EPA/ROD/R04-00/076
2000

EPA Superfund
Record of Decision:

ZELLWOOD GROUND WATER CONTAMINATION
EPA ID: FLD049985302
OU 02
ZELLWOOD, FL
08/23/2000

RECORD OF DECISION

Summary of Remedial
Alternative Selection

for

Ground Water
Operable Unit 2
(OU2)

at the

Zellwood Groundwater Contamination Site
Zellwood, Orange County, Florida

**Prepared by the
United States
Environmental
Protection Agency**

RECORD OF DECISION

Declaration

Site Name and Location

Zellwood Ground Water Contamination Site
Zellwood, Orange County, Florida
FLD049985302

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Zellwood Groundwater Contamination Site in Zellwood, Orange County, Florida, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this site.

The State of Florida, as represented by the Florida Department of Environmental Protection (FDEP), has reviewed the reports which are included in the administrative record for the Site. In accordance with 40 CFR 300.430, as the support agency, FDEP has provided EPA with input on those reports. The State of Florida has recognized that Monitored Natural Attenuation (MNA) may be an appropriate remedy for the Zellwood Site, but does not feel EPA has demonstrated applicability of MNA at this time.

Assessment of the Site

The response action selected in this Record of Decision is necessary to protect the public health or welfare and the environment from actual or threatened releases of hazardous substances, pollutants or contaminants into the environment.

Description of the Selected Remedy

This remedy addresses the remaining threats at the site associated with potential human exposure to contaminants in ground water (operable unit 2). A Remedial Action was completed in 1994 to address the source areas containing contaminated soils and sediments (operable unit 1).

The major components of the remedy include:

- Monitored Natural Attenuation of contaminants in ground water;

- Institutional Controls including ground water use advisories (issued by EPA), and zoning regulations (enforced by Orange county).

- Installation of new, permanent ground water monitoring wells; and

- Development and implementation of a performance monitoring plan to measure and evaluate the effectiveness of natural attenuation.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action and is cost effective. The remedy in this operable unit does not satisfy the statutory preference for treatment as a principal element of the remedy for the following reasons: 1) No source materials constituting a principal threat will be addressed within the scope of this action, and 2) Ground water extraction and treatment would be very costly and may not effectively remediate the site at a quicker rate than the selected remedy.

This remedy will not result in hazardous substances, pollutants or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, but it will take more than five years to attain remedial action objectives and cleanup levels. However, the remedy selected for operable unit 1 did result in hazardous substances, pollutants or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. Therefore a statutory review every five years is required to ensure protectiveness of human health and the environment. Included in this five year review process, will be a review of the selected remedy for operable unit 2.

ROD Data Certification Checklist

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file for this Site.

- Chemicals of Concern (COCs) and their respective concentrations.

- Baseline risk to human health represented by the chemicals of concern.

- Cleanup levels established for chemicals of concern and the basis for these levels.

- Current and future land and ground water use assumptions used in the baseline risk assessment and the ROD.

- Land and ground water use that will be available at the Site as a result of the Selected Remedy.

- Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected.

- Decisive factors that led to selecting the remedy.

AUTHORIZING SIGNATURE

Richard D. Green, Director — 23 AUG '00

Richard D. Green, Director
Waste Management Division

Date

TABLE OF CONTENTS

1.0 SITE LOCATION AND DESCRIPTION 1

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES 3
- 2.1 Onsite Disposal Activities 3
- 2.2 Site Regulatory Actions 4

3.0 COMMUNITY PARTICIPATION 5

4.0 SCOPE AND ROLE OF ACTION 6

5.0 SITE CHARACTERISTICS 6
- 5.1 Physiography and Topography 6
- 5.2 Geology 6
- 5.3 Hydrogeology 7
- 5.4 Surface Water Hydrology 8
- 5.5 Site Contamination 8
  - 5.5.1 Source Areas 9
  - 5.5.2 Ground Water Contamination 9
  - 5.5.3 Sediment and Surface Water Contamination 22

6.0 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES 27

7.0 SUMMARY OF SITE RISKS 27
- 7.1 Contaminants of Concern 28
- 7.2 Exposure Assessment 28
- 7.3 Toxicity Assessment 30
- 7.4 Risk Characterization 31
- 7.5 Environmental Risk 34
  - 7.5.1 Surface Water Evaluation 34
  - 7.5.2 Sediment Evaluation 35

8.0 REMEDIAL ACTION OBJECTIVES 37

9.0 DESCRIPTION OF ALTERNATIVES 38
- 9.1 Alternative 1: No Action 38
- 9.2 Alternative 2: Ground Water Extraction, Treatment Using Chemical Precipitation, Air Stripping, and Biological Reaction, and Surface Water Discharge 39
- 9.3 Alternative 3: Ground Water Extraction, Treatment Using Chemical Precipitation, Reverse Osmosis, and Surface Water Discharge 42
- 9.4 Alternative 4: Monitored Natural Attenuation With Institutional Controls 44

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES 45
10.1 Overall Protection of Human Health and the Environment 45
10.2 Compliance With ARARs 46
10.3 Long-Term Effectiveness and Permanence 47
10.4 Reduction of Toxicity, Mobility, or Volume Through Treatment 47
10.5 Short-Term Effectiveness 47
10.6 Implementability 48
10.7 Cost 48
10.8 State Acceptance 49
10.9 Community Acceptance 49

11.0 PRINCIPAL THREAT WASTES 50

12.0 SUMMARY OF SELECTED REMEDY 50
12.1 Rationale for the Selected Remedy 50
12.2 Description of the Selected Remedy 50
12.2.1 Institutional Controls 50
12.2.2 Natural Attenuation 51
12.2.3 Performance Monitoring 53
12.3 Summary of Estimated Remedy Costs 55
12.4 Expected Outcomes of Selected Remedy 57

13.0 STATUTORY DETERMINATIONS 58
13.1 Protection of Human Health and the Environment 58
13.2 Compliance with ARARs 58
13.3 Cost-Effectiveness 58
13.4 Use of Permanent Solutions and Treatment Technologies 59
13.5 Preference for Treatment as a Principal Element 59
13.6 Five-Year Review Requirements 59

14.0 DOCUMENTATION OF SIGNIFICANT CHANGES 59

Appendix A: Responsiveness Summary
Appendix B: Human Health Risk Assessment Tables

LIST OF FIGURES

FIGURE 1-1: SITE LAYOUT 2

FIGURE 5-1: MONITORING WELL AND SAMPLING LOCATIONS 10

FIGURE 5-2: ESTIMATED EXTENT OF GROUND WATER CONTAMINATION 13

FIGURE 9-1: PROCESS DIAGRAM FOR ALTERNATIVE 2 41

FIGURE 9-2: PROCESS DIAGRAM FOR ALTERNATIVE 3 43

FIGURE 12-2: ESTIMATED GROUND WATER USE ADVISORY AREA 52

LIST OF TABLES

TABLE 5-1: LIST OF ANALYTES EXCEEDING BACKGROUND OR THE GWPS IN GROUND WATER 12

TABLE 5-2: TRENDS IN HISTORICAL DATA FROM SELECTED MONITORING WELLS 17

TABLE 5-3: CONTAMINANTS DETECTED IN SURFACE WATER 23

TABLE 5-4: LIST OF ANALYTES EXCEEDING REMEDIATION GOALS IN SEDIMENT SAMPLES COLLECTED DURING THE SECOND SRI 24

TABLE 5-5: HISTORICAL COMPARISON OF CONTAMINANTS DETECTED IN SEDIMENTS IN THE EASTERN MOST DOUGLAS FERTILIZER POND 26

TABLE 7-1: CONTAMINANTS OF CONCERN IN GROUND WATER 28

TABLE 7-2: POTENTIAL EXPOSURE PATHWAYS 29

TABLE 7-3: SUMMARY OF CANCER RISKS 32

TABLE 7-4: SUMMARY OF NON-CANCER RISKS 33

TABLE 7-5: HISTORICAL COMPARISON OF SURFACE WATER CONTAMINANTS OF ECOLOGICAL CONCERN 35

TABLE 7-6: HISTORICAL COMPARISON OF SEDIMENT CONTAMINANTS OF ECOLOGICAL CONCERN 36

TABLE 8-1: SUMMARY OF REMEDIAL GOALS FOR GROUND WATER 38

TABLE 9-1: SURFACE WATER DISCHARGE STANDARDS 42

TABLE 10-1: COMPARISON OF COST 49

TABLE 12-1: INSTITUTIONAL CONTROLS 51

TABLE 12-2: PERFORMANCE STANDARDS 54

TABLE 12-3: SUMMARY OF PRESENT WORTH COST 55

TABLE 12-4: SUMMARY OF OPERATION AND MAINTENANCE COSTS 56

TABLE 13-1: DESCRIPTION OF ARARS FOR SELECTED REMEDY 58

1.0 SITE LOCATION AND DESCRIPTION

The Zellwood Groundwater Contamination Superfund Site ("the Site") (CERCLIS ID FLD049985302) is located on 57 acres in the northwestern corner of Orange County, Florida. The Site is situated approximately one-half mile west of the rural, unincorporated town of Zellwood. Geographically, the center of the site is located at 28E43'53" N latitude and 81E36'50" W longitude on the 1960 Apopka, Florida, U.S. Geological Survey (USGS) 7.5 minute topographic quadrangle. The Site is occupied by several industries and undeveloped properties including an open field and wooded wetlands. The Supplemental Remedial Investigation and Focused Feasibility Study (SRI/FFS) and Addendum have been completed using Fund monies.

The approximate site boundaries are the Seaboard Coastline Railroad to the north, Jones Avenue to the south, Laughlin Road on the east, and a large grassy field to the west. **Figure 1-1** depicts the site layout.

The Zellwood Site is occupied by active industrial facilities including Drum Service Company of Florida, Chemical Systems of Florida, and Coatings Application and Waterproofing Company. In addition, several other businesses are located in the general area surrounding the site, including an auto shop located on the former Douglas Fertilizer Company property. Residential developments, a nursery, citrus groves, pastureland, and muck farms which process, package, and sell peat and potting soil, also exist near the site.

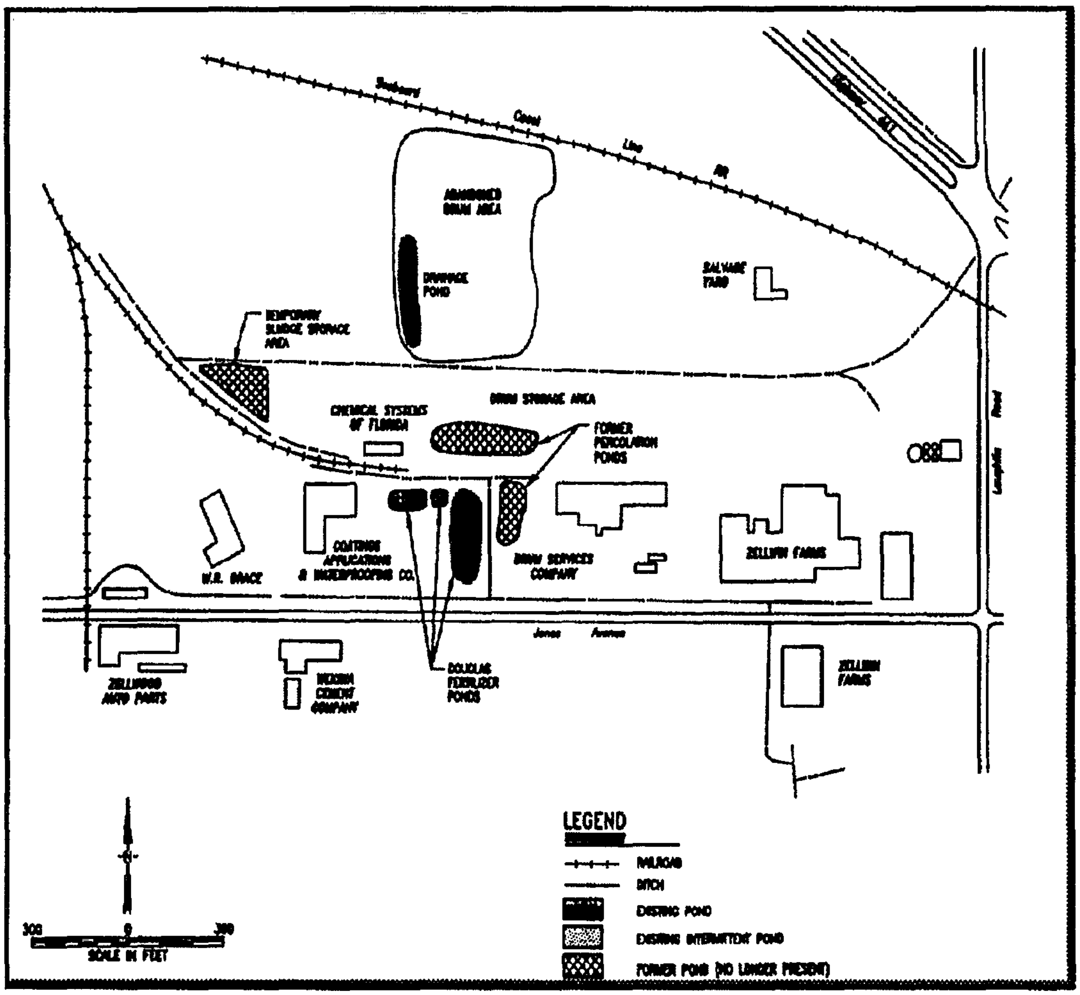
Drum Services Company of Florida is centrally located and occupies the Largest land area at the Zellwood Site. In addition to the main facility where the drums are reclaimed, an area of approximately 8.7 acres north of the facility is used for drum storage. From approximately 1963 to 1975, the company used two unlined evaporation/percolation ponds (hereinafter referred to as the Former Percolation Ponds) for treatment and disposal of wastewater. These ponds have since been drained and backfilled and are now used as drum and equipment storage areas.

Zellwin Farms, located at the easternmost portion of the site, formerly operated a vegetable washing and packaging facility on part of their property; however, this portion of their property was sold in early 1998. Process fines included rinsing and cooling of vegetables. Zellwin Farms consisted of a building located north of Jones Avenue, and a carrot and radish handling facility located south of Jones Avenue. Spent rinse waters were discharged to ditches along Jones Avenue and ditches south of Jones Avenue.

The Chemical Systems of Florida, Inc., facility is located at the western portion of the site. The products manufactured by this facility include cleaning agents for the food industry, and chain lubricants for chain conveyor systems used for food processing.

The Coatings Application and Water Proofing Company facility is also located at the western portion of the site. Until 1984, this facility was occupied by the Douglas Fertilizer and Chemical Company. Prior to 1981 another liquid fertilizer company, Southern Liquid Fertilizer Company, operated at this location. Both companies blended liquid fertilizers and used a series of three unlined evaporation/percolation ponds (hereinafter referred to as the Douglas Fertilizer Ponds).

FIGURE 1-1
SITE LAYOUT



2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

In 1961, Mr. J. Bernard Smith purchased a large tract of land and a drum recycling facility was built on a portion of this property in 1963. The facility, Drum Service Company of Florida, was incorporated in 1963 by Mr. Smith, and several other investors including the Kingsland Company of New Jersey, and Port Drum Company of Texas. In 1965, Northwestern Cooperage acquired an interest in the corporation. This business relationship continued until 1977 when Mr. J. Michael Murphy purchased the Drum Service Company of Florida. In 1998, Drum Services Company of Florida acquired title to the facility property.

The Southern Liquid Fertilizer Company began operations at this location sometime in the 1970s. In approximately 1981, the Douglas Fertilizer Company purchased the plant and began operation of a liquid fertilizer company. In 1984, Mr. Douglas sold the property to Coatings Application and Waterproofing Company. The Douglas Fertilizer and Chemical Company is now located south of the site off Highway 441.

Prior to 1998, the Zellwin Farms Company occupied the land area east of the Drum Service Company. Their former vegetable washing operations, which were initiated prior to 1960, were housed in buildings north and south of Jones Avenue.

2.1 Onsite Disposal Activities

In the course of recycling used steel drurns, Drum Service Company of Florida generated wastewaters through its draining and cleaning procedures. From 1963 to 1971, facility wastewaters were discharged to the ditch located south of the facility. The company then used the two Former Percolation Ponds for treatment and disposal of wastewater from 1971 to 1975. In approximately 1980, the treatment system was redesigned and the company began to eliminate the use of the ponds for waste disposal. Drainage and removal of contaminated sediments was initiated in August, 1981. To complete the cleanup of the two ponds, the Company constructed a temporary sludge storage area consisting of an earthen berm at the western edge of the drum storage area. The sludge was removed from the temporary storage area in 1982 and hauled to an offsite landfill. The areas where the ponds were located were filled in and are now used for equipment and drum storage. The former temporary sludge storage area was used for drum storage.

From 1970 to 1981, the Southern Liquid Fertilizer company owned and operated a liquid fertilizer facility on a portion of the site. From 1981 to 1984, the Douglas Fertilizer Company, which produced blended liquid fertilizer, owned and operated the liquid fertilizer facility. All waste streams from the facility were generated by wash waters used during in-house cleaning. All wastewater was released to Pond 1, with overflow to Pond 2 and eventually Pond 3. No pretreatment occurred prior to discharge to the ponds, and volume was controlled by evaporation and percolation, however numerous discharges to the southern ditch were observed by Orange County officials. Water from Pond 3 was frequently recycled for use as a process make-up water, and as a result of the non-discharge system, the facility operated without an industrial discharge permit.

From 1960 to 1983, all Zellwin Farms Company vegetable rinsing processes were located north of Jones Avenue, and all spent rinse water was discharged to the southern ditch along Jones Avenue. Water used for processing carrots and radishes was screened prior to discharge. In 1983, the carrot and radish handling facility was relocated south of Jones Avenue and the screening of rinse water at this facility was discontinued. In addition, runoff from the parking lot located at the original facility, and the carrot and radish rinse water were redirected to a ditch south of the new facility. In 1998, Zelwin Farms sold its facility and its operations ceased.

Chemical Systems of Florida, Inc., began operation at the Site in 1982 and continues to manufacture cleaning agents for the food industry and chain lubricants for food processing chain conveyor systems. No process solid waste or wastewater is generated.

In December, 1982, EPA representatives discovered an abandoned drum storage area located on an approximately six-acre field north of the northern ditch and south of the Seaboard Coastline Railroad. This area was used by Drum Service Company of Florida for the disposal of drums and other waste. In 1983, an emergency removal operation was conducted. The abandoned drums were assembled and transported to a scrap-metal company and the contaminated soil and material from the waste piles was disposed of in a sanitary landfill.

2.2 Site Regulatory Actions

In 1971, Drum Service Company of Florida was granted Florida Department of Environmental Regulation (FDER) Operation Permit No. IC-1308 for a wastewater treatment system using the Former Percolation Ponds for treatment and disposal of wastes from the plant. In 1975, the system was redesigned to eliminate the use of the ponds except for temporary wastewater storage. FDER issued Operation Permit No. IO48-2077 for this redesigned system. FDER Operation Permit No. IO48-35197 was issued when further design changes eliminated the use of the ponds for wastewater storage.

The Zellwood Site was evaluated in 1981 as part of the nationwide EPA program to rank hazardous waste sites under the mandate of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The site was proposed for inclusion on the National Priorities List (NPL) in December 1982 and placed on the NPL in 1983.

In 1986, a Remedial Investigation/Feasibility Study (RI/FS) was completed and the results indicated that metals and organic compounds were present in the soil, sediment, and ground water at levels of concern. In 1987, a record of decision (ROD) was issued to address soil/sediment and ground water remediation. In 1988, the site was resampled in an effort to better define the extent of contamination, and soil stabilization/solidification treatability studies were performed. The results of the 1988 studies prompted an amendment of the ROD in 1990 to address only the source of contamination (operable unit 1), the soil/sediments. The amended ROD specified excavation and stabilization/solidification of the contaminated soil/sediments and periodic ground water monitoring around the treated soil/sediments disposed of onsite.

In 1992, approximately 7000 cubic yards of contaminated soils were excavated and stockpiled onsite. Soil samples collected during the excavation indicated that in the abandoned drum area, chlordane, chromium, and lead were the major contaminants.

EPA conducted a Supplemental Remedial Investigation and Focused Feasibility Study (SRI/FFS) from February 1993 to January 1995. The purpose of the SRI/FFS was to investigate ground water contamination resulting from metals and nutrients and any remaining sources of these contaminants at the Site. The results of the SRI/FFS indicated that metals and other inorganic contamination was present in the ground water at the Site.

In April 1999, EPA collected ground water samples from two monitoring wells on the Site using a low-flow purging and sampling technique. EPA was concerned that previous ground water samples with moderate to high turbidity might not have been representative of actual ground water quality at the Site. The analytical results collected using the low-flow purging and sampling technique confirmed this suspicion. EPA concluded that additional site characterization using this sampling method was necessary to revise the existing site conceptual model, contaminants of potential concern, and the remedial alternatives considered.

In June and July 1999, a second SRI/FFS was conducted at the Site. This investigation included the installation of eleven permanent monitoring wells, sampling of ground water in the new and existing wells, and sampling of sediment and surface water in the easternmost Douglas Fertilizer Pond, that was suspected of being a continual source of ground water contamination.

3.0 COMMUNITY PARTICIPATION

The Addendum to the SRI/FFS report and Proposed Plan for the Zellwood Site were made available to the public on May 19, 2000. These documents can be found in the Administrative Record file and the information repository maintained at the EPA Docket Room in Region IV and at the Zellwood Elementary School Library, East Washington Avenue, Zellwood, Florida. The notice of the availability of these two documents was published in the Apopka Chief on May 19, 2000. A public comment period was held from May 19, 2000 to June 18, 2000. In addition, a public meeting was held on June 1, 2000 to present the Proposed Plan to the local community in Zellwood.

EPA consulted with the Orange County Zoning Board to determine the current and future intended use of the properties on and around the Zellwood Site. All properties impacted by the ground water contamination have been zoned industrial or agricultural. EPA also had discussions with the St. Johns River Water Management District (SJRWMD), which owns or is planning to own much of the property to the southwest of the Site. SJRWMD has informed EPA of its plan to use the land in conjunction with the Lake Apopka restoration project and has indicated that their properties will not be used for any residential purposes.

4.0 SCOPE AND ROLE OF ACTION

The work at the Zellwood Site was organized into two operable units (OUs):

- Operable Unit 1 for source control of contamination in the soil and sediment and;
- Operable Unit 2 for identification and evaluation of any other potential sources of metals and nutrients contamination and remediation of ground water as necessary.

EPA selected a remedy for OU1 in a ROD signed in December 1987 and a ROD Amendment signed in March 1990. The Remedial Action for OU1 was completed in 1994.

The second operable unit, the subject of this ROD, addresses the contamination in the ground water. Ingestion of ground water from the surficial aquifer at and down gradient of the Site poses a potential risk to human health due to the exceedence of EPA's acceptable risk range and also exceedences of maximum contaminant levels (MCLs) for drinking water. This second operable unit presents the final response action for this site and will restore the surficial aquifer to cleanup goals through a monitored natural attenuation remedy.

5.0 SITE CHARACTERISTICS

5.1 Physiography and Topography

The Site is located in the Central Highlands Physiographic Province of Central Florida, which is characterized by discontinuous, subparallel ridges separated by broad valleys. The ridges are oriented roughly parallel to the Atlantic coastline. The Zellwood Site is located in the Central Valley. This physiographic subdivision is characterized by flat terrain, karst topography, and numerous lakes. From its southern terminus south of Lake Apopka, the Central Valley opens to the northwest into Lake County. Features of karst topography, such as sinkholes, are common in Central Valley subdivisions of the Central Highlands. The development of karst is typical of humid areas underlain by carbonate bedrock. Lake Apopka, a large sinkhole related lake, is located approximately three and one-half miles south of the Site.

The topographic relief over the Site is approximately 16 feet. The highest elevation of 86 feet above mean sea level (amsl) occurs at the northeast corner of the Site and the lowest elevation of 70 feet amsl occurs on the southern site boundary. The surface soils are sloped generally to the south-southwest at less than one percent grade.

5.2 Geology

Orange County is underlain mostly by limestone, dolomite, shale, sand and anhydrite to about 6,500 feet, at which depth granite and other crystalline rock occur. At the Zellwood Site there are three distinct lithostratigraphic units: the surficial undifferentiated sediments, the undifferentiated Hawthorn Group, and the Ocala Limestone. The undifferentiated surficial sediments at the site are represented by distinct sand, clayey-sand, sandy-clay, and clay layers of varying thickness across the site. The lithology of subsurface soils logged from this unit consists of a layer of light brown to black fine to medium grained sand. This sand unit ranges in depth from 24 to 46 feet bgs around the site with an average depth of 31 feet bgs. The stratigraphic change from the undifferentiated surficial sediments to the undifferentiated Hawthorn Group is defined by the increase in the clay content of the basal sands in the unit.

The undifferentiated Hawthorn Group at the site is represented by varying combinations of sand, silt, clay, shells, limestone, and phosphate. The upper portion of the Hawthorn Group is comprised predominantly of sand and clay, which grades into an interbedded sequence of carbonates and clay beds with some sand. The carbonate beds are broken shells interbedded with clay and some sand. Below the carbonate beds are beds of varying percentages of sand, silt, clay, limestone, oolitic sands, fossil casts and molds, and varying percentages of poorly sorted phosphate. The phosphate is present throughout the middle and lower sections of the undifferentiated Hawthorn Group; the absence of phosphate in association with depth can be used as an indicator for the top of the Ocala Limestone Formation. The average depth to the top of the Hawthorn Group at the site is 31 feet bgs and the thickness is estimated to be approximately 200 to 220 feet.

Based on site-specific lithological data collected during the 1986 RI and 1995 SRI, the Hawthorn Group appears to be continuous and intact at the Site, and for the most part, consists of tight formations down to the top of the Ocala Limestone Formation.

The Ocala Limestone Formation in the vicinity of the site is over 26 feet of a white to tan, massive, fine-grained, well fractured, fossiliferous limestone. The thickness of this formation at the site is unknown since only a maximum of 26 feet of this unit was logged; however, regionally this unit is known to range from approximately 30 feet to 120 feet.

5.3 Hydrogeology

The hydrogeology at the Site consists of a surficial aquifer that includes the surficial undifferentiated sediments and the upper portion of the undifferentiated Hawthorn Group. The middle and lower portions of the Hawthorn Group serve as a semi-confining unit or aquatard. Beneath this area is the Floridan aquifer.

Regionally, the water level ranges from immediately below ground surface to greater than twenty feet below ground surface. The surficial aquifer level fluctuates in response to climatic recharge and discharge mechanisms. Water level measurements made in July 1999 indicate that the surficial ground water at the Site generally moves toward the southwest with a distinctive westward component near the Coatings Applications and Waterproofing Corp. and W.R. Grace properties. Previous hydrogeologic investigations conducted at the site concluded that the average horizontal hydraulic conductivity for the surficial aquifer at the site is estimated to be 7.3 feet/day with a range of 0.6 to 46.0 feet/day. This high degree of variability is most likely reflective of the varying types of undifferentiated sediments composing the surficial aquifer (i.e., sands and clays). Based on water level elevations from July 1999, the average hydraulic gradient in the surficial aquifer across the Site is estimated to be approximately 0.0045 feet/feet. With an average horizontal hydraulic conductivity of 7.3 feet/day (determined from previous aquifer testing) and average effective porosity estimated to be 0.25 (typical for fine sandy soils), the average horizontal ground water flow velocity in the surficial aquifer is estimated to be 0.131 feet/day, based on Darcy's Law for ground water flow.

