APPENDICES

Appendix A: Stage Plots of Preliminary Hydraulic Model Calibration and Validation

Appendix B: Profile Plots of Preliminary Alternative Hydraulic Analysis Results

Appendix C: Preliminary Alternative Hydraulic Analysis Results Plan Plots

Appendix D: Profile Plots Depicting Existing and Final Alternative at State Road

Appendix E: Stage Plot of Model Results for October 8 – 10, 2005 Precipitation Event

Appendix F: New Meadows Lake Entrance Flow Analysis (Blue Hill Hydraulics, Inc.)

Appendix G: Tide Station Datum

Appendix A:

Stage Plots of Preliminary Hydraulic Model Calibration and Validation

Figures:

- Figure A.1: Model Calibration Stage Plot (Aug. 6-20, 2005)
- Figure A.2: Model Validation Stage Plot (Sep. 10-24, 2005)
- Figure A.3: Model Calibration and Validation Stage Plot (Period of Tidal Stage Data from Study)

Notes: The following references apply to the legends on the Appendix A Plots:

- "LNML New Meadows River" refers to tidal stage data collected as part of this study in Lower New Meadows Lake.
- "Storage Area Upper NML" refers to calculated water surface elevations in Upper New Meadows Lake.
- "Storage Area Lower NML" refers to calculated water surface elevations in Lower New Meadows Lake.
- "DSBCTD New Meadows River" refers to tidal stage data collected as part of this study in the New Meadows River immediately seaward of the State Road causeway.

Figure A.1: Model Calibration Stage Plot (Aug. 6 – 20, 2005)

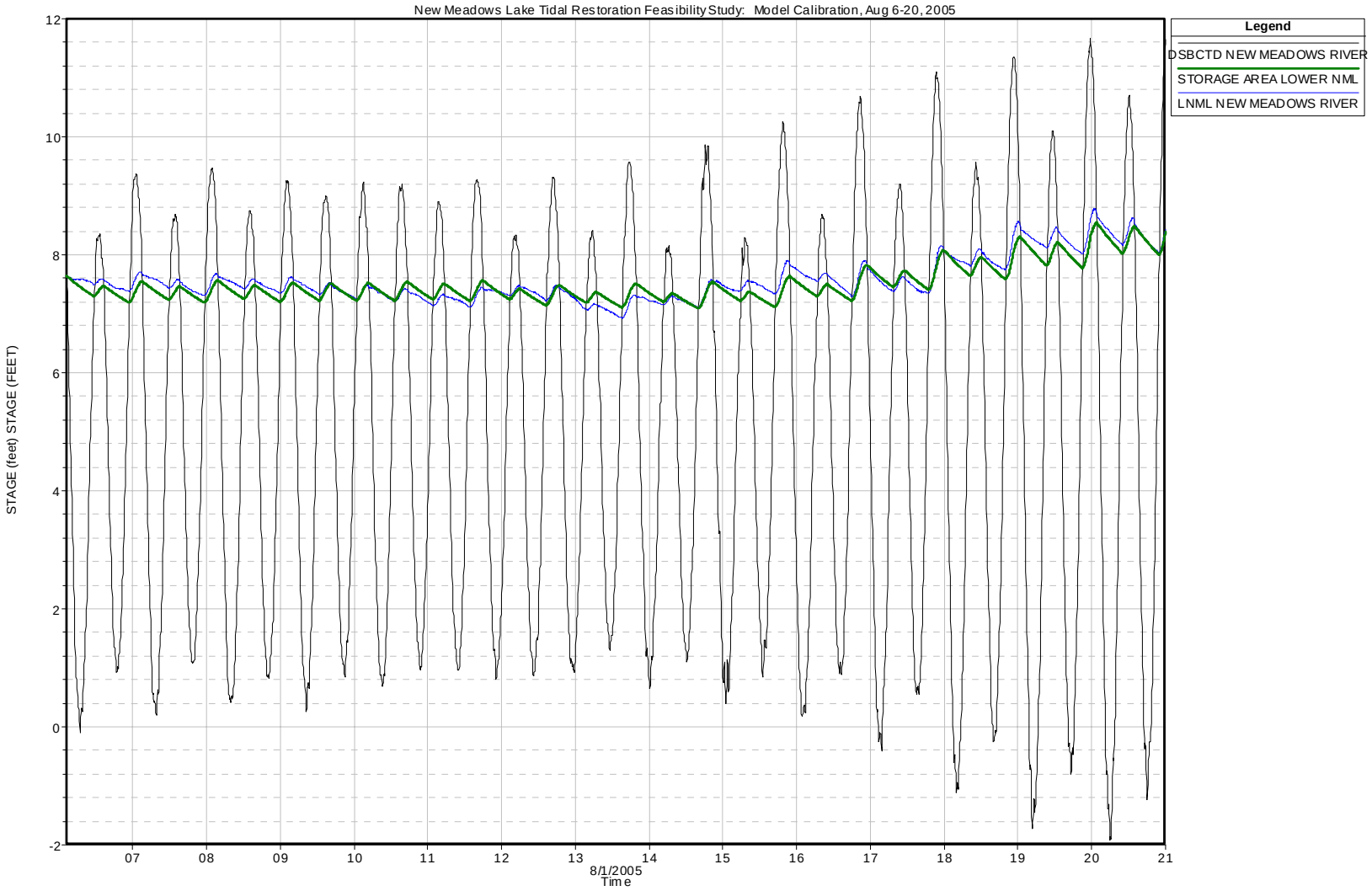


Figure A.2: Model Validation Stage Plot (Sep. 10 – 24, 2005)

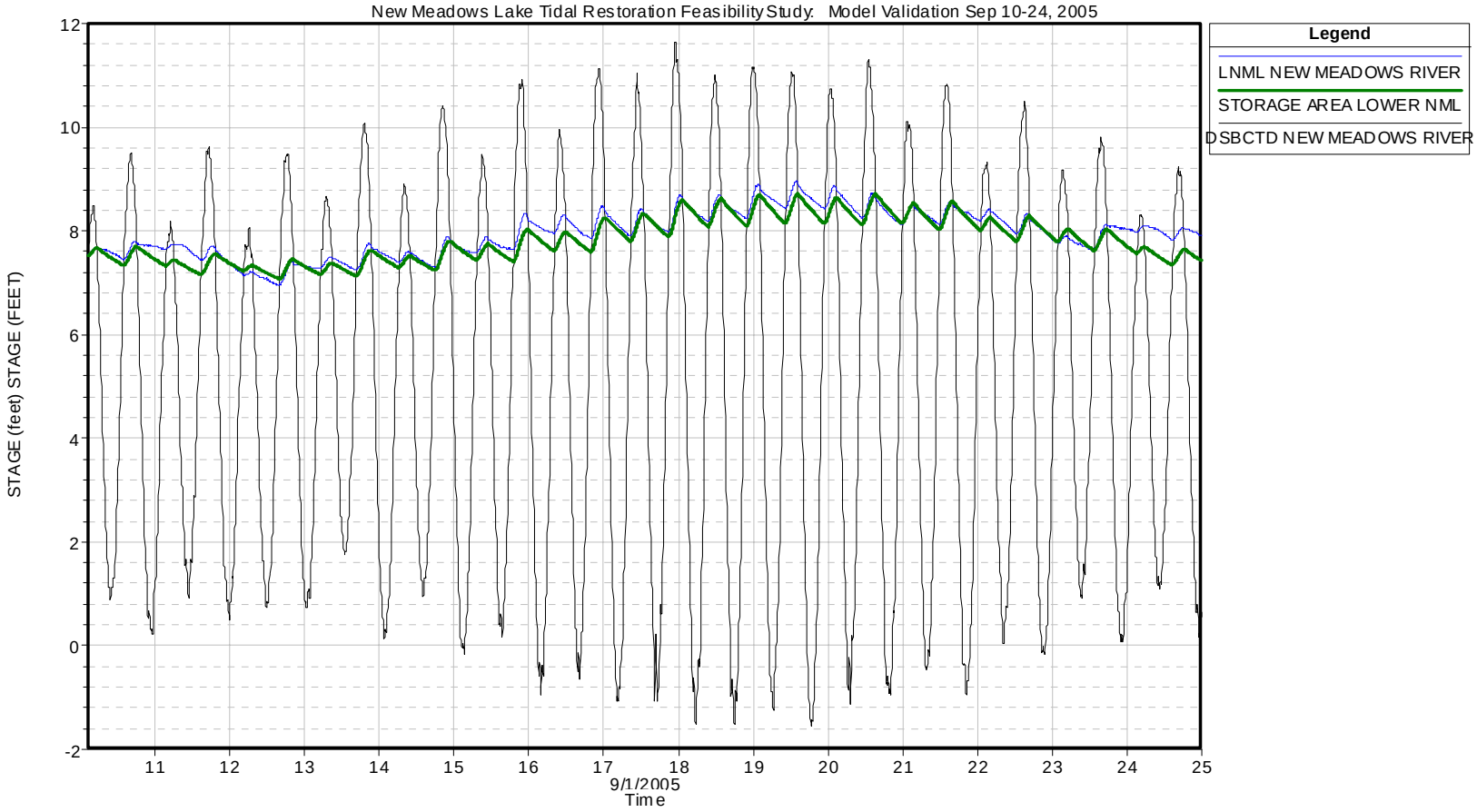
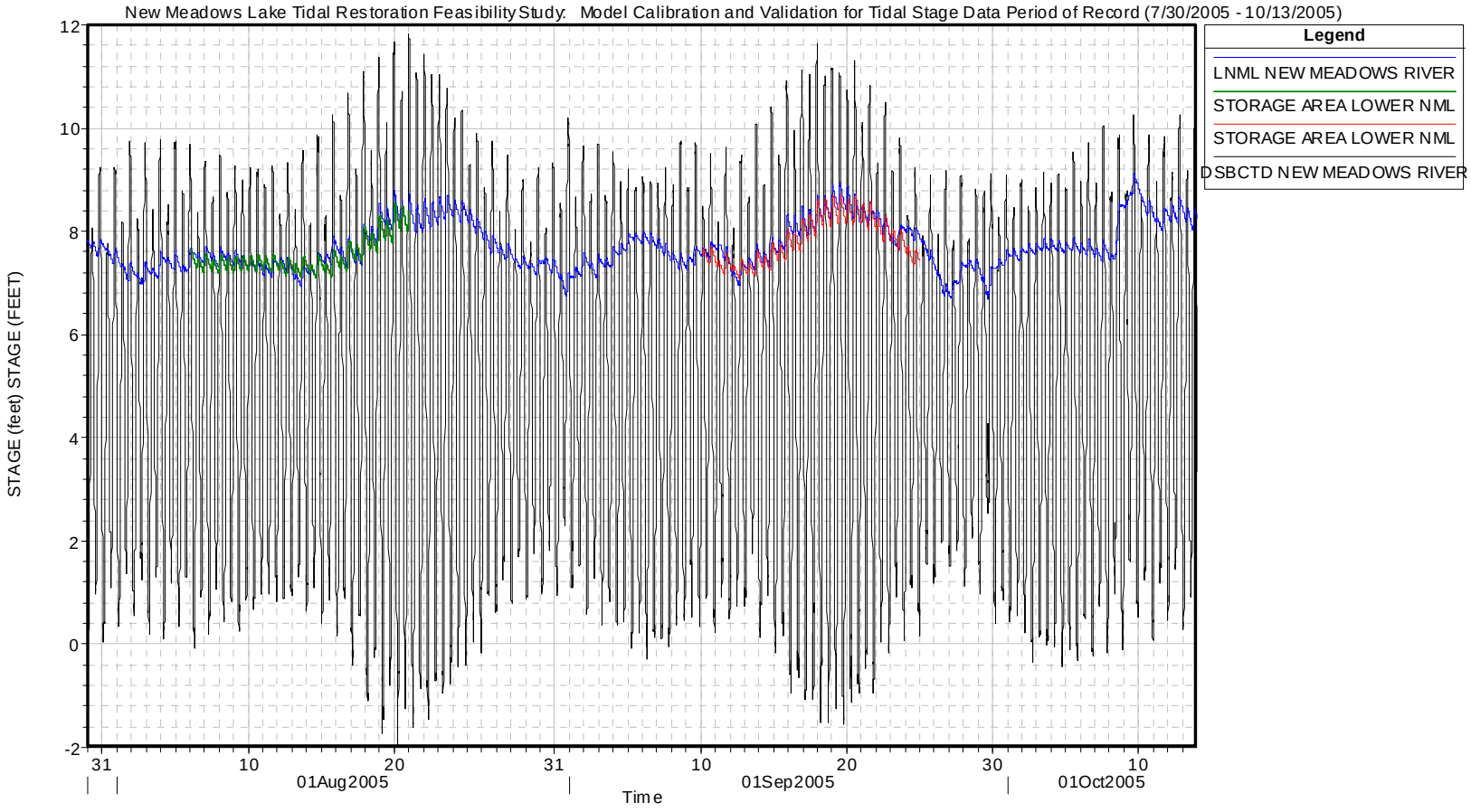


Figure A.3: Model Calibration and Validation Stage Plot (Period of Tidal Stage Data from Study)



Appendix B:

Profile Plots of Preliminary Alternative Hydraulic Analysis Results

Figures:

- Figure B.1: Preliminary Alternative 1 Stage Plot
- Figure B.2: Preliminary Alternative 2 Stage Plot
- Figure B.3: Preliminary Alternative 3 Stage Plot
- Figure B.3: Preliminary Alternative 4 Stage Plot
- Figure B.5: Preliminary Alternative 5 Stage Plot
- Figure B.6: Preliminary Alternative 6 Stage Plot

Notes:

- Plots are for analysis period of September 10-24, 2005

The following references apply to the legends on the Appendix B Plots:

- "LNML New Meadows River" refers to tidal stage data collected as part of this study in Lower New Meadows Lake.
- "Storage Area Upper NML" refers to calculated water surface elevations in Upper New Meadows Lake.
- "Storage Area Lower NML" refers to calculated water surface elevations in Lower New Meadows Lake.
- "DSBCTD New Meadows River" refers to tidal stage data collected as part of this study in the New Meadows River immediately seaward of the State Road causeway.

