ENSR
2 Technology Park Drive, Westford, Massachusetts 01886-3140
T 978.589.3000 F 978.589.3100 www.ensr.aecom.com

February 28, 2007

Mr. Steven Winnett
United Stated Environmental Protection Agency Region I
Mail Code CWQ
One Congress Street
Boston, MA 02114-02023

Subject: Deliverable for Task 2a for New Hampshire TMDL Project; EPA-SMP-07-002

Dear Mr. Winnett,

ENSR is pleased to forward to the United States Environmental Protection Agency (USEPA) Region 1 the first deliverable for **the New Hampshire Total Maximum Daily Load (TMDL) Development** project (EPA –SMP-07-002). This deliverable completes the requirements of Task 2a "Determine Runoff" as part of Task 2 Development of Acid Pond TMDLs. We are submitting the following (two hardcopies and electronic submittal) information: (1) this narrative letter; (2) Table 1 "*Estimated Runoff Values for Watersheds in Acid TMDL Study*"; and (3) two figures – Map 1 "*Estimated Runoff for TMDL Study of Acid-Impaired Lakes, New Hampshire 2007"* and Map 2 "*Example of Runoff Interpolation Using USGS OFR-96-93.5*"

As part of its contract with USEPA, Region 1, ENSR is compiling and synthesizing the watershed and water chemistry data required to develop TMDLs for 266 acid-impaired waterbodies in New Hampshire. The complete suite of 266 waterbodies identified for the Acid TMDL study consist of 150 lakes, 2 impoundments, and 114 associated beaches. Table 1 provides a list of the 152 lakes and impoundments, listed according to their associated Assessment Unit (AU) codes.

As directed by the New Hampshire Department of Environmental Services (NHDES), ENSR will use the Steady State Water Chemistry (SSWC) model developed by Henrikson and Posch (2001) to calculate critical loads and develop TMDLs. This method of determining critical loads is based on water chemistry, annual surface runoff, and specified target Acid Neutralizing Capacity (ANC) as previously developed by the State of New Hampshire (e.g., NHDES, 2004) for acid TMDLs for 86 ponds and as approved by the USEPA.. The following information is provided to detail the sources of data and the process used in Task 2a to derive the runoff values that are proposed for use in the SSWC model for the 152 waterbodies in the study.

The Geographic Information Systems (GIS) files provided by the NHDES (GRANIT GIS system) for use in this study include polygon data for the lakes and watersheds of the selected waterbodies, polyline data of the streams and runoff isopleths (USGS – Randall (1996), and point data of the beaches and Environmental Monitoring Database (EMD) sampling locations.

The watershed areas provided for each of the lakes in the Task 2 TMDL Development study are typically delineated as sub-watersheds that do not include up-gradient sub-watersheds. In these cases, sub-watersheds were merged to derive a watershed delineation that represents the entire drainage area for the lake. The merged watershed areas were used for the derivation of the runoff values.

The unit runoff values provided in the attached table (Table 1) were derived from application of the runoff isopleth polyline GIS data provided by the NHDES to the lake watersheds. The runoff isopleth data was published in 1996 by the USGS in the Open-File-Report 96-395, "*Mean Annual Runoff, Precipitation, and Evapotranspiration in the Glaciated Northeastern United States, 1951-80*", by Allan D. Randall. Randall based the runoff amounts on stream flow from 503 watersheds in the United States and southernmost Canada. The data are presented at a scale of 1:1 million. The accuracy of these data at larger scales is not known. The available runoff isopleth interval is 2 inches. A map of the State of New Hampshire with a color-scaled grid of runoff values, source isopleths of runoff, watersheds, and lakes used in this study is included with this deliverable (Map 1).

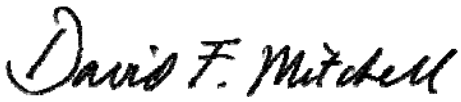
In order to derive unit runoff values for each lake in the study, the mean runoff value within each portion of the watershed was determined (i.e., interpolated from nearest isopleths). This was accomplished by using the GIS (ESRI® ArcMap Spatial Analyst software) to generate a 1,000 by 1,000 foot grid from the runoff isopleth polylines. The runoff values were interpolated and automatically assigned to each of the 1,000 by 1,000 foot grid cells. The cells that were located within each watershed were automatically selected and their mean value calculated for an example watershed – Grafton Pond (Map 2).

