Appendix D:

DEP Sediment Data

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INTEROFFICE MEMO

DATE: 09/02/03

TO: TRACI IOTT

CC: ERNIE PIZUTTO,GUY HOFFMAN, LEE DUNBAR

FROM: CHRIS BELLUCCI

RE: HEMINWAY POND SEDIMENT SAMPLING

Sediment core samples were collected from Heminway Pond on August 28, 2003 by Guy Hoffman and myself. Samples were collected using a piston core sampler on loan from USGS. The Town of Watertown Parks and Recreation Department provided personnel and a rowboat. Samples were collected from the following locations- HP1, HP 2, HP 3, HP 4 and in front of the dam (HP 5,6,7) -see Figure 1. A reference sample was not collected on this date due to time constraints.

Table 1 summarizes the water depth, sediment depth, core retrieval, and sample designation. A total of 18 individual sediment samples were collected. To identify each individual sample, the surface layer (0-0.5') was designated "A", mid-depth (0.5-2.5') was designated "B", and the bottom layer (> 2.5') was designated "C".

Sediments were consistently fine-grained and grey black at HP1, HP2, HP3 (see Figure 2). Sediments at HP 4 were shallow and only a surface layer sample could be collected. Samples from in front of Heminway Pond dam (HP5,HP6,HP7) had noticeably more leaf and plant material and a petroleum odor with noticeable oil sheen when washed in water.

Samples will be held in the walk-in cooler at the DEP lab at the Health Department pending a decision on laboratory funding.

Table 1. Summary of water depth, sediment depth, core retrieval, and sample designation.

Description	Sediment Sampling Location						
	HP 1	**HP 2**	**HP 3**	**HP 4**	**HP 5**	**HP 6**	**HP7**
Water Depth	37 "	22"	25"	45"	37"	35"	37"
Sediment Depth	34"	45"	41"	8"	29.5"	37"	39.5"
Core Retrieval	28"	32"	32"	7.25"	21.5"	29"	32"
Sediment Compaction	6.0 "	13"	9"	0.75 "	8"	8"	7.5"
0-0.5 ft (A layer)	HP1-A	HP2-A	HP3-A	HP4-A	HP5-A*	HP6-A	HP7-A
0.5-2.5 ft (B layer)	HP1-B	HP2-B	HP3-B	None	HP5-B	HP6-B	HP7-B
> 2.5 ft (C layer)	HP1-C*	HP3-C	HP3-C	None	None	HP6-C	HP7-C

* Composite with second core at same location due to lack of representative sample on first core.

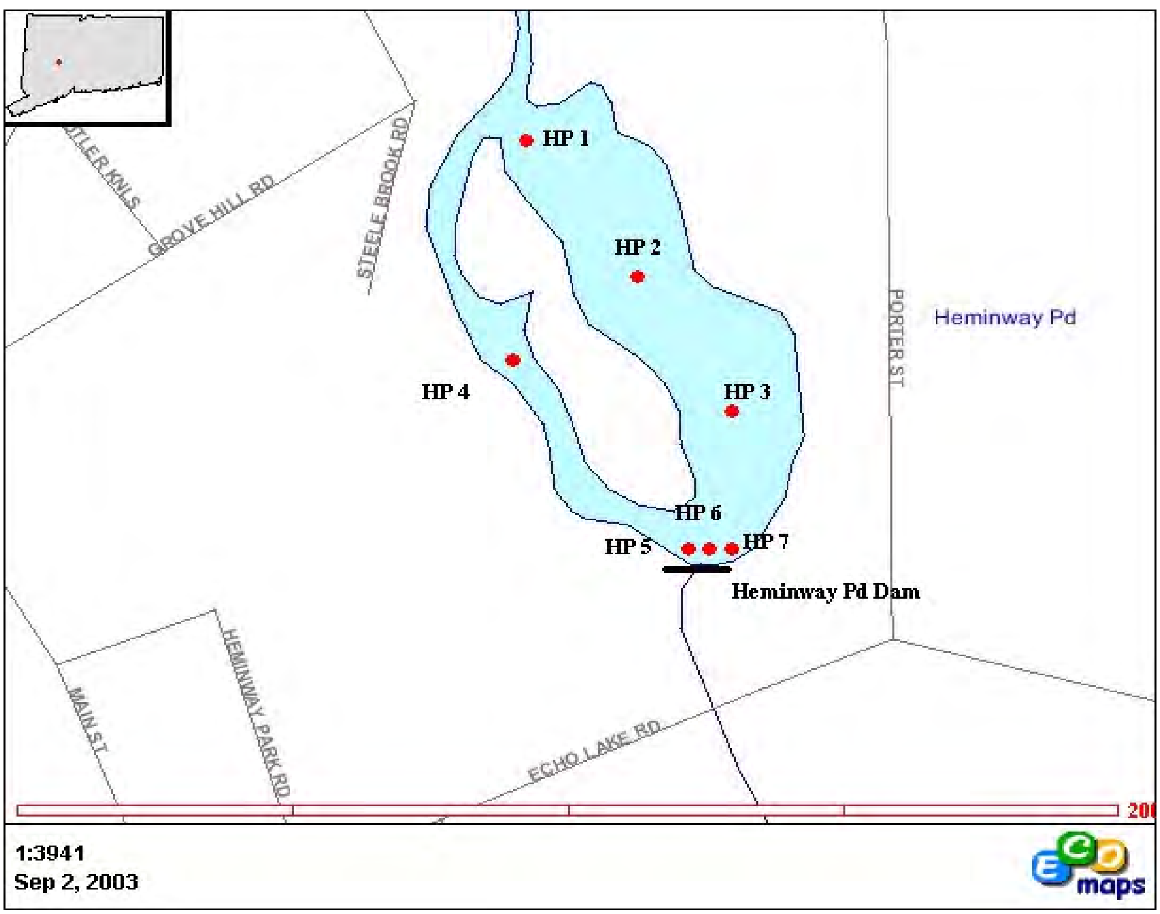

Figure 1. Heminway Pond sediment sampling sites.

Figure 2. Sediment cores from Heminway Pond from HP 3.

Interdepartmental Memo
Department of Environmental Protection
Bureau of Water Management

To: Christopher Bellucci

From: Traci Iott

Date: March 11, 2004

Re: Review of Sediment Data - Hemingway Pond

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I have reviewed the sediment data collected at Hemingway Pond in Watertown on August 28, 2003. Sediment samples were collected at seven locations within the Pond from three sediment horizons (0-0.5 ft, 0.5 - 2.5 ft, > 2.5 ft). The sediments contained metals and Polynuclear Aromatic Hydrocarbons (PAHs), compounds derived from petroleum products. Pesticides and PCBs were not detected in these samples. In general, sediment quality did not vary substantially either among the sampling locations or the sediment horizons. Of all the locations sampled within the pond, sample location 4 had the highest concentrations of metals and PAHs in comparison with the other sampling locations.

Potential risks to both aquatic life and human health were evaluated using environmental benchmarks. The consensus-based freshwater sediment quality benchmarks developed by MacDonald *et al* were used to evaluate potential impacts to aquatic life. While the data does show elevation of some constituents above threshold benchmarks, it is unlikely, with the exception of Station 4, that these sediments pose any substantial risk to aquatic organisms even when aggregate toxicity of both metals and PAHs are considered. The sample collected at Station 4 had elevated copper and lead concentrations as well as the highest levels of PAHs. These sediments may impact aquatic organisms. However, if the dam is removed, this area may become uplands and therefore would not be of concern for aquatic life.

