Kimball (2000)

Lyndhurst/Rutherford Redevelopment Project

Lyndhurst Township, Bergen County, New Jersey

Remedial Investigation Report

For

Avon Landfill

May 24, 2000

Prepared for:

EnCap GOLF
TAMPA, FLORIDA

PREPARED BY:

Joseph W. D'Andrea
Senior Environmental Specialist

James T. Hockensmith PG
Senior Vice President

L. ROBERT KIMBALL & ASSOCIATES, INC.
CONSULTING ARCHITECTS AND ENGINEERS
615 WEST HIGHLAND AVENUE
EBENSBURG, PA

Newark Bay Study Area
NBSA-00073

L. Robert Kimball & Associates

Corporate Headquarters
615 West Highland Avenue, P O Box 1000, Ebensburg, PA 15931 Phone: 814/472-7700 Fax: 814/472-7712
www.lrkimball.com E-Mail: aande@lrkimball.com

May 25, 2000

Mr. Michael S. Kenney
NJ Department of Environmental Protection
Responsible Party Cleanup Element
410 E. State Street
Trenton, NJ 08625-0028

Re: Remedial Investigation Report for Avon Landfill
Lyndhurst/Rutherford Redevelopment Project
Lyndhurst, Bergen County, NJ

Dear Mr. Kenney:

Enclosed is our Remedial Investigation Report for the Avon Landfill conducted for the Lyndhurst/Rutherford Redevelopment Project. Also enclosed are two additional copies of the report and copies of the Referenced Documents for prior investigation activities.

We request your review and comment on the enclosed documents. Please call me at the above number or email me at dandrj@lrkimball.com with any questions or requests for additional information.

Sincerely,

Joseph W. D'Andrea
Senior Environmental Specialist

Enclosures
99-0864/C/A/C/00LT0525
cc: R. Dewan, NJDEP
N. Houseman, NJDEP
D. Sayles, EnCap
W. Gauger, EnCap
J. Cappolla, DFG
J. Koczan, IT
D. Lawler, HMDC

TABLE OF CONTENTS

		Page No.
Executive Summary		ES-1
1.0	INTRODUCTION	1
1.1	Purpose and Objectives	1
1.2	Site Location and Description	1
1.3	Site Ownership and Land Use	3
2.0	PHYSICAL SETTING	5
2.1	Site Soils and Geology	5
2.2	Site Hydrogeology	7
2.3	Study Area Topography	9
2.4	Surface Hydrology	10
2.5	Well Search	11
3.0	RESULTS OF PREVIOUS INVESTIGATIONS	12
3.1	NJ Turnpike Authority Environmental Impact Statement Technical Studies for Turnpike Widening (NJTA 1985)	12
3.1.1	NJTA EIS Surface Water Investigations – 1985	12
3.1.2	NJTA EIS Sediment Investigations – 1985	12
3.2	NJ Sports and Exposition Authority – Wetland Assessment for Proposed Sports Stadium (NJSEA 1987)	13
3.2.1	NJSEA Surface Water Investigation (1987)	13
3.2.2	NJSEA Sediment Investigations – 1987	13
3.3	NJ Turnpike Authority – Site Investigation for Avon Landfill Closure (NJTA 1989)	14
3.3.1	NJTA Soil/Fill/Debris Investigations	14
3.3.2	NJTA Groundwater Investigations – 1989	16
3.3.3	NJTA Surface Water Investigations – 1989	17
3.3.4	NJTA Sediment Investigations –1988	18
3.3.5	NJTA Air Quality Investigations – 1989	18
3.4	USEPA Site Inspection of Avon Sanitary Landfill (USEPA 1990)	19
3.4.1	USEPA Soil/Fill/Debris Investigations – 1990	19
3.4.2	USEPA Groundwater Investigations – 1990	19
3.4.3	USEPA Surface Water Investigations – 1990	20
4.0	TECHNICAL OVERVIEW	21
4.1	Soil/Fill/Debris Investigation	21
4.1.1	Soil/Fill/Debris Sampling	21
4.1.2	Soil/Fill/Debris Sample Analyses	22
4.1.3	Health and Safety Monitoring	22
4.1.4	Significant Events or Seasonal Variations Affecting Sampling and Analysis	22

TABLE OF CONTENTS (Continued)

		Page No.
4.2	Groundwater Investigation	23
	4.2.1 Groundwater Sampling	23
	4.2.2 Results of Groundwater Sample Analyses	24
	4.2.3 Groundwater Flow Characteristics	25
	4.2.4 Tidal Influence upon Site Groundwater	26
	4.2.5 Groundwater Exfiltration	27
	4.2.6 Significant Events or Seasonal Variation Affecting Groundwater Investigations	28
4.3	Surface Water Investigation	28
	4.3.1 Surface Water Sampling	28
	4.3.2 Results of Surface Water Analyses	29
	4.3.3 Significant Events or Seasonal Variations Affecting Sampling or Analysis	30
4.4	Sediment Investigations	30
	4.4.1 Sediment Sampling	30
	4.4.2 Results of Sediment Analyses	31
	4.4.3 Significant Events or Seasonal Variations Affecting Sampling or Analysis	31
4.5	Air Quality Investigations	31
	4.5.1 Air Sampling	31
	4.5.2 Results of Air Analyses	32
	4.5.3 Reliability and Accuracy of Analysis	32
	4.5.4 Significant Events or Seasonal Variations Affecting Sampling or Analysis	32
4.6	Quality Assurance and Quality Control	33
	4.6.1 Field Blanks and Trip Blanks	33
	4.6.2 Field Duplicates	33
	4.6.3 Matrix Spike\Matrix Spike Duplicates	34
	4.6.4 Holding Times	34
	4.6.5 Method Detection Limits	34
	4.6.6 Precision and Accuracy	34
4.7	Health and Safety Monitoring	36
5.0	DISCUSSION AND INTERPRETATION OF COMPILED RESULTS	37
5.1	Soil/Fill/Debris Investigation	37
5.2	Groundwater Investigation	38
5.3	Surface Water and Seep Investigation	39
5.4	Sediment Investigation	40
5.5	Air Quality Investigation	41

TABLE OF CONTENTS (Continued)

		Page No.
6.0	BASELINE ECOLOGICAL EVALUATION	43
6.1	Contaminants of Ecological Concern	43
6.2	Determination of an Environmentally Sensitive Area	44
6.3	Potential Migration Pathways	44
6.4	Conclusions and Recommendations	45
7.0	CONCLUSIONS AND RECOMMENDATIONS	46
7.1	Soil/Fill/Debris Investigation	46
7.2	Groundwater Investigations	46
7.3	Surface Water and Seep Investigation	47
7.4	Sediment Investigation	48
7.5	Air Quality Investigation	48
7.6	Ecological Evaluation	49
8.0	REFERENCES	50

TABLE OF CONTENTS (Continued)

APPENDICES

Appendix A - Sample and Boring Logs
Appendix B - Tidal Study Data
Appendix C - Laboratory Data
Appendix D - Remedial Investigation Work Plans

LIST OF TABLES

Table 1 Property Ownership Summary
Table 2 Hydrologic Data for Berrys Creek
Table 3 Monitor Well and Piezometer Information
Table 4 Surface Water Analysis Results – NJTA EIS 1985
Table 5 Sediment Analysis Results – NJTA EIS 1985
Table 6 Surface Water Analysis Results – NJSEA 1987
Table 7 Sediment Analysis Results – NJSEA 1987
Table 8 Soil Analysis Results - NJTA SI Report 1989
Table 9 Groundwater Analysis Results – NJTA SI Report 1989
Table 10 Surface Water Analysis Results – NJTA SI Report 1989
Table 11 Sediment Analysis Results – NJTA SI Report 1989
Table 12 Soil Analysis Results – USEPA 1990
Table 13 Groundwater Analysis Results – USEPA 1990
Table 14 Surface Water Analysis Results – USEPA 1990
Table 15 Sediment Analysis Results – USEPA 1990
Table 16 Surface Water Analysis Results – HMDC 1999
Table 17 Groundwater Analysis Results – Kimball 2000
Table 18 Surface Water Analysis Results – Kimball 2000
Table 19 Sediment Analysis Results – Kimball 2000
Table 20 Air Analysis Results – Kimball RI 2000
Table 21 Air Monitoring Results – Kimball RI 2000

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

Figure 1	Site Location Map
Figure 2	Site Layout Map
Figure 3	Surficial Geology Map
Figure 4	Surficial Geology Profiles
Figure 5	Extent of Fill
Figure 6	Geologic Profile A-A'
Figure 7	Geologic Profile B-B'
Figure 8	Geologic Profile C-C'
Figure 9	Geologic Profile D-D'
Figure 10	Groundwater Contour Map
Figure 11	Sample Location Map
Figure 12A	Soil/Fill/Debris-Organic Compounds
Figure 12B	Soil/Fill/Debris-Inorganic Analytes
Figure 13A	Groundwater - Organic Compounds
Figure 13B	Groundwater – Organic Compounds
Figure 14A	Groundwater - Inorganic Analytes
Figure 14B	Groundwater - Inorganic Analytes
Figure 15	Hydrographs
Figure 16A	Surface Water and Sediment – Organic Compounds
Figure 16B	Surface Water and Sediment– Organic Compounds
Figure 17A	Surface Water and Sediment– Inorganic Analytes
Figure 17B	Surface Water and Sediment– Inorganic Analytes

EXECUTIVE SUMMARY

L. Robert Kimball and Associates, Inc. (Kimball) prepared this Remedial Investigation Report (RIR) for EnCap Golf of Tampa Florida to document results of investigations conducted at the Avon Landfill in Lyndhurst Township, Bergen County, New Jersey. This RIR was conducted to evaluate prior investigative findings and establish current conditions as needed to support design and construction anticipated in redeveloping the landfill. Research and investigations were conducted to determine subsurface characteristics of the landfill, to establish physical and chemical characteristics of migration pathways, identify the type and concentrations of contaminants in landfilled waste and impacted enviroment, and to collect information needed for design and permitting.

The Avon Landfill is an undeveloped site located near the west bank of the Hackensack River in Lyndhurst Township, Bergen County, New Jersey. The current land surfaces were constructed by filling salt-water marshland with municipal, industrial, commercial and demolition wastes between the late 50's and 1980. The horizontal extent of fill was controlled by existing embankments constructed for the Jersey City Aqueduct, Transcontinental Gas Pipeline, and NJ Transit Main Line rail right of way. Van Winkle Ditch and Bucks Creek are man-made drainage ditches constructed to carry surface runoff from the study area to Berrys Creek and the Hackensack River.

The Avon Landfill Corporation, and various hauling and chemical service firms controlled by Thomas and Frank Viola, operated the site until ceasation of activities in 1980. Currently, the State of New Jersey Bureau of Tidelands owns the portion of the Avon Landfill north of Valley Brook Avenue, and Disiderio et al own the portion of the landfill south of Valley Brook Avenue. Landfill operations filled approximately 103 acres of former marshland, which include lands owned or leased by the operators.

Subsurface investigations identified waste fill of up to 45 feet depth in the center of the landfill. Former marshland organic soil and meadow mat were encountered as a zero to 8 feet thick layer beneath the waste. Former landfill operations had excavated meadowmat for surface cover, resulting in areas absent of marshland soil. A 110 to over 185 feet thick layer of varved silt and clay underlies the full extent of landfilled waste. Permeabilities reported in the silt and clay layer were 10^{-7} to 10^{-8} cm/s. A 10 to 30 feet thick layer of glacial till was reported in the northern end of the landfill. Shale and sandstone bedrock was reported at depths of 110 feet at the southern end of the landfill and over 300 feet at the northern end of the landfill.

A groundwater mound was observed in the landfilled waste. Modeling of potentiometric surfaces in the landfill indicate the mound drives site groundwater outward in all directions, to discharge to nearby surface water bodies. The underlying varved silt and clay layer acts as an aquitard to vertical movement of groundwater into or out of the landfill.

The Hackensack River and tributaries within the immediate vicinity of the site exhibit twice daily tidal flow that ranges between a negative 3.22 feet to about 2.66 feet elevation. The twice daily tidal flood reaches the full extent of Van Winkle Ditch. A tide gate constructed at the end of Bucks

Creek is obstructed with silt and debris and allows the tidal flood to reach portions of Bucks Creek south of Valley Brook Avenue. Over 97 percent of the landfill surfaces are above the 100 year storm flood elevation of about 7.6 feet (8.6 feet 1929 datum).

The Avon Landfill has been investigated several times since 1985 in assessing the site for potential development. The NJ Sports and Exposition Authority investigated the Avon and Lyndhurst Landfills in 1987 for possible development as a baseball stadium. The NJ Turnpike Authority investigated the Avon Landfill in 1988 and 1989 for possible development of roadway interchange. The US Environmental Protection Agency investigated the Avon Landfill in 1990 as part of CERCLA site assessment processes.

Kimball and other team members conducted intrusive investigations of the Avon Landfill in February and March 2000. Soil borings were advanced along the edge and in the center of fill to obtain physical characteristics of waste fill and verify reported extent and type of waste. Groundwater samples were collected from four piezometers and 11 existing monitor wells and analyzed for general landfill parameters, volatile organics, base neutral organics, and heavy metals. Surface water samples were collected from four locations in Bucks Creek and three locations in Van Winkle Ditch and analyzed for general landfill parameters, volatile organics, base neutral organics, and heavy metals. Sediment samples were collected from one location in Bucks Creek and three locations in Van Winkle Ditch and analyzed for general landfill parameters, volatile organics, polycyclic aromatic hydrocarbsons, and heavy metals. Air samples were collected from two gas vents, one borehole and one animal burrow screened/opened to the unsaturated waste fill.

Soil investigations identified dispersed presence of aromatic hyrdrocarbons, phthlates, polycyclic aromatic hydrocarbons and heavy metals in site soil and waste fill at concentrations above and below current restricted use criteria. Pesticides and PCBs were in one of 38 soil samples processed over the years. Although historical records indicate intermingling of industrial wastes in with the municipal waste disposed at the site, site investigations did not encounter localized areas of high contaminant concentration or industrial waste. The level of contamination reported in soil samples exceed at least one restricted use criteria in all portions of the landfill.

Groundwater investigations identified dispersed presence of aromatic hydrocarbons, phthlates and heavy metals in site groundwater exceeding current Class IIA Groundwater Quality Standards. Groundwater modeling and results of surface reconnaissance and sampling indicate the impacted groundwater migrates out of the landfill into Van Winkle Ditch, Bucks Creek, and Kingsland Creek. Site reconnaissance performed in 2000 observed only three discrete landfill seeps along Bucks Creek and no seeps at the toe of slope along the Jersey City Aqueduct. Reconnaissance did identify several areas of saturated soil above Bucks Creek water surfaces indicative of zones of dispersed seepage.

Surface water investigations identified aromatic hydrocarbons, PAHs, phthalates, and heavy metals in seeps and surface water in the northern end of Bucks Creek. Except for the heavy metal mercury, the concentrations of contaminants meet current SE Surface Water Quality Criteria. The aromatic hydrocarbons detected in surface sample ASW-1 (total 1,862ug/L) and seep sample AS-1 (total 33.4 ug/L) indicate impacts from discharge of impacted groundwater to the northern end of

Bucks Creek. Results of analyses performed in the southern end of Bucks Creek and middle and southern portions of Van Winkle Ditch, show absence or at most trace concentrations of the organic contaminants, indicative of natural attenuation along the creek and domination of contaminant mass by tidal flow from Berrys Creek and the Hackensack River.

Sediment investigations detected PAH organic compounds and heavy metal analytes in sediments of Bucks Creek and Van Winkle Ditch at concentrations exceeding Marine/Estuarine Screening Guidelines. Aromatic hydrocarbons were detected at trace concentrations in sediments located at seeps. The contaminants noted in on-site sediments are similar in type and concentration as contaminants reported for areas influenced by Berrys Creek and the Hackensack River.

Air from the unsaturated zone of the landfill was monitored using real-time volatile organic detectors during intrusive investigations in 1988 and 2000. Air samples also were collected from two gas vents, one borehole and one groundhog burrow in 2000 and analyzed for volatile organic compounds. Results of real-time air monitoring indicate methane dominates air quality in landfill gases. Results of air sample analyses show the non-methogenic compounds are few in number and low in concentration.

Results of environmental investigations were used to evaluate the potential for impacts to ecological receptors. Aromatic hydrocarbons, PAHs and heavy metals were identified in site soil, and groundwater above one or more regulatory action levels. These same compounds were detected at lower concentrations in Bucks Creek, Van Winkle Ditch, Berrys Creek and the Hackensack River. Bucks Creek, Van Winkle Ditch and downstream wetland and riverine ecosystems were identified as environmentally sensitive areas adjacent to the Avon Landfill. Pathways between landfilled waste and Bucks Creek and Van Winkle Ditch were confirmed through results of analyses and field reconnaissance.

Historical and intrusive investigations identified co-mingled waste in 103 of 104 acres included in this study to depths of 14 to 35 feet below ground surface. Heavy metals were detected in surface soil and waste fill above restricted use criteria in nine of 38 samples analyzed. Aromatic hydrocarbons were detected in 21 of the samples analyzed, with one sample exhibiting concentrations of benzene and chlorobenzene above restricted use criteria. PCBs were detected slightly above the restricted use criteria in one surface sample. The pesticide 4,4'-DDT was detected in one sample below the applicable restricted use criteria. The 110 soil borings and 38 soil samples analyzed in three investigations provide sufficient quantity and quality of data to characterize the horizontal and vertical extent of fill, as well as the type and level of contamination in site waste and soil. Further investigation in search of discrete, worst-case source areas is not warranted. Therefore, no further soil/fill/debris investigation is recommended.

Groundwater was encountered in the waste fill, in 4 to 8 feet thick layer of original organic soil intermittently beneath the waste, in 120 to over 185 feet thick layer of low-permeability silt and clay underlying the full site, in glacial till encountered beneath the north portion of the site, and in underlying shale and sandstone bedrock. Water level measurements obtained from 20 wells and four piezometers define a mound of groundwater within the fill. The 4 to 7 feet hydraulic head drives site groundwater outward in all directions from the mound. Analytical results show site

groundwater to be impacted by the aromatic hydrocarbons benzene, chlorbenzene, xylene, 2-butanone and toluene; phthalates; naphthalene; and the metals aluminum, arsenic, iron, lead and manganese at concentrations above Class IIA Groundwater Quality Standards. Data collected in three investigations is sufficient in quantity and quality to adequately characterize the type and level of contamination in site groundwater and the migration pathways to off-site receptors. Therefore, no further groundwater investigations are recommended.

The results of analyses performed on 23 surface water samples collected from the Avon Landfill local identified aromatic hydrocarbons, PAHs, and heavy metals in surface water surrounding the landfill. Highest concentrations were detected in the northern portion of Bucks Creek in areas impacted from groundwater discharge. Results of analyses of samples from the south end of Bucks Creek and three locations in Van Winkle Ditch show lower concentrations of heavy metals and only trace concentrations of a few organic ompounds. The findings indicate that contaminant constituents experience natural attentuation and mass dilution in the water ways to the point that current Surface Water Quality Standards are met. The quantity and quality of surface water investigation data are sufficient to characterize the extent, type and level of contamination, therefore no further investigations are recommended.

Real-time monitoring of landfill gases using PID and FID instruments detected landfill gas emitting from gas vents and animal burrows in the landfill. The readings indicate that methane dominates the volatile organic compounds in the gases. The results of four air samples confirm this finding and identify a limited number of volatile organic compounds at low concentrations in site air. No further air investigations are recommended.

Results of surface water and sediment investigations identify levels of organic compounds and heavy metal analytes in sediments in Van Winkle Ditch, Bucks Creek, Berrys Creek, and the Hackensack River. The results also show that the concentrations reported in site sediments is similar in type and concentration to the contamination reported for regional sediment areas. Since site contamination is similar to regional background conditions, no further ecological assessment is recommended.

1.0 INTRODUCTION

L. Robert Kimball and Associates, Inc. (Kimball) has prepared this Remedial Investigation Report for EnCap Golf of Tampa Florida to document results of environmental and physical conditions detected at the Avon Landfill in Lyndhurst Township, Bergen County, New Jersey.

Section 1 outlines the project purpose, objectives, and description of the project. Section 2 presents the physical setting of the project area as developed using historical documents, research, and results of investigations by Kimball and others. Section 3 presents the results of previous investigations performed by others. Section 4 presents the technical overview of the investigative work performed in 1999 and 2000. Section 5 presents the results of investigations performed in 1999 and 2000. Section 6 discusses the compiled results and interpretation of findings associated with the Avon Landfill. Section 7 presents the results of a baseline ecological assessment for the site. Section 8 presents conclusions and recommendations based on the results of investigations and background research.

1.1 Purpose and Objectives

The purpose of this investigation was to evaluate and substantiate previous findings, fill data gaps in the conceptual model, and establish current conditions needed to support design and construction anticipated in closing the landfill. The objectives of this work were to:

- Determine subsurface characteristics of the site, including soil characteristics, horizontal and vertical extent of wastes, and stratigraphy.
- Determine hydrologic characteristics of the site, physical and chemical characteristics of site groundwater and impacts of tidal fluctuations in nearby surface water bodies.
- Determine the type and concentration of contaminants in landfill gas, soil, groundwater, surface water and sediments.
- Collect information needed to establish baseline conditions at the landfill prior to closure and capping activities.

1.2 Site Location and Description

Avon Landfill is situated along the west bank of the Hackensack River in Lyndhurst Township, Bergen County, New Jersey. Figure 1 – Site Location Map, presents the site location at the eastern end of Valley Brook Avenue, south of Route 3 and west of the NJ Turnpike and Hackensack River. The current land surfaces were constructed by filling former saline marshland with soil, debris, and waste over a 23+ year period between approximately 1957 and April 1, 1980. Figure 2 – Site Layout Map and the following describe the significant cultural and geographic surface features noted in the vicinity of the study area.

Avon Landfill - Avon Landfill is a 103-acre site constructed by filling former marshland between about 1957 to 1980 with soil from on-site and off-site sources, various classes of wastes and demolition debris. The landfill area is approximately 600 feet wide and 7800 feet long, with a tapered northern end. Landfill operations covered 91 of 92 acres of the primary property owned or leased by the Avon Landfill Corporation (Block 231, Lot 14 and Block 233, Lot 14), plus an additional 11 acres of property leased from adjoining property owners (Block 231 Lots 13 and 15, Block 233, Lot 13, and Block 235, Lot 30. Landfill operations encompassed former marshland between the earth embankments previously constructed for the Jersey City Aqueduct and NJ Transit Main Line. Landfill activities progressed north to south the full length of the site. An estimated three to four lifts of waste were placed over the site. Approximately one acre of land next to the Transcontinental Pipeline embankment at the southeastern end of the landfill was not filled.

NJ Transit Main Line - The NJ Transit Main Line, formerly owned by Conrail and earlier Erie-Lackawanna Railroad, consists of earth embankment constructed prior to 1900 in former marshland. The rail embankment defines the western extent of the waste fill area.

Jersey City Aqueduct - The Jersey City Aqueduct consists of two 72-inch diameter steel pipes constructed in 1902-1903 on earthen embankment in former marshland. The aqueduct embankment defines the eastern extent of the fill area. The Jersey City Aqueduct encompasses properties owned by the City of Jersey City (Block 231, Lot 13 and Block 233, Lot 13) and operated by the United Water Company. The Avon Landfill Corporation extended landfill operations to the Aqueduct embankment in 1974-75 per a lease with the Jersey City Water Authority.

Van Winkle Ditch - Van Winkle Ditch is a man-made drainage channel constructed along the northern edge of the Jersey City Aqueduct to carry marshland flow to Berrys Creek and the Hackensack River. Van Winkle Ditch flows easterly along the aqueduct embankment to the Transcontinental Pipeline, then northerly along the pipeline to Berrys Creek. With invert elevations of about zero to four feet above mean sea level, Van Winkle Ditch exhibits tidal influence from Berrys Creek and the Hackensack River.

Transcontinental Pipelines - Two steel natural gas pipelines are constructed in an earth embankment in a 60-foot wide easement along the southern property line between the Avon landfill and the NJ Turnpike embankment. The Transcontinental Pipelines were constructed prior to landfill operations and define the southern extent of the waste fill area.

NJ Turnpike - The NJ Turnpike western extension is an earth embankment constructed in 1968-1969 through former marshland between the Transcontinental Pipeline embankment and saline marshland along the western shore of the Hackensack River.

Bucks Creek - Bucks Creek is a man-made drainage ditch excavated along the NJ Transit Main Line embankment and western toe of slope of the Avon Landfill. The ditch is a remnant of former drainage ways excavated in marshland along the rail embankment and filled by landfill operations between 1972 and 1980. A tide gate constructed at the point where the ditch passes

beneath the Transcontinental Pipelines prevents tidal backflow from Mary Anne's Ditch and the Hackensack River. The Bucks Creek tide gate marks the end of Bucks Creek and the beginning of Mary Anne's Ditch. Bucks Creek carries runoff from the NJ Transit Main Line and Avon Landfill embankments, as well as seepage from Avon Landfill.

Mary Anne's Ditch - Mary Anne's Ditch is a man-made drainage ditch constructed along the western edge of the Jersey City Aqueduct embankment to carry the discharge from Bucks Creek and runoff from the Avon Landfill, the Transcontinental Pipeline and the NJ Turnpike embankments to the Hackensack River. The ditch exhibits tidal influence from the Hackensack River.

Lyndhurst Landfill – Lyndhurst Landfill consists of man-made lands north and east of the Jersey City Aqueduct constructed by public and private waste landfill operations between the mid 1950s and 1969. Lyndhurst Landfill extends the full length of Van Winkle Ditch.

Un-named Tributary to Berrys Creek - An un-named tributary to Berrys Creek is connected to Van Winkle Ditch at a point midway along the eastern edge of the Jersey City Aqueduct. The tributary extends from Van Winkle Ditch to Berrys Creek north of Valley Brook Avenue. The tributary directs storm flow from the landfill and natural flow from marshland to Berrys Creek. Branches from the tributary extend around the southern edge and eastern edge of the Viola Tract, which is the northern section of the Lyndhurst Landfill in the study area.

Berrys Creek - Berrys Creek is the primary drainage system within the study area. Original hydrology of the creek was altered several decades ago when the Berrys Creek Canal was excavated north of the study area to replace creek flow capacity reduced by the NJ Transit Bergen Line culvert. Van Winkle Ditch discharges to Berrys Creek at the Transcontinental Pipeline crossing.

Hackensack River - The Hackensack River flows north to south east of the study area. Tidal flows from the river extend into the study area through Mary Anne's Ditch and Van Winkle Ditch.

Valley Brook Avenue – Valley Brook Avenue is the central point of access to the study area. The public roadway crosses the southern half of the Avon Landfill.

1.3 Site Ownership and Land Use

The Avon landfill encompasses current tax Block 231, Lot 14 and Block 233 Lot 14. Landfill operations extended into Jersey City Aqueduct properties (Block 231, Lot 13 and Block 233, Lot 13) per a lease with the Jersey City Water Authority. Landfill operations also appear to have extended into former rail properties (Block 231, Lot 15 and Block 235 Lot 30).

The Avon Landfill Corporation and principals Thomas and Frank Viola were associated with landfill activities throughout the operating life of the landfill. Avon Landfill Corporation obtained a NJDEP permit to operate the landfill as a sanitary landfill in 1972. Intercity Services

Inc. and Industrial Haulage, Inc., both of which had Thomas and/or Frank Viola as principals, also operated at the landfill. The land has remained undeveloped following the end of landfill operations in April 1980.

The properties have changed ownership during and after landfill activities. The current property owners are presented in Table 1 – Property Ownership Summary.

Avon Sanitary Landfill is an inactive landfill that operated between about 1957 through 1980 by the Avon Landfill Corporation and other corporate names of Intercity Services, Inc., and Industrial Haulage, Inc. The principals of the Avon Landfill Corporation, Frank and Thomas Viola, were also principals of other corporate entities. Avon Landfill Corporation was permitted to accept household, commercial, industrial and agricultural refuse; leaves, tree stumps, prunings; bulky items; tires; and dead animals. NJDEP study of regional waste flows in 1968 identified waste streams entering the landfill to be dominated by waste flow from municipal (1,571 tons/day) and industrial (2,642 tons/day) sources, and to a lesser degree waste flow from commercial (99 tons/day) and demolition (94 tons/day) waste sources (Zurn 1970). Mr. Frank Viola stated in a letter to the HMDC in 1978 that 270 trucks per day were delivering waste to the Avon Landfill. USEPA surveys of industrial operations in the region identified waste flows from industrial sources to include base solutions, heavy metals, and other miscellaneous organic and inorganic wastes. (USEPA 1990)

Waste fill is confirmed through historical records and site investigations to extend throughout 92 of 93 acres of the primary properties (Block 231, Lot 14 and Block 233, Lot 14) and an estimated 11 additional acres of land leased for filling of the adjoining Jersey City Aqueduct and former River Rail properties.

2.0 PHYSICAL SETTING

2.1 Site Soils and Geology

The study area is located in areas filled by former private and public landfill operations which placed fill and waste directly into estuarine and salt-marsh sediments associated with the Hackensack River and Berrys Creek. Soil boring logs advanced through the fill and former marsh environment described underlying sedimentary and glacial deposits extending to about 87 feet near the Hackensack River and deeper than 200 feet at the western most edge of the study area. The approximate horizontal extent of fill material can be seen in Figure 5 – Extent of Fill. The boring logs confirm the published surficial geology paraphrased from the enclosed portions of the surficial geology map published by the New Jersey Geological Survey (Stanford 1993) and presented as Figure 3 - Surficial Geology Map and Figure 4 Surficial Geology Profiles and as follow:

Af – Artificial Fill – Artificially emplaced sand, gravel, silt, clay and rock, and man-made materials including cinders, ash, construction materials, and trash. Observed thickness ranging from zero to 45 feet in study area. Maximum recorded thickness by areas of discussion include: Rutherford Landfill, West and North-12 to 15 feet; Rutherford Landfill, East-20 to 33 feet; Lyndhurst Landfill-six to 17 feet; and Avon Landfill-30 to 45 feet.