The runoff values for all of the cells in the watershed areas were used for this calculation. This process interpolates runoff values to an apparent level of accuracy that is likely beyond the accuracy of the source isopleths. This needs to be taken into consideration when applying the resultant runoff values (Q) into the SSWC model. Ideally the results of this method of deriving runoff values should be compared with stream-flow-data records if they are available for the watersheds in the study. The derived runoff values are tabulated in both inches per year and meters per year in Table 1.

To respond to NHDES's request for more accessible documentation of the derivation of runoff, the grids were sorted into 0.5" increments between the minimum and maximum runoff isopleths (e.g. 22.0" - 24.25" for Grafton Pond example) found in the watershed and the proportion of the watershed that fell within those increments calculated. The resulting percentage of watershed area corresponding to each 0.5" increment is shown in the legend of Map 2. As a check of this more approximate method of calculating runoff vs. that generated by the more detailed isopleths calculated by ArcMap, the midrange value for each increment (e.g., 22.25" for the 22.0' - 22.5" increment) was multiplied by the percent watershed area and total runoff calculated. The difference between the total runoff numbers generated by the two methods was less than 1.3%. Given the uncertainty discussed above, we feel that the method using the approximation of watershed area percentages provides a satisfactory estimate of runoff which can be used by NHDES and others should they wish to independently confirm ENSR's runoff values. Following USEPA and NHDES review of this approach, ENSR will provide a table that reports the percentage watershed in respective 0.5" increments for the 152 lakes. However, ENSR will continue to input the ArcMap-derived runoff value as the representative watershed-specific runoff ("Q") value in the SSWQ model calculations.

Please do not hesitate to contact ENSR with any questions regarding the attached table and maps or further clarification on our methods for preparation of these data.

Sincerely yours,



David F. Mitchell, Ph.D., CLM
Acid Pond TMDL Task Manager
dmitchell@ensr.aecom.com

Don, Kretchmer, CLM
Project Manager
dkretchmer@ensr.aecom.com

cc: Al Basile / USEPA Region 1
Bob Estabrook / NHDES
Al Pratt /ENSR
Project files

TABLE 1
ESTIMATED RUNOFF VALUES
FOR WATERSHEDS IN ACID TMDL STUDY

count	AUID	AUName	PrimTown	RUNOFF (in/yr)	RUNOFF (m/yr)
1	NHIMP700060302-02	HAYWARD BROOK - MORRILL POND	CANTERBURY	18.11	**0.46**
2	NHIMP700060502-01	UNKNOWN RIVER - DURGIN POND OUTLET	NORTHWOOD	20.26	**0.51**
3	NHLAK600020202-01	FALLS POND	ALBANY	29.60	**0.75**
4	NHLAK600020302-01-01	ECHO LAKE	CONWAY	28.50	**0.72**
5	NHLAK600020303-03	IONA LAKE	ALBANY	25.81	**0.66**
6	NHLAK600020303-05	BIG PEA PORRIDGE POND	MADISON	28.61	**0.73**
7	NHLAK600020303-06	MIDDLE PEA PORRIDGE POND	MADISON	28.57	**0.73**
8	NHLAK600020303-07-01	PEQUAWKET POND	CONWAY	27.31	**0.69**
9	NHLAK600020303-09	WHITTON POND	ALBANY	25.68	**0.65**
10	NHLAK600020604-03	MOORES POND	TAMWORTH	26.94	**0.68**
11	NHLAK600020701-02	LOWER BEECH POND	TUFTONBORO	21.05	**0.53**
12	NHLAK600020701-04	UPPER BEECH POND	WOLFEBORO	20.87	**0.53**
13	NHLAK600020702-01	DAN HOLE POND	TUFTONBORO	22.24	**0.56**
14	NHLAK600020703-03	PINE RIVER POND	WAKEFIELD	25.06	**0.64**
15	NHLAK600020703-04	WHITE POND	OSSIPEE	26.08	**0.66**
16	NHLAK600020801-01	BLUE POND	MADISON	25.60	**0.65**
17	NHLAK600020801-05	MACK POND	MADISON	25.65	**0.65**
18	NHLAK600020801-06-01	SILVER LAKE	MADISON	26.06	**0.66**
19	NHLAK600020802-04-01	OSSIPEE LAKE	OSSIPEE	25.97	**0.66**
20	NHLAK600020803-01-01	LOWER DANFORTH POND	FREEDOM	27.69	**0.70**
21	NHLAK600020803-01-02	MIDDLE DANFORTH POND	FREEDOM	27.69	**0.70**
22	NHLAK600020803-03	UPPER DANFORTH POND	FREEDOM	28.13	**0.71**
23	NHLAK600020803-08	SHAW POND	FREEDOM	25.70	**0.65**
24	NHLAK600020804-01-01	BERRY BAY	FREEDOM	26.36	**0.67**
25	NHLAK600020804-01-02	LEAVITT BAY	OSSIPEE	25.90	**0.66**
26	NHLAK600020804-01-03	BROAD BAY	FREEDOM	25.79	**0.66**
27	NHLAK600020902-01	PROVINCE LAKE	EFFINGHAM	26.44	**0.67**
28	NHLAK600021001-01	BALCH POND	WAKEFIELD	26.06	**0.66**
29	NHLAK600030403-02	HORN POND	WAKEFIELD	24.85	**0.63**
30	NHLAK600030601-05-01	SUNRISE LAKE	MIDDLETON	21.61	**0.55**
31	NHLAK600030602-03	ROCHESTER RESERVOIR	ROCHESTER	22.23	**0.56**
32	NHLAK600030605-01	NIPPO POND	BARRINGTON	21.78	**0.55**
33	NHLAK600030704-02-01	PAWTUCKAWAY LAKE	NOTTINGHAM	20.67	**0.53**
34	NHLAK600030802-01	HUNT POND	SANDOWN	20.95	**0.53**
35	NHLAK700010104-02	LOON POND	LINCOLN	29.18	**0.74**

