HYDROGEOLOGIC INVESTIGATION
AND
FISH & WILDLIFE IMPACT ANALYSIS

LEHIGH VALLEY RAILROAD DERAILMENT SITE

Town of LeRoy

County of Genesee, New York

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EXECUTIVE SUMMARY

In February 1992, the Department of Environmental Conservation issued a work assignment to Dunn Geoscience Engineering Company, P.C., under its State Superfund Standby Contract, to conduct a Remedial Investigation and Feasibility Study of the Lehigh Valley Railroad Derailment Spill Site. The Site is the location of the December 6, 1970 derailment of a southbound train at the Gulf Road crossing in the Town of LeRoy, Genesee County, New York. The derailment resulted in the release at the grade crossing of thirty-thousand gallons of trichloroethylene (trichloroethene) and an unknown quantity of cyanide.

The initial investigative phase of the remedial investigation began in the spring of 1992. This phase (Phase A) consisted of both office and field research and reconnaissance. The second phase of the investigation (Phase B) included geophysical and soil gas surveys, test pitting, and the collection and analysis of samples of various media. A drilling and monitoring well installation program was undertaken as part of Phase C of the investigation. This phase included a four-month drilling and monitoring well installation program (July-October 1993). The program included drilling, coring and testing at 18 locations in the study area, and the installation of 55 bedrock monitoring wells at various depths at these locations.

The monitoring and analytical program that was initiated during Phase B of the investigation was continued in July at the start of the drilling program, and expanded in scope following installation of the monitoring wells. The expanded monitoring program consisted of water level measurements, and the collection of groundwater, surface water and sediment samples. The analytical program focused on the two chemicals that were spilled at the time of the derailment - trichloroethene (and its degradation products) and cyanide.

The highlights of the subsurface investigation and the sampling and analytical program include the following:

- A large volume of soil at the spill site, estimated at 15,000 cubic yards covering roughly two acres, exceeded one part per million TCE. Within this area, several samples exceeded 100 ppm TCE, and one sample collected by NYSDEC exceeded 500 ppm TCE. The Department's recommended soil cleanup objective for TCE is 700 ppm. Low levels of cyanide (5-25 ppm) were detected in three soil samples collected from two test pits located on the main line railroad grade south of Gulf Road.

- Although cyanide is sporadically present in various media at low concentrations near the spill site, it does not appear to be a threat to human health or the environment. With the exception of samples from wells DC-1A and DC-5A, cyanide levels in aqueous media were consistently well below the New York State groundwater standard (100 micrograms per liter, or µg/l) and drinking water standard (200 µg/l).

- Four contaminated springs have been identified in the Mud Creek gorge. TCE concentrations ranged from non-detect to 630 µg/l during six or fewer sampling events.

Cyanide was detected in only one sample. Five contaminated springs have been identified in the vicinity of Spring Creek. TCE concentrations ranged from less than one µg/l to 1900 µg/l. The spring that yielded the 1900 µg/l sample has been sampled only once. Otherwise, the highest TCE concentration near Spring Creek was 100 µg/l.

- Although our field screening program failed to directly detect the presence of dense, non-aqueous phase liquid (DNAPL) at the spill site as the wells were being drilled, the very high TCE levels detected in subsequent sampling strongly imply the presence of DNAPL near wells DC-1A, DC-5A, and DC-15A. This pattern suggests that substantial DNAPL spreading has occurred in the vadose zone above the normal position of the water table. Rising groundwater during the spring months apparently comes into contact with this residual DNAPL, and creates a highly contaminated "slug" of groundwater. The area underlain by possible DNAPL covers roughly seven to 10 acres and may extend to depths of 65 feet. The slowly dissolving DNAPL acts as a continuing source of groundwater contamination, and is responsible for the presence of the extensive, dissolved-phase TCE plume in the study area.

- A TCE plume underlying approximately three square miles of the study area has been delineated through sampling of monitoring wells, domestic wells, and springs. Approximately 50 domestic wells have been impacted to some extent. Thirty-eight domestic wells which have tested above five µg/l are equipped with carbon filters to remove TCE. The irregular distribution of TCE suggests that bedrock fractures play a significant role in contaminant transport. Two domestic wells that otherwise appear to be located in the plume have consistently tested clean. In some areas, domestic wells at neighboring residences often have dramatically different contaminant levels. TCE concentrations in domestic wells near the spill site have been as high as 7200 µg/l.

- Groundwater levels rose rapidly during springtime precipitation events, probably in response to concentrated recharge from some of the sinking streams in the area. Bedding plane and high-angle fractures act as conduits, and appear to allow relatively rapid "pressurization" of the hydrogeologic system at most monitored stratigraphic intervals throughout the study area. This rapid response produces corresponding rapid changes in the rate of contaminant transport, with large seasonal variations in TCE concentrations occurring in the area to the west of Church Road.

A quantitative Human Health Evaluation and a Fish and Wildlife Impact Analysis were performed to evaluate the potential effect(s) of contaminants on human health and wildlife resources in the impacted area. The results of these studies indicated that the contaminated groundwater, and to some extent the contaminated surface water, posed potential health risks to both present and future residents of the study area, but did not pose a threat to wildlife resources in the impacted areas (Mud Creek and Spring Creek drainageways).

A feasibility analysis was performed to evaluate the extension of water lines from one or more existing public water supply systems in the Town of LeRoy, the Village of Caledonia and Monroe

County. The extension of these systems throughout the impacted area was determined to be impractical as an Interim Remedial Measure. A more limited and cost-effective IRM, however, would consist of a water line extension along Spring Street between Mumford and Caledonia.