Qm – Estuarine and salt-marsh deposits - Organic silt and clay, underlain by fresh-water peat in the Hackensack and Overpeck marshes. Black, dark brown and gray on tidal flats. Brown and gray silt, sand and minor gravel in tidal channels. Observed throughout study area. Maximum recorded thickness by areas of discussion include: Rutherford Landfill - 13 feet in undisturbed marsh, Lyndhurst Landfill - eight feet, and Avon Landfill - four to eight feet. The observed thickness of the organic soil and peat layer beneath landfill materials range from zero to eight feet due to mixing with fill/waste, compression by the fill surcharge, being pushed ahead of filling as a mud wave, and having been excavated for landfill cover.

Qhkl – Lake-bottom deposits – Glacial Lake Hackensack deposits. Deltaic, lake-bottom, and lacustrine-fan deposits. Varved silt and clay, reddish brown to gray. As much as 150 feet thick. Observed throughout the study area. The upper four to 12 feet of clay is stiff due to exposure following deposition.

Qbnl – Lake-bottom deposits – Glacial Lake Bayonne deposits underlying the Lake Hackensack deposits. Deltaic, lake-bottom, and lacustrine-fan deposits. Varved silt and clay, reddish brown to gray. As much as 160 feet thick. Observed throughout the study area. Reported as very soft clay and silt with thin lenses of sand.

Qbnf – Lacustrine-fan deposits – Sand, brown to reddish brown, some gravel. As much as 200 feet thick outside of the study area and tens of feet in study area boring logs. Reported only in the western portion of the Study Area.

Qt – Rahway Till – Reddish brown to reddish yellow silty sand, sandy silt and sand, with some to many subrounded and subangular pebbles and cobbles and few subrounded boulders. As much as 70 feet thick. Continuous and generally more than ten feet thick. Reported ten to 14 feet thick in the eastern portion of the study area and thinning or absent to the west. Top of till reported at 140 to 179 feet below ground surface in study area.

The Johnson Soil Engineering Company researched geotechnical characteristics of site unconsolidated material in preparation of developing the adjoining Kingsland Landfill (former Lyndhurst II Landfill). (Johnson 1968) The following characteristics provided in the Johnson report apply to site subsurface environment:

Upper surface of original marsh characterized as very soft, wet meadow mat, which varies in thickness from five to ten feet. The meadow mat exhibits average water content of 240 percent, dry density of 20 pounds per cubic foot, and organic content of 22 percent to 55 percent, averaging 40 percent. Due to its physical characteristics, the wet meadow mat will not consolidate, but rather tends to displace beneath surface loads. Once dry and spread in a thin lift, the meadow mat will consolidate up to 30 percent under loads of one half ton per square foot, 50 percent under one ton per square foot and up to 65 percent under loads of two tons per square foot. 90 percent of settlement will occur in less than one year up to 12 feet thick. The remaining ten percent of settlement would take ten to 30 years to occur. The permeability of the meadow mat was measured to be 1×10^{-3} cm/sec (medium to low).

- Beneath the meadow mat, in most places, is a layer of organic silt, which is similar in many ways to the meadow mat. The organic silt varies in thickness from zero to 14 feet. Many prior reports do not differentiate between the meadow mat and organic silt. The organic silt layer exhibits average water content of 100 percent, a dry density of 45 pounds per cubic foot, and organic content of nine percent to 14 percent, averaging 11 percent. The liquid limit of the organic silt averaged 100 percent. Settlement characteristics of the organic silt is similar to the meadow mat, with settlements of 20 percent, 30 percent and 45 percent under loads of one half, one, and two tons per square foot respectively. Time for settlement would be slightly longer than the meadow mat. The permeability of the organic silt was measured to be 1×10^{-4} cm/sec (low).

- The meadow mat and organic silt are very similar in strength characteristics. In their natural state, they exhibit a maximum allowable bearing capacity of zero to zero point two tons per square foot.

- Underlying the meadow mat and organic silts is a layer of stiff varved clay with sand lenses, which is sometimes described as the desiccated layer. This layer of stiff clay was exposed in the distant past, allowing it to dry, consolidate and gain strength. This stratum varies in thickness between five and 14 feet and averages 12 feet. The stiff clay exhibited water content of 28 percent and dry density of 100 pounds per cubic foot. Consolidation tests performed on the stiff silt and clay indicate that settlement in this layer for loads up to four

tons per square foot would be negligible. The permeability of the stiff silt and clay was measured to be 1 x 10^{-6} cm/sec (very low).

- Beneath the desiccated zone of varved silt and clay the soil becomes gradually softer, wetter and weaker. The varved clay extends from 70 to 140 feet beneath the surface or more. The soft silt and clay exhibited water content of 35 percent and dry density of 90 pounds per cubic foot. Settlement of the soft silt and clay under loadings of one ton per square foot, which approximates landfill to about 40 feet, will result in one and a half to two and a half inches. The permeability of the soft silt and clay was measured to be 1 x 10^{-5} cm/sec (very low).

- The liquid limit of the clays was about 30 percent.

Site boring log information reports siltstone and sandstone in the west-northwest portions of the study area and shale throughout the central and eastern portion of the study area. Depth to bedrock increases east to west, from about 87 feet at the Hackensack River to over 300 feet west of the Avon Landfill. The gradual slope in local bedrock surface conforms to the enclosed Surficial Geologic Map.

The study area is located within the Newark Geologic Basin and is made up of a thick (7,500m or 24,600 ft) sequence of fluvial and lacustrine rocks and lava flows. Red-brown siltstone, sandstone and shale reported in site boring logs conform to sandy mudstone of the mapped Passaic Formation of the Brunswick Group. The Brunswick Group is reported to strike northeast-southwest and dip to the northwest. (Drake 1996) Drake et al, Bedrock Geologic Map of Northern New Jersey, U.S. Geological Survey, 1996.

Soil boring information collected during this and previous investigations at the site was used to generate several geologic profiles of the Avon Landfill. The profiles are presented to show the relationship of the buried waste material to the underlying peat and varved clay units. Figures 6, 7, 8 and 9 provide geologic profiles of subsurface conditions. Geologic Profiles A-A', B-B' and C-C' show cross-sectional views of the landfill from a southwest to northeast orientation. Geologic Profile D-D', which extends from the New Jersey Turnpike to the northwestern corner of the landfill, is a cross-sectional view of the unconsolidated and consolidated units underlying the landfill.

2.2 Site Hydrogeology

Regional groundwater flow in unconsolidated material beneath and surrounding the site is expected to flow from the topographic highlands, located west of the site, eastward toward the Hackensack River. Numerous manmade utility structures, filled lands, excavated canals and surface water bodies (i.e., Berrys Creek) significantly alter shallow groundwater flow patterns by creating hydraulic divides, hydraulic barriers and preferential pathways for shallow groundwater flow.

Groundwater potentiometric surface measurements obtained in January 1989 and February 2000 depict a groundwater mound within the landfilled waste. As shown on Figures 6, 7, 8, and 9 Geologic Profiles and Figure 10 - Groundwater Contour Map, water elevations within the waste were found to range from about two to four feet above mean sea-level (MSL) along Bucks Creek, seven to ten feet above MSL along the Jersey City Aqueduct embankment, and ten to 14 feet above MSL in the center of the landfill. Modeling of water level measurements shown on Figure 10 Groundwater Contour Map depict groundwater flow potential from the center of the landfill waste to the outer edges.

Variables affecting groundwater flow within the Avon Landfill include heterogeneities in landfill cell layering, presence and absence of underlying natural soil, sediment and clay; constructed earth embankments surrounding the landfill, impermeable pipelines parallel to the eastern edge of the landfill, and man-made surface drainage systems cut into and below the depth of landfill groundwater surfaces. As shown in Figures 6 though 9 Geologic Profiles, the full extent of landfill is underlain by a thin, intermittent layer of organic soil and sands and a much thicker layer of varved silts and clays. The figures also depict earth embankments constructed for pipelines and railroads surrounding the landfill, which have either significantly compressed or removed the original organic soil and sand layer.

As shown in Geologic Profiles A-A', B-B', C-C', & D-D' (Figures 6, 7, 8, and 9, respectively), a 110 to over 185 feet thick layer of varved silt and clay underlies the site. Testing performed on the varved silt and clay measured permeabilities of 1.55×10^{-7} to 5.04×10^{-8} cm/sec. (NJTA 1989) Groundwater measurements in nested wells screened in the waste, mid-way through the varved silt and clay layer and in the underlying glacial till layer indicate varying hydrologic potential for vertical flow. The low permeabilities of the varved silt and clay and varying hydraulic potential between the landfill and underlying unconsolidated zones indicate the varved silts and clays act as an effective aquitard to vertical flow of groundwater to or from the landfill.

The groundwater surface at the western edge of the landfill along Bucks Creek was observed at or slightly above the invert elevation of water in the ditch. Wetland areas observed extending from the ditch up the landfill slope indicate presence of continuous discharge from the landfill above the invert elevation of the ditch at several locations. Few discrete flowing seeps were observed along the landfill toe of slope. The observed elevated discharge points indicate either elevated groundwater mound at those locations or preferential paths for percolation water to flow along waste lifts and intermediate cover layers above the stable groundwater mound elevation. As noted in Figure 10. Groundwater Contour Map, the site groundwater is modeled to flow into and beneath Bucks Creek. The figure also indicates, as is confirmed through site observation, that site groundwater discharges to Bucks Creek and nearby Kingsland Creek.

The groundwater surface on the eastern side of the landfill is noted to be at or above the top of the Jersey City Aqueduct pipes (6 to 8 feet above MSL) and several feet above the invert elevation of Van Winkle Ditch (0 to 4 feet above MSL). This variance in elevations is attributable to the Jersey City Aqueduct acting as a partial hydraulic barrier between the groundwater within the landfill and Van Winkle Ditch. No seeps were observed along the eastern toe of landfill slope, nor along the

pipeline slope toward Van Winkle Ditch. As shown in Figure 10, Groundwater Contour Map, the site groundwater mounds behind the aqueduct pipes and flow beneath the pipes to discharge in Van Winkle Ditch.

2.3 Study Area Topography

The Avon Landfill is a man-made earth and waste rise constructed by filling former tidal marshland. Upper surface elevations east of Valley Brook Avenue range between 27 feet to 30 feet above MSL. Upper surface elevations west of Valley Brook Avenue range between 28 and 35 feet above MSL. Current surface elevations are eight to ten feet lower than elevations reported in 1985.

The eastern slope of the landfill drops at a 6:1 (Horizontal: Vertical) grade down to six to ten feet above MSL as controlled by the Jersey City Aqueduct embankment and a shallow swale that remains between the toe of landfill slope and the aqueduct embankment. The top of the Jersey City Aqueduct embankment ranges in elevation from 6.2 to eight feet east of Valley Brook Avenue to 7.7 to 9.3 feet west of Valley Brook Avenue.

The western slope also drops at about a six to one grade down to the invert of Bucks Creek in the NJ Transit Mainline embankment. The western toe of the landfill slope meets the eastern edge of the rail embankment along Bucks Creek. Bucks Creek is a man-made drainage ditch with invert elevations ranging from about zero feet at the southeastern end to about nine feet at the northwestern end of the landfill.

Avon landfill is located within a topographic lowland located adjacent to the western shoreline of the Hackensack River. Kingsland Creek is located south of the NJ Transit Mainline and Avon Landfill. Berrys Creek and Van Winkle Ditch are located east of the landfill. Sediments in Berrys Creek and Van Winkle Ditch are exposed below the mean high water line of three feet above MSL. Invert elevations in Van Winkle Ditch, located along the eastern slope of the Jersey City Aqueduct embankment, range from slightly below zero elevation at the Transcontinental pipeline to about four feet above MSL at the northwestern end of the ditch. Tidal flows were observed in the majority of Van Winkle Ditch. Van Winkle Ditch north of the culvert to the un-named tributary is dewatered to less than a yard width at low tide.

The Hackensack Meadowlands extends north and south of the study area, with surface elevations rising gradually to the north. Surface topography rises out of the marshland to local man-made earthen rises within and surrounding the study area, and by natural land surfaces to the west.

The NJ Turnpike and Transcontinental Pipelines are constructed on man-made fills through marshland using earth and rock from off-site sources. The NJ Turnpike embankment was constructed in 1968/69. The NJ Turnpike embankment top surface elevations range from a low of 10.5 feet over Berrys Creek to 35.5 feet on the decks of the NJ Transit Bergen and Main Line bridges. The NJ Turnpike east slope drops down to adjacent marsh and waterway edge elevations of one to three feet. The NJ Turnpike west slope drops down to the Transcontinental Pipeline embankment, which has upper surfaces of about seven feet through the study area.

The Jersey City Aqueduct, constructed during 1902 and 1903 using earth fill from off-site sources, runs northwest to southeast through the study area, and comprises the eastern boundary of the Avon Landfill. The eastern edge of the embankment drops steeply to the adjoining Van Winkle Ditch. The upper surface of the aqueduct embankment ranges in elevation from a low of 6.2 feet near the Transcontinental Pipelines to 14 feet at the far northwestern end of the study area.

A ten to 30 foot wide swale with invert elevations slightly below the top of pipeline embankment extends the length of the landfill between the aqueduct embankment and the landfill rise. The swale has no known outlet to local surface waterways.

A 110 by 200 foot oblong pond is located at the northwestern end of the landfill. The pond is a localized depression with no outlet visible or reported. The northernmost tip of the Avon Landfill slopes down to the pond. All other landfill areas slope either to Bucks Creek or Van Winkle Ditch. The end of Bucks Creek is located immediately south and at about a two-foot higher elevation than the pond surface measured at about seven feet above MSL. The end of Van Winkle Ditch is located immediately south and at the same or lower elevation than the pond, but is separated by an area of fill.

2.4 Surface Hydrology

Surface water runoff along the eastern slope of the landfill enters a shallow swale between the landfill rise and the Jersey City Aqueduct. No connection between the swale and nearby Van Winkle Ditch is visible or reported. With less than a foot of elevation difference between the invert of the swale and the top of the aqueduct embankment, storm flows are readily able to flow over the embankment into Van Winkle Ditch. Otherwise, normal runoff collecting in the swale is allowed to percolate into the local groundwater.

A depression located at the southern extreme of the swale has developed into a localized wetland. Historical mapping and aerial photographs indicate that the swale was once connected to Mary Anne's Ditch. Current mapping and field observations indicate that the flow path has been blocked by fill for access roads to the landfill.

Van Winkle Ditch is a man-made drainage system that extends the full length of the east side of Avon Landfill, ending at Berrys Creek 1,300 feet east of the landfill along the Transcontinental Pipeline. The ditch discharges to and exhibits tidal influence from Berrys Creek and the Hackensack River throughout its length. Using 2000 topographic mapping, an estimated 800,000 cubic feet (six million gallons) of water flows through Van Winkle Ditch each tidal cycle.

Tidal measurements were obtained for a National Oceanographic and Atmospheric Agency (NOAA) tide gage installed in a tributary to the Hackensack River identified as Berrys Creek No. 8E. Copies of the tide gage data are provided in Appendix B with Hydrologic Data. A recent

vertical survey of the tide gage benchmark elevation was obtained to convert tide gage measurements to the current NAVD88 elevations.

Based on the 1977 tidal measurements adjusted to 1988 North American Vertical Datum, tide in Berrys Creek and the Hackensack River adjoining the site ranges between a mean low water elevation of about negative 3.2 feet and mean high water of about 2.66 feet. These elevations place the majority of Van Winkle Ditch and Bucks Creek south of Valley Brook Avenue within the tide range. (NOAA 1977)

Per the 1993 NJDEP Flood Plain study, as recorded in the current Federal Emergency Management Agency (FEMA) flood plain maps for the area, the FEMA 100 year flood plain elevation for the area is about 7.6 feet NAVD88 (8.66 feet NGVD29). As such, 97 percent of the Avon Landfill is above the FEMA 100 year flood plain elevation. (FEMA 1993)

The northern half of Van Winkle Ditch is connected to an un-named tributary to Berrys Creek which bisects Lyndhurst landfill. The tributary is tidally influenced through its full length, discharging to Berrys Creek twice a day through a dual culvert under Valley Brook Avenue.

Surface water runoff flowing off the western slope of the Avon Landfill enters Bucks Creek. Bucks Creek flows along the west toe of slope of the Avon Landfill until reaching the Transcontinental pipeline embankment, then turns north to join Mary Anne's Ditch at the Jersey City Aqueduct embankment. Mary Anne's Ditch exhibits tidal influence from the Hackensack River. A tide gate located on the north edge of the Transcontinental pipeline embankment was constructed to prevent tidal backflow into Berrys Creek. Sediment buildup in Berrys Creek has created an elevated ditch invert upgradient of the tide gate.

Invert elevations along the Bucks Creek vary from 7 to 9 feet at the northern end of the landfill, to 2 to 3 feet at Valley Brook Avenue, then 0 to 1 feet at the Transcontinental Pipeline Embankment. Sediment has built up in the ditch creating obstructions to flow at several locations along the ditch. Water was observed to flow north to south throughout the day in the majority of the ditch, indicative of presence of a base flow from site groundwater. Water elevations in the southern end of the ditch were observed to rise and fall slightly during the day, either due to backup of water flow at the tide gate or flood tide passing the tide gate. The tide gate is not visible due to buildup of sediment and debris.

2.5 Well Search

A well search was obtained from the NJDEP Bureau of Water Quality. Another well search was provided along with the Environmental Data Base Research obtained from public and privates sources through Environmental Data Research, Inc. Both well searches indicate that no public or private wells are located within a one-mile radius of the site. Two privately owned production water wells and one public water supply well were reported within a one and one-half mile radius of the site.

3.0 RESULTS OF PREVIOUS INVESTIGATIONS

3.1 NJ Turnpike Authority Environmental Impact Statement Technical Studies for Turnpike Widening (NJTA 1985)

Louis Berger & Associates (LBA), under contract with the NJTA, conducted surface water and sediment sampling and analysis of Berrys Creek and the Hackensack River in 1985 for Technical Studies for an Environmental Impact Study for the NJ Turnpike Widening Project. Copies of sections of the EIS are provided in reference documents.

3.1.1 NJTA EIS Surface Water Investigations - 1985

LBA collected 19 surface water samples from the project vicinity, with 12 samples in the Hackensack River, two samples from Kingsland Creek waterways, one sample from Berrys Creek, and four samples from Berrys Creek Canal. The water samples were analyzed for nitrogen, phosphates, chlorides and priority pollutant metals. The results of analyses are presented in Table 4 – Surface Water Analysis Results – NJTA EIS 1985 and on Figures 16 and 17 - Surface Water Organic Compounds and Inorganic Analytes respectively.

The results of analyses are indicative of saline water in urban conditions as expected for the Hackensack River. Due to reporting of results in milligrams per liter, the incidence of reported non-detection of metals is greater than expected for the local environment.

3.1.2 NJTA EIS Sediment Investigations - 1985

LBA collected sediment samples in the vicinity of Avon Landfill from Berrys Creek, Kingsland Creek, Kingsland Ditch and the Hackensack River. The results of five sediment analyses performed in the vicinity of the Avon Landfill are presented in Table 5 – Sediment Analysis Results – NJTA EIS 1985 and on Figures 16 and 17 – Sediment Water and Sediment Organic Compounds and Inorganic Analytes, respectively.

The results present general quality of shore and marsh sediments in the local environment. The sample locations in Berrys Creek are located at the mouth of the intersection of Van Winkles Ditch. The sample locations in Kingsland Ditch and Kingsland Creek are south of the project area. The sample locations in the Hackensack River are east of the Study area.

The results of analyses indicate inorganic contamination is consistently present in sediments in the Hackensack River and tributaries. Sediment quality is significantly better in Kingsland Ditch. The results are similar between samples collected from exposed sediments and in nearby marshland.

3.2 NJ Sports and Exposition Authority – Wetland Assessment for Proposed Sports Stadium (NJSEA 1987)

The NJ Sports and Exposition Authority (NJSEA) conducted wetland assessments in 1987 in researching properties proposed for developing into a baseball stadium. Geotechnical, surface water and sediment investigations were included in the study which resulted in data pertinent to the Avon Landfill study. The Wetland Evaluation and Mitigation Report For The Proposed Baseball Stadium prepared by Malcolm Pirnie, Inc and dated June 1987 is provided in the reference documents.

3.2.1 NJSEA Surface Water Investigation (1987)

Malcolm Pirnie collected fifteen surface water samples from surface water bodies and landfill seeps surrounding the Avon and Lyndhurst Landfills. Sample W7 was collected from Bucks Creek north of Valley Brook Avenue. Sample W8 was collected from Bucks Creek at the southern end of Avon Landfill. Sample W5 was collected from Van Winkle Ditch at the northern end of the ditch. Sample W9 was collected at the culvert carrying flow between Van Winkle Ditch and the un-named tributary to Berrys Creek. Samples W14 and W15 were collected from Berrys Creek upstream and downstream of Van Winkle Ditch, respectively.

Results of analyses performed on surface water samples are presented in Table 6 and the original report. Results exceeding surface water quality criteria also are presented on Figures 16 and 17 Surface Water Analyses Organic Compounds and Inorganic Analytes, respectively. In general, the results of analyses indicate presence of organic compounds and inorganic analytes typical of the urban environment of the Hackensack River basin.

TCL volatile organics found in the surface water samples include acetone, methylene chloride, 1,1-Dichloroethane, toluene, chlorobenzene, and total xylenes. Acetone, a common laboratory contaminant, was invalidated due to the method blank contamination, while methylene chloride was detected at a low concentration but is also a common laboratory contaminant. 1,1-Dichloroethane was found in trace amounts to 6 mg/l, toluene and chlorobenzene were detected from trace amounts to 19 mg/l and 15 mg/l, respectively, and total xylenes were found to have concentration from trace amounts to 82 mg/l. Seven other volatile organics were detected at trace amounts.

Semi-volatile organics detected include flourene from trace amounts to 20 mg/l, bis(2-ethylhexyl)phthalate from trace amount to 36 mg/l, and five other semi-volatile organic compounds in trace amounts. No PCBs were detected. One pesticide, 4,4'-DDT, was detected at 0.57 mg/l.

3.2.2 NJSEA Sediment Investigations - 1987

The NJSEA collected and analyzed 6 sediment samples from seeps and streams in the Lyndhurst Redevelopment area in 1987 in evaluating redevelopment potential for a proposed baseball stadium. Sediment sample locations are presented on Figure 11 – Sample Location Map and

Figures 16 and 17 – Surface Water and Sediment Results. Sediment analysis results are presented in Table 7 – Sediment Analysis Results – NJSEA 1987 and original data tables in the reference document.

The sample analysis results indicate presence of heavy metals, aromatic hydrocarbons and PAHs at concentrations exceeding Marine/Estuarine effects ranges. Pesticides and PCBs were not detected.

3.3 NJ Turnpike Authority – Site Investigation for Avon Landfill Closure (NJTA 1989)

The NJTA conducted Site Investigations between 1987 and 1989 of the Avon Landfill for possible roadway projects. Technical overview, findings and conclusions of site investigations are presented in the project reference document titled: Site Investigation Report for New Jersey Turnpike Authority, Avon Landfill Closure, Contract D-29 by Malcolm Pirnie. (NJTA 1989)

3.3.1 NJTA Soil/Fill/Debris Investigations

Geophysical Investigations were conducted using proton precision magnetometer and ground conductivity instruments on transects run perpendicular and parallel to the landfill spine. The geophysical grid pattern is shown on Figure 11 – Sample Location Map. The results of geophysical testing are provided as data summary tables and modeled depictions in variation of findings in the reference documents. The results of geophysical modeling identified variation in landfill density with at least three large areas of elevated density in the portion of the landfill west of Valley Brook Avenue. (NJTA 1989)

92 soil borings and ten test pits were advanced in a grid pattern over the landfill to characterize landfill material, subsurface stratigraphy and install inclinometers, piezometers, and monitoring wells. The soil boring location map was not provided with the copy of the NJTA Site Investigation Report, therefore on locations for well borings are presented Figure 11 - Sample Location Map and Figure 12 – Soil-Fill-Debris Maps.

Split-spoon samples were inspected for visible characteristics and screened for volatile organic vapors using a PID. Soil samples were collected from six to 18 inches below ground surface and analyzed for TCL+30. Fill samples were collected from approximate mid-point of the fill and analyzed for TCL+30, PHC, O/G and RCRA characteristics. A select number of biased samples also were submitted for analysis at high PID locations.

Test pits were advanced at ten locations to approximately 20 feet depth along the upper portions of the landfill to provide a general description of the waste materials. Material excavated from the test pits were screened for visible characteristics and with a PID for volatile organic concentrations. One fill sample was collected from each test pit and analyzed for TCL+30, PHC, O/G and RCRA characteristics.

Waste fill was reported throughout the property extending to as much as 45 feet beneath the uppermost landfill surface and about 18 feet beneath the exposed landfill toe of slope. Fill

material recorded in study boring logs included: various types of silt and sand, demolition debris, plastic, wood, brick, paper and glass.

Results of laboratory testing are presented in and summarized in Table 8 – Soil Analysis Results – NJTA SI Report 1989. The original data tables used in developing products for this report are included in the reference document Site Investigation Report for Avon Landfill Closure. Portions of the raw data tables are missing in the copy of the report obtained from historical files. Results of testing exceeding restricted use criteria are provided on Figure 12A – Soil-Fill-Debris Organic Compounds and Figure 12B – Soil-Fill-Debris Inorganic Analytes.

Aromatic volatile and polycyclic aromatic semi-volatile organic compounds were detected in all areas and in all depths of the landfill. Data did not indicate presence of definable trends of contamination distribution across the site. The NJTA report states that inorganic results were evaluated as typical of naturally occurring soil. (NJTA 1989)

Review of NJTA data provides the following general statements concerning soil contamination in the landfill environment.

- Semi-volatile TCL compounds were detected throughout the study area with no discernable distribution.
- Polycyclic Aromatic Hydrocarbons and phthalates were detected in a high percentage of samples and at the highest concentrations.
- Phthalates were detected at concentrations ranging from trace amounts to 30 mg/kg in sample Avon B-1.
- Polycyclic aromatic hydrocarbons (PAHs) were detected in all portions of the landfill. Concentrations of PAHs ranged from non-detect in several samples to ten mg/kg in sample W-125.
- Phenol was detected in two locations near the center of the landfill at concentrations of 2.9 mg/kg at HNTB-5 and 51 mg/kg at Avon W8-F. Phenol was not detected in other parts of the landfill.
- Hexachlorobutadiene was detected in sample W8-S(0.32 mg/kg) and Avon B10-C (200 mg/kg).
- Semivolatile organic compounds were highest at Avon B-10 with total concentrations of 300 mg/kg.
- Aromatic hydrocarbons benzene, chlorobenzene and xylenes were detected at concentrations exceeding restricted use criteria throughout the landfill. Ethylbenzene and styrene also are noted throughout the landfill below restricted use criteria. Dichlorobenzene was detected in the central part of the landfill at locations Avon W8D (0.29 mg/kg), HNTB-50 (0.46 mg/kg), and Avon B-10C (120 mg/kg).
- Sample location Avon B1-S exhibited the highest volatile concentrations with toluene (0.350 mg/kg), ethylbenzene (4.2 mg/kg), xylene (10 mg/kg). Total volatiles at this location were 15 mg/kg.
- Sample location HNTB-10 at the southern end of the landfill exhibited volatile organic concentrations totaling about six mg/kg.
- Pesticides were not detected in the soil samples.

- Aroclor 1254 was detected at 2.5 mg/kg in sample B-1-S. PCBs were not detected elsewhere in the landfill.
- Inorganic ions were reported to be within concentrations expected for natural soils. Our interpretation of the inorganic information presented in the original report data tables indicates the potential that the incorrect units are used. Typically laboratories report organics in ug/kg and inorganics in mg/kg. The data tables show both the organics and inorganics in ug/kg, with inorganic concentrations lower than our expectation for landfill concentrations and/or naturally occurring soils.

As noted in Table 8 – Soil Analysis Results, the compounds detected at concentrations exceeding current restricted use criteria include benzene (2.2 mg/kg), total xylenes (11 mg/kg), phenol (51 mg/kg), hexachlorobutadiene (200 mg/kg), 1,4-dichlorobenzene (120 mg/kg), and thallium (11.2 mg/kg). Antimony, arsenic, beryllium, chromium, lead, selenium, and vanadium also exceed current restricted use criteria.

3.3.2 NJTA Groundwater Investigations - 1989

The NJ Turnpike Authority collected groundwater samples in 1988 and 1989 from 17 monitor wells constructed in the landfill waste, five monitor wells constructed in the underlying varved clay, and five monitor wells constructed in the underlying glacial till. Water level measurements were taken from all wells and the adjoining streams in 1988 and 1989 and a groundwater surface contour map developed. Twenty-seven groundwater samples were collected and analyzed for TCL organics, TAL inorganics, PHC, oil and grease, and additional landfill parameters. Twenty percent of the groundwater samples were analyzed for gross alpha and beta radioactivity. Only a portion of the testing results were included in the copy of the report obtained from historical records. (NJTA, 1989)

The methods used in constructing and developing the wells and collecting the groundwater samples are presented in the Site Investigation Work Plan and Site Investigation Report prepared by the Malcolm Pirnie Team.