The surficial aquifer is underlain by the Hawthorn Formation, which is estimated to be about 220 feet thick at the Site. The clay-like sand in the upper Hawthorn retards the vertical movement of water between the surficial aquifer and the limestone of the Floridan aquifer. Local studies indicate that the average vertical hydraulic conductivity of the Hawthorn unit in this area is on the order of 0.005 ft/day. The vertical hydraulic gradient through the Hawthorn semi-confining unit is estimated to average about 0.17 feet/feet. Using the average effective porosity (estimated to be 0.2 based on sandy clay soils) previously determined applicable for this site, the average vertical ground water flow velocity through the Hawthorn semi-confining unit is estimated to be 0.0042 feet/day, based on Darcy's Law for ground water flow.

In the Floridan aquifer, water moves primarily through underground cavities formed from solutioning in the limestone bedrock. These solution channels generally form along fractures, joints, and bedding planes within the limestone formation. The solution channels formed in the Floridan aquifer provide water to most users in the area. Local ground water movement is difficult to predict; however, regional potentiometric surface maps indicate a northeasterly direction of flow in the Floridan aquifer in Orange County.

5.4 Surface Water Hydrology

Orange county has about 1,100 permanent bodies of open water ranging from large water-filled sinkholes to stream channel widening. Lakes occur in all parts of the County with the vast majority located in the western half. There are several small lakes within close proximity to the Site, including Lakes Maggiore and Minore to the northeast and Lake Fanny to the northwest. Lake Apopka, a large lake, is located three and one-half miles south of the Site.

Most of the surface waters in the county are recharged by rainfall. Approximately 72% of the rainfall returns to the atmosphere via evaporation and transpiration, 16% flows out of the County in streams, and the remaining 12% seeps down through the soils into the ground water system. Some surface waters are also recharged by ground water discharge.

The Zellwood Site is located well outside of the 500-year flood boundary associated with Lake Apopka. The 100-year flood plain boundary associated with the marshy areas located northwest of the Site, however, does include some of the abandoned drum area north of the Site. Current

Site drainage is through a system of interconnected surface ditches and ponds.

5.5 Site Contamination

The second SRI field work was conducted in June and July 1999. The purpose of this investigation was to further characterize the lateral and vertical extent of metals and nutrient contamination in ground water and to determine if and to what extent the eastern most Douglas Fertilizer Pond ("the Pond') was contributing to the ground water contamination.

5.5.1 Source Areas

The purpose of the ground water investigation was to further characterize contamination resulting from past activities on the Coatings Applications and Waterproofing Company property (formerly owned by Douglas Fertilizer and Southern Liquid Fertilizer) and the adjacent property owned by Drum Services Company. The suspected sources of the ground water contamination are the abandoned drum area, the former percolation ponds, the former operations area of Douglas/Southern Liquid Fertilizer, and the Douglas Fertilizer Ponds. The locations of these suspected source areas are presented on **Figure 5-1.** Contaminated soil and sediment in the abandoned drum area, the former percolation ponds and selected areas of the middle ditch were removed during the remedial action for operable unit 1. Any leaching of contaminants to ground water from these source areas would have occurred prior to the remedial action for operable unit 1. The only existing potential source area suspected at the Site is the eastern most Douglas Fertilizer Pond. The surface water and sediment sampling conducted during the SRI focused on this Pond.

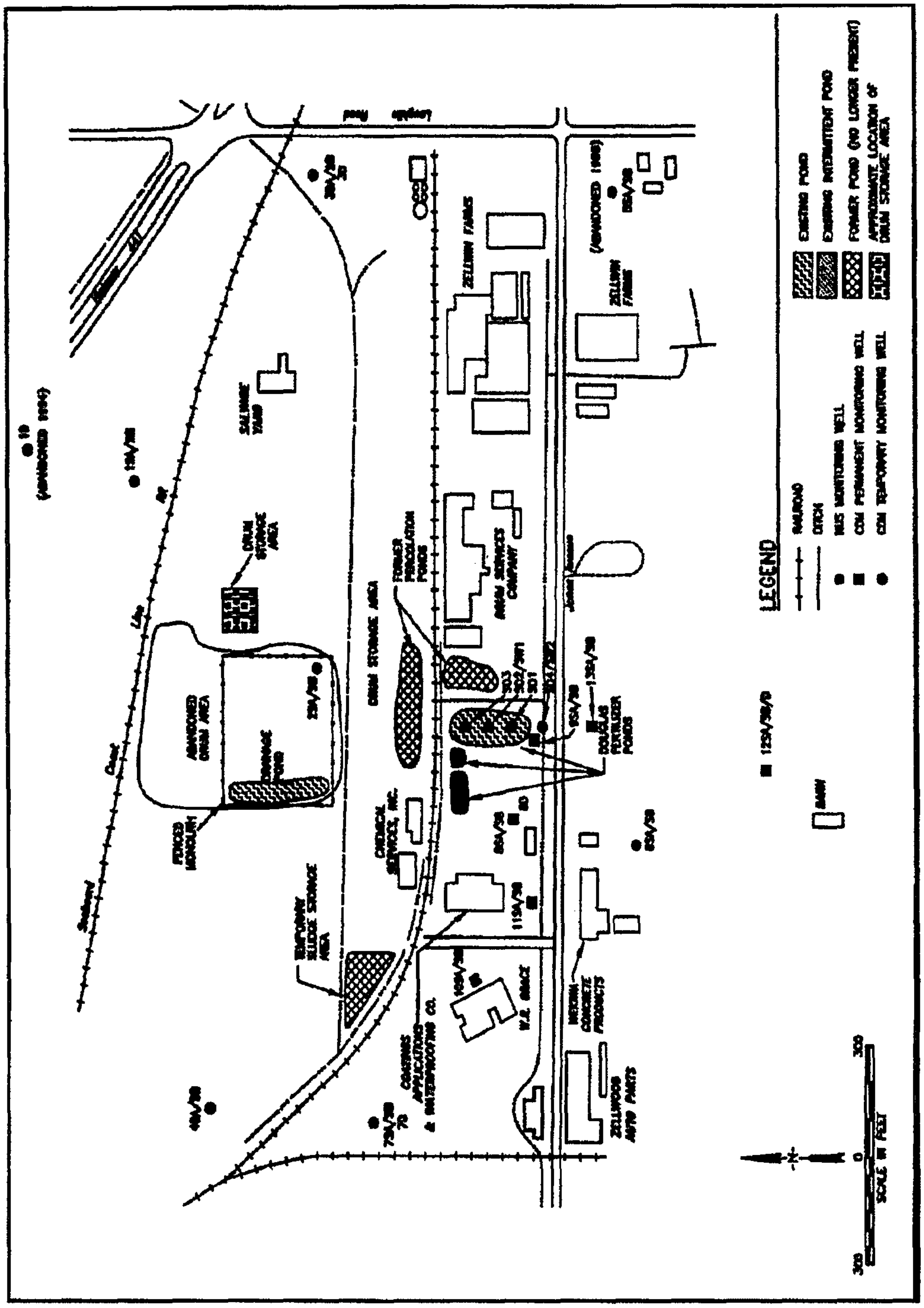
5.5.2 Ground Water Contamination

<u>SRI Activities</u>

A total of eleven new ground water monitoring wells were installed during the June and July 1999 investigation. These wells were installed in four well clusters consisting of two wells (8 wells total) and one well cluster consisting of three monitoring wells. The wells were placed in locations intended to characterize the nature and extent of contamination in ground water originating from the suspected source areas. Monitoring well locations are shown on **Figure 5-1.**

It was proposed in the work plan for the second SRI that a total of 14 new monitoring wells would be installed. The deep monitoring well (100-110 feet bgs) for well clusters #10, 11, 12, and 13 was eliminated when it was determined that these wells, screened deeper within the semi-confining unit (i.e., Hawthorn Formation) did not produce water. A zone of tight clay within the semi-confining unit was encountered during the installation of MW-12D at an approximate depth of 90 feet below ground surface (bgs). This zone consisted of a light greenish-gray to dark greenish-gray clay exhibiting a significantly reduced moisture content in relation to the sands and clays encountered in the upper zone of the semi-confining unit. It was decided that the deep well

FIGURE 5-1
MONITORING WELL AND SAMPLING LOCATIONS



(D) at each of the well clusters would be eliminated and only two wells would be installed at each of the remaining well clusters. The shallow well (SA) at each well cluster was installed to monitor the surficial aquifer which is characterized by interbedded layers of dark brown to brown very fine to fine-grained sand, clayey/silty sand and sandy clay/silt to a depth of around 45 feet. The intermediate well (SB) at each cluster location was installed to monitor the upper portion of the semi-confining unit which exhibited a distinctly different lithology than the surficial zone.

A total of 21 monitoring wells were sampled during the second SRI. Ground water samples were collected from existing well clusters #3, 6, 7, and 8 (10 wells) and the11 newly installed wells (well clusters #9, 10, 11, 12, and 13). The actual number of monitoring wells sampled (21) differs from the total listed in the SRI work plan. The work plan stated that 25 monitoring wells would be sampled. The deviation is the result of the elimination of the third well at well clusters #10, 11 and 13. The fourth well that was not sampled was MW-8D. MW-8D was not sampled because of an obstruction in the well at a depth of 106.5 feet below top of casing. Ground water samples were analyzed for TAL metals, cyanide, hexavalent chromium, nitrate/nitrite, total phosphorous, total kjeldahl nitrogen, total organic carbon, sulfate, chloride and ammonia.

A round of water level measurements were collected in July 1999, for all accessible wells. Well coordinates and top of casing (TOC) elevations were obtained by a surveying subcontractor licensed in the state of Florida, for the new and existing monitoring wells. Ground water flow in the surficial aquifer is generally to the southwest with a more westward component in the vicinity of well clusters 10 and 11. Regional ground water flow in the Floridan aquifer is to the northeast, but water level measurements from three Floridan wells at the Site indicate a southwest flow.

In October 1999, personnel from EPA collected ground water samples from MW-8SA, MW-10SA, and MW-11SA. These wells were selected for re-sampling because of elevated concentrations of metals and/or turbidity levels that were above the goal of 10 NTUs. Samples were analyzed for metals, hexavalent chromium and the sample from MW-11SA was also analyzed for volatile organic compounds due to the presence of a strong odor during the drilling and installation of MW-11SA in July 1999.

Metals / Nutrient Contamination

Sample results from the second SRI indicated the presence of a plume of contaminated ground water in the surficial aquifer, located to the southwest and west of the Douglas Fertilizer pond area. The principal contaminants are nutrients and heavy metals, which are consistent with contaminants of potential concern (COPCs) identified in previous investigations and are constituents related to past operations at the Site. The most frequently detected contaminants were ammonia, nitrate, manganese, and vanadium. **Table 5-1** lists the frequency of analytes detected and the range of detections as compared to background concentrations or the Ground Water Protection Standard (GWPS). The GWPS consists of either State of Florida or Federal primary and secondary maximium contaminant levels (MCLs). The GWPS were used as a screening tool to evaluate the concentrations of contaminants of potential concern.

In general, the highest concentrations for most of the contaminants were found in the shallow

TABLE 5-1
LIST OF ANALYTES EXCEEDING BACKGROUND OR THE GWPS IN GROUND WATER

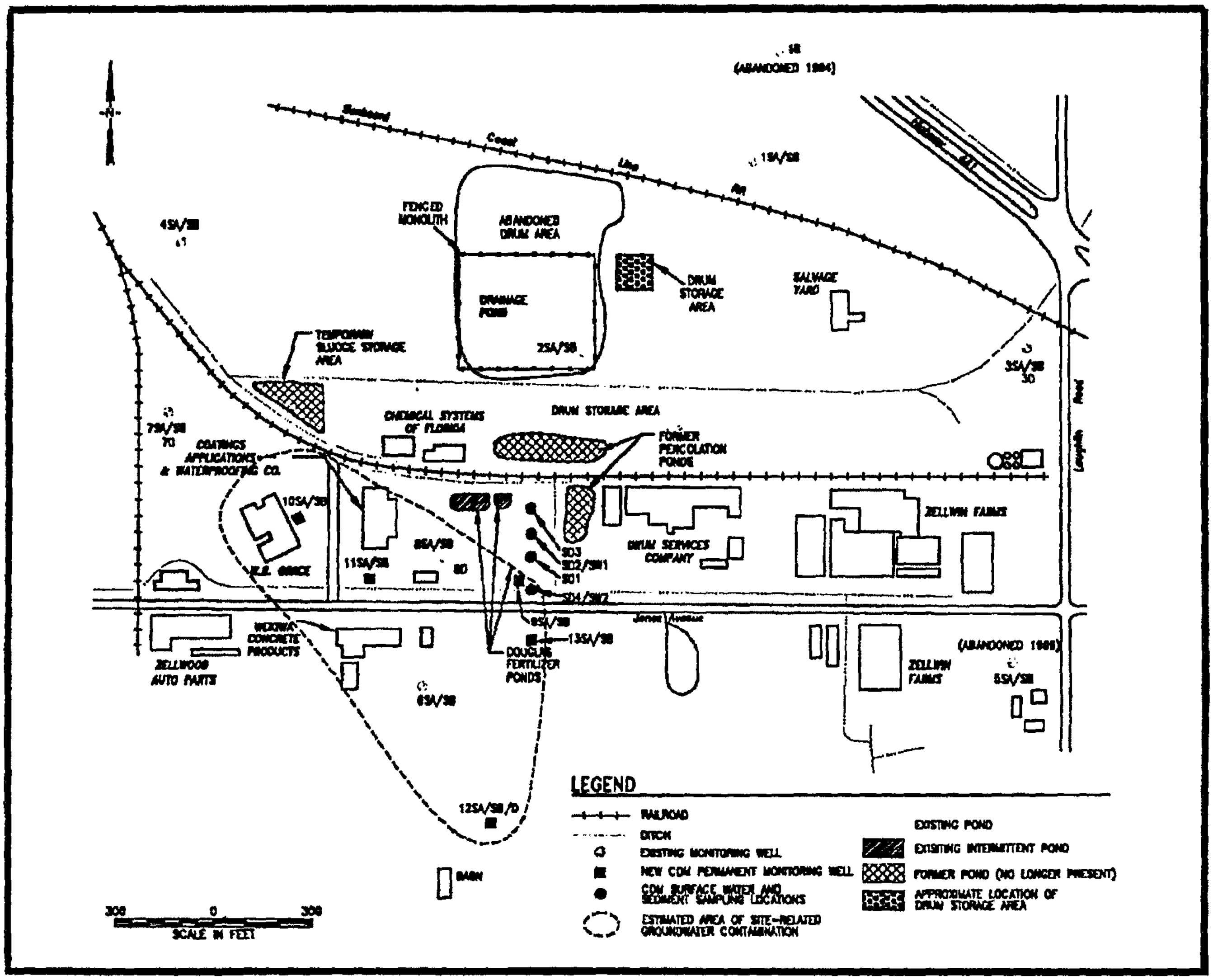
Analyte	GWPS (ug/L)	Background Concentration * (ug/L)	Detected Conc. or Range Above GWPS (ug/L)	No. of Exceedances of GWPS (out of 21 wells)	No. Exceedances of Background (Out of 21 wells)	Comments/ Observations
Aluminum	200*	5,021	8,000 to 27,000 J	—	2	Max. MW-10SA
Antimony	6	NA	60 J	1	—	MW-3D (Floridan) Note: Detection limit exceeds MCL for MW-3SA, MW-3SB, and MW-89SA.
Arsenic	50	1.8	92 and 170	2	—	Detect in MW-8SA and MW-11SA
Cadmium	5	NA	99	1	—	MW-11SB
Chromium	100	72.5	290	1	—	MW-11SA
Copper	1,000*	13.1	1,1000 J	1	—	MW-8SB
Iron	300*	1,163	420 to 6,500		1	Max. MW-10SA
Lead	15	6.8	63 and 220	2	—	Detect in MW-10SA and MW-11SA
Manganese	50*	34.3	56J to 1,000 J	8	—	Max. MW-11SA
Nickel	100	34	120 to 190	3	—	Detected in MW-6SB, 11SA and 11SB. Two highest conc. In MW-11SA and 11SB
Vanadium	49**	18	200 to 690	6	—	Max. MW-11SA
Ammonia	2,800**	1,348	5,000A to 640,000	10	—	Max. MW-11SA. Detected in well clusters 6, 8, 10, 11, and 12
Nitrate	10,000	NV	15,600Q to 167,000	7	—	Two highest concentrations in MW-11SA and 12SA
Chloride	250,000*	27,079	370,000 to 950,000	5	—	Detected in MW-10SB/11SA/11SB
Sulfate	250,000*	21,658	350,000 and 410,000	3	—	Detected in MW-6SB, MW-11SA, and MW-12SA
Calcium	None	9,659	24,000J to 260,000 J	—	11	Nutrient, Max. MW-12SA
Magnesium	None	9,078	1,400J to 32,000 J	—	2	Nutrient, Max. MW-12SA
Potassium	None	9,053	1,800 to 1,000,000 J	—	10	Nutrient, Max. MW-11SA
Selenium	50	5	50 and 360	2	—	MS-8SB and MW-11SA
Sodium	160,000	12,658	1,800 to 510,000 J	1	—	Nutrient, Max. MW-11SA
Thallium	2	ND	5.6 U	17	—	Detection Limit exceeds MCL = 2 µg/L
Total Kjeldahl Nitrogen	None	1,977	250 to 660,000	—	10	Max. MW-11SA
Total Mercury	2	0.2	3.9	1	—	MW-11SA
Total Organic Carbon	None	14,000	1,900 to 460,000 A	—	—	Max. MW-11SA
Total Phosphorus	None	146	20 to 140,000	—	7	Nutrient, Max. MW-8SB
Hexavalent Chromium	100	NV	6.8B to 37 B,G	3	—	Detection limits exceeds MCL for MW-6SA, MW-8SA, and MW-8SB.

Data Qualifiers: A – Average value J – Estimates value
B – Estimated result. Result is less than reporting limit. Q – Elevated reporting limit due to high analyte levels.
G – Elevated reporting limit. The reporting limit is elevated due to matrix interference. NV – No value

* Background concentration listed is the average concentration reported for monitoring wells (MW-1SA/SB, MW-1SA/SB, MW-1SA/SB, MW-2SA/SB, MW-3SA/SB, MW-4SA/SB, MW-5SA/SB, MW-7SA/SB, GWS1/I1, GWS2/I2, GWS3/I3, GWS4/I4, and GWS5/I5.

* Federal Secondary Drinking Water Standard (MCL). ** Florida Department of Environmental Protection Guidance Concentration.

FIGURE 5-2
ESTIMATED EXTENT OF GROUND WATER CONTAMINATION



monitoring wells from well clusters #10, #11, and #12. These well clusters are located in the south-central, central and western portions of the Site area. Based on the 1999 analytical data, the estimated extent of contaminated ground water in the shallow aquifer is shown in **Figure 5-2.** The highest concentrations of ammonia and nitrate were detected in the shallow wells in clusters #11 and 12 and in the intermediate well at cluster #6. The highest concentrations of metals, including manganese, vanadium, lead and nickel, were detected in well clusters # 10 and 11, and generally in the SA well. Another observation from the evaluation of the analytical data is the apparent lack of ground water contamination in the well clusters installed immediately adjacent to and south of the eastern Douglas Fertilizer pond (well clusters #9 and #13). With the exception of slightly elevated concentrations of nitrates and manganese in MW-9SA and MW-13SA, none of the other COPCs were detected at concentrations exceeding their GWPSs. The analytical data supports that contaminants are not leaching from the pond to the extent that the GWPSs are exceeded due to their releases. Based on these observations, it appears that ground water contamination is predominantly west/southwest of the Douglas Fertilizer pond area, and extends south of Jones Avenue toward well clusters #6 and #12.

As previously discussed, the shallow wells in cluster #8, 10 and 11 were re-sampled because of concerns about high turbidity samples. Turbidity was reduced below EPA's goal of 10 nephelometric turbidity units (NTUs) in MW-8SA. The analytical results of this sample showed a decrease in concentration of metals with exceedences of the GWPS for only manganese. Because concentrations of metals can be influenced by the presence of suspended sediment in a sample, the re-sampling result may be a more accurate representation of ground water quality in the shallow well at cluster #8. Turbidity was reduced in MW-11SA, but when the analytical results were compared to the previous sampling some concentrations of metals were higher while others were lower. Turbidity in MW-10SA was high in the re-sampling and the concentrations of metals reported from the re-sampling were generally higher than those from the previous sampling. The issue of turbidity in some of the wells is further complicated by the stained color of the ground water, likely resulting from tannic acid, observed in several sampling events. Turbidity measurements on ground water samples with this stained color could be high because the meter cannot differentiate between suspended sediment in the water and the stained color. Therefore, if the high turbidity is the result of the color of the water, the analytical results are accurate and do represent the quality of the ground water at that location and are not influenced by metals in sediment.

The issue of turbidity at this Site has been thoroughly investigated and conclusions are difficult to make regarding its affect on the metals concentrations reported in samples. However, there are metals concentrations above the GWPS present in wells with low turbid samples which indicate that contamination due to metals is a concern at the Site.

Volatile Organic Contamination

Volatile organic compounds (VOCs) have not been included as potential contaminants of concern at the Zellwood Site since Phase I of the 1993/1994 SRI. EPA decided that ground water samples would not be analyzed for VOCs at the conclusion of the Phase I SRI because they had been detected infrequently at low or trace concentrations during previous investigations. In October 1999, three volatile organic compounds were detected in the sample from MW-11SA;

vinyl chloride, 1,1-dichloroethane, and 1,1-dichloroethene were reported at concentrations of 18 µg/L, 680 µg/L, and 180 µg/L, respectively. The Federal maximum contaminant level (MCL) for 1,1-DCE is 7 µg/L and the MCL for vinyl chloride is 2 µg/L. There is no Federal or State of Florida MCL for 1,1-DCA. The concentrations in MW-11SA exceed their respective MCL for all three VOCs detected. The source of the VOCs detected in MW-1lSA is not believed to be any of the sources identified in previous remedial investigations at the Site. The source of this contamination is believed to be a recent release somewhere from the vicinity of the Hydraulic Services building or the Coatings Applications and Waterproofing Company. Since these contaminants are not related to the sources of contamination previously identified at the Zellwood Site, a separate investigation under EPA's Site Assessment Program will be conducted to determine if this contamination warrants action under CERCLA. The VOC contamination will not be addressed in the selected remedy discussed in this ROD.

Contaminant Migration and Persistence

Ground water flow in the surficial aquifer is generally to the south/southwest toward Lake Apopka; however, in the vicinity of the Coatings Applications and Waterproofing Company building, there appears to be a westward component. Assuming that the rate of contaminant migration is equivalent to the ground water flow rate (velocity), with a horizontal ground water velocity of 0.131 feet/day (detailed in the Addendum to the SRI report), the eastern boundary of the plume would be expected to be approximately 335 feet southwest of the pond. This estimate is conservative since it does not account for the contaminant retardation properties of the aquifer, dispersion, or the physical/chemical properties of the potential contaminants. Well cluster #11 is located approximately 600 feet southwest of the percolation ponds which would indicate that well cluster #11 is located more toward the center of the plume. This is supported by the significantly higher concentrations of contaminants reported in MW-11SA and MW-11SB relative to the surrounding well clusters.

The vertical hydraulic gradient at the site is downward. The percolation ponds, one of the suspected sources, were installed 29 years ago. If contaminants moved at the same rate as ground water does, they would have advanced downward approximately 45 feet. With the current data, EPA's working hypothesis is that the semi-confining unit which is composed of silts and clays is physically retarding vertical contaminant migration due to several conditions: (1) a low vertical hydraulic gradient, (2) increasing clay content with depth and the tendency for contaminants to sorb to clays, and (3) the unit is approximately 200 feet thick.

Persistence is the measure of how long a chemical will exist in the environment before it degrades or transforms into some other chemical. Metals, nitrate/nitrite, chloride and sulfate will persist indefinitely (for all practical purposes) as their half-lives in ground water are in the order of hundreds to thousands of years. Ammonia will degrade more quickly through nitrification. The half-life of this transformation process is on the order of months to years, but will produce the ionic nitrogen compounds nitrate and nitrite which persist longer as discussed above. Metals and other nutrients will undergo other processes which will reduce their concentrations in ground water. Sorption to soil particles and simple dilution are two processes likely to occur overtime at the Zellwood Site. **Table 5-2** presents a historical perspective of selected contaminant concentrations in monitoring wells at the Site. Concentrations of several constituents have demonstrated a decreasing trend since 1985 in several of the monitoring well clusters including # 6, 7, and 8. This trend is distinctive for aluminum, ammonia, iron, lead, and vanadium. Since the sources of this contamination were removed by EPA as a part of the cleanup action for operable unit 1, it is anticipated that the decreasing trend in contaminant concentrations will continue in the future.