Direct Exposure Criteria for Residential Scenarios were used to screen the sediment data for potential risks to people who may come in direct contact with the sediments. This is a conservative evaluation since these criteria are predicated upon the assumption of a daily exposure for a period of thirty years. However, some level of conservatism is warranted given that the western portion of the pond borders a town park. The concentrations of metals and most PAHs are below residential direct exposure criteria. However, these criteria were generally exceeded in most samples for benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene. In most cases, the levels of these compounds were 1.1 to 2 times the criteria values. However, samples collected at depth (>2.5 feet) at location 1 were 2.5 to 3 times greater than criteria values. This is not likely a risk to people given that the sediments are not readily accessible due to depth and location of the sample collection. Surficial sediments from location 4 were between 4 to 5 times greater than applicable criteria values. This is of greater concern since this sampling location is the closest to the town park and is most likely to become accessible as dry land once the dam is removed. I recommend that the placement of clean fill in this area be evaluated as a means of reducing potential contact with the contaminants in the sediments, should this area become accessible.

In summary, most sediment within Hemingway Pond is not likely to pose a risk to either people or aquatic organisms. Removal sediment from the pond is not needed based on the level of chemicals within the sediments. The one exception is the sediments collected at Station 4. Isolation of these sediments, preventing direct contact, should be considered if removal of the dam is likely to allow this area to become more accessible.

As consideration of the removal of the dam proceeds, releases of fine bedded sediments to downstream areas must be prevented, because such releases have deleterious impacts on valuable aquatic life habitat.

Attatchment to Chain of Custody

Parameter List for Aquatic Sedements
Connecticut DEP

Run all parameters for each sample ID:

Metals: Antimony, Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Silver, Zinc
Detection Limit: 1 mg/kg

Pesticides: Chlordane, Total DDT, Dieldrin, Endrin, Heptachor, Lindane
Detection Limit 1ug/kg

PAH's: Acenaphtene, Acenapthylene, Anthracene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Chrysene, Dibenzo(a,h)anthracene, Flouranthene, Flourene, 2-Methylnapthalene, Naphthalene, Phenanthrene, Pyrene, Total PAHs
Detection Limit: 10 ug/kg

PCBs: Congener Specific- 8082
Detection Limit: 10 ug/kg

TOC

Grain Size

Results should be reported as dry weight

Christopher Bellucci
Christopher.bellucci@po.state.ct.us
CTDEP Bureau of Water Management
TMDL Program
79 Elm Street
Hartford, CT 06106
860-424-3735

Heminway Pond Sediments
Sampled 08/28/03

		Site																		
UNITS	ANALYTE	HP 1A	HP 1B	HP 1C	HP 2A	HP 2B	HP 2C	HP 3A	HP 3B	HP 3C	HP 4A	HP 5A	HP 5B	HP 6A	HP 6B	HP 6C	HP 7A	HP 7B	HP 7C
%	% Solids	45.1	48	52	43.1	42.9	54.7	38.7	44.3	50.4	49.3	44.3	42.3	56.1	65.1	52	63	52.2	55.8
mg/kg	Antimony	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Arsenic	1.1	1.64	2.83	0	1.46	1.01	0	1.53	1.09	2.46	1.38	1.71	0.894	0	1.28	0.843	1.28	2.41
	Barium	117	137	116	80.8	124	92	97.9	99	102	106	73.6	112	50.7	66.3	112	58.7	106	93.7
	Cadmium	1.56	1.68	1.67	0.965	1.68	1.25	1.21	1.37	1.48	1.07	0.944	1.46	0.616	0.865	1.35	0.75	1.39	1.23
	Chromium	26.8	33.1	28.1	18	26.1	22.4	23.6	20.8	25.2	22.8	17.3	27	11.8	15.7	26.7	13.5	26.4	23
	Copper	87.5	101	117	47.8	104	71.3	56.4	91.5	86.9	147	56.2	87.9	33.8	52.4	84.6	42.2	79.6	90.1
	Lead	52.8	81.9	104	32.4	62.4	58.8	37.2	54	65.8	104	34.2	120	24.1	38.1	76.4	25.4	58.2	74.3
	Mercury	0.244	0.214	0.235	0	0.285	0	0	0.258	0.268	0.315	0	0.271	0	0	0	0	0.202	0.19
	Nickel	23.6	27.4	23.8	14.9	24.2	18.7	19.6	19.9	20.8	18.6	16.2	21.9	11.1	13.3	21.6	12.4	21.7	19
	Silver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total Organic Carbon	10900	22800	16700	18300	17800	15900	31200	14800	11400	13900	15700	16600	10900	10400	13900	8450	13100	13100
	Zinc	209	188	204	141	235	151	169	204	182	167	144	179	90.4	113	150	110	172	144
N/A	Fractional % Sieve #10 (4750-2000µm)					16.6					5			7.3				7.8	
	Fractional % Sieve #140 (250-106µm)					4.6					13.4			19.6				11.8	
	Fractional % Sieve #20 (2000-850µm)					17.3					6.1			8.6				8	
	Fractional % Sieve #200 (106-75µm)					7.8					35.7			28.6				24.8	
	Fractional % Sieve #230 (75-62.5µm)					28.8					26.9			17.9				34.4	
	Fractional % Sieve #4 (>4750µm)					9.2					2.7			2				2.9	
	Fractional % Sieve #40 (850-425µm)					10.9					4.7			6.6				5.6	
	Fractional % Sieve #60 (425-250µm)					4.8					5.4			9.5				4.7	
ug/kg	2-Fluorobiphenyl	1940	1980	1470	2060	1600	1410	2020	1890	1490	1690	1570	1660	1490	1290	1320	1230	1470	1030
	2-Methylnaphthalene	9.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4,4-DB-Octafluorobiphenyl (Sr)	16	14.4	14.9	9.9	16.2	11.8	17	15	12	12.8	14.6	16.7	12	10.5	12.4	8.93	10.8	10.8
	4,4-DDD (p,p')	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4,4-DDE (p,p')	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4,4-DDT (p,p')	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	a-BHC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Acenaphthene	0	0	174	0	0	0	0	0	0	118	0	0	0	0	0	0	77.2	81.6
	Acenaphthylene	412	528	781	333	317	304	295	270	251	1230	302	322	307	170	277	194	322	387
	Aldrin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Anthracene	487	517	1000	453	354	280	347	313	296	1060	362	285	541	246	349	269	452	534
	b-BHC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Benzo (a) anthracene	1520	1540	2530	1330	1100	800	941	862	797	4030	862	719	1240	566	843	627	1240	1440
	Benzo (a) pyrene	1800	1950	3110	1460	1300	1010	1060	1040	1000	4810	1100	928	1160	731	998	764	1390	1670
	Benzo (b) fluoranthene	1960	2220	3390	1570	1360	1090	1150	1150	1050	5110	1140	1100	1430	844	1070	865	1620	1800
	Benzo (g,h,i) perylene	1230	1190	1640	1250	733	634	678	639	545	2500	1020	702	691	653	719	520	815	1010
	Benzo (k) fluoranthene	1400	1570	2520	1280	1130	836	908	876	757	3450	816	800	998	585	836	614	1120	1310
	Chlordane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chrysene	1800	2030	3300	1620	1380	1060	1190	1070	1060	4900	1100	1090	1410	778	1120	808	1550	1870
	d-BHC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Decachlorobiphenyl (Sr)	14.7	13.3	12.2	14.3	15.1	10.5	13.7	15.6	12.3	10.9	12.8	16.8	6.89	10.4	9.59	7.36	9.31	14.1
	Dibenzo (a,h) anthracene	367	221	361	240	0	0	0	0	0	649	206	0	118	96.3	176	115	178	195
	Dieldrin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Endosulfan I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Endosulfan II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Endosulfan Sulfate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Endrin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Endrin Aldehyde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fluoranthene	3730	3950	6950	3200	2450	1990	2070	1880	1990	8320	1980	1610	2800	1420	2150	1450	2740	3780
	Fluorene	129	142	369	109	99.2	83.7	0	0	99.2	229	103	0	107	73.8	99.5	79.8	149	160
	g-BHC (Lindane)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Heptachlor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Heptachlor Epoxide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Indeno (1,2,3-cd) pyrene	1200	1180	1610	1120	701	611	655	662	571	2490	996	704	684	625	715	511	796	1010
	Methoxychlor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Naphthalene	0	0	0	0	0	0	0	0	0	0	0	0	0	14.1	0	0	0	0
	PCB 1016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PCB 1221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PCB 1232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PCB 1242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PCB 1248	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PCB 1254	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PCB 1260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Phenanthrene	1630	1730	3860	1540	1090	969	0	917	959	3310	1040	831	1350	820	1020	798	1410	1870
	Pyrene	3590	3980	7040	3310	2530	2020	2280	2030	1990	8830	2070	1590	2870	1480	2160	1510	2880	3740
	Terphenyl-dl4	2180	1900	2060	2490	2110	1570	2550	2190	1960	2170	2100	2190	1610	1440	1730	1710	1840	1470