The groundwater surface data collected and modeled in the NJTA 1989 Site Investigation Report depict a groundwater mound within the landfill prism with a centrally located high the full length of the landfill and sloping outward in all directions. The groundwater mound upper-most surface elevations (NGVD29) for January 1989 vary between elevation six to eight feet west of Valley Brook Avenue to elevation seven feet east of Valley Brook Avenue. Water surface elevations in wells adjacent to Bucks Creek were reported at two to four feet, which were below the creek invert elevation. Water surface elevations in wells adjacent to the Jersey City Aqueduct were reported at elevations two point seven to four point five feet, which is above mean tide level in nearby Van Winkle Ditch.

The groundwater surfaces at the western edge of landfill (existing wells W3, 1.99 ft; W7, 1.94 ft; W1, 1.51 ft) were reported at or below Bucks Creek water surface elevations of four to eight feet elevation west of Valley Brook Avenue and two to three feet elevation east of Valley Brook Avenue. The groundwater surfaces at the east edge of landfill along Van Winkle Ditch typically

were reported to be three to eight feet above the ditch invert elevations of about to one and a half feet NGVD29.

Testing performed on the varved clay measured permeability's of 1.55×10^{-7} to 5.04×10^{-8} cm/sec. In four of five groundwater well tests, the net hydraulic potential was downward.

Seeps reported along the drainage ditches in 1988 and observed during site reconnaissance in 1999 and 2000 identify localized points of discharge to all drainage ditches, indicating either preferential pathways along layered lift surfaces or periodic increases to the mound elevations.

The data tables provided with the copy of the report were missing groundwater raw data tables. Data for one sample (W-9-AL) and aromatic hydrocarbons were extracted from portions of the report. As noted in Table 9 – Gourndwater Analysis Results – NJTA SI Report 1989 and reference document, the aromatic hydrocarbons benzene (ND-180 ug/l), toluene (ND - 280 ug/l), total xylenes (ND - 840 ug/l), chlorobenzene (ND - 280 ug/l), ethylbenzene (ND - 130 ug/l) were detected above NJDEP Groundwater Quality Standards in all areas of the landfill. The organo-halides vinyl chloride and trans 1,2 dichloroethylene (combined ND - 390) were detected at well W-11 in the northern half of the landfill above the NJDEP Groundwater Quality Standards. Metals, pesticides and PCBs were not detected at concentration above the standards.

As noted in results of analyses performed on monitor wells screened in the varved silt and clay (CW1-2, CW2-2, CW3-2, CW4-2, CW5-2) and the glacial till layers, contaminants detected in the waste fill were not detected to a significant degree in the underlying varved clay and glacial till layers.

3.3.3 NJTA Surface Water Investigations - 1989

The NJTA collected sixteen surface water samples from surface waters adjoining the landfill, which were analyzed for TCL organics, TAL inorganics, PHC, oil and grease, and additional landfill parameters. Acetone, a common laboratory contaminant, was reported but invalidated due to the method blank contamination. Methylene chloride was detected at a low concentration but was evaluated as a common laboratory contaminant. Volatile organic compounds detected in surface water above current surface water quality criteria include: 1,1-Dichloroethane (trace amounts to six mg/l), toluene (trace amounts to 19 mg/l), chlorobenzene (trace amounts to 15 mg/l), and total xylenes (trace amounts to 82 mg/l). Seven other volatile organics were detected at trace amounts. (NJTA 1989)

Semi-volatile organics detected at concentrations above current surface water quality criteria included: flourene (trace amounts to 20 mg/l), bis(2-ethylhexyl)phthalate (trace amount to 36 mg/l). Five other semi-volatile organic compounds were reported in trace amounts. No PCBs were detected, however, one pesticide, 4,4'-DDT, was detected at 0.57 mg/l. (NJTA 1989)

3.3.4 NJTA Sediment Investigations -1988

The NJ Turnpike Authority collected six sediment samples from drainage systems bordering the Avon Landfill in 1988. The results of analyses are provided in Table 11 –Sediment Analysis Results – NJTA SI Report 1989 and in the reference documents. Results of laboratory analyses reported presence of a limited but consistent number of volatile organic and semivolatile organic compounds. Inorganic results were not provided with the data tables obtained from the NJ Turnpike Authority, but in the data discussion of the report they state that the results are typical of sediment quality noted elsewhere.

Five volatile organic compounds were detected in the sediment analytical results. Three compounds, toluene, methylene chloride, and chlorobenzene, were found in trace amounts, while ethylbenzene was detected at 170 ug/kg and total xylenes were found to range from trace amounts to 530 ug/kg. Three semi-volatile organic compounds were detected in the sediment samples. Di-n-butylphthalate was found in two samples from trace amounts to 9500 ug/kg, dibenzofuran was found at the detection limit, and bis(2-ethylhexyl)phthalate was detected with concentrations ranging from 0.9 to 15 ug/kg. Numerous PAHs were detected in the sediment samples. No PCBs were found, however, one pesticide, 4,4'-DDD, was detected at a sampling station at 1388 ug/kg. (NJTA 1989)

Five volatile organic compounds were detected in the sediment analytical results. Toluene (0.005), chlorobenzene (0.021), and ethylbenzene (0.17) were detected in sample SD-1. Total xylenes were detected in two of six samples at 0.014 and 0.53 mg/kg. Methylene chloride was detected but evaluated as laboratory contamination.

The aromatic hydrocarbon naphthalene was detected in all sediment samples. Five of six sample results exceeded current Marine/Estuarine Sediment Screening Guidelines Effects Range Medium.

Di-n-butylphthalate was found in two of six samples at 0.67 and 9.5 mg/kg, dibenzofuran was found in two of six samples at 0.26 and 0.41 mg/kg, and bis(2-ethylhexyl)phthalate was detected in four of six samples at 0.9 to 15 mg/kg. 16 polycyclic aromatic hydrocarbons (PAH) were detected in the sediment samples, with concentrations consistently above Marine/Estuarine Sediment Screening Guidelines Effects Range Low and below Effects Range Medium.

No PCBs were found, however, one pesticide, 4,4'-DDD, was detected at a sampling station at 1.388 mg/kg.

3.3.5 NJTA Air Quality Investigations - 1989

Air monitoring conducted during the 1987 and 1988 soil and well sampling events reported PID readings of zero to 30 parts per million. Boring logs indicate soil borings in the north end of the landfill were abandoned to excessive off gassing.

3.4 USEPA Site Inspection of Avon Sanitary Landfill (USEPA 1990)

NUS Corporation, under contract with the US Environmental Protection Agency (USEPA), completed site investigations in 1990 under the USEPA Superfund Program. The Site Inspection Report, with sample and analysis documentation, is provided in project reference documents.

3.4.1 USEPA Soil/Fill/Debris Investigations – 1990

The NUS sampling team collected four samples from surface soils along the toe of slope of the landfill rise. One location was collected midway along the eastern property line, and three near the southern property line. The results of sample analysis identified the presence of chromium, lead, polycyclic aromatic hydrocarbons, acetone, chloroform, and methylene chloride. Chromium and lead were detected at concentrations exceeding current NJDEP Restricted Use Criteria. Table 12 – Soil Analysis Results – USEPA 1990 presents the results of soil sample analyses with highest concentrations. The raw data tables are provided with the Site Inspection Report (USEPA 1990).

3.4.2 USEPA Groundwater Investigations - 1990

NUS Corporation collected three groundwater (GW1, GW2 and GW5) samples and one duplicate (GW3) groundwater sample from three monitor wells placed in the outer edge of landfilled waste in June 1990. An additional sample (GW4) was a performance evaluation sample shipped from USEPA and analyzed for inorganics only. It was unclear whether the contractor used existing wells or installed and sampled their own. The USEPA data are included in Table 13 – Groundwater Analysis Results – USEPA 1990 and the reference documents. The USEPA report is provided under separate cover with the project reference documents.

Ground water sample locations are presented Figure 11, Sample Location Map and Figures 13 and 14 - Groundwater Organic Compounds and Inorganic Analytes, respectively. Sample GW1 was collected from a monitor well Number 4 (near or at NJTA well W-4) located in the northwestern corner of the landfill area. Samples GW2 and GW3 (duplicate of GW2) were collected from well No. 26-1294-3 located at Valley Brook Avenue (near or at NJTA well CW2). Sample GW5 was collected from well No. 26-12585 located in the southeastern corner of the landfill (near or at NJTA well W-2)

As noted in Table 3 – Groundwater Analysis Results – USEPA 1990, the contaminants detected above current NJDEP Class IIA Groundwater Quality Standards include: aluminum (559 – 4070 ug/L), arsenic (12.1 ug/L in GW1), iron (24600 – 66900 ug/L), manganese (303 – 686 ug/L), nickel (72.7 – 110 ug/L), 2-butanone (960 ug/L in GW1), benzene (54 – 150 ug/L), chlorobenzene (220 – 300 ug/L). toluene (ND – 3600 ug/l in GW1), aldrin (3.3 ug/L in GW5), and endosulfan 1 (0.53 ug/L in GW5).

3.4.3 USEPA Surface Water Investigations - 1990

NUS Corporation collected two surface water samples from Van Winkle Ditch for the 1990 Site Inspection Report. Data results are presented in Table 15 – Sediment Analysis Results – USEPA 1990 and Figures 16 and 17 Surface Water and Sediment – Organic Compounds and Inorganic Analytes, respectively. The USEPA Site Inspection Report is provided with the reference documents.

One sample (SW1) was collected in the northern half of Van Winkle Ditch. Another sample (SW2) was collected in the southern end of Van Winkle Ditch along the Transcontinental pipeline. Both samples were analyzed for TCL+30. As shown in Table 14 - Surface Water Analysis Results – USEPA 1990, arsenic (J – 29.5 ug/L) and manganese (640 – 686 ug/L) were detected above current NJDEP SE2 Surface Water Standards. Remaining inorganic and organic compounds in the TCL+30 scan were not detected or detected at concentrations below the Surface Water Standard. (USEPA 1990)

4.0 TECHNICAL OVERVIEW

4.1 Soil/Fill/Debris Investigations

Soil/Fill/Debris Investigations were conducted to provide lithologic descriptions of unconsolidated materials to confirm local stratigraphy. Kimball completed four soil borings (AH1, AH2, AH3, AH4) at the toe of slope of the landfill rise to delineate vertical stratigraphy of the waste fill and to collect groundwater samples. Converse Consultants completed 12 soil borings (B1 through B12) in and surrounding the waste fill to obtain stratigraphic descriptions and geotechnical information for surface and waste fill, organic soils and underlying varved silt and clay.

Logs were prepared for all borings to document subsurface conditions, soil types, wastes, depth to groundwater, soil mottling, field instrument measurements, presence of odor, vapors, soil discoloration, and visible concerns. Borings were performed in accordance with the Subsurface and Percolating Waters Act, N.J.S.A. 58:4A-4.1. Field sampling and documentation were performed in accordance with the QAPP, prepared to comply with the Technical Requirements for Site Remediation 7:26E-3.6 through 3.9.

4.1.1 Soil/Fill/Debris Sampling

Figure 11 – Sample Location Map presents the locations of the soil borings completed during this investigation and the Converse Consultants Soil Investigation. Observations obtained during intrusive sampling are noted in Appendix A Sample and Boring Logs.

Borings AH-2, AH-3 and AH-4 were completed using a CME-55 drilling rig mounted on an all-terrain vehicle (ATV). The three drilled soil borings were completed along the edges of the landfill through buried waste and into naturally occurring soils. The borings were advanced with hollow stem augers using split-spoon sampling methods. Split-spoons samples were collected at two-foot intervals to assess waste cover soils, five-foot intervals throughout the waste, and two foot intervals within natural soils. Appendix A – Sample and Boring Logs present observations obtained during drilling and screening of samples.

Each split-spoon was opened and characterized by the field geologist for visible characteristics and indications of contamination and screened for volatile organic vapors using a PID and FID. No soil samples were submitted for laboratory analyses. Results of the VOC screening were reported on the respective boring logs.

Soil boring AH1 was completed using hand held tools due to steeply sloping terrain, which prohibited access and safe operation of the drilling rig. AH1 was advanced to a depth of five feet BGS for installation of a temporary piezometer.

Borings B-1 through B-12 were completed using truck-mounted mud-rotary methods. Split-spoon samples were collected at varying intervals dependent upon the depth and purpose of the boring.

All borings were backfilled with a Portland cement and bentonite grout mix. Auger drill cuttings were scattered within the vicinity of the soil boring. Excess mud was drummed and removed from the site.

4.1.2 Soil/Fill/Debris Sample Analyses

Samples collected during intrusive investigations conducted in 2000 were not analyzed for chemical constituents. The samples were screened for visible presence of waste and volatile organic compounds detectable on PID and FID real-time organic detectors.

Samples collected in 2000 within the Avon Landfill waste contained soil, wood, paper, brick, ash, plastic, metal, and rock. Industrial waste or heavily contaminated solids material were not encountered.

4.1.3 Health and Safety Monitoring

Work was performed in accordance with the Site Health and Safety Plan prepared for site activities. A Kimball Health and Safety Officer (HSO) monitored work procedures, working conditions, and air quality during all investigation activities.

Air monitoring for volatile organic compounds, lower explosive limit (LEL), oxygen, carbon monoxide and hydrogen sulfide were conducted in accordance with the Site Health and Safety Plan. Real time air monitoring was conducted during intrusive sampling activities using hand-held photoionization and flame ionization detectors, and multi-gas meters. Air monitoring was conducted within the worker-breathing zone and immediately atop the open augers or borehole to evaluated the potential for elevated VOC concentrations. On at least three occasions, real-time organic detectors indicated rising concentrations of organic vapors at the drill head upon reaching groundwater. Work was stopped until concentrations met HASP action levels.

Equipment calibration was performed daily and recorded in the Equipment Calibration Log.

4.1.4 Significant Events or Seasonal Variations Affecting Sampling and Analysis

Soft ground conditions were encountered between the landfill rise and the Jersey City Aqueduct embankment. Boreholes AH-3 and AH-4 were located at the toe of landfill rise where firm ground conditions allowed stable equipment placement.

Bucks Creek water was too deep to cross, therefore access to borehole AH2 was gained by driving the drill equipment from the top slope and advancing the boring at the toe of landfill rise. Sample recovery and depth of boring in borehole AH2 was poor due to encountering metal wire or bedsprings, which drove into the augers.

Soil boring AH1 was completed by hand due to steeply sloping terrain, which prohibited access and safe operation of the drilling rig. AH1 was advanced to a depth of five feet BGS for the installation of a temporary piezometer. No soil samples were collected from this location.

4.2 Groundwater Investigations

4.2.1 Groundwater Sampling

Kimball field crews collected groundwater samples from ten monitoring wells installed within the Avon Landfill for the NJTA investigation, plus four temporary piezometers placed in soil borings advanced along the periphery of the landfill. Locations of temporary piezometers were selected to fill data gaps in groundwater quality, investigate the physical and chemical characteristics of the unconfined aquifer and to determine groundwater flow and potential tidal interactions with nearby surface water bodies.

Groundwater samples were collected from the existing monitor wells in accordance with the project Remedial Investigation Work Plan, Project Quality Assurance Plan and the *NJDEP Field Sampling Procedures Manual*. Groundwater samples collected from temporary piezometers installed within soil borings using were sampled in accordance with the *NJDEP Alternative Groundwater Sampling Guidance Document*. Monitoring well and temporary piezometer locations are shown on Figure 11 Sample Location Map. Well Sampling Logs are presented in Appendix A.

- Temporary piezometer AH-1 was installed along the northwestern edge of the Avon Landfill along Bucks Creek near the split in the New Jersey Transit railroad tracks. The well screen was positioned across the water table surface and extended to a depth of approximately five feet BGS.

- Temporary piezometer AH-2 was installed on the western toe of slope, approximately fifteen feet east of Bucks Creek and about 850 feet east of Valley Brook Avenue. The well screen was positioned across the water table surface and extended to a depth of ten feet BGS.

- Temporary piezometer AH-3 was installed along the eastern edge of the Avon Landfill approximately 900 feet northwest of Valley Brook Avenue. The well screen was positioned across the water table surface and extended to a depth of ten feet BGS.

- Temporary piezometer AH-4 was installed on the eastern edge of Avon Landfill about 950 feet east of Valley Brook Avenue. The well screen was positioned across the water table surface and extended to a depth of approximately five feet BGS.

Each temporary piezometer consisted of one-inch, inside diameter, 0.010 slot PVC screen and riser placed within the open borehole after removal of the augers. Five and ten feet long well screens were used with top of screen about two feet above the apparent groundwater table surface. Riser pipe was used to extend the piezometer to the ground surface.

Groundwater samples were collected from ten existing wells and four temporary piezometers on March 21 and April 3, 2000, respectively, in accordance with Section 4.3 of the FSP/QAPP and NJDEP Field Sampling Procedures Manual and Alternate Groundwater Sampling Guidance. Silt

and standing water were purged from each well using a centrifugal pump and from each temporary piezometer using a peristaltic pump. Discharge from the pumps were passed through a YSI closed-cell flow-through testing chamber until field measurements for pH, conductivity, dissolved oxygen, oxidation reduction potential, salinity, and temperature stabilized.

Groundwater samples were collected in sample bottles provided by the laboratory, preserved where applicable and submitted to Chemtech of Edison, NJ for analysis. Fourteen groundwater samples were analyzed for Priority Pollutant Volatiles+10, Priority Pollutant Base Neutrals+20, Priority Pollutant metals, TOC, total solids and total suspended solids. Priority pollutant pesticides and PCBs were not sampled since prior sampling had not shown the parameter groups not to be a concern. Two field blanks and two trip blanks were processed with the samples.

4.2.2 Results of Groundwater Sample Analyses

Results of analyses performed on groundwater samples collected in 2000 are provided in Table 17 – Groundwater Analytical Results - Kimball 2000 and on Figures 13 and 14 – Groundwater Organic Compounds and Inorganic Analytes, respectively. Results of analyses performed in 2000 confirm results of prior investigations that found aromatic hydrocarbons, phthalates, and a limited number of polycyclic aromatic hydrocarbons throughout the landfill.

Volatile aromatic hydrocarbons were detected in all portions of the landfill. The aromatic hydrocarbons benzene, chlorobenzene, and naphthalene were detected at concentrations exceeding groundwater quality standards in wells located in the central and southern portions of the landfill. The aromatic hydrocarbons toluene, ethylbenzene and xylene were detected at lower concentrations with concentrations highest in well W-4 in the northern end of the landfill. Ether also was detected at 560 ug/L to 1,100 ug/L (duplicate) in well W-4. The chlorinated hydrocarbon 1,1,2-trichloroethane (5.7 ug/L) and vinyl chloride (140 ug/L) were detected in well W-7 at Valley Brook Avenue above groundwater quality standards. The phthalates bis(2-ethylhexyl)phthalate and di-n-butylphthalate were detected in all groundwater samples at concentrations 1/3 to 1/10 the associated groundwater quality standards. Napthalene was detected in well W-3 (330 ug/L) at the southern end of the landfill slightly above the applicable groundwater quality standard of 300 ug/L.

Iron and manganese are noted above groundwater quality standards in all sections of the landfill. Lead and arsenic are noted above groundwater quality standards in wells W-3, W-7, and CW1-1 located east of Valley Brook Avenue. Chromium and lead are reported at concentrations near or above groundwater quality standards in well CW4-1 and W-11 located in the northern third of the landfill. BOD (160 to 460 mg/L) and COD (270 to 750 mg/L) are elevated above that reported for surface water adjoining the landfill. Chlorides (160 to 800 mg/L) were detected at concentrations above that expected for fresh water but below that expected and reported for regional saline surface waters.

4.2.3 Groundwater Flow Characteristics

Water level measurements were obtained from 27 monitor wells, four temporary piezometers and four water surface stilling wells to assess depth to groundwater, groundwater flow, and possible impacts due to tidal fluctuations in nearby streams. Measurements are presented in Table 3 – Well and Piezometer Data – March 2000 and data tables and sample logs in Appendix A.

Uppermost groundwater surfaces were measured to be about six to 11 feet above mean sea level (MSL) within the center of the landfill and four to seven feet above MSL at the outer edges of the landfill. As shown in Figure 10 – Groundwater Contour Map, the data indicate presence of groundwater mound within the landfill in general conformance with the surface topography. The groundwater surface contours indicate groundwater hydrologic potential radiates outward in all directions from the groundwater mound within the landfill.

Groundwater surface elevations indicate that the Jersey City Aqueduct acts as a leaky barrier to groundwater flow. As a result, groundwater dams up between the pipelines and the landfill mound and leaks above and/or below the pipelines into Van Winkle Ditch.

Groundwater surface elevations along the western toe of landfill slope indicate that site groundwater flows into and below Bucks Creek. The discharge of site groundwater into Bucks Creek is seen as periodic seeps at the ditch edge. Groundwater contours also indicate that site groundwater discharges to Kingsland Creek west and south of the site.

As noted in Figure 10 – Groundwater Contour Map, contaminated groundwater migrates in all directions from Avon Landfill toward adjoining Van Winkle Ditch, Bucks Creek and Kingsland Creek. The groundwater flow potential within the landfill appears to be radially outward with a hydraulic head of four to seven feet.

Higher piezometric potential exists north of the site, as seen by stable surface water elevations in ponded water and naturally occurring groundwater seeps and wetland north and northwest of the landfill. The groundwater flow potential external to the landfill appears to be from the topographic rise north of the site to the Hackensack River south of the site.

A clay barrier wall and lagoon constructed between the Kingsland Landfill and the Avon Landfill acts as a hydraulic barrier to groundwater flow to the west. The lagoon's stabilized surface elevation of three point four feet defines minimum groundwater table surface elevations west of the landfill. The lagoon discharges to Kingsland Creek at Valley Brook Avenue. As noted on the Groundwater Contour Map, we expect groundwater from Avon Landfill to flow beneath and along the NJ Transit Main Line and discharging to the lagoon and Kingsland Creek west and south of the Avon Landfill.

Also noted on the Groundwater Contour Map is an anomaly associated with the Jersey City Aqueduct along the eastern edge of Avon Landfill. The data indicate that site groundwater builds up behind the 6-foot diameter pipes. As shown on the Figures 6 through 9 - Geologic Profiles, the vertical face available to groundwater flow to the east is limited to the ten to 12 feet distance

between the bottom of the pipelines to the top of the underlying clay lense, plus the one to two feet of soil between the top of the pipelines to the top of the water table surface between the pipelines and the landfill. Due to immediate release of the hydraulic potential at Van Winkle Ditch east of the aqueduct, we anticipate groundwater to flow over and under the western pipeline then under the eastern pipeline and discharging into Van Winkle Ditch.

As noted in Section 2, the groundwater mound within the Avon Landfill is generated by precipitation infiltration into the waste fill. The local area receives an average of 3 to 4 inches of rainfall monthly. The majority of precipitation falling during warmer months, April through September, typically is lost to runoff and evapotranspiration, which would cause the mound surface to drop in elevation. (Oweiss, et al.)

Data collected by Kingsland Landfill operations estimates about 17 inches of rainfall per year infiltrates into the landfill mound. (Converse 2000) Due to shallower outer slopes, larger percentage of disturbed and relatively level land surfaces, we estimate that 20 to 30 inches of annual rainfall may infiltrate into the Avon Landfill groundwater mound and move out of the vertical face of groundwater flow at the outer edges of the landfill.

4.2.4 Tidal Influence upon Site Groundwater

Kimball field crews placed water level sensors in Van Winkle Ditch and various wells and temporary piezometers in the landfill to determine to what extent tidal fluctuations in Van Winkle Ditch and Bucks Creek influence groundwater characteristics in the landfilled waste. Three tidal monitoring studies were conducted over double tidal cycles between March 28 and 31, 2000. The pressure transducers recorded the height of water above the transducer at 15-minute intervals over the period of the study

Raw data tables and graphs of data points over time are presented in Appendix B – Tidal Study Data. Figure 15 - Hydrographs presents relative changes in water table surfaces over time along three sensor lines placed perpendicular to the landfill spine. Water level data were adjusted uniformly over time to separate overlapping data lines and improve clarity of data variation over time on the graphs.

Sensor line A was located in the southern portion of the landfill perpendicular to monitor well W-5 and CW1-1. One sensor was placed in temporary piezometer AH2 located adjacent to Bucks Creek. Sensors were placed in wells W-5 and CW1-1 screened in the waste. Another sensor was placed in temporary piezometer AH4 located at the toe of landfill near the Jersey City Aqueduct. A fifth sensor was located in Van Winkle Ditch at the culvert beneath Valley Brook Avenue.

As shown on Figure 15 – Hydrographs, water levels in Van Winkle Ditch vary about 3 feet along with tidal flows in Berrys Creek and the Hackensack River. The Van Winkle Ditch water level sensor located at the bottom of the stream channel recorded minimum water levels indicative of a base pool elevation of about zero feet above MSL, which is above the mean low tide reported for the Hackensack River and Berrys Creek. As noted in data lines for sensors placed in wells CW1

and W-5, and in temporary piezometers AH4 and AH2, it appears that tidal changes in nearby surface water bodies do not extend to a significant degree into the Avon Landfill.

Sensor Line B was located in the middle of the landfill perpendicular to monitor well W-8 and W-1. One sensor was placed in well W-1 located adjacent to Bucks Creek to monitor changes to groundwater next to the creek. A second sensor was placed in well CW3-1 located near the middle of the landfill rise to monitor water levels in the waste fill. A third sensor was placed in well W-8 in the center of waste fill. A fourth sensor was placed in Van Winkle Ditch on the eastern side of the aqueduct embankment near piezometer AH3. A fifth sensor was placed in Van Winkle Ditch at the culvert beneath Valley Brook Avenue.

As shown on Figure 15 – Hydrographs, water levels in Van Winkle Ditch vary about two and a half to three feet along with tidal flows in Berrys Creek and the Hackensack River. As noted in data lines for sensors placed in wells CW3, W-8 and W-1, it appears that tidal changes in nearby surface water bodies do not extend to a significant degree into the Avon Landfill. A three to four inch rise in water levels over time noted in adjoining wells W-1 and CW3-1 indicate an impact to groundwater levels following a rainfall event. The increase in water levels over time in monitor well W-8 in the center of the landfill is limited to less than one inch.

Sensor Line C was located in the northern end of the landfill perpendicular to monitor well W-11 and CW4-1. One sensor was placed in well W-11 located along the center of the waste fill. A second sensor was placed in well CW4-1 located at the toe of slope along the eastern side of the landfill. A third sensor was placed in Van Winkle Ditch on the eastern side of the aqueduct embankment near well CW4-1. A fourth sensor was suspended in well CW4-1 to monitor changes in ambient barometric pressure. Data from sensors in wells W-11 and CW4-1 were adjusted by subtracting barometric pressure readings.

As shown on Figure 15 – Hydrographs, water levels in Van Winkle Ditch vary about two and a half feet along with tidal flows in Berrys Creek and the Hackensack River. As noted in data lines for sensors placed in wells CW4-1, and W-11, it appears that tidal changes in nearby surface water bodies do not extend to a significant degree into the Avon Landfill.

4.2.5 Groundwater Exfiltration

The clay layer acts as an effective aquitard and prevents groundwater flow upward from or downward to underlying aquifers. The groundwater mound creates a centrally located potentiometric high which creates a driving force for horizontal groundwater exfiltration from the site above the varved clay layer. Since the groundwater mound prevents groundwater infiltration from off-site groundwater source areas, the annual rainfall input to the landfill's hydrologic balance is assumed to dominate impacted ground water generation rates for the Avon Landfill.

The rate and direction of ground water flow out of the landfill depends upon the amount of rainfall entering the landfill groundwater mound, the type and location of landfill heterogeneities, and water elevations in the surface water bodies surrounding the landfill. As noted in the tidal studies reported above, although surrounded by tidally influenced streams, physical barriers to groundwater

flow, including the Jersey City Aqueduct, NJ Transit Mainline embankment and Kingsland Landfill clay barrier, minimize or prevent tidal influence within the landfill mound.

4.2.6 Significant Events or Seasonal Variation Affecting Groundwater Investigations

Increasing barometric pressure on March 28 and 29 offset gradual decreases in water table surface following a wet period. The tidal study data also show observable increases in groundwater mound immediately following rainfall events.

4.3 Surface Water Investigation

4.3.1 Surface Water Sampling

Surface water samples were collected from three locations in Bucks Creek (ASW-1, ASW-2, ASW-3), one seep (AS-1) discharging to the mid-point of Bucks Creek, and three locations in Van Winkle Ditch (LSW-1, LSW-2 and ASW-4). The surface water sample locations are shown on Figure 11 - Sample Location Map and Figures 16 and 17 - Surface Water and Sediment Organic Compounds and Inorganic Analytes, respectively.

Sample ASW –1 was collected from the northern end of Bucks Creek. The portion of Bucks Creek exhibits visible indications of impacts from impacted groundwater seeping out of the landfill at the creek water surface elevation.

Sample AS-1 was collected from a seep encountered between sample ASW-1 and Valley Brook Avenue. The sample location was developed by removing soil and debris from an area of active flow above Bucks Creek water elevation to make a discrete sample point. The sample location was allowed to stabilize for several hours and the amount of suspended solids to subside.

Sample ASW-3 was collected from Bucks Creek flow into the culvert beneath Valley Brook Avenue. Sample ASW-2 was collected from Bucks Creek flow immediately upstream of the tide gate located at the southern end of the Avon Landfill.

