days past the analysis hold date. The QC standards were within acceptance limits.

For the remaining sites, a discussion of the QC results will be provided in the RI Addendum, which will be used to report the results of data gap filling fieldwork and compile and evaluate the complete data set for each of the 11 sites investigated.

3.3.2.2 *Field Quality Assurance/Quality Control*

Field QA/QC procedures, outlined in USAEC's QAP, consist of collection and analyses of field duplicates, rinse blanks, and trip blanks to provide information pertaining to the precision, accuracy, representativeness, and comparability of field data collected.

3.3.2.2.1 ***Field Duplicates.*** Field duplicate samples are duplicative samples collected at the same location, consisting of the same matrix (soils), and analyzed for a similar suite of analytes. Comparison of the results of field duplicates with collected sample results is indicative of the degree to which samples are homogeneous.

3.3.2.2.2 ***Rinse Blanks.*** Rinse blanks are aqueous samples collected from the water used to rinse field sampling equipment after sampling and decontamination. Results associated with these samples provide information on the effectiveness of field decontamination procedures; thus, providing critical information concerning potential cross-contamination between sampling locations. To determine cross-contamination potential, the analysis obtained for the rinse blanks are compared with the chemical composition of the water supply used to rinse the equipment. If a significant difference exists between the two, then cross-contamination between sampling locations could have occurred.

Results for the water supply used during the RI field sampling program are presented in Table 3-4. Sampling of the water supply was conducted at water supply well WW-3 during the TEAD-N Phase I RFI Suspected Releases Program (JMM, 1993). Based on the analytical results, USAEC approved the water supply on June 26, 1992, for a period of 6 months.

Analytical results for the rinse blanks collected during the RI field sampling program are shown in Table 3-5. The results indicate that inorganics detected in the rinse blanks are representative of the water supply used during the field program. Concentrations of copper, iron, lead, and zinc were present in the rinse blanks, although they were not detected in the water supply. However, these metals are present at such low levels that they would not impact the selection of contaminants used in subsequent site evaluations.

Organic compounds detected in the rinse blanks included the common laboratory contaminants, acetone and methylene chloride, and the chlorinated dioxins and furans. These compounds were also detected in the associated method blanks, indicating laboratory contamination as the probable source.

3.3.2.2.3 ***Trip Blanks.*** Trip blanks are aqueous samples transported with the actual samples from the field to the laboratory and are used to identify potential sample contamination during transport. Numerous trip blanks were shipped and analyzed under the RI field sampling program. Trip blanks were analyzed for VOCs since contamination from the air is generally the only way field samples are contaminated during transport.

Analytical results for the trip blanks are shown in Table 3-6. The only analyte detected in the trip blanks was methylene chloride, a common laboratory contaminant. Methylene chloride was also detected in low concentrations in the rinse blanks and method blanks in all associated lots. The consistency with which methylene chloride was detected, and the low concentrations that were found, indicate that it is more than likely the result of laboratory contamination and not indicative of sample contamination.

Table 3-4. Summary of Results for Water Supply Well No. WW-3

Analytical Group	Analyte Detected	Analyte Code	WW-3* (1)	WW-3* (2)	GW-TB*[a]
VOCs	Chloroform	CHCL3	ND[b]	ND	1.2
SVOCs	None Detected		ND	ND	NRQ[c]
Explosives	1,3-Dinitrobenzene	13DNB	0.611	0.611	NRQ
	2,4-Dinitrotoluene	24DNB	0.0637	0.0637	NRQ
	2,6-Dinitrotoluene	26DNB	0.0738	0.0738	NRQ
	HMX	HMX	1.21	1.21	NRQ
	Nitrobenzene	NB	1.17	1.17	NRQ
	Tetryl, Total	TETRYL	1.56	1.56	NRQ
	1,3,5-Trinitrobenzene	135TNB	0.449	0.449	NRQ
	2,4,6-Trinitrobenzene	246TNB	0.635	0.634	NRQ
	2-Nitrotoluene	2NT	0.406	0.406	NRQ
	Nitroguanidine	NQ	31.0	31.0	NRQ
Pesticides	None Detected		ND	ND	NRQ
PCBs	None Detected		ND	ND	NRQ
Metals	Barium, Total	BA	68.6	61.9	NRQ
	Calcium	CA	96,100	97,900	NRQ
	Potassium, Total	K	3,450	3,470	NRQ
	Magnesium	MG	35,600	36,200	NRQ
	Manganese, Total	MN	12.9	6.80	NRQ
	Sodium	NA	96,200	97,800	NRQ
	Arsenic, Total	AS	2.70	2.60	NRQ
Anions	Nitrogen (Nitrate/Nitrite)	N	3,290	3,230	NRQ
	Phosphorus, Total	PO4	14.7	17.5	NRQ
	Chloride	CL	22,500	22,300	NRQ
	Sulfate	SO4	97,300	97,300	NRQ
	Bromide	BR	789	789	NRQ

*All reported values in μg/L.
[a]GW-TB=Groundwater Test Blanks.
[b]ND=Not Detected.
[c]NRQ=Not Requested.

Table 3-5. Summary of Analytes Detected in Rinse Blanks

Sample Date	Analyte	Analyte Code	Reported Value (μg/L)	Lot Designation	Sites Affected
6/08/92	Methylene Chloride	CH2CL2	6.96	VJT*	5, 6, 8
	Heptachlorodibenzodioxin, total	THPCDD	0.0000200	ZUI**	22, 35
6/10/92	Barium	BA	91.0	MFV	41
	Bromide	BR	198.0	IHH	
	Chloride	CL	250,000	IHH	
	Copper	CU	7.37	MFV	
	Iron	FE	28.9	MFV	
	Nitrate	NO3	3,900	IHE	
	Sulfate	SO4	100,000	IHH	
	Zinc	ZN	23.8	MFV	
7/16/92	Acetone	ACET	6.0	VKN	6, 7, 22
	Barium	BA	110	MFV	23, 35, 36
	Methylene Chloride	CH2CL2	8.92	VKN***	40, 41
	Heptachlorodibenzodioxin, total	THPCDD	0.0000381	ZUU	
	Heptachlorodibenzofuran, total	THPCDF	0.0000141	ZUU	
	Hexachlorodibenzofuran, total	THCDF	0.0000070	ZUU	
	Octachlorodibenzodioxin	OCDD	0.0003600	ZUU****	
	Octachlorodibenzofuran	OCDF	0.0000353	ZUU	
	Pentachlorodibenzofuran, total	TPCDF	0.0000006	ZUU	
	2,3,7,8-Tetrachlorodibenzofuran	TCDF	0.0000032	ZUU	
	Tetrachlorodibenzofuran, total	TTCDF	0.0000037	ZUU	

*Method blank corresponding to Lot VJT contained 7.5 μg/L CH2CL2.
**Method blank corresponding to Lot ZUI contained 0.000538 μg/L OCDD.
***Method blank corresponding to Lot VKN contained 8.0 μg/L CH2CL2.
****Method blank corresponding to Lot ZUU contained 0.000401 μg/L OCDD.

Table 3-6. Summary of Results for Trip Blanks

Analytical Group	Analyte Detected*	Analyte Code*	Reported Value	Unit Measure	Lot Designation
Volatile Organic	Methylene Chloride	CH2CL2	37	μg/L	VJT
			6.57	μg/L	VJT
			7.06	μg/L	VJT
			6.96	μg/L	VJT
			6.57	μg/L	VJY
			8.14	μg/L	VKE
			7.65	μg/L	VKE
			9.02	μg/L	VKE
			7.35	μg/L	VKL
			7.69	μg/L	VKL
			8.55	μg/L	VKL
			8.92	μg/L	VKN
			9.61	μg/L	VKN
			9.8	μg/L	VKN
			9.12	μg/L	VKN

*The only analyte detected was methylene chloride.

3.3.3 Interim Data

A database printout of all field sampling results is listed in Appendix F, and the associated quality control data are listed in Appendix G. Appendix F also contains analytical results for several inorganics (Al, Be, Ca, Co, K, Mg, Mn, and V) that were hand calculated from raw output data obtained from the laboratory. These analytes were not originally included in the analytical request submitted to the laboratory, but were part of the suite of metals that were analyzed by the ICP multi-element method; as such, raw data were available for evaluation. Since these data are not quantitative and have not been verified by USAEC protocols, they were not included in the numerical risk assessment conducted for each site. However, these data have been evaluated and it does not appear that the data would impact the final conclusions recommended for each site.

3.4 CONTAMINANT FATE AND TRANSPORT MODELS

This section presents, as a brief background on the mobility of organic and metal contaminants, a semi-analytical model for the fate and transport of a hypothetical contaminant at TEAD-N. This section does not discuss the fate and transport of anion contaminants, which tend to be mobile in soil and subject to leaching. This section serves as a reference for the fate and transport discussions of the contaminants of concern for OUs 4 through 10 in Sections 4.0 through 10.0, respectively.

3.4.1 Fate and Transport of Organic Contaminants

Table 3-7 provides a summary of chemical characteristics for the organic contaminants of concern, and Table 3-8 describes the fate and transport of the organic contaminants of concern. More detailed descriptions of the organic contaminants of concern are presented in Appendix H. Ney (1990) presents a general approach for using the chemical characteristics to evaluate the fate and transport of organic contaminants in the environment. According to this approach, contaminants that have low water solubilities (< 10 mg/L), low vapor pressures (< 1×10^{-6} mm Hg), high-log K_{ow} (octonal-water partition coefficient) values (> 3), and high-log K_{oc} (water-carbon partition coefficient) values (> 4) tend to adsorb strongly to soil and be resistant to leaching. These contaminants typically do not hydrolyze, photolyze, or volatilize; they may biodegrade slowly and bioaccummulate. Conversely, contaminants that have high water solubilities (> 1,000 mg/L), high vapor pressures (> 0.01), low-log K_{ow} values (< 2.7), and low-log K_{oc} values (< 3) tend to be mobile in soils and subject to leaching.

This latter group of contaminants typically do hydrolyze, photolyze, and volatilize; they also typically biodegrade readily and do not bioaccummulate. Contaminants that fall between these chemical characteristic ranges may fall into either fate and transport category. Additionally, contaminants that have a high bioconcentration factor (> about 1,000 to 2,000 for fish) tend to bioconcentrate. According to Sullivan (1991), contaminants that have a high Henry's Law coefficient (> 100 atm) volatilize readily; contaminants that have a moderate

Table 3-7. Summary of Chemical Characteristics for the Organic Contaminants of Concern

Contaminant	CAS #	Water Solubility (mg/L)[a]	Vapor Pressure (mm Hg)[a]	Henry's Law Coeff. (atm)	log K_{ow} (unitless)	log K_{oc} (unitless)	Bioconcentration Factor (BCF) (unitless) (for fish)
Acenaphthene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	83-32-9	3.47 to 3.93	.001 to .01	4.40 to 13.4	3.92 to 4.33	1.25	BCFs of 100 to 2,000 are typical for PAHs.
Benzene (Howard, 1990)	71-43-2	1791	95.19	302	2.13	1.49 to 2.15	3.5 to 4.4 for eels, pacific herring, and goldfish
Benzo[a]anthracene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	56-55-3	.0094 to .014	1.1E-7	.037 to .445	5.61 to 5.90	6.14	BCFs of 100 to 2,000 are typical for PAHs.
Benzo[a]pyrene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	50-32-8	.0038 to .004	5.0E-9 to 5.6E-9	less than .133	5.81 to 6.50	5.60 to 6.29	BCFs of 100 to 2,000 are typical for PAHs.
Benzo[b]fluoranthene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	205-99-2	.0012 to .014	5.0E-7	.667	6.57	5.74	BCFs of 100 to 2,000 are typical for PAHs.
Benzo[g,h,i]perylene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	191-24-2	.00026	1.01E-10	.00778	7.10	6.89	BCFs of 100 to 2,000 are typical for PAHs.
Benzo[k]fluoranthene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	207-08-9	.00055	9.59E-11	57.8	6.85	6.64	BCFs of 100 to 2,000 are typical for PAHs.

Table 3-7. Summary of Chemical Characteristics for the Organic Contaminants of Concern (continued)

Contaminant	CAS #	Water Solubility (mg/L)[a]	Vapor Pressure (mm Hg)[a]	Henry's Law Coeff. (atm)	log K_{ow} (unitless)	log K_{oc} (unitless)	Bioconcentration Factor (BCF) (unitless) (for fish)
Bis(2-ethylhexyl)phthalate (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	117-81-7	.047 to .4	6.2E-8	.612	4.20 to 5.11	5.0	42 to 113 for rainbow trout. 115 to 886 for fathead minnows. 100 to 10,000 in fish and invertebrates.
Butylbenzyl phthalate (Howard, 1989)	85-68-7	2.69	8.6E-6	.0723	4.91	1.81 to 2.55	663 for bluegill sunfish.
Chlordane (Montgomery and Welkom, 1990)	57-74-9	.009 to 1.85	1.0E-5	2.69	6.00	5.15 to 5.57	---*
Chloroform (Howard, 1990)	67-66-3	7950	246	242	1.97	1.64	3.34 to 10.35 for rainbow trout. 6 for bluegill sunfish.
Chrysene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	218-01-9	.0018 to .006	6.3E-9	4.0E-15	5.60 to 5.91	5.39	BCFs of 100 to 2,000 are typical for PAHs.
Diethyl phthalate (Howard, 1989)	84-66-2	1080	1.65E-3	.0267	2.47	1.84	15 to 16 in mullet. 117 in bluegill sunfish.
1,2-Dimethylbenzene & 1,3-Dimethylbenzene	---	---	---	---	---	---	---

Table 3-7. Summary of Chemical Characteristics for the Organic Contaminants of Concern (continued)

Contaminant	CAS #	Water Solubility (mg/L)[a]	Vapor Pressure (mm Hg)[a]	Henry's Law Coeff. (atm)	log K_{ow} (unitless)	log K_{oc} (unitless)	Bioconcentration Factor (BCF) (unitless) (for fish)
2,4-Dinitrotoluene (Howard, 1989)	121-14-2	300	1.1E-4	.0482	1.98	2.45	11 to 103 for bluegill sunfish.
2,6-Dinitrotoluene (Howard, 1989)	606-20-2	---	3.5E-4	.0121	1.72	2.31	5225 for algal biomass estimate of 12 based log K_{ow}.
Ethylbenzene (Howard, 1989)	100-41-4	161	9.53	469	3.15	2.21 to 2.94	1.19 to 4.68 for fish and clams.
Fluoranthene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	206-44-0	.120 to .373	5.0E-6	940	5.22	4.62	BCFs of 100 to 2,000 are typical for PAHs.
HMX	2691-41-0	---	---	---	---	---	---
Indeno[1,2,3-cd]pyrene (Montgomery and Welkom, 1990)	193-39-5	.062	1.0E-10	1.65E-15	5.97 to 7.70	7.49	---
Methyl ethyl ketone (Howard, 1990)	78-93-3	239,000	90.6	.584	.290	1.53	Estimate of 1 based on log K_{ow}.
Nitrobenzene (Howard, 1989)	98-95-3	1900	.150	1.36	1.85	1.49 to 2.36	6 for fish. 24 for green algae.
PCBs Aroclors 1248, 1254 &1260 (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	12672-29-6 11097-69-1 11096-82-5	.0027 to .2	4.05E-5 to 4.94E-4	128 to 395	5.61 to 6.91	5.61 to 6.42	26,000 to 600,000 for fish, shrimp and oysters.

Table 3-7. Summary of Chemical Characteristics for the Organic Contaminants of Concern (continued)

Contaminant	CAS #	Water Solubility (mg/L)[a]	Vapor Pressure (mm Hg)[a]	Henry's Law Coeff. (atm)	log K_{ow} (unitless)	log K_{oc} (unitless)	Bioconcentration Factor (BCF) (unitless) (for fish)
Phenanthrene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	85-01-8	.816-1.29	2.1E-4 to 6.8E-4	1.42 to 7.23	4.16 to 4.57	3.72 to 4.59	BCFs of 100 to 2,000 are typical for PAHs.
Pyrene (Montgomery and Welkom, 1990; SEC Donohue, 1992b)	129-00-0	.013 to .16	6.85E-7 to 2.5E-6	.606 to 1.04	4.88 to 5.32	4.66 to 5.13	72,457 for rainbow trout. 600 to 970 for goldfish and fathead minnows.
RDX	121-82-4	---	---	---	---	---	---
2,3,7,8-Tetrachlorodi-benzo-p-dioxin (Montgomery and Welkom, 1990)	1746-01-6	1.93E-5 to 3.2E-4	6.4E-10 to 1.4E-9	3.0E-18	5.38 to 7.02	6.66	---
Tetryl	---	---	---	---	---	---	---
Toluene (Howard, 1990)	108-88-3	535	28.4	330	2.73	1.57 to 2.25	90 for golden ide fish. 380 for algae.
Trichloroethylene (Howard, 1990)	79-01-6	1100	69.0	573	2.42	1.94 to 2.18	17 to 39 for bluegill sunfish and rainbow trout.
1,3,5-Trinitrobenzene (SEC Donohue, 1992b)	99-35-4	340	3.2E-6	---	1.18	2.02 to 2.25	Estimated at 5 to 23.

Table 3-7. Summary of Chemical Characteristics for the Organic Contaminants of Concern (continued)

Contaminant	CAS #	Water Solubility (mg/L)[a]	Vapor Pressure (mm Hg)[a]	Henry's Law Coeff. (atm)	log K_{ow} (unitless)	log K_{oc} (unitless)	Bioconcentration Factor (BCF) (unitless) (for fish)
2,4,6-Trinitrotoluene (Montgomery, 1991; SEC Donohue, 1992b)	118-96-7	130	4.26E-3 at 54.8°C	---	2.25	2.48	Estimated at 11.5 to 40.

[a]Values for water solubility and vapor pressure were measured at 20° to 25°C.

*---Indicates lack of data.

Table 3-8. Fate and Transport for the Organic Contaminants of Concern

Contaminant	Soil	Water	Air	Biological Systems
Polynuclear Aromatic Hydrocarbons (PAHs): Acenaphthene Benzo[a]anthracene Benzo[a]pyrene Benzo[b]fluoranthene Benzo[k]fluoranthene Chrysene Fluoranthene Phenanthrene (SEC Donohue, 1992b)	Strong tendency to adsorb to soil/sediment. Resistant to leaching.	Low water solubility. Expected to partition to solids such as sediment.	Not volatile. May become airborne through adsorption to particulates; removed by wet and dry deposition.	Resistant to biodegradation. May bioaccumulate, although many organisms eliminate these compounds rapidly.
Benzene (Howard, 1990)	Highly mobile in soil and subject to leaching.	Soluble in water. Not expected to hydrolyze.	Highly volatile. Not subject to direct photolysis. Removal by reaction with atmospheric hydroxyl radicals (half-life 4 hours to 13 days.)	Can biodegrade under aerobic conditions in soil and water. Not expected to bioconcentrate.
Bis(2-ethylhexyl)phthalate (SEC Donohue, 1992b)	Strong tendency to adsorb to soil/sediment. Resistant to leaching.	Low water solubility. Expected to partition to solids such as sediment.	Not volatile. May become airborne through adsorption to particulates; removed by precipitation.	May biodegrade under aerobic conditions. Tends to bioconcentrate in aquatic organisms.
Butylbenzyl phthalate (Howard, 1989)	Expected to adsorb to soil and be resistant to leaching. Abiotic degradation not expected to be significant.	Low water solubility. Expected to partition to solids such as sediment. Photodegradation and hydrolysis are not expected.	Volatilization from soil is expected to be low due to low volatility.	Biodegradation is a primary fate mechanism. Readily biodegraded by activated sludge and under anaerobic conditions. Not expected to bioconcentrate.
Chlordane	Based on chemical characteristics, tends to adsorb to soil and resist leaching.	Expected to adsorb to soil/sediment. Not expected to hydrolyze.	Not expected to volatilize. May adsorb to airborne particulates; removal from wet and dry deposition.	Expected to be resistant to biodegradation; may bioaccumulate.

Table 3-8. Fate and Transport for the Organic Contaminants of Concern (continued)

Contaminant	Soil	Water	Air	Biological Systems
Chloroform (Howard, 1990)	Poor absorbance to soil. Subject to leaching. Not expected to hydrolyze.	Soluble in water. Not expected to hydrolyze.	Volatilizes readily. Slow removal by reaction with hydroxyl radicals (half-life 80 days). May be partially removed by precipitation.	Biodegradation data are conflicting; some data indicate that biodegradation can occur under aerobic and anaerobic conditions. Not expected to bioaccumulate.
Chrysene - see PAHS at top of table.				
Diethyl phthalate (Howard, 1989)	Degree of mobility in soil is not known. Oxidation and chemical hydrolysis are not expected to be significant.	May be subject to leaching. Oxidation, chemical hydrolysis, and photolysis are not expected to be significant.	May volatilize from dry soil. Also adsorbs to airborne particulates. Removal by reaction with hydroxyl radicals (half-life 22 hours).	May biodegrade under aerobic conditions. Not expected to bioaccumulate.
1,2-Dimethylbenzene & 1,3-Dimethylbenzene	---*	---	---	---
2,4-Dinitrotoluene & 2,6-Dinitrotoluene (Howard, 1989)	Slightly mobile in soil. Not susceptible to hydrolysis and photolysis should not be significant.	Slight tendency to adsorb to soil/sediment and biota. Photolysis (surface water) is probably the most significant removal process.	Not volatile.	2,4-DNT may biodegrade in both aerobic and anaerobic zones of soil. Not expected to bioconcentrate in aquatic systems.
Ethylbenzene (Howard, 1989)	Adsorption to soil is moderate. Susceptible to leaching, especially from soil with a low organic carbon content. Does not hydrolyze. Slow biodegradation is likely.	Biodegradation is likely. Some adsorption to soil/sediment may occur. Photolysis and hydrolysis are not significant.	Readily volatilizes. Not expected to photolyze. Removal by reaction with hydroxyl radicals (half life 0.5 hour to 2 days).	Biodegraded fairly rapidly by activated sludge. Resistant to anaerobic biodegradation. Does not bioaccumulate.

Table 3-8. Fate and Transport for the Organic Contaminants of Concern (continued)

Contaminant	Soil	Water	Air	Biological Systems
Fluoranthene - see PAHs at top of table.				
HMX (SEC Donohue, 1992b)	---	Photolysis is the dominant transformation process in surface water.	---	May biodegrade under aerobic and anaerobic conditions.
Indeno[1,2,3-cd]pyrene	Based on chemical characteristics, expected to adsorb to soil and be resistant to leaching.	Not soluble. Not expected to hydrolyze or photolyze.	Not volatile. May adsorb to airborne particulates; removal through wet and dry deposition.	Expected to be resistant to biodegradation. Based on physical properties, may bioconcentrate.
Methyl ethyl ketone (Howard, 1990)	Highly mobile in soil. Highly susceptible to leaching. Does not significantly hydrolyze.	Does not significantly hydrolyze, photooxidize, or adsorb to sediment/soil. May be subject to direct photolysis.	Volatilization from water and soil are likely. May be subject to removal by rain and direct photolysis. Principal degradation is by reaction with hydroxyl radicals (half life of 2.3 days).	May biodegrade slowly in soil and groundwater. Does not bioaccumulate.
Nitrobenzene (Howard, 1989)	Mobile in soil and subject to leaching.	Mobile in water.	Not volatile. Photolyses in the atmosphere.	Biodegradation data are conflicting; some studies indicate the biodegradation is an important removal process. Not expected to bioconcentrate.

Table 3-8. Fate and Transport for the Organic Contaminants of Concern (continued)

Contaminant	Soil	Water	Air	Biological Systems
PCBs (SEC Donohue, 1992b)	Strong adsorption to soil/sediment. Resistant to leaching under most conditions. Will leach in the presence of organic solvents.	Resistant to leaching. Soil and sediment can act as a reservoir from which PCBs may be released slowly over a long period of time. Hydrolysis and oxidation are not significant.	Volatilization is slow, but is an important transport process. The tendency to adsorb to airborne particulates increases as the degree of chlorination increases. Physical removal by wet and dry deposition.	Resistant to biodegradation, although this is the ultimate degradation process. PCBs bioconcentrate in tissue.
Phenanthrene - see PAHs at top of table.				
Pyrene (SEC Donohue, 1992b)	Strong adsorption to soil/sediment. Resistant to leaching. Not expected to hydrolyze.	Resistant to leaching. Will adsorb strongly to sediments and particulate matter.	Not volatile.	Bioconcentrates in aquatic organisms.
RDX (SEC Donohue, 1992b)	Moderate to high mobility in soils. Not expected to hydrolyze.	Moderate to high mobility in soils. Not expected to hydrolyze.	Direct photochemical degradation occurs if RDX is released to surface water (half life of 1.5 hrs). Direct photodegradation will also occur.	Biodegradation is not an important fate process, but anaerobic degradation in soil can occur. Bioaccumulation in aquatic organisms should not be significant.

Table 3-8. Fate and Transport for the Organic Contaminants of Concern (continued)

Contaminant	Soil	Water	Air	Biological Systems
2,3,7,8-Tetrachloro-dibenzo-p-dioxin Based on similar chemical structures, the other dioxin and furan contaminants of concern are expected to behave similarly: Octachlorodibenzodioxin Octachlorodibenzofuran Tetrachlorodibenzo-p-dioxins Tetrachlorodibenzofurans Hexachlorodibenzo-p-dioxins Hexachlorodibenzofurans Heptachlorodibenzo-p-dioxins Heptachlorodibenzofurans Pentachlorodibenzofurans	Based on chemical characteristics, expected to adsorb to soil and be resistant to leaching.	Not soluble. Expected to adsorb to soil/sediment. Not expected to hydrolyze or photolyze.	Not volatile. May adsorb to airborne particulates, with removal by wet and dry deposition.	Resistant to biodegradation. Based on physical properties, may bioconcentrate.
Tetryl	---	---	---	---
Toluene (Howard, 1990)	Moderate to very high mobility in soil. Susceptible to leaching. Does not significantly hydrolyze.	Does not significantly hydrolyze, photolyze, or adsorb to sediment.	Highly volatile. Volatilization from surface soil and water is a significant fate process. Degrades by reaction with hydroxyl radicals (half life 3 hours to a day). Will also wash out with rain. Not subject to direct photolysis.	Readily biodegradable. Biodegradation is possible in soil and water. Bioaccumulation is not significant.

Table 3-8. Fate and Transport for the Organic Contaminants of Concern (continued)

Contaminant	Soil	Water	Air	Biological Systems
Trichloroethylene (Howard, 1990)	Highly mobile in soil and susceptible to leaching. Hydrolysis is not an important process.	Does not significantly hydrolyze, photolyze, or adsorb to sediment.	Highly volatile. Volatilization from surface soil and water is a significant fate process. Degrades fairly rapidly through reaction with hydroxyl radicals (residence time of about 5 days). Not subject to direct photolysis.	Resistant to biodegradation. Slow biodegradation is possible under aerobic and anaerobic conditions. Bioaccumulation is not significant.
1,3,5-Trinitrobenzene (SEC Donohue, 1992b)	Expected to be mobile in soil and subject to leaching.	May photolyze.	May exist partly in vapor phase and partly adsorbed to particulate matter.	May biodegrade. Not expected to bioaccumulate.
2,4,6-Trinitrotoluene (SEC Donohue, 1992b)	Expected to be mobile in soil and subject to leaching.	Not expected to hydrolyze.	Exists largely in the vapor phase, based on vapor pressure. Slow removal through reaction with hydroxyl radicals (half-life 110 days).	Biodegrades slowly under aerobic conditions. Not expected to bioaccumulate.

*---Indicates lack of data.

Henry's Law coefficient (between 10 and 100 atm) are resistant to volatilization; and contaminants that have low Henry's Law coefficients (< 10 atm) tend not to volatilize.

3.4.2 Fate and Transport of Metal Contaminants

The fate and transport of metal contaminants is complex and is generally dependent upon the valence state of the metals and other factors such as the organic content, cation-exchange-capacity, and pH of the soil; and ionic strength, pH, and Eh of the pure water or groundwater. Typically, trace metals tend to adsorb to soil and are leachable under certain geochemical conditions. The fate and transport characteristics of the metal contaminants of concern, based on information that is available from the National Library of Medicine Database (NLM, 1989 and 1990; NLM, 1991 and 1992), are presented in Appendix H.

3.4.3 Vadose Zone Contaminant Fate and Transport

The EPA semi-analytical models HELP and MULTIMED (Sharp-Hansen and others, 1990) were obtained from the EPA to evaluate the potential migration of contaminants through the vadose zone, from their near-surface soil source to the water table. The HELP model was used to compute precipitation and leachate infiltration through a landfill, while MULTIMED was used to estimate contaminant travel times through the unsaturated zone. HELP contains a data base that contains climatological information for major cities across the United States. With this information, in addition to shallow subsurface properties, HELP creates an output file that contains precipitation and percolation rates, which are used as input for MULTIMED simulations.

The objective of this section is to present a simple model that represents the potential of contaminants to migrate vertically through the unsaturated zone and be incorporated into the groundwater. This model consists of two parts: (1) a conceptual model that is based on the hydrogeologic information presented by previous investigations, and (2) a semi-analytical model based on the principles of unsaturated solute transport. The theory of unsaturated flow is applied to the conceptual model through the use of the EPA semi-analytical groundwater flow and contaminant transport model MULTIMED. Because of the complexity of contaminant velocity calculations in the unsaturated zone, it is necessary to utilize an accepted method for performing these calculations.

MULTIMED was chosen over other models because it allows rapid calculations and easy access to the input files to facilitate a sensitivity analysis. Thus, it is possible to run the model numerous times while changing only one variable at a time. This is very useful since there is little site-specific data on the hydrogeologic conditions within and adjacent to the operable units. Consequently, assumptions must be made to estimate the values of key input variables, such as saturated hydraulic conductivity, porosity, longitudinal dispersion, and residual water content. This approach allows bracketing of the possible solution based on the range of values possible for the key input variables.

Vadose zone transport simulation using MULTIMED is controlled by two modules. The first is a transient, one-dimensional, semianalytical module that simulates flow in the unsaturated zone. The output from this module, in the form of water saturation as a function of depth, is used as input for the unsaturated transport module. This module simulates transient vertical transport in the unsaturated zone and takes into account the effects of longitudinal dispersion, linear adsorption, and first order decay. Output from these two modules is used in the semi-analytical saturated zone transport module. The saturated module must be used for MULTIMED simulations, although in this conceptual model only the unsaturated zone is evaluated.

The following paragraphs present the conceptual model for a generic site at TEAD-N, the assumptions made to estimate key input variables, and the results of the contaminant transport calculations in the unsaturated zone.

3.4.3.1 *Conceptual Model*

Although shallow (less than 100 feet bgs) groundwater is not present within the TEAD-N area, deeper groundwater is present within the upper 300 feet. There are no known confining or semi-confining strata between the surface contamination and the water table. Additionally, there are no significant lithologic changes in the upper 300 feet of strata. The vadose zone between the surface-soil contamination and the water table consists primarily of sand, gravel, silt, and clay, deposited as unconsolidated Quaternary and Pleistocene alluvial deposits and associated facies. Figure 3-3 presents a schematic cross section of the TEAD-N area.

For the purpose of this model, the unsaturated zone is represented by one layer of homogeneous and isotropic material. The unsaturated flow is simulated in one dimension with only longitudinal dispersion. In order to remain conservative, retardation is considered to be negligible. Thus, contaminants that tend to precipitate or sorb onto the aquifer material would tend to migrate at a slower rate than indicated by this model. Key variables such as saturated hydraulic conductivity and residual water content were derived primarily from literature on the area's hydrostratigraphy and from tables accompanying the MULTIMED user documentation. (The term "saturated hydraulic conductivity" applies to the conductivity in the unsaturated zone, is defined as $K_{(0)}$, and is dependent on the negative pressure head in the soil.) Figure 3-4 shows the conceptual model on which the following simulation is based.

3.4.3.2 *Simulations and Results*

The simulation process proceeded in two steps. The first step was to estimate the values for the key input variables based on the current knowledge of the hydrostratigraphy. Subsequently, two scenarios were simulated: (1) steady-state (where pressure head and concentration do not change with time) and (2) transient (where pressure head and concentration do change with time). The results of these simulations yielded the best estimates of the real world travel time. In the second step, several simulations were run while changing the input values for the key variables (i.e., saturated hydraulic conductivity, porosity, longitudinal dispersion, and residual water content). The results of the second step

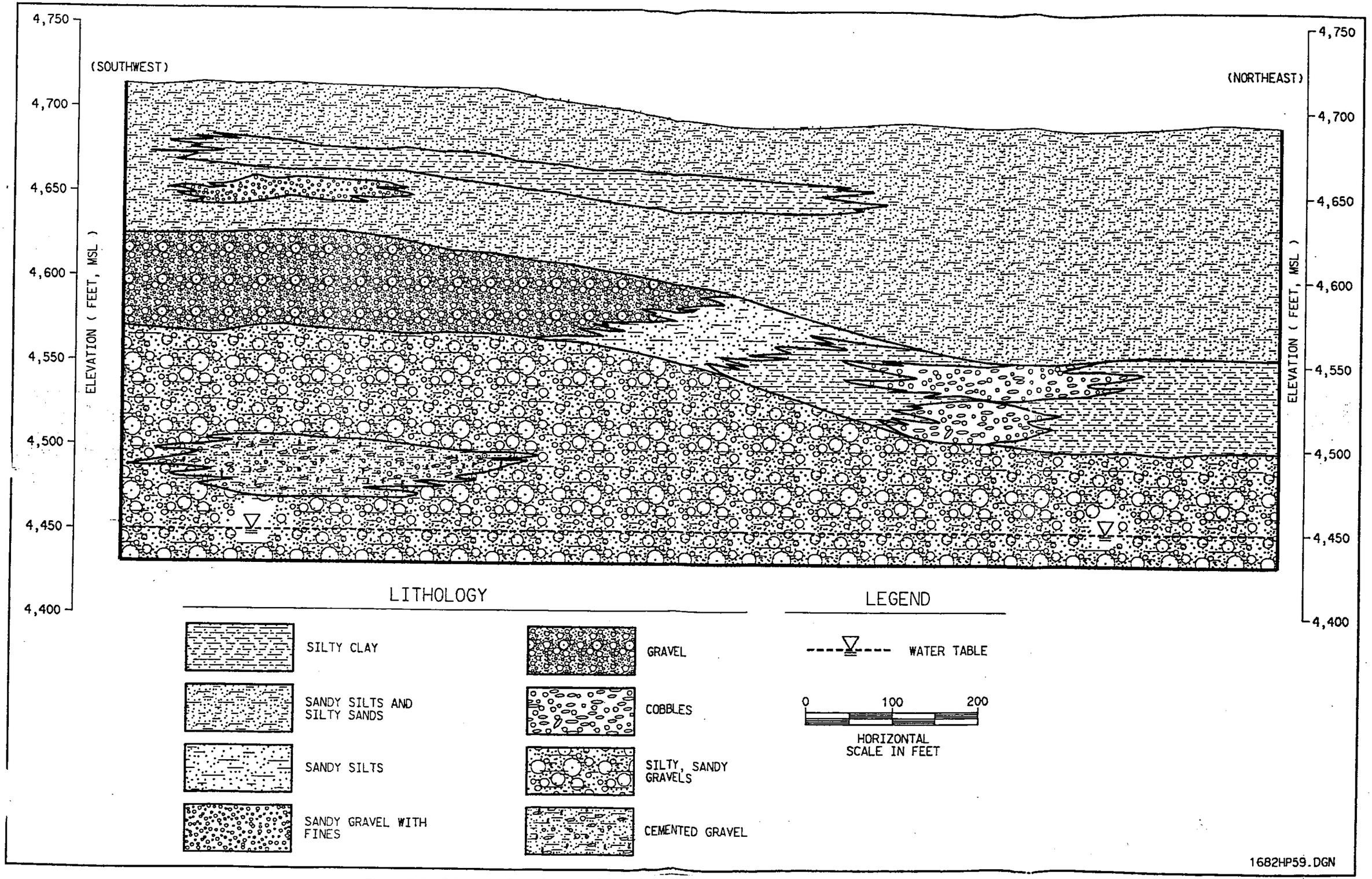


Figure 3-3. Schematic Cross-Section of the TEAD-N Area

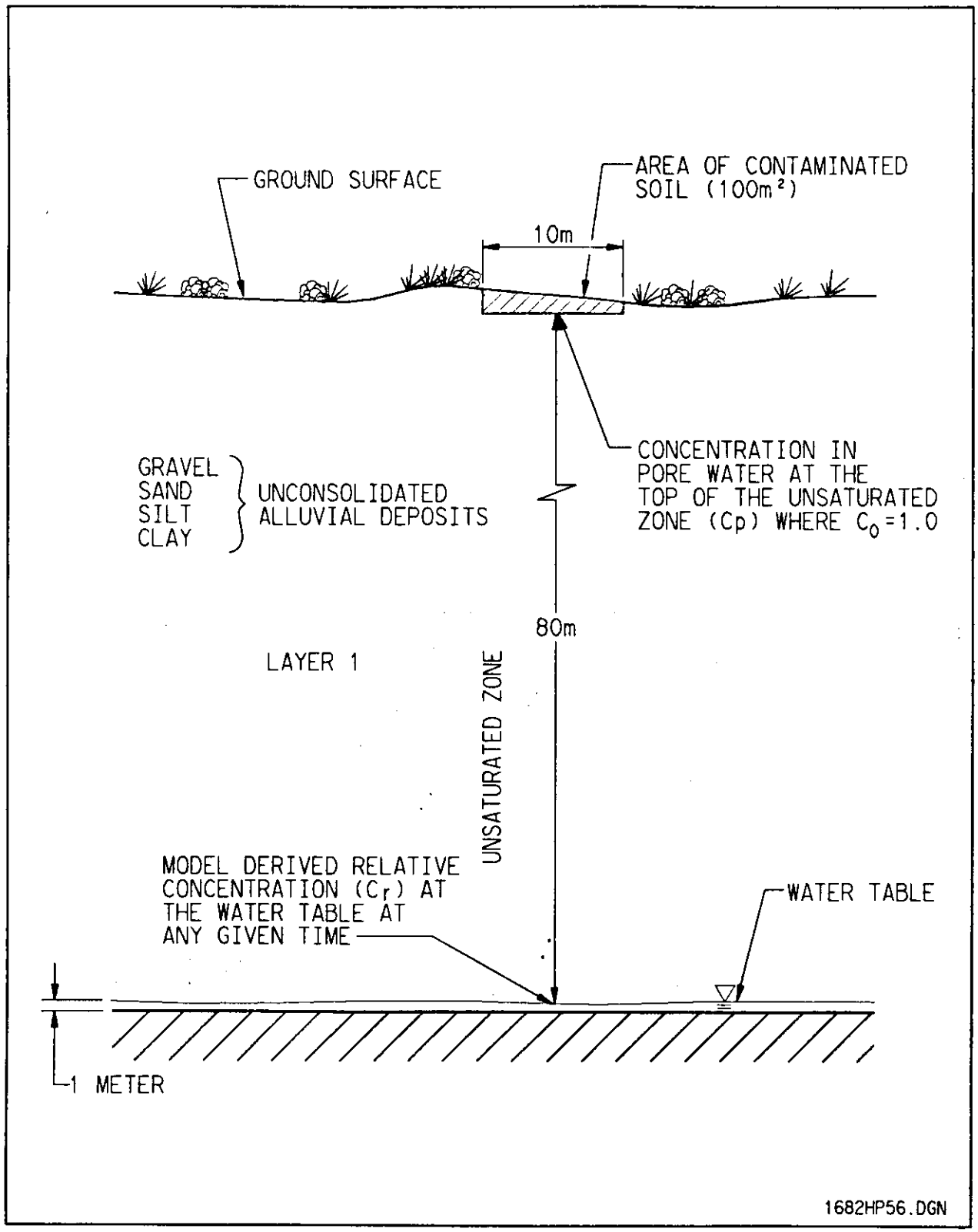


Figure 3-4. Schematic Diagram Showing the Conceptual Model for the MULTIMED Simulations

qualitatively indicated the amount of variability associated with uncertainties in the various parameter estimates.

The initial input values for MULTIMED were obtained from the HELP model and from tables in the MULTIMED user documentation. The infiltration and precipitation rates, estimated by HELP and based on Salt Lake City climatological data, were 0.063 and 0.41 meters per year, respectively. Additionally, several hydrological and geological parameters for the unsaturated zone (see Layer 1, Figure 3-4) must be assigned values. For TEAD-N, there are approximately 80 meters (m) of unsaturated gravelly sand above the water table.

For the unsaturated zone, a conductivity of 3.6 centimeters per hour (cm/hr) was assigned, with a porosity of 0.28, a longitudinal dispersion coefficient of 1.0 m, and a residual water content of 0.065.

Since MULTIMED simulations must include the saturated zone module, 1.0 m of the saturated zone (the minimum allowed) was included in the model. A groundwater gradient of 0.007 with a conductivity of 0.0023 m/yr was estimated for this unit. The organic carbon content of this unit was estimated to be 0.0006 percent, while longitudinal, transverse, and vertical dispersivities were estimated to be 3.0 m, 1.0 m, and 0.168 m, respectively.

3.4.3.2.1 ***Steady-State Simulation.*** The steady-state scenario is based on the assumption that the source is never removed and that the contaminant pulse is generated by a continuous source through time. In this case, a steady-state solution was simulated to estimate the maximum relative solute concentration at the water table, once the system reaches equilibrium. To simulate this condition, the input values described above were used, and the model was set to calculate a steady-state solution. The results from this simulation indicate that once the system has reached equilibrium, the relative concentration (C_r) at the water table is 0.82E-02 or 0.82 percent of the original pore water concentration in the source area (C_0). Since this is a steady-state solution, the estimate of C_r should not be exceeded at any point in time. The model does not estimate a time at which the system reaches the steady-state condition.

3.4.3.2.2 ***Transient Simulation.*** For the transient scenario, the contaminant source was assumed to be a continuous pulse over the first 40 years of the simulation. The 40-year pulse interval is a conservative estimate based on the activity associated with Operable Unit 7, Site 36. It assumes that the source has already been present for 30 years and will be removed within an additional 10 years. Additionally, a continuous source pulse was also simulated and the results were compared to the results of the 40-year source pulse.

MULTIMED was run initially for a period of 126 years at 5-year time intervals. This initial run indicated that the leading edge of the contaminant plume would reach the water table between 106 and 111 years. Subsequently, the last four timesteps were modified to represent the period between 106 and 109 years in 1-year intervals. The resulting simulation indicated that the leading edge of the plume would reach the water table in 107 years.

Table 3-9 shows the relative contaminant concentration (C_r) for a hypothetical contaminant (C) at the various time steps simulated. This relative concentration at 107 years was calculated to be 0.66E-04 (0.0066 percent) of the original pore water concentration (C_0) of 1.0.

The model derived solute concentrations, as they arrive at the water table, are expressed in terms of relative concentrations. The model may be applied to any contaminant of concern by simply converting to the solute specific concentration by multiplying the initial concentration by the relative concentration calculated from the model. This conversion is illustrated by the following example:

The initial measured/estimated concentration of solute **X** in pore water (C_p) in the contaminated soil zone is 500 μg/L.

The initial relative concentration of **X** in pore water (C_0) in the contaminated soil zone is 1.0E+00.

The relative concentration of **X** calculated by the model at the water table (C_r) is 0.23E-02.

$C_r/C_0 = C/C_p$ (**C** = contaminant concentration).

Since C_0 is equal to 1.0, $C_r \times C_p = \mathbf{C}$. Therefore, the predicted concentration of Solute **X** at the water table is 0.23E-02 x 500 μg/L = 1.15 μg/L = **C**.

Therefore, based on the above assumptions and the model derived relative concentration, the leading edge of the simulated plume would reach the water in 107 years at a concentration of 0.0066 percent of the original concentration.

The model input was subsequently revised to calculate the time at which the plume would reach the maximum concentration at the water table assuming that the source pulse was 40 years. The time increments were set at 2 years, beginning at 150 years and continuing through 200 years. The results indicate that the plume would reach a maximum concentration of 0.38 percent of C_0 (the original pore water contaminant concentration in the source area) in 160 years.

The model was again modified to simulate the period between 50 and 300 years by setting the time increments to 10 years with 25 time steps. In addition, the model was run for two scenarios. The first scenario simulated removal of the contaminated soils after a source pulse of 40 years. The second simulation considered no remediation and a continuous source through the 300-year period. The results of these simulations are presented in Figure 3-5. The scenario that includes remediation shows the plume concentrations increasing to 0.39 percent of C_0 at 160 years, then decreasing to 0.00 percent at 290 years; whereas the scenario without remediation shows the plume concentration increasing to 0.70 toward the end of the 300-year period.

Table 3-9. Model Derived Concentrations at Top of Water Table at Various Time Steps for the Transient Plume Simulation with a Contaminant Pulse Duration of 40 Years

Time (years)	Concentration (C_r)
1	0
6	0
11	0
16	0
21	0
26	0
31	0
36	0
41	0
46	0
51	0
56	0
61	0
66	0
71	0
76	0
81	0
86	0
91	0
96	0
101	0
106	0
107	6.6E-05
108	1.2E-04
109	1.7E-04

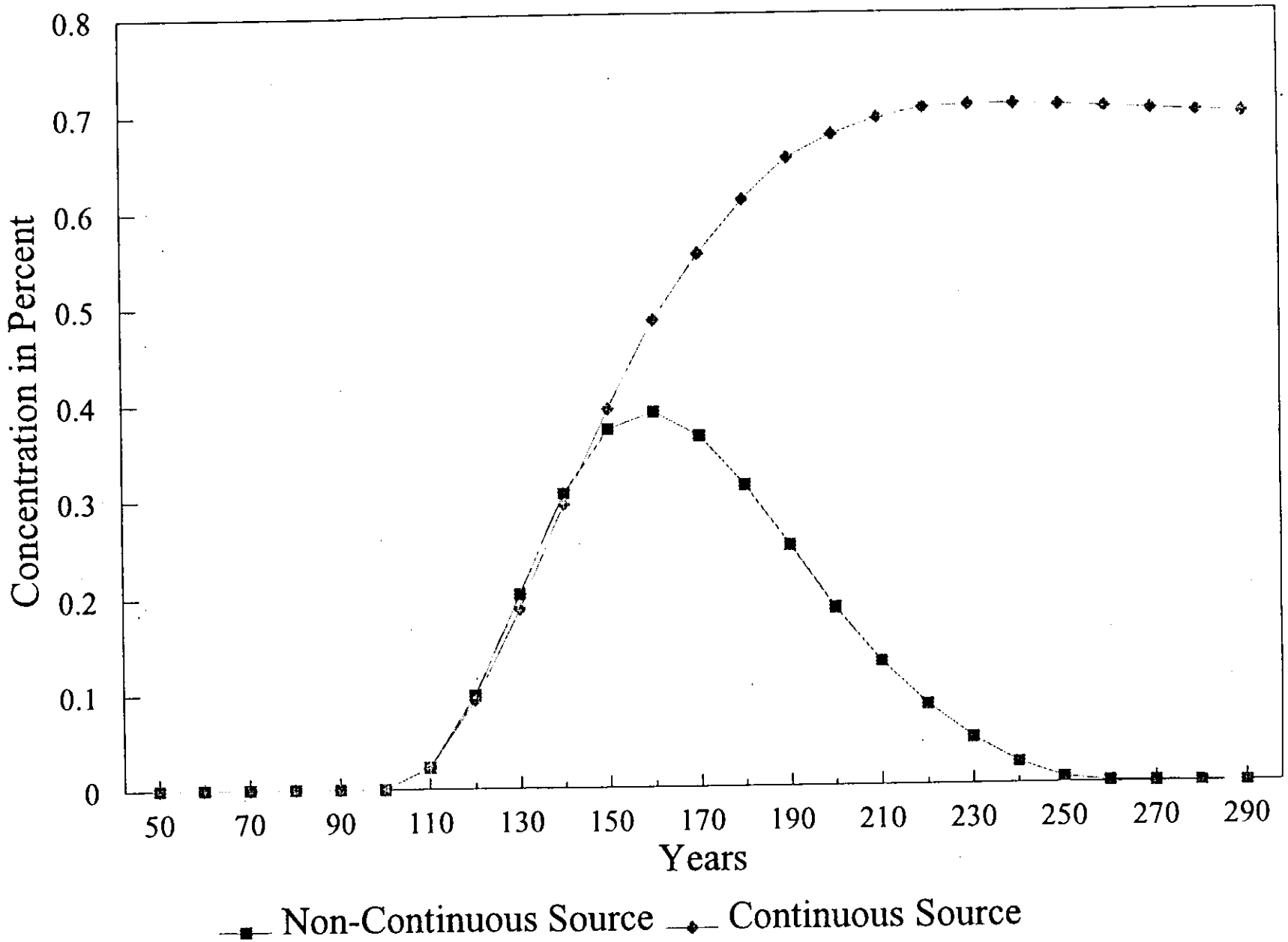


Figure 3-5. Time Versus Concentration Plot for the 40-Year Source Pulse and the Continuous Source Pulse

3.4.3.3 *Sensitivity Analysis*

To qualitatively assess the effects that various key parameters have on the model results, a simplified sensitivity analysis was conducted on the transient simulation. This analysis consisted of modifying the key input variables individually while holding the remaining variables constant and comparing the model results. The variables selected for this analysis consists of the saturated hydraulic conductivity, the porosity, the longitudinal dispersivity, and the residual moisture content. The simulations began with the scenario described in the preceding section. Table 3-10 shows these initial variable input values (run number 1) and summarizes the modifications that were subsequently made. Table 3-11 shows the results of these nine runs by summarizing the time at which the leading edge of the plume reached the water table and the associated C_r, and the time at which the maximum C_r reached the water table. To facilitate this sensitivity analysis, the model timesteps were set to run from 40 years to 300 years at 5-year increments, with a source pulse duration of 40 years.

Table 3-10. Key Variable Input Values for the Nine Sensitivity Analysis Simulations

Model Run	Saturated Hydraulic Conductivity (cm/hr)	Porosity	Longitudinal Dispersion (meters)	Residual Water Content
1	3.6	0.28	1.0	0.065
2	36.0	*	*	*
3	0.36	*	*	*
4	3.6	0.40	*	*
5	*	0.15	*	*
6	*	0.28	10.0	*
7	*	*	0.01	*
8	*	*	1.0	0.10
9	*	*	*	0.03

*Variable did not change from the previous simulation.

It is apparent from Table 3-11 that all four variables substantially affect the model results. However, in the worst case, the leading edge of the plume does not reach the water table within the first 40 years. The effect of the longitudinal dispersivity was particularly interesting since, by using the smallest value allowed by the model (0.001 m), the simulation approached a condition representing advective transport (i.e., the plume moves only as fast as the pore fluid, and dispersion is negligible). In this case, it was estimated that the simulated plume would not reach the water table for at least 160 years and would completely pass through the unsaturated zone within 200 years. This agrees favorably with simulation

number 1 (Table 3-11), where the maximum plume concentrations were reached at approximately 160 years. It should also be noted that, although some of the parameter input values were changed by an order of magnitude, the resulting C_r at a given time only changes by a factor of two or three.

Table 3-11. Results of the Nine Sensitivity Analysis Runs, Showing the Times at which the Leading Edge of the Simulated Plume and Maximum Plume C_r Reaches the Water Table

	Plume Leading Edge		Plume at Maximum Concentration	
Run	**T_L (years)**	**C_r**	**T_m (years)**	**C_r**
1	107	0.66E-04	160	0.38E-02
2	90	0.75E-04	135	0.44E-02
3	135	0.10E-03	195	0.32E-02
4	135	0.16E-03	190	0.32E-02
5	80	0.16E-03	125	0.49E-02
6	45	0.57E-04	125	0.19E-02
7	145	0.81E-03	160	0.19E-02
8	135	0.24E-03	190	0.22E-02
9	85	0.24E-03	130	0.47E-02

3.4.3.4 *Conclusions*

The steady-state simulation indicates that the maximum concentration at the water table would be 0.88E-02 (0.88 percent) of the original pore water concentration in the source area once the unsaturated flow and transport systems reached equilibrium.

The transient simulation indicates that the leading edge of the simulated plume would reach the water table in approximately 107 years at a relative concentration (C_r) of 0.66E-04 (0.0066 percent) of the original pore water concentration in the source area (C_p). Additionally, the maximum C_r of the simulated plume would reach the water table in approximately 160 years at a concentration of 0.38E-02 (0.38 percent) of C_p .

If the contaminants were remediated after being present in the soils for 40 years, the advective portion of the plume would pass through the unsaturated zone within 200 years.

This model is limited by the fact that very little field data are available to facilitate estimates of input variables. The results of the simple sensitivity analysis shown in Table 3-10 give a general indication of the magnitude of the variation associated with the lack of data. Thus, as field data become available, the model should be modified to incorporate the new data.

In general, this model is a useful tool in generating qualitative estimates of contaminant travel times in the unsaturated zone underlying the TEAD-N site. However, data should be collected to enhance the model input values, thus facilitating more accurate results and more site-specific modeling of the various remedial action scenarios.

3.5 BASELINE RISK ASSESSMENT METHODOLOGY

The purpose of the Baseline Risk Assessment (BRA) is to evaluate potential human health risks associated with the no-action alternative. There are four major steps in the baseline risk assessment process. The initial step of the assessment, data collection and evaluation, involves the identification of chemicals present at the site that pose a potential risk to human health based on their prevalence and concentration in the environment and inherent toxicity. After potential contaminants of concern are identified, an exposure assessment is performed to evaluate the pathways by which humans could potentially contact the contaminants. Then, a toxicity assessment is conducted to estimate the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects. The final step, risk characterization, consists of determining the magnitude and probability of current and future human health risks associated with the contaminants of concern. The following sections describe the methods used to complete each of the four steps.

Where the extent of contamination has been defined, exposure pathways are complete and the risk assessment thoroughly characterizes any adverse health effects in a conservative manner. However, for 11 of the 17 sites addressed by this RI, the assessment of contamination has not been fully defined. These sites are presented in Table 3-12.

Additional data needs have been identified and are currently being addressed for the 11 sites. The evaluation of adverse health effects derived for each of these sites "as is", could be an underestimate of the health risk actually associated with the sites. This is reflected in the BRA where data deficiencies have led to incomplete exposure pathways and, consequently, there are inconsistencies in the risk assessment analysis performed for these sites. These inconsistencies will be rectified in an addendum to this report following the collection of additional data.

3.5.1 Data Collection and Evaluation

Data collection and evaluation involved gathering and analyzing site data relevant to the human health evaluation. For each site, contaminants of concern were identified that pose a potential risk to human health based on their prevalence and concentration in the environment and their inherent toxicity. Methods used in data collection and evaluation are discussed in Sections 3.1 through 3.4.

Table 3-12. The Eleven Sites Scheduled for Additional Field Investigation at TEAD-N

Operable Unit	Site No.	Site Name
4	31	Former Transformer Boxing Area
	32	PCB Spill Site
	35	Wastewater Spreading Area
8	6	Old Burn Area
	7	Chemical Range
	13	Tire Disposal Area
	22	Building 1303 Washout Pond
	23	Bomb and Shell Reconditioning Building
	36	Old Burn Staging Area
9	8	Small Arms Firing Range
	40	AED Test Range

3.5.2 Exposure Assessment

Potential human exposure pathways for TEAD-N were identified for current and future land use scenarios (Table 3-13). The current land use scenarios characterize the activities and activity patterns of the potentially exposed populations associated with TEAD-N. Although no specific plans currently exist to change the use of TEAD-N, the future land use scenarios are evaluated. Because residential land is most often associated with the greatest exposures, it is generally the most conservative choice to make when deciding what type of possible land use may occur in the future. The land that makes up the maintenance area (which includes all or parts of OUs 4, 5, and 6) is currently envisioned to be closed and used for industrial purposes by private firms or other government entities. Discussion of closure and re-use of other portions of TEAD-N are underway, but final information is unavailable. However, a residential land use scenario was used to characterize future risk of human exposure for all sites at TEAD-N.

A complete pathway includes chemical source/release, retention or transport medium, exposure point, and route of exposure. Potential human-exposure pathways include incidental soil ingestion, dermal contact, inhalation of fugitive dust, consumption of beef derived from cattle grazing at TEAD-N, and consumption of produce hypothetically grown at TEAD-N.

To address health risks associated with the inhalation pathway, air quality impacts related to VOC and particulate emissions from TEAD-N were derived.

Table 3-13. Exposure Pathway Summary

Exposure Pathway	On-site Worker	Site Specific Worker	Construction Worker	Installation School	Installation Resident	Off-site Resident	Future On-site Resident
DERMAL	X	X	X				X
INGESTION	X	X	X				X
INHALATION	X	X	X	X	X	X	X
BEEF					X	X	X
PRODUCE							X

Air emissions of toxic compounds from the sites can occur by either direct volatilization or by entrainment of contaminated dust from wind erosion. With entrainment, it is assumed that small amounts of the organic compounds or heavy metals are adsorbed onto the surface of dust (soil) particles. At ambient temperatures, the heavy metals can only become airborne by entrainment. The organics can become airborne through either entrainment or volatilization. However, some organics strongly adsorb to soils and exhibit low volatilization rates.

A volatilization emission analysis was performed using a volatilization release estimation equation designed for chemicals spilled or incorporated into soils (EPA, 1988). Results from this analysis indicated negligible air quality impacts derived from volatilization releases from sites located on TEAD-N. In addition, results from previous modeling conducted for adjacent sites with similar VOC concentrations revealed insignificant releases (Rust E&I, 1992b). However, because of fate and transport characteristics of the chemicals detected at Operable Units 4 through 10, potential human exposure from fugitive dust emissions was considered in the risk assessment.

Deposition of airborne contaminants was also evaluated as a potential exposure pathway for human receptors located apart from the operable units. Deposition rates were estimated using the dry deposition formula described in the EPA document, "User's Guide for the Industrial Source Complex (ISC2) Dispersion Models" for particles with a mean diameter of 10 to 30 microns. Particles with a mean diameter greater than 30 microns will generally settle within a few hundred feet of the emission source (EPA, 1988). Particles with a mean diameter of less than 10 microns will tend to be reflected from the ground surface and stay airborne (EPA, 1992). Conservative estimates were made for the deposition rates by assuming a zero reflection coefficient for the 10-to-30-micron particles. Final contaminant concentrations in the soil were then estimated by assuming that the contaminants, upon deposition, would settle within the first 3 centimeters of the existing soil.

Preliminary results showed negligible contaminant concentrations in the soil located at the closest installation boundary. Based on this, incidental soil ingestion and dermal contact were not considered potential risk contributors to human receptors located apart from the operable units.

Cattle grazing is permitted at TEAD-N, with grazing allotments competitively bid and leased every 5 years. Grazing at TEAD-N typically occurs between October 15 and May 31, with calving taking place in January. The calves remain at the facility until May 31 when they are either moved to feed lots or to other grazing areas. The calves typically do not return to TEAD-N after their initial exposure, and they are eventually sold as slaughter cattle for human consumption. The cows are normally utilized as breeding stock and may or may not return to the site during consecutive years.

3.5.2.1 *Identification of Potentially Exposed Populations*

3.5.2.1.1 ***Current Land Use***. Based on a review of census reports, discussions with representatives of TEAD-N, and the cities of Tooele, Stockton, and Grantsville, potentially exposed populations under current land use would be on-site workers, site-specific industrial workers, security personnel, construction workers, installation residents, off-site residents, and students and employees of Tooele Alternative High School. Risk estimates for the site-specific industrial worker and security personnel will be evaluated using the on-site worker scenario. This provides a conservative exposure estimate for all depot employees since the on-site worker is assumed to have the highest exposure frequency and accessibility to the Operable Units. Public access to the facility is controlled, thereby precluding transient exposure.

On-base housing for both civilians and military families is located in the administrative area of TEAD-N. There are 30 military personnel and 62 dependents currently living in on-base housing, for a total of 92 people. The average residence time for the last 5 years is approximately 1 year. No produce (e.g., vegetables, fruit) is grown at TEAD-N. Tooele Alternative High School, a 4-year alternative high school, is located within TEAD-N boundaries. It has 42 full-time and 100 part-time (2 hours/week) students.

The land surrounding TEAD-N is predominately undeveloped and used for livestock grazing, rangeland, and limited cultivation. Residential development within the city of Tooele abuts the northern boundary of TEAD-N. Populations potentially exposed to site-related chemicals are residents of Tooele, Stockton (approximately 3 miles to the south), and Grantsville (approximately 2 miles to the north). Potentially sensitive sub-populations in these areas would be children, students in Grantsville and Tooele public schools, and patients in hospitals. There are no public schools in Stockton. The number of students enrolled in Grantsville and Tooele public schools are 1,530 and 4,088, respectively.

Under current land use, human receptors include the on-site worker, construction worker, installation resident, installation school student/employee, and off-site residents from the nearby cities of Tooele, Stockton, and Grantsville. The on-site worker and construction worker are potentially exposed to contaminants through incidental soil ingestion, dermal contact, and inhalation of fugitive dust. For the installation resident and off-site residents, inhalation of fugitive dust and consumption of beef derived from cattle grazing on TEAD-N were considered complete, potential exposure pathways. Incidental ingestion of soil, inhalation of fugitive dust, and dermal contact were considered complete exposure pathways only for the on-site worker and construction worker due to restricted access to TEAD-N.

Dermal contact and soil ingestion pathways will be considered in the risk estimates for the eleven sites requiring additional sampling.

3.5.2.1.2 *Future Land Use*. On-site land use at TEAD-N could change in the future. While not planned, the most likely land use changes would be additional development or use of areas within the operable units by the Army. Development of the majority of TEAD-N as a residential area or other public use area is uncertain at this time. If the Army decides in the future to release TEAD-N property for public use and such property has been found to pose a hazard to human health and the environment, a Base Realignment and Closure (BRAC) site investigation and risk assessment would be required before any such release. However, for the baseline risk assessment conducted for each site, residential land use was chosen as a conservative exposure scenario.

Complete exposure pathways considered for the future on-site resident are incidental ingestion of soil, dermal contact, inhalation of fugitive dust, consumption of beef derived from cattle grazing on-site, and consumption of produce grown on-site.

3.5.2.2 *Derivation of Exposure Point Concentrations*

For Operable Units 4 and 6 through 10, data from the current RI field activities undertaken by Rust E&I in 1992 were used to estimate exposure concentrations for contaminants of concern in the different media of exposure (e.g., soil, beef, produce, air). For Site 32 in OU 4 and Site 17 in OU 5, existing data from the Preliminary Assessment/Site Investigation (EA, 1988) were used to estimate exposure concentrations for the contaminants of concern.

Two exposure cases were analyzed for each scenario evaluated in the risk assessment. The average or central tendency risk description is the arithmetic mean risk and is derived by using average exposure values. The reasonable maximum exposure (RME) is the high end risk. The RME is estimated by combining upper bound values (95 percent upper confidence limits of the arithmetic mean) so that the results represent an exposure scenario that is both protective and reasonable (EPA 1991).

Air dispersion modeling was performed to estimate exposure-point concentrations for airborne contaminants derived from fugitive dust emissions from TEAD-N sites based on a particle size of 10 to 30 microns (the range of particulates that can be transported and deposited). For the purpose of protecting the public health against the "worse case" pollutant concentrations, maximum 1-hour average concentrations (not exposure durations) were estimated and used for on-site and off-site receptors. Off-site residential impacts were modeled at nearest town boundaries for Tooele, Stockton, and Grantsville. Impacts for on-site receptors, including the installation school student/employee and installation resident, were based on air concentrations estimated to be present at the site.

The air model used was the refined Industrial Source Complex Short Term Model (ISCST2) Version 91323. Emission rates were estimated dependent on wind speeds greater than 11 meters per second using the erosion potential equation described in the EPA document,

Control of Open Fugitive Dust Sources. Emissions were modeled as area sources equal to the general area where soil samples were taken. The shortest distance from each site to the installation/town boundary was used to model impacts to off-site receptors. Impacts to on-site receptors were modeled using a box-model approach. In all cases, the receptor elevations were assumed to be the same as the source elevations. This resulted in the most conservative impact estimates.

To evaluate health risks associated with the consumption of homegrown beef and produce grown on-site, contaminant levels were estimated for plants grown at each site. The extent to which plants will absorb contaminants will vary with plant species and on a chemical-by-chemical basis. Since no bioassays were collected at TEAD-N, plant concentrations were estimated using published plant-chemical uptake factors. Where uptake factors were not available, inferences concerning the uptake were made based on physicochemical properties of the contaminant and the soil-contaminant matrix. As a conservative approach, the concentration of contaminants in the shoot and/or edible part of the plant was considered the same as the concentration in the roots of the plant. Most likely this would not be the case since accumulation of chemicals in plants generally follow three distinct steps:
(1) partitioning of lipophilic chemicals to lipophilic root solids, (2) uptake of polar compounds (high degree of water solubility) into the aqueous phase within the roots, and (3) translocation to the shoots of compounds exhibiting intermediate polarity (Briggs et al., 1982).

Generally, the halogenated hydrocarbons are not expected to be present at significant levels in most plants because of their volatility, adsorption to soil particles, and degradation in soil. In addition, organic chemicals that are stable or have nigh lipophilicity generally are not taken up by plants. An example of these types of chemicals would be the polychlorinated dibenzodioxins (PCDDs) which have a reported plant uptake of about 0.1 percent (Paustenbach, 1989; Wifp et al., 1983). For this risk assessment, 1.0 percent was considered an appropriate and conservative plant uptake for contaminants similar in physicochemical properties to the PCDDs.

For the potential exposure to contamination through consumption of beef, a ratio of contaminant concentration in beef to the concentration in the diet was identified. A ratio of 5:1 has been reported for PCDD concentration in beef fat to the concentration in the diet (Paustenbach, 1989). It has also been reported that the highest concentration of PCDD would accumulate in the fat and liver (Jones et al., 1987). For this risk assessment, a 5:1 beef-fat/liver-to-diet ratio was assumed for contaminants similar in physicochemical properties to the PCDDs. In addition, both dry feed and soil ingestion were used to estimate contaminant levels in the beef although soil ingestion has been identified as the primary route of uptake of environmental contamination by grazing or confined cattle (Kostecki et al., 1989).

3.5.2.3 *Development of Chemical Intakes*

Chemical specific intakes or chronic daily intakes (CDI) were calculated for the identified exposure pathways. The equations used to determine these exposures and the assumptions employed in the equations are discussed in the following sections for both the current land use and future land use scenarios.

3.5.2.3.1 *Current Land Use*

<u>On-Site Worker - Soil/Ingestion</u>

The intake equation for ingestion of chemicals in soil by workers is presented in Equation 1 as

$$Intake\ (mg/kg\text{-}day) = \frac{Cs \times IR \times FI \times EF \times ED \times CF}{BW \times AT}$$

(Equation 1)

where

Cs = concentration of contaminant in soil (mg/kg),
IR = adult ingestion rate (0.05 g/day for average; 0.1 g/day for RME; EPA, 1993),
FI = fraction ingested from chemical source (1.0),
EF = exposure frequency (250 days per year; EPA, 1991),
ED = exposure duration (10 years for average; 25 years for RME; EPA, 1993),
CF = conversion factor (10^{-3} kg/g),
BW = adult body weight (70 kg; EPA, 1993), and
AT = averaging time (25,550 days for carcinogens = 70 year lifetime x 365 days/year; 3,650 days for non-carcinogens = exposure duration of 10 years average exposure x 365 days/year or 9,125 days for non-carcinogens = exposure duration of 25 years RME x 365 days/year).

The contaminant concentration (95 percent upper confidence limits (UCL) on the arithmetic mean) in the surface soil was used to estimate the CDI. The soil ingestion rate of 0.05 grams per day for the average exposure case and 0.1 grams per day for the RME case are standard default values recommended by EPA (1993) for commercial/industrial land use. The fraction ingested from a chemical source is 1.0, calculated under the assumption that all soil ingested by industrial workers is derived from the contaminated sites in the industrial area. The exposure frequency of 250 days per year is the standard EPA default for commercial/industrial land use. A worker is assumed to remain at TEAD-N for 10 years on the average, and for 25 years as a reasonable maximum upper duration (EPA, 1993). The standard default parameters of 70 kilograms (154 pounds) for adult body weight and 70 years for average life span are assumed (EPA, 1993). The averaging time used for carcinogens is 365 days per year for a 70 year lifetime, and for non-carcinogens is 365 days per year for the applicable exposure duration (10 years average exposure; 25 years RME). The difference in averaging times relates to the different mechanisms of action for carcinogens and noncarcinogens, based on the assumption that a higher dose of a carcinogen received over a shorter period of time is equivalent to a corresponding lower dose spread over a lifetime (EPA, 1989). The averaging time for noncarcinogens is for the duration of exposure, not for a lifetime.

On-Site Worker - Soil/Dermal Contact

Potential exposures of on-site workers through dermal contact with chemicals in the soil were calculated using the equation

$$Absorbed\ Dose\ (mg/kg\text{-}day) = \frac{Cs \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT}$$

(Equation 2)

where

Cs = concentration of contaminant in soil (mg/kg),
SA = skin surface area for contact (4,300 cm^2/day; EPA, 1990),
AF = soil-to-skin adherence factor (0.2 mg/cm^2 for average; 1.0 mg/cm^2 for RME; EPA, 1992),
ABS = adult skin absorption factor (0.001 (0.1%) for inorganics, 0.01 (1.0%) for organics EPA Region VIII recommendations; EPA, 1992, pp. 6-12, 6-13),
EF = exposure frequency (250 days per year; EPA, 1991),
ED = exposure duration (10 years for average; 25 years for RME; EPA, 1991),
CF = conversion factor (10^{-6} kg/mg),
BW = adult body weight (70 kg; EPA, 1993), and
AT = averaging time (25,550 days for carcinogens = 70 year lifetime x 365 days/year; 3,650 days for non-carcinogens = exposure duration of 10 years for average exposure x 365 days/year or 9,125 days for non-carcinogens = exposure duration of 25 years RME x 365 days/year).

Exposure factors used are based on estimates of soil-to-skin adherence and skin absorption as reported by EPA (1992). Skin surface area is based on 50th-percentile values for head, hands, and forearms of adult males. Exposure frequency and duration are based on the factors discussed above for soil ingestion. The contaminant concentration (95 percent UCL on the arithmetic mean) in the surface soil was used to estimate the absorbed dose.

On-site Worker - Air/Inhalation of Particulates from Fugitive Dust Emissions

Exposure associated with the inhalation of particulates released from soil was estimated for workers using the equation

$$Intake\ (mg/kg\text{-}day) = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

(Equation 3)

where

CA = exposure point concentration in air (mg/m^3),
IR = adult inhalation rate (0.83 m^3/hour; EPA, 1991),
ET = exposure time (10 hours/workday),
EF = exposure frequency (250 days per year; EPA, 1991),
ED = exposure duration (10 years for average; 30 years for RME; EPA, 1993),
BW = adult body weight (70 kg; EPA, 1993), and
AT = averaging time (25,550 days for carcinogens = 70 year lifetime x 365 days/year; 3,650 days for non-carcinogens = exposure duration of 10 years for average exposure x 365 days/year or 10,950 days for non-carcinogens = exposure duration of 30 years RME x 365 days/year).

Exposure point concentrations for contaminants in the air are based on factors discussed in Section 3.5.2.2 (Derivation of Exposure Point Concentrations). The standard default value of 0.83 m^3 per hour (20m^3/day) was used for worker inhalation (EPA, 1991). An exposure time of 10 hours per day was used based on the 10-hour workday at TEAD-N.

Construction Worker

The construction worker is estimated to work at the site for a total period of 1 year in projects that involve disturbing site soils (i.e., new building construction, road building, and utility installation). Exposure estimates are the same as those for the on-site worker with the following exceptions: contaminant concentrations were based on the entire depth of the soil matrix; the exposure duration is 1 year for both average exposure and RME; and the RME incidental soil ingestion rate and inhalation rate are 480 mg/day and 1.25 m^3/hour, respectively.

Installation School Student/Employee

Exposure associated with inhalation of fugitive dust emissions was estimated for school employees and full-time students. Intake was estimated using Equation 3 from the on-site worker scenario with the following parameter changes: exposure time is 7 hours per day; exposure frequency is 200 days per year; and exposure duration is 2 years for the average exposure case and 4 years for the RME case. These parameters are based on site-specific data for the school employees and full-time students. Exposure parameters were chosen to provide a conservative risk estimate for all students that attend the installation school.

Installation Resident - Air/Inhalation

Exposure associated with the inhalation of fugitive dust emissions and consumption of beef derived from cattle grazing at TEAD-N was estimated for on-site residents. Intake from the inhalation pathway was estimated using Equation 3 from the on-site worker scenario with the following assumptions: a child inhalation rate of 0.625 m^3 per hour (NCRP, 1985) and an

adult inhalation rate of 0.83 m^3 per hour is assumed; exposure time is 20 hours per day for a child and 16 hours per day for an adult; exposure frequency is 234 days per year for average exposure and 350 days per year for RME (EPA, 1993); exposure duration is 2 years for average exposure and 9 years for RME (2 years as a child and 7 years as an adult); and body weight of a child is 15 kg.

Actual site-specific information shows the average length of occupancy for on-base housing is approximately 1 year. For this assessment, however, the average exposure duration was assumed to be 2 years and the RME duration was assumed to be 9 years, with intake estimated at a child's rate for 2 of the 9 years. This is consistent with EPA recommendations for residential exposure duration for the soil ingestion pathway (EPA, 1993). Based on the above assumptions, the exposure estimate is extremely conservative.

<u>Installation Resident - Beef/Consumption</u>

Exposure associated with consumption of beef derived from cattle grazing at TEAD-N was estimated using the equation

$$Intake(mg/kg-day) = \frac{[(CSxPUxRTxFF)+(CSxSIxRTxFF)]xFIxIRxBAxEFxEDxCF}{BWxAT}$$

(Equation 4)

where

CS = concentration of contaminant in soil (mg/kg),
PU = plant uptake factor for the contaminant,
RT = fat/liver to diet ratio for contaminant,
FF = fraction of feed cattle ingest from contaminated area (0.1),
SI = fraction of soil intake for grazing cattle (0.03),
FI = fraction of homegrown beef ingestion (0.44 for average; 0.75 for RME; EPA, 1990),
IR = beef fat and liver ingestion rate (25 g/day - 21 g/day for beef fat and 4 g/day for beef liver, EPA, 1990),
BA = bioavailability of contaminants in beef (1.0),
EF = exposure frequency (350 days/year; EPA, 1993),
ED = exposure duration (2 years for the average; 9 years RME),
CF = conversion factor (10^{-3} kg/g),
BW = body weight (15 kg for a child; 70 kg for an adult, EPA, 1993),
AT = averaging time (25,550 days for carcinogens = 70 year lifetime x 365 days/year; 730 days for non-carcinogens = exposure duration of 2 years for average exposure x 365 days/year or 3,285 days for non-carcinogens = exposure duration of 9 years RME x 365 days/year).

The installation is divided into eight grazing units (Figure 3-6). Grazing is not allowed in the Industrial/Maintenance area. Furthermore, according to personnel at TEAD-N, all wastewater impoundments are fenced to exclude cattle. Specific records could not be located identifying which cows graze on each grazing unit. Therefore, it was assumed that they are moved from unit to unit and are allowed to graze uniformly across all available acreage.

The following sites were selected for consideration in this scenario:

- Site 5 (OU 7);
- Sites 6, 7, 23, 36 (OU 8);
- Site 8, 40 (OU 9); and
- Site 41 (OU 10).

The following sites were not selected for consideration in this scenario:

- Sites 31, 32, and 35 (OU 4) were not evaluated because cattle are prevented from grazing these sites;
- Sites 17 and 33 (OU 5) were not evaluated because the maintenance area is fenced;
- Sites 9 and 18 (OU 6) were not evaluated because the maintenance area is fenced;
- Site 13 (OU 8) Tire Disposal Area, was not evaluated because no data were collected at this site; and
- Site 22 (OU 8) was not evaluated because cattle are excluded from grazing at this site.

Contaminant concentrations in the soil and plant and beef fat/liver uptake factors were discussed in Section 3.5.2.2 (Derivation of Exposure Point Concentrations). Based on site-specific information, approximately 10 percent of vegetative matter that the cattle ingest is assumed to come from a site. This is a very conservative estimate considering the supplemental feeding factor that occurs and the time of year that grazing is permitted at TEAD-N (mid-October through late May). In addition, the sites' percentage of the total acreage available for grazing is low.

Ingestion of soil by grazing cattle was included in the beef consumption pathway since this is generally the primary route of contaminant uptake (Kostecki et al., 1989). Under typical U.S. farm conditions, lactating cows may consume as much as 2 to 3 percent of their dry matter intake as soil, whereas, non-lactating cattle may consume up to 2 percent. A soil intake of 3 percent is assumed for cattle grazing at TEAD-N.

The ingestion rate for beef fat is assumed to be 21 grams per day (average daily beef consumption of 100 grams containing 21 percent fat; EPA, 1990). The ingestion rate for beef liver is assumed to be 4 grams per day (one 250-gram serving 6 times per year; EPA, Region VIII recommendations). The fraction of beef that is annually consumed is estimated to be 0.44 for the average exposure and 0.75 for the RME (EPA, 1990). Children are assumed to consume the same quantity of beef fat and beef liver as adults. The exposure frequency is assumed to be 350 days per year (EPA, 1993).

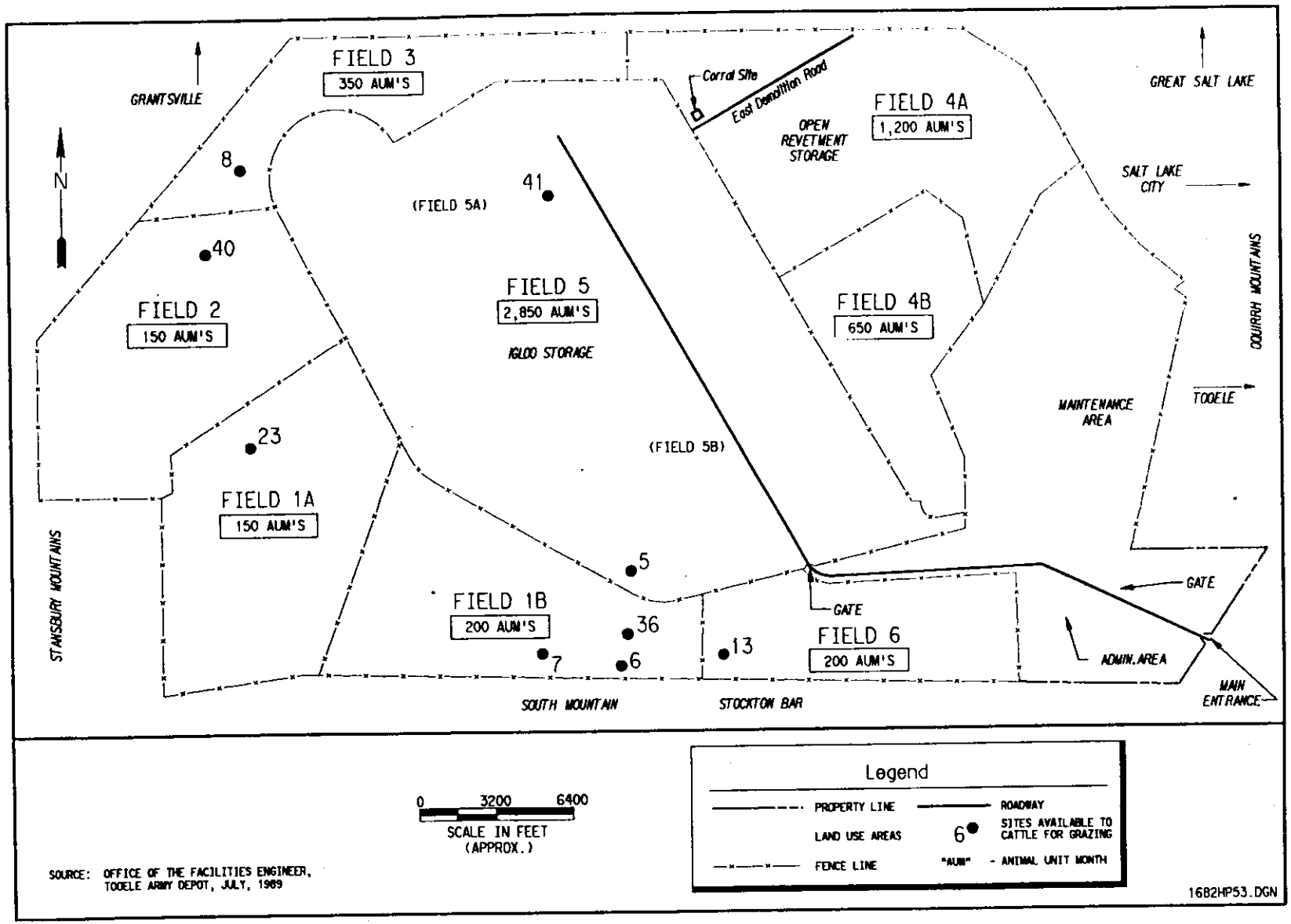


Figure 3-6. Grazing Units at TEAD-N

Off-Site Resident

Soil concentrations from sites within Operable Units 4-10 were used in a screening model to develop particulate concentrations at the installation-town boundaries of Tooele, Stockton, and Grantsville (see Section 3.5.2.2). These data were used to calculate inhalation chronic daily intakes (CDIs) in the same manner in which the on-site resident calculations were performed with the exception of the exposure duration. The exposure duration for off-site residents is assumed to be 9 years for the average exposure case and 30 years for the RME case.

The off-site resident was also assumed to be potentially exposed to contamination through the ingestion of beef derived from cattle grazing at TEAD-N. CDIs were estimated in the same manner in which the on-site resident calculations were performed with the exception of exposure duration. The exposure duration is the same as that noted above for the inhalation pathway for off-site residents.

Table 3-14 provides a summary of the exposure factors used to estimate CDIs for scenarios evaluated under the current land use condition.

3.5.2.3.2 ***Future Land Use***. Exposure pathways considered for the future on-site resident are incidental soil ingestion, dermal contact, inhalation of fugitive dust, homegrown beef consumption, and homegrown produce consumption. CDIs were calculated using the same equations as presented in the current on-site worker scenario with the following parameter additions:

Incidental Soil Ingestion

- Ingestion rate: child 100 mg/day average; 200 mg/day RME
- Exposure frequency: 350 days/year
- Exposure duration: 9 years average; 30 years RME
- Body weight: child 15 kg

Dermal Contact

- Skin surface area: child 2,100 cm^2
- Exposure frequency: 234 days/year average; 350 days/year RME
- Exposure duration: same as incidental soil ingestion
- Body weight: same as incidental soil ingestion

Inhalation of Fugitive Dust

- Inhalation rate: child 0.625 m^3/hour
- Exposure time: child 20 hours/day
  adult 16 hours/day

Table 3-14. Summary of Exposure Factors fc urrent Land Use Conditions (Operable Units 4-10)

Exposure Pathway	Contact Rate	Bioavailability	Surface Area (cm^2)	Soil-to-Skin Adherence Factor (mg/cm^2)	Exposure Frequency (days/years)	Exposure Time (hr/day)	Duration (years)	Body Weight (kg)
On-Site Worker								
Soil Ingestion	50/100 mg/day[a]	1	---[b]	---	250	---	10/25	70
Dermal Contact	---	0.01/0.001[c]	4300	0.2/1.0	250	---	10/25	70
Inhalation	0.83/m^3/hr	1	---	---	250	10	10/25	70
Construction Worker								
Soil Ingestion	50/480 mg/day	1	---	---	250	---	1	70
Dermal Contact	---	0.01/0.001	4300	0.2/1.0	250	---	1	70
Inhalation	0.83 m^3/hr	1	---	---	250	10	1	70
Installation School								
Inhalation	0.83 m^3/hr	1	---	----	200	7	2/4	70
Installation Resident								
Inhalation								
Child	0.625 m^3/hr	1	---	---	234/350	20	0/2	15
Adult	0.83 m^3/hr	1	---	---	234/350	16	2/7	70
Beef Consumption								
Child	25 g/day[d]	1	---	---	350	---	0/2	15
Adult	25 g/day	1	---	---	350	---	2/7	70
Off-Site Residents								
Inhalation								
Child	0.625 m^3/hr	1	---	---	234/350	20	0/6	15
Adult	0.83 m^3/hr	1	---	---	234/350	16	9/24	70
Beef Consumption								
Child	25 g/day	1	---	---	350	---	0/6	15
Adult	25 g/day	1	---	---	350	---	9/24	70

[a]First number represents average exposure case and the second number represents RME case.
[b]---Indicates lack of data.
[c]First number is used for organics and second number is used for inorganics.
[d]The 25 g/day represents 21 g/day of beef fat and 4 g/day of beef liver.

- Exposure duration: same as incidental soil ingestion
- Body weight: same as incidental soil ingestion

The CDI for the future on-site resident for the homegrown beef consumption pathway was calculated using the same assumptions as given for the current on-site resident, with the exception of exposure duration. It is assumed that the future on-site resident would be exposed for 9 years for the average exposure case and 30 years for the RME case.

Future On-Site Resident: Produce/Consumption

Exposure to the future on-site resident from consumption of produce hypothetically grown on-site was estimated using the equation

$$Intake(mg/kg-day) = \frac{CSxPUxIRxFIxEFxEDxCF}{BWxAT}$$

(Equation 5)

where

CS = concentration of contaminant in soil (mg/kg),
PU = plant uptake factor for the contaminant,
IR = ingestion rate (200 g/day for vegetables; 140 g/day for fruit; EPA, 1990),
FI = fraction of homegrown produce consumption (0.25 average and 0.40 RME for vegetables; 0.20 average and 0.30 RME for fruit; EPA, 1990),
EF = exposure frequency (350 days/year; EPA, 1993),
ED = exposure duration (9 years for the average; 30 years for the RME; EPA, 1993),
CF = conversion factor (10^{-3} kg/g),
BW = body weight (15 kg for a child; 70 kg for an adult, EPA, 1993), and
AT = averaging time (25,550 days for carcinogens = 70 year lifetime x 365 days/year; 3,285 days for non-carcinogens = exposure duration of 9 years for average exposure x 365 days/year or 10,950 days for non-carcinogens = exposure duration of 30 years RME x 365 days/year).

Contaminant concentrations in the soil and plant and uptake factors were discussed in Section 3.5.2.2 (Derivation of Exposure Point Concentrations). A total vegetable consumption rate of 200 grams per day and a total fruit consumption rate of 140 grams per day is assumed for exposure to produce hypothetically grown on-site. These values are based on national survey data (USDA, 1980), and represent the total amount of fruits and vegetables consumed on any one day. The percentage of vegetables assumed to be homegrown is 25 percent for the average exposure case and 40 percent for the RME case (EPA, 1990). The percentage of fruit assumed to be homegrown is 20 percent for the average exposure case and 30 percent for the RME case (EPA, 1990). Children are assumed to consume the same quantity of homegrown produce as adults.

Table 3-15 provides a summary of the exposure factors used to estimate CDIs for the future on-site resident scenario.

3.5.3 Toxicity Assessment

The purpose of the toxicity assessment is to weigh available evidence regarding the potential for contaminants of concern to cause adverse effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects. An overview of the toxicity of the contaminants of concern is given in this section. Toxicity information was obtained from the Integrated Risk Information System (IRIS, 1993), the Health Effects Assessment Summary Table (HEAST, 1992), and the EPA.

3.5.3.1 *Carcinogens*

A slope factor (formerly called potency factor) and an accompanying weight-of-evidence determination are the toxicity data most commonly used to evaluate potential carcinogenic risks.

In determining the weight-of-evidence, available data are evaluated to determine the likelihood that the agent is a human carcinogen. The evidence is characterized separately for human studies and animal studies as either sufficient, limited, inadequate, no data, or evidence of no effect. The characterizations of these two types of data are combined and, based on the extent to which the agent has been shown to be a carcinogen in experimental animals, or humans, or both, the agent is given a provisional weight-of-evidence classification. The EPA classification system, based on the strength of evidence that a chemical is a human carcinogen, places each chemical into one of the following classes: A–sufficient human evidence; B1–limited human evidence but sufficient animal evidence; B2–inadequate human evidence but sufficient evidence in animals (both B1 and B2 are considered probable carcinogens); C–no evidence in humans and limited evidence in animals; D-no adequate data (non-classifiable); and E–evidence of noncarcinogenicity for humans.

The EPA's Carcinogen Assessment Group calculates slope factor estimates of the excess cancer risk due to continuous exposure to a chemical throughout the course of a 70-year lifetime for suspected carcinogens. Slope factors are usually the upper 95th percent confidence limit of the slope of the dose-response curve and are expressed as $(mg/kg\text{-}day)^{-1}$. The dose-response assessment generally entails an extrapolation from high doses administered to experimental animals to exposure levels expected from human contact with the contaminant in the environment. Slope factors for contaminants of concern identified at Operable Units 4 through 10 are shown in Table 3-16.

