Golder Associates NC, Inc.

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December 5, 2007

Project No. 063-6507.203

Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
401 Oberlin Road, Suite 150
Raleigh, North Carolina 27605
919-508-8507

Attention: Mr. Brian Wootton
Hydrogeologist

Re: Response to Comments
Design Hydrogeologic Report for Proposed Phase 5
East Carolina Regional Landfill, Permit No. 08-03
Bertie County, North Carolina

Dear Brian,

On behalf of East Carolina Environmental, a subsidiary of Republic Services of North Carolina, LLC (Republic), Golder Associates NC, Inc. (Golder) is submitting this response to comments presented in the November 8, 2007, letter from the Solid Waste Section regarding the *Design Hydrogeologic Report for Phase 5,* for the East Carolina Regional Landfill. The comments from the November 8, 2007, letter are presented below in italics followed by Golder's response.

Design Hydrogeologic Report
Section 3.2.2 Soil Testing
Table 4 – Summary of Laboratory Soils Test Data

Page 5, Section 3.2.2 states in-part: "Soil samples consisted of seven Shelby Tubes"..... "(PZ-117B (22'-24'), and PZ-177B (48'-49.5')) and one composite split tube sample (PZ-177A (10'-18'))".

PZ-177B and PZ-177A are probably typo errors. Please modify to read: PZ-117A and PZ-117B.

Golder agrees with the recommendation. Section 3.2.2 has been revised and replacement page 5 is attached to this letter.

Design Hydrogeologic Report
Section 4.2.4 Layer IV Hydrogeologic Unit
Table 5 – Summary of Aquifer Test Data

Page 10, Section 4.2.4 states in-part: "Hydrogeologic conductivity derived from aquifer testing of piezometers in and around Phase 5 and screened in Layer II ranged from 2.12E-05 cm/sec to 5.23E-04 cm/sec with an average hydraulic conductivity value of 9.94E-05 cm/sec".

Layer II is probably a typo error. Please modify to read: Layer IV.

Golder agrees with the recommendation. Section 4.2.4 has been revised and replacement page 10 is attached to this letter.

Since the July 30, 2007, submittal, the Solid Waste Section Limits have been revised. Please replace the table in Appendix B of the Water Quality Monitoring Plan with the enclosed revised table.

Three copies of revised cover pages, report text pages, and table are attached to this letter. Please replace the original pages with the revised pages. Also, a CD has also been included that contains PDF files of this letter report and attachments, as well as, the complete revised *Design Hydrogeologic Report for Phase 5* text.

If you have any questions, please contact the undersigned at 336-852-4903. We appreciate your assistance with this project.

Sincerely,
GOLDER ASSOCIATES NC, INC.

David "Dusty" Y. Reedy II, P.G.
Project Hydrogeologist

Rachel P. Kirkman, P.G.
Senior Project Geologist

Enclosures

C: William Cooksey, General Manager, Republic Services of North Carolina, LLC, 1922 Republican Road, Aulander, North Carolina, 27805. 252-348-3322.
Ray Hoffman, P.E., Area Engineer, Republic Services, 1220 Commerce Street, SW, Hickory, North Carolina, 28613. HoffmanRJ@repsrvnc.com. 828-464-2414.

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APPLICATION FOR PERMIT TO CONSTRUCT
REPUBLIC SERVICES OF NORTH CAROLINA, LLC

VOLUME I OF II
DESIGN HYDROGEOLOGIC REPORT

EAST CAROLINA REGIONAL LANDFILL
PHASE FIVE
PERMIT NO. 08-03
BERTIE COUNTY, NORTH CAROLINA

JULY 2007
REVISED DECEMBER 2007

PREPARED FOR:

REPUBLIC SERVICES OF NC, LLC
1922 REPUBLICAN ROAD
AULANDER, NORTH CAROLINA 27805

NORTH CAROLINA LICENSED SEAL 1963 GEOLOGIST DAVID YATES REEDY, II 12-5-07

PREPARED BY:

Golder Associates

NORTH CAROLINA LICENSED SEAL 1811 GEOLOGIST RACHEL P. KIRKMAN 12-5-07

GOLDER ASSOCIATES NC, INC.
4900 KOGER BOULEVARD, SUITE 140
GREENSBORO, NORTH CAROLINA 27407

Project No. 063-66507.203

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VOLUME I OF II
DESIGN HYDROGEOLOGIC REPORT

EAST CAROLINA REGIONAL LANDFILL PHASE FIVE PERMIT NO. 08-03 BERTIE COUNTY, NORTH CAROLINA

JULY 2007
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PREPARED FOR:

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3.2.2 Soil Testing

Soil samples were collected from each piezometer or piezometer pair location during drilling activities. Standard penetration tests were performed continuously for each boring using a 2-foot long split spoon sampler. Soil samples from the split spoons were collected so that select samples could be reviewed at a later date or sent to a soil testing laboratory. Undisturbed soil samples were collected using Shelby Tubes at select boring locations to be analyzed at a soil testing laboratory.

Soil samples were sent to the Golder Associates Inc. Soil Testing Laboratory in Atlanta, Georgia. Soil samples consisted of seven Shelby Tubes (PZ-109A (4'-6'), PZ-109A (14'-16'), PZ-109B (33'-35'), PZ-109B (45.5'-47'), PZ-115B (44'-44.5'), PZ-117B (22'-24'), and PZ-117B (48'-49.5')) and one composite split spoon sample (PZ-117A (10'-18')). Samples were analyzed for gradation, Atterberg limits, USCS classification, permeability, total porosity, total unit weight, moisture content, triaxial shear, and consolidation. The results of the soil analysis are summarized in Table 4 and the laboratory report is provided as Appendix C.

3.2.3 Hydrogeologic Testing

The potentiometric surface in the newly installed monitoring wells was measured at the time of well construction, and approximately 24 hours and approximately 7 days after well construction. The potentiometric surface in the existing monitoring wells and piezometers and newly installed piezometers were measured periodically over several months and the data are summarized on Tables 2 and 3. The measurements were collected using a decontaminated electric water level indicator. The surveyed point on the top of the well casing was used as reference, and the measurements were recorded to within 0.01 foot. The groundwater elevation data measured on October 31, 2006, were used to prepare potentiometric surface contour maps and to infer groundwater flow directions for the uppermost and lower aquifers at the site, and are included as Drawings DH-2 and DH-3.

Following development, 5 piezometers (PZ-109A, PZ-110, PZ-115A, PZ-117A, and PZ-118) and 1 monitoring well (GW-16) screened in the uppermost aquifer and 3 piezometers (PZ-109B, PZ-115B, and PZ-117B) screened in the lower aquifer were chosen for aquifer testing (slug tests) during the field investigation. The purpose of the testing was to assess the value of horizontal hydraulic conductivity at various locations within the two aquifers at the site. *In situ* rising- and falling-head slug tests were chosen for the assessment.

Slug tests were conducted between October 31, 2006, and November 3, 2006, by an experienced Golder geologist. Rising- and falling-head tests were performed on each piezometer and well because the water table was above the screened intervals; thus the results were not significantly affected by the porosity of the sand pack.

Prior to slug testing, the piezometers were opened and groundwater levels were allowed to equilibrate. Water level measurements were then collected using an electric water level probe referenced to a point on the top of casing. A stainless steel pressure transducer rated for 15 pounds per square inch (psi) was then lowered inside the well casing and placed 10 to 15 feet

4.2.4 Layer IV Hydrogeologic Unit

Layer IV underlies Layer III and appears to be continuous across the proposed Phase 5 area based on field observations. One boring in the Phase 5 area (PZ-73A) was documented to have fully penetrated Layer IV indicating a thickness of 15 feet. Other borings in the area were advanced up to 22 feet into Layer IV without locating the bottom of the unit. The thickness of Layer IV is expected to be variable and may exceed 50 feet in some locations. The unit is expected to be continuous under the proposed Phase 5 area based on available data. A summary of the thicknesses observed in available piezometers and monitoring wells extending into Layer IV in and around the Phase 5 footprint is provided in Table 6. The associated depths and elevations for each layer are shown on Tables 7 and 8.

Three sediment samples from soil borings from Layer IV advanced inside the Phase 5 footprint were analyzed by a soil testing laboratory during the current investigation. These soil test results are summarized in Table 4 and included in Appendix C. Field and laboratory soil classifications of the samples collected from Layer IV range from fine sand to a sandy clay. The sandy clay is considered to be a minor lithology for the layer and was only encountered locally. Effective porosity calculations were performed utilizing the soil testing results and the textural classification triangle (Johnson, 1967). Effective porosities of the Layer IV samples range from 13.5 to 35 percent. Laboratory-derived vertical permeabilities for Layer IV range from 3.0E-06 cm/sec to 9.0E-04 cm/sec. These results are consistent with those obtained during previous investigations across the site.

An aquifer test for one piezometer screened in Layer IV was performed in the Phase 5 area during previous investigations. Aquifer tests were performed for 3 additional piezometers screened in Layer IV in and around the proposed Phase 5 cell during the current investigation. Aquifer testing results for four piezometers constructed in the vicinity of Phase 5 are presented in Table 5. Hydraulic conductivities derived from aquifer testing of piezometers in and around Phase 5 and screened in Layer IV ranged from 2.12E-05 cm/sec to 5.23E-04 cm/sec with an average hydraulic conductivity value of 9.94E-05 cm/sec.

Based on site observations, laboratory soil testing data, and aquifer test data, Layer IV is considered to be the lower aquifer at the site. Due to the properties of the overlying unit (Layer III), Layer IV is a confined aquifer.

5.0 SITE HYDROGEOLOGY

A significant amount of hydrogeologic investigation has been performed on the site including the drilling of 39 borings in and around the proposed Phase 5 area as described above. The following section discusses the hydrogeologic aspects of the site, with emphasis on the proposed Phase 5 disposal area, based on field and laboratory data obtained from the 39 soil borings.

5.1 Hydrology and Discharge Features

As discussed in Section 2.0, topographic elevations at the facility range from approximately 30 to 70 feet above mean sea level. Along the northern and eastern portions of the facility, surface drainage from the facility and surrounding areas is routed by drainage channels and storm water

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** SWSL = Solid Waste Section Limit