Heminway Pond Sediments
Sampled 08/28/03

UNITS	ANALYTE	HP 1A	HP 1B	HP 1C	HP 2A	HP 2B	HP 2C	HP 3A	HP 3B	HP 3C	HP 4A	HP 5A	HP 5B	HP 6A	HP 6B	HP 6C	HP 7A	HP 7B	HP 7C
	Toxaphene	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix E:

Ground Penetrating Radar Report

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United States Department of Agriculture

Natural Resources Conservation Service

11 Campus Boulevard
Suite 200
Newtown Square, PA 19073

Subject: ENG -- Ground-Penetrating Radar (GPR) Assistance

Date: 28 June, 2007

To: Margo L. Wallace
State Conservationist
USDA-NRCS,
344 Merrow Road, Suite A
Tolland, CT 06084-3917

Purpose:
Considerations are being made for the removal of the dam that impounds Hemingway Pond in Watertown, Connecticut. A bathymetric survey was conducted with ground-penetrating radar (GPR) to assess the thickness of recent sediments within Hemingway Pond.

Participants:
Charles Berger, Town Engineer, Public Works Department, Watertown, CT
Rudy Chlanda, Geologist, USDA-NRCS, Amherst, MA
Jim Doolittle, Research Soil Scientist, USDA-NRCS-NSSC, Newtown Square, PA
Joe Kavan, Civil Engineer, USDA-NRCS, Tolland, CT
Lisa Krall, Soil Scientist, USDA-NRCS, Tolland, CT
Shawn McVey, Assistant State Soil Scientist, USDA-NRCS, Tolland, CT
Donald Parizek, Soil Scientist, USDA-NRCS, Windsor, CT
Benjamin Smith, Hydrologist, USDA-NRCS, Tolland, CT

:tivities:
All field activities were completed on 18 June 2007.

Background:
The dam that impounds Hemingway Pond is being considered for removal. Bottom sediments from the pond were tested and found to contain metals and Polynuclear Aromatic Hydrocarbons (PAHs) (Traci Lott's interdepartmental memo (Connecticut DEP, Bureau of Water Management) to Christopher Bellucci; dated 11 March 2004). Based on the levels of chemicals within these sediments, their removal is not considered necessary. However, the release of sediments downstream needs to be limited to prevent adverse effects on aquatic life habitats. A ground-penetrating radar (GPR) survey was request by the NRCS Engineering Staff in Tolland, Connecticut, to assess the relative thickness of these bottom sediments. Ground-penetrating radar (GPR) has been used to map the topography and characterize the sediments within lakes (Moorman and Michel, 1997; Mellett, 1995; Sellmann et al., 1992; Izbicki and Parker, 1991; Truman et al., 1991; and Haeni et al., 1987) and stream channels (Spicer et al., 1997).

Summary:
1. A GPR survey was completed at Hemingway Pond. The results of this survey are displayed in Figures 4 & 5.

2. All GPR estimated data on the depth to bottom sediment and coordinates of each observation point have been e-mailed to Rudy Chlanda and Benjamin Smith. This data set is contained in the compendium to this report.

It was my pleasure to be of assistance to you and your staff.

With kind regards,

m Doolittle
Research Soil Scientist
National Soil Survey Center

cc:

B. Ahrens, Director, National Soil Survey Center, USDA-NRCS, Federal Building, Room 152, 100 Centennial Mall North, Lincoln, NE 68508-3866

Chlanda, Geologist, USDA-NRCS, 451 West Street, Amherst, MA 01002-2934

Golden, Director of Soil Survey Division, USDA-NRCS, Room 4250 South Building, 14th & Independence Ave. SW, Washington, DC 20250

D. Hammer, National Leader, Soil Investigation Staff, National Soil Survey Center, USDA-NRCS, Federal Building, Room 152, 100 Centennial Mall North, Lincoln, NE 68508-3866

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B. Thompson, MO Staff Leader, USDA-NRCS, 451 West Street, Amherst, MA 01002-2934

W. Tuttle, Soil Scientist (Geophysical), National Soil Survey Center, USDA-NRCS, P.O. Box 974, Federal Building, Room G08, 207 West Main Street, Wilkesboro, NC 28697

Equipment:
The radar unit is the TerraSIRch Subsurface Interface Radar (SIR) System-3000 ®, manufactured by Geophysical Survey Systems, Inc. (GSSI, Salem, NH).[1] The SIR System-3000 consists of a digital control unit (DC-3000) with keypad, SVGA video screen, and connector panel. A 10.8-volt lithium-ion rechargeable battery powers the system. The SIR System-3000 weighs about 9 lbs (4.1 kg) and is backpack portable. A 200 MHz antenna was used in this survey. While not the lowest frequency antenna available to USDA-NRCS, the 200 MHz antenna provided the best balance of penetration depth and resolution at Hemingway Pond. This antenna provided adequate depth (greater than 3 m) and acceptable resolution of subsurface features.

Radar records contained in this report were processed with the RADAN for Windows ® (version 5.0) software program developed by GSSI.[1] Processing included setting the initial pulse to time zero, color transformation, header and marker editing, distance normalization, horizontal stacking, migration, filtration, and range gain adjustments.

An Allegro CX ® field computer (Juniper Systems, North Logan, Utah) and a Garmin Global Positioning System Map 76 ® receiver (with a CSI Radio Beacon receiver, antenna, and accessories that are fitted into a backpack) (Garmin International, Inc., Olathe, Kansas) were used to record the coordinates of the reference stations that were impressed on the radar record.[1] The Garmin GPS receiver was operated in the manual mode. Geodetic datum was WGS-84 (World Geodetic System of 1984). The Geographic Coordinate system (longitude/latitude) was used with units expressed in decimal degrees.

SURFER for Windows ® (version 8.0) (Golden Software, Inc., Golden, CO), was used to construct the images of the estimated water depths and bottom sediment thicknesses displayed in this report.[1] Grids were created using kriging methods with an octant search.

Figure 1. The Web Soil Survey map of the area surrounding Hemingway Pond.

Hemingway Pond Site:
The pond is located off of Echo Lake Road and Porter Street in downtown Watertown, Connecticut (see Figure 1). The pond has formed behind a dam which retards the flow of water along Steele Brook. The pond is irregularly shaped and bounded by dense

[1] Manufacturer's names are provided for specific information; use does not constitute endorsement.

vegetation, commercial buildings, and public parks. The pond shows evidence of sedimentation. The dominate soil located along the floodplain is Pootatuck. The very deep, moderately well drained Pootatuck soils formed in loamy alluvial sediments. Pootatuck is a member of the coarse-loamy, mixed, active, mesic Fluvaquentic Dystrudepts soil taxonomic family. The names of the soil map units identified in the immediate vicinity of Hemingway pond are listed in Table 1.

Table 1. The names and symbols for the soil map units identified in the study areas.