A number of the contaminants do not currently have verified slope factors because they have either not been determined or have not been evaluated by EPA. For contaminants missing quantitative estimates of carcinogenicity, physicochemical properties and toxicological information were evaluated in an attempt to semi-quantitatively estimate a risk factor.

Table 3-15. Summary of Exposure Factors for Future Land Use Conditions (Operable Units 4-10)

Exposure Pathway	Contact Rate	Bioavailability	Surface Area (cm^2/day)	Soil-to-Skin Adherence Factor (mg/cm^2)	Exposure Frequency (days/years)	Exposure Time (hr/day)	Duration (years)	Body Weight (kg)
Future On-Site Resident								
Soil Ingestion								
Child	100/200[a] mg/day	1	---[b]	---	350	---	0/6	15
Adult	50/100 mg/day	1	---	---	350	---	9/24	70
Dermal Contact								
Child	---	0.01/0.001[c]	2100	0.2/1.0	234/350	---	0/6	15
Adult	---	0.01/0.001	4300	0.2/1.0	234/350	---	9/24	70
Inhalation								
Child	0.625 m^3/hr	1	---	---	234/350	20	0/6	15
Adult	0.83 m^3/hr	1	---	---	234/350	16	9/24	70
Beef Consumption								
Child	25 g/day[d]	1	---	---	350	---	0/6	15
Adult	25 g/day	1	---	---	350	---	9/24	70
Produce								
Child	340 g/day[e]	1	---	---	350	---	0/6	15
Adult	340 g/day	1	---	---	350	---	9/24	70

[a]First number represents average exposure case and the second number represents RME case.
[b]---Indicates lack of data.
[c]First number is used for organics and second number is used for inorganics.
[d]The 25 g/day represents 21 g/day of beef fat and 4 g/day of beef liver.
[e]The 340 g/day represents 200 g/day of vegetables and 140 g/day of fruit.

Table 3-16. Slope Factors for the Contaminants of Concern

Analyte	Abbreviation	Slope Factor (mg/kg-day)$^{-1}$ Oral	Inhalation	Dermal	Weight of Evidence	Reference
Antimony	Sb	ND	ND	ND	ND	IRIS
Arsenic	As	1.8E+00	1.5E+01	1.8E+01†	A	IRIS
Barium	Ba	ND	ND	ND	ND	IRIS
Benzo[a]anthracene*	BAANTR	7.3E-01	6.1E-01	1.8E+00††	B2	EPA, 1992
Benzo[a]pyrene	BAPYR	7.3E+00	6.1E+00	1.8E+01††	B2	IRIS
Benzo[b]fluoranthene*	BBFANT	7.3E-01	6.1E-01	1.8E+00††	B2	EPA, 1992
Benzo[g,h,i]perylene	BGHIP	ND	ND	ND	D	IRIS
Benzo[k]fluoranthene*	BKFANT	7.3E-01	6.1E-01	1.8E+00††	B2	EPA, 1992
Bis(2-ethylhexyl)phthalate	B2EHP	1.4E-02	ND	3.5E-02††	B2	IRIS
Cadmium	Cd	ND	6.3E+00	ND	B1	IRIS
Chlordane	CLDAN	1.3E+00	1.3E+00	3.3E+00††	B2	IRIS
Chromium (VI)	Cr	ND	4.2E+01	ND	A	IRIS
Chrysene*	CHRY	7.3E-02	6.1E-02	1.8E-01††	B2	EPA, 1992
Copper	Cu	ND	ND	ND	D	IRIS
Cyanide	CYN	ND	ND	ND	D	IRIS
Cyclonite	RDX	1.1E-01	ND	3.0E-01††	C	IRIS
Cyclotetramethylenetetranitramine	HMX	ND	ND	ND	D	IRIS
Diethyl phthlate	DEP	ND	ND	ND	D	IRIS
Di-N-butyl phthalate	DNBP	ND	ND	ND	D	HEAST/IRIS
2,4-Dinitrotoluene**	24DNT	6.8E-01	ND	ND	B2	IRIS
Diphenyl amine	DPA	ND	ND	ND	ND	IRIS
Fluoranthene*	FANT	ND	ND	ND	D	IRIS
2,3,7,8-Heptachlorodibenzofuran*	HPCDF	1.5E+03	1.5E+03	3.8E+03††	---	EPA, 1989
Other HpCDFs*	----------	0	0	0	---	EPA, 1989
2,3,7,8-Heptachlorodibenzodioxin*	HPCDD	1.5E+03	1.5E+03	3.8E+03††	---	EPA, 1989
Other HpCDDs*	----------	0	0	0	---	EPA, 1989
2,3,7,8-Hexachlorodibenzofuran*	HCDF	1.5E-04	1.5E+04	3.8E+04††	---	EPA, 1989
Other HxCDFs*	----------	0	0	0	---	EPA, 1989
2,3,7,8-Hexachlorodibenzodioxin*	HCDD	1.5E+04	1.5E+04	3.8E+04††	---	EPA, 1989
Other HxCDDs*	----------	0	0	0	---	EPA, 1989
Indeno [1,2,3-cd]pyrene*	ICDPYR	7.3E-01	6.1E-01	1.8E+00††	B2	EPA, 1992
Iron	Fe	ND	ND	ND	ND	HEAST
Lead	Pb	ND	ND	ND	B2	IRIS
Mercury	Hg	ND	ND	ND	D	IRIS

Table 3-16. Slope Factors for the Contaminants of Concern (continued)

Analyte	Abbreviation	Slope Factor (mg/kg-day)$^{-1}$ Oral	Inhalation	Dermal	Weight of Evidence	Reference
Nickel Dust	Ni	ND	8.40E-01	ND	A	IRIS
Nickel, Soluble Salts	Ni	ND	ND	ND	ND	IRIS
Nitrate	NO3	ND	ND	ND	ND	HEAST/IRIS
Nitrites	NO2	ND	ND	ND	ND	IRIS
Nitrobenzene-D5	NBD5	ND	ND	ND	D	IRIS
Octachlorodibenzodioxin*	OCDD	1.5E+02	1.5E+02	3.8E+02[††]	B2	EPA, 1989
Octachlorodibenzofuran*	OCDF	1.5E+02	1.5E+02	3.8E+02[††]	B2	EPA, 1989
PCB 1016 (Aroclor 1016)		ND	ND	ND	ND	IRIS
PCB 1260 (Aroclor 1260)	PCB260	7.7E+00	9.6E+00[†††]	1.9E+01[††]	B2	HEAST
1,2,3,7,8-Pentachlorodibenzofuran*	PCDF	7.5E+03	7.5E+03	1.9E+04[††]	---	EPA, 1989
2,3,4,7,8-Pentachlorodibenzofuran*	---------	7.5E+04	7.4E+04	1.9E+05[††]	---	EPA, 1989
Other PeCDFs*	---------	0	0	0	---	EPA, 1989
Phenanthrene	PHANTR	ND	ND	ND	D	IRIS
Phosphate	PO4	ND	ND	ND	ND	IRIS
Pyrene	PYR	ND	ND	ND	D	IRIS
Silver	Ag	ND	ND	ND	D	IRIS
Sodium	Na	ND	ND	ND	ND	IRIS
Sulfate	SO4	ND	ND	ND	ND	IRIS
2,3,7,8-tetrachlorodibenzodioxin*	TCDD	1.5E+05	1.5E+05	3.8E+05[††]	B2	HEAST, 1992
Other TCDDs*	---------	0	0	0	---	EPA, 1989
2,3,7,8-Tetrachlorodibenzofuran*	TCDF	1.5E+04	1.5E+04	3.8E+04[††]	B2	EPA, 1989
Other TCDFs*	---------	0	0	0	---	EPA, 1989
Tetryl	Tetryl	ND	ND	ND	ND	IRIS
Thallium	TL	ND	ND	ND	D	IRIS
1,2,4--Trichlorobenzene	124TCB	ND	ND	ND	D	IRIS
Trichloroethylene	TRCLE	ND	ND	ND	ND	HEAST/IRIS
1,3,5-Trinitrobenzene	135TNB	ND	ND	ND	ND	IRIS
2,4,6-Trinitrotoluene	246TNT	3.02E-02	ND	7.6E-02[††]	C	HEAST/IRIS
Zinc	Zn	ND	ND	ND	ND	HEAST

---Indicates lack of data.

*Based on toxicity equivalency factor methodology; TEFs obtained from the following references: Dioxins—Interim Procedures for Estimating Risks Associated with Exposure Mixtures of Chlorinated Dibenzo-p-dioxins and Dibenzofurans (CDDs and CDFs) and 1989 update; EPA/625/3-89/016, March 1989. PAHs—Memorandum "New Interim Region IV Guidance", USEPA, Atlanta, GA, February 11, 1992.

[††]Based on 2,4-/2,6-dinitrotoluene mixture.

[†]Estimated from oral slope factor using 10% gastrointestinal absorption efficiency.

[††]Estimated from oral slope factor using 40% gastrointestinal absorption efficiency.

[†††]Estimated from oral slope factor using 40% gastrointestinal absorption efficiency and 50% availability in lungs.

For toxicity values expressed as an administered dose, absorption efficiency adjustments were necessary to evaluate absorbed doses resulting from dermal contact. However, absorption efficiency factors could not be found for many of the identified contaminants. Since assuming 100 percent gastrointestinal absorption efficiency (which is equivalent to 0.0% absorption by tissue) would result in a non-conservative risk estimate, conservative default assumptions were made. A gastrointestinal absorption efficiency of 40 percent for organic contaminants and 10 percent for metals (Lippman, 1992) was used to adjust toxicity values (EPA, 1993b) based on administered doses to values representative of absorbed doses.

3.5.3.2 *Noncarcinogens*

The primary toxic effects of most of the organic, noncarcinogenic contaminants of concern occur in the liver and/or kidneys. These effects are often combined with central nervous system depression. Inorganic chemicals have multiple target tissues and critical effects dependent upon the chemical, age of individual, prior exposure, dose, etc.

Reference doses (RfDs) developed by the EPA are estimates of the daily dose of a chemical to which humans, including sensitive subpopulations, can be exposed without an appreciable risk of deleterious effects during a lifetime (i.e., exposure threshold). The RfD is generally expressed in units of milligrams per kilogram of bodyweight per day (mg/kg-day). The basis of an RfD is usually the highest concentration in experiments on animals at which no adverse effects are demonstrated (i.e., NOAEL or No Observed Adverse Effect Level). This NOAEL is then divided by uncertainty factors and modifying factors to obtain the RfD. Available RfDs for contaminants of concern are given in Table 3-17.

A number of the contaminants of concern do not have verified RfDs because they have either not been determined or have not been evaluated by EPA. In addition, most RfDs are expressed as administered doses. Section 3.5.3.1 (Carcinogens) describes the steps taken to address contaminants with unavailable RfDs and to adjust toxicity values from administered to absorbed doses.

RfDs and NOAELs are not listed for PCDD or PCDF compounds. The EPA is currently in the process of establishing criteria for acceptable levels of dioxins and furans in various environmental components, so exact guidelines do not yet exist (Nosek et al., 1993). One rationale suggests that exposure thresholds for these compounds do not exist because of their persistence in the environment, long biological half-lives in mammals, and their acute toxicity and carcinogenicity in laboratory animals. If public health is protected from the carcinogenic risk associated with these compounds, then the same would be true of the chronic, non-carcinogenic risks. Because of this, hazard indices for Site 5 are not truly representative of the actual chronic risk associated with this site due to the lack of RfD data for dioxins and furans.

Table 3-17. Reference Doses /Concentrations for Contaminants of Concern

Chemical	Chronic RfDs/RfCs[a] (mg/kg/day)			Critical Effect		Uncertainty		Source
	Oral	Inhalation	Dermal	Oral and Dermal	Inhalation	Oral and Dermal	Inhlation	
Metals								
Antimony	4E-04	ND	4E-05**	Longevity, blood glucose, and cholesterol	ND	1000	ND	IRIS
Arsenic	3E-04	ND[b]	3E-05**	Keratosis and hyperpigmentation	NA[c]	3	NA	IRIS
Barium	7E-02	1E-04	7E-03**	Increased blood pressure	Fetotoxicity	3	1000	HEAST/IRIS
Cadmium	1E-03 (food) 5E-04 (water)	ND	1E-04**	Renal damage	Cancer	10	NA	IRIS
Chromium (VI)	5E-03	ND	5E-04**	Not defined	Nasal Mucosa Atrophy	500	ND	IRIS
Copper	3.7E-02	ND	ND	Local GI[e] irritation	NA	NA	NA	HEAST
Lead	NA	NA	NA	CNS[f] effects	CNS effects	NA	NA	IRIS
Iron	ND	ND	ND	ND	ND	ND	ND	HEAST
Mercury	3E-04	9E-05*	3E-05**	Kidney effects	Neurotoxicity	1000	30	HEAST
Nickel Dust	ND	ND	ND	ND	ND	ND	ND	IRIS
Nickel, Soluble Salts	2E-02	4E-03[f]	2E-03**	Reduced body and organ weight	Cancer	300	NA	IRIS
Silver	5E-03	ND	5E-04**	Argy.ia	NA	3	NA	IRIS
Sodium	ND	ND	ND	ND	ND	ND	ND	IRIS
Thallium	7E-05	ND	7E-06**	Increased SGOT and serum LDH levels, alopecia	NA	3000	NA	IRIS

Table 3-17. Reference Doses /Concentrations for Contaminants of Concern (continued)

Chemical	Chronic RfDs/RfCs[a] (mg/kg/day)			Critical Effect		Uncertainty		Source
	Oral	Inhalation	Dermal	Oral and Dermal	Inhalation	Oral and Dermal	Inhlation	
Zinc	3E-01	ND	3E-02**	Anemia	NA	3	NA	IRIS
Organics								
Benzo[a]anthracene	ND	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Benzo[k]fluoranthene	ND	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Benzo[a]pyrene	ND	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Bis(2-ethylhexyl) phthalate	2E-02	ND	2E-03***	Increased relative liver weight	ND	1000	ND	IRIS
Chlordane	6E-05	ND	6E-06***	Regional liver hypertrophy in females	ND	1000	ND	HEAST/IRIS
Chrysene	ND	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Di-N-butyl phthalate	1E-01	ND	1E-02***	Mortality	Mortality	1000	1000	HEAST/IRIS
Diethyl phthalate	8E-01	ND	8E-02***	Decreased growth rate, food consumption and altered organ weights	ND	1000	ND	IRIS
2,4-Dinitrotoluene	2E-03	ND	2E-04***	CNS[f] effects	ND	100	ND	IRIS
2,6-Dinitrotoluene[11]	2E-03	ND	2E-4***	CNS[f] effects	ND	100	ND	IRIS
Diphenylamine	2.5E-02	ND	2.5E-03***	Decreased bodyweight gain, and increased liver and kidney weights	ND	100	ND	IRIS
Fluoranthene	4E-02	ND	4E-3***	Nephropathy; liver weight changes, hematological changes	NA	3000	NA	HEAST/IRIS

Table 3-17. Reference Doses /Concentrations for Contaminants of Concern (continued)

Chemical	Chronic RfDs/RfCs[a] (mg/kg/day)			Critical Effect		Uncertainty		Source
	Oral	Inhalation	Dermal	Oral and Dermal	Inhalation	Oral and Dermal	Inhlation	
Heptachlorodibenzodioxins[#]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
Heptachlorodibenzofurans[#]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
Hexachlorodibenzodioxins[#]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
Hexachlorodibenzofurans[#]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
HMX (cyclotetra-methylenetetranitramine)	5E-02	ND	5E-03***	Heptic Lesions	Hepatic lesions	1000	ND	IRIS
Indeno (1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	HEAST/IRIS
N-nitrosodi-N-propylamine	ND	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Naphthalene	4E-02	ND	4E-03***	Decreased body weight gain	ND	1,000	ND	HEAST
Nitrobenzene	5E0-4	6E-04	5E-05***	Liver effects	ND	10,000	10,000	HEAST/IRIS
Octachlorodibenzodioxins[#]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
Octachlorodibenzofurans[#]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
PCB 1016 (Aroclor 1016)	7E-05	6E-05†††	3E-05	Reduced birth weights	ND	100	ND	IRIS
PCB 1260 (Aroclor 1260)	ND	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Pentachlorodibenzodioxins[#]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
Pentachlorodibenzofurans[#]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Pyrene	3E-02	2E-02†††	3E-03***	Renal effects	NA	3000	NA	IRIS
RDX (cyclonite)	3E-03	ND	3E-04***	Prostate inflammation hemosiderosis	ND	100	ND	IRIS

Table 3-17. Reference Doses /Concentrations for Contaminants of Concern (continued)

Chemical	Chronic RfDs/RfCs[a] (mg/kg/day)			Critical Effect		Uncertainty		Source
	Oral	Inhalation	Dermal	Oral and Dermal	Inhalation	Oral and Dermal	Inhlation	
Tetrachlorodibenzodioxins[g]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
Tetrachlorodibenzofurans[g]	NA	NA	NA	NA	NA	NA	NA	EPA, 1993
Tetryl	1E-02	ND	1E-03***	Histopathological Effect	ND	10,000	ND	HEAST
Trichloroethylene	ND	ND	ND	ND	ND	ND	ND	IRIS
1,3,5-Trinitrobenzene	5E-05	ND	5E-06***	Increased spleen weight	ND	10,000	ND	IRIS
2,4,6-Trinitrotoluene	5E-04	ND	5E-05***	Liver effects	NA	1000	NA	IRIS
Inorganics								
Chloride	ND	ND	ND	ND	ND	ND	ND	IRIS
Cyanide	2E-02	ND	2E-02	Weight loss, thyroid effects and myelin degeneration	ND	100	ND	IRIS
Nitrate	1.6E+00	ND	1.6E+00	Methemoglobinemia	ND	1	ND	IRIS
Nitrite	1E-01	ND	1.0E-01	Methemoglobinemia	ND	10	ND	HEAST/IRIS
Phosphate	ND	ND	ND	ND	ND	ND	ND	IRIS
Sulfate	ND	ND	ND	ND	ND	ND	ND	IRIS

[a]RfDs/RfCs = reference doses/reference concentrations.
[b]ND = not determined.
[c]NA = not available.
[d]GI = gastrointestinal.
[e]CNS = central nervous system.
[f]Inhalation RfD values were derived from a concentration in air (mg/m^3) to an inhaled dose (mg/kg/day) by the following equation: air concentration x (20m^3/day/70 kg) = Inhaled Dose (HEAST).
[g]Based on 2,4-Dinitrotoluene.
**Estimated from oral RfD using 10% gastrointestinal absorption efficiency.
***Estimated from oral RfD using 40% gastrointestinal absorption efficiency.
†Estimated from oral RfD using 10% gastrointestinal absorption efficiency and 50% availability in lungs.
††Estimated from oral RfD using 40% gastrointestinal absorption efficiency and 50% availability in lungs.
[g]RfDs/RfCs are not available—carcinogenic risk estimates used to protect public health (EPA recommendations).

3.5.4 Risk Characterization

For each exposure pathway and land use scenario identified for RI Sites at TEAD-N, the exposure intake estimates described in Section 3.5.2 and the toxicity values described in Section 3.5.3 were used to quantify pathway risks for contaminants of concern, including carcinogenic and noncarcinogenic risk. For each pathway, the total carcinogenic risk and noncarcinogenic hazard index were determined. Risks across pathways for a specific receptor were summed and presented as total risk estimates.

Carcinogenic risk, called risk factor, was determined by multiplying the chronic daily intake of a contaminant by an individual over time (expressed in mg/kg-day) by the slope factor (expressed in $(mg/kg\text{-}day)^{-1}$). The slope factor converts estimated CDIs averaged over a lifetime of exposure to incremental risk of an individual developing cancer.

Noncarcinogenic effects were determined by calculating the ratio of the exposure level to the reference dose, which results in a hazard quotient. This ratio indicates the hazard level associated with exposure to a single contaminant in a single exposure pathway. The hazard index is the sum of more than one hazard quotients for multiple substances and/or multiple exposure pathways at a particular site. When the hazard index exceeds unity, there may be concern for public health effects.

The risk calculations for each site are presented in Appendix I and are summarized in the tables and text of Sections 4.0 through 10.0.

3.5.5 Uncertainty Analysis

There are several categories of uncertainties associated with site risk assessments, including contaminant selection and concentration, exposure assessment, and sources of uncertainty inherent in the toxicity values used to characterize risk. The estimates of human-health risks developed for this risk assessment required a number of assumptions concerning exposure assessment. These are discussed below along with other uncertainties that could affect the numerical risk estimates.

3.5.5.1 *Contaminants of Concern*

Organic contaminants of concern consist of organic compounds that exceeded the certified reporting limit and were not found in corresponding field blanks, trip blanks, or laboratory QC samples. Tentatively identified compounds that could not be identified by the laboratory were disregarded. Therefore, the risk associated with these unknowns was not determined.

Metals and anion contaminants of concern were established by screening site data against background levels. Background levels were calculated as the tolerance limit containing 95 percent of the population with a probability (confidence) of 0.95 (EPA, 1989). Although background samples were taken from several soil types, the soil types were not delineated according to soil type or depth. Natural occurring levels of metals and anions could exhibit

significant variability according to soil type and depth; thus, resulting in a potential for a higher or lower exposure estimate.

A few metals exhibited high analytical detection limits because of sample matrix interference effects. The high detection limits were identified to originate only from samples containing high levels of calcium. These high detection limits were 240 μg/g for arsenic, 140 μg/g for antimony, 5,100 μg/g for selenium, and 1,700 μg/g for thallium. The high detection limits could potentially underestimate the actual risk at a site because of elimination of these metals from contaminant consideration based on nondetectable values reported in the field samples. However, values reported for these metals from field samples exhibiting low detection limits did not exceed established background concentrations.

3.5.5.2 *Exposure Pathways*

Although this risk assessment did not assess every conceivable exposure scenario possible, all exposure pathways were evaluated according to risk contribution. The pathways identified as contributing negligible exposure (e.g., inhalation of VOCs and off-site dermal contact via deposition of airborne particulates) were eliminated from consideration based on preliminary analysis. Since total risk to human health is a sum of all complete pathways known to exist, the lack of quantification of these pathways may underestimate the risk. However, those pathways not quantified represent small sources of exposure and are not expected to influence risk management decisions.

The groundwater pathway was not evaluated, and no groundwater samples were taken during the RI field activities. However, the groundwater table is approximately 300 feet deep. Thus, surface-soil contamination presently only affects the vadose zone and does not contaminate the groundwater table. However, MULTIMED simulations indicate that the groundwater could be affected in approximately 100 years.

Another potential exposure pathway that was not quantitatively evaluated at this time is the ingestion by human receptors of meat from wildlife grazing in contaminated areas of TEAD-N. The possibility of this type of exposure is acknowledged, but the risk contribution was deemed to be negligible.

Many of the sites are abandoned and only rarely visited by on-site workers. Therefore, the exposure time is minimal and much less than the 250 days per year exposure frequency assumed in the calculations. Average exposure frequency for the on-site worker is probably in the range of 20 to 25 days. Based on this, actual exposure is expected to be much less than that calculated for the on-site worker.

Plant and animal uptake factors for contaminants were estimated based on reported values in literature and by analogous procedures using physicochemical properties. Cattle grazing patterns were estimated in terms of the amount of dry feed ingested from contaminated areas. These assumptions could result in either increased or decreased exposure estimates.

The oral bioavailability of contaminants was considered unity for all ingestion pathways. Certain contaminants exhibit a low oral bioavailability. With contaminants present in a soil matrix, one would expect a oral bioavailability less than unity. In addition, all ingested soil was assumed to originate from the contaminated source. These assumptions result in an overestimate of risk.

3.5.5.3 *Contaminant Fate and Transport*

The evaluation of human health risks assumed that environmental media concentrations determined from sampling will remain at the same levels over the assumed periods of exposure. This assumption is likely to result in an overestimation of risk, since concentrations, especially of organic contaminants, are expected to decline over the long-term as natural fate and transport processes degrade, dilute, or remove site contaminants. The rate of the degradation, removal, and/or dilution of chemicals in soil, groundwater, surface water, and sediment is not known; therefore, the magnitude of the overestimate is difficult to determine.

3.5.5.4 *Exposure-Point Concentrations*

The exposure-point concentration used for assessing risks associated with both the central tendency and RME cases was the 95 percent UCL on the arithmetic mean concentration. Nondetected values were treated as concentrations equal to half the detection limit. This procedure could underestimate or overestimate the risk depending on the actual concentrations (if present) of the chemical reported below the detection limits. This uncertainty is most likely when estimating concentrations for those chemicals detected infrequently.

The contaminant concentrations for produce hypothetically grown on-site were assumed to be the same as the concentrations in the soil. Generally, this is unlikely since accumulation of chemicals in plants usually follow three distinct steps: (1) partitioning of lipophilic chemicals to lipophilic root solids, (2) uptake of polar compounds (high degree of water solubility) into the aqueous phase within the roots, and (3) translocation to the shoots of compounds exhibiting intermediate polarity (Briggs et al., 1982).

Soil bioavailability in the cattle grazed at TEAD-N was assumed to be unity with contaminant uptake estimated from both ingestion of vegetative matter and soil. Contaminant levels were also assumed to be the same in the slaughter animal as in the grazing animal. This generally results in an overestimate of risk. Before slaughter, it is general practice to fatten the cattle in feedlots where the animals can gain as much as 60 to 70 percent in body weight. During these periods, contaminant levels are reduced by dilution in the expanding body fat pool (Kostecki, 1989).

3.5.5.5 *Exposure Levels*

The amount of exposure that an individual receives is highly dependent on the details related to their human-activity patterns. There is considerable uncertainty regarding the values assumed in calculating human intake factors. For instance, estimates of soil ingestion rates for all populations are subject to ongoing debate. This may again result in overestimating or underestimating the risk.

3.5.5.6 *Toxicity Values*

Quantification of risk from exposure to a chemical cannot be accomplished in the absence of reliable, appropriate toxicity values (reference doses, slope factors) for all routes and exposure periods. For the chemicals of potential concern at TEAD-N, toxicity values are not available for some chemicals by some routes. In addition, absorption efficiencies were estimated to adjust toxicity values from an administered dose to an absorbed dose. This adds considerable uncertainty to the numerical risk values associated with the sites, but it is not possible to estimate the degree of this uncertainty.

3.5.5.7 *Cancer-Risk Estimates*

The predicted cancer risk due to chemical exposure is often based on cancer-dose response data in animals. There is a long-standing controversy in the scientific community as to the best way by which animal data should be extrapolated to humans. In general, the EPA follows a conservative procedure in the derivation of slope factors, so cancer risk estimates based on these values could be considerably higher than the true risk.

The cancer risks calculated for children are less certain than those calculated for adults. The method utilized in this risk assessment assumes cancer risks are simply proportional to total dose. Actual cancer risk to a child only exposed during childhood could be higher or lower depending on the detailed mechanism of carcinogenicity for each chemical.

3.5.5.8 *Multiple Chemical Exposure*

The risk assessment approach assumes that health risks from multiple chemicals are additive, ignoring both synergistic and antagonistic effects among chemicals. Because of the number of chemicals evaluated at these sites, it is difficult to determine if additivity is a major source of error.

3.5.5.9 *Summary of Uncertainties*

In summary, the estimation of exposure and risk are subject to a number of uncertainties that may lead to either an overestimate or underestimate of risk.

Assumptions made in this risk assessment that are likely to overestimate risk include:

- Exposure point concentrations used 95 percent UCL values.
- Environmental media concentrations are unchanged over time.
- All ingested soil comes from the contaminated source.
- Oral bioavailability of soil-bound contaminants assumed to be unity.
- Soil is ingested at the assumed rate for all populations.
- Human activity patterns and the resultant exposure patterns used to calculate a reasonable maximum exposure are assumed.
- Slope factors are equal to the 95 percent confidence limit of the best estimate of the slope of the dose-response curve.

Factors in this risk assessment that are likely to underestimate risk:

- Not all exposure pathways for all chemicals were quantified.
- Toxicity values are not available for every chemical, for every exposure duration, or for all exposure routes.
- Risks from all Tentatively Identified Compounds were not quantitatively evaluated.
- Risks for chemicals not analyzed for, but possibly present, were not evaluated.

Factors in which the direction of uncertainty cannot be determined or are unknown include:

- High detection limits exhibited for some analytes due to matrix interference effects.
- Use of zero or one-half the detection limit in calculating exposure-point concentrations for samples where a specific chemical was not detected.
- Analytical variations in chemical analyses.
- Lack of information on the interactions among the multiple chemicals contributing to cancer and noncancer risks.
- Assumption of all hypothetical future populations and risks.
- All modeling and input parameters.
- Method for quantifying less than lifetime exposures to carcinogens in childhood.

3.6 ENVIRONMENTAL EVALUATION METHODOLOGY

3.6.1 Soil Survey

As described in Section 2.8, a general soils survey was conducted for TEAD-N. The purpose of this survey was to map the soils of the facility area and to qualitatively describe the mapping units. The basis and primary source of information for the soil survey of TEAD-N was the *SCS Soil Survey Report for Tooele County* (SCS, Unpublished 1992). Supplemental

literature included Weston (1989) and Welsh and others (1987). These data sources were utilized to coordinate data and information obtained during the preparation of this report.

The SCS office in Salt Lake City, Utah, was contacted in order to coordinate soil information for the TEAD-N facility area with the National Cooperative Soils Survey. Established or proposed soil series for this area were used. Soils mapping for this report entailed refining the soil delineations previously established by the SCS survey. The TEAD-N site was mapped in an analogous manner to the SCS survey.

3.6.2 Vegetation Survey

As described in Section 2.8, a general vegetation survey of the TEAD-N facility area was conducted. The purposes of this survey were to (1) derive a plant species list for the TEAD-N facility area, (2) identify and qualitatively describe the range site types within the facility area, and (3) delineate and map these range site types.

The plant species list for the facility area was obtained by a reconnaissance survey in which plant species observed within the area were recorded. Unknown plant species were collected and identified. Botanical nomenclature used follows Welsh et al.(1987), Weber (1987), and SCS (1986). Some plants lacking complete structures needed for field identification were collected and sent to Brigham Young University in Provo, Utah, and to Western State College in Gunnison, Colorado, for identification and verification.

Information from the SCS soil-mapping unit, range site descriptions, aerial photography, selected literature, and field reconnaissance were combined to develop the range site descriptions and mapping unit delineations presented in this report.

3.6.3 Wildlife Survey

As described in Section 2.9, a general wildlife survey of the TEAD-N facility area was conducted. The purposes of this survey were to (1) derive a wildlife species list for the facility area and (2) identify wildlife species of special concern and present information regarding these species for use in the environmental risk assessment.

The wildlife species list was developed from a potential species list for the site (Donohue, 1990). The list also contains notations for actual observations by species identified on site during the field investigation.

Wildlife species of concern were selected from a list prepared by the Army and from known and potential endangered species, candidate species, migrating species, and state-sensitive species. Game species were also included. Information for this report was combined from selected literature sources, field and road reconnaissance, and consultations with the U.S. Fish and Wildlife Service and Bureau of Land Management.

3.6.4 Environmental Risk Assessment

3.6.4.1 *Objectives and Scope*

The Environmental Risk Assessment provides a qualitative environmental evaluation for the TEAD-N facility area. It is based upon site-specific studies, literature reviews, and interviews with resource staff.

Risk assessments evaluate the likelihood that adverse ecological effects will result from exposure to stressors from human activity (such as hazardous substances). Stressors can be any chemical, physical, or biological entity that can cause adverse effects on ecological components. These ecological effects may range from mortality of individuals in a species, to the complete or partial loss of ecosystem function. These ecological effects are referred to as endpoints of concern (Norton et al., 1992).

The scope of this ecological assessment is limited to the characterization of the biological and ecological environment of the TEAD-N area, including the potential risks and impacts resulting from the release of hazardous substances at the site. The scope of the ecological assessment does not include (1) any on-site toxicological studies including bioassays or tissue sampling, (2) remedial-action impacts upon the environment, or (3) any remedial-action goals for environmental parameters.

The objectives of this assessment are three-fold: (1) characterize the biological and environmental resources of each site and the entire TEAD-N facility as a whole, (2) identify actual and potential impacts on these resources related to releases of contaminants at each site (endpoints of concern) and how these affect the entire TEAD-N facility ecosystem, and (3) provide information to determine the need for any additional data collection.

The first objective is met by the soils (Section 2.5), vegetation (Section 2.8), and wildlife (Section 2.9) survey reports. The environmental conditions, as well as the species of concern, are identified and discussed.

The second objective is met by performing a qualitative Environmental Risk Assessment based on observation at the sites and on previously published literature concerning potential contamination as it relates to the intensity of ecological effects. This is done according to the requirements set forth in the *Risk Assessment Guidance Document for Superfund, Volume II; Environmental Evaluation Manual Interim Final* (EPA, 1989). For the purposes of this report, this is defined as reviewing pertinent literature, documents, and other information from existing studies to characterize the ecological impacts and potential risks associated with contaminant releases at the TEAD-N facility and, where necessary, using a bioaccumulation model to further access the impacts from contaminants at certain sites (see Section 3.6.4.7 for discussion of the bioaccumulation model). No plant or animal tissue sample bioassays were taken with this qualitative assessment.

To identify actual and potential impacts on the biological and environmental resources, the following factors were considered:

1. The nature of actual and potential impacts (endpoints of concern) were identified, specifically whether:

   a. the biotic community structure was affected through trophic structure alterations or other community level indicators of disturbance;

   b. the ecological processes such as primary production and nutrient cycling rates were altered;

   c. particular species were affected, in particular threatened or endangered ones;

   d. there was potential for the ecosystem to function as an exposure path to humans for contaminants having potential negative health affects.

2. The potential intensity of actual and potential impacts were evaluated as high, medium, or no effect.

3. A degree of certainty was applied to differentiate between circumstances where either data or references are sufficient for probability projections to be made and where the stress-response relationships are poorly understood or of a highly infrequent occurrence.

4. If warranted by the first three considerations, a probable time scale of recovery was derived following cessation of the stressor.

These considerations were addressed and are the basis for the Ecological Evaluation Conclusions for each site that warranted this depth of qualitative investigation. For some sites, the nature of the contamination and/or the lack of flora and fauna at the sites eliminated this type of in-depth discussion.

The third objective will be met by the collection of additional data. This additional sampling will be performed at representative areas across the TEAD-N facility to further determine the extent of contamination and to re-evaluate the degree of ecological risk. Once the data are collected and analyzed, an RI addendum will be prepared. This addendum will help to identify and evaluate the ecological habitats of TEAD-N, make a selection of the species (and endpoints) of concern, and develop a food-web model. At the four sites most likely to be used by wildlife, an indicator species will be used as a model in the development of a hazard index for the species of concern. Rodent populations will probably be used as the indicator species because they burrow (direct contact with contaminated soil), reproduce frequently (population and age/structure models), and tend to ingest soil through preening (Paustenbach, 1989).

3.6.4.2 *Background*

Several important factors affect the potential impact of the contaminants of concern upon the environment. The fate, transport, and mobility of organic and metal contaminants are discussed in Sections 3.4.1 and 3.4.2 of this RI. Other factors include the toxicity of each

contaminant, the bioaccumulation and biomagnification potential, the uptake potential of plants, and the bioavailability of the contaminant in the soil.

A toxicant is a substance that is harmful to living organisms because of its detrimental effects on tissues, organs, or biological processes (Manahan, 1992). The toxicity of a chemical relates to the potency, or strength, of a toxicant to affect living organisms. Bioaccumulation in organisms includes direct uptake from water and uptake through ingestion of contaminated food organisms. Contribution to bioaccumulation by ingestion of contaminated organisms is species specific and food-chain specific, and is not estimated with the information available for this facility. Biomagnification is the uptake of environmental chemicals through food chains and can result in much higher levels of the chemicals in organisms than would be expected from simple bioaccumulation (Manahan, 1992).

Uptake by terrestrial plants exposed to contaminants in soil and dust deposited on leaves may also contribute to food-chain transfer in terrestrial communities. Root concentration factors for metals detected in surface soils vary widely depending upon the plant species, season, and biological activity. Uptake is dependent upon site characteristics and exposed species (Bodek et al., 1988). This information has not been researched and is not available for TEAD-N. It is not possible to quantitatively evaluate plant uptake at this time without additional information.

The bioavailability of contaminants in soil and sediment is a major factor in interpreting bulk concentration estimates. For example, high concentrations of calcium in soil at the TEAD-N site may reduce bioavailability of other metals to terrestrial plants (Barber, 1984; Miller and Donohue, 1990).

Contaminants may affect the ecosystem by either direct or indirect means. Direct impacts are those that affect individuals of a population, eventually affecting population size. Indirect impacts affect the processes that lead to species adaption and interaction, rather than population size.

With this in mind, the ecological community at TEAD-N must be considered, evaluated, and assessed as a whole rather than the sum of individual parts. Communities are complex dynamic networks of interactive individuals and species of which the effects of toxic substances may appear at points far removed from sites of direct impact, and in ways other than the death of individuals of a population (Levin et. al., 1984).

3.6.4.3 *Estimation of Exposure Concentrations*

The relative abundance of contaminants, the magnitude of the potential exposures, and the exposure pathways are summarized in each of the operable unit sections. Even though the quantitative characterization of potential receptor activity patterns and species abundance at exposure points was not within the scope of this field investigation, it becomes necessary to look at these in a qualitative sense for a thorough assessment. Calculation of doses and intakes for specific populations was also beyond the scope of this assessment and is not

included in this risk assessment. A qualitative risk assessment will be performed from data obtained through a facility-wide ecological study to be conducted at a later date.

The exposure point used for the TEAD-N facility is surface soil. This becomes the most likely exposure pathway of contamination to the ecosystem.

Toxicity profiles have been provided for each of the contaminants of concern and are presented in Appendix H. Biological information (toxicity level, bioaccumulation, biomagnification) has been summarized in Table 3-18 for each of the contaminants. These rating values are subjective and present only a qualitative ranking.

3.6.4.4 *Pathways*

The pathways for transport and distribution of contaminants through an ecosystem are critical in assessing the potential impacts of a contaminant on that ecosystem. Organisms may be exposed to a contaminant by direct or indirect means. Direct exposures include ingestion, inhalation, and dermal contact. Indirect exposure to contaminated media may occur as a result of bioaccumulation and food-chain transfer. Food-chain transfer, which is associated with plant- and decomposer-based food-chains, may occur in both aquatic and terrestrial ecosystems.

For contaminants to pass from the soil to the upper trophic levels of community, wildlife must inhabit, have direct access to, or feed off animals that have access to these sites. The Wildlife Locator Chart (Table 3-19; Benyus, 1989) explains the relationship of the fauna to their habitats and feeding areas in the TEAD-N ecosystem. This chart also gives a good indication of what kinds of wildlife have contact with or are exposed to each other.

Table 3-20 presents a summary of exposure points, general population, and the activity by which environmental exposure may occur for the TEAD-N facility.

The diets for wildlife species of special concern have been discussed, in general terms, in Section 2.9, Wildlife. These food sources represent potential pathways of exposure for the species of concern and may themselves become contaminated through exposure to the identified contaminants of concern.

Vascular plants, tertiary predators, and burrowing animals (earthworms, moles, ground squirrels, badgers, etc.) are likely to receive the highest exposures to contaminants of concern. Small mammals, whose home range is contained entirely on-site, are likely to receive a proportionately greater exposure than larger mammals and birds that may spend a fraction of their time on-site throughout the year or on a seasonal basis. Neither the exposure potential nor the risk for migratory waterfowl or shorebirds were addressed since habitat for these species does not specifically exist on the facility or within any of the operable units addressed in this report.

Table 3-18. Qualitative Risk for Chemicals of Concern

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
alpha-Chlordane	L[a]	H[b]	BA[c]	2[d]	3	—
Antimony	I[e]	L→M[f]	BC[g]	3[h]	3	metal is more toxic than salts
Barium	I	M	BC	3	3	all soluble salts are acute poisons
Benzo[a]anthracene	VL[i]	M	---	2	3	known animal carcinogen
Benzo[a]pyrene	VL	L→M	BC	2	3	known animal carcinogen, low acute oral toxicity, mutagen
Benzo[b]fluoranthene	VL	M	BA	2	3	known animal carcinogen
Benzo[g,h,i]perylene	VL	L→M	BA	---	---	possible animal carcinogen; low oral toxicity
Benzo[k]fluoranthene	VL	M	BA	2	3	known animal carcinogen
Bis(2-ethylhexyl) phthalate	VL	L→M	BC	2	3	known animal carcinogen; low oral toxicity;
Cadmium	VL	M→H	BA	3	3	known animal carcinogen
Chromium	VL	L→H	BC	1[j]	3	many Cr+6 cmpds are animal and human carcinogens
Chrysene	VL	L→M	---	2	3	low oral toxicity, known animal carcinogen
Copper	I	VL→M	BC	3	3	Cu^0 metal toxicity very low; many Cu(II) salts are toxic
Cyanide anion $(CN)^{-1}$	H	H	---	3	3	very poisonous by most routes
Diethyl phthalate	H	VL→L	---	3	3 combustible	v. low acute toxicity in lab animals
Di-n-butyl phthalate	L	VL→L	---	---	3 combustible	low oral toxicity
2,4-Dinitrotoluene	VL	H	---	2,3	3	animal carcinogen, suspect human carcinogen
2,6-Dinitrotoluene	VL	H	BC	2,3	3	animal carcinogen, suspect human carcinogen
Fluoranthene	VL	L→M	---	---	3 combustible	mild oral and dermal toxicity in animals; human mutation data

Table 3-18. Qualitative Risk for Chemicals of Concern (continued)

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
gamma-Chlordane	L	H	BA	2	3	---
Heptachlorodibenzo-p-dioxin	L	H	BA	2	3	less toxic than TCDD; not thought to be carcinogen or teratogen
Heptachlorodibenzofuran	L	H	BA	2	3	less toxic than TCDD
Hexachlorodibenzo-p-dioxin	L	H	BA	2	3	less toxic than TCDD
Hexachlorodibenzofuran	L	H	BA	2	3	less toxic than TCDD
HMX	L	H	---	---	3	---
Indeno[1,2,3-cd]pyrene	VL	---	BC	2	3	known animal carcinogen; no toxicity data
Iron	I	L→H	---	---	3 dust explosive	poison by IP[a] route; questionable animal carcinogen; potentially toxic in all forms
Lead	I	H	BC	2,3	3	acute and chronic toxicant; suspected carcinogen
Mercury	I	H	BA,BC	3	3	highly toxic by most routes incl. inhalation; questionable carcinogen; some evidence of human mutations
Methyl ethyl ketone	H	M	---	3	3 flammable	moderately toxic by most routes
Methyl-n-butyl ketone	L	L	---	3	3 flammable	chronic exposure by inhalation or skin absorption causes nerve disorders; low oral toxicity in rats
N-Nitrosodiphenylamine	L	M	---	2,3	3	moderately toxic by ingestion; carcinogenic in some animals; human mutation data reported
Nickel	I	L→M	BA	1	3 dust explosive	dust is confirmed carcinogen; low oral toxicity for metal;

Table 3-18. Qualitative Risk for Chemicals of Concern (continued)

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
Octachlorodibenzodioxin -nonspecific	L	H	BC,BM[1]	2,3	3	poison by ingestion; teratogen; skin tumors; inadequate animal data
Octachlorodibenzofuran-nonspecific	L	H	BC,BM	2,3	3	less toxic than TCDD
Pentachlorodibenzofuran	L	H	BC,BM	3	[illegible]	less toxic than TCDD
Phenanthrene	I	M	BA	3	3	poison by IV[illegible]; mod. toxic by ingestion
Polychlorinated biphenyl, Aroclor 1260	I→VL	M	BM,BC	2	3	mod. toxic by ingestion and skin contact; teratogen, mutagen
Pyrene	I	M	BC	2	3	inhalation poison; mod. toxicity by ingestion
RDX	I	H	BC	3	3	poison by ingestion, IV, IP; corrosive, irritant to skin, eyes, mucous membranes;
Silver	I	L	BA,BC	---	2 dust sl. flammable	toxicity of metal is low by all exposure routes; dust an irritant; accumulation in the body may produce argyria; soluble cmpds toxic/fatal
2,3,7,8 - Tetrachloro-dibenzo-p-dioxin (TCDD)	I→VL	H	BC	2,3	3	animal carcinogen; teratogen
2,3,7,8 - Tetrachloro-dibenzofuran	I→VL	H	BC	2,3	3	similar toxicity to its TCDD counterpart; teratogen
Tetryl	I	---	---	3	3	very little toxicity info: mutation data, irritant and allergin
Thallium	I	H	BC	3	3	highly toxic in animals and humans;
1,3,5-Trinitrobenzene	I	M	BC	3	3	poison by IV; moderately toxic by ingestion

Table 3-18. Qualitative Risk for Chemicals of Concern (continued)

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
2,4,6-Trinitrotoluene	I	M→H	BC	2,3	3	poison by subcutaneous route; mod. toxic by ingestion; mutation data reported
Zinc	I	VL→L	BC	---	3 dust explosive	many of its cmpds are toxic; dust is an irritant

[a]L=low.
[b]H=high.
[c]BA=bioaccumulate.
[d]2=probable or suspected carcinogen.
[e]I=insoluble.
[f]M=moderate.
[g]BC=bioconcentrate.
[h]3=tissue or organ damage.
[i]VL=very low.
[j]1=carcinogenic.
[k]IP=intraperitoneal.
[l]BM=biomagnification.
[m]IV=intravenous.
--- = unclassified as to carcinogenicity or no data

* Hazard Rating (HR:) was assigned to each material in the form of a number 1, 2, or 3 that briefly identifies the level of the toxicity or hazard. The letter "D" is used where the data available are insufficient to indicate a relative rating. In most cases, a "D" rating is assigned when only in vitro mutagenic or experimental reproductive data are available. Ratings are assigned on the basis of low (1), medium (2), or high (3) toxic, fire, explosive, or reactivity hazard.

- The number "3" indicates an LD50 below 400 mg/kg or an LC50 below 100 ppm; or that the material is explosive, highly flammable, or highly reactive.
- The number "2" indicates an LD50 of 400-4000 mg/kg or an LC50 of 100-500 ppm; or that the material is flammable or reactive.
- The number "1" indicates an LD50 of 4000-40000 mg/kg or an LC50 of 500-4000 ppm; or that the material is combustible.

Solubility information for metals refers to the fully-reduced form, M^o.

Sources: Lewis, Richard J., Sr., Hazardous Chemicals Desk Reference, 2nd Edition, Van Nostrand Reinhold Publishers, New York, 1991.
Patnaik, Pradyot, A Comprehensive Guide to the Hazardous Properties of Chemical Substances, Van Nostrand Reinhold Publishers, New York, 1992.
Sax, N. Irving, and Lewis, Richard J., Sr., Hawley's Condensed Chemical Dictionary, 11th Edition, Van Nostrand Reinhold Publishers, New York, 1987.
U.S. Environmental Protection Agency, Integrated Risk Information System (IRIS) database, January 1993.
National Library of Medicine database, 1991.
Agency for Toxic Substances and Disease Registry.

Table 3-19. Wildlife Locator Chart

	Feeds From Air	Feeds in Upper Canopy	Feeds in Lower Canopy	Feeds on Trunk	Feed on Ground
Nests in Tree Canopy	Peregrine Falcon* Cooper's Hawk Swainson's Hawk* Red-tailed Hawk Ferruginous Hawk* Golden Eagle* Great Horned Owl Black-chinned Hummingbird	Pinyon Jay Clark's Nutcracker Blue-gray Gnatcatcher	Bushtit Black-throated Gray Warbler American Goldfinch Northern Oriole		Bald Eagle* Mourning Dove Steller's Jay Scrub Jay American Robin Chipping Sparrow House Finch Abert Squirrel
Nests in Trunk Cavity	American Kestrel Western Screech-Owl Ash-throated Flycatcher Little Brown Myotis California Myotis Big Brown Bat Spotted Bat*	Porcupine	Black-capped Chickadee Plain Titmouse Porcupine	Red-shafted Woodpecker	Common Raven Mountain Bluebird Pinyon Mouse
Nests on Shrubs	Gray Flycatcher Loggerhead Shrike	Black-headed Grosbeak	Gray Vireo Black-throated Sparrow Western Yellow-billed Cuckoo*		Northern Mockingbird Brown Towhee White-crowned Sparrow
Nests on Ground	Prairie Falcon Common Poorwill Townsend's Solitaire Ferruginous Hawk*		Virginia's Warbler		Rosy Finch Mule Deer* Pronghorn Antelope* Mountain Sheep Mountain Plover* Sage Grouse* Chukar*

Table 3-19. Wildlife Locator Chart (continued)

	Feeds From Air	Feeds in Upper Canopy	Feeds in Lower Canopy	Feeds on Trunk	Feed on Ground
Nest Beneath Ground or Debris		Porcupine			Badger Striped Skunk Nuttalls Cottontail Black-tailed Jackrabbit Cliff Chipmunk Least Chipmunk Rock Squirrel Townsend's Ground Squirrel Great Basin Kangaroo Rat Great Basin Pocket Mouse Skull Valley Pocket Gopher* Coyote Red Fox Ringtail Mountain Lion Bobcat Western Whiptail Collared Lizard Great Basin Skink Sagebrush Lizard Side-blotched Lizard Great Basin Rattlesnake Great Basin Gopher Snake Striped Whipsnake Western Yellow-bellied Racer

*Threatened, endangered or sensitive species.

Table 3-20. Exposure Scenarios for Ecological Populations

Exposure Point	Exposure Activity	Magnitude of Exposure
Plants	Growth in contaminated soil; uptake	Lifetime.
Invertebrates	Ingestion of contaminated soil and plant matter	Lifetime.
Small Mammals[a]	Ingestion of contaminated soil, insects, and vegetation; dermal contact; inhalation of vapors and contaminated soil particulates.	Lifetime; may migrate.
Large Mammals	Ingestion of contaminated vegetation (foliage, fruit, roots); dermal contact; inhalation of vapors and contaminated particulates.	Primarily exposed during feeding; may be seasonal.
Passerine Birds	Ingestion of contaminated vegetation (foliage, fruit, seeds); dermal contact; inhalation of vapors and contaminated particulates.	Exposed during feeding; may be seasonal.
Raptors	Ingestion of contaminated carrion or animals.	Exposed during feeding; may be seasonal.

[a]Burrowing animals may be included in this category (e.g., moles, ground squirrels, badgers, etc.)

3.6.4.5 *Cumulative Effects*

Certain species tend to use the TEAD-N installation on a community level. These include most of the bird species, in particular the raptors, and some of the larger mammals such as the coyotes, bats, mule deer, and rabbits. Because of their mobility, these species feed and forage in a much larger area than is contained in most of the individual sites, which increases their potential for contamination. The species that would tend to stay on or in close proximity to these individual sites would be the reptiles and smaller mammals.

Cumulative effects of contaminants can also occur through cross contamination between sites. This scenario could occur through the mobility exhibited by animals at the higher trophic levels, when they feed or forage at numerous sites. If the death of one of these species occurred, the potential exists for it to become the source of contaminated carrion at a site other than where contaminated food or forage was eaten. This scenario would increase the potential of bioaccumulation at other sites as well as increasing the potential for the ecosystem to function as a vector for routes of exposure to humans.

3.6.4.6 *Ecological Endpoints*

An ecological risk assessment must consider that population-level effects in one species might actually be a source of risk in itself to other ecosystem components. For example, a decline in population of a particular species (or extinction thereof) may affect the feeding habits of other species and, in turn, the function of the ecosystem as a whole (Lipton et al., 1993). These "risk cascades" may eventually alter the structure at the community level by affecting the competitive advantage of certain species (Connell, 1983).

The effects of contaminants upon exposed organisms may be ranked in a hierarchical manner. The most direct exposure impacts occur to organisms exposed to contaminants at the bottom of the food-chain, with indirect adverse effects through bioaccumulation and biomagnification occurring at the higher levels of ecological organization at the top.

Ecological endpoints are the outcome of or the effect that exposure to stressors have on an ecosystem (Suter, 1990). These are usually assessed in two ways: either at the species level (populations) or at the ecosystem level. Endpoints of concern at the species level are expressed in terms of changes in mortality rates, reproduction rates, growth rates, physiological and behavioral abnormalities, and environmental stress susceptibility. Endpoints at the Ecosystem Level are expressed in terms of changes in species diversity, location (migrations), productivity, biomass accumulation, energy and nutrient cycling, resilience, species interaction, taxonomic variability, and resistance to disruptive events.

Potential adverse impacts to individual organisms exposed to contaminants of concern include:

- Direct toxicity (reduced survival or increased mortality),
- Sublethal effects (physiological changes, reduced growth, reduced reproduction, tissue anomalies, etc.),
- Changes in behavior (home range, site avoidance, etc.), and
- Increased susceptibility to predation and disease as a result of sublethal effects of exposure (Peterle, 1991).

3.6.4.7 *Development of the Bioaccumulation Model*

The bioaccumulation model that was used in the risk assessment (proposed by Thomas, 1981; modified by Fordham, 1981) for Sites 17 and 5 was initially intended to evaluate chemical transfer through an aquatic food chain. It has been modified to evaluate transfer of contaminants through a terrestrial environment by linking chemical concentrations of the COCs in soil to maximum acceptable tissue concentrations in biota and the corresponding biomagnification factors for the upper level consumers of the potential exposure pathways being investigated.

Tissue concentrations that caused reproductive failure at the second and third order consumer levels (i.e., raptor) were used as the benchmark to obtain PCB and PCDD soil concentrations

that represented the lowest level at which reproductive failure might occur due to the selected group of COCs.

The following assumptions concerning bioconcentration factors (BCFs) were made and used in this model:

- The chemical concentration in the soil is in equilibrium with the chemical concentration of the vegetative tissue; hence, the bioconcentration factor between the soil and plants is assumed to be one (BCF=1).

- The first order consumers each have a bioconcentration factor of 2 (BCF=2). (Bioconcentration is the uptake of a chemical from water; terrestrial species have minimal uptake from water; most of their uptake of water is from food items, not from direct water ingestion.)

- A bioconcentration factor of 2 was also assumed for the predators at the top of the food chain (BCF=2).

- All of these BCFs are conservative.

Bioaccumulation factors (BAFs) only apply to second order consumers or above, and were calculated as follows:

- Food Chain Level 1: C(soil) = C(vegetation); BCF(vegetation) = 1
- Food Chain Level 2: BAFs = BCF2 + f2(BCF1)
- Food Chain Level 3: BAF3 = BCF3 + f3(BCF2) + f3f2(BCF1)

where

C = chemical concentration
BAF = bioaccumulation factor
BCF = bioconcentration factor
f = food term.

The food term f = [(A x D x I)/L] x F

where

A = assimilation efficiency (weight ingested)
D = daily food intake
I = percent of food in daily diet
L = loss rate, a fraction/day
F = foraging area factor (expressed as a percent of the actual site being assessed in relation to the foraging area of the species).

In calculating the food term, a conservative assimilation efficiency of 0.9 was used, which means that for every 10 mg of chemical ingested, 9 mg are assimilated (Spacie et al, 1985). Loss rate, or depuration, is the loss of a chemical due to growth, dilution, excretion, and/or metabolism. For avian species, a value of 0.36 was used; while for mammals, 0.40 was used (ESE, 1988). Specific information on the species identified in the food chains such as average weights, daily food consumption, food items consumed, as well as the percent of these various foods in relation to their total diets, is also used in the food term equation (see Table 7-10).

Biomagnification is the result of an increase in the chemical concentration of the COC as it passes up the food chain, in this case, to the raptor. Once the food term for each species is calculated, and consequently the BAFs for each key species in the pathway is calculated, then the biomagnification factors (BMF) associated with the upper level consumers are determined using the following equation:

$$BMFi = BCFi + \text{sum of } fi\ (BAFi\text{-}1)$$

where

i = the species at the highest consumer level

and

i-1 = the species at one level down from the highest consumer level.

The total BMF is then used to determine the maximum allowable soil concentration (C soil) that would potentially cause reproductive failure in the target species population by relating environmental media concentrations (in this case, in the soil) to the maximum acceptable tissue concentrations (MATC) of the targeted species using the following equation:

$$MATC/\text{Total } BMFi = C\ (\text{soil})$$

where C represents the lowest concentration in the soil that could potentially biomagnify up the food chain to the target species and cause reproductive failure to occur.

3.6.4.8 *Discussion of Uncertainty*

The absence of site-specific information requires the use of conservative assumptions to be made and used in (1) the ecological risk assessment and (2) any models used in the assessment. This, of course, results in risk parameters and a risk estimate that are conservative. The data that were used to evaluate the potential risk to the biota, and in the bioaccumulation model, were largely based on literature values except for the site-specific species lists that were used in the formulation of the potential receptor-pathways. The selection of receptor species and the benchmarks associated with upper level consumer populations were derived from these site-specific lists, yet the selections themselves were based on literature reviews and information gained from past ecological assessments. The

concentrations of contaminants of concern at the sites were from data collected at TEAD-N as part of this RI.

Because of the lack of site-specific data, it is not possible to validate any of the calculations or parameters used in the ecological risk assessment. This, in turn, causes uncertainty in the final estimates of bioaccumulation and transfer through the food chain of the contaminants of concern.

The lack of site-specific data required that all values used in calculating the bioconcentration, bioaccumulation, and biomagnification factors be derived from literature data for similar or related species. Calculations of BCFs, BACs, and BMFs were non-chemical specific, but instead were identical for each species, independent of what chemical was of concern. This results in one BMF per key (upper level consumer) species, rather than a separate BMF for each chemical evaluated. Despite the conservative approach to the bioaccumulation model parameters, it is possible that one or more of the contaminants in question accumulates in tissues greater than estimated. The loss rates and assimilation efficiency data used in the food term calculations were also not site specific and could cause uncertainty in the model. The assumptions mentioned in Section 3.6.4.7 concerning the bioconcentration factors also have a level of uncertainty associated with them, such that the final biomagnification factors could actually overestimate the risk.

Normally, in a bioaccumulation model similar to the one used for this assessment, the "no effects" concentration in the soil (C) is derived from an equation where the MATC is divided by the total BMF for the key species. However, because no MATCs were listed for the chemicals in question, these values were extrapolated from values that caused some sort of reproductive failure (either death in the offspring after hatching or a reduced number of hatchings per nest due to eggshell thinning). The tissue concentrations were then back calculated to give a value that represented the concentration in the adult where reproductive failure would occur in the offspring.

There is uncertainty in the toxicity and exposure assessment as well as uncertainty in the risk assessment. The assumptions of exposure, bioconcentration factors, and the lack of site-specific data all increase the uncertainty of the conclusions of potential harm to the biota from the contaminants of concern. Uncertainty in the exposure assessment is related to the accuracy with which the designated exposure pathways correctly predict contact with the contaminants of concern through different media, and the corresponding use of the concentrations of these contaminants in the bioaccumulation model. Uncertainty is also influenced by assumptions regarding exposure and toxicities which are the results of sampling and analysis data, as well as the literature data used in the bioaccumulation model.

4.0 OPERABLE UNIT 4

4.1 FORMER TRANSFORMER BOXING AREA (Site 31)

4.1.1 Site Characteristics

The Former Transformer Boxing Area (Site 31) was located on Open Storage Lot 680 (see Figure 1-4). This area is located approximately 1,600 feet east of the PCB Spill Site (Site 32). Lot 680 was used from about 1979 to 1980 for the temporary storage of transformers that were once stored at the Former Transformer Storage Area (Site 17). From Lot 680, the transformers were sent for off-site disposal or they were transferred to Building 659 (Site 33).

4.1.2 Previous Investigations and RI Activities

This area was used only for short-term storage of transformers, and no leaks or spills were reported. No surface-soil staining was detected during a review of historical aerial photographs of this site (CNES, 1992). Site walkovers also failed to identify any areas of surface staining or other evidence that would indicate that a spill or leak had occurred.

4.1.3 Nature and Extent of Contamination

Although there are no data that indicate that a release of PCBs has ever occurred at Site 31, the possibility of past oil spills suggests that sampling and additional site characterization is justified.

4.1.4 Contaminants of Concern

PCBs are the potential contaminants of concern at this site.

4.1.5 Contaminant Fate and Transport

Because there are no existing contaminant data at this site, an assessment of contaminant fate and transport characteristics was not conducted.

4.1.6 Potential Exposure Pathways

Because there are no existing contaminant data at this site, an assessment of exposure pathways was not conducted.

4.1.7 Baseline Risk Assessment

4.1.7.1 *Human Health Evaluation*

Because there are no data to characterize a contaminant release at this site, a human health evaluation for Site 31 was not conducted.

4.1.7.2 *Environmental Evaluation*

4.1.7.2.1 ***Site Characterization***. Site 31 is an open storage lot in an industrial area of TEAD-N. Gravel covers the surface of the site. Because of frequent human activity in the area, the most likely wildlife inhabitants are rodents or other small mammals. Although a wildlife inventory has not been conducted, there is no indication that this area is a critical habitat.

4.1.7.2.2 ***Biological Effects of Contaminants***. An assessment of biological effects was not conducted because of the lack of definitive contamination data for Site 31.

4.1.7.2.3 ***Potential Pathways***. No contamination was identified at Site 31, so none of the potential exposure pathways are considered to be complete.

4.1.7.2.4 ***Environmental Evaluation Conclusions***. No contamination was identified at this site. Therefore, this site has a low probability of impacting the environment.

4.1.8 Conclusions

Although there is no evidence of soil staining at Site 31, it still has potential for contamination. PCBs have been found at Site 17, the Former Transformer Storage Area, from which transformers were moved to Site 31.

4.1.9 Recommendations

Soil samples should be taken at Site 31 and analyzed for PCBs to allow characterization and risk analysis.

4.2 PCB SPILL SITE (Site 32)

4.2.1 Site Characteristics

The PCB Spill Site is located in the southern corner of Open Storage Lot 665D (Figure 1-4). In October of 1980, a transformer oil spill occurred at the southwestern corner of the lot. Two transformers, reportedly containing a total of 1,000 gallons of PCB-contaminated oil, were punctured with a fork-lift blade during transformer removal operations. The spill occurred on the unpaved ground surface, and the spill area was reportedly less than one-half acre. Cleanup involved excavating oil-saturated soils, containerizing the soils in 55-gallon drums, and properly disposing these drums. Some of the oil leaking from the transformers was collected and was also placed in 55-gallon drums for disposal. Approximately 440 55-gallon drums of contaminated soil and 18 drums of contaminated oil were removed (EA, 1988). The excavation area was backfilled with imported fill material. Lot 665D is currently used for vehicle-related equipment storage.

4.2.2 Previous Investigations and RI Activities

EA conducted a site investigation at the PCB Spill Site (Site 32) to confirm that the soils remaining after the excavation were not contaminated with PCBs (EA, 1988). A total of 17 discrete surface-soil samples were collected by EA from an area measuring approximately 45 feet by 50 feet (Figure 4-1). Three of the 20 proposed samples (10, 14, and 18) could not be collected because equipment covered the sampling locations. The samples were composited into five samples (PCB-SLC1 through PCB-SLC5), which were analyzed for the PCB Aroclors 1016, 1254, and 1260. Aroclor 1260 was detected in all five samples, ranging from 0.0764 to 0.2140 μg/g (Table 4-1). If it were assumed that one of the discrete samples in a composite contained all the PCBs, a maximum concentration of approximately 0.64 μg/g can be calculated. This result is below the EPA guidelines (EPA, August 1990) of one μg/g and TSCA cleanup standards of 10 μg/g. TSCA's cleanup standard for soil applies to PCB spills in nonrestricted access areas with at least 10 inches of soil removed and 10 inches of clean soil cover (having less than 1 μg/g PCBs) applied to the affected area (40 CFR761.125(c)(4)). On the basis of these findings, no additional investigations were proposed for this RI and no samples were taken by Rust E&I. However, further review of sample files, plus the fact that part of the area was not previously sampled, has resulted in the conclusion that additional sampling is required. Specifically, 31 soil samples at depths of 0, 5, and 20 feet are scheduled to be analyzed for PCBs. These data will be used to re-calculate and assess human health and environmental risks. Conclusions concerning site remediation will be reported in an RI Report Addendum and future FS.

4.2.3 Nature and Extent of Contamination

Existing analytical results from surface-soil composite samples indicate that PCBs are only present in trace amounts (up to 0.214 μg/g) and that these concentrations fall below EPA guidelines and the TSCA cleanup standard for nonrestricted areas (Section 4.2.2).

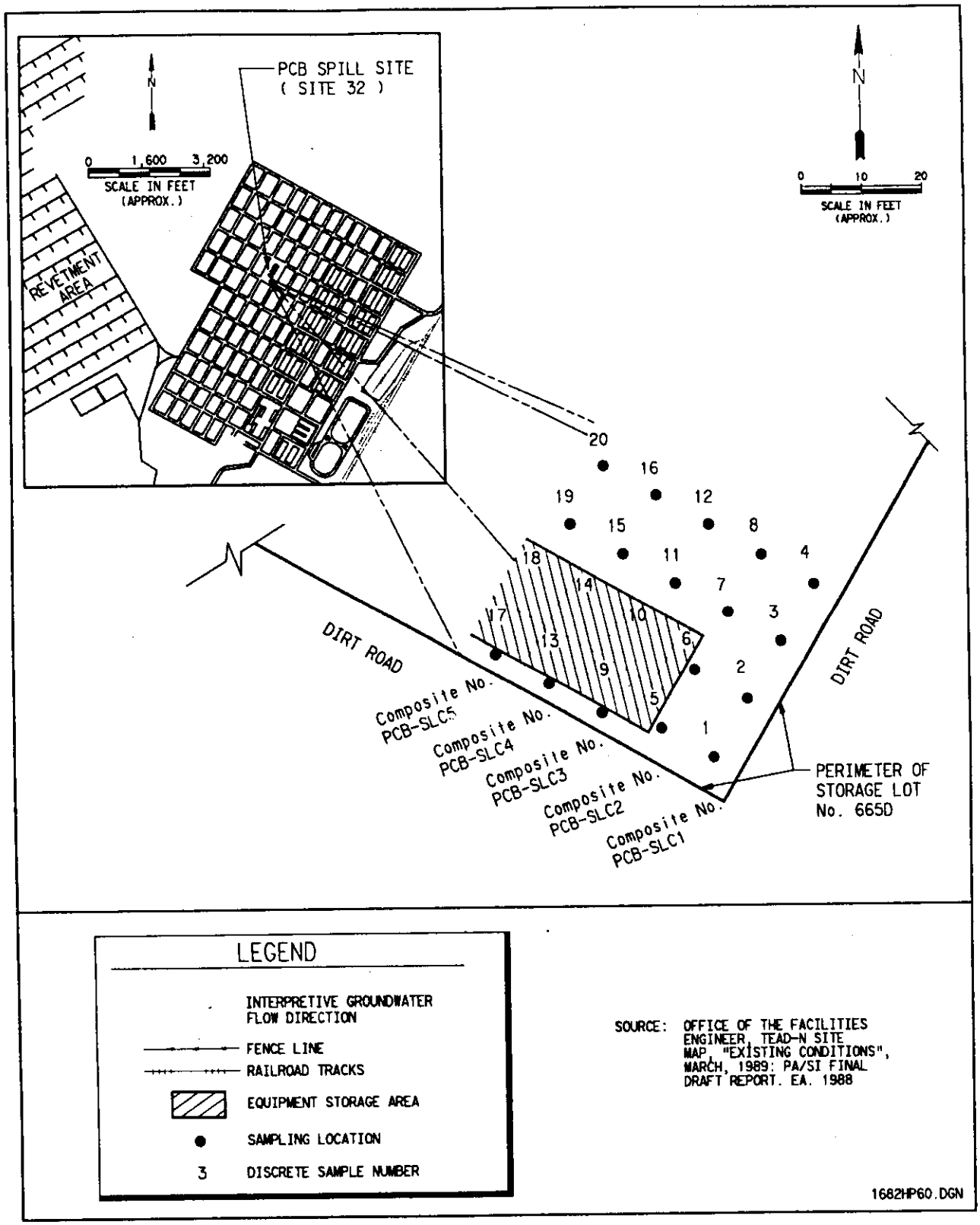


Figure 4-1. Surface Soil Sampling Grid at the PCB Spill Site (Site 32)

Table 4-1. Analytical Results for Composite Surface Soil Samples Collected at the PCB Spill Site (Site 32), February 20, 1987

Parameter	SLC1* (μg/g)	SLC2* (μg/g)	SLC3* (μg/g)	SLC4* (μg/g)	SLC5* (μg/g)
Aroclor 1016	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1254	ND	ND	ND	ND	ND
Aroclor 1260	0.0804	0.1150	0.2140	0.1740	0.0764

Note.—ND indicates a compound not assigned a certified reporting limit (CRL) and not detected above the analytical detection limit. The parameters listed were determined according to methods not certified by USATHAMA.

*Samples were taken at 6-inch depths.

Source: EA, 1988

4.2.4 Contaminants of Concern

The contaminant of concern at Site 32 is the PCB Aroclor 1260 (Table 4-2).

4.2.5 Contaminant Fate and Transport

Table 3-8 in Section 3.4.1 describes the fate and transport characteristics of PCBs. PCBs strongly adsorb to soils and are resistant to leaching. Because the depth to groundwater is approximately 280 feet bgs at this site, and the detected concentrations of PCBs in the surface soil are low (up to 0.64 μg/g), the leaching of PCBs to groundwater is highly unlikely. However, PCBs may enter the atmosphere through adsorption to windborne particulates; removal would occur through wet and dry deposition. PCBs resist biodegradation and tend to bioconcentrate in tissue.

4.2.6 Potential Exposure Pathways

Figure 4-2 presents a conceptual model of the most likely exposure pathways for PCBs at Site 32. These pathways are via dermal contact, ingestion, and particulate inhalation. The coarse nature of the sand and gravel covering the lot results in a minimal amount of fugitive dust that could affect the air pathway. Because the open lot where the contamination is present is graveled and used for vehicle-related equipment storage, the likelihood of bioaccumulation is very small.

Section 3.4.3 includes a discussion on vadose zone modeling that evaluates the possible effects of contaminant leaching to groundwater. Because groundwater data are not available to determine contaminants of concern, this exposure pathway was not evaluated in the Baseline Risk Assessment.

Table 4-2. Contaminant of Concern for Surface Soil at the PCB Spill Site (Site 32)

Analyte	Total Detects	Total Samples	Low	High	Average	95% Confidence	Statistical Background Concentration	Method	Sample Quantitation Limit
Polychlorinated Biphenyl 1260	5	5	0.076	0.214	0.132	0.189	---	99	0.07

Note.—All results are reported as μg/g. Surface soil included all soil samples from depths of less then 6 inches. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration values for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

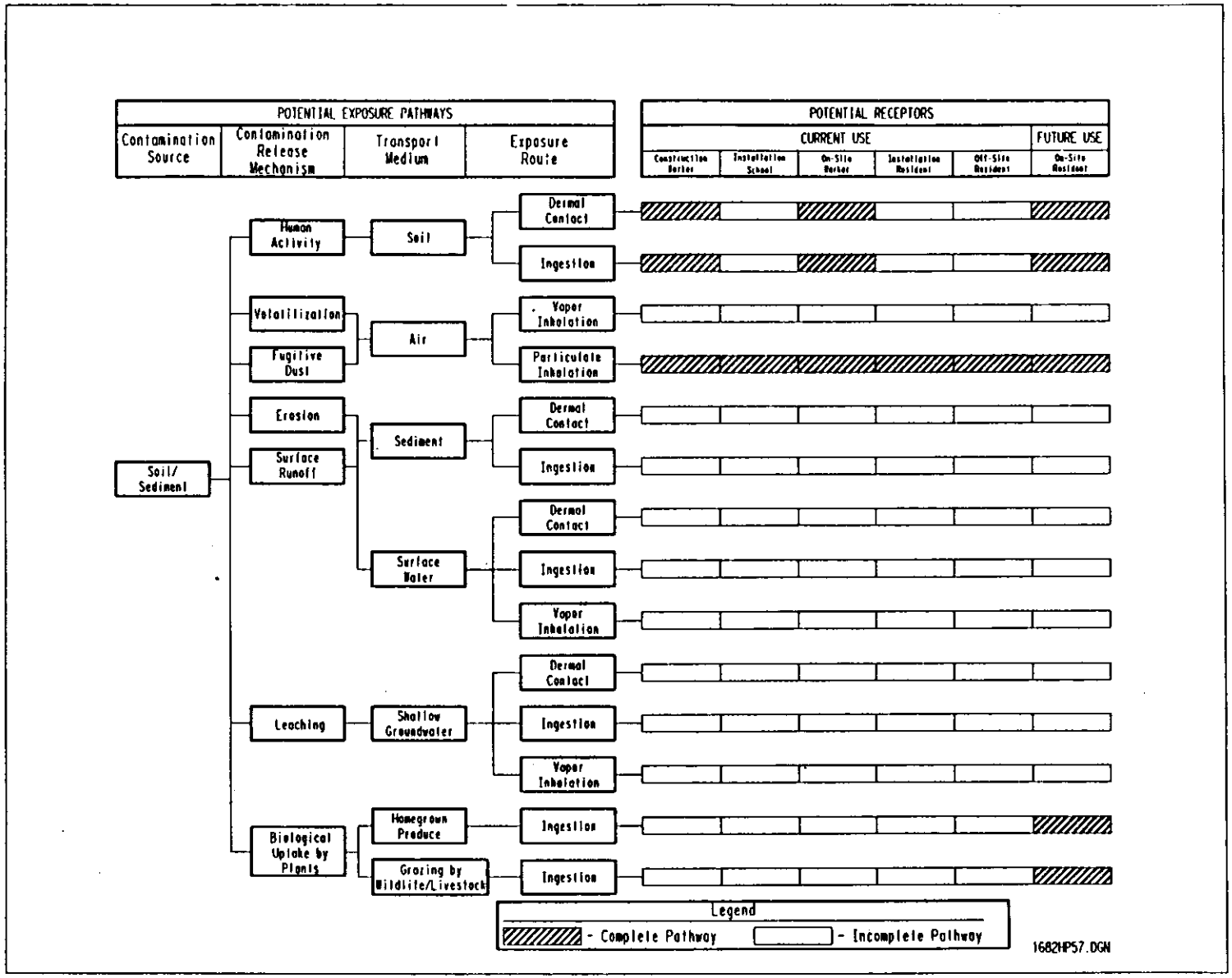


Figure 4-2. Potential Human Exposure Pathway Conceptual Model for the PCB Spill Site (Site 32)

4.2.7 Baseline Risk Assessment

4.2.7.1 *Human Health Evaluation*

This section presents the results from the Human Health Risk Assessment performed for the PCB Spill Site (Site 32). Noncarcinogenic risk estimates and carcinogenic risk estimates for the inhalation pathway were not evaluated. These risks will be calculated and included in an addendum to the RI. Tables 4-3 and 4-4 present the risk assessment results.

4.2.7.1.1 *Current Land Use*. This section discusses the risk estimates for each exposure scenario assessed under current site use conditions.

Potential exposures through inhalation to installation students, installation residents, and off-site residents were not evaluated. Risks for these exposure scenarios will be calculated in the forthcoming RI Addendum utilizing all available data.

4.2.7.1.1.1 *On-Site Worker*

CARCINOGENIC RISK

The total carcinogenic risk factor for on-site workers at Site 32 for the average exposure level is 5E-07. The risk factor from dermal exposure is 4E-07 and from soil ingestion is 7E-08.

The total soil pathway carcinogenic risk factor from RME is 2E-06. The risk from dermal exposure is 2E-06 and from soil ingestion is 3E-07.

The total carcinogenic risk estimates of 5E-07 and 2E-06 fall within or below the EPA target range for residual risk of 1E-04 to 1E-06.

NONCARCINOGENIC RISK

The noncarcinogenic hazard indices for on-site workers at Site 32 will be calculated and evaluated in the RI Addendum.

4.2.7.1.1.2 *Construction Worker*

CARCINOGENIC RISK

The total carcinogenic risk factor for the construction worker at Site 32 for the average exposure level is 5E-08. The risk from dermal exposure is 4E-08 and from soil ingestion is 7E-09.

Table 4-3. Risk Estimate Summary Using Average Exposure Level for the PCB Spill Site (Site 32)

Exposure Pathway/Analyte	On-Site Worker [a]	Construction Worker[b]	On-Site Resident[b]
	RF[c]	RF	RF
INGESTION			
PCB Aroclor 1260	7.10E-08	7.10E-09	8.9E-08
DERMAL			
PCB Aroclor 1260	4.40E-07	4.40E-08	5.6E-07
Site Total	5.11E-07	5.11E-08	6.4E-07

[a]Current Land Use exposure pathway.
[b]Future Land Use exposure pathway.
[c]RF=risk factor.

Note.—The hazard indices for this site will be calculated in the RI Addendum. Risk factors for the installation school, installation resident, and off-site resident will also be calculated in the addendum.

Table 4-4. Risk Estimate Summary Using Reasonable Maximum Exposure Level for the PCB Spill Site (Site 32)

Exposure Pathway/Analyte	On-Site Worker [a]	Construction Worker[b]	On-Site Resident[b]
	RF[c]	RF	RF
INGESTION			
PCB Aroclor 1260	3.0E-07	9.78E-08	3.6E-07
DERMAL			
PCB Aroclor 1260	1.9E-06	6.32E-08	4.4E-06
Site Total	2.2E-06	1.61E-07	4.8E-06

[a]Current Land Use exposure pathway.
[b]Future Land Use exposure pathway.
[c]RF=risk factor.

Note.—The hazard indices for this site will be calculated in the RI Addendum. Risk factors for the installation school, installation resident, and off-site resident will also be calculated in the addendum.

The total soil pathway carcinogenic risk factor from RME is 2E-07. The risk from dermal exposure is 6E-08 and from soil ingestion is 1E-07.

NONCARCINOGENIC RISK

The noncarcinogenic hazard indices for construction workers at Site 32 will be calculated and evaluated in the RI Addendum.

4.2.7.1.2 *Future Land Use*

A future on-site residential scenario has been considered for Site 32. The risk estimates for this exposure scenario, which were evaluated using average exposure level and RME for carcinogenic risks, are discussed below. However, as stated previously, prior to any transfer of Army property to public use, a complete re-examination and re-evaluation would be required to assume that there would be no risk to human health and the environment.

4.2.7.1.2.1 *Future On-Site Resident*

CARCINOGENIC RISK

The total carcinogenic risk factor for future on-site residents at Site 32 for the average exposure level is 6E-07. The risk from dermal exposure is 6E-07 and from soil ingestion is 9E-08.

The total pathway carcinogenic risks factor from RME, using the 95 percent upper confidence limit, is 5E-06. The risk from dermal exposure is 4E-06 and from soil ingestion is 4E-07.

NONCARCINOGENIC RISK

The noncarcinogenic hazard indices for future on-site residents at Site 32 will be calculated and evaluated in the RI Addendum.

4.2.7.2 *Environmental Evaluation*

The environmental evaluation for Site 32 is qualitative and did not include a detailed inventory or bioassays of the vegetation and wildlife. Data gap sampling is needed to provide additional information to further determine the extent of contamination and the degree of ecological risk. The findings from additional sampling will be issued as an RI addendum and in an ecological assessment report.

4.2.7.2.1 *Site Characterization*. Site 32 is an open storage lot in an industrial area of TEAD-N. Gravel covers the surface of the site. Because of frequent human activity in the

area, the most likely wildlife inhabitants are rodents or other small mammals. There is no indication that this area is a critical habitat.

4.2.7.2.2 ***Biological Effects of Contaminants.*** Table 4-5 summarizes the relevant information for the contaminant of concern at Site 32 taken from Table 3-18.

Table 4-5. Summary of Contaminants (Site 32)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
(PCB) Aroclor 1260	I[a]→VL[b]	M[c]	BM[d],BC[e]	2[f]	3	mod. toxic by ingestion and skin contact; teratogen, mutagen

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]I = insoluble.
[b]VL = very low.
[c]M = moderate.
[d]BM = biomagnification.
[e]BC = bioconcentrate.
[f]2 = probable or suspected carcinogen.

4.2.7.2.3 ***Potential Pathways.*** No biological samples were obtained, thus the uptake of contaminants by flora and fauna cannot be evaluated at this time. The most probable pathways of contaminants through the ecosystem are as follows:

- Plants

-Direct uptake through root system

- Wildlife

-Ingestion of contaminated soil
-Ingestion of contaminated foliage
-Ingestion of contaminated insects
-Ingestion of contaminated carrion, animals
-Dermal contact
-Inhalation of vapors
-Inhalation of contaminated particulates

Potential pathways are shown in Figure 4-3.

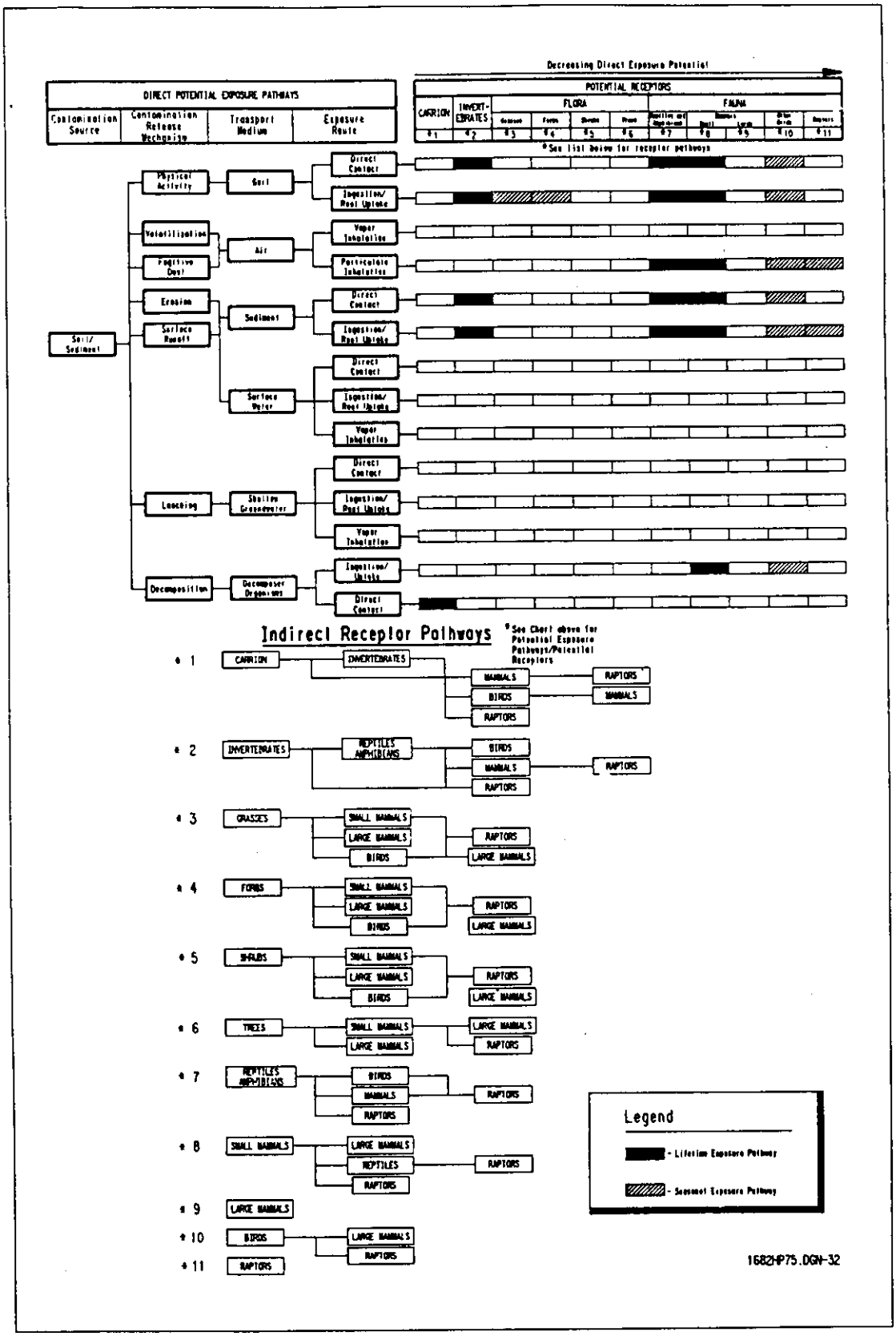


Figure 4-3. Potential Ecological Exposure Pathways for Site 32

4.2.7.2.4 ***Potentially Affected Populations.*** Table 4-6 presents a summary of exposure points, general population, and the activity by which ecological exposure may occur. The table is listed in decreasing exposure potential.

Table 4-6. Exposure Scenarios for Ecological Populations at Site 32

Exposure Point	Exposed Population	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Occasional exposure, only when feeding at this site, due to heavy industrial activity.
Terrestrial Location	Raptors	Ingestion of contaminated carrion or animals.	Unlikely; exposed when feeding in other areas on prior inhabitants of the site.

4.2.7.2.5 ***Environmental Evaluation Conclusions.*** The contaminant of concern for Site 32 is the PCB Aroclor 1260. In addition to the information provided in Table 3-18 and 4-5, the qualitative biological hazard ranking for this contaminant is high since it is toxic, adsorbs to soil, resists leaching, bioaccumulates, and biomagnifies. Site 32 is a poor habitat for plants and wildlife because of the industrial activity in the area. Because the detections of PCB in composite soil samples were at low concentrations (0.0764 to 0.214 μg/g), and the site is in an industrial area, the overall potential risk to ecological receptors at Site 32 appears to be low. Because of the ability of PCB Aroclor 1260 to bioaccumulate in the food chain, birds and mammals at the tertiary and quaternary trophic levels (such as raptors) are at risk as receptors from the cumulative effects of the contamination from this and other sites.

Alterations to the trophic structure and ecological processes at Site 32 cannot be evaluated until further data are collected. Recovery times cannot be derived or predicted from the information evaluated.

4.2.8 Conclusions

Based on the results of the risk assessment using available data, no significant threat to human health or the environment exists at the PCB Spill Site (Site 32). Uncertainty remains, however, because of the prior sampling protocol and incomplete risk assessment.

The potential risk to environmental pathways cannot be evaluated until further data are collected.

4.2.9 Recommendations

Because of the uncertainty of prior sampling results and scope, additional sampling at Site 32 is required. The additional data will be used to re-evaluate human health and environmental risks associated with Site 32.

4.3 WASTEWATER SPREADING AREA (SITE 35)

4.3.1 Site Characteristics

Operable Unit 4 consists of the Wastewater Spreading Area (Site 35) in the southeastern portion of TEAD-N (see Figure 1-5). Site 35 is located approximately 1,500 feet south of the Administration Area and 4,000 feet west of a former residential complex. Wastewater was apparently discharged from the former residential complex and flowed westward through two culverts under railroad tracks into two unlined ditches, each approximately 4 to 6 feet deep (EA, 1988). After crossing under the railroad tracks, the ditches cross a grassy field until they discharge into a ravine. The ravine drops 40 to 50 vertical feet and continues to the west where it discharges into a relatively flat spreading area covered with vegetation, including cottonwood trees and brush. The depth to bedrock at this site is estimated to be 1,750 feet bgs (Ertec, 1982). The depth to groundwater is approximately 380 feet bgs, with groundwater flow toward the northwest.

Site 35 was identified during a review of historical aerial photographs from 1953, 1959, 1966, and 1981, which were analyzed to determine the potential environmental impact of past installation activities (EPA, 1982). The Wastewater Spreading Area was identified from the 1953 photographs as a potential waste site because of the presence of liquids in the ditches, trenches, and ravine. The suspected source of the liquids was wastewater discharge from the residential complex. The area also appeared active in the 1959 photographs, but the use of the ditches declined with the removal of the residential complex. The housing area was leveled in 1966. Currently, only concrete foundations remain in the former housing area, and the site is fenced and used as part of the TEAD-N horse stable complex. Horse grazing occurs on the Wastewater Spreading Area. During the field investigation program conducted by Rust E&I in the summer of 1992, the ditches, ravine, and spreading area were dry; there was no evidence of continued discharging. The ditches contain vegetation and, in many places, are difficult to discern.