CAS Number	Name	Other Names	2L Std.	GWP* Std.	SWSL**	SW ID	App I
630-20-6	1,1,1,2-Tetrachloroethane	Ethane, 1,1,1,2-tetrachloro-	NE	1.3	5	190	I
71-55-6	1,1,1-Trichloroethane; Methylchloroform	Ethane, 1,1,1-trichloro-	200	--	1	200	I
79-34-5	1,1,2,2-Tetrachloroethane	Ethane, 1,1,2,2-tetrachloro-	NE	0.18	3	191	I
79-00-5	1,1,2-Trichloroethane	Ethane, 1,1,2-trichloro-	NE	0.6	1	202	I
75-34-3	1,1-Dichloroethane; Ethyldidene chloride	Ethane, 1,1-dichloro-	70	--	5	75	I
75-35-4	1,1-Dichloroethylene; 1,1-Dichloroethene;	Ethene, 1,1-dichloro-	7	--	5	77	I
563-58-6	1,1-Dichloropropene	1-Propene, 1,1-dichloro-	NE	NE	5	85	II
96-18-4	1,2,3-Trichloropropane	Propane, 1,2,3-trichloro-	0.005	--	1	206	I
95-94-3	1,2,4,5-Tetrachlorobenzene	Benzene, 1,2,4,5-tetrachloro-	NE	NE	10	189	II
120-82-1	1,2,4-Trichlorobenzene	Benzene, 1,2,4-trichloro-	NE	70	10	199	II
96-12-8	1,2-Dibromo-3-chloropropane; DBCP	Propane, 1,2-dibromo-3-chloro-	0.025	--	13	67	I
106-93-4	1,2-Dibromoethane; Ethylene dibromide; EDB	Ethane, 1,2-dibromo-	0.0004	--	1	68	I
107-06-2	1,2-Dichloroethane; Ethylene dichloride	Ethane, 1,2-dichloro-	0.38	--	1	76	I
78-87-5	1,2-Dichloropropane	Propane, 1,2-dichloro-	0.51	--	1	82	I
142-28-9	1,3-Dichloropropane; Trimethylene dichloride	Propane, 1,3-dichloro-	NE	NE	1	83	II
130-15-4	1,4-Naphthoquinone	1,4-Naphthalenedione	NE	NE	10	149	II
134-32-7	1-Naphthylamine	1-Naphthalenamine	NE	NE	10	150	II
594-20-7	2,2-Dichloropropane; Isopropylidene chloride	Propane, 2,2-dichloro-	NE	NE	15	84	II
58-90-2	2,3,4,6-Tetrachlorophenol	Phenol, 2,3,4,6-tetrachloro-	210	--	10	193	II
93-76-5	2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	Acetic acid, (2,4,5-trichlorophenoxy)-	NE	NE	2	188	II
95-95-4	2,4,5-Trichlorophenol	Phenol, 2,4,5-trichloro-	NE	700	10	204	II
88-06-2	2,4,6-Trichlorophenol	Phenol, 2,4,6-trichloro-	NE	NE	10	205	II
94-75-7	2,4-D; 2,4-Dichlorophenoxyacetic acid	Acetic acid, (2,4-dichlorophenoxy)-	70	--	2	59	II
120-83-2	2,4-Dichlorophenol	Phenol, 2,4-dichloro-	NE	NE	10	80	II
105-67-9	2,4-Dimethylphenol; m-Xylenol	Phenol, 2,4-dimethyl-	140	--	10	95	II
51-28-5	2,4-Dinitrophenol	Phenol, 2,4-dinitro-	NE	NE	50	99	II
121-14-2	2,4-Dinitrotoluene	Benzene, 1-methyl-2,4-dinitro-	NE	NE	10	100	II
87-65-0	2,6-Dichlorophenol	Phenol, 2,6-dichloro-	NE	NE	10	81	II
606-20-2	2,6-Dinitrotoluene	Benzene, 2-methyl-1,3-dinitro-	NE	NE	10	101	II
53-96-3	2-Acetylaminofluorene; 2-AAF	Acetamide, N-9H-fluoren-2-yl-	NE	NE	20	6	II
91-58-7	2-Chloronaphthalene	Naphthalene, 2-chloro-	NE	NE	10	47	II
95-57-8	2-Chlorophenol	Phenol, 2-chloro-	0.36	--	10	48	II
591-78-6	2-Hexanone; Methyl butyl ketone	2-Hexanone	NE	280	50	124	I
91-57-6	2-Methylnaphthalene	Naphthalene, 2-methyl-	14	--	10	145	II
91-59-8	2-Naphthylamine	2-Naphthalenamine	NE	NE	10	151	II
91-94-1	3,3'-Dichlorobenzidine	[1,1'-Biphenyl]-4,4'-diamine,3,3'-dichloro-	NE	NE	20	72	II
119-93-7	3,3'-Dimethylbenzidine	[1,1'-Biphenyl]-4,4'-diamine,3,3'-dimethyl-	NE	NE	10	94	II
56-49-5	3-Methylcholanthrene	Benz[j]aceanthrylene,1,2-dihydro-3-methyl-	NE	NE	10	138	II
72-54-8	4,4'-DDD	Benzene 1,1'-(2,2-dichloroethylidene)bis[4-chloro-	0.14	--	0.1	60	II
72-55-9	4,4'-DDE	Benzene, 1,1'-(dichloroethenylidene)bis[4-chloro-	NE	NE	0.1	61	II
50-29-3	4,4'-DDT	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-chloro-	0.1	--	0.1	62	II
534-52-1	4,6-Dinitro-o-cresol; 4,6-Dinitro-2-methylphenol	Phenol, 2-methyl-4,6-dinitro-	NE	NE	50	98	II
92-67-1	4-Aminobiphenyl	[1,1'-Biphenyl]-4-amine	NE	NE	20	11	II
101-55-3	4-Bromophenyl phenyl ether	Benzene, 1-bromo-4-phenoxy-	NE	NE	10	31	II
7005-72-3	4-Chlorophenyl phenyl ether	Benzene, 1-chloro-4-phenoxy-	NE	NE	10	49	II
108-10-1	4-Methyl-2-pentanone; Methyl isobutyl ketone	2-Pentanone, 4-methyl-	NE	560	100	147	I
99-55-8	5-Nitro-o-toluidine	Benzenamine, 2-methyl-5-nitro-	NE	NE	10	157	II
57-97-6	7,12-Dimethylbenz[a]anthracene	Benz[a]anthracene, 7,12-dimethyl-	NE	NE	10	93	II
83-32-9	Acenaphthene	Acenaphthylene, 1,2-dihydro-	80	--	10	1	II
208-96-8	Acenaphthylene	Acenaphthylene	210	--	10	2	II
67-64-1	Acetone	2-Propanone	700	--	100	3	I
75-05-8	Acetonitrile; Methyl cyanide	Acetonitrile	NE	42	55	4	I
98-86-2	Acetophenone	Ethanone, 1-phenyl-	NE	700	10	5	II
107-02-8	Acrolein	2-Propenal	NE	3.5	53	7	II
107-13-1	Acrylonitrile	2-Propenenitrile	NE	NE	200	8	II

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CAS Number	Name	Other Names	2L Std.	GWP* Std.	SWSL**	SW ID	App I
309-00-2	Aldrin	1,4:5,8-Dimethanonaphthalene,1,2,3,4,10,10 -hexachloro-1,4,4a,5,8,8a-hexahydro-(1,4,4a,5,8,8a)-	NE	NE	0.05	9	II
107-05-1	Allyl chloride	1-Propene, 3-chloro-	NE	NE	10	10	II
319-84-6	alpha-BHC	Cyclohexane,1,2,3,4,5,6-hexachloro-,(1a,2a,3β,4a,5□,6□)-	NE	0.006	0.05	24	II
120-12-7	Anthracene	Anthracene	2100	--	10	12	II
7440-36-0	Antimony	Antimony	NE	1.4	6	13	I
7440-38-2	Arsenic	Arsenic	50	--	10	14	I
7440-39-3	Barium	Barium	2000	--	100	15	I
71-43-2	Benzene	Benzene	1	--	1	16	I
56-55-3	Benzo[a]anthracene; Benzanthracene	Benz[a]anthracene	0.0479	--	10	17	II
50-32-8	Benzo[a]pyrene	Benzo[a]pyrene	0.00479	--	10	21	II
205-99-2	Benzo[b]fluoranthene	Benz[e]acephenanthrylene	0.0479	--	10	18	II
191-24-2	Benzo[ghi]perylene	Benzo[ghi]perylene	210	--	10	20	II
207-08-9	Benzo[k]fluoranthene	Benzo[k]fluoranthene	0.479	--	10	19	II
100-51-6	Benzyl alcohol	Benzenemethanol	NE	3500	20	22	II
7440-41-7	Beryllium	Beryllium	NE	4	1	23	I
319-85-7	beta-BHC	Cyclohexane,1,2,3,4,5,6-hexachloro-,(1a,2□,3a,4□,5a,6□)-	NE	0.019	0.05	25	II
SW316	Biological Oxygen Demand	BOD	NE	NE	NE	316	
108-60-1	Bis(2-chloro-1-methylethyl) ether; 2,2'-Dichlorodiisopropyl ether; DCIP, See footnote 4	Propane, 2,2'-oxybis[1-chloro-	NE	NE	10	46	II
111-91-1	Bis(2-chloroethoxy)methane	Ethane, 1,1'-[methylenebis(oxy)]bis [2-chloro	NE	NE	10	42	II
111-44-4	Bis(2-chloroethyl)ether; Dichloroethyl ether	Ethane, 1,1'-oxybis[2-chloro-	NE	0.031	10	43	II
117-81-7	Bis(2-ethylhexyl) phthalate	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl)ester	NE	NE	15	111	II
74-97-5	Bromochloromethane; Chlorobromethane	Methane, bromochloro-	NE	0.6	3	28	I
75-27-4	Bromodichloromethane; Dichlorobromomethane	Methane, bromodichloro-	0.56	--	1	29	I
75-25-2	Bromoform; Tribromomethane	Methane, tribromo-	4.43	--	3	30	I
85-68-7	Butyl benzyl phthalate; Benzyl butyl phthalate	1,2-Benzenedicarboxylicacid, butyl phenylmethyl ester	100	--	10	32	II
7440-43-9	Cadmium	Cadmium	1.75	--	1	34	I
75-15-0	Carbon disulfide	Carbon disulfide	700	--	100	35	I
56-23-5	Carbon tetrachloride	Methane, tetrachloro-	0.269	--	1	36	I
SW317	Chemical Oxygen Demand	COD	NE	NE	NE	317	
57-74-9	Chlordane	4,7-Methano-1H-indene,1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-	0.1	--	0.5	339	II
108-90-7	Chlorobenzene	Benzene, chloro-	50	--	3	39	I
510-15-6	Chlorobenzilate	Benzeneacetic acid, 4-chloro-(4-chlorophenyl)--hydroxy-, ethyl ester	NE	NE	10	40	II
75-00-3	Chloroethane; Ethyl chloride	Ethane, chloro-	2800	--	10	41	I
67-66-3	Chloroform; Trichloromethane	Methane, trichloro-	70	--	5	44	I
126-99-8	Chloroprene	1,3-Butadiene, 2-chloro-	NE	NE	20	50	II
7440-47-3	Chromium	Chromium	50	--	10	51	I
218-01-9	Chrysene	Chrysene	4.79	--	10	52	II
156-59-2	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	Ethene, 1,2-dichloro-,(Z)-	70	--	5	78	I
10061-01-5	cis-1,3-Dichloropropene	1-Propene, 1,3-dichloro-, (Z)-	0.19	--	1	86	I
7440-48-4	Cobalt	Cobalt	NE	70	10	53	I
7440-50-8	Copper	Copper	1000	--	10	54	I
57-12-5	Cyanide	Cyanide	70	--	10	58	II
319-86-8	delta-BHC	Cyclohexane,1,2,3,4,5,6-hexachloro-,(1a,2a,3a,4□,5a,6□)-	NE	0.019	0.05	26	II
2303-16-4	Diallate	Carbamothioic acid,bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl) ester	NE	NE	10	63	II
53-70-3	Dibenz[a,h]anthracene	Dibenz[a,h]anthracene	0.0047	--	10	64	II
132-64-9	Dibenzofuran	Dibenzofuran	NE	28	10	65	II

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124-48-1	Dibromochloromethane; Chlorodibromomethane	Methane, dibromochloro-	NE	0.41	3	66	I
75-71-8	Dichlorodifluoromethane; CFC 12	Methane,dichlorodifluoro-	1400	--	5	74	II
60-57-1	Dieldrin	2,7:3,6-Dimethanonaphth[2,3-b]oxirene,3,4,5,6,9,9-hexachloro -1a,2,2a,3,6,6a,7,7a-octahydro-,(1aa,2□,2aa,3□,6□,6aa,7□,7aa)-	0.0022	--	0.075	88	II
84-66-2	Diethyl phthalate	1,2-Benzenedicarboxylicacid, diethyl ester	5000	--	10	90	II
60-51-5	Dimethoate	Phosphorodithioic acid,O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester	NE	NE	20	91	II
131-11-3	Dimethyl phthalate	1,2-Benzenedicarboxylicacid, dimethyl ester	NE	NE	10	96	II
84-74-2	Di-n-butyl phthalate	1,2-Benzenedicarboxylic acid, dibutyl ester	700	--	10	33	II
117-84-0	Di-n-octyl phthalate	1,2-Benzenedicarboxylicacid, dioctyl ester	140	--	10	168	II
88-85-7	Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol	Phenol, 2-(1-methylpropyl)-4,6-dinitro-	NE	7	1	102	II
122-39-4	Diphenylamine	Benzenamine, N-phenyl-	NE	NE	10	103	II
298-04-4	Disulfoton	Phosphorodithioic acid,O,O-diethyl S-[2-(ethylthio)ethyl]ester	0.28	--	10	104	II
959-98-8	Endosulfan I	6,9-Methano-2,4,3-benzodiox-athiepin,6,7,8,9,10,10 -hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide,	NE	NE	0.1	105	II
33213-65-9	Endosulfan II	6,9-Methano-2,4,3-benzodioxathiepin,6,7,8,9,10,10 -hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide,(3a,5aa,6□,9□,9aa)-	42	--	0.1	106	II
1031-07-8	Endosulfan sulfate	6,9-Methano-2,4,3-benzodioxathiepin,6,7,8,9,10,10 -hexachloro-1,5,5a,6,9,9a-hexahydro-, 3,3-dioxide	NE	NE	0.1	107	II
72-20-8	Endrin	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aa,2□,2a□,3a,6a,6a□,7□,7aa)	2	--	0.1	108	II
7421-93-4	Endrin aldehyde	1,2,4-Methenocyclo-penta[cd]pentalene-5-carboxaldehyde,2,2a,3,3,4,7 -hexachlorodecahydro-(1a,2□,2a□,4□,4a□,5□,6a□,6b□,7R*)-	2.1	--	0.1	109	II
97-63-2	Ethyl methacrylate	2-Propenoic acid, 2-methyl-, ethyl ester	NE	NE	10	112	II
62-50-0	Ethyl methanesulfonate	Methanesulfonic acid,ethyl ester	NE	NE	20	113	II
100-41-4	Ethylbenzene	Benzene, ethyl-	550	--	1	110	I
52-85-7	Famphur	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl]-O, O-dimethyl ester	NE	NE	20	114	II
206-44-0	Fluoranthene	Fluoranthene	280	--	10	115	II
86-73-7	Fluorene	9H-Fluorene	280	--	10	116	II
58-89-9	gamma-BHC; Lindane	Cyclohexane,1,2,3,4,5,6-hexachloro-,(1a,2a,3□,4a,5a,6□)-	0.2	--	0.05	27	II
76-44-8	Heptachlor	4,7-Methano-1H-indene,1,4,5,6,7,8,8-heptachloro- 3a,4,7,7a-tetrahydro-	0.0078	--	0.05	117	II
1024-57-3	Heptachlor epoxide	2,5-Methano-2H-indeno[1,2-b]oxirene,2,3,4,5,6,7,7 -heptachloro-1a,1b,5,5a,6,6a, -hexahydro-,(1aa,1b□,2a,5a,5a□,6□,6aa)	0.0038	--	0.075	118	II
118-74-1	Hexachlorobenzene	Benzene, hexachloro-	0.02	--	10	119	II
87-68-3	Hexachlorobutadiene	1,3-Butadiene,1,1,2,3,4,4-hexachloro-	NE	0.44	10	120	II
77-47-4	Hexachlorocyclopentadiene	1,3-Cyclopentadiene,1,2,3,4,5,5-hexachloro-	NE	50	10	121	II
67-72-1	Hexachloroethane	Ethane, hexachloro-	NE	2.5	10	122	II
1888-71-7	Hexachloropropene	1-Propene, 1,1,2,3,3,3-hexachloro-	NE	NE	10	123	II
193-39-5	Indeno(1,2,3-cd)pyrene	Indeno[1,2,3-cd]pyrene	0.0479	--	10	125	II