TABLE 5-2
TRENDS IN HISTORICAL DATA FROM SELECTED MONITORING WELLS

Sample ID	Aluminum (µg/L)							Ammonia (µg/L)						
	1985	**1988**	**Nov 93**	**Mar 94**	**Apr 98**	**July 99**	**Oct. 99**	**1985**	**1988**	**Nov 93**	**Mar 94**	**Apr 98**	**July 99**	**Oct. 99**
MW03SA	3900	2700J	2100	580	–	360	–	120	–	ND	140	–	150	–
MW03SB	785	12000J	1100	ND	–	1300	–	ND	–	ND	ND	–	ND	–
MW03D	190	970J	150	59	–	260	–	ND	–	ND	140	–	ND	–
MW06SA	4800	6000J	9800	8800	–	8000	–	328000	–	200000	220000	–	63000	–
MW06SB	2400	22000J	2900	4500	505	570	–	300000J	–	370000	310000	190000	170000	–
MW07SA	13000	4900J	2200	2900	–	190	–	ND		ND	100	–	240	–
MW07SB	510	43000	710	580	–	42	–	11000		13000	12000	–	770A	–
MW07D	280	ND	300	100	–	ND	–	160		ND	610	–	180A	–
MW08SA	–	–	–	100000J	32000	3000	1200	–	–	–	114000	90000	19000	–
MW08SB	–	–	–	4200J	3300	4800	–	–	–	–	425000	120000	110000	–
MW08D	–	–	–	16000	560	–	–	–	–	–	220	240	–	–
GWPS	36500	36500	36500	36500	36500	36500	36500							

Sample ID	Arsenic (µg/L)							Cadmium (µg/L)						
	1985	**1988**	**Nov 93**	**Mar 94**	**Apr 98**	**July 99**	**Oct. 99**	**1985**	**1988**	**Nov 93**	**Mar 94**	**Apr 98**	**July 99**	**Oct. 99**
MW03SA	ND	ND	ND	ND	–	ND	–	ND	ND	–	–	–	ND	–
MW03SB	ND	ND	ND	ND	–	ND	–	ND	ND	–	–	–	ND	–
MW03D	ND	3	ND	ND	–	ND	–	ND	ND	–	–	–	ND	–
MW06SA	ND	17J	24J	16	–	34	–	ND	ND	–	–	–	ND	–
MW06SB	ND	ND	ND	ND	ND	ND	–	10	ND	–	–	ND	ND	
MW07SA	ND	ND	ND	ND	–	ND	–	ND	ND	–	–	–	ND	–
MW07SB	ND	ND	ND	ND	–	ND	–	ND	ND	–	–	–	ND	–
MW07D	ND	ND	ND	ND	–	ND	–	ND	ND	–	–	–	ND	–
MW08SA	–	–	–	898J	26	170	18	–	–	–	32	ND	ND	ND
MW08SB	–	–	–	77J	29	29	–	–	–	–	16	ND	ND	–
MW08D	–	–	–	ND	ND	–	–	–	–	–	ND	ND	–	–
GWPS	50							5						

TABLE 5-2 (continued)
TRENDS IN HISTORICAL DATA FROM SELECTED MONITORING WELLS

Sample ID	Chloride (µg/L)							Chromium III (µg/L)						
	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99
MW03SA	10000J	–	4800	3800	–	3900	–	17	ND	19	ND	–	ND	–
MW03SB	20000J	–	21000	20000	–	18000	–	13	1500J	630	8	–	10J	–
MW03D	6000J	–	7200	7100	–	7700	–	15	11J	9J	ND	–	ND	–
MW06SA	1150000	–	440000	950000	–	140000	–	92	120J	96	92	–	44	–
MW06SB	2500000	–	1200000	510000	–	510000	–	83	340J	110	31	7	28	–
MW07SA	ND	–	30000	28000	–	25000A	–	102	ND	52	32	–	1.9J	–
MW07SB	201000	–	140000	130000	–	76000	–	51	140J	46	32	–	ND	–
MW07D	10000J	–	6900	8700	–	14000	–	22	33J	17	ND	–	ND	–
MW08SA	–	–	–	650000	–	73000	–	–	–	–	270	86	11	8.9
MW08SB	–	–	–	584000	–	86000	–	–	–	–	48	54	39	–
MW08D	–	–	–	12000	–	–	–	–	–	–	9	41	–	–
GWPS	25000							100						

Sample ID	Chromium-Hex (µg/L)							Copper (µg/L)						
	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99
MW03SA	–	–	–	–	–	ND	–	ND	ND	ND	ND	–	ND	–
MW03SB	–	–	–	–	–	ND	–	ND	ND	5	ND	–	ND	–
MW03D	–	–	–	–	–	ND	–	ND	ND	ND	ND	–	ND	–
MW06SA	–	–	–	–	–	ND	–	–	–	250	290	–	150J	–
MW06SB	–	–	–	–	–	ND	–	–	–	160	ND	110	120J	–
MW07SA	–	–	–	–	–	ND	–	ND	ND	46	16	–	5.1J	–
MW07SB	–	–	–	–	–	ND	–	ND	150	19	16	–	17J	–
MW07D	–	–	–	–	–	ND	–	ND	ND	5J	ND	–	ND	–
MW08SA	–	–	–	–	–	ND	ND	–	–	–	1000J	190	200J	41
MW08SB	–	–	–	–	–	ND	–	–	–	–	540J	990	1100J	–
MW08D	–	–	–	–	–	–	–	–	–	–	ND	39	–	–
GWPS											1			

TABLE 5-2 (continued)
TRENDS IN HISTORICAL DATA FROM SELECTED MONITORING WELLS

	Iron (µg/L)							Lead (µg/L)						
Sample ID	**1985**	**1988**	**Nov 93**	**Mar 94**	**Apr 98**	**July 99**	**Oct. 99**	**1985**	**1988**	**Nov 93**	**Mar 94**	**Apr 98**	**July 99**	**Oct. 99**
MW03SA	860	1000J	440	ND	–	170	–	ND	5	7J	ND	–	ND	–
MW03SB	380	7500J	1100	ND	–	570	–	ND	12	4J	5J	–	ND	–
MW03D	190000	1700J	460	ND	–	21J	–	ND	14	4J	ND	–	ND	–
MW06SA	1100	910J	680	650	–	270	–	290	350	180J	7J	–	14	–
MW06SB	1600	2900J	1300	1200	ND	720	–	ND	13	11	ND	ND	ND	–
MW07SA	950	380J	180	ND	–	27J	–	440	110	17J	4	–	ND	–
MW07SB	410	4600	280	ND	–	52	–	ND	61J	17J	ND	–	ND	–
MW07D	370	ND	ND	ND	–	85	–	ND	20J	5J	4	–	ND	–
MW08SA	–	–	–	3800J	2100	510	190	–	–	–	41J	35	6.6	2.3J
MW08SB	–	–	–	6500	ND	440	–	–	–	–	6J	10	11	–
MW08D	–	–	–	–	540	–	–	–	–		7J	4	–	–
GWPS								15						

	Manganese (µg/L)							Mercury (µg/L)						
Sample ID	**1985**	**1988**	**Nov 93**	**Mar 94**	**Apr 98**	**July 99**	**Oct. 99**	**1985**	**1988**	**Nov 93**	**Mar 94**	**Apr 98**	**July 99**	**Oct. 99**
MW03SA	41	ND	ND	ND	–	ND	–	ND	ND	ND	ND	–	ND	–
MW03SB	33	510	96	34J	–	34	--	ND	ND	ND	ND	–	ND	–
MW03D	3.8	30	ND	ND	–	ND	–	ND	ND	ND	ND	–	ND	–
MW06SA	39	20	50	35J	–	56J	–	0.8J	0.6J	1.1	0.5	–	0.96	–
MW06SB	190	200	54	72J	26	39J	–	ND	ND	ND	ND	ND	ND	–
MW07SA	ND	7	ND	ND	–	10J	–	1J	1.1J	1.2	0.32J	–	ND	–
MW07SB	42	ND	19	16	–	8.6J	–	ND	0.9J	ND	ND	–	ND	–
MW07D	7.4	ND	ND	ND	–	ND	–	ND	ND	ND	ND	–	ND	–
MW08SA	–	–	–	1400J	990	460J	260	–	–	–	1.6	0.27	ND	ND
MW08SB	–	–	–	58J	140	150J	–	–	–	–	1.3	0.88	1.3	–
MW08D	–	–	–	90J	ND	–	–	–	–	–	ND	ND	–	–
GWPS	50													

TABLE 5-2 (continued)
TRENDS IN HISTORICAL DATA FROM SELECTED MONITORING WELLS

Sample ID	Nickel (µg/L)							N–N Nitrogen (µg/L)				Nitrate (µg/L)		
	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99
MW03SA	12	ND	ND	ND	–	ND	–	1700	–	160	100	–	330B	–
MW03SB	6.2	360	35	ND	–	ND	–	7000	–	8800	7900	–	–	–
MW03D	ND	ND	ND	ND	–	ND	–	ND	–	130	ND	–	ND	–
MW06SA	170	240	110	100	–	42	–	214000	–	52000	42000	–	1200	–
MW06SB	130	ND	130	130	89	140	–	205000	–	150000	140000	56000	40600Q	–
MW07SA	58	ND	18J	76	–	29J	–	2500	–	1100	5600	–	6500	–
MW07SB	30	ND	22	25	–	ND	–	23000	–	21000	21000	–	15600Q	–
MW07D	9	ND	ND	ND	–	ND	–	ND	–	ND	ND	–	ND	–
MW08SA	–	–	–	150	ND	12	ND	–	–	–	11000	3200	3800	–
MW08SB	–	–	–	101	ND	46	–	–	–	–	33000	14000	8100	–
MW08D	–	–	–	ND	ND	–	–	–	–	–	110	160	–	–
GWPS								10000						

Sample ID	Nitrite (µg/L)							Selenium (µg/L)						
	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99
MW03SA	–	–	–	–	–	ND	–	ND	ND	ND	ND	–	ND	–
MW03SB	–	–	–	–	–	ND	–	ND	ND	ND	ND	–	ND	–
MW03D	–	–	–	–	–	ND	–	ND	ND	ND	ND	–	ND	–
MW06SA	–	–	–	–	–	ND	–	ND	36J	140J	33	–	19	–
MW06SB	–	–	–	–	–	ND	–	ND	13J	38J	16	ND	20	–
MW07SA	–	–	–	–	–	ND	–	ND	9J	11	8	–	18	–
MW07SB	–	–	–	–	–	ND	–	ND	63J	ND	ND	–	ND	–
MW07D	–	–	–	–	–	ND	–	ND	ND	ND	ND	–	ND	–
MW08SA	–	–	–	576	–	ND	–	–	–	–	21J	ND	5.5	ND
MW08SB	–	–	–	ND	–	500	–	–	–	–	30J	57	50	–
MW08D	–	–	–	24	–	–	–	–	–	–	ND	ND	–	–
GWPS														

TABLE 5-2 (continued)
TRENDS IN HISTORICAL DATA FROM SELECTED MONITORING WELLS

Sample ID	Sulfate (µg/L)							Vanadium (µg/L)						
	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99	1985	1988	Nov 93	Mar 94	Apr 98	July 99	Oct. 99
MW03SA	200000J	–	9800	14000	–	12000	–	7	ND	5.3J	ND	–	ND	–
MW03SB	100000J	–	28000	29000	–	19000	–	15	ND	10	ND	–	ND	–
MW03D	ND	–	4700	2900	–	3000	–	ND	ND	ND	ND	–	ND	–
MW06SA	1000000J	–	190000	130000	–	85000	–	600	850	410	360	–	200	–
MW06SB	500000J	–	680000	500000	–	280000	–	29	ND	64	85	190	420	–
MW07SA	600000J	–	9000	19000	–	37000A	–	ND	ND	11	15	–	4.4J	–
MW07SB	24000	–	13000	11000	–	16000	–	15	120	20	13	–	16J	–
MW07D	7500	–	11000	8900	–	4500	–	ND	ND	ND	ND	–	ND	–
MW08SA	–	–	–	63000	–	98000	–	–	–	–	420J	190	56	24
MW08SB	–	–	–	195000	–	92000	–	–	–	–	2000J	210	240	–
MW08D	–	–	–	4300	–	–	–	–	–	–	ND	ND	–	–
GWPS	250000													

Data Qualifiers:

– = Not sampled.
ND = Not detected.
A = Average value.
B = Estimated result. Result is less than reporting limit.
G = Elevated reporting limit due to matrix interference.
J = Estimated value.
Q = Elevated reporting limit due to high analyte levels.

5.5.3 Sediment and Surface Water Contamination

Sediment and surface water samples were collected from the eastern most Douglas Fertilizer Pond and adjacent drainage ditch to determine if and to what extent the Pond was a continual source of ground water contamination. Surface water and sediment sampling locations are shown on **Figure 5-1**. Sediment samples were collected from the upper two feet of sediment at three locations within the easternmost Douglas Fertilizer Pond and one location in the adjacent drainage ditch located south of the pond. One surface water sample was collected from within the pond and one from the drainage ditch. Each surface water and sediment sample was analyzed for TAL metals, cyanide, hexavalent chromium, nitrate/nitrite, total phosphorus, total kjeldahl nitrogen, total organic carbon, sulfate, chloride, and ammonia.

<u>Surface Water</u>

The analytical results for contaminants detected in the surface water samples are presented in **Table 5-3**. Several nutrients and metals were detected in both the easternmost Douglas Fertilizer Pond and the ditch surface water samples. The analytical results for each of the three surface water samples (2 samples/1 duplicate) were compared to Federal and State of Florida water quality criteria to initially assess whether concentrations were elevated above levels expected in unaffected areas.

Four sources of surface water quality criteria were used to evaluate metals and nutrients detected in surface water samples collected in 1999; (1) Florida Department of Environmental Protection (FDEP) values for Class V–Industrial Use, (2) FDEP values for Class III–Predominantly Freshwater, (3) EPA Freshwater Criterion Maximum Concentration (CMC) and (4) EPA Recommended Freshwater CMC. Three metals (aluminum, beryllium, and copper) and ammonia exceeded at least one of the four criteria; however, none of the Florida DEP Industrial Use criteria were exceeded. Numerous detections of other inorganics and nutrients were found; however, the four surface water criterion used did not have criteria for these parameters. In general, constituents were typically detected at higher concentrations in the pond surface water compared to surface water from the ditch.

TABLE 5-3
CONTAMINANTS DETECTED IN SURFACE WATER

Contaminant	Concentrations (ug/L)		
	SW-01 Center	SW-02 Ditch	SW-52 (Dup)
Aluminum	1790	1030	1200
Ammonia	14900	2600	2600
Arsenic	5.2B	5.6B	3.1B
Barium	12.5	10.2	10.1
Beryllium	5U	1.5B	5U
Calcium	14400	14000	15400
Chloride	33800	27700	28100
Chromium	8.9B	7.1B	7.8B
Copper	14.5	6.1B	8.5B
Iron	530	586	574
Lead	6.3	3.6	4.7
Magnesium	14500	10500	11800
Manganese	1260	886	1000
Potassium	40700	38000	38200
Sodium	26700	30700	31100
Sulfate	27000	28700	29200
Total Kjeldahl Nitrogen	13700Q	16500Q	4300
Total Phosphorus	28700Q	17200Q	16500Q
Total Organic Carbon	39800	31600	33400
Vanadium	11	8.3B	8.8B
Zinc	59.7	20.9	24.5

Data Qualifiers:

B - Estimated result. Result is less than reporting limit.
Q - Elevated reporting limit due to high analyte levels.
U - Not detected, value is reporting limit.

Sediment

Sediment analytical data from the second SRI were evaluated to identify contaminants of potential concern in the sediment samples collected from the eastern Douglas Fertilizer Pond and the drainage ditch located immediately south of the pond. The analytical results for each sediment sample were compared to the remediation goals developed for the 1995 SRI/FFS Report. The remediation goals consist of background concentrations, practical quantitation limits, and concentrations developed for the protection of ground water based on the remediation goals for ground water. The remediation goals used for the 1995 SRI/FFS Report were selected for the preliminary evaluation of the sediment data because they provide a benchmark for comparison. **Table 5-4** provides the remediation goal for each analyte, the detected concentration or range for each analyte, the number of exceedances, and any relevant comments or observations.

TABLE 5-4
LIST OF ANALYTES EXCEEDING REMEDIATION GOALS IN SEDIMENT SAMPLES COLLECTED DURING THE SECOND SRI

Analyte	Remediation Goal (mg/kg)	Detected Concentration or Range Above Remediation Goal (mg/kg)	No. of Exeedances (4 locations total)	Comments/Observations
Aluminum	1,600	2,630	1	Detected in ZWSD04 (ditch)
Barium	1	1.1B to 4.2 (pond) 62.8 (ditch)	4	Max. in ditch sample ZWSD04
Cadmium	1.6	2.1	1	Detected in ZWSD04 (ditch)
Iron	230	248 and 5,351 (pond) 5,690 (ditch)	3	Max. in ditch sample ZWSD04
Manganese	2.5	40.2 to 246	4	Max. in ditch sample ZWSD04
Vanadium	1	1.2B and 7.1	2	Max. in ditch sample ZWSD04
Ammonia	3	23.7 to 63.5	4	Max. in pond sample ZWSD03
Nitrate	1	3.8 and 4.3	2	Max. in ditch sample ZWSD04
Nitrate	1	2.2	1	Detected in pond sample ZWSD03
Sulfate	12	13.4 to 33.4 (pond) 96.2 (ditch)	4	Max. in ditch sample ZWSD04
Chloride	12	24.1 to 29.1 (pond) 43.6 (ditch)	4	Max. in ditch sample ZWSD04 approximately 2 times concentration in pond samples

Barium, manganese, ammonia, chloride, and sulfate were the most frequently detected analytes in the sediment samples collected during the second SRI. The analytes were detected at concentrations exceeding their remediation goal in all four of the sediment samples. Iron, vanadium, and nitrates were also reported at concentrations exceeding their remediation goals in at least two of the four samples. Aluminum and cadmium were detected in the sample from the drainage ditch (ZWSD04) located on the south end of the pond.

Several analytes that do not have a remediation goal were detected in the sediment samples. These analytes include calcium, cobalt, magnesium, potassium, phosphorus, total kjeldahl nitrogen, and total organic carbon. With the exception of ammonia and nitrate, the reported concentrations (for all analytes) in the ditch sample are several orders of magnitude higher than any of the pond samples from the eastern most Douglas Fertilizer Pond. Since the ditch is connected to the pond by the culvert and eventually drains to the primary drainage ditch that runs parallel to Jones Avenue, there is the potential that contaminants have been transported and deposited in the primary drainage ditch during storm events or periods of heavy flow.

Contaminants detected in the sediment samples collected during the SRI were suspected of potentially acting as a continuous, although decreasing, source of ground water contamination as the contaminants desorb from the sediment particles into the ground water. Concentrations of contaminants in the Pond have decreased significantly since the last sampling conducted in February 1994. **Table 5-5** presents a comparison of sediment data collected in 1994 and 1999 from similar locations in the Pond. This data indicates that the sediments in the eastern most Douglas Fertilizer Pond may no longer be a significant source of ground water contamination. In support of this conclusion is the fact that ground water contaminant concentrations in monitoring well cluster #9 are significantly lower than those in other down- and cross-gradient well clusters at the Site. The concentration of nitrate in well 9SA is 16,000 ug/l. This exceeds the MCL of 10,000 ug/l, but is relatively low compared to nitrate levels in wells 11SA, 6SB and 12SA, located further down gradient of the Pond. Also, monitoring well 13SA, down gradient of well cluster 9, contains nitrate at 16,000 ug/l. If the Pond is currently a significant source of ground water contamination, concentrations of contaminants, including nitrate, should be higher closer to the source. The current data indicates that this is not the case. Contaminant concentrations actually increase with distance from the Pond. Therefore, it appears that the eastern Douglas Fertilizer Pond sediment is not currently a significant source of the ground water contamination.

TABLE 5-5
HISTORICAL COMPARISON OF CONTAMINANTS DETECTED IN SEDIMENTS
EASTERN MOST DOUGLAS FERTILIZER POND

Chemical	SD-01 South 2/94	SD-02 North 2/94	SD-01 South 7/99	SD-02 North 7/99	SD-03 Center 7/99
Aluminum	24000	22000	288	234J	101J
Ammonia	2600	1400	36.6	63.5	57.5
Arsenic	16	13	0.31B	1.3U	1.3U
Barium	270	410	3.7	4.2	1.1B
Cadmium	16	30	0.13B	0.36B	0.10B
Chloride	310	160	29.1	24.1	27.4
Chromium	390	210	2.4	1.8	0.84B
Copper	5100	4900	47.8	53.6	40.4
Iron	52000	40000	248	351	133
Lead	600	460	7.5	4.6	2.4
Manganese	19000	17000	56.1	161	58.8
Mercury	3.0	3.1	0.032UJ	0.019B	0.012UJ
Vanadium	60	34	1.2B	1.0B	0.42B

Units are mg/kg
Data Qualifiers:
J - Estimated Value
B - Estimated Result. Result is less than reporting limit.
U - Analyzed for but not detected

6.0 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

The Zellwood Ground Water Contamination Site is located on property currently occupied by industrial and commercial businesses. The surrounding area to the south and west is industrial and agricultural. There is an auto salvage yard located immediately to the north and northeast of the Site. Further to the north is a residential neighborhood. To the east of the Site is an agricultural facility.

EPA consulted with the Zoning Division of the Orange County Growth Management & Environmental Resources Department to confirm the future intended use for the Site and surrounding area. The properties that make up the official Superfund Site are all zoned industrial. Areas to the south and southwest of the Site, which have been or may be impacted by contaminated ground water, are zoned industrial, agricultural or have been purchased by the St. Johns River Water Management District (SJRWMD). SJRWMD is purchasing land south and southwest of the Site to be used in conjunction with the Lake Apopka restoration project.

Ground water is used in the day to day operations of the industrial and commercial businesses located on the Site. Bottled water or potable water from other sources is consumed by workers. No report of human consumption of Site ground water has been discovered through numerous inquiries by EPA. Most of the surrounding businesses have ground water wells, installed at various depths, but these are not used as drinking water sources. General water quality in the area is poor and bottled water is used for drinking purposes.

The surficial aquifer is currently classified as Class II (potential source of drinking water) by EPA and as Class G-II (potable water use) by the Florida Department of Environmental Protection (FDEP). Therefore, consideration of this aquifer as a future drinking water source is required. However, future residential development of the areas impacted by contamination is not anticipated since most of this land is being purchased by the St. Johns River Water Management District.

7.0 SUMMARY OF SITE RISKS

CERCLA directs EPA to conduct a baseline risk assessment to determine whether a Superfund Site poses a current or potential threat to human health and the environment in the absence of any remedial action. The baseline risk assessment provides the basis for taking action and indicates the exposure pathways that need to be addressed by the remedial action. EPA conducted a Baseline Risk Assessment for Human Health (BRA-HH) for the Zellwood Groundwater Contamination Site, based on data collected as a part of the second SRI. An Environmental Risk Assessment (ERA) was completed as a part of the 1995 SRI report. A second ERA was not completed based on the 1999 data, however, EPA screened and evaluated the data from an ecological perspective.

The conceptual site model that is developed in the risk assessment, considers the potential for human exposure to contaminants in ground water and surface water. At this Site, contaminants are thought to have migrated, through infiltration and percolation, from source areas into the ground water. The conceptual site model addresses potential exposure to both site visitors and future residents.

7.1 Contaminants of Concern

The chemicals measured in the various environmental media during the SRI were included in this discussion of the site risks if the results of the risk assessment indicated that a contaminant might pose a significant current or future risk or contribute to a cumulative risk which is significant. The criteria for a significant risk was a carcinogenic risk level above EPA's acceptable risk range, i.e., $1x10^{-4}$ to $1x10^{-6}$, or a hazard quotient (HQ) greater than 1.0 (unity).

Contaminants of Concern were selected for ground water because the carcinogenic risk range and/or the HQ of 1.0 was exceeded given the exposure scenario. There were no COCs selected for surface water or soils at the Site because EPA's acceptable human health risk was not exceeded. **Table 7-1** presents the COCs for ground water, and includes the frequency of detection and range of detection for these contaminants.

TABLE 7-1
CONTAMINANTS OF CONCERN IN GROUND WATER

Contaminant	Frequency of Detections	Range of Concentrations Detected (ug/l)
Aluminum	17/21	42 - 27,000
Ammonia	18/21	80 - 640,000
Arsenic	6/21	4.8 - 100
Cadmium	4/21	1.6 - 99
Chromium	11/21	1.9 - 340
Iron	19/21	1.5 - 6,500
Lead	7/21	2.3 - 220
Manganese	18/21	8.6 - 1,000
Mercury	4/21	0.25 - 2.9
Nickel	11/21	3.5 - 190
Nitrate	12/21	880 - 167,000
Nitrite	1/21	500
Selenium	7/21	9.5 - 400
Vanadium	16/21	2.7 - 630

7.2 Exposure Assessment

An exposure assessment identifies pathways whereby receptors may be exposed to site contaminants and estimates the frequency, duration, and magnitude of such exposures.

Whether a chemical is actually a concern to human health and the environment depends upon the likelihood of exposure, i.e. whether the exposure pathway is currently complete or could be complete in the future. A complete exposure pathway (a sequence of events leading to contact with a chemical) is defined by the following four elements:

- A source and mechanism of release from the source,
- A transport medium (e.g., ground water, surface water, air) and mechanisms of migration through the medium,
- The presence or potential presence of a receptor at the exposure point, and
- A route of exposure (ingestion, inhalation, dermal absorption).

An analysis was conducted of all current and/or future potentially complete exposure pathways. The current pathways represent exposure pathways which could exist under current Site conditions while the future pathways represent exposure pathways which could exist, in the future, if the current exposure conditions change. The only current potential exposure pathway identified was exposure to surface water by a site visitor. Future exposure pathways evaluated included exposure to contaminated ground water by a future resident and exposure to surface water by a future visitor. **Table 7-2** lists the exposure pathways that were evaluated in the BRA-HH.

TABLE 7-2
POTENTIAL EXPOSURE PATHWAYS

Media	Scenario	Receptor	Exposure Pathways
Ground Water	Future	Resident, Adult & Child	Ingestion of GW & Inhalation of Ammonia While Showering
Surface Water	Current, Future	Teenage Trespasser / Visitor	Incidental Ingestion & Dermal Contact

The RME concentrations for ground water were determined according to EPA Region 4 guidance. Generally, the arithmetic averages of the concentrations of COPCs found in the center of the contaminant plume are used as the RME concentrations. EPA used the lower of the 95% UCL of the average or the maximum detected value for the Exposure Point Concentration because the center of the contaminant plume could not be adequately determined. Tables 3.1RME and 3.2RME in Appendix B present the RME point concentrations.

Reasonable maximum exposure (RME) point concentrations for surface water were calculated according to EPA Region 4 guidance using the lesser of the 95% upper confidence limit (UCL) on the arithmetic average for a lognormal distribution or the maximum detected value. Where a COPC was not detected at a given location, one-half the sample quantitation limit (SQL) was used as a proxy concentration; however, if either the proxy concentration or the UCL exceeded the maximum detected value, the maximum detected value was used as the RME concentration.

Human intakes were calculated for each chemical and receptor using the RME concentrations. Estimates of human intake, expressed in term of mass of chemical per unit body weight per time (mg/kg-day), were calculated differently depending on whether the COPC is a non-carcinogen or a carcinogen. For non-carcinogens, intake was averaged over the duration of exposure and is referred to as the average daily dose (ADD). For carcinogens, intake was averaged over the average life span of a person (70 years) and is referred to as the lifetime average daily dose (LADD). ADDs and LADDs were calculated using standard assumptions and professional judgment. The assumptions that were used in calculating intakes are presented in standard format in Tables 4.1RME through 43RME in Appendix B.

As a measure of conservatism and to avoid redundancy, an effort was made to identify the most sensitive receptor to calculate non-cancer hazards and excess cancer risk levels. In the case of non-carcinogens, a child resident is the most sensitive receptor, owing to its lower body mass relative to the amount of chemical intake. For carcinogens, a lifetime resident (child through adult), is the most sensitive receptor because the excess cancer risk for the child (exposure duration of six years) is assumed to be additive to that of an adult (exposure duration of 24 years). For this reason, no calculations of excess cancer risk are included for child residents and no calculations of non-cancer hazards are included for lifetime residents.

7.3 Toxicity Assessment

Toxicity values are used in conjunction with the results of the exposure assessment to characterize site risk. EPA has developed critical toxicity values for carcinogens and noncarcinogens. Cancer slope factors (CSFs) have been developed for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CSFs, which are expressed in units of $(mg/kg/day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg/day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term “upper bound” reflects the conservative estimate of the risks calculated from the CSF. Use of this conservative approach makes underestimation of the actual cancer risk highly unlikely. CSFs are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting non-carcinogenic effects. RfDs, which are expressed in units of mg/kg/day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse non-carcinogenic effects to occur.

