WELLS (WEL) National Estuarine Research Reserve Water Quality Metadata Report
January-December 1998
Latest Update: December 5, 2001

I. Data Set & Research Descriptors

1. Principal investigator(s) & contact persons:

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2. Entry verification:

The data are directly downloaded in the YSI-PC6000 format (as a .dat file) and the Comma Delimited format (as a .csv file) from the dataloggers to an IBM laptop. The data are reviewed using the PC6000 software (Eco-Watch). Graphs and basic statistics are then generated with the Eco-Watch program and the information is printed out for each data file. These graphs are used to determine any obvious data outliers and sonde and/or probe malfunction. All downloaded data files from the dataloggers (both raw unedited .dat and .csv files) are then transferred via disk to a Power Mac G3, where all files are reviewed and formatted for CDMO and stored. Here the raw unedited .csv data files are imported into Microsoft Excel 98. After a complete month of data has been recorded, each file is ready to review which requires several steps. The NERR CDMO QA/QC Excel macros are used for all data. A data file is created (from the merged raw unedited .csv data files) in Excel format with a full month of data. The first step is to make sure that the parameter columns are in the

correct order, specified by the NERR CDMO. If any parameters are not collected due to probe failure or other causes, the cells with this missing data are filled in with periods (.) and documented and explained in the appropriate section of the metadata. Secondly, missing dates and times are inserted in the data file where data were not collected due to maintenance, sonde failure, etc., and the cells with this missing data are filled in with periods (.) and documented and explained in the appropriate section of the metadata. The first NERR CDMO QA/QC Excel macro is then run to determine if there are any missing dates and times; and if so these missing dates and times are inserted. Next, the second NERR CDMO QA/QC Excel macro is used to find and filter all data readings outside the sonde specification measuring range for each parameter. Here the "outlier" data generated by the second macro are examined and determined as either explained or unexplained anomalies, as specified by NERR CDMO Operations Manual. All anomalous data (explained and unexplained) are documented and explained in the appropriate sections of the metadata. The explained anomalous data are then removed from the data file and replaced by periods. The unexplained anomalous data are investigated for validity based on weather data, field observations, instrument diagnostics, and Eco-Watch printouts. If these data are rejected from the file then these are removed and replaced by periods. Lastly, the third and final NERR CDMO QA/QC Excel macro is used to reformat all the columns in the data file to the correct number of significant digits. After this last step, once the file has been completely formatted and edited as specified by NERR CDMO, the file is saved as a Tab delimited (.txt) text file and sent by FTP to the CDMO. The metadata form is also submitted with the data file to the CDMO, sent also as a text file (text only with line breaks). Scott Orringer is responsible for this task of entry verification with the analyses of suspect and anomalous data. Michele Dionne supervises, proofs and answers questions with the evaluation of suspect and anomalous data.

3. Research objectives:

The Webhannet River estuary is located in proximity to heavily used beaches in Wells, Maine. It has a shoreline that is highly developed with residential and commercial structures. The estuary receives water from a 14 sq. mi. watershed that is well forested. We are measuring variations in hydrologic variables in the Webhannet River estuary at the head of tide and at the inlet. Data from head of tide will integrate surface and ground water inputs (from both point and non-point sources) from the freshwater watershed into the estuary. Data from the inlet will integrate surface and ground water inputs from the freshwater watershed and the estuarine watershed. Differences in data between the head of tide and the inlet will indicate inputs from the estuarine portion of the watershed (on the ebb tide), and inputs from the Gulf of Maine on the flood tide. The instruments will track runoff events via salinity, and will measure pollutant-carrying sediment particles via turbidity. Our working hypothesis is that the freshwater watershed is the primary source of sediment and therefore potential NPS pollutants in the estuary. These two variables will indicate the potential for non-point source pollutants to enter the estuary, and whether they are of upland, estuarine or Gulf of Maine origin. Other variables measured by the data loggers (DO, temperature, pH, specific conductivity, and water level) will provide important baseline data to track changes in the estuary's physico-chemical parameters over the long term. These variables can be affected by changes in human water use, and by natural or human induced changes in inlet and river channel morphology, climate, and organic loadings. The inlet site is heavily impacted at the Wells Harbor dock and is our long-term monitoring site. The head of tide site is relatively unimpacted, located just east of the Route One bridge, and is our "roving" site.