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78-83-1	Isobutyl alcohol	1-Propanol, 2-methyl-	NE	NE	100	126	II
465-73-6	Isodrin	1,4,5,8-Dimethanonaphthalene,1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a hexahydro-(1a,4a,4a□,5□,8□,8a□)-	NE	NE	20	127	II
78-59-1	Isophorone	2-Cyclohexen-1-one,3,5,5-trimethyl-	36.8	--	10	128	II
120-58-1	Isosafrole	1,3-Benzodioxole, 5-(1-propenyl)-	NE	NE	10	129	II
143-50-0	Kepone	1,3,4-Metheno-2H-cyclobuta-[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-	NE	NE	20	130	II
7439-92-1	Lead	Lead	15	--	10	131	I
108-39-4	m-Cresol; 3-Methylphenol	Phenol, 3-methyl-	35	--	10	345	II
541-73-1	m-Dichlorobenzene; 1,3-Dichlorobenzene	Benzene, 1,3-dichloro-	170	--	5	70	II
99-65-0	m-Dinitrobenzene	Benzene, 1,3-dinitro-	NE	NE	20	97	II
7439-97-6	Mercury	Mercury	1.05	--	0.2	132	II
126-98-7	Methacrylonitrile	2-Propenenitrile, 2-methyl-	NE	NE	100	133	II
91-80-5	Methapyrilene	1,2,Ethanediamine, N,N-dimethyl-N'-2-pyridinyl-N'-(2-thienylmethyl)-	NE	NE	100	134	II
72-43-5	Methoxychlor	Benzene, 1,1'-(2,2,2,trichloroethylidene)bis [4-methoxy-	35	--	1	135	II
74-83-9	Methyl bromide; Bromomethane	Methane, bromo-	NE	NE	10	136	I
74-87-3	Methyl chloride; Chloromethane	Methane, chloro-	2.6	--	1	137	I
78-93-3	Methyl ethyl ketone; MEK; 2-Butanone	2-Butanone	4200	--	100	141	I
74-88-4	Methyl iodide; Iodomethane	Methane, iodo-	NE	NE	10	142	I
80-62-6	Methyl methacrylate	2-Propenoic acid, 2-methyl-, methyl ester	NE	NE	30	143	II
66-27-3	Methyl methanesulfonate	Methanesulfonic acid,methyl ester	NE	NE	10	144	II
298-00-0	Methyl parathion; Parathion methyl	Phosphorothioic acid,O,O-dimethyl	NE	NE	10	146	II
74-95-3	Methylene bromide; Dibromomethane	Methane, dibromo-	NE	NE	10	139	I
75-09-2	Methylene chloride; Dichloromethane	Methane, dichloro-	4.6	--	1	140	I
99-09-2	m-Nitroaniline; 3-Nitroaniline	Benzenamine, 3-nitro-	NE	NE	50	153	II
91-20-3	Naphthalene	Naphthalene	21	--	10	148	II
7440-02-0	Nickel	Nickel	100	--	50	152	I
SW303	Nitrate (as N)		10000	--	10000	303	
98-95-3	Nitrobenzene	Benzene, nitro-	NE	NE	10	156	II
55-18-5	N-Nitrosodiethylamine	Ethanamine, N-ethyl-N-nitroso-	NE	NE	20	160	II
62-75-9	N-Nitrosodimethylamine	Methanamine, N-methyl-N-nitroso-	0.0007	--	10	161	II
924-16-3	N-Nitrosodi-n-butylamine	1-Butanamine, N-butyl-N-nitroso-	NE	NE	10	162	II
86-30-6	N-Nitrosodiphenylamine	Benzenamine, N-nitroso-N-phenyl-	NE	NE	10	163	II
621-64-7	N-Nitrosodipropylamine; N-Nitroso-N-dipropylamine; Di-n-propylnitrosamine	1-Propanamine, N-nitroso-N-propyl-	NE	NE	10	164	II
10595-95-6	N-Nitrosomethylethalamine	Ethanamine, N-methyl-N-nitroso-	NE	NE	10	165	II
100-75-4	N-Nitrosopiperidine	Piperidine, 1-nitroso-	NE	NE	20	166	II
930-55-2	N-Nitrosopyrrolidine	Pyrrolidine, 1-nitroso-	NE	NE	10	167	II
126-68-1	O,O,O-Triethyl phosphorothioate	Phosphorothioic acid,O,O,O-triethyl ester	NE	NE	10	207	II
297-97-2	O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin	Phosphorothioic acid,O,O-diethyl O-pyrazinyl ester	NE	NE	20	89	II
95-48-7	o-Cresol; 2-Methylphenol	Phenol, 2-methyl-	NE	35	10	56	II
95-50-1	o-Dichlorobenzene; 1,2-Dichlorobenzene	Benzene, 1,2-dichloro-	24	--	5	69	I
88-74-4	o-Nitroaniline; 2-Nitroaniline	Benzenamine, 2-nitro-	NE	NE	50	154	II
88-75-5	o-Nitrophenol; 2-Nitrophenol	Phenol, 2-nitro-	NE	NE	10	158	II
95-53-4	o-Toluidine	Benzenamine, 2-methyl-	NE	NE	10	197	II
60-11-7	p-(Dimethylamino)azobenzene	Benzenamine, N,N-dimethyl-4-(phenylazo)-	NE	NE	10	92	II
56-38-2	Parathion	Phosphorothioic acid,O,O-diethyl-O-(4-nitrophenyl) ester	NE	NE	10	169	II
106-47-8	p-Chloroaniline	Benzenamine, 4-chloro-	NE	NE	20	38	II
59-50-7	p-Chloro-m-cresol; 4-Chloro-3-methylphenol	Phenol, 4-chloro-3-methyl-	NE	NE	20	45	II
106-44-5	p-Cresol; 4-Methylphenol	Phenol, 4-methyl-	3.5	NE--	10	344	II
106-46-7	p-Dichlorobenzene; 1,4-Dichlorobenzene	Benzene, 1,4-dichloro-	1.4	--	1	71	I
608-93-5	Pentachlorobenzene	Benzene, pentachloro-	NE	NE	10	171	II
82-68-8	Pentachloronitrobenzene	Benzene,pentachloronitro-	NE	NE	20	172	II
87-86-5	Pentachlorophenol	Phenol, pentachloro-	0.29	--	25	173	II
62-44-2	Phenacetin	Acetamide, N-(4-ethoxyphenyl)	NE	NE	20	174	II
85-01-8	Phenanthrene	Phenanthrene	210	--	10	175	II

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108-95-2	Phenol	Phenol	300	--	10	177	II
298-02-2	Phorate	Phosphorodithioic acid,O,O-diethyl S-[(ethylthio)methyl]ester	1.4	--	10	178	II
SW412	Total Phosphorus	Total Phosphorus	NE	NE	NE	412	
100-01-6	p-Nitroaniline; 4-Nitroaniline	Benzenamine, 4-nitro-	NE	NE	20	155	II
100-02-7	p-Nitrophenol; 4-Nitrophenol	Phenol, 4-nitro-	NE	NE	50	159	II
1336-36-3	Polychlorinated biphenyls; PCBs 1016/1242	1,1'-Biphenyl,chloro derivatives Method 1016/1242	NE	0.5	2	434	II
106-50-3	p-Phenylenediamine	1,4-Benzenediamine	NE	NE	10	176	II
23950-58-5	Pronamide	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-	NE	NE	10	179	II
107-12-0	Propionitrile; Ethyl cyanide	Propanenitrile	NE	NE	150	180	II
129-00-0	Pyrene	Pyrene	210	--	10	181	II
94-59-7	Safrole	1,3-Benzodioxole, 5-(2-propenyl)-	NE	NE	10	182	II
7782-49-2	Selenium	Selenium	50	--	10	183	I
7440-22-4	Silver	Silver	17.5	--	10	184	I
93-72-1	Silvex; 2,4,5-TP	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-	50	--	2	185	II
100-42-5	Styrene	Benzene, ethenyl-	100	--	1	186	I
14808-79-8	Sulfate		250000	--	250000	315	
18496-25-8	Sulfide	Sulfide	NE	NE	1000	187	II
99-35-4	sym-Trinitrobenzene	Benzene, 1,3,5-trinitro-	NE	NE	10	208	II
127-18-4	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	Ethene, tetrachloro-	0.7	--	1	192	I
7440-28-0	Thallium	Thallium	NE	0.28	5.5	194	I
7440-31-5	Tin	Tin	NE	NE	100	195	II
108-88-3	Toluene	Benzene, methyl-	1000	--	1	196	I
8001-35-2	Toxaphene	Toxaphene	0.031	--	1.5	198	II
156-60-5	trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	Ethene, 1,2-dichloro-,(E)-	100	--	5	79	I
10061-02-6	trans-1,3-Dichloropropene	1-Propene, 1,3-dichloro-, (E)-	0.19	--	1	87	I
110-57-6	trans-1,4-Dichloro-2-butene	2-Butene, 1,4-dichloro-, (E)-	NE	NE	100	73	I
79-01-6	Trichloroethylene; Trichloroethene	Ethene, trichloro-	2.8	--	1	201	I
75-69-4	Trichlorofluoromethane; CFC-11	Methane,trichlorofluoro-	2100	--	1	203	I
7440-62-2	Vanadium	Vanadium	NE	3.5	25	209	I
108-05-4	Vinyl acetate	Acetic acid, ethenylester	NE	7000	50	210	I
75-01-4	Vinyl chloride; Chloroethene	Ethene, chloro-	0.015	--	1	211	I
1330-20-7	Xylene (total)	Benzene, dimethyl-	530	--	5	346	I
7440-66-6	Zinc	Zinc	1050	--	10	213	I

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630-20-6	1,1,1,2-Tetrachloroethane	Ethane, 1,1,1,2-tetrachloro-	NE	1.3	5	190	I
71-55-6	1,1,1-Trichloroethane; Methylchloroform	Ethane, 1,1,1-trichloro-	200	--	1	200	I
79-34-5	1,1,2,2-Tetrachloroethane	Ethane, 1,1,2,2-tetrachloro-	NE	0.18	3	191	I
79-00-5	1,1,2-Trichloroethane	Ethane, 1,1,2-trichloro-	NE	0.6	1	202	I
75-34-3	1,1-Dichloroethane; Ethyldidene chloride	Ethane, 1,1-dichloro-	70	--	5	75	I
75-35-4	1,1-Dichloroethylene; 1,1-Dichloroethene;	Ethene, 1,1-dichloro-	7	--	5	77	I
563-58-6	1,1-Dichloropropene	1-Propene, 1,1-dichloro-	NE	NE	5	85	II
96-18-4	1,2,3-Trichloropropane	Propane, 1,2,3-trichloro-	0.005	--	1	206	I
95-94-3	1,2,4,5-Tetrachlorobenzene	Benzene, 1,2,4,5-tetrachloro-	NE	NE	10	189	II
120-82-1	1,2,4-Trichlorobenzene	Benzene, 1,2,4-trichloro-	NE	70	10	199	II
96-12-8	1,2-Dibromo-3-chloropropane; DBCP	Propane, 1,2-dibromo-3-chloro-	0.025	--	13	67	I
106-93-4	1,2-Dibromoethane; Ethylene dibromide; EDB	Ethane, 1,2-dibromo-	0.0004	--	1	68	I
107-06-2	1,2-Dichloroethane; Ethylene dichloride	Ethane, 1,2-dichloro-	0.38	--	1	76	I
78-87-5	1,2-Dichloropropane	Propane, 1,2-dichloro-	0.51	--	1	82	I
142-28-9	1,3-Dichloropropane; Trimethylene dichloride	Propane, 1,3-dichloro-	NE	NE	1	83	II
130-15-4	1,4-Naphthoquinone	1,4-Naphthalenedione	NE	NE	10	149	II
134-32-7	1-Naphthylamine	1-Naphthalenamine	NE	NE	10	150	II
594-20-7	2,2-Dichloropropane; Isopropylidene chloride	Propane, 2,2-dichloro-	NE	NE	15	84	II
58-90-2	2,3,4,6-Tetrachlorophenol	Phenol, 2,3,4,6-tetrachloro-	210	--	10	193	II
93-76-5	2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	Acetic acid, (2,4,5-trichlorophenoxy)-	NE	NE	2	188	II
95-95-4	2,4,5-Trichlorophenol	Phenol, 2,4,5-trichloro-	NE	700	10	204	II
88-06-2	2,4,6-Trichlorophenol	Phenol, 2,4,6-trichloro-	NE	NE	10	205	II
94-75-7	2,4-D; 2,4-Dichlorophenoxyacetic acid	Acetic acid, (2,4-dichlorophenoxy)-	70	--	2	59	II
120-83-2	2,4-Dichlorophenol	Phenol, 2,4-dichloro-	NE	NE	10	80	II
105-67-9	2,4-Dimethylphenol; m-Xylenol	Phenol, 2,4-dimethyl-	140	--	10	95	II
51-28-5	2,4-Dinitrophenol	Phenol, 2,4-dinitro-	NE	NE	50	99	II
121-14-2	2,4-Dinitrotoluene	Benzene, 1-methyl-2,4-dinitro-	NE	NE	10	100	II
87-65-0	2,6-Dichlorophenol	Phenol, 2,6-dichloro-	NE	NE	10	81	II
606-20-2	2,6-Dinitrotoluene	Benzene, 2-methyl-1,3-dinitro-	NE	NE	10	101	II
53-96-3	2-Acetylaminofluorene; 2-AAF	Acetamide, N-9H-fluoren-2-yl-	NE	NE	20	6	II
91-58-7	2-Chloronaphthalene	Naphthalene, 2-chloro-	NE	NE	10	47	II
95-57-8	2-Chlorophenol	Phenol, 2-chloro-	0.36	--	10	48	II
591-78-6	2-Hexanone; Methyl butyl ketone	2-Hexanone	NE	280	50	124	I
91-57-6	2-Methylnaphthalene	Naphthalene, 2-methyl-	14	--	10	145	II
91-59-8	2-Naphthylamine	2-Naphthalenamine	NE	NE	10	151	II
91-94-1	3,3'-Dichlorobenzidine	[1,1'-Biphenyl]-4,4'-diamine,3,3'-dichloro-	NE	NE	20	72	II
119-93-7	3,3'-Dimethylbenzidine	[1,1'-Biphenyl]-4,4'-diamine,3,3'-dimethyl-	NE	NE	10	94	II
56-49-5	3-Methylcholanthrene	Benz[j]aceanthrylene,1,2-dihydro-3-methyl-	NE	NE	10	138	II
72-54-8	4,4'-DDD	Benzene 1,1'-(2,2-dichloroethylidene)bis[4-chloro-	0.14	--	0.1	60	II
72-55-9	4,4'-DDE	Benzene, 1,1'-(dichloroethenylidene)bis[4-chloro-	NE	NE	0.1	61	II
50-29-3	4,4'-DDT	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-chloro-	0.1	--	0.1	62	II
534-52-1	4,6-Dinitro-o-cresol; 4,6-Dinitro-2-methylphenol	Phenol, 2-methyl-4,6-dinitro-	NE	NE	50	98	II
92-67-1	4-Aminobiphenyl	[1,1'-Biphenyl]-4-amine	NE	NE	20	11	II
101-55-3	4-Bromophenyl phenyl ether	Benzene, 1-bromo-4-phenoxy-	NE	NE	10	31	II
7005-72-3	4-Chlorophenyl phenyl ether	Benzene, 1-chloro-4-phenoxy-	NE	NE	10	49	II
108-10-1	4-Methyl-2-pentanone; Methyl isobutyl ketone	2-Pentanone, 4-methyl-	NE	560	100	147	I
99-55-8	5-Nitro-o-toluidine	Benzenamine, 2-methyl-5-nitro-	NE	NE	10	157	II
57-97-6	7,12-Dimethylbenz[a]anthracene	Benz[a]anthracene, 7,12-dimethyl-	NE	NE	10	93	II
83-32-9	Acenaphthene	Acenaphthylene, 1,2-dihydro-	80	--	10	1	II
208-96-8	Acenaphthylene	Acenaphthylene	210	--	10	2	II
67-64-1	Acetone	2-Propanone	700	--	100	3	I
75-05-8	Acetonitrile; Methyl cyanide	Acetonitrile	NE	42	55	4	I
98-86-2	Acetophenone	Ethanone, 1-phenyl-	NE	700	10	5	II
107-02-8	Acrolein	2-Propenal	NE	3.5	53	7	II
107-13-1	Acrylonitrile	2-Propenenitrile	NE	NE	200	8	II