Sample ASW-4 was collected from Van Winkle Ditch near the culvert connecting Van Winkle Ditch with the un-named tributary to Berrys Creek. The sample location was chosen to represent surface water moving from the northern portion of the ditch to both the southern portion of Van Winkle Ditch and the un-named tributary.

Sample LSW-2 was collected from Van Winkle Ditch at the upstream end of the culvert passing beneath Valley Brook Avenue. LSW-1 was collected from Van Winkle Ditch at the southern end of the Avon Landfill.

Surface water samples were collected in accordance with the project Remedial Investigation Work Plan and the project QAPP, copies of which are enclosed in Appendices. Samples ASW-3, ASW-4, LSW-1 and LSW-2 were collected at low tide to increase the probability that the sample contains

impacted groundwater from the Avon Landfill. Sample bottles without preservatives were filled by direct submersion into the water body. Sample bottles with preservative were filled from the unpreserved bottles by carefully transferring the sample into the appropriate bottles. VOA vials were filled from the unpreserved bottles leaving no headspace or air bubbles.

Field parameter measurements (pH, specific conductivity, dissolved oxygen and oxygen reduction potential [ORP]) were collected for all surface water and seep samples using a YSI Water Quality Meter.

4.3.2 Results of Surface Water Analyses

Surface water samples were analyzed for PP Volatile Organic and Base Neutral Organic Compounds, PP Metals, COD, BOD, Chlorides, pH, Nitrate Nitrogen, Total Solids and Total Suspended Solids. Based on results of prior investigations, pesticides and PCBs were not analyzed. The results of analyses are provided in Table 18 – Surface Water Analysis Results – Kimball 2000 and on Figures 16 and 17 – Surface Water and Sediment– Organic Compounds and Inorganic Analytes, respectively.

BOD was detected at similar concentrations in all samples, ranging between 40 and 86 mg/L. COD was detected at elevated concentrations, ranging from 120 to 140 mg/L in samples ASW-1, AS-1 and ASW-3 representative of Bucks Creek north of Valley Brook Avenue. Concentrations of COD ASW-2 and ASW-4 were 97and 66, respectively, representative of tidally influenced areas.

Heavy metals were detected in all surface water samples. The concentrations of heavy metals were all below surface water quality standards, except for mercury. Mercury was detected at similar concentrations in all surface and ground water samples collected on the same day except for the field blanks. Due to the varied location and source of water, the consistent presence of mercury in the database at similar concentrations, the positive presence of mercury in all actual samples and absence in blanks, we suspect the reported concentrations to be artifacts of interferences from one or more analytes from the local environment.

Aromatic hydrocarbons were detected in the three surface water samples collected from Bucks Creek. All concentrations were below Surface Water Quality Standards. Concentrations of aromatic hydrocarbons were highest at the northern end of Bucks Creek and decreased in concentration with flow to the south. Concentration of total volatile organics decreased along Bucks Creek from 1,870 ug/L in ASW-1 to non-detect in ASW-3 at Valley Brook Avenue and 2.0 ug/L in ASW-2 at the southern end of Bucks Creek. Volatile organic compounds were not detected in samples ASW-4, LSW-1 nor LSW-2 from Van Winkle Ditch.

The semivolatile organic compounds Di-n-butylphthalate and Fluorene were detected in samples from Bucks Creek at concentrations below Surface Water Quality Standards. Di-n-butylphthalate was detected at 14 ug/L in ASW-1 and 33 ug/L in ASW2. Fluorene was detected at 5.2 ug/L in AS-1.

4.3.3 Significant Events or Seasonal Variations Affecting Sampling or Analysis

Flood tide from the Hackensack River reaches throughout Van Winkle Ditch and a portion of Bucks Creek. Therefore, surface water collected from those locations contain water from sources external and internal to the landfill study area. The twice daily change from tidal exchange dominates the surface water volume and contaminant mass in the study area. The surface water samples were collected at low tide to maximize the percentage of impacted groundwater in the surface water samples.

4.4 Sediment Investigations

4.4.1 Sediment Sampling

Four sediment samples were collected and analyzed to confirm prior investigation findings conducted adjoining the landfills and to obtain data needed for a Baseline Ecological Assessment. Sediment samples were collected from one location in Bucks Creek and three locations in Van Winkle Ditch to assess level of contamination in sediments in streams affected from impacted ground water seepage from the landfill. Sediment sample locations are presented on Figure 11 – Sample Location Map and Figures 16 and 17 – Surface Water and Sediment Organic Compounds and Inorganic Analytes Maps. Each sediment sample was analyzed for Priority Pollutant metals, Priority Pollutant volatile organics + 10, Priority Pollutant base neutrals + 20, TOC, pH, and Grain Size. Results of analysis are presented in Table 19 – Sediment Analysis Results – Kimball 2000 and in laboratory summary reports.

Sediment samples were collected by manually driving a core sampler, equipped with an acetate liner, through the sediment layer until naturally occurring sand and gravel layers are encountered. However, no sediment samples locations were advanced four feet below ground surface. Sediment sampling procedures will follow sampling procedures described in the QAPP. Sample logs were prepared for all sediment samples to document sediment conditions, materials encountered, thickness of sediment, field instrument measurements, presence of odor, vapors, discoloration, and free-phase product. Field sampling and documentation were performed in accordance with the QAPP, prepared to comply with the Technical Requirements for Site Remediation 7:26E-3.6 through 3.9.

Sample logs, provided in Appendix A, were prepared for sediment sample locations to document materials encountered, thickness of sediment, field instrument measurements, presence of odor, vapors, discoloration, and free-phase product.

4.4.2 Results of Sediment Analyses

Sample AD1 was collected from sediments in the southern end of Berrys Creek prior to discharge to Mary Anne's Creek and the Hackensack River. Inorganics and polycyclic aromatic hydrocarbons are present at concentrations above Marine/Estuarine Effects Range Low and below

Effects Range Medium. Positive detections are presented in Table 19 – Sediment Analysis Results – Kimball 2000.

Sample LD2 was collected from sediments in the southern end of Van Winkle Ditch prior to discharge to Berrys Creek and the Hackensack River. Inorganics and polycyclic aromatic hydrocarbons are present at concentrations above Marine/Estuarine Effects Range Low and below Effects Range Medium.

Sample LD4 and duplicate LD4D were collected from sediments in Van Winkle Ditch at Valley Brook Avenue. A limited number of polycyclic aromatic hydrocarbons were detected at concentrations below Marine/Estuarine Effects Range Low. Inorganic analytes similar to other sediment samples were detected at comparable concentrations. Concentrations of organic compounds detected are similar. Concentrations of inorganic analytes in sample LD4 are one half the reported concentrations in sample LD4D.

4.4.3 Significant Events or Seasonal Variations Affecting Sampling or Analysis

During sediment sampling, subsurface obstructions were encountered at each of the sediment sample locations, which prohibited the advancement of the sample corer to the full depth of four feet. In addition, low sample recoveries were also noted due to the extremely soft nature of the sediments. The soft sediments would not readily enter the sample corer beyond the sample catcher device. When the sample catcher device was removed to try and improve sample recovery, vacuum created by withdrawal of the sample device pulled the soft sediments out of the corer.

4.5 Air Quality Investigations

4.5.1 Air Sampling

Kimball field crews sampled gases in the landfill using PID, FID and multi-gas meters. Landfill gases were measured in wells, piezometers and animal burrows the full length of the landfill.

Calibrated photoionization detector (PID), flame ionization detector (FID) and multigas meter were used to measure concentrations of organic compounds in gases trapped in site monitor wells, and emitting out of gas vents and animal burrows. Real-time readings were recorded in field log books. Sample locations are presented on Figure 11 -- Sample Location Map.

Four air samples were collected from wells and piezometers spaces along the length of the landfill and submitted to American Westech Inc. of Harrisburg, PA for analysis of volatile organic compounds in air. Sample locations are presented on Figure 11 – Sample Location Map.

Samples were collected using summa canisters with tubing to extend the point of collection down into gas vents and piezometers. The summa canisters were obtained from the laboratory fully evacuated. A four foot section of polyethylene tubing was attached to the control valve on the canister, and placed down at least two feet into the gas vent, well, and piezometers used to access

subsurface gases. The canister control valve was opened and canister vacuum used to fill the canister to ambient conditions. The control valve was closed and the canister sealed, labeled, and packaged for shipment. The canisters were delivered to the laboratory the day following sample collection.

4.5.2 Results of Air Analyses

Air monitoring conducted during the 2000 site reconnaissance and well sampling reported FID readings of 30 to 400 ppm at impacted ground water seeps and groundhog borrows, and in excess of 500 ppm at closed wells in the north central portion of the landfill. FID readings do not differentiate between various organic compounds and includes methane. Readings obtained during field sampling efforts are resented in Table 20.

Positive results of air sample analyses are presented in Table 20 – Air Analysis Results – Kimball 2000. 2,3 Dihydrofuran (AA1 15.9 ppbv & AA2 10.4 ppbv) and 1,3,5-cycloheptatriene (AA1 12 ppbv) and 1,3-dimethylbenzene (AA2 14.2 ppbv) were detected at trace concentrations in gas vents north of Valley Brook Avenue. Halocarbon 12 (AAH4 64.1 ppbv) was detected in landfill gases issuing of a groundhog burrow near the aqueduct south of Valley Brook Avenue.

4.5.3 Reliability and Accuracy of Analysis

Field instruments used to monitor air quality included photo-ionization detectors (PIDs), flame ionization detectors (FIDs), and multi-gas meters. The field instruments were calibrated daily and checked several times per day for ability to report variation in readings.

Water vapor interferes with PID level of detection. Readings during and immediately after rain events therefore are qualified as potentially exhibiting negative bias.

Condensation of water vapor on PID photocell decreases the level of detection. Therefore, PID use immediately after movement from warm environments may exhibit negative bias.

Standard methods established by the USEPA were used for collection, handling and analysis of air samples. New tubing was used to extend air sampling zone down into riser pipes to reduce the influence of dilution by ambient air.

4.5.4 Significant Events or Seasonal Variations Affecting Sampling or Analysis

No significant events or seasonal variations affecting sampling or analysis were observed during sampling.

Contaminant concentrations in landfill vents are expected to be stable, but flow rates are expected to increase with warmer weather.

Contaminant concentrations in monitor wells are expected to be artificially elevated as trapped landfill gases saturate closed well casings. Of particular note were elevated readings in all three

wells of the CW5 well nest, indicating probable breaks in the well casings above the groundwater surface elevation.

4.6 Quality Assurance and Quality Control

Sample collection and analysis quality were monitored through the processing of field blanks, trip blanks, and field duplicates as discussed below.

4.6.1 Field Blanks and Trip Blanks

Field blanks and trip blanks were processed for water samples only.

Field blanks were analyzed for all the same parameters as water samples collected that day at a rate of one per day. The laboratory reported no blank contamination.

One trip blank was processed per shipment of water samples ordered for volatiles analysis, by carrying laboratory supplied volatiles vials in the shipping container from the laboratory and back to the laboratory. The vials were analyzed for volatiles only. The laboratory reported no blank contamination.

4.6.2 Field Duplicates

Duplicate samples were collected in the field for both non-aqueous and aqueous matrix samples. The purpose of duplicate sample collection is to provide evaluation of the analytical laboratory's performance. One duplicate sample per sample matrix was collected for every twenty samples collected.

Aqueous duplicate samples were collected by alternately filling two sets of identical sample bottles from each location. Volatile samples must be filled first and from the same bailer full of water, when possible. Remaining sample bottles for the other various parameters were filled in the proper sequence as stated in the NJDEP Field Sample Manual. Volatile samples in surface waters or surface seeps were filled first and in succession until all VOA vials are filled.

Sediment samples collected for VOC analysis were taken from discrete locations or intervals without compositing or homogenizing. Non-volatile soil samples were homogenized prior to the filling of the sample container. Homogenization were accomplished by filling a properly decontaminated stainless steel tray or bowl with the sample and mixing it with a decontaminated stainless steel instrument or by placing the sample into a sealed plastic bag and mixing it by hand. Mixing will take place until a consistent physical appearance is obtained prior to filling of sample containers. After mixing, the samples were divided in half and scooped alternately from each half.

4.6.3 Matrix Spike\Matrix Spike Duplicates

One matrix spike and one matrix spike duplicate was processed by the laboratory for every twenty samples of a particular matrix submitted for analysis and laboratory duplicate analysis for inorganic to evaluate the precision. Percent recoveries were calculated for these QA/QC samples to evaluate if the data quality objectives were met. Listed below is a summary of the findings.

SDG Number	Comments
L7488NJ	All Matrix Spike/Matrix Spike Duplicate recoveries met the criteria except mercury.
L7510NJ	All Matrix Spike/Matrix Spike Duplicate recoveries met the criteria except Benzene, and zinc.
L7521NJ	All Matrix Spike/Matrix Spike Duplicate recoveries met the criteria.
L7547NJ	All Matrix Spike/Matrix Spike Duplicate recoveries met the criteria except mercury.
L7631NJ	All Matrix Spike/Matrix Spike Duplicate recoveries met the criteria.
L7658NJ	All Matrix Spike/Matrix Spike Duplicate recoveries met the criteria.
L7682NJ	All Matrix Spike/Matrix Spike Duplicate recoveries met the criteria except mercury.

4.6.4 Holding Times

Holding times for individual parameters are dictated by the specific analytical method that was used. All of the samples in the following sample delivery groups (SDGs) met the extraction and analysis holding times: L7488NJ; L7510NJ; L7521NJ; L7547NJ; L7658NJ; L7631NJ; and L7682NJ.

4.6.5 Method Detection Limits

Data was reviewed to determine if dilutions were made that elevated the detection limits for the compounds/analytes. Detection limits for samples in the following SDGs were within the normal detection limit range: L7488NJ; L7510NJ; L7521NJ; L7547NJ; L7658NJ; L7631NJ; and L7682NJ.

4.6.6 Precision and Accuracy

Field blanks, trip blanks, and field duplicate samples were processed by field sampling personnel and the laboratory to evaluate the potential for contamination from ambient air, sample bottle preparation and sampling instruments. The following is a summarization of the QA/QC data.

SDG Number: L7488NJ - Samples, duplicate, and field blank were analyzed for PP volatiles, PP base/neutral semi-volatiles, PP metals, BOD, COD, nitrate, chloride, TS, TSS, TOC and pH. The original sample and duplicate sample have diethylphthalate, bis(2-ethylhexyl)phthalate concentrations that exceeded the 20 percent RPD criteria. Diethylphthalate, bis(2-ethylhexyl) phthalate, mercury and zinc concentrations in the field blank were above the detection limit. There were no volatile compounds detected in the trip blank above the detection limit.

SDG Number: L7510NJ - Samples, and field blank were analyzed for PP volatiles. PP base/neutral semi-volatiles, PP metals, BOD, COD, nitrate, chloride, TS, TSS, TOC and pH. Beryllium, mercury, nickel and zinc concentrations in the field blank were above the detection limit. There were no volatile compounds detected in the trip blank above the detection limit. A duplicate sample was not analyzed with this SDG.

SDG Number: L7521NJ - Samples, and field blank were analyzed for PP volatiles, PP base/neutral semi-volatiles, PP metals, BOD, COD, nitrate, chloride, TS, TSS, TOC and pH. Bis(2-ethylhexyl)phthalate, lead and zinc concentrations in the field blank were above the detection limit. There were no volatile compounds detected in the trip blank above the detection limit. A duplicate sample was not analyzed with this SDG.

SDG Number: L7547NJ - Samples, duplicate, and field blank were analyzed for PP volatiles, PP base/neutral semi-volatiles, PP metals, BOD, COD, nitrate, chloride, TS, TSS, TOC and pH. The original sample and duplicate sample have chromium, copper, lead, and zinc concentrations that exceeded the 20 percent RPD criteria. Beryllium, mercury, selenium, and zinc concentrations in the field blank were above the detection limit. There were no volatile compounds detected in the trip blank above the detection limit.

SDG Number: L7631NJ - Samples and field blank were analyzed for PP volatiles, PAH, PCBs, TOC, and pH. The zinc concentration in the field blank was detected above the detection limit. Trip blank and duplicate samples were not analyzed with this SDG.

SDG Number: L7658NJ - Samples, duplicate, and field blank were analyzed for PP volatiles, PP base/neutral semi-volatiles, PP metals, BOD, COD, nitrate, chloride, TS, TSS, TOC and pH. Copper and zinc concentrations in the field blank were above the detection limit. There were no volatile compounds detected in the trip blank above the detection limit. A duplicate sample was not analyzed with this SDG.

SDG Number: L7682NJ - Samples, duplicate, and field blank were analyzed for PP volatiles, PP base/neutral semi-volatiles, PP metals, BOD, COD, nitrate, chloride, TS, TSS, TOC and pH. The original sample and duplicate sample have Diethylphthalate, bis(2-ethylhexyl)phthalate, chromium, copper, mercury, nickel, lead, selenium, and zinc concentrations that exceeded the 20 percent RPD criteria. Di-n-bytylphthalate, beryllium, chromium, copper, nickel, selenium, and zinc concentrations in the field blank were above the detection limit. There were no volatile compounds detected in the trip blank above the detection limit.

4.7 Health and Safety Monitoring

A Kimball Health and Safety Officer (HSO) monitored work procedures, working conditions, and air quality during all subsurface investigation activities.

Air monitoring for volatile organic compounds, lower explosive limit (LEL), oxygen, carbon monoxide and hydrogen sulfide were conducted in accordance with the Site Health and Safety Plan. Real time air monitoring was conducted during intrusive sampling activities using hand-held photoionization and flame ionization detectors, and multi-gas meters. Air monitoring was conducted within the worker-breathing zone and immediately atop the open augers or borehole to evaluated the potential for elevated VOC concentrations. When elevated readings were noted within the breathing zone, work was temporarily ceased until the elevated concentrations of vapors dissipated. Equipment calibration was performed daily and recorded in the Equipment Calibration Log.

5.0 DISCUSSION AND INTERPRETATION OF COMPILED RESULTS

5.1 Soil/Fill/Debris Investigation

The Avon Landfill Corporation, operating from about 1957 to 1980, filled 103 acres of former marshland with waste originating from municipal, industrial, commercial, and demolition waste sources. The horizontal extent of fill was limit by earth embankments constructed prior to landfill operations for the Jersey City Aqueduct along the eastern border, Transcontinental Pipeline along the southern border, and the NJ Transit (Formerly Conrail) railroad along the western and northern borders.

Waste was placed directly into former marshland by end-dump method, resulting in waste being placed in open water. Former marshland meadow mat and organic soil were pushed aside as a mud wave and excavated as fill activity progressed from north to south through the landfill area. As such, the vertical extent of waste was identified in borings to have reached nine to 12 feet below MSL. In some borings, dominated by borings around the edge of fill, the waste ends on top of the meadow mat soil. In the majority of the borings, the waste fill extended to underlying varved clay. The natural varved clay was measured to depths of 140 to over 170 feet below MSL.

Waste fill progressed in multiple lifts over the operating life of the landfill, ultimately achieving upper surface elevations of 35 to 42 feet above MSL. Due to waste decomposition and settlement, current landfill uppermost surfaces vary between 27 and 35 feet above MSL.

Industrial wastes co-mingled with the municipal, commercial and demolition wastes, as developed through NJDEP records, included base solutions (pH > 12), heavy metals and miscellaneous organic and inorganic wastes. Waste streams identified by disposers through the USEPA Notification of Hazardous Waste Site forms included metal bearing and organic printing wastes, paints, pigments, flammable liquids, and vitamin production byproducts. (NUS 1990)

Soil investigations performed in 1988, 1990 and 2000 did not report encountering discrete masses of solid or semi-solid industrial wastes. Real-time volatile organic detector readings obtained in 1988 and 2000 indicate presence of organic compounds in landfill gases indicative of volatile organic compounds in site groundwater zone. Positive detection on FID and negative detection on PID indicate that methane dominates the organic compounds in the Avon Landfill gases.

Results of soil analyses performed at ground surface and in the waste fill identified aromatic hydrocarbons, PAH, and phthalate organic compounds, and heavy metal species at concentrations exceeding current NJDEP restricted use criteria. The contaminants were detected in all portions of the landfill and multiple depths. Results of geophysical surveys and groundwater studies identify localized anomalies indicative of higher concentration of contaminants in the north-central portion and the southeast corner of the landfill.

Due to uncontrolled access to the landfill by human, avian, amphibians, and mammals, contamination in surface soil remains as an on-going risk factor. The dense growth of phragmities and mudwart that covers the landfill has developed a strong surface thatch and resultant reduction in surface erosion. Surface erosion continues along access roads, resulting in exposed waste at a limited number of areas.

5.2 Groundwater Investigation

Water level measurements collected in 1988, 1989 and 2000 confirm presence of a groundwater mound within the landfill. Uppermost surface elevations in the center of the mound were recorded as seven to 11 feet above MSL in 1988/1989 and nine to 11 feet in 2000. The groundwater mound surface is observed to decrease radially outward, ending at elevations at or below ground surface at the outer edge of fill.

Goundwater surface elevations measured in wells W-7 (6.55 ft) and W-3 (3.28 ft) and piezometer AH-2 (3.26 ft) confirm groundwater surface elevations at or above the nearby Bucks Creek invert elevations of 1 to 3 feet above MSL south of Valley Brook Avenue. Groundwater surface elevations measured in wells W-1 (4.5 ft) and W-6 (8.77 ft) and piezometer AH-1 (5.94 ft) confirm groundwater surface elevations at or above the nearby Bucks Creek invert elevations of 3 to 9 feet above MSL north of Valley Brook Avenue. Saturated surface soil and at least two visible seeps are visible along the toe of slope immediately above Bucks Creek. These findings indicate that impacted groundwater discharges to Bucks Creek and passes beneath Bucks Creek toward Kingsland Creek.

Groundwater surface elevations measured in wells W-2 (5.53 ft), CW2-1(4.67 ft), CW4-1 (6.98 ft), and W-10 (7.85 ft), and piezometers AH3 (7.78 ft) and AH-4 (5.29 ft) confirm groundwater surface elevations along the Jersey City Aqueduct to be four to five feet above the invert elevations of one foot below to four feet above MSL in Van Winkle Ditch. The measured groundwater elevations are at the same approximate elevation as the top of the aqueduct pipes and about one to two feet below the elevation of the top of the aqueduct embankment.

Water surface elevations measured in nearby Van Winkle Ditch varied between about zero feet to about three feet above MSL. The difference between groundwater measurements west of the Jersey City pipelines and surface water measurements east of the pipelines indicate groundwater mounds behind the pipelines. As noted in Figures 6 through 9 – Geologic Profiles, the groundwater is able to flow by the six-foot diameter pipelines through about two feet of earth above the pipeline and 10 to 12 feet of earth and organic soil between the pipeline and the underlying varved clay stratum.

Results of analyses performed on groundwater collected from Avon Landfill in 1988/89, 1990 and 2000 identified similar types and concentrations of contaminants. Aromatic hydrocarbons, phthalates and polycyclic aromatic hydrocarbons were detected at or above NJDEP Class IIA Groundwater Quality Standards in all portions of the landfill. Aromatic hydrocarbons benzene and

chlorobenzene were identified in the majority of samples collected and at the highest concentrations of organic compounds detected.

Chlorinated hydrocarbons vinyl chloride and trans 1,2 dichloroethylene were detected at a combined concentration of 390 ug/l in monitor well W-11, located in the north-central portion of the landfill. The chlorinated hydrocarbons were not detected in other wells.

Permeability tests run on the varved clay beneath the site measured vertical permeabilities of 10^{-7} to 10^{-8} cm/s. The varved clay layer was found to extend 140 to over 170 feet beneath the full extent of fill. Chemical analysis of groundwater samples collected in 1989 found positive presence of organic contaminants in the waste fill and little to no presence of organic contaminants in the underlying varved clay and glacial till strata. This information confirms that the varved clay layer is an effective aquitard to vertical migration of contaminants from the landfill.

5.3 Surface Water and Seep Investigation

Bucks Creek is a man-made drainage ditch cut along the western edge of the landfill. The ditch invert drops in elevation from about nine feet at the northern end of the ditch to about three feet at Valley Brook Avenue, then to about one foot at the southern end of the landfill. Sediment buildup and slope slumping have created several obstructions to surface flow, areas of standing water and vegetated channel. Surface water flow through the ditch was observed to be slow but consistently north to south throughout the days monitored. Groundwater discharge into the ditch is observed as the primary source of water flowing in Bucks Creek.

Due to siltation and debris at the tide gate, ebb tide back flow was observed in the southern most portion of Bucks Creek. Elevated chloride and total solids concentrations noted in sample ASW2, collected from Bucks Creek near the tide gate, when compared with concentrations noted in sample ASW3 collected at Valley Brook Avenue indicate presence of saline water from the Hackensack River on the upstream side of the tide gate.

An isolated depression with ponded water remains at the northern end of the landfill. Water elevations in the pond were measured at about seven feet in 1985, 1992, and 2000. Inspection of the pond revealed no outlet to either Van Winkle Ditch or Bucks Creek. The probable source of water in the pond is evaluated as localized surface runoff and groundwater infiltration from adjoining rail, industrial, chemical facility and landfill areas.

The two-foot difference between the pond water surface (seven feet above MSL) and the upper reach of Bucks Creek (nine feet above MSL) indicates a potential ability for ponded water to flow into Bucks Creek during extreme storm events. The additional two feet of fill (ten to 12 feet above MSL) along the Jersey City Aqueduct at the pond prevents flow across the pipelines and into Van Winkle Ditch.

Sample ASW-1, collected from the northern extreme of Bucks Creek, exhibited the greatest number and concentrations of contaminants in the surface waters sampled to date. The aromatic hydrocarbons, PAHs, and heavy metals observed in ASW-1 are similar in type and lower in concentration to that observed in nearby monitor wells W-4 and W-6. The level of impact observed in the surface water sample confirms the opinion that the stream base flow originates from discharge of impacted groundwater.

Sample AS-1 is a seep sample collected midway between the north end of the landfill and Valley Brook Avenue. Contaminants detected in the seep sample are similar in type and concentration to the contaminants detected in nearby monitor wells W-9 and W-11. Although only two discrete areas of actively flowing seeps were noted along the west toe of the landfill, numerous areas of visibly saturated soil immediately above the ditch water surface elevation indicate active non-point source discharge of impacted groundwater to Bucks Creek.

Surface water sample ASW-3 was collected from Bucks Creek at Valley Brook Avenue. Contaminants observed in surface water sample ASW-3 are similar to but at lower concentrations than the contaminants detected in upstream samples ASW-1 and AS-1. The results are interpreted to show natural attenuation of organic compounds and inorganic analytes in Bucks Creek due to volatilization, sedimentation, adsorption and absorption processes.

Results of analyses performed on samples collected from Van Winkle Ditch and Bucks Creek and nearby water ways in 1989, 1990 and 2000 detected trace concentrations of aromatic hydrocarbons and PAHs, plus various heavy metal species. Pesticides and PCBs were not detected in sampling conducted in 1985, 1987 and 1990.

The HMDC monitors heavy metal and general water quality parameters at fourteen locations in the Hackensack River watershed on a quarterly basis. The results of analyses performed on samples collected in tidally influenced surface waters (ASW-2, ASW-4, LSW 1 and LSW-2) indicate that the concentrations of metals and general water quality parameters in surface water discharging from the site are the same as or less than concentrations reported for other portions of the Hackensack River watershed. The concentrations of BOD and zinc are above the regional surface water quality, indicating some impact from organic decomposition in the landfill. Therefore, as the water quality in the tidal ditches adjacent to the Avon Landfill is comparable to the quality observed in the region, the Avon Landfill does not exhibit a measurable impact to the water quality in the tidal ditches.

5.4 Sediment Investigation

Investigations performed over the past 15 years on sediments in Bucks Creek, Van Winkle Ditch, and Berrys Creek have confirmed presence of PAH organic compounds and heavy metals species throughout the local environment. The source(s) of these contaminants is evaluated as urban runoff, tidal flows from Berrys Creek and the Hackensack River, and discharge of impacted groundwater from site and off-site landfills.

Various PAHs have been detected above Marine/Estuarine Sediment Screening Guidelines. Effects Range Low in sediments sampled in Berrys Creek, Bucks Creek, Van Winkle Ditch and the Hackensack River. The PAH compounds detected most often at concentrations of concern include benzo(a)anthracene, benzo(b)fluranthene, chrysene, benzo(a)pyrene, indeno(1,2,3-cd) pyrene, phenanthrene, and pyrene. A few of these compounds have been detected at concentrations exceeding Marine/Estuarine Effects Range Medium.

Aromatic hydrocarbons have been detected at trace concentrations in sediments collected from within the area of influence of landfill seeps. Benzene, ethylbenzene and total xylenes were detected in the immediate vicinity of landfill seeps on adjoining landfills at concentrations above Marine/Estuarine Effects Range Low. Sediment samples collected in 2000 in Bucks Creek and Van Winkle Ditch downstream of seeps did not detect these compounds. As with the results of surface water sample analyses, the effects of volatile organic contaminants migrating with landfill groundwater are dissipated by natural attenuation within the site boundaries.

Heavy metal contamination is most consistent and pervasive throughout the sediment regime. The heavy metals arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc have been detected throughout the local estuarine and river ecosystems at concentrations exceeding Marine/Estuarine Effects Range Low. Silver also has been detected in site sediments during most recent investigations at concentrations exceeding Marine/Estuarine Effects Range Low and in two of four samples above Effects Range Medium. The sources of metal contamination in sediments from tidally influenced water ways is evaluated as a combination of off-site and on-site sources. The concentration of contaminants appears not to vary substantially between on-site and off-site environments, indicating a general background poor quality of sediment in the local watershed.