Figure B.1: Preliminary Alternative 1 Stage Plot

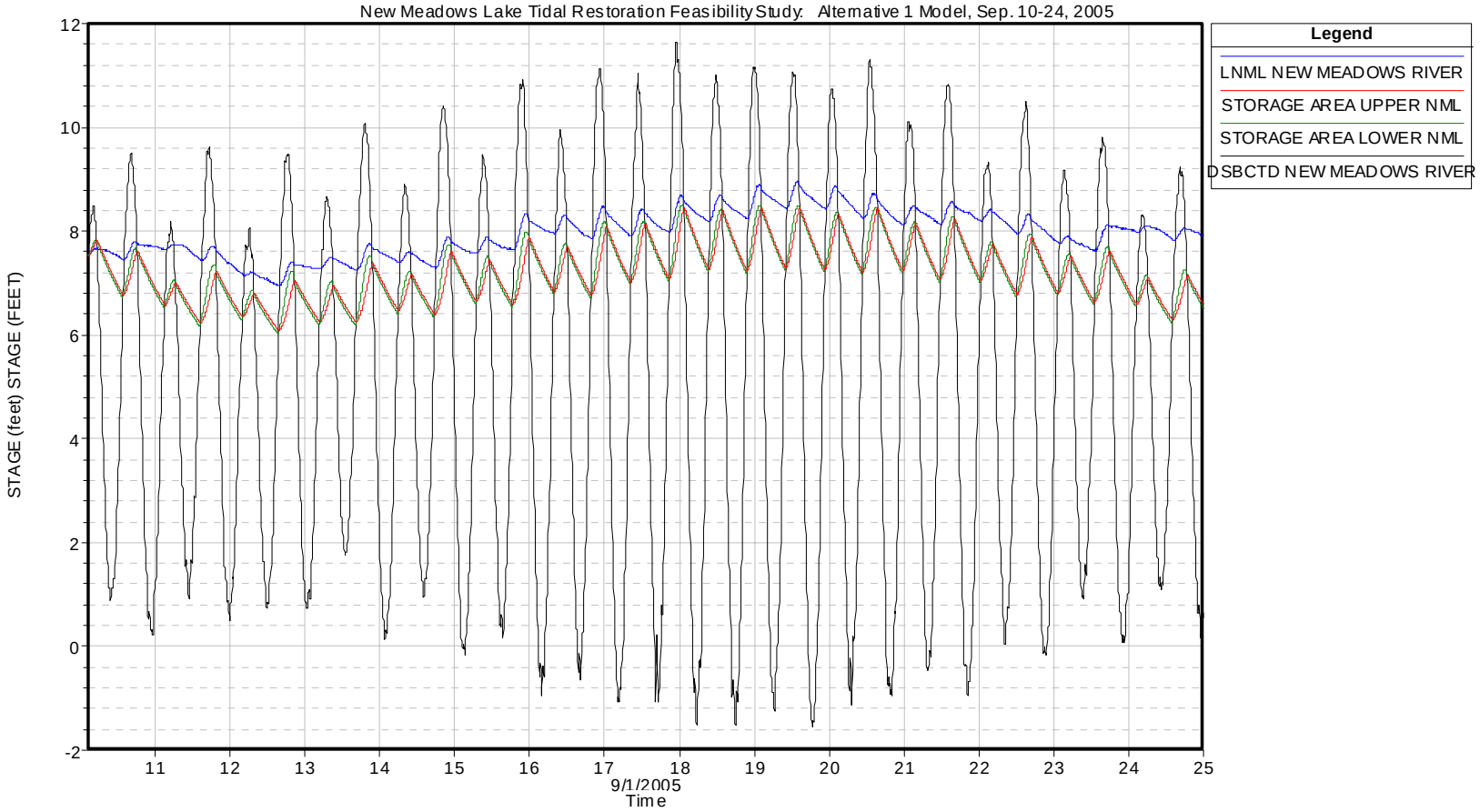


Figure B.2: Preliminary Alternative 2 Stage Plot

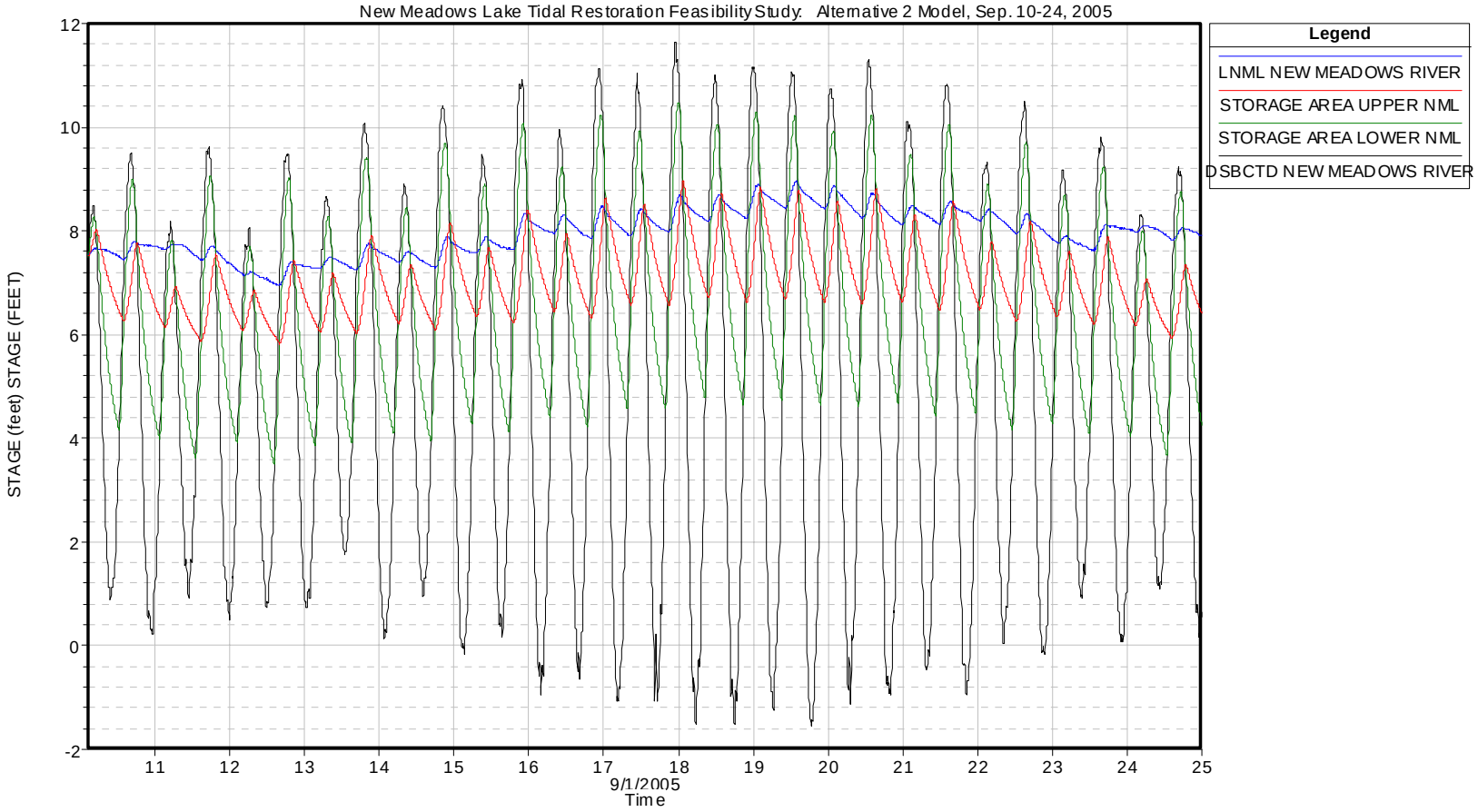


Figure B.3: Preliminary Alternative 3 Stage Plot

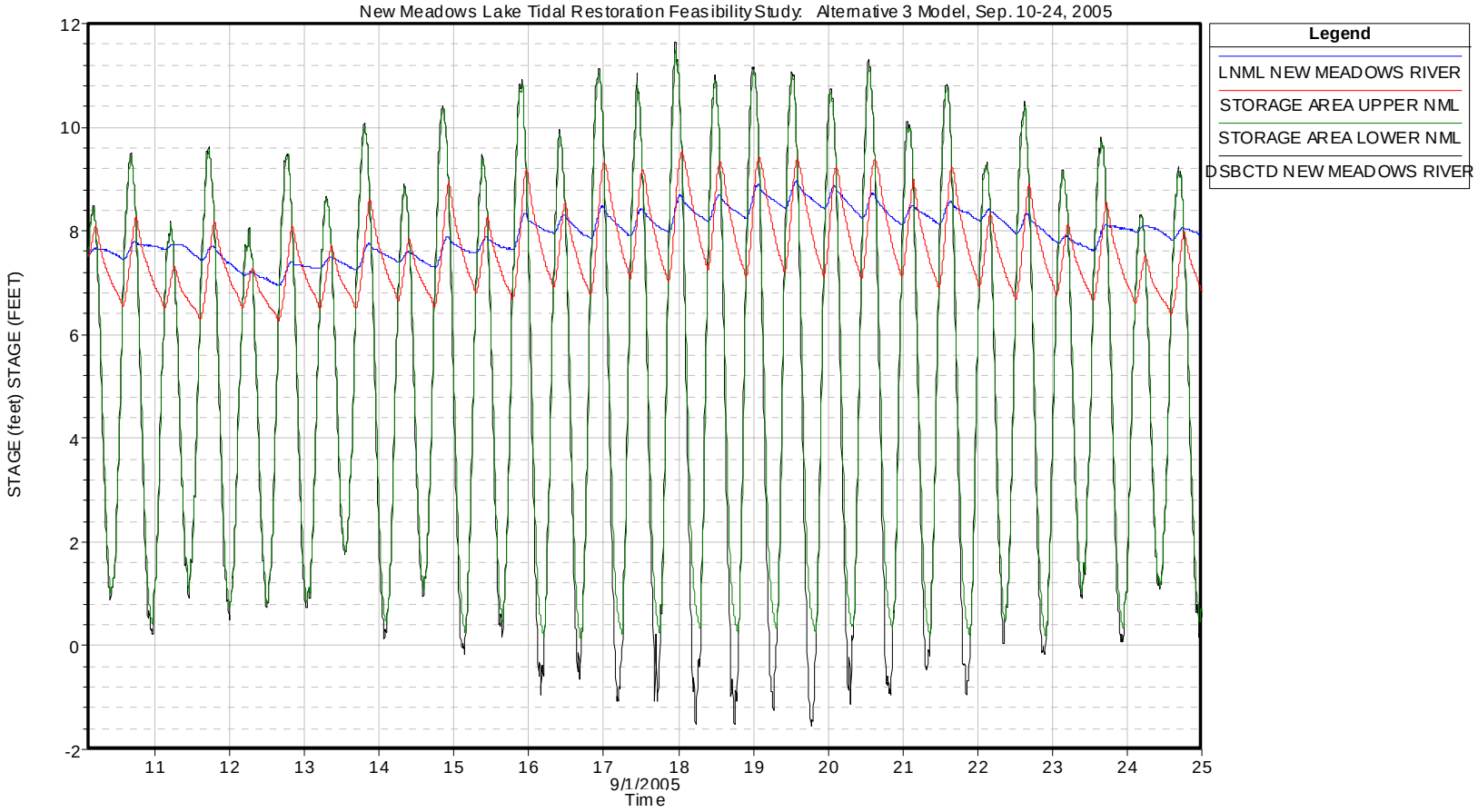


Figure B.4: Preliminary Alternative 4 Stage Plot

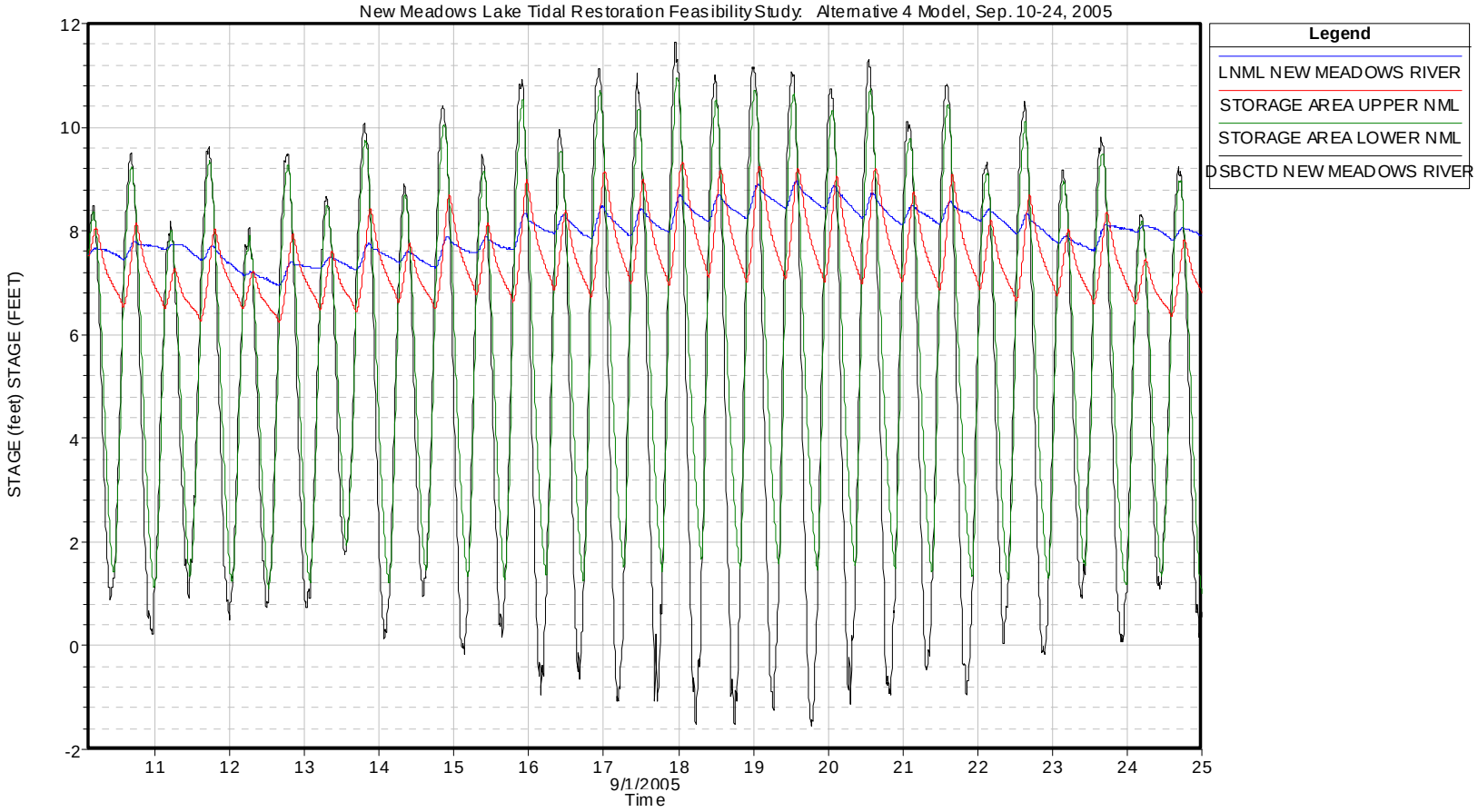


Figure B.5: Preliminary Alternative 5 Stage Plot

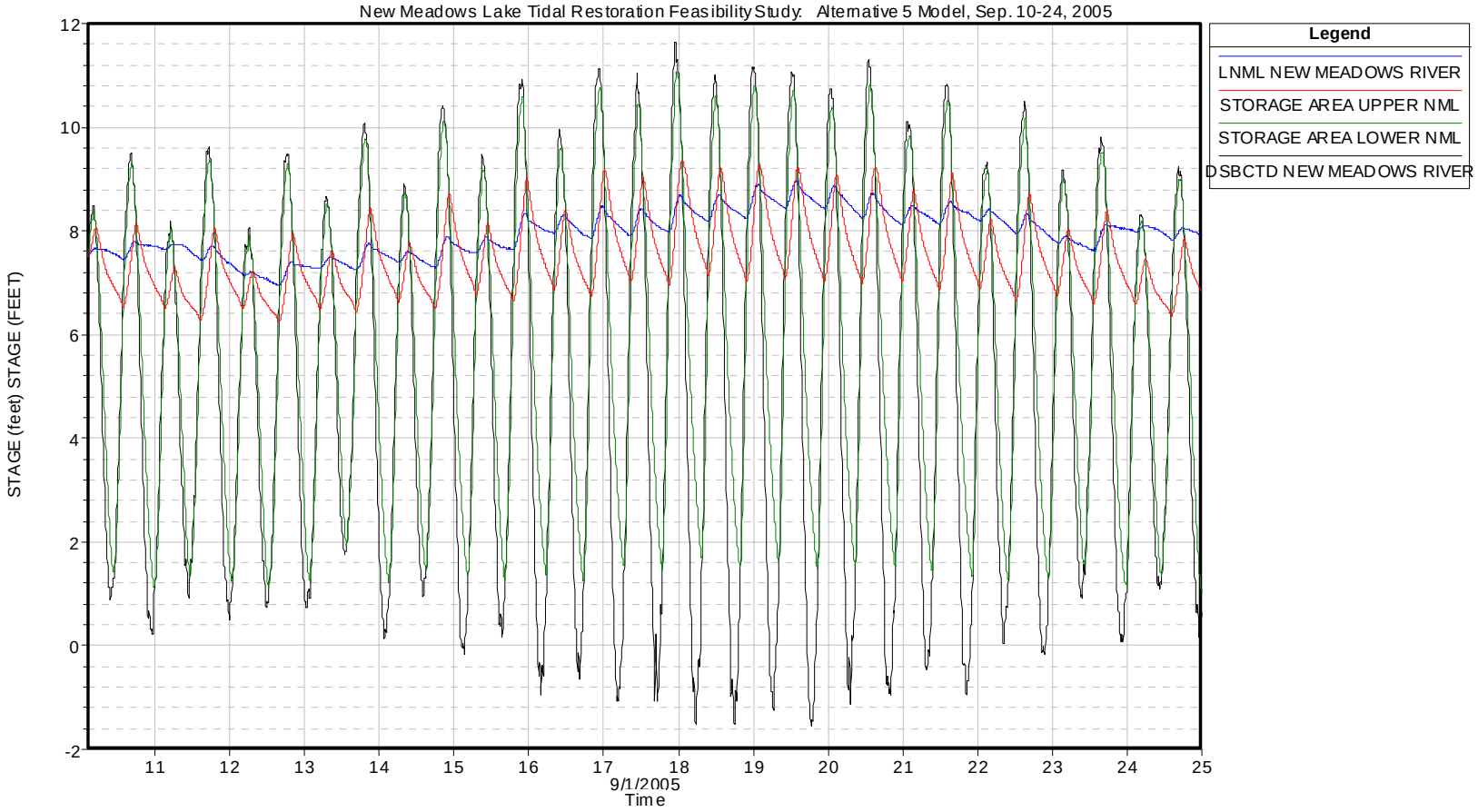
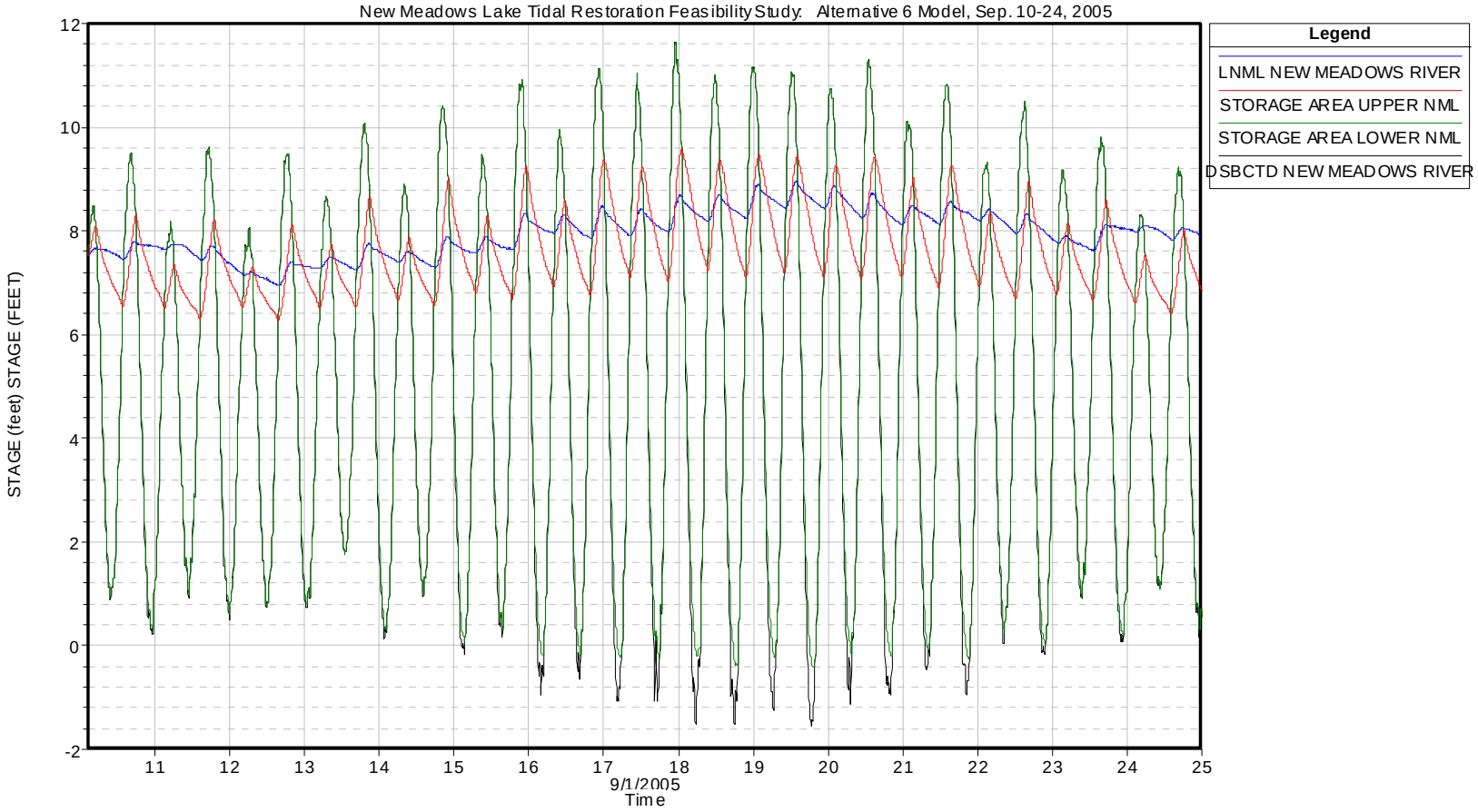


Figure B.6: Preliminary Alternative 6 Stage Plot