A Feasibility Study (first and second phases) was performed to identity various technologies that could be incorporated into one or more viable alternatives to remediate the spill site and impacted area. The identified alternatives were screened on the basis of effectiveness and implementability, and were configured into groups of remedial alternatives for subsequent detailed analysis in a Phase 3 Feasibility Study. Among the alternatives that passed the screening was the extension of existing public water supply systems throughout the impacted area, earlier rejected as an IRM. This alternative was retained as a potential option to be evaluated in conjunction with other retained remedial alternatives.

This document presents historical information and a site description, plus details of the geology and hydrogeology of the study area, the results of the monitoring and analytical program, a discussion of the fate and transport of the spill-related contamination, and the results of the Fish and Wildlife Impact Analysis. An Addendum to the RI rounds out the contents of Volume I of the RI report. Volume II of the RI report comprises the quantitative Human Health Evaluation, whereas Volume III includes the Appendices for the Volume I reports. A separate submittal contains the First, Second and Third Phase Feasibility Study reports.

1.0 INTRODUCTION

As a result of the December 6, 1970 derailment of a southbound Lehigh Valley Railroad train at the Gulf Road Crossing in the Town of LeRoy, Genesee County, New York, thirty-thousand gallons of trichloroethylene (trichloroethene or TCE) and an unknown quantity of cyanide were spilled onto the ground surface in the vicinity of Gulf Road. The liquid TCE flowed across the snow-covered ground and seeped into the overburden (soil, fill, etc) and the shallow bedrock. The crystalline cyanide was temporarily covered and reportedly removed from the area shortly after the derailment/spill.

Approximately 20 years later, sampling of domestic wells by the New York State Department of Health (NYSDOH) identified TCE in a well east of the spill site. Subsequent sampling by NYSDOH identified TCE in domestic wells farther to the east, in Livingston and Monroe Counties. In response to these findings, the NYSDOH and three county health departments joined forces in 1991 to conduct an extensive domestic well sampling program between the spill site in Genesee County and the villages of Caledonia (Livingston County) and Mumford (Monroe County). Wells at approximately 31 residences/businesses were found to contain levels of TCE in excess of the State Drinking Water Standard and the Federal Maximum Contaminant Level of five µg/l. These residences/businesses were first provided with bottled water, and then with whole-house point-of-entry water treatment systems.

Upon review of the facts, the Lehigh Valley Railroad Derailment Spill Site was placed on the New York State Department of Environmental Conservation's Registry of Inactive Hazardous Waste Disposal Sites in April 1991, as Site Number 819014. The Site was classified as a "2," that is, a site that poses a significant threat to public health or the environment.

The Remedial Investigation report is presented in three volumes. Volume I contains the results of the Remedial Investigation. Volume II provides the results of the quantitative Human Health Evaluation. Volume III contains the Appendices for the volume I documents. A separate submittal presents the complete Feasibility Study report.

1.1 SITE HISTORY

On December 6, 1970, a portion (25 cars) of a southbound 114-car freight train operated by the Lehigh Valley Railroad derailed at the railroad intersection with Gulf Road. Refer to Figure 1-1 for photographs of the wreck taken from the Knickerbocker Hotel shortly after the derailment. Two tank cars ruptured or leaked and discharged their contents, reportedly consisting of 30,000 gallons of TCE, onto the ground at Gulf Road. Another freight car discharged part of its load of cyanide in the accident. Representatives of American Cyanamid Company, from Niagara Falls, NY, were called upon to address the cyanide spill. The cyanide was reportedly covered with plastic and/or tarpaulins until it could be recovered and removed from the area.

Subsequent to the derailment, on or about December 10, 1970, the owners of the Knickerbocker Hotel, located approximately 200 feet north of the ruptured or leaking tank cars, reported solvent odors in the basement of the hotel. In response to this situation, plans were made to flush the TCE out of the ground in the immediate area of the spill in an attempt to alleviate the odor problem in the hotel. In addition, several homes to the east of the spill site (on Gulf and Church Roads) experienced contamination in their wells within several days to a month of the spill. In particular, the well located at 8389 Gulf Road reportedly produced a TCE "emulsion" or non-aqueous phase liquid (NAPL) within several days of the spill. A Gulf Road residence (G-2) and two residences on Church Road (G-9 and G-10) also reported well contamination following the derailment. These wells did not produce NAPL. Interestingly, the well closest to the spill site, i.e. at the Knickerbocker Hotel, was not reported to have been impacted. Geologic conditions north of the spill site, i.e. to the southwest of the Knickerbocker Hotel, discovered during the performance of the Remedial Investigation, may account for this unusual situation. Well water samples were collected and run through carbon filters to evaluate carbon filtration as a method of treating the private water supplies. As a result of this testing, the Lehigh Valley Railroad provided carbon filtration units for some of the impacted residences and provided cash settlements to the owners of others.

In early 1971, the Lehigh Valley Railroad undertook a limited "cleanup" of the TCE by constructing ditches, berms and other physical containment features in the area of the spill. Plans were made to obtain water from a pond or sump at the General Crushed Stone Company quarry located to the north/northwest of the spill site. Some reports indicate that the water may have been hauled to the Site by truck, from sources other than the quarry. The ditches were reportedly flooded with approximately one million gallons of water in an attempt to flush the TCE out of the ground. It was reported (Marshall, 1992) that, as a result of the flushing, the odors in the hotel dissipated and/or were no longer a problem.