4.3.2 Previous Investigations and RI Activities

At the Wastewater Spreading Area, there were no environmental investigations prior to the current RI. Rust E&I conducted surface- and subsurface-soil sampling from the ditches, ravine, and spreading areas to determine if contaminants were released to site soils as a result

of previous wastewater discharge. The sample locations are shown in Figure 4-4. Surface-soil samples were collected at a depth of 0 to 6 inches, and subsurface-soil samples were collected at depths of 2 to 6 feet. Subsurface sample WSB-92-01 was taken on the berm of the ditch. Subsurface samples WSB-92-03 through WSB-92-06 were taken directly in the bottom of the ditch. Subsurface samples WSB-92-07 through WSB-92-09 were biased samples taken at a stained area adjacent to the ditch. Table 4-7 provides a list of the soil samples and the corresponding analytical parameters. Because of a coarse cobble gravel encountered in most of the shallow soil borings, the sample depths at some locations vary from the proposed sample depths of 2, 4, and 6 feet. In addition, a small area (WSS-92-04), void of vegetation, was sampled to determine if the barren area was a result of contamination or was a natural surface feature.

4.3.3 Nature and Extent of Contamination

Appendix F provides the complete analytical results for the soil samples. Figure 4-5 shows the distribution of analytes that were detected at levels above background. Several unknown organic compounds were detected but could not be identified because of low concentrations. Two VOCs were detected in most of the surface- and subsurface-soil samples: acetone, at concentrations less than or equal to 0.024 μg/g; and methylene chloride, at concentrations less than or equal to 0.008 μg/g. These detections are considered to be laboratory artifacts because acetone and methylene chloride were also detected in corresponding field blank and method blank samples at concentrations as high as 0.012 μg/g and 0.008 μg/g, respectively.

Table 4-8 summarizes the results of the sampling conducted during the RI. Semi-VOCs were detected in one surface-soil sample only: the pesticides alpha-chlordane and gamma-chlordane, each detected at 10.0 μg/g in sample WSS-92-02. Based on the sampling results, additional sampling of the area is needed to define the areal and vertical extent of pesticide contamination.

All detections of metals and anions not listed in Table 4-8 were less than the established background soil concentrations. Anions that were detected at levels greater than background include chloride, nitrate, phosphate, and sulfate. Chloride, nitrate, and sulfate were detected in surface- and subsurface-soil samples along the former ditches (Figure 4-5). Phosphate detections occurred in soil samples throughout the site. Metals at concentrations above background include iron, lead, and zinc. Iron and zinc were only detected above background concentrations in one sample. Lead was detected in three surface soil samples but not in subsurface soil samples.

Additional sampling has been scheduled to better delineate the extent of chlordane contamination. Results from this sampling will be used to re-calculate and assess risks to human health and the environment. These results will be reported and analyzed in an RI Report Addendum and future FS.

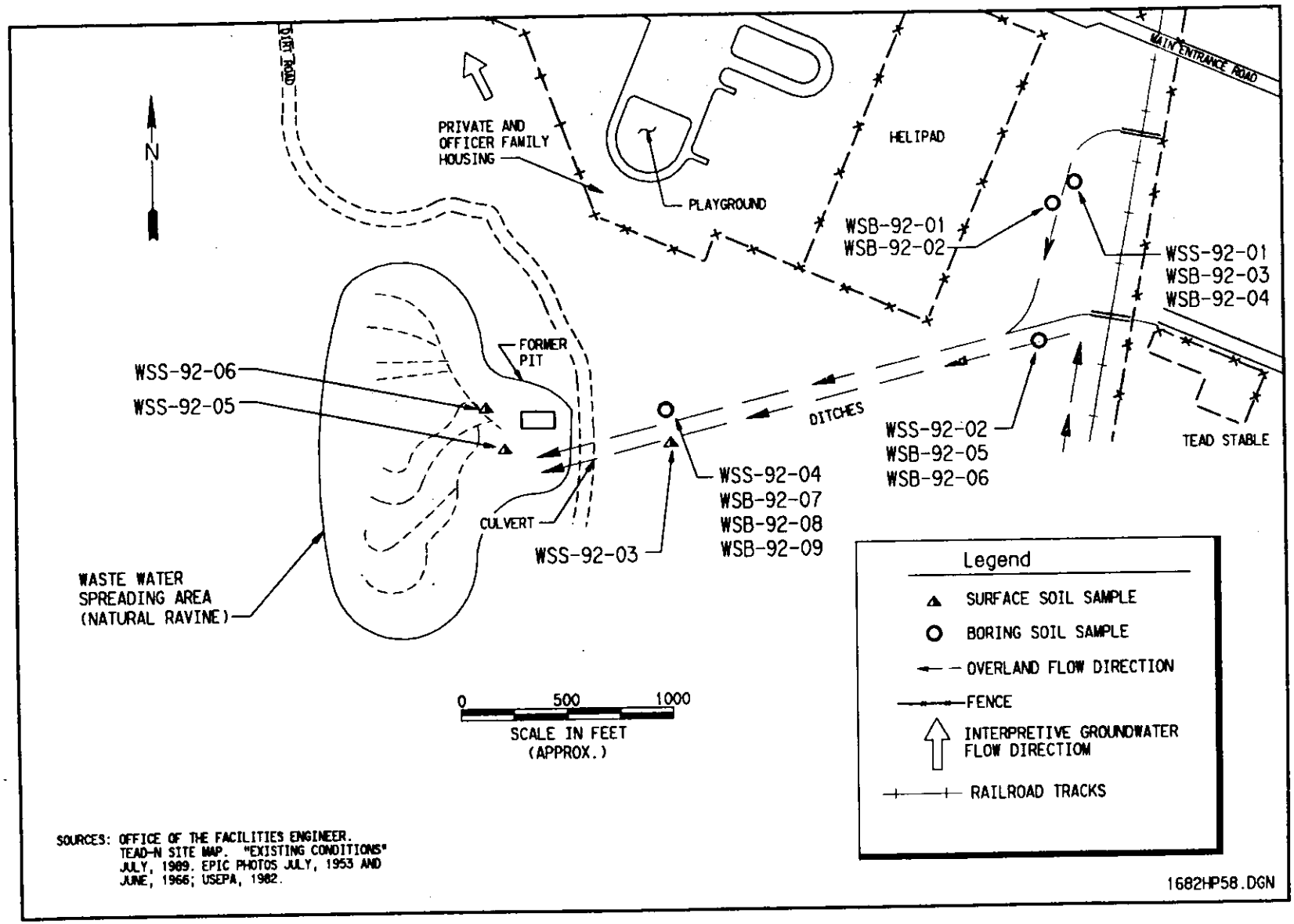


Figure 4-4. RI Sample Locations for the Wastewater Spreading Area (Site 35)

Table 4-7. RI Sampling and Analysis Program for the Wastewater Spreading Area (Site 35)

Site ID	Media	Depth (ft)	Analytical Parameters
WSS-92-01	soil	0	VOCs, Semi-VOCs, Metals, Anions
WSS-92-02	soil	0	VOCs, Semi-VOCs, Metals, Anions
WSS-92-03	soil	0	VOCs, Semi-VOCs, Metals, Anions
WSS-92-04	soil	0	VOCs, Semi-VOCs, Metals, Anions
WSS-92-05	soil	0	VOCs, Semi-VOCs, Metals, Anions
WSS-92-06	soil	0	VOCs, Semi-VOCs, Metals, Anions
WSB-92-01	soil	2	VOCs, Semi-VOCs, Metals, Anions
WSB-92-02	soil	4	VOCs, Semi-VOCs, Metals, Anions
WSB-92-03	soil	2	VOCs, Semi-VOCs, Metals, Anions
WSB-92-04	soil	3	VOCs, Semi-VOCs, Metals, Anions
WSB-92-05	soil	2	VOCs, Semi-VOCs, Metals, Anions
WSB-92-06	soil	3	VOCs, Semi-VOCs, Metals, Anions
WSB-92-07	soil	2	VOCs, Semi-VOCs, Metals, Anions
WSB-92-08	soil	4	VOCs, Semi-VOCs, Metals, Anions
WSB-92-09	soil	6	VOCs, Semi-VOCs, Metals, Anions

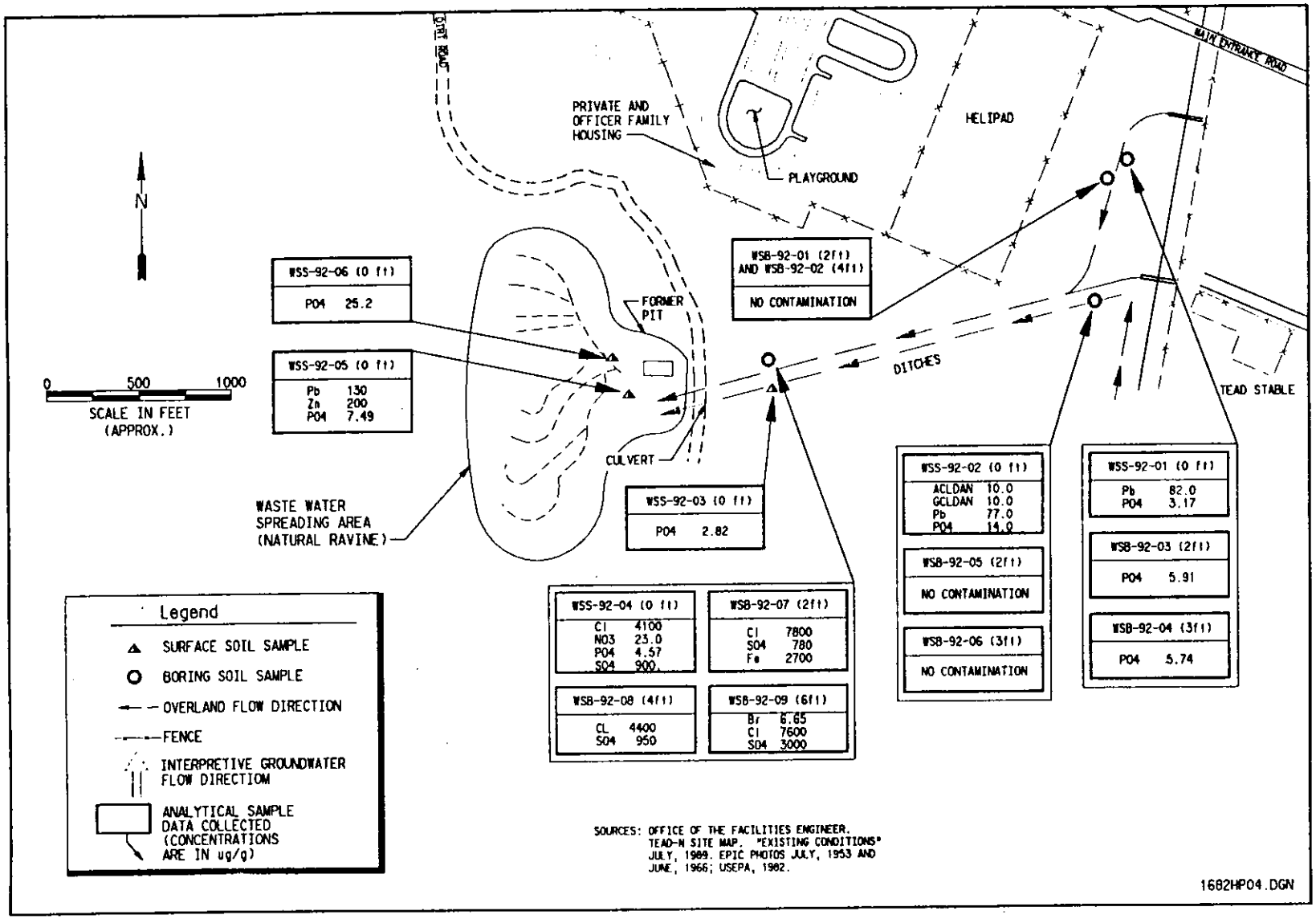


Figure 4-5. RI Sampling and Analysis Results for the Wastewater Spreading Area (Site 35)

Table 4-8. Summary of Analytes Above Background Concentrations for the Wastewater Spreading Area (Site 35)

Analytes	WSB-92-01 (2 ft)	WSB-92-02 (4 ft)	WSB-92-03 (2 ft)	WSB-92-04 (3 ft)	WSB-92-05 (2 ft)	WSB-92-06 (3 ft)	WSB-92-07 (2 ft)	WSB-92-08 (4 ft)	WSB-92-09 (6 ft)	Background Concentrations
	Concentrations in $\mu g/g$									
VOCs	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
SVOCs										
alpha-Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
gamma-Chlordane	NA	NA	ND	ND	ND	ND	ND	ND	ND	---
Anions										
Chloride	NA	NA	LT	LT	LT	LT	7800	4400	7600	336
Nitrate	NA	NA	<BKGD	<BKGD	LT	LT	<BKGD	<BKGD	LT	9.45
Phosphate	NA	NA	5.91	5.74	ND	ND	ND	ND	ND	5.00
Sulfate	NA	NA	LT	LT	LT	LT	780	950	3000	466
Inorganics										
Iron	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	27000	<BKGD	<BKGD	25400
Lead	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	63.4
Zinc	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	169

Notes.—ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations. NA=Not analyzed for the sample.

Table 4-8. Summary of Analytes Above Background Concentrations for the Wastewater Spreading Area (Site 35) (continued)

Analytes	WSS-92-01*	WSS-92-02*	WSS-92-03*	WSS-92-04*	WSS-92-05*	WSS-92-06*	Background Concentrations
	Concentrations in µg/g						
VOCs	ND	ND	ND	ND	ND	ND	---
SVOCs							
alpha-Chlordane	ND	10.0	ND	ND	ND	ND	---
gamma-Chlordane	NA	10.0	NA	NA	NA	NA	---
Anions							
Chloride	<BKGD	LT	LT	4100	LT	LT	336
Nitrate	<BKGD	<BKGD	<BKGD	23.0	<BKGD	<BKGD	9.45
Phosphate	<BKGD	14.0	<BKGD	<BKGD	7.49	25.2	5.00
Sulfate	<BKGD	<BKGD	LT	900	LT	LT	466
Inorganics							
Iron	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	25400
Lead	82.0	77.0	<BKGD	<BKGD	130	<BKGD	63.4
Zinc	<BKGD	<BKGD	<BKGD	<BKGD	200	<BKGD	169

Notes.--ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations. NA=Not analyzed for the sample.

*Samples were taken 0 to 6 inches.

4.3.4 Contaminants of Concern

Table 4-9 summarizes the contaminants of concern in surface soil at Site 35. The contaminants of concern for surface soil are the pesticide chlordane (alpha and gamma); the metals lead and zinc; and the anions chloride, nitrate, phosphate, and sulfate. The risk assessment for the on-site worker, installation resident, installation school, off-site resident, and potential future on-site resident considers exposure to these contaminants.

Table 4-10 summarizes the contaminants of concern in combined surface and subsurface soils at Site 35. The contaminants of concern for total soil are the pesticide chlordane (alpha and gamma); the anions chloride, phosphate, and sulfate; and the metals lead and zinc. The risk assessment for the construction worker considers exposure to these contaminants.

4.3.5 Contaminant Fate and Transport

Table 3-8 in Section 3.4.1 describes the fate and transport characteristics of alpha-chlordane and gamma-chlordane. Both are expected to adsorb to soil and resist leaching. These compounds are not expected to volatilize, but may adsorb to windborne particulates and be removed through wet and dry deposition. Alpha- and gamma-chlordane are expected to resist biodegradation and may bioconcentrate.

Lead is a very stable metal and is generally insoluble in soil, although it dissolves in acid. It also forms complexes with organic matter and clay minerals, which limit its mobility. Information on the bioconcentration of lead is inconclusive: lead does not appear to bioconcentrate significantly in fish, but does in some shellfish such as mussels. The National Library of Medicine database did not contain any information for the environmental fate of zinc. Information on the biological fate of zinc is variable, with some studies indicating that bioconcentration may occur.

Generally, anions are readily leachable and are mobile in soil.

4.3.6 Potential Exposure Pathways

The potential exposure pathways for the contaminants of concern are outlined in Figure 4-6. The soil pathway is complete for the various types of workers that could possibly work at this site, as well as future on-site residents. The air pathway is available for all categories of individuals through particulate inhalation.

Section 3.4.3 includes a discussion on vadose zone modeling that evaluates the possible effects of contaminant leaching to groundwater. Because groundwater data are not available to determine contaminants of concern, this exposure pathway was not evaluated in the baseline risk assessment. However, Water Well 1, located north-northeast and potentially downgradient of Site 35, is planned to be sampled to determine if surface contaminants have migrated to the groundwater.

Table 4-9. Contaminants of Concern for Surface Soil at the Wastewater Spreading Area (Site 35)

Analyte	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background* Concentration	Method	Sample Quantitation Limits
alpha-Chlordane	1	6	10.0	10.0	2.08	5.27	---	LM15	1.0
Chloride	2	6	42.1	4100	704	2072	336	KT04	39.6
gamma-Chlordane	1	1	10.0	10.0	10.0	10.0	---	LM15	5.0
Lead	6	6	17.0	130	66.3	99.0	63.4	JD15	0.319
Nitrate	6	6	2.60	23.0	7.72	13.9	9.45	KT04	1.68
Phosphate	6	6	2.82	25.2	9.54	16.7	5.00	KT04	2.82-5.00
Sulfate	3	6	12.7	900	158	457	466	KT04	14.4
Zinc	6	6	53	200	107	150	169	JD15	7.96

Note.—All results are reported as $\mu g/g$. Surface soil includes all soil samples from depths of less than 6 inches. Gamma-Chlordane results reported in only 1 of the 6 samples by the lab. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration. Where less than three samples were taken, the highest detected concentration was used instead of the 95% UCL.

*Background concentrations were derived as mean plus 2 standard deviations from background data for conservative approach (tolerance limit).

Table 4-10. Contaminants of Concern for Combined Surface and Subsurface Soils at the Wastewater Spreading Area (Site 35)

Analyte	Total Detects	Total Samples	Low	High	Average	95% Confidence	Statistical Background Concentration	Method	Sample Quantitation Limits
alpha-Chlordane	1	15	10.0	10.0	1.13	2.25	---	LM15	1.0
Chloride	2	13	42.1	7800	1854	3349	336	KT04	39.6
gamma-Chlordane	1	8	10.0	10.0	3.44	5.21	---	LM15	5.0
Lead	15	15	7.5	130	34.4	50.8	63.4	JD15	0.319
Phosphate	8	13	2.82	25.2	6.26	9.50	5.00	KT04	14.4
Sulfate	6	13	12.7	3000	439	862	466	KT04	14.4
Zinc	15	15	11.6	200	64.7	87.4	169	JD15	7.96

Note.—All results are reported as $\mu g/g$. Soil includes all soil samples. Gamma-Chlordane results reported in only 8 of the 15 samples by the lab. Two anion samples exceeded holding time and were not recollected. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

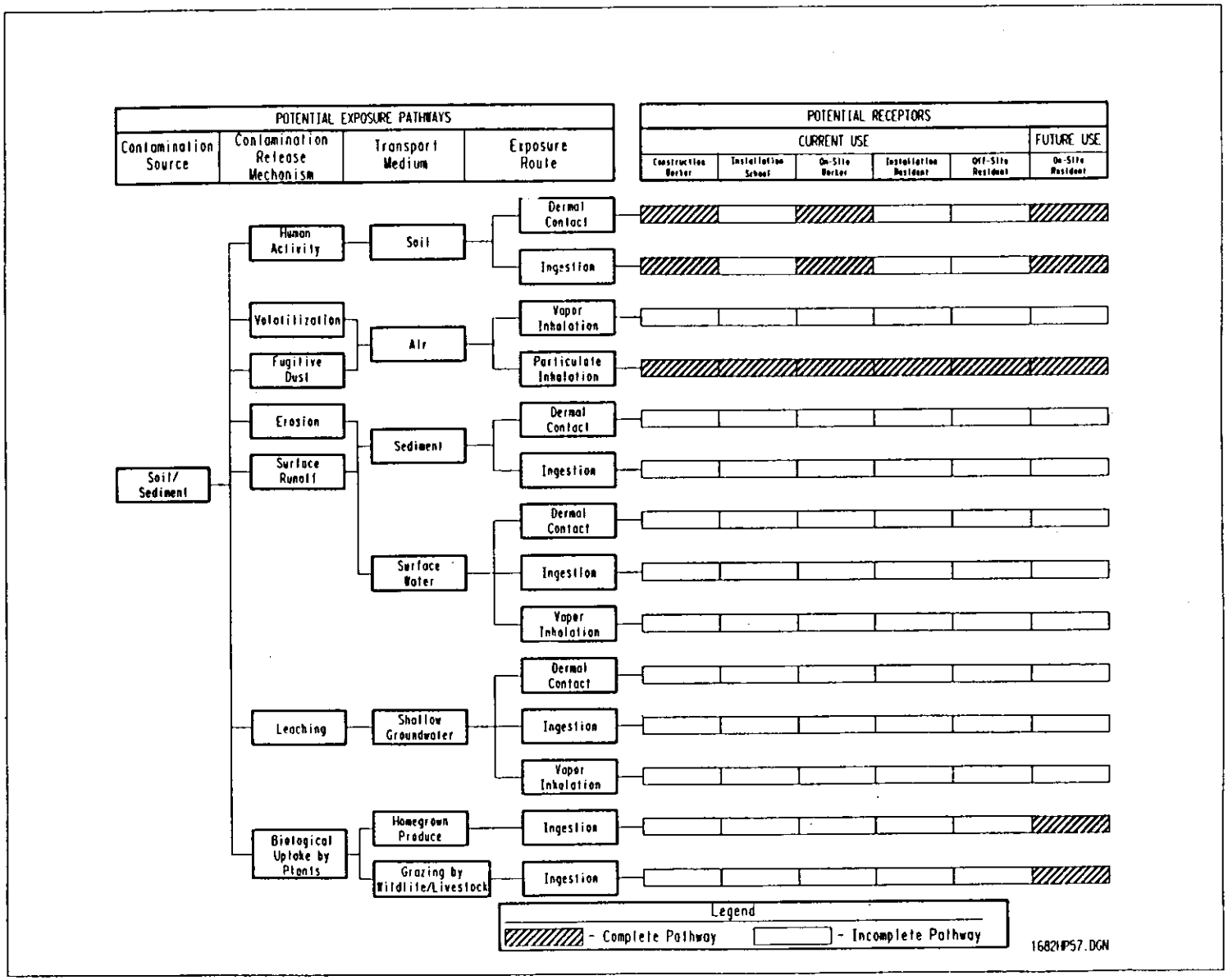


Figure 4-6. Potential Human Exposure Pathway Conceptual Model for the Wastewater Spreading Area (Site 35)

4.3.7 Baseline Risk Assessment

4.3.7.1 *Human Health Evaluation*

This section presents the results of the risk assessment performed for the Wastewater Spreading Area. The following section discusses the risk factors (RFs) and hazard indices (HIs) for the contaminants of concern. Lead was not evaluated in the risk assessment but will be addressed in the RI Report Addendum risk assessment using the EPA Lead Uptake/Biokinetic model. Because no slope factors or reference doses are available for chloride or sulfate, no RFs or HIs were calculated for these analytes. These anions are extracted from the soil by a distilled water leach and, therefore, probably occur as water soluble salts within the soils.

4.3.7.1.1 *Current Land Use*. The risk estimates for each exposure scenario evaluated under current site use conditions are presented in Tables 4-11 and 4-12. They are discussed below by scenario, including average exposure and reasonable maximum exposure level at upper confidence level for both carcinogenic and noncarcinogenic risks.

4.3.7.1.1.1 *On-site Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for on-site workers at Site 35 for the average exposure is 8E-06. The risk from dermal exposure is 7E-06, from soil inhalation is 2E-09, and from soil ingestion is 1E-06.

The total carcinogenic risk factor for RME is 3E-05. The risk from dermal exposure is 3E-05, from soil inhalation is 1E-06, and from soil ingestion is 4E-06.

Carcinogenic risk estimates are within the EPA target range for residual risk of 1E-04 to 1E-06. These risks, however, are very conservative because the on-site worker is assumed to spend 250 days per year for 10 years at Site 35. Under present use conditions of open pasture, an on-site worker actually spends very little time at Site 35, probably less than 25 days per year.

NONCARCINOGENIC RISKS

The total noncarcinogenic hazard index for on-site workers for the average exposure is 1E-01. The risk from dermal contact is 3E-05 and from soil ingestion is 1E-01.
The total soil pathway noncarcinogenic hazard index from RME is 1E-01. The risk from dermal exposure is 4E-05 and from soil ingestion is 1E-01.

Table 4-11. Risk Estimate Summary Using Average Exposure Level for the Wastewater Spreading Area (Site 35)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
alpha-Chlordane	1.89E-07	1.70E-02	1.03E-08	9.24E-03											2.38E-07	2.37E-02
gamma-Chlordane	9.09E-07	8.15E-02	3.12E-08	2.80E-02											1.14E-06	1.14E-01
Nitrate		2.36E-06		1.72E-06												3.30E-06
Zinc		1.74E-04		1.06E-04												2.44E-04
	1.10E-06	9.87E-02	4.15E-08	3.74E-02											1.38E-06	1.38E-01
Inhalation																
alpha-Chlordane	5.38E-10		5.38E-14		4.31E-13		2.41E-13		3.77E-13		3.86E-13		1.07E-13		1.09E-12	
gamma-Chlordane	1.02E-09		1.02E-13		8.18E-13		4.58E-13		7.15E-13		7.30E-13		2.04E-13		2.06E-12	
	1.56E-09		1.56E-13		1.25E-12		6.99E-13		1.09E-12		1.11E-12		3.11E-13		3.15E-12	
Dermal																
alpha-Chlordane	1.17E-06		6.38E-08												1.48E-06	
gamma-Chlordane	5.63E-06		1.94E-07												7.10E-06	
Nitrate		1.46E-05		1.07E-05												2.05E-05
Zinc		1.08E-05		6.54E-04												1.51E-05
	6.80E-06	2.55E-05	2.57E-07	6.65E-04											8.57E-06	3.65E-05
Total for Site	**7.90E-06**	**9.87E-02**	**2.99E-07**	**3.80E-02**	**1.25E-12**		**6.99E-13**		**1.09E-12**		**1.12E-12**		**3.11E-13**		**9.96E-06**	**1.38E-01**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

Table 4-12. Risk Estimate Summary Using Reasonable Maximum Exposure Level for the Wastewater Spreading Area (Site 35)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a]						On-Site Resident[b]	
									Tooele		Stockton		Grantsville			
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
alpha-Chlordane	1.44E-06	4.30E-02	1.96E-07	1.76E-01											3.49E-06	3.41E-01
gamma-Chlordane	2.73E-06	8.15E-02	4.54E-07	4.08E-01											6.61E-06	6.47E-01
Nitrate		4.25E-06		2.46E-05												3.37E-05
Zinc		2.45E-04		1.37E-03												1.94E-01
	4.16E-06	1.25E-01	6.51E-07	5.85E-01											1.01E-05	9.90E-01
Inhalation																
alpha-Chlordane	3.77E-07		1.89E-11		1.01E-10		7.99E-10		4.93E-10		5.04E-10		1.40E-10		1.42E-09	
gamma-Chlordane	7.16E-07		3.59E-11		1.91E-10		1.51E-09		9.36E-10		9.54E-10		2.67E-10		2.69E-09	
	1.09E-06		5.48E-11		2.91E-10		2.31E-09		1.43E-09		1.46E-09		4.07E-10		4.11E-09	
Dermal																
alpha-Chlordane	8.91E-06		1.27E-07												2.09E-05	
gamma-Chlordane	1.69E-05		2.93E-07												3.96E-05	
Nitrate		2.64E-05		1.59E-05												1.98E-01
Zinc		1.52E-05		8.84E-04												1.14E-01
	2.58E-05	4.15E-05	4.20E-07	9.00E-04											6.04E-05	3.12E-04
Total for Site	**3.00E-05**	**1.25E-01**	**1.07E-06**	**5.86E-01**	**2.91E-10**		**2.31E-09**		**1.43E-09**		**1.46E-09**		**4.07E-10**		**7.06E-05**	**9.90E-01**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

4.3.7.1.1.2 *Construction Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for construction workers for the average exposure is 3E-07. The risk from dermal exposure is 3E-07, from soil inhalation is 2E-13, and from soil ingestion is 4E-08.

The total carcinogenic risk factor from RME is 1E-06. The risk from dermal exposure is 4E-07, from soil inhalation is 6E-11, and from soil ingestion is 7E-07. The construction worker calculations utilize soil contaminant concentration values from below-surface samples. The RME risk factor is within the EPA target range of 1E-04 to 1E-06 for the construction worker.

NONCARCINOGENIC RISKS

The total noncarcinogenic hazard index for construction workers for the average exposure is 4E-02, which is derived from soil ingestion and dermal contact.

The total noncarcinogenic hazard index from RME is 6E-01 on the basis of the soil ingestion and dermal contact exposure pathways. No noncarcinogenic risks were calculated for the inhalation exposure pathway. The average and RME hazard indices are below the EPA goal for a residual hazard index of 1 or less.

4.3.7.1.1.3 *Installation School*

CARCINOGENIC RISKS

The carcinogenic risk for average exposure is 1E-12, and the carcinogenic risk for the RME is 3E-10.

NONCARCINOGENIC RISKS

The hazard indices could not be calculated because reference doses were not available for the contaminants of concern.

4.3.7.1.1.4 *Installation Resident*

CARCINOGENIC RISKS

The carcinogenic risk for average exposure is 7E-13, and the carcinogenic risk for the RME is 2E-09.

NONCARCINOGENIC RISKS

Hazard indices could not be calculated because reference doses were not available for the contaminants of concern.

4.3.7.1.1.5 *Off-site Residents*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the off-site residents because of the distance from the wastewater spreading area. Soil concentrations from the wastewater spreading area were used in a refined model to develop particulate concentrations at the city of Tooele, Stockton, and Grantsville. The carcinogenic risk factors are summarized in Table 4-13.

Table 4-13. Carcinogenic Risk Factors

City	Average	RME
Tooele	1E-12	1E-09
Stockton	1E-12	1E-09
Grantsville	3E-13	4E-10

4.3.7.1.2 *Future Land Use*. The only scenario considered under future land use is for a future on-site resident. Results from this exposure scenario are discussed below.

CARCINOGENIC RISKS

The total carcinogenic risk factor for future on-site residents at Site 35 for the average exposure is 1E-05. The risk from dermal exposure is 9E-06, from soil inhalation is 3E-12, and from soil ingestion is 1E-06.

The total carcinogenic risk factor from RME, using 95 percent upper confidence limits, is 7E-05. The risk from dermal exposure is 6E-05, from soil inhalation is 4E-09, and from soil ingestion is 1E-05. The carcinogenic risk estimates for the future on-site resident are within the EPA target range of 1E-04 to 1E-06 for a residual risk.

NONCARCINOGENIC RISKS

The total noncarcinogenic hazard index for future on-site residents at Site 35 for the average exposure is 1E-01. The risk from dermal exposure is 4E-05 and from soil ingestion is 1E-01.

The total noncarcinogenic hazard index from RME is 1E+00. The risk from dermal exposure is 3E-04 and from soil ingestion is 1E+00. RfD factors were unavailable for inhalation of the contaminants of concern and, therefore, no risks were calculated for the inhalation exposure pathway. The noncarcinogenic risk estimate for RME is equal to the EPA goal for a residual hazard index of 1 or less. However, the exposure assessment for this scenario is based on conservative assumptions.

4.3.7.2 *Environmental Evaluation*

The environmental evaluation for Site 35 at this time is qualitative and does not include bioassays of the vegetation and wildlife or an inventory of animal species. An inventory of vegetation was compiled for this site and is listed in Table 4-14. A data gap sampling program to collect additional information to further determine the extent of contamination and the degree of ecological risk is planned. The findings from additional sampling and analysis will be issued in the future.

4.3.7.2.1 ***Site Characterization.*** The predominant vegetation at Site 35 is grass. According to TEAD-N personnel, the area was farmed at one time. This site is unique in that it is one of the few sites at TEAD-N where cottonwood trees exist. Despite the fact that there are no more than a few dozen individuals, these trees are important ecologically because they may serve as hunting perches and nesting sites for raptors, especially during the winter months.

Human activity, including vehicle traffic, is infrequent at this site. Therefore, many of the potential wildlife species identified on TEAD-N (Section 2.9) could inhabit the area and remain relatively undisturbed. The nesting habitat potential for other birds is good.

No surface water or evidence of surface water was observed during the field investigation. However, the area is located at the mouth of a small drainage area, which receives free-flowing surface water during storm events and snow melt.

4.3.7.2.2 ***Biological Effects of Contaminants.*** Table 4-15 summarizes the relevant information for the contaminants of concern for Site 35 taken from Table 3-18.

4.3.7.2.3 ***Potential Pathways.*** No biological samples were obtained, thus the uptake of contaminants by flora and fauna cannot be evaluated at this time. The most probable pathways of contaminants through the ecosystem are as follows:

- Plants

–Direct uptake through root system

Table 4-14. Vegetation Inventory (Site 35)

Scientific Name	Common Name
PRIMARY VEGETATION SPECIES	
Agropyron cristatum	Crested wheatgrass
Chrisothamnus nauseosus	Rabbitbrush
OTHER VEGETATION SPECIES	
Medicago sativa	Alfalfa
Helianthus annuus	Annual Sunflower
Asteraceae sp	Aster
Convolvulus arvensis	Bindweed
Acer negundo	Boxelder
Poa bulbosa	Bulbous bluegrass
Cirsium vulgre	Bull thistle
Bromus tectorum	Cheatgrass
Typhadomingensis	Common cattail
Linaria dalmatica	Dalmiation toadflax
Sphaeralcea coccinea	Globe mallow
Sarcobatus vermiculatus	Greasewood
Grindella squarrosa	Gumweed
Machaeranthere canescens	Hoary aster
Stipa hymenoides	Indian ricegrass
Sophora sp	Locust tree
Lepidium perfoliatum	Peppergrass
Lactuca scariola	Prickly lettuce
Opuntia polyacantha	Prickly pear cactus
Salsola iberica	Russian thistle
Artemisia tridentata	Sagebrush
Sporobolus Cryptandrus	Sand dropseed
Erodium cicutarium	Storksbill
Aristida purpurea	Three-awn; No-etum

Table 4-14. Vegetation Inventory (Site 35) (continued)

Scientific Name	Common Name
OTHER VEGETATION SPECIES (Cont.)	
Sisymbrium officinale	Tumbling mustard
Juniperus osteosperma	Utah juniper
Astragalus utahensis	Utah milkvetch
Chrysothamnus viscidiflorus	Viscid rabbitbrush
Melilotus albus	White sweetclover
Cardaria draba	Whitetop
Tragopogon dubius	Yellow goats beard
Melilotus officinalis	Yellow sweetclover

Table 4-15. Summary of Contaminants (Site 35)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
alpha-Chlordane	L[a]	H[b]	BA[c]	2[d]	3	--
gamma-Chlordane	L	H	BA	2	3	--
Lead	I[e]	H	BC[f]	2,3	3	acute and chronic toxicant; suspected carcinogen
Zinc	I	VL[g]→L[h]	BC	--	3	many of its compounds are toxic; dust is an irritant

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]L=low.
[b]H=high.
[c]BA=bioaccumulates.
[d]2=probable or suspected carcinogen.
[e]I=insoluble.
[f]BC=bioconcentrate.
[g]VL=very low.
[h]L=low.

- Wildlife

-Ingestion of contaminated soil
-Ingestion of contaminated foliage
-Ingestion of contaminated insects
-Ingestion of contaminated carrion/animals
-Dermal contact
-Inhalation of vapors
-Inhalation of contaminated particulates

Potential pathways are shown in Figure 4-7.

4.3.7.2.4 ***Potentially Affected Populations.*** Table 4-16 presents a summary of exposure points, general population, and the activity by which ecological exposure may occur. The table is listed in decreasing exposure potential.

4.3.7.2.5 ***Environmental Evaluation Conclusions.*** The primary contaminant of concern at this site is chlordane. In addition to the information in Tables 3-18 and 4-15, this contaminant has a qualitative biological hazard ranking of high because it is toxic, adsorbs to soil, resists leaching, and bioaccumulates. Only 1 out of 15 soil samples showed a detection of chlordane (at 10 μg/g), so the extent of contamination as well as the potential for exposure appear to be limited.

Lead and zinc were both detected slightly above background in one sample. Although the qualitative biological hazard ranking for these contaminants is high, the site concentration levels are relatively low. Therefore, receptor exposure is likely to be limited.

Overall, the potential risk to ecological receptors at Site 35 appears to be low. In order to completely assess the ecological risk at this site, a species inventory and bioassays are needed.

Alterations to the trophic structure and ecological processes at Site 35 or to the TEAD-N facility cannot be evaluated until further data are collected. Recovery times cannot be derived or predicted from the information evaluated.

4.3.8 Conclusions

Based on the results of the risk assessment, the threat to human health and the environment appears low, except for the on-site worker and future on-site resident scenarios using RME levels. The exposure assessment estimated for these scenarios are based on conservative exposure values. However, not all contaminants were completely evaluated for possible human health and environmental risks.

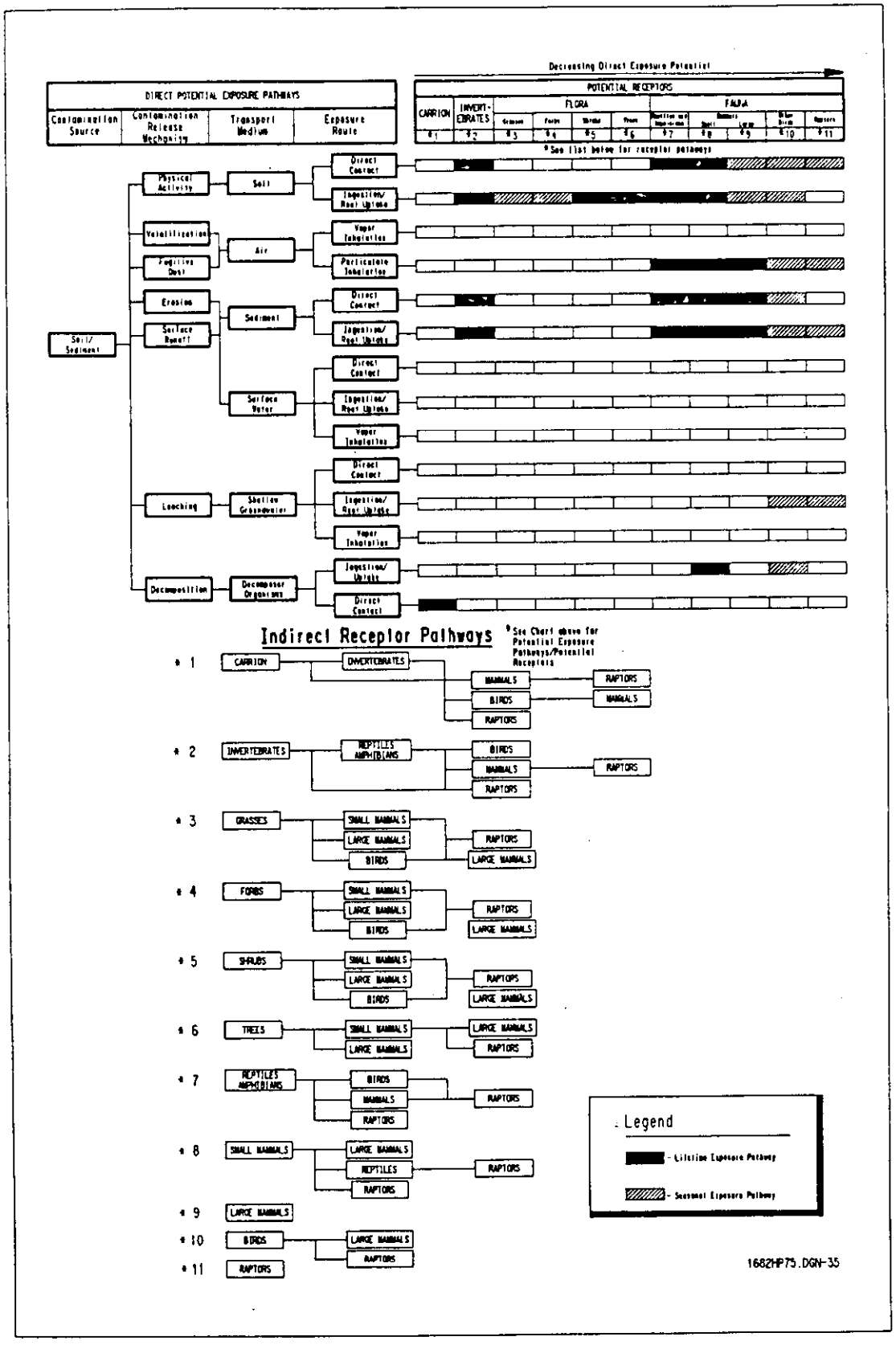


Figure 4-7. Potential Ecological Exposure Pathways for Site 35

Table 4-16. Exposure Scenarios for Ecological Populations at Site 35

Exposure Point	Exposed Population	Exposure Activity	Ranking
Terrestrial	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial	Large Mammals	Ingestion of contaminated vegetation; foliage,fruit, and, potentially, roots.	Primarily exposed while feeding at this site; may be reduced to seasonal exposure.
Terrestrial	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Exposed only when feeding at this site; likely only seasonally.
Terrestrial	Raptors	Ingestion of contaminated carrion or animals.	Occasional exposure; exposed when feeding on prior inhabitants of the site.

In addition to this incomplete risk assessment, further uncertainty remains over the areal and vertical extent of pesticide contamination that may exist at Site 35.

4.3.9 Recommendations

Because of the residual uncertainties over the extent of pesticide contamination and the possibility of groundwater contamination from surface migration, additional sampling of Site 35 is necessary. Once the additional data needs are met, a risk assessment will be performed utilizing the data. This will include the evaluation of potential health effects associated with lead contamination at the site using EPA's Lead Uptake/Biokinetic model.

5.0 OPERABLE UNIT 5

5.1 FORMER TRANSFORMER STORAGE AREA (Site 17)

5.1.1 Site Characteristics

The Former Transformer Storage Area (see Figure 1-6 and Figure 5-1) refers to Open Storage Lot No. 675B, located in the northern portion of the Maintenance Area of TEAD-N approximately 500 feet northwest of Building S-670. The lot is unpaved but graveled and covers an area of approximately 5 acres (350 x 600 feet). One of the responsibilities of TEAD-N has been the receiving, storage, maintenance, and shipment of oil-containing electrical transformers and capacitors. Prior to 1979, long-term storage of thousands of transformers and capacitors was performed at Lot 675B. Many of these transformers contained PCB-contaminated oil (EA, 1988).

In 1979, all transformers were removed from the lot and either properly disposed of or transferred to Building 659 for storage. Building 659 has continued to operate as the transformer storage facility since 1979. Lot 675B is currently used for the storage of vehicle-related equipment. A drainage ditch is present along the northern edge of the lot, which parallels the adjacent road.

5.1.2 Previous Investigations and RI Activities

Following removal of the transformers in 1979, TEAD Facilities Engineering Division reportedly collected surface soil samples (0 to 3 inches) at Site 17. TEAD personnel verbally reported that the sampling results indicated that the soils contained less than 50 μg/g total PCBs (EA, 1988). In February 1987, EA conducted a follow-up sampling of the site to confirm the reported TEAD results because no permanent record of these results could be obtained. Samples were collected from 30 grid point locations (Figure 5-2) at 0 to 6 inches in depth and were composited to form 6 composite samples (N-PCB-CST1 through N-PCB-CST6). These six samples were analyzed for the PCB Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260 (EA, 1988). Analytical results from the EA sampling event showed that two PCB Aroclors were detected in the samples. Aroclors 1254 was detected in one soil sample at 0.019 μg/g. (Although Aroclor 1254 was detected at 0.019 μg/g, this value is below the CRL of 0.05 μg/g, which was established subsequent to the February 1987 sampling conducted by EA.) Aroclor 1260 was detected in two samples at concentrations of 0.100 to 0.108 μg/g, respectively (Table 5-1). Because the soil concentrations used for risk analyses are based upon the composite samples, a conservative approach was taken. For this conservative approach, it was assumed that all of the PCBs detected in the composite originated in one of the five individual samples, so to determine this single high concentration, the composite value (0.108 μg/g) was multiplied by five to obtain a concentration of 0.5 μg/g PCB 1260 (rounded from 0.54). This concentration was used in the risk calculations. EPA guidance on Remedial Actions for Superfund Sites with PCB Contamination (EPA, August, 1990b) recommends that remedial action be considered when PCB levels exceed 1 ppm (1 mg/kg) for residential land use and 10 to 25 ppm for industrial land use. Available data for Site 17 indicate that soil contamination is below the most

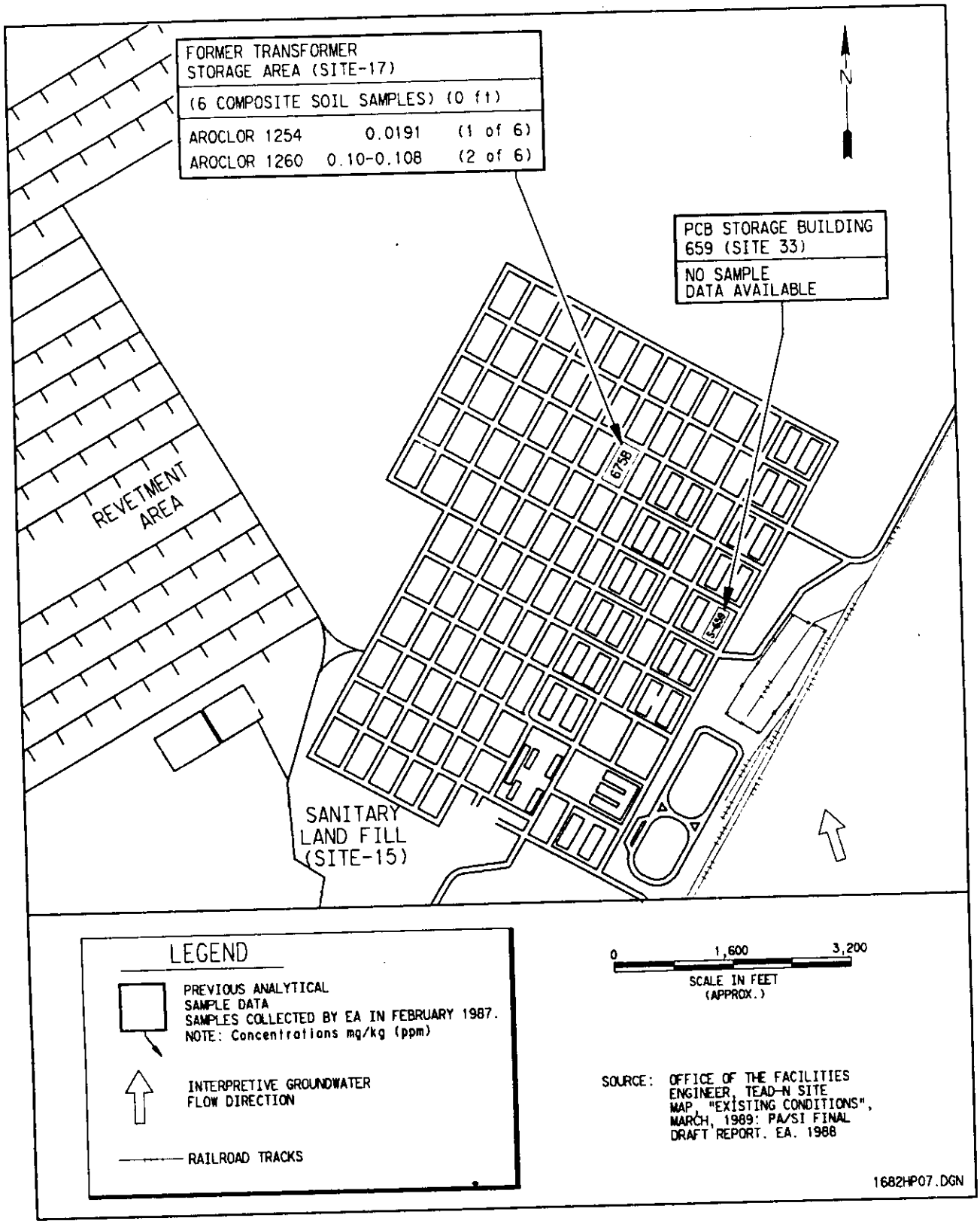


Figure 5-1. Soil Sampling Results Summary for the Two Sites (17 and 33) in OU 5

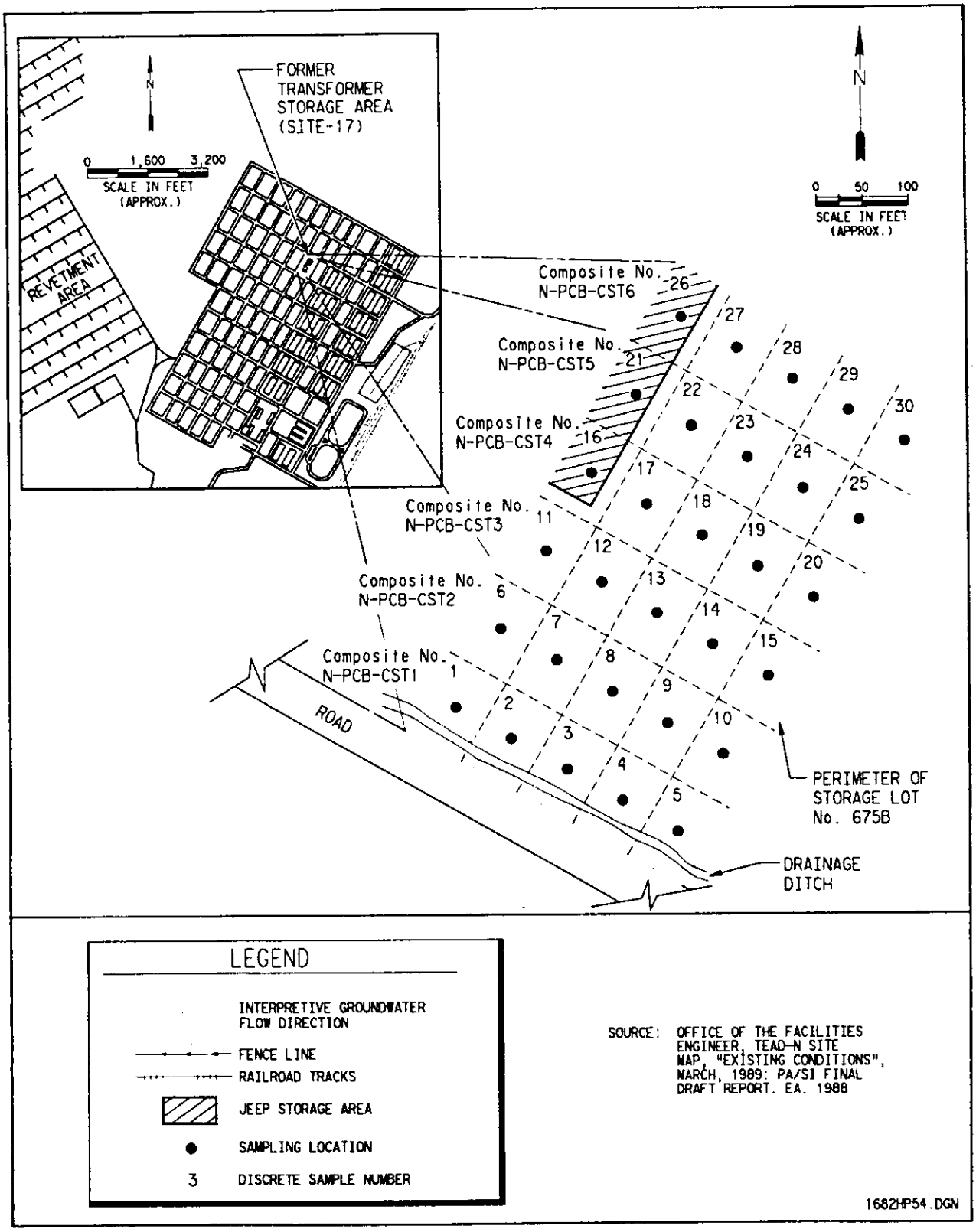


Figure 5-2. Surface Soil Sample Grid at the Former Transformer Storage Area (Site 17)

Table 5-1. Analytical Results for Composite Surface Soil Samples Collected at the Former Transformer Storage Area (Site 17), February 23, 1987

Parameter	CST1* (μg/g)	CST2* (μg/g)	CST3* (μg/g)	CST4* (μg/g)	CST5* (μg/g)	CST6* (μg/g)
Aroclor 1016	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1254	ND	ND	0.0191	ND	ND	ND
Aroclor 1260	<0.07	<0.07	<0.07	<0.07	0.108	0.10

Note.—ND indicates a compound not assigned a certified reporting limit (CRL) and not detected above the analytical detection limit. The parameters listed were determined according to methods not certified by USAEC.

*Samples were taken at 6-inch depths.

Source: EA, 1988

stringent of these levels. Furthermore, the available data for Site 17 indicate that the existing site soils qualify as clean soil (having less than 1 mg/kg PCBs) under TSCA clean-up requirements, although clean soil has not been intentionally placed in the site. On the basis of these findings, no RI samples were taken by Rust E&I.

5.1.3 Nature and Extent of Contamination

Rust E&I could find no information to indicate that significant releases of PCB-contaminated soils occurred at this site. Soil staining was not noted on historical photographs of the area (EPA, 1982), and analytical results from surface-soil samples indicate that PCBs are present at very low concentrations relative to available standards.

5.1.4 Contaminants of Concern

The contaminant of concern at Site 17 is the PCB Aroclor 1260 (Table 5-2). Aroclor 1254 was not considered as a contaminant of concern because the concentration detected is below the CRL.

5.1.5 Contaminant Fate and Transport

Table 3-8 in Section 3.4.1 briefly describes the fate and transport characteristics of PCBs while Appendix H provides a more detailed description. In summary, PCBs strongly adsorb to soils and are resistant to leaching as is reflected in their low water solubilities and high octanol-water partition coefficients. In general, the higher the degree of chlorination of PCBs, the more resistant to biodegradation and the more persistent in the environment. Water solubilities for PCBs decrease with an increase in the degree of chlorination and are very immobile under conditions where the PCB concentration in the aqueous phase is

Table 5-2. Contaminants of Concern for Surface Soil at the Former Transformer Storage Area (Site 17)

Analyte	Total Detects	Total Samples	Low	High	Average	Calculated Concentration	Background Concentration	Method	Sample Quantitation Limit
Polychlorinated biphenyl 1260	2	6	0.100	0.108	0.058	0.50	---	99	0.07

Note.—All results are reported as $\mu g/g$. Surface soil included all soil samples from depths of less then 6 inches. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration values for the non-detects in computing the average value. The calculated concentration was derived by taking the highest composite sample concentrations (0.108 $\mu g/g$) and multiplying by the number of samples in the composite (5). This method assumes the high concentration to be in only one of the five samples of the composite.

controlled by the aqueous solubility of PCBs (EPA, 1990). Leaching of PCBs to the groundwater at Site 17 is highly unlikely because of the large depth to groundwater at the site (approximately 280 feet), the low concentrations of PCBs detected in the soil, and the relative immobility of PCBs in soils.

The chemical and environmental stability of PCBs coupled with their strong adherence to soils results in relatively long half-lives especially for the more chlorinated isomers. Although PCBs are highly persistent compounds exhibiting generally low volatilization rates, over time photolysis and volatilization of PCBs are major removal processes. In addition, PCBs may enter the atmosphere through adsorption to airborne particulates with removal occurring through wet and dry deposition. The tendency of PCBs to adsorb to particulates increases as the degree of chlorination increases.

5.1.6 Potential Exposure Pathways

Figure 5-3 presents a conceptual model of the most likely human exposure pathways for PCBs at Site 17. The most likely exposure pathways for PCBs at Site 17 are via dermal contact, incidental soil ingestion, and inhalation of fugitive dust. However, fugitive dust emissions from Site 17 are minimal because of the coarse nature of the sand and gravel covering the lot.

Although PCBs are not appreciably taken up by plants, they do bioconcentrate in adipose tissue because of their stability, high lipid solubility and/or binding, and low water solubility. In addition to the low bioavailability of PCBs in soils, the current physical nature of Site 17 (graveled storage lot) minimizes any likelihood of possible PCB bioaccumulation. Site 17 is part of a large industrial complex at TEAD-N and, as such, is not available for locally grazed cattle or homegrown produce; therefore, these pathways are not considered complete for current land use conditions, but are considered complete for the future residential scenario.

Because of the relative immobility of PCBs in soil, the magnitude of the depth to groundwater at Site 17, and results of vadose zone contaminant fate and transport modeling, groundwater was not considered as a complete exposure pathway. In addition, PCB soil cleanup levels based on direct contact assumptions will generally provide sufficient protection of groundwater (EPA, 1990).

5.1.7 Baseline Risk Assessment

5.1.7.1 *Human Health Evaluation*

The purpose of the Human Health Risk Assessment is to evaluate potential human health risks associated with hazardous substance releases from sites under the assumption of no-action. This section summarizes the results of the Human Health Risk Assessment that was completed for the Former Transformer Storage Area (Site 17).

The risk assessment evaluates scenarios for both present land use and future land use conditions for carcinogenic and chronic, non-carcinogenic health effects. Current base

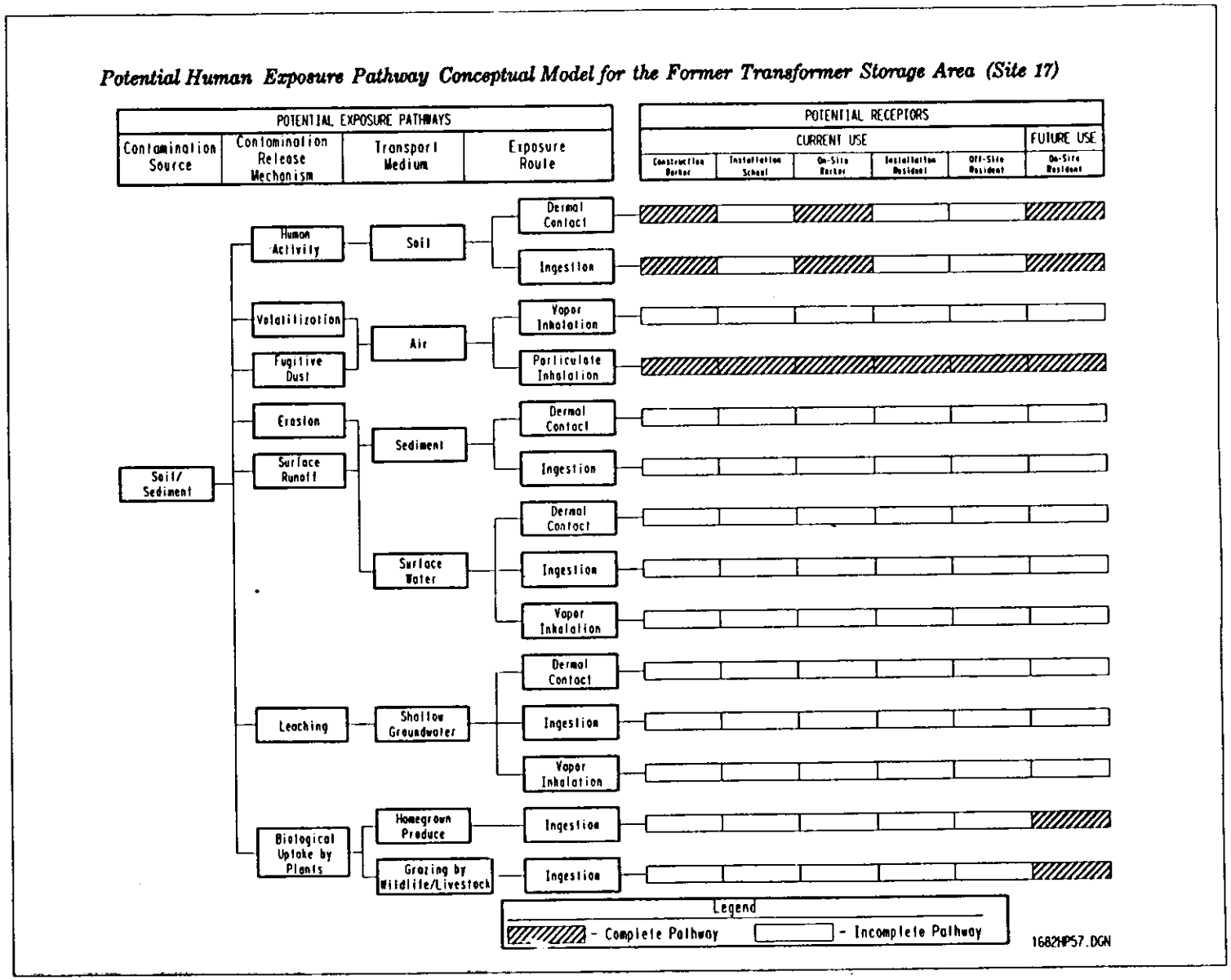


Figure 5-3. Potential Exposure Pathway Model for the Former Transformer Storage Area (Site 17)

closure plans envision that the TEAD-N Maintenance Area, in which Site 17 is located, will be utilized for industrial purposes by private firms or other government entities. However, for this risk assessment, residential land use was chosen as a conservative exposure scenario.

For each scenario evaluated, two exposure cases are analyzed as part of the BRA. The central tendency risk description presented in Table 5-3 is the average or arithmetic mean risk and is derived by using average exposure factors but using maximum concentrations back calculated from the highest composite sample concentration (N-PCB-CST5) for each pathway/site considered. The RME description presented in Table 5-4 is the high-end risk. The RME is estimated by combining upper bound exposure values with the same concentration back calculated from the highest composite sample concentration, N-PCB-CST5, so that the result represents an exposure scenario that is both protective and reasonable (EPA, 1991). Thus, for Site 17, a conservative value of 0.5 mg/kg PCB was used as the soil concentration for both the average and RME calculations. Both Table 5-3 and 5-4 include carcinogenic and noncarcinogenic risk estimates for all complete pathways.

As explained in Section 3-5, Baseline Risk Assessment Methodology, the estimation of exposure and risk for the scenarios considered for each pathway/site at TEAD-N were derived using conservative exposure estimates. Because of limitations in site-specific exposure data for the sites, conservative exposure estimates were used to provide risk descriptors that would be protective of public health. These exposure estimates were then used in conjunction with toxicity values derived from upper-bound dose-response assessments resulting in highly conservative risk descriptors.

5.1.7.1.1 ***Current Land Use.*** Under current land use conditions, human receptors include the on-site worker, construction worker, installation resident, installation school student/employee, and off-site resident from the nearby cities of Tooele, Stockton, and Grantsville. The on-site worker and construction worker are potentially exposed through incidental ingestion of soil, dermal contact, and inhalation of fugitive dust. For the remaining current land use receptors, inhalation of fugitive dust was considered the only complete, potential exposure pathway because of restricted access to TEAD-N. Site 17 is part of a large industrial complex at TEAD-N and, as such, is not available for locally grazed cattle or homegrown produce; therefore, these pathways are not considered complete for current land use conditions, but are considered complete for the future residential scenario.

5.1.7.1.1.1 ***On-Site Worker***

The total carcinogenic risk factor for average exposure to the on-site worker is 4E-07, below the EPA target range for residual risk of 1E-04 to 1E-06, and for RME is 3E-06, just within the target range.

In addition, the chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the on-site worker at Site 17 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 5E-03 and for RME is 1E-02.

Table 5-3. Summary of Human Health Risk Assessment Results Using Average Exposure Levels for Site 17

	On-Site Worker[c]		Construction Worker[d]		Installation School[e]		Installation Resident[f]		Off-Site Resident[g] Tooele		Off-Site Resident[g] Stockton		Off-Site Resident[g] Grantsville		Future On-Site[h] Resident	
Analyte	RF[a]	HI[b]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
PCB 1260	2.69E-07	3.49E-03	2.69E-08	3.49E-03											9.67E-07	5.06E-02
Inhalation																
PCB 1260	8.64E-11	1.13E-06	8.64E-12	1.13E-06	9.68E-12	6.30E-07	2.59E-11	1.69E-06	4.70E-13	6.80E-09	7.99E-13	1.16E-08	3.98E-12	5.76E-08	1.16E-10	1.69E-06
Dermal																
PCB 1260	1.14E-07	1.50E-03	1.14E-08	1.50E-03											9.62E-08	1.41E-03
Beef Consumption																
PCB 1260															1.16E-06	1.67E-02
Vegetable Consumption																
PCB 1260															3.39E-07	4.89E-03
Fruit Consumption																
PCB 1260															1.90E-07	2.74E-03
Site Total	3.83E-07	5.00E-03	3.83E-08	5.00E-03	9.68E-12	6.30E-07	2.59E-11	1.69E-06	4.70E-13	6.80E-09	7.99E-13	1.16E-08	3.98E-12	5.76E-08	2.75E-06	7.63E-02

[a]Risk factor.
[b]Hazard index.
[c]On-Site Worker is assumed to work at Site 17 10 hours per day 250 days per year for 10 years.
[d]Construction Worker is assumed to work at Site 17 10 hours per day for 250 days.
[e]Installation School Students/Employees are assumed to be at the school site 7 hours per day 200 days per years for 2 years.
[f]Installation Resident is assumed to live on TEAD-N for 2 years.
[g]Off-Site Residents are assumed to live in the TEAD-N vicinity for 2 years.
[h]Future On-Site Residents are assumed to live on Site 17 land for 9 years.

Table 5-4. Summary of Human Health Risk Assessment Results Using Reasonable Maximum Exposure Levels for Site 17

	On-Site Worker[c]		Construction Worker[d]		Installation School[e]		Installation Resident[f]		Off-Site Resident[g] Tooele		Off-Site Resident[g] Stockton		Off-Site Resident[g] Grantsville		Future On-Site[h] Resident	
Analyte	RF[a]	HI[b]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
PCB 1260	1.35E-06	6.99E-03	2.58E-07	3.35E-02											6.03E-06	1.01E-01
Inhalation																
PCB 1260	2.16E-10	1.13E-06	1.30E-11	1.69E-06	1.94E-11	6.30E-07	3.06E-10	1.36E-05	3.93E-12	5.48E-08	6.71E-12	9.35E-08	3.33E-11	4.64E-07	9.75E-10	1.36E-05
Dermal																
PCB 1260	1.43E-06	7.51E-03	5.71E-08	7.51E-03											3.01E-06	3.45E-02
Beef Consumption																
PCB 1260															1.14E-05	1.61E-01
Vegetable Consumption																
PCB 1260															3.13E-06	4.44E-02
Fruit Consumption																
PCB 1260															1.65E-06	2.33E-02
Site Total	2.77E-06	1.45E-02	3.15E-07	4.11E-02	1.94E-11	6.30E-07	3.06E-10	1.36E-05	3.93E-12	5.48E-08	6.71E-12	9.35E-08	3.33E-11	4.64E-07	2.52E-05	3.64E-01

[a]Risk factor.
[b]Hazard index.
[c]On-Site Worker is assumed to work at Site 17 10 hours per day 250 days per year for 25 years.
[d]Construction Worker is assumed to work at Site 17 10 hours per day for 250 days.
[e]Installation School Students/Employees are assumed to be at the school site 7 hours per day 200 days per year for 4 years.
[f]Installation Resident is assumed to live on TEAD-N for 2 years as a child and 7 years as an adult.
[g]Off-Site Residents are assumed to live in the TEAD-N vicinity for 30 years.
[h]Future On-Site Residents are assumed to live on Site 17 land for 30 years.

5.1.7.1.1.2 *Construction Worker*

Both the average exposure and RME total carcinogenic risk factors for the construction worker at Site 17 are below the EPA target range for residual risk of 1E-04 to 1E-06. The total carcinogenic risk factor for average exposure to the construction worker is 4E-08 and for RME is 3E-07.

In addition, the chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the construction worker at Site 17 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 5E-03 and for RME is 4E-02.

5.1.7.1.1.3 *Installation School*

The total carcinogenic risk factors for the installation school student/employee calculated for average exposure and RME to inhalation of fugitive dust from Site 17 are below the EPA target range for residual risk of 1E-04 to 1E-06. The total carcinogenic risk factor for average exposure to the installation school student/employee is 1E-11 and for RME is 2E-11.

In addition, the chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the installation school student/employee potentially exposed to fugitive dust from Site 17 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for the average exposure is 6E-07 and for RME is 6E-07. A longer exposure duration was used in the exposure estimate for the installation school student/employee RME scenario. Since the exposure duration impacts the averaging time for chronic, noncarcinogenic health effects, the hazard index calculated for the average and RME cases are equal.

5.1.7.1.1.4 *Installation Resident*

Both the average exposure and RME total carcinogenic risk factors for the installation resident calculated for potential exposure to inhalation of fugitive dust from Site 17 are below the EPA target range for residual risk of 1E-04 to 1E-06. The total carcinogenic risk factor for average exposure to the installation resident is 3E-11 and for RME is 3E-10.

In addition, the chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the installation resident potentially exposed to fugitive dust from Site 17 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for the average exposure is 2E-06 and for RME is 1E-05.

5.1.7.1.1.5 *Off-Site Residents*

Both the average exposure and RME total carcinogenic risk factors for the off-site residents calculated for potential exposure to inhalation of fugitive dust from Site 17 are below the EPA target range for residual risk of 1E-04 to 1E-06. The total carcinogenic risk factors for

average exposure to the off-site residents at Tooele, Stockton, and Grantsville are 5E-13, 8E-13, and 4E-12, respectively. The total carcinogenic risk factors for RME to the off-site residents at Tooele, Stockton, and Grantsville are 4E-12, 7E-12, and 3E-11, respectively.

In addition, the chronic, noncarcinogenic risk estimates for both the average and RME cases for off-site residents potentially exposed to fugitive dust from Site 17 are below the EPA goal for a residual hazard index of 1 or less. The hazard indices for the average exposure at Tooele, Stockton, and Grantsville are 7E-09, 1E-08, and 6E-08, respectively. The hazard indices for the RME at Tooele, Stockton, and Grantsville are 6E-08, 9E-08, and 5E-07, respectively.

5.1.7.1.2 Future Land Use. The scenario evaluated for the future land use condition is on-site residential use. As previously stated, it is unlikely that TEAD-N property will be developed as a residential area; however, for this risk assessment, residential land use was chosen as a conservative scenario. Complete exposure pathways considered for the future on-site resident are incidental ingestion of soil, dermal contact, inhalation of fugitive dust, consumption of beef derived from cattle grazing at Site 17, and consumption of produce grown at Site 17. The risk descriptors estimated for this scenario are extremely conservative values. Because of the current nature of Site 17, extensive development would be required for future residential use, including the need for a large quantity of fill material. The fill material would minimize potential contact and/or uptake of contaminants at Site 17.

5.1.7.1.2.1 ***Future On-Site Resident***

The average exposure total carcinogenic risk factor for the future on-site resident at Site 17 falls just within the EPA target range for residual risk of 1E-04 to 1E-06 with a value of 3E-06. The RME total carcinogenic risk factor for the future on-site resident at Site 17 is 3E-05, within the EPA target range. The exposure pathways driving the RME risk are incidental soil ingestion and consumption of homegrown beef. As previously discussed, the risk descriptors calculated for each pathway/site are derived from conservative exposure estimates. Section 3-5, Risk Assessment Methodology, more fully characterizes the conservative methodology utilized in the numerical risk assessment.

The chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the future on-site resident at Site 17 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 8E-02 and for RME is 4E-01.

5.1.7.2 ***Environmental Evaluation***

The ecological risk assessment for Site 17 was qualitative and did not include tissue sampling or bioassays of the vegetation and wildlife. Site 17 is an open storage lot in an industrial area of TEAD-N with gravel covering most of the site. Because of frequent human activity, the most likely wildlife inhabitants are small mammals, large mammals, and birds. There is no

indication that this area is a critical habitat for any endangered or threatened species. Species of vegetation that have been observed at Site 17 are presented in Table 5-5.

Table 5-5. Vegetation Inventory (Site 17)

Scientific Name	Common Name
VEGETATION	
Melilotus albus	White sweet clover
Melilotus officinalis	Yellow sweet clover
Helianthus annuus	Annual sunflower
Salsola pestifer	Russian thistle
Sisymbrium officinale	Tumbling mustard
Duscruainia sophia	Tansy mustard
WILDLIFE	
Lepus californicus	Jackrabbit

Note.—Entire area is covered by storage containers.

5.1.7.2.1 ***Contaminants of Concern.*** The contaminants of concern at Site 5 are PCBs. These compounds are toxic and bioaccumulate to varying degrees depending on the pathways. A summary of relevant information for this contaminant is presented in Table 5-6, which was taken from Table 3-18.

Table 5-6. Summary of Contaminants (Site 17)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
(PCB) Aroclor 1260	I[a]→VL[b]	M[c]	BM[d], BC[e]	2[f]	3	mod. toxic by ingestion and skin contact; teratogen, mutagen

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]I = insoluble.
[b]VL = very low.
[c]M = moderate.
[d]BM = biomagnification.
[e]BC = bioconcentrate.
[f]2 = probably or suspected carcinogen.

Very little is known about their behavior in a terrestrial environment, the lethal and chronic affects associated with these contaminants, or their movement up a food chain. This is mainly due to the interspecies differences in sensitivity to these compounds that exist, even between species of biota that are related taxonomically.

5.1.7.2.2 ***Potential Pathways and Conceptual Food Web.*** The most likely pathways of contaminants through the ecosystem are listed below and are graphically presented in Figure 5-4. Standing surface water was not considered as a means of transport at this site because of the infrequent nature of downpours and because of the well-drained, manmade topography of the storage lot that makes up Site 17.

- Plants

-Direct uptake through the root systems of existing vegetation

- Wildlife

-Ingestion of contaminated soil
-Ingestion of contaminated vegetation
-Ingestion of contaminated insects/invertebrates
-Ingestion of carrion/smaller animals
-Through direct dermal contact with contaminated soil
-Inhalation of contaminated vapors
-Inhalation of contaminated particles

Table 5-7 presents a summary of exposure points, resident populations, and ecological exposure activities that may occur at Site 17. The table is listed in decreasing exposure potential.

5.1.7.2.3 ***Development of the Pathway-Receptor Model.*** While there are many variations of receptor pathways that exist at this site as shown in Figure 5-4, two main exposure routes were chosen that best typify what would occur at this site. The following receptor pathways were used in the bioaccumulation model:

Soil→Plants→Mammals→Raptors
Soil→Plants→Birds→Raptors

While these pathways do not include invertebrates/insects, reptiles, or carrion and are thus not complete, they are representative of what occurs at Site 17 and illustrate the potential major routes of contaminant movement from the source to the biotic receptors. For the development of this model, the species used to represent mammals in the pathway is the jackrabbit and for raptors, the red-tailed hawk.

5.1.7.2.4 ***Risk Characterization and Conclusions.*** Bioaccumulation factors (BAFs) were calculated for the key species in each level of the food chain. In calculating the food term used in the BAF equation, the average weights of the key species were needed, along with their daily food consumption, food items eaten, and the percent of these various foods in their diets. This information is presented in Table 5-7.

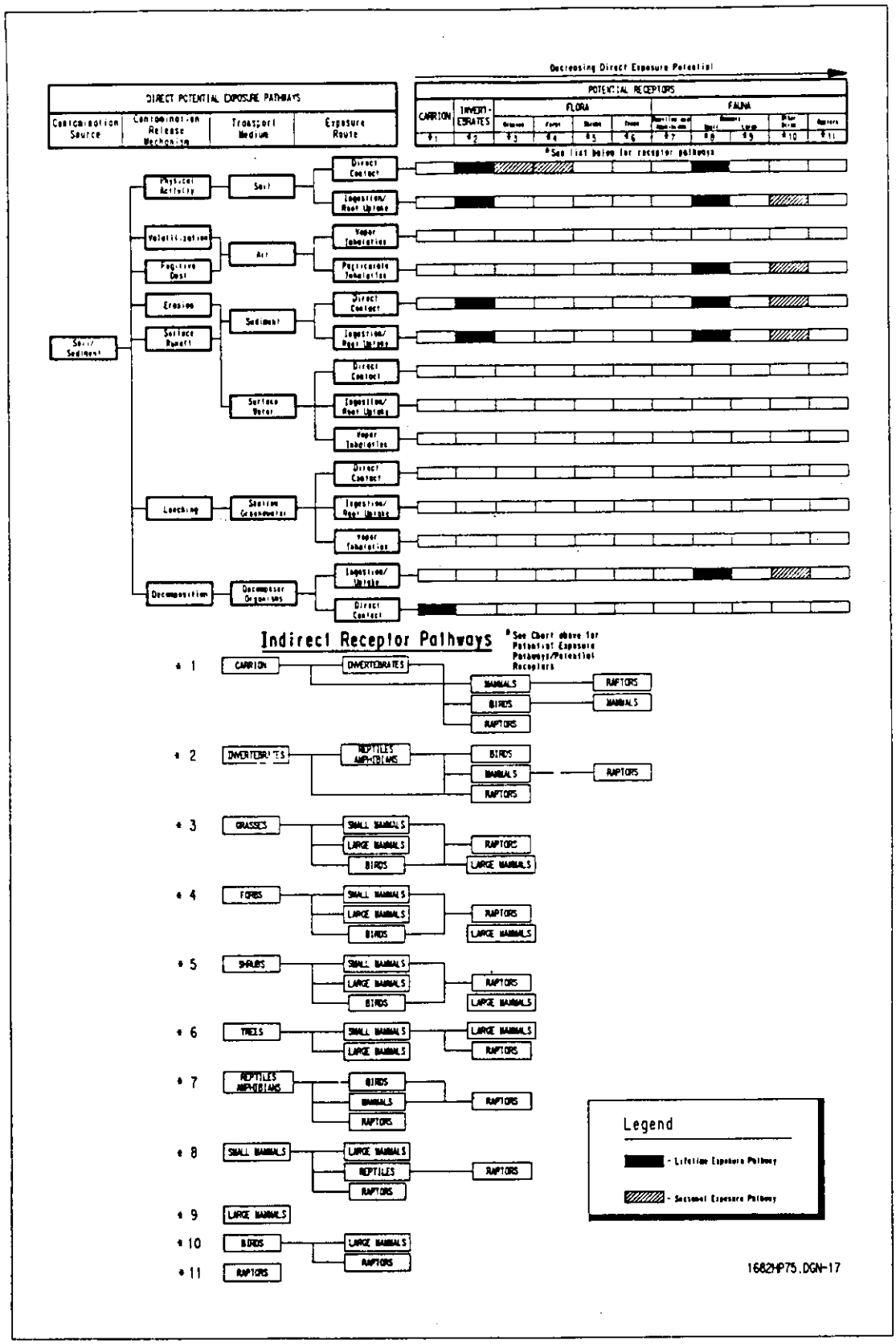


Figure 5-4. Potential Ecological Exposure Pathway for Site 17

Table 5-7. Food Consumption and Food Item Percentages Used to Estimate Bioaccumulation Factors

Species	Daily Food Consumption (g/kg bw/day)	Average Weight (g)	Food Items	Percent in Diet
Jackrabbit (Lepus Californicus)	282	2,000	Insects	50% (2)
			Vegetation	50% (2)
Red-tailed Hawk (Buteo Jamaicensis)	200	1,500	Snakes	5% (1)
			Birds	8% (1)
			Small Mammals	47% (1)
			Rabbits	40% (1)

Sources: (1) Craighead et al, 1969
(2) Jones et al., 1985

Through the use of the bioaccumulation model, a conservative total BMF for the red-tailed hawk was calculated to be 20. This total BMF was then used to evaluate the maximum allowable soil concentration that would potentially cause reproductive failure in the red-tailed hawk population by using the equation, C(soil) = MATC/Total BMFi (see Section 3.6.4.7 for discussion of the bioaccumulation model). Using a MATC value calculated to be 23.6 μg/g (U.S. Fish and Wildlife, 1986; Anthony et al., 1993), the C(soil) was calculated to be 1.2 μg/g.

Using conservative maximum acceptable tissue levels and biomagnification factors, the lowest concentration of PCBs in the soil that would cause a reproductive failure (1.2 μg/g) was above the highest detected level of PCB contamination (0.108 μg/g average from composite sample; 0.54 μg/g using the highest possible calculated detection from composite sample CST5).

Because the PCB concentrations in the soil were below the conservative benchmark value for reproductive failure and because all future land use scenarios used in the risk assessment included human activity, the overall risk to ecological receptors on this site, and to the TEAD-N ecosystem as a whole, appears to be minimal. Alterations to the trophic structure and ecological processes at Site 17 or to the TEAD-N facility due to existing contaminants at Site 17 are unlikely.

5.1.8 Conclusions

Based on the results of the risk assessment, no significant threat to human health or the environment exists at the Former Transformer Storage Area (Site 17). All of the chronic, noncarcinogenic risk estimates fall below the EPA goal for a residual hazard index of 1 or less. All of the carcinogenic risks fall below or within the EPA target range for residual risk of 1E-04 to 1E-06. Carcinogenic risks for two of the potential receptors, (the current on-site worker [RME case only] and the future on-site resident), are calculated to be within the target range; risks for all other potential receptors (both average and RME) are below the target range. The on-site worker risk for the maximum (RME) case is calculated to be 3E-06, just within the target range. As explained in Section 3.5, the assumptions used in this calculation are conservative (i.e., assumes a worker will be on Site 17 for 250 days per year for 25 years).

For the future on-site resident scenario, the cancer risks are calculated as 3E-06 for the average case and 2.5E-05 for the maximum (RME) case. Again, assumptions used in these calculations are conservative. For example, the RME case assumes an incidental soil ingestion rate of 200 mg/day for a child and 100 mg/day for an adult with all of the ingested soil emanating from Site 17. In addition, it is assumed that 75 percent of all beef consumed by a future Site 17 resident comes from cattle that have grazed on Site 17.

5.1.9 Recommendations

Because the results of the risk assessment do not indicate a significant threat to human health or to the environment, it is recommended that no further remedial investigation be performed and that a feasibility study be conducted for Site 17.

5.2 PCB STORAGE BUILDING 659 (Site 33)

5.2.1 Site Characteristics

The PCB Storage Facility in Building 659 at TEAD-N (see Figure 5-1) is a TSCA-permitted facility used to store transformers. The facility has a sealed cement floor and has a perimeter berm and diversion structures at each entrance for the containment of oil spills. The surface around the building is also paved (EA, 1988). The facility began operating in 1979 and is used to store thousands of transformers that were once stored in open storage sites. The transformers are stored on open pallets and in wooden crates within the building. According to a discussion with facility personnel during a site visit in November 1992, PCB-contaminated transformers are still being removed from TEAD-N, with temporary storage occurring at Building 659 during the removal process. During the site visit, no PCB-contaminated transformers were being stored at the facility.

Procedures are in place to ensure that any spills that may occur within the facility are contained, cleaned up, and properly disposed of. There is no evidence that any uncontrolled release to environmental pathways has occurred as a result of the operations of this facility.

Any contaminated cleanup materials such as oil absorbent and protective clothing are drummed, appropriately marked, and stored for off-site disposal by U.S. Pollution Control, Inc., of West Murray, Utah. PCB-contaminated material is disposed of at the Grassy Mountain Hazardous Waste Landfill in Utah (EA, 1988).

5.2.2 Previous Investigations and RI Activities

There have been no previous investigations at the PCB Storage Building 659. No RI activities were conducted at this site because facility operation is conducted in compliance with a TSCA permit, and there is no evidence or data to indicate that PCB-contaminated wastes have been released to the environment in the vicinity of Building 659.

5.2.3 Nature and Extent of Contamination

PCB spills have occurred within the confines of the permitted area at Site 33; however, the contaminated cleanup materials such as oil absorbent and protective clothing were drummed, appropriately marked, and stored for disposal (EA, 1988). PCB disposal is managed by the Defense Reutilization and Marketing Office (DRMO) and conducted by the U.S. Pollution Control, Inc., of West Murray, Utah. Soil and dust are collected during periodic sweep downs of the building and are properly drummed and disposed of. Because the facility is TSCA-permitted, well maintained and operated, and all spills properly cleaned up and contained, releases from the facility are unlikely.

There is no evidence or data to indicate that PCB-contaminated wastes have ever been released to the environment due to operation at Site 33. For instance, a 1981 PCB Inspection Report conducted by EPA personnel showed that:

- Although three transformers had been placed inside the building, outside the bermed area (i.e., outside the permitted storage area) no leakage or PCB contamination had occurred. The transformers were moved inside the permitted area following the inspection.

- Analysis of a sample taken from an oil stain just outside a Building 659 outside door showed less than 1 ppm PCB.

- Although the berm had been damaged, it was appropriately repaired.

A copy of the correspondence related to this inspection follows as Appendix J.

5.2.4 Contaminants of Concern

PCBs are the potential contaminants of concern at this site. However, there are no indications that a release of PCB-contaminated oil to the environment has occurred at this site.

5.2.5 Contaminant Fate and Transport

Because there are no indications of a contaminant release at this site, an assessment of contaminant fate and transport characteristics was not conducted.

5.2.6 Potential Exposure Pathways

Because there are no indications of a contaminant release at this site, an assessment of exposure pathways was not conducted.

5.2.7 Baseline Risk Assessment

5.2.7.1 *Human Health Assessment*

Because there are no indications of a contaminant release at this site, a human health evaluation for Site 33 was not conducted.

5.2.7.2 *Environmental Evaluation*

5.2.7.2.1 *Site Characterization.* Site 33 is a storage facility inside a building in an industrial area of TEAD-N. There is no vegetation at the site. Because the site is well-maintained and there is frequent human activity, it is unlikely that any wildlife (with the exception of possible small mammals, such as rodents) inhabit the site.

5.2.7.2.2 *Biological Effects of Contaminants.* No contaminants of concern were identified for Site 33. Therefore, an assessment of biological effects is not warranted.

5.2.7.2.3 *Potential Pathways.* No contaminants of concern were identified at this site, so none of the potential exposure pathways are considered to be complete.

5.2.7.2.4 *Environmental Conclusions.* No contaminants of concern were identified at this site. Therefore, this site has a low probability of impacting the environment.

5.2.8 Conclusions

The facility is TSCA-permitted, well maintained and operated, and any spills are contained and properly cleaned up. As long as the facility remains under Army control with TSCA permits in place, there is little likelihood of contamination occurring. If the facility were to be changed from PCB storage or transferred from Army control, a complete examination and re-evaluation would take place prior to any such transfer under TSCA rules and BRAC closure regulations, thus ensuring continued protection of human health and the environment.

5.2.9 Recommendations

On the basis of reviews of operational and cleanup procedures at the building, it does not appear that additional investigations are warranted at Site 33 until such time as the facility is removed as a TSCA-permitted facility under Army control.

6.0 OPERABLE UNIT 6

6.1 DRUMMED RADIOACTIVE WASTE STORAGE AREA (Site 9)

6.1.1 Site Characteristics

The Drummed Radioactive Waste Storage Area (Site 9) (Figures 1-7 and 6-1) consists of a concrete pad and adjacent field area that was used for the temporary storage of containerized low-level radioactive waste. The material was stored for a number of years on or around a concrete pad southwest of Building S-753. It was then moved to a field area to the northwest of the building. In 1978, the material was removed for off-site disposal by the TEAD-N Radiation Protection Office. The materials reportedly included transmitting tubes used to generate microwaves for radar systems and possibly speedometers, luminous watch dials, contaminated tools, and decontamination materials. Previous investigations (USATHAMA, 1979 and NUS, 1987) reported a list of radioactive isotopes that may have been present at TEAD-N and, consequently, may have been present in the drummed wastes, as follows: iridium-192, cobalt-60, nickel-63, carbon-14, polonium-210, cesium-139, hydrogen-3, promethium-147, krypton-85, plutonium-239, and radium-226. There are no records that identify the exact storage locations of the containerized waste and no indication that any radioactive spills have occurred at Site 9. Currently, a small wooden storage shed is located on the concrete pad thought to have been used for container storage. The field to which one drum was suspected to have been moved includes Lot 707 (Figure 6-1), which is an area now used for storage of 4-wheel-drive vehicles.

6.1.2 Previous Investigations and RI Activities

In 1992, Rust E&I conducted radiological surveys in the suspected drum storage areas utilizing the methodology outlined in Section 3.2.7. The north survey area was gridded and a walking survey was conducted over the entire area using a hand-held probe with a 3-foot extension. Because of the presence of 4-wheel-drive vehicles in the survey area, it is estimated that approximately 90 percent coverage was achieved (i.e., only the soil directly under vehicle tires was not surveyed).

The instrument used for the radiation survey was a Ludlum Ratemeter Model 12 with a Beta/Gamma Ludlum Model 44-9 probe. The instrument was calibrated at Rust-Geotech facilities according to their Technical Procedure ELP-318, which conforms to all applicable DOE standards.