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count	AUID	AUName	PrimTown	RUNOFF (in/yr)	RUNOFF (m/yr)
36	NHLAK700010205-01	MIRROR LAKE	WOODSTOCK	26.65	**0.68**
37	NHLAK700010304-04	MCCUTCHEON POND	DORCHESTER	19.49	**0.50**
38	NHLAK700010304-05	POUT POND	DORCHESTER	19.66	**0.50**
39	NHLAK700010401-03	CONE POND	THORNTON	25.22	**0.64**
40	NHLAK700010402-03	LOWER HALL POND	SANDWICH	21.92	**0.56**
41	NHLAK700010402-05	UPPER HALL POND	SANDWICH	22.06	**0.56**
42	NHLAK700010402-08	LITTLE PERCH POND	CAMPTON	22.27	**0.57**
43	NHLAK700010501-01	BARVILLE POND	SANDWICH	19.41	**0.49**
44	NHLAK700010501-02	INTERVALE POND	SANDWICH	19.74	**0.50**
45	NHLAK700010501-03	KUSUMPE POND	SANDWICH	19.47	**0.49**
46	NHLAK700010502-04	SKY POND	NEW HAMPTON	22.73	**0.58**
47	NHLAK700010701-03	ORANGE POND	ORANGE	24.00	**0.61**
48	NHLAK700010701-05	WAUKEENA LAKE	DANBURY	23.83	**0.61**
49	NHLAK700010702-02	SCHOOL POND	DANBURY	23.76	**0.60**
50	NHLAK700010802-03-01	HERMIT LAKE	SANBORNTON	21.63	**0.55**
51	NHLAK700010802-04	RANDLETT POND	MEREDITH	22.23	**0.56**
52	NHLAK700010802-05	MOUNTAIN POND	SANBORNTON	21.71	**0.55**
53	NHLAK700010804-01-01	HIGHLAND LAKE	ANDOVER	22.84	**0.58**
54	NHLAK700010804-02-01	WEBSTER LAKE	FRANKLIN	22.37	**0.57**
55	NHLAK700020101-05-01	LAKE WENTWORTH	WOLFEBORO	21.89	**0.56**
56	NHLAK700020101-07-01	RUST POND	WOLFEBORO	21.69	**0.55**
57	NHLAK700020108-02-01	LAKE WAUKEWAN	MEREDITH	22.72	**0.58**
58	NHLAK700020108-02-02	LAKE WINONA	NEW HAMPTON	22.79	**0.58**
59	NHLAK700020108-04	HAWKINS POND	CENTER HARBOR	22.71	**0.58**
60	NHLAK700020110-02-01	PAUGUS BAY	LACONIA	21.88	**0.56**
61	NHLAK700020110-02-19	LAKE WINNIPESAUKEE	ALTON	21.20	**0.54**
62	NHLAK700020110-05	SALTMARSH POND	GILFORD	21.14	**0.54**
63	NHLAK700020201-05-01	LAKE WINNISQUAM	LACONIA	21.43	**0.54**
64	NHLAK700020202-03	POUT POND	BELMONT	19.50	**0.50**
65	NHLAK700020202-04	SARGENT LAKE	BELMONT	20.43	**0.52**
66	NHLAK700030101-08	GRASSY POND	RINDGE	24.46	**0.62**
67	NHLAK700030101-12	POOL POND	RINDGE	23.06	**0.59**
68	NHLAK700030101-13	BULLET POND	RINDGE	24.75	**0.63**
69	NHLAK700030103-03	JUGGERNAUT POND	HANCOCK	25.44	**0.65**
70	NHLAK700030103-09	SPOONWOOD LAKE	NELSON	25.64	**0.65**