4. Research Methods*†

The Wells NERR YSI monitoring program began in April 1995 at one site (head of tide site-HT) and May 1995 at a second site (inlet site-IN) in the Webhannet River estuary. The two data loggers are installed with bottom moorings, as described below. Both data loggers have 1/4 inch black vector mesh placed on the outside (using rubber bands) of the sonde guard to prevent fouling and unwanted animals. All deployment structures (PVC tubes) described below are labeled with the Wells NERR information.

*The YSI telemetry unit at the inlet site (IN) began reading on 3/16/98 at 10:30:00. Before this date/time (from Wells NERR 1997 Metadata):
The inlet site (IN) deployment methods changed starting on 12/19/97 at 10:30.
The YSI telemetry unit was installed to this site. A 23 foot, 4 inch diameter high grade PVC tube was installed against a dock piling. Four steel flat bars with bolts were used to attach this 23 foot PVC tube against the dock piling. A 3 by 1.5 inch PVC transducer was glued on the inside bottom of the PVC tube to allow the sonde to sit exactly 1.0 meter (3.28 ft) off the bottom. Several vertical holes, representative of the sonde guard, were cut out the circumference near the bottom of the PVC pipe to allow water flow to the probes.
An "L" shaped steel bar with two end-holes is placed through two created slits about a half of foot from the top of the PVC tube. A stainless steel wire (1/16") is attached to the sonde bail using two stainless steel clips; and to one end of the "L" shaped steel bar for sonde deployment and retrieval. A marine lock is attached through the other end of the "L" shaped steel bar to hold the bar, wire, and sonde in place and for security. A PVC threaded cap screws in to the threaded top of the PVC tube, also for security. A hole was created in the PVC cap to allow the sonde to hook up with the telemetry unit using the 50 foot cable. The collection of data parameters at the inlet (IN) site are slightly different then at the head of tide (HT) site, due to the telemetry unit installation. This is explained in the Wells 1998 metadata [BELOW], as we didn't actually begin the telemetry unit data collection until

1998; we just installed the new 23 foot PVC tube (see YSI's Eco-Watch Users Guide). Thus, the actual data parameter collection from 12/19/97 10:30 to 12/31/97 23:30 was the same as prior to that.

The inlet site (IN) deployment methods are different than the other three sites, due to the installation of a YSI telemetry unit. A 23 foot, 4 inch diameter high grade PVC tube was installed against a dock piling. Four steel flat bars with bolts were used to attach this 23 foot PVC tube against the dock piling. A 3 by 1.5 inch PVC transducer was glued on the inside bottom of the PVC tube to allow the sonde to sit exactly 1.0 meter (3.28 ft) off the bottom. Several vertical holes, representative of the sonde guard, were cut out the circumference near the bottom of the PVC pipe to allow water flow to the probes. An "L" shaped steel bar with two end-holes is placed through two created slits about a half of foot from the top of the PVC tube. A stainless steel wire (1/16") is attached to the sonde bail using two stainless steel clips; and to one end of the "L" shaped steel bar for sonde deployment and retrieval. A marine lock is attached through the other end of the "L" shaped steel bar to hold the bar, wire, and sonde in place and for security. A PVC threaded cap screws in to the threaded top of the PVC tube, also for security. A hole was created in the PVC cap to allow the sonde to hook up with the telemetry unit using the 50 foot cable. The collection of data parameters at the inlet (IN) site are slightly different then at the roving (HT) site, due to the telemetry unit installation. Two to four week variable sampling periods were chosen due to limitations created by the life of the dissolved oxygen membrane and probe fouling. Battery power is not needed anymore within the sonde itself (although, battery power is needed during calibrations and downloading) at the time of deployment at this site because of the telemetry unit's solar batter power. Measurements of temperature, specific conductivity, salinity, percent saturation, dissolved oxygen, depth, pH, and turbidity are recorded at 30 minute

intervals throughout the deployment period. Time, date, and battery voltage are no longer programmed to be recorded by the sonde, since these parameters are already programmed with the Eco-Watch Program (see YSI's Eco-
Watch Users Guide).