It was determined that an alpha radiation survey was not necessary because no elevated beta/gamma readings were reported (Section 6.1.3). Further, the radiological surface contamination survey was accomplished using a Ludlum model 12 instrument equipped with a 44-9 pancake probe detector. The mylar covering the window of this detector is referenced in the manufacturer specs at only 0.8 mg/cm^2 thick and has been tested and proven to detect alpha emissions with energies greater than 3.0 million electron volts (M.E.V.). The isotopes

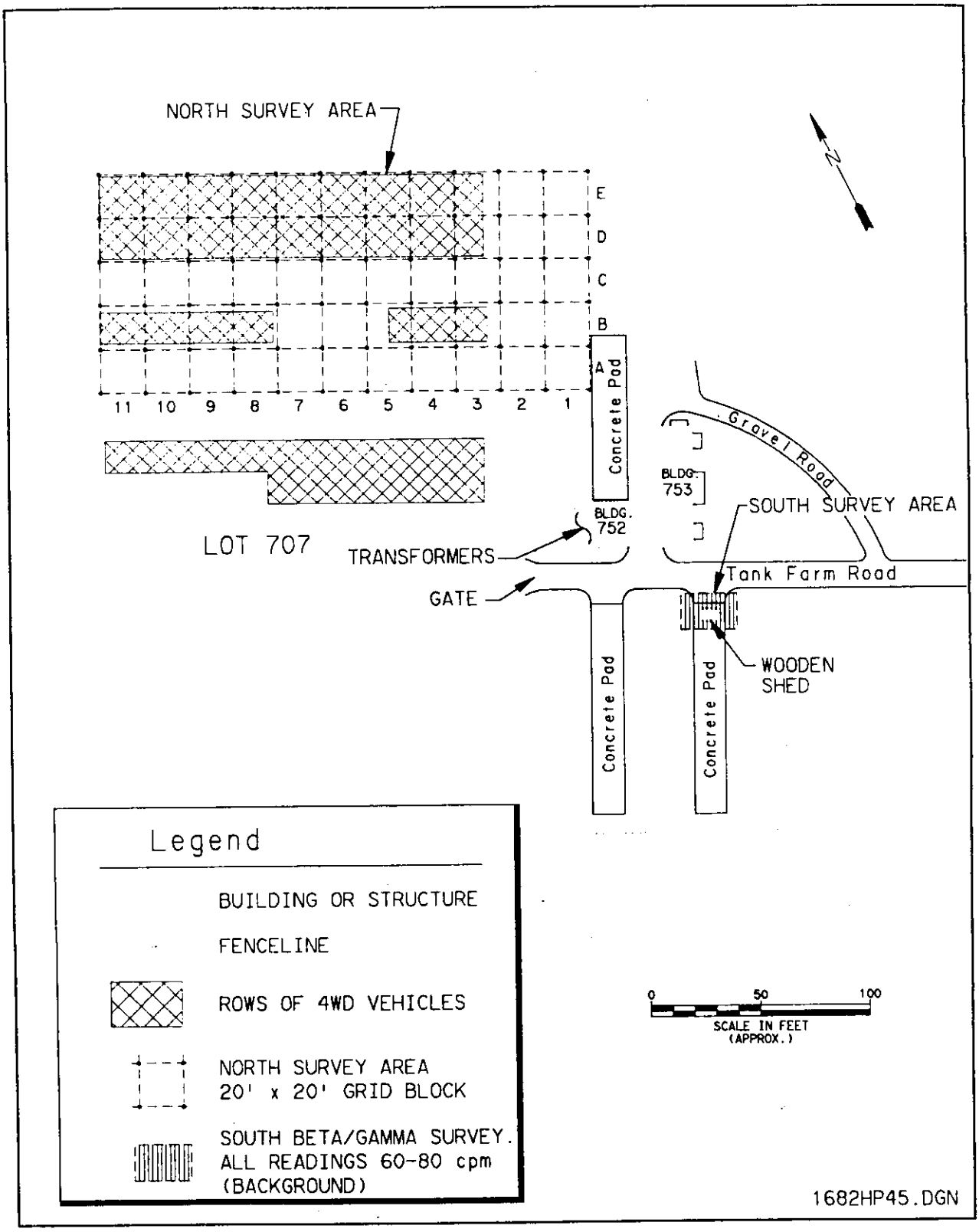


Figure 6-1. Radiological Survey Areas at the Drummed Radioactive Waste Storage Area (Site 9), at TEAD-N

that decay with alpha emissions, which were included on the list of possible contaminants, all decay with energies at 4.7 to 5.3 M.E.V. and, therefore, would have been detected with this survey.

6.1.3 Nature and Extent of Contamination

The surface-radiation survey conducted by Rust E&I (Section 6.1.2) indicated that there are no locations of elevated radiation within the suspected drum storage areas (Table 6-1). Background was established by readings taken outside the suspected drum storage areas, which averaged 60 to 80 counts per minute (CPM). Average measurement readings for grids in the survey areas ranged from 50 to 95 CPM. This indicates that no radioactive materials were released at Site 9.

6.1.4 Contaminants of Concern

There are no contaminants of concern at Site 9.

6.1.5 Contaminant Fate and Transport

Because there are no indications of contamination at Site 9, an assessment of contaminant fate and transport characteristics is not warranted.

6.1.6 Potential Exposure Pathways

On the basis of the results of the RI, it appears that no environmental pathways have been affected by previous radiological storage activities associated with Site 9. Therefore, no exposure pathways were evaluated for this site.

6.1.7 Baseline Risk Assessment

6.1.7.1 *Human Health Evaluation*

Because there are no indications of a contaminant release at this site, the human health evaluation for Site 9 was not conducted.

6.1.7.2 *Environmental Evaluation*

6.1.7.2.1 *Site Characterization*. Because Site 9 is in an industrial area of TEAD-N, the site is sparsely vegetated. Except for occasional transient species, the most likely wildlife inhabitants are rodents, other small mammals, and birds. A wildlife inventory has not been

Table 6-1. Results of Beta/Gamma Radiation Survey at the Drummed Radioactive Waste Storage Area (Site 9)

Grid Station[a]	Readings (CPM)[b] Minimum	Average	Maximum	Comments[c]
A-1	40	60	80	Grid blocks A-1 through E-1, included the area from the west border of the grid blocks to the fence (Figure 6-1).
B-1	30	50	70	
C-1	40	60	80	
D-1	50	65	80	
E-1	50	65	80	
A-2	40	70	100	Grid blocks A-2 through E-2, included the area west of the fence to the west border of the grid blocks (Figure 6-1).
B-2	60	75	90	
C-2	60	80	100	
D-2	40	50	60	
E-2	40	55	70	
A-3	50	75	100	Lot vacant except grid blocks B-3, D-3, and E-3, which were partially occupied by vehicles.
B-3	80	90	100	
C-3	60	85	110	
D-3	40	60	80	
E-3	70	85	100	
A-4	80	95	110	Lot vacant except grid blocks B-4, D-4, and E-4.
B-4	70	95	110	

Table 6-1. Results of Beta/Gamma Radiation Survey at the Drummed Radioactive Waste Storage Area (Site 9) (continued)

Grid Station[a]	Readings (CPM)[b] Minimum	Average	Maximum	Comments[c]
C-4	50	80	110	
D-4	60	70	80	
E-4	50	60	70	
A-5	40	65	90	Lot vacant except for grid blocks B-5, D-5, and E-5.
B-5	30	55	80	
C-5	40	60	80	
D-5	80	90	100	
E-5	70	85	100	
A-6	50	70	90	Lot vacant except grid blocks D-6 and E-6.
B-6	40	70	100	
C-6	40	65	90	
D-6	40	55	70	
E-6	70	85	100	
A-7	40	50	60	Lot vacant except grid blocks D-7 and E-7.
B-7	40	60	80	
C-7	60	80	100	
D-7	60	55	80	
E-7	60	75	90	
A-8	40	70	100	Lot vacant except grid blocks B-8, D-8, and E-8.
B-8	50	70	90	

Table 6-1. Results of Beta/Gamma Radiation Survey at the Drummed Radioactive Waste Storage Area (Site 9) (continued)

Grid Station[a]	Readings (CPM)[b] Minimum	Average	Maximum	Comments[c]
C-8	60	70	80	
D-8	50	70	90	
E-8	70	90	110	
A-9	40	60	80	Lot vacant except grid blocks B-9, D-9, and E-9.
B-9	50	65	80	
C-9	50	65	80	
D-9	60	75	90	
E-9	60	80	100	
A-10	60	75	90	Lot vacant except grid blocks B-10, D-10, and E-10.
B-10	60	75	90	
C-10	60	70	80	
D-10	60	75	90	
E-10	50	75	100	
A-11	50	75	90	Lot vacant except grid blocks B-11, D-11, and E-11.
B-11	60	75	90	
C-11	60	80	100	
D-11	40	55	70	
E-11	60	70	80	

[a] See Figure 6-1 for grid station locations.
[b] Counts Per Minute.
[c] In grid blocks where vehicles were being stored, an attempt was made to survey the majority of the area under each of the vehicles.

conducted for this site; there is no indication that this site is a critical habitat. A site-specific inventory of vegetation has been compiled and is listed in Table 6-2.

Table 6-2. Vegetation Inventory (Site 9)

Scientific Name	Common Name
PRIMARY VEGETATION SPECIES	
Grindelia squarrosa	Gumweed
Melilotus albus	White sweetclover
Melilotus officinalis	Yellow sweetclover
OTHER VEGETATION SPECIES	
Chrysothamnus nauseosus	Rabbitbrush
Helianthus annuus	Annual sunflower
Convolvulus arvensis	Bindweed
Poa bulbosa	Bulbous bluegrass
Bromus tectorum	Cheatgrass
Elymus elymoides	Squirrel tailgrass
Elymus elongatus	Tall wheatgrass
Aristida purpurea	Three-awn; No-etum
Astragalus utahensis	Utah milkvetch
Verbena Bracteata	Verbena

6.1.7.2.2 ***Biological Effects of Contaminants***. No contaminants of concern were identified at this site. Therefore, an assessment of biological effects is not warranted.

6.1.7.2.3 ***Potential Pathways***. No contaminants of concern were identified at Site 9, so none of the potential exposure pathways are considered to be complete.

6.1.7.2.4 ***Potentially Affected Populations***. No contaminants of concern were identified for the site. Therefore, none of the potentially affected populations are addressed.

6.1.7.2.5 ***Environmental Evaluation Conclusions.*** No contaminants of concern were identified at this site. Therefore, this site has a low probability of impacting the environment.

6.1.8 Conclusions

The results from the radiological survey that was conducted at Site 9 indicate that there is not a contamination problem at the site.

6.1.9 Recommendations

Because there are no indications of a contaminant release at Site 9, no additional investigations are warranted and a feasibility study should be conducted for this site.

6.2 RADIOACTIVE WASTE STORAGE BUILDING (Site 18)

6.2.1 Site Characteristics

The Radioactive Waste Storage Building (Site 18) (see Figure 1-8 on page 1-12) is located in the northeastern corner of Building S-659, which is also the building used for the storage of transformers (Site 33). The Radioactive Waste Storage Area consists of a secured room within Building S-659 that is licensed by the Nuclear Regulatory Commission (NRC) to store radioactive materials (EA, 1988). The area is an active facility that stores low-level radioactive materials. The room has a bermed concrete floor and is enclosed and isolated from the remainder of the building. Materials stored in this area include radiation-detection meters, compasses, sights, range finders, radioactive luminous compounds, and depleted uranium. The wastes are stored in Department of Transportation (DOT)-approved containers. Periodic monitoring of the facility is conducted to determine if radioactive releases have occurred. Access to the facility is controlled by a locked door.

6.2.2 Previous Investigations and RI Activities

There have been no investigations at Site 18. No RI activities were conducted at this site because there are no data to suggest that a contamination problem exists at Site 18.

6.2.3 Nature and Extent of Contamination

Radiological surveys are conducted periodically at the Building 659 Radioactive Waste Storage Area. No indications of uncontrolled releases have been reported to date (Appendix E presents examples of these radiation survey results). On the basis of the monitoring results and site walkovers, no additional investigation of this site appears to be warranted.

6.2.4 Contaminants of Concern

There are no contaminants of concern at Site 18.

6.2.5 Contaminant Fate and Transport

Because there are no indications that Site 18 is contaminated, an assessment of contaminant fate and transport characteristics is not warranted.

6.2.6 Potential Exposure Pathways

On the basis of the periodic radiological surveys that are conducted at the site, it appears that no environmental pathways have been affected by site operations. Therefore, no exposure pathways were evaluated for this site.

6.2.7 Baseline Risk Assessment

6.2.7.1 *Human Health Evaluation*

Because there are no indications that Site 18 is contaminated, a human health evaluation was not performed for this site.

6.2.7.2 *Environmental Evaluation*

6.2.7.2.1 *Site Characterization*. Site 18 is a storage facility inside a building in an industrial area of TEAD-N. There is no vegetation at the site. Because the site is well maintained and human activity is frequent in the area, it is unlikely that any wildlife (with the possible exception of small mammals, such as rodents) inhabit the site.

6.2.7.2.2 *Biological Effects of Contaminants*. No contaminants of concern were identified at this site. Therefore, an assessment of biological effects is not warranted.

6.2.7.2.3 *Potential Pathways*. No contaminants of concern were identified at Site 18, so none of the potential exposure pathways are considered to be complete.

6.2.7.2.4 *Potentially Affected Populations*. No contaminants of concern were identified for the site. Therefore, none of the potentially affected populations are addressed.

6.2.7.2.5 *Environmental Evaluation Conclusions*. No contaminants of concern were identified at this site. Therefore, this site has a low probability of impacting the environment.

6.2.8 Conclusions

No contaminants of concern were identified at Site 18. As long as the facility remains under Army control with NRC permits in place, there is little probability of contamination occurring. If the facility were to be changed from radioactive materials storage or transferred from Army control, a complete examination and re-evaluation would take place prior to any such transfer under NRC rules and BRAC closure regulations, thus ensuring continued protection of human health and the environment.

6.2.9 Recommendations

Because there are no indications of contamination at Site 18 and the site is operated under an NRC license, no additional investigations are warranted for this site until such time as the facility is changed from an NRC-licensed facility under Army control.

7.0 OPERABLE UNIT 7

7.1 POLE TRANSFORMER PCB SPILL (Site 5)

7.1.1 Site Characteristics

In 1976, a fire occurred in a pole-mounted electrical transformer. As a result, the transformer, located on pole No. 184 (Figure 1-9), leaked PCB-containing oil from the pole to the surrounding soils. The oil-saturated soils were excavated adjacent to the pole to the north. The excavation measured approximately 5 feet by 5 feet and 3 feet deep. From the excavation, 11 55-gallon drums of soil were collected. The drums were stored near the utility pole, but were then moved to the PCB Storage Building (Building 659). A composite sample was collected from the 11 drums and analyzed for PCBs, and the drums were properly disposed of off-site. The excavation was not backfilled and still exists.

7.1.2 Previous Investigations and RI Activities

Prior to the RI, data from the spill site were lacking. No samples were collected at the time of excavation. Following the excavation, only a single composite sample from the drummed soils was collected. This sample contained 3.45 μg/g of the PCB Aroclor 1260. Confirmation sampling in and surrounding the excavation was completed as part of the current RI. A total of nine soil samples were collected at depths from 0 to 5 feet. Sampling locations are shown in Figure 7-1, while Table 7-1 presents the sampling program.

7.1.3 Nature and Extent of Contamination

A previous investigation at Site 5 included the collection of a composite soil sample from the 11 drums of excavated soil and an analysis for PCBs. This sample contained 3.45 μg/g of PCB 1260. The RI sampling and analysis program characterized the surface and subsurface soils within and immediately surrounding the former excavation to determine if residual contamination is present. The results of the sampling conducted during the RI are presented in Figure 7-2 and Table 7-2. It appears that some contaminants remain after the cleanup of the soils in 1976. Residual contamination consists of the PCB Aroclor 1260, which is present in low but detectable concentrations in three (PPS-92-01, PPS-92-02, and PPS-92-04) of the four surface-soil samples and in one of the subsurface soil samples (PPT-92-05) collected in the excavation at Site 5; however, the concentration of PCB detected in sample PPS-92-04 is below the CRL of 0.054 μg/g. Detected concentrations were 0.117 μg/g, 0.098 μg/g, 0.052 μg/g, and 0.331 μg/g, respectively. PCBs were not detected in subsurface samples collected at depths of up to 5 feet around the perimeter of the excavation. Detectable concentrations of PCDDs and PCDFs were also present in most of the samples collected. These contaminants were detected in the parts per trillion range (total PCDDs ranged from 2.8E-05 to 3.8E-04 μg/g; and PCDFs ranged from 8.0E-06 to 8.0E-05 μg/g). Octachlorodibenzodioxin was detected in the method blank at 3.4E-05 μg/g. Total heptachlorodibenzodioxin was detected

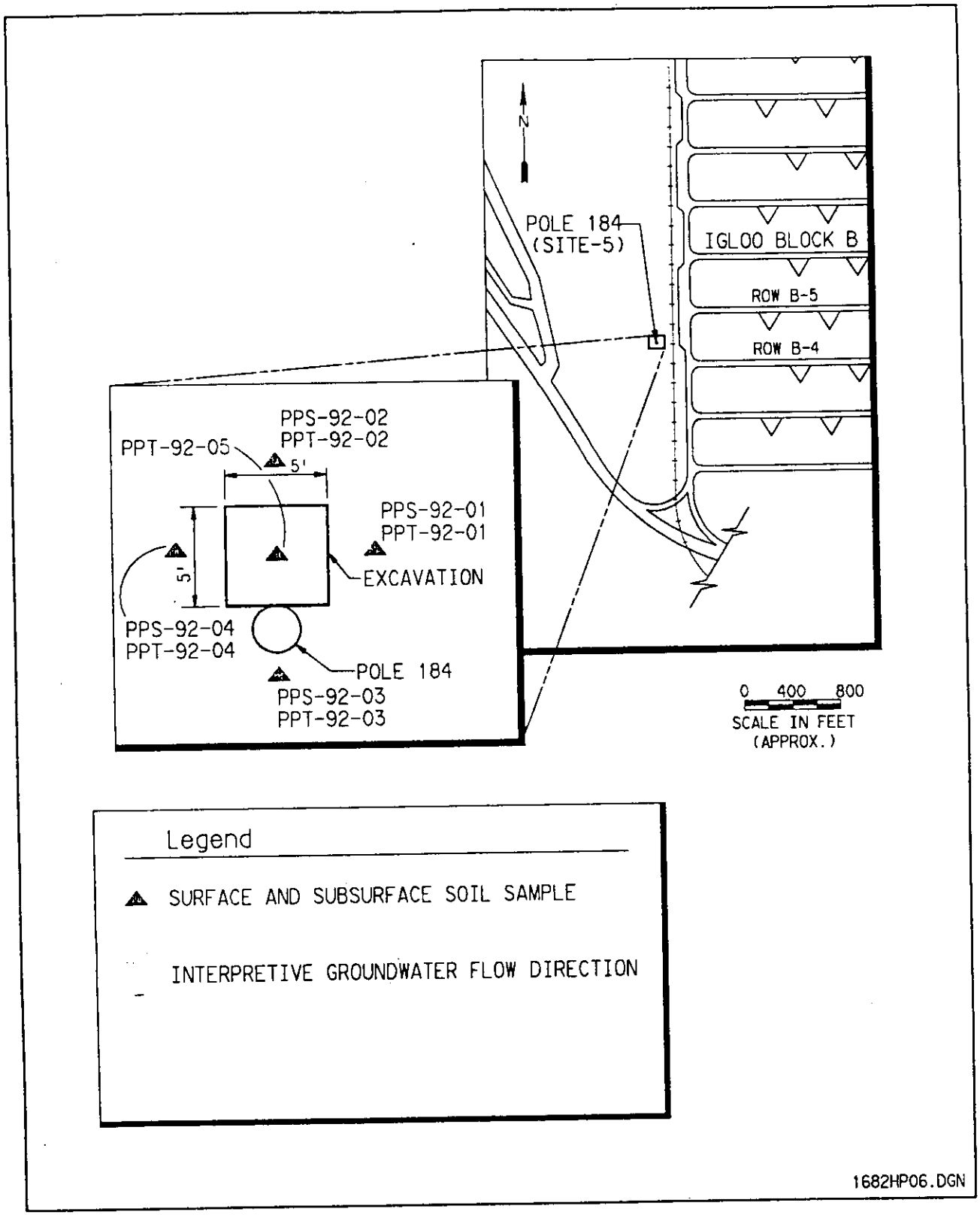


Figure 7-1. RI Soil Sample Location Map for the Pole Transformer PCB Spill Site (Site 5)

Table 7-1. RI Sampling and Analysis Program for the Pole Transformer PCB Spill Site

Site ID No.	Media	Depth (ft)	Analytical Parameters
PPS-92-01	Soil	0	PCBs, Dioxin/Furans
PPT-92-01	Soil	0-5 composite	PCBs, Dioxin/Furans
PPS-92-02	Soil	0	PCBs, Dioxin/Furans
PPT-92-02	Soil	0-5 composite	PCBs, Dioxin/Furans
PPS-92-03	Soil	0	PCBs, Dioxin/Furans
PPT-92-03	Soil	0-5 composite	PCBs, Dioxin/Furans
PPS-92-04	Soil	0	PCBs, Dioxin/Furans
PPT-92-04	Soil	0-5 composite	PCBs, Dioxin/Furans
PPT-92-05	Soil	4	PCBs, Dioxin/Furans

in the method blank at 2.0E-06 μg/g. Therefore, sample concentrations below the action level of five times the blank concentration were qualified as non-detects.

On the basis of the RI sampling results, it appears that the residual PCB and associated PCDD and PCDF contamination at Site 5 are restricted to levels of near-surface contamination as well as concentrations which were detected 4 feet beneath the surface at the previously excavated spill area. The highest concentration of any individual contaminant in surface samples that surround the previously excavated (and filled) spill area was octachlorodibenzodioxin; the highest concentration from other sample locations was pentachlorodibenzofuran (Table 7-2).

7.1.4 Contaminants of Concern

The contaminants of concern for Site 5 are PCB Aroclor 1260, the polychlorinated dibenzodioxins, and polychlorinated dibenzofurans (Tables 7-3 and 7-4).

7.1.5 Contaminant Fate and Transport

Table 3-8 in Section 3.4.1 briefly describes the fate and transport characteristics of PCBs, while Appendix H provides a more detailed description. In summary, PCBs strongly adsorb to soils and are resistant to leaching as is reflected in their low water solubilities and high octanol-water partition coefficients. In general, the higher the degree of chlorination of PCBs, the more resistant to biodegradation and the more persistent in the environment. Water solubilities for PCBs decrease with an increase in the degree of chlorination (EPA, 1990). Leaching of PCBs to the groundwater at Site 5 is highly unlikely because of the

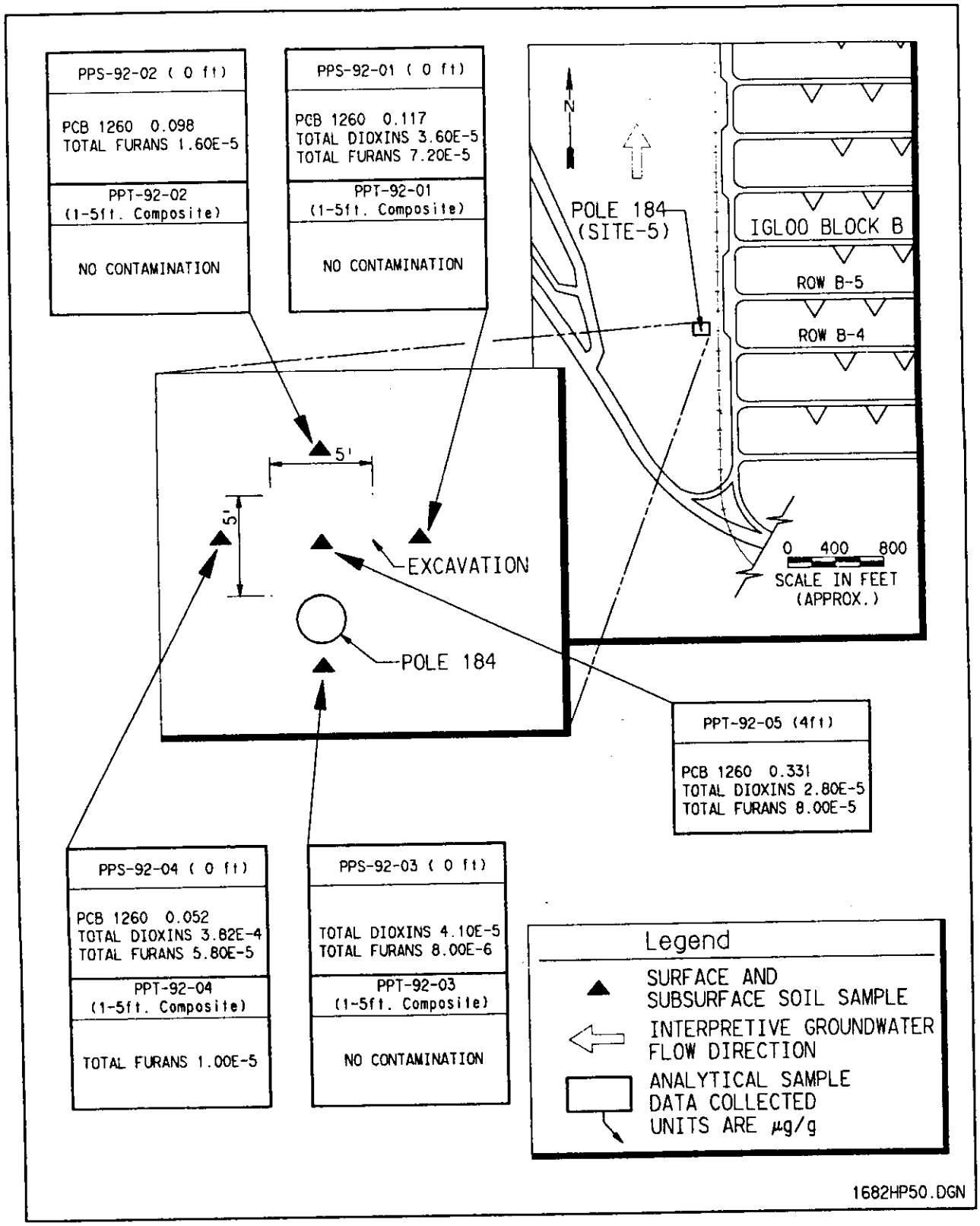


Figure 7-2. RI Soil Sampling and Analyses Results for the Pole Transformer PCB Spill Site (Site 5)

Table 7-2. Summary of Analytes Detected in Soils at the Pole Transformer PCB Spill Site (Site 5)

Analyte	PPS-92-01 (Surface)	PPS-92-02 (Surface)	PPS-92-03 (Surface)	PPS-92-04 (Surface)	PPT-92-01 (Composite 1-5 ft)	PPT-92-02 (Composite 1-5 ft)	PPT-92-03 (Composite 1-5 ft)	PPT-92-04 (Composite 1-5 ft)	PPT-92-05 (Taken at 4 ft)
Dioxins/Furans									
Octachlorodibenzodioxin	ND	ND	ND	3.0E-04	ND	ND	ND	ND	ND
Octachlorodibenzofuran	6.0E-06	2.0E-06	4.0E-06	9.0E-06	ND	ND	ND	1.0E-05	4.0E-06
2,3,7,8-Tetrachlorodibenzodioxin	ND	ND	1.5E-05	ND	ND	ND	ND	ND	ND
2,3,7,8-Tetrachlorodibenzofuran	1.0E-06	ND	ND	1.0E-06	ND	ND	ND	ND	2.0E-06
Total Hexachlorodibenzodioxin	4.0E-06	ND	ND	1.1E-05	ND	ND	ND	ND	3.0E-06
Total Hexachlorodibenzofuran	1.9E-05	5.0E-06	1.0E-06	1.1E-05	ND	ND	ND	ND	2.4E-05
Total Heptachlorodibenzodioxin	3.2E-05	ND	1.0E-05	7.2E-05	ND	ND	ND	ND	2.5E-05
Total Heptachlorodibenzofuran	7.0E-06	2.0E-06	3.0E-06	1.3E-05	ND	ND	ND	ND	8.0E-06
Total Pentachlorodibenzofuran	2.8E-05	6.0E-06	ND	2.0E-05	ND	ND	ND	ND	2.8E-05
Total Tetrachlorodibenzodioxin	ND	ND	1.6E-05	ND	ND	ND	ND	ND	ND
Total Tetrachlorodibenzofuran	1.1E-05	1.0E-06	ND	4.0E-06	ND	ND	ND	ND	1.4E-05
PCBs									
PCB 1260	0.117	0.098	ND	0.0517	ND	ND	ND	ND	0.331

Note.—Concentrations are in $\mu g/g$.
ND = Analyte not detected.
LT = Analyte is less than certified reporting limit.

Table 7-3. Contaminants of Concern in Surface Soil at the Pole Transformer PCB Spill Site (Site 5)

Analyte	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration	Method	Method Detection Limit
Octachlorodibenzodioxin	1	4	3.0E-04	3.0E-04	7.5E-05	2.5E-04	--	99	3.0E-07
Octachlorodibenzofuran	4	4	2.0E-06	9.0E-06	5.3E-06	8.8E-06	--	99	4.0E-07
2,3,7,8-Tetrachlorodibenzodioxin	1	4	1.5E-05	1.5E-05	3.8E-06	1.3E-05	--	99	2.0E-07
2,3,7,8-Tetrachlorodibenzofuran	2	4	1.0E-06	1.0E-06	5.3E-07	1.2E-06*	--	99	1.0E-07
Total Hexachlorodibenzodioxin	2	4	4.0E-06	1.1E-05	2.9E-06	9.3E-06	--	99	3.0E-07
Total Hexachlorodibenzofuran	4	4	1.0E-06	1.9E-05	9.0E-06	1.8E-05	--	99	3.0E-07
Total Heptachlorodibenzodioxin	3	4	1.0E-06	7.2E-05	2.9E-05	6.6E-05	--	99	3.0E-07
Total Heptachlorodibenzofuran	4	4	2.0E-06	1.3E-05	6.3E-06	1.2E-05	--	99	2.0E-07
Total Pentachlorodibenzofuran	3	4	6.0E-06	2.8E-05	1.4E-05	2.8E-05	--	99	3.0E-07
Total Tetrachlorodibenzodioxin	1	4	1.6E-05	1.6E-05	4.0E-06	1.3E-05	--	99	2.0E-07
Total Tetrachlorodibenzofuran	3	4	1.0E-06	1.1E-05	4.0E-06	9.8E-06	--	99	1.0E-07
PCB 1260	2	4	0.098	0.117	0.067	0.123*	--	99	0.054

Note.—Concentrations are in $\mu g/g$.

*=The concentration of the high detect was used for risk calculations because the 95% UCL on the mean was greater than the high detect.

Table 7-4. Contaminants of Concern in Surface and Subsurface Soil at the Pole Transformer PCB Spill Site (Site 5)

Analyte	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration	Method	Method Detection Limit
Octachlorodibenzodioxin	1	9	3.0E-04	3.0E-04	3.3E-05	1.3E-04	--	99	3.0E-07
Octachlorodibenzofuran	6	9	2.0E-06	1.0E-05	4.0E-06	7.4E-06	--	99	4.0E-07
2,3,7,8-Tetrachlorodibenzodioxin	1	9	1.5E-05	1.5E-05	1.8E-06	6.4E-06	--	99	2.0E-07
2,3,7,8-Tetrachlorodibenzofuran	3	9	1.0E-06	2.0E-06	4.8E-07	1.1E-06	--	99	1.0E-07
Total Hexachlorodibenzodioxin	3	9	3.0E-06	1.1E-05	2.1E-06	5.5E-06	--	99	3.0E-07
Total Hexachlorodibenzofuran	5	9	1.0E-06	2.4E-05	6.7E-06	1.5E-05	--	99	3.0E-07
Total Heptachlorodibenzodioxin	4	9	1.0E-06	7.2E-05	1.6E-05	3.8E-05	--	99	3.0E-07
Total Heptachlorodibenzofuran	5	9	2.0E-06	1.3E-05	2.4E-06	5.3E-06	--	99	2.0E-07
Total Pentachlorodibenzofuran	4	9	6.0E-06	2.8E-05	9.2E-06	2.1E-05	--	99	3.0E-07
Total Tetrachlorodibenzodioxin	1	9	1.6E-05	1.6E-05	1.9E-06	6.8E-06	--	99	2.0E-07
Total Tetrachlorodibenzofuran	4	9	1.0E-06	1.4E-05	3.4E-06	8.4E-06	--	99	1.0E-07
PCB 1260	3	9	0.098	0.331	0.079	0.173	--	99	0.054

Note.—Concentrations are in μg/g.

depth to groundwater at the site (approximately 300 feet), the low concentrations of PCBs detected in the soil, and the relative immobility of PCBs in soils.

The chemical and environmental stability of PCBs, coupled with their strong adherence to soils, results in relatively long half-lives especially for the more chlorinated isomers. Although PCBs are highly persistent compounds exhibiting generally low volatilization rates, photolysis and volatilization of PCBs are major removal processes over time. In addition, PCBs may enter the atmosphere through adsorption to airborne particulates with removal occurring through wet and dry deposition. The tendency of PCBs to adsorb to particulates increases as the degree of chlorination increases.

The fate and transport of PCDDs and PCDFs are similar to the fate and transport of PCBs, and are, in fact, usually present as trace impurities in PCBs. PCDDS and PCDFs are chemically and environmentally stable, relatively insoluble in water, highly persistent, and have long environmental half-lives.

7.1.6 Potential Exposure Pathways

Figure 7-3 shows a conceptual model of the most likely human exposure pathways for PCBs, PCDDs, and PCDFs at Site 5. The most likely exposure pathways at Site 5 are via dermal contact, incidental soil ingestion, inhalation of fugitive dust, and ingestion of beef derived from cattle potentially exposed to contamination while grazing at TEAD-N. However, fugitive dust emissions from Site 5 are minimal because of the small size and location of Site 5.

Although PCBs, PCDDs, and PCDFs are not appreciably taken up by plants, they do bioconcentrate in adipose tissue due to their stability, high lipid solubility and/or binding, and low water solubility. In addition to the low bioavailability of PCBs, PCDDS, and PCDFs in soils, the current physical nature of Site 5 minimizes any likelihood of possible bioaccumulation. Currently, Site 5 is available to grazing cattle on TEAD-N but is not available for homegrown produce; therefore, homegrown produce consumption was not considered a complete pathway for current land use conditions, but was for the future residential scenario.

Because of the relative immobility of PCBs, PCDDs, and PCDFs in soil, the large depth to groundwater at Site 5, and results of vadose zone contaminant fate and transport modeling, groundwater was not considered as a complete exposure pathway. In addition, PCB soil cleanup levels based on direct contact assumptions will generally provide sufficient protection of groundwater (EPA, 1990).

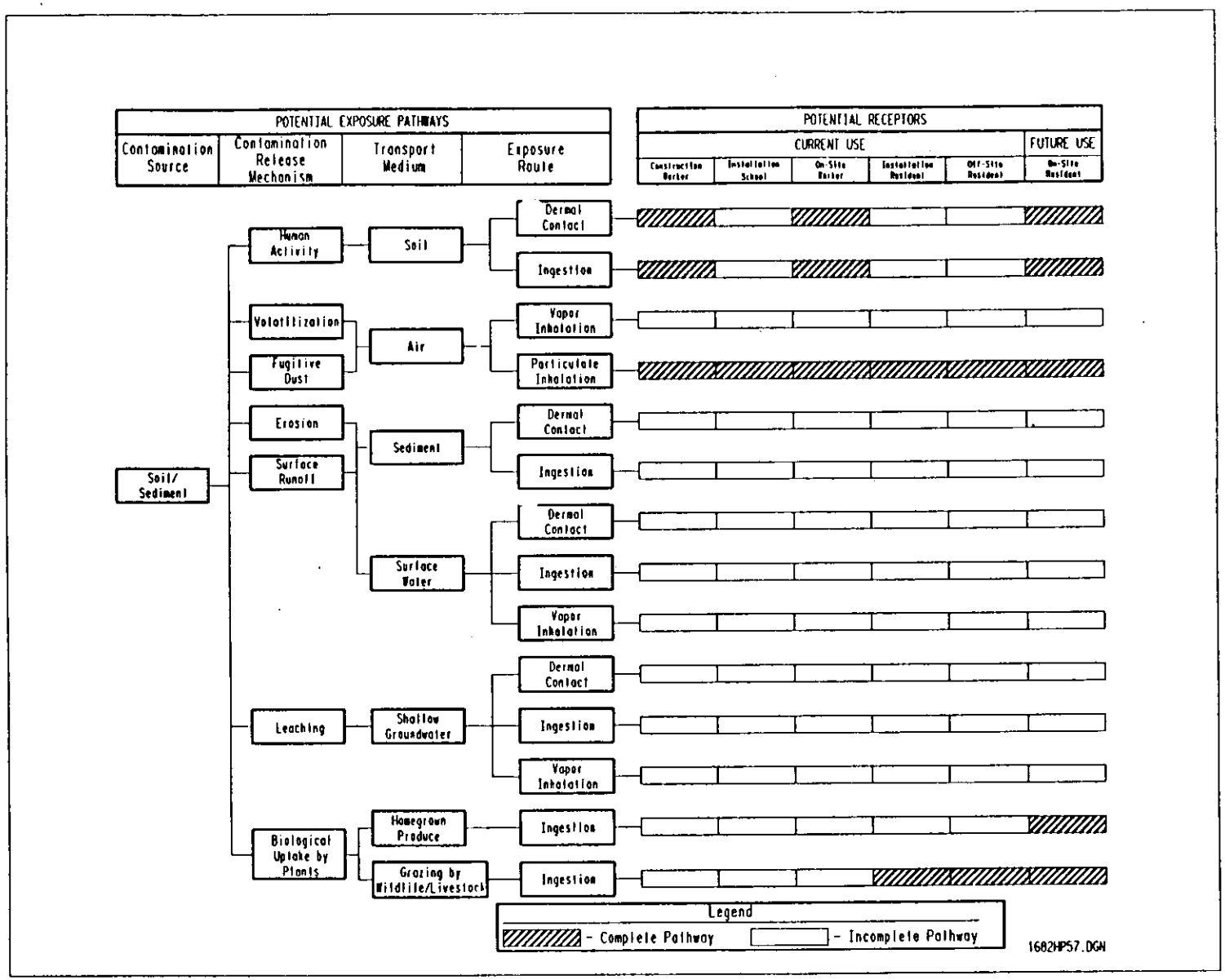


Figure 7-3. Potential Human Exposure Pathway Conceptual Model for the Pole Transformer PCB Spill Site (Site 5)

7.1.7 Baseline Risk Assessment

7.1.7.1 *Human Health Evaluation*

The purpose of the Human Health Risk Assessment is to evaluate potential human health risks associated with hazardous substance releases from sites under the assumption of no-action. This section summarizes the results of the Human Health Risk Assessment that was completed for the Pole Transformer PCB Spill Site (Site 5).

The risk assessment evaluates scenarios for both present land use and future land use conditions for carcinogenic and chronic, noncarcinogenic health effects. Since there is no construction planned at Site 5, the construction worker scenario can be considered a future case. Residential development in the area of Site 5 is uncertain at this time. However, for this risk assessment, residential land use was chosen as a conservative future exposure scenario.

For the complete exposure pathways discussed above, two exposure cases are analyzed as part of the BRA. The central tendency risk description presented in Table 7-5 is the average or arithmetic mean risk and is derived by using average exposure values for each pathway/site considered. The RME description presented in Table 7-6 is the high end risk. The RME is estimated by combining upper bound values (either the 95 percent UCL of the arithmetic mean, or the high concentration if the 95 percent UCL was greater than the highest concentration) so that the result represents an exposure scenario that is both protective and reasonable (EPA, 1991). Both Tables 7-5 and 7-6 include carcinogenic and noncarcinogenic risk estimates for all complete pathways. Chronic, noncarcinogenic risk estimates were not calculated for exposure to 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD) and equivalents (see Section 3.5.3.2). As a result, the noncarcinogenic risks calculated for this site may not be conservative. However, a reasonable approach suggests that, since the carcinogenic risks attributable to these chemicals at this site are protective of public health, noncarcinogenic risks would also be protective.

7.1.7.1.1 ***Current Land Use.*** Under current land use conditions, human receptors include the on-site worker, installation resident, installation school student/employee, and off-site resident from the nearby cities of Tooele, Stockton, and Grantsville. The on-site worker is potentially exposed through incidental ingestion of soil, dermal contact, and inhalation of fugitive dust. For the installation resident and off-site residents, inhalation of fugitive dust and contaminated beef consumption was considered complete, potential exposure pathways. Inhalation of fugitive dust was considered the only complete, potential exposure pathway for the installation school student/employee.

Table 7-5. Summary of Human Health Risk Assessment Results Using Average Exposure Levels for Site 5

	On-Site Worker		Construction Worker		Installation School		Installation Resident		Off-Site Resident Tooele		Off-Site Resident Stockton		Off-Site Resident Grantsville		Future On-Site Resident	
Analyte	RF[a]	HI[b]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
2,3,7,8-TCDD Equiv.[c]	3.24E-07		2.06E-08												1.16E-06	
PCB 1260	6.30E-08	8.18E-04	9.31E-09	1.21E-03											2.26E-07	1.18E-02
Inhalation																
2,3,7,8-TCDD Equiv.	2.94E-11		2.94E-12		3.28E-12		8.79E-12		8.99E-17		1.25E-16		6.86E-17		3.96E-11	
PCB 1260	7.12E-12	9.27E-08	7.12E-13	9.27E-08	7.97E-13	5.19E-08	2.13E-12	1.39E-07	2.18E-17	3.15E-13	3.02E-17	4.37E-13	1.67E-17	2.41E-13	9.59E-12	1.39E-07
Dermal																
2,3,7,8-TCDD Equiv.	1.41E-07		8.97E-09												1.19E-07	
PCB 1260	2.67E-08	3.52E-04	3.95E-09	5.20E-04											2.25E-08	3.29E-04
Beef Consumption																
2,3,7,8-TCDD Equiv.							3.09E-07		1.39E-06		1.39E-06		1.39E-06		1.39E-06	
PCB 1260							6.01E-08	3.90E-03	2.71E-07	3.90E-03	2.71E-07	3.90E-03	2.71E-07	3.90E-03	2.71E-07	3.90E-03
Vegetable Consumption																
2,3,7,8-TCDD Equiv.															4.08E-07	
PCB 1260															7.93E-08	1.14E-03
Fruit Consumption																
2,3,7,8-TCDD Equiv.															2.29E-07	
PCB 1260															4.44E-08	6.41E-04
Site Total	5.55E-07	1.17E-03	4.28E-08	1.73E-03	4.08E-12	5.19E-08	3.69E-07	3.90E-03	1.66E-06	3.90E-03	1.66E-06	3.90E-03	1.66E-06	3.90E-03	8.34E-06	1.78E-02

[a]Risk factor.
[b]Hazard index.
[c]Risk estimates for polychlorinated dibenzodioxins and polychlorinated dibenzofurans are calculated in terms of 2,3,7,8-TCDD based on toxicity equivalence factors (TEFs).

Table 7-6. Summary of Human Health Risk Assessment Results Using Reasonable Maximum Exposure Levels for Site 5

	On-Site Worker		Construction Worker		Installation School		Installation Resident		Off-Site Resident Tooele		Off-Site Resident Stockton		Off-Site Resident Grantsville		Future On-Site Resident	
Analyte	RF[a]	HI[b]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
2,3,7,8-TCDD Equiv.[c]	1.62E-06		1.98E-07												7.25E-06	
PCB 1260	3.15E-07	1.64E-03	8.94E-08	1.16E-02											1.41E-06	2.37E-02
Inhalation																
2,3,7,8-TCDD Equiv.	7.34E-11		4.41E-12		6.57E-12		1.04E-10		7.52E-16		1.04E-15		5.73E-16		3.30E-10	
PCB 1260	1.78E-11	9.27E-08	1.07E-12	1.40E-07	1.59E-12	5.19E-08	2.52E-11	1.12E-06	1.82E-16	2.54E-12	2.53E-16	3.52E-12	1.39E-16	1.94E-12	8.03E-11	1.12E-06
Dermal																
2,3,7,8-TCDD Equiv.	1.76E-06		4.48E-08												3.73E-06	
PCB 1260	3.34E-07	1.76E-03	1.98E-08	2.60E-03											7.05E-07	8.07E-03
Beef Consumption																
2,3,7,8-TCDD Equiv.							4.30E-06		1.37E-05		1.37E-05		1.37E-05		1.37E-05	
PCB 1260							8.37E-07	3.77E-02	2.66E-06	3.77E-02	2.66E-06	3.77E-02	2.66E-06	3.77E-02	2.66E-06	3.77E-02
Vegetable Consumption																
2,3,7,8-TCDD Equiv.															3.77E-06	
PCB 1260															7.33E-07	1.04E-02
Fruit Consumption																
2,3,7,8-TCDD Equiv.															1.98E-06	
PCB 1260															3.85E-07	5.45E-03
Site Total	4.03E-06	3.40E-03	3.52E-07	1.42E-02	8.16E-12	5.19E-08	5.14E-06	3.77E-02	1.64E-05	3.77E-02	1.64E-05	3.77E-02	1.64E-05	3.77E-02	7.68E-05	8.53E-02

[a]Risk factor.
[b]Hazard index.
[c]Risk estimates for polychlorinated dibenzodioxins and polychlorinated dibenzofurans are calculated in terms of 2,3,7,8-TCDD based on toxicity equivalence factors (TEFs).

7.1.7.1.1.1 *On-Site Worker*

The average exposure total carcinogenic risk factor for the on-site worker at Site 5 is below the EPA target range for residual risk of 1E-04 to 1E-06 with a value of 6E-07. The RME total carcinogenic risk factor is 4E-06, just within the EPA target range. The exposure pathways driving the RME risk are incidental soil ingestion and dermal contact. As previously discussed, the risk descriptors calculated for each pathway/site are derived from conservative exposure estimates. Section 3-5, Risk Assessment Methodology, describes the parameters and assumptions used for the values obtained in the numerical risk assessment.

The chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the on-site worker at Site 5 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 1E-03 and for RME is 3E-03.

7.1.7.1.1.2 *Installation School*

The total carcinogenic risk factors for the installation school student/employee calculated for average exposure and RME to inhalation of fugitive dust from Site 5 are below the EPA target range for residual risk of 1E-04 to 1E-06. The total carcinogenic risk factor for average exposure to the installation school student/employee is 4E-12 and for RME is 8E-12.

In addition, the chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the installation school student/employee potentially exposed to fugitive dust from Site 5 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for the average exposure is 5E-08 and for RME is 5E-08. A longer exposure duration was used in the exposure estimate for the installation school student/employee RME scenario.

Since the exposure duration impacts the averaging time for chronic, noncarcinogenic health effects, the hazard index calculated for the average exposure and RME cases are equal.

7.1.7.1.1.3 *Installation Resident*

The average exposure total carcinogenic risk factor for the installation resident potentially exposed to contamination from Site 5 is below the EPA target range for residual risk of 1E-04 to 1E-06 with a value of 4E-07. The RME total carcinogenic risk factor is 5E-06, just within the EPA target range. The exposure pathway driving the RME risk is consumption of homegrown beef. As previously discussed, the risk descriptors calculated for each pathway/site are derived from conservative exposure estimates. Section 3-5, Risk Assessment Methodology, describes the parameters and assumptions used for the values obtained in the numerical risk assessment.

The chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the installation resident potentially exposed to contamination from Site 5 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 4E-03 and for RME is 4E-02.

7.1.7.1.1.4 *Off-Site Residents*

Both the average exposure and RME total carcinogenic risk factors for the off-site residents potentially exposed to contamination from Site 5 are within the EPA target range for residual risk of 1E-04 to 1E-06. The total carcinogenic risk factor for average exposure to off-site residents living in Tooele, Stockton, and Grantsville is 2E-06. The total RME carcinogenic risk factor is 2E-05. Again, the exposure pathway driving the RME risk is consumption of homegrown beef. As previously discussed, the risk descriptors calculated for each pathway/site are derived from conservative exposure estimates.

The chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for off-site residents potentially exposed to contamination from Site 5 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure to off-site residents living in Tooele, Stockton, and Grantsville is 4E-03. The RME hazard index RME is 4E-02.

7.1.7.1.2 Future Land Use. The scenarios evaluated for the future land use condition include on-site construction or residential use. As previously stated, it is uncertain that TEAD-N property will be developed as a residential area; however, for this risk assessment, residential land use was chosen as a conservative scenario. Complete exposure pathways considered for the future on-site resident are incidental ingestion of soil, dermal contact, inhalation of fugitive dust, consumption of beef derived from cattle grazing at Site 5, and consumption of produce grown at Site 5. The risk descriptors estimated for this scenario are extremely conservative values. The small size of Site 5 minimizes potential contact and/or uptake of contaminants.

7.1.7.1.2.1 *Construction Worker*

Both the average exposure and RME total carcinogenic risk factors for the construction worker at Site 5 are below the EPA target range for residual risk of 1E-04 to 1E-06. The total carcinogenic risk factor for average exposure to the construction worker is 4E-08 and for RME is 4E-07.

In addition, the chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the construction worker at Site 5 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 2E-03 and for RME is 1E-02.

7.1.7.1.2.2 *Future On-Site Resident*

Both the average exposure and RME total carcinogenic risk factors for the future on-site resident at Site 5 are within the EPA target range for residual risk of 1E-04 to 1E-06. For the average exposure, the value is 8E-06 and, for the RME, it is 8E-05. For both exposure cases, all pathways, with the exception of inhalation of fugitive dust, are contributing to the

total risk. The risk descriptors calculated for each pathway/site are derived from conservative exposure estimates (see Section 3-5).

The chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the future on-site resident at Site 5 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 2E-02 and for RME is 9E-02.

7.1.7.2 *Ecological Evaluation*

The ecological risk assessment for Site 5 was qualitative and did not include tissue sampling or bioassays of the vegetation and wildlife. The predominant vegetation at this site are sagebrush and wild grasses, which is typical of the region. Human activity at this site is infrequent. Site 5 is very small (approximately 25 square feet) and the potential wildlife inhabitants are mammals, birds, and several of the raptor species. There is no indication that this area is a critical habitat for any endangered or threatened species. Species of vegetation that have been observed at Site 5 are presented in Table 7-7.

Table 7-7. Vegetation Inventory (Site 5)

Scientific Name	Common Name
PRIMARY VEGETATION SPECIES	
Stipa comata	Needle-and-thread grass
OTHER VEGETATION SPECIES	
Bromus tectorum	Cheatgrass
Sphaeralcea coccinea	Globe mallow
Stipa hymenoides	Indian ricegrass
Lactuca scariola	Prickly lettuce
Salsola pestifer	Russian thistle
Tragopogon dubius	Yellow goats beard

No surface water or evidence of surface water was observed during the field investigation. It is unlikely that any significant surface water ever accumulates on this site as the result of storm episodes or snow melt.

7.1.7.2.1 *Contaminants of Concern*. The contaminants of concern at Site 5 are PCBs, PCDDs, and PCDFs. All of these compounds are toxic and bioaccumulate to varying degrees

depending on the pathways. A summary of the relevant information for these contaminants is presented in Table 7-8, which was taken from Table 3-18.

Table 7-8. Summary of Contaminants (Site 5)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	I[a]→VL[b]	H[c]	BC[d]	2[e],3[f]	3	animal carcinogen, teratogen
2,3,7,8-Tetrachlorodibenzofurans	I→VL	H	BC	2,3	3	similar toxicity to its TCDD counterpart; teratogen
Octochlorodibenzodioxin	L	H	BC, BM[g]	2,3	3	poison by ingestion; teratogen; skin tumors; inadequate animal data
Octochlorodibenzofurans	L	H	BC, BM	2,3	3	less toxic than TCDD
(PCB)Aroclor 1260	I→VL	M	BA[h]	2	3	mod. toxic by ingestion and skin contact; teratogen, mutagen
Heptachlorodibenzo-p-dioxin	L	H	BA	2	3	less toxic than TCDD; not thought to be carcinogen or teratogen
Heptachlorodibenzofuran	L	H	BA	2	3	less toxic than TCDD
Hexachlorodibenzo-p-dioxin	L	H	BA	2	3	less toxic than TCDD
Hexachlorodibenzofuran	L	H	BA	2	3	less toxic than TCDD
Pentachlorodibenzofuran	L	H	BC, BM	3	3	less toxic than TCDD

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]I = insoluble.
[b]VL = very low.
[c]H = high.
[d]BC = bioconcentrate.
[e]2 = probable or suspected carcinogen.
[f]3 = tissue or organ damage.
[g]BM = biomagnification.
[h]BA = bioaccumulates.

Very little is known about these contaminants' behavior in a terrestrial environment, the lethal and chronic affects associated with them, or their movement up a food chain. This is mainly due to the interspecies differences in sensitivity to these compounds that exist, even between species of biota that are related taxonomically. The compound 2,3,7,8-TCDD is one of the most toxic contaminants in existence and, because of this, was chosen along with PCB Aroclor 1260 as representative contaminants of concern for the bioaccumulation model used in the ecological risk assessment for Site 5.

7.1.7.2.2 *Potential Pathways and Conceptual Food Web*. The most likely pathways of contaminants through the ecosystem are listed below and are graphically presented in Figure 7-4. Standing surface water was not considered as a means of transport at this site because of the infrequent nature of downpours and because of the well-drained topography of Site 5.

- Plants

-Direct uptake through the root systems of existing vegetation

- Wildlife

-Ingestion of contaminated soil
-Ingestion of contaminated vegetation
-Ingestion of contaminated insects/invertebrates
-Ingestion of contaminated carrion/smaller animals
-Direct dermal contact with contaminated soil
-Inhalation of contaminated vapors
-Inhalation of contaminated particulates

Table 7-9 presents a summary of exposure points, resident populations, and ecological exposure activities that may occur at Site 5. The table is listed in decreasing exposure potential.

7.1.7.2.3 *Development of the Pathway-Receptor Model*. While there are many variations of receptor pathways that exist at this site as shown in Figure 7-4, one exposure scenario was chosen that most typified what would occur at this site. The following receptor pathway was used in the bioaccumulation model:

Soil→Plants→Mammals→Raptors

While this pathway does not include invertebrates/insects, reptiles or carrion and is not considered complete, it is representative of what occurs at Site 5. This pathway illustrates the potential major route of contaminant movement from the source to the biotic receptors. For the development of this model, which is based on the observation of species as well as available data about these species in literature and research papers, the species used as representative of mammals in the proposed pathway was the jackrabbit. The red-tailed hawk was chosen as being representative of the raptor group.

7.1.7.2.4 *Risk Characterization and Conclusions*. BAFs were calculated for the key species in each level of the food chain. In calculating the food term used in the BAF equation, the average weights of the key species were needed, along with their daily food consumption, food items eaten, and the percent of these various foods in their diets. This information is presented in Table 7-10.

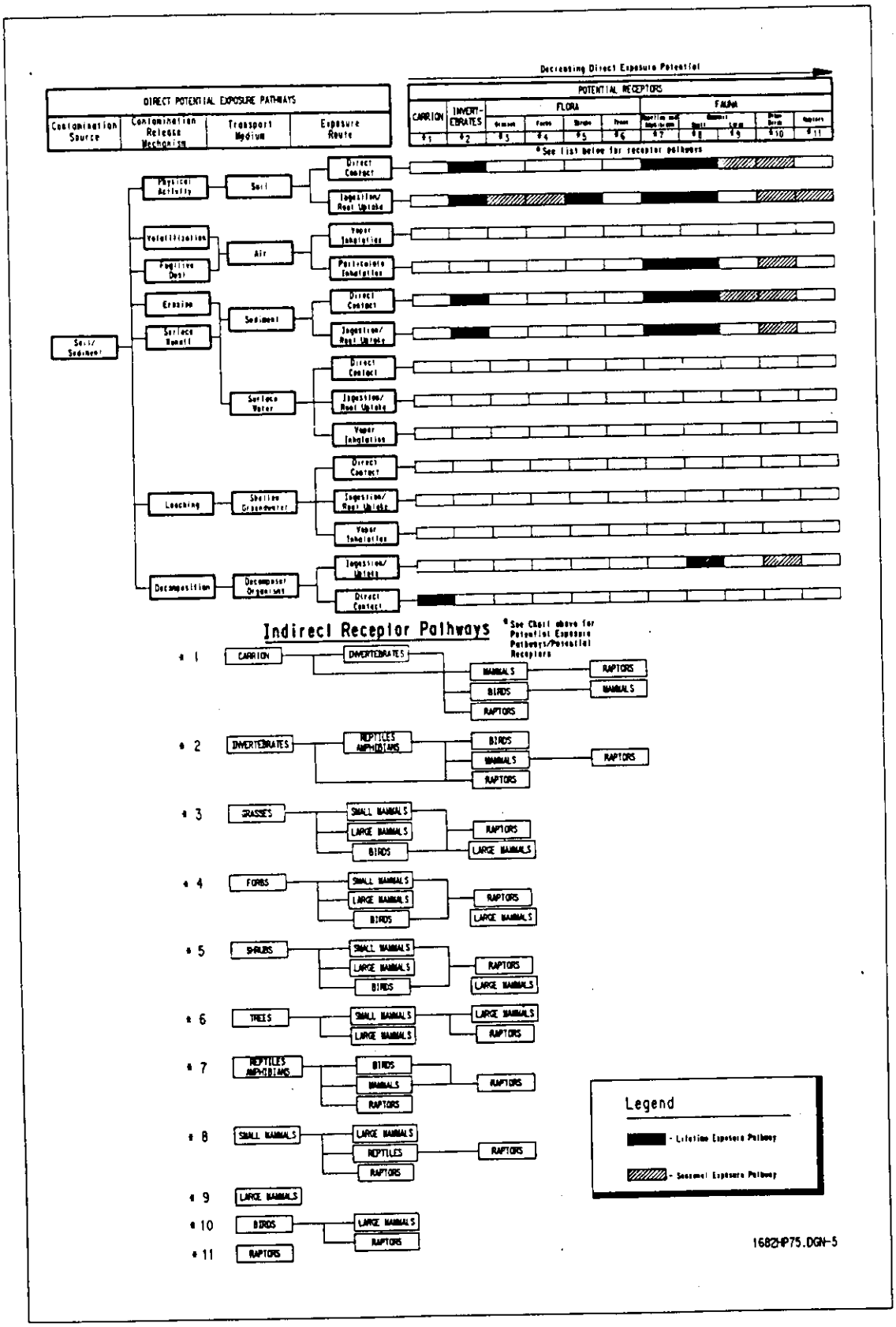


Figure 7-4. Potential Ecological Exposure Pathways for Site 5

Table 7-9. Exposure Scenarios for Ecological Populations (Site 5)

Exposure Point	Exposed Population	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Large Mammals	Ingestion of contaminated vegetation; foliage,fruit, and potentially roots.	Unlikely due to very small size of site.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Occasional exposure, only when feeding at this site, due to heavy industrial activity.
Terrestrial Locations	Raptors	Ingestion of contaminated carrion or animals.	Unlikely; exposed when feeding in other areas on prior inhabitants of the site.

Table 7-10. Food Consumption and Food Item Percentages Used to Estimate Bioaccumulation Factors

Species	Daily Food Consumption (g/kg bw/day)	Average Weight (g)	Food Items	Percent in Diet
Jackrabbit (Lepus Californicus)	282	2,000	Insects	50% (2)
			Vegetation	50% (2)
Red-tailed Hawk (Buteo Jamaicensis)	200	1,500	Snakes	5% (1)
			Birds	8% (1)
			Small Mammals	47% (1)
			Rabbits	40% (1)

Sources: (1) Craighead et al, 1969
(2) Jones et al, 1985

Through the use of the bioaccumulation model, a conservative total BMF for the red-tailed hawk was calculated to be 23. This total BMF was then used to evaluate the maximum allowable soil concentration that would potentially cause reproductive failure in the red-tailed hawk population by using the equation: C(soil) = MATC/Total BMFi (see Section 3.6.4.7 for development of the bioaccumulation model). Maximum allowable tissue concentrations (MATC) that ranged from 2.9E-03 μg/g to 6.6E-04 μg/g for TCDD, and 23.6 μg/g for the PCB compounds (U.S. Fish and Wildlife, 1986) (Anthony et al, 1993) were used to calculate the "no effects" soil concentrations (C soil) for both of these representative compounds.

Using conservative maximum acceptable tissue levels and biomagnification factors, the lowest concentration of TCDDs in the soil that would cause a reproductive failure (2.9E-05 μg/g) was above the highest detected level of TCDD contamination (1.5E-05 μg/g). This concentration (2.9E-05 μg/g) was, however, below the highest single detected concentration of another dioxin present in the soil (3.0E-04 μg/g octachlorodibenzodioxin at location PS-92-04) and was also below the 95 percent confidence level of that group of samples (2.5E-04 μg/g). Because it has more chlorine atoms, octachlorodibenzodioxin does not behave exactly the same as 2,3,7,8-TCDD (the representative contaminant of concern used in the model) and is considered much less toxic.

If the average MATC and BMF values are used rather than conservative values, then the C soil is calculated to be 4.1E-04. This concentration where reproductive failure could occur is above the highest single detection of any PCDDs or PCDFs.

The lowest concentration of PCBs in the soil that would cause reproductive failure at this site (1.6 μg/g) was also above the highest detected level of PCB contamination (0.117 μg/g).

Because the PCDD, PCDF, and PCB concentrations in the soil were near or below benchmark value for reproductive failure and because this particular site is extremely small (approximately 25 square feet), the overall risk to ecological receptors on this site, and to the TEAD-N ecosystem as a whole, appears to be minimal. Alterations to the trophic structure and ecological processes at Site 5 or to the TEAD-N facility due to existing contaminants at Site 5 are unlikely.

7.1.8 Conclusions

Analytical results of soil samples collected during the current RI indicate that residual concentrations of PCBs, PCDDS, and PCDFs are present at Site 5. However, because of the low contaminant concentrations detected and the extremely small area of Site 5, the threat to public health and the environment is small. Carcinogenic risk factors for Site 5 are within or below the EPA target range for residual risk of 1E-04 to 1E-06. In addition, the chronic, noncarcinogenic hazard indices for Site 5 were below the EPA goal of 1 or less. Overall, the methodology used for this risk assessment is health protective, which means that the true risks from the site are unlikely to be higher than the derived estimates, and are most likely lower.

7.1.9 Recommendations

It is recommended that no further remedial investigation of this site be performed and that a feasibility study should be conducted.

8.0 OPERABLE UNIT 8

8.1 OLD BURN AREA (SITE 6)

8.1.1 Site Characteristics

The Old Burn Area (Figure 1-10) is a gently sloping area that was used until the 1970s for the testing of hydrocarbon-filled smoke munitions, fuses, and propellants. It was also used for the widespread burning of wooden boxes and crates on the surface and in trenches. Numerous trenches were present according to EPIC photographs from the 1950s, but the trenches have all been filled and the area has been graded and revegetated. Geophysical surveys by Weston (1990) and Rust E&I (1992) detected several areas of buried metal wastes. A revetment area in the eastern portion of the area contained several buried trenches, which showed the greatest amount of buried metal waste in the area, according to the geophysical surveys.

8.1.2 Previous Investigations and RI Activities

Previous investigations at the site (Weston, 1990) include geophysical surveys, designed to identify buried trenches, and a limited number of soil borings near, but not in, the trenches identified by the geophysical surveys (Figure 8-1). Samples from these borings were analyzed for explosives, metals, and anions. Results of the sampling and analysis indicated possible metals contamination of site soils (Table 8-1). No explosives were detected, and the only anion present above reporting limits was fluoride. No data were collected within the trenches because of safety concerns.

Rust E&I completed geophysical surveys across the entire Old Burn Area as defined by a review of disturbed areas and trenches on EPIC photographs. Results of these surveys are presented in Appendix B. Figure 8-2 is a summary map showing the identified buried targets from the previous and current RI geophysical surveys.

Test pits were dug and sampled within three of the trenches identified from the geophysical survey during the RI (Figure 8-3); the samples were analyzed for explosives, VOCs, semi-VOCs, inorganics, and anions. During the excavation of these test pits, a variety of buried materials were uncovered, ranging from steel banding to possible UXO. Test-pit logs generated during each test-pit excavation are presented in Appendix C. Photographs of two of the test pits during excavation are shown in Appendix D. In addition to trenches identified by the geophysical survey, a fourth test pit was excavated on the basis of surface debris observed by field personnel at the time of geophysical surveying. There was no corresponding geophysical anomaly at this location. Two observation pits were also dug to determine the source of two small geophysical anomalies in an area not previously identified as a disturbed area from aerial photographs.

Additional samples were collected from drainage gullies that drain the Old Burn Area to the north. On the basis of a site visit in October of 1991, five gully samples were selected for sampling and analysis. The gully samples were also analyzed for explosives, VOCs, semi-

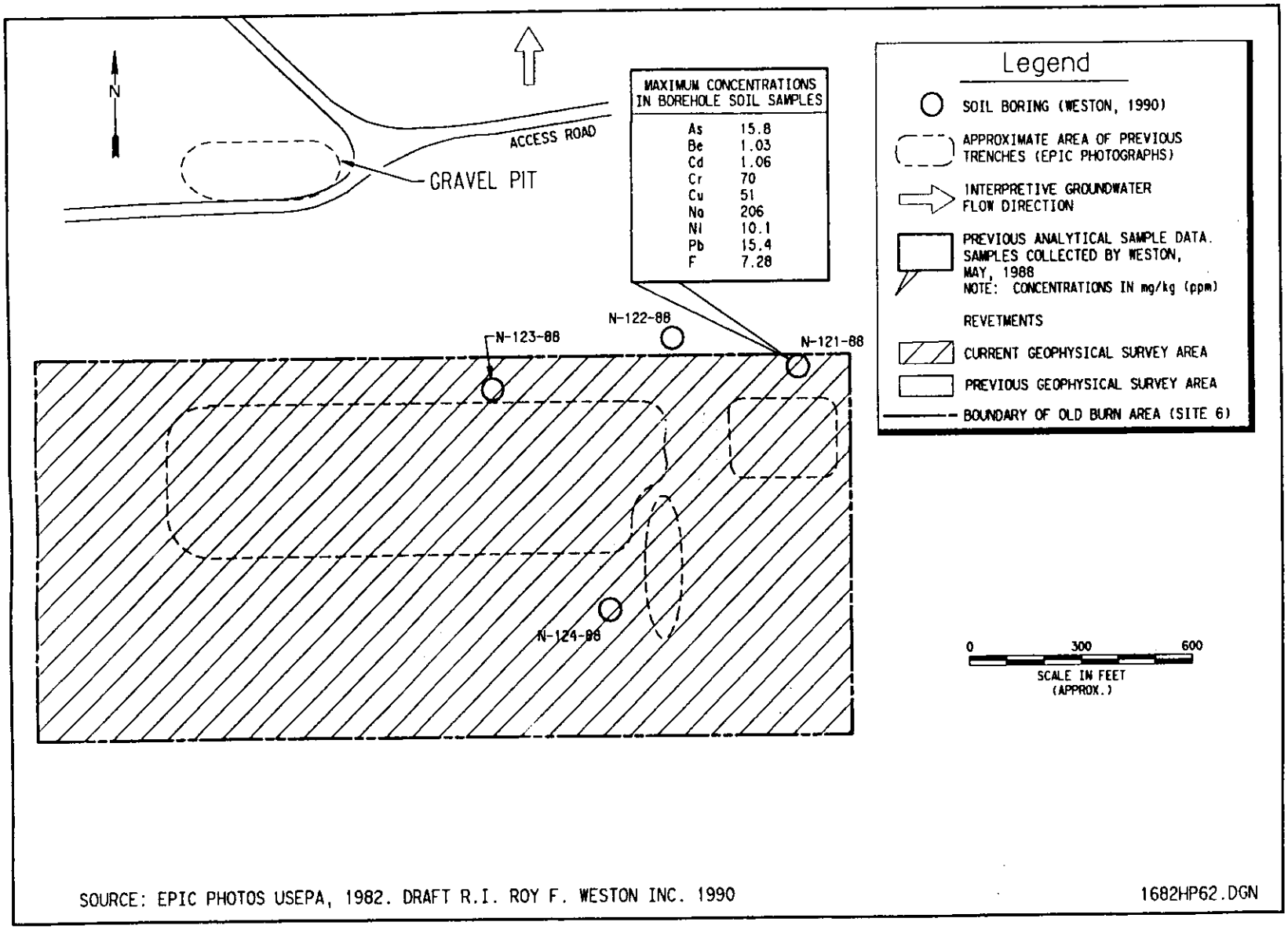


Figure 8-1. Previous Investigation Results for the Old Burn Area (Site 6)

Table 8-1. Analyses of Previous Investigation Borehole Samples From the Old Burn Area

	Borehole N-121-88								Borehole N-122-88							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Depth (ft)	**4.5**	**9.5**	**14.5**	**19.5**	**24.5**	**29.5**	**39.5**	**49.5**	**4.5**	**9.5**	**14.5**	**19.5**	**24.5**	**29.5**	**39.5**	**49.5**
Analyte (μg/g)																
Metals																
Arsenic	10.9		15.8	10.7												
Beryllium	0.47		1.03	0.79												0.337
Cadmium				1.06												
Chromium	45.9	5.43	70	62	6.87	5.96	7.47	10.6	11.5	11	13.6	6	10.1	9.64	8.35	15.1
Copper	33.8	6.5	41.7	51	4.75			6.57	6.93	10.1	8.3				6.72	8.36
Sodium	96.3	68.5	45.4	97.5	187	213	431	206	102	56.8	97.6	127	394	138	627	78.4
Nickel		7.52	6.52	5.25				10.1	14.9	7.4	15.6			5.7	8.06	12.7
Lead	10.6		12.9	15.4												
Zinc																69.2
Anions																
Fluoride	6.18	7.28														
	Borehole N-123-88								**Borehole N-124-88**							
Metals																
Beryllium								0.419								0.787
Cadmium									2.36							
Chromium					6.03	4.33	6.45	13.5			5.1	5.22		7.97	8.31	53.6
Copper					6.38		6.88	8.83					5.22	6.92	4.89	25.7
Sodium	97	79.7	96.1	80	163	66.2	606	97.9	65.9	62.3	95.3	148	160	95.4	518	109
Nickel		8.18		44.5			10.5	13.5					7.03	23	6.81	64
Lead				10.1												
Zinc																69.2

Note.—Samples were analyzed for explosives, metals, and anions. Table only includes values above the reporting limit. Source: Weston, 1990

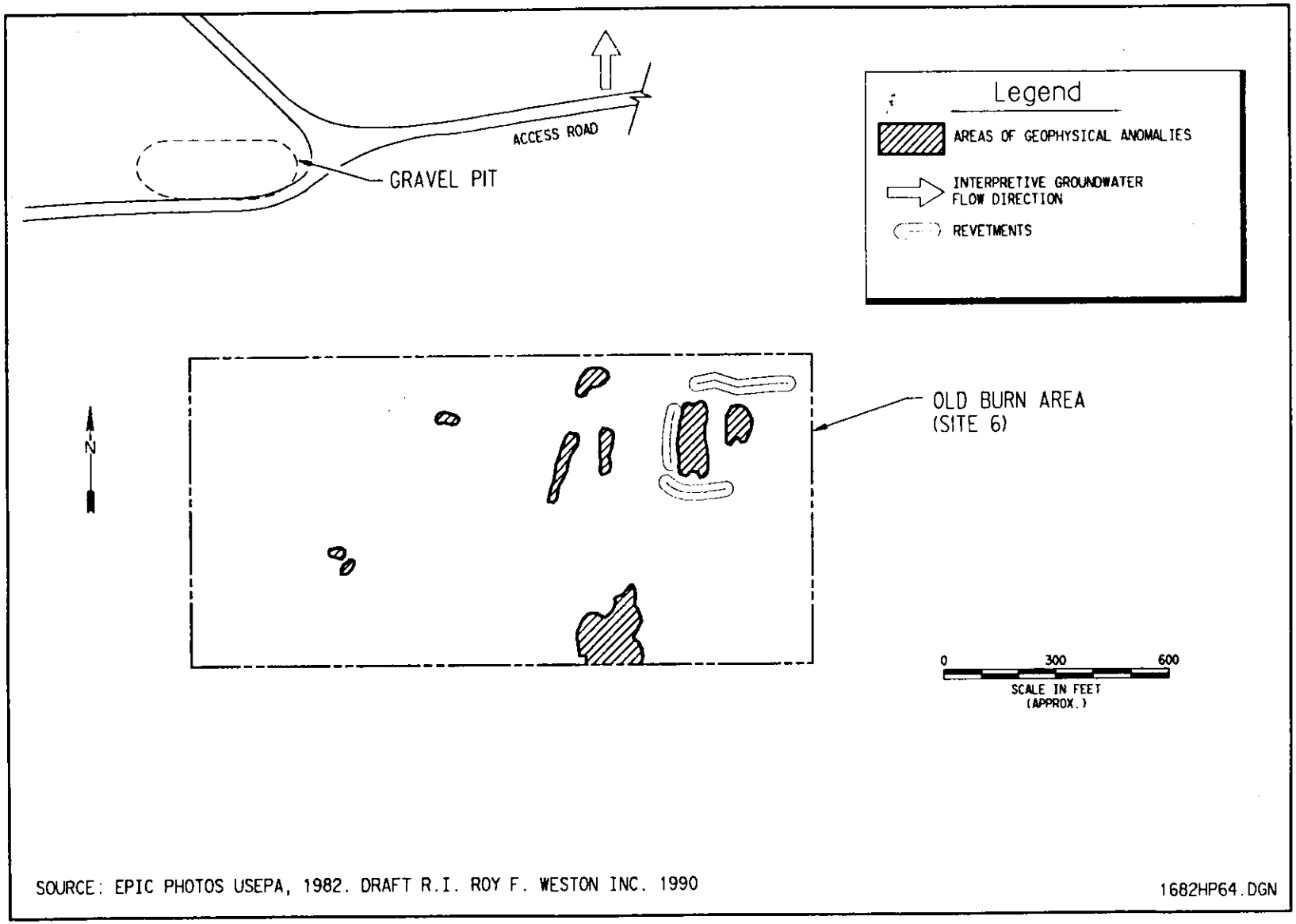


Figure 8-2. Summary of RI Geophysical Survey Target Areas

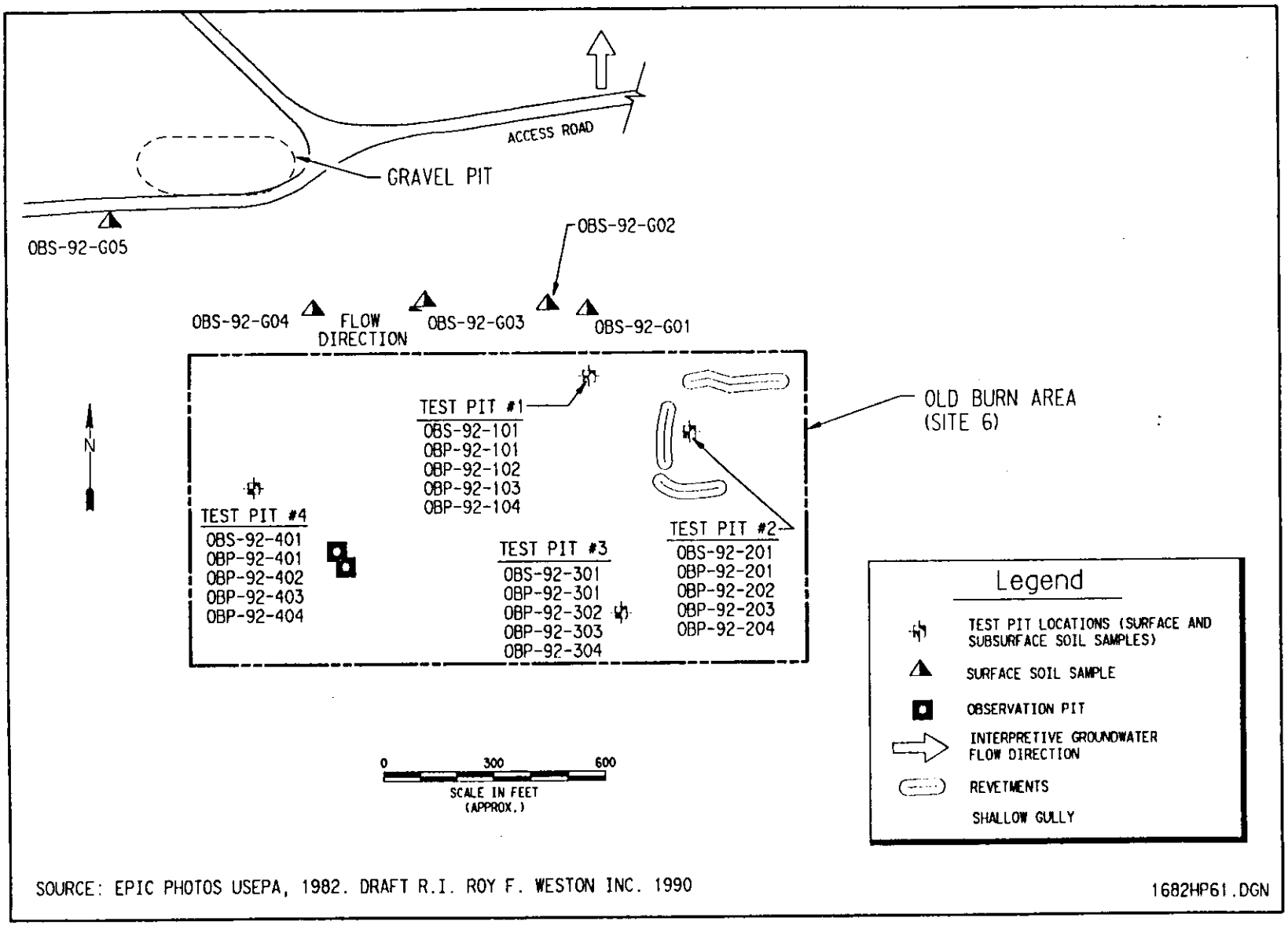


Figure 8-3. RI Sample Location Map for the Old Burn Area

VOCs, inorganics, and anions. These locations are shown on Figure 8-3. Table 8-2 provides a summary of the sample program at Site 6.

8.1.3 Nature and Extent of Contamination

Test Pit 1 (Figure 8-4) was found to contain elevated concentrations of phosphate, copper, and mercury in the surface sample (OBS-92-101, Table 8-3). Phosphate and metals, including chromium, copper, iron, mercury, lead, and zinc, were found in concentrations exceeding background in the sample (OBP-92-101) collected at 5.0 feet. Mercury was the only analyte detected above background concentrations in a second sample (OBP-92-102) also collected at a depth of 5 feet. A sample (OBP-92-103) collected at a depth of 4 feet contained chromium, mercury, lead, and zinc above background levels. The last sample (OBP-92-104), collected at a depth of 10 feet, only contained low levels of mercury. On the basis of the data for Test Pit 1, it appears that metals contamination has not migrated below the bottom of the previous trench. The horizontal extent of contamination is unknown, but could be estimated on the basis of the geophysical anomaly that corresponds to the extent of buried metal debris in the former trench.

Test Pit 2 (see Figure 8-4) contained elevated concentrations of cadmium, chromium, copper, iron, lead, silver, and zinc in the surface sample collected at the test pit location (Table 8-3). Subsurface soil from the test pit contained elevated concentrations of barium, copper, lead, mercury, silver, and zinc at a depth of 2 feet; whereas, the samples collected at depths of 5 feet and 7.5 feet contained elevated concentrations of silver, arsenic, barium, chromium, copper, iron, nickel, lead, and zinc. Also present at the 5-foot depth was slightly elevated sulfate. At a depth of 12 feet, only chromium and iron were detected above background concentrations. It appears that no significant vertical migration of metal contaminants has occurred below the level of the former trench. The horizontal extent of contamination is unknown, but can be estimated on the basis of the geophysical survey which delineates the area containing buried metal debris.

Unlike Test Pits 1 and 2, Test Pit 3 (see Figure 8-4) contained elevated concentrations of 1,3,5-trinitrobenzene and 2,4,6-trinitrotoluene at depths of 1 foot and 5 feet. No metals above background concentrations were detected in the surface or the subsurface samples. Anions detected were at depths of 5, 7.5, and 10 feet and included chlorine, phosphate, and sulfate.

Test Pit 4, which was located in a disturbed area that was identified visually rather than by geophysical methods, contained low concentrations of 2,4-dinitrotoluene in the samples collected from the surface, 2.5 feet, and 7.5 feet. The surface soil sample and the sample from 2.5 feet also contained low concentrations of N-nitrosodiphenylamine. None of the contamination detected appears to be widespread or in significant concentrations. No determination of contaminant extent could be made on the basis of the data for this test pit. Butyl benzyl phthalate and di-N-butyl phthalate were also reported, but are suspected laboratory contaminants.

Table 8-2. RI Sampling and Analysis Program for the Old Burn Area (Site 6)

Site Identifier*	Media	Sample Depth (ft)	Analytical Parameters***
Gully Samples			
OBS-92-G01	Soil	0.0**	E, SV, I, A
OBS-92-G02	Soil	0.0	E, SV, I, A
OBS-92-G03	Soil	0.0	E, SV, I, A
OBS-92-G04	Soil	0.0	E, SV, I, A
OBS-92-G05	Soil	0.0	E, SV, I, A
Test Pit #1			
OBS-92-101	Soil	0.0	E, SV, I, A
OBP-92-101	Soil	5.0	E, V, SV, I, A
OBP-92-102	Soil	5.0	E, SV, I, A
OBP-92-103	Soil	4.0	E, SV, I, A
OBP-92-104	Soil	10.0	E, SV, I, A
Test Pit #2			
OBS-92-201	Soil	0.0	E, SV, I, A
OBP-92-201	Soil	2.0	E, V, SV, I, A
OBP-92-202	Soil	5.0	E, SV, I, A
OBP-92-203	Soil	7.5	E, SV, I, A
OBP-92-204	Soil	12.0	E, SV, I, A
Test Pit #3			
OBS-92-301	Soil	0.0	E, SV, I, A
OBP-92-301	Soil	1.0	E, V, SV, I, A
OBP-92-302	Soil	5.0	E, SV, I, A
OBP-92-303	Soil	7.5	E, SV, I, A
OBP-92-304	Soil	10.0	E, SV, I, A
Test Pit #4			
OBS-92-401	Soil	0.0	E, SV, I, A
OBP-92-401	Soil	2.5	E, V, SV, I, A
OBP-92-402	Soil	5.0	E, SV, I, A
OBP-92-403	Soil	7.5	E, SV, I, A
OPB-92-404	Soil	9.0	E, SV, I, A

*See Figure 8-4 for locations.
**Surface samples were collected at depths from 0 to 6 inches.
***E=explosives, V=VOCs, SV=semi-VOCs, I=inorganics, A=anions.

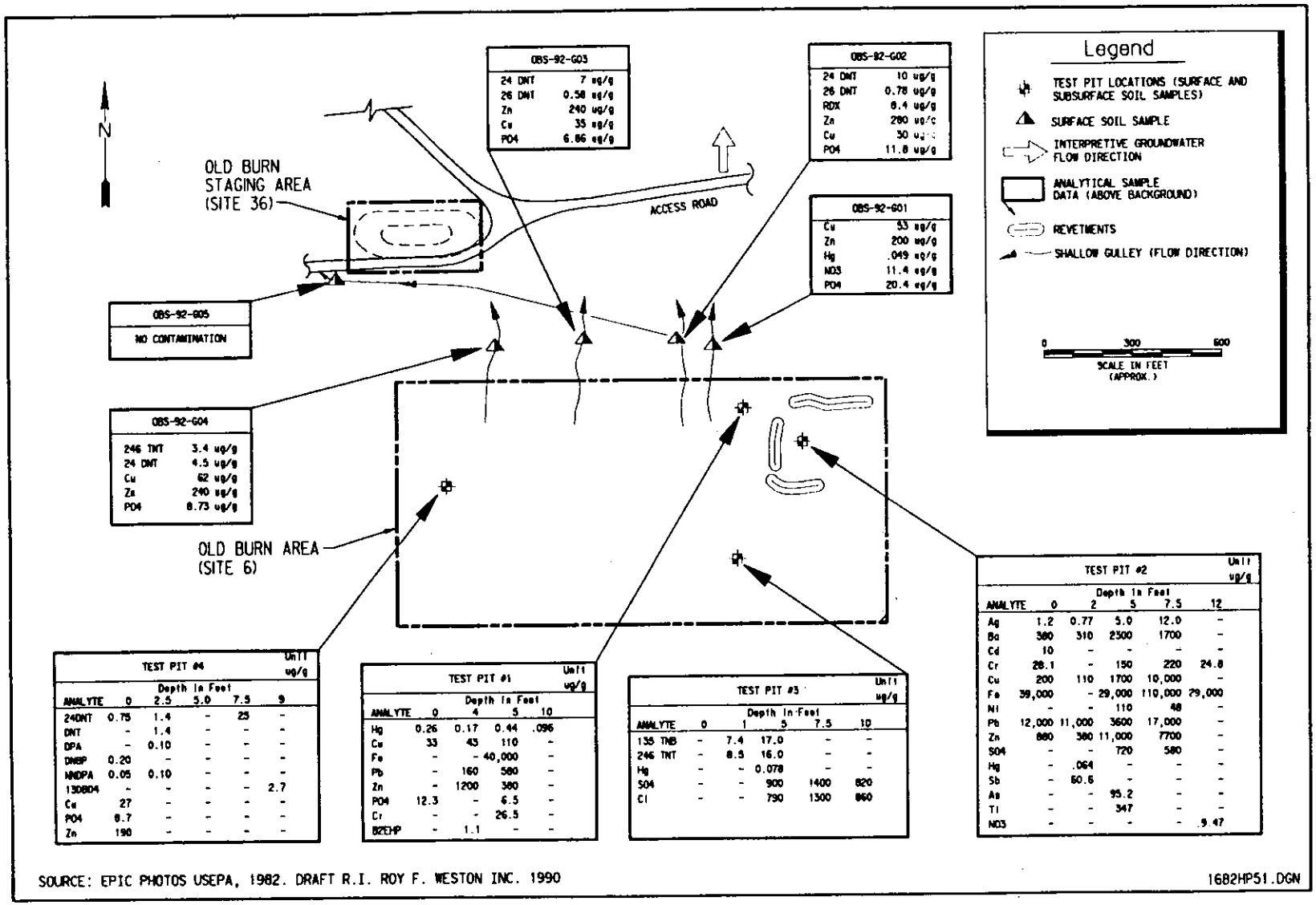


Figure 8-4. RI Sampling and Analysis Results for the Old Burn Area (Site 6)

Table 8-3. Summary of Analytes Above Background Concentrations for the Old Burn Area (Site 6)

Analytes	OBS-92-G01 (Gulley)*	OBS-92-G02 (Gulley)*	OBS-92-G03 (Gulley)*	OBS-92-G04 (Gulley)*	OBS-92-G05 (Gulley)*	Background Concentrations
			Concentrations in µg/g			
VOCs	ND	ND	ND	ND	ND	
SVOC						
Bis(2-ethylhexyl)phthalate	LT	LT	LT	LT	LT	---
Butylbenzyl phthalate	.180	ND	.290	.190	.310	---
Di-N-butyl phthalate	ND	ND	ND	ND	ND	---
N-Nitroso diphenylamine	ND	ND	ND	ND	ND	---
Anions						
Chloride	LT	LT	LT	LT	LT	336
Nitrate	11.4	< BKGD	< BKGD	< BKGD	< BKGD	9.45
Phosphate	20.4	11.8	6.86	8.73	< BKGD	5.00
Sulfate	< BKGD	LT	LT	< BKGD	LT	466
Explosives						
1,3,5-Trinitrobenzene	LT	LT	LT	LT	LT	---
2,4,6-Trinitrotoluene	LT	LT	LT	3.40	LT	---
2,4-Dinitrotoluene	LT	10.0	7.00	4.50	LT	---
2,6-Dinitrotoluene	LT	.780	.580	LT	LT	---
RDX	LT	8.36	LT	LT	LT	---
Inorganics						
Arsenic	LT	LT	LT	LT	LT	76.0
Barium	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	277
Cadmium	LT	LT	LT	LT	LT	.847
Chromium	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	22.8
Copper	53.0	30.0	35.0	62.0	< BKGD	28.2
Iron	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	25400
Lead	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	63.4
Mercury	.049	LT	LT	< BKGD	LT	.037
Nickel	LT	LT	LT	LT	LT	19.3
Silver	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	.749
Zinc	200	280	< BKGD	240	< BKGD	169

Notes.— ND = Analyte not detected in sample. LT = Analyte is less than certified reporting limit. --- = It is assumed that organics are not present in background soil. < BKGD = Analyte is less than background concentrations. *Samples were taken from 0 to 6 inches.