Soil Map Unit Symbol	Soil Map Unit Name
34C	Merrimac sandy loam, 8 to 15 % slopes
102	Pootatuck fine sandy loam
306	Udorthents-Urban land complex
307	Urban land

Survey Procedures:
The radar system and 200 MHz antenna were mounted in a fiberglass canoe. The canoe was powered by a small trolling motor. The canoe made eight traverses across different portions and arms of Hemingway Pond. Except along the center lines of channels, which formed the two northward extending arms of the pond, traverse lines were serendipity located and were adjusted to avoid grounding on sand bars and entanglement in overlying tree limbs. The canoe frequently bottomed-out on underwater sandbanks. Reference points for both GPS and GPR were recorded simultaneously at intervals of 10 seconds. Because of wave-path masking from dense vegetation, differential GPS was not always available.

Calibration of GPR:
Ground-penetrating radar is a time scaled system. This system measures the time that it takes electromagnetic energy to travel from an antenna to an interface (e.g., soil horizon, bedrock, stratigraphic layer) and back. To convert the travel time into a depth scale, either the velocity of pulse propagation or the depth to a reflector must be known. The relationships among depth (D), two-way pulse travel time (T), and velocity of propagation (v) are described in the following equation (Daniels, 2004):

$$v = 2D/T \qquad [1]$$

The velocity of propagation is principally affected by the relative dielectric permittivity (E_r) of the profiled material(s) according to the equation (Daniels, 2004):

$$E_r = (C/v)^2 \qquad [2]$$

where C is the velocity of propagation in a vacuum (0.298 m/ns). Velocity is expressed in meters per nanosecond (ns). For water, the E_r is 80 and the v is 0.033 m/ns.

As the physical properties of the bottom sediments were unknown at the time of this investigation, hyperbola matching techniques were used to estimate the average propagation velocity. When radar waves impinge on a point object of contrasting electrical properties, a diffraction hyperbola is produced on the radar record. The resulting hyperbola is caused by the radar's hemispherical wavefront. The apex of the hyperbola is produced when the GPR is directly over the point object (the shortest travel path). As the antenna move away from the object, the signal travels farther and thus appears later in time or deeper in the record. The slope of the hyperbola asymptotes is related to the propagation velocity thru the material. The asymptotes become steeper as the velocity of the material decreases. During post processing, modeled hyperbolic shapes were fitted to the shapes of point reflectors buried in the bottom sediments. This resulted in the estimation of an average velocity of 0.066 m/ns and an E_r of 25 for the bottom sediments.

On radar records, reflections from interfaces spaced closer than one-half wavelength apart are indistinguishable due to constructive and destructive interference (Daniels, 2004). Daniels (2004) used the following equation to show the relationship between velocity of propagation (v), antenna center frequency (f), and wavelength (λ):

$$\lambda = v/f \qquad [3]$$

Equation [3] shows that the propagated wavelength will decrease with decreasing propagation velocity and increasing antenna frequency. Using equation [3] and the velocity of pulse propagation through the bottom sediments (0.066 m/ns) results in a wavelength of about 30 cm for the 200 MHz antenna. With the 200 MHz antenna, submerged layers spaced closer (vertically) than ½ a wavelength (or about 15 cm) are indistinguishable on radar records.

'th the 200 MHz antenna the lake-bottom sediments were penetrated. Variations in sediments are distinguishable on radar ...ords. However, the compositions of these layers are unknown. As no borings were made through these sediments at the time of this survey, the identity of these layers can not be verified nor their thickness accurately estimated.

Interpretation of GPR Data:
Radar records were of good interpretative quality. Figures 2 and 3 are portions of radar records collected in Hemingway Pond. In both figures, the depth and distance scales are expressed in meters. Although the radar provides a continuous profile, measurements of the water depth were restricted to the reference points (white, vertical lines at the top of the radar records shown in Figures 2 and 3). On these radar records, these lines appear at a distance interval of about 5 meters.

In Figure 2, the horizontal, moderate-amplitude (colored red) reflector at the top of the radar record represents the reflection from the water's surface. Below the surface reflection, the first series of high-amplitude reflections represents the water/ bottom sediment interface. On this portion of the radar record, this interface varies in depth from about 75 to 110 cm. Typically, the bottom sediments consist of a series of weak to moderate amplitude, slightly inclined, parallel, planar reflectors (in Figure 2, see imagery between the 5 and 25 m distance marks). However, in some portions of the pond, reflectors were higher in amplitude, and were more irregular or segmented in appearance (in Figure 2, see imagery between the 0 and 5 m distance marks), or consisted of multiple interfaces that were difficult to discriminate from the original bottom sediments. In these portions of the pond, the distinction of bottom sediments from original bottom materials was unclear and more ambiguous. In general, the contact between bottom sediments and original bottom materials was abrupt and highly contrasting, indicating substantial differences in moisture content and density. As a consequence, this interface provided a high amplitude continuous planar reflection that could be traced laterally across most portions of the radar records. As seen in Figure 2, the original bottom materials have a unique graphic signature or appearance that enables their distinction from the overlying, more recent bottom sediments. Compared with the bottom sediments, the original bottom materials generally consisted of segmented, irregular and wavy, high amplitude reflectors.

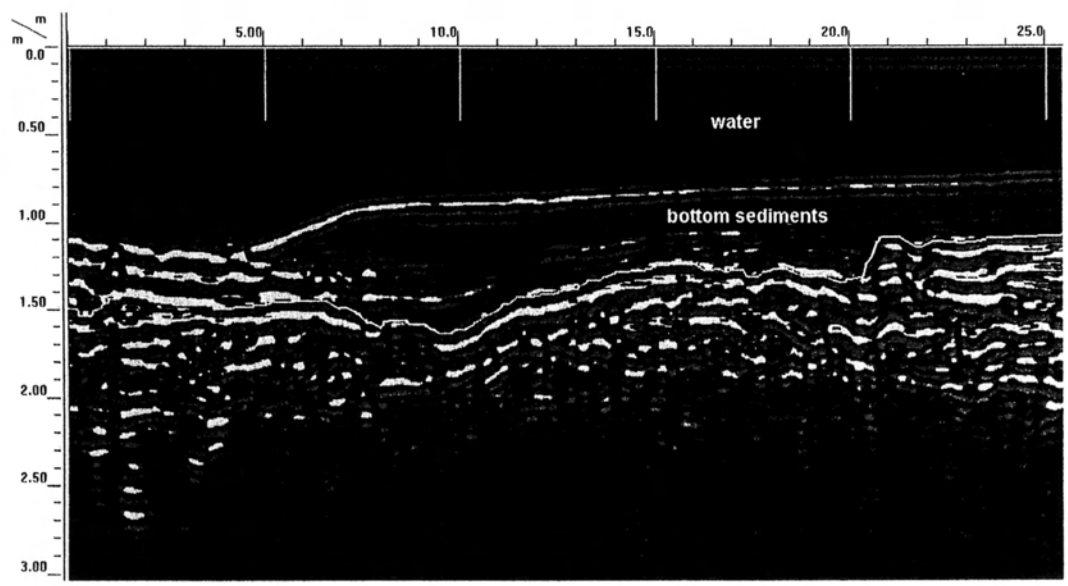

Figure 2. Each material has dissimilar dielectric properties and unique graphic signatures on this portion of a radar record from Hemingway Pond.

In shallower portions (< 30 cm) of Hemingway Pond the surface pulse and the water/ bottom sediment interface were superimposed and difficult to differentiate (see Figure 3 between the 15 and 25 m distance marks). In some portions of the pond, because of slight differences in particle sizes and densities, or the occurrence of gradational boundaries, the contact between the bottom sediments and the original bottom materials was ambiguous. The interface separating the recent bottom sediments and the original ttom sediments provides a high amplitude reflection in the left-hand portion of the radar record shown in Figure 3. Here the ..aterials are assumed to have abrupt and highly contrasting dielectric properties. However, in the right-hand portion of the radar record shown in Figure 3, the materials have gradational and/or less contrasting dielectric properties and the interface is less obvious and more interpretative.

