APPENDIX P

HYDROGEOLOGICAL CALCULATIONS

APPENDIX P.1 HELP COMPUTER MODELLING RESULTS

APPENDIX P.2 HYDRAULIC GRADIENT CALCULATIONS

APPENDIX P.1

HELP COMPUTER MODELLING RESULTS

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NEPERA INC. FORMER LAGOON SITE (NATIVE AREA)
HAMPTONBURGH, NY
AUGUST 10, 1995

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LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.3526 VOL/VOL
FIELD CAPACITY	=	0.2440 VOL/VOL
WILTING POINT	=	0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2440 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000927999965 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	75.00
TOTAL AREA OF COVER	=	1430000. SQ FT
EVAPORATIVE ZONE DEPTH	=	20.00 INCHES
UPPER LIMIT VEG. STORAGE	=	7.0520 INCHES
INITIAL VEG. STORAGE	=	3.9687 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	29.2800 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR POUKEEPSIE NEW YORK

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 123
END OF GROWING SEASON (JULIAN DATE) = 290

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
24.40	26.80	36.20	48.00	58.30	67.50
72.40	70.60	62.70	51.50	40.90	29.30

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.74	1.59	2.75	4.59	2.33	4.30
	2.79	3.35	4.15	4.39	3.40	3.51
STD. DEVIATIONS	0.49	0.60	0.55	1.97	0.51	1.67
	1.27	2.17	1.68	1.80	1.14	0.74
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.010	0.004	0.014	0.128	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.023	0.008	0.022	0.281	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.672	1.201	2.418	3.538	2.702	3.890
	2.651	3.108	2.788	2.264	1.415	0.731
STD. DEVIATIONS	0.318	0.332	0.137	0.948	0.703	1.432
	1.122	1.899	0.988	0.445	0.216	0.098
PERCOLATION FROM LAYER 1						
TOTALS	1.7631	1.1425	1.1741	0.9247	0.8323	0.5154
	0.4768	0.3816	0.4227	1.2872	1.0780	1.7005
STD. DEVIATIONS	0.5002	0.3082	0.6138	0.4820	0.4887	0.2246
	0.2780	0.1862	0.1761	1.4572	0.8972	1.5625

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	38.89	(4.050)	4633915.	100.00
RUNOFF	0.156	(0.301)	18537.	0.40
EVAPOTRANSPIRATION	27.379	(2.317)	3262634.	70.41
PERCOLATION FROM LAYER 1	11.6990	(3.4626)	1394125.	30.09
CHANGE IN WATER STORAGE	-0.347	(0.797)	-41380.	-0.89

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	4.33	515991.7
RUNOFF	0.630	75117.3
PERCOLATION FROM LAYER 1	0.3435	40936.7
SNOW WATER	1.92	229306.6

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2989
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1357

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	26.49	0.2208
SNOW WATER	0.00	

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NEPERA INC. FORMER LAGOON SITE (LAGOONS)
HAMPTONBURGH, NY
AUGUST 10, 1995

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LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	120.00 INCHES
POROSITY	=	0.3792 VOL/VOL
FIELD CAPACITY	=	0.2440 VOL/VOL
WILTING POINT	=	0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2440 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000107000000 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	65.00
TOTAL AREA OF COVER	=	100000. SQ FT
EVAPORATIVE ZONE DEPTH	=	20.00 INCHES
UPPER LIMIT VEG. STORAGE	=	7.5840 INCHES
INITIAL VEG. STORAGE	=	5.0390 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	29.2800 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR POUKEEPSIE NEW YORK

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 123
END OF GROWING SEASON (JULIAN DATE) = 290

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
24.40	26.80	36.20	48.00	58.30	67.50
72.40	70.60	62.70	51.50	40.90	29.30