Recent (1990-1994) sampling of wells to the east of the spill site has identified numerous (approximately 50) wells contaminated with chlorinated solvents, consisting primarily of TCE. It is unclear at the present time if all of the wells contaminated with TCE have been impacted by the spill or if other sources of TCE are also present in the area. The source(s) of the other volatile organic compounds unrelated to TCE is (are) not known, but the contaminants are not suspected of being related to the derailment/spill. In 1991, the U.S. Environmental Protection Agency (USEPA or EPA) provided bottled water to all known (31 at that time) affected homeowners under the USEPA's emergency response program. More recently (1992-1994), whole-house point-of-entry carbon filtration units have been installed on 39 of the most significantly impacted residences, i.e., those with contaminant levels in excess of the USEPA's maximum contaminant level (MCL) of 5μg/l (ppb). The units have been provided by the USEPA and/or the New York State Department of Environmental Conservation (NYSDEC or Department) under the Federal and State Superfund Programs. In 1993, the NYSDEC assumed responsibility for the operation and maintenance of the filtration units under the State Superfund Program. This work is being performed by Dunn Engineering Company (DUNN) under a separate project known as the Lehigh Valley Railroad Operation and Maintenance (Lehigh Valley Railroad O&M) Project.

1.2 SITE/STUDY AREA LOCATION

The Lehigh Valley Railroad derailment/spill site (the "spill site" or the "Site") consists of the general area of the derailment at the railroad intersection with Gulf Road in the Town of LeRoy, Genesee County, N.Y. The Site is located on the west side of a contiguous area of interest relative to the remedial investigation, consisting of approximately 28 square miles bounded roughly by the Oatka Creek Valley on the north, North Street on the west, Harris Road/Cider Street on the south and the Spring Creek valley on the east. This area has been or may be impacted by the spill and has been studied to evaluate the areal and vertical extent of the contamination and the fate and transport of the spilled materials. This area is referred to as the "Study Area." Figures 1-2 and 1-3 identify the locations of the Site and the Study Area, respectively. Plate 1 (in pocket) is a topographic base map of the Site and immediate surroundings, east to Church Road.

1.3 SITE DESCRIPTION

The immediate location of the derailment/spill consists of a fairly flat and level grade crossing of the northwest-southeast aligned Lehigh Valley main line railroad and the east-west aligned Gulf Road. East and west of the Site, the land is also fairly flat, with the exception of a gradual slope to the northeast of the Gulf Road crossing. Gulf Road is fairly level and contains shallow drainage ditches along both sides of the road. These ditches drain generally to the east, following the local grade of the road, and discharge storm drainage into Mud Creek near Neid Road. Two-hundred feet to the north of the spill site are the burned out ruins of the former Knickerbocker Hotel and, approximately 375 feet to the north, is a 45± foot high northeast-southwest oriented face of the abandoned General Crushed Stone Company quarry. Just to the northwest of the spill site, a railroad switching point connected the Lehigh Valley main line, via a north-south spur connector, to the Chessie Railroad line located approximately 4,000 feet to the south. Following the Lehigh Valley main line to the east some 500 to 600 feet, the railroad bed enters a fill section through the valley of Mud Creek. A stone and masonry arch culvert conveys Mud Creek through the railroad fill from the southwest to the northeast. To the north of the culvert, the creekbed occupies a closed depression having the surface appearance of a sinkhole or "swallet". The ponded water in this depression rises substantially in the spring in response to increased runoff and possibly as a reflection of the rising local water table. For the remainder of the year, the water level drops to an elevation below the concrete sill of the arch culvert. Refer to Plate 1 for the location and details of these features.

1.4 SITE/STUDY AREA SETTING

1.4.1 Physiographic Setting

The Site and Study Area are situated within the Glaciated Allegheny Plateau Physiographic Province of western New York. The area is underlain by sedimentary rocks (primarily carbonate rocks and shales) of Paleozoic (Devonian and Silurian) age. Erosion of these rocks has produced gentle slopes, except where the more resistant rocks have been eroded to produce cuestas or escarpments (ridges or cliffs) and where the surface drainage has been incised into the landscape. Glaciation during the Pleistocene period of geologic history has modified the plateau through both erosion and deposition.

The spill site itself, being relatively small in areal extent and having been modified by human activities, is relatively devoid of significant natural features. The Study Area and the surrounding terrain exhibit a wide variety of landforms that reflect the effects of both glaciation and deglaciation during the Pleistocene. More recent modification to the ground surface within the Study Area has resulted from surface, and possibly subsurface, erosion. Surface streams have been incised into the rock by erosion and have deposited the eroded material farther downstream in the wider portions of their valleys. Subsurface dissolution of evaporite (gypsum, anhydrite) - bearing rocks is known to affect some of the bedrock formations (Camillus and Syracuse) that underlie the Study Area. This process has been reported to be a possible cause of the very irregular ridge and basin topography found within the Study Area from Mud Creek to just east of Flint Hill (Livingston County)/Lime Rock Road. The result of all of these processes is a variable surface topography that is characterized by rolling plains, cigar shaped hills, ridges and basins, an escarpment, zig-zag drainage channels, waterfalls and flood plains. Refer to Section 4.0 for greater details of these features and applicable figures or plates.

1.4.2 Topographic Setting

The surface topography in the Study Area is relatively undisturbed by man with the exception of the quarries and minor cultural features. The land is generally flat, reflecting the configuration of the underlying, gently dipping (to the south) sedimentary strata of the Onondaga Formation and underlying bedrock units. On a regional scale, north and east of the Site, the ground surface slopes gradually to the north and northeast. The slope increases as the less resistant bedrock units of the Akron, Bertie and Camillus Formations is exposed at the surface and as the land surface descends into the Oatka and Spring Creek valleys. Differential erosion of the bedrock formations has created steep slopes and, in some locations, cliffs and escarpments. The terrain has been further modified by glacial deposition and erosion by meltwater drainage. More recent erosion and drainage, such as by Oatka and Mud Creeks, continue to modify these topographic features.