5.5 Air Quality Investigation

Real-time air monitoring instruments recorded volatile organic compounds discharging from the landfill through vents placed in the landfill by Avon Landfill Corporation, monitor wells, disturbed soil and animal burrows. The presence of elevated organic compound concentrations was observed in all portions of the landfill.

Results of analysis conducted on four air samples collected from along the landfill identified a limited number of volatile organic compounds. Compounds detected in air vents west of Valley Brook Avenue included 2,3-dihydrofuran (15.9 ppbv and 10.4 ppbv), 1,3,5-Cycloheptatriene (12.0 ppbv), and 1.3-dimethylbenzene (14.2 ppbv).

Organic vapors detected by real-time instruments varied considerably over the landfill. Concentrations in animal burrows south of Valley Brook Avenue ranged between 100 and 400 ppm Concentrations detected in sealed monitor wells immediately upon opening ranged between non-detect in deep wells to as high as more than 50,000 ppm in well nest CW5 casings. The high readings in well CW5 casings were rechecked after letting the well stand open for three

minutes, resulting in concentrations of zero ppm. The changes in readings indicates that the vapors had concentrated in the sealed wells.

FID readings consistently exceeded PID readings, indicative of significant presence of methane, which the PID does not detect. Potentially ignitable vapors were detected in well nest CW5 located in the north end of the landfill and well W-3 located at the south end of the landfill.

When compared with the results of real-time air monitoring, the concentrations of volatile organic compounds detected in the air samples collected from the Avon Landfill appear to make up less than one tenth of one percent of total organic compounds detected in the landfill gases. The low number and concentration of toxic volatile organic compounds in air samples collected from unsaturated waste volume leads us to believe that the positive organic vapor escaping from the landfilled wastes detected by real-time instruments at ground surface is dominated by methogenic compounds generated by decomposition processes and not the aromatic and PAH compounds detected in site groundwater.

6.0 BASELINE ECOLOGICAL EVALUATION

This Baseline Ecological Evaluation complies with N.J.A.C. 7:26E-3.11 Site Investigation - Ecological Evaluation to provide a qualitative evaluation of the site and associated contamination and effects, and to determine if further sampling and evaluation is required.

6.1 Contaminants of Ecological Concern

Soil, groundwater, surface water and sediment sampling and analysis were performed in source areas, drainage systems, and local estuarine and river ecological systems over a 15-year period. Sample analysis parameters included volatile organic compounds, semi-volatile organic compounds, inorganic analytes, herbicides, pesticides and PCBs.

Results of analyses performed on soil samples from the Avon Landfill identified presence of aromatic hydrocarbons, PAHs, and priority pollutant metal species above NJDEP soil cleanup criteria. The aromatic hydrocarbons benzene, chlorobenzene, toluene, zylene, acetone, and ethylbenzene in 20 to 30% of soil samples analyzed. The PAHs were detected in less than 10% of samples processed, with no PAHs exceeding cleanup criteria. Bis(2-ethylhexyl)phthalate was detected in 20 soil samples, with one sample (B-4-D 130 mg/kg) at a concentration exceeding a soil cleanup criteria. Hexachlorobutadiene was detected in two samples with one sample (Avon B10C 200 mg/kg) reported above soil cleanup criteria. Pesticide and PCB analyses in general were negative except for detection of 4,4 DDT (0.43 mg/kg and duplicate 0.21 mg/kg) in one surface soil sample in 1990 and Aroclor 1254 (0.13 mg/kg and 2.5 mg/kg) in 2 soil samples in 1988. The type and concentrations of contaminants detected in site soil are comparable to background levels reported for urban, non-industrial areas in the region. (Bradley et al 1994) Therefore, the contaminants reported in site soil do not represent contaminants of potential ecological concern.

Results of analyses performed on groundwater samples from Avon Landfill identified the aromatic hydrocarbon benzene and the base neutral compound Bis(2-ethylhexyl)phthalate at concentrations exceeding Class IIA Groundwater Quality Criteria and SE2 Surface Water Quality Criteria. Bis(2-ehtylhexyl)phthalate was detected at concentrations similar to site concentrations throughout the Berrys Creek drainage area, therefore it is evaluated as a background contaminant and not a contaminant of ecological concern. The aromatic hydrocarbons chlorobenzene and xylene, plus the metals lead, mercury, nickel, and sodium were detected in site groundwater at concentrations exceeding Class IIA Groundwater Quality Criteria and below SE Surface Water Quality Criteria. Pesticide and PCB analyses in general were negative with one sample detection in 1990 for aldrin (3.3 ug/L), endosulfan I (0.53 ug/L) and endrin ketone (0.57 ug/L). Given the above, benzene is identified a contaminant of ecological concern.

Results of analyses performed on surface water samples collected from drainage systems adjacent to Avon Landfill identified presence of trace concentrations of aromatic hydrocarbon, chlorinated hydrocarbons, and PAHs and a limited number of metal species. The organic compounds were detected in surface water at concentrations meeting SE2 Surface Water Criteria.

The inorganic analytes were detected in surface water at concentrations similar to that reported in the HMDC quarterly monitoring of regional surface water bodies. Therefore, contaminants noted in site surface water are not retained as contaminants of potential ecological concern.

Based on analyses performed on sediment samples collected from zero to one foot in drainage systems adjacent to the Avon Landfill, sediments in and surrounding the site contain PAHs and heavy metal species at concentrations exceeding Marine/Estuarine Sediment Screening Guidelines. Contaminants detected in site sediments are similar in type and concentration to contaminants detected in Berrys Creek and the Hackensack River. Pesticides and PCBs were not detected. Since contaminants detected in site sediment are similar to the type and concentration of contaminants reported for the regional tidal and urban areas surrounding the site, they are not retained as contaminants of potential ecological concern.

The concentrations of total organic carbon in samples collected surrounding Avon Landfill ranged from 75,000 mg/kg to 200,000 mg/kg confirming that the samples were collected in the depositional zone of the local water ways.

6.2 Determination of Environmentally Sensitive Areas

The Avon Landfill is located in the Hackensack River watershed, classified as an estuarine and riverine ecosystem. Van Winkle Ditch and Bucks Creek, which surround the Avon Landfill, discharge to the Hackensack River through Berrys Creek and Mary Ann Ditch, respectively. Wetland delineation performed in 2000 identified Van Winkle Ditch and Bucks Creek as regulated wetland. Therefore, as stated in the Technical Regulations, the Van Winkle Ditch and Bucks Creek, as well as down stream ecosystems qualify as Environmentally Sensitive Areas.

6.3 Potential Migration Pathways

The Avon Landfill is fully vegetated with thick stands of phragmities and mugwart, which act to contain surface erosion within the landfill area. Therefore, migration of contaminated soil to environmentally sensitive areas by surface runoff is not evaluated as a significant concern.

Groundwater discharge and surface runoff from the Avon Landfill and NJ Transit Main Line are the sources for Bucks Creek flow. Concentrations of organic contaminants reported in the north end of Bucks Creek exhibit impacts from contaminated groundwater. Results of analyses performed on surface water samples collected from the rest of Bucks Creek and all of Van Winkle Ditch indicate that site groundwater does not create a measurable impact upon surface water in the tidally influenced streams surrounding the site.

The data also indicate that the level of contamination reported in the lower reaches of Bucks Creek and all of Van Winkle Ditch are similar to that reported for Berrys Creek and the Hackensack River, which dominate the area ecosystems. Therefore, migration of contaminants

with surface water flow is evaluated not to result in measurable impact to off-site environmtally sensitive areas.

The PAHs benzo(a)anthracene and benzo(k)fluoranthene, plus metals arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver and zinc were detected at concentrations exceeding Marine/Estuarine Sediment Screening Guidelines, Effects Range Low. None of these compounds were detected at concentrations exceeding Effects Range Medium. Concentrations of contaminants in sediments collected from Van Winkle Ditch and Bucks Creek are similar in type and concentration as those detected in Berrys Creek and the Hackensack River. Given the above, a migration pathway does exist between contamination in site sediments and identified environmentally sensitive areas.

6.4 Conclusions and Recommendations

Contaminants detected in site soil above regulatory action levels are effectively contained by dense vegetation that covers the landfill.

Impacted groundwater is observed to discharge to Bucks Creek and to Van Winkle Ditch, yet the results of surface water analyses indicate that natural attenuation quickly removes the contaminants to levels below surface water quality criteria. Also, the type and concentration of contaminants identified in site surface water are similar to that detected in Berrys Creek and the Hackensack River, therefore, contaminants identified in Van Winkle Ditch and the southern end of Bucks Creek may originate from off-site as well as on-site sources.

Contaminants were detected in sediments in Bucks Creek and Van Winkle Ditch at concentrations between the Marine/Estuarine Sediment Screening Effects Range Low and Effects Range Medium Guidelines. The types and concentrations of contaminants detected in site sediments is similar to those reported for sediments from Berrys Creek and the Hackensack River. As such, the quality of site sediments is similar to regional background conditions.

Given the above, we recommend no further ecological assessment of Bucks Creek nor Van Winkle Ditch.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Soil/Fill/Debris Investigation

Historical documentation and the results of geophysical surveys, over 110 soil borings, at least ten test pits and physical evidence visible at ground surface confirm the horizontal and vertical extent of the waste fill. The investigations indicate that the fill is dominated by soil, debris and municipal and commercial waste. Although not encountered during the site investigations, historical records indicate active disposal of potentially hazardous industrial wastes mixed in with the other waste fill.

Thirty-eight soil sample analyses were performed in NJTA 1988 and USEPA 1990 investigations, distributed over the Avon Landfill area of concern. Heavy metal analytes were detected at concentrations exceeding at least one restricted use criteria in nine samples analyzed. Volatile organic compounds were detected in 21soil samples analyzed, with the aromatic hydrocarbons benzene and chlorobenzene detected at concentrations exceeding restricted use criteria in one sample (HNTB-10S). PCBs were detected in two samples analyzed, with the PCB Aroclor 1254 detected above restricted use criteria at 2.5 mg/kg in one sample (B-1-S). The pesticide 4,4'-DDT was detected in one sample analyzed (NJC2-S2 & Duplicate NJC2-S3) at concentrations that meet the NJDEP restricted us criteria. The above results indicate presence of contaminants of concern with no defined pattern of distribution nor areas of significant source.

The over 110 soil borings and 38 soil sample analyses provide sufficient quantity and quality of data to characterize the horizontal and vertical extent of fill, as well as the type and level of contamination in site waste fill and surface soil. Soil and waste containing contaminants exceeding current restricted use criteria have been detected in all portions of the Avon Landfill. In general, the concentrations of contaminants detected meet current NJDEP non-residential direct contact soil cleanup criteria and impact to groundwater criteria. The results of investigations conducted to date indicate that further investigation in search of discrete, worst-case source areas is not warranted. Therefore, we recommend no further soil/fill/debris investigation.

7.2 Groundwater Investigations

Four zones of groundwater exist beneath the site: groundwater within the landfill waste and a 4 to 8 feet thick layer of organic soil and sand beneath the waste, groundwater in a 110 to over 170 feet thick fully saturated silt and clay layer, groundwater in an intermittent 10 to over 30 feet thick layer of glacial till, and groundwater in underlying shale and sandstone bedrock. The unconsolidated aquifers are not used for water supply. Water withdrawal from the bedrock aquifer does not occur within one mile of the site.

The low-permeability (10^{-7} to 10^{-8} cm/s) silt and clay layer exists beneath the full extent of the landfill. Results of groundwater sample analyses performed on wells screened in and below the silt and clay layer indicate that contamination identified in the landfill has not migrated down into the silt and clay layer. The low permeability, homogeneous coverage and lack of

contaminant migration indicate that the silt and clay layer is an effective barrier to vertical movement of groundwater into or out of the landfill.

A groundwater mound exists in the landfill, oriented along the center of the landfill. The groundwater mound is recharged by rainfall infiltration. Modeling of the groundwater mound potentiometric surface elevations indicates that a 4 to 7 feet hydraulic head drives the groundwater outward in all directions from the center of the landfill, to discharge to Van Winkle Ditch, Bucks Creek and Kingsland Creek through earth embankments and underlying organic soil and sand layers.

Site groundwater is impacted by the aromatic hydrocarbons benzene, chlorobenzene, xylene, 2-butanone and toluene; phthalates; naphthalene; and the metals aluminum, arsenic, iron, lead and manganese at concentrations above current NJDEP Class IIA groundwater quality standards. Concentrations of BOD and COD also indicate elevated non-differentiated organic and inorganic oxygen demand. The number and concentrations of organic compounds detected in site groundwater in 2000 is less than those detected in 1989 and 1990, indicating active natural attenuation of the contaminants.

Data collected over multiple years and by multiple parties is evaluated as relevant and useable for this site. Groundwater data collected to date is sufficient in quantity and quality to adequately characterize the type and level of contamination in the source area and migration pathways to potential off-site receptors. Therefore, we recommend no further groundwater investigations in defining the level and extent of contamination in the groundwater regime.

7.3 Surface Water and Seep Investigation

Sixteen surface water samples were collected in 1988 during the NJTA Site Investigation, two surface water samples in 1990 by the USEPA and five samples in 2000 by Kimball. The quantity and quality of data collected to date is sufficient to adequately characterize the type and level of contamination impacting site surface water from the Avon Landfill.

Results of analyses performed on samples collected at visible seep locations on the Avon Landfill indicate groundwater impacted by aromatic hydrocarbons, polycyclic aromatic hydrocarbons, phthalates, and heavy metals is discharging from the landfill into adjoining surface water bodies. Results of analyses performed on surface waters down-stream of the seeps indicates that these contaminants are readily removed from the surface water through natural attenuation processes. Results of analyses performed on surface water samples in main flow channels of Van Winkle Ditch and Bucks Creek indicate the concentrations of the contaminants leaving the site either are not detectable or meet current SE2 Surface Water Quality Standards.

The concentrations of heavy metals, including mercury, and general water quality parameters, such as BOD and COD, detected in site surface water are the same as or less than concentrations reported at surface water monitoring stations throughout the Hackensack river basin.

Given the above, additional surface water sampling to characterize surface water quality in the two tidal ditches adjacent to the Avon Landfill is not technically warranted. Therefore, we recommend no further investigation of surface water impacts associated with the Avon Landfill.

7.4 Sediment Investigation

Three sediment samples were collected in 1987 by the NJSEA, six samples were collected in 1988 by the NJTA, and four samples were collected by Kimball in 2000 from surface water bodies potentially impacted from surface runoff and/or discharge of impacted groundwater from the Avon Landfill. The results of prior and current investigations have identified polycyclic aromatic hydrocarbons and heavy metals in site sediments at concentrations above Marine/Estuarine Effects Range Low Criteria and below the applicable Effects Range Medium Criteria.

Due to fact that tidal flow dominates the surface water volume and contaminant mass in Van Winkle Ditch, differentiating on-site and off-site sources of sediment contamination in tidally influenced water ways is not feasible.

The quantity and quality of data gathered to date are adequate to characterize the type and level of contamination in sediments potentially impacted by surface runoff and/or groundwater discharge from the Avon Landfill. The identified impacts to sediment within or immediately downstream of the Avon Landfill area of influence are the same as or lower those detected in sediment samples collected from other locations in Berrys Creek and the Hackensack River. Therefore, additional investigation to determine the extent of contamination in Van Winkle Ditch and Bucks Creek is not technically warranted. We recommend no further investigation of site sediment quality.

7.5 Air Quality Investigation

Results of real-time air monitoring conducted on landfill gases in site monitor wells, air vents and animal burrows indicates that the gases emitting from the Avon Landfill contain less than one percent organic vapors. The fact that PID readings were consistently less than FID readings indicates that the organic compounds in the landfill gases are dominated by methane. The concentrations of detectable gases was observed to drop to non-detect after letting wells air out for several minutes, indicating low mass concentration in venting gases but ability to buildup in confined spaces.

Results of four air samples collected from monitor wells and piezometers screened in the landfilled waste detected trace concentrations of volatile organic compounds in the landfill gases. The concentrations of non-methogenic volatile organic compounds in the landfill gases is less than health-based action levels. Therefore, we recommend no additional air quality investigations.

7.6 Ecological Assessment

Impacts associated with migration of identified soil and groundwater contamination from the landfill to Bucks Creek and Van Winkle Ditch are effectively attenuated within site boundaries. Therefore, we recommend no further ecological assessment.

8.0 REFERENCES

Drake et al. Bedrock Geologic Map of Northern New Jersey, United States Geological Survey, 1996.

Herpers, Henry and Henry C. Barksdale. Preliminary Report On The Geology And Ground-Water Supply Of The Newark, New Jersey, Area. Special Report 10. State of New Jersey, Department of Conservation and Economic Development. 1951.

Johnson Soil Engineering Company, A Report on Site Conditions and a Method of Operating a Sanitary Landfill at the Lyndhurst, New Jersey Site, 1968.

Kummel, Henry, B. The Geology of New Jersey. Jersey Printing Company. Bayonne, NJ. 1940.

Laing Associates. WLIB Radio Tower Expansion Mitigation Wetland Plan and Construction Specification. January 1997.

Lehr, Frank H. Associates. Soil Analysis Valley Brook Avenue Improvements. March 1985.

L. Robert Kimball and Associates, Inc. Quality Assurance Project Plan. 1999

L. Robert Kimball and Associates, Inc. Site Health and Safety Plan. 1999

Malcolm Pirnie, Inc. Work Plan For Investigation, Potential Stadium Site, Lyndhurst, New Jersey. 1987.

Malcolm Pirnie, Inc. Final Work Plan For Investigation, Avon Landfill. January 29, 1988.

McNally Engineering (McNally), Soil and Foundation Report for the Proposed Spanish Broadcasting Systems (SBS) Transmitting Facility. January 1996.

NOAA. Coastal Hazardous Waste Site Review. April 13,1984.

NJDEP. Alternative Groundwater Sampling Guidelines Document. 1992

NJDEP. Field Sampling Procedures Manuel. 1992

NJDEP. New Jersey Superfund Sites on the National Priority List as of February 1, 1999. August 24, 1999.

NJDEP. Known Contaminated Sites in New Jersey as of September 1997. July 1999.

NJDEP. Technical Requirements for Site Remediation, 7:26E-3.6 through 3.9. 1999

NJDOC. Special Report 10: Preliminary Report on the Geology and Ground-Water Supply of the Newark, New Jersey Area. 1951.

NJTA. Environmental Impact Statement. 1985

NJTA. Site Investigation For The Avon Landfill Closure. 1989.

Oweis. I. And Biswas, G., Leachate Mound Changes in Landfills due to Changes in Percolation by a Cap, Ground Water, Volume 31, No. 4, July-August 1993

Oweis et. Al., Hydraulic Charateristics of Municipal Refuse, Journal of Geotechnical Engineering, Volume 116, No. 4, April 1990

Port Authority of New York & New Jersey. Data Package: Red Brown Silty Clay for Alternative Uses Focus Group. March 1999.

Stanford, Scott D. Surficial Geology Of The Weehawken And Central Park Quadrangles, Bergen, Hudson, And Passaic Counties, New Jersey. New Jersey Geological Survey. 1993.

NJ Sports and Exposition Authority. Wetland Evaluation and Mitigation Report For The Proposed Baseball Stadium. June 1987.

United States Geological Survey (USGS). Weehawken Quadrangle, 7.5 Minute Topographic Quadrangle Map. 1981.

United States Geological Survey (USGS). Weehawken Quadrangle, 7.5 Minute Topographic Quadrangle Map. 1995.

USEPA Office of Solid Waste. Summary of Data on Municipal Solid Waste Leachate Characteristics, July 1988

USEPA. Site Inspection Report. 1990

Zurn Environmental Engineers. Analysis of Alternative Solid Wastes Management Systems For the Hackensack Meadowlands District. May 1970.

Table 1
Property Ownership Summary
Avon Landfill, Lyndhurst Township, Bergen County, NJ

Block/Lot	Owner Name & Address	Acreage, Date, Deed Book & Page	Comment
231/Lot 13	City of Jersey City, Division of Water Route 440 and Culver Ave. Jersey City, NJ	3.55 ac 80 foot-wide right of way Constructed 1902-1903	Avon Landfill operations filled portions of property per lease agreement.
231/Lot 14	Desiderio et.al c/o F. Desiderio 454 Prospect Ave. #44 West Orange, NJ 07052	25.126 ac	Avon Landfill East of Valley Brook Avenue. 60 foot wide easement for Transcontinental Gas Pipelines along east property line.
231/Lot 15	State of New Jersey Bureau of Tidelands 1035 Parkway Ave., CN229 Trenton, NJ 08625	3.72 ac	Avon Landfill operations encroached into property. 50 foot wide property along the east edge of NJ Transit Mainline ROW
233/Lot 13	City of Jersey City, Division of Water Route 440 and Culver Ave Jersey City, NJ	10 42 ac 80 foot-wide right of way Constructed 1902-1903	Avon Landfill operations filled portions of property per lease agreement.
233/Lot 14	State of New Jersey Bureau of Tidelands 1035 Parkway Ave., CN229 Trenton, NJ 08625	66.624 ac	Avon Landfill west of Valley Brook Avenue. 60 foot wide easement for Transcontinental Gas Pipelines along east property line.
235/Lot 30	State of New Jersey Bureau of Tidelands 1035 Parkway Ave., CN229 Trenton, NJ 08625	5.1 ac	Avon Landfill operations encroached into property. 50 foot wide property along the east edge of NJ Transit Mainline ROW

TABLE 2
HYDROLOGIC DATA FOR BERRY'S CREEK

Berry's Creek No. 8 Tide Gage		Tide Gage Averages 9/76 to 8/77	Elevations above NGVD29	Elevations above NAVD88
Bench Mark D		13.65	11.48	10.42
100 Year Flood Elevation	FEMA		9	8
Highest Observation	9/25/77	8.07	5.9	4.84
Mean Higher High Water	MHHW	5.87	3.7	2.64
Mean High Water	MHW	5.56	3.39	2.33
Mean Tide Level	MTL	2.9	0.73	-0.33
Mean Low Water	MLW	0.23	-1.94	-3
Mean Lower Low Water	MLLW	0	-2.17	-3.23

NGVD29 = National Geodetic Vertical Datum 1929
NAVD 88 - North American Vertical Datum 1988
Mean Lower Low Water set at data collection base elevation.

TABLE 3
WELL and PIEZOMETER DATA – KIMBALL, MARCH 2000

Well & Piezometer Number	Ground Elevation NAVD88	Elevation top of PVC NAVD88	Elevation top of Casing NAVD88	Depth to Water	Water Elevation Mar2000 NAVD88	Northing	Easting	Screened Layer
						NJ State Plane Coordinate		
AH-1	7.43	7.52	Not Appl.	1.58	5.94	714677.3152	600737.7705	Fill
AH-2	5.76	8.61	Not Appl.	5.35	3.26	711477.0150	603368.2870	Fill
AH-3	10.28	10.64	Not Appl.	2.86	7.78	713279.2670	602619 6990	Fill
AH-4	5.85	7.29	Not Appl.	2.00	5.29	711789.9760	603859.5250	Fill
CW1-1	30.41	32.47	32 66	23.62	8.85	711589.4000	603452.8710	Fill
CW1-2	29.53	31.54	31.75	21.04	10.5	711589.4000	603452.8710	Silt/Clay
CW1-3	29.3	31.29	31.52	28.63	2.66	711589.4000	603452.8710	Till
CW2-1	12.45	13 83	13.95	9.16	4.67	712578.3900	603183.2400	Fill
CW2-2	11.52	13 87	13 75	10.25	3.62	712578.3900	603183.2400	Silt/Clay
CW2-3	11.5	12.33	12.53	5.25	7.08	712578.3900	603183.2400	Till
CW3-1	30.87	33.08	33.05	25.32	7.76	713031.3580	602286.5360	Fill
CW3-2	30.34	33.01	32.98	20.10	12.91	713031.3580	602286.5360	Silt/Clay
CW3-3	29.34	30.6	31.16	26.31	4.29	713031.3580	602286.5360	Till
CW4-1	7.8	9.47	10.41	3.43	6.98	715022.0000	601222.0000	Fill
CW4-2	7.72	8.75	9.21	5.15	4.06	715022.0000	601222.0000	Silt/Clay
CW4-3	8 41	9 73	10.01	4.70	5.31	715022.0000	601222.0000	Till
CW5-1	35.4	37.95	38.08	26.64	11.44	715460.3720	600374.0190	Fill
CW5-2	36	37.77	38.21	32.80	4.97	715460.3720	600374.0190	Silt/Clay
CW5-3	36.38	38.87	38.82	21.25	17.57	715460.3720	600374.0190	Till
W-1	5.23	6.82	8.35	2.32	4.5	712896.1820	602196 4750	Fill
W-2	5.87	7.97	8.89	2.44	5.53	711351.1930	604255.7830	Fill
W-3	6.53	6 27	8.25	4.97	3.28	710813.3590	604006.2360	Fill
W-4	15.41	17.28	17.29	10.34	6.94	716511.0000	600030.0000	Fill
W-5	29.95	31.39	31.62	21.04	10.35	711669.6980	603692.2890	Fill
W-6	9.6	11.7	12 03	2.93	8.77	716364.0000	599777.0000	Fill
W-7	7.46	9	9.77	2.45	6.55	712142.2250	602900.0790	Fill
W-8	33.47	36.17	36.89	27.00	9.17	713123.3310	602424.3180	Fill
W-9	35.7	37.5	38.04	26.25	11.25	714608.3440	601258.8470	Fill
W-10	8.87	10.17	11.19	2.32	7.85	715340.1800	600981.5670	Fill
W-11	35.5	36.92	37 71	26.64	10.28	715026.9890	600758.4250	Fill

TABLE 4
SURFACE WATER ANALYSIS RESULTS
ENVIRONMENTAL IMPACT STUDY
NEW JERSEY TURNPIKE 1985-1990 WIDENING

Sample ID		43360	43361	43362	43363	43364	43365	43366	43367	43368	43369
Sample Location	Surface Water Criteria	Hackensack River	Hackensack River	Hackensack River	Hackensack River	Hackensack River	Hackensack River	Hackensack River	Hackensack River	Hackensack River	Hackensack River
Date Sampled		8/1/85	8/1/85	8/1/85	8/1/85	8/2/85	8/2/85	8/2/85	8/2/85	8/2/85	8/2/85
Total Solids	N/A	1.2%	1 2%	1.3%	1.5%	1.6%	1.3%	1 3%	1.3%	1.2%	1.4%
Total Dissolved Solids	N/A	1.2%	1.2%	1.1%	1.2%	0.99%	1.1%	1.3%	1.2%	1.1%	1.4%
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Total Kjeldahl Nitrogen	N/A	81.00	12.00	34.00	ND	7.00	37.00	44.00	28.00	40.00	39.00
Nitrate Nitrogen	N/A	5.20	1.50	0 30	0.87	0.72	0.84	6.00	0.84	0.62	0.77
Nitrite Nitrogen	N/A	0.24	0.26	0.23	0.20	0.22	0 22	0.21	0.26	0.24	0.22
Phosphate	N/A	1.50	1.50	1.50	1.40	1.20	1 60	1.50	1.70	1.50	1.30
Chloride	N/A	3500	2700	3800	4100	3300	2800	2700	2100	4300	2300
Cadmium	N/A	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	3.23	0.09	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	N/A	0.08	0.04	ND	ND	ND	ND	ND	ND	ND	ND
Iron	N/A	18.00	12.00	2.30	0 31	0.56	0.09	1.60	1.60	0.46	0.62
Lead	N/A	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	0.0001460	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	3 90	0.04	0.03	ND	ND	ND	ND	ND	ND	0 02	ND
Zinc	N/A	0.02	0 12	0.03	0.02	0.10	0.02	0.02	0.03	0 03	0.03

N/A = Not Available
ND = Not Detected

TABLE 4
SURFACE WATER ANALYSIS RESULTS
ENVIRONMENTAL IMPACT STUDY
NEW JERSEY TURNPIKE 1985-1990 WIDENING

Sample ID		43370	43371	43054	40825	40826	41916	41926	41933	41939
Sample Location	**Surface Water Criteria**	Hackensack River	Hackensack River	Kingsland Ditch	Kingsland Creek	Berrys Creek	Berrys Creek Canal	Berrys Creek Canal	Berrys Creek Canal	Berrys Creek Canal
Date Sampled		8/2/85	8/2/85	7/31/85		6/13/85	7/5/85	7/5/85	7/5/85	7/5/85
Total Solids	N/A	1 5%	1 4%	1.5%	1.6%	1.0%	1.4%	1.5%	1.5%	1.2%
Total Dissolved Solids	N/A	1.3%	1.2%	1.3%	1.2%	0.86%	1.2%	1.3%	1.5%	1.1%
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Total Kjeldahl Nitrogen	N/A	40 00	46.00	NA	50	28	25	44	40	40
Nitrate Nitrogen	N/A	0.65	0.77	0.61	0.91	1.10	0.97	0.80	0.46	0.25
Nitrite Nitrogen	N/A	0.22	0.25	0.19	0.29	0.08	0.56	25.00	0.32	0.25
Phosphate	N/A	1.30	1.30	1.30	0.94	1	0.06	1.10	1.10	1.50
Chloride	N/A	2200	2500	5900	6100	4500	3400	2300	5600	3900
Cadmium	N/A	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	3.23	ND	ND	ND	ND	ND	0.01	ND	ND	ND
Copper	N/A	ND	ND	0.003	ND	ND	0.005	0.009	0.010	ND
Iron	N/A	0 61	0.58	0.50	0.38	2.00	0.40	0.10	0.31	0.29
Lead	N/A	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	0.0001460	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	3.90	ND	ND	ND	ND	ND	0.01	0.02	0.02	ND
Zinc	N/A	0.02	ND	0.04	ND	ND	0.04	0.04	ND	0.06

N/A = Not Available
ND = Not Detected

TABLE 5
SEDIMENT ANALYSIS RESULTS
ENVIRONMENTAL IMPACT STATEMENT
NEW JERSEY TURNPIKE 1985-1990 WIDENING

	NJDEP Marine EstuarineSediment Screening Guidelines		Hackensack River		Kingsland Ditch	Kingsland Creek	Berrys Creek	
Sample ID	Effects	Effects	40854	42636	40837	40848	43106	43105
te Sampled	Range	Range	7/15/85	7/15/85	7/31/85	7/31/85	7/31/85	7/31/85
Type	Low	Medium	shore	marsh	shore	shore	shore	marsh
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Arsenic	8.2	70	5.9	14	1.5	12	8.8	19
Cadmium	1 2	9.6	1.1	0.53	ND	3.3	5.6	6.1
Chromium	81	370	200	330	12	250	320	380
Copper	34	270	110	82	12	140	170	220
Iron	N/A	N/A	35000	27000	850	33000	35000	41000
Lead	47	218	67	57	1.5	5.3	130	170
Mercury	0.15	0.71	ND	ND	ND	ND	ND	0.32
Nickel	21	52	31	25	8	53	68	63
Zinc	150	410	480	260	18	300	410	530
PHC	N/A	N/A	170	240	44	150	320	250
pH*	N/A	N/A	6.9	4.6	7.2	5	6.1	5.8
Phenols	N/A	N/A	0.67	0.7	0.21	0.7	0.57	0.79
Chloride	N/A	N/A	5700	880	3600	3500	13000	17000
Sulfate	N/A	N/A	5700	4900	230	2800	9500	8900
Sulfide	N/A	N/A	3.92	ND	ND	ND	4.2	9.4

N/A = Not Available

ND = Not detected

* pH is presented in Standard Units

** - The NJ Criteria is taken from Table 2 - Marine/Estuarine Sediment Screening Guidelines in the Guidance For Sediment Quality Evaluations. The Low Effects Range values were taken from Long et al., National Oceanic and Atmosperic Administration, 1995.