Table 8-3. Summary of Analytes Above Background Concentrations for the Old Burn Area (Site 6) (continued)

Analytes	OBS-92-101*	OBP-92-101 (5 ft)	OBP-92-102 (5 ft)	OBP-92-103 (4 ft)	OBP-92-104 (10 ft)	Background Concentrations
			Concentrations in µg/g			
VOCs	NA	ND	NA	NA	NA	---
SVOCs						
Bis(2-ethylhexyl)phthalate	LT	LT	LT	1.10	LT	---
Butylbenzyl phthalate	ND	ND	ND	ND	ND	---
Di-N-butyl phthalate	ND	ND	ND	ND	ND	---
N-Nitroso diphenylamine	ND	ND	ND	ND	ND	---
Anions						
Chloride	LT	LT	LT	LT	LT	336
Nitrate	<BKGD	LT	LT	<BKGD	LT	9.45
Phosphate	12.3	6.48	ND	ND	ND	5.00
Sulfate	LT	LT	<BKGD	<BKGD	LT	466
Explosives						
1,3,5-Trinitrobenzene	LT	LT	LT	LT	LT	---
2,4,6-Trinitrotoluene	LT	LT	LT	LT	LT	---
2,4-Dinitrotoluene	LT	LT	LT	LT	LT	---
2,6-Dinitrotoluene	LT	LT	LT	LT	LT	---
RDX	LT	LT	LT	LT	LT	---
Inorganics						
Arsenic	LT	LT	LT	LT	LT	76.0
Barium	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	277
Cadmium	LT	LT	LT	LT	LT	.847
Chromium	<BKGD	26.5	<BKGD	<BKGD	<BKGD	22.8
Copper	33.0	110	<BKGD	43.0	<BKGD	28.2
Iron	<BKGD	40000	<BKGD	<BKGD	<BKGD	25400
Lead	<BKGD	580	<BKGD	160	<BKGD	63.4
Mercury	.250	.443	.054	.168	.096	.037
Nickel	LT	<BKGD	LT	LT	LT	19.3
Silver	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	.749
Zinc	<BKGD	380	<BKGD	1200	<BKGD	169

Notes.— ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations. NA=Not analyzed for sample. *Samples were taken from 0 to 6 inches.

Table 8-3. Summary of Analytes Above Background Concentrations for the Old Burn Area (Site 6) (continued)

Analytes	OBS-92-201*	OBP-92-201 (2 ft)	OBP-92-202 (5 ft)	OBP-92-203 (7.5 ft)	OBP-92-204 (12 ft)	Background Concentrations
			Concentrations in µg/g			
VOCs	NA	ND	NA	NA	NA	---
SVOCs						
Bis(2-ethylhexyl)phthalate	LT	LT	LT	LT	LT	---
Butylbenzyl phthalate	ND	ND	ND	ND	ND	---
Di-N-butyl phthalate	ND	ND	ND	ND	ND	---
N-Nitroso diphenylamine	ND	ND	ND	ND	ND	---
Anions						
Chloride	LT	LT	<BKGD	<BKGD	LT	336
Nitrate	LT	LT	LT	LT	9.47	9.45
Phosphate	LT	LT	LT	LT	LT	5.00
Sulfate	<BKGD	<BKGD	720	580	<BKGD	466
Explosives						
1,3,5-Trinitrobenzene	LT	LT	LT	LT	LT	---
2,4,6-Trinitrotoluene	LT	LT	LT	LT	LT	---
2,4-Dinitrotoluene	LT	LT	LT	LT	LT	---
2,6-Dinitrotoluene	LT	LT	LT	LT	LT	---
RDX	LT	LT	LT	LT	LT	---
Inorganics						
Arsenic	LT	LT	95.2	LT	LT	76.0
Barium	<BKGD	310	2300	1700	<BKGD	277
Cadmium	10.0	LT	LT	LT	LT	.847
Chromium	28.1	<BKGD	150	220	24.8	22.8
Copper	200	110	1700	10000	<BKGD	28.2
Iron	39000	<BKGD	29000	110000	29000	25400
Lead	12000	11000	3600	17000	<BKGD	63.4
Mercury	LT	.064	LT	LT	LT	.037
Nickel	<BKGD	LT	110	48.0	LT	19.3
Silver	1.20	.770	5.00	12.0	<BKGD	.749
Zinc	880	380	11000	7700	<BKGD	169

Notes.– ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations. NA=Not analyzed for sample. *Samples were taken from 0 to 6 inches.

Table 8-3. Summary of Analytes Above Background Concentrations for the Old Burn Area (Site 6) (continued)

Analytes	OBS-92-301*	OBP-92-301 (1 ft)	OBP-92-302 (5 ft)	OBP-92-303 (7.5)	OBP-92-304 (10 ft)	Background Concentrations
	Concentrations in µg/g					
VOCs	NA	ND	NA	NA	NA	---
SVOCs						
Bis(2-ethylhexyl)phthalate	LT	LT	LT	LT	LT	---
Butylbenzyl phthalate	.283	ND	ND	ND	ND	---
Di-N-butyl phthalate	ND	ND	ND	ND	ND	---
N-Nitroso diphenylamine	ND	ND	ND	ND	ND	---
Anions						
Chloride	LT	LT	790	1300	860	336
Nitrate	LT	< BKGD	< BKGD	LT	< BKGD	9.45
Phosphate	ND	ND	< BKGD	< BKGD	ND	5.00
Sulfate	LT	< BKGD	900	1400	820	466
Explosives						
1,3,5-Trinitrobenzene	LT	7.40	17.0	LT	LT	---
2,4,6-Trinitrotoluene	LT	8.52	16.0	LT	LT	---
2,4-Dinitrotoluene	LT	LT	LT	LT	LT	---
2,6-Dinitrotoluene	LT	LT	LT	LT	LT	---
RDX	LT	LT	LT	LT	LT	---
Inorganics						
Arsenic	LT	LT	LT	LT	LT	76.0
Barium	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	277
Cadmium	LT	LT	LT	LT	LT	.847
Chromium	< BKGD	< BKGD	< BKGD	LT	LT	22.8
Copper	< BKGD	< BKGD	< BKGD	LT	< BKGD	28.2
Iron	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	25400
Lead	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	63.4
Mercury	LT	LT	LT	LT	LT	.037
Nickel	LT	LT	LT	LT	LT	19.3
Silver	< BKGD	< BKGD	< BKGD	LT	LT	.749
Zinc	< BKGD	< BKGD	< BKGD	LT	LT	169

Notes.— ND = Analyte not detected in sample. LT = Analyte is less than certified reporting limit. --- = It is assumed that organics are not present in background soil. < BKGD = Analyte is less than background concentrations. NA = Not analyzed for sample. *Samples were taken from 0 to 6 inches.

Table 8-3. Summary of Analytes Above Background Concentrations for the Old Burn Area (Site 6) (continued)

Analytes	OBS-92-401*	OBP-92-401 (2.5 ft)	OBP-92-402 (5 ft)	OBP-92-403 (7.5 ft)	OBP-92-404 (9ft)	Background Concentrations
			Concentrations in µg/g			
VOCs	NA	ND	NA	NA	NA	---
SVOCs						
Bis(2-ethylhexyl)phthalate	LT	LT	LT	LT	LT	---
Butylbenzyl phthalate	.370	.190	ND	.071	.170	---
Di-N-butyl phthalate	.210	ND	ND	ND	ND	---
N-Nitroso diphenylamine	.051	.101	ND	ND	ND	---
Anions						
Chloride	LT	LT	LT	LT	LT	336
Nitrate	<BKGD	LT	<BKGD	LT	LT	9.45
Phosphate	8.74	ND	ND	ND	ND	5.00
Sulfate	LT	LT	LT	LT	LT	466
Explosives						
1,3,5-Trinitrobenzene	LT	LT	LT	LT	LT	---
2,4,6-Trinitrotoluene	LT	LT	LT	LT	LT	---
2,4-Dinitrotoluene	.752	1.40	LT	25.0	LT	---
2,6-Dinitrotoluene	LT	LT	LT	LT	LT	---
RDX	LT	LT	LT	LT	LT	---
Inorganics						
Arsenic	LT	LT	LT	LT	LT	76.0
Barium	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	277
Cadmium	LT	LT	LT	LT	LT	.847
Chromium	<BKGD	<BKGD	<BKGD	<BKGD	LT	22.8
Copper	27.0	<BKGD	<BKGD	<BKGD	<BKGD	28.2
Iron	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	25400
Lead	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	63.4
Mercury	<BKGD	LT	LT	<BKGD	LT	.037
Nickel	LT	LT	LT	LT	LT	19.3
Silver	<BKGD	<BKGD	<BKGD	LT	LT	.749
Zinc	190	<BKGD	<BKGD	<BKGD	<BKGD	169

Notes.– ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations. NA=Not analyzed for sample. *Samples were taken from 0 to 6 inches.

Five shallow drainage (gulley) areas at the Old Burn Area were sampled. The first drainage located northeast of the revetment area (sample OBS-92-G01 in Figure 8-4) contained elevated concentrations of copper, mercury, and zinc (Table 8-3). Nitrate and phosphate were also detected in above background concentrations.

The second drainage sample (sample OBS-92-G02 in Figure 8-4) is located at the head of a manmade drainage ditch. The explosive contaminants 2,4-dinitrotoluene, 2,6-dinitrotoluene, and RDX were detected at this location. Metals and anions were at or below background concentrations with the exception of phosphate, copper, and zinc.

The third drainage sample, which drains the central portion of the Old Burn Area, was collected at a point just above the location where the drainage is intercepted by the manmade drainage ditch (sample OBS-92-G03 in Figure 8-4). At this location, 2,4-dinitrotoluene and 2,6-dinitrotoluene were also present. As with the second location, the only anions and metals exceeding background were phosphate, copper, and zinc, respectively.

The fourth drainage sample (OBS-92-G04) was collected in the northwestern portion of Site 6 at a point above the manmade drainage ditch designed to intercept runoff from the drainages. The explosives 2,4,6-trinitrotoluene and 2,4-trinitrotoluene were again present. Also present in concentrations exceeding background were phosphate, copper, and zinc.

The fifth drainage sample (OBS-92-G05) was collected in the bottom of the manmade drainage ditch near the point where it crosses the road via a metal culvert. Because the smaller drainages empty into this ditch, the discharge point from the Old Burn Area should provide an indication of contaminants migrating off-site via the surface-water pathway. However, no contaminants of concern were identified in this sample. No explosives were detected, and metals were at or below background levels.

In summary, the identified trench area and the drainage areas appear to be contaminated by a variety of metals and low concentrations of explosives. The trenches were identified by the geophysical survey because of the abundance of buried metal debris in the area. Although metals contamination appears to be widespread in the trench areas, the horizontal extent has not been determined. On the basis of the subsurface data, it appears that significant vertical migration of the metal contaminants has not occurred. The presence of widespread explosives contamination on the surface may be related to the surface-burning activities at the site or caused by munitions-testing activities that may have occurred at the site. The extent of explosives contamination has not been determined. There do not appear to be any areas of VOC contamination (determined by scanning soils with a PID). Semi-VOC contamination appears to be related to laboratory contamination rather than contamination of site soils, and no areas appear to be contaminated by PAHs. However, the full extent of contamination has not been determined. To better characterize the site, 10 additional test pits are scheduled to be excavated and sampled. In addition, a comprehensive surface soil sampling program is scheduled. All soil samples will be analyzed for explosives and metals. Results from these analyses will be used to re-calculate and assess risks to human health and the environment. These results will be analyzed and reported in an RI Report Addendum and future FS.

8.1.4 Contaminants of Concern

Tables 8-4 and 8-5 presents contaminants of concern for surface soils and combined surface and subsurface soils, respectively, identified from the test pit and drainage sampling conducted at Site 6. These contaminants are primarily metals, explosives, and anions.

8.1.5 Contaminant Fate and Transport

On the basis of vadose zone modeling, it appears that migration of metals to the groundwater table from Site 6 is unlikely (see Section 3.4.3). This takes into account the general low solubility and mobility of the metals of concern, the depth to groundwater (>300 feet), low amounts of annual precipitation, and the neutral to slightly basic pH of the soils. Metals were detected in high concentrations in the former trench areas and were also present in above-background concentrations in the gully drainages on the site. Barium, chromium, copper, iron, lead, silver, and zinc were at above background concentrations in nearly all samples collected. Mercury was present in nearly half of the surface and subsurface samples. The sample collected at the exit point of the ditch, which intersects the gully drainages and directs surface water runoff to the north of the site, did not contain any metals above background concentrations. This indicates that off-site migration of metal contaminants via the surface-water pathway has been minimal at Site 6.

Explosives were present both in the former trench areas and at the surface over much of the area, as evidenced by the presence of explosives in most of the drainages that were sampled. Although not present at the exit point, it appears that the off-site migration of explosives contamination may occur via the surface-water pathway. The surface contaminants may also provide particulates to the air pathway at this site. On the basis of the test-pit data, it does not appear that vertical migration of explosives contamination has occurred. The results of vadose zone modeling for contaminants indicates that it would take over 100 years for the contaminants to migrate to the water table and, at that time, the concentrations would be orders of magnitude lower than current levels in soils (Section 3.4.3).

8.1.6 Potential Exposure Pathways

The exposure pathways most likely affected by the contaminants of concern at Site 6 are presented in Figure 8-5. On-site workers and fauna may be exposed via dermal contact, ingestion, or inhalation (fugitive dust). The greatest potential for exposure would be through any subsurface construction or cleanup activities because the greatest concentrations of contaminants are found in subsurface soils related to former trenches. Grazing of livestock in the Site 6 area could result in bioaccumulation of contaminants by ingestion, followed by human ingestion of the meat from the livestock. Off-site exposure may occur as a result of inhalation of particulates from fugitive dust emissions. There are no water-supply wells downgradient of Site 6, and, as the results of the vadose zone modeling (Section 3.4.3) indicate, it is unlikely that the groundwater has been impacted by contamination in soils of the Old Burn Area. Therefore, the groundwater pathway does not appear to be an exposure

Table 8-4. Contaminants of Concern for Surface Soil for the Old Burn Area (Site 6)

Analytes	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration*	Method	Sample Quantitation Limit
2,4-Dinitrotoluene	4	9	.752	10	2.68	4.94	---	LW26	.744
2,4,6-Trinitrotoluene	1	9	3.40	3.40	.791	1.40	---	LW26	.931
2,6-Dinitrotoluene	2	9	0.580	0.780	.474	.553	---	LM15	.530
Cadmium	1	9	10.0	10.0	1.30	3.32	.847	JS15	.424
Copper	9	9	13.9	200	52.1	87.9	28.2	JS15	1.95
Lead	9	9	16	12000	1365	3840	63.4	JD13	.319
Mercury	4	9	.028	0.250	.0467	.0946	.037	JB03	.026
Phosphate	7	9	2.98	20.4	8.53	12.1	5.00	KT04	2.50
RDX	1	9	8.36	8.36	1.13	2.81	---	LW26	.502
Zinc	9	9	43	880	253	407	169	JS15	7.96

Notes.—All results are reported as µg/g. Surface soil includes all soil samples from depths less than 6 inches. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

*Background concentrations were derived as mean plus 2 standard deviations from background data for conservative approach (tolerance limit).

Table 8-5. Contaminants of Concern for Soil for the Old Burn Area (Site 6)

Analyte	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration *	Method	Sample Quantitation Limit
1,3,5-Trinitrobenzene	2	25	7.40	17.0	1.14	2.37	---	LW26	0.176
2,4-Dinitrotoluene	6	25	.752	25	2.22	4.04	---	LW26	.744
2,4,6-Trinitrotoluene	3	25	3.40	16.0	1.53	2.71	---	LW26	.931
2,6-Dinitrotoluene	2	25	.580	.780	.436	.463	---	LM15	.530
Barium	25	25	33.0	2300	297	477	277	JS15	2.61
Cadmium	1	25	10.0	10.0	.604	1.27	.847	JD01	.424
Chromium	22	25	5.96	220	26.9	43.7	22.8	JD01	3.90
Copper	24	25	2.61	10000	501	1190	28.2	JS15	1.95
Iron	25	25	2700	290000	26100	45200	25400	JS15	1.89
Lead	25	25	2.40	17000	1790	3330	63.4	JD01	.319
Mercury	11	25	.028	.443	.0588	.0923	.0371	JB03	.026
Phosphate	10	25	2.98	20.4	4.92	6.44	5.00	KT04	2.50
RDX	1	25	8.36	8.36	.548	1.10	---	LW26	.502
Silver	21	25	.028	12.0	.816	1.68	.749	JD13	.015
Sulfate	13	25	7.87	1400	196	324	466	KT04	14.4
Zinc	23	25	14.9	11000	937	1820	169	JS15	7.96

Notes.—All results are reported as $\mu g/g$. Soil includes all soil samples. Average concentrations that are greater than the highest detected concentrations are due to high Sample Quantitation Limits (SQLs) for the non-detected samples, (one-half of the SQL is used as a value for the non-detected samples when computing the average and the 95% confidence value.) It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

*Background concentrations were derived as mean plus 2 standard deviation from background data for conservative approach (tolerance limit).

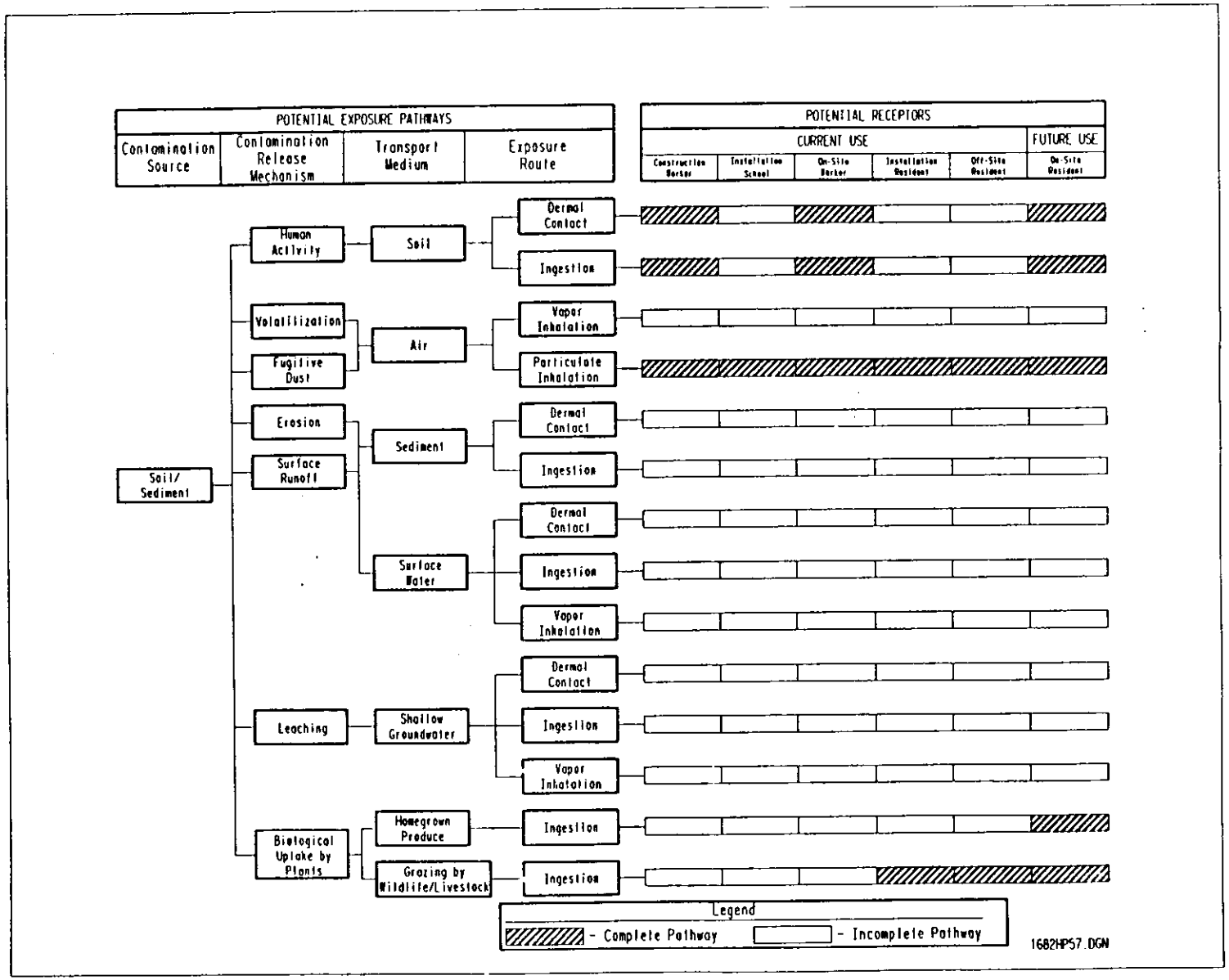


Figure 8-5. Potential Exposure Pathway Conceptual Model for the Old Burn Area (Site 6)

pathway of concern. Grazing by wildlife and livestock is a potential exposure pathway because of the abundant vegetation present at Site 6.

8.1.7 Baseline Risk Assessment

8.1.7.1 *Human Health Evaluation*

This section presents the Risk Assessment results for Site 6. The risk estimates for each exposure scenario are presented in Tables 8-6 and 8-7. These estimates are discussed below by scenario, which includes average exposure and RME for both carcinogenic and noncarcinogenic risks. Tables showing risk factors for individual contaminants of concern are presented in Appendix I.

8.1.7.1.1 *Current Land Use.* The risk estimates for each exposure scenario evaluated under current site use conditions, as shown in Figure 8-5, are presented in Tables 8-6 and 8-7 and are discussed below.

8.1.7.1.1.1 *On-site Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for on-site workers at Site 6 for average exposure is 7E-08. The estimated risk factor from dermal exposure is 6E-08, from soil ingestion is 1E-12, and from soil inhalation is 1E-08.

The total carcinogenic risk factor for RME, using the 95 percent upper confidence limit, is 5E-07. The estimated risk factor for dermal exposure is 5E-07, from soil inhalation is 7E-10, and from soil ingestion is 7E-08.

Carcinogenic risk factors for the Old Burn Area are below the EPA target range of 1E-04 to 1E-06 for residual risk. It should be noted that the exposure duration used (Section 3.5) is a very conservative estimate because the likelihood of the on-site worker spending a long period in this area is low. There are currently no daily work activities being performed at Site 6. In addition, the high concentrations of metals detected are present in the buried trenches; whereas, surface-soil samples contained very few metals above background levels. Therefore, normal on-site worker activities would not result in high exposures to metals.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for on-site workers at Site 6 for the average exposure is 1E-02. The hazard index for soil ingestion is 1E-02, for soil inhalation is 4E-10, and dermal exposure is 5E-03.

Table 8-6. Risk Estimates Summary Using Average Exposure Level for Old Burn Area (Site 6)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
2,4-Dinitrotoluene		6.56E-04		5.43E-04												9.18E-04
2,4,6-Trinitrotoluene	1.67E-09	7.74E-04	3.23E-10	1.12E-02											2.10E-09	1.08E-03
1,3,5-Trinitrobenzene				1.12E-02												
Barium				2.08E-03											1.09E-08	2.58E-04
RDX	8.69E-09	1.84E-04	4.21E-10	8.94E-05												
Silver				7.98E-05												8.90E-04
Cadmium		6.63E-04		5.91E-04												9.64E-03
Copper		6.89E-03		6.62E-02												1.07E-04
Mercury		7.62E-05		9.59E-05												5.78E-04
Zinc		4.13E-04		1.53E-03												
Chromium				2.63E-03											1.30E-08	1.35E-02
	1.04E-08	9.63E-03	7.44E-10	9.62E-02												
Inhalation																
Cadmium	1.04E-12		1.04E-13		8.33E-13		4.66E-13				6.46E-15				2.10E-12	
Mercury		3.79E-10		3.79E-10		3.03E-10		8.49E-10	3.68E-15	1.49E-12		2.61E-12	2.74E-15	1.11E-12		8.49E-10
	1.04E-12	3.79E-10	1.04E-13	3.79E-10	8.33E-13	3.03E-10	4.66E-13	8.49E-10	3.68E-15	1.49E-12	6.46E-15	2.61E-12	2.74E-15	1.11E-12	2.10E-12	8.49E-10
Dermal																
Cadmium		7.89E-05		3.66E-05												1.10E-04
Mercury		4.72E-06		5.95E-06												6.61E-06
2,4-Dinitrotoluene		4.06E-03		3.37E-03												5.69E-03
2,4,6-Trinitrotoluene	1.40E-08		2.00E-09												1.30E-08	
1,3,5-Trinitrobenzene				6.92E-02												
RDX	5.39E-08	1.14E-03	2.61E-09	5.54E-04											6.79E-08	1.60E-03
Barium				1.29E-04												
Chromium				1.63E-04												
Zinc		2.56E-05		9.47E-05												3.58E-05
	6.42E-08	5.32E-03	4.61E-09	7.36E-02											8.09E-08	7.44E-03
Total for Site	**7.46E-08**	**1.49E-02**	**5.36E-09**	**1.70E-01**	**8.32E-13**	**3.03E-10**	**4.66E-13**	**8.49E-10**	**3.68E-15**	**1.49E-12**	**6.46E-15**	**2.61E-12**	**2.74E-15**	**1.11E-12**	**9.40E-08**	**2.09E-02**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

Table 8-7. Risk Estimates Summary Using Reasonable-Maximum Exposure Level for Old Burn Area (Site 6)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
1,3,5-Trinitrobenzene				2.23E-01												
2,4-Dinitrotoluene		1.21E-03		9.49E-03												9.59E-03
2,4,6-Trinitrotoluene	8.86E-09	1.37E-03	5.49E-09	2.55E-02											2.14E-08	1.09E-02
Barium				3.20E-01												
RDX	6.48E-08	4.58E-04	8.12E-09	1.72E-03											1.57E-07	3.64E-03
Silver				1.58E-03												
Cadmium		1.62E-03		1.19E-02												1.29E-02
Copper		1.16E-02		1.51E+00												9.22E-02
Mercury		1.54E-04		1.45E-03												1.22E-03
Zinc		6.64E-04		2.85E-02												5.27E-03
Chromium				4.10E-02												
	7.37E-08	1.71E-02	1.36E-08	2.17E+00											1.79E-07	1.36E-01
Inhalation																
Cadmium	7.30E-10		3.67E-11		1.95E-10		1.55E-09		4.81E-12		8.46E-12		3.58E-12		2.75E-09	
Mercury		8.85E-08		1.33E-07		7.08E-08		1.07E-06		1.87E-09		3.29E-09		1.40E-09		1.07E-06
	7.30E-10	8.85E-08	3.67E-11	1.33E-07	1.95E-10	7.08E-08	1.55E-09	1.07E-06	4.81E-12	1.87E-09	8.46E-12	3.29E-09	3.58E-12	1.40E-09	2.75E-09	1.07E-06
Dermal																
Mercury		9.56E-06		9.33E-06												7.18E-05
Cadmium		2.01E-04		7.70E-05												1.51E-03
2,4-Dinitrotoluene		7.49E-03		6.13E-03												5.63E-02
2,4,6-Trinitrotoluene	5.50E-08		3.55E-09												1.29E-07	
1,3,5-Trinitrobenzene				1.44E-01												
RDX	4.02E-07	2.84E-03	5.24E-09	1.11E-03											9.41E-07	2.13E-02
Barium				2.07E-04												
Chromium				2.65E-04												
Zinc		4.12E-05		1.84E-04												3.09E-04
	4.57E-07	1.06E-02	8.79E-09	1.52E-01											1.07E-06	7.95E-02
Total for Site	**5.31E-07**	**2.77E-02**	**2.24E-08**	**2.32E+00**	**1.95E-10**	**7.08E-08**	**1.55E-09**	**1.07E-06**	**4.81E-12**	**1.87E-09**	**8.46E-12**	**3.29E-09**	**3.58E-12**	**1.40E-09**	**1.25E-06**	**2.15E-01**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

The total hazard index for noncarcinogenic risk for on-site workers at Site 6 for the RME, using the 95 percent upper confidence limit, is 3E-02. The hazard index for soil ingestion is 2E-02, for soil inhalation is 9E-08, and dermal exposure is 1E-02.

The hazard indices are below the EPA goal for a residual hazard index of 1 or less.

8.1.7.1.1.2 *Construction Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for the construction worker at Site 6 for the average exposure is 5E-09. The risk factor for dermal exposure is 5E-09, for soil ingestion is 1E-13, and for soil inhalation is 7E-10.

The total carcinogenic risk factor from RME is 2E-08. The risk factor for dermal exposure is 9E-09, for soil inhalation is 4E-11, and for soil ingestion is 1E-08.

Both average exposure and RME risk factors for carcinogenic risk are below the EPA target range of 1E-04 to 1E-06 for residual risk.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for construction workers at Site 6 for the average exposure is 2E-01. The hazard index for soil ingestion is 1E-01, the hazard index for soil inhalation is 4E-10, and for dermal exposure is 7E-02.

The total hazard index for noncarcinogenic risk for the construction worker at Site 6 for the RME is 2E+00. The hazard index for soil ingestion is 2E+00, for soil inhalation is 1E-07, and for dermal exposure is 1E-01.

The RME hazard index exceeds the EPA goal for a residual hazard index of 1 or less primarily because of the additive effect of several metals in the soils at Site 6. High concentrations of metals are present in the subsurface soils associated with former trenches. The construction worker would have the highest potential risk through dermal contact and ingestion of metals-contaminated soils.

8.1.7.1.1.3 *Installation School*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the installation school because of the distance from the school to Site 6. Potential exposure at the on-site school is associated with inhalation of particulates released from soil from Site 6. The carcinogenic risk for average exposure is 8E-13, and the carcinogenic risk for the RME is 2E-10.

NONCARCINOGENIC RISKS

The hazard index for average exposure is 3E-10, and the hazard index for the RME is 7E-08.

8.1.7.1.1.4 *Installation Resident*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the installation resident because of the distance from the housing area to Site 6. Potential exposure at the installation housing is associated with inhalation of particulates released from soils at Site 6. The carcinogenic risk for the average exposure is 5E-13, and the carcinogenic risk for the RME is 2E-09.

NONCARCINOGENIC RISKS

The hazard index for the average exposure is 8E-10, and the hazard index for the RME is 1E-06.

8.1.7.1.1.5 *Off-Site Residents*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the off-site residents because of the distance from the Old Burn Area to off-site residents. Soil concentrations of contaminants from the Old Burn Area were used to model predicted particulate concentrations at Tooele, Stockton, and Grantsville. The carcinogenic risk factors are shown in Table 8-8.

Table 8-8. Carcinogenic Risk Factors at Tooele, Stockton, and Grantsville from the Old Burn Area (Site 6)

	Carcinogenic Risk Factors	
	Average	**RME**
Tooele	4E-15	5E-12
Stockton	6E-15	8E-12
Grantsville	3E-15	4E-12

NONCARCINOGENIC RISKS

The total hazard index for the average exposure and RME of particulates released from soil are summarized in Table 8-9.

Table 8-9. Total Hazard Index of Soil Particulates from the Old Burn Area (Site 6)

Noncarcinogenic Risk Factors		
	Average	**RME**
Tooele	1E-12	2E-09
Stockton	3E-12	3E-09
Grantsville	1E-12	1E-09

8.1.7.1.2 ***Future Land Use***. The only future land use scenario considered is for possible future on-site residents. Results from this exposure scenario are discussed below.

CARCINOGENIC RISKS

The total carcinogenic risk factor for future on-site residents at Site 6 for the average exposure is 9E-08. The risk factor for dermal exposure is 8E-08, for soil ingestion is 1E-08, and for soil inhalation is 2E-12.

The total carcinogenic risk from RME, using the 95 percent upper confidence limit is 1E-06. The risk factor for dermal exposure is 1.1E-06, for soil ingestion is 2E-07, and for soil inhalation is 3E-09.

The risk factors for the future on-site resident show that carcinogenic risks are within the lower end of the EPA target range of 1E-06 to 1E-04 for residual risk.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for future on-site residents at Site 6, using the average exposure, is 2E-02. The hazard index for soil ingestion is 1E-02, for soil inhalation is 8E-10, and for dermal exposure is 7E-03.

The total hazard index for noncarcinogenic risk from RME, using the 95 percent upper confidence limit, is 2E-01. The hazard index for soil ingestion is 1E-01, for soil inhalation is 1E-06, and for dermal exposure is 8E-02.

Hazard indices for average exposure and RME meet the EPA goal of a residual hazard index of 1 or less.

8.1.7.2 *Environmental Evaluation*

8.1.7.2.1 *Site Characterization*. Operable Unit 8, which includes Site 6, is located near the south-central boundary of the facility. The primary vegetation at this site is sagebrush and grasses, as is typical of the region.

This site contains largely usable habitat for most of the species identified at TEAD-N. Site 6 receives little industrial or human use. Therefore, it offers reasonably good potential habitat for wildlife, and many of the potential wildlife species identified for TEAD-N (Section 2.9) could inhabit the area and remain relatively undisturbed. The environmental evaluation for Site 6 is qualitative and did not include bioassays of the vegetation and wildlife or an inventory of the wildlife. A site-specific inventory of vegetation was made and is included in Table 8-10, Vegetation Inventory (Site 6).

Data gap sampling to collect additional information is needed for this site to further determine the extent of contamination and the degree of ecological risk. The findings would be issued in the future.

No surface water or evidence of surface water was observed during the field investigation. Furthermore, it is unlikely that any significant surface water accumulates within this site as a result of storm episodes or snowmelt.

8.1.7.2.2 *Biological Effects of Contaminants*. Table 8-11 summarizes the relevant information for the contaminants of concern for Site 6, which was taken from Table 3-18.

8.1.7.2.3 *Potential Pathways*. No biological samples were obtained, thus, the uptake of contaminants by flora and fauna cannot be evaluated at this time. The most probable pathways of contaminants through the ecosystem are as follows:

- Plants

-Direct uptake by plants through roots

- Wildlife

-Ingestion of contaminated soil
-Ingestion of contaminated foliage
-Ingestion of contaminated insects
-Ingestion of contaminated carrion/animals
-Dermal contact
-Inhalation of vapors
-Inhalation of contaminated particulates

Potential pathways are shown in Figure 8-6.

Table 8-10. Vegetation Inventory (Site 6)

Scientific Name	**Common Name**
PRIMARY VEGETATION SPECIES	
Bromus tectorum	Cheatgrass
Agropyron cristatum	Crested wheatgrass
Chrysothamnus viscidiflorus	Viscid rabbitbrush
OTHER VEGETATION SPECIES	
Helianthus annus	Annual sunflower
Cirsium vulgre	Bull thistle
Sphaeralcea coccinea	Globe mallow
Grindelia squarrosa	Gum weed
Stipa hymenoides	Indian ricegrass
Stipa comata	Needle-and-threadgrass
Lepidium perfoliatum	Peppergrass
Lactuca scariola	Prickly lettuce
Opuntia polyacantha	Prickly pear cactus
Chrysothamnus nauseosus	Rabbitbrush
Salsola iberica	Russian thistle
Artemisia tridentata	Sagebrush
Sporobolus cryptandrus	Sand dropseed
Lupinus brevicaulis	Shortstem lupine
Elymus elymoides	Squirreltail
Erodium cicutarium	Storksbill
Duscurainia sophia	Tansy mustard
Sisymbrium officinale	Tumbling mustard
Juniperus osteoperma	Utah juniper
Astragalus utahensis	Utah milkvetch
Melilotus albus	White sweetclover
Tragopogon dubius	Yellow goats beard
Melilotus officinalis	Yellow sweetclover

Table 8-11. Summary of Contaminants (Site 6)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
2,4-Dinitrotoluene	VL[a]	H[b]	--	2[c],3[d]	3	animal carcinogen, suspect human carcinogen
2,4,6-Trinitrotoluene	I[e]	M[f]→H	BC[g]	2,3	3	poison by subcutaneous route; mod. toxic by ingestion; mutation data reported
Antimony	I	L[h]→M	BC	3	3	metal is more toxic than salts
Barium	I	M	BC	3	3	all soluble salts are acute poisons
Bis(2-ethylhexyl)phthalate	VL	L→M	BC	2	3	known animal carcinogen; low oral toxicity
Cadmium	VL	M→H	BA[i]	3	3	known animal carcinogen
Chromium	VL	L→H	BC	1[j]	3	many Cr+6 cmpds are animal and human carcinogens
Copper	I	VL→M	BC	3	3	Cu metal toxicity very low; many Cu(II) salts are toxic
Di-n-butyl phthalate	L	VL→L	--	--	3 combustible	low oral toxicity
Iron	I	L→H	--	--	3 dust explosive	poison by IP[k] route; questionable animal carcinogen; potentially toxic in all forms
Mercury	I	H	BA, BC	3	3	highly toxic by most routes incl. inhalation; questionable carcinogen; some evidence of human mutations
Nickel	I	L→M	BA	1	3 dust explosive	dust is confirmed carcinogen; low oral toxicity for metal
N-nitrosodiphenylamine	L	M	--	2,3	3	moderately toxic by ingestion; carcinogenic in some animals; human mutation data reported
RDX	I	H	BC	3	3	poison by ingestion, IV[l], IP; corrosive, irritant to skin, eyes, mucous membranes

Table 8-11. Summary of Contaminants (Site 6) (continued)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
Silver	I	L	BA, BC	--	2 dust sl. flammable	toxicity of metal is low by all exposure routes; dust an irritant; accumulation in the body may produce argyria; soluble cmpds toxic/fatal
Thallium	I	H	BC	3	3	highly toxic in animals and humans
Zinc	I	VL→L	BC	--	3	many of its cmpds are toxic; dust is an irritant

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]VL=very low.
[b]H=high.
[c]2=suspected carcinogen.
[d]3=tissue or organ damage.
[e]I=insoluble.
[f]M=moderate.
[g]BC=bioconcentrates.
[h]L=low.
[i]BA=bioaccumulates.
[j]1=carcinogen.
[k]IP=intraperitoneal.
[l]IV=intravenous.

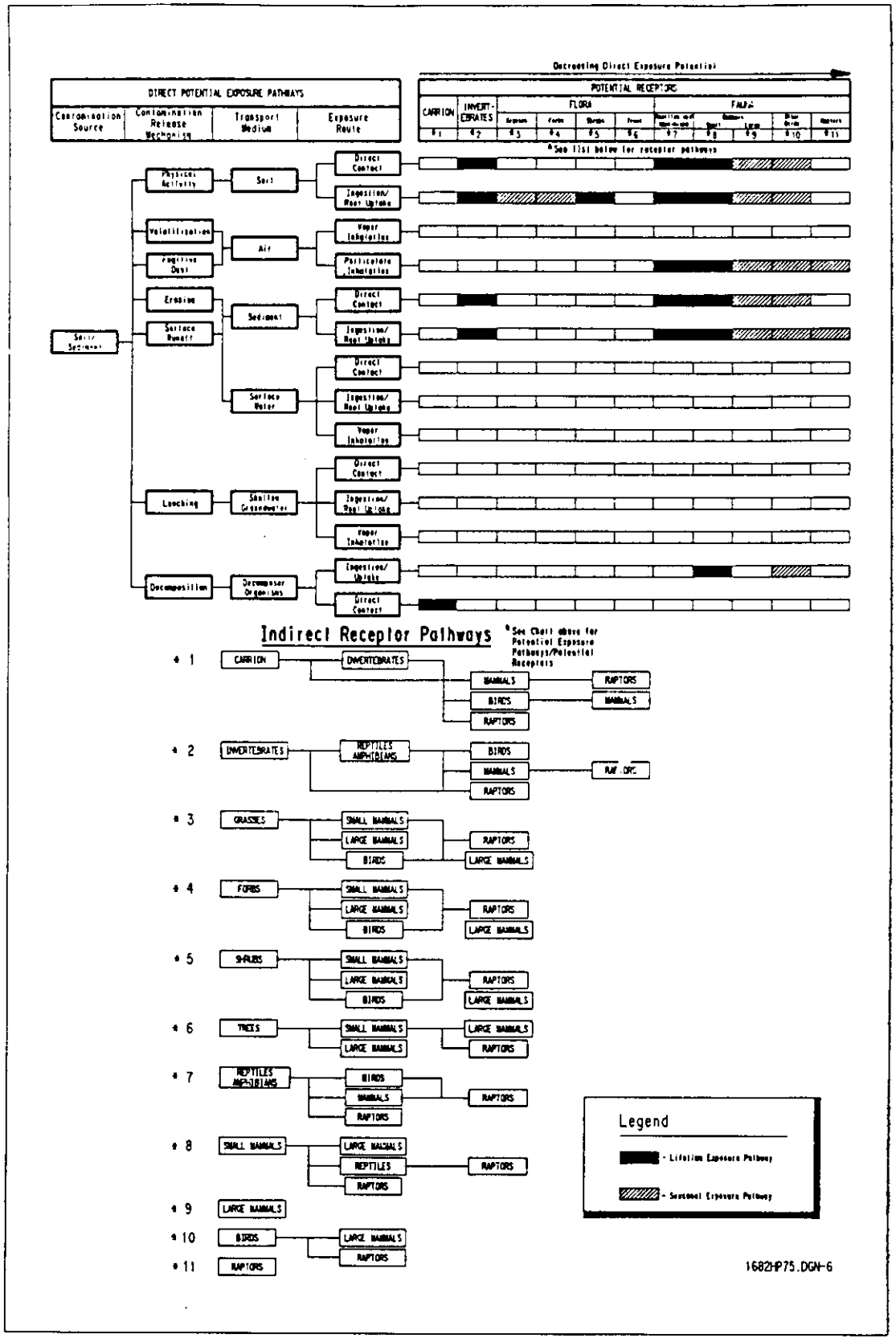


Figure 8-6. Potential Ecological Pathways for Site 6

8.1.7.2.4 ***Potentially Affected Populations.*** Table 8-12 presents a summary of exposure points, general population, and the activity by which ecological exposure may occur. The table is listed in decreasing exposure potential.

Table 8-12. Exposure Scenarios for Ecological Populations (Site 6)

Exposure Point	Exposed Populations	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Large Mammals	Ingestion of contaminated vegetation; foliage, fruit, and potentially roots.	Likely, little industrial use and human activity at this end area make it largely usable habitat.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Occasional exposure, only when feeding at this site.
Terrestrial Locations	Raptors	Ingestion of contaminated carrion or animals.	Unlikely; exposed when feeding in other areas on prior inhabitants of the site.

8.1.7.2.5 ***Environmental Evaluation Conclusions.*** The primary contaminants of concern at this site are explosives and metals. These contaminants generally have a qualitative biological hazard ranking of moderate to high. Cadmium and mercury were ranked as high because both are toxic and bioaccumulate. Most of the other contaminants were ranked as moderate to high because (1) little is known about the biological or ecological effects of the contaminants or (2) they are less toxic or do not bioaccumulate.

Alterations to the trophic structure and ecological processes at Site 6 or to the TEAD-N facility cannot be evaluated until further data are collected. Recovery times cannot be derived or predicted from the information evaluated.

In order to completely assess the ecological risk at this site, biological sampling and analysis is necessary. Tissue sampling of vegetation and wildlife, analyses for chemicals of concern during the growing season, and a species inventory are warranted.

8.1.8 Conclusions

The RI field program at Site 6 was designed to identify potential sites of buried debris in former trenches and to determine the types of contamination associated with the buried materials. It was also designed to determine whether surface-soil contamination is present and whether that contamination is migrating off-site via surface-water drainage. The extent of contamination was not fully defined for any of the areas of contamination at Site 6.

The geophysical surveys at Site 6 identified several target areas for buried trenches or pits. Three of these targets were selected for investigation via test-pit characterization. Other target areas from the geophysical surveys remain unevaluated.

Results of the geophysical surveys show that trenches in the revetment area contain the greatest concentration of buried materials at Site 6. Test pits within the revetment area show that a variety of munitions-related debris has been buried in a series of trenches. Samples from these trenches primarily contained elevated levels of metals. The samples also show that the zone of contamination is confined mainly to the depths of burial and has not migrated vertically. Generally, samples collected below the zone of buried debris contained near-background concentrations of metals. Trenches outside of the revetment area appear to contain debris associated with the burning of wooden boxes and crates as evidenced by the abundance of metal banding encountered in Test Pit 1. Samples from Test Pit 1 also contained elevated levels of metals.

Surface-soil samples, including those collected within the shallow drainage areas, were found to contain explosives as well as elevated metals. It appears that this surface contamination is widespread and is due to airborne transport from years of open burning of explosive-contaminated materials as well as explosives testing. Although widespread, this contamination appears to be in low concentrations and does not pose a significant risk.

Although there are a variety of contaminants identified at Site 6, results of the baseline risk assessment show that there is a threat to human health primarily associated with inhalation of heavy metals such as cadmium, chromium, copper, and mercury.

8.1.9 Recommendations

On the basis of the RI results, it appears that additional characterization of the contamination related to the revetment area is warranted. Additional test pits within the revetment area are necessary to define the horizontal and vertical extent of contamination. Additional subsurface investigations in the areas outside of the revetment area do not appear to be warranted.

Surface contamination of explosives, however, appears to be widespread throughout Site 6. A broad area of contamination appears to be a result of windblown particulates derived from burning and testing operations in the area of Site 6. A site-wide surface-sampling program is recommended to better characterize the area. The additional data will be used to complete the risk assessment for Site 6, including the utilization of EPA's Lead Uptake/Biokinetic model to evaluate health risks associated with lead contamination at the site.

8.2 CHEMICAL RANGE (Site 7)

8.2.1 Site Characteristics

Chemical and pyrotechnic-type munitions, excluding agent-filled munitions, were tested and disposed of at the Chemical Range (Figure 1-11). Munition tests included flares, smoke grenades, smoke pots, projectiles, incendiary items such as bombs, pouch and document destroyers, riot-control munitions, and flame-thrower igniters. At least two trenches and possibly a third (identified by geophysical surveying) were used to dispose of spent munitions following testing operations. In 1990, E.C. Jordan (1990a) described two of the trenches as being open and described the contents observed. However, in 1991, prior to the Rust E&I field investigation, the two open trenches were backfilled with the berm materials surrounding the trenches, and the area was graded. Therefore, additional geophysical surveys were required during the current RI to relocate the former trenches.

8.2.2 Previous Investigations and RI Activities

Previous environmental investigations included a geophysical survey, which identified a potential third trench at the site, in addition to the two trenches that were open until 1991. Also included was surface soil sampling from berm materials surrounding the formerly open trenches (Figure 8-7). A total of 12 samples were collected and analyzed for explosives, metals, and anions. Only nickel and zinc were present in above background concentrations. No sampling was done within the trenches because of safety concerns. The results of the previous sampling at the site are presented in Table 8-13 (Weston, 1990).

The current RI included a geophysical survey (Appendix B) designed to better define the suspected third trench and to relocate the former open trenches. On the basis of the target areas from the geophysical survey as shown in Figure 8-8, three test-pit locations were excavated and sampled in order to characterize the buried materials in each trench location and to determine if contaminants have been released to subsurface soils. These test pit locations are shown in Figure 8-9. The samples were analyzed for explosives, semi-VOCs, inorganics, and anions. Table 8-14 presents a summary of analytes found at above background concentrations at the site. The test-pit logs that were generated during the excavation of the test pits are included in Appendix C.

8.2.3 Nature and Extent of Contamination

Test Pit 1 was located north of the building foundation in a target area identified by the geophysical survey. This test pit was found to contain burned metal debris including munition containers, slap flares, smoke flares, and trip flares. In spite of the buried materials present, only zinc at a depth of 5 feet was found.

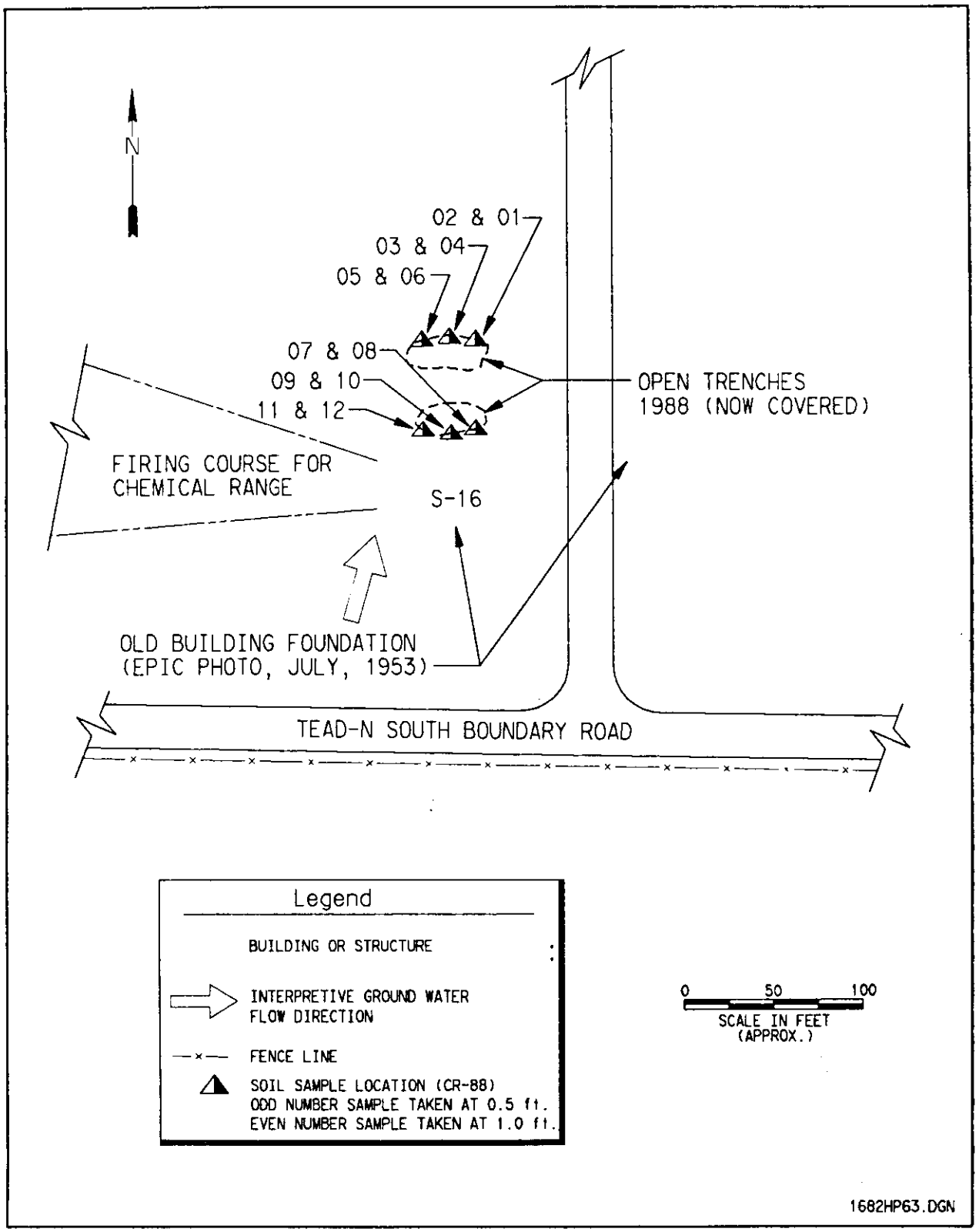


Figure 8-7. Previous Investigation Sample Location Map for the Chemical Range (Site 7)

Table 8-13. Previous Investigation Soil Sample Results for the Chemical Range (Site 7)

Parameters	CR-88-01 (0.5 ft.)	CR-88-02 (1.0 ft.)	CR-88-03 (0.5 ft.)	CR-88-04 (1.0 ft.)	CR-88-05 (0.5 ft.)	CR-88-06 (1.0 ft.)	CR-88-07 (0.5 ft.)	CR-88-08 (1.0 ft.)	CR-88-09 (0.5 ft.)	CR-88-10 (1.0 ft.)	CR-88-11 (0.5 ft.)	CR-88-12 (1.0 ft.)
	Concentrations in ug/g											
Explosives	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metals												
Silver												
Arsenic												
Beryllium	.381	.328	.331	.375	.403	.411		.292	.431	.511	.361	.398
Cadmium	1.66						3.19				1.51	
Chromium	18.7	14.8	15.3	20.0	19.6	21.4	17.3	17.7	21.8	21.7	20.4	17.9
Copper	19.8	11.6	12.2	9.75	16.9	12.2	15.8	8.73	11.5	11.6	22.4	11.3
Mercury												
Sodium	119	13.2	50.2	213	149	144	108	117	117	112	116	131
Nickel	17.9			17.7	20.0	16.7	17.4	26.9	15.5	23.9	19.3	21.1
Lead	10.8	37.1	7.91	6.22	9.77	7.24	8.29		8.87	7.51	13.7	8.64
Antimony												
Selenium												
Thallium												
Zinc	384	2,000	137	118	111	77.2	752		70.5		886	125
Anions	ND	ND	ND	ND	ND	ND				ND	ND	
Bromide												
Chloride												
Fluoride							5.86	6.45	6.2			6.26
Nitrate												
Sulfate												

Notes: Samples analyzed for all parameters indicated. A blank indicates that the parameter concentration was less than the reporting limit. Sampling interval was 0.5 to 1 foot below soil surface.
Source: Weston, 1990.

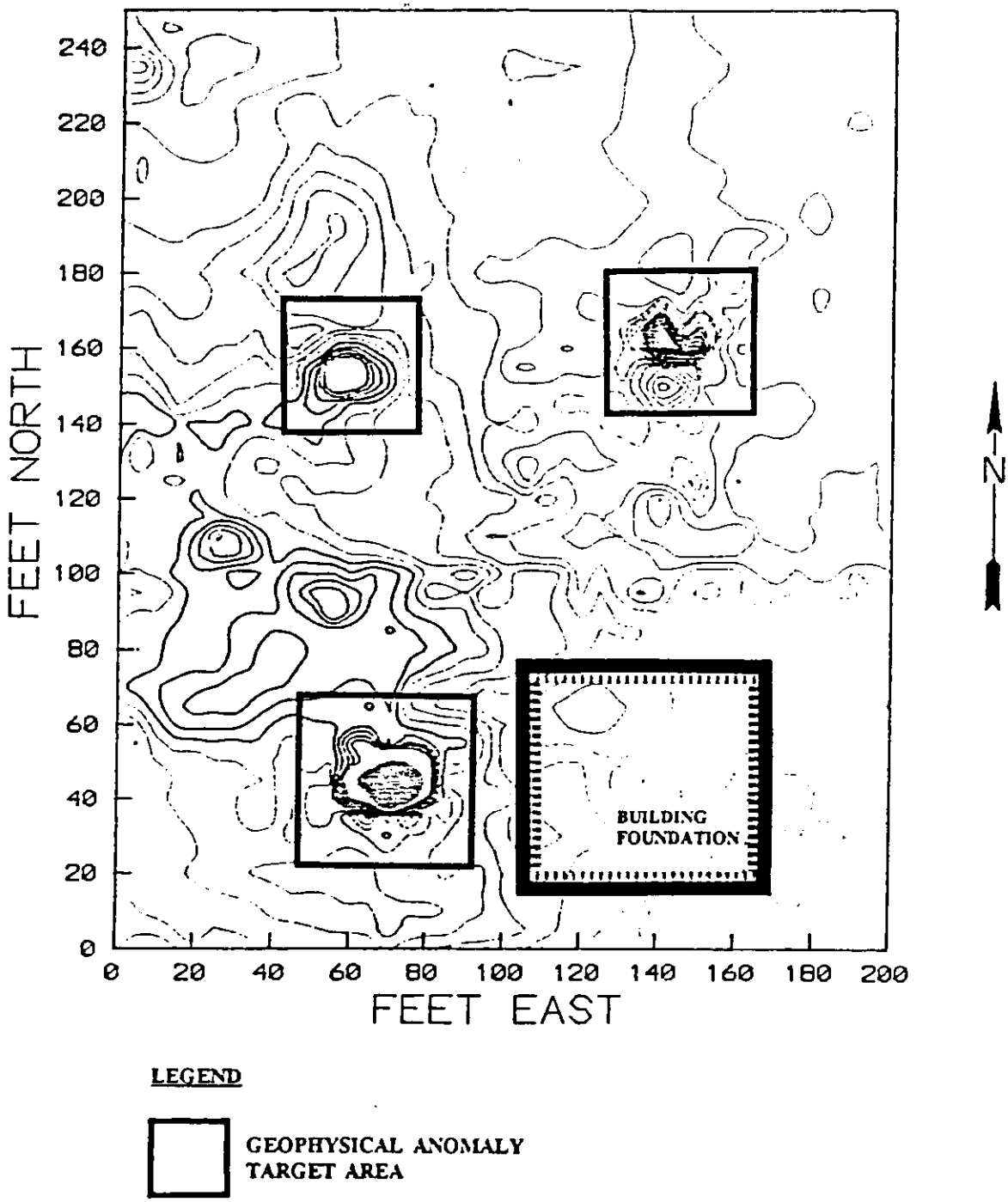


Figure 8-8. RI Geophysical Survey Target Areas for the Chemical Range (Site 7)

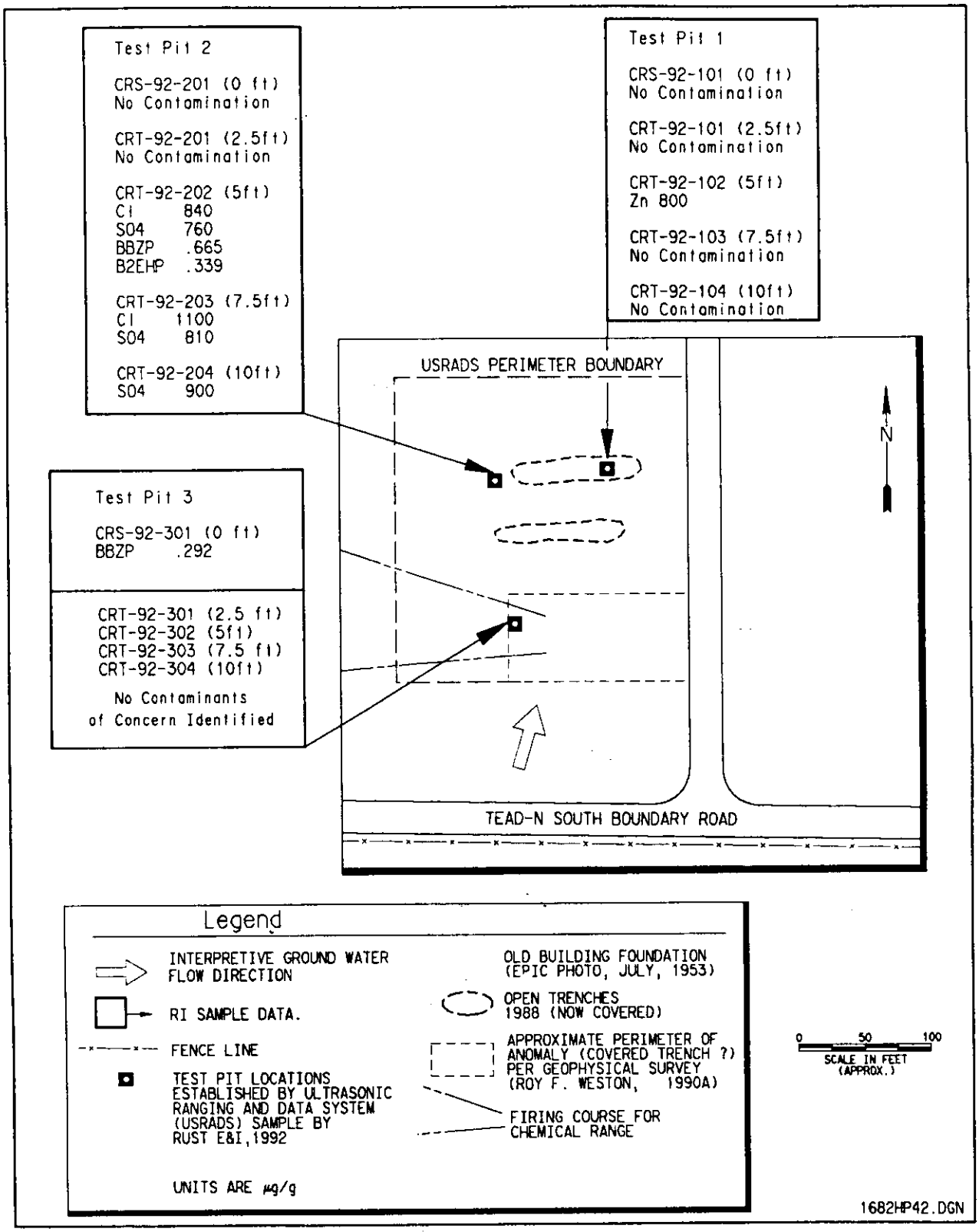


Figure 8-9. RI Test Pit Sampling and Analysis Results for the Chemical Range (Site 7)

Table 8-14. Summary of Analytes Above Background Concentrations for the Chemical Range (Site 7)

Analytes	CRS-92-101 (0 ft)*	CRT-92-101 (2.5 ft)	CRT-92-102 (5 ft)	CRT-92-103 (7.5 ft)	CRT-92-104 (10 ft)	Background Concentrations
	Concentrations in µg/g					
SVOCs						
Bis(2-ethylhexyl)phthalate	LT	LT	LT	LT	LT	---
Butylbenzyl phthalate	ND	ND	ND	ND	ND	---
Anions						
Chloride	LT	<BKGD	<BKGD	<BKGD	LT	336
Sulfate	<BKGD	<BKGD	<BKGD	<BKGD	LT	466
Explosives	ND	ND	ND	ND	ND	---
Inorganics						
Zinc	<BKGD	<BKGD	800	<BKGD	<BKGD	169

Notes.–ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations.

*Samples were taken from 0 to 6 inches.

Table 8-14. Summary of Analytes Above Background Concentrations for the Chemical Range (Site 7) (continued)

Analytes	CRS-92-201 (0 ft)*	CRT-92-201 (2.5 ft)	CRT-92-202 (5 ft)	CRT-92-203 (7.5 ft)	CRT-92-204 (10 ft)	Background Concentrations
	Concentrations in μg/g					
SVOCs						
Bis(2-ethylhexyl)phthalate	LT	LT	.339	LT	LT	---
Butylbenzyl phthalate	ND	ND	.665	ND	ND	---
Anions						
Chloride	<BKGD	<BKGD	840	1100	<BKGD	336
Sulfate	<BKGD	<BKGD	760	810	900	466
Explosives	ND	ND	ND	ND	ND	---
Inorganics						
Zinc	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	169

Notes.— ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations.

*Samples were taken from 0 to 6 inches.

Table 8-14. Summary of Analytes Above Background Concentrations for the Chemical Range (Site 7) (continued)

Analytes	CRS-92-301 (0 ft)*	CRT-92-301 (2.5 ft)	CRT-92-302 (5 ft)	CRT-92-303 (7.5 ft)	CRT-92-304 (10 ft)	Background Concentrations
	Concentrations in µg/g					
SVOCs						
Bis(2-ethylhexyl)phthalate	LT	LT	LT	LT	LT	---
Butylbenzyl phthalate	.292	ND	ND	ND	ND	---
Anions						
Chloride	LT	LT	LT	LT	LT	366
Sulfate	<BKGD	LT	LT	<BKGD	<BKGD	466
Explosives	ND	ND	ND	ND	ND	---
Inorganics						
Zinc	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	169

Notes.—ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations.

*Samples were taken from 0 to 6 inches.

Test Pit 2 at Site 7 was excavated in an area identified during the geophysical survey northwest of the building foundation that appeared to correspond to the western portion of one of the former disposal trenches at the site. The surface sample collected at the test-pit location contained no contaminants above background levels. Chloride and sulfate were detected in concentrations above background in samples collected from 5 and 7.5 feet. At a depth of 10 feet, only sulfate was detected above background concentrations. Two semi-VOCs, bis(2-ethylhexyl)phthalate and butylbenzyl phthalate, were detected at low concentrations in the sample taken at a depth of 5 feet. It appears that the test pit was located just west of the target trench. No debris was encountered in this test pit.

Test Pit 3 was located west of the building foundation. This area was identified by both geophysical surveys as an area of potential buried debris. No analytes were detected at this location with the exception of butylbenzyl phthalate. This was detected in the surface soil sample (CRS-92-301) at 0.292 μg/g. No debris was encountered in the test pit, and the source of the geophysical anomaly remains unknown.

In summary, although open trenches were filled with a variety of debris at this site, the results of the test-pit sampling from one of these trenches indicate that the subsurface soils do not contain significant contamination. The location of the second trench was not readily discernable on the basis of the geophysical survey. It is not certain why the trench failed to show as a distinct anomaly given the fact that both trenches reportedly contained metal debris.

To address these concerns and more completely characterize the site, additional test pit and surface soil sampling is scheduled. These samples will be analyzed for metals and explosives. Results from this investigation will be combined with all other available data and used to re-calculate and assess risks to human health and the environment. These results will be reported and analyzed in an RI Report Addendum and future FS.

8.2.4 Contaminants of Concern

Tables 8-15 and 8-16 summarize the chemicals of concern for surface soils and combined surface and subsurface soils, respectively. The contaminants of concern include data from this RI as well as data collected previously. However, it should be noted that the previous data could not be verified by analytical results obtained for this RI. Cadmium and zinc are contaminants of concern for surface soils, and cadmium, chloride, sulfate, zinc, and bis(2-ethylhexyl)phthalate are contaminants of concern for combined soils. The organic bis(2-ethylhexyl) phthalate was detected in low concentrations and is a suspected laboratory contaminant. Since the concentration of bis(2-ethylhexyl)phthalate exceeded 10 times the concentration detected in the blank, it was carried through the risk assessment. No PAHs were detected at the site although they are normally a byproduct of combustion of organic compounds.

Table 8-15. Contaminants of Concern for Surface Soil at the Chemical Range (Site 7)

Analyte	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration *	Method	Sample Quantitation Limits
Cadmium	3	15	1.51	3.19	0.919	1.26	0.743	JD01	0.424
Zinc	13	15	45	2000	326	569	148	JS15	7.96

Note.—All results are reported as $\mu g/g$. Surface soil includes all soil samples from depths of less than 6 inches. This table contains previous and recent investigative surface data for metals and anions. The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

*Background concentrations were derived as mean plus 2 standard deviation from background data for conservative approach (tolerance limit).

Table 8-16. Contaminants of Concern for Soil at the Chemical Range (Site 7)

Analyte	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration*	Method	Sample Quantitation Limits
Bis(2-ethylhexyl) phthalate	1	15	0.339	0.339	0.205	0.222	---	LM15	0.195
Cadmium	3	27	1.51	3.19	0.605	0.820	0.743	JD01	0.424
Chloride	8	15	31.9	1100	164	315	279	KT04	39.6
Sulfate	12	15	8.27	900	187	338	290	KT04	14.4
Zinc	25	27	10.9	2000	230	371	148	JS15	7.96

Note.—All results are reported as $\mu g/g$. Soil includes all soil samples. This table contains previous and recent investigative data for metals and anions. The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---).

8.2.5 Contaminant Fate and Transport

Chloride and sulfate contamination in Test Pit 2 is restricted to the subsurface. The metals contamination according to Weston (1990) data appeared to be widespread in samples collected from the berm materials at the edge of the trenches. However, this material apparently was used to backfill the trenches in 1991, and the surface was likely covered with clean soil and graded. Current surface samples from the same area contain no metals above background concentrations. Vadose zone modeling shows that the migration of contaminants to the groundwater pathway would take over 100 years, and the resulting concentrations at that time would be orders of magnitude lower (Section 3.4.3). Metals generally have a lower mobility than other contaminants in the soil environment. As a result, the groundwater pathway does not appear to be a concern even if the metals-contaminated soils are present within the trenches. There are no major surface-water drainage areas in the immediate area of Site 7, and surface water during heavy precipitation events would infiltrate prior to reaching a major drainage area. Transport of contaminants via surface-water pathways does not appear to be a concern for Site 7. Metals contamination at the surface may be transported as particulates in the air pathway. This pathway was evaluated further because contaminant transport is likely.

8.2.6 Potential Exposure Pathways

Potential exposure pathways for Site 7 are summarized in Figure 8-10. Exposure by dermal contact, ingestion, and inhalation was considered on the basis of the contamination that was previously identified in surface soils. It should be noted that the former trenches were filled and the present surface materials are not the same as those sampled in 1990. There is no major surface-water drainage in the Chemical Range area and most precipitation would infiltrate into the gravelly soils of the area. The surface-water pathway does not appear to be a concern at this location. Vadose zone modeling (Section 3.4.3) also shows that the groundwater pathway is not a concern because of the length of time required for contaminants to reach the water table and the reduced concentrations that would be present at the time they did reach the groundwater. Wildlife and livestock grazing is a potential exposure pathway at Site 7. A grass cover is currently present in the Site 7 area.

8.2.7 Baseline Risk Assessment

8.2.7.1 *Human Health Evaluation*

The risk estimates for each exposure scenario, as shown in Figure 8-10, are presented in Tables 8-17 and 8-18. Tables showing risk factors for individual contaminants of concern are presented in Appendix I. The estimates are discussed below by scenario, which includes average exposure and reasonable maximum exposure at the 95 percent upper confidence level for carcinogenic and noncarcinogenic risks. Again, it should be noted that many of the exposure scenarios were based on contact with metals contamination that may no longer be present at the surface of the site.

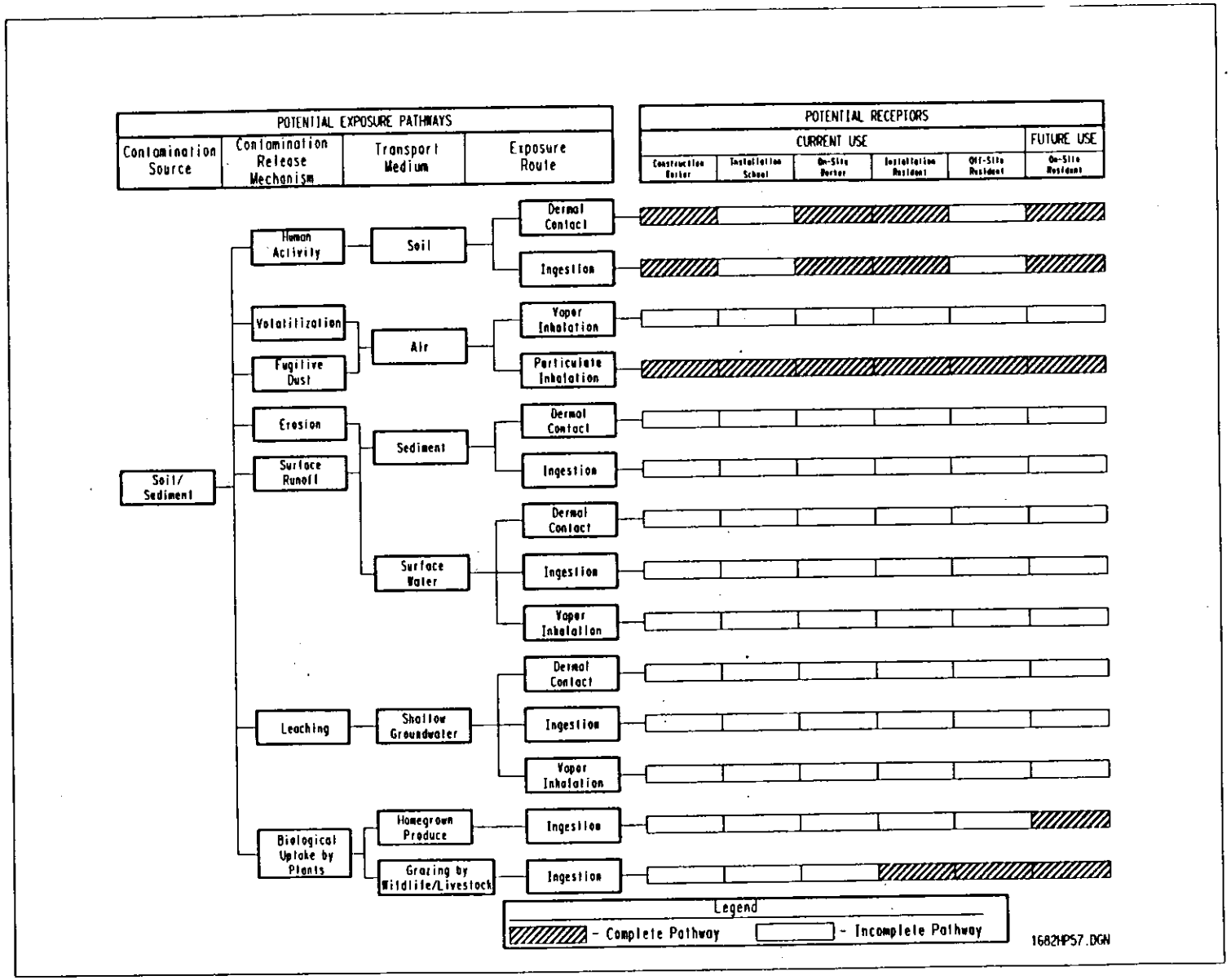


Figure 8-10. Potential Human Exposure Pathway Conceptual Model for the Chemical Range (Site 7)

Table 8-17. Risk Estimate Summary Using Average Exposure Level for the Chemical Range (Site 7)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
Bis(2-ethylhexyl)phthalate			2.01E-11	5.01E-06												
Cadmium		4.50E-04		5.92E-04												6.29E-04
Zinc		5.32E-04		3.75E-04												7.44E-04
		9.81E-04	2.01E-11	9.72E-04												1.37E-03
Inhalation																
Cadmium	3.27E-13		3.27E-14		2.62E-13		1.46E-13		3.71E-17		6.75E-17		3.14E-17		6.59E-13	
	3.27E-13		3.27E-14		2.62E-13		1.46E-13		3.71E-17		6.75E-17		3.14E-17		6.59E-13	
Dermal																
Bis(2-ethylhexyl)phthalate			1.24E-10													
Cadium		5.85E-05		3.67E-05												7.81E-05
Zinc		3.30E-05		2.33E-05												4.61E-05
		8.87E-05	1.24E-10	6.00E-05												1.24E-04
Total for Site	**3.27E-13**	**1.07E-03**	**1.44E-10**	**1.03E-03**	**2.62E-13**		**1.46E-13**		**3.71E-17**		**6.75E-17**		**3.14E-17**		**6.59E-13**	**1.50E-03**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

Table 8-18. Risk Estimate Summary Using Reasonable-Maximum Exposure Level for the Chemical Range (Site 7)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
Bis(2-ethylhexyl)phthalate			2.09E-10	5.21E-05												4.98E-03
Cadmium		6.16E-04		7.70E-03												7.36E-03
Zinc		9.28E-04		5.81E-03												
		1.54E-03	2.09E-10	1.36E-02												1.23E-02
Inhalation																
Cadmium	2.29E-10		1.15E-11		6.11E-11		4.85E-10		4.84E-14		8.78E-14		4.10E-14		8.62E-10	
	2.29E-10		1.15E-11		6.11E-11		4.85E-10		4.84E-14		8.78E-14		4.10E-14		8.62E-10	
Dermal																
Cadmium		7.64E-05		4.97E-05												5.85E-04
Zinc		5.75E-05		3.75E-05												4.32E-04
Bis(2-ethylhexyl)phthalate			1.35E-10													
		1.34E-04	1.35E-10	8.73E-05												1.02E-03
Total for Site	**2.29E-10**	**1.68E-03**	**3.56E-10**	**1.37E-02**	**6.11E-11**		**4.85E-10**		**4.84E-14**		**8.78E-14**		**4.10E-14**		**8.62E-10**	**1.34E-02**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

8.2.7.1.1 *Current Land Use*. The risk estimates for each exposure scenario evaluated under current site use conditions are presented in Tables 8-17 and 8-18 and are discussed below.

8.2.7.1.1.1 *On-Site Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for on-site workers at Site 7 for the average exposure is 3E-13, which is based on inhalation of cadmium in site soils.

The total carcinogenic risk factor from RME, using the 95 percent upper confidence limit, is 2E-10 based on inhalation of cadmium in site soils.

Estimated carcinogenic risks for Site 7 are below the EPA target range for residual risk of 1E-04 to 1E-06. Additionally, the estimates for exposure duration are very conservative estimates because the likelihood of the on-site worker spending a long period of time in this area is low (Section 3.5). There are currently no daily work activities at Site 7.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for on-site workers at Site 7, using the average exposure, is 1E-03 based on the hazard index for soil ingestion.

The total hazard index for noncarcinogenic risk for on-site workers at Site 7 for the RME is 2E-03. The hazard index for soil ingestion is 2E-03 and for dermal exposure is 1E-04. The average and RME exposures meet the EPA hazard index goal of 1 or less.

The risk is primarily due to potential ingestion of cadmium and zinc in site soils. Again, these estimates are very conservative estimates and there does not appear to be any immediate threat to human health at Site 7.

8.2.7.1.1.2 *Construction Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for the construction worker at Site 7, using the average exposure, is 1E-10. The risk factor for dermal exposure is 1E-10, for soil ingestion is 2E-11, and for soil inhalation is 3E-14.

The total carcinogenic risk factor from RME, using the 95 percent upper confidence limit, is 4E-10. The risk factor for dermal exposure is 1E-10, for soil ingestion is 2E-10, and for soil inhalation is 1E-11. Both average exposure and RME risk factors are below the EPA target range for residual risk of 1E-04 to 1E-06.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for construction workers at Site 7 for average estimated exposure is 1E-03. The hazard index for soil ingestion is 1E-03 and for dermal exposure is 6E-05.

The total hazard index for noncarcinogenic risk for the construction worker at Site 7 for the RME is 1E-02. The hazard index for soil ingestion is 1E-02 and for dermal exposure is 9E-05.

The hazard indices meet the EPA goal for a residual hazard index of 1 or less.

8.2.7.1.1.3 *Installation School*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the on-site school because of the distance from the Chemical Range. Exposure at the on-site school would be associated with inhalation of particulates released from Site 7 soil. The carcinogenic risk for average exposure is 3E-13, and the carcinogenic risk for the RME is 6E-11.

NONCARCINOGENIC RISKS

Hazard indices could not be calculated because reference doses are not available for the contaminants of concern.

8.2.7.1.1.4 *Installation Resident*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the current installation resident because of the distance of the housing from the Chemical Range. Potential exposure at the installation housing would be associated with inhalation of particulates released from Site 7 soil for the carcinogenic pathway. The carcinogenic risk for average exposure is 1E-13, and the carcinogenic risk for the RME is 5E-10.

NONCARCINOGENIC RISKS

Hazard indices could not be calculated because reference doses are not available for inhalation of the contaminants of concern.

8.2.7.1.1.5 *Off-Site Residents*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the off-site residents because of the distance from the Chemical Range to off-site housing. Soil concentrations from the Chemical Range were used to model predicted particulate concentrations at Tooele, Stockton, and Grantsville. The carcinogenic risk factors are summarized in Table 8-19.

Table 8-19. Carcinogenic Risk Factors

City	Average	RME
Tooele	4E-17	5E-14
Stockton	7E-17	9E-14
Grantsville	3E-17	4E-14

NONCARCINOGENIC RISKS

Noncarcinogenic risks could not be calculated because reference doses were not available for the contaminants of concern.

8.2.7.1.2 *Future Land Use*. The only future land use scenario considered is for possible future on-site residents. Results from this exposure scenario are discussed below.

CARCINOGENIC RISKS

The total carcinogenic risk factor for future on-site residents at Site 7 for average exposure is 7E-13 based on soil inhalation.

The total risk factor from RME is 9E-10 based on soil inhalation. Both the average exposure and RME are below the EPA target range for residual risk of 1E-04 to 1E-06.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for future on-site residents at Site 7 for average exposure is 2E-03. The hazard index for soil ingestion is 1E-03 and for dermal exposure is 1E-04.

The total hazard index for noncarcinogenic risk from RME is 1E-02. The hazard index for soil ingestion is 1E-02 and for dermal exposure is 1E-03.

Average exposure and RME hazard indices meet the EPA goal of a residual hazard index of 1 or less.

8.2.7.2 *Environmental Evaluation*

8.2.7.2.1 ***Site Characterization***. Operable Unit 8, which includes Site 7, is located near the south-central boundary of the facility. The primary vegetation at this site is sagebrush and grasses, which is typical of the region.

Site 7 receives little industrial or human use, therefore, it offers reasonably good potential habitat for wildlife, and many of the potential wildlife species identified for TEAD-N (Section 2.9) could inhabit the area and remain relatively undisturbed. The environmental evaluation for Site 7 is qualitative and did not include bioassays of the vegetation and wildlife or an inventory of wildlife. A site-specific inventory of vegetation was compiled and is listed in Table 8-20.

A data gap sampling plan to collect additional information is needed at this site to further determine the extent of contamination and the degree of ecological risk. The findings would be issued as an RI report addendum.

No surface water or evidence of surface water was observed during the field investigation. Furthermore, it is unlikely that any significant surface water accumulates within this site as a result of storm episodes or snowmelt.

8.2.7.2.2 ***Biological Effects of Contaminants***. Table 8-21 summarizes the relevant information for the chemicals of concern for Site 7, which was taken from Table 3-18.

8.2.7.2.3 ***Potential Pathways***. No biological samples were obtained, thus, the uptake of contaminants by flora and fauna cannot be evaluated at this time. The most probable pathways of contaminants through the ecosystem are as follows:

- Plants

–Direct uptake by plants through roots

- Wildlife

–Ingestion of contaminated soil
–Ingestion of contaminated foliage
–Ingestion of contaminated insects
–Ingestion of contaminated carrion/animals
–Dermal contact
–Inhalation of vapors
–Inhalation of contaminated particulates

Potential pathways are shown in Figure 8-11.

Table 8-20. Vegetation Inventory (Site 7)

Scientific Name	**Common Name**
PRIMARY VEGETATION SPECIES	
Bromus tectorum	Cheatgrass
Artemisia tridentata	Sagebrush
Chrysothamnus viscidiflorus	Viscid rabbitbrush
OTHER VEGETATION SPECIES	
Helianthus annus	Annual sunflower
Veronica biloba	Bilobed speedwell
Cirsium vulgre	Bull thistle
Ranunculus testiculatus	Bur-buttercup
Cirsium arvense	Canadian thistle
Chenopodium sp	Chenopod
Agropyron cristatum	Crested wheatgrass
Oenothera pallida	Evening-primrose
Hordeum jubatum	Foxtail barley
Sphaeralcea coccinea	Globe mallow
Sarcobatus vermiculatus	Greasewood
Grindelia squarrosa	Gumweed
Halogeton glomeratus	Halogenton
Stipa hymenoides	Indian ricegrass
Elymus hispidus	Intermediate wheatgrass
Oenothera caespitosa	Morning lilly
Stipa comata	Needle-and-threadgrass
Lepidium perfoliatum	Peppergrass
Lactuca scariola	Prickly lettuce
Opuntia polyacantha	Prickly pear cactus
Chrysothamnus nauseosus	Rabbitbrush
Lygodesmia grandiflora	Rush pink
Salsola iberica	Russian thistle

Table 8-20. Vegetation Inventory (Site 7) (continued)

Scientific Name	**Common Name**
OTHER VEGETATION SPECIES (Cont.)	
Sporobolus cryptandrus	Sand dropseed
Calochortus nuttallii	Sego lily
Elymus elymoides	Squirreltail
Erodium cicutarium	Storksbill
Duscurainia sophia	Tansy mustard
Aristida purpurea	Three-awn
Sisymbrium officinale	Tumbling mustard
Juniperus osteosperma	Utah juniper
Astragalus utahensis	Utah milkvetch
Verbascum vergatum	Wand mullein
Melilotus albus	White sweetclover
Tragopogon dubius	Yellow goats beard
Melilotus officinalis	Yellow sweetclover

Table 8-21. Summary of Contaminants (Site 7)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
Cadmium	VL[a]	M[b]→H[c]	BA[d]	3[e]	3	known animal carcinogen
Chromium	VL	L[f]→H	BC[g]	1[h]	3	many Cr+6 cmpds are animal and human carcinogens
Copper	I[i]	VL→M	BC	3	3	Cu° metal toxicity very low; many Cu(II) salts are toxic
Nickel	I	L→M	BA	1	3	dust is confirmed carcinogen; low oral toxicity for metal
Zinc	I	VL→L	BC	--	3 dust explosive	many Zn cmpds are toxic; dust is an irritant

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]VL=very low.
[b]M=moderate.
[c]H=high.
[d]BA=bioaccumulates.
[e]3=tissue or organ damage.
[f]L=low.
[g]BC=bioconcentrate.
[h]1=carcinogenic.
[i]I=insoluble.

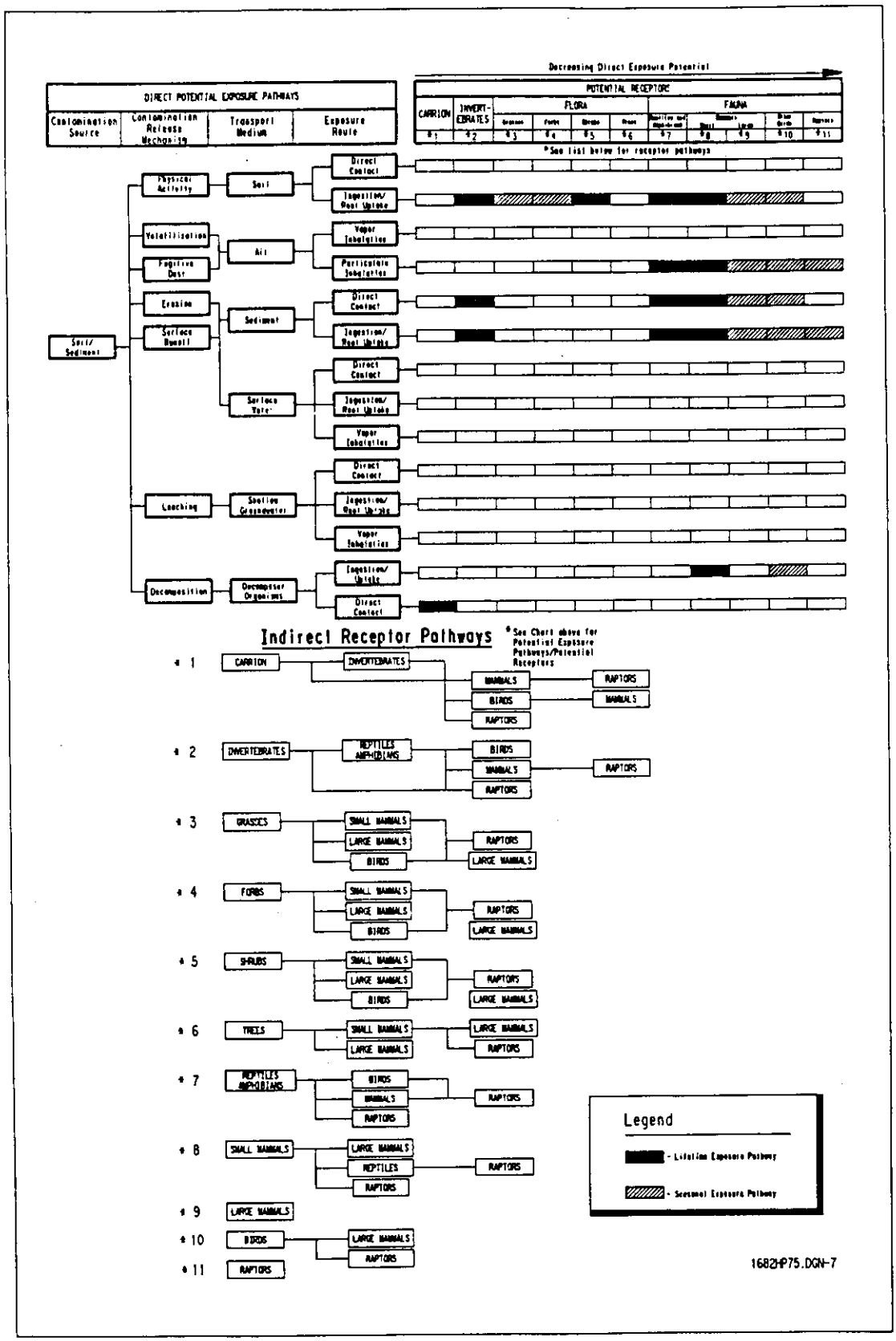


Figure 8-11. Potential Ecological Exposure Pathways for Site 7

8.2.7.2.4 ***Potentially Affected Populations.*** Table 8-22 presents a summary of exposure points, general population, and the activity by which ecological exposure may occur. The table is listed in decreasing exposure potential.