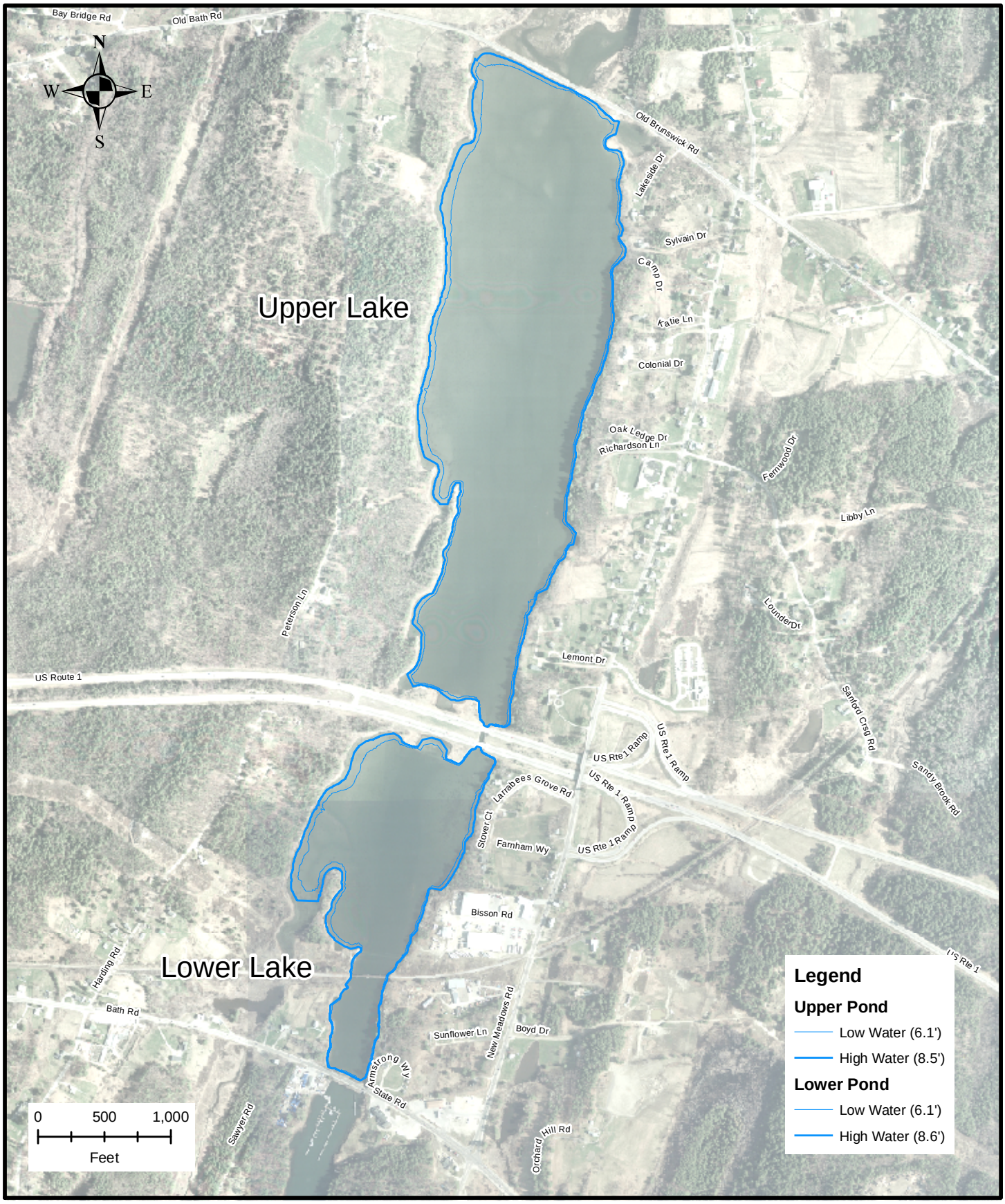


Appendix C:

Preliminary Alternative Hydraulic Analysis Results Plan Plots

Figures:

- Figure Alt 1: Preliminary Alternative 1 Plan Plot
- Figure Alt 2:Preliminary Alternative 2 Plan Plot
- Figure Alt 3:Preliminary Alternative 3 Plan Plot
- Figure Alt 4:Preliminary Alternative 4 Plan Plot
- Figure Alt 5:Preliminary Alternative 5 Plan Plot
- Figure Alt 6:Preliminary Alternative 6 Plan Plot



Prepared By:

WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

105062-alt1.mxd

Sheet Title:

Phase 1 - Alternative 1 Plan

Project:

New Meadows Lake
Tidal Restoration Feasibility Study

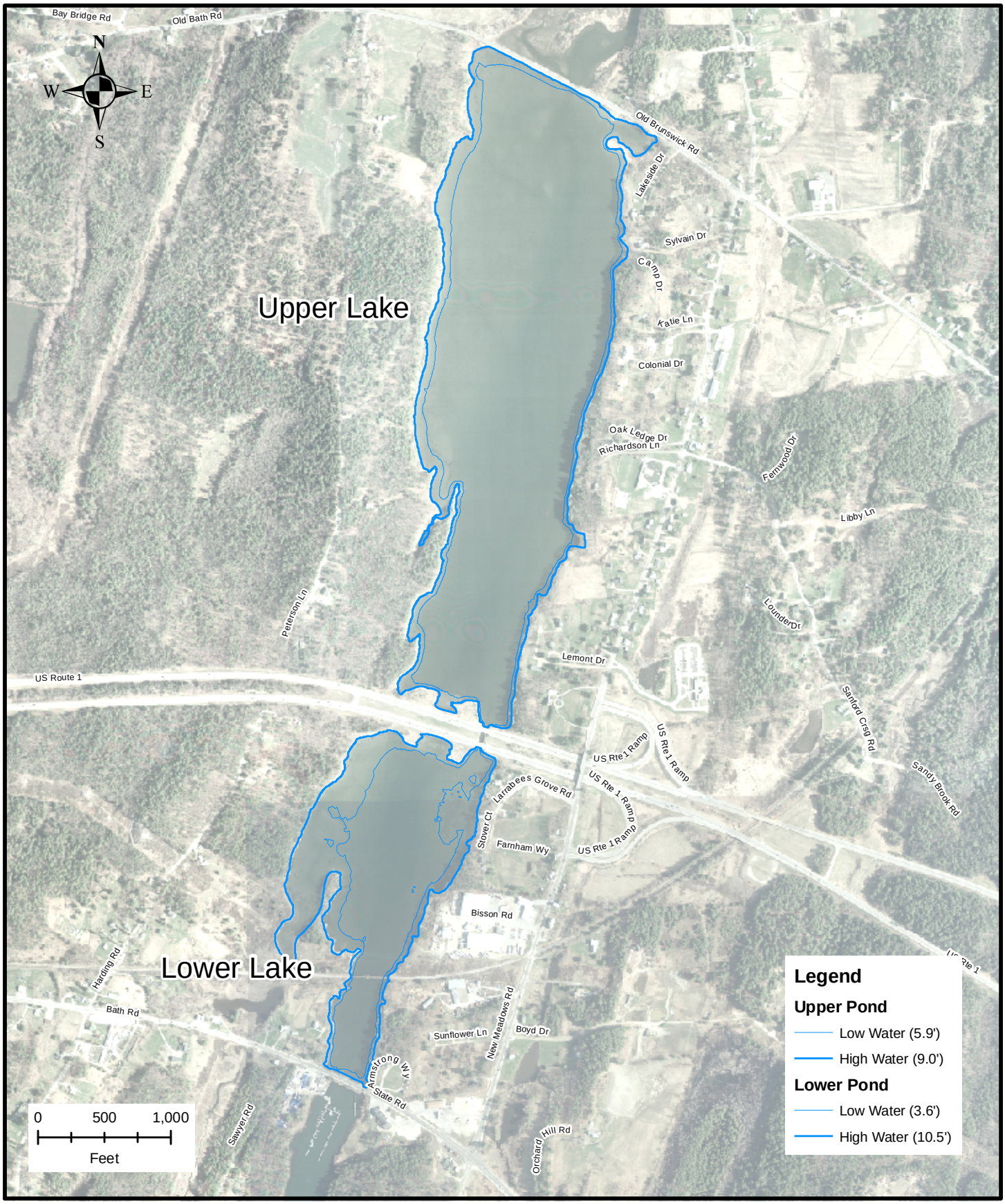
Date: July 2006

Scale: 1"=1000'

Proj. No.: 105062.05

Figure:

Alt 1



Prepared By:

WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

105062-alt2.mxd

Sheet Title:

Phase 1 - Alternative 2 Plan

Project:

New Meadows Lake
Tidal Restoration Feasibility Study

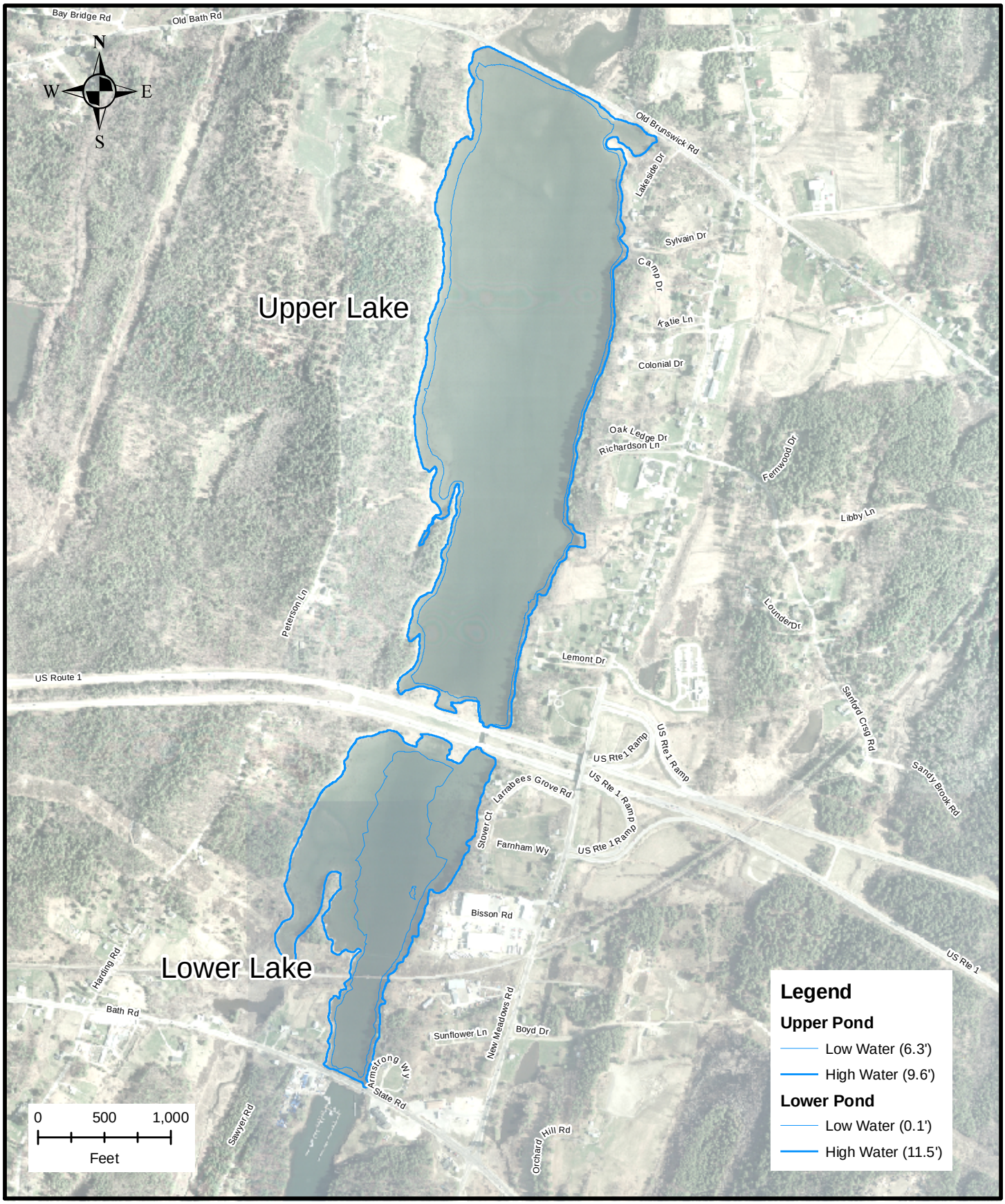
Date: July 2006

Scale: 1"=1000'

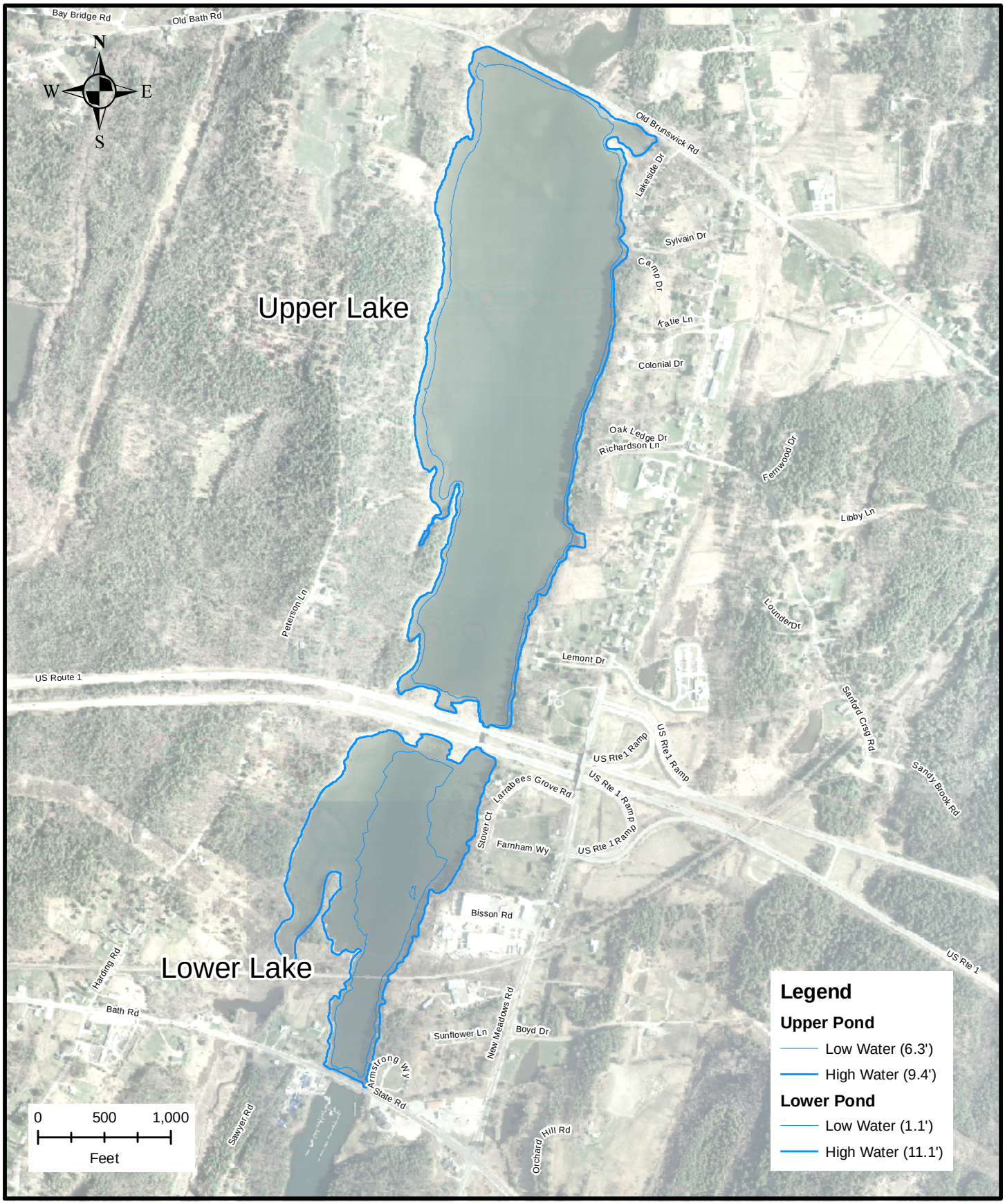
Proj. No.: 105062.05

Figure:

Alt 2



Prepared By: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS *105062-alt3.mxd*	*Sheet Title:* Phase 1 - Alternative 3 Plan *Project:* New Meadows Lake Tidal Restoration Feasibility Study	*Date:* July 2006 *Scale:* 1"=1000' *Proj. No.:* 105062.05 *Figure:* Alt 3



Prepared By:

WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

105062-alt4.mxd

Sheet Title:

Phase 1 - Alternative 4 Plan

Project:

New Meadows Lake
Tidal Restoration Feasibility Study

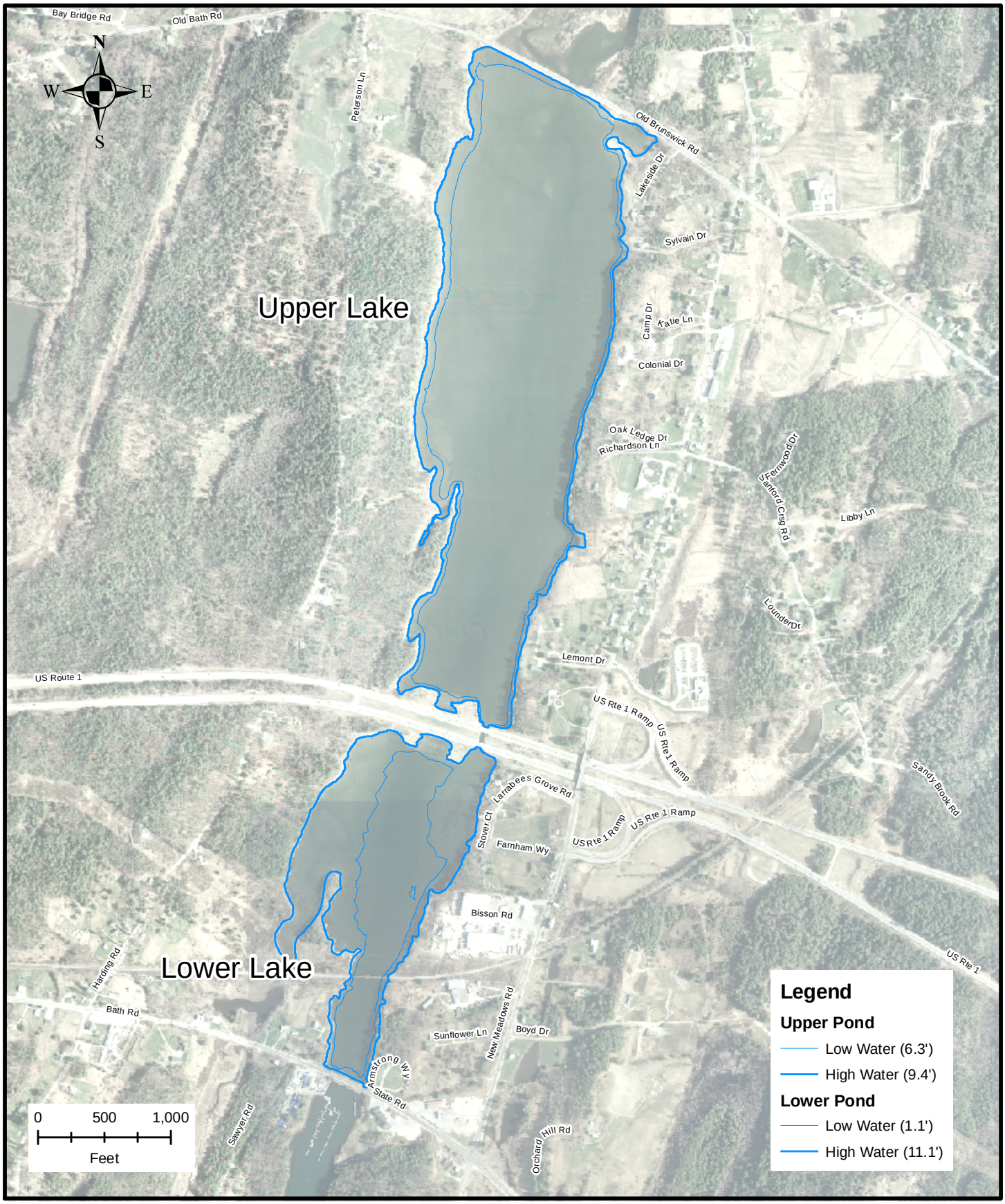
Date: July 2006

Scale: 1"=1000'

Proj. No.: 105062.05

Figure:

Alt 4



Prepared By:

WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

105062-alt5.mxd

Sheet Title:

Phase 1 - Alternative 5 Plan

Project:

New Meadows Lake
Tidal Restoration Feasibility Study

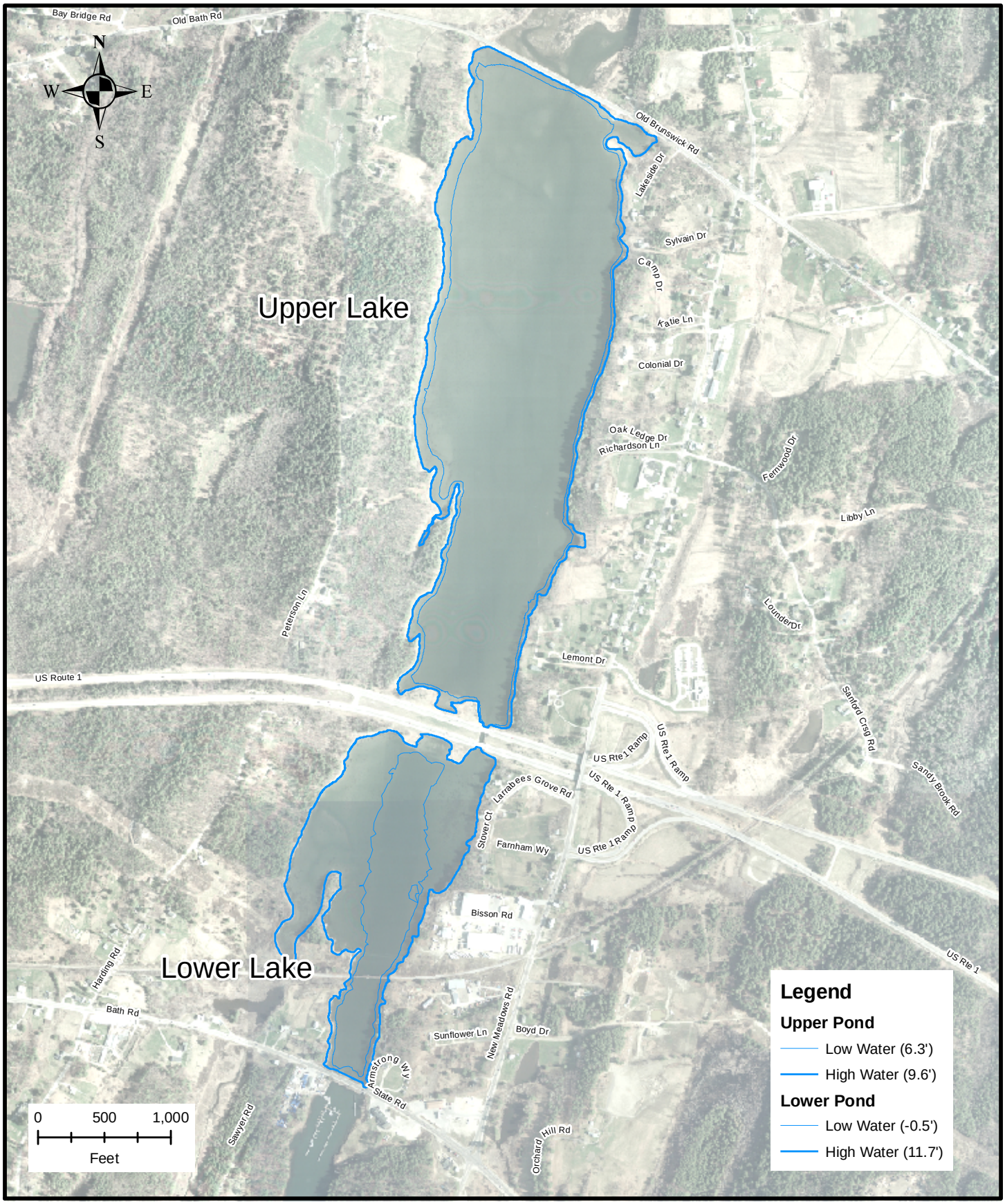
Date: July 2006

Scale: 1"=1000'

Proj. No.: 105062.05

Figure:

Alt 5



Prepared By:

WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

105062-alt6.mxd

Sheet Title:

Phase 1 - Alternative 6 Plan

Project:

New Meadows Lake
Tidal Restoration Feasibility Study

Date: July 2006

Scale: 1"=1000'

Proj. No.: 105062.05

Figure:

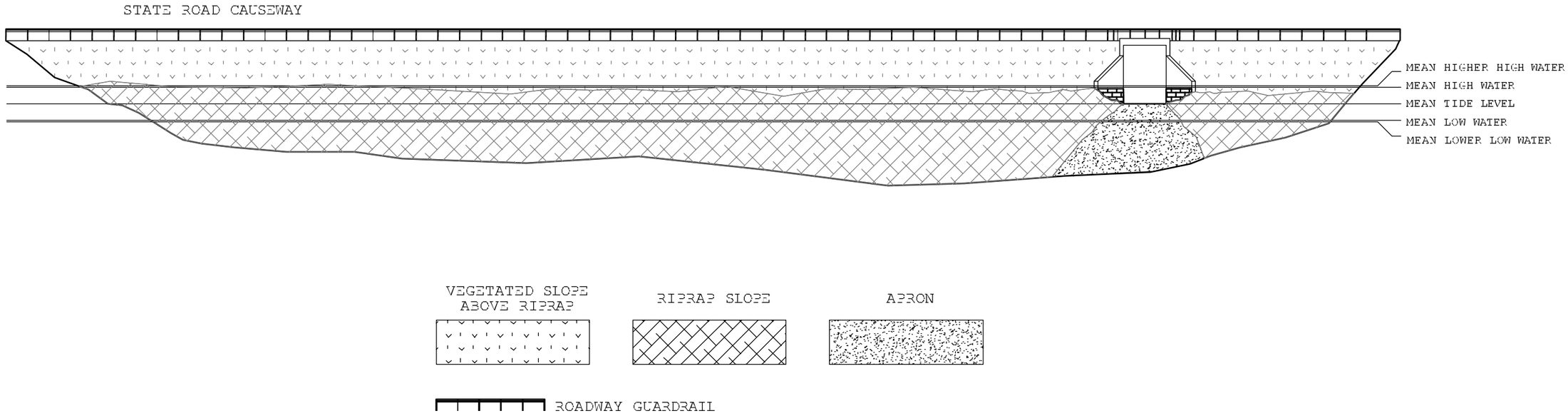
Alt 6

Appendix D:

Profile Plots Depicting Existing and Final Alternative at State Road

Figures:

- Figure P1: Existing Conditions Profile Plot
- Figure P2: Final Alternative 1 Profile Plot
- Figure P3: Final Alternative 2 Profile Plot
- Figure P4: Final Alternative 3 Profile Plot



GENERAL NOTES:
1) TERRAIN FEATURES ARE APPROXIMATE.

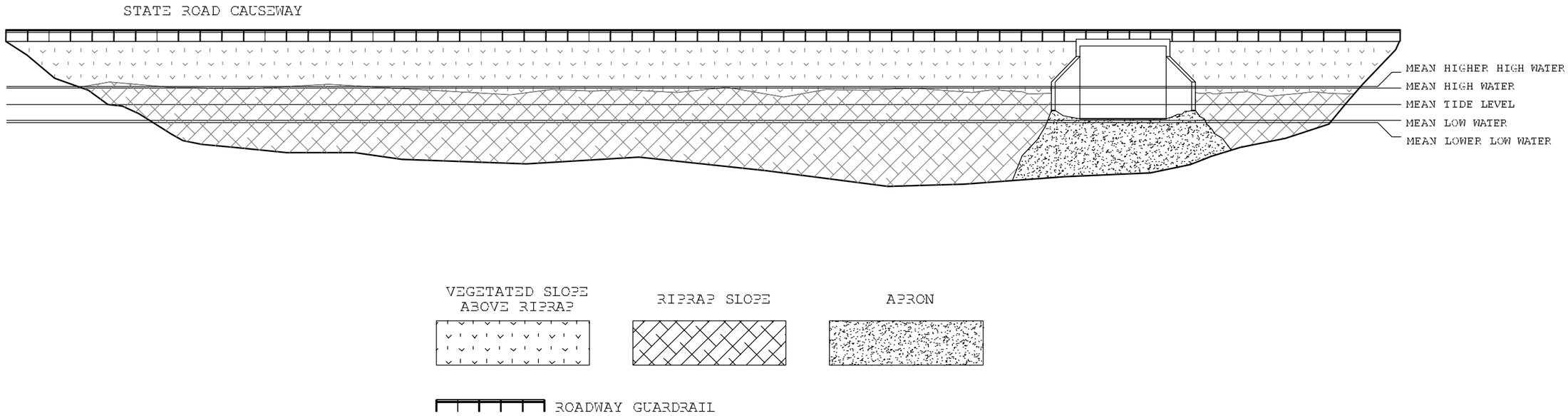
EXISTING CONDITIONS NOTES:
A) LOCATION AND DIMENSIONS OF CULVERT WINGWALLS AND APRON ARE APPROXIMATE.

SHEET TITLE:
EXISTING CONDITIONS
CAUSEWAY PROFILE
VIEW TO NORTH FROM NEW MEADOWS RIVER

PROJECT:
NEW MEADOWS LAKE
TIDAL RESTORATION FEASIBILITY STUDY
BRUNSKICK/BATH/WEST BATH, MAINE
CASCO BAY ESTUARY PARTNERSHIP

PREPARED BY:
WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS
105062 ALTERNATIVE PROFILES.dwg

DATE: July 2006
SCALE: 1"=30'
PROJ. NO. 105062
FIGURE:
P1



GENERAL NOTES:
1) TERRAIN FEATURES ARE APPROXIMATE.

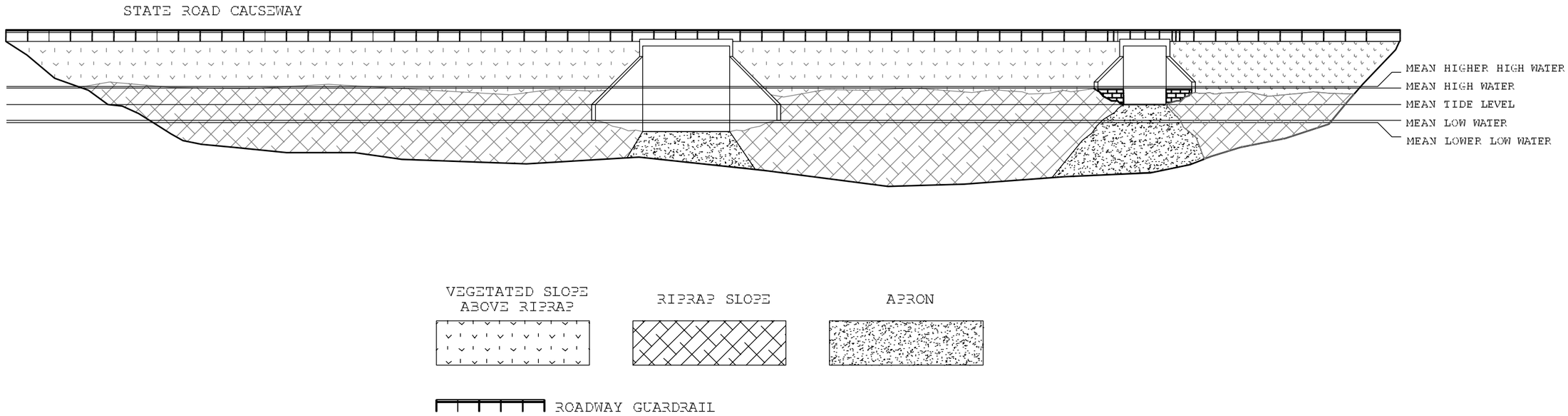
ALTERNATIVE-SPECIFIC NOTES:
A) CUVERT WIDTH IS 24-FT (2X EXISTING CULVERT).
B) CULVERT INVERT SET 4.5-FT BELOW EXISTING CULVERT INVERT).

SHEET TITLE:
FINAL ALTERNATIVE 1
CAUSEWAY PROFILE
VIEW NORTH FROM NEW MEADOWS RIVER

PROJECT:
NEW MEADOWS LAKE
TIDAL RESTORATION FEASIBILITY STUDY
BRUNSKICK/BATH/WEST BATH, MAINE
CASCO BAY ESTUARY PARTNERSHIP

PREPARED BY:
WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS
105062 ALTERNATIVE PROFILES.dwg

DATE: July 2006
SCALE: 1"=30'
PROJ. NO. 105062
FIGURE:
P2



GENERAL NOTES:
1) TERRAIN FEATURES ARE APPROXIMATE.

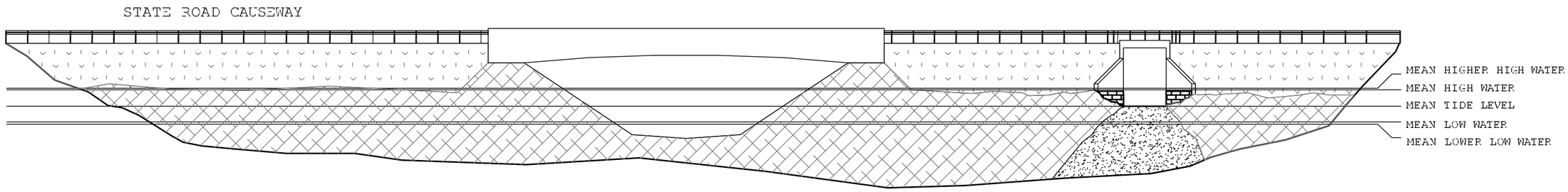
ALTERNATIVE-SPECIFIC NOTES:
A) CUVERT WIDTH IS 24-FT (2X EXISTING CULVERT).
B) CULVERT INVERT SET 7.5-FT BELOW EXISTING CULVERT INVERT).
C) ALTERNATIVE 4 INCLUDES ONLY CULVERT IN CENTER OF CAUSEWAY.
D) ALTERNATIVE 5 INCLUDES EXISTING CULVERT.

SHEET TITLE:
FINAL ALTERNATIVE 2
CAUSEWAY PROFILE
VIEW NORTH FROM NEW MEADOWS RIVER

PROJECT:
NEW MEADOWS LAKE
TIDAL RESTORATION FEASIBILITY STUDY
BRUNSKICK/BATH/WEST BATH, MAINE
CASCO BAY ESTUARY PARTNERSHIP

PREPARED BY:
WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS
105062 ALTERNATIVE PROFILES.dwg

DATE: July 2006
SCALE: 1"=30'
PROJ. NO. 105062
FIGURE:
P3



VEGETATED SLOPE ABOVE RIPRAP

RIPRAP SLOPE

APRON

ROADWAY GUARDRAIL

GENERAL NOTES:
1) TERRAIN FEATURES ARE APPROXIMATE.