TABLE 6
SURFACE WATER ANALYSIS RESULTS
WETLAND EVALUATION AND MITIGATION REPORT
NEW JERSEY SPORTS AND EXPOSITION AUTHORITY - 1987

Sample Number	NJDEP	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	SW-9
Sample Location	SE Surface	W1	W2	W3	W4	W5	W6	W7	W8	W9
Matrix	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Date	Criteria	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Inorganics:										
Aluminum	*	7170	5160	356000	77200	2080	261	229	285	481
Arsenic		ND (21)	ND (21)	ND (21)	ND (21)	ND (21)	ND (21)	ND (21)	ND (21)	ND (21)
Barium	*	972	2770	68800	1680	433	1340	49B	44J	108J
Beryllium	*	ND(1.1)	ND(1.1)	25	5 5	1.2J	ND(1 1)	ND(1 1)	ND(1 1)	ND(1 1)
Cadmium	*	31	85	2410	246	4 5J	6 3	3 0J	ND(2 3)	ND(2 3)
Calcium	*	64900	96600	421000	72800	91700	205000	108000	53800	83000
Chromium	3,230	28	885	3.6J	1750	8.1J	ND(3 6)	11J	ND(3 6)	4 9J
Cobalt	*	39J	63	208	59	5.0J	3 6J	7.5J	ND(3.0)	ND(3 0)
Copper	*	875	1390	55000	453	137	34	ND(8 5)	37	17J
Iron	*	268000	408000	4870000	234000	25800	47700	11500	919	2460
Lead	*	696	1870	592999	4170	251	19	65	70	85
Magnesium	*	35100	26500	704000	124000	19900	55400	63100	7660	81100
Manganese	100	2460	2270	13200	2960	1170	1030	1210	318	295
Mercury	0 146	ND(0.1)	ND(0.1)	10	11	ND(0.1)	ND(0 1)	ND(0.1)	ND(0 1)	ND(0 1)
Nickel	3,900	92	354	5520	358	58	ND(9 7)	32J	13J	19J
Potassium	*							105000	32100	39200
Sodium	*							451000	639000	626000
Zinc	*							21	35	79
Volatile Organics:										
Acetone		ND (10)	120 B	1100 B	13 B	10 B	15 B	31 B	10 B	ND (10)
Methylene Chloride		5 B	20 JB	200 JB	8 B	6 B	6 B	4 JB	5 B	4 JB
Benzene	71	ND(5)	10J	200J	5	ND(5)	2J	ND(5)	ND(5)	ND(5)
Toluene	200,000	1J	460	100J1	2J	2J	1J	ND(5)	1JB	1JB
Chlorobenzene	21,000	ND(5)	ND(50)	200J	19	ND(5)	10	ND(5)	ND(5)	ND(5)
Ethylbenzene	27,900	ND(5)	ND(50)	1600	2J	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Total Xylenes	*	ND(5)	60	6600	ND(5)	ND(5)	ND(5)	5	ND(5)	ND(5)
2-Butanone	*	ND(10)	ND(100)	ND(1000)	ND(10)	2J	ND(10)	5J	ND(10)	ND(10)
Chloroform	470	ND(5)	ND(50)	ND(500)	ND(5)	ND(5)	ND(5)	ND(5)	1J	1J
trans-1,2-Dichlorethene	*	ND(5)	ND(50)	ND(500)	ND(5)	ND(5)	ND(5)	4J	ND(5)	ND(5)
Tetrachloroethene	*	ND(5)	ND(50)	ND(500)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Semi-Volatiles Org.:										
1,4 Dichlorobenzene	3,159	ND(20)	ND(20)	18J	12J	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)
1,2-Dichlorobenzene	16,500	ND(20)	ND(20)	32	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)
Napthalene	*	ND(20)	ND(20)	80	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)
2-Methylnapthalene	*	ND(20)	ND(20)	10J	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)
Acenaphthene	*	ND(20)	ND(20)	2J	ND(20)	ND(20)	2J	ND(20)	ND(20)	ND(20)
Dibenzofuran	*	ND(20)	ND(20)	2J	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)
Pesticides/PCBs:										
Aroclors 1016-1260	0 030(c) 0.000247(hc)	ND(0.05)	ND(0 05)	ND(0.05)	ND(0 05)	ND(0.05)	ND(0.05)	ND(0 05)	ND(0 05)	ND(0 05)
Heptachlor	0.053(a) 0 0036(c) 0.000106(hc)	ND(0.05)	ND(0 05)	0.03	ND(0 05)	ND(0 05)	ND(0 05)	ND(0.05)	ND(0 05)	ND(0 05)

ND(20) = Parameter not detected above method detection limit provided in parentheses
J = Estimated value below method detection limit
(a) = Standard based on acute aquatic life protection criteria
(c) = Standard based on chronic aquatic life protection criteria
(h) = Non-carcinogenic effect-based human health criteria
(hc) = Non-carcinogenic effect-based human health criteria as a 70-year average

TABLE 6
SURFACE WATER ANALYSIS RESULTS
WETLAND EVALUATION AND MITIGATION REPORT
NEW JERSEY SPORTS AND EXPOSITION AUTHORITY - 1987

Sample Number	NJDEP	SW-10	SW-11	SW-12	SW-13	SW-14	SW15	Duplicate	Field	Trip
Sample Location	SE Surface	W10	W11	W12	W13	W14	W15	Water	Blank	Blank
Matrix	Water	Water	Water	Water	Water	Water	Water			
Date	Criteria	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Inorganics:										
Aluminum	*	774	705	2230	1190	845	548	1060		
Arsenic		ND (21)	ND (21)	ND (21)	ND (21)	ND (21)	ND (21)	ND (8 2)	ND (8 2)	
Barium	*	424	66J	87J	105J	37J	32J	290	ND (3 9)	
Beryllium	*	ND(1.1)	ND(1 1)	ND(1 1)	ND(1.1)	ND(1 1)	ND(1.1)			
Cadmium	*	ND(2.3)	ND(2 3)	3 2J	2.5J	ND(2.3)	ND(2.3)			
Calcium	*	42600	55900	68100	111000	54200	52100			
Chromium	3,230	8.2J	12J	46	8 0J	11	5.2J			
Cobalt	*	ND(3 0)	ND(3 0)	3 5J	4 3J	3.3J	ND(3 0)			
Copper	*	163	29	52	31	20J	9.6J			
Iron	*	1450	1930	4660	5840	1720	1080			
Lead	*	417	76	172	106	89	69			
Magnesium	*	67500	62800	110000	36500	73500	79800			
Manganese	100	275	384	1520	633	290	243			
Mercury	0 146	ND(0 1)	ND(0 1)	ND(0 1)	ND(0 1)	ND(0 1)	ND(0 1)			
Nickel	3,900	11J	25J	34J	21J	15J	17J			
Potassium	*	26600	24400	46700	22800	26100	28500			
Sodium	*	563000	51000	939000	131000	609000	664000			
Zinc	*	108	57	184	79	52	35			
Volatile Organics:										
Acetone		ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	10 B	5 B
Methylene Chloride		4 JB	7 B	5 B	5 B	6 B	4 JB	3 JB	22 B	8 JB
Benzene	71	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND	ND	ND
Toluene	200,000	ND(5)	1JB	1JB	1JB	1JB	1JB	ND	ND	ND
Chlorobenzene	21,000	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND	ND	ND
Ethylbenzene	27,900	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND	ND	ND
Total Xylenes	*	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND	ND	ND
2-Butanone	*	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND	ND	ND
Chloroform	470	ND(5)	ND(5)	ND(5)	ND(5)	1J	1J	ND	ND	ND
trans-1,2-Dichlorethene	*	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND	ND	ND
Tetrachloroethene	*	ND(5)	ND(5)	ND(5)	ND(5)	1J	2J	ND	ND	ND
Semi-Volatiles Org.:										
1 4 Dichlorobenzene	3,159	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND	ND	
1 2-Dichlorobenzene	16,500	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND	ND	
Napthalene	*	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND	ND	
2-Methylnapthalene	*	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND	ND	
Acenaphthene	*	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND	ND	
Dibenzofuran	*	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND(20)	ND	ND	
Pesticides/PCBs:										
Aroclors 1016-1260	0 030(c) 0 000247(hc)	ND(0 05)	ND(0 05)	ND(0.05)	ND(0 05)	ND(0 05)	ND(0 05)	ND(0 05)	ND(0 05)	
Heptachlor	0 053(a) 0 0036(c) 0 000106(hc)	ND(0 05)	ND(0 05)	ND(0 05)	ND(0.05)	ND(0 05)	ND(0 05)			

ND(20) = Parameter not detected abov
J = Estimated value below method dete
(a) = Standard based on acute aquatic
(c) = Standard based on chronic aquat
(h) = Non-carcinogenic effect-based h
(hc) = Non-carcinogenic effect-based

TABLE 7
SEDIMENT ANALYSIS RESULTS
WETLAND EVALUATION AND MITIGATION REPORT
NEW JERSEY SPORTS AND EXPOSITION AUTHORITY 1987

Sample Number	SD-1	SD-2	SD-3	SD-4	SD-5	SD-6	Marine/Estuarine	
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment Screening	
Date Sampled	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	4/23/87	Guidelines	
Depth	0-1	0-1	0-1	0-1	0-1	0-1	ERL	ERM
Inorganics:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Aluminum	13100	6820	7430	14000	12200	4780	*	*
Barium	2060	772	355	269J	718	986	*	*
Beryllium	ND(2.1)	ND(2.0)	ND(2 3)	ND(2 4)	2 7J	ND(1 0)	*	*
Cadmium	21	13	17	29	5.5J	8.4	1 2	9 6
Calcium	ND(104)	666J	3000	2180J	10700	4470	*	*
Chromium	926	915	57	375	157	283	81	370
Cobalt	27J	17J	10J	14J	34J	10J	*	*
Copper	861	427	552	397	177	673	34	270
Iron	102200	88400	44300	51500	30800	63200	*	*
Lead	4810	1640	950	1300	528	2010	47	218
Magnesium	7490J	4530J	2960J	7280J	3150J	4750	*	*
Manganese	838	321	127	431	427	333	*	*
Mercury	20	3.6	6 6	21	1.9	2	0 15	0 71
Nickel	206	307	183	104	400	202	21	52
Potassium	2100J	911J	1170J	3490J	1430J	732	*	*
Sodium	2060J	745J	2020J	5370J	502J	495J	*	*
Zinc	1690	960	3490	768	547	1300	150	410
Volatiles:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Acetone	0.13	0.16	0.67	0 68	0.8	0 13		
Benzene			0 17	0 44		0 008J		
Toluene	0 007JB	0.007JB		0 3	0 008JB	0 006JB		
Chlorobenzene	0.017	0.007JB	0 53	1 2	0 008JB	0 047		
Ethylbenzene			2 6	1 1	0 005J			
Total Xylenes			0 56	1 2				
2-Butanone	0 030J	0 043	0 170J	0 120J	0 015J	0 022J		
4-Methyl-2-pentanone	0 013 J							
2-Hexanone	0 037							
trans-1,2-Dichlorethene				0.020J				
Semi-Volatiles:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1,4 Dichlorobenzene			0 370J				*	*
1,2-Dichlorobenzene			0 370J				*	*
Isophorone	0 22 J							
Napthalene			0.560J		0 170J		0 16	2 1
2-Methylnapthalene		0.11			0.083J		0 07	0 67
Acenaphthene					0 170J	0.093J	0 016	0 500
Diethylphthalate		0 33 J					*	*
Fluorene					0.250 J	0.190 J	0 019	0 54
Phenanthrene			2.2		1 23	1	0 24	1 5
Anthracene			0 74 J		3.3		0 085	1 1
Di-n-Butylphthalate		0.44 J		0.27 J		0 93		
Fluoranthene		0.44 J	4.8	0.27 J		1 5	0 6	5 1
Pyrene		0.33 J	3.9			0 93	0 665	2 6
Benzo(a)anthracene		0 33 J	2 8				0 261	1 6
Bis(2-Ethylhexyl)phthal	17	4.9	2	8 9		3 2		
Chrysene		0.44 J	2.6				0 384	2 8
Benzo(k)Fluoranthene		0 89 J					0 24	1480
Benzo(a)pyrene		0.56 J	2.23			0.56 J	0 43	1 6
Indene(1,2,3-cd)pyrene		0.56 J	3				0.2	320
Benzo(g,h,i)perylene			2 2		1.5		0 17	320
Pesticides/PCBs								
None Detected							*	*

* No criteria given

* Volatiles, Semivolatiles, Pesticides in ug/L

* Inorganics in mg/kg

* ND - indicates compound was analyzed for but not detected number in perantheses is the minimum attainable detection limit for the smaple

* B - indicates compound was present in the blank as well as the sample

* J - indictes the result is less than the specified detection limit but greater than zero

TABLE 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION REPORT
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample No	Restricted Use Criteria		B-1-D		B-1-F		8-1-S		B-2-F		B-3-D		B-4-D		B-4-F		8-6-D		B-6-F		B-7D		B-7F	
Matrix	Res.	N Res	Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil	
Date			1988		1988		1988		1988		1988		1988		1988		1988		1988		1988		1988	
	mg/kg	mg/kg	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q
Aluminum			4690		9800		8150		8510		17200		11000		3410		18000		5750		9860		2960	
Antimony	14	340					16.9										15.2							
Arsenic	20	20	18.7		24.4		16.1		11.3		20.4		12.1		14.3		22		5.7		4.5			
Barium	700	47000	266		522		481		504		102		72 1		73.8		97 0		314		64.2		170.1	
Beryllium	2	2	0.38	B J	1.3	B J	3.8	B J	0 4	B J	0.54	B J	0 76	B J			0 81	B J	0.000	B J	0.5	B J		
Cadmium	39	100	4.1	J	9.2	J	8.2	J	5.7	J	4.2	J	0 92	J	4	J	1 4	J	1.7	J			5 7	J
Calcium			9880		20400		19600		27900		4000		4340		13300		4740		17400		7220		11793	
Chromium	120000		72.7		284		167		388		37.1		17.9		50		29.4		214		11.2		39.1	
Cobalt			6.3	B J	19.2	B J	14	BJ	9.2	B J	13.7	B J	14 1	B J	9	B J	16.5	B J	8.7	B J	7	B J	4.7	B J
Copper	600	600	66.8		146		125		1360		26.6		30.7		64		62		165		18 4		90.8	
Iron			27800		66600		55200		3200		31900		24000		99200		34600		37200		21370		20756	
Lead	400	600	338		1040		534		355		4.5		35.2		682		38.1		488		3.9			
Magnesium			2080	J	4710		5530	J	4490	J	8030	J	6690	J	4950	J	8550	J	4580	J	5120	J	9354	J
Manganese			270		644		474		718		640		879		783		935		363		794		602	
Mercury	14	270	0		2		1.3		0.2				0.53		0 32								2	
Nickel	250	2400	46.1		206		90.3		44				25.4		0 32		30.9		58.1		11 4		28.1	
Potassium			702	B J	1560		1330	B J	1660	B J	2680	B J	1100	B J	40.5	B J	3020	B J	1060	B J	1615	B J	1880	B J
Selenium	63	3100													925									
Silver	110	4100							6.9						3.2								9.1	
Sodium			1950	J	4020	J	3420	J	1650	J	1750	J	607	J					1670	J	420	J	19027	J
Thalium	2	2													11200									
Vanadium	370	7100	15.5	J	35 9	J	30.1	J	27.8	J	36.9	J	23.2	J			38.5	J	26.3	J	20.3	J	7 4	J
Zinc	1500	1500	807		1680		1450		502		99.9		89.3		4.5		107		704		25.2		795	

* Res - Residential
* N Res - Non Residential
* I T G - Impact Ground Water
* J - Estimated values
* B - Compound detected in blank

Blank cell indicates compound not detected above MDL

TABLE 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION REPORT
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample No.	Restricted Use Criteria		B-9-D		B-9-F		B-10-C		B-10-D		B-10-S		B-12-A		B-12-B		B-13		B-15-D		B-15-F	
Matrix	Res.	N.Res	Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil	
Date			1988		1988		1988		1988		1988		1988		1988		1988		1988		1988	
	mg/kg	mg/kg	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q
Aluminum			5848.9		6740.2		143		5680		4570		10300		10800		9430		16200		6930	
Antimony	14	340											5.8		5.9							
Arsenic	20	20	12.6		5.3				8.6		31.3		11		19.8				15.1		8.3	
Barium	700	47000	490.4		732.6		163		126		112		81.1		77.2		73.5		92.7		54.7	
Beryllium	2	2	0.7	B J			0	B J	0.49	B J			0.79	B J	0.45	B J	0.62	B J	0.56	B J		
Cadmium	39	100	13.4	J	12.2	J	1.2	J	1.3	J	5.7	J	3	J	1.9	J	1.8	J	4.2	J	2.4	J
Calcium			59269.5		42728		616		2430		8800		7610		4900		5080		4510		3220.00	
Chromium	120000		55.4		38.1		2.4		16.9		65.3		21.8		22.6		17.4		44.4		218	
Cobalt			32.4	B J	14.1	B J			7.9	B J	5.6	B J	15.7	B J	13.9	BJ	14.1	BJ	15.3	BJ	3.9	BJ
Copper	600	600	220		150.6		4.9		25		117		34.9		25.4		28.9		27.1		47.9	
Iron			74600		74300		7220		14100		51300		41400		28900		26300		32600		12600	
Lead	400	600	11.2		5		1.8		6		14.3		14.2		16.5		9.1		8.6		49.9	
Magnesium			24200	J	16867.9	J	99.9	J	2890	J	2110	J	7460	J	6740	J	6470	J	8610	J	3190	J
Manganese			1520		615		53		201		336		2420		755		863		675		160	
Mercury	14	270							0.86		3.9										0.29	
Nickel	250	2400	93.7		79.3				17.2		54.9		28.7		25		23.1		32 2		17.8	
Potassium			2290	B J	705	B J			571	B J	668	B J	928	B J	1020	B J	851	B J	3930	B J	1870	B J
Selenium	63	3100																				
Silver	110	4100																				
Sodium			2250	J	1270	J	159	J	1560	J	2080	J	1220	J	437	J	424	J	1700	J	2660	J
Thalium	2	2																				
Vanadium	370	7100	46900	J	16 2	J	1.6	J	16.5	J	8.2	J	30.3	J	28.9	J	26.2	J	34.8	J	17.3	J
Zinc	1500	1500	983		653		122		73.8		497		90.8		85		78.7		102		238	

* Res - Residential
* N Res - Non Residential
* I T G - Impact Ground Water
* J - Estimated values
* B - Compound detected in blank

TABLE 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION REPORT
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample No	Restricted Use Criteria		B-17-A		B-17-D		W8D		W8F		W8S		W-9C AL		HNTB-5D		HNTB-5B9		HNTB-10S	
Matrix	Res.	N Res	Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil	
Date			1988		1988		1988		1988		1988		1988		1988		1988		1988	
	mg/kg	mg/kg	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q
Aluminum			NA		3630		7470		NA		2840		12000		14700 0		2460		4930	
Antimony	14	340	NA						NA				14.6						34	
Arsenic	20	20	NA				5 4		NA		25.1		33.3		13.2		68.8		9.1	
Barium	700	47000	NA		29 1		127		NA		319		75		56.10		1360		1930	
Beryllium	2	2	NA	B J					NA	B J			0.43	B J	0.47	B J				
Cadmium	39	100	NA	J	0.81	J	1.4	J	NA	J	3.3	J	1.00	J	1.8	J	3.4	J	3.6	J
Calcium			NA		5940		4060		NA		5280		4000		2620		17100		15600	
Chromium	120000		NA		8 4		22.8		NA		96 9		20		24		42		756	
Cobalt			NA	BJ	5 4	BJ	12.1	BJ	NA	BJ	11.1	BJ	11 8	BJ	15.3	BJ	4.8	BJ	4.5	BJ
Copper	600	600	NA		10		52.4		NA		331		21.9		23.9		38.9		53.7	
Iron			NA		12000		22000		NA		60000		26600		34300		51200		16100	
Lead	400	600	NA				7.7		NA		10.2		15.5		13.9		4.5		5.2	
Magnesium			NA	J	4150	J	4700	J	NA	J	2400	J	7420	J	7210	J	3160	J	3030	J
Manganese			NA		264		716		NA		334		694		576		305		399	
Mercury	14	270	NA						NA		0.72								4.9	
Nickel	250	2400	NA		8 9		31 1		NA		149		22		28.5		194		41.1	
Potassium			NA	B J	343	B J	572	B J	NA	B J	908	B J	1220	B J	1380	B J	678	B J	702	B J
Selenium	63	3100	NA						NA		1.6								5.2	
Silver	110	4100	NA						NA											
Sodium			NA	J	543	J	1890	J	NA	J	3430	J	328	J	777	J	1150	J	3180	J
Thalium	2	2	NA		1 8				NA											
Vanadium	370	7100	NA	J	13 2	J	19.9	J	NA	J	2.5	J	27.4	J	34.1	J	5.3	J	7.8	J
Zinc	1500	1500	NA		28.8		172		NA		490		67 6		79.1		1040		566	

* Res - Residential
* N Res - Non Residential
* I T G - Impact Ground Water
* J - Estimated values
*B - Compound detected in blank

TABLE 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION REPORT
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Restricted Use Criteria			B-1-D	B-1-F	B-1-S	B-2-F	B-3-D	B-4-D	B-4-F	B-6-D	B-6-F
Matrix	Res.	N Res	I T G	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date				1988	1988	1988	1988	1988	1988	1988	1988	1988
Depth (ft)				NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatiles	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Chloroethane												
Methylene Chloride	49	210	1			0.69JB			0.012			
1,1-Dichloroethane	8	150	10									
1,1,1-Trichloroethane	210	1000(d)	50									
Benzene	3	13	1		0 035J							0.016J
Toluene	1000(d)	1000(d)	500		0.39	0.35J						0.012J
Chlorobenzene	37	680	1		0.19							0 17
Total Xylenes	410	1000(d)	50		1 7	10						0 86
Chloroform	19(k)	28(k)	1									
1,1,2,-Tetrachloroethane	34	70(k)	1									
4-Methyl-2-Pentanone	1000(d)	1000(d)	50									
Trans-1,2-Dichloroethene												
Acetone	1000(d)	1000(d)	100			25			0.033	0.048		0.230
Ethylbenzene	1000(d)	1000(d)	100		0.86	4.2						0.21
Styrene	23	97	100									0 02
2-Hexanone												
Tetrachloroethene	4(k)	6(k)	1									
2-Butanone	1000(d)	1000(d)	50									
Vinyl Acetate												
Carbon Disulfide												
Trichloroethene	23	54(k)	1									

* Res - Residential * N Res - Non Residential * I T G - Impact Ground Water

* J - Estimated values *B - Compound detected in blank Blank cell indicates compound not detected above MDL

(d) = Health based criterion exceeds 1,000 mg/kg maximum for total volatile organics

(k) = Criteria based on inhalation exposure pathways, which yielded a more strinent criterion than the incidental ingestion exposure pathway

TABLE 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION REPORT
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Restricted Use Criteria			B-7D	B-7F	B-9-D	B-9-F	B-10-C	B-10-S	B-12-A	B-12-B	B-13
Matrix	Res	N Res	I T G	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date				1988	1988	1988	1988	1988	1988	1988	1988	1988
Depth (ft)				NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatiles	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Chloroethane												
Methylene Chloride	49	210	1									
1,1-Dichloroethane	8	150	10									
1,1,1-Trichloroethane	210	1000(d)	50									
Benzene	3	13	1				0.64	7.5				0.001J
Toluene	1000(d)	1000(d)	500				0 18					0.001J
Chlorobenzene	37	680	1		0.014		0 22	64				
Total Xylenes	410	1000(d)	50		11		0.11					
Chloroform	19(k)	28(k)	1									0.001J
1,1,2,-Tetrachloroethane	34	70(k)	1									
4-Methyl-2-Pentanone	1000(d)	1000(d)	50				0 18					
Trans-1,2-Dichloroethene												
Acetone	1000(d)	1000(d)	100					14				0.041
Ethylbenzene	1000(d)	1000(d)	100		0.036		0 11					0.003J
Styrene	23	97	100									
2-Hexanone												
Tetrachloroethene	4(k)	6(k)	1									0.001J
2-Butanone	1000(d)	1000(d)	50									
Vinyl Acetate												
Carbon Disulfide												0.003J
Trichloroethene	23	54(k)	1									0.001J

* Res - Residential * N Res - Non Residential

* J - Estimated values *B - Compound detected in blank

(d) = Health based criterion exceeds 1,000 mg/kg maximum for total v

(k) = Criteria based on inhalation exposure pathways, which yielded a

TABLE 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION REPORT
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Restricted Use Criteria			B-15-D	B-15-F	B-17-D	B-17-A	HNTB-6	HNTB-5D	HNTB-5B9	HNTB-10S	W-8-D
Matrix	Res.	N Res	I T G.	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date				1988	1988	1988	1988	1988	1988	1988	1988	1988
Depth (ft)				NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatiles	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Chloroethane												
Methylene Chloride	49	210	1		0.008J		0.005					0.011J
1,1-Dichloroethane	8	150	10									
1,1,1-Trichloroethane	210	1000(d)	50									
Benzene	3	13	1				0.001J				2.2	
Toluene	1000(d)	1000(d)	500				0.005J					0.007J
Chlorobenzene	37	680	1				0 005J		0.015		1.3	0 04
Total Xylenes	410	1000(d)	50								2.10	0 98
Chloroform	19(k)	28(k)	1									
1,1,2,-Tetrachloroethane	34	70(k)	1									
4-Methyl-2-Pentanone	1000(d)	1000(d)	50									
Trans-1,2-Dichloroethene												
Acetone	1000(d)	1000(d)	100									
Ethylbenzene	1000(d)	1000(d)	100								0 75	0 84
Styrene	23	97	100								0.32	
2-Hexanone												
Tetrachloroethene	4(k)	6(k)	1									
2-Butanone	1000(d)	1000(d)	50									
Vinyl Acetate												
Carbon Disulfide												
Trichloroethene	23	54(k)	1									

* Res - Residential * N Res - Non Residential

* J - Estimated values *B - Compound detected in blank

(d) = Health based criterion exceeds 1,000 mg/kg maximum for total v

(k) = Criteria based on inhalation exposure pathways which yielded a

TABLE 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION REPORT
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Restricted Use Criteria			W-8-F	W-8-S	W-9-A AL	W-9-B AL	W-9C AL	W-12D	W-12S	W-12D	Blank
Matrix	Res	N.Res	I.T G	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date				1988	1988	1988	1988	1988	1988	1988	1988	1988
Depth (ft)				NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatiles	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Chloroethane												
Methylene Chloride	49	210	1									
1,1-Dichloroethane	8	150	10									
1,1,1-Trichloroethane	210	1000(d)	50									
Benzene	3	13	1		0 15J					0.048		
Toluene	1000(d)	1000(d)	500		0.016J	1 J				0 002J		
Chlorobenzene	37	680	1		0.2J					0.065		
Total Xylenes	410	1000(d)	50		0.089J	1.5			0 004J	0.1	0 004J	
Chloroform	19(k)	28(k)	1									
1,1,2,-Tetrachloroethane	34	70(k)	1									
4-Methyl-2-Pentanone	1000(d)	1000(d)	50									
Trans-1,2-Dichloroethene												
Acetone	1000(d)	1000(d)	100			10		0.014				0.013
Ethylbenzene	1000(d)	1000(d)	100		0.048J	0.75 J				0.026		
Styrene	23	97	100								0.001J	
2-Hexanone										0.015J		
Tetrachloroethene	4(k)	6(k)	1									
2-Butanone	1000(d)	1000(d)	50			9.5						
Vinyl Acetate						6.3						
Carbon Disulfide												
Trichloroethene	23	54(k)	1									