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.74	1.59	2.75	4.59	2.33	4.30
	2.79	3.35	4.15	4.39	3.40	3.51
STD. DEVIATIONS	0.49	0.60	0.55	1.97	0.51	1.67
	1.27	2.17	1.68	1.80	1.14	0.74
RUNOFF						
TOTALS	0.000	0.000	0.010	0.003	0.000	0.060
	0.024	0.069	0.188	0.369	0.010	0.004
STD. DEVIATIONS	0.000	0.000	0.022	0.007	0.000	0.067
	0.054	0.129	0.187	0.690	0.022	0.009
EVAPOTRANSPIRATION						
TOTALS	0.670	1.209	2.468	3.641	2.973	4.250
	3.056	3.014	3.087	2.386	1.423	0.727
STD. DEVIATIONS	0.313	0.352	0.228	0.834	0.741	1.274
	0.803	1.871	1.180	0.182	0.228	0.096
PERCOLATION FROM LAYER 1						
TOTALS	1.6465	1.1264	1.1799	0.9314	0.8951	0.5840
	0.4658	0.3589	0.2905	0.5571	0.6825	1.2439
STD. DEVIATIONS	0.6882	0.3915	0.5683	0.3218	0.4372	0.2229
	0.1731	0.1064	0.0682	0.5392	0.5783	1.0558

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	38.89	(4.050)	324050.	100.00
RUNOFF	0.736	(0.668)	6135.	1.89
EVAPOTRANSPIRATION	28.905	(2.649)	240875.	74.33
PERCOLATION FROM LAYER 1	9.9621	(2.0758)	83017.	25.62
CHANGE IN WATER STORAGE	-0.717	(2.089)	-5978.	-1.84

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	4.33	36083.3
RUNOFF	1.595	13289.5
PERCOLATION FROM LAYER 1	0.1344	1120.2
SNOW WATER	1.92	16035.4

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3442
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1344

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	31.07	0.2589
SNOW WATER	0.00	

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APPENDIX P.2

HYDRAULIC GRADIENT CALCULATIONS

HYDRAULIC GRADIENTS
NEPERA INC., FORMER LAGOON SITE
HAMPTONBURGH, NEW YORK

I. *Vertical hydraulic gradients (i_V) between the shallow and the bedrock aquifers measured at the following well nests on-Site:*

The seasonally low (DRY) groundwater conditions will be represented by the June 17, 1993, July 24, 1995, and July 12, 2001 data. The seasonally high (WET) conditions will be represented by the May 12, 1993, January 12, 1995, June 1, 1995 and June 3, 2002 data.

The vertical hydraulic gradients are calculated as the difference in static groundwater elevation divided by the vertical difference between the base of the shallow monitoring well and the midpoint of the monitored interval of the bedrock monitoring well. Elevations are in feet AMSL.

a) Northern portion of the Site:

i) MW-5U-95 (shallow) bottom elevation = 340.6
MW-5D-95 (bedrock) midpoint of open corehole
$= \frac{324 + 263.0}{2} = 293.5$
dl = 340.6 - 293.5 = 47.1 ft

Water levels:		MW-5U-95	MW-5D-95	dh	i_V (dh/dl)
WET:	May 12/93		(predates well installations)		
WET:	June 1/95		(predates well installations)		
DRY:	July 24/95	355.12	354.76	0.36	0.0076 (downward)
DRY:	July 12/2001	356.23	352	4.23	0.090 (downward)
WET:	June 3/2002	358.39	353.87	4.52	0.096 (downward)

ii) SW-2 (shallow) bottom elevation = 349.10
DW-2 (bedrock) midpoint of open corehole (original)
$= \frac{302.1 + 188.1}{2} = \frac{490.2}{2} = 245.1$
dl = 349.10 - 245.1 = 104.0 ft (original)

DW-2-95 (bedrock) midpoint of monitor interval (converted)
$= \frac{266.1 + 261.1}{2} = \frac{527.2}{2} = 263.6$
dl = 349.10 - 263.6 = 85.5 ft (converted)