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count	AUID	AUName	PrimTown	RUNOFF (in/yr)	RUNOFF (m/yr)
71	NHLAK700030103-10	DINSMORE POND	HARRISVILLE	25.12	**0.64**
72	NHLAK700030105-01-01	ZEPHYR LAKE	GREENFIELD	25.98	**0.66**
73	NHLAK700030105-02-01	OTTER LAKE	GREENFIELD	26.02	**0.66**
74	NHLAK700030105-03-01	SUNSET LAKE	GREENFIELD	26.32	**0.67**
75	NHLAK700030107-01	WILLARD POND	ANTRIM	25.19	**0.64**
76	NHLAK700030202-06	BAGLEY POND	WINDSOR	24.01	**0.61**
77	NHLAK700030203-02	SMITH POND	WASHINGTON	24.91	**0.63**
78	NHLAK700030203-03	TROUT POND	STODDARD	24.28	**0.62**
79	NHLAK700030204-04	LOON POND	HILLSBOROUGH	23.81	**0.60**
80	NHLAK700030302-02	BLAISDELL LAKE	SUTTON	23.88	**0.61**
81	NHLAK700030304-05	TOM POND	WARNER	22.00	**0.56**
82	NHLAK700030304-08	LAKE WINNEPOCKET	WEBSTER	22.01	**0.56**
83	NHLAK700030401-02	BUTTERFIELD POND	WILMOT	24.13	**0.61**
84	NHLAK700030402-01	CHASE POND	WILMOT	24.22	**0.62**
85	NHLAK700030402-02-01	PLEASANT LAKE	NEW LONDON	24.35	**0.62**
86	NHLAK700030403-05	HORSESHOE POND	ANDOVER	23.37	**0.59**
87	NHLAK700030502-03	BEAR POND	WARNER	22.24	**0.56**
88	NHLAK700030505-01	CLEMENT POND	HOPKINTON	22.07	**0.56**
89	NHLAK700040401-01-01	MELENDY POND	BROOKLINE	23.12	**0.59**
90	NHLAK700040401-02-01	POTANIPO POND	BROOKLINE	23.59	**0.60**
91	NHLAK700060101-01	SHAW POND	FRANKLIN	21.74	**0.55**
92	NHLAK700060101-02-01	SONDOGARDY POND	NORTHFIELD	19.69	**0.50**
93	NHLAK700060201-01-01	LOON POND	GILMANTON	20.59	**0.52**
94	NHLAK700060201-03	NEW POND	CANTERBURY	19.19	**0.49**
95	NHLAK700060202-03-01	CLOUGH POND	LOUDON	17.89	**0.45**
96	NHLAK700060202-04	CROOKED POND	LOUDON	17.93	**0.46**
97	NHLAK700060401-02-01	CRYSTAL LAKE	GILMANTON	21.87	**0.56**
98	NHLAK700060401-06	MANNING LAKE	GILMANTON	21.76	**0.55**
99	NHLAK700060401-12	SUNSET LAKE	ALTON	22.10	**0.56**
100	NHLAK700060402-03	HALFMOON LAKE	ALTON	20.64	**0.52**
101	NHLAK700060402-05	HUNTRESS POND	BARNSTEAD	19.93	**0.51**
102	NHLAK700060403-01	BIG WILLEY POND	STRAFFORD	20.30	**0.52**
103	NHLAK700060403-02	LITTLE WILLEY POND	STRAFFORD	20.25	**0.51**
104	NHLAK700060501-03	WILD GOOSE POND	PITTSFIELD	19.98	**0.51**
105	NHLAK700060501-08	BERRY POND	PITTSFIELD	19.90	**0.51**