The RfDs and CSFs used in this assessment were obtained from EPA's Integrated Risk Information System (IRIS) database, Health Effects Assessment Summary Tables (HEAST) and the National Center for Environmental Assessment. Since neither a RfD or CSF is available for lead, blood lead concentrations were used to measure exposure to lead. Since children are the most vulnerable to lead toxicity, the integrated exposure uptake biokinetic model (IEUBK) was used to assess chronic, non-carcinogenic exposures of children to lead. When the model indicates that the detected concentrations are acceptable to the most vulnerable group (children) then it is not necessary to address adult exposure. Non-cancer toxicity data and cancer toxicity data is presented in Tables 5.1, 5.2, 6.1, and 6.2 in Appendix B.

7.4 Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual's likelihood of developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

Risk = CDI x SF

where:

Risk = a unitless probability (e.g., 2 x 10^{-5}) of an individual's developing cancer
CDI = chronic daily intake averaged over 70 years (mg/kgday)
SF = slope factor, expressed as (mg/kgday).

These risks are probabilities that usually are expressed in scientific notation (e.g., 1 x10^{-6}). An excess lifetime cancer risk of 1x10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site related exposure. This is referred to as an "excess lifetime cancer risk", because it would be in addition to the risk of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site related exposures is 1 x 10^{-4}, to 1 x 10^{-6}.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. A RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. Conversely, A HI > 1 indicates that site related exposures may present a risk to human health.

The HQ is calculated as follows:
Noncancer HQ = CDI/RfD

where:
CDI = chronic daily intake
RfD = reference dose.

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, sub-chronic, or short- term).

The Site risk characterization results showed unacceptable risks (i.e., upper-bound excess lifetime cancer risks exceeding the upper limit of EPA's target risk range) were associated with potential future residential exposures to contaminated ground water. The total incremental lifetime cancer risk estimate for lifetime residents is 1×10^{-3}. This estimate is above EPA's target range for Superfund Sites. Exposure to arsenic accounts for the excess cancer risk. Arsenic is classified as a Group A, Known Human Carcinogen. The BRA-HH evaluated risk related to exposure to volatile organic compounds, however, since these contaminants are not being addressed by this remedy, the risks associated with these contaminants are not presented here. **Table 7-3** presents a summary of the carcinogenic risk. Table 7.3 in Appendix B presents a more detailed analysis of the carcinogenic risk.

TABLE 7-3
SUMMARY OF CANCER RISKS

Receptor	Pathway	Carcinogenic Risk
Future Resident	Ingestion of ground water Arsenic	$1x10^{-3}$
	TOTAL:	$1x10^{-3}$

The Site risk characterization results indicated that non-carcinogenic effects are possible (hazard indices greater than one) from potential future residential exposure to contaminated ground water. Non-cancer effects are possible based on a HI of 1,476. Exposure to ammonia via inhalation of vapors while showering (HQ equal to 1,432) accounts for the majority of potential non-cancer hazard. Ingestion exposure to aluminum, arsenic, cadmium, chromium, iron, manganese, mercury, selenium, vanadium and nitrates results in HQs greater than or equal to one as well. **Table 7-4** presents a summary of non-carcinogenic risk. Table 7.2 in Appendix B presents a more detailed analysis of the non-carcinogenic risks.

TABLE 7-4
SUMMARY OF NON-CANCER RISKS

Receptor	Pathway	Non-Carcinogenic Hazard
Future Resident	Ingestion of ground water:	
	Aluminum	2.0
	Arsenic	10.0
	Cadmium	5.0
	Chromium	7.0
	Copper	2.0
	Iron	1.0
	Manganese	1.0
	Selenium	2.0
	Mercury	1.0
	Nitrate	7.0
	Vanadium	6.0
	Inhalation of Vapors While Showering:	
	Ammonia	1,432
	TOTAL:	1,476

Lead was detected in the ground water at concentrations ranging from 2 to 160 µg/L; the 95% UCL of the average concentration was 100 µg/L. This value was input into version 0.99d of EPA’s IEUBK model. Default lead concentrations were used for the remaining parameters. The probability density histogram from the model is provided in Appendix B. To determine whether or not the ground water concentration is acceptable, less than 5% of the exposed population must be below a blood lead level of 10 µg lead per deciliter. The projected blood lead levels for more than half the population are above this threshold indicating that lead concentrations are above the acceptable range.

Uncertainty analysis identifies those factors which may underestimate or overestimate the potential risk calculated for a site. Several sources of uncertainty were encountered in this risk assessment. The ground water data used in this risk assessment could contribute to the uncertainty of the overall assessment. The presumption that contaminant concentrations will remain the same over time may overestimate the potential risk. Also, collection of ground water samples that are turbid may lead to erroneous data results. The problem occurs because naturally occurring metals contained in the suspended sediment are extracted from the sediment as part of the chemical analysis. Metal concentrations reported in a sample under these conditions may not reflect the concentrations of the metal dissolved in water and may overstate risk. The relevance of this uncertainty factor is questionable at the Site because some of the high turbidity is related to the "stained" color of the ground water caused by tannic acid, and not related to the presence of suspended sediment in the sample. In these samples, the concentrations of metals reported are believed to represent the metals dissolved in the ground water. The unknowns associated with the concentrations of contaminants in ground water may also underestimate the risk. If higher concentrations of contaminants are present in the ground water, but have not been discovered, then the risk may be underestimated.

The current and future exposure scenarios considered also contribute to the uncertainty of the risk assessment. The assumptions used in the exposure assessment may result in a potential conservative estimate of risk. RfDs and CSFs are determined with varying degrees of uncertainty and are generally conservative, resulting in the possible overestimation of risks.

7.5 Environmental Risk

An Environmental Risk Assessment (ERA) was not completed as a part of the 1999 second SRI. However, an ERA was completed in 1995 to evaluate the potential for adverse biological effects associated with the discharge of contaminated ground water to surface water bodies. This document, included in the 1995 SRI/FFS report, is included in the Administrative Record. The ERA concluded, based on ground water flow analysis, that contamination of surface water bodies as a result of ground water discharge is not a concern. Data gathered in 1995 did indicate that contamination was present in the eastern most Douglas Fertilizer Pond. The environmental impacts associated with this pond were evaluated as part of the ERA. This evaluation concluded that adverse effects to aquatic organisms and benthic organisms in this pond may have occurred due to the presence of contaminants in water and sediment. However, based on the physical and biological characteristics of the pond, the ERA concluded that it offered limited habitat for aquatic organisms.

EPA evaluated the 1999 surface water and sediment data from the eastern most Douglas Fertilizer Pond to further determine if environmental concerns warranted a remedial action. Contaminant concentrations were compared to data collected in 1994 and to ecological screening values. This evaluation concluded that although some concentrations of contaminants exceeded screening values, no remediation of the Pond was warranted. EPA's ecological screening of the 1999 sediment and surface water data is included in the Administrative Record.

7.5.1 Surface Water Evaluation

In 1999, one surface water sample was collected from the eastern most Douglas Fertilizer Pond, and one sample (with a duplicate) was collected from the ditch adjacent to the Pond. Previously, in 1994, one surface water sample (with a duplicate) was collected from the same fertilizer pond. **Table 7-5** compares concentrations detected in the Pond in 1999 to those detected in 1994 for those surface water contaminants of ecological concern identified in the 1995 Ecological Risk Assessment.

TABLE 7-5
HISTORICAL COMPARISON OF SURFACE WATER CONTAMINANTS OF ECOLOGICAL CONCERN

Contaminant of Ecological Concern (from 1995 SRI)	1994 Concentration* (ug/L)	1999 Concentration (ug/L)
Aluminum	950	1790
Ammonia	550	14900
Barium	20UJ	12.5
Chromium	12	8.9B
Iron	530	530
Lead	4	6.3
Manganese	1100	1260
TKN	2600	13700Q
Total Phosphorus	13000J	28700Q
Vanadium	11J	11
Zinc	180	59.7

* - Value represents the greater of two samples.
B- Estimated result. Result is less than reporting limit.
Q- Elevated reporting limit due to high analyte levels.
U -Not detected, value is reporting limit.

Generally, concentrations of metals have remained the same since 1994. Other inorganics such as ammonia and phosphorus have increased in concentration since 1994. Based on EPA's physical and biological evaluation of the Pond in 1995 and the more recent ecological screening of contaminants in 2000, EPA concluded that surface water did not pose a significant ecological problem which would warrant a remedial action.

7.5.2 Sediment Evaluation

Three sediment samples were collected from the easternmost Douglas Fertilizer Pond in 1999. Previously, in 1994, two sediment samples were collected from the same pond in similar locations. **Table 7-6** presents a comparison of historical concentrations for sediment contaminants of ecological concern, as identified in the 1995 ecological risk assessment. Concentrations of contaminants in sediments from the Pond have decreased significantly since 1994. Based on this decreasing trend in concentrations and the most recent ecological screening of the sediment data, EPA concluded that the Pond sediments do not pose a significant risk to environmental receptors and therefore the Pond does not warrant a remedial action.

TABLE 7-6
HISTORICAL COMPARISON OF SEDIMENT CONTAMINANTS OF ECOLOGICAL CONCERN

Contaminant of Ecological Concern (from 1995 SRI)	SD-01 South 2/94	SD-02 North 2/94	SD-01 South 7/99	SD-02 Center 7/99	SD-03 North 7/99
Aluminum	24000	22000	288	101J	234J
Ammonia	2600	1400	36.6	57.5	63.5
Arsenic	16	13	0.31B	1.3U	1.3U
Barium	270	410	3.7	1.1B	4.2
Cadmium	16	30	0.13B	0.10B	0.36B
Chromium	390	210	2.4	0.84B	1.8
Cobalt	28	15	0.31B	1.3U	0.26B
Copper	5100	4900	47.8	40.4	53.6
Iron	52000	40000	248	133	351
Lead	600	460	7.5	2.4	4.6
Manganese	19000	17000	56.1	58.8	161
Mercury	3.0	3.1	0.032UJ	0.012UJ	0.019B
TKN	18000	5300	374	148J	326J
Total Phosphorus	140000	70000	47.4	116	158Q
Vanadium	60	34	1.2B	0.42B	1.0B
Zinc	13000	13000	46.8	44.8	119

Units are mg/kg
Data Qualifiers:
J - Estimated Value
B - Estimated Result. Result is less than reporting limit.
U - Analyzed for but not detected.
Q- Elevated reporting limit due to high analyte levels.

8.0 REMEDIAL ACTION OBJECTIVES

The remedial alternatives considered for operable unit 2 at the Zellwood Groundwater Contamination Site are based on Remedial Action Objectives (RAOs). RAOs provide a general description for what the selected cleanup alternative will accomplish. The RAOs for this operable unit are:

- To prevent human exposure to ground water containing contaminants of concern in excess of the remediation goals and;

- To restore ground water in the surficial aquifer to remedial goals within a reasonable time frame.

The remedial action objectives are based on the risk posed by future human use of or contact with contaminated surficial ground water. Human exposure to contaminated ground water could occur if areas impacted by the site were developed into residential areas. The RAOs specified for operable unit 2 will eliminate the risk posed by contaminants by limiting ground water use in the area. **Table 8-1** lists the contaminant specific Remedial Goals for the ground water at the Site.

TABLE 8-1
SUMMARY OF REMEDIAL GOALS FOR GROUND WATER

Contaminant of Concern	Remediation Goal (Fg/L)	Basis
Aluminum	15,600	RGO @ HQ = 1
Ammonia	1,340	RGO @ HQ = 3
Arsenic	50	Florida MCL) Primary Standard
Cadmium	5	Florida MCL) Primary Standard
Chromium (total)	100	Florida MCL) Primary Standard
Iron	4,700	RGO @ HQ = 1
Lead	15	Florida MCL) Primary Standard
Manganese	375	RGO @ HQ = 1
Mercury	2	Florida MCL) Primary Standard
Nickel	100	Florida MCL) Primary Standard
Nitrate	10,000	Florida MCL) Primary Standard
Nitrite	1,00	Florida MCL) Primary Standard
Selenium	50	Florida MCL) Primary Standard
Vanadium	110	RGO @ HQ = 1

Note:
MCL - Maximum Contaminant Level
RGO - Remedial Goal Option

9.0 DESCRIPTION OF ALTERNATIVES

The purpose of this section is to briefly summarize the remedial alternatives developed for ground water, operable unit 2.

9.1 Alternative 1: No Action

The no action alternative was developed as required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the regulation implementing the Superfund law. It is used as a baseline for comparing other alternatives. Under this alternative, EPA would take no action to remedy any contaminated media at the Site. The potential risks associated with the contamination would not be minimized by this action.

- Estimated construction costs: $ 0
- Estimated O&M costs: $ 0
- Total present worth cost: $ 0

9.2 Alternative 2: Ground Water Extraction, Treatment Using Chemical Precipitation, Air Stripping, and Biological Reaction, and Surface Water Discharge

Alternative 2 consists of the following components:

- Institutional controls;
- Ground water monitoring of the surficial aquifer;
- Ground water recovery via extraction wells;
- Ground water treatment using some or all of the following processes: equalization, precipitation/flocculation/sedimentation, filtration, air stripping, biological reaction, and/or carbon adsorption; and
- Discharge to an onsite infiltration gallery or surface water via onsite canal.

Figure 9-1 illustrates the treatment system proposed for this alternative. The processes proposed in this alternative would be required to reduce aluminum, ammonia, arsenic, cadmium, chloride, iron, lead, manganese, mercury, nitrate/nitrite, and vanadium prior to surface water discharge. Waste by-products generated as a result of treatment would have to be disposed of in either a solid waste landfill or a RCRA-permitted landfill depending on TCLP analytical results.

A National Pollutant Discharge Elimination System (NPDES) permit would be required to discharge treated ground water to a surface water body. Special consideration during design would be necessary to ensure that chloride levels did not exceed surface water quality standards. Surface water discharge requirements are provided in **Table 9-1**.

A ground water monitoring program would be necessary to ensure that the ground water treatment system is effective and that contaminants do not migrate. While this alternative would likely achieve the remediation goals for the mobile inorganic contaminants of concern at the Site which have relatively high remediation goals (i.e., ammonia, nitrate, and nitrite) within 10 years, it is likely that a much longer time would be required to achieve the remediation goals for the heavy metals in the ground water. However, pumping would expedite the remediation time frame as compared to natural attenuation.

Institutional controls are included as a component of this remedial alternative. The objectives of institutional controls are to prevent prolonged exposure to contaminants , control future development, and prevent the installation of wells within the contaminant plume boundary.

This alternative was originally evaluated in the 1995 FFS. It included a component for excavation and offsite disposal of sediments from the eastern most Douglas Fertilizer Pond. This component has been removed from Alternative 2 because EPA concluded in the 1999 SRI that the Pond did not warrant a remedial action (see Sections 5.5 and 7.5).

The costs associated with Alternative 2 are:

- Estimated construction costs: $ 1,188,700
- Estimated O&M costs: $ 3,980,900
- Total present worth cost: $ 5,169,600

FIGURE 9-1
PROCESS DIAGRAM FOR ALTERNATIVE 2

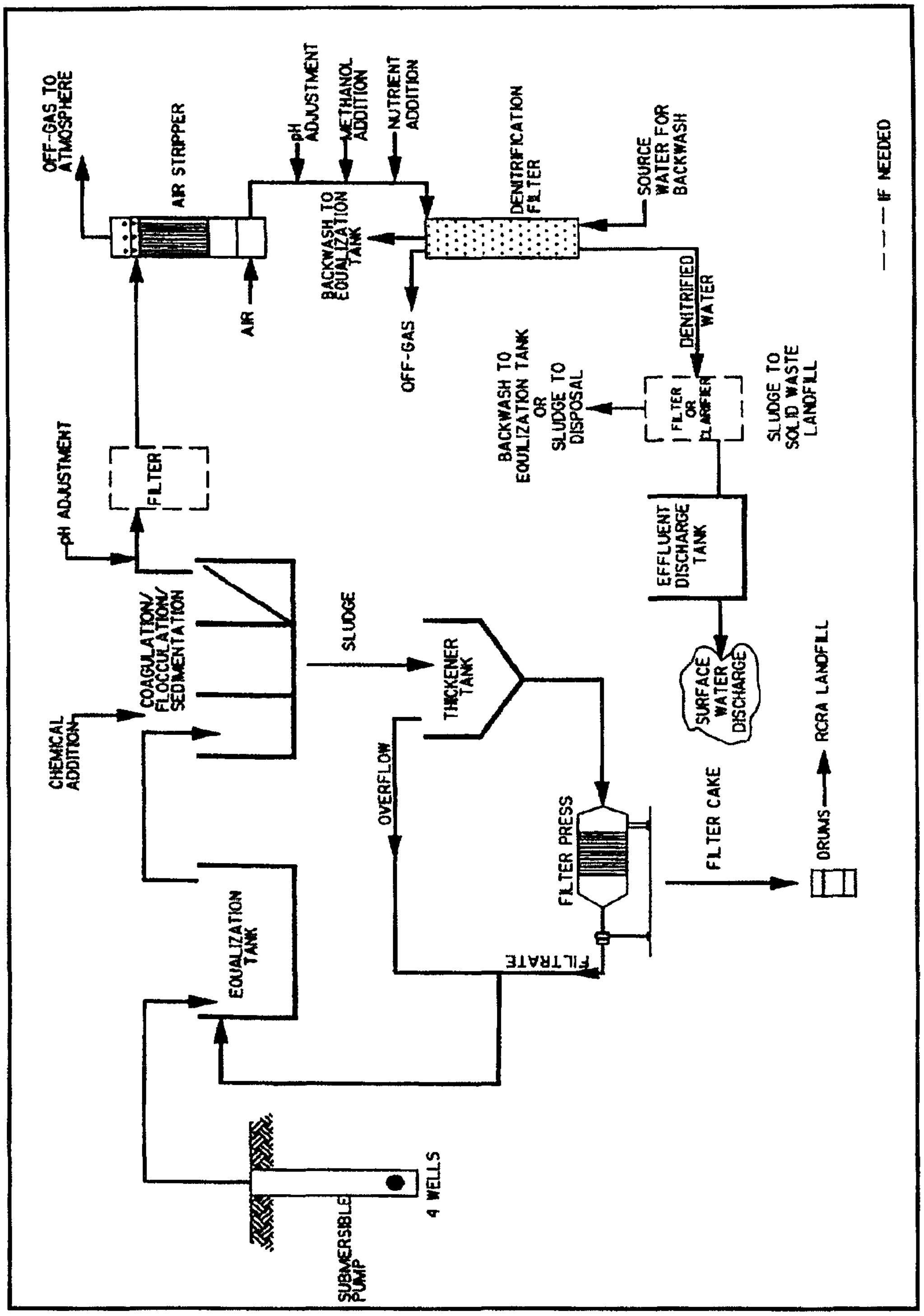


TABLE 9-1
SURFACE WATER DISCHARGE STANDARDS

Contaminant of Concern	Discharge Level (ug/L)
Aluminum	130[(a)]
Ammonia (un-ionized)	20
Arsenic	50
Barium	2,000[(b)]
Cadmium	$e^{(0.7852[1nH]-3.49)}$ (c)
Chloride	250,000
Chromium III	$e^{(0.819[1nH]+1.561)}$ (c)
Copper	$e^{(0.845[1nH]-1.465)}$ (c)
Cyanide	5.2
Iron	1,000
Lead	15
Manganese	50[(b)]
Mercury	0.012
Nickel	$e^{(0.846[1nH]+1.645)}$ (c)
Nitrate	10,000
Nitrite	1,000[b]
Selenium	5
Sulfate	250,000[(b)]
Vanadium	49[(b)]

<u>Note</u>:

Values taken from the Criteria for Surface Water Quality Classification table in florida Statute 17-302.530, F.A.C. for Class III, Predominantly Fresh Water.

[(a)] Background concentration found in the Northwest Pond during the 1986 RI. No standard given for fresh waters.

[(b)] Florida Maximum Contaminant Level for drinking water. No standard given for fresh waters.

[(c)] "1n H" means the natural logarithm of total hardness expressed as mg/L of $CaCO_3$.

9.3 Alternative 3: Ground Water Extraction, Treatment Using Chemical Precipitation, Reverse Osmosis, and Surface Water Discharge

Alternative 3 consists of the following components:

- Institutional controls;
- Ground water monitoring of the surficial aquifer;
- Ground water recovery via extraction wells,
- Ground water treatment using some or all of the following processes: equalization, precipitation/flocculation/sedimentation, filtration, and/or reverse osmosis and
- Discharge to an onsite infiltration gallery or surface water via onsite canal.

Figure 9-2 illustrates the treatment system proposed for this alternative. The processes proposed in this alternative would be required to reduce aluminum, ammonia, arsenic, cadmium, chloride, iron, lead, manganese, mercury, nitrate/nitrite, and vanadium prior to surface water discharge. Waste by-products generated as a result of treatment would have to be disposed of in either a solid waste landfill or a RCRA-permitted landfill depending on TCLP analytical results.

A National Pollutant Discharge Elimination system (NPDES) permit would be required to discharge treated ground water to a surface water body. Special consideration would not be necessary for chloride removal during design, in this alternative, because reverse osmosis would remove chlorides. Surface water discharge requirements are provided in **Table 9-1**.

A ground water monitoring program would be necessary to ensure that the ground water treatment system is effective and that contaminants do not migrate. While this alternative would likely achieve the remediation goals for the mobile inorganic contaminants of concern at the Site which have relatively high remediation goals (i.e., ammonia, nitrate and nitrite,) within 10 years, it is likely that a much longer time would be required to achieve the remediation goals for the heavy metals in the ground water. However, pumping would expedite the remediation time frame as compared to natural attenuation.

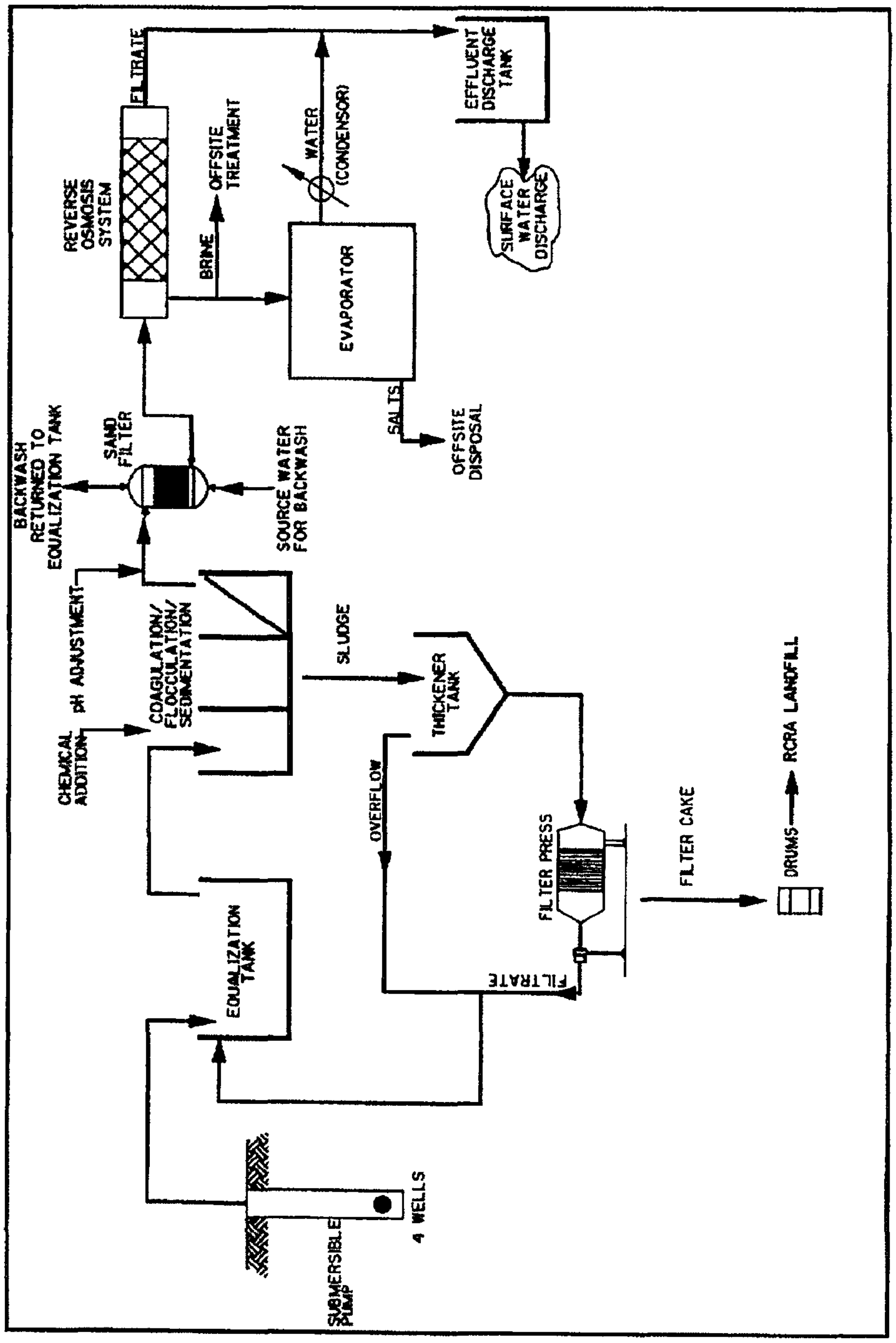
Institutional controls are included as a component of this remedial alternative. The objectives of institutional controls are to prevent prolonged exposure to contaminant concentrations, control future development, and prevent the installation of wells within the contaminant plume boundary.

This alternative was originally evaluated in the 1995 FFS. It included a component for excavation and offsite disposal of sediments from the eastern most Douglas Fertilizer Pond. This component has been removed from Alternative 2 because EPA concluded in the 1999 SRI that the Pond did not warrant a remedial action (see Sections 5.5 and 7.5).

The costs associated with Alternative 3 are:

- Estimated construction costs: $ 2,285,100
- Estimated O&M costs: $ 6,761,000
- Total present worth cost: $ 9,046,100

FIGURE 9-2
PROCESS DIAGRAM FOR ALTERNATIVE 3



9.4 Alternative 4: Monitored Natural Attenuation With Institutional Controls

Alternative 4 consists of the following components:

- Institutional controls;
- Natural attenuation of ground water contaminants,
- Installation of new, permanent monitoring wells; and
- Development of a performance monitoring plan to monitor and evaluate the effectiveness of the natural attenuation remedy.

Alternative 4 would serve as a monitored natural attenuation remedy that would reduce contaminant concentrations through natural processes. The alternative is not considered a “no action” alternative because it does not leave the contaminant plumE as is. In addition to using natural processes to reduce contaminant concentrations, the alternative employs institutional controls to prevent prolonged exposure to contaminated ground water until remedial goals are met. In addition, monitoring well installation, an extensive amount of sampling, and data evaluation to assess the remedy’s effectiveness, are also key components of this alternative.

Natural Attenuation makes use of natural processes to reduce the concentration and amount of pollutants at a site. Natural attenuation processes are often categorized as destructive or non-destructive. Destructive processes destroy the contaminant while non-destructive processes cause a reduction in contaminant concentrations. Monitored natural attenuation may effectively reduce the dissolved concentrations and/or toxic forms of inorganic contaminants in ground water. Metals may be attenuated by sorption reactions such as precipitation, adsorption on the surfaces of soil minerals, absorption into the matrix of soil minerals, or partitioning into organic matter. Oxidation-reduction reactions can transform the valence states of some inorganic contaminants to less soluble and thus less mobile forms and/or to less toxic forms (e.g., hexavalent chromiurn to trivalent chromium). Performance monitoring is a critical component of this remediation approach because monitoring is needed to ensure that the remedy is protective and that natural processes are reducing contamination levels as expected.