Water levels:		SW-2	DW-2	dh	i_V (dh/dl)
WET:	May 12/93	361.77	361.46 (original)	0.31	0.003 (downward)
WET:	June 1/95	360.37	356.21 (converted)	4.16	0.049 (downward)
DRY:	July 24/95	358.54	354.89 (converted)	3.65	0.043 (downward)
DRY:	July 12/2001	359.69	343.37 (converted)	16.32	0.191 (downward)
WET:	June 3/2002	361.83	358.05 (converted)	3.78	0.044 (downward)

HYDRAULIC GRADIENTS
NEPERA INC., FORMER LAGOON SITE
HAMPTONBURGH, NEW YORK

iii) MW-9U-01 (shallow) bottom elevation = 342.10
MW-9D-01 (bedrock) midpoint of open corehole

$$= \frac{325.8 + 315.8}{2} = \frac{641.6}{2} = 320.8$$

dl = 342.10 - 320.8 = 21.3 ft

Water levels:		MW-9U-01	MW-9D-01	dh	i_V (dh/dl)
DRY:	July 12/2001	346.94	348.18	-1.24	-0.058 (upward)
WET:	June 3/2002	347.99	349.64	-1.65	-0.077 (upward)

iv) MW-10U-01 (shallow) bottom elevation = 332.50
MW-10D-01 (bedrock) midpoint of open corehole

$$= \frac{297.6 + 287.6}{2} = \frac{585.2}{2} = 292.6$$

dl = 332.50 - 292.6 = 39.9 ft

Water levels:		MW-10U-01	MW-10D-01	dh	i_V (dh/dl)
DRY:	July 12/2001	348.26	348.73	-0.47	-0.012 (upward)
WET:	June 3/2002	351.69	351.18	0.51	0.013 (downward)

b) Area of former lagoons:

i) SW-3 (shallow) bottom elevation = 362.40
MW-1D-91 (bedrock) midpoint of open corehole =

$$\frac{365 + 346}{2} = \frac{711}{2} = 355.5$$

dl = 362.40 - 355.2 = 6.9 ft

Water levels:		SW-3	MW-1D-91	dh	i_V (dh/dl)
WET:	May 12/93	369.34	369.46	-0.12	-0.017 (upward)
DRY:	June 17/93	366.01	365.45	0.56	0.08 (downward)
DRY:	July 24/95	Dry	361.86	--	--
DRY:	July 12/2001	365.05	364.98	0.07	0.010 (downward)
WET:	June 3/2002	369.64	369.74	-0.10	-0.014 (upward)

ii) SW-4 (shallow) bottom elevation = 361.3
MW-2D-91 (bedrock) midpoint of open corehole =

$$\frac{353.2 + 325.2}{2} = \frac{678.4}{2} = 339.2$$

dl = 361.3 - 339.2 = 22.1 ft

HYDRAULIC GRADIENTS
NEPERA INC., FORMER LAGOON SITE
HAMPTONBURGH, NEW YORK

Water levels:		SW-4	MW-2D-91	dh	i_V (dh/dl)
WET:	May 12/93	373.41	371.01	2.4	0.109 (downward)
DRY:	July 24/95	367.28	364.88	2.4	0.109 (downward)
DRY:	July 12/2001	368.96	366.68	2.28	0.103 (downward)
WET:	June 3/2002	373.08	370.29	2.79	0.126 (downward)

c) Southern portion of the Site:

i) SW-7 (shallow) bottom elevation = 356.7
MW-4D-91 (bedrock) midpoint of open corehole =
$\frac{352.1 + 346.9}{2} = \frac{699}{2} = 349.5$
dl = 356.7 - 349.5 = 7.2 ft