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count	AUID	AUName	PrimTown	RUNOFF (in/yr)	RUNOFF (m/yr)
106	NHLAK700060502-03	CHESTNUT POND	EPSOM	20.17	**0.51**
107	NHLAK700060503-01	BEAR HILL POND	ALLENSTOWN	20.26	**0.51**
108	NHLAK700060601-01	DEERING RESERVOIR	DEERING	24.51	**0.62**
109	NHLAK700060601-02	DUDLEY POND	DEERING	23.15	**0.59**
110	NHLAK700060601-03-01	PLEASANT POND	HENNIKER	23.02	**0.58**
111	NHLAK700060602-02	MOUNT WILLIAM POND	WEARE	21.87	**0.56**
112	NHLAK700060607-03	LONG POND	DUNBARTON	20.83	**0.53**
113	NHLAK700060702-03	MASSABESIC LAKE	AUBURN	20.43	**0.52**
114	NHLAK700060802-02	LAKINS POND	HOOKSETT	20.04	**0.51**
115	NHLAK700060802-03	PINNACLE POND	HOOKSETT	19.86	**0.50**
116	NHLAK700060803-02	STEVENS POND	MANCHESTER	20.61	**0.52**
117	NHLAK700061002-03	HORSESHOE POND	MERRIMACK	22.85	**0.58**
118	NHLAK700061101-01-01	ISLAND POND	HAMPSTEAD	21.27	**0.54**
119	NHLAK700061203-06-01	ROBINSON POND	HUDSON	21.96	**0.56**
120	NHLAK700061204-02	LITTLE ISLAND POND	PELHAM	21.71	**0.55**
121	NHLAK700061204-03	ROCK POND	WINDHAM	21.67	**0.55**
122	NHLAK700061205-01	GUMPAS POND	PELHAM	22.09	**0.56**
123	NHLAK801010102-03	ROUND POND	PITTSBURG	30.37	**0.77**
124	NHLAK801010707-01-01	CHRISTINE LAKE	STARK	28.95	**0.74**
125	NHLAK801040201-03	LAKE TARLETON	PIERMONT	22.07	**0.56**
126	NHLAK801040203-01-01	POST POND	LYME	22.50	**0.57**
127	NHLAK801060101-03	CUMMINS POND	DORCHESTER	19.36	**0.49**
128	NHLAK801060101-05	RESERVOIR POND	DORCHESTER	19.10	**0.49**
129	NHLAK801060103-02	LITTLE GOOSE POND	CANAAN	19.44	**0.49**
130	NHLAK801060104-02	GRAFTON POND	GRAFTON	23.24	**0.59**
131	NHLAK801060401-06	EASTMAN POND	GRANTHAM	21.24	**0.54**
132	NHLAK801060401-08-01	KOLELEMOOK LAKE	SPRINGFIELD	24.29	**0.62**
133	NHLAK801060402-04-01	LITTLE SUNAPEE LAKE	NEW LONDON	26.26	**0.67**
134	NHLAK801060402-05-01	SUNAPEE LAKE	SUNAPEE	27.25	**0.69**
135	NHLAK801060402-11	MOUNTAINVIEW LAKE	SUNAPEE	28.60	**0.73**
136	NHLAK801060402-12-01	OTTER POND	SUNAPEE	25.52	**0.65**
137	NHLAK801060403-01	GILMAN POND	UNITY	20.98	**0.53**
138	NHLAK801060403-04-01	RAND POND	GOSHEN	28.43	**0.72**
139	NHLAK801060404-01	ROCKYBOUND POND	CROYDON	21.81	**0.55**
140	NHLAK801070503-01-01	SPOFFORD LAKE	CHESTERFIELD	20.41	**0.52**