Table 8-22. Exposure Scenarios for Ecological Populations

Exposure Point	Exposed Populations	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Large Mammals	Ingestion of contaminated vegetation; foliage, fruit, and potentially roots.	Likely, because of usable habitat and little industrial or human use.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Occasional exposure, only when feeding at this site.
Terrestrial Locations	Raptors	Ingestion of contaminated carrion-or animals.	Unlikely; exposed when feeding in other areas on prior inhabitants of the site.

8.2.7.2.5 ***Environmental Evaluation Conclusions.*** The primary contaminants of concern at this site are metals, which have a qualitative biological hazard ranking of moderate to high because these contaminants are toxic and may bioaccumulate. Concentrations of these contaminants above background levels could be problematic at the individual and local species population level; the specific effects cannot be evaluated with the available data. While the potential biological hazard ranking for these contaminants is high, the surface-soil concentration levels are at background concentrations; therefore, surface receptor exposure is unlikely. Plant species and burrowing animals have the highest risk of exposure because of the subsurface contamination at this site.

Alterations to the trophic structure and ecological processes at Site 7 or to the TEAD-N facility cannot be evaluated until further data are collected. Recovery times cannot be derived or predicted from the information evaluated.

In order to completely assess the ecological risk at this site, biological sampling and analysis is necessary. Tissue sampling of vegetation and wildlife, analyses for chemicals of concern during the growing season, and a species inventory are warranted.

8.2.8 Conclusions

The extent of contamination at Site 7 was not defined. Test Pit 1, which encountered debris from one of the former trenches, contained only elevated concentrations of zinc at the surface and at a depth of 5 feet. Test Pit 2, although located in the area of the former trenches, did not contain buried debris. It is believed that this test pit was excavated in the edge or just outside of a former trench. It contained elevated levels of anions, and low levels of two phthalate esters. Test Pit 3, which was excavated in an area where two geophysical surveys indicated a target for buried materials, contained no contaminants of concern with the exception of one detection of butylbenzyl phthalate. The source of the geophysical anomaly is still unknown.

Surface samples collected during the RI contained no detectable concentrations of contaminants. The soils sampled by Weston (1990), which did contain elevated concentrations of metals, are no longer present. The soils apparently were used to backfill the two open trenches sometime in the 1990-1991 time frame.

8.2.9 Recommendations

To better characterize the site, a second test-pit sampling program is necessary. The data obtained from the sampling will be used to re-evaluate potential health effects associated with the site.

8.3 TIRE DISPOSAL AREA (Site 13)

8.3.1 Site Characteristics

The Tire Disposal Area (Figure 1-12) consists of a large pit that resulted from previous gravel-mining operations. The area covers approximately 11 acres in the southern portion of TEAD-N. Unreclaimable tire carcasses from TEAD-N vehicles had been disposed of in the former gravel-mining pit since 1965. Thousands of tires were placed on the ground surface of the pit and, in some areas of the pit, the tires were covered with gravel. The majority of the tires, however, had lain exposed on the ground surface.

8.3.2 Previous Investigations and RI Activities

No environmental investigations have been conducted at this site, and no sampling and analysis has been performed chiefly because of the relatively stable condition of potential contaminants within the tires. No sampling was conducted at this site during the current RI. A site walkover was conducted, however, to determine if there was evidence of the disposal of any other potentially hazardous materials. The results of this walking survey indicate that no other types of waste disposal were conducted at this site. Photographs of the tire disposal area taken during the RI are presented in Appendix D. Subsequent to the RI, all of the tires were removed off-site for re-use.

8.3.3 Nature and Extent of Contamination

There have been no previous investigations at Site 13, and no sampling activities were conducted during the RI. A visual survey of the site during the RI revealed that approximately 100,000 tires were placed in Site 13, of which about 85 percent were 20-inch truck tires, 10 percent were 16-inch automobile tires, and 5 percent were heavy equipment tires. With the exception of wooden pallets, no other disposal activities appear to have occurred at Site 13. Some concern remains over the possibility of soil contamination that may have resulted from the tire disposal operation.

8.3.4 Contaminants of Concern

There were no chemicals of concern identified for Site 13 because RI sampling was not performed.

8.3.5 Contaminant Fate and Transport

The tires have been removed. However, residual contaminants may be present in the soil.

8.3.6 Potential Exposure Pathways

Because there are no existing contaminant data at Site 13, an assessment of exposure pathways was not conducted.

8.3.7 Baseline Risk Assessment

8.3.7.1 *Human Health Evaluation*

No human health evaluation was performed for Site 13 because there are no data to characterize a contaminant release at this site.

8.3.7.2 *Environmental Evaluation*

8.3.7.2.1 *Site Characterization*. Operable Unit 8, which includes Site 13, is located near the south-central boundary of the facility. The primary vegetation at this site is sagebrush and grasses, which is typical of the region.

This site is largely usable habitat for most of the species identified at TEAD-N. Site 13 receives little industrial or human use; therefore, it offers reasonably good potential habitat for wildlife. Many of the potential wildlife species identified for TEAD-N (Section 2.9) could inhabit the area and remain relatively undisturbed. A wildlife inventory of the area has

not been conducted, but a site-specific inventory of vegetation has been compiled and is listed in Table 8-23.

Table 8-23. Vegetation Inventory (Site 13)

Scientific Name	Common Name
PRIMARY VEGETATION SPECIES	
Bromus tectorum	Cheatgrass
Chrysothamnus nauseosus	Rabbitbrush
Artemisia tridentata	Sagebrush
OTHER VEGETATION SPECIES	
Helianthus annuus	Annual sunflower
Cirsium vulgre	Bull thistle
Agropyron cristatum	Crested wheatgrass
Grindelia squarrosa	Gumweed
Halogenton glomeratus	Halogenton
Stipa comata	Needle-and-threadgrass
Lepidium perfoliatum	Peppergrass
Lactuca scariola	Prickly lettuce
Opuntia polyacantha	Prickly pear cactus
Salsola iberica	Russian thistle
Erodium cicutarium	Storksbill
Chrysothamnus viscidiflorus	Viscid rabbitbrush
Melilotus albus	White sweetclover
Tragopogon dubius	Yellow goats beard
Melilotus officinalis	Yellow sweetclover

No surface water or evidence of surface water was observed during the field investigation. While it is unlikely that any significant surface water accumulates within this site as a result of storm episodes or snowmelt, it is possible this could occur, which would influence migration of resident populations.

8.3.7.2.2 ***Biological Effects of Contaminants.*** No contaminants of concern were identified at this site. Therefore, biological effects were not addressed.

8.3.7.2.3 ***Potential Pathways.*** No biological samples were obtained. Thus, the potential uptake of contaminants by flora and fauna cannot be evaluated at this time. Furthermore, no contaminants of concern were identified at this site. Therefore, none of the potential exposure pathways are considered to be complete.

8.3.7.2.4 ***Potentially Affected Populations.*** No contaminants of concern were identified for this site. Therefore, none of the potentially affected populations have been addressed.

8.3.7.2.5 ***Environmental Evaluation Conclusions.*** No chemicals of concern have been identified for this site to date. Sampling and data analysis would allow characterization of any environmental impacts.

8.3.8 Conclusions

There is no evidence that contaminants have been released to the environment as a result of the tire disposal operations at Site 13. Although a walkover survey conducted at the site showed no other wastes disposed at this site, soil sampling and analysis are indicated to verify the absence of contamination.

8.3.9 Recommendations

Soil samples should be taken at Site 13 to allow characterization and risk analysis.

8.4 BUILDING 1303 WASHOUT POND (Site 22)

8.4.1 Site Characteristics

The Building 1303 Washout Pond (Site 22) is located in the southwestern portion of TEAD-N (see Figure 1-13). Site 22 consists of a shallow depression that reportedly received washdown water from Building 1303. Building 1303 was a facility for sawing apart high explosive bombs and projectiles. It is believed that the washdown water may have contained explosives as it left the building. The washdown water ran from the building doors, across a concrete pad, into an unlined ditch, and to a shallow depression referred to as the Building 1303 Washout Pond. Most of the liquids from the washdown operation would have infiltrated the ground. It is possible, however, that the depression may have filled and overflowed, resulting in the spreading of potentially contaminated water to surface soils.

8.4.2 Previous Investigations and RI Activities

No previous environmental investigations have been conducted at Site 22. There are also no operating records that define the composition of the washdown effluent. Sampling and analysis for the current RI consisted of 10 surface-soil samples collected in the shallow drainage ditch (adjacent to the cement pad), small depression (pond), and spreading area downstream from Building 1303. Locations of these samples are shown in Figure 8-12.

These samples were analyzed for explosives, inorganics, and anions. A small area of the drainage ditch was heavily stained at the time of sampling, indicating a high potential for contamination. Photographs of the sampling locations are provided in Appendix D.

8.4.3 Nature and Extent of Contamination

RI activities included the collection and analysis of 10 surface-soil samples (Figure 8-13). All soil samples were analyzed for explosives, inorganics, and anions; sample BWS-92-02 was also analyzed for reactivity. Results of analytes detected above background are shown in Table 8-24. The following explosives were detected: 1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, HMX, and RDX. The following metals were detected at levels above background: chromium, copper, iron, lead, nickel, and zinc. The anions nitrite and cyanide were each detected in one sample at levels above background. The areal extent of explosives and metals contamination appears to extend from the area near Building 1303 to the shallow depression northeast of the building. Soil samples from the shallow depression showed the highest concentrations of explosives. Soil samples from the area northeast of the depression (samples BWS-92-05 through BWS-92-10) did not show explosives or metals contamination, except for 9.11 μg/g of 2,4,6-TNT in sample BWS-92-08. The vertical extent of explosives and metals contamination has not been assessed because there were no subsurface-soil samples taken at this site. In addition, several metals (antimony, arsenic, selenium, and thallium) exhibited high detection limits because of sample matrix interferences. The detection limits were 10-170 μg/g for antimony, 24-240 μg/g for arsenic, 250-2,000 μg/g for selenium, and 16.6-170 for thallium.

Additional soil borings and surface samples are scheduled to be taken and analyzed for explosives and metals to more fully characterize the site. Data from these analyses will be combined with all available data to recalculate and assess risks to human health and the environment. These results will be reported and analyzed in an RI Report Addendum and future FS.

8.4.4 Contaminants of Concern

Table 8-25 presents a summary of the contaminants of concern for Site 22, including the range of detected concentrations, and comparisons against the certified reporting limit and background concentrations.

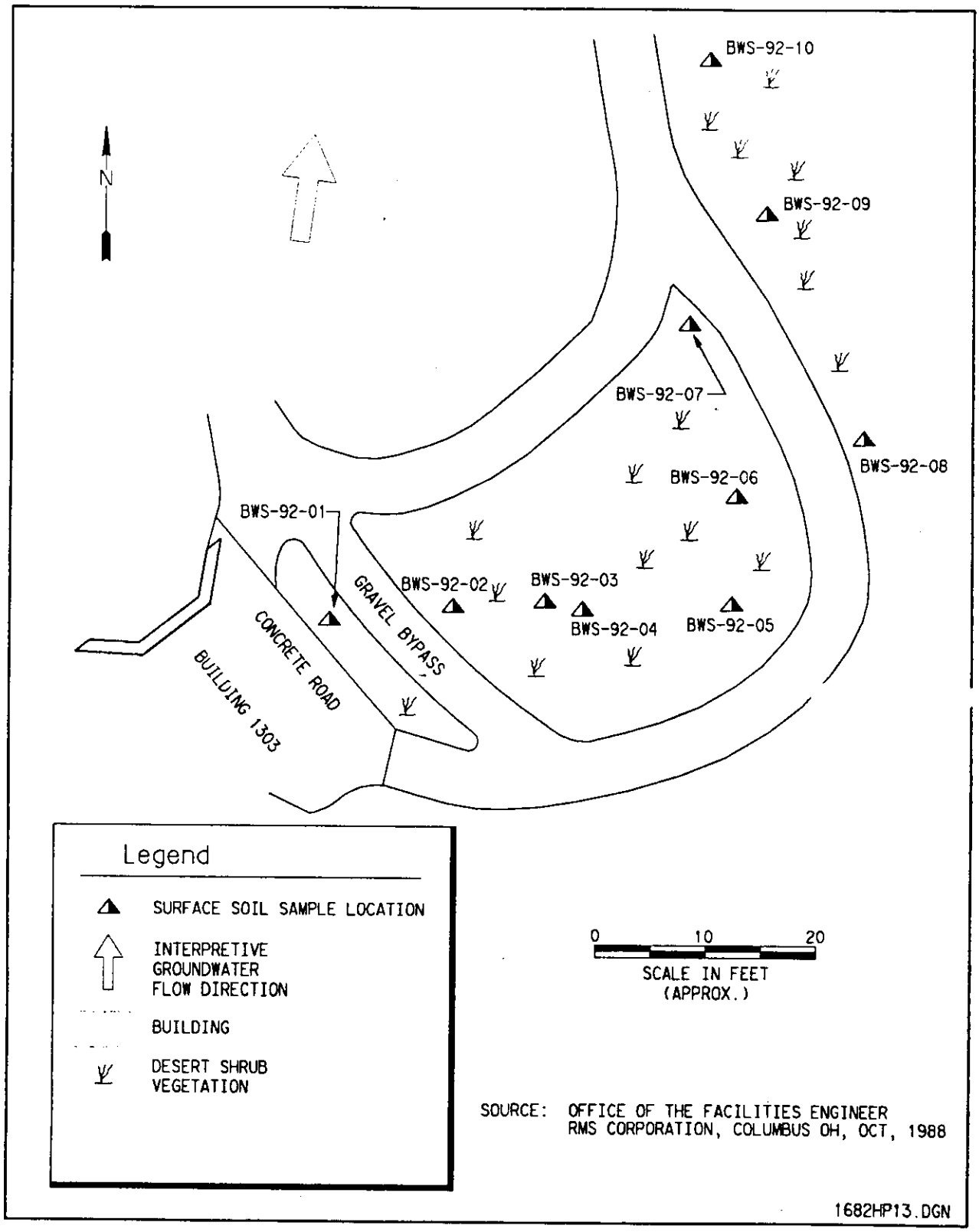


Figure 8-12. RI Soil Sample Locations at the Building 1303 Washout Pond Site

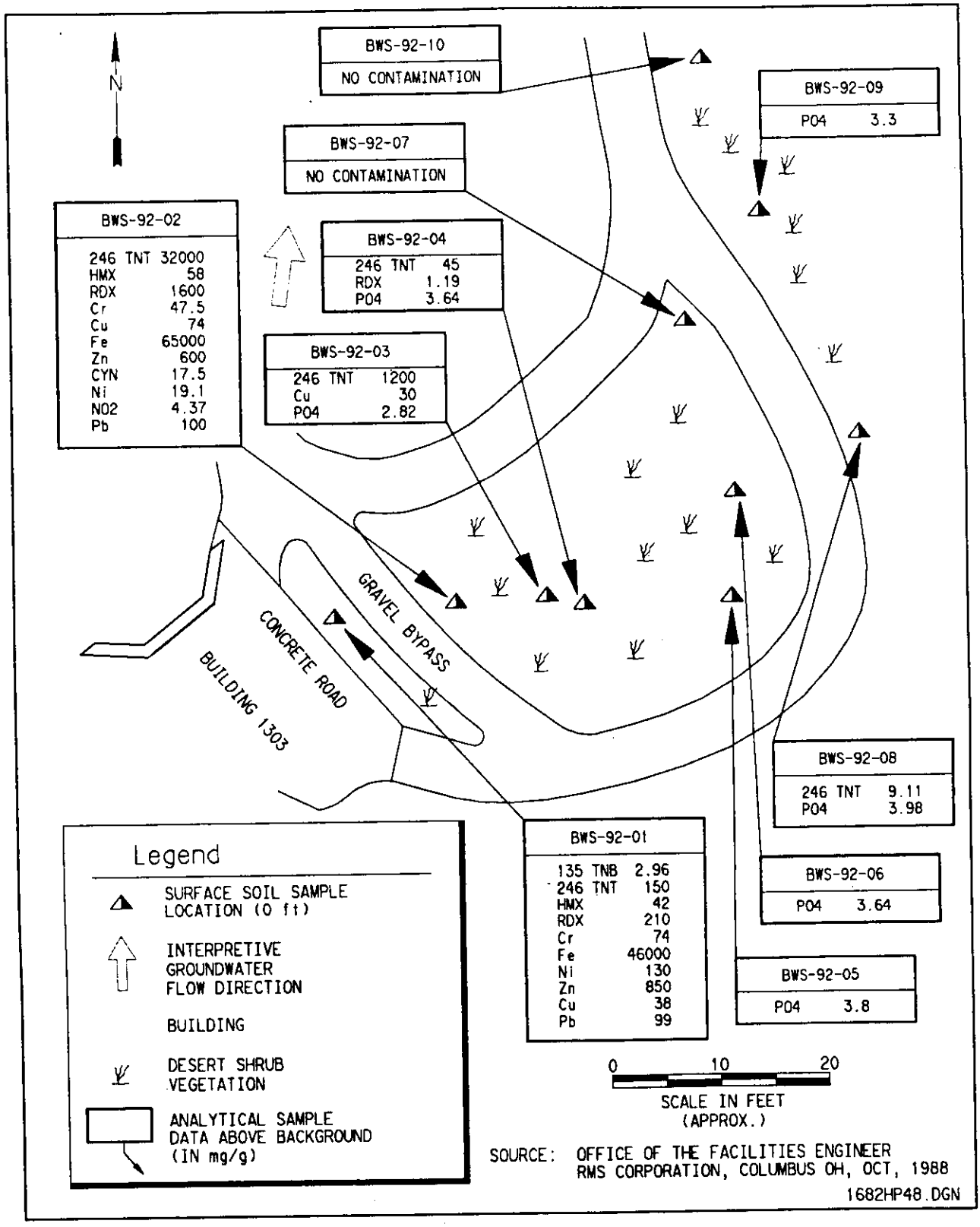


Figure 8-13. RI Soil Sample Results for the Building 1303 Washout Pond (Site 22)

Table 8-24. Summary of Analytes Above Background Concentrations for Surface Soil Samples at Building 1303 Washout Pond (Site 22)

Analytes	BWS-92-01*	BWS-92-02*	BWS-92-03*	BWS-92-04*	BWS-92-05*	BWS-92-06*	BWS-92-07*	BWS-92-08*	BWS-92-09*	BWS-92-10*	Background Concentrations
	Concentrations in µg/g										
Anions											
Nitrite	LT	4.37	LT	LT	LT	LT	LT	LT	LT	LT	3.16
Cyanide	LT	17.5	LT	LT	LT	LT	LT	LT	LT	LT	0.92
Explosives											
1,3,5-Trinitrobenzene	2.96	LT	LT	LT	LT	LT	LT	LT	LT	LT	---
2,4,6-Trinitrotoluene	150	32000	1200	45.0	LT	LT	LT	9.11	LT	LT	---
HMX	42.0	58.0	LT	LT	LT	LT	LT	LT	LT	LT	---
RDX	210	1600	LT	1.19	LT	LT	LT	LT	LT	LT	---
Inorganics											
Chromium	74.0	47.5	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	22.8
Copper	38.0	74.0	30.0	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	28.2
Iron	46000	65000	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	25400
Lead	99.0	100	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	63.4
Nickel	130	<BKGD	LT	LT	LT	LT	LT	LT	LT	LT	19.3
Zinc	850	600	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	169

Notes.—ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations.

*Samples were taken from 0 to 6 inches.

Table 8-25. Contaminants of Concern for Surface Soil at Building 1303 Washout Pond (Site 22)

Analyte	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration *	Method	Sample Quantitation Limit
1,3,5-Trinitrobenzene	1	10	2.96	2.96	0.769	1.35	---	LW26	0.352
2,4,6-Trinitrotoluene	5	10	9.11	32000	3341	9172	---	LW26	.931
Chromium	10	10	7.10	74.0	18.7	32.0	21.6	JS15	3.90
Copper	10	10	5.55	74.0	19.0	32.0	25.2	JS15	1.95
Cyanide	1	10	17.5	17.5	4.000	6.75	3.59	KY07	5.00
HMX	2	10	42.0	58.0	10.6	22.9	---	LW26	0.755
Iron	10	10	6600	65000	18370	30009	23040	JS15	1.89
Lead	10	10	9.2	100	31.2	52.2	63.4	JD13	0.319
Nickel	2	10	19.1	130	15.9	39.3	18.4	JS15	2.46
Nitrite	1	10	4.37	4.37	1.86	2.37	1.58	KT04	3.16
Phosphate	6	10	2.82	3.98	3.11	3.47	2.50	KT04	2.82-5.00
RDX	3	10	1.19	1600	1818	4720	---	LW26	0.502
Zinc	10	10	28.0	85000	177	3480	148	JS15	7.96

Notes.—All results are reported as $\mu g/g$. Surface soil includes all soil samples from depth of less than 6 inches. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

*Background concentrations were derived as mean plus 2 standard deviation from background data for conservative approach (tolerance limit).

8.4.5 Contaminant Fate and Transport

Section 3.4 provides a description of the fate and transport processes for the organic contaminants of concern. In general, explosives are expected to be mobile in soil and subject to leaching. Most explosives are not expected to be present in the vapor phase, except for 2,4,6-trinitrotoluene. Explosives may biodegrade and are not expected to bioaccumulate.

The fate and transport of metals is complex and is dependent upon such factors as the valence state of the metals and the pH of the soil. Typically, metals are expected to be immobile in soil and resistant to leaching. An exception is the chromium (VI) ion, which is subject to leaching.

8.4.6 Potential Exposure Pathways

Figure 8-14 presents the potential exposure pathways for this site. At this site, the primary exposure pathways are dermal contact with, ingestion of, and inhalation of contaminated soils on site. Present and future on-site workers and future on-site residents are potential receptors. Additionally, if soil contaminants leach to groundwater, future on-site residents could be exposed to contaminated groundwater through the installation of on-site water supply wells. Bioconcentration is not expected to occur for explosives, and the concentrations of explosives detected in soil samples do not indicate an explosion hazard.

8.4.7 Baseline Risk Assessment

8.4.7.1 *Human Health Evaluation*

Tables 8-26 and 8-27 present risk estimates for each exposure scenario under current site use conditions and future use. The estimates are discussed below by scenario, which include average exposure and reasonable maximum exposure for carcinogenic and noncarcinogenic risks. Tables showing risk factors by individual contaminant of concern are presented in Appendix I.

8.4.7.1.1 ***Current Land Use.*** This section discusses estimates for each exposure scenario assessed under current site-use conditions.

8.4.7.1.1.1 ***On-site Worker***

CARCINOGENIC RISKS

The total carcinogenic risk factor for on-site workers at Site 22 for average exposure is 6E-05. The risk factor for dermal exposure is 5E-05, for soil inhalation is 5E-11, and for soil ingestion is 8E-06.

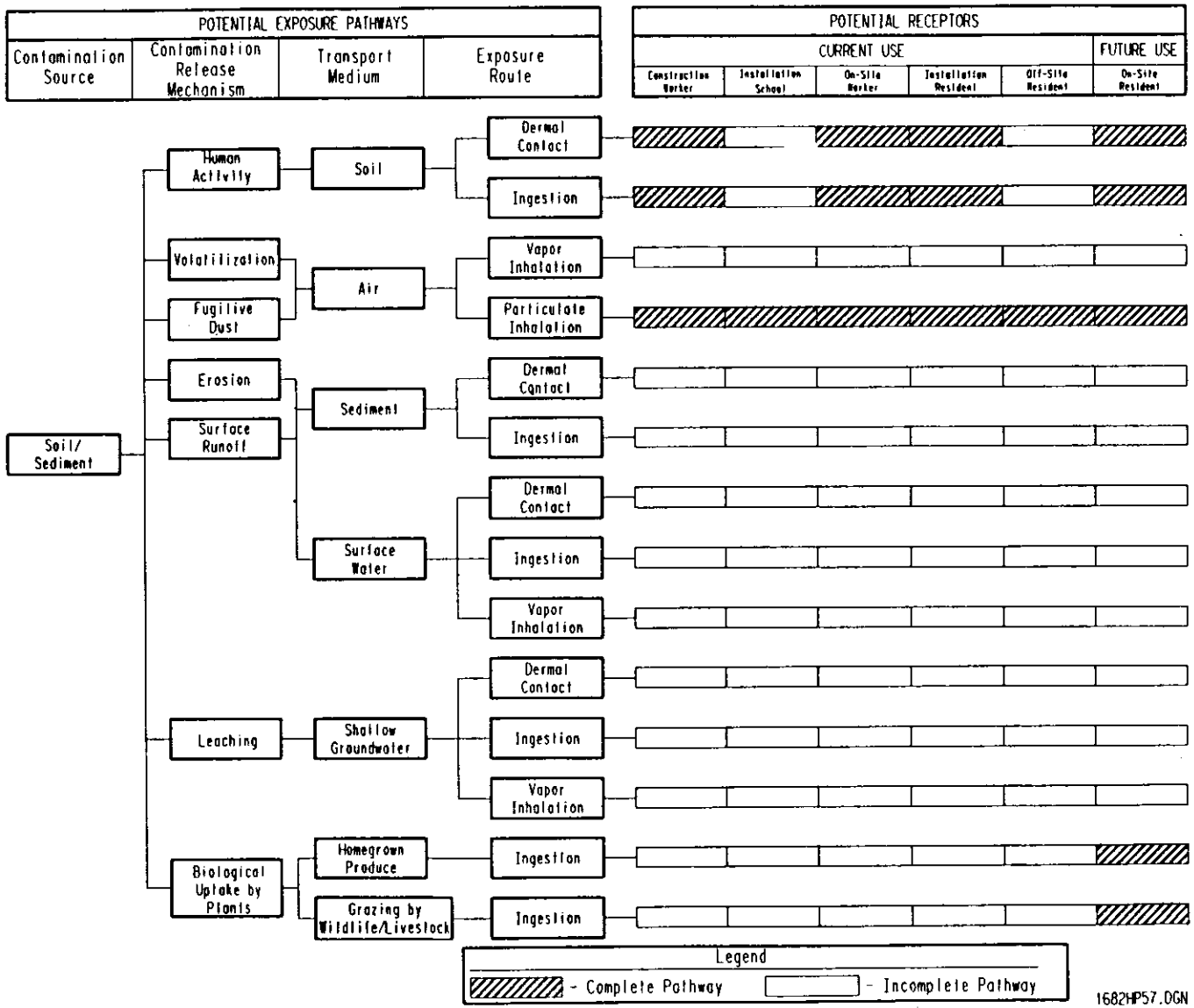


Figure 8-14. Potential Human Exposure Pathway Conceptual Model for the Building 1303 Washout Pond (Site 22)

Table 8-26. Risk Estimate Summary Using Average Exposure Levels for the Building 1303 Washout Pond (Site 22)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
1,3,5-Trinitrobenzene		7.53E-03		7.52E-03												1.05E-02
2,4,6-Trinitrotoluene	7.05E-06	3.27+E00	7.05E-07	3.27E+00											8.89E-06	4.58E+00
Chromium		1.83E-03		1.83E-03												2.56E-03
Copper		2.51E-03		2.51E-03												3.52E-03
Cyanide		9.78E0-5		2.78E-05												1.37E-04
HMX		1.04E-04		1.04E-03												1.46E-04
Nickel		3.89E-04		3.89E-03												5.45E-04
Nitrite		9.09E-06		9.10E-06												1.27E-05
RDX	1.40E0-06	2.96E-02	1.40E-07	2.96E-02											1.75E-06	4.14E-02
Zinc		2.88E-04		2.89E-04												4.04E-04
	8.45E-06	3.31E+00	8.45E-07	3.31E+00											1.06E-05	4.64E+00
Inhalation																
Chromium	4.50E-11		4.50E-12		3.60E-11		2.01E-11		3.92E-15		5.92E-15		4.80E-15		9.06E-11	
Nickel	1.13E-12		1.13E-13		9.04E-13		5.06E-13		9.86E-17		1.49E-16		1.21E-16		2.28E-12	
	4.61E-11		4.61E-12		3.69E-11		2.06E-11		4.02E-15		6.07E-15		1.21E-16		9.29E-11	
Dermal																
1,3,5-Trinitrobenzene		4.67E-02		4.67E-02												6.53E-02
2,4,6-Trinitrotoluene	4.37E-05		4.37E-06												5.51E-05	
Chromium		1.13E-04		1.13E-04												1.58E-04
Cyanide		6.07E-04		6.07E-04												8.49E-04
HMX																
Nickel		2.41E-05		2.41E-05												3.38E-05
Nitrite		5.64E-05		5.64E-05												7.89E-05
RDX	8.65E-06	1.83E-01	8.65E-07	1.83E-01											1.09E-05	2.57E-01
Zinc		1.79E-05		1.79E-05												2.50E-05
	5.24E-05	2.31E-01	5.24E-06	2.31E-01											6.60E-05	3.23E-01
Total for Site	**6.08E-05**	**3.54E+00**	**6.08E-06**	**3.54E+00**	**3.69E-11**		**2.06E-11**		**4.02E-15**		**6.07E-15**		**4.93E-15**		**7.66E-05**	**4.96E+00**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

Table 8-27. Risk Estimate Summary Using Reasonable Maximum Exposure Levels for the Building 1303 Washout Pond (Site 22)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
1,3,5-Trinitrobenzene		1.32E-02		1.27E-01												1.05E-01
2,4,6-Trinitrotoluene	5.81E-05	8.97E+00	1.86E-05	8.62E-01											1.41E-04	7.12E+01
Chromium		3.13E-03		3.01E-02												2.48E-02
Copper		4.24E-03		4.06E-02												3.36E-02
Cyanide		1.65E-04		1.59E-03												1.31E-03
HMX		2.24E-04		2.15E-03												1.78E-03
Nickel		9.62E-04		9.23E-03												7.63E-03
Nitrite		1.16E-05		1.11E-04												9.20E-05
RDX	1.09E-05	7.70E-02	3.49E-06	7.40E-01											2.64E-05	6.11E-01
Zinc		5.68E-04		5.45E-03												4.50E-03
	6.90E-05	9.07E+00	2.21E-05	8.71E+01											1.67E-04	7.20E+01
Inhalation																
Chromium	3.15E-08		1.58E-09		8.41E-09		6.68E-07		5.16E-12		7.73E-12		6.28E-12		1.19E-07	
Nickel	7.92E-10		3.98E-11		2.11E-10		1.68E-09		1.30E-13		1.95E-13		1.58E-13		2.98E-09	
	3.23E-08		1.62E-09		8.62E-09		6.84E-08		5.29E-12		7.92E-12		6.44E-12		1.22E-07	
Dermal																
1,3,5-Trinitrobenzene		8.21E-02		8.19E-02												6.17E-01
2,4,6-Trinitrotoluene	3.60E-04		1.20E-05												8.43E-04	
Chromium		1.94E-04		1.94E-04												1.46E-03
Cyanide		1.02E-03		1.02E-03												7.68E-03
HMX																5.40E-04
Nickel		5.96E-05		5.96E-05												4.48E-04
Nitrite		7.19E-05		7.19E-05											1.58E-04	3.59E+00
RDX	6.76E-05	4.78E-01	2.25E-06	4.78E-01												2.64E-04
Zinc		3.52E-05		3.52E-05											1.01E-03	4.22E+00
	4.28E-04	5.61E-01	1.43E-05	5.61E-01												
Total for Site	**4.97E-04**	**9.64E+00**	**3.63E-05**	**8.77E+01**	**8.62E-09**		**6.84E-08**		**5.29E-12**		**7.92E-12**		**6.44E-12**		**1.17E-03**	**7.62E+01**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

The total carcinogenic risk factor from RME is 5E-04. The risk for dermal exposure is 4E-04, for soil inhalation is 3E-08, and for soil ingestion is 7E-05.

Carcinogenic risks for the RME at the Building 1303 Washout Pond are higher than the EPA target range of 1E-04 to 1E-06 primarily because of risk due to ingestion of explosives and dermal exposure to explosives. These risk estimates are very conservative because the on-site worker is assumed to spend 250 days per year (50 weeks per year) for 10 years at Site 22.

However, there are currently no daily work activities performed at Site 22, so the actual exposure duration would be much less than that indicated by the risk assessment. These risks are also biased from high contaminants found in a small stained area at the site. The surrounding soils contain much lower concentrations of metals and explosives.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for on-site workers at Site 22 for the average exposure is 4E+00. The hazard index for soil ingestion is 3E+00 and for dermal exposure is 2E-01.

The total hazard index for noncarcinogenic risk from RME is 1E+01. The hazard index for soil ingestion is 9E+00 and for dermal exposure is 6E-01. The hazard indices for average exposure and RME exceed the EPA goal for a residual hazard index of 1 or less. However, as explained for the carcinogenic risks above, these estimates are very conservative.

8.4.7.1.1.2 *Construction Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for the construction worker at Site 22, using average exposure, is 6E-06. The risk factor for dermal exposure is 5E-06, for soil inhalation is 5E-12, and for soil ingestion is 8E-07.

The total carcinogenic risk factor from RME is 4E-05. The risk factor for dermal exposure is 1E-05, for soil inhalation is 2E-09, and for soil ingestion is 2E-05. The RME risk factors are within the EPA target range of 1E-04 to 1E-06 for residual risk.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for the construction worker at Site 22, using average exposure, is 4E+00. The hazard index for soil ingestion is 3E+00 and for dermal exposure is 2E-01.

The total hazard index for noncarcinogenic risk from RME is 9E+01. The Hazard Index for soil ingestion is 9E+01 and for dermal exposure is 6E-01.

The hazard indices for the average exposure and RME exceed the EPA goal of a residual hazard index of 1 or less for the construction worker. This is due primarily to the potential for ingestion of explosives. The high risk is based on high concentrations of metals and explosives found in a small area of surface staining. Surrounding soils contain lower concentrations and would pose less of a risk to human health.

8.4.7.1.1.3 *Installation School*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the installation school because of the distance from the school to the Building 1303 Washout Pond. Potential exposure at the installation school would be associated with inhalation of particulates released from Site 22 soil. The carcinogenic risk for average exposure is 4E-11, and the carcinogenic risk for the RME is 9E-09.

NONCARCINOGENIC RISKS

Because of a lack of RfDs for contaminants of concern at Site 22, no calculations of noncarcinogenic risks were performed.

8.4.7.1.1.4 *Installation Resident*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the installation resident because of the distance from the housing area to the Building 1303 Washout Pond. Exposure at installation housing would be associated with inhalation of particulates released from Site 22 soil. The carcinogenic risk for average exposure is 2E-11, and the carcinogenic risk for the RME is 7E-08.

NONCARCINOGENIC RISKS

Because of a lack of RfDs for contaminants of concern at Site 22, no calculations of noncarcinogenic risk were performed.

8.4.7.1.1.5 *Off-Site Residents*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the off-site resident because of the distance from the Building 1303 Washout Pond to off-site housing. Soil contaminant concentrations from the Building 1303 Washout Pond were used to model particulate concentrations at Tooele, Stockton, and Grantsville. The carcinogenic risk for average exposure is 4E-15 for Tooele,

6E-15 for Stockton, and 5E-15 for Grantsville. The carcinogenic risk for the RME is 5E-12 for Tooele, 8E-12 for Stockton, and 6E-12 for Grantsville.

NONCARCINOGENIC RISKS

No RfDs were available for contaminants of concern at Site 22 and, therefore, no calculations of noncarcinogenic risk were performed:

8.4.7.1.2 ***Future Land Use***. The only future land use scenario considered is for possible future on-site residents. Results from this exposure scenario are discussed below.

CARCINOGENIC RISKS

The total carcinogenic risk factor for future on-site residents at Site 22 for the average exposure is 8E-05. The risk factor for dermal exposure is 7E-05, for soil inhalation is 9E-11, and for soil ingestion is 1E-05.

The total carcinogenic risk factor from RME is 1E-03. The risk factor for dermal exposure is 1E-03, for soil inhalation is 1E-07, and for soil ingestion is 2E-04. Results show that the risk factor for dermal exposure under the RME exposure condition exceeds the EPA target range of 1E-04 to 1E-06 for residual risk. This is primarily due to potential exposure to explosives.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for future on-site residents at Site 22 for average exposure is 5E+00. The hazard index for soil ingestion is 5E+00 and for dermal exposure is 3E-01.

The total hazard index for noncarcinogenic risk from RME, using the 95 percent upper confidence limit, is 8E+01. The hazard index for soil ingestion is 7E+01 and for dermal exposure is 4E+00.

The total hazard indices for average exposure and RME exceed the EPA goal of a residual hazard index of 1 or less. Again, potential ingestion of explosive contaminants is the primary concern for future on-site residents at Site 22.

8.4.7.2 Environmental Evaluation

8.4.7.2.1 ***Site Characterization***. Operable Unit 8 contains Site 22, which is located on hilly terrain. Although juniper occurs throughout the OU, the dominant vegetation is sagebrush and grasses. The OU is satisfactory habitat for many of the wildlife species identified at TEAD-N (Section 2.9).

The environmental evaluation for Site 22 is qualitative and did not include bioassay of vegetation or wildlife or an inventory of wildlife. A site-specific inventory of vegetation was compiled and is listed in Table 8-28, Vegetation Inventory (Site 22).

Table 8-28. Vegetation Inventory (Site 22)

Scientific Name	Common Name
PRIMARY VEGETATION SPECIES	
Bromus tectorum	Cheatgrass
Chrysothamnus nauseosus	Rabbitbrush
Artemisia tridentata	Sagebrush
Juniperus osteosperma	Utah juniper
OTHER VEGETATION SPECIES	
Helianthus annuus	Annual sunflower
Oenothera pallida	Evening primrose
Gilia leptomeria	Gilia
Sphaealcea coccinea	Globe mallow
Grindelia squarrosa	Gumweed
Balsamorhiza hookeri	Hooker's balsamroot
Stipa hymenoides	Indian ricegrass
Stipa comata	Needle-and-threadgrass
Opuntia polyacantha	Prickly pear cactus
Cryptantha micrantha	Purpleroot
Salsola iberica	Russian thistle
Sporobolus Cryptandrus	Sand dropseed
Erodium cicutarium	Storksbill
Aristida purpurea	Three-awn; No-etum
Astragalus utahensis	Utah milkvetch
Chrysothamnus viscidiflorus	Viscid rabbitbrush
Tragopogon dubius	Yellow goats beard

Data gap sampling to collect additional information is needed at this site to further determine the extent of contamination and the degree of ecological risk. The findings will be issued as an ecological assessment report.

No evidence of permanent surface water was identified during the field investigation.

8.4.7.2.2 ***Biological Effects of Contaminants***. Table 8-29 summarizes the relevant information for the chemicals of concern for Site 22, which was taken from Table 3-18.

Table 8-29. Summary of Contaminants (Site 22)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
1,3,5-Trinitrobenzene	I[a]	M[b]	BC[c]	3[d]	3	poison by IV; moderately toxic by ingestion
2,4,6-Trinitrotoluene	I	M→H[e]	BC	2[f],3	3	poison by subcutaneous route; mod toxic by ingestion; mutation data reported
Chromium	VL[g]	L[h]→H	BC	1[i]	3	many Cr+6 cmpds are animal and human carcinogens
Copper	I	VL→M	BC	3	3	Cu° metal toxicity very low; many Cu(II) salts are toxic
HMX	L	H	--	--	3	--
Iron	I	L→H	--	--	3 dust explosive	poison by IP[j] route; questionable animal carcinogen; potentially toxic in all forms
Nickel	I	L→M	BA[k]	1	3 dust explosive	dust is confirmed carcinogen; low oral toxicity for metal

Table 8-29. Summary of Contaminants (Site 22) (continued)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
RDX	I	H	BC	3	3	poison by ingestion, IV[l], IP; corrosive, irritant to skin, eyes, mucous membranes
Zinc	I	VL→L	BC	--	3	many Zn cmpds are toxic; dust is an irritant

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]I=insoluble.
[b]M=moderate.
[c]BC=bioconcentrate.
[d]3=tissue or organ damage.
[e]H=high.
[f]2=probable or suspected carcinogen.
[g]VL=very low.
[h]L=low.
[i]1=carcinogenic.
[j]IP=intraperitoneal.
[k]BA=bioaccumulates.
[l]IV=intravenous.

8.4.7.2.3 ***Potential Pathways.*** No biological samples were obtained; thus, the uptake of contaminants by flora and fauna cannot be evaluated at this time. The most probable pathways of contaminants through the ecosystem are as follows:

- Plants

–Direct uptake through root system

- Wildlife

–Ingestion of contaminated soil
–Ingestion of contaminated foliage
–Ingestion of contaminated insects
–Ingestion of contaminated carrion, animals
–Dermal contact
–Inhalation of vapors
–Inhalation of contaminated particulates

Potential pathways are shown in Figure 8-15.

8.4.7.2.4 ***Potentially Affected Populations.*** Table 8-30 presents a summary of exposure points, general population, and the activity by which ecological exposure may occur. The table is listed in decreasing exposure potential.

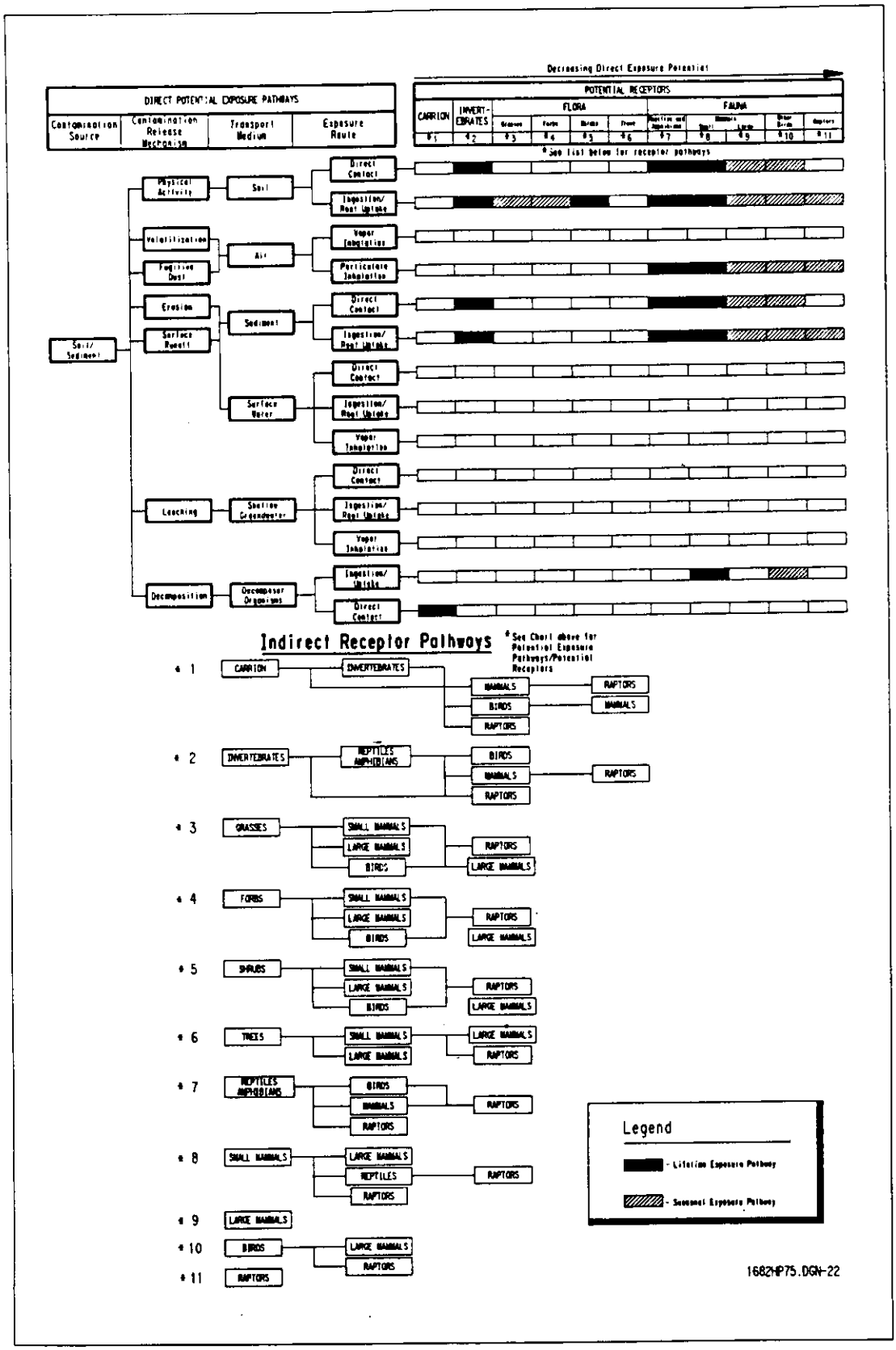


Figure 8-15. Potential Ecological Exposure Pathways for Site 22

Table 8-30. Exposure Scenarios for Ecological Populations (Site 22)

Exposure Point	Exposed Population	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Large Mammals	Ingestion of contaminated vegetation; foliage, fruit, and potentially roots.	Likely due to remoteness of the site and excellent habitat it offers.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Likely when feeding at this site; the site also offers good nesting habitat.
Terrestrial Location	Raptors	Ingestion of contaminated carrion or animals.	Likely when feeding on prey or carrion from this site.

8.4.7.2.5 ***Environmental Evaluation Conclusions.*** The primary contaminants of concern at this site are explosives and metals. In addition, the metal contaminants have a qualitative biological hazard ranking of high because they are toxic and frequently bioaccumulate. The explosive contaminant potential biological hazard ranking is largely unknown. Concentrations of metals above background levels may be problematic at the individual and local species population level; the specific effects cannot be evaluated with the available data.

Alterations to the trophic structure and ecological processes at Site 22 or to the TEAD-N facility cannot be evaluated until further data are collected. Recovery times cannot be derived or predicted from the information evaluated.

In order to completely assess the ecological risk at this site, biological sampling and analysis is necessary. Tissue sampling of vegetation and wildlife, analyses for chemicals of concern during the growing season, and a species inventory are warranted.

8.4.8 Conclusions

At Site 22, the contaminants of concern are the explosives 1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, HMX, and RDX; the metals chromium, copper, iron, lead, nickel, and zinc; and the anions nitrate and cyanide. The highest concentrations of contaminants are located adjacent to the concrete pad for Building 1303. Horizontal and vertical limits of contamination have not been adequately defined.

8.4.9 Recommendations

Additional soil sampling is necessary to determine the horizontal and vertical extent of the soil contamination. The additional data will be used to re-evaluate the risk assessment for Site 22. This will include the evaluation of adverse health effects associated with lead contamination at the site using EPA's Lead Uptake/Biokinetic model.

Several soil borings in the area of the stained soils and shallow depression (washout pond) are needed to determine the vertical extent of contamination. Additional surface soil samples are warranted to define the areal extent of contamination.

8.5 BOMB AND SHELL RECONDITIONING BUILDING (Site 23)

8.5.1 Site Characteristics

The Bomb and Shell Reconditioning Building (Site 23) is located in the western portion of TEAD-N and consists of Buildings 1343, 1344, and 1345 (see Figure 1-14). From the late 1950s to 1977, the main building, Building 1345, was used for performing external work on large munitions. Munitions and parts were taken to the site for reconditioning, which included sandblasting and painting. Floor drains in the building are located near the paint booths in Building 1345. These drains discharge liquids to two ditches that parallel the road and then cross the road via culverts to areas where the liquids are discharged to surface soils. During a site visit in October of 1991, Rust E&I personnel observed several stained areas around the perimeter of the paved areas adjacent to the buildings. In addition, a pile of material containing metal cuttings, oil, and grease was observed behind Building 1343. Building 1343 houses a boiler that was likely used for hot-water or steam washing during the bomb and shell reconditioning process. Although bomb and shell reconditioning activities are no longer conducted at this site, Building 1345 is still used occasionally as a paint shop.

8.5.2 Previous Investigations and RI Activities

No previous environmental investigations had been conducted at Site 23. During a site visit by E.C. Jordan (1990a), two areas of surface staining were observed where two drain pipes discharged into a ditch that parallels the road. In addition, it was noted that areas of staining also were present on the paved surface adjacent to the main building (Building 1345). During the site visit by Rust E&I in October of 1991, additional areas of staining were observed in the soils surrounding the perimeter of the paved area of the facility. To characterize these areas of surface staining and to characterize the areas of wastewater discharge, Rust E&I conducted surface-soil sampling at six locations around the pavement perimeter, and conducted surface-water and sediment sampling in the ditches and downstream spreading areas. The locations of these sampling points are shown in Figure 8-16. Table 8-31 lists the samples collected and describes the location sampled.

Samples were analyzed for VOCs, semi-VOCs, inorganics, anions, and explosives. At the time of sampling, neither area of wastewater discharge was flowing. Five days later,

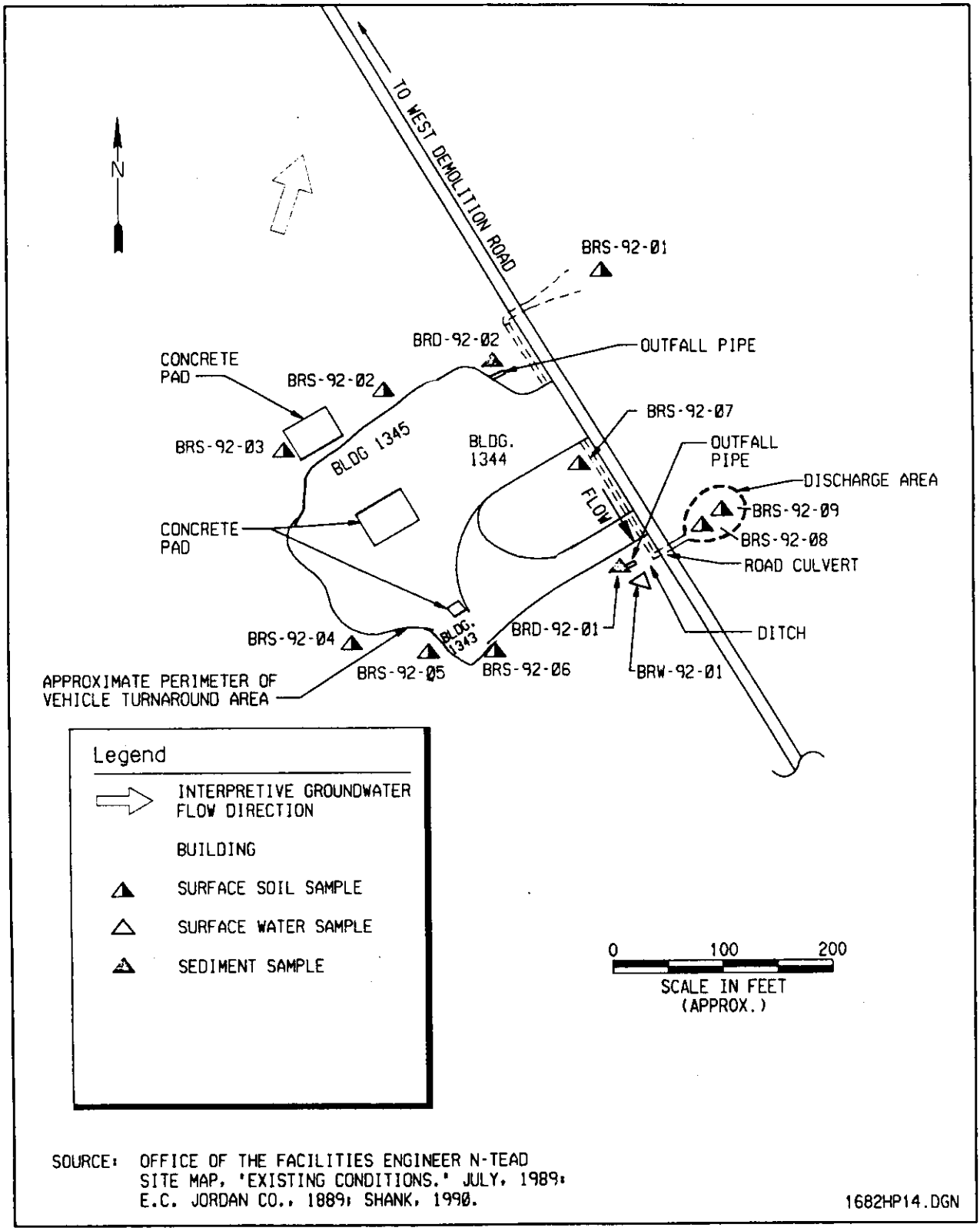


Figure 8-16. RI Sampling Locations at the Bomb and Shell Reconditioning Building (Site 23)

Table 8-31. Summary of Sampling Locations at Site 23

Sample ID No.	Description of Location
BRD-92-01	Sediment from point of discharge for southern discharge pipe.
BRD-92-02	Sediment from point of discharge for northern discharge pipe.
BRS-92-01	Surface soil from ponding area for northern discharge ditch.
BRS-92-02	Surface soil from area of surface staining on northeastern portion of Building 1345.
BRS-92-03	Surface soil from area of surface staining on southeastern portion of Building 1345.
BRS-92-04	Surface soil from surface staining on southern edge of the paved area near pile of waste asphalt.
BRS-92-05	Surface soil from waste pile of oil and grease with metal cutting located south of Building 1343.
BRS-92-06	Surface soil from area of surface staining from a washdown area on the northeastern corner of Building 1343.
BRS-92-07	Surface-soil sample from drainage area located between the two wastewater discharge pipes that drain the paved area.
BRS-92-08	Surface soil from spreading area for the southern discharge pipe.
BRS-92-09	Surface soil from spreading area further downgradient from sample BRS-92-08.
BRW-92-01	Surface water taken from the discharge point of the southern wastewater discharge pipe.

however, the southernmost ditch contained flowing water from wastewater discharge, and a surface-water sample was collected. All of the sampling conducted at Site 23 was biased sampling with emphasis on areas of surface staining. This sampling approach was designed to identify areas of contaminant releases to environmental pathways. Therefore, the extent of contamination was not defined at any of the sampling areas at Site 23. Photographs of Site 23 are provided in Appendix D.

8.5.3 Nature and Extent of Contamination

RI activities included the collection and analysis of nine surface-soil samples, two sediment samples, and one surface-water sample (Figure 8-17). All samples were analyzed for VOCs, semi-VOCs, explosives, inorganics, and anions. The sediment samples and surface-water sample were also analyzed for pesticides/PCBs and anions. Surface-soil sample BRS-92-04 and sediment sample BRD-92-01 were analyzed for reactivity. Results of analytes detected above background concentrations are presented in Tables 8-32 and 8-33.

Low concentrations of several semi-volatile compounds were detected in one sediment sample (BRD-92-02) and surface-soil sample (BRS-92-06). The source of these organic contaminants in the surface soil appears to be a small area on the northeastern corner of Building 1343 where washout operations appear to have occurred (evidenced by staining of the asphalt and soils adjacent to the asphalt). The sediment sample (BRD-92-02) also represents a similar stained area adjacent to a discharge pipe that is used for washdown water in Building 1345. None of the contaminants, however, were found in high concentrations.

The following inorganics and anions were detected in soil and sediment samples at levels above background: cadmium, chromium, copper, iron, lead, mercury, nickel, silver, zinc, cyanide, nitrate, and phosphate. The analytes detected in the surface-water sample were inorganics and anions. These included barium, copper, iron, lead, zinc, chloride, nitrate, phosphate, and sulfate. A comparison to background cannot be made for this sample because there are no background data for surface water.

PCBs were detected in both of the sediment samples. PCB 1254 was detected at 0.646 $\mu g/g$ in sample BRD-92-01, and PCB 1248 was detected at 5.20 $\mu g/g$ in sample BRD-92-02. Both detections are below the EPA remediation guidelines of 10 ppm for industrial areas. There were no PCBs detected in the surface-water sample.

The vertical extent of the soil and sediment contamination has not been assessed because there were no subsurface-soil samples taken at this site. The areal extent of semi-VOC and metals contamination has not been defined for soils and sediment near Building 1343, the drainage ditches, and the discharge area (Figure 8-17). Metals above background concentrations were found in most of the surface-soil samples collected, indicating that transport of metals from the painting operations via washout operations to the paved area has resulted in widespread contamination around the perimeter of the site. The presence of elevated metals in the samples from the surface-water discharge area indicates that washdown water is a source of metals contamination.

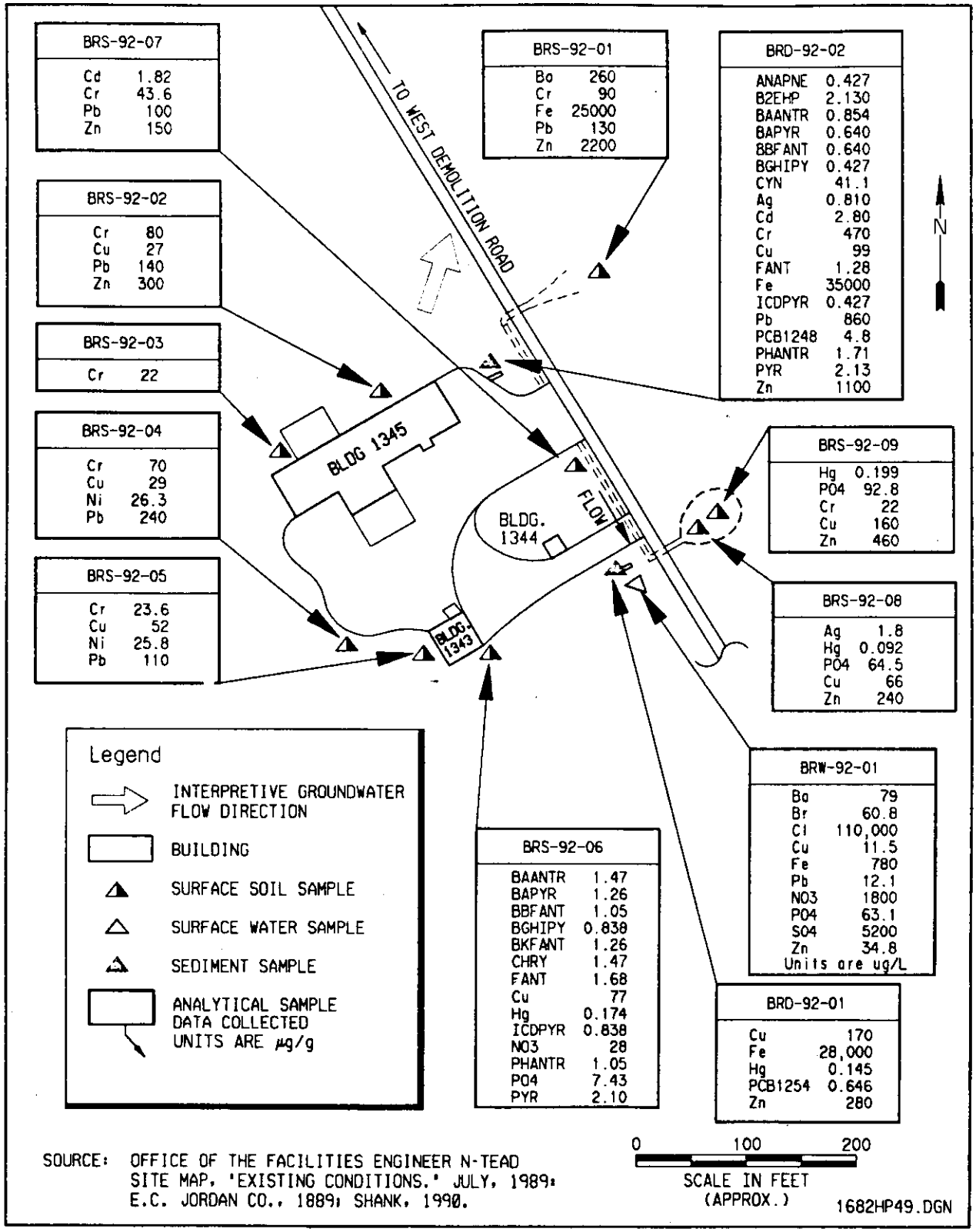


Figure 8-17. RI Sample Results for the Bomb and Shell Reconditioning Building (Site 23)

Table 8-32. Summary of Analytes Above Background Concentrations for Surface Soil Samples at the Bomb and Shell Reconditioning Building (Site 23)

Analytes	BRS-92-01*	BRS-92-02*	BRS-92-03*	BRS-92-04*	BRS-92-05*	BRS-92-06*	BRS-92-07*	BRS-92-08*	BRS-92-09*	Background Concentrations
	Concentrations in µg/g									
VOCs	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
SVOCs										
Benzo[a]anthracene	LT	LT	LT	LT	LT	1.47	LT	LT	LT	---
Benzo[a]pyrene	LT	LT	LT	LT	LT	1.26	LT	LT	LT	---
Benzo[b]fluoranthene	LT	LT	LT	LT	LT	1.05	LT	LT	LT	---
Benzo[g,h,i]perylene	LT	LT	LT	LT	LT	.839	LT	LT	LT	---
Benzo[k]fluoranthene	LT	LT	LT	LT	LT	1.26	LT	LT	LT	---
Chrysene	LT	LT	LT	LT	LT	1.47	LT	LT	LT	---
Fluoranthene	LT	LT	LT	LT	LT	1.68	LT	LT	LT	---
Indeno[1,2,3-cd]pyrene	LT	LT	LT	LT	LT	.839	LT	LT	LT	---
Phenanthrene	LT	LT	LT	LT	LT	1.05	LT	LT	LT	---
Pyrene	LT	LT	LT	LT	LT	2.10	LT	LT	LT	---
Anions										
Nitrate	LT	LT	LT	<BKGD	<BKGD	28.0	LT	<BKGD	<BKGD	9.45
Phosphate	ND	ND	ND	ND	ND	7.43	ND	64.5	92.8	5.00
Explosives	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Inorganics										
Cadmium	LT	<BKGD	LT	LT	LT	LT	1.82	LT	LT	.847
Chromium	90.0	80.0	<BKGD	70.0	23.6	<BKGD	43.6	<BKGD	22.0	22.8
Copper	<BKGD	<BKGD	<BKGD	29.0	52.0	77.0	<BKGD	66.0	160	28.2
Lead	130	140	<BKGD	240	110	<BKGD	100	<BKGD	<BKGD	63.4
Mercury	LT	LT	LT	LT	LT	.174	LT	.092	.199	.037
Nickel	LT	LT	LT	26.3	25.8	LT	<BKGD	LT	LT	19.3
Silver	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	1.80	<BKGD	.749
Zinc	2200	300	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	240	460	169

Notes.—ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations. *Samples were taken from 0 to 6 inches.

Table 8-33. Summary of Analytes Above Background Concentrations for Sediment at the Bomb and Shell Reconditioning Building (Site 23)

Analytes	BRD-92-01	BRD-92-02	Background Concentrations
	Concentrations in μg/g		
VOCs	ND	ND	---
SVOCs			
Acenaphthene	LT	.427	---
Benzo[a]anthracene	LT	.854	---
Benzo[a]pyrene	LT	.640	---
Benzo[b]fluoranthene	LT	.640	---
Benzo[g,h,i]perylene	LT	.427	---
Bis(2-ethylhexyl)phthalate	LT	2.13	---
Butylbenzyl phthalate	.470	ND	---
Chrysene	LT	1.07	---
Fluoranthene	LT	1.28	---
Indeno[1,2,3-cd]pyrene	LT	.427	---
Phenanthrene	LT	1.71	---
Pyrene	LT	2.13	---
Anions			
Phosphate	25.7	ND	5.00
Explosives	ND	ND	---
Inorganics			
Cadmium	LT	2.80	.847
Chromium	<BKGD	470	22.8
Copper	170	99.0	28.2
Cyanide	LT	41.1	.92
Iron	28000	35000	25400
Lead	<BKGD	860	63.4
Mercury	.145	LT	.037
Silver	<BKGD	.810	.749
Zinc	280	1100	169
PCBs			
PCB 1248	ND	5.20	---
PCB 1254	.646	ND	---

Notes.– ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations.

To address these data gaps and to more fully characterize the site, extensive additional sampling is scheduled. Additional borings are scheduled in the drainage ditches, underneath the paved area, and in the unpaved area. Further, ten additional surface soil samples are scheduled. All of these samples will be analyzed for semi-volatile organics and metals and the results used for recalculation and assessment of the risks to human health and the environment. These results will be reported and analyzed in an RI Report Addendum and future FS.

8.5.4 Contaminants of Concern

Tables 8-34, 8-35, and 8-36 present a summary of the contaminants of concern for Site 23, including the range of detected concentrations, and comparisons against the certified reporting limit and background concentrations.

8.5.5 Contaminant Fate and Transport

Section 3.4 provides a description of the fate and transport processes for the contaminants of concern. In general, semi-VOCs are expected to adsorb to soil and be resistant to leaching.

Semi-VOCs are not volatile, but may become airborne through adsorption to windblown soil or sediment. Semi-VOCs are resistant to biodegradation and may bioaccumulate.

The fate and transport of metals is complex and is dependent upon such factors as the valence state of the metals and the pH of the soil. Typically, metals are expected to be immobile in soil and resistant to leaching. An exception is the chromium (VI) ion which is subject to leaching. Anions are expected to be mobile in soil and subject to leaching.

At Site 23, wastewater discharge appears to be a significant transport mechanism for metals contamination originating from the painting process within Building 1345. Metals in solution may be transported a considerable distance from the Site 23 source area. Data from soils within the discharge and drainage area indicate that contaminants from the wastewater are being retained by the soils and sediment.

8.5.6 Potential Exposure Pathways

Figure 8-18 presents the potential exposure pathways for this site. Results of the vadose zone modeling (see Section 3.4) indicate that, because of the depth to the water table, contaminants released from Site 23 would take over 100 years to reach the groundwater and the concentrations of contaminants at that time would be several orders of magnitude lower than current surface concentrations. Therefore, the groundwater pathway does not appear to be a potential exposure pathway for Site 23 contaminants. The surface-water pathway is a likely exposure pathway for environmental receptors such as wildlife and livestock because there are limited sources of water within the TEAD-N area. However, discharge of

Table 8-34. Contaminants of Concern for Sediment at the Bomb and Shell Reconditioning Building (Site 23)

Analytes	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration*	Method	Sample Quantitation Limit
Benzo[a]anthracene	1	2	0.854	0.854	0.577	2.32	---	99	---
Benzo[a]pyrene	1	2	0.640	0.640	0.510	1.33	---	99	---
Benzo[b]fluoranthene	1	2	0.640	0.640	0.500	1.38	---	99	---
Benzo[g,h,i]perylene	1	2	0.427	0.427	0.334	0.923	---	99	---
Bis(2-ethylhexyl)phthalate	1	2	2.13	2.13	1.26	6.75	---	99	---
Cadmium	1	2	2.80	2.80	1.61	9.11	.847	JS15	0.424
Chromium	2	2	17.0	470	244	1673	22.8	JS15	3.90
Copper	2	2	99.0	170	135	359	28.2	JS15	1.95
Cyanide	1	2	41.1	41.1	21.8	144	0.92	KY07	5.00
Fluoranthene	1	2	1.28	1.28	0.900	3.298	---	99	---
Indeno[1,2,3-cd]pyrene	1	2	0.427	0.427	0.319	1.003	---	99	---
Iron	2	2	28000	35000	31500	53585	25400	JS15	1.89
Lead	2	2	80.0	860	470	2931	63.4	JD13	0.319
Mercury	1	2	0.145	0.145	0.079	0.495	.037	JB03	0.026
Nickel	2	2	8.00	8.15	8.08	8.55	19.3	JS15	2.46
PCB 1248	1	2	5.20	5.20	NA	5.20	---	99	0.054
PCB 1254	1	2	.646	.646	NA	.646	---	99	0.054
Phenanthrene	1	2	1.71	1.71	1.06	5.16	---	99	---
Pyrene	1	2	2.13	2.13	1.28	6.67	---	99	---
Silver	2	2	0.029	0.810	0.420	2.884	.749	JD13	0.015
Zinc	2	2	280	1100	690	3277	169	JS15	7.96

Note.—All results are reported as $\mu g/g$. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

*Background concentrations were derived as mean plus 2 standard deviation from background data for conservative approach (tolerance limit).

Table 8-35. Contaminants of Concern for Surface Soil at the Bomb and Shell Reconditioning Building (Site 23)

Analytes	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration*	Method	Sample Quantitation Limit
Benzo[a]anthracene	2	11	0.854	1.47	1.67	2.39	---	99	0.60-6.0
Benzo[a]pyrene	2	11	0.640	1.26	2.02	2.96	---	99	0.64-7.6
Benzo[b]fluoranthene	2	11	0.640	1.05	1.90	2.80	---	99	0.64-7.2
Benzo[g,h,i]perylene	2	11	0.427	0.838	1.28	1.87	---	99	0.42-4.8
Benzo[k]fluoranthene	1	11	1.26	1.26	4.08	6.13	---	99	1.26-16.0
Bis(2-ethylhexyl)phthalate	1	11	2.13	2.13	2.13	3.09	---	99	0.78-7.8
Cadmium	3	11	0.515	2.80	0.738	1.19	.847	JS15	0.424
Chromium	11	11	13.0	470	79.0	151	22.8	JS15	3.90
Chrysene	2	11	1.07	1.47	2.42	3.52	---	99	0.90-9.0
Copper	11	11	7.20	170	65.8	96.7	28.2	JS15	1.95
Cyanide	1	11	41.1	41.1	6.01	12.4	0.92	KY07	5.00
Fluoranthene	2	11	1.28	1.68	2.80	4.07	---	99	1.04-10.4
Indeno[1,2,3-cd]pyrene	2	11	0.427	0.838	1.14	1.65	---	99	0.42-4.2
Lead	11	11	29.0	860	167	297	63.4	JD13	0.319
Mercury	4	11	0.092	0.199	0.064	0.105	0.037	JB03	0.026
Nitrate	6	11	5.11	28.0	6.11	10.3	9.45	KT04	3.36
Phenanthrene	2	11	1.05	1.71	2.25	3.24	---	99	0.82-8.2
Phosphate	4	11	7.43	92.8	18.9	35.8	5.00	KT04	5.0
Pyrene	2	11	2.10	2.13	2.43	3.42	---	99	0.84-8.4
Zinc	11	11	40.0	2200	464	817	169	JS15	7.96

Notes.—All results are reported as µg/g. Average concentrations that are greater than the highest detected concentrations are due to high Sample Quantitation Limits (SQLs) for the non-detected samples, (one-half of the SQL is used as a value for the non-detected samples when computing the average and the 95% confidence value). Surface soil includes all soil samples from depths less than 6 inches. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

*Background concentrations were derived as mean plus 2 standard deviations from background data for conservative approach (tolerance limits).

Table 8-36. Contaminants of Concern for Surface Water at the Bomb and Shell Reconditioning Building (Site 23)

Analyte	Method	Detect Value (μg/L)	Certified Reporting Limit
Barium	SS16	79.0	1.52
Chloride	TT08	110,000	273
Copper	SS16	11.5	4.29
Iron	SS16	780	24.6
Lead	SD24	12.1	4.74
Nitrate	TT08	1800	24.3
Phosphate	TT08	63.1	33.0
Sulfate	TT08	52,000	137
Zinc	SS16	34.8	19.4

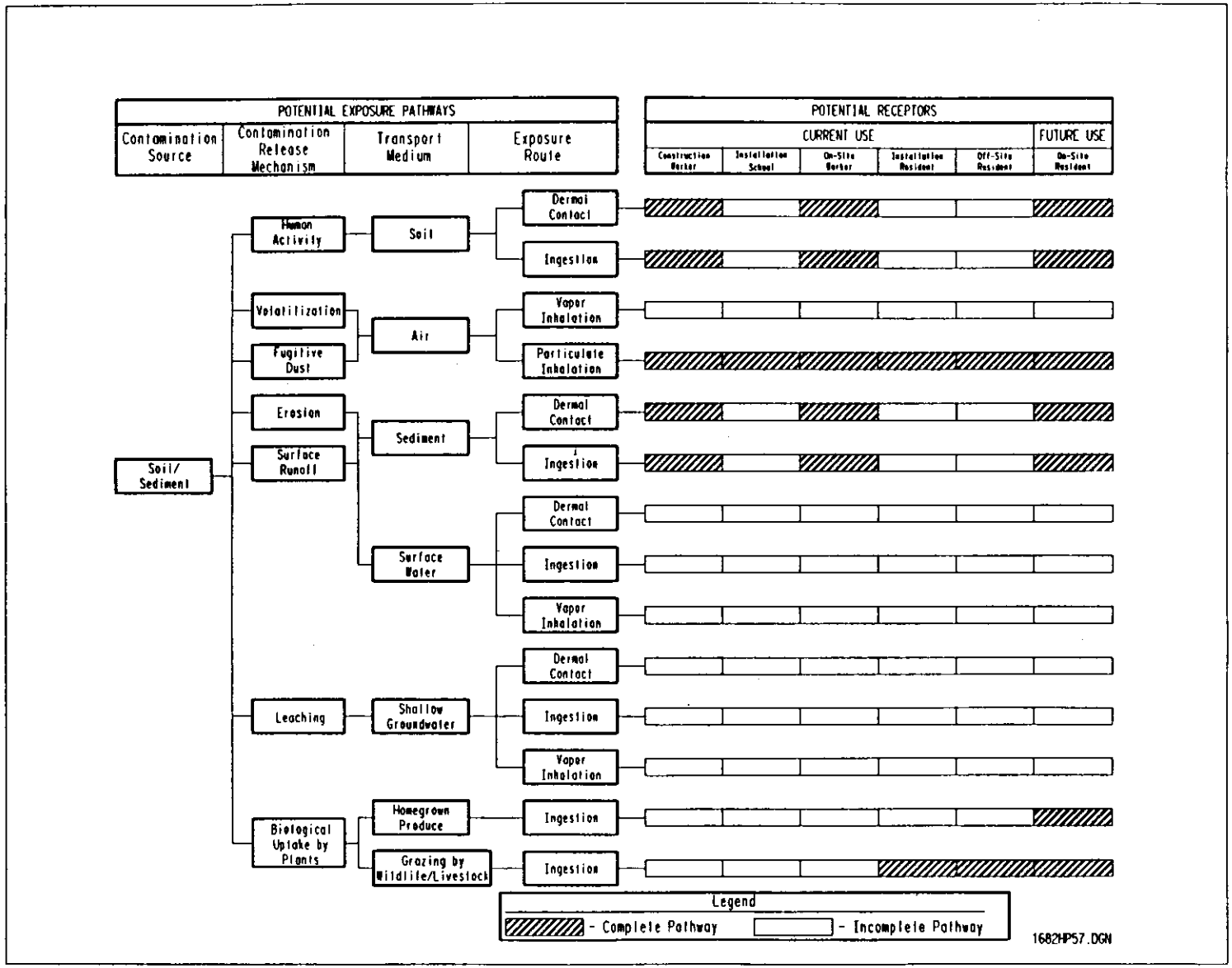


Figure 8-18. Potential Exposure Pathways for the Bomb and Shell Reconditioning Building (Site 23)

wastewater is no longer done on a daily basis. During the RI field investigation program in May through July of 1992, wastewater was only discharged for a period of 1 day.

Because of the presence of surface metals contamination, dermal contact, ingestion, and inhalation are potential exposure pathways for metals-contaminated particulates by human and environmental receptors.

8.5.7 Baseline Risk Assessment

8.5.7.1 *Human Health Evaluation*

Tables 8-37 and 8-38 provide the risk estimates for each exposure scenario. The risk estimates are discussed below by scenario, with assessments for average exposure and RME for both carcinogenic and noncarcinogenic scenarios. Risk from ingestion of contaminated surface water was not estimated since only one sample was collected. This exposure pathway should be considered for the future on-site resident after additional data are collected.

8.5.7.1.1 *Current Land Use*. This section discusses estimates for each exposure scenario assessed under current site-use conditions.

8.5.7.1.1.1 *On-site Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for on-site workers at Site 23 using the estimated average exposure is 1E-05. The risk factor for dermal exposure is 9E-06, for soil inhalation is 3E-10, and for soil ingestion is 1E-06.

The total carcinogenic risk factor from RME is 5E-05. The risk factor for dermal exposure is 4E-05, for soil inhalation is 2E-07, and for soil ingestion is 7E-06.

The average and RME carcinogenic risks for the Bomb and Shell Reconditioning Building are within the EPA target range of 1E-04 to 1E-06 for residual risk.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for on-site workers at Site 23, using estimated average exposure, is 2E-02. The hazard index for soil inhalation is 4E-10, for soil ingestion is 2E-02, and for dermal is 2E-03.

The total hazard index for noncarcinogenic risk from RME is 3E-02. The hazard index for soil inhalation is 1E-07, for soil ingestion is 3E-02, and for dermal exposure is 4E-03. Both average exposure and RME hazard indices meet the EPA goal of a residual hazard index of 1 or less.

Table 8-37. Risk Estimate Summary Using Average Exposure Levels for the Bomb and Shell Reconditioning Building (Site 23)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
Benzo(a)anthracene	8.52E-08		8.52E-09												1.07E-07	
Benzo(a)pyrene	1.03E-06		1.03E-07												1.30E-06	
Benzo(b)fluoranthene	9.72E-08		9.72E-09												1.22E-07	
Benzo(k)fluoranthene	2.08E-07		2.08E-08												2.62E-07	
Bis(2-ethylhexyl)phthalate															7.29E-05	
Cadmium		3.61E-04		3.61E-04												5.05E-04
Chromium		7.73E-03		7.73E-03												1.08E-02
Chrysene	1.23E-08		1.23E-09												1.56E-08	
Copper		8.70E-03		8.71E-03												1.22E-02
Cyanide		1.47E-04		1.47E-04												2.06E-04
Fluoranthene		3.42E-05		3.42E-05												4.79E-05
Indeno[1,2,3-cd]pyrene	5.80E-08		5.80E-08												7.33E-08	
Mercury		1.04E-04		1.04E-04												1.46E-04
Nitrate		1.87E-06		1.87E-06												2.62E-06
Phenanthrene		3.67E-05		3.67E-05												5.14E-05
Pyrene		3.96E-05		3.96E-04												5.55E-05
Zinc		7.57E-04		7.57E-04												1.06E-03
	1.49E-06	1.79E-02	1.49E-07	1.79E-02											1.88E-06	2.51E-02
Inhalation																
Benzo(a)anthracene	7.50E-14		7.50E-15		6.00E-14		3.36E-14		1.21E-16		1.51E-16		2.51E-16		1.51E-13	
Benzo(a)pyrene	9.34E-13		9.34E-14		7.47E-13		4.19E-13		1.50E-15		1.87E-15		3.11E-15		1.88E-12	
Benzo(b)fluoranthene	8.85E-14		8.85E-15		7.08E-14		3.96E-14		1.42E-16		1.77E-16		2.94E-16		1.78E-13	
Benzo(k)fluoranthene	1.93E-13		1.93E-14		1.55E-13		8.66E-14		3.11E-16		3.87E-16		6.45E-16		3.90E-13	
Cadmium	3.74E-13		3.74E-14		3.00E-13		1.68E-13		6.61E-16		7.50E-16		1.25E-15		6.44E-10	
Chromium	3.20E-10		3.20E-11		2.56E-10		1.43E-10		5.14E-13		6.40E-13		1.06E-12		7.55E-13	
Mercury		4.21E-10		4.21E-10		3.37E-10		9.44E-10		7.56E-13		9.38E-13		1.56E-12		9.48E-10
	3.21E-10	4.21E-10	3.21E-11	4.21E-10	2.57E-10	3.37E-10	1.44E-10	9.44E-10	5.17E-13	7.56E-13	6.43E-13	9.38E-13	1.07E-12	1.56E-12	6.48E-10	9.48E10

Table 8-37. Risk Estimate Summary Using Average Exposure Levels for the Bomb and Shell Reconditioning Building (Site 23) (continued)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Dermal																
Benzo(a)anthracene	5.28E-07		5.28E-08												6.66E-07	
Benzo(a)pyrene	6.39E-06		6.39E-07												8.05E-06	
Benzo(b)fluoranthene	6.02E-07		6.02E-08												7.59E-07	
Benzo(k)fluoranthene	1.29E-06		1.29E-07												1.63E-06	
Bis(2-ethylhexyl)phthalate																6.27E-05
Cadmium		4.48E-05		4.48E-05												6.71E-04
Chromium		4.79E-04		4.97E-04											9.64E-08	
Chrysene	7.65E-08		7.65E-09													1.28E-03
Cyanide		9.11E-04		9.11E-04												2.97E-04
Fluoranthene		2.12E-04		2.12E-04											4.53E-07	
Indeno[1,2,3-cd]pyrene	3.59E-07		3.59E-08													9.06E-06
Mercury		6.44E-06		6.47E-06												1.62E-05
Nitrate		1.16E-05		1.16E-05												3.44E-04
Pyrene		2.45E-04		2.45E-04												6.57E-05
Zinc		4.69E-05		4.69E-05												3.18E-04
Phenathrene															1.17E-05	3.06E-03
	9.26E-06	2.19E-03	9.25E-07	2.19E-03												
Total for Site	**1.07E-05**	**2.01E-02**	**1.07E-06**	**2.01E-02**	**2.57E-10**	**3.37E-10**	**1.44E-10**	**9.44E-10**	**5.17E-13**	**7.56E-13**	**6.43E-13**	**9.38E-13**	**1.07E-12**	**1.56E-12**	**1.35E-05**	**2.81E-02**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

Table 8-38. Risk Estimate Summary Using Reasonable Maximum Exposure Levels for the Bomb and Shell Reconditioning Building (Site 23)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
Benzo(a)anthracene	3.66E-07		1.17E-07												8.89E-07	
Benzo(a)pyrene	4.53E-06		1.45E-06												1.10E-05	
Benzo(b)fluoranthene	4.28E-07		1.37E-07												1.04E-06	
Benzo(k)fluoranthene	9.38E-07		3.00E-07												2.28E-06	
Bis(2-ethylhexyl)phthalate	9.08E-09		2.90E-09												2.20E-06	
Cadmium		5.82E-04	5.59E-03													4.60E-03
Chromium		1.48E-02	1.42E-01													1.18E-01
Chrysene	5.39E-08		1.73E-08												1.31E-07	
Copper		1.28E-02		1.23E-01												1.01E-01
Cyanide		3.02E-04		2.91E-03												2.41E-03
Fluoranthene		4.98E-05		4.78E-04												3.95E-04
Indeno[1,2,3-cd]pyrene	2.53E-07		8.08E-08												6.13E-07	
Mercury	1.70E-04			1.64E-03												1.35E-03
Nitrate		3.14E-04		3.02E-05												2.49E-05
Pyrene		5.57E-05		5.35E-04												4.42E-04
Zinc		1.33E-03		1.28E-02												1.06E-02
Phenanthrene																4.19E-04
	6.58E-06	3.01E-02	2.11E-06	2.89E-01											1.60E-05	2.39E-01
Inhalation																
Benzo(a)anthracene	5.20E-11		2.61E-12		1.39E-11		1.10E-10		1.58E-03		1.94E-13		3.24E-13		1.96E-10	
Benzo(a)pyrene	6.43E-10		3.23E-11		1.72E-10		1.36E-09		1.95E-12		2.40E-12		4.02E-12		2.42E-09	
Benzo(b)fluoranthene	6.09E-11		3.06E-12		1.62E-11		1.29E-10		1.85E-13		2.28E-13		3.80E-13		2.29E-10	
Benzo(k)fluoranthene	1.33E-10		6.69E-12		3.54E-11		2.82E-10		4.04E-13		4.98E-13		8.30E-13		5.01E-10	
Cadmium	2.59E-10		1.30E-11		6.91E-11		5.48E-10				9.66E-13		1.61E-12		9.74E-10	
Chromium	2.21E-07		1.11E-08		5.90E-08		4.68E-07		6.70E-10		8.26E-10		1.37E-09		8.32E-07	
Mercury		9.75E-08		1.47E-07		7.80E-08		1.18E-06		9.40E-10		1.17E-09		1.94E-09		1.18E-06
	2.22E-07	9.75E-08	1.12E-08	1.47E-07	5.93E-08	7.80E-08	4.71E-07	1.18E-06	6.73E-10	9.40E-10	8.31E-10	1.17E-09	1.38E-09	1.94E-09	8.36E-07	1.18E-06

Table 8-38. Risk Estimate Summary Using Reasonable Maximum Exposure Levels for the Bomb and Shell Reconditioning Building (Site 23) (continued)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Dermal																
Benzo(a)anthracene	2.27E-06		7.57E-08												5.32E-06	
Benzo(a)pyrene	2.81E-05		9.37E-07												6.58E-05	
Benzo(b)fluoranthene	2.66E-06		8.85E-08												6.22E-06	
Benzo(k)fluoranthene	5.82E-06		1.94E-07												1.36E-05	
Bis(2-ethylhexyl)phthalate	5.63E-08		1.87E-09												1.32E-07	
Cadmium		7.22E-05		7.22E-05												5.40E-04
Chromium		9.18E-04		9.16E-04												6.90E-03
Chrysene	3.34E-07		1.11E-08												7.83E-07	
Cyanide		1.87E-03		1.88E-04												1.41E-02
Fluoranthene		3.09E-04		3.09E-04												2.32E-03
Indeno[1,2,3-cd]pyrene	1.57E-06		5.22E-08												3.67E-06	
Mercury		1.06E-05		1.06E-05												7.94E-05
Nitrate		1.95E-05		1.95E-05												1.46E-04
Phenanthrene				3.28E-04												2.46E-03
Pyrene		3.46E-04		3.46E-04												2.60E-03
Zinc		8.26E-05		8.26E-05												6.21E-04
	4.08E-05	3.96E-03	1.36E-06	3.96E-03											9.56E-05	2.98E-02
Total for Site	**4.76E-05**	**3.41E-02**	**3.48E-06**	**2.93E-01**	**5.93E-08**	**7.80E-08**	**4.71E-07**	**1.18E-06**	**6.73E-10**	**9.40E-10**	**8.31E-10**	**1.17E-09**	**1.38E-09**	**1.94E-09**	**1.12E-04**	**2.69E-01**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

8.5.7.1.1.2 *Construction Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for a construction worker at Site 23 using the estimated average exposure is 1E-06. The risk factor for dermal exposure is 9E-07, for soil inhalation is 3E-11, and for soil ingestion is 1E-07.

The total carcinogenic risk factor from RME is 3E-06. The risk factor for dermal exposure is 1E-06, for soil inhalation is 1E-08, and for soil ingestion is 2E-06. The carcinogenic risk factors are within the EPA target range for residual risk.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for the construction worker at Site 23, using estimated average exposure, is 2E-02. The hazard index for soil inhalation is 4E-10, for soil ingestion is 2E-02, and for dermal is 2E-03.

The total hazard index for noncarcinogenic risk from RME is 3E-01. The hazard index for soil inhalation is 1E-07, for soil ingestion is 3E-01, and for dermal exposure is 4E-03. The average and RME hazard indices meet the EPA goal for a residual hazard index of 1 or less.

8.5.7.1.1.3 *Installation School*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the installation school because of the distance of the school from the Bomb and Shell Reconditioning Building. Exposure at the installation school would be associated with inhalation of particulates released from Site 23. The carcinogenic risk for average exposure is 3E-10, and the carcinogenic risk for the RME is 6E-08. The average and RME risk factors are below the EPA target range for residual risk.

NONCARCINOGENIC RISKS

The hazard index for average exposure is 3E-10, and the hazard index for the RME is 7E-08. The noncarcinogenic hazard indices for average and RME are below the EPA goal for a residual hazard of 1 or less.

8.5.7.1.1.4 *Installation Resident*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the installation resident because of the distance from the Bomb and Shell Reconditioning Building to the installation housing area. Exposure at the installation housing would be associated with inhalation of particulates released from

Site 23 soil. The carcinogenic risk for average exposure is 1E-10, and the carcinogenic risk for the RME is 5E-07. The average and RME risk factors are below the EPA target range for residual risk.

NONCARCINOGENIC RISKS

The hazard index for average exposure is 9E-10, and the hazard index for the RME is 1E-06.

8.5.7.1.1.5 ***Off-site Residents***

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the off-site residents because of the distance of off-site housing from the Bomb and Shell Reconditioning Building. Concentrations of contaminants in soils at Site 23 were used to model estimated particulate concentrations at Tooele, Stockton, and Grantsville. The carcinogenic risks for average exposure are 5E-13 for Tooele, 6E-13 for Stockton, and 1E-12 for Grantsville. The carcinogenic risks for the RME are 7E-10 for Tooele, 8E-10 for Stockton, and 1E-09 for Grantsville.

NONCARCINOGENIC RISKS

The hazard indices for average exposure are 8E-13 for Tooele, 9E-13 for Stockton, and 2E-12 for Grantsville. The hazard indices for the RME are 9E-10 for Tooele, 1E-09 for Stockton, and 2E-09 for Grantsville.

8.5.7.1.2 ***Future Land Use***

The only future land use scenario considered is for possible future on-site residents. Results from this exposure scenario are discussed below.