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309-00-2	Aldrin	1,4:5,8-Dimethanonaphthalene,1,2,3,4,10,10 -hexachloro-1,4,4a,5,8,8a-hexahydro-(1,4,4a,5,8,8a)-	NE	NE	0.05	9	II
107-05-1	Allyl chloride	1-Propene, 3-chloro-	NE	NE	10	10	II
319-84-6	alpha-BHC	Cyclohexane,1,2,3,4,5,6-hexachloro-,(1a,2a,3β,4a,5□,6□)-	NE	0.006	0.05	24	II
120-12-7	Anthracene	Anthracene	2100	--	10	12	II
7440-36-0	Antimony	Antimony	NE	1.4	6	13	I
7440-38-2	Arsenic	Arsenic	50	--	10	14	I
7440-39-3	Barium	Barium	2000	--	100	15	I
71-43-2	Benzene	Benzene	1	--	1	16	I
56-55-3	Benzo[a]anthracene; Benzanthracene	Benz[a]anthracene	0.0479	--	10	17	II
50-32-8	Benzo[a]pyrene	Benzo[a]pyrene	0.00479	--	10	21	II
205-99-2	Benzo[b]fluoranthene	Benz[e]acephenanthrylene	0.0479	--	10	18	II
191-24-2	Benzo[ghi]perylene	Benzo[ghi]perylene	210	--	10	20	II
207-08-9	Benzo[k]fluoranthene	Benzo[k]fluoranthene	0.479	--	10	19	II
100-51-6	Benzyl alcohol	Benzenemethanol	NE	3500	20	22	II
7440-41-7	Beryllium	Beryllium	NE	4	1	23	I
319-85-7	beta-BHC	Cyclohexane,1,2,3,4,5,6-hexachloro-,(1a,2□,3a,4□,5a,6□)-	NE	0.019	0.05	25	II
SW316	Biological Oxygen Demand	BOD	NE	NE	NE	316	
108-60-1	Bis(2-chloro-1-methylethyl) ether; 2,2'-Dichlorodiisopropyl ether; DCIP, See footnote 4	Propane, 2,2'-oxybis[1-chloro-	NE	NE	10	46	II
111-91-1	Bis(2-chloroethoxy)methane	Ethane, 1,1'-[methylenebis(oxy)]bis [2-chloro	NE	NE	10	42	II
111-44-4	Bis(2-chloroethyl)ether; Dichloroethyl ether	Ethane, 1,1'-oxybis[2-chloro-	NE	0.031	10	43	II
117-81-7	Bis(2-ethylhexyl) phthalate	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl)ester	NE	NE	15	111	II
74-97-5	Bromochloromethane; Chlorobromethane	Methane, bromochloro-	NE	0.6	3	28	I
75-27-4	Bromodichloromethane; Dichlorobromomethane	Methane, bromodichloro-	0.56	--	1	29	I
75-25-2	Bromoform; Tribromomethane	Methane, tribromo-	4.43	--	3	30	I
85-68-7	Butyl benzyl phthalate; Benzyl butyl phthalate	1,2-Benzenedicarboxylicacid, butyl phenylmethyl ester	100	--	10	32	II
7440-43-9	Cadmium	Cadmium	1.75	--	1	34	I
75-15-0	Carbon disulfide	Carbon disulfide	700	--	100	35	I
56-23-5	Carbon tetrachloride	Methane, tetrachloro-	0.269	--	1	36	I
SW317	Chemical Oxygen Demand	COD	NE	NE	NE	317	
57-74-9	Chlordane	4,7-Methano-1H-indene,1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-	0.1	--	0.5	339	II
108-90-7	Chlorobenzene	Benzene, chloro-	50	--	3	39	I
510-15-6	Chlorobenzilate	Benzeneacetic acid, 4-chloro-(4-chlorophenyl)--hydroxy-, ethyl ester	NE	NE	10	40	II
75-00-3	Chloroethane; Ethyl chloride	Ethane, chloro-	2800	--	10	41	I
67-66-3	Chloroform; Trichloromethane	Methane, trichloro-	70	--	5	44	I
126-99-8	Chloroprene	1,3-Butadiene, 2-chloro-	NE	NE	20	50	II
7440-47-3	Chromium	Chromium	50	--	10	51	I
218-01-9	Chrysene	Chrysene	4.79	--	10	52	II
156-59-2	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	Ethene, 1,2-dichloro-,(Z)-	70	--	5	78	I
10061-01-5	cis-1,3-Dichloropropene	1-Propene, 1,3-dichloro-, (Z)-	0.19	--	1	86	I
7440-48-4	Cobalt	Cobalt	NE	70	10	53	I
7440-50-8	Copper	Copper	1000	--	10	54	I
57-12-5	Cyanide	Cyanide	70	--	10	58	II
319-86-8	delta-BHC	Cyclohexane,1,2,3,4,5,6-hexachloro-,(1a,2a,3a,4□,5a,6□)-	NE	0.019	0.05	26	II
2303-16-4	Diallate	Carbamothioic acid,bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl) ester	NE	NE	10	63	II
53-70-3	Dibenz[a,h]anthracene	Dibenz[a,h]anthracene	0.0047	--	10	64	II
132-64-9	Dibenzofuran	Dibenzofuran	NE	28	10	65	II

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124-48-1	Dibromochloromethane; Chlorodibromomethane	Methane, dibromochloro-	NE	0.41	3	66	I
75-71-8	Dichlorodifluoromethane; CFC 12	Methane,dichlorodifluoro-	1400	--	5	74	II
60-57-1	Dieldrin	2,7:3,6-Dimethanonaphth[2,3-b]oxirene,3,4,5,6,9,9-hexachloro -1a,2,2a,3,6,6a,7,7a-octahydro-,(1aa,2□,2aa,3□,6□,6aa,7□,7aa)-	0.0022	--	0.075	88	II
84-66-2	Diethyl phthalate	1,2-Benzenedicarboxylicacid, diethyl ester	5000	--	10	90	II
60-51-5	Dimethoate	Phosphorodithioic acid,O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester	NE	NE	20	91	II
131-11-3	Dimethyl phthalate	1,2-Benzenedicarboxylicacid, dimethyl ester	NE	NE	10	96	II
84-74-2	Di-n-butyl phthalate	1,2-Benzenedicarboxylic acid, dibutyl ester	700	--	10	33	II
117-84-0	Di-n-octyl phthalate	1,2-Benzenedicarboxylicacid, dioctyl ester	140	--	10	168	II
88-85-7	Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol	Phenol, 2-(1-methylpropyl)-4,6-dinitro-	NE	7	1	102	II
122-39-4	Diphenylamine	Benzenamine, N-phenyl-	NE	NE	10	103	II
298-04-4	Disulfoton	Phosphorodithioic acid,O,O-diethyl S-[2-(ethylthio)ethyl]ester	0.28	--	10	104	II
959-98-8	Endosulfan I	6,9-Methano-2,4,3-benzodiox-athiepin,6,7,8,9,10,10 -hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide,	NE	NE	0.1	105	II
33213-65-9	Endosulfan II	6,9-Methano-2,4,3-benzodioxathiepin,6,7,8,9,10,10 -hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide,(3a,5aa,6□,9□,9aa)-	42	--	0.1	106	II
1031-07-8	Endosulfan sulfate	6,9-Methano-2,4,3-benzodioxathiepin,6,7,8,9,10,10 -hexachloro-1,5,5a,6,9,9a-hexahydro-, 3,3-dioxide	NE	NE	0.1	107	II
72-20-8	Endrin	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aa,2□,2a□,3a,6a,6a□,7□,7aa)	2	--	0.1	108	II
7421-93-4	Endrin aldehyde	1,2,4-Methenocyclo-penta[cd]pentalene-5-carboxaldehyde,2,2a,3,3,4,7 -hexachlorodecahydro-(1a,2□,2a□,4□,4a□,5□,6a□,6b□,7R*)-	2.1	--	0.1	109	II
97-63-2	Ethyl methacrylate	2-Propenoic acid, 2-methyl-, ethyl ester	NE	NE	10	112	II
62-50-0	Ethyl methanesulfonate	Methanesulfonic acid,ethyl ester	NE	NE	20	113	II
100-41-4	Ethylbenzene	Benzene, ethyl-	550	--	1	110	I
52-85-7	Famphur	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl]-O, O-dimethyl ester	NE	NE	20	114	II
206-44-0	Fluoranthene	Fluoranthene	280	--	10	115	II
86-73-7	Fluorene	9H-Fluorene	280	--	10	116	II
58-89-9	gamma-BHC; Lindane	Cyclohexane,1,2,3,4,5,6-hexachloro-,(1a,2a,3□,4a,5a,6□)-	0.2	--	0.05	27	II
76-44-8	Heptachlor	4,7-Methano-1H-indene,1,4,5,6,7,8,8-heptachloro- 3a,4,7,7a-tetrahydro-	0.0078	--	0.05	117	II
1024-57-3	Heptachlor epoxide	2,5-Methano-2H-indeno[1,2-b]oxirene,2,3,4,5,6,7,7 -heptachloro-1a,1b,5,5a,6,6a, -hexahydro-,(1aa,1b□,2a,5a,5a□,6□,6aa)	0.0038	--	0.075	118	II
118-74-1	Hexachlorobenzene	Benzene, hexachloro-	0.02	--	10	119	II
87-68-3	Hexachlorobutadiene	1,3-Butadiene,1,1,2,3,4,4-hexachloro-	NE	0.44	10	120	II
77-47-4	Hexachlorocyclopentadiene	1,3-Cyclopentadiene,1,2,3,4,5,5-hexachloro-	NE	50	10	121	II
67-72-1	Hexachloroethane	Ethane, hexachloro-	NE	2.5	10	122	II
1888-71-7	Hexachloropropene	1-Propene, 1,1,2,3,3,3-hexachloro-	NE	NE	10	123	II
193-39-5	Indeno(1,2,3-cd)pyrene	Indeno[1,2,3-cd]pyrene	0.0479	--	10	125	II