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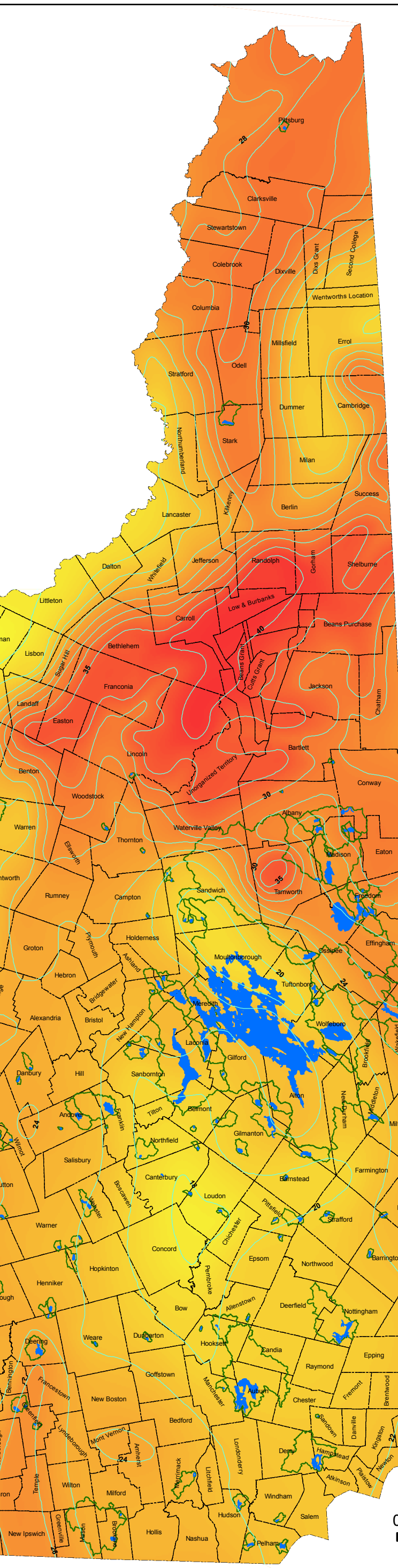
ESTIMATED RUNOFF VALUES
FOR WATERSHEDS IN ACID TMDL STUDY

count	AUID	AUName	PrimTown	RUNOFF (in/yr)	RUNOFF (m/yr)
141	NHLAK802010102-05	BARRETT POND	WASHINGTON	23.72	**0.60**
142	NHLAK802010104-01	CALDWELL POND	ALSTEAD	19.98	**0.51**
143	NHLAK802010104-03	CRANBERRY POND	ALSTEAD	20.72	**0.53**
144	NHLAK802010202-02	CHILDS BOG	HARRISVILLE	25.98	**0.66**
145	NHLAK802010202-07	RUSSELL RESERVOIR	HARRISVILLE	24.79	**0.63**
146	NHLAK802010202-14	BABBIDGE RESERVOIR	ROXBURY	23.63	**0.60**
147	NHLAK802010302-01-01	SWANZEY LAKE	SWANZEY	20.50	**0.52**
148	NHLAK802010303-02	MEETINGHOUSE POND	MARLBOROUGH	24.38	**0.62**
149	NHLAK802010303-07	SAND POND	TROY	21.61	**0.55**
150	NHLAK802010303-10	WILSON POND	SWANZEY	22.15	**0.56**
151	NHLAK802020103-04	EMERSON POND	RINDGE	24.55	**0.62**
152	NHLAK802020202-01	COLLINS POND	FITZWILLIAM	21.50	**0.55**

MAP 1
ESTIMATED RUNOFF FOR ACID TMDL STUDY OF SELECTED LAKES IN NEW HAMPSHIRE 2007



Legend

- Acid Study Lakes (NHDES 2007)

Runoff Isopleth (USGS-Randall 1996)

- 2-Inch Interval
- Town Boundary
- TMDL Lake Watersheds (NHDES 2007)

Interpolated Runoff

Value (inches)

High : 41.3268

Low : 16.8373

Development of Acid Pond Total Maximum Daily Loads (TMDL)
New Hampshire
RFP No. EPA-SMP-07-002