ALTERNATIVE-SPECIFIC NOTES:
A) EXISTING CULVERT SHOWN FOR REFERENCE.

SHEET TITLE:
FINAL ALTERNATIVE 3 (BRIDGE)
CAUSEWAY PROFILE
VIEW NORTH FROM NEW MEADOWS RIVER

PROJECT:
NEW MEADOWS LAKE
TIDAL RESTORATION FEASIBILITY STUDY
BRUNSKICK/BATH/WEST BATH, MAINE
CASCO BAY ESTUARY PARTNERSHIP

PREPARED BY:
WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS
105062 ALTERNATIVE PROFILES.dwg

DATE: July 2006
SCALE: 1"=30'
PROJ. NO. 105062
FIGURE:
P4

Appendix E:

Plot of Model Results for October 8 – 10, 2005 Precipitation Event

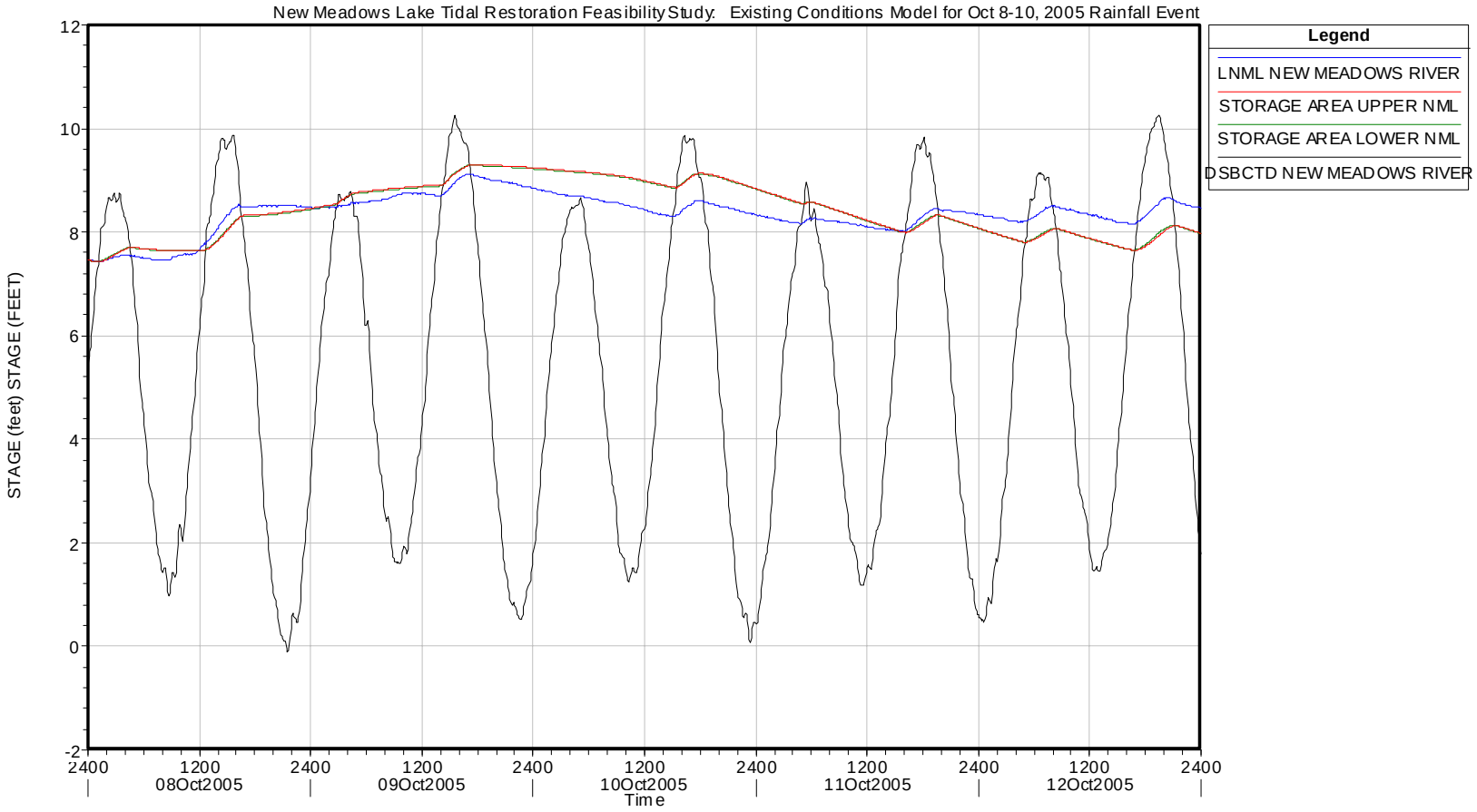
Figure:

- Figure E.1: Stage Plot of Existing Conditions Model Evaluation of October 8-10, 2005 Extreme Precipitation Event

Notes: The following references apply to the legends on the Appendix E Plot:

- "LNML New Meadows River" refers to tidal stage data collected as part of this study in Lower New Meadows Lake.
- "Storage Area Upper NML" refers to calculated water surface elevations in Upper New Meadows Lake.
- "Storage Area Lower NML" refers to calculated water surface elevations in Lower New Meadows Lake.
- "DSBCTD New Meadows River" refers to tidal stage data collected as part of this study in the New Meadows River immediately seaward of the State Road causeway.

Figure E.1: Stage Plot of Existing Conditions Model Evaluation of October 8-10, 2005 Precipitation Event



Appendix F:

New Meadows Lake Entrance Flow Analysis

Attachment:

- New Meadows Lake Entrance Flow Analysis (Blue Hill Hydraulics, Inc.)

Lower Lake Entrance Flow Analysis

New Meadows Lake
Tidal Restoration Feasibility Study
Casco Bay Estuary Partnership

1.0 Objective

The primary objective of this analysis is to determine whether or not high speed flows entering the New Meadows Lower Lake will propagate into the deep hole shown in Figure 1.

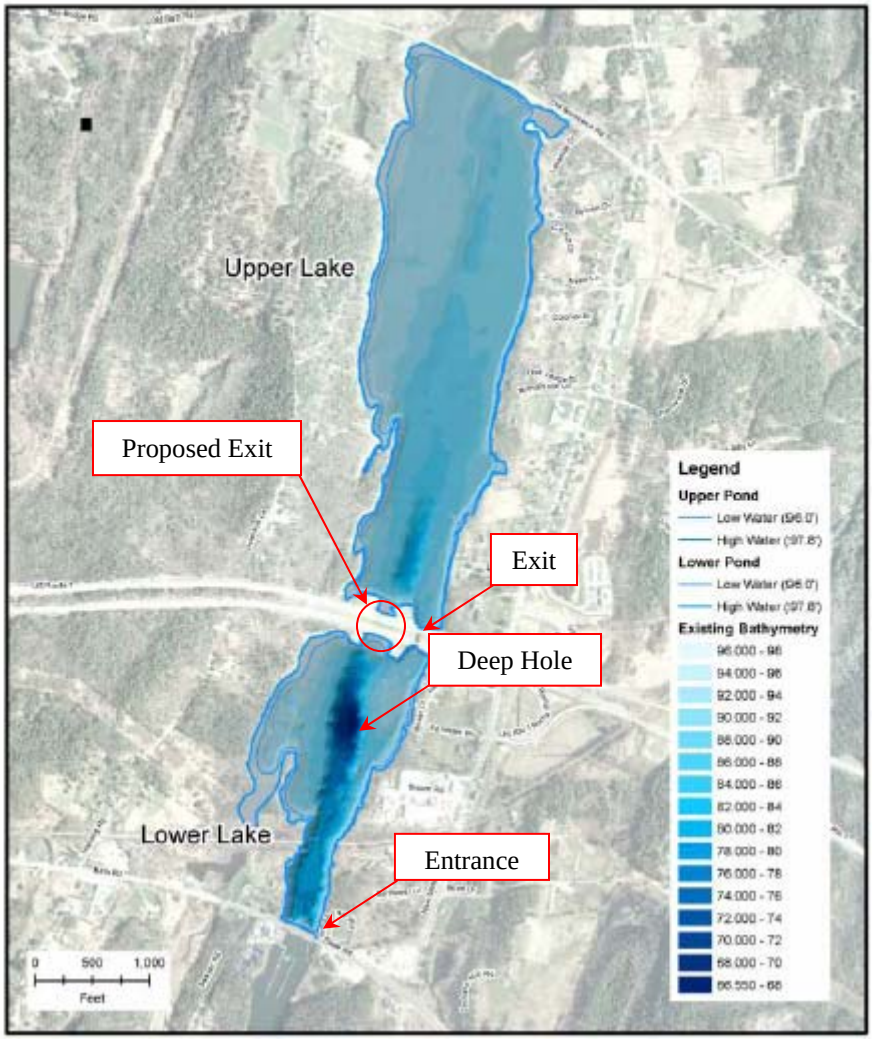


Figure 1: New Meadows Lake Bathymetry
(adapted from Woodlot Alternatives, Inc. – main body report Figure 2)

2.0 Approach

A three-step approach for calculating the spatial extent of high speed flows entering the lower lake was devised as follows:

1. Three different entrance flow scenarios for study were derived from list of six alternative flow conditions. These are referred to as Scenarios 1, 2, and 3 and are defined in Table 1 below.

2. A circular jet analysis (Fischer *et al.*, 1979) was completed for each of the three entrance flow scenarios. The results of these calculations provide order of magnitude estimates for the size of the area affected by high speed flows entering the lower lake.

3. A three-dimensional analysis of flows was completed for each of the three scenarios. Final conclusions were drawn from these results.

Table 1: Jet Scenarios

Scenario	Alternative No.	Velocity (ft/s)	Flow Rate (ft^3/s)	Area (ft^2)	Distance of Jet above Bottom (ft)	Local Water Depth (ft)
1	2	15	1,100	72	10	16
2	3,6	3	1,800	550	5	16
3	4,5	5	1,350	260	5	16

3.0 Results

3.1 Circular Jet Analysis

These analyses assume that the jet entering the lower lake is circular in cross-section and provide estimates its size and shape. In addition to this, the following assumptions and definitions apply.

1) The jet enters a body of like fluid,
2) The *Zone of Flow Establishment (ZFE)* is the region from the jet orifice to a distance six jet diameters in the direction of flow where the velocity core is constant,
3) The *Zone of Established Flow (ZEF)* is the region where mean velocities and concentration profiles are "self-similar" – *e.g.*, within this region the time-averaged velocity can be expressed in terms of a maximum value and measure of width.

Jet properties used in the analysis are provided in Table 2 (note: nomenclature is from Fischer *et al.*, 1979).

Table 2: Jet Properties

Scenario No.	Initial Volume Flow Rate (Q)	Initial Specific Momentum Flux (M)	Characteristic Length Scale (l_Q)	Length of ZFE Assuming Round Jet
1	1100	1.7E+04	8	57
2	1800	5.9E+03	23	159
3	1350	7.0E+03	16	109

Figures 2 and 3 provide plots of the maximum time averaged velocity within the jets and jet width as a function of distance from the jet orifice. As illustrated by the results shown in Figure 2, the average centerline velocity of the jets is relatively small at distances beyond 700 - 800 ft downstream from the jet orifice. In addition to this, it should be noted that this analysis does not take into account the effect the lower lake's shape or the interaction between the lake's bottom and the evolving jets (the results provided in sections 3.2, 3.3, and 3.4 do incorporate site specific characteristics aspects of the problem).