* Res - Residential * N Res - Non Residential

* J - Estimated values *B - Compound detected in blank

(d) = Health based criterion exceeds 1,000 mg/kg maximum for total v

(k) = Criteria based on inhalation exposure pathways, which yielded a

TABLE 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION REPORT
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Restricted Use Criteria			Blank	Blank	Blank	Blank	Blank	Blank	Blank	Blank
Matrix	Res	N.Res	I.T.G	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date				1988	1988	1988	1988	1988	1988	1988	1988
Depth (ft)				NA	NA	NA	NA	NA	NA	NA	NA
Volatiles	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Chloroethane											
Methylene Chloride	49	210	1	0.008		001J		0.003J		0 001J	0 001J
1,1-Dichloroethane	8	150	10								
1,1,1-Trichloroethane	210	1000(d)	50								
Benzene	3	13	1								
Toluene	1000(d)	1000(d)	500								
Chlorobenzene	37	680	1								
Total Xylenes	410	1000(d)	50								
Chloroform	19(k)	28(k)	1								
1,1,2,-Tetrachloroethane	34	70(k)	1								
4-Methyl-2-Pentanone	1000(d)	1000(d)	50								
Trans-1,2-Dichloroethene											
Acetone	1000(d)	1000(d)	100	0 031	0 011	.008J	0.01	0.01	0.014	0.01	0 01
Ethylbenzene	1000(d)	1000(d)	100								
Styrene	23	97	100								
2-Hexanone											
Tetrachloroethene	4(k)	6(k)	1								
2-Butanone	1000(d)	1000(d)	50								
Vinyl Acetate											
Carbon Disulfide											
Trichloroethene	23	54(k)	1								

* Res - Residential * N Res - Non Residential

* J - Estimated values *B - Compound detected in blank

(d) = Health based criterion exceeds 1,000 mg/kg maximum for total v

(k) = Criteria based on inhalation exposure pathways, which yielded a

T E 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Restricted Use Criteria			B-1-F	B-1-S	B-1-D	B-2-F	B-3-D	B-4-F	B-4-D	B-6-D	B-6-F
Matrix	Res	N Res	I T G	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date				1988	1988	1988	1988	1988	1988	1988	1988	1988
Depth (ft)				NA	NA	NA	NA	NA	NA	NA	NA	NA
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Semivolatiles												
Phenol	10000	10000	50									
1,2-Dichlorobenzene	5100	10000	50									
Hexachlorcyclopentadiene	400	7300	100									
Bis(2-Ethylhexyl)Phthalate	49	210 00	100		17 0J					130.0J	0.950	0.710
Acenaphtylene												
Di-n-Butylphthalate	5700	10000	100	0 290J	14 0J							
Benzo(b)Flouranthene	0 9	4	500									
Di-n-Octyl Phthalate	1100	10000	100									
2-Methylnaphthalene				0 120J			0.380J					
Naphthalene	230	4200	100	1 50								2 20
Hexachlorobutadiene	1	21	100									
Acenaphthene	3400	10000	100	0.058J								0.160
Hexachlorobenzene	0 66	2	100									
Anthracene	10000	10000	100	0 120J								2 30
Fluoranthene	2300	10000	100	1 40								
Butylbenzylphthalate	100	10000	100	2 10								
1,4-Dichlorobenzene	570	10000	100									
Phenanthrene				0 470J								
Pyrene	1700	10000	100	0 640			3 80					
Isophorone	1100	10000	50	0.580		0.61						
Dibenzofuran				0.058J								
Diethyl Phalate	10000	10000	50	0.058J								
Flourene	2300	10000	100	0 120J								
Benzo(a)Anthracene				0 410J								
Chrysene	9	40	500	0 470J								
Benzo(k)Flouranthene	0 9	4	500	0.350J								
Benzo(a)Pyrene	0 66	0.66	100	0 410J								
Indno(1,2,3-cd)Pyrene	0 9	4	500	0.230J								
3,3-Dichlorobenzidine	2	6	100									
Pest/PCB												
Arochlor-1254	0 49	2	50		2.5J	0 130J						

* Res - Residential
* N.Res - Non Residential
* I T G. - Impact Ground Water
* J - Estimated values
*B - Compound detected in blank
Blank cell indicates compound not detected above MDL

TABLE 8
SOIL ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Restricted Use Criteria			B-7D	B-7F	B-9-D	B-9-F	B10C	B10D	B10S	B-12-A	B-12-B
Matrix	Res	N Res	1 T G	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date				1988	1988	1988	1988	1988	1988	1988	1988	1988
Depth (ft)				NA	NA	NA	NA	NA	NA	NA	NA	NA
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Semivolatiles												
Phenol	10000	10000	50									
1,2-Dichlorobenzene	5100	10000	50									
Hexachlorcyclopentadiene	400	7300	100									
Bis(2-Ethylhexyl)Phthalate	49	210 00	100	0 770	2 10	0 760	3 20			0 430J	0 130J	0 130J
Acenaphtylene												
Di-n-Butylphthalate	5700	10000	100									0 044J
Benzo(b)Flouranthene	0 9	4	500									
Di-n-Octyl Phthalate	1100	10000	100									
2-Methylnaphthalene												
Naphthalene	230	4200	100		0 190							
Hexachlorobutadiene	1	21	100					200.0J				
Acenaphthene	3400	10000	100									
Hexachlorobenzene	0 66	2	100									
Anthracene	10000	10000	100									
Fluoranthene	2300	10000	100				0 300J			2 60		
Butylbenzylphthalate	100	10000	100				2 10					
1,4-Dichlorobenzene	570	10000	100					120.0J	3 70J			
Phenanthrene							0 260J					
Pyrene	1700	10000	100									
Isophorone	1100	10000	50									
Dibenzofuran												
Diethyl Phalate	10000	10000	50									
Flourene	2300	10000	100									
Benzo(a)Anthracene												
Chrysene	9	40	500									
Benzo(k)Flouranthene	0 9	4	500									
Benzo(a)Pyrene	0 66	0 66	100									
Indno(1,2,3-cd)Pyrene	0 9	4	500									
3,3-Dichlorobenzidine	2	6	100									
Pest/PCB												
Arochlor-1254	0 49	2	50									

* Res - Residential
* N Res - Non Residential
* J - Estimated values
*B - Compound detected in blank

T, Ξ 8

SOIL ANALYSIS RESULTS

AVON LANDFILL SITE INVESTIGATION

NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Restricted Use Criteria			B-13	B-15-D	B-15-F	B-17-A	B-17-D
Matrix	Res	N Res	I T G	Soil	Soil	Soil	Soil	Soil
Date				1988	1988	1988	1988	1988
Depth (ft)				NA	NA	NA	NA	NA
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Semivolatiles								
Phenol	10000	10000	50					
1,2-Dichlorobenzene	5100	10000	50					
Hexachlorcyclopentadiene	400	7300	100					
Bis(2-Ethylhexyl)Phthalate	49	210 00	100	0.960	0.640	1.40		
Acenaphtylene								
Di-n-Butylphthalate	5700	10000	100	0.044J				
Benzo(b)Flouranthene	0.9	4	500					
Di-n-Octyl Phthalate	1100	10000	100					
2-Methylnaphthalene								
Naphthalene	230	4200	100					
Hexachlorobutadiene	1	21	100					
Acenaphthene	3400	10000	100					
Hexachlorobenzene	0.66	2	100					
Anthracene	10000	10000	100					
Fluoranthene	2300	10000	100					
Butylbenzylphthalate	100	10000	100					
1,4-Dichlorobenzene	570	10000	100					
Phenanthrene								
Pyrene	1700	10000	100					
Isophorone	1100	10000	50					
Dibenzofuran								
Diethyl Phalate	10000	10000	50					
Flourene	2300	10000	100					
Benzo(a)Anthracene								
Chrysene	9	40	500					
Benzo(k)Flouranthene	0.9	4	500					
Benzo(a)Pyrene	0.66	0.66	100					
Indno(1,2,3-cd)Pyrene	0.9	4	500					
3,3-Dichlorobenzidine	2	6	100					
Pest/PCB								
Arochlor-1254	0 49	2	50					

* Res - Residential
* N.Res - Non Residential
* J - Estimated values
*B - Compound detected in blank

TABLE 9
GROUNDWATER ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION REPORT
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Class IIA	CW1-1	CW1-2	CW1-3	CW2-1	CW2-2	CW2-3	CW3-1	CW3-2	CW3-3
Date	GW Quality	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89
Depth (feet)	Standards	18	80	205	NA	58	132.4	19	80	217
Volatile Organics		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Total Volatiles	1000	2	ND	4	536	5	ND	50	ND	ND
Benzene	1	ND	NA	NA	2	NA	NA	2	NA	NA
Toluene	1000	NA	NA	NA	4	NA	NA	ND	NA	NA
Ethyl benzene	700	ND	NA	NA	ND	NA	NA	ND	NA	NA
Total Xylenes	40	23	NA	NA	250	NA	NA	12	NA	NA
Chloro benzene	4	2	NA	NA	280	NA	NA	36	NA	NA
Trans-1,2-dichloroethylene	100	ND			ND			ND		

Sample Number	Class IIA	CW4-1	CW4-2	CW4-3	CW5-1	CW5-2	CW5-3	W-1	W-2	W-3
Date	GW Quality	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89	Jan-89
Depth (feet)	Standards	5	78	171	25	78	348	3	4	6
Volatile Organics		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Total Volatiles	1000	537	ND	ND	496	1	ND	63	494	34
Benzene	1	55	NA	NA	180	NA	NA	ND	110	ND
Toluene	1000	180	NA	NA	9	NA	NA	ND	5	ND
Ethyl benzene	700	130	NA	NA	88	NA	NA	ND	9	ND
Total Xylenes	40	150	NA	NA	89	NA	NA	ND	110	12
Chloro benzene	4	22	NA	NA	130	NA	NA	63	260	22
Trans-1,2-dichloroethylene	100	ND			ND			ND	ND	ND

Sample Number	Class IIA	W-4	W-5	W-6	W-7	W-8	W-9	W-10	W-11	W-12D
Date	GW Quality	Jan-89	Jan-89	Jan-89	Jan-89	Mar-89	Mar-89	Jan-89	Jan-89	Jan-89
Depth (feet)	Standards	15	18	7	4.9	NA	NA	5	25	20
Volatile Organics		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Total Volatiles	1000	3510	358	ND	59	NA	NA	266	2490	571
Benzene	1	130	40	ND	16	NA	NA	170	120	200
Toluene	1000	2400	46	ND	1	NA	NA	4	280	19
Ethyl benzene	700	60	22	ND	ND	NA	NA	1	130	22
Total Xylenes	40	640	140	ND	ND	NA	NA	28	160	190
Chloro benzene	4	280	110	ND	42	NA	NA	63	210	140
Trans-1,2-dichloroethylene	100	ND	ND	ND	ND	NA	NA	ND	390	ND

NA = Not Analyzed
ND = Not Detected

TABLE 10
SURFACE WATER ANALYSIS - SEMIVOLATILE ORGANICS
AVON LANDFILL SITE INVESTIGATION
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	Surface	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8
Matrix	Water	Water	Water	Water	Water	Water	Water	Water	Water
Date	Quality	1988	1988	1988	1988	1988	1988	1988	1988
Depth	Standards	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatiles	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Bis(2-Ethylhexyl)Phthalate	5.92	24	24	16J	36	34	18J	14J	16J
2-Methylnaphthalene									
Naphthalene		18J							
Fluoranthene	393								
Phenanthrene									
Pyrene	8970								
Diethyl phalate									
Flourene				20			10J		

Sample Number	Surface	SW-9	SW-10	SW-11	SW-12	SW-13	SW-14	SW-15	SW-16
Matrix	Water	Water	Water	Water	Water	Water	Water	Water	Water
Date	Quality	1988	1988	1988	1988	1988	1988	1988	1988
Depth	Standards	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatiles	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Bis(2-Ethylhexyl)Phthalate	5.92	28	11J	26	24J	30	22	28.0	34
2-Methylnaphthalene						4J			
Naphthalene						10J			
Fluoranthene	393					4J			
Phenanthrene						4J			
Pyrene	8970					4J			
Diethyl phalate							4J		
Flourene		4J					14J		

TABLE 11
SEDIMENT ANALYSIS RESULTS
AVON LANDFILL SITE INVESTIGATION
NEW JERSEY TURNPIKE AUTHORITY - 1989

Sample Number	**Marine/Estuarine**		**SD-1**	**SD-2**	**SD-3**	**SD-4**	**SD-5**	**SD-6**
Matrix	**ER-L**	**ER-M**	sediment	sediment	sediment	sediment	sediment	sediment
Date			1988	1988	1988	1988	1988	1988
Depth			0-6 in	0-6 in	0-6 in	0-6 in	0-6 in	0-6 in
Semivolatile Organics								
Bis(2-Ethylhexyl)Phthalate			4	0.9		15	8	
Acenaphtylene	0.044	0.64		.38J	.68J	.51J	.56J	.63J
Di-n-Butylphthalate			9.5				.67J	
Benzo(b)Flouranthene	2.4	1340	.7J	2.2	4.4	2.9		1.6
2-Methylnaphthalene			3.5J		0.2J	0.17		
Naphthalene	0.16	2.1	11	1.6	2.7	2.9	7.8J	3.20
Acenaphthene	0.016	0 5			.54J	.26J		
Anthracene	0.085	1.1					.22J	
Fluoranthene	0.6	5.1		3.5	11	5.4	1.7J	3.1
Phenanthrene	0.24	1.5	1.6J	1.5	6.1	4	8.9J	1.9
Pyrene	0.665	2.6		1.6	2.8	2.4	.89J	1.2
Dibenzofuran					.48J	.26J		
Benzo(a)Anthracene	0.261	1.6		1.1			.78J	0.9
Chrysene	0.384	2 8	.35J	1.6	5.6	2	.78J	1.3
Benzo(a)Pyrene	0 43	1.6		1.2	2.1	1.5		0.97
Indno(1,2,3-cd)Pyrene	0.2	320		.58J	1.3	1.1		.42J
Benzo(ghi)Perylene	0.17	320		.45J	0.88	.77J		
Volatile Organics								
Toluene			.005J					
Chlorobenzene			.021J					
Ethylbenzene			0.17					
Total Xylenes			0 53				0 014	

* all units mg/kg

TABLE 12
SOIL ANALYSIS RESULTS
USEPA SITE INVESTIGATION REPORT - 1990

Sample ID No.	Restricted Use Criteria			NJC2	NJC2	NJC2	NJC2
	Res.	N.Res	I.T.G.	S1	S2	S3D	S4
Matrix				Soil	Soil	Soil	Soil
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
INORGANICS				MBDF03	MBDF04	MBDF05	MBDF06
Lead	400	600		391	411	405 E	247
SEMI-VOLATILES				BEN21	BEN22	BEM23	BEM24
Benzo(a)anthracene	0.9	4	500	1.2	J	J	J
Benzo(b)fluoranthene	0.9	4	500	2	J		J
bis(2-Ethylhexyl)phthalate	49	210	100	J	3.0 E	2.7	J
Butylbenzylphthalate	1100	10000c	100	J	2.0 E	J	
Chrysene	9	40	500	1.3	J	J	J
Fluoranthene	2300	10000c	100	2.5	J	J	J
Pyrene	1700	10000c	100	2.5	1.6 E	J	1.2
Total Semivolatiles				11.3	6.6	2.7	1.2
VOLATILES				BEN21	BEN22	BEM23	BEM24
Acetone	1000(d)	1000(d)	100	0.12			0.062
Chloroform	19(k)	28(k)	1	0.025	0.019 E	J	J
Methylene Chloride	49	210	1	0.048	0.082 E	0.17	0.1
Total Volatiles				0.258	0.101	0.17	0.302
PESTICIDES/PCBs				BEN21	BEN22	BEM23	BEM24
4.4'-DDT	2	9	500		0 43	0.21	

TABLE 13
GROUNDWATER ANALYSIS RESULTS
USEPA SITE INSPECTION – AVON LANDFILL - 1990

Sample Group	Class IIA	SE	NJC2	NJC2	NJC2	NJC2
Sample ID No.	Groundwater	Surface Water	GW1	GW2	GW3D	GW5
Matrix	Quality	Quality	Water	Water	Water	Water
Units	Standard	Standard	ug/L	ug/L	ug/L	ug/L
INORGANICS	**ug/L**	**ug/L**	**MBBS89**	**MBBS90**	**MBBS91**	**MBB296**
Aluminum	200		4070	614	559	1100
Arsenic	8	0.136	12.1	J	J	J
Barium	2000		652	619	608	565
Calcium			79300	92300	91000	136000
Chromium	100	3230	45	R	R	R
Cobalt			4			
Copper	1000		R	R	R	R
Iron	300		32100	24600	23700	66900
Lead	10		R	R	R	R
Magnesium			117000	104000	103000	75000
Manganese	50	100	303	316	304	686
Nickel	100	3900	110	72.7	78.1	J
Potassium			21800 E	2178000 E	230000 E	125000 E
Sodium			686000	72800	724000	453000
Zinc	5000		1600	R	R	153
SEMI-VOLATILES	**ug/L**	**ug/L**	**BBY57**	**BBY58**	**BBY71**	**BBY73**
1,2-Dichlorobenzene	600	16500		J	J	R
1,4-Dichlorobenzene	75	3159		25	21	J
2,4-Dimethylphenol	100			20	13	
2-Chlorophenol	40	402		J		
2-Methylnaphthalene			J	J	J	13E
4-Methylphenol		0	22		J	
Benzoic acid			J			R
bis(2-Ethylhexyl)phthalate	30	5.92		18	J	J
Dibenzofuran					J	R
Fluoranthene	300	393				R
Indeno(1,2,3-cd)pyrene	20	0.031				R
Napthalene	300		21	69	56	43E
Phenanthrene					J	J
Pyrene	200	8970				R
VOLATILES	**ug/L**	**ug/L**	**BBY57**	**BBY58**	**BBY71**	**BBY73**
2-Butanone	300		960E	R	R	R
Acetone	700		71			12
Benzene	1	71	150	54	56	110
Chlorobenzene	50	21000	300	280	220	220
Chloroethane				150	160	
Ethylbenzene	700	27900	170	J	J	J
Toluene	1000	200000	3600			

E = Estimated Value above MDL

R = Rejected Data

J - Estimated Value below MDL

Blank cell indicated parameter not detected above method detection level.

TABLE 14
SURFACE WATER ANALYSIS RESULTS
USEPA SITE INSPECTION REPORT
AVON SANITARY LANDFILL - 1990

Sample ID No.	Surface Water Stnd	NJC2 SW1 Water	NJC2 SW2 Water
Matrix			
Units	ug/L	ug/L	ug/L
INORGANICS		**MBBS98**	**MBBS99**
Aluminum		651	621
Arsenic	0.136	J	29.5
Barium		557	J
Calcium		151000	106000
Chromium	3230	R	R
Copper		54.7 E	J
Iron		6810	1850
Lead		R	R
Magnesium		67000	202000
Manganese	100	640	358
Potassium		8300 E	122000 E
Sodium		330000	1700000
Zinc		128	86.4
SEMI-VOLATILES		**BBY93**	**BBY94**
bis(2-Ethylhexyl)phthalate	5.92		14
VOLATILES		**BBY93**	**BBY94**
Dilution Factor		1	1
2-Butanone		R	R
Acetone		23	18
Chlorobenzene	21000	J	
Chloroform	470		J
Methylene Chloride	1600		J
PESTICIDES/PCBs		**BBY93**	**BBY94**
None Detected			

E = Estimated Value above MDL

R = Rejected Data

J - Estimated Value below MDL

Blank cell indicated parameter not detected above method detection

TABLE 15
SEDIMENT ANALYSIS RESULTS
USEPA SITE INSPECTION REPORT – 1990
AVON SANITARY LANDFILL

Sample Number	SED-1		SED-2		Marine/Estuarine	
Date Sampled	3/15/90		3/15/90		Effects Range Low	Effects Range Medium
Depth	0-6 in		0-6 in			
	mg/kg	Q	mg/kg	Q	mg/kg	mg/kg
PP VOCs						
Methylene Chloride	0.068		0.08			
Chloroform	0.031		0.044			
Benzene	0.018		ND			
Chlorobenzene	0 21			J		
PP Base Neutrals						
Anthracene	ND			J	0 044	0.64
Benzo(a)anthracene		J		J	0.261	1.6
Benzo(a)pyrene		J		J	0 43	1 6
Benzo(b)fluoranthene		J		J		
Benzo(g.h,i)perylene		J		J	0.17	320
Benzo(k)fluoranthene	ND		ND		0.24	1340
Bis(2-ethylhexyl)phthalate	5.4		22			
Chrysene		J		J	384	2.8
Di-n-bytylphthalate	ND		ND			
Fluoranthene		J		J	0.6	5.1
Indeno(1,2.3-cd)pyrene		J		J	0.2	320
Napthalene	ND			J	0.16	2 1
Phenanthrene		J		J	0.24	1 5
Pyrene		J		J	0.665	2 6
Pesticides/PCBs						
None Detected	ND		ND			
PP Metals						
Antimony	ND		ND			
Arsenic	17.9	E	28.9	E	8.2	70
Beryllium	ND		ND			
Cadmium	ND		ND		1 2	9 6
Chromium	168	E	340	E	81	370
Copper		R		R	34	270
Lead	250	E	229	E	47	218
Mercury	3.6	E	6.8	E	0.15	0.71
Nickel		R		R	21	52
Selenium	ND		ND			
Silver	ND			J	1	3 7
Thallium	ND		ND			
Vanadium	47.5	E	47.4	E		
Zinc	495	E	434	E	150	410

ND = Not detected
E = Estimated Value
R = Rejected Data
J = Detected below MDL

TABLE 16
SURFACE WATER ANALYSIS RESULTS
SURFACE WATER MONITORING - 1999
HACKENSACK MEADOWLANDS DEVELOPMENT COMMISSION

	Winter 1999	Cadmium	Chromium	Copper	Iron	Lead	Nickel	Zinc	Fecal Coliforms	BOD	COD
	Sampled 8&9 Mar 99	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	MPN/100ml	mg/L	mg/L
1	Hackensack River	8.00	4.40	11 8	385	35.2	31.9	35.6	130	6.60	32.0
2	Hackensack River	12 1	6.50	13.1	298	47.0	45.7	43.5	130	7.10	25.6
3	Hackensack River	18 8	8.60	19.7	332	70.6	76 1	42.6	40	5.10	32.0
4	Hackensack River	25 5	10.7	27.7	245	130	104	43.5	40	3.70	51 0
5	Hackensack River	34.0	16.0	34 9	269	159	153	41.9	130	3 40	64.0
6	Penhorn Creek	5.80	4.40	6.50	510	58 8	20.8	18.1	130	3.70	32.0
7	Sawmill Creek	29.5	12.8	29.0	363	141	128	44.7	40	4.90	32.0
8	Berry's Creek	19.2	12.7	18.4	385	94.2	73.3	43.9	170	4.80	44.8
9	Mill Creek	13.0	10.7	15.8	338	58.8	56.7	46.2	20	7.40	32.0
10	Cromakill Creek (Lower)	9.80	6.50	15.8	289	70.6	51.2	42.6	40	7.30	26.0
11	Cromakill Creek (Upper)	8.00	6 50	10.5	282	35.2	15.3	43.9	40	9.40	32.0
12	Overpeck Creek	8.90	4.40	5.20	432	35.2	12.5	34.7	260	9.60	19.2
13	Kearny Marsh	4.90	4.40	7.80	285	47.0	23.6	18.5	20	11.0	44.8
14	Belleville Pike Drainage Lagoon	5.80	8.60	5.20	735	35.2	16.1	29.2	20	3.80	19.2
	Average	14.5	8.37	15.8	368	72.7	57.9	37.8	86	6.27	34.8

	Spring 1999	Cadmium	Chromium	Copper	Iron	Lead	Nickel	Zinc	Fecal Coliforms	BOD	COD
	Sampled 7&8 June 99	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	MPN/100ml	mg/L	mg/L
1	Hackensack River	12.8	6.40	11.5	410	52.4	55.2	26.9	130	12.8	15.5
2	Hackensack River	20.5	8.50	14.8	239	69.5	87.4	32.4	130	12.0	31.0
3	Hackensack River	35.9	12.6	18.1	305	121	134	37.4	170	8.40	54.2
4	Hackensack River	46.1	18.8	26.3	308	258	178	31.4	20	5.30	116
5	Hackensack River	67.7	31.4	41.2	515	438	278	54.0	40	4.00	92.9
6	Penhorn Creek	12.8	6.40	8.30	54.0	69.5	49.4	16.4	1100	6.20	23.2
7	Sawmill Creek	57.1	27.2	38.7	595	370	244	50.3	300	4.10	77.4
8	Berry's Creek	32.3	18.8	19.8	559	190	131	41.8	220	9.00	54.2
9	Mill Creek	16.5	8.50	13.2	403	155	81.6	30.4	1300	11.0	23.2
10	Cromakill Creek (Lower)	21 3	6.40	13.2	441	104	78.7	44.8	5000	10.4	54.2
11	Cromakill Creek (Upper)	2.70	6.40	11.5	260	69.5	17.2	26.9	500	10.6	31.0
12	Overpeck Creek	4.30	6.40	6.60	260	35.2	23.0	7.90	40	10.0	15.5
13	Kearny Marsh	8 40	8.50	5.00	155	69.5	55.2	14.4	20	9.70	54.2
14	Belleville Pike Drainage Lagoon	5.50	12.6	8 30	472	52.4	61.1	45.3	800	4.50	155
	Average	24.6	12.8	17.3	355	147	105	32.9	698	8.43	57.0

TABLE 16
SURFACE WATER ANALYSIS RESULTS
SURFACE WATER MONITORING - 1999
HACKENSACK MEADOWLANDS DEVELOPMENT COMMISSION

	Winter 1999	NH 4	Nitrate	TSS	TDS	Turb	Temp	Cond	Salinity	Chloride	Sulfate	pH	DO
	Sampled 8&9 Mar 99	mg/L	mg/L	mg/L	mg/L	NTU	°C	mS/cm	ppt	mg/L	mg/L	SU	mg/L
1	Hackensack River	6.50	0.87	40.1	1632	9.50	4.40	2.91	1.60	840	131	6.85	8.70
2	Hackensack River	8.00	0.94	24.0	2691	15.0	4 00	4.82	2.80	1490	210	6.78	9.30
3	Hackensack River	6.60	0.90	17.5	4177	14.5	3.80	7.25	4.30	2339	348	6.17	9.90
4	Hackensack River	3.80	1.20	9.50	6729	9.80	3.10	12.6	7.80	3979	494	7.20	10.8
5	Hackensack River	3.90	1.31	5.40	9644	6.20	4.50	15.7	10.0	5578	701	6.79	10.7
6	Penhorn Creek	1.30	0.36	3.80	1029	5.50	2.10	1.66	0.90	436	48.9	7.23	12.3
7	Sawmill Creek	3.40	1.11	9.70	7446	13.5	3.40	7.04	6.70	4379	597	7.18	10.8
8	Berry's Creek	5.50	1.24	40.5	4482	20.0	3.30	7.34	4.30	2489	345	6.51	9.80
9	Mill Creek	6.80	0.91	36.1	3299	17.3	3.90	5.65	3.30	1789	248	6.94	9.10
10	Cromakill Creek (Lower)	5.90	0.83	34.7	3117	15.2	4.10	5.43	3.20	1739	241	6.74	9.70
11	Cromakill Creek (Upper)	7.10	1.47	26.4	701	7.70	9.20	1.21	0.60	316	44.8	6.75	8.20
12	Overpeck Creek	2.00	1.02	10.8	494	4.50	3.70	0.91	0.40	236	37.2	6.90	13.1
13	Kearny Marsh	0.60	0.33	16.1	1306	8.60	0.40	2.39	1.30	676	51.7	7.40	14.4
14	Belleville Pike Drainage Lagoon	4.40	0.57	5.00	473	5.00	2.3	0.81	0.40	179	39.6	6.30	11.7
	Average	4.70	0.93	20.0	3373	10.9	3.84	5.41	3.40	1890	253	6.84	10.6