In addition to performance monitoring, Alternative 4 also would involve implementation of institutional measures to control, limit, and monitor activities onsite. The objectives of institutional controls are to prevent prolonged exposure to contaminant concentrations, control future development, and prevent the installation of wells within the contaminated plume boundary. The enforcement of institutional controls during the attenuation process is key to the remedy remaining protective of human health and the environment.

This remedy also requires that additional permanent monitoring wells be placed at the edge and within the ground water contamination plume. These wells, along with the existing wells, should be sampled frequently and have hydraulic head data collected to ensure that natural attenuation is occurring.

The costs associated with Alternative 2 are:

- Estimated construction costs: $101,900

- Estimated O&M costs: $1,179,100
- Total present worth cost: $1,281,000

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The alternatives are evaluated against one another by using the following nine criteria:

- Overall protection of human health and the environment.
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs).
- Long term effectiveness and permanence.
- Reduction of toxicity, mobility, or volume through treatment.
- Short term effectiveness.
- Implementability.
- Costs.
- State Acceptance.
- Community Acceptance.

The NCP categorized the nine criteria into three groups:

(1) Threshold criteria: the first two criteria, overall protection of human health and the environment and compliance with ARARs (or invoking a waiver), are the minimum criteria that must be met in order for an alternative to be eligible for selection

(2) Primary balancing criteria: the next five criteria are considered primary balancing criteria and are used to weigh major trade-offs among alternative cleanup methods

(3) Modifying criteria: state and community acceptance are modifying criteria that are formally taken into account after public comment is received on the proposed plan. Community acceptance is addressed in the responsiveness summary of the ROD.

10.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

With the exception of the no-action alternative (Alternative 1), all of the alternatives are protective of human health and the environment by eliminating, reducing or controlling risks posed by contaminated ground water at the Site. Alternative 4 would reduce the level of risk through institutional controls designed to prevent or reduce exposure to contaminated ground water. The natural attenuation component of this remedy would, over time, reduce contaminant concentrations to levels protective of human health and the environment. Similarly to Alternative 4, Alternatives 2 and 3 would reduce the level of risk through institutional controls. Alternatives 2 and 3 would also remove contamination from the ground water via extraction and treatment. Alternatives 2 and 3 also have the potential to provide more protection of human health and the environment as compared to Alternative 4, by controlling further migration of the ground water plume. Alternative 3, however, would be more protective than Alternative 2, because Alternative 2 could potentially have chloride exceedances in the surface water discharge that might adversely impact the environment. Since Alternative 1 did not pass this threshold criteria for providing protection of human health and the environment, it was eliminated from further consideration.

10.2 Compliance With ARARs

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA section 121 (d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site address problems or situations sufficiently similar to those encountered at the Site and that their use is well suited to the particular site.

To-Be-Considered Criteria (TBCs) are non-promulgated advisories and guidance that are not legally binding, but should be considered in determining the necessary level of cleanup for protection of human health or the environment. While TBCs do not have the status of ARARS, EPA's approach to determining if a remedial action is protective of human health and the environment involves consideration of TBCs along with ARARs.

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely on the basis of location. Examples of location-specific ARARs include state and federal requirements to protect floodplains, critical habitats, and wetlands, and solid and hazardous waste facility siting criteria.

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Since there are usually several alternative actions for any remedial site, various requirements can be ARARs.

Chemical- specific ARARs are specific numerical quantity restrictions on individually-listed contaminants in specific media. Examples of chemical-specific ARARs include the MCLs specified under the Safe Drinking Water Act as well as the ambient water quality criteria that are enumerated under the Clean Water Act. Because there are usually numerous contaminants of potential concern for any remedial site, various numerical quantity requirements can be ARARs.

All of the remaining alternatives (2, 3 and 4) have ARARs associated with drinking water standards for the protection of ground water. Additionally, Alternatives 2 and 3 would have to meet air quality and emissions standards since these alternatives involve construction of an onsite treatment system These two alternatives must also comply with effluent discharge requirements and ambient water quality criteria. Location-specific ARARs apply to Alternatives 2 and 3 to ensure that the extraction wells and treatment system are sited in an area that is protective of wetlands and outside the 100-year flood plain.

Alternative 2, 3 and 4 may effectively achieve chemical-specific ARARs relating to ground water quality, Through institutional controls, these alternatives would all limit exposure to ground water exceeding ARARs (i.e. MCLs) until such time as MCLs are attained. Alternatives 2 and 3 should meet all effluent discharge requirements with the possible exception of chloride in Alternative 2.

10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Alternatives 2, 3 and 4 are all effective and permanent remedies, but will take varying durations to achieve contaminant specific remedial goals in ground water. Alternatives 2 and 3 actively address ground water contamination (i.e., through pumping and treating ground water), where as, Alternative 4 passively addresses ground water contamination (i.e., through natural attenuation). Health risks associated with consumption of contaminated ground water would be reduced through the use of institutional controls with all three of these alternatives. Alternatives 2 and 3 may reduce ground water contamination to cleanup levels more quickly than Alternative 4.

Reviews at least every five years, as required, would be necessary to evaluate the effectiveness of any of these alternatives for as long as hazardous substances remain in the ground water above MCLs or health-based levels.

10.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of the remedy.

Alternative 4 relies on natural attenuation rather than treatment to restore ground water to remedial goals. Alternatives 2 and 3 would provide comparable reductions in the toxicity, mobility, and volume of ground-water contamination at the Site. Alternatives 2 and 3 would hasten reduction in toxicity, mobility and volume as compared to Alternative 4.

10.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community and the environment during construction and operation of the remedy until cleanup levels are achieved.

All of the alternatives would require workers to use Level D protective equipment during implementation of the remedies.

Alternative 2 and 3 would both require significant time for design and construction of a ground water extraction and treatment system. No exposure of construction workers or the surrounding community to site contamination is anticipated, however improper handling of chemical additives for the treatment system could result in injury. The treatment system and the operation of drilling equipment could produce additional noise or nuisance problems.

10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other government entities are also considered.

The necessary equipment and materials are commercially available for implementation of all of the alternatives. Alternative 2 and 3 would require six to nine months for design and contractor selection and another six to nine months for construction. A number of engineering considerations would be required in the development of the ground water extraction, treatment and discharge design.. Pilot-scale studies and a NPDES permit would be required. Alternatives 2 and 3 utilize technology that is well established but requires operator attention on a daily basis. Alternative 3 requires a great deal of energy to operate.

Alternative 4 is the easiest to implement because it involves only the establishment of institutional controls, installation of several new monitoring wells and the development of a performance monitoring plan. This alternative could be implemented in several months.

10.7 Cost

A summary of the present worth costs which includes the construction cost as well as the annual operation and maintenance cost for each of the alternatives is presented in **Table 10-1**. Alternative 3 is the most expensive alternative. Alternative 2 is less expensive than Alternative 3. Alternative 4 is the least expensive option.

TABLE 10-1
COMPARISON OF COST

Alternative	Total Present Worth Cost	Total Construction Cost	Total Operation and Maintenance Cost
1. No Action	$0	$0	$0
2. Ground Water Extraction, Treatment Using Chemical Precipitation, Air Stripping, and Biological Reaction, and Surface Water Discharge	$ 5,169,600	$ 1,188,700	$ 3,980,900[ab]
3. Ground Water Extraction, Treatment Using Chemical Precipitation, Reverse Osmosis, and Surface Water Discharge	$ 9,046.100	$ 2,285,100	$ 6,761,000[ab]
4. Monitored Natural Attenuation with Institutional Controls	$ 1,281,000	$ 101,900	$ 1,179,100[b]

a - Alternatives 2 and 3 assume 30 year operation period for the treatment system.
b - Alternatives 2, 3 and 4 assume 2 years of quarterly, 3 years of semi-annual and 25 years of annual ground water monitoring.

10.8 State Acceptance

The State of Florida, as represented by the Florida Department of Environmental Protection (FDEP), has been the support agency during the second Supplemental Remedial Investigation and Focused Feasibility Study (SRI/FFS) process for the Zellwood Groundwater Contamination Site. In accordance with 40 C.F.R. § 300.430, FDEP as the support agency, has provided input during this process by reviewing major documents in the Administrative Record. FDEP has recognized that Alternative 4 may be a viable option for cleanup of the Site, but has expressed several concerns about the applicability of natural attenuation at the Site. At this time FDEP does not concur with the selected remedy.

10.9 Community Acceptance

EPA held a public meeting to discuss the proposed remedy on June 1, 2000. During the public comment period, several local residents expressed their support for Alternative 4. EPA received comments from one of the Potentially Responsible Parties (PRPs) expressing concern about the details involved with Alternative 4. The St. Johns River Water Management District also notified EPA of concerns relating to the proposed remedy and its relationship to their property located near the Site. Specific responses to issues raised by the community can be found in Appendix A, The Responsiveness Summary.

11.0 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430(a)(1)(iii)(A)). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contaminants to ground water, surface water or air, or acts as a source for direct exposure. Contaminated ground water generally is not considered to be a source material.

There is no principal waste threat remaining at the Zellwood Groundwater Contamination Site. The remedial action is being selected to address residual ground water contamination from the Site.

12.0 SUMMARY OF SELECTED REMEDY

12.1 Rationale for the Selected Remedy

Based upon consideration of the requirements of CERCLA, the NCP, the detailed analysis of alternatives and public and state comments, EPA has selected Alternative 4: Monitored Natural Attenuation With Institutional Controls. This remedy is selected because it is protective of human health and the environment and complies with all ARARs. It represents the best balance among tradeoffs with respect to the Primary Balancing Criteria. This remedy will reduce risk and prevent exposure to contaminated ground water through institutional controls. Natural processes will decrease contaminant concentrations over time, and these concentrations can be monitored and evaluated periodically to ensure that the remedy remains protective. Implementation of Alternative 4 requires installation of new monitoring wells, developing a performance monitoring plan and also establishing new, and maintaining existing institutional controls. This remedy is easily implementable because it builds upon an existing monitoring well network. Alternative 4 is also selected because it is significantly cheaper than the ground water extraction and treatment alternatives. Operation of a ground water extraction and treatment system is not guaranteed to achieve remedial goals in an efficient manner and would not provide a significantly greater degree of protectiveness of human health and the environment. Monitored Natural Attenuation With Institutional Controls is the most appropriate remedy because it is protective of human health and the environment and it allows EPA to monitor and evaluate the contaminant plume to continually verify the remedy's effectiveness. This remedy is the most cost effective option given the specific site characteristics. The present worth cost of this remedy is $ 1,281,000.

12.2 Description of the Selected Remedy

12.2.1 Institutional Controls

Institutional Controls are Administrative and/or legal means that minimize potential exposure to contamination by limiting land or resource use. Institutional controls would be used as the principal tool for preventing human exposure to contaminated ground water at and down gradient of the Zellwood Groundwater Contamination Site. Maintenance of institutional controls is an essential component of the selected remedy and is necessary to prevent future risk resulting from consumption of contaminated ground water. **Table 12-1** presents the institutional controls that will be used as a part of the selected remedy.

TABLE 12-1
INSTITUTIONAL CONTROLS

Control	Area of Emphasis	Governing Institution	Status
Zoning Regulations	Site and down gradient properties	Orange County Growth Management & Environmental Resources Department	Current
Ground Water Use Advisory Zone	Site and down gradient properties	EPA Region IV	Future

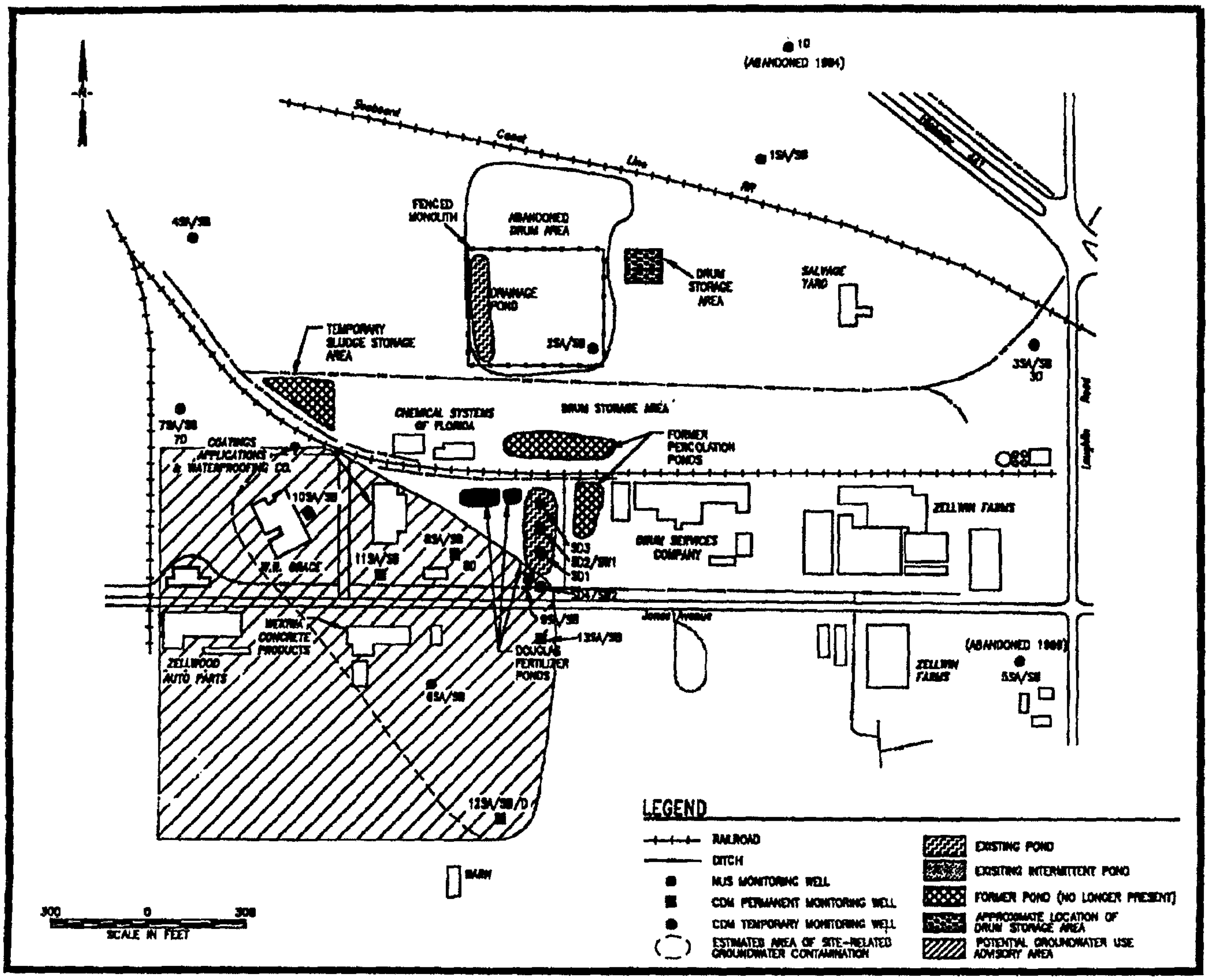
Several controls are in place or can be implemented which will achieve EPA's goal of protecting human health and the environment. Existing zoning regulations on the Site property and surrounding properties have restricted use to agricultural and industrial uses (Orange County Growth Management & Environmental Resources Department). This will restrict residential development and prevent exposure to ground water contamination. A ground water use advisory zone will be established in the areas impacted by the ground water contamination. A notice will be sent to the property owners in this area. This notice will inform the property owners as to the nature of contamination present in the surficial aquifer beneath their property and advise them of the potential risks associated with drinking such ground water. **Figure 12-2** depicts the estimated ground water advisory area.

12.2.2 Natural Attenuation

Natural Attenuation makes use of natural processes to reduce the concentration and amount of pollutants at a site. Natural attenuation processes are often categorized as destructive or nondestructive. Destructive processes destroy the contaminant while non-destructive processes cause a reduction in contaminant concentrations. Monitored natural attenuation may effectively reduce the dissolved concentrations and/or toxic forms of inorganic contaminants in ground water. Metals may be attenuated by sorption reactions such as precipitation, adsorption on the surfaces of soil minerals, absorption into the matrix of soil minerals, or partitioning into organic matter. Oxidation-reduction reactions can transform the valence states of some inorganic contaminants to less soluble and thus less mobile forms and/or to less toxic forms (e.g., hexavalent chromium to trivalent chromium). Performance monitoring is a critical component of this remediation approach because monitoring is needed to ensure that the remedy is protective and that natural processes are reducing contamination levels as expected.

FIGURE 12-2

ESTIMATED GROUNDWATER USE ADVISORY AREA



12.2.3 Performance Monitoring

Performance monitoring for this remedy will consist of supplementing the existing monitoring well network with new, permanent monitoring wells, the development of a performance monitoring and data evaluation plan, and the periodic sampling of new and existing monitoring wells within and around the contaminant plume.

New monitoring wells will be installed around and within the contaminant plume boundary in areas which will provide the most beneficial concentration and hydraulic head data for evaluating the progress of natural attenuation processes. For cost estimating purposes, seven new monitoring wells were assumed to be required. Included in this estimate were both a shallow and intermediate surficial aquifer well at three locations and a deeper Floridan aquifer well at one location. The specific number and locations of new monitoring wells will be specified in the post-ROD monitoring plan. These wells should be installed at various depths in the surficial aquifer in order to evaluate the changes in contaminant concentrations vertically. Also, a strategy for continued monitoring of the Floridan aquifer should be developed. In addition, monitoring well 8D, which was not sampled in 1999 due to an obstruction, should be repaired or replaced.

A network of wells, consisting of a combination of both newly installed and existing monitoring wells, should be selected for the performance monitoring. The network of wells selected for the performance monitoring plan should include wells located within and at the edge of the plume boundary. A sufficient number of wells should be monitored so that a comprehensive evaluation of the changing characteristics of the plume can be completed periodically. Ground water samples should be analyzed for parameters listed as contaminants of concern along with any indicator parameters deemed appropriate for attenuation of metals and nutrients. The performance standards for the contaminants of concern are shown in **Table 12-2**. Analysis of hydraulic head data will be compiled and evaluated along with concentration data in order to track plume movement and fate.

The frequency of sampling should initially provide a baseline data set, indicating the relationship between contaminant concentrations and seasonal fluctuations in ground water levels. Upon establishing these relationships, a less frequent sampling schedule for ground water will be initiated. Ground water monitoring will continue until clean up goals are met or until asymptotic concentrations are observed. At this point, a re-evaluation of the effectiveness of the monitored natural attenuation remedy will be made.

TABLE 12-2
PERFORMANCE STANDARDS

Media: Ground water
Site Area: Site and areas impacted by ground water plume
Available use: Future industrial/commercial
Controls to Ensure restricted Use: Ground water use advisory, zoning

Chemicals of Concern	Cleanup Level (ug/L)	Basis for Cleanup Level	Risk at Cleanup Level
Aluminum	15,600	Risk Assessment	HQ = 1
Ammonia	1,340	Risk Assessment	HQ = 3
Arsenic	50	Florida MCL	N/A
Cadmium	5	Florida MCL	N/A
Iron	4,700	Risk Assessment	HQ = 1
Lead	15	Florida MCL	N/A
Manganese	375	Risk Assessment	HQ = 1
Mercury	2	Florida MCL	N/A
Nickel	100	Florida MCL	N/A
Nitrate	10,000	Florida MCL	N/A
Nitrite	1,000	Florida MCL	N/A
Selenium	50	Florida MCL	N/A
Vanadium	110	Risk Assessment	HQ = 1

1. Cleanup levels and residual risk information presented in this table are based on the risk associated with exposure to ground water through ingestion and inhalation while showering by future residents.

12.3 Summary of Estimated Remedy Costs

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the post-ROD sampling. Major changes may be documented in the form of a memorandum to the Administrative Record file, an ESD or a ROD Amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost. The total present worth cost of Alternative 4 is $ 1,281,000.

Table 12-3 lists the estimated present worth cost of the selected remedy and **Table 12-4** presents a more detailed analysis of the operation and maintenance component. All of the assumptions made, including the number of new monitoring wells, the number of wells included in the performance monitoring plan and the frequency of sampling, are estimates based on the current data available at the Site. Actual costs to successfully implement this remedy may be different based on new data or if the number and frequency of wells sampled is reduced due to decreasing contaminant concentrations.

TABLE 12-3
SUMMARY OF PRESENT WORTH COST

ALTERNATIVE 4 (GROUNDWATER) — Monitored Natural Attenuation With Institutional Controls				
Site Name: Zellwood **Site Location: Florida**		**PRESENT WORTH COST** **Discount Rate: 7%**		
Item Description	**Units**	**Quantity**	**Unit Price Dollars**	**Total Cost Dollars**
ADDITIONAL DATA COLLECTION				
Pump Test (Existing Wells)	Lump Sum	1	$25,000.00	$25,000
Determine Extent of GW Contamination	Lump Sum	1	$25,000.00	$25,000
Installation of Additional Monitor Wells	Well	7	$5,700.00	$39,900
Subtotal — Capital Cost				$89,900
Engineering & Administrative (3% of Capital cost)				$2,697
Subtotal				$92,597
Contingency (10% of Subtotal)				$9,260
TOTAL CONSTRUCTION COST				$101,857
PRESENT WORTH O&M COST				$1,179,099
TOTAL PRESENT WORTH COST				$1,280,956

TABLE 12-4
SUMMARY OF OPERATION AND MAINTENANCE COSTS

Alternative 4 (Groundwater) — Monitored Natural Attenuation With Institutional Controls Site Name: Zellwood Site Location: Florida				**OPERATION & MAINTENANCE COSTS Discount Rate: 7%**		
Item Description	**Units**	**Quantity**	**Unit Price Dollars**	**Total Annual Cost (Dollars)**	**Operation Time (Years)**	**Present Worth**
QUARTERLY GROUNDWATER MONITORING						
Personnel (2-man crew @ 5 12-hour days)	Hours	480	$50	$24,000	2	$43,392
Supplies/Travel	Days	28	$3,000	$84,000	2	$151,874
Groundwater Sampling and Lab Testing	Sample	80	$500	$40,000	2	$72,321
Report Preparation	Lump sum	4	$5,000	$20,000	2	$36,160
SEMIANNUAL GROUNDWATER MONITORING						
Personnel (2-man crew @ 5 12-hour days)	Hours	240	$50	$12,000	3	$31,492
Supplies/ Travel	Days	14	$3,000	$42,000	3	$110,221
Groundwater Sampling and Lab Testing	Sample	40	$500	$20,000	3	$52,486
Report Preparation	Lump Sum	2	$5,000	$10,000	3	$26,243
ANNUAL GROUNDWATER MONITORING						
Personnel (2-man crew @ 5 12-hour days)	Hours	120	$50	$6,000	25	$69,921
Supplies/ Travel	Days	7	$3,000	$21,000	25	$244,725
Groundwater Sampling and Lab Testing	Sample	20	$500	$10,000	25	$116,536
Report Preparation	Lump Sum	1	$10,000	$10,000	25	$116,536
O&M SUBTOTAL				$202,500		$1,071,908
CONTINGENCY (10% of Subtotal)				$20,250		$107,191
SUBTOTAL				$222,750		$1,179,099

Component costs are based on quantities estimated in 1995 FFS, 1999 RS Means Data and previous FS cost estimates prepared within the last two years.

12.4 Expected Outcomes of Selected Remedy

The purpose of this response action is to control the risk associated with human exposure to contaminated ground water at the Zellwood Site and surrounding area. The shallow ground water at the Site is considered by the State of Florida to be a potential source of drinking water. Therefore, the surficial ground water will be restored to levels protective of human health or to State of Florida primary drinking water standards (i.e MCLs).

The Site and impacted area are currently available for industrial, commercial and agricultural use and it is anticipated that these activities will not be restricted during the implementation of the selected remedy. Institutional controls will restrict residential use of the properties impacted by the ground water contamination until remediation goals are attained. A statutory review (5-year review) will be conducted every five years to evaluate and assess the effectiveness of the remedy.

Table 12-2 presents the final cleanup levels for the surficial ground water. Since this operable unit addresses ground water contamination, the primary basis for selection of clean up goals are Federal and/or State of Florida primary drinking water standards (i.e. MCLs). For COCs that do not have a Federal or State primary standard, risk based cleanup goals were established. Concentrations associated with a Hazard Quotient (HQ) of one were selected as the clean up goal. For ammonia, a concentration at a HQ equal to three was selected because this value seems more appropriate given ammonia concentrations in background ground water samples.

Due to multiple variables in the attenuation process, the specific timeframe required to reach the clean up goals can not be quantified. Monitoring of the remedy will continue until contaminant concentrations reach asymptotic levels. At that point, the remedy will be re-evaluated to determine if attenuation of contaminants down to clean up goals is possible based on site conditions.

13.0 STATUTORY DETERMINATIONS

13.1 Protection of Human Health and the Environment

The selected remedy will protect human health by controlling risks associated with human exposure to contaminated ground water at the Zellwood Site and in areas impacted by the ground water contamination. Institutional controls will be implemented as discussed in Section 12.2. The only unacceptable risk associated with contaminated ground water for the Site is based on a future residential exposure scenario. Therefore, if residential development of the area is controlled, then the unacceptable risk will be eliminated. The selected remedy will eventually reduce contaminant concentrations to MCLs or to EPA's acceptable risk level.

13.2 Compliance with ARARs

The selected remedy will comply with all of the Applicable or Relevant and Appropriate Requirements presented in **Table 13-1**.

TABLE 13-1
DESCRIPTION OF ARARS FOR SELECTED REMEDY

Requirement	Status	Description	Action to Attain Requirement
Federal			
National Primary Drinking Water Standards, Maximum Contaminant Levels (MCLs)	Relevant and Appropriate	MCLs have been established for a number of organic and inorganic contaminants. These regulate the concentrations of contaminants in public drinking water supplies.	Selected remedy will comply with these regulations by protecting water supplies through institutional controls. These standards will be met through monitored natural attenuation.
State			
State of Florida Primary Drinking Water Standards	Relevant and Appropriate	MCLs have been established to regulate concentrations of contaminants in potable water supplies.	Same as Federal MCLs

13.3 Cost-Effectiveness

In EPA's judgement, the selected remedy is cost effective and represents a reasonable value for the money to be spent. The following definition was used in making this determination: "A remedy shall be cost effective if its costs are proportional to its overall effectiveness." (40 CFR 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination: long term effectiveness and permanence, reduction in toxicity, mobility, and volume through treatment, and short term effectiveness. Overall effectiveness was then compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence represent a reasonable value for the money to be spent.