171 Daniel Webster Highway
Suite 11
Belmont, New Hampshire 03220
ph: (603) 524-8866
www.ensr.aecom.com

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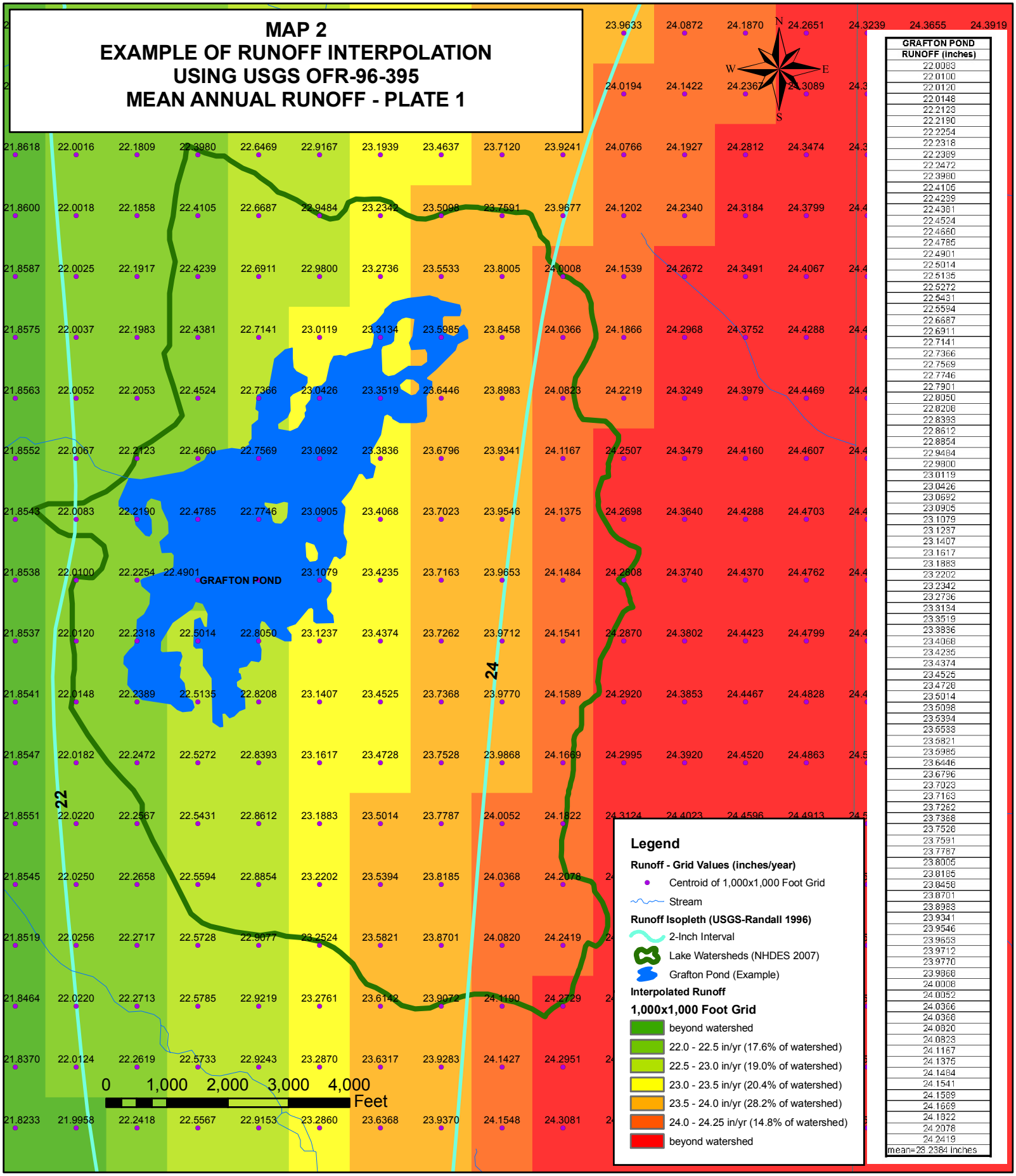
Proj# 09090-107
February 2007

MAP 2
EXAMPLE OF RUNOFF INTERPOLATION USING USGS OFR-96-395 MEAN ANNUAL RUNOFF - PLATE 1



Development of Acid Pond Total Maximum Daily Loads (TMDL)
New Hampshire
RFP No. EPA-SMP-07-002

171 Daniel Webster Highway
Suite 11
Belmont, New Hampshire 03220
ph: (603) 524-8866
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