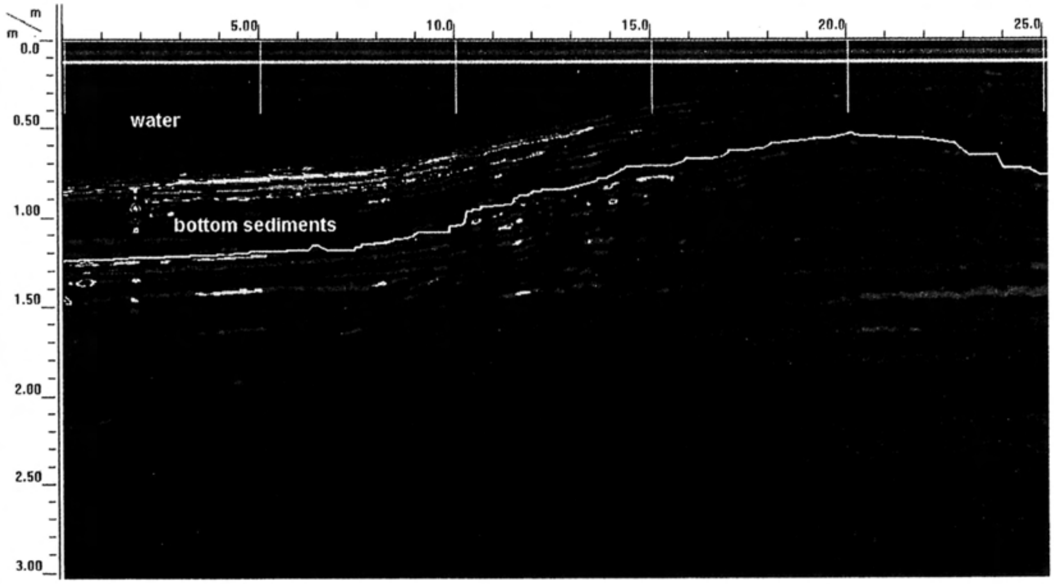

Figure 3. In some portions of Hemingway Pond interfaces are too closely spaced, gradational, or separate less dissimilar materials and are difficult to interpret.

Depth Estimates and Contouring:
The radar survey was completed in 1/2 day. The depths to bottom sediments were recorded at 202 points using GPR and GPS. Based on GPR interpretations, the average water depth was 40 cm with a range of 10 to 134 cm. At one half of the reference points, the water depth was between 24 and 54 cm. Based on GPR interpretations, the thickness of the recent bottom sediments averaged 134 cm with a range of 49 to 270 cm. At one half of the reference points, the thickness of the bottom sediments was between 101 and 165 cm.

.. nile these statistics are useful, two-dimensional plots of these estimates provide more coherent pictures of spatial variations within Hemingway Pond. In Figures 4 and 5, the outline of Hemingway Pond was digitized off of recent photographs. In these plots, it must be emphasized that data were collected only in areas covered with sufficient water and where the canoe's steerageway could be maintained. Because of sedimentation, large areas of Hemingway Pond are covered by sand bars, or are too shallow or overgrown with vegetation to be surveyed. These areas are colored green in the accompanying plots.

Figure 4 is a two-dimensional contour map of water depths. In this plot, the contour interval is 25 cm. Figure 5 is a two-dimensional contour map of sediment thicknesses. In this plot, the contour interval is 50 cm. In each plot, colors have been used to help express differences in estimated depths or thicknesses.

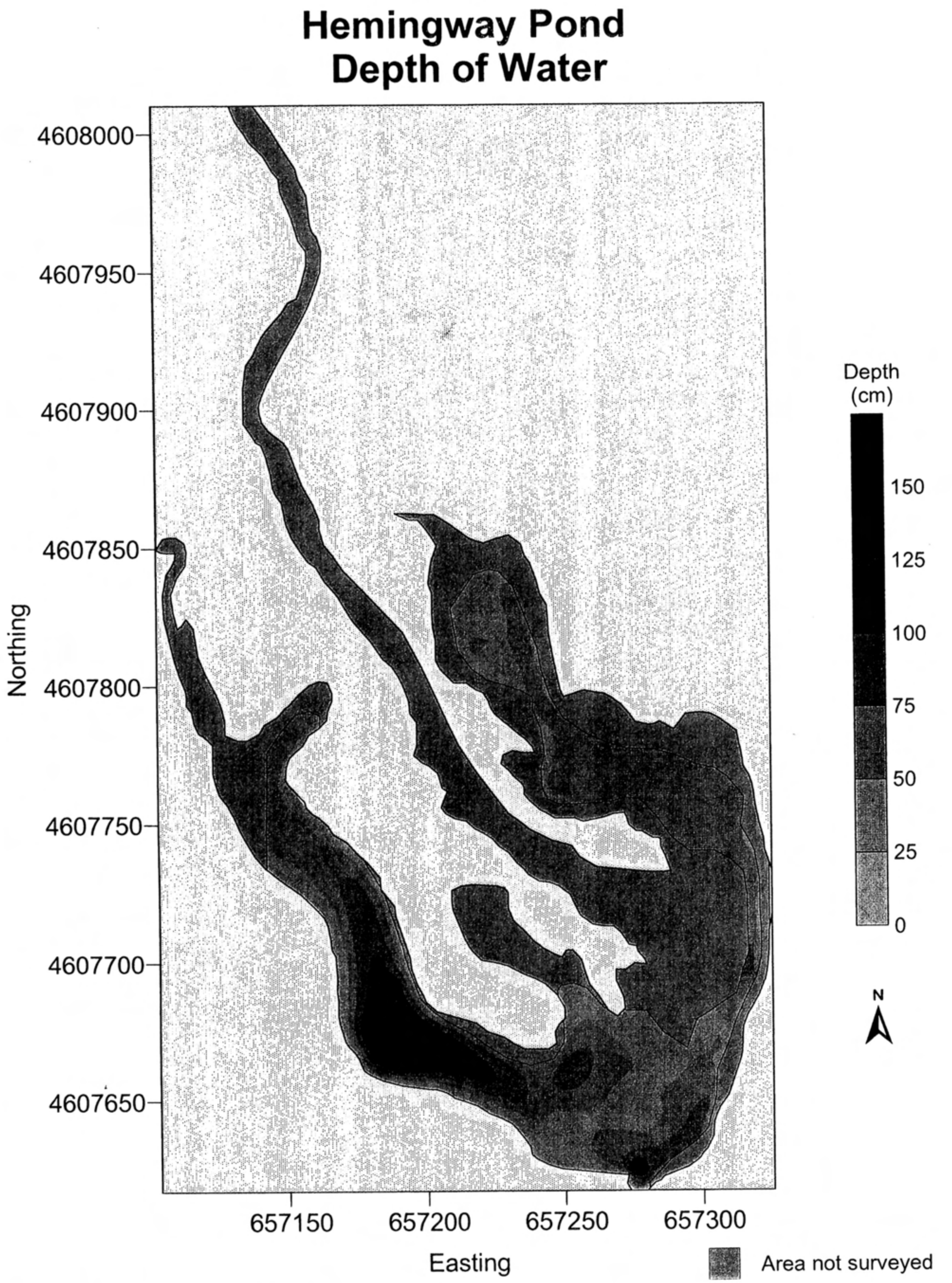

Figure 4. GPR interpreted depths of water within Hemingway Pond. The extensive areas shown in green were not surveyed because they were too shallow or too overgrown with vegetation.