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78-83-1	Isobutyl alcohol	1-Propanol, 2-methyl-	NE	NE	100	126	II
465-73-6	Isodrin	1,4,5,8-Dimethanonaphthalene,1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a hexahydro-(1a,4a,4a□,5□,8□,8a□)-	NE	NE	20	127	II
78-59-1	Isophorone	2-Cyclohexen-1-one,3,5,5-trimethyl-	36.8	--	10	128	II
120-58-1	Isosafrole	1,3-Benzodioxole, 5-(1-propenyl)-	NE	NE	10	129	II
143-50-0	Kepone	1,3,4-Metheno-2H-cyclobuta-[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-	NE	NE	20	130	II
7439-92-1	Lead	Lead	15	--	10	131	I
108-39-4	m-Cresol; 3-Methylphenol	Phenol, 3-methyl-	35	--	10	345	II
541-73-1	m-Dichlorobenzene; 1,3-Dichlorobenzene	Benzene, 1,3-dichloro-	170	--	5	70	II
99-65-0	m-Dinitrobenzene	Benzene, 1,3-dinitro-	NE	NE	20	97	II
7439-97-6	Mercury	Mercury	1.05	--	0.2	132	II
126-98-7	Methacrylonitrile	2-Propenenitrile, 2-methyl-	NE	NE	100	133	II
91-80-5	Methapyrilene	1,2,Ethanediamine, N,N-dimethyl-N'-2-pyridinyl-N'-(2-thienylmethyl)-	NE	NE	100	134	II
72-43-5	Methoxychlor	Benzene, 1,1'-(2,2,2,trichloroethylidene)bis [4-methoxy-	35	--	1	135	II
74-83-9	Methyl bromide; Bromomethane	Methane, bromo-	NE	NE	10	136	I
74-87-3	Methyl chloride; Chloromethane	Methane, chloro-	2.6	--	1	137	I
78-93-3	Methyl ethyl ketone; MEK; 2-Butanone	2-Butanone	4200	--	100	141	I
74-88-4	Methyl iodide; Iodomethane	Methane, iodo-	NE	NE	10	142	I
80-62-6	Methyl methacrylate	2-Propenoic acid, 2-methyl-, methyl ester	NE	NE	30	143	II
66-27-3	Methyl methanesulfonate	Methanesulfonic acid,methyl ester	NE	NE	10	144	II
298-00-0	Methyl parathion; Parathion methyl	Phosphorothioic acid,O,O-dimethyl	NE	NE	10	146	II
74-95-3	Methylene bromide; Dibromomethane	Methane, dibromo-	NE	NE	10	139	I
75-09-2	Methylene chloride; Dichloromethane	Methane, dichloro-	4.6	--	1	140	I
99-09-2	m-Nitroaniline; 3-Nitroaniline	Benzenamine, 3-nitro-	NE	NE	50	153	II
91-20-3	Naphthalene	Naphthalene	21	--	10	148	II
7440-02-0	Nickel	Nickel	100	--	50	152	I
SW303	Nitrate (as N)		10000	--	10000	303	
98-95-3	Nitrobenzene	Benzene, nitro-	NE	NE	10	156	II
55-18-5	N-Nitrosodiethylamine	Ethanamine, N-ethyl-N-nitroso-	NE	NE	20	160	II
62-75-9	N-Nitrosodimethylamine	Methanamine, N-methyl-N-nitroso-	0.0007	--	10	161	II
924-16-3	N-Nitrosodi-n-butylamine	1-Butanamine, N-butyl-N-nitroso-	NE	NE	10	162	II
86-30-6	N-Nitrosodiphenylamine	Benzenamine, N-nitroso-N-phenyl-	NE	NE	10	163	II
621-64-7	N-Nitrosodipropylamine; N-Nitroso-N-dipropylamine; Di-n-propylnitrosamine	1-Propanamine, N-nitroso-N-propyl-	NE	NE	10	164	II
10595-95-6	N-Nitrosomethylethalamine	Ethanamine, N-methyl-N-nitroso-	NE	NE	10	165	II
100-75-4	N-Nitrosopiperidine	Piperidine, 1-nitroso-	NE	NE	20	166	II
930-55-2	N-Nitrosopyrrolidine	Pyrrolidine, 1-nitroso-	NE	NE	10	167	II
126-68-1	O,O,O-Triethyl phosphorothioate	Phosphorothioic acid,O,O,O-triethyl ester	NE	NE	10	207	II
297-97-2	O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin	Phosphorothioic acid,O,O-diethyl O-pyrazinyl ester	NE	NE	20	89	II
95-48-7	o-Cresol; 2-Methylphenol	Phenol, 2-methyl-	NE	35	10	56	II
95-50-1	o-Dichlorobenzene; 1,2-Dichlorobenzene	Benzene, 1,2-dichloro-	24	--	5	69	I
88-74-4	o-Nitroaniline; 2-Nitroaniline	Benzenamine, 2-nitro-	NE	NE	50	154	II
88-75-5	o-Nitrophenol; 2-Nitrophenol	Phenol, 2-nitro-	NE	NE	10	158	II
95-53-4	o-Toluidine	Benzenamine, 2-methyl-	NE	NE	10	197	II
60-11-7	p-(Dimethylamino)azobenzene	Benzenamine, N,N-dimethyl-4-(phenylazo)-	NE	NE	10	92	II
56-38-2	Parathion	Phosphorothioic acid,O,O-diethyl-O-(4-nitrophenyl) ester	NE	NE	10	169	II
106-47-8	p-Chloroaniline	Benzenamine, 4-chloro-	NE	NE	20	38	II
59-50-7	p-Chloro-m-cresol; 4-Chloro-3-methylphenol	Phenol, 4-chloro-3-methyl-	NE	NE	20	45	II
106-44-5	p-Cresol; 4-Methylphenol	Phenol, 4-methyl-	3.5	NE--	10	344	II
106-46-7	p-Dichlorobenzene; 1,4-Dichlorobenzene	Benzene, 1,4-dichloro-	1.4	--	1	71	I
608-93-5	Pentachlorobenzene	Benzene, pentachloro-	NE	NE	10	171	II
82-68-8	Pentachloronitrobenzene	Benzene,pentachloronitro-	NE	NE	20	172	II
87-86-5	Pentachlorophenol	Phenol, pentachloro-	0.29	--	25	173	II
62-44-2	Phenacetin	Acetamide, N-(4-ethoxyphenyl)	NE	NE	20	174	II
85-01-8	Phenanthrene	Phenanthrene	210	--	10	175	II

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108-95-2	Phenol	Phenol	300	--	10	177	II
298-02-2	Phorate	Phosphorodithioic acid,O,O-diethyl S-[(ethylthio)methyl]ester	1.4	--	10	178	II
SW412	Total Phosphorus	Total Phosphorus	NE	NE	NE	412	
100-01-6	p-Nitroaniline; 4-Nitroaniline	Benzenamine, 4-nitro-	NE	NE	20	155	II
100-02-7	p-Nitrophenol; 4-Nitrophenol	Phenol, 4-nitro-	NE	NE	50	159	II
1336-36-3	Polychlorinated biphenyls; PCBs 1016/1242	1,1'-Biphenyl,chloro derivatives Method 1016/1242	NE	0.5	2	434	II
106-50-3	p-Phenylenediamine	1,4-Benzenediamine	NE	NE	10	176	II
23950-58-5	Pronamide	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-	NE	NE	10	179	II
107-12-0	Propionitrile; Ethyl cyanide	Propanenitrile	NE	NE	150	180	II
129-00-0	Pyrene	Pyrene	210	--	10	181	II
94-59-7	Safrole	1,3-Benzodioxole, 5-(2-propenyl)-	NE	NE	10	182	II
7782-49-2	Selenium	Selenium	50	--	10	183	I
7440-22-4	Silver	Silver	17.5	--	10	184	I
93-72-1	Silvex; 2,4,5-TP	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-	50	--	2	185	II
100-42-5	Styrene	Benzene, ethenyl-	100	--	1	186	I
14808-79-8	Sulfate		250000	--	250000	315	
18496-25-8	Sulfide	Sulfide	NE	NE	1000	187	II
99-35-4	sym-Trinitrobenzene	Benzene, 1,3,5-trinitro-	NE	NE	10	208	II
127-18-4	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	Ethene, tetrachloro-	0.7	--	1	192	I
7440-28-0	Thallium	Thallium	NE	0.28	5.5	194	I
7440-31-5	Tin	Tin	NE	NE	100	195	II
108-88-3	Toluene	Benzene, methyl-	1000	--	1	196	I
8001-35-2	Toxaphene	Toxaphene	0.031	--	1.5	198	II
156-60-5	trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	Ethene, 1,2-dichloro-,(E)-	100	--	5	79	I
10061-02-6	trans-1,3-Dichloropropene	1-Propene, 1,3-dichloro-, (E)-	0.19	--	1	87	I
110-57-6	trans-1,4-Dichloro-2-butene	2-Butene, 1,4-dichloro-, (E)-	NE	NE	100	73	I
79-01-6	Trichloroethylene; Trichloroethene	Ethene, trichloro-	2.8	--	1	201	I
75-69-4	Trichlorofluoromethane; CFC-11	Methane,trichlorofluoro-	2100	--	1	203	I
7440-62-2	Vanadium	Vanadium	NE	3.5	25	209	I
108-05-4	Vinyl acetate	Acetic acid, ethenylester	NE	7000	50	210	I
75-01-4	Vinyl chloride; Chloroethene	Ethene, chloro-	0.015	--	1	211	I
1330-20-7	Xylene (total)	Benzene, dimethyl-	530	--	5	346	I
7440-66-6	Zinc	Zinc	1050	--	10	213	I

APPLICATION FOR PERMIT TO CONSTRUCT
REPUBLIC SERVICES OF NORTH CAROLINA, LLC

VOLUME I OF II
DESIGN HYDROGEOLOGIC REPORT

EAST CAROLINA REGIONAL LANDFILL
PHASE FIVE
PERMIT NO. 08-03
BERTIE COUNTY, NORTH CAROLINA

JULY 2007
REVISED DECEMBER 2007

PREPARED FOR:

REPUBLIC SERVICES OF NC, LLC
1922 REPUBLICAN ROAD
AULANDER, NORTH CAROLINA 27805

PREPARED BY:

GOLDER ASSOCIATES NC, INC.
4900 KOGER BOULEVARD, SUITE 140
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Project No. 063-66507.203

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1.0 INTRODUCTION

In accordance with Title 15A of the North Carolina Administrative Code (NCAC) Subchapter 13B.1623, Republic Services of North Carolina, LLC (Republic) is submitting this Design Hydrogeologic Report for the Phase 5 lateral expansion of the municipal solid waste (MSW) landfill at East Carolina Regional Landfill. The East Carolina Regional Landfill is operated by East Carolina Environmental, a subsidiary of Republic Services of North Carolina, LLC under Permit No. 08-03 issued by the North Carolina Department of Environment and Natural Resources (DENR). The purpose of this report is to characterize the hydrogeologic conditions in and around the Phase 5 waste footprint and compliance boundary. This report will also discuss the relationship of the site groundwater flow regime relative to local and regional hydrogeologic features, with emphasis on the relationship of MSW landfill units to potential groundwater receptors and groundwater discharge features.

2.0 SITE DESCRIPTION

The East Carolina Regional Landfill is a Subtitle D landfill located on Republican Road near the town of Aulander, North Carolina. The facility encompasses approximately 470 acres, of which approximately 149 acres is approved by the Solid Waste Section for a lined landfill and ancillary features. The facility began accepting waste in October 1993 and contains a capped area of approximately 4.5 acres and an approximately 82-acre, lined landfill (Cells 3 through 11). The proposed Phase 5 waste footprint will comprise a 24.1-acre lined cell. The site location, property boundaries, and surrounding topography are shown on an inset topographic map on Drawing DH-1. The site is located in the Coastal Plain Physiographic Province.

The facility is bound to the north and east by undeveloped property and the Connaritsa Swamp, to the west by State Route 1225 and undeveloped and agricultural property, and to the south by State Route 1221, wooded property, and undeveloped bottomlands associated with the easterly flowing Cashie River.

Topographic elevations at the facility range from approximately 30 to 70 feet above mean sea level. Along the northern and eastern portions of the facility, surface drainage from the facility and surrounding areas is routed by drainage channels and storm water control structures to tributaries of the southerly flowing Connaritsa Swamp, a tributary system of the Cashie River. Along the western and southern portions of the facility, surface drainage from the facility and surrounding areas is routed by drainage channels and storm water control structures to tributaries of the southeasterly flowing Cashie River. The Cashie River discharges to the greater Roanoke River south of the Town of Windsor. Two sediment ponds are located near the southwest corner of the waste footprint and are shown on Drawing DH-1.

Prior to construction of the landfill, the site consisted primarily of farmland and timber. Current site improvements consist of previously permitted waste cells, borrow areas, maintenance buildings and access roads. A large portion of the property is undeveloped. The proposed Phase 5 expansion area consists mainly of pine timber and some farmland in the northern portion of the proposed waste footprint.

3.0 FIELD INVESTIGATIONS

The following sections summarize the previous and current field investigation activities. Pertinent data from previous investigations are also summarized in select tables as described below.

3.1 Previous Investigations

The first hydrogeologic investigation performed at the site was associated with the initial siting requirements of the MSW landfill and was submitted to NC DENR in December 1992. Since then, four phases have been proposed, approved and constructed. Hydrogeologic investigations have been performed with each of these phases. A number of hydrogeologic investigations have been performed since the initial site characterization and a summary of available reports is listed below.