The other site, head of tide (HT), is deployed similarly, except for sonde
height off the bottom (see below). This site uses a 5 foot, 4 inch diameter
high grade PVC tube. The PVC tube is attached to a 12 foot, heavy steel sign
post using a stainless steel bolt at the bottom of the tube, a stainless steel
cable wrap at the top, and several thick electrical cable ties in between.
The steel sign post was pounded in about 7 feet into the river bottom, such that
the bottom of the PVC tube was flat on the river bottom. The PVC tube has one 3
by 1.5 inch PVC transducer glued on the inside bottom of the PVC tube to allow
the sonde to sit exactly at a certain height off the bottom (see below).
Several vertical holes, representative of the sonde guard, were cut out the
circumference near the bottom of the PVC pipe to allow water flow to the probes.
An "L" shaped steel bar with two end-holes is placed through two created slits
about a half of foot from the top of the PVC tube. A stainless steel wire
(1/16") is attached to the sonde bail using two stainless steel clips; and to
one end of the "L" shaped steel bar for sonde deployment and retrieval. A
marine lock is attached through the other end of the "L" shaped steel bar to
hold the bar, wire, and sonde in place and for security. A flotation buoy is
tied to the PVC tubes incase the deployment structure ever gets dislodged. The
deployment depth for the head of tide site (HT) is such that the probe-end of
the data logger is secured 0.30 meters (1.0 ft) off the bottom.

Two to four week variable sampling periods were chosen for the data sonde
due to limitations created by the life of the dissolved oxygen membrane, probe
fouling, and limited battery power. Measurements of temperature, specific
conductivity, salinity, percent saturation, dissolved oxygen, depth, pH, and

turbidity are recorded at 30 minute intervals throughout the deployment period.

After the deployment period, the data logger is brought back into the Wells Reserve Laboratory for downloading, cleaning, and calibration. These procedures are carried out to the methods described in the YSI Operating Manual. Calibration standards are needed and used for only specific conductivity (10 mS/cm), pH (buffer solutions of pH 4, 7, and 10), and turbidity (100 NTU). Conductivity and pH standards are purchased from Fisher Scientific. Turbidity standards are purchased from Advanced Polymer Systems, Inc. (Redwood City, CA). The dissolved oxygen membranes are replaced and sit 6-24 hours before each deployment. After approximately 6-24 hours of down time for cleaning, maintenance and recalibration, the YSI Data logger is redeployed for another sampling period. Also, with our extra data sonde, we have been reducing the amount of time of missing data from calibrations and maintenance for this site.

†Note: The Wells NERR two Drakes Island sites (see previous metatdata) are being monitored, but we are using the data for another project (CICEET-Wells Harbor dredge; see Wells NERR metadata 1999) and not collecting the dissolved oxygen or percent saturation parameters.

5. Site location and character

The Wells National Estuarine Research Reserve is located in York County, within the Town of Wells, on the coast of southern Maine and faces the Atlantic Ocean. The Wells NERR is approximately 31 km (20 miles) south of Portland, Maine and 110 km (70 miles) north of Boston, Massachusetts. The Reserve encompasses 1,690 acres along the Gulf of Maine coastline of tidally-flushed wetlands, riparian and transitional upland fields and forests within the Little River Estuary and the larger Webhannet River Estuary. Both estuaries arise in the sandy glacial outwash plain about eight miles inland. Both rivers empty into Wells Bay, a sandy basin stretching for approximately ten miles along the Atlantic coast. Bordering each river's inlet are double spit barrier