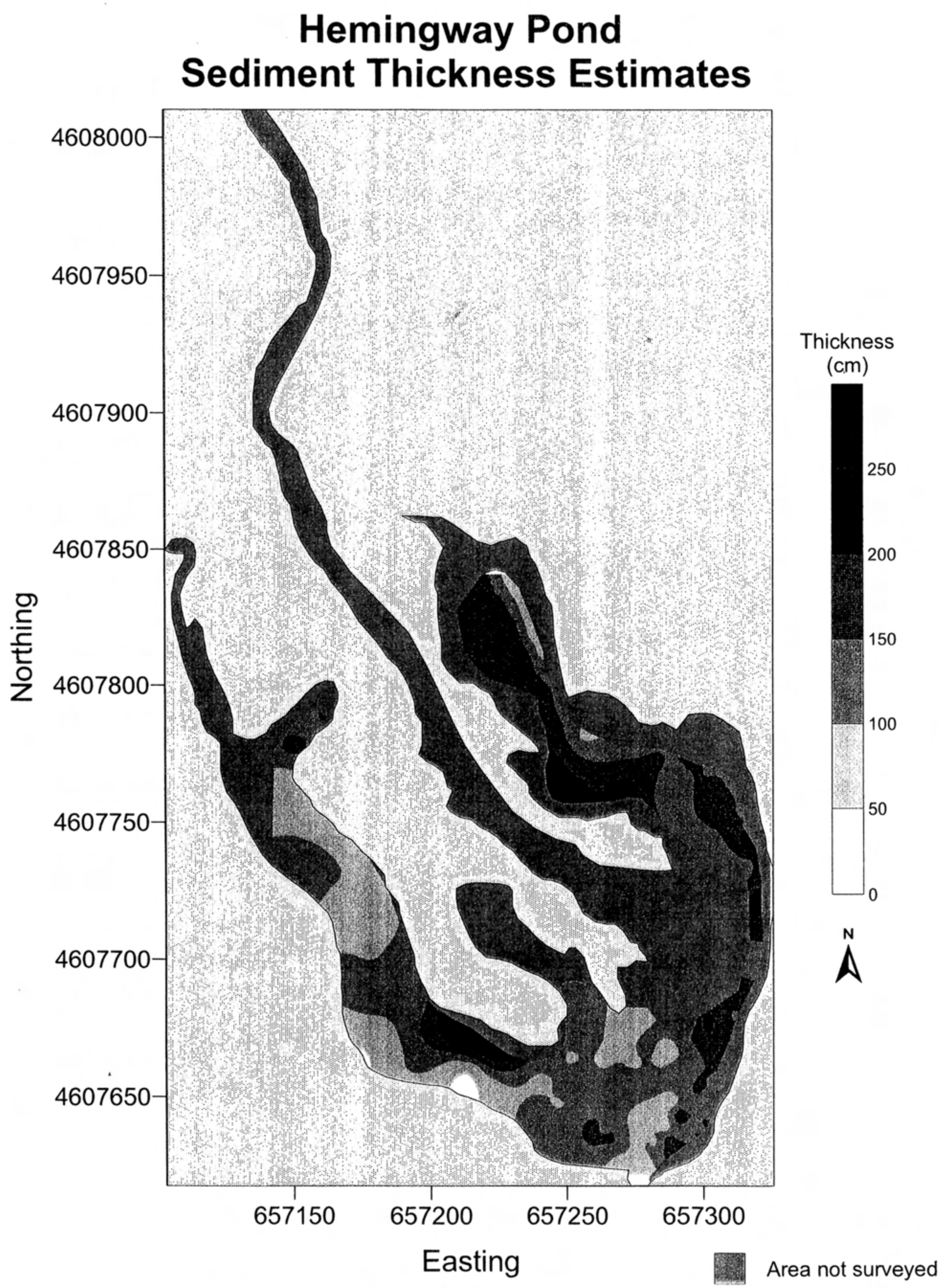

Figure 5. GPR interpreted thickness of bottom sediments within Hemingway Pond. The extensive areas shown in green were not surveyed because they were too shallow or too overgrown with vegetation.

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Data Collected on Hemingway pond with GPR and GPS

Observation	Easting	Northing	Water Depth (cm)	Thickness of Bottom Sediments
1	657280	4607621	70	66
2	657274	4607625	134	49
3	657267	4607631	58	112
4	657260	4607633	28	155
5	657252	4607637	24	132
6	657246	4607642	23	157
7	657240	4607647	41	147
8	657233	4607650	59	92
9	657222	4607655	79	75
10	657215	4607661	91	62
11	657208	4607662	95	76
12	657198	4607661	89	114
13	657192	4607661	87	110
14	657185	4607663	106	62
15	657180	4607668	100	57
16	657177	4607675	103	58
17	657177	4607682	79	119
18	657178	4607691	77	154
19	657178	4607700	72	96
20	657176	4607708	68	92
21	657174	4607716	65	84
22	657169	4607724	53	82
23	657165	4607732	44	111
24	657158	4607737	37	122
25	657149	4607740	36	120
26	657142	4607746	35	97
27	657159	4607788	50	152
28	657155	4607785	54	80
29	657152	4607780	50	177
30	657148	4607775	52	152
31	657147	4607768	37	83
32	657148	4607760	32	63
33	657151	4607752	35	82
34	657156	4607747	37	85
35	657163	4607742	40	89
36	657170	4607737	44	86
37	657175	4607729	54	89
38	657180	4607721	64	75
39	657183	4607711	64	92
40	657186	4607702	73	106
41	657191	4607693	75	105
42	657195	4607684	78	120
43	657202	4607677	82	200
44	657209	4607673	82	261
45	657216	4607669	75	271
46	657224	4607664	70	238
47	657233	4607659	58	136
48	657240	4607654	38	66
49	657247	4607648	21	57
50	657255	4607643	17	115
51	657263	4607638	30	127
52	657271	4607634	40	104
53	657279	4607632	67	114
54	657287	4607630	66	178

55	657297	4607639	70	111
56	657292	4607637	48	106
57	657285	4607637	29	96
58	657278	4607638	24	92
59	657269	4607642	22	115
60	657262	4607644	20	110
61	657254	4607647	29	129
62	657248	4607650	41	137
63	657247	4607656	54	112
64	657248	4607662	56	115
65	657251	4607664	58	84
66	657255	4607664	59	97
67	657262	4607663	47	88
68	657268	4607660	30	108
69	657275	4607658	10	127
70	657282	4607653	21	113
71	657287	4607650	30	100
72	657294	4607649	43	96
73	657301	4607649	60	122
74	657304	4607652	56	125
75	657303	4607657	32	119
76	657299	4607662	31	101
77	657294	4607665	20	109
78	657286	4607667	14	62
79	657289	4607661	22	113
80	657287	4607655	25	96
81	657288	4607647	28	71
82	657286	4607639	35	52
83	657283	4607634	43	67
84	657277	4607632	39	87
85	657271	4607632	33	123
86	657266	4607635	27	180
87	657260	4607640	17	195
88	657258	4607647	35	102
89	657256	4607654	49	123
90	657256	4607661	55	128
91	657256	4607668	57	122
92	657256	4607676	35	110
93	657257	4607684	22	127
94	657255	4607689	16	100
95	657280	4607680	21	63
96	657281	4607677	21	99
97	657283	4607673	18	113
98	657282	4607671	18	108
99	657281	4607668	14	110
100	657279	4607665	20	106
101	657275	4607661	26	89
102	657273	4607657	22	122
103	657271	4607653	17	115
104	657269	4607651	14	114
105	657269	4607645	16	109
106	657272	4607641	21	98
107	657277	4607639	23	86
108	657281	4607637	32	108
109	657285	4607636	43	192
110	657289	4607636	67	157
111	657292	4607636	74	128
112	657297	4607637	56	152
113	657300	4607641	57	155