CARCINOGENIC RISKS

The total carcinogenic risk factor for future on-site residents at Site 23, using average exposure, is 1E-05. The risk factor for dermal exposure is 1E-05, for soil inhalation is 7E-10, and for soil ingestion is 2E-06.

The total carcinogenic risk from RME is 1E-04. The risk factor for dermal exposure is 1E-04, for soil inhalation is 8E-07, and for soil ingestion is 2E-05. The average exposure carcinogenic risk factor is within the EPA target range for residual risk of 1E-04 to 1E-06, but the RME total risk factor exceeds the EPA range.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for future on-site residents at Site 23, using average exposure, is 3E-02. The hazard index for soil inhalation is 1E-09, for soil ingestion is 3E-02, and for dermal exposure is 3E-03.

The total hazard index for noncarcinogenic risk from RME is 3E-01. The hazard index for soil inhalation is 1E-06, for soil ingestion is 2E-01, and for dermal exposure is 3E-02. The hazard indices meet the EPA goal of 1 or less for a residual hazard index.

8.5.7.2 *Environmental Evaluation*

8.5.7.2.1 ***Site Characterization***. Operable Unit 8 contains Site 23, which is located on gently sloping hillsides. Although juniper occurs throughout the OU, the dominant vegetation are sagebrush and grasses. The OU is satisfactory habitat for many of the wildlife species identified at TEAD-N (Section 2.9).

The environmental evaluation for Site 23 is qualitative and did not include a bioassay of vegetation or wildlife or an inventory of wildlife. A site-specific inventory of vegetation was compiled and is listed in Table 8-39 Vegetation Inventory (Site 23).

No evidence of permanent surface water was identified during the field investigation; however, surface water is present during periods of operation at Site 23. This water is intermittent, and it disseminates rapidly.

8.5.7.2.2 ***Biological Effects of Contaminants***. Tables 8-40, 8-41, and 8-42 summarize the relevant information for the chemicals of concern for surface water, sediment, and soil at Site 23 taken from Table 3-18.

8.5.7.2.3 ***Potential Pathways***. No biological samples were obtained; thus, the uptake of contaminants by flora and fauna cannot be evaluated at this time. The most probable pathways of contaminants through the ecosystem are as follows:

- Plants

-Direct uptake through root system

- Wildlife

-Ingestion of contaminated soil
-Ingestion of contaminated foliage
-Ingestion of contaminated insects
-Ingestion of contaminated carrion, animals
-Dermal contact
-Inhalation of vapors
-Inhalation of contaminated particulates

Table 8-39. Vegetation Inventory (Site 23)

Scientific Name	Common Name
PRIMARY VEGETATION SPECIES	
Artemisia tridentata	Sagebrush
Chrysothamnus nauseosus	Rabbitbrush
OTHER VEGETATION SPECIES	
Helianthus annuus	Annual sunflower
Bromus tectorum	Cheatgrass
Oenothera pallida	Evening primrose
Sphaeralcea coccinea	Globe mallow
Grindelia squarrosa	Gumweed
Opuntia polyacantha	Prickly pear cactus
Salsola iberica	Russian thistle
Erodium cicutarium	Storksbill
Sisymbrium officinale	Tumbling mustard
Tragopogon dubius	Yellow goats beard
Cirsium vulgre	Bull thistle
Lepidium perfoliatum	Peppergrass
Chrysothamnus viscidiflorus	Viscid rabbitbrush
Melilotus albus	White sweetclover
Melilotus officinalis	Yellow sweetclover

Table 8-40. Summary of Contaminants for Surface Water (Site 23)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
Barium	I[a]	M[b]	BC[c]	3[d]	3	all soluble salts are acute poisons
Copper	I	VL[e]→M	BC	3	3	Cu^0 metal toxicity very low; many Cu(II) salts are toxic
Iron	I	L[f]→H[g]	--	--	3 dust explosive	poison by IP[h] route; questionable animal carcinogen; potentially toxic in all forms
Zinc	I	VL→L	BC	--	3	many Zn cmpds are toxic; dust is an irritant

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]I = insoluble.
[b]M = moderate.
[c]BC = bioconcentrate.
[d]3 = tissue or organ damage.
[e]VL = very low.
[f]L = low.
[g]H = high.
[h]IP-intraperitoneal.

Table 8-41. Summary of Contaminants for Sediment (Site 23)

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
Benzo[a]pyrene	VL[a]	L[b]→M[c]	BC[d]	2[e]	3	known animal carcinogen, low acute oral toxicity, mutagen
Benzo[b]fluoranthene	VL	M	BA[f]	2	3	known animal carcinogen
Benzo[g,h,i]perylene	VL	L→M	BA	---	---	possible animal carcinogen; low oral toxicity
Bis(2-ethylhexyl) phthalate	VL	L→M	BC	2	3	known animal carcinogen; low oral toxicity;
Cadmium	VL	M→H[g]	BA	3	3	known animal carcinogen
Chromium	VL	L→H	BC	1[h]	3	many Cr+6 cmpds are animal and human carcinogens
Copper	I[i]	VL→M	BC	3	3	Cu^0 metal toxicity very low; many Cu(II) salts are toxic
Cyanide anion $(CN)^{-1}$	H	H	---	3	3	very poisonous by most routes
Fluoranthene	VL	L→M	---	---	3 combustible	mild oral and dermal toxicity in animals; human mutation data
Indeno[1,2,3-cd]pyrene	VL	---	BC	2	3	known animal carcinogen; no toxicity data
Iron	I	L→H	---	---	3 dust explosive	poison by IP[j] route; questionable animal carcinogen; potentially toxic in all forms
Lead	I	H	BC	2,3	3	acute and chronic toxicant; suspected carcinogen
Mercury	I	H	BA,BC	3	3	highly toxic by most routes incl. inhalation; questionable carcinogen; some evidence of human mutations
Phenanthrene	I	M	BA	3	3	poison by IV[k]; mod. toxic by ingestion
Pyrene	I	M	BC	2	3	inhalation poison; mod. toxicity by ingestion

Table 8-41. Summary of Contaminants for Sediment (Site 23) (continued)

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
Silver	I	L	BA,BC	---	2 dust sl. flammable	toxicity of metal is low by all exposure routes; dust an irritant; accumulation in the body may produce argyria; soluble cmpds toxic/fatal
Zinc	I	VL→L	BC	---	3 dust explosive	many Zn cmpds are toxic; dust is an irritant

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]VL=very low.
[b]L=low.
[c]M=moderate.
[d]BC=bioconcentrate.
[e]2=probable or suspected carcinogen.
[f]BA=bioaccumulate.
[g]H=high.
[h]2=carcinogenic.
[i]I=insoluble.
[j]IP=intraperitoneal.
[k]IV=intravenous.

Table 8-42. Summary of Contaminants for Soil (Site 23)

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
Benzo[a]anthracene	VL[a]	M[b]	---	2[c]	3	known animal carcinogen
Benzo[a]pyrene	VL	L[d]→M	BC[e]	2	3	known animal carcinogen, low acute oral toxicity, mutagen
Benzo[b]fluoranthene	VL	M	BA[f]	2	3	known animal carcinogen
Benzo[g,h,i]perylene	VL	L→M	BA	---	---	possible animal carcinogen; low oral toxicity
Bis(2-ethylhexyl) phthalate	VL	L→M	BC	2	3	known animal carcinogen; low oral toxicity;
Cadmium	VL	M→H[g]	BA	3	3	known animal carcinogen
Chromium	VL	L→H	BC	1[h]	3	many Cr+6 cmpds are animal and human carcinogens
Chrysene	VL	L→M	---	2	3	low oral toxicity, known animal carcinogen
Copper	I[i]	VL→M	BC	3	3	Cu^0 metal toxicity very low; many Cu(II) salts are toxic
Cyanide anion $(CN)^{-1}$	H	H	---	3	3	very poisonous by most routes
Fluoranthene	VL	L→M	---	---	3 combustible	mild oral and dermal toxicity in animals; human mutation data
Indeno[1,2,3-cd]pyrene	VL	---	BC	2	3	known animal carcinogen; no toxicity data
Iron	I	L→H	---	---	3 dust explosive	poison by IP[j] route; questionable animal carcinogen; potentially toxic in all forms
Lead	I	H	BC	2,3	3	acute and chronic toxicant; suspected carcinogen
Mercury	I	H	BA,BC	3	3	highly toxic by most routes incl. inhalation; questionable carcinogen; some evidence of human mutations
Phenanthrene	I	M	BA	3	3	poison by IV[m]; mod. toxic by ingestion

Table 8-42. Summary of Contaminants for Soil (Site 23) (continued)

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
Pyrene	I	M	BC	2	3	inhalation poison; mod. toxicity by ingestion
Silver	I	L	BA,BC	---	2 dust sl. flammable	toxicity of metal is low by all exposure routes; dust an irritant; accumulation in the body may produce argyria: soluble cmpds toxic/fatal
Zinc	I	VL→L	BC	---	3 dust explosive	many Zn cmpds are toxic; dust is an irritant

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]VL = very low.
[b]M = moderate.
[c]2 = probable or suspected carcinogen.
[d]L = low.
[e]BC = bioconcentrate.
[f]BA = bioaccumulates.
[g]H = high.
[h]1 = carcinogenic.
[i]I = insoluble.
[j]IP = intraperitoneal.
[k]IV = intravenous.

Potential ecological exposure pathways are shown in Figure 8-19.

Discharge water from the main building results in abundant vegetation in the drainage area downstream from the site. Uptake of contaminants by this vegetation is likely. The surface water may also provide a source of drinking water, which may be ingested by wildlife, during periods of discharge.

8.5.7.2.4 ***Potentially Affected Populations.*** Table 8-43 presents a summary of exposure points, general population, and the activity by which ecological exposure may occur. The table is listed in decreasing exposure potential. While infrequent in nature, surface water can accumulate after downpours in areas normally devoid of standing water. With this surface water, the number of potential contaminant pathways is increased, and several normally low population species (e.g., Great Basin Spadefoot Toad and other amphibians) may become objects of concern. Flash-flooding in washes on this site, while infrequent, can transport contaminants greater distances than via subsurface means.

8.5.7.2.5 ***Environmental Evaluation Conclusions.*** The primary contaminants of concern at this site are PAHs, semi-VOCs, and metals. In addition, the metal contaminants have a qualitative biological hazard ranking of high because metal contaminants are toxic and will frequently bioaccumulate. The PAH and semi-VOC contaminant qualitative biological hazard ranking is predominately high, largely because they are carcinogenic as well as somewhat toxic. Concentrations of these contaminants above background levels may be problematic at the individual and local species population level; the specific effects cannot be evaluated with the available data.

Alterations to the trophic structure and ecological processes at Site 23 or to the TEAD-N facility cannot be evaluated until further data are collected. Recovery times cannot be derived or predicted from the information evaluated.

In order to completely assess the ecological risk at this site, bioassays such as tissue sampling of vegetation and analyses for chemicals of concern and a species inventory are warranted.

8.5.8 Conclusions

At Site 23, the vadose zone modeling indicates that contaminants would take over 100 years to reach the groundwater pathway and, at that time, the contaminants would be several orders of magnitude lower than present concentrations. Therefore, the potential for significant contaminant migration to groundwater is low. The work areas at Site 23 are either concrete floored or paved. Therefore, exposure to contaminated soils by current on-site workers would be limited.

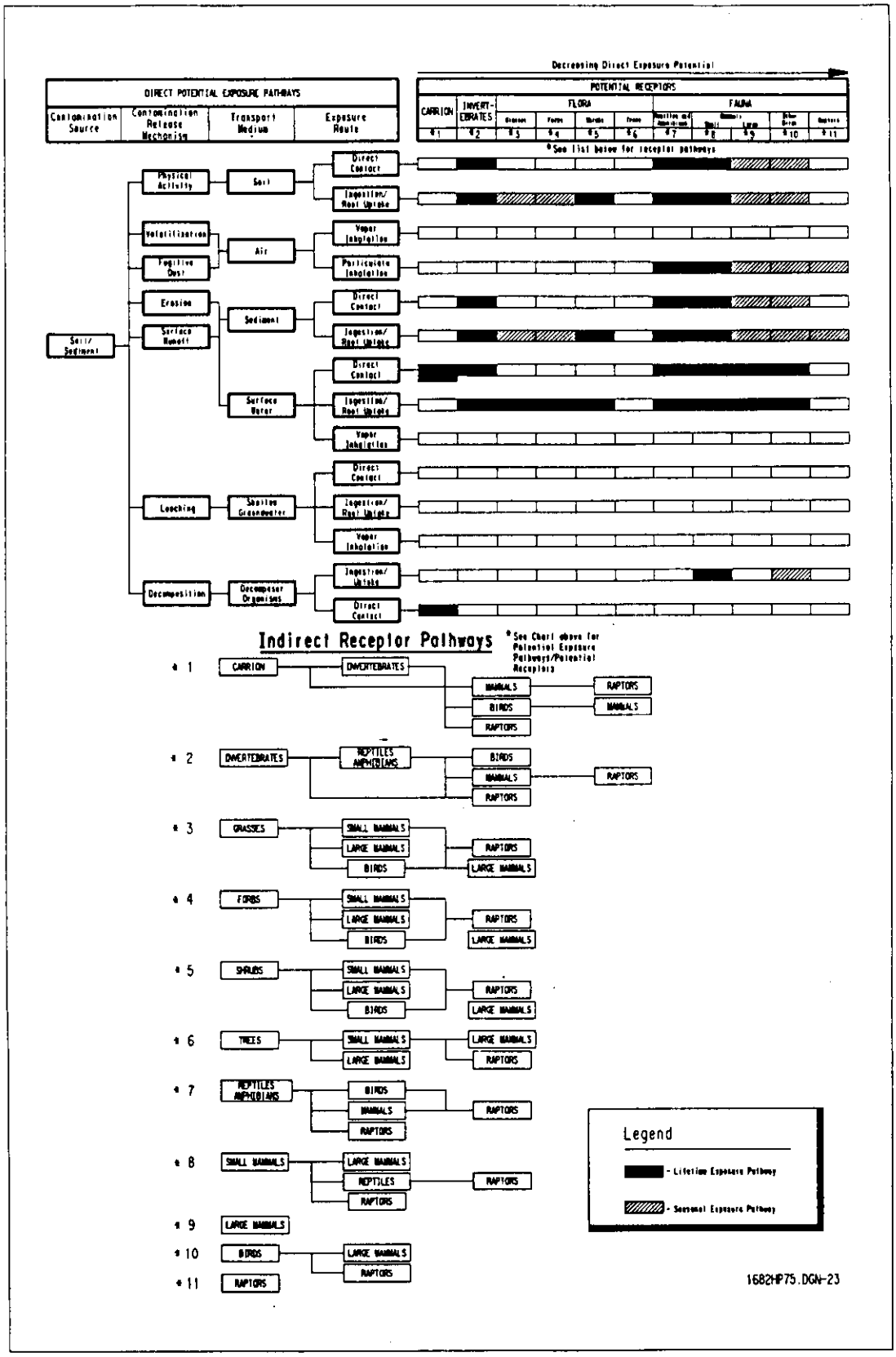


Figure 8-19. Potential Ecological Exposure Pathways for Site 23

Table 8-43. Exposure Scenarios for Ecological Populations (Site 23)

Exposure Point	Exposed Population	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Large Mammals	Ingestion of contaminated vegetation; foliage, fruit, and potentially roots.	Likely due to remoteness of the site and excellent habitat it offers.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Likely when feeding at this site; the site also offers good nesting habitat.
Terrestrial Location	Raptors	Ingestion of contaminated carrion or animals.	Likely when feeding on prey or carrion from this site.

Contaminants from operations at Site 23 appear to be migrating off-site via the surface-water pathway through runoff from the paved areas and through direct wastewater discharge to two ditches leading across the road to a discharge area to the north. However, wastewater is no longer discharged on a regular basis. Surface water and sediments both contained contaminants of concern. The extent of contamination is not yet defined.

8.5.9 Recommendations

Additional surface-water and sediment samples in the drainage areas downstream of the discharge area for wastewater are needed to determine the extent of off-site contamination. Additional surface-soil samples are needed outward from the perimeter of the paved area to determine the horizontal extent of contamination.

Soil borings in areas with the highest surface contamination are needed to determine the vertical extent of contamination. Soil borings through the pavement are needed to determine if contamination exists under the pavement as a result of washdown operations, spills, or leaks in the wastewater discharge pipe.

8.6 OLD BURN STAGING AREA (SITE 36)

8.6.1 Site Characteristics

The Old Burn Staging Area is located immediately north of the Old Burn Area (see Figure 1-10) and consists of a gravel pit, which was used to store items that were to be burned or disposed of at the Old Burn Area. From Environmental Photographic Interpretation Center (EPIC) photographs, it was believed that there may have been trenches in the bottom of the pit and that liquid may have been present around the perimeter of the pit bottom.

8.6.2 Previous Investigations and RI Activities

Walkovers of Site 36 indicate that scrap wood and metal are scattered across the area. EPIC photographs from 1959 show dark mounded material in the bottom of the pit. Photographs from 1953 show three short trenches containing dark material covering the floor of the pit, and photographs from 1966 show dark material ringing the perimeter of the pit. On the basis of observations made during the site visit by Rust E&I in October of 1991, it appears that the dark areas observed on the photographs may have been burn areas rather than liquid. There are several dark areas in the bottom of the pit today that contain charred materials.

Outside of the EPIC photographs, no additional information or data were available for this site. To confirm whether or not trenching in the pit had taken place in the past, geophysical surveying of the pit was conducted (Figure 8-20). The results of this surveying indicated that trenching had not been done within the pit. Surface-soil sampling conducted during the current RI at this site is shown in Figure 8-20. These samples were analyzed for explosives, VOCs, semi-VOCs, inorganics, and anions. Photographs of the pit area are included in Appendix D.

Just to the north of the staging area pit, several areas containing scrap metal, wood, and charred wood scattered on the ground surface were observed during the October 1991 site visit by Rust E&I. Geophysical surveying was conducted across these areas during the RI to determine whether there was evidence of former trenches or pits, or whether the area was just used for surface burning. On the basis of the geophysical survey results (see Appendix B), it appears that the area was used for burning wooden boxes, crates, etc. on the ground surface only. Surface-soil samples were collected from the areas containing surface debris, and the samples were analyzed for explosives, semi-VOCs, inorganics, and anions.

8.6.3 Nature and Extent of Contamination

Of the surface samples collected (Figure 8-21), elevated concentrations of barium, copper, lead, and zinc were found in samples OSS-92-05 and OSS-92-06 (Table 8-44). Chromium was detected in one sample (OSS-92-10) above background concentrations. Sample OSS-92-13 contained elevated concentrations of several metals including barium, copper, iron, lead, silver, and zinc. Butylbenzyl phthalate and di-N-butyl phthalate were detected at low concentrations in several samples. Samples OSS-92-05 and OSS-92-06 are located along the

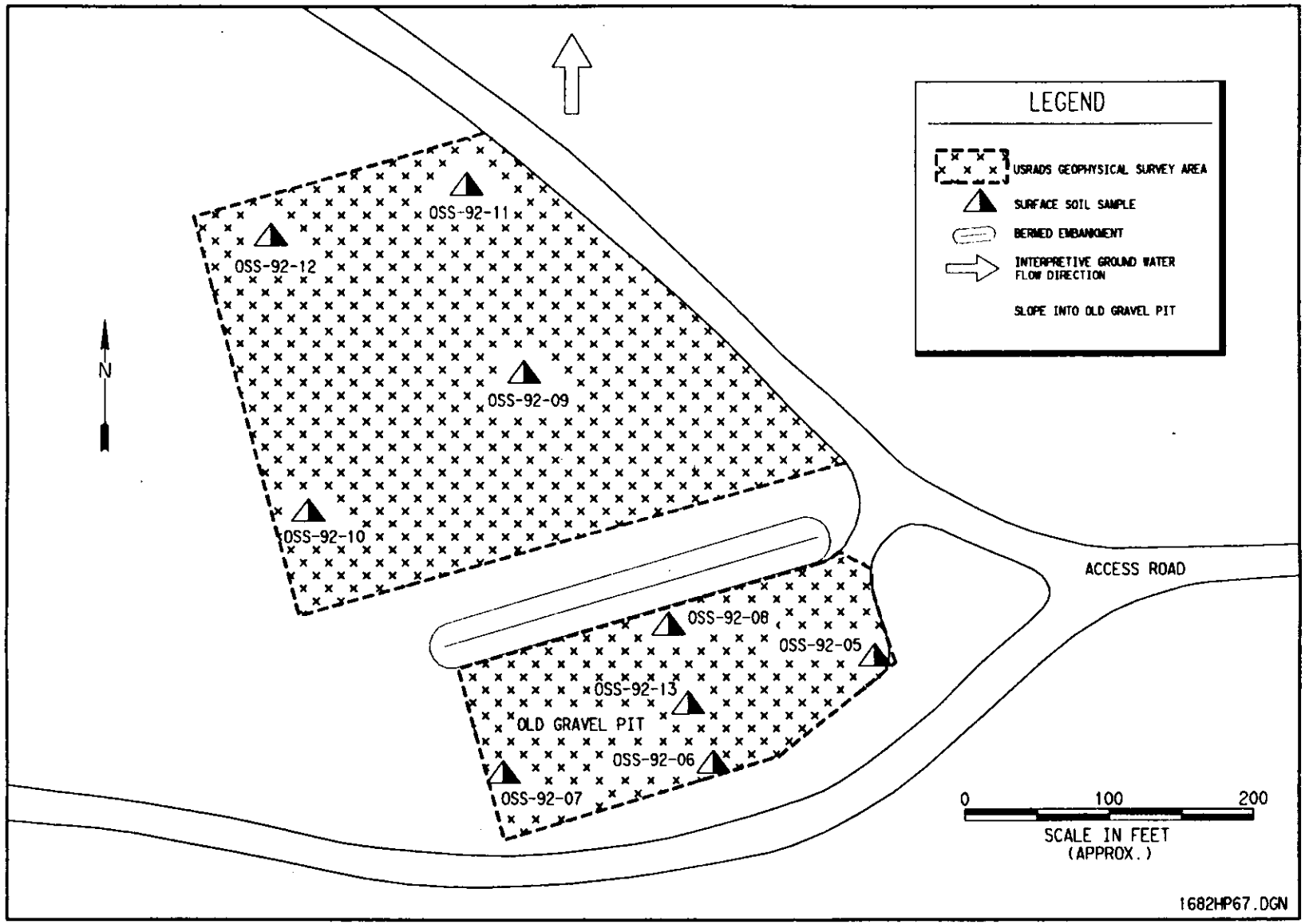


Figure 8-20. RI Geophysical Survey and Soil Sample Location Map for the Old Burn Staging Area (Site 36)

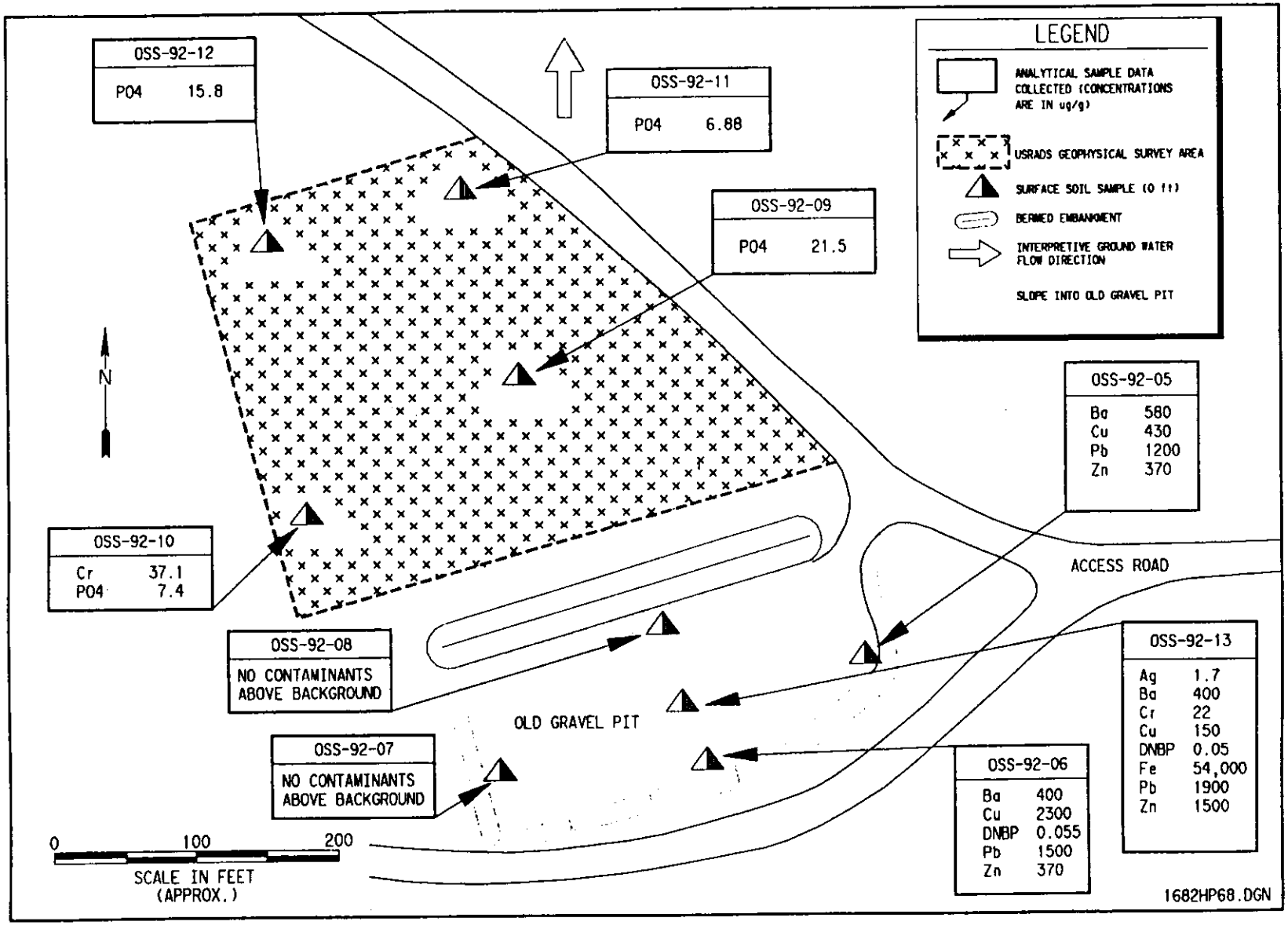


Figure 8-21. RI Sampling and Analysis Results for the Old Burn Staging Area (Site 36)

Table 8-44. Summary of Analytes Above Background Concentrations Surface Soil Samples at the Old Burn Staging Area (Site 36)

Analytes	OSS-92-05*	OSS-92-06*	OSS-92-07*	OSS-92-08*	OSS-92-09*	OSS-92-10*	OSS-92-11*	OSS-92-12*	OSS-92-13*	Background Concentrations
	Concentrations in µg/g									
VOCs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SVOCs										
Butylbenzyl phthalate	.250	.020	ND	.054	ND	.022	.025	ND	.047	---
Di-N-butyl phthalate	ND	.055	ND	ND	ND	ND	ND	ND	.049	---
Anions										
Phosphate	ND	ND	ND	ND	21.5	7.40	6.88	15.8	ND	5.00
Explosives	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Inorganics										
Barium	580	400	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	400	277
Chromium	<BKGD	<BKGD	LT	LT	<BKGD	37.1	<BKGD	<BKGD	<BKGD	22.8
Copper	430	2300	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	150	28.2
Iron	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	54000	25400
Lead	1200	1500	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	1900	63.4
Silver	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	1.70	.749
Zinc	370	370	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	<BKGD	1500	169

Notes.—ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations.

*Samples were taken from 0 to 6 inches.

perimeter of the pit, and sample OSS-92-13 is located in the central portion of the pit. The pit area appears to have been used for surface burning.

The extent of contamination is as yet unknown at Site 36, but elevated concentrations appear to be restricted to specific areas within the pit where surface burning has occurred. These areas are easily identified by the charred metal debris and soil staining present at the surface.

Additional sampling is scheduled to more fully characterize Site 36. Six additional borings are scheduled to be drilled and sampled. The soil samples will be analyzed for metals. Data from those analyses will be combined with all existing data and used to re-calculate and assess risks to human health and the environment. These results will be reported and analyzed in an RI Report Addendum and future FS.

8.6.4 Contaminants of Concern

Barium, chromium, copper, iron, lead, silver, and zinc are contaminants of concern at Site 36. In addition to metals, di-N-butyl phthalate and butylbenzyl phthalate were detected in several of the samples collected at Site 36; however, the phthalates were considered laboratory artifacts and not related to field contamination. The metals contamination is thought to be related to surface burning of various materials related to munitions. The burn areas within the pit contained burned casings and electrical components. No PAHs were detected at the site although they are normally a byproduct of combustion of organic compounds. The contaminants of concern are shown on Table 8-45.

8.6.5 Contaminant Fate and Transport

Because of low mobility and solubility of the contaminants of concern, vertical migration through the subsurface soils to the groundwater table is unlikely. Vadose zone modeling shows that contaminant migration to the water table will take over 100 years with the resulting contaminant concentration at that time being several orders of magnitude lower (Section 3.4.3). The contamination present in the pit is not available for migration to any surface-water pathway because any water in the pit infiltrates through the coarse gravels present in the floor of the pit (former gravel pit). Also, being in the bottom of the pit, the contamination is sheltered from much of the wind that would typically result in contaminant migration via fugitive dust. Contamination north of the pit, however, would most likely be transported in the air pathway. The surface area north of the pit is generally flat or gently sloping, and little surface-water runoff occurs. Most precipitation infiltrates before reaching a surface-water pathway.

8.6.6 Potential Exposure Pathways

Potential exposure pathways are presented in Figure 8-22. Because the metals contamination was identified in surface soils, potential exposure to humans and fauna would be through dermal contact, ingestion, or inhalation. In the pit area, this exposure would be restricted to

Table 8-45. Contaminants of Concern for Surface Soil for the Old Burn Staging Area (Site 36)

Analytes	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration*	Method	Sample Quantitation Limit
Barium	9	9	40.0	580	213	334	277	JS15	2.61
Chromium	7	9	7.73	37.1	13.6	20.4	22.8	JD01	3.90
Copper	9	9	5.54	2300	329	795	28.2	JS15	1.95
Iron	9	9	5900	54000	17656	26342	25400	JS15	1.89
Lead	9	9	8.30	1900	522	1005	63.4	JD13	.319
Phosphate	4	9	6.88	21.5	7.12	11.4	5.00	KT04	5.00
Silver	9	9	0.035	1.70	0.288	0.620	.749	JD13	0.015
Zinc	9	9	30.0	1500	290	584	169	JS15	7.96

Notes.—All results are reported as µg/g. Surface soil includes all soil samples from depths less than 6 inches. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

*Background concentrations were derived as mean plus 2 standard deviations from background data for conservative approach (tolerance limit).

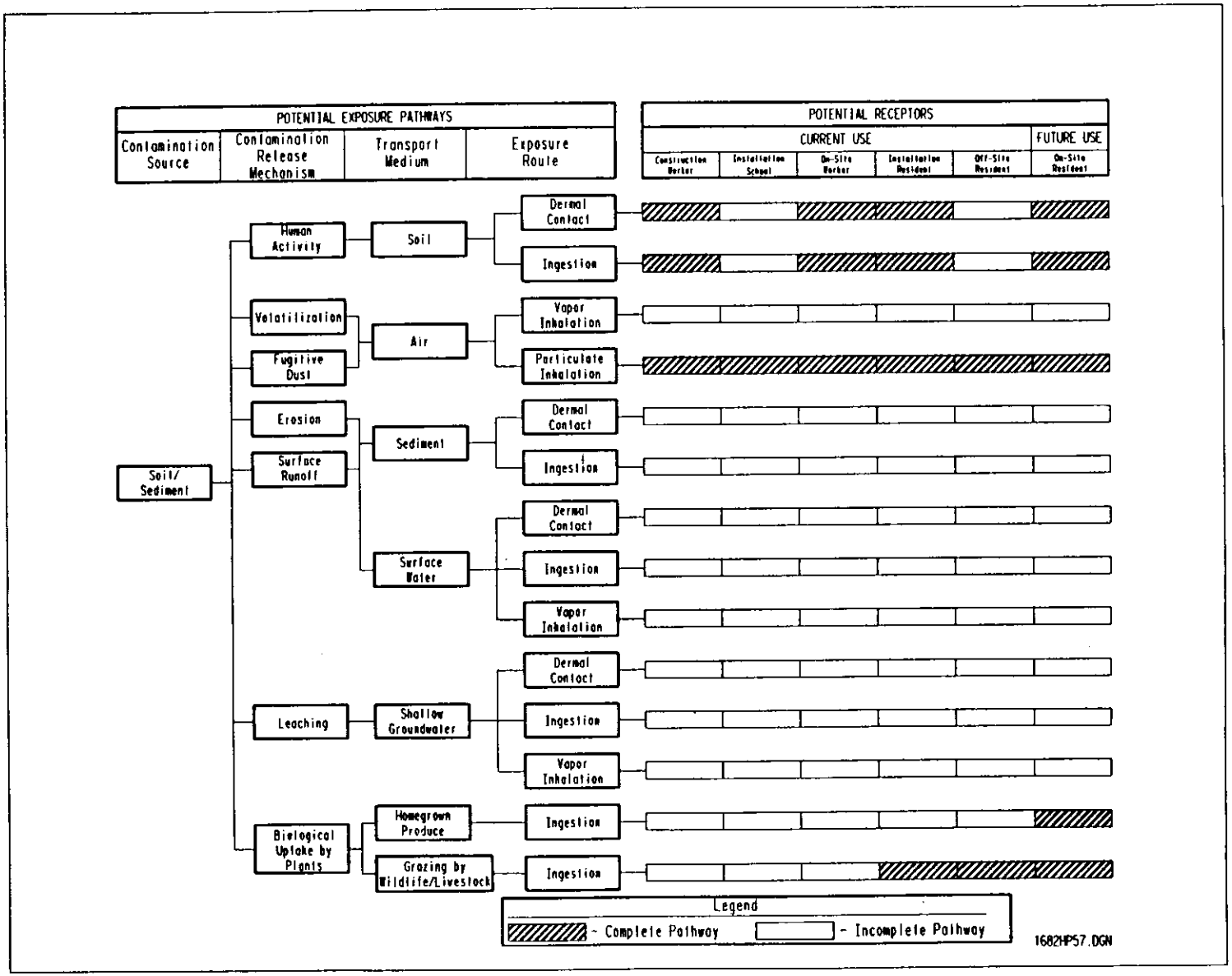


Figure 8-22. Potential Human Exposure Pathway Conceptual Model for the Old Burn Staging Area (Site 36)

on-site personnel or fauna while in the bottom of the former gravel pit. Surface contamination northwest of the pit could also result in exposure to humans or fauna via dermal contact, ingestion, or inhalation. Although the surrounding areas are grassy, the pit area contains only sparse vegetation, making bioaccumulation through grazing of livestock an unlikely exposure pathway. In addition to the on-site worker and local fauna, the air pathway could result in off-site exposure through inhalation of fugitive dust. No other exposure pathway was identified for Site 36. Surface-water and groundwater pathways do not appear to be viable for the contaminants present at Site 36.

Section 3.4.3 includes a discussion on vadose zone modeling that evaluates the possible effects of contaminant leaching to the shallow groundwater pathway. Because groundwater data are not available to determine contaminants of concern, this exposure pathway was not evaluated in the baseline risk assessment.

8.6.7 Baseline Risk Assessment

8.6.7.1 *Human Health Evaluation*

The risk estimates for each exposure scenario are presented in Tables 8-46 and 8-47. Tables showing risk factors for individual contaminants of concern are presented in Appendix I.

The resulting risk estimates are discussed below by scenario, which include average exposure and RME for noncarcinogenic risks for current on-site workers, construction workers, and possible future on-site residents. Carcinogenic risks are not calculated for Site 36 because slope factors were unavailable for the contaminants of concern. Noncarcinogenic risks for the installation school, installation resident, and the off-site resident could not be calculated because reference doses were not available for inhalation of the contaminants of concern.

8.6.7.1.1 *Current Land Use.* The risk estimates for each exposure scenario evaluated under current site use conditions are presented in Tables 8-46 and 8-47 and are discussed below.

8.6.7.1.1.1 *On-Site Worker*

CARCINOGENIC RISKS

Slope factors were unavailable for the contaminants of concern at Site 36 and, therefore, estimates of risk were not calculated.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for on-site workers at Site 36 for average exposure is 5E-02. The hazard index for soil ingestion is 5E-02 and for dermal exposure is 1E-04.

Table 8-46. Risk Estimate Summary Using Average Exposure Level for Old Burn Staging Area (Site 36)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
Barium		1.49E-03		1.49E-03												2.08E-03
Copper		4.35E-02		4.35E-02												6.08E-02
Zinc		4.73E-02		4.73E-04												6.63E-04
		4.54E-02		4.54E-02												6.36E-02
Dermal																
Copper																4.11E-05
Zinc		2.94E-05		2.94E-05												1.29E-04
Barium		9.23E-05		9.23E-05												
		1.22E-04		1.22E-04												1.70E-04
Total for Site		**4.55E-02**		**4.55E-02**												**6.38E-02**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

Table 8-47. Risk Estimate Using Reasonable-Maximum Exposure Level for Old Burn Area (Site 36)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
Barium		2.23E-03		2.24E-02												1.85E-02
Copper		1.05E-01		1.01E+00												8.34E-01
Zinc		9.52E-04		9.14E-03												7.55E-03
		1.06E-01		1.04E+00												8.60E-01
Dermal																
Copper																
Zinc		5.90E-05		5.90E-05												1.09E-03
Barium		1.45E-04		1.45E-04												4.43E-04
		2.04E-04		2.04E-04												1.53E-03
Total for Site		**1.09E-01**		**1.04E+00**												**8.62E-01**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

The total hazard index for noncarcinogenic risk from RME is 1E-01. The hazard index for dermal exposure is 2E-04 and for soil ingestion is 1E-01.

The hazard indices for average exposure and RME meet the EPA goal of a residual hazard index of 1 or less.

8.6.7.1.1.2 ***Construction Worker***

CARCINOGENIC RISKS

Slope factors were unavailable for the contaminants of concern at Site 36, and estimates of risk were not calculated.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for the construction worker at Site 36, using average exposure, is 5E-02. The hazard index for soil ingestion is 5E-02 and for dermal exposure is 1E-04.

The total hazard index for noncarcinogenic risks from RME is 1E+00. The hazard index for soil ingestion is 1E+00 and for dermal is 2E-04.

The hazard index for average exposure meets the EPA goal for a residual hazard index of 1 or less. The hazard index for RME exceeds the EPA goal due primarily to potential ingestion of copper. High concentrations of copper are present in surface soils.

8.6.7.1.2 ***Future Land Use.*** The only future land use scenario considered is the future on-site resident. Results from this exposure scenario are discussed below.

CARCINOGENIC RISKS

Slope factors were unavailable for contaminants of concern. No risk estimates were calculated.

NONCARCINOGENIC RISKS

The total noncarcinogenic hazard index for future on-site residents at Site 36 for the average exposure is 6E-02. The risk from soil ingestion is 6E-02 and for dermal is 2E-04.

The total soil pathway noncarcinogenic hazard index from RME is 9E-01. The risk from soil ingestion is 9E-01 and for dermal is 2E-03.

8.6.7.2 *Environmental Evaluation*

8.6.7.2.1 *Site Characterization.* Operable Unit 8, which includes Site 36, is located near the south-central boundary of the facility. The primary vegetation surrounding this site is sagebrush and grass, which is typical of the region. Because of the lack of soil in the former gravel pit, vegetation is sparse within the actual staging area, and the vegetation that does exist is stressed. The gravel pit does not support sufficient vegetation for grazing or wildlife habitat.

Site 36 has received little industrial or human use. Therefore, the area surrounding it offers reasonably good potential habitat for wildlife, and many of the potential wildlife species identified for TEAD-N (Section 2.9) could inhabit the area and remain relatively undisturbed. The environmental evaluation for Site 36 is qualitative and did not include bioassay of the vegetation and wildlife or an inventory of the wildlife. A site specific inventory of vegetation was compiled and is listed in Table 8-48.

A data gap sampling plan to collect additional information will be developed for this site in order to determine the extent of contamination and the degree of ecological risk. The findings will be issued as an RI addendum and an ecological assessment report.

No surface water or evidence of surface water was observed during the field investigation. Furthermore, it is unlikely that any significant surface water accumulates within this site as a result of storm episodes or snowmelt. The gravelly nature of the pit prevents ponding of the water through rapid infiltration.

8.6.7.2.2 *Biological Effects of Contaminants.* Table 8-49, taken from Table 3-18, summarizes the relevant information for the chemicals of concern for Site 36.

8.6.7.2.3 *Potential Pathways.* No biological samples were obtained. Thus, the potential uptake of contaminants by flora and fauna cannot be evaluated at this time. The most probably pathways of contaminants through the ecosystem are as follows:

- Plants

-Direct uptake by plants through roots

- Wildlife

-Ingestion of contaminated soil
-Ingestion of contaminated foliage
-Ingestion of contaminated insects
-Ingestion of contaminated carrion/animals
-Dermal contact
-Inhalation of vapors
-Inhalation of contaminated particulates

Table 8-48. Vegetation Inventory (Site 36)

Scientific Name	Common Name
PRIMARY VEGETATION SPECIES	
Bromus tectorum	Cheatgrass
Erodium cicutarium	Storksbill
Aristida purpurea	Three-awn; No-etum
Chrysothamnus viscidiflorus	Viscid rabbitbrush
OTHER VEGETATION SPECIES	
Helianthus annus	Annual sunflower
Cirsium vulgre	Bull thistle
Agropyron cristatum	Crested wheatgrass
Sphaeralcea coccinea	Globe mallow
Grindelia squarros	Gumweed
Stipa hymenoides	Indian ricegrass
Gutierrezia sarothrae	Matchweed
Stipa comata	Needle-and-threadgrass
Lactuca scariola	Prickly lettuce
Opuntia polyacantha	Prickly pear cactus
Chrysothamnus nauseosus	Rabbitbrush
Salsola iberica	Russian thistle
Artemisia tridentata	Sagebrush
Sporobolus cryptandrus	Sand dropseed
Poa secunda	Sandberg's bluegrass
Calochortus nuttallii	Sego lily
Elymus elymoides	Squirreltail
Duscurainia sophia	Tansy mustard
Sisymbrium officinale	Tumbling mustard
Juniperus osteosperma	Utah juniper
Tragopogon dubius	Yellow goats beard

Table 8-49. Summary of Contaminants (Site 36)

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
Barium	I[a]	M[b]	BC[c]	3[d]	3	all soluble *salts* are acute poisons
Chromium	VL[e]	L[f]→H[g]	BC	1[h]	3	many Cr+6 cmpds are animal and human carcinogens
Copper	I	VL→M	BC	3	3	Cu° metal toxicity very low; many Cu(II) salts are toxic
Iron	I	L→H	---	---	3 dust explosive	poison by IP route; questionable animal carcinogen; potentially toxic in all forms
Lead	I	H	BC	2[i],3	3	acute and chronic toxicant; suspected carcinogen
Mercury	I	H	BA[j],BC	3	3	highly toxic by most routes incl. inhalation; questionable carcinogen; some evidence of human mutations
Nickel	I	L→M	BA	1	3 dust explosive	dust is confirmed carcinogen; low oral toxicity for metal;
Silver	I	L	BA,BC	---	2 dust sl. flammable	toxicity of metal is low by all exposure routes; dust an irritant; accumulation in the body may produce argyria; soluble cmpds toxic/fatal
Zinc	I	VL→L	BC	---	3 dust explosive	many Zn cmpds are toxic; dust is an irritant

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]I = insoluble.
[b]M = moderate.
[c]BC = bioconcentrate.
[d]3 = tissue or organ damage.
[e]VL = very low.
[f]L = low.
[g]H = high.
[h]1 = carcinogenic.
[i]2 = probable or suspected carcinogen.
[j]BA = bioaccumulate.

Potential ecological exposure pathways are shown in Figure 8-23.

8.6.7.2.4 ***Potentially Affected Populations.*** Table 8-50 presents a summary of exposure points, exposed populations, and the activities by which ecological exposure may occur. The table is listed in decreasing exposure potential.

Table 8-50. Exposure Scenarios for Ecological Populations

Exposure Point	Exposed Populations	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Large Mammals	Ingestion of contaminated vegetation; foliage, fruit, and potentially roots.	Unlikely as pit contains sparse vegetation.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Occasional exposure, only when feeding at this site, due to heavy industrial activity.
Terrestrial Locations	Raptors	Ingestion of contaminated carrion or animals.	Unlikely, exposed when feeding in other areas on prior inhabitants of the site.

8.6.7.2.5 ***Environmental Evaluation Conclusions.*** The primary contaminants of concern at this site are heavy metals. In addition, these contaminants have a qualitative biological hazard ranking of high, with a few rated as moderate to high. These biological hazard rankings are high because metals are typically toxic and will bioaccumulate. At these concentrations, the contaminants may be problematic at the individual and local species population level; the specific effects cannot be evaluated with the available data.

Alterations to the trophic structure and ecological processes at Site 36 or to the TEAD-N facility cannot be evaluated until further data are collected. Recovery time cannot be derived or predicted from the information evaluated.

In order to completely assess the ecological risk at this site, biological sampling and analysis are necessary. Tissue sampling of vegetation and wildlife, analyses for chemicals of concern during the growing season, and a species inventory are warranted.

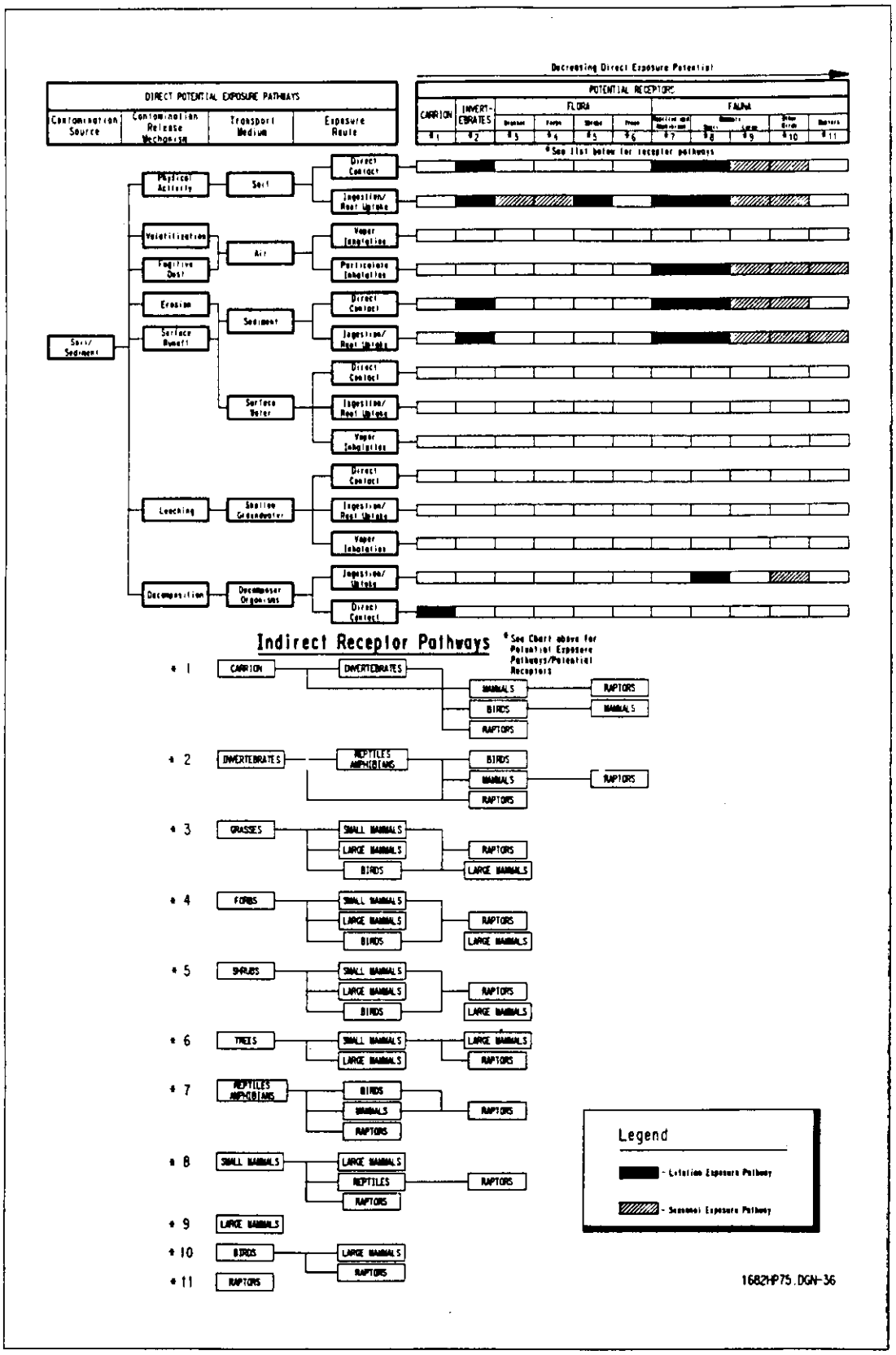


Figure 8-23. Potential Ecological Exposure Pathways for Site 36

8.6.8 Conclusions

On the basis of geophysical surveying and visual observations at Site 36, it appears that the dark areas within the former gravel pit, which were interpreted to represent standing liquid from EPIC aerial photographs, correspond to dark areas of surface staining resulting from surface burning. Other evidence of surface burning was found in surface soils north of the pit. The geophysical survey conducted north of the pit indicates that no pits or trenches were used and that metal debris and charred wood are a result of surface burning.

The vertical and horizontal extent of the contamination in these burn areas is currently unknown.

8.6.9 Recommendations

Shallow soil borings in former burn areas within the pit are planned to define vertical extent of contamination. Additional surface-soil samples are also scheduled to define the horizontal extent of the burn areas. The sample locations would be biased toward the perimeter of the burn areas following mapping of the areas by visual observation of metal debris, charred wood, and stained soils. The additional data will be used to re-evaluated adverse health effects associated with the site.

9.0 OPERABLE UNIT 9

9.1 SMALL ARMS FIRING RANGE (Site 8)

9.1.1 Site Characteristics

The Small Arms Firing Range (see Figure 1-15) is located along the extreme western boundary of TEAD-N and has been used by the National Guard, Army Reserve, Navy, and TEAD military personnel for training in the use of small fire arms (e.g., M-16s, M-60 machine guns, and pistols). The range contains 20 firing stations with targets located at 25, 50, 100, and 200 meters. Bermed areas behind the targets are used to stop the rounds fired at the targets. Currently, the site is only occasionally used for training. There was no evidence of recent use of the firing range during the site visit by Rust E&I in October of 1991. A new small arms firing range was established in 1992, and most of the training is now conducted at the new range.

9.1.2 Previous Investigations and RI Activities

No previous environmental investigations were conducted at Site 8. Following the site visit by Rust E&I in October 1991, it was determined that four composite surface-soil samples were needed to characterize the potential contaminants in the soils related to the thousands of rounds of ammunition fired into the bermed areas behind the target areas. The composite samples consisted of five subsamples taken over an approximate 100-square-foot area per sample. The five subsamples were combined and homogenized to form a composite sample. The resulting four composite samples were analyzed for metals. Because of a sampling oversight, the original samples were analyzed for TCLP metals only. In December 1992, the same locations were resampled for total metals (target analyte list). Results from these samples are incorporated. The total-metals-versus-TCLP-metals results were used to help determine contaminant fate and transport through leaching in soils. Photographs of the sampling area are presented in Appendix D.

9.1.3 Nature and Extent of Contamination

RI activities included the collection of four composite surface-soil samples (Figure 9-1) for total TAL and TCLP metals analysis. Total metals detected in soils are presented in Table 9-1. Of the metals detected, only lead exceeded background levels. TCLP analysis results (Table 9-2) indicate detectable amounts of leachable barium, cadmium, lead, and mercury. However, only lead exceeds regulatory levels for TCLP.

The vertical and horizontal extent of soils contamination has not been assessed for this site. The areal extent of soils contamination has not been defined, but lead contamination appears to be highest in the northernmost bermed area represented by Sample SAS-92-02 (Figure 9-1).

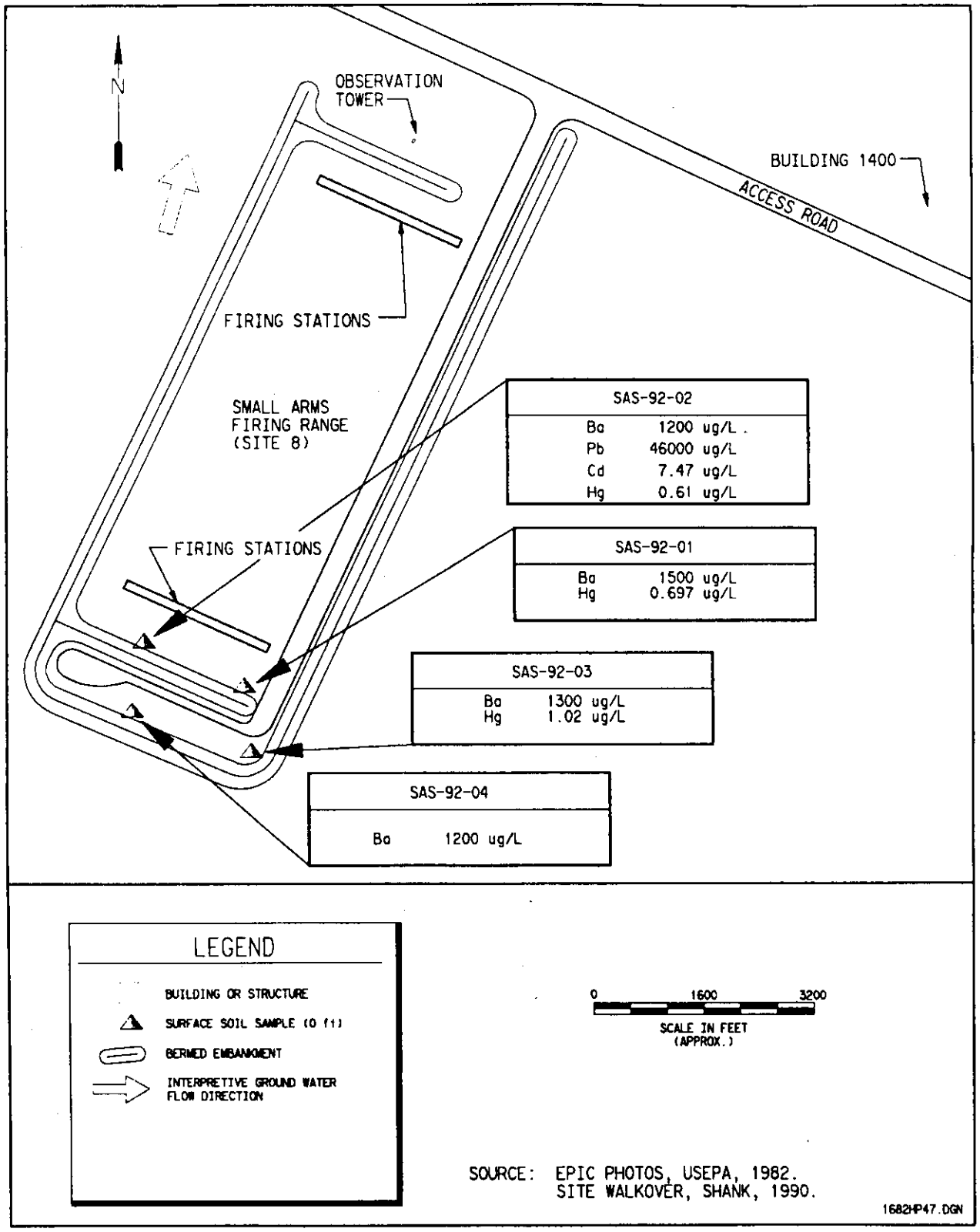


Figure 9-1. RI Sample Locations and Results for the Small Arms Firing Range (Site 8)

Table 9-1. Summary of Total Metals Above Reporting Limits for Surface Soil Samples at the Small Arms Firing Range (Site 8)

	Results in μg/g				
Analyte	**SAS-92-01***	**SAS-92-02***	**SAS-92-03***	**SAS-92-04***	**Background Tolerance Limit**
Aluminum	14,000	13,100	15,100	19,200	31,700
Arsenic	5.72	7.34	10.8	8.47	76.0
Barium	183	199	185	185	277
Beryllium	0.57	0.49	0.54	0.60	1.92
Boron	10.8	9.79	10.5	19.3	Not Available
Calcium	84,000	47,300	35,200	31,200	131,000
Chromium	16.0	14.6	18.1	22.3	22.8
Cobalt	4.91	6.28	6.22	6.40	7.32
Copper	18.8	14.6	13.1	17.8	28.2
Lead	190	480	31.0	28.0	63.4
Magnesium	8,720	10,100	9,000	10,800	28,000
Manganese	307	308	441	405	787
Nickel	13.8	14.2	16.6	15.6	19.3
Potassium	2,690	2,710	3,990	5,050	8,920
Sodium	247	289	275	358	1,840
Vanadium	21.4	20.8	26.2	30.3	33.1
Zinc	52.9	53.9	62.4	71.7	169

*Samples were taken from 0 to 6 inches.

Table 9-2. Summary of TCLP Metals Detected for the Small Arms Firing Range (Site 8)

	Results in mg/L				
Analyte	**SAS-92-01**	**SAS-92-02**	**SAS-92-03**	**SAS-92-04**	**TCLP Regulatory Level**
Barium	1.5	1.2	1.3	1.2	100
Cadmium	LT*	0.007	LT	LT	1.0
Mercury	0.0007	0.0006	0.0010	LT	0.2
Lead	LT	46.0	LT	LT	5.0

*Less than method reporting limit.

To obtain the needed data to be able to characterize Site 8, 50 additional soil samples are scheduled to be taken and analyzed for metals. The results of these analyses will be used to calculate and assess risks to human health and the environment. These results will be reported and analyzed in an RI Report Addendum and future FS.

9.1.4 Contaminants of Concern

Table 9-3 summarizes sampling parameters for lead, which is the contaminant of concern at the Small Arms Firing Range.

9.1.5 Contaminant Fate and Transport

Section 3.4 provides a description of the fate and transport processes for the contaminant of concern. The fate and transport of metals is complex and is dependent upon such factors as the valence state of the metals and the pH of the soil. Typically, lead is expected to be immobile in soil and resistant to leaching. TCLP results indicate that there is a potential for leaching of lead from the berm soils under acidic conditions, making it a potential hazardous waste. Acidic conditions simulated by TCLP, however, are not expected to occur in soils present in the berms at Site 8.

9.1.6 Potential Exposure Pathways

Figure 9-2 presents the potential exposure pathways for Site 8. It is assumed that metals associated with bullets and bullet casings are not highly mobile in the vadose zone. Vadose zone modeling indicates that contaminants in this environment would take over 100 years to reach the groundwater and, at that time, the levels of the contaminants would be several orders of magnitude lower than at present (see Section 3.4.3). It is also likely that much of the metals contamination would not be available as particulate size fraction for transport in the air pathway. However, dermal contact, ingestion, and inhalation are all potential exposure pathways for contaminants related to Site 8. There are no major surface-water drainage areas at Site 8, and surface runoff during periods of precipitation would infiltrate into the gravelly soils prior to going off-site.

Environmental exposure is also possible for this area through ingestion and several other pathways by burrowing animals in the contaminated soils and by grazing wildlife and livestock.

9.1.7 Baseline Risk Assessment

9.1.7.1 *Human Health Evaluation*

Because of the toxicological effects associated with lead, especially in children, additional sampling is required to define the extent of lead contamination at Site 8 before a risk

Table 9-3. Contaminants of Concern for the Small Arms Firing Range (Site 8)

		Results in μg/g				
Analyte	**Detects**	**Low**	**High**	**Average**	**95% Upper Confidence**	**Background Concentration**
Lead	4/4	28	480	182	347	169

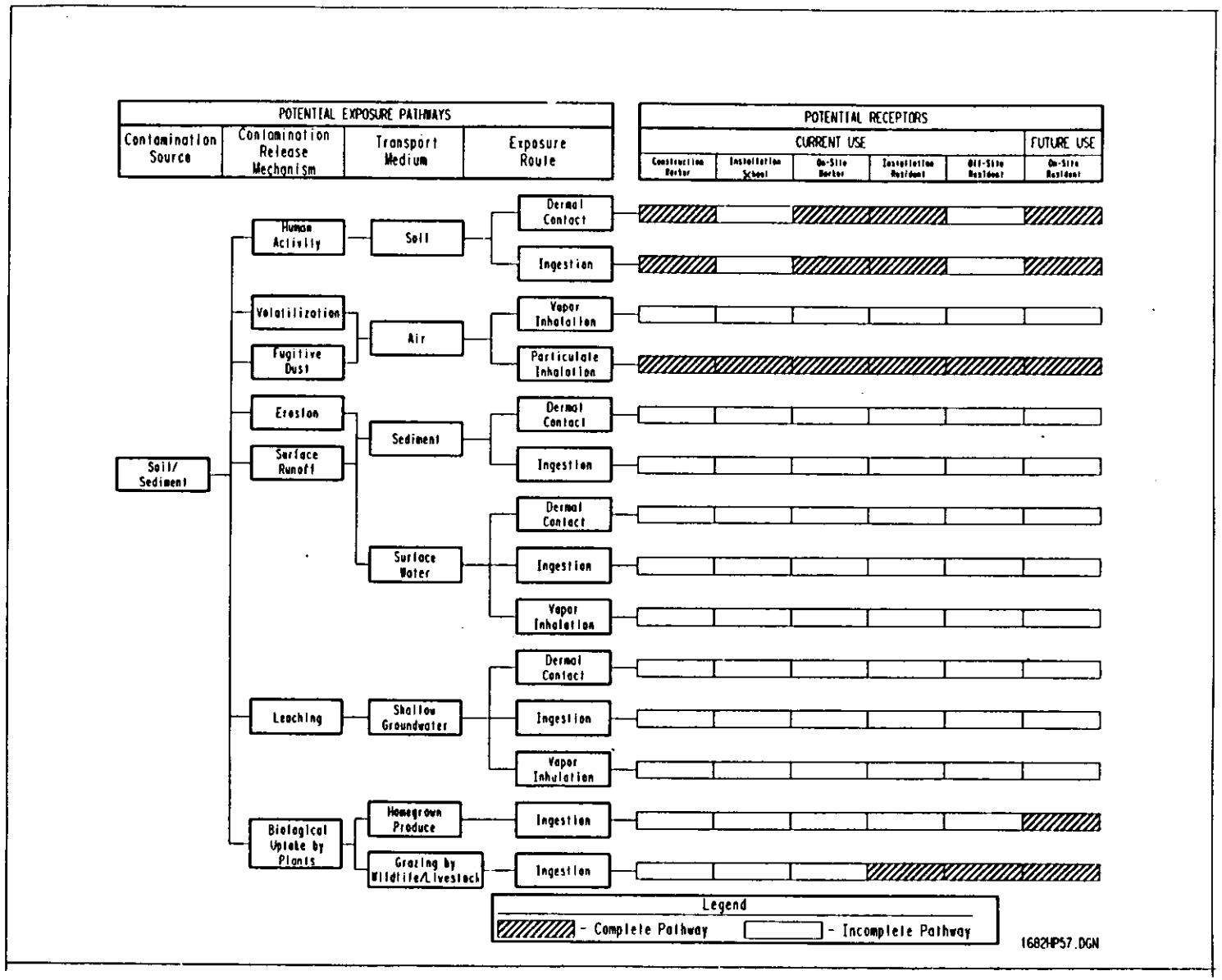


Figure 9-2. Potential Human Exposure Pathway Conceptual Model for the Small Arms Firing Range (Site 8)

assessment can be performed. The data will be used with EPA's Lead Uptake/Biokinetic model to establish health risks associated with lead contamination at Site 8.

9.1.7.2 *Environmental Evaluation*

9.1.7.2.1 ***Site Characterization***. Operable Unit 9 includes Site 8. The area surrounding this site is relatively flat; it is characterized predominantly by sagebrush and grasses. Vegetation observed during the RI field investigation appeared healthy and no areas of stressed vegetation were noted. This area is relatively remote from human activity, and wildlife in this area is largely undisturbed by installation activities. The habitat at this site is satisfactory for many of the wildlife species identified as potential occupants at TEAD-N (Section 2.9). No permanent surface water was identified at this site during the field investigation.

The environmental evaluation for Site 8 is qualitative and did not include a bioassay of vegetation or wildlife or an inventory of wildlife. A site-specific inventory of vegetation was compiled and is listed in Table 9-4.

Data gap sampling to collect additional information is planned at this site to further determine the extent of contamination and the degree of ecological risk. The findings will be issued as an RI report addendum and ecological assessment report. Of particular interest is the availability of the lead for plant and animal uptake. Most of the contamination is suspected to be in large bullet fragments that are stable and resistant to leaching.

9.1.7.2.2 ***Biological Effects of Contaminants***. Table 9-5 summarizes the relevant information for the chemical of concern for Site 8, which was taken from Table 3-18.

9.1.7.2.3 ***Potential Pathways***. No biological samples were obtained, thus, the uptake of contaminants by flora and fauna cannot be evaluated at this time. The most probable pathways of contaminants through the ecosystem are as follows:

- Plants

-Direct uptake through root system

- Wildlife

-Ingestion of contaminated soil
-Ingestion of contaminated foliage
-Ingestion of contaminated insects
-Ingestion of contaminated carrion/animals
-Dermal contact
-Inhalation of vapors
-Inhalation of contaminated particulates

Potential pathways are shown in Figure 9-3.

Table 9-4. Vegetation Inventory (Site 8)

Scientific Name	Common Name
PRIMARY VEGETATION SPECIES	
Bromus tectorum	Cheatgrass
Erodium cicutarium	Storksbill
Chrysothamnus viscidiflorus	Viscid rabbitbrush
OTHER VEGETATION SPECIES	
Helianthus annuus	Annual sunflower
Astragalus cibarius	Browse milkvetch
Crisium vulgre	Bull thistle
Ranunculus testiculatus	Bur-buttercup
Arctium minus	Burdock
Agropyron cristatum	Crested wheatgrass
Euphorbia glyptosperma	Euphorb
Oenothera pallida	Evening primrose
Sphaeralcea coccinea	Globe mallow
Grindellia squarrosa	Gumweed
Halogenton glomeratus	Halogenton
Gutierrezia sarothrae	Matchweed
Verbascum thapsus	Mullein
Lepidium perfoliatum	Peppergrass
Lactuca scariola	Prickly lettuce
Salsola iberica	Russian thistle
Artemisia tridentata	Sagebrush
Sporobolus Cryptandrus	Sand dropseed
Elymus elymoides	Squirreltail grass
Chrysothamnus nauseosus	Tall rabbitbrush
Aristida purpurea	Three-awn; No-etum
Sisymbrium officinale	Tumbling mustard
Tragopogon dubius	Yellow goats beard
Melilotus officinalis	Yellow sweetclover

Table 9-5. Summary of Contaminants (Site 8)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	*Hazard Rating	Comments
Lead	I[a]	H[b]	BC[c]	2[d],3[e]	3	acute and chronic toxicant; suspected carcinogen

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]I = insoluble.
[b]H = high.
[c]BC = bioconcentrate.
[d]2 = probable or suspected carcinogen.
[e]3 = tissue or organ damage.

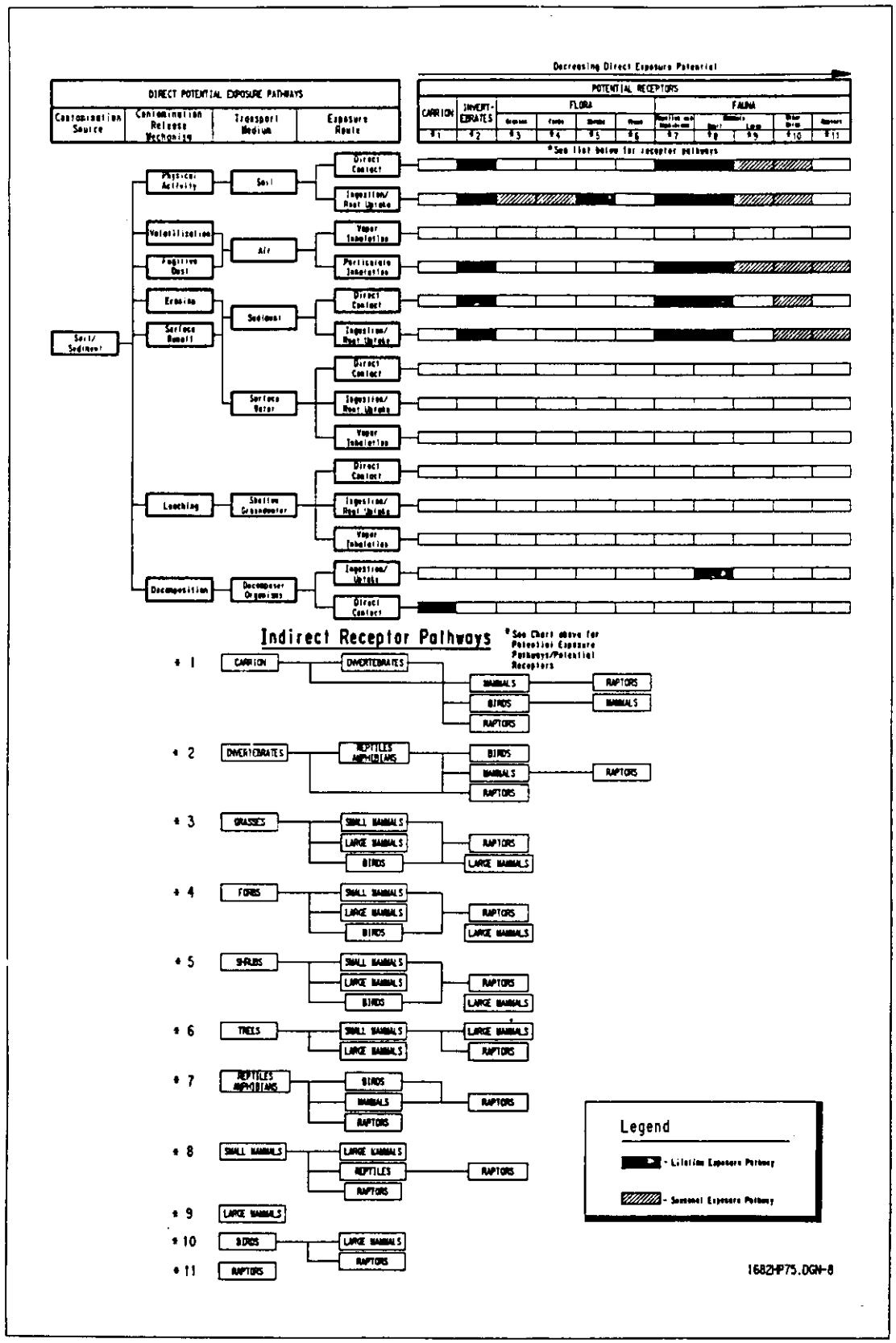


Figure 9-3. Potential Ecological Exposure Pathways for Site 8

9.1.7.2.4 *Potentially Affected Populations*. Table 9-6 presents a summary of exposure points, general population, and the activity by which ecological exposure may occur. The table is listed in order of decreasing exposure potential.

Table 9-6. Exposure Scenarios for Ecological Populations (Site 8)

Exposure Point	Exposed Population	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Large Mammals	Ingestion of contaminated vegetation; foliage, fruit, and potentially roots.	Primarily exposed while feeding at this site; may be reduced to seasonal exposure.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Exposed only when feeding at this site; likely only seasonal.
Terrestrial Locations	Raptors	Ingestion of contaminated carrion or animals.	Exposed when feeding on prior inhabitants of the site.

9.1.7.2.5 *Environmental Evaluation Conclusions*. The contaminant of concern for this site is lead. In addition, the qualitative biological hazard ranking for this contaminant is generally high because it is toxic and may bioaccumulate. The most likely population to be affected by the contamination at Site 8 would be burrowing animals since the berm areas would provide a suitable habitat for rodents and other small mammals.

Alterations to the trophic structure and ecological processes at Site 8 or to the TEAD-N facility cannot be evaluated until further data are collected. Recovery time cannot be derived or predicted from the information evaluated.

In order to completely assess the ecological risk at this site, bioassays such as tissue sampling of vegetation, analyses for chemicals of concern, and a species inventory are warranted.

9.1.8 Conclusions

Initial results from surface-soil samples indicate that elevated concentrations of lead exist in soils behind the target areas at Site 8. Since composite samples were collected, areas of highest contaminant concentrations have not been adequately characterized. Without the extent of contamination fully defined, the risk assessment could not be performed.

9.1.9 Recommendations

Additional surface- and subsurface-soil samples are planned to further define the levels and extent of lead contamination at the Small Arms Firing Range. Since most of the lead is likely to be contained within bullet fragments, select samples should be sieved. A comparison of results for the complete soils (i.e., fine and coarse) with the results for the fine-fraction soil only, will help determine the distribution of the lead in soils. The results will be used to support the risk assessment and the feasibility study. Once the extent of metals contamination is defined, potential health risks associated with Site 8 can be evaluated.

9.2 AED TEST RANGE (Site 40)

9.2.1 Site Characteristics

The AED Test Range (see Figure 1-16) is located in the northwestern area of TEAD-N and was used for the testing of munitions. The site consisted of several bermed revetments, a drop tower, a deactivation furnace, and an observation bunker. Testing ranged from large (i.e., 1 ton) bombs to small munitions and, also, included the testing of rocket engines. The area contains both spent materials and UXO. A foundation is present from a former test building, which was used to test conveyor spacing for a deactivation furnace. The furnace and building were damaged as a result of explosions that took place during the testing. Testing in the AED Test Range was largely conducted by personnel observing the test from an observation bunker located on a hill to the southeast of the testing revetments. This area appears to have been used extensively, and UXO still exists at the site. Fragments of propellant for rocket engines were also observed in the revetment surrounding the drop tower.

9.2.2 Previous Investigation and RI Activities

No previous environmental investigations have been conducted at the AED Test Range. The area appears to have been used extensively over the years for all types of munitions testing, including the detonation of 1-ton bombs as evidenced by over 20 bomb craters in the northern portion of the test range. Because of the presence of UXO (one projectile was found during the site visit), Rust E&I utilized EOD Technologies, Inc., to conduct a UXO sweep of areas to be characterized as part of the current RI. Following the UXO sweeps, field-investigation activities at the AED Test Range consisted of (1) geophysical surveying to determine if buried metal wastes were present in the revetments, (2) surface-soil sampling around the building

foundation and the floor of the revetments, and (3) sampling of test pits for the characterization of any subsurface materials identified by the geophysical surveys.

Geophysical surveys were conducted over the entire floor area of six of the major berm areas where evidence of previous testing activities was present. Figure 9-4 shows the location of the geophysical surveys and the target anomalies identified. The results of the geophysical surveying are presented in Appendix B of this report.

The locations of each test pit and each surface-soil sample are shown in Figure 9-5. Table 9-7 provides a summary of the samples collected at the AED Test Range. Photographs of the test-pit excavation activities are presented in Appendix D. All samples were analyzed for semi-VOCs, inorganics, anions, and explosives. Measurements with a PID showed no evidence of VOCs in materials sampled; therefore, no samples for VOCs were necessary. The originally proposed field activities included the characterization of a trench in the northwestern portion of the site. During the site visit by Rust E&I in October of 1991, the trench, which is still open, was visually inspected and no evidence of waste disposal was observed. Therefore, no further investigation of the trench appeared to be warranted.

One surface-soil sample in the revetment containing the drop tower was biased toward (within 1 foot) an unidentified pile of yellow and green materials that appear to be related to explosives or propellants. Large fragments of reddish-brown rocket propellant were also observed to be present on the ground surface in this area.

9.2.3 Nature and Extent of Contamination

There have been no previous investigations at Site 40. RI activities included geophysical surveys using magnetometry and GPR, and the collection and analysis of 11 surface-soil samples and 5 subsurface-soil samples (Figure 9-5). The samples were analyzed for semi-VOCs, explosives, inorganics, and anions. Results of analytes detected on concentrations above background are shown in Table 9-8. The only semi-VOCs detected, diethyl phthalate and di-N-butyl phthalate, were limited to one soil sample each. Explosives were detected in five of the revetments; these included HMX, RDX, tetryl, 2,4-dinitrotoluene, and 2,4,6-trinitrotoluene. The metals that were detected at concentrations exceeding background included cadmium, copper, lead, silver, and zinc. No anions were detected above background concentrations.

Additional data are necessary to better delineate the extent of contamination and characterize the site. Sixty locations across the site are to be sampled at 0, 3, and 5 foot depths. These 180 soil samples will be analyzed for metals and explosives. The results of these analyses will be used to re-calculate and assess risks to human health and the environment. These results will be reported and analyzed in an RI report addendum and future FS.

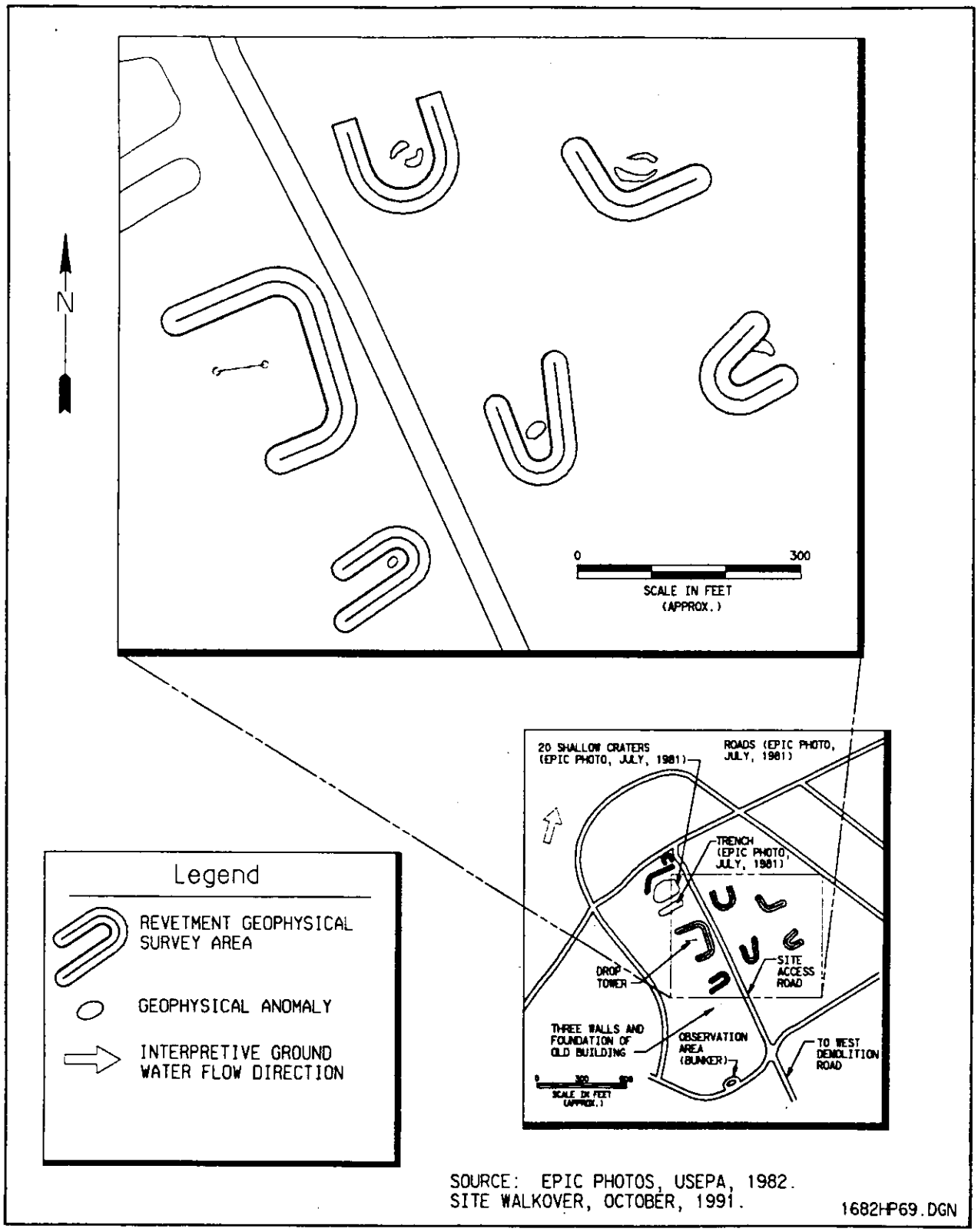


Figure 9-4. Locations of the Geophysical Surveys and Target Anomalies at Site 40

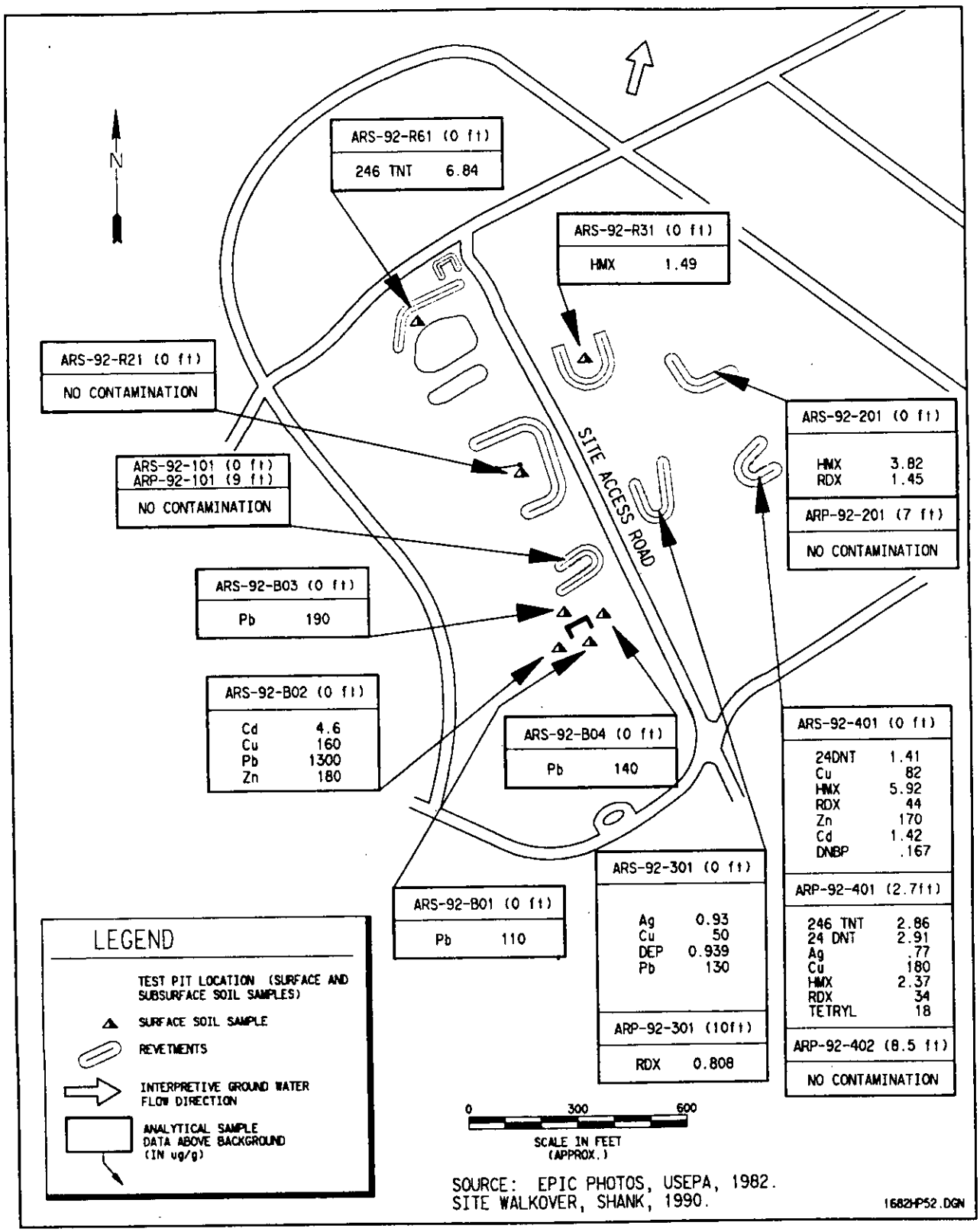


Figure 9-5. RI Sample Locations and Results for the AED Test Range (Site 40)

Table 9-7. Summary of Sampling Locations at the AED Test Range

Sample ID Number	Depth (ft)	Description
ARS-92-101	0	Test Pit 1 in revetment north of building foundation
ARP-92-101	9	Sample near bottom of Test Pit 1
ARS-92-201	0	Test Pit 2 in northeast revetment
ARP-92-201	7	Sample near bottom of Test Pit 2
ARS-92-301	0	Test Pit 3 in revetment east of access road in southern portion of the site
ARP-92-301	10	Sample near bottom of test Pit 3
ARS-92-401	0	Test Pit 4 is southeast revetment
ARP-92-401	2.7	Sample in zone of metal debris in Test Pit 4
ARP-92-402	8.5	Sample near bottom of Test Pit 4
ARS-92-B01	0	Sample on the south perimeter of building foundation
ARS-92-B02	0	Sample on west perimeter of building foundation
ARS-92-B03	0	Sample on north perimeter of building
ARS-92-B04	0	Sample on east perimeter of building
ARS-92-R21	0	Sample near-surface explosives debris near drop tower (wooden hoisting apparatus)
ARS-92-R31	0	Sample in revetment east of access road in northern portion of the site
ARS-92-R61	0	Sample in revetment north of bomb craters

Table 9-8. Summary of Analytes Above Background Concentrations for the AED Test Range (Site 40)

Analytes	ARS-92-101* (0 ft)	ARP-92-101 (9 ft)	ARS-92-201 (0 ft)	ARP-92-201 (7 ft)	ARS-92-301* (0 ft)	ARP-92-301 (10 ft)	ARS-92-401* (0 ft)	ARP-92-401 (2.7 ft)	ARP-92-402 (8.5 ft)	Background Concentrations
	Concentrations in µg/g									
SVOC										
Diethyl phthalate	ND	ND	ND	ND	.939	ND	ND	ND	ND	---
Di-N-butyl phthalate	ND	ND	ND	ND	ND	ND	.167	ND	ND	---
Anions										
Nitrate	<BKGD	LT	<BKGD	LT	11.2	LT	<BKGD	LT	LT	9.45
Explosives										
2,4-Dinitrotoluene	LT	LT	LT	LT	LT	LT	1.41	2.91	LT	---
2,4,6-Trinitrotoluene	LT	LT	LT	LT	LT	LT	LT	2.86	LT	---
HMX	LT	LT	3.82	LT	LT	LT	5.92	2.37	LT	---
RDX	LT	LT	1.45	LT	LT	.808	44.0	34.0	LT	---
Tetryl	LT	LT	LT	LT	LT	LT	LT	18.0	LT	---
Inorganics										
Cadmium	LT	LT	LT	LT	LT	LT	1.42	LT	LT	.847
Copper	<BKGD	<BKGD	<BKGD	LT	50.0	<BKGD	82.0	180	<BKGD	28.2
Lead	<BKGD	<BKGD	<BKGD	<BKGD	130	<BKGD	<BKGD	<BKGD	<BKGD	63.4
Silver	<BKGD	<BKDG	<BKGD	LT	.930	<BKGD	<BKGD	.770	<BKGD	.749
Zinc	<BKGD	<BKGD	<BKGD	LT	<BKGD	<BKGD	170	<BKGD	<BKGD	169

Notes.—ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. <BKGD=Analyte is less than background concentrations. *Samples were taken from 0-6 inches.