beaches attached to the mainland. The backbarrier system is approximately 5 sq. km and is composed of large intertidal marshes (predominantly S. patens and S. alterniflora), intertidal sand and mud flats, and tidal channels. The watershed for the Webhannet River estuary covers an area of 35 sq. km and has a total of 6 streams, brooks or creeks which enter the estuary. These tributaries flow across sand and gravel deposits near the headwaters and the impermeable sandy muds of the Presumpscot Formation in the lower reaches. The Webhannet River is connected to the ocean via Wells Inlet, which has a spring tidal prism of 28,200,000 cub. m (Ward 1993). The force and volume of tidal action affect the salinity level of both rivers. In the Wells region, the annual mean wave height is almost 20 inches. The estuarine system is dominated by semi-diurnal tides having a range of 8.5 to 9.8 feet. The volume of freshwater influx into both estuaries is moderate to low (on the order of 0.5 cubic meters/second), especially in the summer, because of the rivers' relatively small drainage areas and the presence of deep glacial deposits. The relatively low flows from these two rivers taken in with the 20 inch per year average runoff of the area surrounding the estuaries combine to form a fresh water flow which is dwarfed by tidal flushing. Twelve-foot tides dwarf the freshwater flow into the Webhannet estuary, which has a drainage area of 14.1 square miles. The Webhannet estuary, fed by both Blacksmith and Depot Brooks, is adjacent to the harbor and greatly developed land. It offers a valuable opportunity for comparison with the relatively pristine Little River estuary. The land use of the Webhannet estuary include a total of 15% for wetland, fresh water, and tidal marsh; a total of 63.7 % for woodland; and a total of 18.6% for developed land (compared to a total of 5.7% development in the Little River estuary) (WNERR RMA 1996; Holden 1997).

There are two sampling sites in the Webhannet River estuary. These are located at the head of tide and at the inlet. The tidal range at each of these sites is 2.6-2.9 meters.

The head of tide site is located 4 miles south of the Wells Reserve, just

downstream of the Webhannet Falls (freshwater) and 10 feet east of Route One (43 deg 17' 54.25227" Latitude, 70 deg 35' 13.82728" Longitude). Route One is used heavily with traffic all year, especially during the summer tourist months. This site has soft mud, sand, and a rocky substrate, and the low and high tide depth is relatively shallow. The salinity range here is 0-31 ppt, with a mean of 3.6 ppt. These head waters of the Webhannet are relatively undeveloped. This site is located just 10 feet east of the Route One bridge, and is our "roving" site.

The inlet site is located 1.5 miles south of the Wells Reserve, at the Wells Harbor pier (43 deg 19' 12.44804" Latitude, 70 deg 33' 13.82728" Longitude). The mouth of the Webhannet estuary forms an extensive wetland/salt marsh area which is surrounded by development. Wells Harbor, which was most recently dredged in 1971, has moorings for approximately 200 commercial fishing and recreational boats. The mouth of the river flows between two jetties to the Atlantic Ocean. This channel was dredged in 1974. This site has a predominately sand substrate and is characterized by strong current during incoming and outgoing tides. The salinity range here is 7-35 ppt, with a mean of 31 ppt. The inlet site is heavily impacted at the Wells Harbor dock and is our long-term monitoring site.

6. Data collection period:

The Webhannet River head of tide (HT) site data collection was re-deployed (after being pulled in December 1995, December 1996, and December 1997) on April 1, 13:00 and pulled December 31, 11:00 for the winter months to prevent ice damage. This site gets a large amount of ice coverage from December through late March.

The Webhannet River inlet (IN) site data collection began May 29, 1995, 13:00. The IN datalogger is ongoing throughout the year and is considered our long-term monitoring site, as this site remains relatively ice-free.

7. Associated researchers and projects

Ongoing research at the Wells Reserve is designed to address issues of concern to the Gulf of Maine management community; sea level rise, beach erosion, coastal water quality and nutrient enrichment, coastal habitat value, habitat restoration of shellfish and finfish, marsh plant community dynamics, and plant-soil-nutrient relationships. Active research topics include:

- rates of accretion of salt marsh peat
- hydrologic and ecological response of impounded marshes to restoration
- assessment of shellfish resources in the Webhannet River flats
- assessment of resident and migratory fish use of Little River estuary
- use of large wading birds as indicators of salt marsh habitat health
- watershed nutrient loading to Little and Webhannet River estuaries
- linkage between estuarine nutrient enrichment and oxygen dynamics throughout coastal Maine
- climatic versus competitive control of salt marsh plant communities
- effects of climate on salt marsh plant phenology and phenotype
- associations between marsh plant distribution, soil nutrients, and soil type

Although many of these projects are ongoing some of the findings to date are:

- Impounded salt marshes can respond quickly to restored tidal flow, with early colonization by salt marsh vegetation and by resident and migratory marsh fishes.
- Seed clam density declines with distance from the Webhannet River inlet, indicating an external as opposed to an internal source of recruitment to the clam population. There is a small but significant relationship between density and sediment organic matter.
- Juvenile striped bass utilize the Little River estuary as a food resource; diet analysis indicates a preference for sand shrimp.
- The Reserve's estuaries appear to be nitrogen limited; primary nitrogen source is ocean water. Nutrients from fresh surface water influence nutrient concentrations in the upper estuary. Ground water may be a significant source of nitrogen in the upper Webhannet River estuary.
- Maine's estuaries and embayments show no serious oxygen depletion, with a few exceptions. Dissolved oxygen and nitrogen levels are related to freshwater runoff, indicating that activities in the watershed can influence the

estuaries even in the face of the high tidal flushing rates typical of Maine's estuaries.

• Salt marsh plant phenology varies significantly between Wells NERR and Prudence Island NERR; trends suggest possible genetic variation within species.

• Soil nitrogen concentrations are directly related to forbe distribution on the Reserve's salt marshes.

The Research Program's volunteer water quality monitoring program (W.E.T.) has been monitoring fecal coliform contamination and other water quality parameters in the estuaries since 1991. W.E.T. (Watershed Evaluation Team) was established to characterize and monitor the aquatic environment of the Little and Webhannet River estuaries. This program allows students from local schools and volunteers to participate in "hands-on" scientific research and management activities at the Reserve. Information yielded by this effort is valuable as baseline data for research conducted at the Reserve and may help in guiding current management priorities. Reserve staff with W.E.T. volunteers and students, working with the Town of Wells and the Maine Department of Marine Resources (DMR), have recently opened selected shellfish beds (for two years now) in the Webhannet River after nine years of closure. This was a direct result of monitoring fecal coliform contamination (and other water quality parameters), which is the major source of non-point source pollution in southern Maine.

University of New Hampshire researchers completed a year long monitoring project measuring the volume, nutrient concentrations, and total suspended solids of freshwater discharge into the Webhannet River estuary, relating these inputs to precipitation, and measuring their effects on estuarine water quality; using a hydrolab. Research staff and students have completed a four year study of hydrology and vegetation of a degraded Webhannet River marsh recovering from roadway impoundment after restoration of tidal flow. In June of 1994, Reserve research staff and students completed an 18 month survey of larval fish

distribution and abundance in the Wells Reserve's estuaries and in the near-
shore waters of Wells Bay. University of New Hampshire researchers are working
with eelgrass beds in Wells Embayment to develop criteria for siting and
evaluating eel grass restoration projects. Both salt marsh and eelgrass are
thought to be important habitats for many Gulf of Maine fishes. University of
Maine Machias is collaborating with Reserve staff to determine the status of the
soft-shell clam resource in the Reserve's estuaries. Reserve staff are working
with the Maine Dept. of Environmental Protection to survey the dissolved oxygen
status of 25 estuaries throughout Maine, using data sondes to measure oxygen
depletion as an indicator of non-point source pollution (Coastal Hypoxia
Study).

RESEARCH PROJECTS 1998: During 1998, the research program at the wells reserve
will address questions regarding management of water quality, finfish and
shellfish, and other wildlife as they apply to marsh-dominated estuaries and
their watersheds throughout the Gulf of Maine.

Softshell Clam Enhancement: This is a continuing project in collaboration with
the town of Wells, the University of Maine Machias, and the Beals Island
Shellfish Hatchery. The long term goal of the project is to understand the
factors (both ecological and human-related) that determine clam productivity.
During 1998 we will be conducting experiments with seed clam to determine their
growth and survival in different conditions throughout the Webhannet River
Estuary.

Estuarine Fish Distribution: Since 1992 we have been surveying fishes in both
the Little River and Webhannet River estuaries, using a variety of techniques.
Our long term goal is to quantify the value of marsh-dominated estuaries and
their watersheds for the survival, growth and reproduction of Gulf of Maine
fishes. In 1998 we will be using beach seines to track winter flounder growth
in both the Webhannet and Little rivers. We will also complete sample
processing and data analysis for previous surveys of larval fish and juvenile

and adult pelagic fish.