A subtle but noticeable change in the surface topography occurs from the west to the east of Mud Creek. The bedrock is relatively undisturbed in the areas occupied by quarries, i.e., west of Mud Creek, and the surface topography is fairly flat. These quarries are significant in that their bedrock exposures provide geologic and hydrologic information about conditions in the shallow subsurface close to the Site. They appear to be located in an area of relatively undisturbed bedrock and provide good exposures of the various members of the Onondaga Formation, the bedrock unit that directly underlies the Site and much of the Study Area. East of Mud Creek the surface topography is more irregular with arcuate ridges, depressions - both circular and elongate basins, sinking streams and other somewhat unusual landforms and configurations. These features are more common than the topographic maps indicate, due to the 10-foot contour interval of the maps. It is also interesting to note that no quarries are located east of Mud Creek. Whether this is due to geologic or institutional constraints, economics, or other unknown factors, has not been determined. Refer to Plates 1 and 2 (in pocket) for the topographic features of the site and Study Area.

1.4.3 Cultural Setting

The Study Area encompasses primarily rural properties with local population centers on the outer limits of the area, such as in the villages of Caledonia, LeRoy and Mumford. Additional developed areas exist along Route 5 near the southern limits of the area and in Limerock, located on Route 5 between the villages of Caledonia and LeRoy. Homes, farms, sportsmens clubs, a campground, church property, a museum and small businesses are scattered throughout the Study Area. Many of these are operated or utilized on a seasonal basis, such as the Genesee Country Campground and the Lime Rock Speedway in Livingston County.

A major feature of the western part of the Study Area is the existence of seven former or currently operating quarries. These include several former stone quarries of the General Crushed Stone Company, located to the north, northwest and southwest of the Site. The Lehigh Valley Railroad apparently served the General Crushed Stone quarries by transporting crushed stone to available markets by rail. Southwest of the Site is the operating quarry of Dolomite Products Company, Inc. and further to the west and west-southwest are the current operations of the Northrup Contracting and Genesee-LeRoy Crushed Stone Corporation quarries. Refer to Plate 2 for the locations of these quarries.

1.4.4 Geologic Setting

The spill site and Study Area lie primarily within an east-west outcrop belt of sedimentary rocks of Paleozoic (Silurian and Devonian) age. The Silurian rocks consist of dolomites and shales that are generally less resistant to weathering than the overlying limestones of Devonian age. This entire sequence of rocks is relatively flat lying but exhibits a gentle dip to the south of approximately 60 feet per mile (1/2°). For these reasons, the Silurian formations crop out in, or underlie, the major stream valleys within or bordering the Study Area, such as the lower (northern) section-below the falls - of Mud Creek and , also, Spring and Oatka Creeks. These valleys are located primarily in the north and east sections of the Study Area. The more resistant Devonian limestones underlie a majority of the Study Area west of a line roughly between the Genesee Country Museum Nature Center on the north and the Caledonia Fairgrounds on the south. The spill site and the quarries located to the northwest and southwest of the Site are all located in the limestone strata. Refer to Section 4.0 of this report for a more detailed discussion and figures relating to the geology of the spill site and the Study Area.

1.4.5 Recent Glacial History

The topography of the region, including that of the Study Area, reflects the affects of recent (Wisconsin) periods of Pleistocene glaciation and the final episodes of deglaciation. Although the region has been subjected to several such glacial cycles, the more recent and final episodes have created the landforms that are readily evident on topographic maps, aerial photographs and in the field. Features such as the till covered uplands to the south of the Study Area, the drumlinized till plain to the northeast and morainal deposits to the west, southwest and southeast of the Study Area reflect both ice advance and ice stagnation events. Additional features resulting from glaciation of the area are the scoured till and bedrock surface features, a complex network of meltwater channels, and deltaic deposits where the meltwaters entered the ponded waters of local glacial lakes and released their sediment load.

Within the Study Area, and of significance relative to the hydrogeologic regime of the area, is a network of somewhat obscure glacial meltwater channels that cross the Study Area in an east-west direction. These channels are postulated to have been created during one or several periods of drainage to the east and ultimately to a Mohawk drainage outlet near Syracuse (Fairchild, 1909; Muller, 1988; Wilson, 1981). It is unclear if these channels were created in a proglacial position (adjacent to the ice front) or beneath the ice mass or both. The channels transmitted a vast quantity of water from west to east across the Study Area. As the ice front retreated to the north of the Onondaga cuesta between Batavia and Caledonia, and the ground thawed, much of the surface water was free to find its way into the natural bedrock fracture system. Once in the subsurface, the water moved in a direction from high head to low head, which, in this case, was also from west to east. This flow direction was consistent with the direction of the surface drainage that found its outlet to the south through the north-south oriented channels known as the Taylor Channel and the White Creek Channel.

Both prior to and subsequent to this sequence of events, several significant glacial lakes occupied areas south of the ice front. Lake Warren I and Lake Wayne probably covered the Study Area, whereas Lake Warren III does not appear to have achieved an elevation such that it occupied the Study Area south of the Onondaga cuesta. This is evidenced by the preserved scour surfaces and channel features, and the absence of glacial lake deposits over most of the Study Area.

Much of the sediment transported through and eroded from these channels was deposited in a large delta located to the east and southeast of the Village of Caledonia. The thickness of this deltaic material is known to reach 100 feet on the Jones Chemical Company property located east of the village. The deep channels in which Oatka Creek, White Creek, Dugan Creek and Blue Pond are located were likely created as eastward drainage continued through lower outlets to the east, causing a decline in base level. This is probably the time period in which the falls in Mud Creek were initially created. The deep stream channels were later filled with marl and capped by organic material in restricted-flow areas. More recent alluvium has been deposited in the more prominent valleys, such as along Oatka Creek. Refer to Section 4 for further discussion of the glacial history and impact on the Site and Study Area.