- *Report of Geologic and Hydrogeologic Assessment of Proposed Solid Waste Landfill, Spruil Farms Property*, Law Engineering Job Number 2490472602, dated December 1, 1992.
- *Submittal in Response to Completeness Review by the NCSWMD, Report of Geologic and Hydrogeologic Assessment of Proposed Solid Waste Landfill*, Law Engineering Job Number 2490472605, dated April 28, 1993.
- *Design Hydrogeologic Report, Cells 3-6 (Phase 1)*, Law Engineering Job Number 2490472607, dated July 21-29, 1993.
- *Submittal of Additional Soil Test Borings and Piezometer Data, Design Hydrogeologic Report, Cells 3-6 (Phase I)*, Law Engineering job Number 2490472607, dated July 21, 1993.
- *Report of Monitoring Well Installation*, Law Engineering Job Number 2490472612, dated September 29, 1993.
- *Site Transition Plan*, Law Engineering Job Number 249472618, dated March 31, 1994 and April 29, 1994.
- *Design Hydrogeologic Report*, Cells 7-8 (Phase II), Law Engineering Job Number 30220-5-4726.36, dated March 12, 1996 and revised August 7, 1996.
- *Ground-Water Monitoring Well Installation Report: GW-10*, Law Engineering Job number 2490472642, dated September 16, 1996.
- *Ground-Water Monitoring Well Installation Report: Phase II [GW-11]*, Bunnell-Lammons Engineering (BLE) Project Number J97-1001-11, dated May 7, 1997.
- *Site Hydrogeologic Report*, BLE Project Number J96-1001-03, dated July 16, 1998, revised April 11, 2003.
- *Design Hydrogeologic Report, Cells 9-11 (Phase III)*, BLE Project Number J98-1001-18, dated January 25, 2000.
- *Ground-Water Monitoring Well Installation Report: GW-13*, BLE Project Number J00-1001-32, dated November 20, 2000.
- *Design Hydrogeologic Report, Phase 4 (Cells 11-12)*, BLE Project Number J01-1001-46, dated January 7, 2005, revised May 2, 2005.

- *Ground-Water Monitoring Well and Gas Probe Installation Report, Cell No. 11 Lower End*, BLE Project Number J05-1001-53, dated February 10, 2006.

Since field activities began in 1992, 16 monitoring wells and more than 160 piezometers and borings have been installed at the facility. The boring logs and well and piezometer construction records for the previously installed monitoring wells and piezometers can be located in the reports documented above. The monitoring well and piezometer construction data are summarized in Table 1 and the locations are provided on Drawing DH-1.

During previous investigations, three piezometers (PZ-10A, PZ-72A, and PZ-73A) and one monitoring well (GW-14) were installed in the proposed Phase 5 footprint. An additional 12 piezometers (PZ-41A, PZ-41B, PZ-56A, PZ-67A, PZ-68A, PZ-88A, PZ-95A, PZ-97A, PZ-106A, BE-5, BE-6, and C8.7) were installed in close proximity to the proposed Phase 5 waste cell during previous investigations. All of the previously installed piezometers have been properly decommissioned except PZ-10A. Monitoring well GW-14 is part of the compliance monitoring well network. Groundwater elevations, aquifer tests, and soil tests were performed during the previous investigations. The pertinent data collected in the proposed Phase 5 area have been incorporated into the current investigation.

3.2 Current Investigation

The field activities for this investigation were performed in May through October 2006. The initial fieldwork consisted of the installation of 22 piezometers, a field survey of the new piezometers, well development and aquifer testing of selected piezometers, and measurement of groundwater elevations.

3.2.1 Drilling Program

Twenty-two piezometers (PZ-107A, PZ-107B, PZ-108, PZ-109A, PZ-109B, PZ-110, PZ-111, PZ-112, PZ-113, PZ-114, PZ-115A, PZ-115B, PZ-116, PZ-117A, PZ-117B, PZ-118, PZ-119, PZ-120, PZ-121, PZ-122, PZ-123A, and PZ-123B) were installed in and around the proposed Phase 5 footprint between May 9 and May 23, 2006. Monitoring well GW-16 was also installed on May 24, 2006, to monitor the newly constructed Cell 11 of Phase 4. Geologic Exploration of Statesville, North Carolina performed drilling and well installation activities. The drilling equipment consisted of a Deidrich D-50 track-mounted drilling rig equipped with 4.25-inch inner diameter (ID) hollow-stem augers and a 3.75-inch outer diameter (OD) tricone bit for mud-rotary drilling. Continuous split-spoon samples were obtained and logged by the geologist for the boreholes, except in locations where nested piezometer pairs were installed. A licensed Golder geologist was present to observe the drilling, log the boreholes, and supervise the piezometer construction. An experienced Golder field technician developed monitoring wells and piezometers selected for aquifer testing. The boring logs, piezometer construction records, and well development forms for the newly installed piezometers are included as Appendix A. The piezometer and well construction data are summarized in Table 1 and the locations are provided on Drawing DH-1. Well and piezometer construction was performed in accordance with the standards described in the *RCRA Technical Enforcement Guidance Document* (1986) and the

Draft North Carolina Water Quality Monitoring Guidance Document for Solid Waste Facilities (1995).

Seventeen piezometers (PZ-107A, PZ-108, PZ-109A, PZ-110, PZ-111, PZ-112, PZ-113, P-114, PZ-115A, PZ-116, PZ-117A, PZ-118, PZ-119, PZ-120, PZ-121, PZ-122, and PZ-123A) were installed in the uppermost aquifer in and around the proposed Phase 5 footprint and range in depth from 14 to 28 feet below ground surface with screen lengths that range from 4 to 15 feet, depending on the aquifer thickness. Five piezometers (PZ-107B, PZ-109B, PZ-115B, PZ-117B, and PZ-123B) were installed in the lower aquifer, which is separated from the uppermost aquifer by a confining unit. The lower aquifer piezometers range in depth from 50 to 52 feet below ground surface with screen lengths that range from 5 to 20 feet.

Unless specified below, piezometers were grouted to ground surface and lockable expansion caps installed in each casing. Piezometers PZ-110 and PZ-118 were covered by lockable anodized aluminum protective casings installed into 3x3x0.5-foot concrete aprons to protect their integrity. Piezometers that may be converted into monitoring wells will have lockable protective casings and concrete aprons installed prior to the first compliance sampling event. Wells and piezometers within the Phase 5 footprint will be decommissioned prior to construction.

On June 27 and 28, 2006, piezometers PZ-110 and PZ-118 and monitoring well GW-16 were developed with a submersible pump to remove accumulated sediments resulting from the drilling and construction process, and to hydraulically connect the piezometers with the surrounding soils. On August 28 and 29, 2006, piezometers PZ-107A, PZ-107B, PZ-109A, PZ-109B, PZ-115, PZ-115B, PZ-117A, PZ-117B were also developed with a submersible pump. The piezometers exhibited continuous recharge during development, with approximately 15 to 37 gallons of water were purged from each piezometer. Well development forms are included in Appendix A. The remaining piezometers that will be converted into permanent monitoring wells will be developed using similar procedures prior to the first sampling event.

The 22 newly installed piezometers and monitoring well GW-16 were surveyed in July 2006 by Wright and Fields Land Surveying, Inc. of Troy, North Carolina. Elevations and horizontal locations were referenced to the N.C. Grid Coordinate System. The piezometer survey map and a sealed letter prepared by Wright and Fields Land Surveying are provided in Appendix B.

A historical summary of the static groundwater elevations for monitoring wells and Phase 5 investigation piezometers screened in the uppermost aquifer is included in Table 2. A historical summary of the static groundwater elevations for monitoring wells and Phase 5 investigation piezometers screened in the lower aquifer is included in Table 3. Static water level measurements of the newly installed piezometers were collected at the time of drilling, approximately 24 hours after construction, and on or about 7 days after construction. Water levels were periodically measured for existing site monitoring wells and Phase 5 investigation piezometers during additional site visits through October 2006.

3.2.2 Soil Testing

Soil samples were collected from each piezometer or piezometer pair location during drilling activities. Standard penetration tests were performed continuously for each boring using a 2-foot long split spoon sampler. Soil samples from the split spoons were collected so that select samples could be reviewed at a later date or sent to a soil testing laboratory. Undisturbed soil samples were collected using Shelby Tubes at select boring locations to be analyzed at a soil testing laboratory.

Soil samples were sent to the Golder Associates Inc. Soil Testing Laboratory in Atlanta, Georgia. Soil samples consisted of seven Shelby Tubes (PZ-109A (4'-6'), PZ-109A (14'-16'), PZ-109B (33'-35'), PZ-109B (45.5'-47'), PZ-115B (44'-44.5'), PZ-117B (22'-24'), and PZ-117B (48'-49.5')) and one composite split spoon sample (PZ-117A (10'-18')). Samples were analyzed for gradation, Atterberg limits, USCS classification, permeability, total porosity, total unit weight, moisture content, triaxial shear, and consolidation. The results of the soil analysis are summarized in Table 4 and the laboratory report is provided as Appendix C.

3.2.3 Hydrogeologic Testing

The potentiometric surface in the newly installed monitoring wells was measured at the time of well construction, and approximately 24 hours and approximately 7 days after well construction. The potentiometric surface in the existing monitoring wells and piezometers and newly installed piezometers were measured periodically over several months and the data are summarized on Tables 2 and 3. The measurements were collected using a decontaminated electric water level indicator. The surveyed point on the top of the well casing was used as reference, and the measurements were recorded to within 0.01 foot. The groundwater elevation data measured on October 31, 2006, were used to prepare potentiometric surface contour maps and to infer groundwater flow directions for the uppermost and lower aquifers at the site, and are included as Drawings DH-2 and DH-3.

Following development, 5 piezometers (PZ-109A, PZ-110, PZ-115A, PZ-117A, and PZ-118) and 1 monitoring well (GW-16) screened in the uppermost aquifer and 3 piezometers (PZ-109B, PZ-115B, and PZ-117B) screened in the lower aquifer were chosen for aquifer testing (slug tests) during the field investigation. The purpose of the testing was to assess the value of horizontal hydraulic conductivity at various locations within the two aquifers at the site. *In situ* rising- and falling-head slug tests were chosen for the assessment.

Slug tests were conducted between October 31, 2006, and November 3, 2006, by an experienced Golder geologist. Rising- and falling-head tests were performed on each piezometer and well because the water table was above the screened intervals; thus the results were not significantly affected by the porosity of the sand pack.

Prior to slug testing, the piezometers were opened and groundwater levels were allowed to equilibrate. Water level measurements were then collected using an electric water level probe referenced to a point on the top of casing. A stainless steel pressure transducer rated for 15 pounds per square inch (psi) was then lowered inside the well casing and placed 10 to 15 feet

below the top of the water table. A polyvinyl chloride (PVC) slug measuring 5 feet in length was used to displace water inside the wells. Downhole equipment used during the slug testing was decontaminated prior to use and between wells.

The first portion of the test was a falling-head test that measured the rate of water level decline following the injection of the PVC slug. The transducer was used to record water level changes on a logarithmic time interval. An electronic water level indicator was used to obtain periodic depth to water readings during the tests for the purpose of verifying the data recorded by the pressure transducer. Falling-head tests were terminated after water levels had recovered to within approximately 99% of their pre-test level. A rising-head test was performed on each well after the falling-head test was completed. The rising-head test was conducted by initiating a new logarithmic recording step on the data logger simultaneous with the removal of the PVC slug. The transducer recorded data were checked with hand held readings, and the tests were terminated after water levels had recovered to within approximately 99% of the pre-test level.

In situ rising- and falling-head tests provide a quantitative estimate of horizontal hydraulic conductivity (K) and a qualitative estimate of aquifer anisotropy in water-bearing units. The slug test data were analyzed using the Bouwer and Rice (1976 and 1989) equation, which is applicable to fully or partially penetrating wells in unconfined or confined aquifers. Well or piezometer specific aquifer thicknesses of 4.2 to 22 feet were assumed for the uppermost aquifer based upon information available from the boring logs. An aquifer thickness of 50 feet was assumed for the lower aquifer. A packing porosity of 25% was assumed for the well filter pack. Computer software AQTESOLV, produced by HydroSOLVE, Inc., was utilized to assist in the analysis and plotting of data. The individual data points, computer plots of time versus groundwater displacement, and associated formulae are presented in Appendix D. A summary of aquifer testing results from wells in and around the proposed Phase 5 footprint is included in Table 5. A geometric mean for hydraulic conductivity values for each of the hydrogeologic units was calculated as shown on Table 5.

As presented, the geometric mean of the horizontal hydraulic conductivity of Layer II is approximately 4.72E-04 centimeters per second (cm/sec), and the geometric mean of the horizontal hydraulic conductivity for Layer IV is approximately 9.94E-05 cm/sec.

4.0 REGIONAL AND LOCAL GEOLOGY

This section describes the geology in the region of the landfill and site specific geological conditions that may affect the performance of engineered features upon the land surface in the proposed cell area, the groundwater flow regime, and the ability to effectively monitor water quality at the site.

4.1 Regional Geology

The East Carolina Regional Landfill is located within the Coastal Plain Physiographic Province. The Coastal Plain of North Carolina comprises approximately 45 percent of the state. It consists of a 'wedge' of mostly marine sediments that thickens to the east. Coastal Plain sediments

typically range in age from Cretaceous to present. A generalized geologic map of North Carolina is provided as Figure 1.
The portion of Bertie County, where the site is located, is underlain by the Yorktown and Black Creek Formations. The Yorktown Formation is Tertiary in age and generally consists of alternating sand and clay deposits representing a series of transgression and regression events. The Yorktown Formation correlates stratigraphically with the Duplin Formation, which has a similar lithology. The two formations are separated laterally by the Neuse River.

Underlying the Yorktown Formation is the Black Creek Formation. The Black Creek Formation consists of lignitic sand and clay that represent fluvial and shallow marine environments from the late Cretaceous. Locally, the formation consists of an upper sandy clay confining layer and a lower sandy unit with thinly laminated clay units that contain lignitic wood fragments.