Water levels:		SW-7	MW-4D-91	dh	i_V (dh/dl)
WET:	May 12/93	360.57	360.48	0.09	0.0125 (downward)
DRY:	June 17/93	358.89	358.75	0.14	0.0194 (downward)
DRY:	July 24/95	Dry	357.03	--	--
DRY:	July 12/2001	358.89	358.75	0.14	0.0194 (downward)
WET:	June 3/2002	361.02	360.91	0.11	0.0153 (downward)

ii) SW-9 (shallow) bottom elevation = 351.5
DW-1 (bedrock) midpoint of open corehole = $\frac{343 + 215.2}{2} = 279.1$

dl = 351.5 - 279.1 = 72.4 ft

DW-1-95 (bedrock) midpoint of monitor interval (converted) = $\frac{252.4 + 247.4}{2}$ =
$\frac{499.8}{2} = 249.9$
dl = 351.5 - 249.9 = 101.6 ft

Water levels:		SW-9	DW-1	dh	i_V (dh/dl)
WET:	May 12/93	360.68	353.70 (original)	6.98	0.096 (downward)
WET:	June 1/95	358.94	352.80 (converted)	6.14	0.060 (downward)
DRY:	July 24/95	357.93	345.94 (converted)	11.99	0.118 (downward)
DRY:	July 12/2001	358.52	347.09 (converted)	11.43	0.113 (downward)
WET:	June 3/2002	361.26	351.63 (converted)	9.63	0.095 (downward)

iii) MW-11U-01 (shallow) bottom elevation = 336.7
MW-11D-01 (bedrock) midpoint of open corehole =
$\frac{321.5 + 311.5}{2} = \frac{633}{2} = 316.5$
dl = 336.7 - 316.5 = 20.2 ft

HYDRAULIC GRADIENTS
NEPERA INC., FORMER LAGOON SITE
HAMPTONBURGH, NEW YORK

Water levels:		MW-11U-01	MW-11D-01	dh	i_V (dh/dl)
DRY:	July 12/2001	343.48	343.36	0.12	0.0059 (downward)
WET:	June 3/2002	344.39	344.07	0.32	0.0158 (downward)

II. *Horizontal Hydraulic Gradients in the Shallow Aquifer*
The horizontal hydraulic gradient (i_H) is the ratio of the difference in static water elevation compared to the plan distance between wells.

a) Area of northward flow in the Shallow Aquifer:

- from SW-4 to MW-1

$$i_H = \frac{dh}{dl} = \frac{367.28 - 350.75}{560} = \frac{16.53}{560} = 0.030 \text{ (July 24, 1995)}$$

$$= \frac{367.10 - 350.93}{570} = \frac{16.17}{570} = 0.028 \text{ (August 14, 1995)}$$

$$= \frac{368.96 - 351.9}{570} = \frac{17.06}{570} = 0.030 \text{ (July 12, 2001)}$$

$$= \frac{373.08 - 355.6}{570} = \frac{17.48}{570} = 0.031 \text{ (June 3, 2002)}$$

- from MW-3 to MW-1

$$i_H = \frac{dh}{dl} = \frac{366.89 - 350.75}{400} = \frac{16.14}{400} = 0.040 \text{ (July 24, 1995)}$$

$$= \frac{366.51 - 350.93}{400} = \frac{15.58}{400} = 0.039 \text{ (August 14, 1995)}$$

$$= \frac{368.65 - 351.9}{400} = \frac{16.75}{400} = 0.042 \text{ (July 12, 2001)}$$

$$= \frac{371.85 - 355.6}{400} = \frac{16.25}{400} = 0.041 \text{ (June 3, 2002)}$$

$i_{average} = 0.036$

b) Area of southward flow in the Shallow Aquifer:

- from MW-4 to PZ-3

$$i_H = \frac{dh}{dl} = \frac{367.17 - 360.66}{270} = \frac{6.51}{270} = 0.024 \text{ (July 24, 1995)}$$

$$= \frac{365.86 - 360.33}{270} = \frac{5.53}{270} = 0.021 \text{ (August 14, 1995)}$$