1.4.6 Hydrologic Setting

1.4.6.1 Site/Study Area Setting

The Site, being relatively small in areal extent and insignificant with respect to gross hydrologic features, will not be discussed separately in this section. The Study Area lies within the Genesee River Basin and is drained primarily by Oatka Creek which borders the area on the west and north. Two tributaries to Oatka Creek (Mud Creek and Spring Creek) flow adjacent to the Site, and border the Study Area on the east, respectively. Several unnamed seasonal tributaries drain the uplands to the south and pass through or beneath the Study Area. These drainage features convey water from south to north, and/or west to east, either on the surface or in the subsurface, and enter Oatka Creek or Spring Creek east of the Site. In the southeast corner of the Study Area, south of Caledonia, surface drainage is to the southeast into the Genesee River Valley. Refer to Figures 1-2 and 1-3 for the location of these surface water features.

Although little was initially known about the subsurface hydrologic regime, i.e., groundwater movement in the Study Area, the general rule-of-thumb is that the piezometric surface or water table in an unconfined aquifer roughly mimics the surface topography. Since groundwater movement would be downgradient, i.e., from high head to low head, it could be presumed that the subsurface flow direction would be from the south to north throughout much of the Study area west of Flint Hill/Limerock Road (Livingston/Monroe County). East of this road, the surface topography slopes to the east and northeast toward Spring Creek and the Village of Mumford. As such, groundwater movement would be expected to be toward the east and northeast. Most of the surface drainage does, in fact, follow this flow pattern. However, the subsurface flow pattern, as evidenced by the apparent contaminant plume, is in more of an easterly and to some degree a southeasterly direction, somewhat in contradiction to what might be expected. This interpretation assumes that all of the detected contamination is derived from a single source, i.e., the derailment/spill.

Surface drainage in the Study Area follows a dendritic pattern. Most of the surface drainage within the Study Area consists of relatively indistinct streams, many of which are intermittent or seasonal, i.e., they don't flow all year around. These streams are notable in that they disappear or sink into the ground and discharge somewhere further downgradient. The major surface drainage feature of the area is Oatka Creek, which flows northward near the western border of the Study Area, over Buttermilk Falls, and then eastward along the northern border of the Study Area. Mud Creek drains a large portion of the western end of the Study Area, including the spill site, as it flows to the northeast over the "Mud Creek falls" to join Oatka Creek approximately 2.6 miles west of the Village of Mumford. Spring Creek appears to be a major outlet for much of the subsurface drainage from within the Study Area. This creek forms the eastern boundary of the Study Area, as it flows north from Caledonia to join Oatka Creek at the Village of Mumford.

All of surface streams within the Study Area, with the exception of Oatka and Spring Creek, are either seasonal or intermittent. This is due either to the poorly developed or juvenile nature of the system, or to the influence of the fractured nature of the bedrock found at the ground surface over much of the Study Area. The Onondaga limestone, which is the predominant bedrock formation exposed at the ground surface over much of the Study Area, is fractured and allows surface water to enter and penetrate the unit such that flow can exist within the formation, entirely below the ground surface. In fact, much of the area is underdrained, i.e., drained in the subsurface rather than by surface streams, during much of the year. North of Gulf Road, groundwater has been observed flowing out of the underlying formation, the Akron/Bertie, along the disconformity with the Onondaga Formation, as well as along high and medium angle joints in the Bertie Formation. This situation was observed at Buttermilk Falls to the west of the Site and at the falls in Mud Creek north of the Northwoods Sportsmen's Club. At the latter point, water was observed emanating from the

Onondaga - Bertie contact, as well as from joints in the Bertie, when the creek bed and overlying Onondaga Formation appeared to be dry.

The other, less well developed, streams located primarily to the south and east of the Site flow out of either the uplands to the south (south of Route 5) or out of the Onondaga and the Akron/Bertie contact, and across the ground surface to Oatka or Spring Creek. These streams disappear along their routes and discharge at downgradient locations. Flow in these steams is greatly affected by seasonal impacts, i.e., normal wet (spring) and dry (summer/fall) periods. They are also subject to high and low flow periods as a result of significant rainfall events and extended dry periods.

The dry creek beds can fill rapidly to produce flash floods, as evidenced by their scoured surface, direction (west to east) -oriented flattened vegetation, and the presence of mats of vegetative debris at the base of the more substantial shrubs and trees within and along the beds. Mud Creek is an example of such a stream, whereas Spring Creek is primarily spring fed and exhibits a rather consistent flow of water throughout most of the year.

1.4.6.2 Groundwater Resources

Groundwater resources in the overburden are insignificant throughout most of the Study Area due to the minimal thickness and nature of the overburden material (glacial till and weathered bedrock). The overburden increases in thickness near Spring Creek where shallow dug and drilled wells can yield an adequate supply of water to meet residential needs.

The specific groundwater resources of the bedrock in the three counties encompassed in the Study Area are not well documented with respect to specific conditions or details. Groundwater supplies can be obtained from the Onondaga Formation as well as the underlying formations. However, the location (horizontal and vertical) and volume of groundwater is random and somewhat unpredictable. Water supply bulletins report that wells in the Onondaga Formation produce an average yield of 10 gallons per minute (gpm), "moderate", and 22 gpm in Genesee, Livingston and Monroe counties, respectively. The underlying formations supply similar amounts of water to wells completed in them; however, this water is of generally poor quality as a result of the dissolution of the evaporite deposits present in the deeper rock formations. The dissolved minerals result in water that is hard, sometimes sulfurous or saline, and/or contains high quantities of total dissolved solids (TDS).