There were various trade-offs between the alternatives that relate to their overall effectiveness and thus, their cost effectiveness. Alternatives 2 and 3 would require long term operation and maintenance of a ground water extraction and treatment system as well as long term maintenance of institutional controls and ground water monitoring to maintain protectiveness. Alternative 4 would provide an equal amount of long term protectiveness, but would not require operation and maintenance of a treatment system. Alternatives 2 and 3 may provide more reduction intoxicity, mobility and volume compared to Alternative 4. All of the alternatives would provide for short-term effectiveness, however, Alternatives 2 and 3 would require more onsite construction and therefore could present more hazards to workers and the community. The estimated present worth cost of the selected remedy is $ 1,281,000. This is significantly lower than costs associated with the treatment alternatives (2 and 3). The selected remedy will provide a comparable amount of protectiveness with respect to the other alternatives at a considerably lower cost.

13.4 Use of Permanent Solutions and Treatment Technologies

The selected alternative makes use of a permanent solution to restore ground water to State and Federal primary drinking water standards or to levels protective of human health. The treatment alternatives (2 and 3) would provide an equal amount of permanence as the selected remedy, but they are not cost effective.

13.5 Preference for Treatment as a Principal Element

The selected remedy does not satisfy the preference for treatment. The selected remedy makes use of natural attenuation to reduce concentrations of contaminants in ground water. The benefits of selecting one of the treatment alternatives are not significant enough to off set the substantial added cost.

13.6 Five-Year Review Requirements

The statutory five-year review process has begun at the Site due to the remedial action for operable unit 1. As a part of this on-going five-year review process, the operable unit 2 remedy will be reviewed and its protectiveness will be evaluated.

14.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for the Zellwood Groundwater Contamination Site was released for public comment in May 2000. The Proposed Plan identified Alternative 4, Monitored Natural Attenuation with Institutional Controls as the preferred alternative. EPA has reviewed all of the written and verbal comments submitted during the comment period. The Agency has determined that no significant changes to the remedy are necessary based on these comments.

APPENDIX A

RESPONSIVENESS SUMMARY

RESPONSIVENESS SUMMARY
OPERABLE UNIT 2
ZELLWOOD GROUNDWATER CONTAMINATION SUPERFUND SITE

The responsiveness summary for the Zellwood Groundwater Contamination Site, documents for the public record, the concerns and issues raised during the comment period for the Proposed Plan and provides EPA responses to these comments. The thirty day comment period began on May 19, 2000 and ended on June 18, 2000. The Proposed Plan public meeting was held at the Zellwood Community Center on June 1, 2000. Both written and oral comments were received from interested parties including the general public, the Potential Responsible Parties (PRPs), the Florida Department of Environmental Protection (FDEP) and the St. Johns River Water Management District (SJRWMD). EPA's response to significant comments have been grouped together based on the subject matter of the comment. The significant comments received and EPA's responses are presented below.

Nature and Extent of Ground Water Contamination

1. The FDEP and SJRWMD expressed concern about the lack of a fully defined ground water contaminant plume boundary for the surficial aquifer at the Site. Recommendations were made regarding conducting an additional investigation to further determine the vertical and horizontal extent of the plume.

    EPA Response:

    The estimated plume boundary described in the SRI Addendum was developed based upon the available data. The available data was deemed sufficient to determine the implementability of each alternative, however, it was accepted that the plume boundary would need refining before implementation of the remedy. In response to the concerns regarding the plume boundary, EPA conducted an investigation in June 2000 using Direct Push Technology (DPT) to refine the extent of contamination to the west and south of the existing permanent monitoring well network. Thirteen sampling locations were selected and ground water samples were collected from various depths at each of these locations. The field work procedures, analytical data collected and the revised estimate of the extent of contamination is presented in the August 2000, DPT Field Investigation Letter Report, included in the Administrative Record. The results of this investigation indicate that the contamination due to metals extends south and southwest of the Site, with the southern boundary near the southernmost Wekiwa Concrete property line and the western boundary in the vicinity of Shelley's Septic Tank Service. As would be expected, contamination due to nutrients is more widespread and extends further to the south than the metals.

2. The FDEP and SJRWMD expressed concern about the volatile organic compounds (VOCs) detected in monitoring well 11SA in October 1999. It was recommended that EPA continue to investigate this plume and search for possible source areas. Included

with this investigation should be a re-sampling of the existing monitoring well network for VOCs to get a current picture of the extent of the VOC ground water contamination. Additionally, FDEP suggested that the extent of the VOC contamination must be known before EPA can evaluate and select a final remedy for the Site. Also, FDEP recommended including specific cleanup goals for VOCs in the selected remedy.

EPA Response:

A discussion of EPA's position regarding the detection of VOCs at the Site is presented in Section 5.5.2 of the Record of Decision (ROD). Additionally, in response to these comments, EPA collected samples for VOC analysis during the DPT investigation conducted in June 2000. The purpose of this sampling was to further determine areas impacted by VOC contamination and to provide some evidence that might indicate the location of source areas. Samples from monitoring well clusters 10 and 11 and two DPT locations were analyzed for VOCs. Sampling results indicate the presence of a VOC plume containing 1,1-DCA, 1,1-DCE, vinyl chloride, acetone and chloroethane in an area between monitoring well clusters 10, 11 and the southwest corner of the W. R. Grace property (see Administrative Record, August 2000, "DPT Investigation Letter Report"). As discussed in the ROD, the VOC contamination is suspected to be a recent release and is not associated with the source areas investigated and remediated as a part of the Zellwood Groundwater Contamination Superfund Site. Contamination from VOCs will be further investigated and addressed through the EPA Site Assessment program. Contamination due to VOCs was not a concern in past investigations at the Site and the sources of these contaminants are different from those originally addressed at this Site. Also, this VOC contamination is likely the result of a recent release. Since this ROD is intended to select a remedy for ground water contamination resulting from past activities at the Drum Service Company and the property formerly occupied by Douglas Fertilizer Company / Southern Liquid Fertilizer, cleanup goals for volatile organic compounds are not included in the ROD.

3. The SJRWMD noted concern regarding contamination in the Floridan aquifer. Specifically, historically high levels of phosphorus in monitoring well (MW) 8D and recent detections of phosphorus in 12D were noted as the basis of this concern.

EPA Response:

Total phosphorus was detected at 6,600 ug/L in MW-8D in 1994. Total phosphorus was detected in MW-12D at 4,200 ug/L in 1999. While this data indicates that the Floridan aquifer may be impacted by phosphorus concentrations above site background levels, it is unclear as to the source of the phosphorus. While phosphorus would be expected in waste streams from the past operations at the Douglas Fertilizer / Southern Liquid Fertilizer facility, there are other significant sources of phosphorus (i.e the former muck farms) in areas upgradient of flow in the Floridan aquifer. Phosphorus is also naturally occurring in the Floridan aquifer due to the presence of limestone and the phosphate-containing Hawthorn Formation above it. Additionally, phosphorus was not identified as posing an unacceptable risk in the Baseline Risk Assessment for Human Health, conducted for this Site, and therefore was not selected as a contaminant of potential concern (COPC).

MW-8D was not sampled in 1999 because of a blockage in the well. Numerous attempts to free the blockage and sample the well were unsuccessful. Due to the concern about migration of contaminants to the Floridan aquifer, repair or replacement of MW-8D and continued monitoring of the Floridan wells are components of the selected remedy.

4. FDEP commented that the ground water contaminant plume boundary map should encompass monitoring wells 9SA and 13SA since nitrate was detected above the remediation goal presented in the Proposed Plan.

   EPA Response:

   The maps denoting the ground water plume in the ROD have been revised to include MW 9SA and 13SA.

5. A community member was concerned that EPA tested for heavy metals at the Site, but excluded pesticides, which were reportedly found at Lake Apopka.

   EPA Response:

   EPA sampled for pesticides in ground water during previous investigations, including Phase I of the 1995 Supplemental Remedial Investigation. The results of these investigations concluded that pesticides were not a concern in ground water at the Site. During the most recent investigation in 1999, EPA focused on the nature and extent of contamination of inorganic contaminants (metals and nutrients) in surficial ground water.

6. A community member noted that current levels of arsenic in ground water at the Site are low, in contrast to very elevated levels reported in initial studies from the 1980s.

   EPA Response:

   The level of arsenic in ground water has attenuated or diluted over time, reducing the concentration to its current low level. Contaminated soil containing arsenic was stabilized in the monolith located in the northern part of the Site. EPA monitors the wells next to the monolith for various constituents as part of the five-year review process.

Contaminant Migration and Ground Water Flow

7. Several comments were received questioning the direction of ground water flow in the Floridan aquifer as presented in the Addendum to the Supplemental Remedial Investigation (SRI) report.

EPA Response:

The flow direction of ground water in the Floridan aquifer stated in the Addendum to the SRI report was based on water level elevations from 1993 and 1994 in monitoring wells 3D, 7D and 8D. Analysis of this data indicated a southwest flow direction. However, regional ground water flow in the Floridan aquifer has been documented to be toward the northeast. EPA believes that the predominant flow direction of the Floridan aquifer is northeasterly, but localized flow may vary. A more accurate ground water flow direction estimate can be made using new water level measurements, including data from well 8D and any new Floridan monitoring well installed, as a part of the post-ROD sampling effort.

8. FDEP requested that EPA conduct an extensive investigation regarding the change in the ground water flow pattern which was discovered during recent field work activities.

EPA Response:

Data collected in 1999 indicates that surficial ground water, in the vicinity of monitoring wells 10 and 11, has a distinct westerly flow pattern. Ground water in this area had not previously been investigated and this westerly flow component is believed to be localized. Ground water in the surficial aquifer generally flows to the southwest, but local variations in this pattern are not unusual. More information regarding ground water flow direction in this area will be available once additional wells are installed as a component of the post-ROD sampling effort. EPA believes this data will be sufficient to document the ground water flow pattern and its effect on the contaminant plume migration.

9. FDEP expressed concern about the possible effects on contaminant migration and ground water flow caused by SJRWMD's Lake Apopka restoration project activities. FDEP recommended that EPA consult with SJRWMD staff regarding their planned activities and possible impacts these activities would have on the selected remedy at the Zellwood Site.

EPA Response:

EPA forwarded the FDEP's comments to the SJRWMD and are awaiting their response. EPA will be continuing its evaluation of ground water at the Site in an effort to insure the future and continued effectiveness of the remedy. Measuring fluctuations in ground water levels and ground water flow patterns will be included in the evaluation process.

10. FDEP stated that the drainage ditch, located immediately south of the eastern most Douglas Fertilizer pond, could be acting as a continuing source of contamination and noted EPA's Ecological Risk Review dated February 29, 2000 recommending further sampling of this pond and ditch. FDEP agreed that this sampling should be conducted to evaluate this possibility.

EPA Response:

The drainage ditch is located adjacent to the eastern most Douglas Fertilizer Pond. Overflow from the Pond likely enters the ditch during rainfall events. The eastern most Douglas Fertilizer Pond was suspected to be a source of ground water contamination. The most recent sampling suggests that it is no longer a continuing source to ground water contamination (see ROD Section 5.5.3). Contamination in the ditch is likely the result of historical overflow from the Pond and also from other sources upgradient of the ditch. The ditch is not believed to be a continual source of contamination in ground water. Data from the monitoring wells near the Pond and ditch support this conclusion.

Well Construction and Sampling Practices

11. One commentor stated that additional sample collection activities are needed to obtain data representative of actual site conditions, since previous field investigation efforts used inappropriate well construction/development methods and ground water sampling techniques. Specifically, the commentor states that EPA did not design and install the well screen filter pack material correctly on several of the new monitoring wells installed in 1999. Additionally, several problems with the placement of the sand pack around the well screen were noted. The commentor concludes that these deficiencies contributed to high turbidity levels in samples which influenced the constituent concentrations detected and the human health risk assessment assumptions.

    <u>EPA Response</u>:

    EPA selected the well screen size and filter pack material for wells installed in 1999 based on the well design and construction designs developed during the 1995 Supplemental Remedial Investigation. At the time, EPA felt comfortable following these procedures, however EPA acknowledges that using a different filter pack material and slot screen size may result in a more sound monitoring well. Regarding the placement of the sand pack, EPA's contractor was concerned about the collapse of the boring during drilling and being able to keep the borehole cleaned out. Drilling mud thick enough to "seal off" the borehole was used so that the borehole would remain open during drilling and sand pack placement. This resulted in a longer well development time than is usually required. EPA recognizes that well construction could have contributed to the high turbidity samples collected from some of the monitoring wells. However, there are several other factors to consider when making conclusions about turbidity and its affect on the concentrations of contaminants detected. Turbidity is discussed further in comment number 12.

12. One commentor stated that ground water samples with turbidity levels in excess of 10 Nephelometric Turbidity Units (NTUs) resulted in incorrectly reported metals concentrations that are higher than what are actually present in the samples. The commentor concluded that some metals constituents in monitoring well samples are present in the particulate phase rather than the dissolved phase.

EPA Response:

This comment challenges EPA's use of ground water data collected from samples with high (greater than 10 NTUs) turbidity and questions whether the metals concentrations reported represent the actual concentrations of metals in the ground water. In order to be protective of human health and the environment, EPA has been conservative in its use of data collected at the Zellwood Site. Since metals contamination in source areas has been documented and remediated in operable unit 1 and metals contamination has been detected in ground water above maximum contaminant levels (MCLs) in samples with low turbidity (< 10 NTUs), EPA has used the available data conservatively to ensure that risk from human consumption of or contact with ground water from the surficial aquifer is properly assessed.

Sample turbidity and its relationship to metals concentrations detected in ground water has been an issue of much debate at this Site for many years. It is understood that metals attached to suspended sediment, present in a ground water sample, can lead to a misrepresentation of ground water quality in analytical results. However, conclusions regarding high turbidity and its relationship to metals concentrations in ground water at the Site are difficult to make.

There is evidence contrary to the commentor's conclusion that the elevated levels of metals are due to sediment in the ground water. EPA and the PRPs have made several efforts to reduce turbidity in some of the monitoring wells in order to collect representative samples. Most recently, EPA re-sampled MW-8SA, 10SA and 11SA in October 1999. Compared to the sample collected in July 1999, turbidity was significantly lower in sample 8SA (<10NTUs) in October 1999, and consequently the analytical data showed a significant decrease in several metals concentrations. In sample 11SA, the turbidity was reduced from >200 NTUs in July 1999 to 54.8 NTUs in October 1999. However, some metals concentrations decreased while others increased in the October 1999 sample when compared to the July 1999 sample. The October 1999 sample for MW-10SA resulted in even higher turbidity when compared to the July 1999 sample.

The relationship between high turbidity and elevated concentrations of metals in ground water is not consistently supported by the October 1999 re-sampling. For MW-8SA, concentrations of metals were reduced in the low turbidity sample, however, this relationship at wells MW-10SA and 11SA was not always demonstrated.

In further response to the public comment regarding the issue of turbidity, EPA allowed one of the PRPs to re-sample MW-10SA and 11SA in May 2000, using a 5 Micron in-line filter. Results from this sampling showed that filtering the samples had no effect on the concentrations of metals reported. Additionally, EPA personnel, EPA contractors and one of the PRP's contractors have all noted the "stained" color of the ground water in some of the SA wells (including 10SA and 11SA), likely due to tannic acid. These observations made during sampling are not consistent with the commentor's claims that high turbidity is mainly the result of suspended sediment in the ground water samples. The staining of the water is a possible cause of the high turbidity readings documented during the various sampling investigations because the turbidity meter cannot differentiate between the presence of suspended solids and the dark, naturally stained water. High turbidity samples of ground water with this characteristic may accurately represent the metals concentrations in the ground water.

EPA recognizes that the turbidity of ground water samples is a significant concern at the Zellwood Groundwater Contamination Site. However, EPA cannot ignore the past history of the Site, including a remedial action to remove soil contaminated with metals, and conclude that the metals detected in ground water are merely due to excessive turbidity. It is reasonable to expect ground water contamination due to metals, given the previous findings of metals contamination in the source areas. Additionally, several ground water samples have been collected, with turbidity less than 10 NTUs, that contain metals at concentrations above the State of Florida and Federal primary drinking water standards.

Location / Use of Wells in Site Vicinity

13. The community is concerned about the current source(s) of drinking water used by industries at the Site.

    EPA Response:

    As part of its investigation, EPA conducted a public and private well survey within the Site vicinity. For drinking water, employees at the Site use bottled water or other alternative water supply sources.

14. One person wanted to know if any drinking water or irrigation wells are located in the shallow aquifer within or downgradient of the Site.

    EPA Response:

    To the best of EPA's knowledge, there are no drinking water wells in the shallow aquifer either within the Site boundary or immediately downgradient. Residents have indicated that there are some drinking water wells located in the shallow aquifer to the north of the Site. Some of the businesses located on and around the Site have wells at varying depths (60 to 200 feet) that are used in the day to day operations of their facilities.

Risk Assessment

15. Community members wanted to confirm that the Site poses no immediate threat to the health or welfare of the community.

EPA Response:

The risk associated with ground water contamination is through a future use scenario. The Site does not pose any current risk to community members in terms of drinking contaminated ground water since there are no downgradient potable wells.

16. Residents inquired about the basis for future risk. They are concerned about further residential development in the affected area of groundwater contamination.

EPA Response:

In this case, the future risk scenario deals with development of the affected land area for residential purposes, which would pose a risk to human health if accompanying well installations were to intercept contaminants. EPA's preferred remedy for the Site, monitored natural attenuation with institutional controls (Alternative 4 of the Proposed Plan), would reduce contaminant levels and prevent future exposure to contaminated groundwater through advisories on groundwater use and adherence to existing zoning restrictions, which are industrial and agricultural.

17. Residents questioned why anyone would want to install a well in the affected area of the surficial aquifer, given the poor quality of water.

EPA Response:

Ground water in the shallow aquifer has been demonstrated to be of poor quality. This could influence anyone's decision to install a drinking water well in this aquifer. A drinking water well in the deeper, Floridan aquifer, would most likely be preferred. However, the surficial aquifer has been designated as a potential future drinking water resource by the State of Florida and must be considered as such in future risk assumptions.

18. The comment was made that the Site risk was overestimated at the site due to the elevated turbidity (over 10 NTUs) of the groundwater samples from MW-10SA and MW11SA.

EPA Response:

See response to comment number 12 for a detailed explanation of the turbidity issues at this site. As stated in the above mentioned response, the cause of the high NTU reading in MW-10SA and MW-11SA is not a clear cut issue. Due to the uncertainties associated with the turbidity in these two wells and the fact that filtered samples (May, 2000) showed similar concentrations of metals, it cannot be concluded that the risks are overstated in these wells.

19. The Risk Assessment used as a basis for the selected remedy overstates the Site risk since the maximum or UCL (upper confidence limit) contaminant concentration was used for the Exposure Point Concentration (EPC) rather than the average concentration.

EPA Response:

The comment states that the risk is overstated because the 95% UCL (upper confidence limit) or the maximum detected concentration (whichever was lower) was used for the EPC (exposure point concentration) instead of the average concentration. The use of the lower of the 95% UCL or the maximum detected concentration as the EPC follows EPA's Risk Assessment Guidance for Superfund, Part D, when the center of the plume can not be clearly distinguished. This guidance is designed to provide the best EPC for the groundwater at a site when the location of the center of the contaminant plume has not been completely defined.

20. Given that the published land use for the Site is industrial and controls are currently in place to restrict the use of ground water beneath the site, why does EPA consider residential use in the future?

EPA Response:

EPA considers future residential use of any groundwater that is designated as a potential future drinking water resource. Since the State of Florida has designated the surficial aquifer as a potential future drinking water resource, the risk assessment was correct in evaluating the risks to the surficial groundwater as such.

Proposed Remedy - Monitored Natural Attenuation (MNA) With Institutional Controls

21. FDEP expressed concern that the high level of nitrates, etc. detected in monitoring well 11 SA and SB may indicate another source area located on the property once owned by the Douglas Fertilizer Company and the Southern Liquid Fertilizer Company. Monitored natural attenuation (MNA) as a remedy cannot be applied to the Site if there is still a source area.

EPA Response:

EPA believes that all of the source areas, causing ground water contamination with nutrients and metals were identified and remediated during the investigation and remedial action for operable unit 1.

22. FDEP stated that they use primary and/or secondary drinking water standards as remedial goals. However, the Proposed Plan listed risk-based remedial goals for aluminum, ammonia, iron, manganese and vanadium instead of secondary drinking water standards.

EPA Response:

EPA selected the remedial goals for the Site based on a hierarchy of primary drinking water standards and site specific risk-based goals. EPA selects remedial goals based on protection of human health and the environment. Secondary drinking water standards do not relate to concentrations of contaminants that are protective of human health or the environment. Pursuant to CERCLA, EPA would not take an independent enforcement action for violations of secondary standards alone. A specific, detailed discussion regarding the selection of remedial goals is presented in a letter to FDEP dated May 18, 2000 and is available in the Administrative Record.

23. The SJRWMD expressed concern that the MNA remedy will not stop migration of the ground water plume onto their property. At a minimum the SJRWMD requests assurances from EPA that they will not become a PRP due to the selection of a passive remedy.

EPA Response:

EPA will monitor the ground water plume throughout the attenuation process and expects a decrease in contaminant concentrations over time. However, should the plume migrate or increase in concentrations in the short-term, EPA would likely exercise its enforcement discretion by not taking action against property owners when the contamination has come to the property solely as a result of subsurface migration.

24. FDEP stated that there is not enough historical information on the ground water plume to demonstrate that MNA is a prudent alternative. Additionally, the MNA alternative suffers from the distinct possibility that it may not result in a reduction of ground water contaminants in a reasonable time frame.

EPA Response:

The Zellwood Site has been investigated for more than 14 years. In that time, numerous ground water samples have been collected from various areas of the site and surrounding area. The most recent Addendum to the Supplemental Remedial Investigation (SRI) included a discussion of the historical sampling and presented historical data showing general decreasing concentrations of contaminants of over time. EPA believes that this information, along with the fact that contaminated soil from source areas was excavated and stabilized, provides evidence that attenuation is occurring. As with any remedy, the possibility exists that contaminant concentrations will not be effectively reduced to clean up levels in an appropriate time frame. However, EPA believes this remedy will allow for continued monitoring of the ground water plume and will provide an opportunity to reevaluate the selected alternative should site conditions warrant such an action.

25. Several commentors questioned whether this remedy is appropriately applied to the contaminants of concern at this Site. An analysis of the chemical processes involved in natural attenuation and the time required to meet the remedial objectives should be evaluated in more detail prior to making the remedy decision.

EPA Response:

As stated in comment number 24, EPA feels that the historical decreases in concentrations of contaminants in ground water does support the selection of the natural attenuation remedy. A detailed analysis of the monitoring data collected during implementation of the remedy will provide information needed to evaluate the remedy's effectiveness.

26. One commentor questioned the number of monitoring wells to be installed and the frequency of sampling estimated in the Focused Feasibility Study for the proposed remedy. The commentor asked why all the monitoring wells must be tested when the plume extent is so small.

EPA Response:

The ground water monitoring plan (including number of wells and frequency of sampling) presented in the cost estimate for the proposed remedy was a conservative estimate given the unknowns associated with estimating the extent of ground water contamination. The actual number of wells and frequency of sampling will be determined based on the results of the June 2000 DPT investigation prior to the post-ROD monitoring. Sampling wells within and around the ground water contaminant plume will be necessary to monitor contaminant concentrations and plume migration.

Responsible Parties and the Superfund

27. One long-time resident wondered why the potentially responsible parties (PRPs) are allowed to remain in business and whether their activities continue to contaminate the environment.

EPA Response:

The Superfund program does not shut down businesses. The Resource Conservation and Recovery Act (RCRA) is a Federal law envisioned by Congress to monitor active facilities. RCRA is a regulatory system that tracks hazardous substances from their generation to disposal. The law requires facility operators to apply for permits to discharge contaminants into the environment. RCRA is designed to prevent the creation of new, uncontrolled hazardous waste sites. Therefore, the active facilities at the Site should be operating under current applicable State/Federal environmental regulations.

27. Community members asked about the measures that EPA takes against parties who are potentially responsible for contamination at a Superfund site.

EPA Response:

As part of the Superfund program, EPA works with PRPs through technical and legal actions, to clean up hazardous waste sites resulting from past operations. Usually, the polluter to investigate and cleanup the site. In some cases, EPA conducts the investigation and the PRP performs the cleanup with EPA oversight. In other cases, where EPA is unable to reach an agreement with the PRP, EPA uses money from the Superfund to investigate and clean up the Site, and recoups the costs afterwards through legal action.

28. One resident asked if EPA had attempted to collect any money from the PRPs at the Site.

EPA Response:

The process for recovering EPA's past costs is currently underway. Typically, it takes several years for EPA to recover all of its costs through a settlement with the PRPs. To date, EPA has reached a partial settlement with several of the Site PRPs.

APPENDIX B

HUMAN HEALTH RISK ASSESSMENT TABLES

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Water	Surface Water	Pond/Ditch	Trespasser/ Visitor	Adolescents	Ingestion	On-site	Quant.	Pond/ditch is accessible to site visitors who may come into contact with water.
						Dermal	On-site	Quant.	Pond/ditch is accessible to site visitors who may come into contact with water.
Future	Ground-water	Ground-water	Well	Resident	Child	Ingestion	On-site	Quant.	Groundwater may be used as a drinking water source in the future.
		Air	Well	Resident	Child	Inhalation	On-site	Quant.	Exposure to volatiles while showering may be a complete exposure route.
		Ground-water	Well	Resident	Adult	Ingestion	On-site	Quant.	Groundwater may be used as a drinking water source in the future.
		Air	Well	Resident	Adult	Inhalation	On-site	Quant	Exposure to volatiles while showering may be a complete exposure route.