HYDRAULIC GRADIENTS
NEPERA INC., FORMER LAGOON SITE
HAMPTONBURGH, NEW YORK

- from MW-4 to SW-8

$$i_H = \frac{dh}{dl} = \frac{367.17 - 359.16}{380} = \frac{8.01}{380} = 0.021 \text{ (July 24, 1995)}$$

$$= \frac{365.86 - 358.78}{430} = \frac{7.08}{430} = 0.0165 \text{ (August 14, 1995)}$$

$$= \frac{367.85 - 360.04}{430} = \frac{7.81}{430} = 0.020 \text{ (July 12, 2001)}$$

$$= \frac{372.57 - 363.91}{430} = \frac{8.66}{430} = 0.020 \text{ (June 3, 2002)}$$

$i_{average} = 0.020$

III. *Horizontal Hydraulic Gradients in the Bedrock Aquifer*

a) Area of northward flow in the Bedrock Aquifer:

- from MW-2D-91 to DW-2-95

$$i_H = \frac{dh}{dl} = \frac{364.88 - 354.89}{400} = \frac{9.99}{400} = 0.025 \text{ (July 24, 1995)}$$

$$= \frac{364.63 - 354.95}{420} = \frac{9.68}{420} = 0.023 \text{ (August 14, 1995)}$$

$$= \frac{366.68 - 343.37}{420} = \frac{23.31}{420} = 0.056 \text{ (July 12, 2001)}$$

$$= \frac{370.29 - 358.05}{420} = \frac{12.24}{420} = 0.029 \text{ (June 3, 2002)}$$

$i_{average} = 0.033$

HYDRAULIC GRADIENTS
NEPERA INC., FORMER LAGOON SITE
HAMPTONBURGH, NEW YORK

b) Area of southward flow in the Bedrock Aquifer:

- from MW-2D-91 to MW-4D-91

$$i_H = \frac{dh}{dl} = \frac{364.88 - 357.03}{400} = \frac{7.85}{400} = 0.020 \text{ (July 24, 1995)}$$

$$= \frac{366.68 - 358.75}{400} = \frac{7.93}{400} = 0.020 \text{ (July 12, 2001)}$$

$$= \frac{370.29 - 360.91}{400} = \frac{9.38}{400} = 0.023 \text{ (June 3, 2002)}$$

- from MW-2D-91 to DW-1-95

$$i_H = \frac{dh}{dl} = \frac{364.88 - 345.94}{840} = \frac{18.94}{840} = 0.023 \text{ (July 24, 1995)}$$

$$= \frac{364.63 - 345.69}{840} = \frac{18.94}{840} = 0.023 \text{ (August 14, 1995)}$$

$$= \frac{366.68 - 347.09}{840} = \frac{19.59}{840} = 0.023 \text{ (July 12, 2001)}$$

$$= \frac{370.29 - 351.63}{400} = \frac{18.66}{400} = 0.022 \text{ (June 3, 2002)}$$

- from MW-1D-91 to MW-3D-91

$$i_H = \frac{dh}{dl} = \frac{362.44 - 347.64}{590} = \frac{14.80}{590} = 0.025 \text{ (August 14, 1995)}$$

$$= \frac{364.98 - 349.54}{590} = \frac{15.44}{590} = 0.026 \text{ (July 12, 2001)}$$

$$= \frac{369.74 - 351.16}{590} = \frac{18.58}{590} = 0.031 \text{ (June 3, 2002)}$$

$i_{average} = 0.024$

HYDRAULIC GRADIENTS
NEPERA INC., FORMER LAGOON SITE
HAMPTONBURGH, NEW YORK

$$i_H = \frac{dh}{dl} = \frac{362.44 - 347.64}{590} = \frac{14.80}{590} = 0.025 \text{ (August 14, 1995)}$$

$$= \frac{364.98 - 349.54}{590} = \frac{15.44}{590} = 0.026 \text{ (July 12, 2001)}$$

$$= \frac{369.74 - 351.16}{590} = \frac{18.58}{590} = 0.031 \text{ (June 3, 2002)}$$

$i_{average} = 0.024$