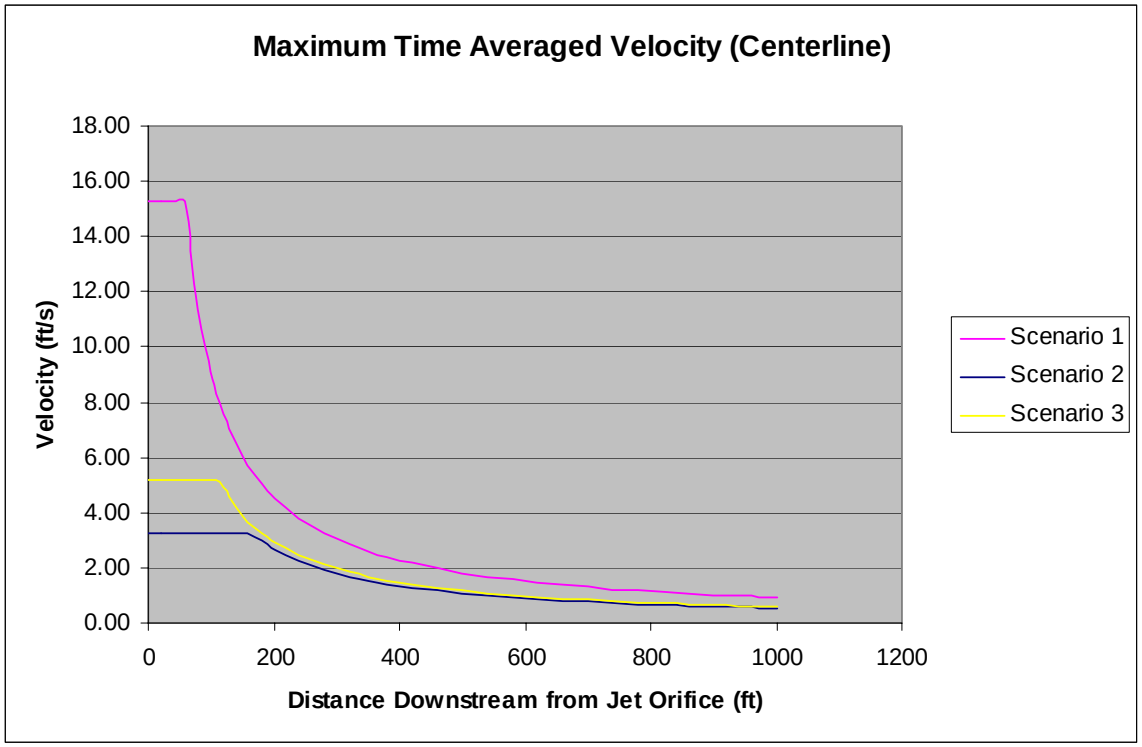


Figure 2: Maximum Time Averaged Velocity vs. Distance from Jet Orifice

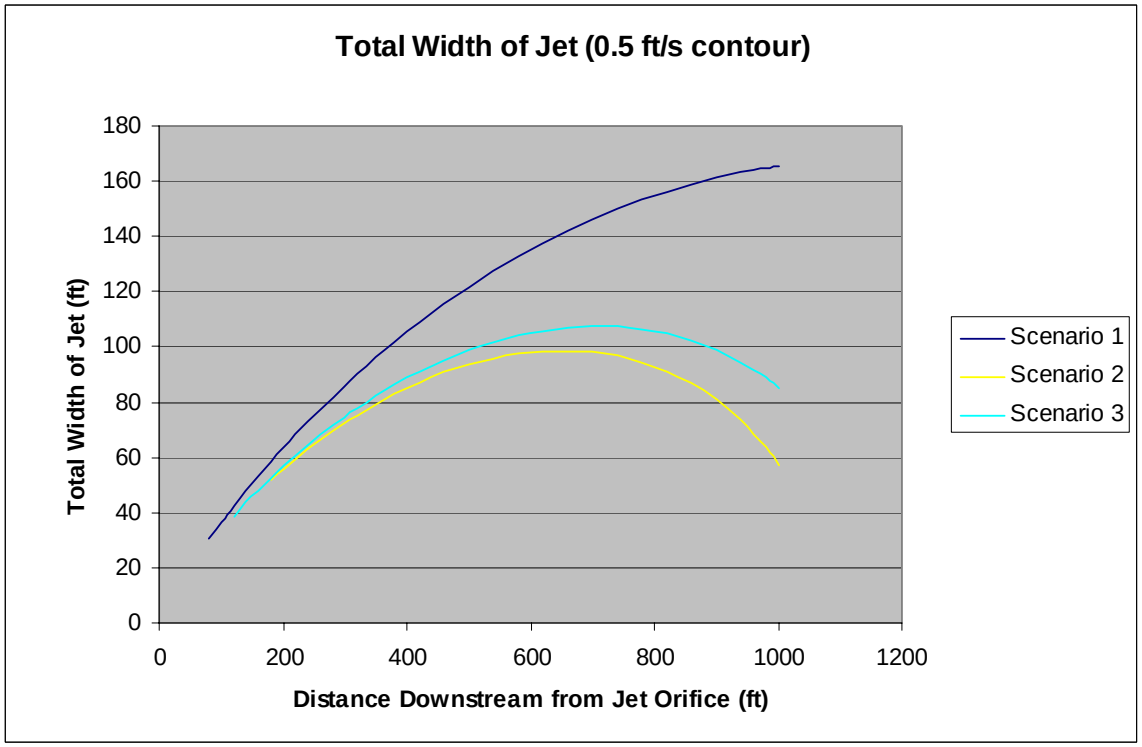


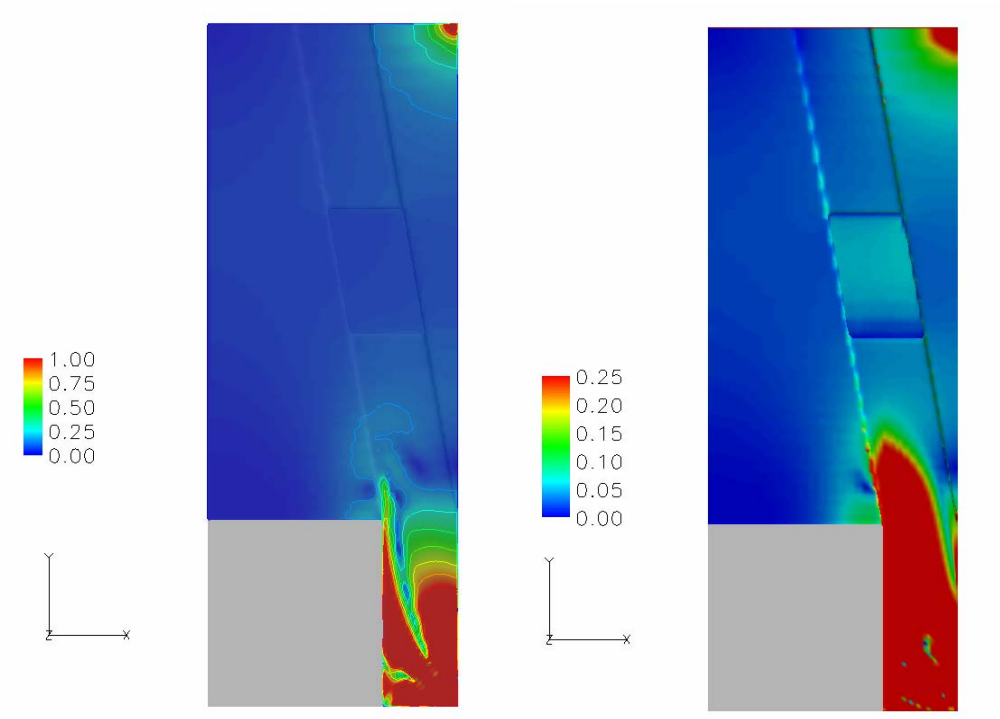
Figure 3: Jet Width vs. Distance from Jet Orifice

3.2 Scenario 1 – 1,100 cfs

A three-dimensional model of the lower lake was constructed using an idealized representation of the lake's bathymetry and steady flow patterns within the lake were calculated for Scenarios 1, 2, and 3 as defined in Table 1.

Figure 4 shows results of the Scenario 1 simulation. As shown in frame (a), the jet does not propagate into the main body of the lower pond significantly. In fact, in this calculation, jet velocities exceed 1 ft/s for a distance equal to only about 800 ft downstream of the orifice.

Figure 4 (b) shows the distribution of flow speeds at the bottom of the lake. As one would expect, velocities near the lake's bottom particularly in the deep hole are quite small (< 0.1 ft/s for this flow condition).



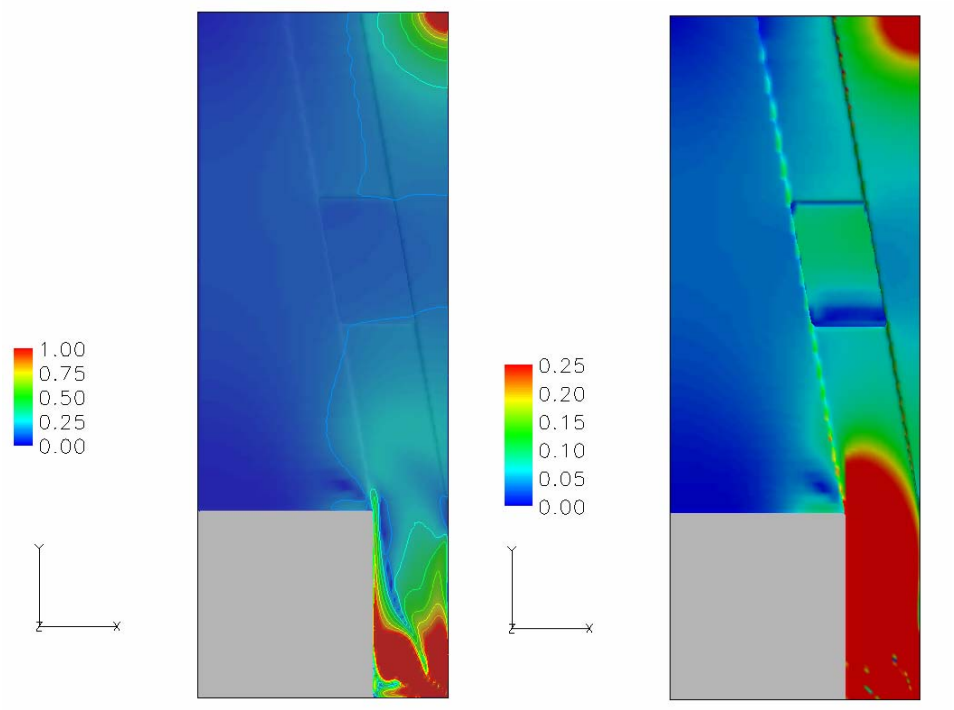
(a) (b)

Figure 4: Lower Lake Velocity Distributions (units are ft/s)
(a) surface velocities, (b) bottom velocities

3.3 Scenario 2 – 1,800 cfs

Figure 5 shows results of the Scenario 2 simulation. As before, the jet does not propagate into the main body of the lower pond significantly, and flow speeds at the bottom of the lake are small (< 0.15 ft/s for this flow condition).

Compared to the results shown in Figure 4, the size of the jet - defined as the region where surface velocities exceed 1 ft/s - is smaller for Scenario 2. This is because the momentum flux associated with the Scenario 2 jet is about three times less than the momentum flux associated with the Scenario 1 jet.



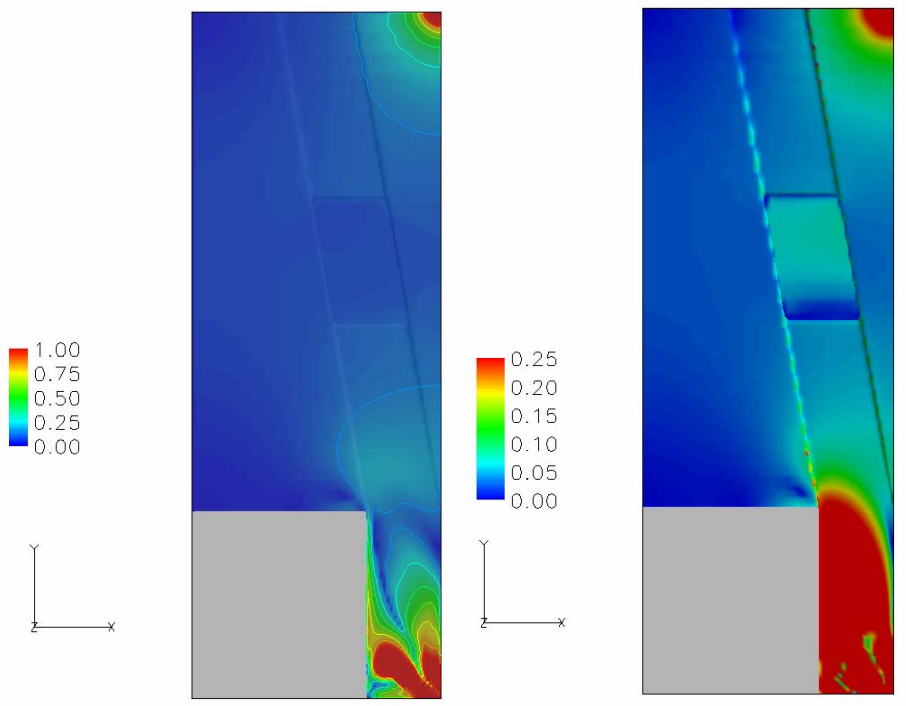
(a) (b)

Figure 5: Lower Lake Velocity Distributions (units are ft/s)
(a) surface velocities, (b) bottom velocities

3.4 Scenario 3 – 1,350 cfs

Figure 6 shows results of the Scenario 3 simulation. Similar to the previous results, the jet does not propagate into the main body of the lower pond significantly, and flow speeds at the bottom of the lake are small (< 0.1 ft/s for this flow condition).

The size of the jet shown in Figure 6 compares closely to the size of the jet shown in Figure 5. This is to be expected since the momentum flux associated with the Scenario 2 jet is about the same as the momentum flux associated with the Scenario 3 jet.



(a) (b)

Figure 6: Lower Lake Velocity Distributions (units are ft/s)
(a) surface velocities, (b) bottom velocities

4.0 Conclusions

The following conclusions were reached as a result of these analyses.

1) High-speed flows entering the lower lake at its entrance (see Figure 1) should not be expected to propagate into its main body,

2) Flows entering the lake tend to move through the deeper regions of the lake, and

3) To increase the circulation of water through the deeper regions of the lower lake the following changes to the lake's entrance and exit should be considered:

    a. The entrance could be re-aligned so that the inflow jet(s) are directed towards in lake's main body,
    b. The exit could be moved to the proposed location shown in Figure 1 – this would direct flows through the deeper portions of the lake, and
    c. Culvert geometries (*i.e.,* entrance and exit geometries) could be chosen to maximize the momentum flux associated with the in-flow and exit-flow jets; however, additional considerations for headloss should be made.

5.0 References

Fischer H.B. *et al.* (1979), Mixing in Inland and Coastal Waters, Academic Press, Boston, MA.

Appendix G:

Tide Station Datum

Attachment:

- Discussion of Portland, Maine Tide Station Datum Rectification
- Elevations on Station Datum for Station No. 8418150
- Published Benchmark Sheet for Station No. 8418150

Appendix G: Tide Station Datum

Project work was initially referenced to an arbitrary vertical datum established during survey work by Woodlot at the existing State Road culvert. The reference point for this datum was an eye-bolt protruding from the west wingwall of the culvert on the north (New Meadows Lake) side of the culvert. An arbitrary elevation of 100-feet (ft) was assigned to this point. Tidal stage data and bathymetric data subsequently obtained by Woodlot were referenced to this datum.

At the request of the project team following their review of the draft final report, Woodlot rectified the project vertical datum to a local tidal station. Woodlot used data for the NOAA tide station in Portland, Maine (Station ID: 8418150) for this work. Project data was rectified by taking an average of the entire 6-minute tidal stage data set collected over a period of 77 days south of State Road in the New Meadows River to provide a reference Mean Sea Level (MSL) elevation. The data set obtained by Woodlot appears reasonable for this purpose, as there is no indication that the recording equipment was above low water during the recording period. This elevation was determined to be 93.86-ft, based on the project vertical datum.

Note that MSL was used in lieu of the Mean Tide Level (MTL) as a reference because the determination of MTL requires the evaluation of minimum and maximum tide elevations for each tidal cycle, which is complicated by the typical appearance of a number of minima and maxima when collecting data over a high period.

The value of MSL reference to the project datum was rectified to selected NOAA station datum using a direct comparison of the calculated MSL value and the reported MSL value for NOAA Station ID 8418150 of 13.49-ft. A correction of -80.37-ft (93.86-13.49) was applied to report data to rectify the project vertical datum to the referenced NOAA tide station. Note that Mean Lower-Low Water (MLLW) reference elevation for the NOAA tide station is 8.55-ft, not 0.0-ft. The vertical datum for the Phase 2 modeling work was subsequently rectified to MLLW = 0.00 by subtracting 8.55-ft from reported datums for the NOAA tide station.