Estuarine Water Quality: The Wells NERR conducts long term monitoring of physical, chemical and biological water quality parameters. These data are used to detect improvements and declines in water resources that can result from changes in land use and other human activities. We use automated instruments deployed in the estuaries and a bimonthly sampling program to measure water quality. Samples are analyzed in our on-site laboratory.

Wading Bird Monitoring: Wading birds are top predators in the salt marsh food web, and depend on the marshes for food. Changes in wading bird populations are potential indicators of changes in the quality of salt marsh habitat. We have been monitoring the number and location of great blue herons and snowy egrets in the Reserve's marshes since 1991, and they have been fairly stable over that time.

Salt Marsh Restoration: The Wells NERR has been instrumental in identifying and measuring the damaging effects of tidal restriction (due to roads and culverts) on salt marsh ecosystems. We are involved in long-term monitoring of several salt marsh tidal restoration sites. In 1998 we will collect data on marsh plant communities at one of these sites on the Webhannet River.

Coastal Watershed Land Use: In 1998 we are beginning a new project to document and map preserved lands in southern coastal Maine. We will be collecting information on the types and location of protected lands from a variety of state, local and private partners, especially land trusts and conservation commissions. The information will be compiled using a geographic information system. The data will be displayed as maps at a number of public forums to stimulate the development of forward thinking habitat protection strategies.

In addition to the Reserve-sponsored projects outlined above, numerous visiting investigators will be involved in on-site research. Topics include: the effects of land use, sea level, and climate on estuarine productivity; the relationship between soil nutrients and plant community patterns; the influence of soil

salinity on plant community interactions; the effect of tidal restriction on marsh peat accretion; the comparative ecology of fringe marshes and back barrier marshes; habitat use by upland birds, and the ecology of lyme disease.

-Other publications/reports including the above sited ones:

Bryan, R., M.Dionne, R. Cook, J. Jones and A. Goodspeed (1997) Maine citizens guide to evaluating, restoring, and managing tidal marshes. Maine Audubon Society, Falmouth, ME.

Burdick, D., M.Dionne, R.Boumans and F.Short (1997) Ecological responses to tidal restoration in two New England salt marshes. Wetlands Ecology and Management 4:129-144.

Hoffman, C. 1997. Drakes Island Marsh Restoration Project Report. Contracted out by the Wells NERR.

Holden, W.F. 1997. Fresh water, suspended sediment and nutrient influx to the Little River and Webhannet River Estuaries, Wells, Maine. Ph.D. dissertation, Boston University. pp 1-179

Ward, L. G. 1993. Precipitation, streamflow, and water characteristics (physical and chemical) of the Webhannet River Estuary, Wells, Maine. Draft final report by UNH, Jackson Estuarine Laboratory, Durham, NH. NOAA Technical Memorandum, pp. 1-13.

WNERR RMA 1996. Wells NERR Management Plan. Prepared by the WNERR Management Authority (RMA) and NOAA, SRD Division. pp. 1-120.

II. Physical Structure Descriptors

8. Variable sequence, range of measurements, units, resolution, and accuracy:

YSI 6000 datalogger

Variable	Range of Measurements	Resolution	Accuracy
Date	1-12, 1-31, 00-99 (Mo,Day,Yr)	1 mo, 1 day, 1 yr	NA
Time	0-24, 0-60, 0-60 (Hr,Min,Sec)	1 hr, 1 min, 1 s	NA
Temp	-5 to 45 (c)	0.01 C	+/- 0.15C

Sp COND	0-100(mS/cm)	0.01mS/cm	+/-0.5% Of reading + 0.001mS/Cm
Salinity	0-70 Parts per thousand (ppt)	0.01 ppt	+/- 1% of Reading or 0.1 ppt, (whichever is greater)
DO	0-200 (% air saturation)	0.1% @air sat	+/-2% @air Saturation
DO	200-500 (% air saturation	0.1% @ air sat	+/- 6% @ Saturation
DO	0-20 (mg/l)	0.01 mg/l	+/- 0.2mg/l
DO	20-50 (mg/l)	0.01 mg/l	+/- 0.6mg/l
Depth (shallow)	0-9.1 (m)	0.001m	+/- 0.018m
PH	2-14 units	0.01 units	+/- 0.2units
Turb	0-1000 NTU	0.1 NTU	+/- 5% of Reading or 2 NTU (whichever is greater)

Data columns are separated by tabs. Each file contains a two line column header at the top of the page which identifies measurements and units for each column.