A preliminary review of local well yields from a small sampling of sources indicates that yields of 5 to 10 gpm at depths of less than 100 feet are common. It has generally not been necessary to drill deeper than this to produce an adequate yield of water to supply normal domestic residential needs. However, during 1991, many wells within the Study Area suffered diminished well yields and, in fact, some went dry (Dave Napier, NYSDOH and Tim Nothnagle, Nothnagle Drilling; personal communication). Local well drillers were called in to deepen these wells in an attempt to locate a subsurface supply at a greater depth. Many of these attempts were successful, and supplies of 5 to 10 gpm were reestablished. Unfortunately, however, many of the deepened wells produced water contaminated by the TCE from the derailment/spill. Based on the topography, surface geology and the known thickness of the geologic units in the Study Area, it appears that many of the wells were deepened from the Onondaga into the Bertie or Camillus Formations, which have been discovered to contain dissolved phase TCE.

Several public water supply sources are located within or near the Study Area. The reservoir and wells providing these sources are located in the southwest corner of the Study Area, in the Town of LeRoy, and east of the Village of Caledonia, respectively. The Village of Mumford obtains its water from the Monroe County Water Authority, which gets its water from Lake Ontario.

1.5 OBJECTIVES

1.5.1 Project Objectives

The objectives of the Lehigh Valley Railroad Derailment Site Remedial Investigation/Feasibility Study (RI/FS) were to:

- Determine if a residual source or sources of TCE contamination existed at and/or in the vicinity of the spill site, and to identify the location and extent of the source(s);

- Determine if residual DNAPL could be located in the subsurface and, if so, to identify a remedial alternative to optimize the control and/or removal of such DNAPL;

- Determine if preferred contaminant migration pathways existed in the subsurface and, if so, could they be identified, located and utilized to understand current contaminant occurrences, to predict continued contaminant movement, to identify additional potential locations of contaminant concentrations, and to focus attention on areas that could be selected for efficient and effective remediation;

- Identify additional areas of historic or present contamination that could provide insight into contaminant migration, collection points and "hot spots" that could represent ongoing environmental or public health threats and could require remediation;

- Determine and assess present evidence of any threat to wildlife within the Study Area due to the impact of the spill, through the performance of a Habitat Based Assessment (Fish and Wildlife Impact Analysis);

- Determine and assess present evidence of any threat to the public health due to the spill, through the performance of a quantitative Health Risk Assessment (Human Health Evaluation);

- Perform a focused feasibility study of various options for providing alternative sources of potable water to the impacted water supplies within the Study Area;

- Perform a feasibility study of various alternatives to remediate the remaining effects of the spill and to select the alternative(s) most capable of effectively reducing or eliminating continuing impacts; and

- Provide the Department of Environmental Conservation with the information necessary to select a remedy or remedies for the impacted areas/media.

1.5.2 Data Quality Objectives

On the basis of available information relating to the derailment and spill, the compounds of concern (COC) were determined to be trichloroethene; its potential breakdown products cis- and trans-1,2-dichloroethene and monochloroethene [vinyl chloride (VC)]; and cyanide. Although the cyanide was reported to have been spilled in crystalline form and was also reported to have been isolated and removed from the spill site, it was still identified as a compound to be investigated.

Data quality objectives (DQOs) were established for the various COC depending upon the medium being investigated. That is, the objectives were based on or related to investigations of surface water, groundwater and "soil". The "soil" consists of the overburden at the spill site and sediment collected from the various drainageways within the Study Area.

The DQOs established for the COC (TCE, DCE, VC, and cyanide) in surface water, groundwater, soil and sediment are as follows:

		Data Quality Objectives		
COC	Surface Water (1)	Ground Water (2)	Soil (3)	Sediment (4)
TCE	11μg/l	5μg/l	700μg/kg	46 μg/kg, H(B); 5,225 μg/kg, A
DCE (total)	5μg/l*	5μg/l	300μg/kg	6,707 μg/kg, A
VC	No Standard	2μg/l	200μg/kg	NA
Cyanide	100μg/l	100μg/l	Site-Specific	NA

Units: μg/l = ppb μg/kg = ppb mg/kg = ppm

NA = Not Applicable H(B) = Health Bioaccumulation Based A = Aquatic Based

(1) NYSDEC Surface Water Standards and Guidance Values* (6 NYCRR part 703) and Technical and Operational Guidance Series (TOGS) 1.1.1.

(2) NYSDEC Class GA Drinking Water Standards and USEPA National Primary Drinking Water Standards and Maximum Contaminant Levels (MCL).

(3) NYSDEC Division of Hazardous Waste Remediation Technical and Administrative Guidance Memorandum (TAGM): HWR-94-4046 REVISED, Determination of Soil Cleanup Objectives and Cleanup Levels.

(4) NYSDEC Division of Fish and Wildlife Technical Guidance for Screening Contaminated Sediments, November 1993. The listed DQOs were established during the FWIA, following the collection of necessary field data.

Analytical methods were selected and adjusted in order to obtain analytical data of sufficient quality and at a reporting level conducive to an evaluation of the results with respect to standards, guidance values and cleanup objectives. As such, analyses of samples collected during the initial phases of the remedial investigation were performed by gas chromatography/ mass spectroscopy (GC/MS) in accordance with the NYSDEC Contact Laboratory Program (CLP), Analytical Services Protocol (ASP) of December, 1991. Upon review of the results, and refinement of the DQOs, surface water, sediment and groundwater samples were generally analyzed by GC methods in accordance with USEPA SW-846, Method 8010, with NYSDEC CLP Category B deliverables, during later phases of the Remedial Investigation. Soil and sediment samples continued to be analyzed for cyanide by CLP methods with Category B deliverables. The use of these methods allowed detection of the COC that were consistent with applicable quality standards/guidance values and recommended cleanup objective levels, and allowed the investigation to achieve the DQOs established for the project.