4.2 Local Geology

The drilling and installation of 22 piezometers and one monitoring well performed during this investigation provided geological and hydrogeological information consistent with previous investigations, which includes information from more than 160 borings across the site. In general, the subsurface consists of 4 distinguishable hydrogeologic units. The uppermost unit consists primarily of silty clay and acts as an aquitard. The second unit consists mainly of silty sand and is the uppermost aquifer at the site. Based on regional geologic descriptions, these two units are believed to be part of the Yorktown Formation. The third unit consists of primarily of sandy fat clay that acts as an aquitard. The fourth unit consists mainly of silty sand and is the lower aquifer at the site. The third and fourth units are believed to be part of the Black Creek Formation based on regional geologic descriptions. In order to maintain consistency with previous investigations, these units will be referred to as Layers I through IV with Layer I being the uppermost unit. These layers are described further in the sections below.

4.2.1 Layer I Hydrogeologic Unit

Layer I is the uppermost unit in the Phase 5 area and extends from ground surface to depths of 3 to 18 feet below ground surface. Based on soil boring data, the layer appears to be continuous across the proposed Phase 5 area with an average thickness of approximately 11 feet. Soil borings advanced in and around the Phase 5 area encountered Layer I. A summary of the thicknesses of Layer I encountered during installation of piezometer and monitoring wells in and around the Phase 5 footprint is presented in Table 6. The associated depths and elevations for each layer are shown on Tables 7 and 8. An isopach map of Layer I showing the thickness of the unit across the Phase 5 area is provided as Drawing DH-4.

Layer I primarily consists of silty clay, but may vary locally from fat clay, sandy clay, sandy silt, or clayey sand based on boring logs and laboratory analysis utilizing the USCS classification system. The soil type from ground surface to approximately 1 foot below ground sometimes consists of silty sand. During previous investigations, four samples from borings adjacent to the Phase 5 footprint were analyzed by a soil testing laboratory. The results are summarized in Table 4. Two samples were analyzed from borings advanced inside the proposed waste footprint during the current investigation, the results from which are also summarized in Table 4 and

included in Appendix C. Effective porosity calculations were performed utilizing the soil testing results and the textural classification triangle (Johnson, 1967). Effective porosities of 1.6 and 4.2 percent were calculated for the Layer I samples. An additional effective porosity calculation was determined to be within Johnson's "Area of No Samples," is indicative of a low effective porosity. Laboratory derived permeabilities for the samples were 4.20E-06 cm/sec and 9.9E-08 cm/sec. In other areas of the site, the permeability results for Layer I typically range from E-08 to E-07 cm/sec. The 4.20E-06 cm/sec result most likely represents a localized variation in soil type with limited vertical extent.

Based on laboratory permeability test results and field observations, Layer I is considered to be an aquitard that comprises a confining unit for the underlying Layer II. This is further substantiated by previous investigations. During the 1996 field investigation associated with the Phase Design Hydrogeologic Investigation, test pits were advanced adjacent to existing piezometers. These test pits were advanced to depths greater than depth-to-water measurements taken from the piezometers and no water was observed to enter the test pits during the investigation, confirming that Layer I is a confining unit to the underlying Layer II and that water level measurements collected from piezometers screened in Layer II represent potentiometric heads and not the depth of the groundwater surface.

4.2.2 Layer II Hydrogeologic Unit

Layer II underlies Layer I and appears to be continuous across the proposed Phase 5 area based on the data obtained from the soil borings advanced in the study area. The thickness of the unit is highly variable in the Phase 5 area with observed thicknesses ranging from 4.2 to 25 feet. The average thickness of the unit in the Phase 5 area is approximately 15 feet. A summary of the thicknesses of Layer II encountered during installation of piezometers and monitoring wells in and around the Phase 5 footprint is provided in Table 6. The associated depths and elevations for each layer are shown on Tables 7 and 8. An isopach map of Layer II showing the thickness of the unit across the Phase 5 area is provided as Drawing DH-5.

Layer II primarily consists of fine to silty sand based on field descriptions and laboratory analyses utilizing the USCS classification system. Three samples from borings adjacent to the Phase 5 footprint were analyzed by a soil testing laboratory during previous investigations. An additional sample was analyzed from a boring inside the proposed waste footprint during the current investigation. A summary of these soil test results are included in Table 4 and the laboratory data from the current investigation is included in Appendix C. Laboratory soil classifications of the samples collected from Layer II range from silty sand to poorly sorted sand. Effective porosity calculations were performed utilizing the soil testing results and the textural classification triangle (Johnson, 1967). Effective porosities of the Layer II samples range from 28 to 38 percent. Laboratory derived permeability for Layer II media was 5.80E-04 cm/sec. These results are consistent with those obtained during previous investigations across the site.

Aquifer tests for 5 piezometers and 1 monitoring well screened in Layer II were performed in and around the Phase 5 footprint during previous investigations. Aquifer tests were performed for 5 additional piezometers and one monitoring well screened in Layer II in and around the proposed Phase 5 cell during the current investigation. One piezometer (PZ-117A) that

underwent aquifer testing is partially screened in Layer I. As presented in Table 5, hydraulic conductivities derived from aquifer testing of piezometers in and around Phase 5 and screened in Layer II ranged from E-05 cm/sec to E-03 cm/sec with a geometric mean of 4.72E-04 cm/sec (Table 5).

Based on laboratory soil testing data and aquifer test data, Layer II is considered to be the site's uppermost aquifer. Due to the properties of the overlying unit, Layer I, and the underlying unit, Layer III, Layer II is a confined aquifer. Water levels obtained from piezometers and monitoring wells screened in Layer II represent potentiometric heads and not the groundwater surface, as groundwater measurements typically extend above the Layer I and Layer II interface.

4.2.3 Layer III Hydrogeologic Unit

Layer III underlies Layer II and ranges in thickness from 3.5 to 18 feet in the Phase 5 area based on field observations summarized in the soil boring logs. The layer appears to be continuous across the proposed Phase 5 area with an average thickness of approximately 10 feet. A summary of the thicknesses of Layer III encountered during advancement of the soil borings used for the construction of piezometer and monitoring wells in and around the Phase 5 footprint is summarized in Table 6. The associated depths and elevations for each layer are presented in Tables 7 and 8. An isopach map of Layer III showing the thickness of the unit across the Phase 5 area is provided as Drawing DH-6.

During previous investigations, four samples of Layer III material from soil borings advanced in areas adjacent to the Phase 5 footprint were analyzed by a soil testing laboratory. The results of these analyses are summarized in Table 4. Two samples were analyzed from soil borings advanced inside the proposed waste footprint during the current investigation, the results from which are also summarized in Table 4 and included in Appendix C. Laboratory soil classification of samples from Layer III ranged from clayey silt, silty clay, and lean silt. Effective porosity calculations were performed utilizing the soil testing results and the textural classification triangle (Johnson, 1967). Effective porosities of the Layer III samples range from less than 1 percent to 5 percent. Laboratory derived permeability for Layer III media was 3.70E-08 cm/sec. These results are consistent with those obtained during previous investigations across the site.

Based on laboratory permeability test results and field observations, Layer III is considered to be an aquitard that separates the uppermost aquifer of Layer II and an underlying aquifer in Layer IV. Water level measurements taken from nested piezometers show significant head differences between piezometers screened in Layer II and Layer IV. Water level measurements obtained on October 31, 2006, which are consistent with historical water level obtained from site wells, indicate that there is a downward gradient across Layer III from Layer II to Layer IV, with potentiometric surface differentials ranging from 1.1 to 4.9 feet between the layers. These data support that Layer III is a confining unit, separating the Layer II aquifer from the Layer IV aquifer.

4.2.4 Layer IV Hydrogeologic Unit

Layer IV underlies Layer III and appears to be continuous across the proposed Phase 5 area based on field observations. One boring in the Phase 5 area (PZ-73A) was documented to have fully penetrated Layer IV indicating a thickness of 15 feet. Other borings in the area were advanced up to 22 feet into Layer IV without locating the bottom of the unit. The thickness of Layer IV is expected to be variable and may exceed 50 feet in some locations. The unit is expected to be continuous under the proposed Phase 5 area based on available data. A summary of the thicknesses observed in available piezometers and monitoring wells extending into Layer IV in and around the Phase 5 footprint is provided in Table 6. The associated depths and elevations for each layer are shown on Tables 7 and 8.

Three sediment samples from soil borings from Layer IV advanced inside the Phase 5 footprint were analyzed by a soil testing laboratory during the current investigation. These soil test results are summarized in Table 4 and included in Appendix C. Field and laboratory soil classifications of the samples collected from Layer IV range from fine sand to a sandy clay. The sandy clay is considered to be a minor lithology for the layer and was only encountered locally. Effective porosity calculations were performed utilizing the soil testing results and the textural classification triangle (Johnson, 1967). Effective porosities of the Layer IV samples range from 13.5 to 35 percent. Laboratory-derived vertical permeabilities for Layer IV range from 3.0E-06 cm/sec to 9.0E-04 cm/sec. These results are consistent with those obtained during previous investigations across the site.

An aquifer test for one piezometer screened in Layer IV was performed in the Phase 5 area during previous investigations. Aquifer tests were performed for 3 additional piezometers screened in Layer IV in and around the proposed Phase 5 cell during the current investigation. Aquifer testing results for four piezometers constructed in the vicinity of Phase 5 are presented in Table 5. Hydraulic conductivities derived from aquifer testing of piezometers in and around Phase 5 and screened in Layer IV ranged from 2.12E-05 cm/sec to 5.23E-04 cm/sec with an average hydraulic conductivity value of 9.94E-05 cm/sec.

Based on site observations, laboratory soil testing data, and aquifer test data, Layer IV is considered to be the lower aquifer at the site. Due to the properties of the overlying unit (Layer III), Layer IV is a confined aquifer.

5.0 SITE HYDROGEOLOGY

A significant amount of hydrogeologic investigation has been performed on the site including the drilling of 39 borings in and around the proposed Phase 5 area as described above. The following section discusses the hydrogeologic aspects of the site, with emphasis on the proposed Phase 5 disposal area, based on field and laboratory data obtained from the 39 soil borings.

5.1 Hydrology and Discharge Features

As discussed in Section 2.0, topographic elevations at the facility range from approximately 30 to 70 feet above mean sea level. Along the northern and eastern portions of the facility, surface drainage from the facility and surrounding areas is routed by drainage channels and storm water

control structures to tributaries of the southerly flowing Connaritsa Swamp, a tributary system of the Cashie River. Along the western and southern portions of the facility, surface drainage from the facility and surrounding areas is routed by drainage channels and storm water control structures to tributaries of the southeasterly flowing Cashie River. The Cashie River discharges to the greater Roanoke River.

Site investigations indicate that there is no water table aquifer present in the vicinity of Phase 5, and that the uppermost aquifer beneath the site (Layer II) is naturally confined. Site data indicate that the upper confining layer (Layer I) may have been breached locally by stormwater control structures, resulting in direct connection between surface water and Layer II locally (e.g., area of PZ-117A/B and PZ-118).

5.2 Site Groundwater Flow Regime

As previously discussed, shallow groundwater flow (upper 50 feet) occurs in two separate confined aquifers. Layer II is the uppermost aquifer and Layer IV is the lower aquifer. Each of these aquifers is bound by overlying sandy to silty clay aquitards. Potentiometric surface contour maps for water level measurements taken on October 31, 2006, for each aquifer are provided as Drawings DH-2 and DH-3 and the potentiometric surface elevations for each aquifer are summarized in Tables 2 and 3.

Several hydrogeologic cross-sections are provided to further illustrate the structural components of the aquifers and provide additional representation of groundwater flow (Drawing DH-8). Groundwater flow arrows on Drawings DH-2 and DH-3 and site-specific data were used to determine groundwater flow directions and velocities.

5.2.1 Layer II Aquifer

The sediments that comprise Layer II are expected to exhibit properties on a macroscopic scale such that groundwater flow directions are expected to be perpendicular to the potentiometric surface contours developed based on data obtained from the piezometer and monitoring wells. Locally, variation in soil type, clay microtards (laminations), and aquifer structure results in an irregular potentiometric surface and flow paths. Because of the confined nature of the aquifer, groundwater flow is not expected to mimic the site's topography. The overlying confining unit is an aquitard and is not totally impenetrable to water, but recharge will be severely limited except in areas where the Layer II aquifer is not overlain by Layer I. The overlying confining unit is continuous in and around the Phase 5 footprint and very little vertical recharge is expected to occur in this area. Recharge is anticipated to occur further west, where Layer II is the uppermost unit.

A northwest-southeast trending groundwater divide is located in the southern portion of the proposed Phase 5 footprint (Drawing DH-2). North of this divide, groundwater flow is to the east-northeast. South of the groundwater divide, groundwater flow is primarily to the south-southwest. An irregular groundwater high exists in the southeastern corner of the proposed Phase 5 cell at piezometer pair PZ-117A/B. This feature is believed to be due to the thinning of the aquifer from an average thickness of 15 feet to 4.2 feet in that area as seen on hydrogeologic

cross-sections B-B' and C-C' on Drawing DH-8. Also, in the area of PZ-117A/B, the Layer II aquifer is composed of clayey silt to lean clay. This material is much finer than the typical Layer II aquifer soil type of silty sand. The combination of finer aquifer material and a thinning of the aquifer in this area cause greater hydraulic head around PZ-117A/B and a higher potentiometric surface.

5.2.2 Layer IV Aquifer

The sediments that comprise Layer IV are expected to exhibit properties on a macroscopic scale, such that groundwater flow directions conform to the potentiometric surface defined by the piezometers. Locally, variation in soil type, clay microtards (laminations), and aquifer structure may result in an irregular potentiometric surface and flow paths. Because of the confined nature of the aquifer, groundwater flow is not expected to mimic the site's topography. The overlying confining unit is an aquitard and is not totally impenetrable to water, but vertical recharge from the Layer II aquifer will be severely limited except in areas where the overlying confining unit thins or pinches out. The overlying confining unit is continuous in and around the Phase 5 footprint and very little vertical recharge is expected to occur in this area. The primary recharge area for the Layer IV aquifer is believed to be located west of the site where the formation outcrops.