	Spring 1999	NH 4	Nitrate	TSS	TDS	Turbidity	Temperature	Conductivity	Salinity	Chloride	Sulfate	pH	DO
	Sampled 7&8 June 99	mg/L	mg/L	mg/L	mg/L	NTU	°C	mS/cm	ppt	mg/L	mg/L	SU	mg/L
1	Hackensack River	2.20	0.27	9.60	2841	9.80	25.5	4.86	2.90	1540	209	7.08	1.90
2	Hackensack River	8.60	0.50	5.40	3875	8.10	25.1	6.44	4.00	1979	287	7.07	2.40
3	Hackensack River	6.20	0.45	5.50	5940	7.60	25.2	9.48	6.00	3279	421	7.07	2.30
4	Hackensack River	2.80	0.49	3.70	9614	7.40	25.0	14.8	9.70	5298	673	6.99	0.90
5	Hackensack River	4.40	0.56	3.50	13975	7.70	25.5	21.0	14.2	7798	1,027	6.53	2.60
6	Penhorn Creek	5.50	0.09	7.20	1408	16.0	22.0	2.18	1.20	563	34.2	7.05	0.80
7	Sawmill Creek	1.10	0.41	6.60	12086	9.20	25.6	17.8	11.9	6631	838	6.76	2.90
8	Berry's Creek	1.90	0.39	25.7	6206	14.5	25.4	10.3	6.40	3479	445	7.01	2.70
9	Mill Creek	2.40	2.87	9.40	4146	9.90	26.6	6.75	4.20	2189	287	7.09	3.00
10	Cromakill Creek (Lower)	5.50	0.24	7.10	4227	9.50	26.1	6.90	4 30	2189	274	6.96	1.80
11	Cromakill Creek (Upper)	12.2	0.52	2.30	528	6.70	23.6	0.91	0.40	198	50.7	7.50	4.00
12	Overpeck Creek	0.60	0.04	14.0	365	14 8	24.3	0.61	0.30	148	27 4	8.47	11.9
13	Kearny Marsh	2.60	0 07	13.2	1680	10 3	24 1	2.84	1 70	795	31.5	7.26	6 00
14	Belleville Pike Drainage Lagoon	1.00	0.22	3.70	1930	9.60	20.2	3.16	1.80	870	119	6.50	5.30
	Average	4 07	0.51	8.35	4916	10.1	24 6	7.71	4 93	2640	337	7.10	3 46

TABLE 16
SURFACE WATER ANALYSIS RESULTS
SURFACE WATER MONITORING - 1999
HACKENSACK MEADOWLANDS DEVELOPMENT COMMISSION

	Summer 1999	Cadmium	Chromium	Copper	Iron	Lead	Nickel	Zinc	Fecal Coliforms	BOD	COD
	Sampled 6&7 Jul 99	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	MPN/100ml	mg/L	mg/L
1	Hackensack River	19.4	7.90	23 0	678	97.8	103	33.1	800	10.0	40.9
2	Hackensack River	26.7	12.4	27.2	444	110	120	37 9	300	9.60	48.4
3	Hackensack River	30.3	16.9	32.7	488	133	170	39.2	300	5.30	160
4	Hackensack River	40 3	21.4	42.4	548	204	199	109	70	3.40	115
5	Hackensack River	47.4	27.6	56.0	471	329	217	53 4	20	2.90	242
6	Penhorn Creek	8.40	7.90	9.10	2,626	74.2	38.2	23.6	16000	9.20	26.0
7	Sawmill Creek	42.9	23.1	46.3	500	299	201	48.2	300	3.20	167
8	Berry's Creek	28.8	19.1	36.9	541	180	111	41.8	230	7.20	123
9	Mill Creek	29.8	12.4	29.9	511	180	114	37.9	260	6 10	167
10	Cromakill Creek (Lower)	28.8	14.6	31.3	779	97.8	108	40.0	3000	4.60	101
11	Cromakill Creek (Upper)	5.80	7.90	10 5	350	39.0	11.9	28.4	16000	10.9	63.3
12	Overpeck Creek	8.40	7.90	2.20	397	27.2	9.00	10.6	170	4.70	11.2
13	Kearny Marsh	11.0	7.90	9.10	169	39.0	41.2	15.0	40	8.10	63.3
14	Belleville Pike Drainage Lagoon	24.1	16.9	29.9	678	145	85.0	34.4	500	5.70	48.0
	Average	25.2	14.6	27.6	656	140	109	39.5	2714	6.49	98.3

	Fall 1999	Cadmium	Chromium	Copper	Iron	Lead	Nickel	Zinc	Fecal Coliforms	BOD	COD
	Sampled 18 & 19 Oct 99	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	MPN/100ml	mg/L	mg/L
1	Hackensack River	3.60	6.50	7.00	281	35.6	24.1	18.3	800	5.30	9.70
2	Hackensack River	6.90	6.50	8.60	271	73.6	33.3	23.3	5000	8.10	22.6
3	Hackensack River	10.3	9.10	11.8	277	98.9	67.0	35.6	300	7.20	22.6
4	Hackensack River	17.4	14.1	19.9	274	112	116	36.1	40	6.00	16.1
5	Hackensack River	21.7	22.4	32.2	246	237	198	48.8	40	4.40	48.3
6	Penhorn Creek	3.20	9.10	3.85	159	35.6	33.3	32.4	300	4.00	22.6
7	Sawmill Creek	15.2	16.1	26.6	322	148	149	39.5	800	4.80	54.8
8	Berry's Creek	5.30	6.50	54	165	73.6	60.8	29.2	80	13.3	22.6
9	Mill Creek	4.40	6.50	20	459	60.9	57.8	32.0	500	6.50	35.4
10	Cromakill Creek (Lower)	4.80	9.10	10	268	60.9	70.0	29.7	800	6.70	22.6
11	Cromakill Creek (Upper)	4.40	6.50	8.60	299	48.2	18.0	22.8	16000	8.60	61.2
12	Overpeck Creek	1.10	6.50	3.80	237	35.6	51.7	11.0	230	5.10	22.6
13	Kearny Marsh	1.90	6.50	5.40	234	35.6	30.2	10.1	80	6.40	67.7
14	Belleville Pike Drainage Lagoon	4.40	11.6	7.00	994	35.6	33.3	21.9	340	9.70	29.0
	Average	7.47	9 79	15.6	320	77.9	67.3	27.9	1808	6.86	32.7

TABLE 16
SURFACE WATER ANALYSIS RESULTS
SURFACE WATER MONITORING - 1999
HACKENSACK MEADOWLANDS DEVELOPMENT COMMISSION

	Summer 1999	NH 4	Nitrate	TSS	TDS	Turbidity	Temperature	Conductivity	Salinity	Chloride	Sulfate	pH	DO
	Sampled 6&7 Jul 99	mg/L	mg/L	mg/L	mg/L	NTU	°C	mS/cm	ppt	mg/L	mg/L	SU	mg/L
1	Hackensack River	3.90	0.48	27.4	5726	14.0	29.8	13.1	8.60	3089	469	7.31	7.10
2	Hackensack River	6.30	0.61	13.1	7414	7.50	29.0	11.3	7.30	3779	570	7.25	4.80
3	Hackensack River	4.90	0.59	25.6	9661	4.40	29.3	14 4	9.50	5278	782	7.36	6.50
4	Hackensack River	2.40	0.71	43.3	12810	8.20	29.7	18.5	12.4	6798	950	7.12	5.70
5	Hackensack River	2.90	0.67	29.8	17106	3.40	30.6	24.3	16.8	8631	1,389	6.70	3.50
6	Penhorn Creek	4.00	0.40	35.6	2892	15.0	27.5	4.23	2.60	1196	101	7.36	1.00
7	Sawmill Creek	1.70	0.39	36.3	15972	2.30	30.3	22.7	15.6	7798	1,299	6.89	4.30
8	Berry's Creek	2.10	0.51	20.8	9456	10.0	30.0	14.1	9.30	5078	746	7.32	11.1
9	Mill Creek	4.30	0.69	25.4	8748	7.00	29.8	13.1	7.60	4789	734	7.31	7.10
10	Cromakill Creek (Lower)	3.80	0.55	49.6	8261	8.00	30.0	12.9	8.50	4739	722	7.22	7.80
11	Cromakill Creek (Upper)	14.0	0.34	1.80	661	3.00	25.6	1.20	0.60	320	66.4	7.28	3.70
12	Overpeck Creek	0.40	0.25	13 3	573	4.20	28.1	1.01	0.50	248	44.7	7.72	8.80
13	Kearny Marsh	0.60	0 22	24.2	2019	11.0	29.7	3.37	2.00	4439	44.7	7.68	7.80
14	Belleville Pike Drainage Lagoon	4 10	0.30	51.5	8253	10.0	29.5	12.7	8.30	2239	577	7.78	14.0
	Average	3.96	0.48	28.4	7825	7.71	29.2	11.92	7.83	4173	607	7.31	6.66

	Fall 1999	NH 4	Nitrate	TSS	TDS	Turbidity	Temperature	Conductivity	Salinity	Chloride	Sulfate	pH	DO
	Sampled 18 & 19 Oct 99	mg/L	mg/L	mg/L	mg/L	NTU	°C	mS/cm	ppt	mg/L	mg/L	SU	mg/L
1	Hackensack River	2.80	0.76	16.1	1435	25.0	16.4	2.47	1 40	720	110	7.17	8.00
2	Hackensack River	5.40	0.56	21.3	1874	8.70	16.7	3.30	1.90	995	143	7.10	6.90
3	Hackensack River	5.00	0.66	24.6	3315	6.50	16.2	5.57	3.30	1789	246	7.21	6.70
4	Hackensack River	2.70	0.77	9.70	5784	6.80	16.5	9.26	5.90	3279	452	7.29	7.70
5	Hackensack River	0.90	0.85	1.60	10778	6.20	16.8	14.4	10.6	6078	743	7.29	6.10
6	Penhorn Creek	1.90	0.11	7 40	924	10.2	17.2	1.31	0.70	318	47.2	6.86	2.80
7	Sawmill Creek	1.80	0.90	31.3	8297	17.0	13.8	13.1	8.30	4779	587	7.48	7.90
8	Berry's Creek	0.60	0.89	9.80	3706	10.2	15.8	5.94	3.60	2089	259	7.80	8.07
9	Mill Creek	4 10	1.31	32.2	3049	20.0	16.2	4.89	2.90	1689	209	7.12	6.80
10	Cromakill Creek (Lower)	4.00	0.61	17.5	2914	11.0	16 2	4.80	2.90	1689	216	7.33	7 50
11	Cromakill Creek (Upper)	8 00	0.37	2.60	413	7.80	16.3	0.69	0.30	128	39.9	7 32	8.70
12	Overpeck Creek	1.30	0.67	12.6	406	10.5	19.4	0.68	0.30	158	38.6	6.91	3.80
13	Kearny Marsh	0.40	0 08	29.2	1460	9.80	16.5	2.43	1.30	716	42.6	7.25	5 40
14	Belleville Pike Drainage Lagoon	2.90	0.52	2.10	763	17.5	15.5	1 07	0 60	296	64 5	7.09	6.90
	Average	2.99	0.65	15 6	3223	11 9	16.4	4 99	3.14	1766	228	7.23	6 66

TABLE 17
GROUNDWATER ANALYSIS RESULTS
AVON LANDFILL REMEDIAL INVESTIGATION
L. ROBERT KIMBALL ASSOCIATES 2000

Sample	Ground	Average	AH1	AH1F	AH2	AH2F	AH3	AH3F	AH3D	AH3DF	AH4	AH4F	AW 1	AW 2	AW 2MS	AW 2MSD
Location	Water	Conc.	AH1	AH1	AH2	AH2	AH3	AH3	AH3	AH3	AH4	AH4	W-3	W-2	W-2	W-2
Date Sampled	Quality	23	04/04/00	04/04/00	03/31/00	03/31/00	04/03/00	04/03/00	04/03/00	04/03/00	03/31/00	03/31/00	03/22/00	03/22/00	03/22/00	03/22/00
Time Sampled	Standard	Samples	12 00	12 00	10 30	10 30	9.50	9.50	9 50	9:50	9 45	9:45	14 26	13 10	13:10	13.10
[redacted]	Class IIA	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater
BOD (mg/l)		183	50		17		170		300		39		610	220	222	NR
COD (mg/l)		373	580		200		460		470		610		1000	360	430	430
nitrates (mg/l)		1	<0.5		0 71		<0.5		<0.5		<0.5		<0.5	<0 5	10	9.6
chlorides (mg/l)		328	33		200		480		420		530		780	360	400	370
TS (mg/l)		1437	1200		940		2000		2000		2000		3000	1600	1900	1900
TSS (mg/l)		165	420		48		210		200		220		180	150	160	160
pH (lab)		5	6 5		7 2		6.8		6.8		6.9		7 1	7.1	7.1	7.1
pH		7	6 23		6 35		6 11		6.11		6.62		8 34	8.33	8.33	8.33
salinity ppt		2	1.03		1.24		3		3		1 23		0.54	0 40	0.40	0.40
Ox pot. mV		-35	188.7		47 1		171.4		171.4		66.3		-76 3	7.9	7.9	7.9
PP metals	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Aluminum	200															
Arsenic	8	3				9.4 B			4 3 B			20.8				
Barium	2000	295														
Beryllium	20	1	5.3	1.4 B			5	1.4 B	5 4	1.2 B						
Cadmium	4	0			1.1 B											
Chromium	100	24	85.2	6.5 B	14.9	6.8 B	29.7	9.0 B	46 4	13 5	51.5	11.4	12.6	16.2		
Copper	1000	22	128	4 2 B	44.4	12.8 B	61.5	3.2 B	107	5.9 B	19.6 B	1.4 B	22 2 B	1.8 B		
Iron	300	3251														
Lead	10	45		46.3	50.1	4.4	161	4	294	6.1	60		35.7	3 5		
Manganese	50	92	367													
Mercury	2	1	1.4 N		1.7		2 6		2		1.9		0.94	0.6		
Nickel	100	31	28 4 B	3 4 B	38.2 B	33.5 B	82	43.5	114		25 4 B	16.8 B	57	17.4 B		
Selenium	50	3				8 2		17.4		12.9	5.1	68.6				
Silver	20	1								1 7 B						
Sodium	50000	126565														
Thallium	10	2								12.6						
Vanadium		0														
Zinc	5000	220	1080	194	459	180	491	47 3	769	59.3	275	29.3	264	210		

B = Detected in blank
J = Estimated value detected below MDL
R = Rejected
Blank cell indicates not detected

TABLE 17
GROUNDWATER ANALYSIS RESULTS
AVON LANDFILL REMEDIAL INVESTIGATION
L. ROBERT KIMBALL ASSOCIATES 2000

Sample	Ground	AW 3	AW 4	AW 5	AW5F	AW 6	AW 6F	AW 7	AW 8	AW 8F	AW 9	AW9D	AW9F	AW9DF	AW 10	AW 10 I
Location	Water	W-5	W-7	W-8	W-8	CW3-1	CW3-1	W-11	CW4-1	CW4-1	W-4	W-4	W-4	W-4	CW5-1	CW5-1
Date Sampled	Quality	03/23/00	03/23/00	03/21/00	03/21/00	03/21/00	03/21/00	03/23/00	03/22/00	03/22/00	03/21/00	03/21/00	03/21/00	03/21/00	03/21/00	03/21/00
Time Sampled	Standard	9 10	9:50	14 33	15 30	15 55	15:55	11:09	9 39	9:39	9:16	9 25	9:25	9:25	12:42	12:45
Matrix	Class IIA	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater
BOD (mg/l)		340	200	160		280		460	400		290	260			190	
COD (mg/l)		540	310	270		400		700	750		370	370			330	
nitrates (mg/l)		<0.50	<.5	<0.5		0 74		<.0 5	<0 5		<0.5	<0.5			<0 5	
chlorides (mg/l)		320	420	160		670		720	800		380	360			150	
TS (mg/l)		1700	1500	1700		2000		3200	1800		1600	1600			1400	
TSS (mg/l)		150	200	340		99		120	770		150	150			76	
pH (lab)		7.1	7	7		7.1		7.3	7.3		7	7			7	
pH		6 31	6.39	6.08	6.08	6 22	6.22	6.68	8 46		5.94	5.94	5 94	5.94	6.06	6.06
salinity ppt		3.38	3 34	1.65	1.65	2.20	2.20	6 67	0 6		2 5	2.5	2.5	2.5	1.73	1.73
Ox pot. mV		-126 90	-51.8	-28 2	-28.2	-48.0	-48.0	-148.1	-79.6		-109.5	-109 5	-109.5	-109.5	-74.1	-74 1
PP metals	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Aluminum	200				117 B		121 B			164 B			143 B	143 B		108 B
Arsenic	8		9.9 B													9.2 B
Barium	2000				1400		1340			693		NR	1640	1640	NR	766
Beryllium	20															
Cadmium	4															
Chromium	100	89 1	20.2	30 5	3.1 B	30 3	6 5 B	10.4	110	47.7	8.7 B	8.4 B	6 6 B	6.6 B	13	
Copper	1000	5 6 B	55.8	7.9 B		9.5 B		14 5	48		3.7 B	3.9 B			1.2 B	6.0 B
Iron	300				11500	NR	11700			9660	NR	NR	23600	24200	NR	3780
Lead	10	23.5	142	16		73 5		36	108	3.5	9.8	11	6.9		4 7	
Manganese	50				457	NR	256			261	NR	NR	260	255	NR	526
Mercury	2	0.75	0.78	0 6		0 64		0 52	1.6		0 64	0 63	0 28		0.54	0 19 B
Nickel	100	14.1 B	21 4 B	35 6 B	10 1 B	40 9	26.2 B	52 9	52.9	41 3	46	45 5	41 1	40 7	8 2 B	8 7 B
Selenium	50	14 9	11.9					4.8								22.6
Silver	20							1	1 2 B							
Sodium	50000				428000		920000			1170000	NR	NR	605000	610000	NR	348000
Thallium	10															
Vanadium					3 1 B		3 9 B			5 7 B	NR	NR	3.8 B	3 8 B	NR	2 7 B
Zinc	5000	123	114	247	24 6	101	24 1	86 6	271 N	48 9 N	182	183	42 9	33 6	48 2	28 8

B = Detected in blank
J = Estimated value detected below MDL
R = Rejected
Blank cell indicates not detected

TABLE 17
GROUNDWATER ANALYSIS RESULTS
AVON LANDFILL REMEDIAL INVESTIGATION
L. ROBERT KIMBALL ASSOCIATES 2000

Sample	Ground	Average	AH1	AH2	AH3	AH3D	AH4	AW 1	AW 2	AW 2MS	AW 2MSD	AW 3
Location	Water	Conc.	AH1	AH2	AH3	AH3	AH4	W-3	W-2	W-2	W-2	W-5
Date Sampled	Quality	23	04/04/00	03/31/00	04/03/00	04/03/00	03/31/00	03/22/00	03/22/00	03/22/00	03/22/00	03/23/00
Time Sampled	Standard	Samples	12:00	10:30	9.50	9:50	9:45	14.26	13:10	13:10	13:10	9:10
Matrix	Class IIA	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater
PP volatiles	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Chlorethane						18						
Benzene	1	53	5		200	200		46	44	100	110	25
Toluene	1000	46			5.3	5.1		1.2	1.2	51	53	12
Chlorobenzene	4	97	2.1		170	160		30	170	210	190	82
Ethyl Benzene	700	10						1.5	1.5	51	53	8.1
m/p-Xylenes	40	68			79	71		2.1	21	120	120	80
o-Xylene	40	18			5.3	4.9		1.7	2.7	53	55	45
1,4-Dichlorobenzene	600	6			5.8	5.5		8.9	3.5	51	54	
1,2-Dichlorobenzene	600	5								48	51	
Acrylonitrile			6 J									
Total TICs					183	151		144.6 J	150.3 J			388.1 J
PP base neutrals	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Naphthalene	300	23	5.5		21	18	60	12	15			330
Diethylphthalate					14	10						
Phenanthrene						4.4						
Anthracene						1.3 J						
Di-n-butylphthalate	900	6	1.9		5.5	3.3		10	1.2			1.2
Fluoranthene						3.2						
Pyrene						5.7						
Benzo(a)anthracene						1.6						
Chrysene						1.7						
Bis(2-Ethylhexyl)phthalate	30	11	1.7	1.3	48	160	1	2.5	1			8.6

B = Detected in blank
J = Estimated value detected below MDL
R = Rejected
Blank cell indicates not detected

TABLE 17
GROUNDWATER ANALYSIS RESULTS
AVON LANDFILL REMEDIAL INVESTIGATION
L. ROBERT KIMBALL ASSOCIATES 2000

Sample	Ground	AW 4	AW 5	AW 6	AW 7	AW 8	AW 9	AW9D	AW 10
Location	Water	W-7	W-8	CW3-1	W-11	CW4-1	W-4	W-4	CW5-1
Date Sampled	Quality	03/23/00	03/21/00	03/21/00	03/23/00	03/22/00	03/21/00	03/21/00	03/21/00
Time Sampled	Standard	9:50	14:33	15:55	11:09	9:39	9:16	9:25	12:42
Matrix	Class IIA	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater	Gwater
PP volatiles	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Chlorethane									
Benzene	1	7.7	20	27	200	57	65	64	42
Toluene	1000	1.2			17	1.2	450	450	
Chlorobenzene	4	30	190	58	160	26	300	300	160
Ethyl Benzene	700	1.5			2.2	1.5	46	45	2.1
m/p-Xylenes	40	1.5			18	4.5	520	520	2.4
o-Xylene	40	1.7			3.6	1.7	120	120	
1,4-Dichlorobenzene	600		4.7						8.8
1,2-Dichlorobenzene	600								3.1
Acrylonitrile									
Total TICs		78.1 J	13.2 J	21.2 J					
PP base neutrals	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Naphthalene	300	1.2	6.8	3.1	38	1.4	4.6	3.9	3.2
Diethylphthalate									
Phenanthrene									
Anthracene									
Di-n-butylphthalate	900	2.1	43	29	1.2	1.2	11	14	12
Fluoranthene									
Pyrene									
Benzo(a)anthracene									
Chrysene									
Bis(2-Ethylhexyl)phthalate	30	1	2.7	3.2	10	1.5	1.3	2.5	4.2

B = Detected in blank
J = Estimated value detected below MDL
R = Rejected
Blank cell indicates not detected

TABLE 18
SURFACE WATER ANALYSIS RESULTS
AVON LANDFILL REMEDIAL INVESTIGATION
L. ROBERT KIMBALL ASSOCIATES, INC. 2000

Sample Number	SE Surface	AS 1	ASW 1	ASW 2	ASW 3	ASW 4	LSW1	LSW2	TB4	TB7	TB8
Date Sampled	Water	24-Mar	21-Mar	22-Mar	21-Mar	22-Mar	22-Mar	21-Mar	24-Mar	31-Mar	3-Apr
Time Sampled	Quality	10:30	10:30	13:45	14:55	16:10	13.25	15:15			
Matrix	Criteria	Seep	Swater	Swater	Swater	Swater	Swater	Swater	Blank	Blank	Blank
BOD		76	50	40	86	50	38	27			
COD		140	120	97	130	66	66	59			
Nitrate Nitrogen	10,000	<0.5	<0.5	2.5	0.78	2.4	2	2.5			
Chlorides	239,000	180	37	2800	200	4500	5400	4600			
TS		2200	800	4200	1100	5600	8300	6100			
TSS		1100	140	15	48	16	25	37			
pH (lab)		7.6	7	7.2	7.8	7.4	7.8	7.5			
pH (field)		7.10	5.97	9.31	7.46	9.79	9.33	7.56			
Temp o C		9.37	6.98	9.34	6.96	6.73	8.52	6.96			
umho / cm		1992.0	1280.0	13367.0	3030	1169.0	1616.0	4222.0			
d.o.		50.08	617.07	6.77	498.14	8.74	7.59	607.5			
d.o.%			999.9	57.5	999.9	69.6	62	999.9			
salinity ppt		0.99	0.68	0.68	1.53	0.58	0.82	2.23			
Ox pot. mV		188.8	51.2	102.2	62.3	31.2	76.6	66.1			
PP metals		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L			
antimony	4,300										
arsenic	0.136										
beryllium		7.2									
cadmium	10		1.6 B								
chromium	3,230	11.9	54.2	3.2 B	6 B	1.2 B	1.5 B	2.6 B			
copper	7.9(a) 5.6(c)	31.3	69.0	2.6 B	10.4 B	3.1 B		7.8 B			
lead	5	117	101		20.8			3.6			
mercury	0.146	0.85 N	1.0	0.6	0.78	0.67	0.6	0.68			
nickel	3,900	23.8 B	54.0	12.5 B	26 B	7.4 B	4.8 B	7.2 B			
selenium	10										
silver	164		2 B			4.8 B					
thallium	6.22		6.4 B								
zinc		182 E	510	99.3	56.6	64.9	40	74.9			

B = Detected in Blank

J = Detected below MDL

E = Estimated value

Blank cell = Not detected

TABLE 18
SURFACE WATER ANALYSIS RESULTS
AVON LANDFILL REMEDIAL INVESTIGATION
L. ROBERT KIMBALL ASSOCIATES, INC. 2000

Sample Number	SE Surface	AS 1	ASW 1	ASW 2	ASW 3	ASW 4	LSW1	LSW2	TB4	TB7	TB8
Date Sampled	Water	24-Mar	21-Mar	22-Mar	21-Mar	22-Mar	22-Mar	21-Mar	24-Mar	31-Mar	3-Apr
Time Sampled	Quality	10:30	10:30	13:45	14:55	16:10	13:25	15:15			
Matrix	Criteria	Seep	Swater	Swater	Swater	Swater	Swater	Swater	Blank	Blank	Blank
PP volatiles			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L			
Benzene	71	2.2			2.6						
Toluene	200,000		3.9								
Chlorobenzene	21,000	7.3		2	5.4						
Ethylbenzene	27,900		7.6								
m/p-Xylenes			22								
o-Xylene			81								
Total TICs		7.2	1756 J				7.8 J				
PP base neutrals			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L			
Fluorene		2									
Di-n-butylphthalate	15,700		14		33	1.2		24			
Bis(2-Ethylhexyl)phthalate						1.4					
Total TICs			99.5	38.7	183.5	365.6	63.2 J	29.7 J			

B = Detected in Blank
J = Detected below MDL
E = Estimated value
Blank cell = Not detected

TABLE 19
SEDIMENT ANALYSIS RESULTS
AVON LANDFILL REMEDIAL INVESTIGATION
L. ROBERT KIMBALL ASSOCIATES, INC. 2000

Sample Number	AD1		LD2		LD4		LD4D		Marine/Estuarine	
Date Sampled	3/24/00		3/24/00		3/24/00		36609		Effects Range Low	Effects Range Medium
Depth	0-6 in		0-6 in		0-6 in		0-6 in			
	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	mg/kg
PP Metals										
Antimony	3	B			1	B	2	B		
Arsenic	10.2		14.1		6.3		12.7		8.2	70
Beryllium	0.71	B	0.97	B	0.35	B	0.84	B		
Cadmium	1.1	B	3.2		1.5		2.9		1.2	9.6
Chromium	288		274		128		244		81	370
Copper	128		157		61.4		145		34	270
Lead	193		163		73.7		162		47	218
Mercury	3.7		2.6				3.6		0.15	0.71
Nickel	39.6		43.7		20 7		37.8		21	52
PH	8.1		7.6		8.1		8.1			
Selenium	2.3		3 3		1.3		2.6			
Silver	2.8	B	4		1 6		4.8		1	3.7
Thallium	2 2	B	3		1.5		3.5			
TOC	200,000		75,000		120,000		110,000			
Zinc	288		359		176		395		150	410
PP VOCs										
None detected										
PP Base Neutrals										
Acenaphthylene			0.11						0.044	0.64
Benzo(a)anthracene	0.29						0.11		0 261	1 6
Benzo(a)pyrene	0.32		0.3				0.12	J	0.43	1.6
Benzo(b)fluoranthene	0.24		0.23				0.09			
Benzo(g,h,i)perylene	0.16		0.13						0.17	320
Benzo(k)fluoranthene	0.39		0.27		0 09		0.12		0.24	1340
Chrysene	0.34		0.29				0.12	J	384	2.8
Fluoranthene	0.56		0.35		0 11		0.19		0.6	5.1
Indeno(1,2,3-cd)pyrene	0.16	J	0.15						0.2	320
Phenanthrene	0.23								0.24	1.5
Pyrene	0.41		0.26		0 09		0.14		0.665	2.6

B = Detected in blank
J = Detected below MDL
E = Estimated value
Blank cell = Not detected

TABLE 20
AIR ANALYSIS RESULTS
AVON LANDFILL REMEDIAL INVESTIGATION
L. ROBER KIMBALL & ASSOCIATES - 2000

Sample No.	AA1	AA2	AAH3	AAH4
Sample Location	AH1	AH2	AH3	AH4
Depth	2 FT	2 FT	2 FT	2 FT
Units	ppbv	ppbv	ppbv	ppbv
2,3 Dihydrofuran	15.9	10.4	ND	ND
1,3,5 - cycloheptatriene	12	ND	ND	ND
1,3-dimethylbenzene	ND	14.2	ND	ND
Halocarbon 12	ND	ND	ND	64.1

TABLE 21
AIR ANALYSIS RESULTS
AVON LANDFILL REMEDIAL INVESTIGATION
L. ROBER KIMBALL & ASSOCIATES - 2000

WELL #	PID (ppm)	FID (ppm)	LEL (%)	O2 (%)	CO (%)	H2S (%)
W-4 (AW9)	61 6	89 0	0	22.8	0	0
CW5-1 (shallow)	33 8	750000	54	21.9	0	0
CW5-2 (medium)	28.2	750000	6	22.6	0	0
CW5-3 (deep)	138.0	750000	178	10.5	0	7
CW3-1	0.0	malfunction	0	21.4	0	0
CW3-2	0.0	-	0	21.9	0	0
CW3-3	0.0	-	0	21.5	0	0
CW4-1	0.0	653.7	0	22.1	0	0
CW4-2	0 0	0.0	0	22.2	0	0
CW4-3	0.0	0.0	0	22.0	0	0
W-2	0.0	138.7	0	21.0	0	0
W-3	0.0	1149.0	14	22.1	0	0
W-5	7.6	14 1	0	22 1	0	0
W-7	0.0	101 3	0	22 1	0	0
W-11	100.0	510.0	0	21.7	0	0