Additional "data quality objectives" (dqos) were established specifically with respect to laboratory performance in analyzing the samples collected throughout the duration of the project. These dqo's were established to ensure that the data generated were of sufficient and adequate quality for their intended uses, i.e., to meet project DQOs. The dqo's include: precision, accuracy, representativeness, comparability and completeness (PARCC). The reader is referred to the project Quality Assurance Project Plan (QAPjP) for complete definitions of these terms.

1.6 REMEDIAL INVESTIGATION

Because of the age of the spill (almost 24 years ago), the assumed significance of the geology, and the potential complexity of the hydrogeology of the Study Area, it was decided to proceed with a phased approach to the Remedial Investigation. Three phases of investigation were identified and implemented, as follows:

- Phase A-Initial Background and Site/Study Area Investigations;
- Phase B-Focused Investigation of Soil Contamination at the Spill Site and an Initial Domestic Well and Environmental Sampling Program; and
- Phase C - Comprehensive Hydrogeologic Investigation, Habitat Based Assessment (Fish and Wildlife Impact Analysis) and Health Risk Assessment (Quantitative Human Health Evaluation).

1.6.1 Phase A - Initial Background and Site/Study Area Investigation

This phase of the RI involved a compilation and review of historical records relating to the derailment and spill, records relating to subsequent impacts and actions taken to alleviate or mitigate those impacts, documents pertaining to the geology in the immediate vicinity of the Site as well as the Study Area, and other pertinent records and documents. Most of this information was provided to DUNN by the NYSDEC, while other information was obtained from DUNN's review of its library and project files, data bases, and subsequent requests for documents from other available sources. A listing of the documents and their authors or sources are provided in Section 12.0 of this report. Additional information was obtained by the Department in the process of conducting its enforcement case against potentially responsible parties (PRPs), and provided to DUNN. Examples of this information include an interview with Mrs. Elizabeth Knickerbocker, former owner of the Knickerbocker Hotel; interviews with, and the deposition and report of, Mr. George Marshall, geological consultant to the Lehigh Valley Railroad for a period of time shortly after the derailment and spill; and communications with potential generators of the spilled chemicals.

Other office and field work conducted as part of Phase A included the procurement and review of aerial photographs covering the Site and Study Area, an air photo interpretation and fracture trace analysis, a field reconnaissance, surficial geophysical surveys, and an "active" soil gas survey. These activities were performed during the period from April through June, 1992. A report of the results of the Phase A activities entitled "Task 2, Phase A Report State Superfund Standby Program Lehigh Valley Railroad Derailment Site RI/FS Town of LeRoy County of Genesee, New York", dated August 1992, provides complete details of this phase of the RI.

1.6.2 Phase B - Focused Investigation of Soil Contamination at the Spill Site and an Initial Domestic Well and Environmental Sampling Program

This phase of the RI included a focused investigation of soil contamination at the Site, and the collection of samples from selected domestic wells and from environmental sampling locations consisting of streams, springs and ponds. The Phase B activities were designed to address the results, conclusions and recommendations contained in the previously referenced Task 2, Phase A Report, and subsequent discussions between NYSDEC and DUNN project personnel. The results of the Phase B test pitting, and soil sampling and analysis, are presented in the report immediately preceding this one in Volume I of the RI report.

Phase B of the RI also included the collection of samples from selected domestic wells and from various environmental sampling locations within the valleys of Mud Creek, Spring Creek and Oatka Creek. This initial sampling event was conducted in December, 1992. The domestic well sampling locations were concentrated in an area along Route 5 south of the spill site. This area was targeted for sampling to investigate the potential migration of a dense, nonaqueous phase liquid (DNAPL) and/or a dissolved phase plume in the down dip direction, and because not many wells had previously been sampled in the area. Homes with the deepest reported well depths were selected so as to intersect the greatest vertical extent of bedrock strata and to enhance the chances of intercepting any contamination migrating in a southerly direction.

The environmental sampling locations were selected on the basis of previous sampling results from State (NYSDEC and NYSDOH) and Federal (USEPA) studies in the area, from photos, maps and field observations, on the anticipated movement of water in the surface and subsurface hydrogeologic regime, and on the basis of potential collection/release points of contaminants originating from the derailment spill. The environmental samples were collected from streams, springs and ponds, and consisted of both aqueous and non aqueous (solid-sediment) matrices, however, samples of both matrices were not collected at all locations for various reasons.

A description of the Phase B domestic well and environmental sampling activities, and the analytical results therefrom, are presented in a report entitled "Domestic Well and Initial Environmental Sampling Report Lehigh Valley Railroad Derailment Site RI/FS Town of LeRoy County of Genesee, New York", dated May 1993. A summary of the conclusions and recommendations contained in that report is presented in Appendix A (Volume III) of the RI report.

1.6.3 Phase C - Comprehensive Hydrogeologic Investigation, Habitat Based Assessment and Health Risk Assessment

The third and final phase of the RI consisted of:

1) the drilling of core holes and boreholes for the:
   - collection of rock cores;
   - performance of downhole geophysical and video surveys;
   - collection and real-time analysis of depth-discrete groundwater samples; and
   - installation, development, testing and sampling of groundwater monitoring wells;
2) collection of multiple rounds of samples from the y installed monitoring wells and selected domestic wells and environmental sampling locations;
3) chemical analysis, data validation and evaluation/interpretation of the results;
4) performance of a Habitat Based Assessment (Fish and Wildlife Impact Analysis); and
5) performance of a quantitative Health Risk Assessment (Human Health Evaluation).