TABLE 2.1
OCCURRENCE AND DISTRIBUTION OF CHEMICALS OF POTENTIAL CONCERN
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical	Minimum Concentration/ Qualifier[1]		Maximum Concentration/ Qualifier[1]		Units	Location of Maximum Concentration	Detection Frequency[2]	Range of Detection Limits	Concentration used for Screening	Background Value[3]	Screening Toxicity Value [4, 5, 6]	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Contaminant Selection or Deletion[7]
Pond	7429-90-5	***Aluminum***	1,200	-	1,790	-	µg/L	SW01	2 / 2	NA / NA	1,790	NA	13	13	4	Y	ASL
Pond	7440-38-2	Arsenic	5.2	J	5.6	J	µg/L	SW02	2 / 2	NA / NA	6	NA	190	190	5	N	BSL
Pond	7440-39-3	Barium	10	-	13	-	µg/L	SW01	2 / 2	NA / NA	13	NA	119	119	4a	N	BSL
Pond	7440-41-7	Beryllium	1.500	-	1.500	J	µg/L	SW02	1 / 2	5.0 / 5.0	1.5	NA	15.0	15.0	6	N	BSL
Pond	7440-70-2	Calcium	14,400	-	15,400	-	µg/L	SW02	2 / 2	NA / NA	15,400	NA	NA	NA	NA	N	Nut
Pond	18540-29-9	Chromium (Total)	7.8	J	8.9	J	µg/L	SW02	2 / 2	NA / NA	9	NA	11	11	5	N	BSL
Pond	7440-50-8	***Copper***	8.5	-	14.5	-	µg/L	SW02	2 / 2	NA / NA	15	NA	6.5	7	5	Y	ASL
Pond	7439-89-6	Iron	530	-	586	-	µg/L	SW02	2 / 2	NA / NA	586	NA	1,000	1,000	5	N	BSL
Pond	7439-92-1	***Lead***	4.7	-	6.3	-	µg/L	SW01	2 / 2	NA / NA	6	NA	1.3	1.3	5	Y	ASL
Pond	7439-95-4	Magnesium	11,800	-	14,500	-	µg/L	SW01	2 / 2	NA / NA	14,500	NA	NA	NA	NA	N	Nut
Pond	7439-96-5	***Manganese***	1,000	-	1,260	-	µg/L	SW01	2 / 2	NA / NA	1,260	NA	50	50	6	Y	ASL
Pond	7440-09-7	Potassium	38,200	-	40,700	-	µg/L	SW01	2 / 2	NA / NA	40,700	NA	NA	NA	NA	N	Nut
Pond	7440-23-5	Sodium	26,700	-	31,100	-	µg/L	SW02	2 / 2	NA / NA	31,100	NA	1,275	1,275	4	N	Nut
Pond	7440-62-2	Vanadium	8.8	-	11.0	-	µg/L	SW01	2 / 2	NA / NA	11	NA	26	26	6	N	BSL
Pond	7440-66-6	***Zinc***	25	-	60	-	µg/L	SW01	2 / 2	NA / NA	60	NA	59	59	5	Y	ASL
Pond	7664-41-7	Ammonia	2,600	-	14,900	-	µg/L	SW01	2 / 2	NA / NA	14,900	NA	NA	NA	NA	N	NA
Pond	NA	Chloride	28,100	-	33,800	-	µg/L	SW01	2 / 2	NA / NA	33,800	NA	NA	NA	NA	N	Nut
Pond	NA	***Sulfate***	27,000	-	29,200	-	µg/L	SW02	2 / 2	NA / NA	29,200	NA	23,800	23,800	4a	Y	ASL

Footnotes:

1. SW (surface water) samples SW01 and SW02. Multiple results (e.g., duplicates) were combined using the higher detected value, or a single detection to represent that sample event.
2. Number of samples taken and analyzed for the constituent. Sample number varies based on the number of usable results.
3. Background: None available.
4. Florida Department of Environmental Protection Target Cleanup Levels for Surface Water, Chapter 62-777, F.A.C.

4a. Florida Department of Environmental Protection Target Cleanup Levels for Surface Water, Chapter 62-777, F.A.C. Not greater than 10% above background.

5. AWQC, Freshwater Aquatic Life Criteria, water and organism consumption. Units are µg/L.
6. Risk-based concentrations for groundwater obtained from: EPA Region III, Risk-Based Concentration Table, obtained on-line 12/22/99. Units are µg/L.
7. Rationale Codes

Selection Reason:

Deletion Reason:
- ASL - Above screening level
- BSL - Below screening level
- Nut - Essential nutrient
- NA - No relevant standard

Definitions:
- *COPC* = *Chemical of Potential Concern (indicated by bold italics)*
- NA = Not Applicable
- ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

TABLE 2.2
OCCURRENCE AND DISTRIBUTION OF CHEMICALS OF POTENTIAL CONCERN
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration/ Qualifier[1]		Maximum Concentration/ Qualifier[1]		Units	Location of Maximum Concentration	Detection Frequency[2]	Range of Detection Limits	Concentration used for Screening	Background Value[3]	Screening Toxicity Value [4,5,6]	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Contaminant Selection or Deletion[7]
Well	7429-90-5	***Aluminum***	110	J	27,000	J	µg/L	MW10SA	10 / 15	77 / 400	27,000	830	3,650	N	200	SMCL	Y
Well	7440-36-0	***Antimony***	2	-	25	-	µg/L	MW11SA	2 / 15	2 / 4.2	25	ND	1.46	N	6	MCL	Y
Well	7440-38-2	***Arsenic***	5	-	100	-	µg/L	MW08SA	5 / 15	3 / 6.4	100	ND	0.045	C	50	MCL	Y
Well	7440-39-3	***Barium***	5	-	280	-	µg/L	MW11SA	15 / 15	NA / NA	280	120	256	N	2,000	MCL	Y
Well	7440-41-7	Beryllium	0.7	J	1.3	J	µg/L	MW10SA	2 / 15	0.2 / 21	1	ND	7.3	N	4	MCL	N
Well	7440-43-9	***Cadmium***	2	J	99	-		MW11SB	4 / 15	0.4 / 42	99	ND	1.8	N	5	MCL	Y
Well	7440-70-2	Calcium	5,000	J	260,000	J	µg/L	MW12SA	15 / 15	NA / NA	260,000	8,450	NA		NA	NA	N
Well	18540-29-9	***Chromium (Total)***	3	J	340	-		MW11SA	9 / 15	1 / 1.2	340	7	11	N	100	MCL	Y
Well	18540-29-9	***Chromium (Hexavalent)***	7	J	7	J		MW11SA	1 / 11	10 / 250	7	4	11	N	100	MCL	Y
Well	7440-48-4	Cobalt	2	J	22	J	µg/L	MW11SB/12SA	5 / 15	2 / 35	22	4	219	N	420	GC	N
Well	7440-50-8	***Copper***	3	J	1,100	J	µg/L	MW08SB	12 / 15	3 / 2.5	1,100	3	146	N	1,000	SMCL	Y
Well	57-12-5	Cyanide	0	J	21	J		MW11SA	5 / 13	10 / 10	21	5	73	N	200	MCL	N
Well	7439-89-6	***Iron***	2	-	6,500	-	µg/L	MW10SA	13 / 15	77 / 81	6,500	370	1,095	N	300	SMCL	Y
Well	7439-92-1	***Lead***	2	-	160	-	µg/L	MW11SA	7 / 15	2 / 2.9	160	ND	15		15	MCL	Y
Well	7439-95-4	Magnesium	950	J	32,000	J	µg/L	MW12SA	15 / 15	NA / NA	32,000	6,250	NA		NA	NA	N
Well	7439-96-5	***Manganese***	19	J	1,000	J	µg/L	MW11SA	15 / 15	NA / NA	1,000	17	73	N	50	SMCL	Y
Well	7440-02-0	***Nickel***	4	J	190	-		MW11SB	10 / 15	2 / 10	190	ND	73	N	100	MCL	Y
Well	7440-09-7	Potassium	2,600	J	1,100,000	J	µg/L	MW11SA	14 / 15	NA / NA	1,100,000	2,200	NA		NA	NA	N
Well	7782-49-2	***Selenium***	10	-	400	-		MW11SA	6 / 15	2 / 4.8	400	ND	18	N	50	MCL	Y
Well	7440-23-5	***Sodium***	9,000	-	540,000	J	µg/L	MW11SA	15 / 15	NA / 540,000	5,900NA	160,000	MCLY	ARAR			
Well	7439-97-6	***Total Mercury***	0.3	-	3	-	µg/L	MW11SA	4 / 15	0.1 / 0.2	3	ND	0.37	N	2	MCL	Y
Well	7440-62-2	***Vanadium***	3	J	630	-	µg/L	MW11SA	14 / 15	4 / 4.1	630	ND	26	N	49	GC	Y
Well	7440-66-6	Zinc	6	J	480	-	µg/L	MW11SA	15 / 15	NA / NA	480	23	1,095	N	5,000	SMCL	N
Well	7664-41-7	***Ammonia***	1,300	-	640,000	-	µg/L	MW11SA	11 / 11	NA / NA	640,000	88	21	N	2,800	GC	Y
Well	NA	***Chloride***	28,000	-	950,000	-	µg/L	MW11SA	11 / 11	NA / NA	950,000	10,950	NA		250,000	SMCL	Y
Well	NA	***Sulfate***	12,000	-	410,000	-	µg/L	MW11SA	11 / 11	NA / NA	410,000	15,500	NA		250,000	SMCL	Y
Well	14797-55-8	***Nitrate***	880	-	167,000	-	µg/L	MW11SA	8 / 11	500 / 500	167,000	ND	5,840	N	10,000	MCL	Y
Well	14797-65-0	***Nitrite***	160	J	160	J	µg/L	MW12SB	1 / 11	500 / 10000	160	ND	365	N	1,000	MCL	Y
Well	75-34-3	***1,1-Dichloroethane***	680	-	680	-	µg/L	MW11SA	1 / 1	NA / NA	680	NA	79.8	N	70	GC	Y
Well	75-35-4	***1,1-Dichloroethene***	180	-	180	-	µg/L	MW11SA	1 / 1	NA / NA	180	NA	0.044	C	7	MCL	Y
Well	75-01-4	***Vinyl chloride***	18	-	18	-	µg/L	MW11SA	1 / 1	NA / NA	18	NA	0.019	C	1	MCL	Y

Footnotes:

1. Data for monitor wells (MW) 06SA, 06SB, 08SA, 08SB, 9SA, 9SB, 10SA, 10SB, 11SA, 11SB, 12D, 12SA, 12SB, 13SA, and 13SB. Data for 08SA and 11SA obtained from October 1999 sampling event. All others are from July 1999.
2. Number of samples taken and analyzed for the constituent. Sample number varies based on the number of usable results.
3. Background: Average concentration for monitor wells (MW)-3SA/SB.
4. Risk-based concentrations for groundwater obtained from: EPA Region III, Risk-Based Concentration Table, obtained on-line 12/22/99. Units are µg/L.
5. Toxicity value surrogate: Methylmercury used for mercury.
6. Rationale Codes

Selection Reason:	ASL	-	Above screening level
	Class	-	Member of a class of compounds that are COPCs
	ARAR	-	Exceeds ARAR
	TBC	-	Exceeds To-Be-Considered
Deletion Reason:	BSL	-	Below screening level
	Nut	-	Essential nutrient
	NA	-	No relevant standard

Definition:	***COPC***	**=**	***Chemical of Potential Concern (indicated by bold italics)***
	NA	=	Not applicable
	ND	=	Not detected
	ARAR/TBC	=	Applicable or Relevant and Appropriate Requirement/To-Be-Considered
	MCL	=	Florida Maximum Contaminant Level
	SMCL	=	Florida Secondary Maximum Contaminant Level
	GC	=	Florida Groundwater Guidance Concentration
	C	=	Carcinogenic
	N	=	Non-Carcinogenic

TABLE 3.1 RME
OCCURRENCE AND DISTRIBUTION OF CHEMICALS OF POTENTIAL CONCERN
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Log-Transformed Data	Maximum Concentration/ Qualifier[1]	Exposure Point Concentration			
						Value	Units	Statistic[2]	Rationale
Pond	Aluminum	µg/L	1,495	4,875	1,790	1,790	µg/L	Maximum	Reg 4 Guidance
Pond	Copper	µg/L	12	86	15	15	µg/L	Maximum	Reg 4 Guidance
Pond	Lead	µg/L	5.5	11	6	6	µg/L	Maximum	Reg 4 Guidance
Pond	Manganese	µg/L	1,130	1,949	1,260	1,260	µg/L	Maximum	Reg 4 Guidance
Pond	Zinc	µg/L	42	6,368	60	60	µg/L	Maximum	Reg 4 Guidance
Pond	Sulfate	µg/L	28,100	32,748	29,200	29,200	µg/L	Maximum	Reg 4 Guidance

Footnotes:
1. "-" is a result that did not require qualification.
2. 95% UCL of log-transformed data (95% UCL-T).

TABLE 3.2RME
OCCURRENCE AND DISTRIBUTION OF CHEMICALS OF POTENTIAL CONCERN
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future

Medium: Groundwater

Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Log-Transformed Data	Maximum Concentration/	Qualifier[1]	Exposure Point Concentration Value	Units	Statistic[2]	Rationale
Well	Aluminum	µg/L	3,495	60,444	27,000	J	27,000	µg/L	Maximum	Reg 4 Guidance
Well	Antimony	µg/L	3	4	25	-	4	µg/L	95% UCL-T	Reg 4 Guidance
Well	Arsenic	µg/L	13.7	45	100	-	45	µg/L	95% UCL-T	Reg 4 Guidance
Well	Barium	µg/L	108	353	280	-	280	µg/L	Maximum	Reg 4 Guidance
Well	Cadmium	µg/L	9	41	99	-	41	µg/L	95% UCL-T	Reg 4 Guidance
Well	Chromium (Total)	µg/L	36	799	340	-	340	µg/L	Maximum	Reg 4 Guidance
Well	Chromium (Hexavalent)	µg/L	36	206	7	J	7	µg/L	Maximum	Reg 4 Guidance
Well	Copper	µg/L	128	2,976	1,100	J	1,100	µg/L	Maximum	Reg 4 Guidance
Well	Iron	µg/L	765	13,339	6,500	-	6,500	µg/L	Maximum	Reg 4 Guidance
Well	Lead	µg/L	18	100	160	-	100	µg/L	95% UCL-T	Reg 4 Guidance
Well	Manganese	µg/L	169	371	1,000	J	371	µg/L	95% UCL-T	Reg 4 Guidance
Well	Nickel	µg/L	46	538	190	-	190	µg/L	Maximum	Reg 4 Guidance
Well	Selenium	µg/L	37	188	400	-	188	µg/L	95% UCL-T	Reg 4 Guidance
Well	Sodium	µg/L	58,267	86,722	540,000	J	86,722	µg/L	95% UCL-T	Reg 4 Guidance
Well	Total Mercury	µg/L	0.4	1	3	-	1	µg/L	95% UCL-T	Reg 4 Guidance
Well	Vanadium	µg/L	129	2,845	630	-	630	µg/L	Maximum	Reg 4 Guidance
Well	Ammonia	µg/L	114,800	4,303,808	640,000	-	640,000	µg/L	Maximum	Reg 4 Guidance
Well	Chloride	µg/L	330,818.2	1,447,085	950,000.0	-	950,000	µg/L	Maximum	Reg 4 Guidance
Well	Sulfate	µg/L	145,364	605,245	410,000	-	410,000	µg/L	Maximum	Reg 4 Guidance
Well	Nitrate	µg/L	30,739	8,996,953	167,000	-	167,000	µg/L	Maximum	Reg 4 Guidance
Well	Nitrite	µg/L	1,242	4,646	160	J	160	µg/L	Maximum	Reg 4 Guidance
Well	1,1-Dichloroethane	µg/L	680	NA	680	-	680	µg/L	Maximum	Reg 4 Guidance
Well	1,1-Dichloroethene	µg/L	180	NA	180	-	180	µg/L	Maximum	Reg 4 Guidance
Well	Vinyl Chloride	µg/L	18	NA	18	-	18	µg/L	Maximum	Reg 4 Guidance

Footnotes:

1. Data for monitor wells (MW) 06SA, 06SB, 08SA, 08SB, 9SA, 9SB, 10SA, 10SB, 11SA, 11SB, 12D, 12SA, 12SB, 13SA and 13SB.
2. "-" is a result that did not require qualification.
3. 95% UCL of log-transformed data (95% UCL-T)
4. Maximum used as the exposure point concentration when exceeds the maximum.

TABLE 4.1RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Current/Future

Medium: Surface Water

Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/Model Name
Ingestion	Trespasser/ Visitor	Adolescent	Pond	CW	chemical concentration in water	See Table 3	µg/L	See Table 3	Chronic daily intake = CW x IR x ET x EF x ED x CF x 1/BW x 1/AT
				IR	ingestion rate	0.01	liters/hour	EPA 1995	
				ET	exposure time	2	hours	Judgement	
				EF	exposure frequency	50	days/year	Judgement	
				ED	exposure duration	10	years	EPA 1995	
				CF	conversion factor	0.001	mg/µg	--	
				BW	body weight	45	kg	EPA 1995	
				AT-C	averaging time	25550	days	EPA 1989a	
				AT-N	averaging time (non-cancer)	3650	days	EPA 1989a	
Dermal	Trespasser/ Visitor	Adolescent	Pond	CW	chemical concentration in water	See Table 3	µg/L	See Table 3	Chronic daily intake = CW x CF^1 x SA x PC x ET x CF^2 x EF x ED x 1/BW x 1/AT
				CF^1	conversion factor 1	0.001	mg/µg	--	
				SA	surface area	5800	cm^2	EPA 1997b	
				PC	permeability constant	Chem. Spec.	cm/hour	--	
				ET	exposure time	2	hours	Judgement	
				CF^2	conversion factor 2	0.001	L/cm^3	--	
				EF	exposure frequency	50	days/year	Judgement	
				ED	exposure duration	10	years	EPA 1995	
				BW	body weight	45	kg	EPA 1995	
				AT-C	averaging time (cancer)	25550	days	EPA 1989a	
				AT-N	averaging time (non-cancer)	3650	days	EPA 1989a	

U.S. EPA. 1989a. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A) December. Appendix A.
U.S. EPA. 1995. "Supplemental Guidance to RAGS: Region 4 Bulletins. Human Health Risk Assessment." November.
U.S. EPA. 1997b. Exposure Factors Handbook, Volume 1, General Factors. Prepared by the Office of Research and Development. August

TABLE 4.2RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future

Medium: Groundwater

Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/Model Name
Ingestion	Resident	Child	Well Area	CW	chemical concentration in water	See Table 3	µg/L	See Table 3	Chronic daily intake = CW x IR x EF x ED x CF x 1/BW x 1/AT
				IR	ingestion rate	1	liters/days	EPA 1991a	
				EF	exposure frequency	350	days/year	EPA 1991a	
				ED	exposure duration	6	years	EPA 1991a	
				CF	conversion factor	0.001	mg/µg	EPA 1991a	
				BW	body weight	15	kg	EPA 1991a	
				AT-N	averaging time (non-cancer)	2190	days	EPA 1989a	
Showering[1] (Inhalation/ dermal)	Resident	Child	Well Area	CW	chemical concentration in water	See Table 3	µg/L	See Table 3	Chronic daily intake = CW x NIEE x EF x ED x CF x 1/BW x 1/AT
				NIEE	non-ingestion exposure rate	1	liters/day	EPA 1991c	
				EF	exposure frequency	350	days/year	EPA 1991a	
				ED	exposure duration	6	years	EPA 1991a	
				CF	conversion factor	0.001	mg/µg	EPA 1991a	
				BW	body weight	15	kg	EPA 1991a	
				AT-N	averaging time (non-cancer)	2190	days	EPA 1989a	

[1]U.S. EPA. 1995. "Supplemental Guidance to RAGS: Region 4 Bulletins. Human Health Risk Assessment." November.

U.S. EPA. 1989a. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A) December. Appendix A.

U.S. EPA. 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors," OSWER Directive 9298.6-03, March 25.

TABLE 4.3RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future

Medium: Groundwater

Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/Model Name
Ingestion	Resident	Child to Adult	Well	CW	chemical concentration in water	See Table 3	µg/L	See Table 3	Chronic daily intake (mg/kg-day) = CW x IF x EF x CF x 1/AT
				IF	ingestion factor	1.09	liters-yr/kg-day	EPA 1991a, b	
				EF	exposure frequency	350	days/year	EPA 1991a	
				CF	conversion factor	0.001	mg/µg	--	
				AT-C	averaging time (cancer)	25550	days	EPA 1991a	
Showering[1] (Inhalation/ dermal)	Resident	Child to Adult	Well	CW	chemical concentration in water	See Table 3	µg/L	See Table 3	Chronic daily intake (mg/kg-day) = CW x IF x EF x CF x 1/AT
				IF	ingestion factor	1.09	liters-yr/kg-day	EPA 1991a, b, c	
				EF	exposure frequency	350	days/year	EPA 1991a	
				CF	conversion factor	0.001	mg/µg	--	
				AT-C	averaging time (cancer)	25550	days	EPA 1991a	

[1]U.S. EPA. 1995. "Supplemental Guidance to RAGS: Region 4 Bulletins. Human Health Risk Assessment." November.

U.S. EPA. 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors," OSWER Directive 9298.6-03, March 25.

U.S. EPA. 1991b. Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals, OSWER Directive 9285.7-01B, December 13.

U.S. EPA. 1991c. "Guidance on Estimating Exposures to VOCs During Showering," Office of Research and Development. July 10.

TABLE 5.1
NON-CANCER TOXICITY DATA — ORAL/DERMAL
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Absorption Efficiency (for Dermal)[1]	Dermal RfD[2,3]		Primary Target Organ(s)	Combined Uncertainty/ Modifying Factors	RfD: Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s)
Aluminum	Chronic	1E+00	mg/kg/day	20%	2E-01	mg/kg/day	CNS (Neurotoxicity)	100	NCEA	8/13/99
Antimony	Chronic	4E-04	mg/kg/day	20%	8E-05	mg/kg/day	Blood Chemistry	1000	IRIS	2/1/91
Arsenic	Chronic	3E-04	mg/kg/day	100%	3E-04	mg/kg/day	Skin (Hyperpigmentation, keratosis)	3	IRIS	4/10/98
Barium	Chronic	7E-02	mg/kg/day	20%	1E-02	mg/kg/day	Kidney	3	IRIS	1/21/99
Cadmium	Chronic	5E-04	mg/kg/day	20%	1E-04	mg/kg/day	Significant proteinuria	10	IRIS	2/1/94
Chromium (Total)	Chronic	3E-03	mg/kg/day	2%	6E-05	mg/kg/day	No adverse affect	900	IRIS	9/3/98
Chromium (Hexavalent)	Chronic	3E-03	mg/kg/day	2%	6E-05	mg/kg/day	No adverse affect	900	IRIS	9/3/98
Copper	Chronic	4E-02	mg/kg/day	20%	8E-03	mg/kg/day	No adverse affect	unk	HEAST	6/17/05
Iron	Chronic	3E-01	mg/kg/day	20%	6E-02	mg/kg/day	No adverse affect	1	NCEA	1999
Lead	Chronic	NA	mg/kg/day	100%	NA	mg/kg/day	CNS (Neurotoxicity)	NA	IRIS	2/1/91
Manganese[5]	Chronic	2.4E-02	mg/kg/day	5%	1E-03	mg/kg/day	CNS (Neurotoxicity)	3	Region 4	6/17/05
Nickel	Chronic	2E-02	mg/kg/day	20%	4E-03	mg/kg/day	Decreased body and organ weights	300	IRIS	12/1/96
Selenium	Chronic	5E-03	mg/kg/day	20%	1E-03	mg/kg/day	Clinical selenosis	3	IRIS	9/1/91
Sodium	Chronic	NA	mg/kg/day	NA	NA	mg/kg/day	NA	NA	NA	NA
Total Mercury[4]	Chronic	1E-04	mg/kg/day	20%	2E-05	mg/kg/day	Developmental neuro. abnormalities	10	IRIS	5/1/95
Vanadium	Chronic	7E-03	mg/kg/day	3%	2E-04	mg/kg/day	Decreased hair cystine	unk	HEAST	6/19/05
Zinc	Chronic	3E-01	mg/kg/day	20%	6E-02	mg/kg/day	Decreased ESOD concentration	3	IRIS	10/1/92
Ammonia	Chronic	NA	mg/kg/day	NA	NA	mg/kg/day	No adverse affects	NA	IRIS	5/1/91
Chloride	Chronic	NA	mg/kg/day	NA	NA	mg/kg/day	NA	NA	NA	NA
Sulfate	Chronic	NA	mg/kg/day	NA	NA	mg/kg/day	NA	NA	NA	NA
Nitrate	Chronic	1.6E+00	mg/kg/day	20%	3E-01	mg/kg/day	Methemoglobinemia	1	IRIS	10/1/91
Nitrite	Chronic	1E-01	mg/kg/day	20%	2E-02	mg/kg/day	Methemoglobinemia	10	IRIS	10/1/97
1,1-Dichloroethane	Chronic	1E-01	mg/kg/day	100%	1E-01	mg/kg/day	None observed	1000	HEAST	1997
1,1-Dichloroethene	Chronic	9E-03	mg/kg/day	100%	9E-03	mg/kg/day	Liver	1000	IRIS	4/1/89
Vinyl Chloride	Chronic	NA	mg/kg/day	NA	NA	mg/kg/day	NA	NA	NA	NA

Notes:

3. ATSDR toxicological profiles consulted. When absorption efficiency exceeded 50% in the toxicological profile, EPA Region 4 policy is to default to 100% (EPA 1999). Where no data were available. The following defaults were used: 20% inorganics, 50% semivolatiles, 80% volatiles.
4. EPA 1989. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A) December. Appendix A.
5. Equation used for derivation: RfD x oral to dermal adjustment factor.
6. Toxicity value surrogates: Methylmercury used for mercury.
7. The RfDo for manganese in IRIS is 1.4E-1 mg/kg/day based on the NOAEL of 10 mg/day. For soil exposure, Region 4 policy is to subtract the average daily dietary exposure (5 kg/day) from the NOAEL to determine a "soil" RfDo. When this is done, a "soil" RfDo of 7E-2 kg/kg/day results. For water, a neonate is considered a sensitive receptor for the neurological effects of manganese. Thus, caution (in the form of a modifying factor) is warranted until more data are available. Using a modifying factor of 3 results in a "water" RfDo of 2.4E-2 mg/kg/day.

Acronyms:

ATSDR - Agency for Toxic Substances and Disease Registry
ESOD - Erythrocyte superoxide dismutase
HEAST - Health Effects Assessment Summary Tables
IRIS - Integrated Risk Information System
NCEA - National Center for Environmental Assessment
RfD - Reference dose

TABLE 5.2
NON-CANCER TOXICITY DATA — ORAL/DERMAL
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Adjusted RfD[1]		Primary Target Organ	Combined Uncertainty/ Modifying Factors	RfC: Target Organ(s)	
		Values	Units	Values	Units			Source(s)	Date(s)
Ammonia	Chronic	1E-01	mg/m^3	2.9E-02	mg/kg/day	Lung	30	IRIS	5/1/91
1,1-Dichloroethane	Chronic	5E-01	mg/m^3	1.4E-01	mg/kg/day	Kindey	1000	HEAST	1997

1. Equation used for derivation: RfC divided by 70 kg (assumed human body weight) multiplied by 20 m^3/day (assumed human intake rate).