Online datum information for NOAA Station ID 8418150 can be found at the following website:

http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=8418150%20Portland,%20ME&type=Datums

Online benchmark information for NOAA Station ID 8418150 can be found at the following website:http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=8418150%20Portland,%20ME&type=Bench%20Mark%20Sheets

The following datum information for NOAA Station ID 8418150 that was used to rectify the project vertical datum:

ELEVATIONS ON STATION DATUM
National Ocean Service (NOAA)

Station: 8418150 T.M.: 0 W
Name: PORTLAND, CASCO BAY, ME Units: Feet
Status: Accepted Epoch: 1983-2001

Datum	Value	Description
MHHW	18.46	Mean Higher-High Water
MHW	18.02	Mean High Water
DTL	13.51	Mean Diurnal Tide Level
MTL	13.46	Mean Tide Level
MSL	13.49	Mean Sea Level
MLW	8.90	Mean Low Water
MLLW	8.55	Mean Lower-Low Water
GT	9.91	Great Diurnal Range
MN	9.12	Mean Range of Tide
DHQ	0.44	Mean Diurnal High Water Inequality
DLQ	0.34	Mean Diurnal Low Water Inequality
HWI	3.59	Greenwich High Water Interval (in Hours)
LWI	9.75	Greenwich Low Water Interval (in Hours)
NAVD	13.81	North American Vertical Datum
Maximum	22.68	Highest Water Level on Station Datum
Max Date	19780207	Date Of Highest Water Level
Max Time	10:30	Time Of Highest Water Level
Minimum	5.10	Lowest Water Level on Station Datum
Min Date	19551130	Date Of Lowest Water Level
Min Time	17:18	Time Of Lowest Water Level

To refer Water Level Heights to a Tidal Datum, apply the desired Datum Value.

Click HERE for further station information including New Epoch products.

To refer Water Level Heights to either
NGVD (National Geodetic Vertical Datum of 1929) or
NAVD (North American Vertical Datum of 1988), apply the values located at:
National Geodetic Survey

Published Bench Mark Sheet for 8418150 PORTLAND, CASCO BAY MAINE
U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 8418150 PUBLICATION DATE: 10/30/2003
Name: PORTLAND, CASCO BAY MAINE
NOAA Chart: 13292 Latitude: 43° 39.4' N
USGS Quad: PORTLAND EAST Longitude: 70° 14.8' W

To reach the tidal bench marks from north bound Interstate 295 in Portland, take the Waterfront Exit (Alt. U.S. 1) to Commercial Street, then continue NE along Commercial Street for 2.4 km (1.5 mi) to the Maine State Pier, the last pier-warehouse along the waterfront. The bench marks are located within 1.6 km (1 mi) radius of tide station. The tide gage is located in the south corner on the off shore end of the Maine State Pier.

T I D A L B E N C H M A R K S

PRIMARY BENCH MARK STAMPING: ELEV 14.501 FT TIDAL 31
DESIGNATION: TIDAL 31 STA 84

MONUMENTATION: Tidal Station disk VM#: 173
AGENCY: US Coast and Geodetic Survey (USC&GS) PID#: OC0005
SETTING CLASSIFICATION: Stone foundation

The primary bench mark is a disk set vertically in the NE face of the stone foundation of a three story building located along Commercial Street between India and Franklin Streets, 63 m (206.7 ft) SW of the SW curb of India Street, 12.65 m (41.5 ft) NNE of fire hydrant on the NW side of Commercial Street, 2.71 m (8.9 ft) NW of the NW curb of Commercial Street, and 0.15 m (0.5 ft) above the sidewalk.

BENCH MARK STAMPING: 38 1919
DESIGNATION: TIDAL 38 STA 84

MONUMENTATION: Tidal Station disk VM#: 174
AGENCY: US Coast and Geodetic Survey (USC&GS) PID#: OC0011
SETTING CLASSIFICATION: Stone shelf

The bench mark is a disk set in a stone shelf at the west wing of the City Hall, located at the intersection of Congress and Chestnut Streets, 17.22 m (56.5 ft) NE of NE curb of Chestnut Street, 8.2 m (27 ft) NW of NW curb of Congress Street, 1.07 m (3.5 ft) NE of the NE face of the building wing, and 1.2 m (4 ft) above the level of the sidewalk.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Name: PORTLAND, CASCO BAY
MAINE
NOAA Chart: 13292 Latitude: 43° 39.4' N
USGS Quad: PORTLAND EAST Longitude: 70° 14.8' W

T I D A L B E N C H M A R K S

BENCH MARK STAMPING: NO 3 1971
DESIGNATION: 841 8150 TIDAL 3

MONUMENTATION: Tidal Station disk VM#: 175
AGENCY: US Coast and Geodetic Survey (USC&GS) PID#: AJ2726
SETTING CLASSIFICATION: Granite sea wall

The bench mark is a disk set in the granite seawall located along the NE side of Commercial Street north of the Bath Iron Works pier, 17.83 m (58.5 ft) NE of the NE corner formed by the pier and seawall intersection, 6.10 m (20.0 ft) SW of the NW corner formed by the edge of the seawall and a projection out from the seawall, and 0.3 m (1 ft) east of the concrete parking lot barrier.

BENCH MARK STAMPING: NO 43 1975
DESIGNATION: 841 8150 TIDAL 43

MONUMENTATION: Tidal Station disk VM#: 176
AGENCY: National Ocean Survey (NOS) PID:
SETTING CLASSIFICATION: Granite step

The bench mark is a disk set in the first step of the stairs at the SE entrance of the Cumberland County Courthouse, 21.0 m (69 ft) SE of the SE corner of Pearl and Federal Streets, 12.16 m (39.9 ft) east of the centerline of Pearl Street, and 0.76 m (2.5 ft) west of the west wall of the courthouse.

Station ID: 8418150 PUBLICATION DATE: 10/30/2003
Name: PORTLAND, CASCO BAY
MAINE
NOAA Chart: 13292 Latitude: 43° 39.4' N
USGS Quad: PORTLAND EAST Longitude: 70° 14.8' W

T I D A L B E N C H M A R K S

BENCH MARK STAMPING: 8150 A 1978
DESIGNATION: 841 8150 A

MONUMENTATION: Tidal Station disk VM#: 177
AGENCY: National Ocean Survey (NOS) PID:
SETTING CLASSIFICATION: Concrete loading pad

The bench mark is a disk set in a concrete loading pad near the NW corner of the

Maine State Pier located on the NE side of Commercial Street, 23.77 m (78.0 ft) east of the east face of a parking garage, 12.01 m (39.4 ft) SW of the NW corner of a warehouse, 1.68 m (5.5 ft) west of the west side of a building, and 0.3 m (1.0 ft) above ground.

BENCH MARK STAMPING: 841-8150 C 1979
DESIGNATION: 841 8150 C

MONUMENTATION: Tidal Station disk VM#: 179
AGENCY: National Ocean Survey (NOS) PID:
SETTING CLASSIFICATION: Granite step

The bench mark is a disk set in the granite step at the doorway leading to the building at 40 Pearl Street located between Middle and Milk Streets, 19.75 m (64.8 ft) NW of the centerline of Milk Street, 9.8 m (32 ft) SW of the centerline of Pearl Street, 6.00 m (19.7 ft) SE of the north corner of the building, and 0.24 m (0.8 ft) above ground.

Station ID: 8418150 PUBLICATION DATE: 10/30/2003
Name: PORTLAND, CASCO BAY MAINE
NOAA Chart: 13292 Latitude: 43° 39.4' N
USGS Quad: PORTLAND EAST Longitude: 70° 14.8' W

T I D A L B E N C H M A R K S

BENCH MARK STAMPING:
DESIGNATION: TIDAL 2 USE STA 84
ALIAS: NO 2 USE 1901

MONUMENTATION: Drill Hole VM#: 181
AGENCY: PID#: OC0003
SETTING CLASSIFICATION: Water table

The bench mark is a drill hole in the top of a water table between the bases of two stone columns at the NE side of the entrance to the U.S. Custom House located at the intersection of Commercial and Pearl Streets, 20.00 m (65.6 ft) NW of the centerline of Commercial Street, 12.50 m (41.0 ft) NE of the SW corner of the Custom House, 8.70 m (28.5 ft) SW of the NE corner of the Custom House, and 0.3 m (1.0 ft) above the sidewalk.

BENCH MARK STAMPING:
DESIGNATION: TIDAL 30 STA 84
ALIAS: NO 30 (1910)

MONUMENTATION: Chiseled Cross VM#: 182
AGENCY: PID#: OC0006
SETTING CLASSIFICATION: Granite sill

The bench mark is a chiseled cross in the granite sill at the SE corner of the foundation for the Grand Trunk Railway building located at the intersection of Commerce and India Streets, 10.61 m (34.8 ft) north of power pole numbered 1.11, 7.99 m (26.2 ft) ESE of the emergency telephone at the intersection of Commerce and India Streets, 7.6 m (25 ft) NE of the NE curb of India Street, 5.00 m (16.4 ft) SSE of the south side of the steps leading into the Grand Trunk Railway building, and 0.40 m (1.3 ft) above ground.

Station ID: 8418150 PUBLICATION DATE: 10/30/2003
Name: PORTLAND, CASCO BAY MAINE
NOAA Chart: 13292 Latitude: 43° 39.4' N
USGS Quad: PORTLAND EAST Longitude: 70° 14.8' W

T I D A L B E N C H M A R K S

BENCH MARK STAMPING:
DESIGNATION: TIDAL 33 STA 84
ALIAS: NO 33 1910

MONUMENTATION: Chiseled Cross VM#: 183
AGENCY: PID#: OC0004
SETTING CLASSIFICATION: Stone window sill

The bench mark is a chiseled cross in the lower stone sill of the second window SW of the NE corner of the W. L. Blake Building at 19 Commercial Street, 16.18 m (53.1 ft) SSE of the centerline of Commercial Street, 6.71 m (22.0 ft) SW of the center of the Blake Building entrance, 4.79 m (15.7 ft) SW of the NE corner of the building, and 0.91 m (3.0 ft) above the sidewalk.

BENCH MARK STAMPING: 8150 E 1991
DESIGNATION: 841 8150 E

MONUMENTATION: Tidal Station disk VM#: 13803
AGENCY: National Ocean Service (NOS) PID:
SETTING CLASSIFICATION: Set in pile cap

The bench mark is a disk set on the SE side of the Bath Iron Works concrete pier located on the NE side of Commercial Street, 39.32 m (129.0 ft) NE of the tide gauge house, 9.91 m (32.5 ft) ENE of the SE corner of the Bath Iron Works building, 2.13 m (7.0 ft) SSE of the southernmost bollard, 1.22 m (4.0 ft) WSW of the eastern edge of the pier, and 0.37 m (1.2 ft) above the pier deck.

Name: PORTLAND, CASCO BAY
MAINE
NOAA Chart: 13292 Latitude: 43° 39.4' N
USGS Quad: PORTLAND EAST Longitude: 70° 14.8' W

T I D A L D A T U M S

Tidal datums at PORTLAND, CASCO BAY based on:

LENGTH OF SERIES: 19 YEARS
TIME PERIOD: January 1983 - December 2001
TIDAL EPOCH: 1983-2001
CONTROL TIDE STATION:

Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in METERS:

HIGHEST OBSERVED WATER LEVEL (02/07/1978)	= 4.305
MEAN HIGHER HIGH WATER (MHHW)	= 3.019
MEAN HIGH WATER (MHW)	= 2.886
NORTH AMERICAN VERTICAL DATUM-1988 (NAVD)	= 1.601
MEAN SEA LEVEL (MSL)	= 1.505
MEAN TIDE LEVEL (MTL)	= 1.495
MEAN LOW WATER (MLW)	= 0.105
MEAN LOWER LOW WATER (MLLW)	= 0.000
LOWEST OBSERVED WATER LEVEL (11/30/1955)	= -1.053

National Geodetic Vertical Datum (NGVD 29)

Bench Mark Elevation Information In METERS above:

Stamping or Designation	MLLW	MHW
ELEV 14.501 FT TIDAL 31	5.799	2.913
38 1919	22.616	19.730
NO 3 1971	4.733	1.847
NO 43 1975	17.723	14.837
8150 A 1978	4.917	2.031
841-8150 C 1979	12.323	9.437
TIDAL 2 USE STA 84	5.662	2.777
TIDAL 30 STA 84	6.337	3.451
TIDAL 33 STA 84	5.306	2.421
8150 E 1991	5.275	2.389

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

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MAINE
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D E F I N I T I O N S

Mean Sea Level (MSL) is a tidal datum determined over a 19-year National Tidal Datum Epoch. It pertains to local mean sea level and should not be confused with the fixed datums of North American Vertical Datum of 1988 (NAVD 88).

NGVD 29 is a fixed datum adopted as a national standard geodetic reference for heights but is now considered superseded. NGVD 29 is sometimes referred to as Sea Level Datum of 1929 or as Mean Sea Level on some early issues of Geological Survey Topographic Quads. NGVD 29 was originally derived from a general adjustment of the first-order leveling networks of the U.S. and Canada after holding mean sea level observed at 26 long term tide stations as fixed. Numerous local and wide-spread adjustments have been made since establishment in 1929. Bench mark elevations relative to NGVD 29 are available from the National Geodetic Survey (NGS) data base via the World Wide Web at
National Geodetic Survey.

NAVD 88 is a fixed datum derived from a simultaneous, least squares, minimum constraint adjustment of Canadian/Mexican/United States leveling observations. Local mean sea level observed at Father Point/Rimouski, Canada was held fixed as the single initial constraint. NAVD 88 replaces NGVD 29 as the national standard geodetic reference for heights. Bench mark elevations relative to NAVD 88 are available from NGS through the World Wide Web at
National Geodetic Survey.

NGVD 29 and NAVD 88 are fixed geodetic datums whose elevation relationships to local MSL and other tidal datums may not be consistent from one location to another.

The Vertical Mark Number (VM#) and PID# shown on the bench mark sheet are unique identifiers for bench marks in the tidal and geodetic databases, respectively. Each bench mark in either database has a single, unique VM# and/or PID# assigned. Where both VM# and PID# are indicated, both tidal and geodetic elevations are available for the bench mark listed.

The NAVD 88 elevation is shown on the Elevations of Tidal Datums Table Referred to MLLW only when two or more of the bench marks listed have NAVD 88 elevations. The NAVD 88 elevation relationship shown in the table is derived from an average of several bench mark elevations relative to tide station datum. As a result of this averaging, NAVD 88 bench mark elevations computed indirectly from the tidal datums elevation table may differ slightly from NAVD 88 elevations listed for each bench mark in the NGS database.