Additional activities performed during this phase of the RI included, but were not limited to:

- the performance of additional surficial geophysical surveys;
- a water budget analysis;
- a field survey and base map preparation; and
- a determination of Applicable or Relevant and Appropriate Requirements (ARARs) and/or Standards, Criteria and Guidelines (SCGs).

Details of the performance and results of Phase C of the RI are presented in the following sections of this report.

1.7 FEASIBILITY STUDY

A multi-phased feasibility study (FS) was also performed to assess remedial technologies and alternatives for the contaminated media present at the Site and within the Study Area. For the purposes of the FS, two operable units were identified for specific attention. A description of the two operable units is as follows:

The first operable unit consists of the contaminated overburden (soil, railroad ballast, broken rock, fill, etc.) at the spill site. The Department is performing a focused feasibility study for this operable unit.

The second operable unit consists of a combination of the unsaturated, contaminated bedrock above the water table (vadose zone) and the contaminated groundwater below the water table, at the spill site. Although consisting of both unsaturated bedrock and groundwater in the bedrock, this operable unit has been designated as the groundwater operable unit. It was previously reported that the unsaturated bedrock zone of this operable unit varies in thickness in response to water level/elevation changes throughout the year. It has been demonstrated during the RI that these changes can be significant, not only on a seasonal basis, but also on a short term basis in response to significant rainfall events and the spring thaw. The rising and falling of the water table, and the constant downward percolation of meteoric water and/or water derived from locally perched water bearing zones in the bedrock, can cause new "pulses" or "slugs" of contamination to be flushed from the rock and released into the groundwater beneath the spill site.

The contamination that is apparently still present in the rock beneath the spill site, and the dissolved phase plume that originates at the spill site and migrates away from the Site in response to gravity, hydrodynamic and hydraulic forces, are both part of the groundwater operable unit. Current evidence appears to indicate that the contamination may migrate away from the spill site in a radial (360°) pattern during at least some portion of the year. The groundwater operable unit has been evaluated with respect to the possible presence of nonaqueous phase liquids (NAPL), or very high concentrations of contamination (> 11,000 ppb of TCE), and the dissolved phase plume of contamination that is generally characterized by contaminant levels below one part per million (1,000 ppb).

The feasibility study report comprises a separate submittal. The First Phase FS (Development of Alternatives) consisted of an identification of various technologies that might be applicable to remediating the contamination in the groundwater operable unit and the development of potential remedial alternatives based on an evaluation of the various technologies. The existence of two distinct conditions (unsaturated and saturated zone) in the same operable unit resulted in identifying and evaluating diverse contaminated rock/groundwater treatment technologies and remedies. The Second Phase FS (Preliminary Screening of Alternatives) consisted of a preliminary screening of the alternatives identified in the First Phase FS, with the goal of refining the list into a manageable range of viable options. The screening process focused on the effectiveness and implementability of the identified alternatives and the potential applicability of the various options to the components of the groundwater operable unit. Cost was not considered during this phase of the FS process. Potential innovative technologies were identified and evaluated throughout the screening process, as was the potential applicability of the EPA's presumptive remedy process to the groundwater operable unit. The Third Phase FS entailed a detailed analysis of various remedial alternative combinations.

2.0 FIRST PHASE RI: PHASE C FIELD ACTIVITIES

2.1 INTRODUCTION

As indicated in Section 1.6, the Lehigh Valley Railroad Derailment Site Remedial Investigation (RI) was performed in three phases. Phase A consisted of the initial background and spill site/Study Area investigation. Phase B consisted of both non-intrusive and intrusive field investigations at the spill site and throughout the Study Area. Phase C consisted of:

- additional geophysical surveys,
- a comprehensive drilling and monitoring well installation program,
- downhole geophysical and video logging,
- an environmental monitoring program,
- a comprehensive analytical and data validation program,
- a hydrogeologic investigation,
- a habitat-based assessment (Fish and Wildlife Impact Analysis or FWIA),
- a quantitative Human Health Evaluation (HHE),
- a determination of Standards, Criteria and Guidelines (SCGs) applicable to the Site and to performing the Feasibility Study, and the selection of an appropriate remedy for the Site and Study Area.

This section provides details of the field component of the Phase C activities. Details of the hydrogeologic investigation, the environmental monitoring program, and the FWIA are described in other sections of this document whereas, due to its distinct nature and subject matter, the HHE is described in a separate volume (Volume II) of the RI report.

Prior to commencement of Phase C activities, a field office trailer was moved to the spill site and installed on the railroad grade between Gulf Road and the valley of Mud Creek. The field office trailer was supplied with power for cooling/heating, a telephone for communications, a mini-lab for conducting real-time analysis of field samples and other field related tests, as well as an office and drafting space. A combined copying/fax machine was also installed to facilitate project operations and communications. A drum storage area, consisting of graded fill and a berm, was contructed on the railroad grade adjacent to (southeast of) the trailer. The storage area was covered with a polyethylene geomembrane liner and a sewn geotextile fabric. This area was designated for the storage of contaminated materials such as: drill cuttings; drilling fluids; development and purge waters; decon materials and dismantled decon pads; field laboratory supplies; testing materials and waste samples; and other contaminated waste materials generated during the investigation. The drum storage area also contained plywood sheets and pallets upon which to place the drummed waste materials. This arrangement was designed to protect the geotextile fabric, to allow ease of movement of the drums, and to elevate the drums for periodic inspection. The entire storage area and field office trailer location was enclosed by chain link fencing and posted with readily visible *"Danger - Authorized Personnel Only"* signs on all four sides. The chain link fence was equipped with a man-gate and two 12-foot wide leaf gates for delivery of the trailer, for equipment access and for port-a-let servicing. Both gates were padlocked when authorized personnel were not in the vicinity of the trailer.