Groundwater flow in the Layer IV aquifer is to the east-northeast in the proposed Phase 5 area (Drawing DH-3). South of the Phase 5 area groundwater flow is to the southeast. Based on the information available, groundwater flow velocity and direction in the Layer IV aquifer is uniform.

5.2.3 Horizontal Gradient Calculations

Horizontal hydraulic gradients for the proposed Phase 5 disposal area were calculated using gradient segments from the October 31, 2006, potentiometric surface contour maps for Layers II and IV shown on Drawings DH-2 and DH-3. These gradient segments were selected to represent gradients within the two confined aquifers. The gradient calculations were focused within the Phase 5 area.

Estimates of hydraulic conductivity were obtained from slug tests and laboratory permeability tests performed on piezometers and wells in and around the proposed Phase 5 disposal area during the current and previous investigations. Hydraulic conductivity values generated by slug test recovery data on individual wells at this site are considered to be higher than actual conductivities for site-scale movement of groundwater. Curves generated by the slug test recovery data indicate that the data are dominated by near-field, or 'skin effects,' and are reflective, in part, of the properties of the well screen filter pack judged to have greater hydraulic conductivity than the surrounding *in-situ* soils. The hydraulic conductivities (Ks), as determined by the single well aquifer tests, range from 5.48E-03 to 2.65E-05 cm/sec in the Layer II aquifer and range from 5.25E-04 to2.13E-05 cm/sec in the Layer IV aquifer. The geometric mean of K values was calculated for each of the two confined aquifers (Layer II = 4.72E-04; Layer IV = 9.94E-05) and used for groundwater flow calculations.

The average horizontal gradients for gradient calculation segments, estimated effective porosities, and the geometric mean of available K values for each aquifer were used to estimate linear groundwater flow velocities. Average linear groundwater flow velocities were computed using the following modified Darcy equation:

$$V = Ki/n_e$$

where V = average linear velocity (feet per day), K = hydraulic conductivity (ft/day), i = horizontal hydraulic gradient (unitless), and n_e = effective porosity (unitless). Effective porosity values were calculated for each of the three hydrogeologic units, as described in Section 4.2. and are shown on Table 4.

Data and calculations for the horizontal gradients are presented in Table 9. The calculated horizontal gradients in the Layer II aquifer from groundwater flow segments on Drawing DH-2 in the vicinity of the proposed Phase 5 area range from approximately 0.002 to 0.004 foot per foot. Calculated linear groundwater flow velocities are approximately 1.5 to 7.0 feet per year for Layer II. The calculated horizontal gradient in the Layer IV aquifer from groundwater flow segments in the vicinity of the proposed Phase 5 area was 0.002 foot per foot. Calculated linear groundwater flow velocity is approximately 1.5 feet per year for Layer IV.

5.2.4 Vertical Gradient Calculations

Five nested piezometer pairs (PZ-107A/B, PZ-109A/B, PZ-115A/B, PZ-117A/B, and PZ-123A/B) were utilized for the purpose of measuring a vertical hydraulic gradient. Four of these pairs are located in each quadrant of the proposed phase. The PZ-123A/B pair is located outside of the proposed Phase 5 area to the east. For each of the piezometer pairs, the piezometers that are identified with an "A" are screened in Layer II and those identified with a "B" are screened in Layer IV. The only piezometer pair that does not meet this criterion is PZ-117A/B. Piezometer PZ-117A is screened across Layer I and Layer II.

Calculations were performed using water levels measured on three different dates. Vertical gradients were calculated using the vertical distance between the screen midpoints of the pairs. The screened intervals were fully submerged at the time of water level measurements. As discussed previously, the potentiometric surface elevations in the piezometer pairs indicate that Layer II and Layer IV are separated by an aquitard. Though the piezometers screened in Layer II have a higher potentiometric head than piezometers screened in Layer IV, the downward gradient is going to be limited by Layer III, which has a hydraulic conductivity of 3.7E-08 cm/sec and has an average thickness of 10 feet. Seepage velocities through the Layer III unit were calculated to average less than 0.2 foot per year. A summary of available vertical gradient and velocity data is presented in Table 10. Several hydrogeologic cross-sections are also provided to illustrate the limitations on the vertical component of groundwater flow (Drawing DH-8).

6.0 SITE SUITABILITY

The following sections discuss the proposed site's suitability as a MSW management facility with attention to the proposed area

6.1 Relationship Between Hydrogeology and The Proposed Phase 5 Waste Disposal Unit

Numerous borings and piezometers have been drilled and data collected on site, and available site information indicates that the area has been adequately characterized. The geologic characteristics of the site are typical of those observed in other locations of the Coastal Plain. Specifically, the site is underlain by a sequence of strata composed of interbedded units that alternately exhibit aquitard and aquifer properties. At this facility, the uppermost aquifer is confined, with the top of the uppermost aquifer located between 2 and 17 feet below grade in the Phase 5 area. Since the base grades for Phase 5 will generally be at elevations close to the existing grades, the naturally occurring Layer I unit will supplement the Phase 5 liner in providing a physical barrier to the potential migration of contaminants from the landfill to the uppermost aquifer in the event of a release. There appear to be no conditions that would limit the ability to effectively monitor groundwater in the proposed Phase 5 area. Base grades for Phase 5 are designed to be above-grade.

6.1.1 Vertical Separation From Bedrock

Bedrock was not encountered in the upper 50 feet of the subsurface. Thus the bedrock will not affect landfill design, nor will it affect the ability to effectively monitor groundwater beneath the facility.

6.1.2 Vertical Separation From Seasonal High Water Table

The potentiometric surface elevations of onsite monitoring wells and piezometers in and around the proposed Phase 5 expansion are included as Tables 2 and 3. Table 2 includes wells and piezometers screened in Layer II and Table 3 includes wells and piezometers screened in Layer IV. The tables document potentiometric surface elevations from 1993 to present. Data from selected site monitoring wells screened in the uppermost Layer II aquifer are presented on the hydrograph illustrated as Figure 2. As presented, significant fluctuations in the potentiometric surface have occurred at the site in the Layer II aquifer since monitoring was initiated in 1993. In general, the degree and type of fluctuation is similar across the site, with the most significant fluctuations observed in upgradient well GW-2. It is noted that the range in fluctuation is less in GW-7, GW-8, GW-9 and GW-10, relative to GW-2, GW-3 and GW-5, possibly indicating a stabilizing influence associated with the site stormwater ponds.

The potentiometric surface fluctuations appear to be influenced by precipitation events. Historical precipitation data from 1933 to present for the nearby town of Edenton, North Carolina is provided as Table 11. A graphic representation of the precipitation data since 1993 is shown on Figure 3. A comparison of the precipitation data on Figure 3 with the potentiometric surface data on Figure 2 shows that periods of greater precipitation typically result in increases in potentiometric surface elevations. This is more evident in the winter and spring months, due to

the effects of evapotranspiration during the summer months that limit the amount of recharge to the aquifers, even though the summer months typically experience the most precipitation.

Potentiometric surface maps for Layer II and Layer IV have been included as Drawings DH-2 and DH-3 for water level data obtained on October 31, 2006. Because the aquifers underlying the site are confined, the water levels obtained from monitoring wells and piezometers at the site represent potentiometric surfaces rather than the groundwater surface. Layer I is an aquitard above the Layer II aquifer that restricts the upward movement of groundwater. Therefore, the potentiometric surface elevation is higher than the actual depth to groundwater. A map showing the top of Layer II is provided as Drawing DH-9, which also represents the highest elevation that saturated conditions can vertically extend as supported by previous investigations. Therefore, the top of Layer II also represent the seasonal and long-term seasonal high groundwater elevation for the proposed Phase 5 area. To account for capillary fringe, an extra foot of separation was taken into account in the design of base grades for Phase 5, such that the base grades were designed at least 9 feet above the top of Layer II. This separation is adequate to account for settlement of the landfill over time. Detailed discussion of anticipated settlement will be addressed in the *Engineering Plan*. Hydrogeologic cross-sections showing the separation between the seasonal high groundwater contours and the proposed Phase 5 base grades are included on Drawing DH-8.

6.2 Potential Groundwater Receptors

There is one onsite water supply wells located approximately 2,125 feet southwest of the proposed Phase 5 limits of waste. The location of the well is represented as PW-1 on Drawing DH-1. The well is screened at a depth of 349 feet below ground surface. With a separation of at least 300 feet vertically, there is little to no interaction between the well screens and the confined uppermost aquifer. Also, the wells are tested semiannually for Appendix I parameters. There are no other known potential groundwater receptors between the Phase 5 area and onsite downgradient groundwater discharge features (i.e., swamps) for the uppermost aquifer.

6.3 Ability To Effectively Monitor Groundwater

No known or potential significant sources of contamination have been identified within 2,000 feet of the facility boundary. Groundwater flowing east-northeast and south-southwest in the uppermost aquifer from the Phase 5 area will be monitored by the well network described in the *Water Quality Monitoring Plan* presented as Appendix E.

There are no known conditions, physical or hydrogeologic, which will interfere with the effective monitoring of the proposed Phase 5 waste unit or previously permitted phases. The discharge features (i.e., swamps) along the southern facility boundary serve as effective groundwater flow boundaries between the proposed cell and potential receptors that may be located further to the south of the site. Surface water monitoring points are included in the proposed monitoring program as additional safeguards for detecting a release from the facility.

7.0 CONCLUSIONS

The purpose of the Hydrogeologic Report is to present the assessment of geologic and hydrogeologic characteristics of the proposed site, especially as they relate to proposed MSW landfill construction. Furthermore, the report must present data in support (or non-support) of the site's use for MSW waste management activities. This report presents the current understanding of the hydrogeologic characteristics of the site and the relationship of the solid waste management units to groundwater receptors and groundwater discharge features. In addition, this report demonstrates that the proposed site can be monitored effectively for potential releases using a conventional groundwater monitoring network.

In summary, a review of the geologic and hydrogeologic data indicates that the site is located within typical Coastal Plain terrane. The uppermost aquifer is confined by overlying and underlying silty to sandy clay units that act as aquitards. A second confined aquifer lies under the uppermost aquifer, separated by a confining unit. Site observations indicate that each of the aquifers and confining units are laterally continuous across the proposed Phase 5 area. No geologic or hydrogeologic features that would affect the ability to monitor Phase 5 were discovered during this investigation.

8.0 REFERENCES

Bunnell-Lammons Engineering (BLE), 1997, *Ground-Water Monitoring Well Installation Report: Phase II [GW-11]*, BLE Project Number J97-1001-11, May 7.

BLE, 1998, *Site Hydrogeologic Report*, BLE Project Number J96-1001-03, July 16, revised April 11, 2003.

BLE, 2000, *Design Hydrogeologic Report, Cells 9-11 (Phase III)*, BLE Project Number J98-1001-18, January 25.

BLE, 2000, *Ground-Water Monitoring Well Installation Report: GW-13*, BLE Project Number J00-1001-32, November 20.

BLE, 2005, *Design Hydrogeologic Report, Phase 4 (Cells 11-12)*, BLE Project Number J01-1001-46, January 7, revised May 2.

BLE, 2006, *Ground-Water Monitoring Well and Gas Probe Installation Report, Cell No. 11 Lower End*, BLE Project Number J05-1001-53, February 10.

Bouwer, H. and Rice, R.C., June 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells; Water Resources Research, American Geophysical Union, pp. 423-428.

Bouwer, H., 1989, The Bouwer and Rice slug test-an update; Ground Water, vol. 27, No. 3, May-June, pp. 304 - 309.

Fetter, C.W., 1988. Applied Hydrogeology (Second Edition), Merrill Publishing Company, Columbus, O.H.

Freeze, R.A. and Cherry, J.A. 1976. Groundwater, Prentice-Hall, Englewood Cliffs, N.J.

Johnson, A.I., 1967, Specific Yield – Compilation of Specific Yields For Various Materials: U.S. Geological Survey Water Supply Paper 1662-D.

Law Engineering, 1992, *Report of Geologic and Hydrogeologic Assessment of Proposed Solid Waste Landfill, Spruil Farms Property*, Law Engineering Job Number 2490472602, December 1.

Law Engineering, 1993, *Submittal in Response to Completeness Review by the NCSWMD, Report of Geologic and Hydrogeologic Assessment of Proposed Solid Waste Landfill*, Law Engineering Job Number 2490472605, April 28.

Law Engineering, 1993, *Design Hydrogeologic Report, Cells 3-6 (Phase 1)*, Law Engineering Job Number 2490472607, July 21-29.

Law Engineering, 1993, *Submittal of Additional Soil Test Borings and Piezometer Data, Design Hydrogeologic Report, Cells 3-6 (Phase I)*, Law Engineering job Number 2490472607, July 21.

Law Engineering, 1993, *Report of Monitoring Well Installation*, Law Engineering Job Number 2490472612, September 29.

Law Engineering, 1994, *Site Transition Plan*, Law Engineering Job Number 249472618, March 31 and April 29.

Law Engineering, 1996, *Design Hydrogeologic Report*, Cells 7-8 (Phase II), Law Engineering Job Number 30220-5-4726.36, March 12 and revised August 7.

Law Engineering, 1996, *Ground-Water Monitoring Well Installation Report: GW-10*, Law Engineering Job number 2490472642, September 16.

North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR), 1995, Draft N.C. Water Quality Monitoring Guidance Document for Solid Waste Facilities.

RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD), 1986.

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