114	657301	4607645	60	140
115	657301	4607648	64	122
116	657301	4607652	45	134
117	657301	4607655	40	165
118	657301	4607659	32	175
119	657301	4607663	26	182
120	657301	4607667	26	182
121	657301	4607673	16	204
122	657302	4607679	10	212
123	657318	4607698	66	113
124	657320	4607704	59	125
125	657321	4607712	24	198
126	657320	4607719	24	222
127	657319	4607727	55	169
128	657319	4607735	41	189
129	657316	4607742	26	226
130	657312	4607750	36	196
131	657309	4607757	40	185
132	657304	4607765	40	192
133	657298	4607770	33	187
134	657291	4607773	40	149
135	657283	4607775	37	154
136	657274	4607776	41	135
137	657266	4607777	40	120
138	657256	4607781	45	89
139	657249	4607787	43	145
140	657244	4607795	36	160
141	657242	4607804	34	131
142	657239	4607811	31	102
143	657237	4607819	35	78
144	657234	4607826	40	92
145	657231	4607835	29	79
146	657227	4607840	25	86
147	657224	4607841	23	132
148	657225	4607838	20	132
149	657226	4607832	24	156
150	657229	4607826	22	160
151	657232	4607819	26	166
152	657236	4607811	26	174
153	657236	4607801	21	169
154	657230	4607801	19	172
155	657224	4607804	16	188
156	657219	4607807	17	179
157	657215	4607813	28	158
158	657212	4607819	17	158
159	657211	4607826	14	195
160	657219	4607839	16	171
161	657224	4607835	20	146
162	657228	4607830	21	147
163	657231	4607823	24	164
164	657234	4607815	25	161
165	657237	4607809	26	165
166	657240	4607800	30	177
167	657242	4607792	33	158
168	657245	4607784	19	191
169	657246	4607774	21	207
170	657244	4607768	21	238
171	657244	4607763	28	216
172	657246	4607760	21	240

173	657251	4607758	22	240
174	657257	4607759	33	208
175	657266	4607760	45	202
176	657273	4607762	34	233
177	657280	4607760	32	159
178	657286	4607754	41	143
179	657290	4607747	39	134
180	657297	4607743	35	142
181	657304	4607743	32	111
182	657310	4607746	33	186
183	657314	4607753	35	124
184	657314	4607760	35	126
185	657310	4607765	30	122
186	657302	4607769	37	111
187	657295	4607768	32	139
188	657290	4607762	34	118
189	657311	4607739	29	146
190	657318	4607735	40	121
191	657321	4607730	47	177
192	657320	4607724	21	228
193	657322	4607716	24	189
194	657321	4607704	54	127
195	657319	4607696	58	131
196	657315	4607688	30	183
197	657311	4607680	36	140
198	657308	4607671	30	172
199	657303	4607662	27	180
200	657297	4607652	28	170
201	657291	4607643	30	216
202	657288	4607634	63	160

Data Collected on Hemingway pond with GPR and GPS

Observation	Easting	Northing	Water Depth (cm)	Thickness of Bottom Sediments
1	657280	4607621	70	66
2	657274	4607625	134	49
3	657267	4607631	58	112
4	657260	4607633	28	155
5	657252	4607637	24	132
6	657246	4607642	23	157
7	657240	4607647	41	147
8	657233	4607650	59	92
9	657222	4607655	79	75
10	657215	4607661	91	62
11	657208	4607662	95	76
12	657198	4607661	89	114
13	657192	4607661	87	110
14	657185	4607663	106	62
15	657180	4607668	100	57
16	657177	4607675	103	58
17	657177	4607682	79	119
18	657178	4607691	77	154
19	657178	4607700	72	96
20	657176	4607708	68	92
21	657174	4607716	65	84
22	657169	4607724	53	82
23	657165	4607732	44	111
24	657158	4607737	37	122
25	657149	4607740	36	120
26	657142	4607746	35	97
27	657159	4607788	50	152
28	657155	4607785	54	80
29	657152	4607780	50	177
30	657148	4607775	52	152
31	657147	4607768	37	83
32	657148	4607760	32	63
33	657151	4607752	35	82
34	657156	4607747	37	85
35	657163	4607742	40	89
36	657170	4607737	44	86
37	657175	4607729	54	89
38	657180	4607721	64	75
39	657183	4607711	64	92
40	657186	4607702	73	106
41	657191	4607693	75	105
42	657195	4607684	78	120
43	657202	4607677	82	200
44	657209	4607673	82	261
45	657216	4607669	75	271
46	657224	4607664	70	238
47	657233	4607659	58	136
48	657240	4607654	38	66
49	657247	4607648	21	57
50	657255	4607643	17	115
51	657263	4607638	30	127
52	657271	4607634	40	104
53	657279	4607632	67	114
54	657287	4607630	66	178

55	657297	4607639	70	111
56	657292	4607637	48	106
57	657285	4607637	29	96
58	657278	4607638	24	92
59	657269	4607642	22	115
60	657262	4607644	20	110
61	657254	4607647	29	129
62	657248	4607650	41	137
63	657247	4607656	54	112
64	657248	4607662	56	115
65	657251	4607664	58	84
66	657255	4607664	59	97
67	657262	4607663	47	88
68	657268	4607660	30	108
69	657275	4607658	10	127
70	657282	4607653	21	113
71	657287	4607650	30	100
72	657294	4607649	43	96
73	657301	4607649	60	122
74	657304	4607652	56	125
75	657303	4607657	32	119
76	657299	4607662	31	101
77	657294	4607665	20	109
78	657286	4607667	14	62
79	657289	4607661	22	113
80	657287	4607655	25	96
81	657288	4607647	28	71
82	657286	4607639	35	52
83	657283	4607634	43	67
84	657277	4607632	39	87
85	657271	4607632	33	123
86	657266	4607635	27	180
87	657260	4607640	17	195
88	657258	4607647	35	102
89	657256	4607654	49	123
90	657256	4607661	55	128
91	657256	4607668	57	122
92	657256	4607676	35	110
93	657257	4607684	22	127
94	657255	4607689	16	100
95	657280	4607680	21	63
96	657281	4607677	21	99
97	657283	4607673	18	113
98	657282	4607671	18	108
99	657281	4607668	14	110
100	657279	4607665	20	106
101	657275	4607661	26	89
102	657273	4607657	22	122
103	657271	4607653	17	115
104	657269	4607651	14	114
105	657269	4607645	16	109
106	657272	4607641	21	98
107	657277	4607639	23	86
108	657281	4607637	32	108
109	657285	4607636	43	192
110	657289	4607636	67	157
111	657292	4607636	74	128
112	657297	4607637	56	152
113	657300	4607641	57	155

114	657301	4607645	60	140
115	657301	4607648	64	122
116	657301	4607652	45	134
117	657301	4607655	40	165
118	657301	4607659	32	175
119	657301	4607663	26	182
120	657301	4607667	26	182
121	657301	4607673	16	204
122	657302	4607679	10	212
123	657318	4607698	66	113
124	657320	4607704	59	125
125	657321	4607712	24	198
126	657320	4607719	24	222
127	657319	4607727	55	169
128	657319	4607735	41	189
129	657316	4607742	26	226
130	657312	4607750	36	196
131	657309	4607757	40	185
132	657304	4607765	40	192
133	657298	4607770	33	187
134	657291	4607773	40	149
135	657283	4607775	37	154
136	657274	4607776	41	135
137	657266	4607777	40	120
138	657256	4607781	45	89
139	657249	4607787	43	145
140	657244	4607795	36	160
141	657242	4607804	34	131
142	657239	4607811	31	102
143	657237	4607819	35	78
144	657234	4607826	40	92
145	657231	4607835	29	79
146	657227	4607840	25	86
147	657224	4607841	23	132
148	657225	4607838	20	132
149	657226	4607832	24	156
150	657229	4607826	22	160
151	657232	4607819	26	166
152	657236	4607811	26	174
153	657236	4607801	21	169
154	657230	4607801	19	172
155	657224	4607804	16	188
156	657219	4607807	17	179
157	657215	4607813	28	158
158	657212	4607819	17	158
159	657211	4607826	14	195
160	657219	4607839	16	171
161	657224	4607835	20	146
162	657228	4607830	21	147
163	657231	4607823	24	164
164	657234	4607815	25	161
165	657237	4607809	26	165
166	657240	4607800	30	177
167	657242	4607792	33	158
168	657245	4607784	19	191
169	657246	4607774	21	207
170	657244	4607768	21	238
171	657244	4607763	28	216
172	657246	4607760	21	240