Acronyms:
RfD - Reference dose
RfC - Reference concentration
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables

TABLE 6.1
CANCER TOXICITY DATA — ORAL/DERMAL
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Chemical of Potential Concern	Oral Cancer Slope Factor		Absorption Efficiency (for Dermal)	Adjusted Cancer Slope Factor (for Dermal)[1,2]		Weight of Evidence/Cancer Guideline Description[4,5]	Oral CSF: Absorption Efficiency	
	Value	Units		Value	Units		Source(s)	Date(s)
Aluminum	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Antimony	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Arsenic	1.5E+00	$(mg/kg/day)^{-1}$	100%	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	4/10/98
Barium	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Cadmium	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Chromium (Total)	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Chromium (Hexavalent)	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Copper	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Iron	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Lead	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Manganese	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Nickel	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Selenium	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Sodium	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Total Mercury [6]	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	C	IRIS	5/5/98
Vanadium	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Zinc	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Ammonia	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Chloride	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Sulfate	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Nitrate	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
Nitrite	NA	$(mg/kg/day)^{-1}$	NA	NA	$(mg/kg/day)^{-1}$	D	NA	NA
1,1-Dichloroethane	NA	$(mg/kg/day)^{-1}$	100%	NA	$(mg/kg/day)^{-1}$	C	IRIS	12/7/89
1,1-Dichloroethene	6E-01	$(mg/kg/day)^{-1}$	100%	6.0E-01	$(mg/kg/day)^{-1}$	C	IRIS	1/7/87
Vinyl Chloride	1.9E+00	$(mg/kg/day)-^{-1}$	100%	1.9E+00	$(mg/kg/day)-^{-1}$	A	HEAST	1997

Notes:

1. ATSDR toxicological profiles consulted. When absorption efficiency exceeded 50% in the toxicological profile, EPA Region IV policy is to default to 100% (EPA 1999). Where no data were available, the following defaults were used: 20% inorganics, 50% semivolatiles, 80% volatiles.
2. EPA 1989. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A) December. Appendix A.
3. Equation used for derivation: CSF divided by oral dermal adjustment factor.
4. Weight of Evidence:
   Known/Likely
   Cannot be Determined
   Not Likely
5. EPA Group:
   A - Human carcinogen
   B1 - Probable human carcinogen - indicates that limited human data are available
   B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
   C - Possible human carcinogen
6. Methylmercury used for mercury carcinogenicity

Acronyms:
ATSDR - Agency for Toxic Substances and Disease Registry
IRIS - Integrated Risk Information System
CSF - Cancer Slope Factor

D - Not classified as a human carcinogen
E - Evidence of noncarcinogenity
NE - Not evaluated
W - Withdrawn; Agency position pending

TABLE 6.2
CANCER TOXICITY DATA — ORAL/DERMAL
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Chemical of Potential Concern	Unit Risk		Adjustment[1]	Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description[2,3]	Source(s)	Date(s)
	Value	Units		Value	Units			
1,1-Dichloroethene	5.0.E-05	ug/m^3	3500	1.8.E-01	$(mg/kg/day)^{-1}$	C	IRIS	1/7/87
Vinyl chloride	0.000084	ug/m^3	3500	2.9.E-01	$(mg/kg/day)^{-1}$	A	HEAST	1997

Notes:

1. Adjustment: 70 kg (assumed human body weight) divided by20 m^3/day (assumed human intake rate) multiplied by 1,000 ug/mg or 1,000,000,000 pg/mg (conversion factors).
2. Weight of Evidence:
   Known/Likely
   Cannot be Determined
   Not Likely
3. EPA Group:
   A - Human carcinogen
   B1 - Probable human carcinogen - indicates that limited human data are available
   B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
   C - Possible human carcinogen
   D - Not classified as a human carcinogen
   E - Evidence of noncarcinogenicity
   W - Withdrawn; Agency position pending

Acronyms:

ATSDR - Agency for Toxic Substances and Disease Registry
CSF - Cancer Slope Factor
HEAST - Health Effects Assessment Summary Tables
IRIS - Integrated Risk Information System
NCEA - National Center for Environmental Assessment

TABLE 7.1
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS — REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Current/Future

Receptor Population: Visitor

Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	Exposure Point Concentration		Cancer Risk Calculations					Non-Cancer Hazard Calculation				
							Intake/Exposure Dose		CSF/Unit Risk		Cancer Risk	Intake/Exposure Dose		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water	Surface Water	Ditch	Ingestion	Aluminum	1,790	µg/L	2E-05	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA	1E-04	mg/kg/day	1E+00	mg/kg/day	0.0001
				Copper	15	µg/L	1E-07	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA	9E-07	mg/kg/day	4E-02	mg/kg/day	0.00002
				Lead	6	µg/L	5E-08	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA	4E-07	mg/kg/day	NA	mg/kg/day	NA
				Manganese	1,260	µg/L	1E-05	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA	8E-05	mg/kg/day	2E-02	mg/kg/day	0.003
				Zinc	60	µg/L	5E-07	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA	4E-06	mg/kg/day	3E-01	mg/kg/day	0.00001
				Sulfate	29,200	µg/L	3E-04	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA	2E-03	mg/kg/day	NA	mg/kg/day	NA
			Exposure Route Total								**NA**					0.003
Surface Water	Surface Water	Ditch	Dermal	Aluminum	1,790	µg/L	1E-06	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA	1E-05	mg/kg/day	2E-01	mg/kg/day	0.00005
				Copper	15	µg/L	1E-08	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA	8E-08	mg/kg/day	8E-03	mg/kg/day	0.00001
				Lead	6	µg/L	5E-09	mg/kg/day	0E+00	$(mg/kg/d)^{-1}$	NA	4E-08	mg/kg/day	NA	mg/kg/day	NA
				Manganese	1,260	µg/L	1E-06	mg/kg/day	0E+00	$(mg/kg/d)^{-1}$	NA	7E-06	mg/kg/day	1E-03	mg/kg/day	0.01
				Zinc	60	µg/L	5E-08	mg/kg/day	0E+00	$(mg/kg/d)^{-1}$	NA	3E-07	mg/kg/day	6E-02	mg/kg/day	0.00001
				Sulfate	29,200	µg/L	2E-05	mg/kg/day	0E+00	$(mg/kg/d)^{-1}$	NA	2E-04	mg/kg/day	NA	mg/kg/day	NA
			Exposure Route Total								**NA**					**0.01**
Medium Total											**NA**					**0.01**
									Total Receptor Risks Across All Media		**NA**	**Total Receptor Hazards Across All Media**				**0.01**

TABLE 7.2
CALCULATION OF CHEMICAL NON-CANCER HAZARDS — REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future

Receptor Population: Resident

Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	Exposure Point Concentration		Non-Cancer Hazard Calculations				
							Intake/Exposure Dose		RfD/RfC		
					Value	Units	Value	Units	Value	Units	Hazard Quotient
Groundwater	Groundwater	Well	Ingestion	Aluminum	27,000	µg/L	2E+00	mg/kg/day	1E+00	mg/kg/day	2
				Antimony	4	µg/L	2E-04	mg/kg/day	4E-04	mg/kg/day	1
				Arsenic	45	µg/L	3E-03	mg/kg/day	3E-04	mg/kg/day	10
				Barium	280	µg/L	2E-02	mg/kg/day	7E-02	mg/kg/day	0.3
				Cadmium	41	µg/L	3E-03	mg/kg/day	5E-04	mg/kg/day	5
				Chromium (Total)	340	µg/L	2E-02	mg/kg/day	3E-03	mg/kg/day	7
				Chromium (Hexavalent)	7	µg/L	4E-04	mg/kg/day	3E-03	mg/kg/day	0.1
				Copper	1,100	µg/L	7E-02	mg/kg/day	4E-02	mg/kg/day	2
				Iron	6,500	µg/L	4E-01	mg/kg/day	3E-01	mg/kg/day	1
				Lead	100	µg/L	6E-03	mg/kg/day	NA	mg/kg/day	NA
				Manganese	371	µg/L	2E-02	mg/kg/day	2E-02	mg/kg/day	1
				Nickel	190.0	µg/L	1E-02	mg/kg/day	2E-02	mg/kg/day	0.6
				Selenium	188	µg/L	1E-02	mg/kg/day	5E-03	mg/kg/day	2
				Sodium	86,722	µg/L	6E+00	mg/kg/day	NA	mg/kg/day	NA
				Total Mercury	1	µg/L	8E-05	mg/kg/day	1E-04	mg/kg/day	1
				Vanadium	630	µg/L	4E-02	mg/kg/day	7E-03	mg/kg/day	6
				Ammonia	640,000	µg/L	4E+01	mg/kg/day	NA	mg/kg/day	NA
				Chloride	950,000	µg/L	6E+01	mg/kg/day	NA	mg/kg/day	NA
				Sulfate	410,000	µg/L	3E+01	mg/kg/day	NA	mg/kg/day	NA
				Nitrate	167,000	µg/L	1E+01	mg/kg/day	2E+00	mg/kg/day	7
				Nitrite	160	µg/L	1E-02	mg/kg/day	1E-01	mg/kg/day	0.1
				1,1-Dichloroethane	680	µg/L	4E-02	mg/kg/day	1E-01	mg/kg/day	0.4
				1,1-Dichloroethene	180	µg/L	1E-02	mg/kg/day	9E-03	mg/kg/day	1
				Vinyl chloride	18	µg/L	1E-03	mg/kg/day	NA	mg/kg/day	NA
			Exposure Route Total								**47**

TABLE 7.2 (CONTINUED)

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	Exposure Point Concentration Value	Exposure Point Concentration Units	Non-Cancer Hazard Calculation: Intake/Exposure Dose Value	Intake/Exposure Dose Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Well	Inhalation	Aluminum	27,000	µg/L	2E+00	mg/kg/day	NA	mg/kg/day	NA
				Antimony	4	µg/L	2E-04	mg/kg/day	NA	mg/kg/day	NA
				Arsenic	45	µg/L	3E-03	mg/kg/day	NA	mg/kg/day	NA
				Barium	280	µg/L	2E-02	mg/kg/day	NA	mg/kg/day	NA
				Cadmium	41	µg/L	3E-03	mg/kg/day	NA	mg/kg/day	NA
				Chromium (Total)	340	µg/L	2E-02	mg/kg/day	NA	mg/kg/day	NA
				Chromium (Hexavalent)	7	µg/L	4E-04	mg/kg/day	NA	mg/kg/day	NA
				Copper	1,100	µg/L	7E-02	mg/kg/day	NA	mg/kg/day	NA
				Iron	6,500	µg/L	4E-01	mg/kg/day	NA	mg/kg/day	NA
				Lead	100	µg/L	6E-03	mg/kg/day	NA	mg/kg/day	NA
				Manganese	371	µg/L	2E-02	mg/kg/day	NA	mg/kg/day	NA
				Nickel	190.0	µg/L	1E-02	mg/kg/day	NA	mg/kg/day	NA
				Selenium	188	µg/L	1E-02	mg/kg/day	NA	mg/kg/day	NA
				Sodium	86,722	µg/L	6E+00	mg/kg/day	NA	mg/kg/day	NA
				Total Mercury	1	µg/L	8E-05	mg/kg/day	NA	mg/kg/day	NA
				Vanadium	630	µg/L	4E-02	mg/kg/day	NA	mg/kg/day	NA
				Ammonia	640,000	µg/L	4E+01	mg/kg/day	3E-02	mg/kg/day	1,432
				Chloride	950,000	µg/L	6E+01	mg/kg/day	NA	mg/kg/day	NA
				Sulfate	410,000	µg/L	3E+01	mg/kg/day	NA	mg/kg/day	NA
				Nitrate	167,000	µg/L	1E+01	mg/kg/day	NA	mg/kg/day	NA
				Nitrite	160	µg/L	1E-02	mg/kg/day	NA	mg/kg/day	NA
				1,1-Dichloroethane	680	µg/L	4E-02	mg/kg/day	NA	mg/kg/day	NA
				1,1-Dichloroethene	180	µg/L	1E-02	mg/kg/day	NA	mg/kg/day	NA
				Vinyl chloride	18	µg/L	1E-03	mg/kg/day	NA	mg/kg/day	NA
			Exposure Route Total								**1,432**
Medium Total											**1,479**
										Total Receptor Hazards Across All Media	**1,479**

TABLE 7.3
CALCULATION OF CHEMICAL CANCER RISKS — REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future

Receptor Population: Lifetime Resident

Receptor Age: Child to Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	Exposure Point Concentration		Cancer Risk Calculations				
							Intake/Exposure Dose		CSF/Unit Risk		
					Value	Units	Value	Units	Value	Units	Cancer Risk
Groundwater	Groundwater	Well	Ingestion	Aluminum	27,000	µg/L	4E-01	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Antimony	4	µg/L	6E-05	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Arsenic	45	µg/L	7E-04	mg/kg/day	1.5E+00	$(mg/kg/d)^{-1}$	1E-03
				Barium	280	µg/L	4E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Cadmium	41	µg/L	6E-04	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Chromium (Total)	340	µg/L	5E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Chromium (Hexavalent)	7	µg/L	1E-04	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Copper	1,100	µg/L	2E-02	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Iron	6,500	µg/L	1E-01	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Lead	100	µg/L	1E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Manganese	371	µg/L	6E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Nickel	190.0	µg/L	3E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Selenium	188	µg/L	3E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Sodium	86,722	µg/L	1E+00	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Total Mercury	1	µg/L	2E-05	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Vanadium	630	µg/L	9E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Ammonia	640,000	µg/L	1E+01	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Chloride	950,000	µg/L	1E+01	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Sulfate	410,000	µg/L	6E+00	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Nitrate	167,000	µg/L	2E+00	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Nitrite	160	µg/L	2E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				1,1-Dichloroethane	680	µg/L	1E-02	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				1,1-Dichloroethene	180	µg/L	3E-03	mg/kg/day	6.0E-01	$(mg/kg/d)^{-1}$	2E-03
				Vinyl chloride	18	µg/L	3E-04	mg/kg/day	1.9E+00	$(mg/kg/d)^{-1}$	5E-04
			Exposure Route Total								**3E-03**

TABLE 7.3 (CONTINUED)

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	Exposure Point Concentration		Cancer Risk Calculation				
							Intake/Exposure Dose		CFS/Unit Risk		
					Value	Units	Value	Units	Value	Units	Cancer Risk
Groundwater	Groundwater	Well	Inhalation	Aluminum	27,000	µg/L	4E-01	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Antimony	4	µg/L	6E-05	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Arsenic	45	µg/L	7E-04	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Barium	280	µg/L	4E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Cadmium	41	µg/L	6E-04	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Chromium (Total)	340	µg/L	5E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Chromium (Hexavalent)	7	µg/L	1E-04	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Copper	1,100	µg/L	2E-02	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Iron	6,500	µg/L	1E-01	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Lead	100	µg/L	1E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Manganese	371	µg/L	6E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Nickel	190.0	µg/L	3E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Selenium	188	µg/L	3E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Sodium	86,722	µg/L	1E+00	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Total Mercury	1	µg/L	2E-05	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Vanadium	630	µg/L	9E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Ammonia	640,000	µg/L	1E+01	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Chloride	950,000	µg/L	1E+01	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Sulfate	410,000	µg/L	6E+00	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Nitrate	167,000	µg/L	2E+00	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				Nitrite	160	µg/L	2E-03	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				1,1-Dichloroethane	680	µg/L	1E-02	mg/kg/day	NA	$(mg/kg/d)^{-1}$	NA
				1,1-Dichloroethene	180	µg/L	3E-03	mg/kg/day	1.8E-01	$(mg/kg/d)^{-1}$	5E-04
				Vinyl chloride	18	µg/L	3E-04	mg/kg/day	2.9E-01	$(mg/kg/d)^{-1}$	8E-05
			Exposure Route Total								**5E-04**
Medium Total											**4E-03**
										Total Receptor Risks Across All Media	**4E-03**

TABLE 8.1 RME
CALCULATION OF RADIATION CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

There are no radiation hazards associated with this site; therefore, completion of this table is not applicable.

TABLE 9.1
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs — REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Current/Future

Receptor Population: Visitor

Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Chemical of Potential Concern	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Surface Water	Surface Water	Ditch	Aluminum	NA	NA	NA	NA	Aluminum	CNS (Neurotoxicity)	0.00011	0.003	NA	0.003
			Copper	NA	NA	NA	NA	Copper	No adverse effect	0.000022	0.000012	NA	0.00003
			Lead	NA	NA	NA	NA	Lead	CNS (Neurotoxicity)	NA	NA	NA	NA
			Manganese	NA	NA	NA	NA	Manganese	CNS (Neurotoxicity)	0.003	0.003	NA	0.007
			Zinc	NA	NA	NA	NA	Zinc	Decreased ESOD concentration	0.000012	0.000051	NA	0.00006
			Sulfate	NA	NA	NA	NA	Sulfate	NA	NA	0.000010	NA	0.000010
			Total	**NA**	**NA**	**NA**	**NA**	**Total**		**0.000**	**0.003**	**NA**	**0.003**

Total Risk Across All Media and All Exposure Routes: **NA**

Total Hazard Index Across All Media and All Exposure Routes: 0.003

Conclusions:
1. The excess cancer risk level is below EPA's acceptable range (10-4 and 10-6).
2. The hazard index is less than one, indicating non-cancer effects are not likely.

TABLE 9.2
SUMMARY OF RECEPTOR HAZARDS FOR COPCs — REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future

Receptor Population: Resident

Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Non-Carcinogenic Hazard Quotient				
				Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Groundwater	Groundwater	Well	Aluminum	CNS (Neurotoxicity)	2	NA	NA	2
			Antimony	Blood chemistry	1	NA	NA	1
			Arsenic	Skin (Hyperpigmentation, keratosis)	10	NA	NA	10
			Barium	Kidney	0.3	NA	NA	0.3
			Cadmium	Significant proteinuria	5	NA	NA	5
			Chromium (Total)	No adverse effect	7	NA	NA	7
			Chromium (Hexavalent)	No adverse effect	0.1	NA	NA	0.1
			Copper	No adverse effect	2	NA	NA	2
			Iron	No adverse effect	1	NA	NA	1
			Lead	CNS (Neurotoxicity)	NA	NA	NA	NA
			Manganese	CNS (Neurotoxicity)	1	NA	NA	1
			Nickel	Decreased body and organ weights	0.6	NA	NA	0.6
			Selenium	Clinical selenosis	2	NA	NA	2
			Sodium	NA	NA	NA	NA	NA
			Total Mercury	Developmental neuro. abnormalities	1	NA	NA	1
			Vanadium	Decreased hair cystine	6	NA	NA	6
			Ammonia	Lung	NA	NA	1,432	1,432
			Chloride	NA	NA	NA	NA	NA
			Sulfate	NA	NA	NA	NA	NA
			Nitrate	Methemoglobinemia	7	NA	NA	7
			Nitrite	Methemoglobinemia	0.1	NA	NA	0.1
			1,1-Dichloroethane	None observed	0.4	NA	NA	0.4
			1,1-Dichloroethene	Liver	1	NA	NA	1
			Vinyl chloride	NA	NA	NA	NA	NA
			Total	**Total**	**47**	**NA**	**1,432**	**1,479**

Total Hazard Index Across All Media and All Exposure Routes	**1,479**
Total lung HI Across All Media =	**1,432**
Total skin HI Across All Media =	**10**
Total methemoglobinemia HI Across All Media =	**7**
Total decreased cystine HI Across All Media =	**6**
Total CNS HI Across All Media =	**3**

Conclusions:
The hazard index is greater than one, indicating non-cancer effects are possible.

TABLE 9.3
SUMMARY OF RECEPTOR RISKS FOR COPCs — REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future

Receptor Population: Resident

Receptor Age: Child to Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Routes Total
Groundwater	Groundwater	Well	Aluminum	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA
			Arsenic	1E-03	NA	NA	1E-03
			Barium	NA	NA	NA	NA
			Cadmium	NA	NA	NA	NA
			Chromium (Total)	NA	NA	NA	NA
			Chromium (Hexavalent)	NA	NA	NA	NA
			Copper	NA	NA	NA	NA
			Iron	NA	NA	NA	NA
			Lead	NA	NA	NA	NA
			Manganese	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA
			Sodium	NA	NA	NA	NA
			Total Mercury	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA
			Ammonia	NA	NA	NA	NA
			Chloride	NA	NA	NA	NA
			Sulfate	NA	NA	NA	NA
			Nitrate	NA	NA	NA	NA
			Nitrite	NA	NA	NA	NA
			1,1-Dichloroethane	NA	NA	NA	NA
			1,1-Dichloroethene	2E-03	NA	5E-04	2E-03
			Vinyl chloride	5E-04	NA	8E-05	6E-04
			Total	**3E-03**	**NA**	**5E-04**	**4E-03**

Total Risk Across All Media and All Exposure Routes	**4E-03**

Conclusions:
The excess cancer risk level is above EPA's acceptable range (10-4 and 10-6).

TABLE 10.1
RISK ASSESSMENT SUMMARY — REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Current/Future
Receptor Population: Visitor
Receptor Age: Adolescent

Conclusions:

1. The excess cancer risk level is within EPA's acceptable range (10-4 and 10-6).
2. The hazard index is less than one, indicating non-cancer effects are not likely.
3. Based on these conclusions, there are no Chemicals of Concern and preparation of Table 10 is not applicable.

TABLE 10.2
RISK ASSESSMENT SUMMARY — REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future

Receptor Population: Resident

Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Non-Carcinogenic Hazard Quotient				
				Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Groundwater	Groundwater	Well	Aluminum	CNS (Neurotoxicity)	2	NA	NA	2
			Antimony	Blood chemistry	1	NA	NA	1
			Arsenic	Skin (Hyperpigmentation, keratosis)	10	NA	NA	10
			Barium	Kidney	0.3	NA	NA	0.3
			Cadmium	Significant proteinuria	5	NA	NA	5
			Chromium (Total)	No adverse effect	7	NA	NA	7
			Chromium (Hexavalent)	No adverse effect	0.1	NA	NA	0.1
			Copper	No adverse effect	2	NA	NA	2
			Iron	No adverse effect	1	NA	NA	1
			Lead	CNS (Neurotoxicity)	NA	NA	NA	NA
			Manganese	CNS (Neurotoxicity)	1	NA	NA	1
			Nickel	Decreased body and organ weights	0.6	NA	NA	0.6
			Selenium	Clinical selenosis	2	NA	NA	2
			Sodium	NA	NA	NA	NA	NA
			Total Mercury	Developmental neuro. abnormalities	1	NA	NA	1
			Vanadium	Decreased hair cystine	6	NA	NA	6
			Ammonia	Lung	NA	NA	1,432	1,432
			Chloride	NA	NA	NA	NA	NA
			Sulfate	NA	NA	NA	NA	NA
			Nitrate	Methemoglobinemia	7	NA	NA	7
			Nitrite	Methemoglobinemia	0.1	NA	NA	0.1
			1,1-Dichloroethane	None observed	0.4	NA	NA	0.4
			1,1-Dichloroethene	Liver	1	NA	NA	1
			Vinyl chloride	NA	NA	NA	NA	NA
			Total	**Total**	**47**	**NA**	**1,432**	**1,479**

Total Hazard Index Across All Media and All Exposure Routes	**1,479**
Total lung HI Across All Media =	**1,432**
Total skin HI Across All Media =	**10**
Total methemoglobinemia HI Across All Media =	**7**
Total decreased cystine HI Across All Media =	**6**
Total CNS HI Across All Media =	**3**

Conclusions:
The hazard index is greater than one, indicating non-cancer effects are possible.

TABLE 10.3
RISK ASSESSMENT SUMMARY — REASONABLE MAXIMUM EXPOSURE
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Scenario Timeframe: Future

Receptor Population: Resident

Receptor Age: Child to Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Routes Total
Groundwater	Groundwater	Well	Aluminum	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA
			Arsenic	1E-03	NA	NA	1E-03
			Barium	NA	NA	NA	NA
			Cadmium	NA	NA	NA	NA
			Chromium (Total)	NA	NA	NA	NA
			Chromium (Hexavalent)	NA	NA	NA	NA
			Copper	NA	NA	NA	NA
			Iron	NA	NA	NA	NA
			Lead	NA	NA	NA	NA
			Manganese	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA
			Sodium	NA	NA	NA	NA
			Total Mercury	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA
			Ammonia	NA	NA	NA	NA
			Chloride	NA	NA	NA	NA
			Sulfate	NA	NA	NA	NA
			Nitrate	NA	NA	NA	NA
			Nitrite	NA	NA	NA	NA
			1,1-Dichloroethane	NA	NA	NA	NA
			1,1-Dichloroethene	2E-03	NA	5E-04	2E-03
			Vinyl chloride	5E-04	NA	8E-05	6E-04
			Total	**3E-03**	**NA**	**5E-04**	**4E-03**

Total Risk Across All Media and All Exposure Routes	4E-03

Conclusions:
The excess cancer risk level is above EPA's acceptable range (10-4 and 10-6).

TABLE 11.1
RISK-BASED REMEDIAL GOAL OPTIONS AND ARARs FOR GROUNDWATER
RESIDENTIAL LAND USE ASSUMPTIONS
ZELLWOOD SITE
ORANGE COUNTY, FLORIDA

Chemicals of Concern	Detection[1] (µg/L)		Cancer Risk Level[2] (µg/L)			Hazard Quotient Level[3] (µg/L)			ARAR/TBC (µg/L)	
	Min	Max	1E-6	1E-5	1E-4	HQ=0.1	HQ=1	HQ=3		
Aluminum	110	27,000	NA	NA	NA	1,564	15,643	46,929	200	SMCL
Antimony	1.6	25	NA	NA	NA	0.6	6	19	6	MCL
Arsenic	4.8	100	0.04	0.4	4	0.5	5	14	50	MCL
Barium	5.4	280	NA	NA	NA	110	1,095	3,285	2,000	MCL
Cadmium	1.6	99	NA	NA	NA	1	8	23	5	MCL
Chromium (Total)	2.6	340	NA	NA	NA	5	47	141	100	MCL
Chromium (Hexavalent)	6.8	7	NA	NA	NA	5	47	141	100	MCL
Copper	3.0	1,100	NA	NA	NA	63	626	1,877	1,300	MCLG
Iron	1.5	6,500	NA	NA	NA	469	4,693	14,079	300	SMCL
Lead	2.3	160	NA	NA	NA	NA	NA	NA	15	MCL
Manganese	19	1,000	NA	NA	NA	38	375	1,126	50	SMCL
Nickel	3.5	190	NA	NA	NA	31	313	939	100	MCL
Selenium	10	400	NA	NA	NA	8	78	235	50	MCL
Sodium	9,000	540,000	NA	NA	NA	NA	NA	NA	160,000	MCL
Total Mercury	0.3	3	NA	NA	NA	0.2	2	5	2	MCL
Vanadium	3	630	NA	NA	NA	11	110	329	49	GC
Ammonia	1,300	640,000	NA	NA	NA	45	447	1,341	2,800	GC
Chloride	28,000	950,000	NA	NA	NA	NA	NA	NA	250,000	SMCL
Sulfate	12,000	410,000	NA	NA	NA	NA	NA	NA	250,000	SMCL
Nitrate	880	167,000	NA	NA	NA	2,503	25,029	75,086	10,000	MCL
Nitrite	160	160	NA	NA	NA	156	1564	4693	1000	MCL
1,1-Dichloroethane	680	680	NA	NA	NA	156	1564	4693	70	GC
1,1-Dichloroethene	180	180	0.1	0.9	9	14	141	422	7	MCL
Vinyl chloride	18	18	0.03	0.3	3	NA	NA	NA	1	MCL

1. Data for monitor wells (MW) 06SA, 06SB, 08SA, 08SB, 9SA, 9SB, 10SA, 10SB, 11SA, 11SB, 12D, 12SA, 12SB, 13SA and13SB.
2. Remediation goals based on ingestion of groundwater and inhalation of volatiles using Lifetime Resident Exposure Assumptions.
3. Remediation goals based on ingestion of groundwater and inhalation of volatiles using Child Resident land use exposure assumptions
   The combination of Lifetime Resident exposure assumptions for carcinogens and Child Resident exposure assumptions for non-carcinogens results in the lowest (most protective) risk-based concentrations.
4. ARAR/TBC: Applicable or Relevant and Appropriate Requirement/To-Be-Considered
   MCL = Florida Maximum Containment Level (ARAR)
   SMCL = Florida Secondary Maximum Containment Level (TBC)
   GC = Florida Groundwater Guidance Concentration (TBC)

Acronyms:
NA: Not applicable
HQ: Hazard quotient (noncancer risk)