Table 9-8. Summary of Analytes Above Background Concentrations for the AED Test Range (Site 40) (continued)

Analytes	ARS-92-B01* (0 ft)	ARS-92-B02* (0 ft)	ARS-92-B03* (0 ft)	ARS-92-B04* (0 ft)	ARS-92-R21* (0 ft)	ARS-92-R31* (0 ft)	ARS-92-R61* (0 ft)	Background Concentrations
	Concentrations in µg/g							
SVOC								
Diethyl phthalate	ND	ND	ND	ND	ND	ND	ND	---
Di-N-butyl phthalate	ND	ND	ND	ND	ND	ND	ND	---
Anions								
Nitrate	< BKGD	LT	< BKGD	< BKGD	LT	LT	LT	9.45
Explosives								
2,4-Dinitrotoluene	LT	LT	LT	LT	LT	LT	LT	---
2,4,6-Trinitrotoluene	LT	LT	LT	LT	LT	LT	6.84	---
HMX	LT	LT	LT	LT	LT	1.49	LT	---
RDX	LT	LT	LT	LT	LT	LT	LT	---
Tetryl	LT	LT	LT	LT	LT	LT	LT	---
Inorganics								
Cadmium	LT	4.60	LT	LT	LT	LT	LT	.847
Copper	< BKGD	160	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	28.2
Lead	110	1300	190	140	< BKGD	< BKGD	< BKGD	63.4
Silver	< BKGD	< BKDG	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	.749
Zinc	< BKGD	180	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	169

Notes.—ND=Analyte not detected in sample. LT=Analyte is less than certified reporting limit. ---=It is assumed that organics are not present in background soil. < BKGD=Analyte is less than background concentrations. *Samples were taken from 0 to 6 inches.

9.2.4 Contaminants of Concern

Tables 9-9 and 9-10 present the contaminants of concern for the AED Test Range. The contaminants of concern consist primarily of explosives and metals. These contaminants differ from revetment to revetment as a result of the types of explosives-related testing that has occurred at the AED test range over the years. Low levels of diethyl phthalate and di-N-butyl phthalate were present in surface soil from Revetment 3 and 4, respectively. However, they were not evaluated as part of the human health risk assessment due to infrequent detections (1 out of 16) and the likelihood that they are laboratory artifacts and not related to field contamination.

9.2.5 Contaminant Fate and Transport

Section 3.4 provides a description of the fate and transport processes for the contaminants of concern. In general, the mobility of metals in the soils of TEAD-N is likely to be low, whereas the explosives contaminants show a significantly higher mobility in the same environment. Vadose zone modeling has shown that contaminants in the vadose zone would take over 100 years to reach groundwater, and, at that time, the concentrations would be orders of magnitude lower than the original source levels. On the basis of this modeling, it appears that the groundwater pathway is not presently a concern for this site.

No major surface-water drainages are present in the immediate area of Site 40. Because of the sandy and gravelly nature of the soils of the area, surface-water runoff during precipitation events would infiltrate before reaching a surface-water drainage. Therefore, off-site transport of contaminants via the surface-water pathway is unlikely.

Because of the abundance of surface contaminants, off-site transport in the form of particulates via the air pathway is possible.

9.2.6 Potential Exposure Pathways

The potential exposure pathways for Site 40 are presented in Figure 9-6. At this site, the primary exposure pathways for human exposure are incidental soil ingestion, dermal contact, and inhalation of particulates from fugitive dust emissions. These exposure pathways were evaluated for several potential receptors, including the on-site worker, construction worker, installation resident, installation school student, off-site resident, and future on-site resident.

For environmental receptors the same types of exposure pathways were identified, such as dermal contact and ingestion by burrowing animals or ingestion by grazing wildlife and livestock.

Table 9-9. Contaminants of Concern in Soil at the AED Test Range (Site 40)

Analytes	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration*	Method	Sample Quantitation Limit
2,4-Dinitrotoluene	2	16	1.41	2.91	0.596	0.888	---	LW26	0.744
2,4,6-Trinitrotoluene	2	16	2.86	6.84	1.01	1.74	---	LW26	0.931
Cadmium	2	16	1.42	4.60	0.575	1.06	.847	JS15	0.424
Copper	15	16	3.14	180	36.6	61.2	28.2	JS15	1.95
Diethyl phthalate	1	16	0.939	0.939	0.213	0.298	---	LM15	0.33
Di-N-butyl phthalate	1	16	0.167	0.167	0.165	0.165	---	LM15	0.33
HMX	4	16	1.49	5.92	1.13	1.84	---	LW26	0.755
Lead	16	16	2.50	1300	129	268	63.4	JD13	0.319
RDX	4	16	0.808	44.0	5.18	11.0	---	LW26	0.502
Silver	15	16	0.020	0.930	0.217	0.347	.749	JD13	0.015
Tetryl	1	16	18.0	18.0	1.61	3.52	---	LW26	1.04
Zinc	16	16	11.5	180	65.3	91.7	169	JS15	7.96

Note.—All results are reported as μg/g. Soil includes all soil samples. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

*Background concentrations were derived as mean plus 2 standard deviations from background data for conservative approach (tolerance limit).

Table 9-10. Contaminants of Concern in Surface Soil at the AED Test Range (Site 40)

Analytes	Total Detects	Total Samples	Low	High	Average	95% Confidence	Background Concentration*	Method	Sample Quantitation Limit
2,4-Dinitrotoluene	1	11	1.41	1.41	.466	.637	---	LW26	0.744
2,4,6-Trinitrotoluene	1	11	6.84	6.84	1.05	2.10	---	LW26	0.931
Cadmium	2	11	1.42	4.60	.721	1.45	.847	JS15	0.424
Copper	11	11	5.65	160	35.6	61.4	28.2	JS15	1.95
Diethyl phthalate	1	11	0.939	0.939	0.235	0.362	---	LM15	0.33
Di-N-butyl phthalate	1	11	0.167	0.167	0.165	0.165	---	LM15	0.33
HMX	3	11	1.49	5.92	1.30	2.32	---	LW26	0.755
Lead	11	11	11.0	1300	182	388	63.4	JD13	0.319
RDX	2	11	1.45	44.0	4.31	11.5	---	LW26	0.502
Silver	11	11	0.048	0.930	0.239	0.400	.749	JD13	0.015
Zinc	11	11	19.7	180	84.3	119	169	JS15	7.96

Note.—All results are reported as μg/g. Surface soil includes soil samples from depths of less than 6 inches. It is assumed that background soil does not contain organic compounds, as indicated by the dash marks (---). The average concentration is the average of the detected concentrations. If a contaminant was detected in some samples, but not in others, one-half of the sample quantitation limit was used as the concentration value for the non-detects in computing the average value. The 95% confidence concentration is the 95% upper confidence limit on the arithmetic average concentration.

*Background concentrations were derived as mean plus 2 standard deviations from background data for conservative approach (tolerance limit).

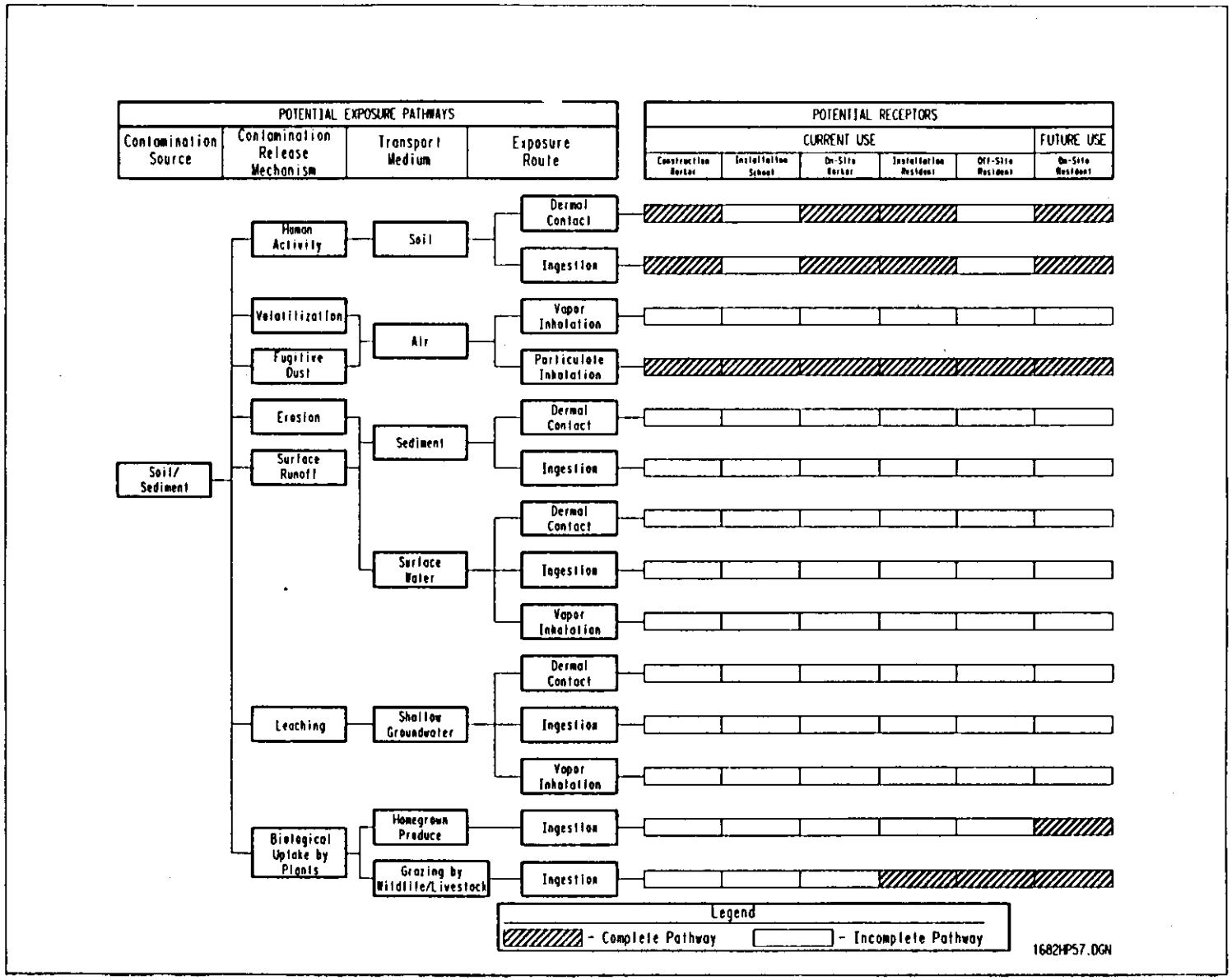


Figure 9-6. Potential Human Exposure Pathway Conceptual Model for the AED Test Range (Site 40)

9.2.7 Baseline Risk Assessment

9.2.7.1 *Human Health Evaluation*

A summary of the risk estimates for each exposure scenario evaluated are presented in Tables 9-11 and 9-12. The risks estimated for individual contaminants are presented in Appendix I. The total risk estimates are discussed below by scenario, which includes average exposure and RME for carcinogenic and noncarcinogenic risks.

9.2.7.1.1 *Current Land Use*. This section discusses estimates for each exposure scenario assessed under current site use conditions.

9.2.7.1.1.1 *On-Site Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for on-site workers at Site 40 for the estimated average exposure is 3E-07. The risk factor for dermal exposure is 2E-07, for soil inhalation is 4E-10, and for soil ingestion is 4E-08.

The total carcinogenic risk from RME is 2E-06. The risk factor for dermal exposure is 2E-06, for soil inhalation is 3E-07, and for soil ingestion is 3E-07. Risk factors for the average exposure and RME are within or below EPA target range of 1E-04 to 1E-06 for residual risk.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for on-site workers at Site 40, using the estimated average exposure, is 1E-02. The hazard index for soil ingestion is 7E-03 and for dermal exposure is 5E-03.

The total hazard index for noncarcinogenic risk from RME is 3E-02. The hazard index for soil ingestion is 1E-02 and for dermal exposure is 1E-02. Both average exposure and RME hazard indices meet the EPA goal for a residual hazard index of 1 or less.

9.2.7.1.1.2 *Construction Worker*

CARCINOGENIC RISKS

The total carcinogenic risk factor for the construction worker at Site 40 using the estimated average exposure is 3E-08. The risk factor for dermal exposure is 3E-08, for soil inhalation is 4E-14, and for soil ingestion is 4E-09.

Table 9-11. Risk Estimate Summary Using Average Exposure Levels for the AED Test Range (Site 40)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
2,4,6-Trinitrotoluene	2.20E-09	1.03E-03	2.14E-10	9.92E-04												1.44E-03
2,4-Dinitrotoluene		1.14E-04		1.46E-04											2.77E-09	1.60E-04
Cadmium		3.52E-04		5.63E-04												4.93E-04
Copper		4.71E-03		4.84E-03												6.59E-03
HMX		1.27E-05		1.11E-05												1.78E-05
RDX	3.31E-08	7.03E-04	3.98E-09	8.45E-04											4.18E-08	9.84E-04
Silver		2.34E-05		2.12E-05												3.27E-05
Zinc		1.37E-04		1.06E-04												1.92E-04
	3.53E-08	7.08E-03	4.20E-09	7.52E-03											4.45E-08	9.91E-03
Inhalation																
Cadmium	4.13E-10		4.13E-14		3.30E-13		1.85E-13		2.07E-16		2.25E-16		6.35E-16		8.32E-13	
	4.13E-10		4.13E-14		3.30E-13		1.85E-13		2.07E-16		2.25E-16		6.35E-16		8.32E-13	
Dermal																
2,4,6-Trinitrotoluene	1.36E-08		1.33E-09												1.72E-08	
2,4-Dinitrotoluene		7.07E-04		9.04E-04												9.89E-04
Cadmium		4.37E-05		3.49E-05												6.12E-05
RDX	2.05E-07	4.36E-03	2.47E-08	5.24E-03											2.59E-07	6.10E-03
Zinc		8.52E-06		6.60E-06												
	2.47E-07	5.12E-03	2.60E-08	6.19E-03											2.67E-07	7.16E-03
Total for Site	**2.83E-07**	**1.22E-02**	**3.02E-08**	**1.37E-02**	**3.30E-13**		**1.85E-13**		**2.07E-16**		**2.25E-16**		**6.36E-16**		**3.21E-07**	**1.71E-02**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

Table 9-12. Risk Estimate Summary Using Reasonable Maximum Exposure Levels for the AED Test Range (Site 40)

Analytes	On-Site Worker[a]		Construction Worker[a]		Installation School[a]		Installation Resident[a]		Off-Site Resident[a] Tooele		Off-Site Resident[a] Stockton		Off-Site Resident[a] Grantsville		On-Site Resident[b]	
	RF[c]	HI[d]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
2,4,6-Trinitrotoluene	1.33E-08	2.05E-03	3.53E-09	1.64E-02											3.21E-08	1.63E-02
2,4-Dinitrotoluene		1.56E-04		2.09E-03												1.24E-03
Cadmium		1.42E-02		9.98E-03												5.63E-03
Copper		8.12E-03		7.76E-02												6.44E-02
HMX		2.27E-05		1.72E-04												1.80E-04
RDX	2.65E-07	1.88E-03	8.13E-08	1.72E-02											6.44E-07	1.49E-02
Silver		3.91E-05		3.26E-04												3.11E-04
Zinc		1.94E-04		1.44E-03												1.54E-03
	2.79E-07	1.39E-02	8.48E-08	1.25E-01											6.76E-07	1.04E-01
Inhalation																
Cadmium	2.89E-07		1.45E-11		7.70E-11		6.11E-10		2.72E-13		2.94E-13		8.30E-13		1.09E-09	
	2.89E-07		1.45E-11		7.70E-11		6.11E-10		2.72E-13		2.94E-13		8.30E-13		1.09E-09	
Dermal																
2,4,6-Trinitrotoluene	8.74E-08		2.28E-09												1.92E-07	
2,4-Dinitrotoluene		9.66E-04		1.35E-03												7.26E-03
Cadmium		8.80E-05		6.45E-05												6.61E-04
HMX		1.41E-04														1.06E-03
RDX	1.64E-06	1.16E-02	5.25E-08	1.11E-02											3.85E-06	8.73E-02
Zinc		1.20E-05		9.27E-04												
	1.73E-06	1.28E-02	5.48E-08	1.35E-02											4.04E-06	9.64E-02
Total for Site	**2.01E-06**	**2.67E-02**	**1.40E-07**	**1.39E-01**	**7.70E-11**		**6.11E-10**		**2.72E-13**		**2.94E-13**		**8.30E-13**		**4.72E-06**	**2.01E-01**

[a] Current land use
[b] Future land use
[c] RF = Risk Factor
[d] HI = Hazard Index

The total carcinogenic risk from RME is 1E-07. The risk factor for dermal exposure is 5E-08, for soil inhalation is 1E-11, and for soil ingestion is 8E-08. Both average exposure and RME carcinogenic risk factors are below the EPA target range for residual risk.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for the construction worker at Site 40, using the estimate average exposure, is 1E-02. The hazard index for soil ingestion is 8E-03 and for dermal exposure is 6E-03.

The total hazard index for noncarcinogenic risk from RME is 1E-01. The hazard index for soil ingestion is 1E-01 and for dermal exposure is 1E-02. The hazard indices for average and RME exposures meet the EPA goal for a residual hazard index of 1 or less.

9.2.7.1.1.3 *Installation School*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the installation school because of the distance from the AED Test Range to the school. Exposure at the installation school area would be associated with inhalation of wind-released soil particulates from Site 40. The carcinogenic risk for average exposure is 3E-13, and the carcinogenic risk for the RME is 8E-11.

NONCARCINOGENIC RISKS

Noncarcinogenic risk estimates were not calculated because reference doses were not available for inhalation of the contaminants of concern.

9.2.7.1.1.4 *Installation Resident*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the installation resident because of the distance of the housing area from the AED Test Range. Exposure at the installation housing would be associated with inhalation of wind-released particulates from Site 40. The carcinogenic risk for average exposure is 2E-13, and the carcinogenic risk for the RME is 6E-10.

NONCARCINOGENIC RISKS

Noncarcinogenic risk estimates were not calculated because reference doses were not available for inhalation of the contaminants of concern.

9.2.7.1.1.5 *Off-Site Residents*

CARCINOGENIC RISKS

Inhalation is the only pathway considered for the off-site residents because of the distance from off-site housing to the AED Test Range. Average contaminant concentrations from the AED Test Range were used to model estimated particulate concentrations at Tooele, Stockton, and Grantsville. The carcinogenic risks for average and RME exposures are shown in Table 9-13.

Table 9-13. Carcinogenic Risk Factors

City	Average	RME
Tooele	2E-16	3E-13
Stockton	2E-16	3E-13
Grantsville	6E-16	8E-13

NONCARCINOGENIC RISKS

Noncarcinogenic risk estimates were not calculated because reference doses were not available for inhalation of the contaminants of concern.

9.2.7.1.2 *Future Land Use*. The only future land use scenario considered is for possible future on-site residents. Results from this exposure scenario are discussed below.

CARCINOGENIC RISKS

The total carcinogenic risk factor for future on-site residents at Site 40, using the estimated average exposure, is 3E-07. The risk factor for dermal exposure is 3E-07, for soil inhalation is 8E-13, and for soil ingestion is 4E-08.

The total carcinogenic risk factor from RME is 5E-06. The risk factor for dermal exposure is 4E-06, for soil inhalation is 1E-09, and for soil ingestion is 7E-07. The risk factors for average exposure and RME are within or below the EPA target range of 1E-04 to 1E-06 for residual risk.

NONCARCINOGENIC RISKS

The total hazard index for noncarcinogenic risk for future on-site residents at Site 40, using the estimated average exposure, is 2E-02. The hazard index for soil ingestion is 1E-02 and for dermal exposure is 7E-03.

The total hazard index for noncarcinogenic risk from RME is 2E-01. The hazard index for soil ingestion is 1E-01 and for dermal exposure is 1E-01. The hazard indices for average exposure and RME meet the EPA goal of a residual hazard index of 1 or less.

9.2.7.2 *Environmental Evaluation*

9.2.7.2.1 ***Site Characterization***. Operable Unit 9 includes Site 40. The area surrounding this OU is relatively flat, characterized predominantly by sagebrush and grasses. The vegetation during the RI field investigation appeared healthy and no evidence of stressed vegetation was observed. This area is relatively remote, and wildlife in this area is largely undisturbed by installation activities. The habitat at this site is satisfactory for many of the wildlife species identified as potential occupants at TEAD-N (Section 2.9). No permanent surface water was identified at this site during the field investigation.

The environmental evaluation for Site 40 is qualitative and did not include a bioassay of vegetation and wildlife or an inventory of wildlife. A site-specific inventory of vegetation was compiled and is listed in Table 9-14.

Data gap sampling to collect additional information is planned at this site to further determine the extent of contamination and the degree of ecological risk. The findings will be issued as an RI report addendum and ecological assessment report.

9.2.7.2.2 ***Biological Effects of Contaminants***. Table 9-15 summarizes the relevant information for the chemicals of concern for Site 40, which was taken from Table 3-18.

9.2.7.2.3 ***Potential Pathways***. No biological samples were obtained, thus, the uptake of contaminants by flora and fauna cannot be evaluated at this time. The most probable pathways of contaminants through the ecosystem are as follows:

- Plants

–Direct uptake through root system

- Wildlife

–Ingestion of contaminated soil
–Ingestion of contaminated foliage
–Ingestion of contaminated insects
–Ingestion of contaminated carrion/animals
–Dermal contact
–Inhalation of vapors
–Inhalation of contaminated particulates

Potential pathways are shown in Figure 9-7.

Table 9-14. Vegetation Inventory (Site 40)

Scientific Name	Common Name
Bromus tectorum	Cheatgrass
Artemisia tridentata	Sagebrush
Elymus elymoides	Squirreltail grass
Erodium cicutarium	Storksbill
Chrysothamnus nauseosus	Tall rabbitbrush
Chrusothamnus viscidiflorus	Viscid rabbitbrush
OTHER VEGETATION SPECIES	
Helianthus annuus	Annual sunflower
Lepidium perfoliatum	Peppergrass
Chaenactic douglasii	Dusty miller
Oenothera pallida	Evening primrose
Atriplex canescens	Four-wing saltbush
Sphaeralcea coccinea	Globe mallow
Machaeranthere canescens	Grey aster
Grindelia squarrosa	Gumweed
Halogenton glomeratus	Halogenton
Stipa hymenoides	Indian ricegrass
Cryptantha humilis	Cryptantha
Cirsium neomexicanum	New Mexico thistle (Utah variety)
Lactuca scariola	Prickly lettuce
Opuntia polyacantha	Prickly pear cactus
Stanleya pinnata	Prince's plume
Ambrosia acanthicarpa	Ragweed
Salsola pestifer	Russian thistle
Sporobolus cryptandrus	Sand dropseed
Aristida purpurea	Three-awn; No-etum
Sisymbrium officinale	Tumbling mustard

Table 9-14. Vegetation Inventory (Site 40) (continued)

Scientific Name	Common Name
OTHER VEGETATION SPECIES (Cont.)	
Juniperus osteosperma	Utah juniper
Melilotus albus	White sweetclover
Tragopogon dubius	Yellow goats beard
Melilotus officinalis	Yellow sweetclover

Table 9-15. Summary of Contaminants (Site 40)

Chemical	Water Solubility	Toxicity	Biological Effects	Critical Effect	*Hazard Rating	Comments
Cadmium	VL[a]	M[b]→H[c]	BA[d]	3[e]	3	known animal carcinogen
Copper	I[f]	VL→M	BC[g]	3	3	Cu° metal toxicity very low; many Cu(II) salts are toxic
Diethyl phthalate	H	VL→L[h]	---	3	3 combustible	low acute toxicity in lab animals
2,4-Dinitrotoluene	VL	H	---	2[i],3	3	animal carcinogen, suspect human carcinogen
2,6-Dinitrotoluene	VL	H	BC	2,3	3	animal carcinogen, suspect human carcinogen
HMX	L	H	---	---	3	---
RDX	I	H	BC	3	3	poison by ingestion, IV, IP; corrosive, irritant to skin, eyes, mucous membranes;
Silver	I	L	BA,BC	---	2 dust sl. flammable	toxicity of metal is low by all exposure routes; dust an irritant; accumulation in the body may produce argyria; soluble cmpds toxic/fatal
Zinc	I	VL→L	BC	---	3 dust explosive	many Zn cmpds are toxic; dust is an irritant

*See footnote on page 3-92, Table 3-18, for definition of hazard ratings 1, 2, and 3.
[a]VL = very low.
[b]M = moderate.
[c]H = high.
[d]BA = bioaccumulate.
[e]3 = tissue or organ damage.
[f]I = insoluble.
[g]BC = bioconcentrate.
[h]L = low.
[i]2 = probable or suspected carcinogen.

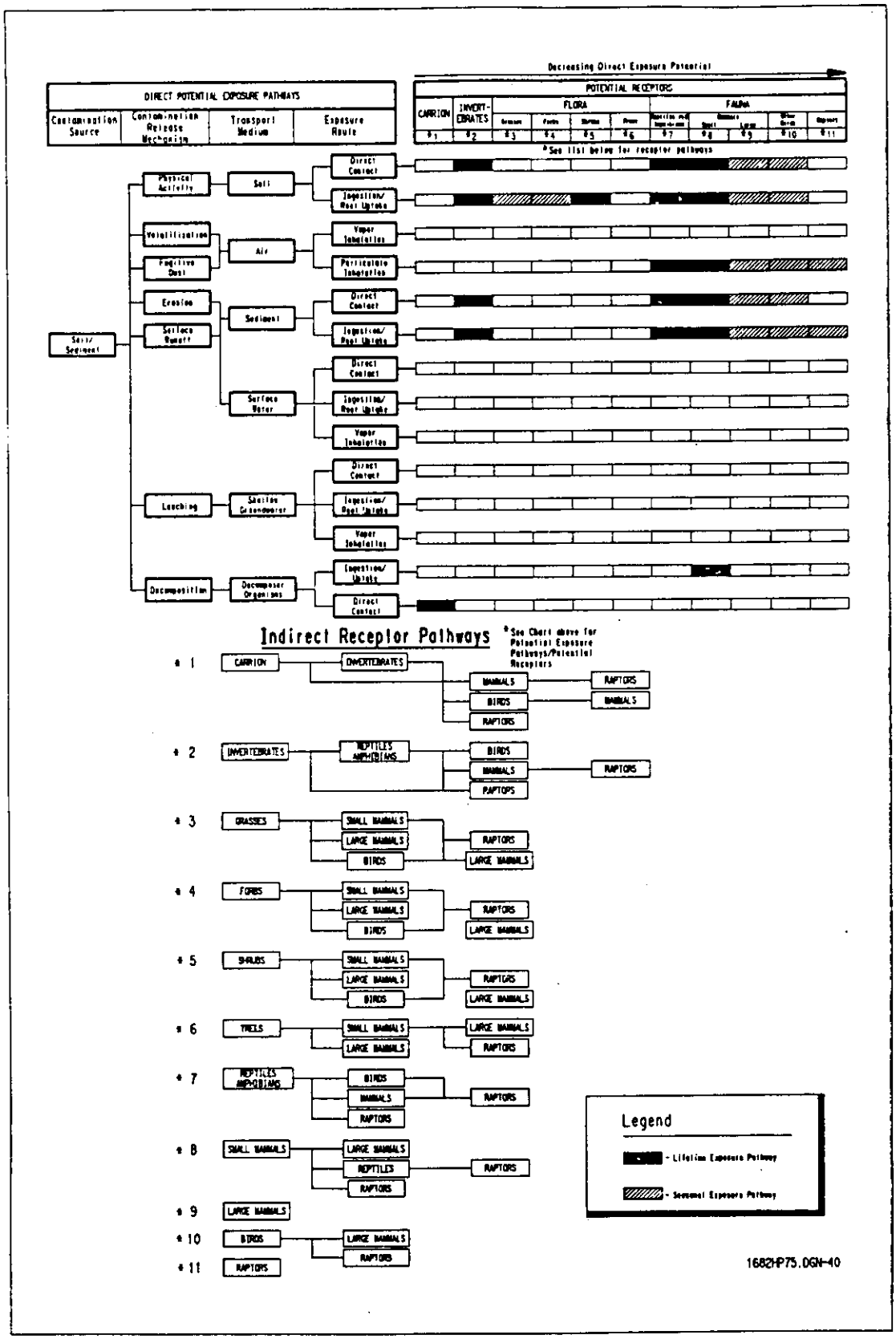


Figure 9-7. Potential Ecological Exposure Pathways for Site 40

9.2.7.2.4 *Potentially Affected Populations*. Table 9-16 presents a summary of exposure points, general population, and the activity by which ecological exposure may occur. The table is listed in decreasing exposure potential.

Table 9-16. Exposure Scenarios for Ecological Populations (Site 40)

Exposure Point	Exposed Population	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Large Mammals	Ingestion of contaminated vegetation; foliage, fruit, and potentially roots.	Primarily exposed while feeding at this site; may be reduced to seasonal exposure.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Exposed only when feeding at this site; likely only seasonally.
Terrestrial Locations	Raptors	Ingestion of contaminated carrion or animals.	Exposed when feeding on prior inhabitants of the site.

9.2.7.3 *Environmental Evaluation Conclusions*

The contaminants of concern for this site are explosives and metals. The qualitative biological hazard rankings for the explosives are largely unknown; these contaminants may or may not present a problem in the environment. The metal contaminants have a potentially high biological hazard ranking because metal contaminants are toxic and will frequently bioaccumulate. The site concentrations for lead and copper were especially high. Concentrations of these contaminants above background levels may be problematic at the individual and local-species population level; the specific effects cannot be evaluated with the available data.

Alterations to the trophic structure and ecological processes at Site 40 or to the TEAD-N facility cannot be evaluated until further data are collected. Recovery time cannot be derived or predicted from the information evaluated.

10.0 OPERABLE UNIT 10

10.1 BOX ELDER DRUM SITE (SITE 41)

10.1.1 Site Characteristics

The Box Elder Wash Drum Site is located southeast of Row J of the Igloo Storage Area (see Figure 1-17). The site contains 21 drums in the Box Elder Wash streambed, which carries intermittent runoff from the southwestern corner of TEAD-N, north through the Igloo Storage Area, and across the north-central TEAD-N boundary.

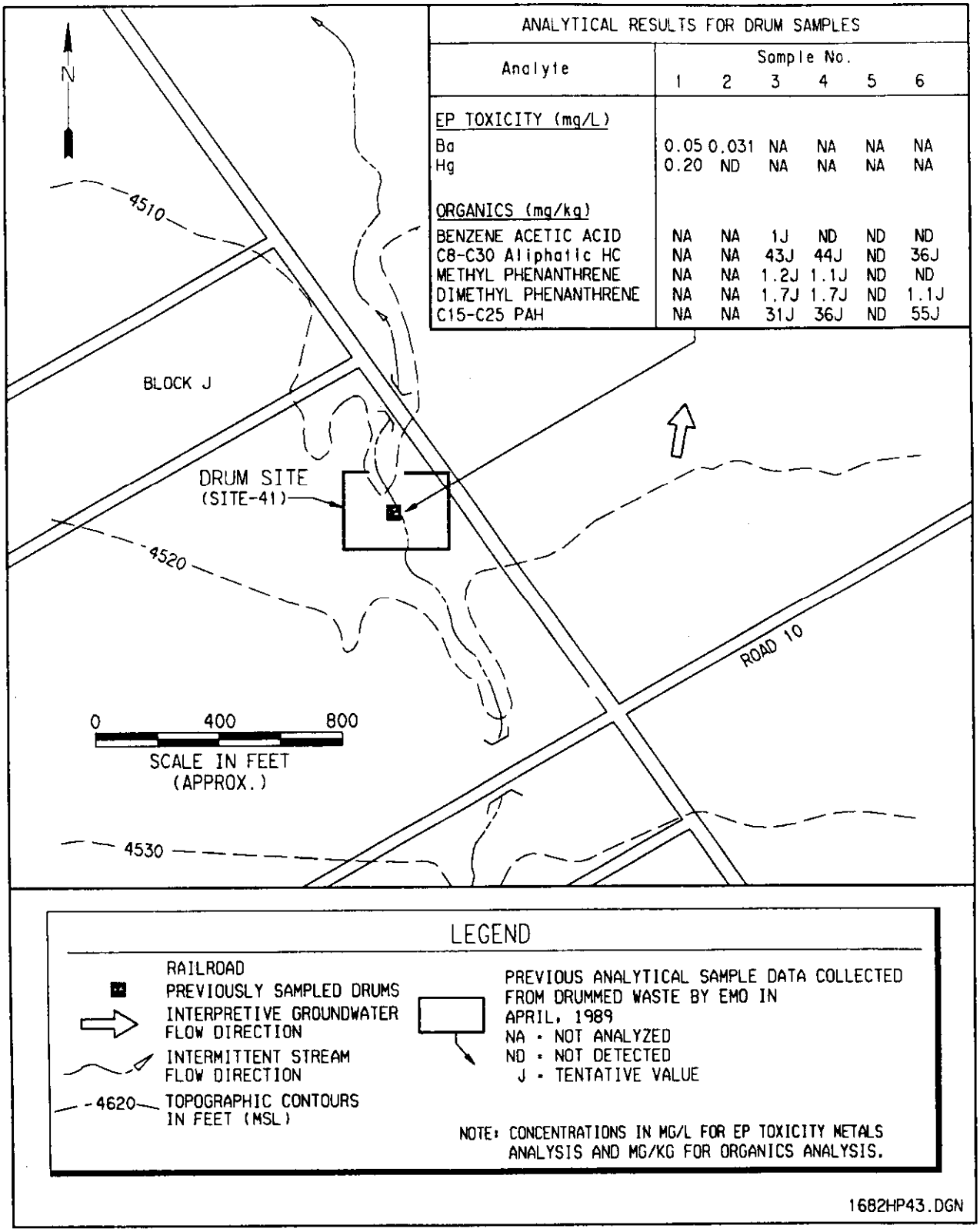
The drums in the streambed were apparently dumped off the eastern edge and lie in the lower bank and bottom of the wash. The drums are present in a 200-foot-long stretch of the wash, and most of the drums are at least partially obscured by soil and/or vegetation. The soil covering the drums appeared to be the result of sedimentation occurring during periods of surface-water flow and by caving of the steep stream bank. The drums are in various stages of deterioration and have no obvious markings. The drums contain a black tarry substance that resembles roofing tar. There are small areas of stained soil associated with the drums and one area of a surface tar spill above the wash channel.

10.1.2 Previous Investigations and RI Activities

In April of 1989, the Environmental Management Office (EMO) of TEAD collected solid samples of a black tarry substance from four of the open drums at Site 41. The samples were analyzed for a limited range of organic compounds and for EP Toxicity of selected metals. The results of this sampling are summarized in Figure 10-1 and Table 10-1. The samples obtained from the drums contained elevated concentrations of benzene, acetic acid, phenanthrene, pyrene, and unidentified aliphatic and polycyclic aliphatic hydrocarbons. In addition, the metal mercury was present at a concentration of 0.2 mg/l from EP Toxicity tests. This result was at the EPA regulatory level of 0.2 mg/l for mercury, indicating that the drum potentially contained a hazardous waste, with the characteristic of EP toxicity for mercury (40 CFR 261.24, 1989).

On the basis of previous recommendations by E.C. Jordan (1991b) and an October of 1991 site visit by Rust E&I, it was determined that the following RI activities should be completed at Site 41:

- Geophysical survey to determine the potential location(s) of buried drums in the Box Elder Wash channel.
- Hand excavation of buried or partially buried barrels for sampling.
- Resampling of previously sampled drums.
- Sampling of soils surrounding the drums (surface and subsurface).
- Sampling of soils downstream of the drum site.



ANALYTICAL RESULTS FOR DRUM SAMPLES

Analyte	Sample No. 1	2	3	4	5	6
EP TOXICITY (mg/L)						
Ba	0.05	0.031	NA	NA	NA	NA
Hg	0.20	ND	NA	NA	NA	NA
ORGANICS (mg/kg)						
BENZENE ACETIC ACID	NA	NA	1J	ND	ND	ND
C8-C30 Aliphatic HC	NA	NA	43J	44J	ND	36J
METHYL PHENANTHRENE	NA	NA	1.2J	1.1J	ND	ND
DIMETHYL PHENANTHRENE	NA	NA	1.7J	1.7J	ND	1.1J
C15-C25 PAH	NA	NA	31J	36J	ND	55J

Figure 10-1. Analytical Results of Previous Drum Sampling from the Box Elder Wash Drum Site (Site 41)

Table 10-1. Analytical Results of Previous Drum Samples from Box Elder Wash Drum Site (SWMU 41)

	Sample					
	1320-01	**1320-02**	**1320-03**	**1320-04**	**1320-05**	**1320-06**
	Organics (mg/kg)					
Benzene acetic acid	NA[a]	NA	1J[b]	ND[c]	ND	ND
C8-C30 Aliphatic HC	NA	NA	43J	44J	ND	36J
C15-C25 PAH	NA	NA	31J	36J	ND	55J
Dimethyl phenanthrenes	NA	NA	1.7J	1.7J	ND	1.1J
Methyl phenanthrenes	NA	NA	1.2J	1.1J	ND	ND
	1320-01	**1320-02**	**1320-03**	**1320-04**	**1320-05**	**1320-06**
	Inorganics[d] (mg/L)					
Barium	0.05	0.031	NA	NA	NA	NA
Mercury	0.20	ND	NA	NA	NA	NA

[a]NA = Not analyzed.
[b]J = indicates a tentative value.
[c]ND = Analyte not detected in sample.
[d]Inorganics were analyzed for EP Toxicity.

The geophysical survey consisted of a walking survey and the use of a hand-held magnetic utility locator capable of locating buried drums to a depth of approximately 8 feet. The survey was conducted for a distance of approximately 200 feet upstream and 400 feet downstream of the drum disposal site. The walking survey covered the entire width of the wash channel. No data were collected but the surface location of each buried target was flagged.

Figure 10-2 shows the location of the sample locations for Site 41. Table 10-2 and 10-3 provide analytical results for the RI sampling. These samples were analyzed for VOCs, semi-VOCs, inorganics, TCLP metals, and anions. Sampling of the barrels proved to be extremely difficult because of the sticky nature of the tar. Problems were encountered with the tarry substance, particularly during the heat of the day. Sampling of the material was best in the cool of the morning when the tarry material was solid.

In addition, during a site tour in April of 1992, a surface location of tarry material was observed above the Box Elder Wash channel between the road and the wash. This spill of tarry materials was sampled to determine if the surface spill contained the same contaminants as the barrels in the bottom of the wash.

The drums exposed and sampled were marked with a drum ID number that corresponds to the sample number for that drum. A photograph showing the drums labeled and sampled is presented in Appendix D.

10.1.3 Nature and Extent of Contamination

Benzene, phenanthrenes, unidentified aliphatic and polycyclic aliphatic hydrocarbons, barium, and mercury were detected in drum samples taken in a previous investigation. During the current RI, eight additional drum samples were taken to confirm the results of the previous investigation and to determine the nature of the contents of each drum. All of the sampled drums contained a black tarry substance resembling roofing tar. The current RI analytical results for the samples taken from the drums are shown in Table 10-2. Various organics, inorganics, and explosives were detected in the drum samples. The organics detected included acetone, 1,2-dimethylbenzene, 1,3-dimethylbenzene, ethylbenzene, methyl ethyl ketone, benzene, and toluene. The inorganics included barium, beryllium, cadmium, chromium, copper, iron, lead, nickel, silver, and zinc. The two explosives detected, HMX and nitrobenzene, were present at low concentrations.

In addition to the total analysis performed on the drum samples, TCLP analysis for metals was performed to confirm the previous sampling which indicated one drum potentially contained a characteristic hazardous waste. As the results in Table 10-4 show, the metals did not exceed EPA regulatory levels.

Soil samples were collected from the surface and subsurface soils adjacent to the drums, and surface-soil samples were collected downstream of the drum site. As shown in Table 10-3, very few samples had detectable levels of potential contaminants. Sample BES-92-02, located immediately downstream of and adjacent to barrel BER-92-05 (Figure 10-3),

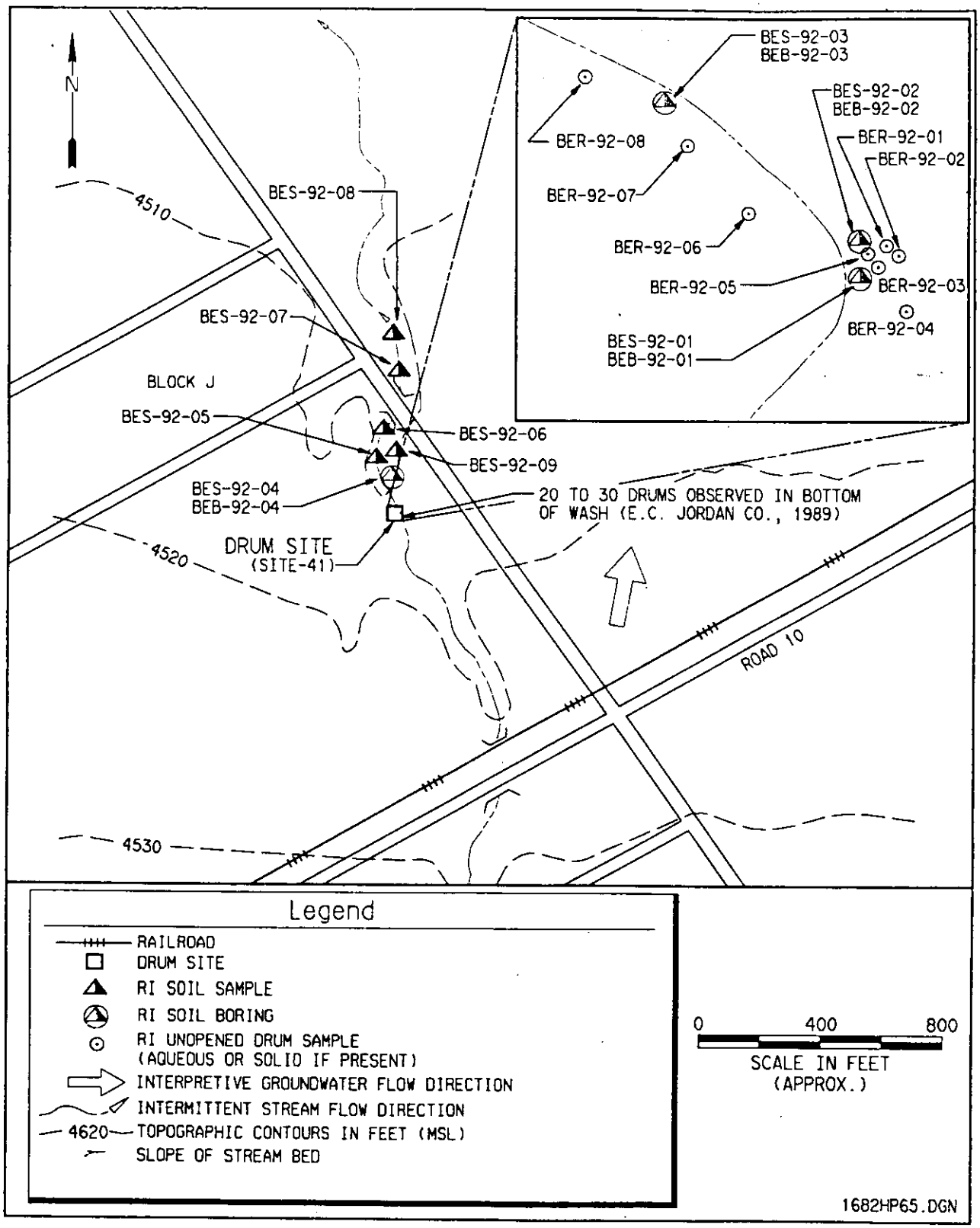


Figure 10-2. RI Sample Locations for the Box Elder Wash Drum Site (Site 41)

Table 10-2. Summary of Analytes Detected in Drum Samples from the Box Elder Wash Drum Site (Site 41)

Analyte	BER-92-01	BER-92-02	BER-92-03	BER-92-04	BER-92-05	BER-92-06	BER-92-07	BER-92-08
	Concentrations in μg/g							
VOCs								
1,2-Dimethylbenzene	0.007	ND[a]	ND	0.005	0.019	ND	ND	ND
1,3-Dimethylbenzene	0.014	ND	0.004	0.011	0.04	ND	ND	ND
Acetone	0.2	ND	ND	0.1	1	0.06	0.02	ND
Ethylbenzene	0.004	LT[b]	LT	LT	0.006	LT	LT	LT
Methyl ethyl ketone	0.071	0.07	ND	0.048	0.2	ND	ND	ND
Methyl N-butyl ketone	ND	ND	ND	0.0096	ND	ND	ND	ND
Toluene	LT	LT	LT	0.014	0.018	LT	LT	LT
Benzene	LT	LT	LT	LT	0.004	LT	LT	LT
ANIONS								
Chloride	LT	41.4	104	100	57.5	186	LT	LT
Fluoride	LT	LT	62.9	LT	LT	LT	LT	LT
Nitrate	LT	11.1	LT	28	6.23	LT	LT	6.44
Nitrite	LT	LT	LT	48.9	LT	LT	LT	LT
Phosphate	ND	15.4	ND	41.6	ND	ND	ND	ND
Sulfate	LT	56.5	41.4	890	LT	33.2	LT	LT
METALS								
Barium	4.34	LT	7.77	3.21	11.2	LT	LT	18.2
Beryllium	0.099	LT	0.605	LT	LT	LT	LT	LT
Cadmium	2.21	LT	LT	LT	LT	LT	LT	LT
Chromium	36.9	16.3	160	15	72	12.5	11.2	29.7

Table 10-2. Summary of Analytes Detected in Drum Samples from the Box Elder Wash Drum Site (Site 41) (continued)

Analyte	BER-92-01	BER-92-02	BER-92-03	BER-92-04	BER-92-05	BER-92-06	BER-92-07	BER-92-08
	Concentrations in μg/g							
METALS (cont.)								
Copper	5.63	LT	16.3	LT	LT	2.94	LT	6.42
Iron	1700	2800	700	470	1600	1100	3200	6300
Lead	17	1.15	0.6	4.2	3.2	0.462	LT	1.86
Nickel	110	120	770	82	110	100	65	120
Silver	0.07	0.068	LT	0.094	LT	LT	0.71	LT
Zinc	LT	96	12.7	LT	LT	LT	LT	22.8
EXPLOSIVES								
HMX	LT	LT	LT	1.8	LT	LT	LT	LT
Nitrobenzene	ND	LT	LT	2	2.49	ND	LT	1.15

[a]ND = Analyte not detected in sample.
[b]LT = Analyte is less than certified reporting limits.

Table 10-3. Summary of Analytes Detected in Soils and Tar Spill at the Box Elder Wash Drum Site (Site 41)

Analyte	BES-92-01*	BES-92-02*	BES-92-03*	BES-92-04*	BES-92-05*	BES-92-06*	BES-92-07*
	Concentrations in μg/g						
VOCs							
Methyl ethyl ketone	ND[a]	0.013	ND	ND	ND	ND	ND
Methyl N-butyl ketone	ND	0.009	ND	ND	ND	ND	ND
SVOCs							
Butylbenzyl phthalate	ND	ND	0.51	ND	ND	ND	ND
Pyrene	LT[b]	LT	LT	LT	LT	LT	0.99
Anions							
Chloride	NA[c]	36.3	LT	LT	LT	NA	NA
Nitrate	NA	LT	1.95	LT	2.94	NA	NA
Phosphate	NA	3.08	3.04	ND	4.96	NA	NA
Sulfate	NA	19.1	LT	LT	LT	NA	NA
Inorganics							
Barium	110	110	63	65	86	110	140
Chromium	13.9	16.2	6.16	8.26	10.5	16.3	15
Copper	8.64	7.1	3.32	3.51	4.89	8.98	8
Iron	15,000	15,000	720	7,500	11,000	15,000	18,000
Lead	12	9.9	6.8	6.7	9.9	14	14
Mercury	LT	LT	LT	LT	LT	LT	0.027
Nickel	LT	LT	LT	LT	LT	LT	LT
Silver	0.068	0.05	0.022	0.026	0.033	0.081	0.078
Zinc	43	37	15	16.9	25.8	40	46

Table 10-3. Summary of Analytes Detected in Surface Soil at the Box Elder Wash Drum Site (Site 41) (continued)

Analyte	BES-92-08*	BES-92-09**	BEB-92-01 (3 ft)***	BEB-92-02 (4 ft)***	BEB-92-03 (3 ft)***	BEB-92-04 (3 ft)***	Background
			Concentrations in μg/g				
VOCs							
Methyl ethyl ketone	ND	ND	ND	ND	ND	ND	--
Methyl N-butyl ketone	ND	ND	ND	ND	ND	ND	--
SVOCs							
Butylbenzyl phthalate	ND	ND	ND	ND	ND	ND	--
Pyrene	LT	LT	LT	LT	LT	LT	--
Anions							
Chloride	NA	LT	LT	LT	LT	LT	336
Nitrate	NA	LT	LT	LT	LT	LT	9.45
Phosphate	NA	ND	ND	2.6	ND	ND	5
Sulfate	NA	LT	LT	LT	LT	LT	466
Inorganics							
Barium	110	66	75	110	68	76	277
Chromium	16	13.7	11.7	13.1	8.6	11.4	22.8
Copper	8.4	11.6	4.14	6.1	3.37	4.19	28.2
Iron	14,000	8,500	9,000	12,000	8,300	11,000	25,407
Lead	46	22	7.8	9.8	6	7.7	63.4
Mercury	LT	LT	LT	LT	LT	LT	0.037
Nickel	LT	48[d]	LT	LT	LT	LT	19.3
Silver	0.08	0.08	0.032	0.073	0.018	0.043	0.749
Zinc	42	41	20.3	33	17.6	20.9	169

[a]ND = Analyte not detected in sample.
[b]LT = Analyte is less than certified reporting limits.
[c]NA = Analyte not analyzed in sample.
[d]Exceeded background.
-- = It is assumed that background soil does not contain organics.
*Samples were taken from 0 to 6 inches.
**Sample of tar spill material.
***Samples were taken from 3 to 4 feet deep.

Table 10-4. Summary of TCLP Metals in Drum Samples from the Box Elder Wash Drum Site (Site 41)

Analyte	BER-92-01	BER-92-02	BER-92-03	BER-92-04	BER-92-05	BER-92-06	BER-92-07	BER-92-08	Regulatory Limit
				Concentrations in mg/L					
Arsenic	LT[a]	LT	LT	LT	LT	LT	LT	LT	5.0
Barium	0.430	0.150	0.120	1.705	0.330	0.190	0.160	0.260	100.0
Cadmium	0.006	LT	LT	LT	LT	LT	LT	LT	1.0
Chromium	0.027	0.016	0.020	0.043	0.094	0.009	0.009	LT	5.0
Lead	LT	LT	LT	LT	LT	LT	LT	LT	5.0
Mercury	0.001	--[b]	--	--	--	--	--	--	0.2
Selenium	LT	LT	LT	LT	LT	LT	LT	LT	1.0
Silver	LT	LT	LT	LT	LT	LT	LT	LT	5.0

[a]LT=Analyte is less than sample quantitation limits.
[b]--=Laboratory did not perform TCLP analysis based on non-detects for total analysis.

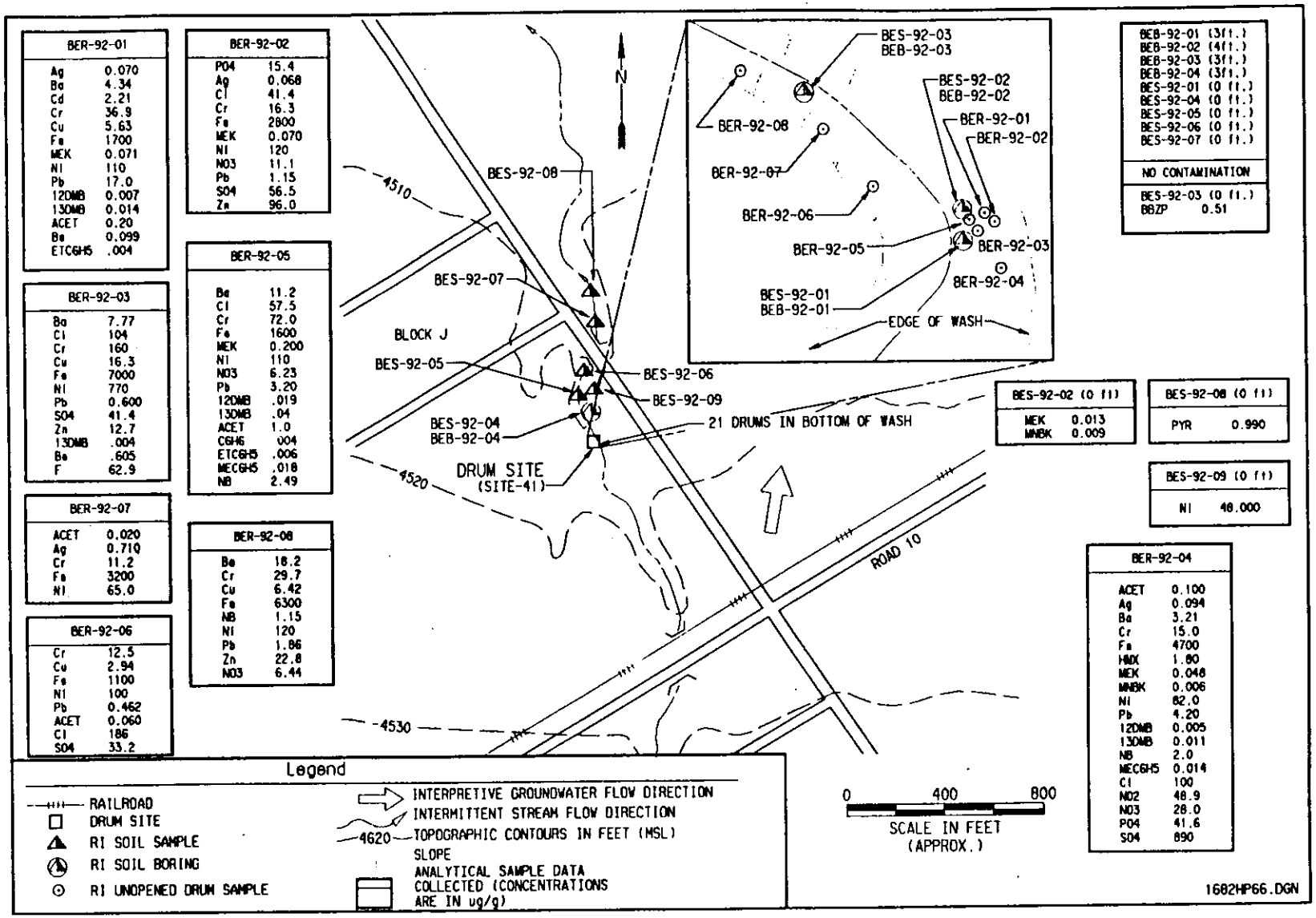


Figure 10-3. RI Sampling and Analysis Results for the Box Elder Wash Drum Site (Site 41)

contained low concentrations of methyl ethyl ketone and methyl N-butyl ketone. Sample BES-92-03, located slightly farther downstream but within the drum disposal area, contained butylbenzyl phthalate at 0.51 μg/g. Still farther downstream, pyrene was detected at 0.99 μg/g in sample BES-92-07 and nickel was detected at 48 μg/g in the sample of the spilled tar above the wash (BES-92-09). Samples taken from subsurface soils contained no detectable concentrations of contaminants.

On the basis of the soil sampling results, soil contamination at Site 41 appears to be minimal, if at all. Subsurface-soil samples showed no evidence of contamination and results from surface-soil sampling showed low concentrations of methyl ethyl ketone, methyl N-butyl ketone, butylbenzyl phthalate, pyrene, and nickel. These potential contaminants were detected with low frequency and at low concentrations, but not in any discernable array in relation to the drums. In addition, the two ketones and the phthalate are common chemicals used in the laboratory setting for glassware cleaning.

10.1.4 Contaminants of Concern

Based on the low frequency of detections and the high probability of laboratory contamination, methyl ethyl ketone, methyl N-butyl ketone, and butylbenzyl phthalate were not considered contaminants of concern at Site 41. The contaminant of concern, pyrene, was detected in 1 sample out of 13 at a location downstream from the drums. Table 10-5 presents the range of detected concentrations and comparisons against the certified reporting limit and naturally occurring background levels for pyrene.

Table 10-5. Detection Parameters for Pyrene in Surface Soils at the Box Elder Wash Drum Site (Site 41)

Analyte	Total Detects	Total Samples	Concentration	Method	Sample Quantitation Limits
Pyrene	1	13	0.990	LM15	0.42

Note.—All results are reported as μg/g. Soil includes all soil samples.

10.1.5 Contaminant Fate and Transport

Table 3-8 in Section 3.4.1 briefly describes the fate and transport characteristics of pyrene, while Appendix H provides a more detailed description. Pyrene strongly adsorbs to soil and is resistant to leaching as is reflected in its low water solubility and high octanol-water partition coefficient. Pyrene exhibits low volatilization rates, although it may enter the atmosphere through adsorption to airborne particulates with removal occurring through wet and dry deposition.

Leaching of pyrene to groundwater at Site 41 is highly unlikely because of the large depth to groundwater at the site, the low concentration of pyrene detected in the soil, and the strong adherence of pyrene to soils.

10.1.6 Potential Exposure Pathways

Figure 10-4 presents a conceptual model of the most likely exposure pathways for pyrene at Site 41. The most likely exposure pathways at Site 41 are via dermal contact, incidental soil ingestion, inhalation of fugitive dust, and ingestion of beef derived from cattle potentially exposed to contamination while grazing at TEAD-N. However, fugitive dust emissions from Site 41 are minimal because of the vegetative cover at this site that limits potential dust emissions and the fact that Site 41 is located in a wash below ground surface.

Although pyrene is not appreciably taken up by plants, it does bioconcentrate in tissue because of its stability, high lipid solubility and/or binding, and low water solubility. The overall potential for pyrene to bioaccumulate at Site 41 is minimal because of the low concentrations detected and the infrequency of detections.

Currently, Site 41 is available to grazing cattle on TEAD-N but is not available for homegrown produce; therefore, homegrown produce consumption was not considered a complete pathway for current land use conditions but was for the future residential scenario.

Because of the relative immobility of pyrene in soil, the large depth to groundwater at Site 41, and the results of vadose zone contaminant fate and transport modeling, groundwater was not considered as a complete exposure pathway.

10.1.7 Baseline Risk Assessment

10.1.7.1 *Human Health Evaluation*

The purpose of the Human Health Risk Assessment is to evaluate potential human health risks associated with hazardous substance releases from sites under the assumption of no-action. This section summarizes the results of the Human Health Risk Assessment that was completed for the Box Elder Wash Drum Site (Site 41).

The risk assessment evaluates scenarios for both present land use and future land use conditions for human health effects. Since no construction is planned for Site 41, the construction worker scenario can be considered a future case. The scenario evaluated for the future land use condition is on-site residential use, the most conservative scenario for evaluating potential adverse health effects associated with a site. Residential development at Site 41 is questionable because of its location in a drainage area.

For the complete exposure pathways discussed above, two exposure cases are analyzed as part of the BRA. The central tendency risk description presented in Table 10-6 is the arithmetic mean risk and is derived by using average exposure values for each pathway/site

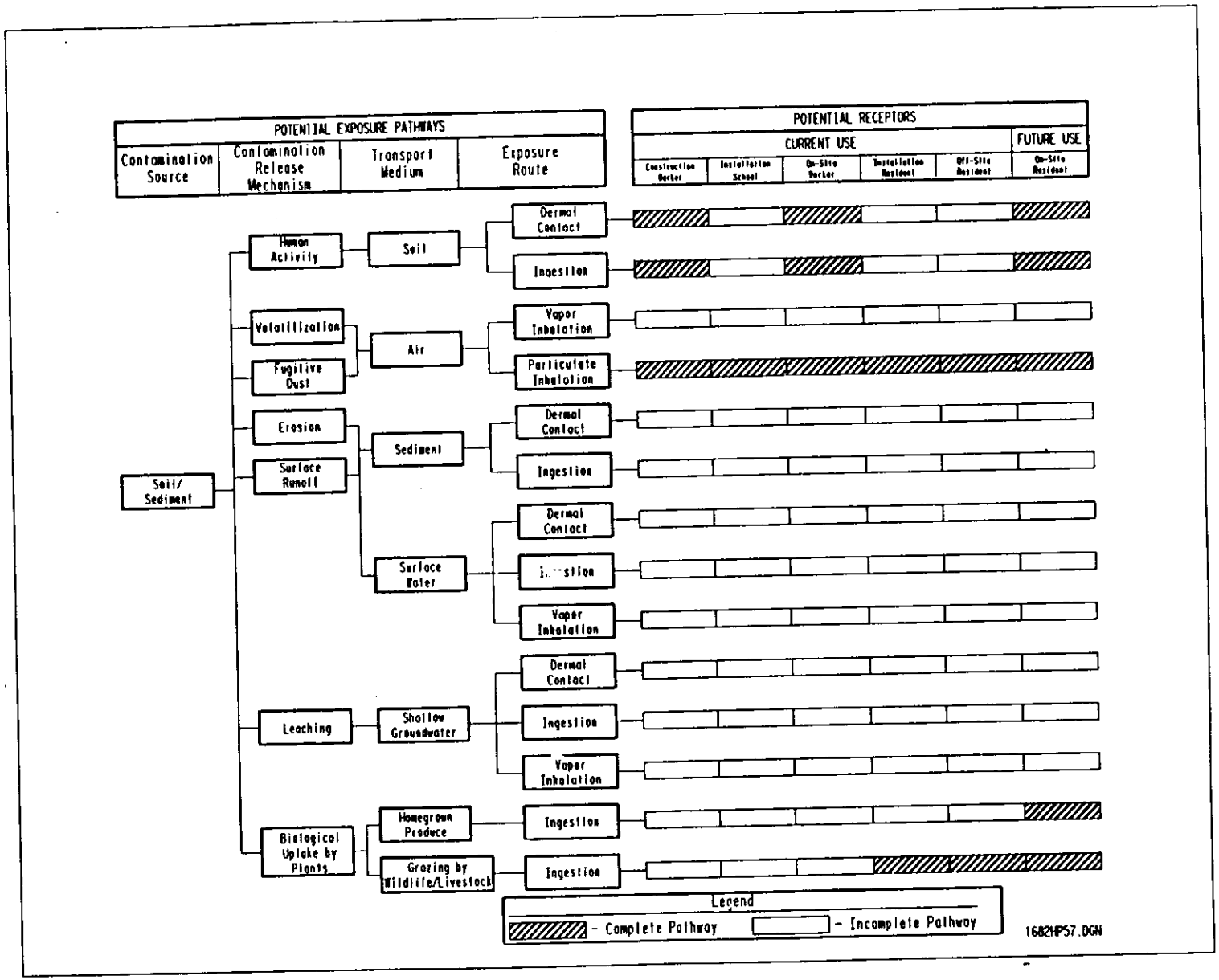


Figure 10-4. Potential Human Exposure Pathway Conceptual Model for the Box Elder Wash Drum Site (Site 41)

Table 10-6. Summary of Human Health Risk Assessment Results Using Average Exposure Levels for Site 41

	On-Site Worker[c]		Construction Worker[d]		Installation School[e]		Installation Resident[f]		Off-Site Resident[g] Tooele		Off-Site Resident[g] Stockton		Off-Site Resident[g] Grantsville		Future On-Site[h] Resident	
Analyte	RF[a]	HI[b]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
Pyrene		8.04E-06		6.39E-06												1.16E-04
Inhalation																
Pyrene		1.41E-09		1.41E-09		7.92E-10		2.12E-09		3.58E-11		2.90E-11		6.13E-11		2.12E-09
Dermal																
Pyrene		3.46E-06		2.75E-06												3.24E-06
Beef Consumption																
Pyrene								3.84E-05		3.84E-05		3.84E-05		3.84E-05		3.84E-05
Vegetable Consumption																
Pyrene																1.13E-05
Fruit Consumption																
Pyrene																6.30E-06
Site Total		1.15E-05		9.14E-06		7.92E-10		3.84E-05		3.84E-05		3.84E-05		3.84E-05		1.75E-04

[a]Risk factor.
[b]Hazard index.
[c]On-Site Worker is assumed to work at Site 41 10 hours per day 250 days per year for 10 years.
[d]Construction Worker is assumed to work at Site 41 10 hours per day for 250 days.
[e]Installation School Students/Employees are assumed to be at the school site 5 hours per day 200 days per year for 2 years.
[f]Installation Resident is assumed to live on TEAD-N for 2 years.
[g]Off-Site Residents are assumed to live in the TEAD-N vicinity for 2 years.
[h]Future On-Site Residents are assumed to live on Site 41 land for 9 years.

considered. The RME description presented in Table 10-7 is the high end risk. The RME is estimated by combining upper bound values (95 percent upper confidence limits of the arithmetic mean) so that the result represents an exposure scenario that is both protective and reasonable (EPA, 1991). Both Tables 10-6 and 10-7 present noncarcinogenic risk estimates for all complete pathways. Carcinogenic risk estimates were not derived because pyrene is not classifiable as to human carcinogenicity. This is based on no human data available and mixed results in animal studies that have been completed to date (IRIS, 1993).

As explained in Section 3-5, Baseline Risk Assessment Methodology, the estimation of exposure and risk for the scenarios considered for each pathway/site at TEAD-N were derived using conservative exposure estimates. Because of limitations in site-specific exposure data for the sites, conservative exposure estimates were used to provide risk descriptors that would be protective of public health. These exposure estimates were then used in conjunction with toxicity values derived from upper-bound dose-response assessments resulting in highly conservative risk descriptors.

10.1.7.1.1 ***Current Land Use.*** Under current land use conditions, human receptors include the on-site worker, construction worker, installation resident, installation school student/employee, and off-site resident from Tooele, Stockton, and Grantsville. The on-site worker and construction worker are potentially exposed through incidental ingestion of soil, dermal contact, and inhalation of fugitive dust. For the installation resident and off-site residents, inhalation of fugitive dust and contaminated beef consumption were considered complete, potential exposure pathways. Inhalation of fugitive dust was considered the only complete, potential exposure pathway for the installation school student/employee. Incidental ingestion of soil and dermal contact were considered a complete exposure pathway for only the on-site worker and construction worker because of the restricted access to TEAD-N.

10.1.7.1.1.1 ***On-Site Worker***

Carcinogenic risk factors were not calculated for the on-site worker at Site 41 since no carcinogenic contaminants of concern were identified.

The chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the on-site worker at Site 41 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 1E-05 and for RME is 3E-05.

10.1.7.1.1.2 ***Construction Worker***

Carcinogenic risk factors were not calculated for the construction worker at Site 41.

The chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the construction worker at Site 41 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 9E-06 and for RME is 8E-05.

Table 10-7. Summary of Human Health Risk Assessment Results Using Reasonable Maximum Exposure Levels for Site 41

	On-Site Worker[c]		Construction Worker[d]		Installation School[e]		Installation Resident[f]		Off-Site Resident[g] Tooele		Off-Site Resident[g] Stockton		Off-Site Resident[g] Grantsville		Future On-Site[h] Resident	
Analyte	RF[a]	HI[b]	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI	RF	HI
Ingestion																
Pyrene		1.61E-05		6.14E-05												2.33E-04
Inhalation																
Pyrene		1.41E-09		2.13E-09		7.92E-10		1.71E-08		2.89E-10		2.34E-10		4.95E-10		1.71E-08
Dermal																
Pyrene		1.73E-05		1.37E-05												7.94E-05
Beef Consumption																
Pyrene								3.71E-04		3.71E-04		3.71E-04		3.71E-04		3.71E-04
Vegetable Consumption																
Pyrene																1.02E-04
Fruit Consumption																
Pyrene																5.36E-05
Site Total		3.34E-05		7.51E-05		7.92E-10		3.71E-04		3.71E-04		3.71E-04		3.71E-04		8.39E-04

[a]Risk factor.
[b]Hazard index.
[c]On-Site Worker is assumed to work at Site 41 10 hours per day 250 days per year for 25 years.
[d]Construction Worker is assumed to work at Site 41 10 hours per day for 250 days.
[e]Installation School Students/Employees are assumed to be at the school site 7 hours per day 200 days per year for 4 years.
[f]Installation Resident is assumed to live on TEAD-N for 2 years as a child and 7 years as an adult.
[g]Off-Site Residents are assumed to live in the TEAD-N vicinity for 30 years.
[h]Future On-Site Residents are assumed to live on Site 41 land for 30 years.

10.1.7.1.1.3 *Installation School*

Carcinogenic risk factors were not calculated for the installation school student/employee because no carcinogenic contaminants of concern were identified.

Chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the installation school student/employee potentially exposed to fugitive dust from Site 41 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for both the average and RME exposure is 8E-10. A longer exposure duration was used in the exposure estimate for the installation school student/employee RME scenario. Since the exposure duration impacts the averaging time for chronic, noncarcinogenic health effects, the hazard index calculated for the average and RME cases are equal.

10.1.7.1.1.4 *Installation Resident*

Carcinogenic risk factors were not calculated for the installation resident case.

Chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for the installation resident potentially exposed to contamination from Site 41 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure is 4E-05 and for RME is 4E-04.

10.1.7.1.1.5 *Off-Site Residents*

Carcinogenic risk factors were also not calculated for off-site residents.

Chronic, noncarcinogenic risk estimates for both the average exposure and RME cases for off-site residents potentially exposed to contamination from Site 41 are below the EPA goal for a residual hazard index of 1 or less. The hazard index for average exposure to off-site residents living in Tooele, Stockton, and Grantsville is 4E-05. The RME hazard index is 4E-04.

10.1.7.1.2 Future Land Use. The scenario evaluated for the future land use condition is on-site residential use. As previously stated, it is unlikely that Site 41 will be developed as a residential area; however, for this risk assessment, residential land use was chosen as a conservative scenario. Complete exposure pathways considered for the future on-site resident are incidental ingestion of soil, dermal contact, inhalation of fugitive dust, consumption of beef derived from cattle grazing at Site 41, and consumption of produce grown at Site 41.

The risk descriptors estimated for this scenario are extremely conservative values. The extent of actual contamination at Site 41 appears minimal. Pyrene was detected above natural occurring background levels in only 1 sample out of 13.

10.1.7.1.2.1 *Future On-Site Resident*

Carcinogenic risk factors were not calculated for the future on-site resident at Site 41.

The chronic, noncarcinogenic risk estimate for the average exposure case for the future on-site resident at Site 41 is 2E-04. The hazard index for the RME case for the future on-site resident at Site 41 is 8E-04. Both values are less than the EPA goal of a residual hazard index of 1 or less.

10.1.7.2 *Environmental Evaluation*

10.1.7.2.1 Site Characterization. No permanent surface water was identified at this site during the field investigation. However, Box Elder Wash traverses TEAD-N from its southwestern corner to the west and then to its mid-northern boundary. Although the wash normally has water in it only during storm and snowmelt episodes, there is evidence that sufficient water is present at times to transport contaminants from this site downstream.

The site is within an igloo storage compound surrounded by an 8-foot security fence. The fence will discourage entrance by large game animals, but is accessible to all other wildlife in the region. The native vegetation surrounding Site 41 is generally disturbed. It is routinely controlled by mechanically mowing and potentially by agriculture chemical applications, and it is traversed by gravel roads between bunker rows. The dominant vegetation types are sagebrush and grasses.

The environmental evaluation for Site 41 is qualitative and did not include a bioassay of vegetation and wildlife or an inventory of wildlife. A site-specific inventory of vegetation was compiled and is listed in Table 10-8.

10.1.7.2.2 Biological Effects of Contaminants. Table 10-9 summarizes the relevant information for pyrene, the chemical of concern for Site 41, which was taken from Table 3-18.

10.1.7.2.3 Potential Pathways. No biological samples were obtained, thus the uptake of contaminants by flora and fauna cannot be evaluated at the time. The most probable pathways of contaminants through the ecosystem are as follows:

- Plants

-Direct uptake through root system

- Wildlife

-Ingestion of contaminated soil
-Ingestion of contaminated foliage
-Ingestion of contaminated insects

Table 10-8. Vegetation Inventory (Site 41)

Scientific Name	Common Name
PRIMARY VEGETATION SPECIES	
Bromus tectorum	Cheatgrass
Sarcobatus vermiculatus	Greasewood
Lepidium perfoliatum	Peppergrass
OTHER VEGETATION SPECIES	
Helianthus annus	Annual sunflower
Poa bulbosa	Bulbous bluegrass
Cirsium vulgre	Bull thistle
Agropyron cristatum	Crested wheatgrass
Camelima microcarpa	False flax
Atriplex canescens	Four-wing saltbrush
Grindelia squarros	Gumweed
Halogenton glomeratus	Halogenton
Chenopodium album	Pigweed
Lactuca scariola	Prickly lettuce
Opuntia polyacantha	Prickly pear cactus
Chrysothamnus nauseosus	Rabbitbrush
Salsola iberica	Russian thistle
Artemisia tridentata	Sagebrush
Erodium cicutarium	Storksbill
Elymus elongatus	Tall wheatgrass
Duscurainia sophia	Tansy mustard
Sisymbrium officinale	Tumbling mustard
Chrysothamnus viscidiflorus	Viscid rabbitbrush
Tragopogon dubius	Yellow goats beard

Table 10-9. Summary of Contamination (Site 41)

Contaminants	Water Solubility	Toxicity	Biological Effects	Critical Effects	Hazard Rating	Comments
Pyrene	I[a]	M[b]	BC[c]	2[d]	3[e]	inhalation poison; mod. toxicity by ingestion

[a]I = insoluble.
[b]M = moderate.
[c]BC = bioconcentrate.
[d]2 = suspected carcinogen.
[e]3 = tissue or organ damage.

-Ingestion of contaminated carrion, animals
-Dermal contact
-Inhalation of vapors
-Inhalation of contaminated particulates

Potential pathways are shown in Figure 10-5.

10.1.7.2.4 Potentially Affected Population. Table 10-10 presents a summary of exposure points, general population, and the activity by which ecological exposure may occur. The table is listed in decreasing exposure potential.

10.1.7.2.5 Environmental Evaluation Conclusions. The primary contaminant of concern at this site is pyrene. Pyrene has a qualitative biological hazard ranking of high. Concentrations of pyrene above background levels may be problematic at the individual and local species population level; the specific effects cannot be quantitatively evaluated with the available data.

Several chemicals of potential concern were identified within the drums at this site. These chemicals could be of concern to wildlife if they come into contact with these contaminants. Small mammals frequently burrow, nest, or otherwise utilize habitat formed by natural rock cairns, felled trees, or shrubs, as well as manmade formations such as piles of trash, lumber, etc. In this case, small mammals may utilize habitat created by the drums, thereby being exposed to these contaminants. Six of the contaminants identified within the drums are metals: barium, cadmium, chromium, lead, mercury, and silver. These contaminants are known to bioaccumulate to some degree, although there is evidence that they are eventually eliminated or transformed to other metabolites (Paustenback, 1989). Additionally, these inorganic contaminants are known to be toxic. Many of the other contaminants identified are also toxic, and may bioaccumulate as well. Thus, it is advisable that these drums, and the associated contaminants, be removed as quickly as practicable in order to eliminate this source of environmental degradation.

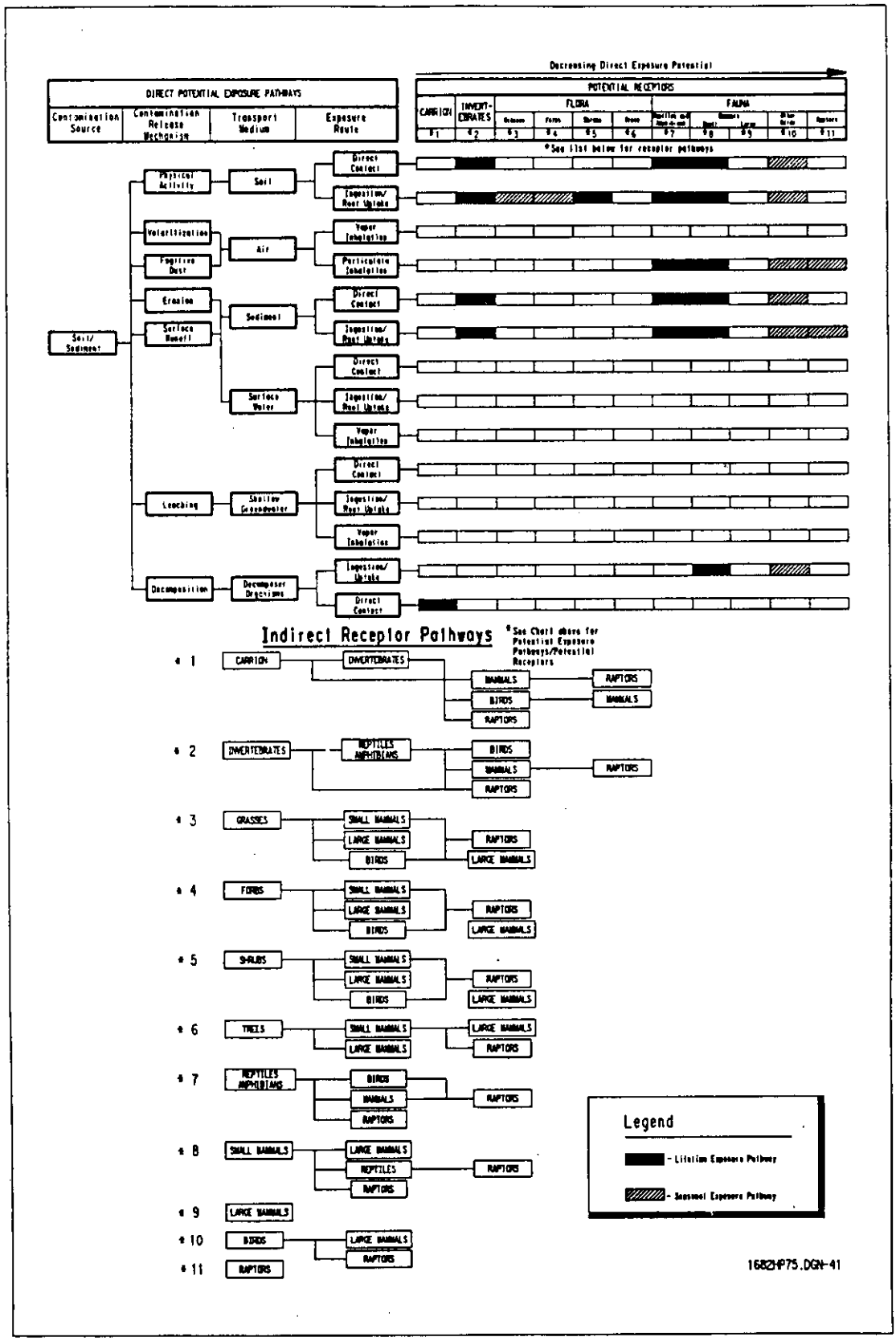


Figure 10-5. Potential Ecological Exposure Pathways for Site 41

Table 10-10. Exposure Scenarios for Ecological Populations (Site 41)

Exposure Point	Exposed Population	Exposure Activity	Ranking
Terrestrial Locations	Terrestrial Invertebrates	Ingestion of contaminated soil and plant matter.	Lifetime.
Terrestrial Locations	Small Mammals	Burrowing, ingestion of contaminated soil, insects, and vegetation.	Lifetime potential, however, may spend part of life away from site.
Terrestrial Locations	Large Mammals	Ingestion of contaminated vegetation; foliage, fruit, and potentially roots.	Primarily exposed while feeding at this site; may be reduced to seasonal exposure.
Terrestrial Locations	Birds	Ingestion of vegetation matter (primarily seeds) and insects.	Exposed only when feeding at this site; likely only seasonally.
Terrestrial Locations	Raptors	Ingestion of contaminated carrion or animals.	Exposed when feeding on prior inhabitants of the site.

Alterations to the trophic structure and ecological processes at Site 41 or to the TEAD-N facility are possible. There is little potential for this ecosystem to function as an increased means of exposure to humans. Recovery times cannot be derived or predicted from the information evaluated.

10.1.8 CONCLUSIONS

Based on the results of the risk assessment, the threat to human health and the environment at the Box Elder Wash Drum Site (Site 41) is extremely low. Nickel and pyrene were found in surface soils at low concentrations with a low frequency of detections (nickel was detected in 1 sample out of 7 and pyrene was detected in 1 sample out of 13).

Based upon sampling results, the contents of the drums are potentially hazardous. The drums and any soils associated with spillage from the drums should be remediated. Remaining soils will pose little threat to human health and the environment.

Carcinogenic risk estimates for Site 41 are below the EPA target range for a residual risk of 1E-04 to 1E-06. Chronic, noncarcinogenic risk estimates are below the EPA goal for a residual hazard of 1 or less with the exception of the future on-site resident scenario. However, these risks are based on conservative exposure estimates associated with contaminant uptake in homegrown produce.

10.1.9 RECOMMENDATIONS

Because the results of the risk assessment indicate a potential threat to human health and the environment from the drums and soils associated with drum spillage, it is recommended that removal of the drums and stained soil be evaluated in a feasibility study after which no further remedial investigation be performed for Site 41.

11.0 CONCLUSIONS AND RECOMMENDATIONS

Site-specific conclusions and recommendations were provided for each of the 17 sites within the 7 OUs in Sections 4.0 through 10.0 of this report. This section briefly summarizes these conclusions and recommendations. The conclusions are based on the information gathered from both previous investigations and data collected during the RI. The recommendations are based on the results of assessments conducted for contaminant fate and transport and risk to human health and the environment. Overall, it was concluded that further investigations are not required for the following six sites:

- Former Transformer Storage Area (Site 17)
- PCB Storage Building (Site 33)
- Drummed Radioactive Waste Area (Site 9)
- Radioactive Waste Storage Building (Site 18)
- Pole Transformer PCB Spill (Site 5)
- Box Elder Wash Drum Site (41)

These conclusions were based primarily on no contamination being found or only low levels of contaminants with corresponding low estimated risks to human health and the environment. Although no further field investigations were recommended for these sites, they will be carried through the FS process to a Record of Decision.

On the basis of the RI results, it was concluded that further investigations are warranted for the following 11 sites:

- Former Transformer Boxing Area (Site 31)
- PCB Spill Site (Site 32)
- Wastewater Spreading Area (Site 35)
- Old Burn Area (Site 6)
- Chemical Range (Site 7)
- Tire Disposal Area (Site 13)
- Building 1303 Washout Pond (Site 22)
- Bomb and Shell Reconditioning Building (Site 23)
- Old Burn Staging Area (Site 36)
- Small Arms Firing Range (Site 8)
- AED Test Range (Site 40)

For the above 11 sites, the conclusions and recommendations for further study were based primarily on elevated levels of contaminants identified during the RI sampling and analysis, undefined extent of contamination, and/or marginal or unacceptable estimated risks to human health or the environment through the baseline risk assessment process. The following summarizes the conclusions and recommendations for these 11 sites:

SITE	CONCLUSION	RECOMMENDATION
Former Transformer Boxing Area (Site 31)	Although similar storage sites have shown contamination, Site 31 is as yet uncharacterized.	Additional soil samples are needed to determine extent of contamination, if any.
Wastewater Spreading Area (Site 35)	The construction worker risk values exceed EPA limits. Extent of pesticide contamination is not defined.	Additional soil samples are needed to define extent of contamination.
PCB Spill Site (Site 32)	Extent of earlier sampling deemed inadequate to define limits of contamination.	Additional soil samples are needed to define vertical and horizontal extent of contamination.
Old Burn Area (Site 6)	Elevated concentrations of metals and explosives are present in the revetment area of the site. Nature and extent of contamination is not defined.	Additional test pits are needed in the revetment area. Results of geophysical survey shows two additional trenches are present.
Chemical Range (Site 7)	Data results to date cause uncertainty in extent of contamination. A new area of potential contamination was identified subsequent to the RI.	Additional test-pit and surface soil samples are necessary to define the extent and types of contamination.
Tire Disposal Area (Site 13)	The extent of residual contamination remaining after removal of the tires is unknown.	Soil samples are necessary to define the presence and extent of contamination.
Building 1303 Washout Pond (Site 22)	Elevated levels of explosives and metals identified in small surface area of Site 22. The extent of contamination is unknown.	Shallow soil borings in the contaminated areas are needed to define the vertical extent of contamination. The potential human health and environmental risks from explosives need to be assessed.
Bomb and Shell Reconditioning Building (Site 23)	RI results indicate several areas of primarily metals contamination. Extent has not been defined. Waste-water discharge appears to have resulted in off-site surface water pathway contamination with metals and semi-VOCs.	Shallow soil borings are needed in identified contaminant areas to define horizontal and vertical extent of contamination. Down-stream sediment samples are needed to assess extent of off-site migration of contaminants.

SITE	CONCLUSION	RECOMMENDATION
Old Burn Staging Area (Site 36)	Several surface burn areas were identified in the Site 36 area. Surface soils samples show elevated levels of metals in the surface burn areas. Horizontal and vertical extent is unknown.	Additional surface soil samples are needed to define horizontal extent of contamination in the pit area. Soil borings are needed in identified burn areas to determine vertical extent of contamination.
Small Arms Firing Range (Site 8)	RI sampling results indicate both total and TCLP lead contamination. Extent of contamination has not been defined.	Additional surface and subsurface soil sampling are needed to define the levels and extent of contamination.
AED Test Range (Site 40)	RI results are insufficient to characterize the site.	Additional test-pit samples are necessary to define types and extent of contamination.

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13.0 ACRONYMS AND ABBREVIATIONS

ABs	absorption factor
AED	Ammunition Equipment Directorate
AF	adherence factor
Ag	silver
ARARs	Applicable or Relevant and Appropriate Requirements
As	arsenic
ASTM	American Society for Testing and Materials
AT	averaging time
atm	atmosphere
BA	bioaccumulate
BC	bioconcentrate
bgs	below ground surface
BKGD	background
BM	biomagnification
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
BW	body weight
CA	concentration in air
CAP	Corrective Action Permit
CAR	carcinogenic
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	conversion factor
CFR	Code of Federal Regulations
Cl	chlorine
CLP	Contract Laboratory Program
CNES	Chem Nuclear Environmental Services
CPM	counts per minute
Cr	Chromium
CRL	Certified Reporting Limit
CS	concentration of chemical in soil
Cu	copper
DDT	Dichlorodiphenyltrichloroethane
DOD	Department of Defense
DOT	Department of Transportation
DQO	Data Quality Objectives
DRMO	Defense Reutilization and Marketing Office
EA	EA Engineering, Science and Technology, Inc.
ED	exposure duration
EF	exposure frequency
EMO	Environmental Management Office
EOD	Explosives Ordnance Disposal
EM	Electromagnetic
EPA	Environmental Protection Agency

EPIC	Environmental Photographic Interpretation Center
ET	exposure time
Fe	iron
FFA	Federal Facilities Agreement
FI	fraction ingested
FS	Feasibility Study
FSP	Field Sampling Plan
ft/d	feet per day
GPR	Ground-Penetrating Radar
HEAST	Health Effects Assessment Summary Tables
HELP	Hydrologic Evaluation of Landfill Performance
Hg	mercury
HI	Hazard Index
HMX	octahydro-tetranitro-tetrazocide
ID	Identification
IR	ingestion rate
IRDMS	Installation Restoration Data Management System
IRIS	Integrated Risk Information System
ISCSTZ	Industrial Source Complex Short Term Model
IWL	Industrial Waste Lagoon
Jordan	E.C. Jordan Co.
JMM	James M. Montgomery Engineers, Inc.
m	meters
MCL	maximum contaminant level
M.E.V.	Million Electron Volts
μg/g	micrograms per gram
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mm	millimeters
MS/MSD	matrix spike/matrix spike duplicate
MTL	maximum tolerable level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCRP	National Council on Radiation Protection
NEPA	National Environmental Protection Act
Ni	nickel
NLM	National Library of Medicine
NOAEL	no observed adverse effect level
NPL	National Priority List
NRC	Nuclear Regulatory Commission
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PCB	polychlorinated biphenyl
PCDF	polychlorinated dibenzofuran
PCDD	polychlorinated dibenzodioxin
PID	photoionization Detector
PPDDT	1,1,1-trichloroethane

ppm	parts per million
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Program
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/ Feasibility Study
RDX	cyclonite
RF	Risk Factor
RfD	reference dose
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RPD	Recovered Percent Differences
Rust E&I	Rust Environment and Infrastructure
SARA	Superfund Amendments and Reauthorization Act of 1986
SCS	Soil Conservation Service
SEC Donohue	SEC Donohue, Inc.
semi-VOCs	semi-volatile organic compounds
SI	Site Inspection (or Site Investigation)
SO_4	sulfate
SOPs	Standard Operating Procedures
SQL	Sample Quantification Limit
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCE	trichloroethylene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TEAD	Tooele Army Depot
TEAD-N	Tooele Army Depot-North Area
TEAD-S	Tooele Army Depot-South Area
Tl	thallium
TNB	trinitrobenzene
TNT	trinitrotoluene
TSCA	Toxic Substances Control Act
UCL	Upper Confidence Limit
UDEQ	Utah Department of Environmental Quality
UDWR	Utah Department of Wildlife Resources
USAEC	U.S. Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
USRADS	Ultrasonic Ranging and Data System
UXO	unexploded ordnance
VOCs	volatile organic compounds
Weston	Roy F. Weston, Inc.
Zn	zinc