173	657251	4607758	22	240
174	657257	4607759	33	208
175	657266	4607760	45	202
176	657273	4607762	34	233
177	657280	4607760	32	159
178	657286	4607754	41	143
179	657290	4607747	39	134
180	657297	4607743	35	142
181	657304	4607743	32	111
182	657310	4607746	33	186
183	657314	4607753	35	124
184	657314	4607760	35	126
185	657310	4607765	30	122
186	657302	4607769	37	111
187	657295	4607768	32	139
188	657290	4607762	34	118
189	657311	4607739	29	146
190	657318	4607735	40	121
191	657321	4607730	47	177
192	657320	4607724	21	228
193	657322	4607716	24	189
194	657321	4607704	54	127
195	657319	4607696	58	131
196	657315	4607688	30	183
197	657311	4607680	36	140
198	657308	4607671	30	172
199	657303	4607662	27	180
200	657297	4607652	28	170
201	657291	4607643	30	216
202	657288	4607634	63	160

Appendix F:

Cultural Resources Form and/or Report

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Attachment #5 **April 7, 2005 –Rev.2**

Practice Description Form for Cultural Resources Review

***Instructions:** -Refer to the State Level Agreement, Standard Operating Procedures for the NRCS planner (attachment 4), and Classification of Practices for Disturbance (attachment 3). -Complete this sheet for G and PG activities planned. -Send this and a USGS quad sheet copy and aerial photo locating the proposed practice to the Cultural Resources Coordinator (CRC) at least 3 months before anticipated construction/application. A site visit by the State Archaeologist and SHPO Archaeologist may be required before any construction begins.*

Landowner/Operator/Sponsor DEP, Town of Watertown Town Watertown, CT

USGS Quad. Waterbury, CT Quad Aerial Photo CT Statewide Map

1. Describe the activity planned and the size of the area to be disturbed: Feasibility Study for the removal of Heminway Pond Dam and potential removal of sediments behind the dam. Natural stream design in the area of the current impounded water.
2. Distance to a stream, river or wetland area: In stream (Steele Brook)
3. Soil conditions (hardpan, gravel, wet, ledge) Wet
4. Planned excavation: Depth 0-10' Length, Width 900', 360'
5. Has area been disturbed before –filled or excavated? (explain)- When the dam was constructed there was most likely excavation in the pool to construct the diversion and the abutments of the concrete weir dam.
6. Any historic structures/features onsite? Potential historic rock channel
7. Has owner /operator found artifacts on the site (arrowheads, pottery chards, etc.)? Not to my know
8. When is practice application/construction expected to begin? No sooner than 2010
9. Which NRCS Program is involved? Reimbursable agreement with DEP

Submitted By: Joseph J. Kavan

Review Actions by NRCS Coordinator: ____________________

Name/Date

Review Actions with State Archaeologist and SHPO:
Site File/Map Review Findings SITE REVIEW Requested

[signature] Name/Date

Field Review Findings (if required)
3/20/08 → historic review, photodocumentation 7/28/08

Name/Date

Any Final Actions No adverse effect on dam ; sluice

Y

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USGS 5 km E of Watertown, Connecticut, United States 01 Jul 1989

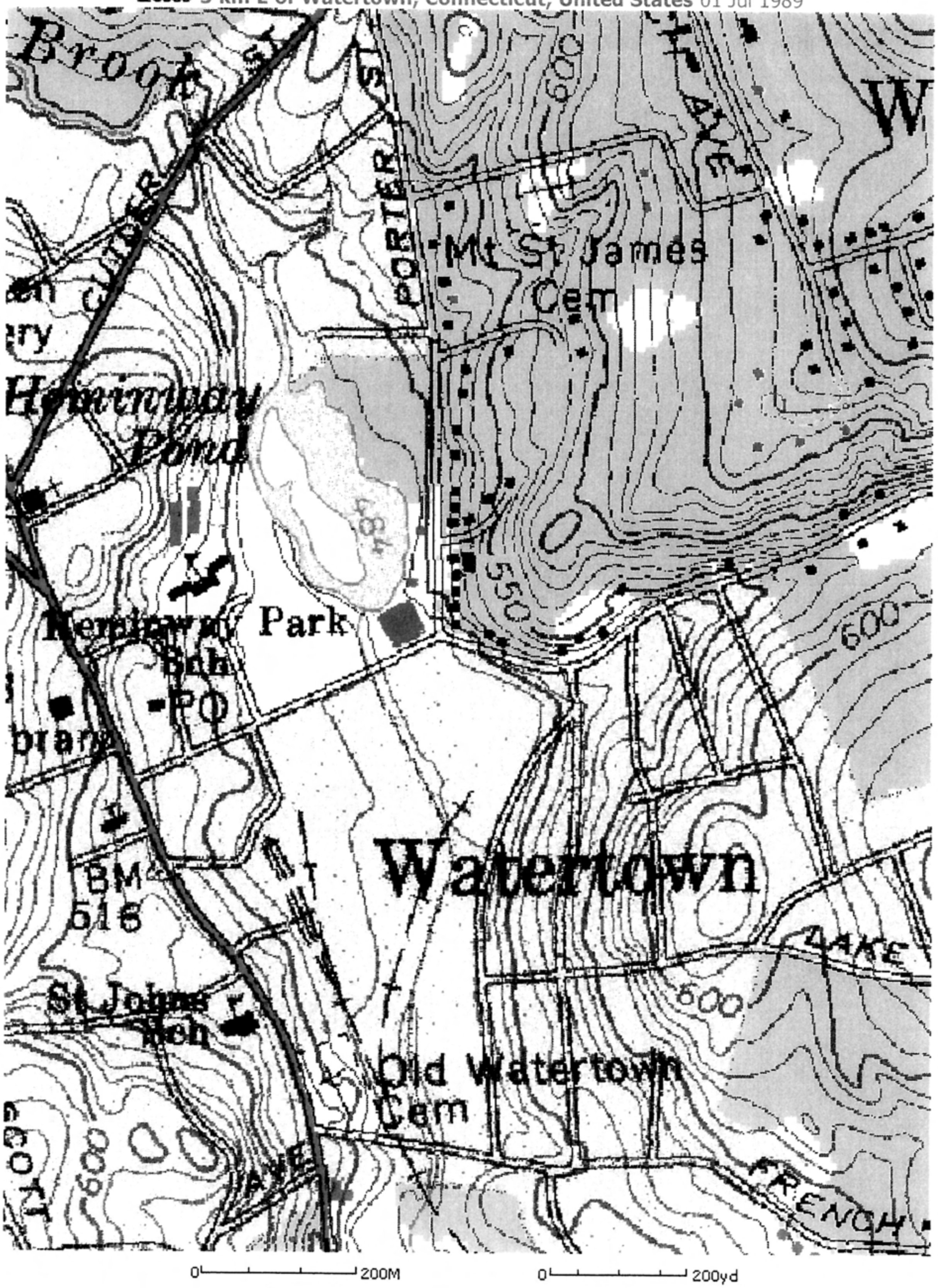

Image courtesy of the U.S. Geological Survey