9. Coded variable indicator and variable code definitions:

Site definitions: HT = Head of Tide of Webhannet River
IN = Inlet at Webhannet River Mouth

File definitions: YSI deployment site/month/year (ex.: IN0795 = Webhannet Inlet data from July 1995).

10. Data anomalies:

January, 1998 Sampling Period
Head of Tide: None to report; sonde not deployed until April.
Inlet:
Small negative turbidity values were recorded throughout the following time span: 1/14 11:00-1/15 14:00 (logging period recorded 12 anomalies), possibly due to a small calibration error. These data were not deleted.
No pH data from 1/13 15:30 to 1/21 11:30 due to a pH probe crash. The pH immediately dropped to a value of 1.69 (outside the probe range) on 1/13 15:30 from the overall data record, and then thereafter displayed erratic readings and

"noise". These data were suspect and deleted. The post-cal was unreliable and
the probe could not be recalibrated upon return to the lab.

February, 1998 Sampling Period
Head of Tide: None to report; sonde not deployed until April.
Inlet:
There were two pH data spikes on 2/18 9:30 (3.36) and 11:00 (3.18) that are not
consistent with the overall data record.
These data were suspect but not deleted, although these readings appear totally
unreasonable, as the post-cal was reliable and the probe could be recalibrated
upon return to the lab.

March, 1998 Sampling Period
Head of Tide: None to report; sonde not deployed until April.
Inlet:
DO deleted from 3/16 10:30 to 11:00; first few records are low compared to rest
the rest of deployment. Membrane may have still been settling.
The following were several "roll over" episodes (>1000 NTU), with a range of
high positive turbidity spikes (<1000 NU) that were not consistent with the
overall data record. Beginning on 3/27 14:00, these 22 turbidity anomalies
(range from 47.3 to 1284.8; with eleven values >1000, and a mean of 936.7) were
observed immediately increasing to the "roll over" readings of >1000 NTU and
then falling back down to the overall data record before immediately increasing
to these large positive values
. These suspect data were not deleted, as we are not absolutely sure that these
values were bad.
3/27 14:00 1273.9; 14:30 1275.3; 15:30 878.1; 16:00 1276.6; 18:00 357.4;
18:30 538.2
3/28 16:30 644.7; 17:00 785.0; 17:30 47.3; 18:30 468.5; 19:00 710.9
3/29 15:00 1232.9; 15:30 1282.4; 16:30 933.7; 17:00 1281.3; 19:00 1281.1; 19:30 1281.2
3/30 19:30 561.2
3/31 18:30 1131.8; 19:00 1284.8; 20:30 795.9; 21:00 1284.3

April, 1998 Sampling Period
Head of Tide: None to report.
Inlet:
No data on 4/18 1:00-2:00; due to a data gap. Logger did not record data within
this time range, possibly due to an overwrite of data.
No turbidity data from 4/23 14:00 to 4/30 23:30 due to a turbidity probe

malfunction.
The following are episodes (44 readings) of low DOsat (range 12.8 to 60.6; mean
of 27.29 percent) and DOmg (range 1.38 to 6.23; mean of 2.784 mg/l) during
several low tide fluctuations; beginning with the 4/23 14:00 deployment, that
were not consistent with the overall data record (at high tide the readings
returned to the consistency of the overall data record). These suspect data
were not deleted, as we are not absolutely sure that these values are bad.
4/23 14:00-16:00
4/24 15:00-16:30
4/25 3:30-5:00, 16:00-17:30
4/26 4:30-6:00, 17:00-18:00
4/27 5:00-7:00, 18:00-19:00
4/28 6:00-8:00, 19:00-19:30
4/29 7:00-9:00

May, 1998 Sampling Period
Head of Tide:
There following were high positive turbidity spikes that were not consistent
with the overall data record. These suspect data were not deleted, as we are
not absolutely sure that these values are bad.
5/8 14:30 (74.8)
5/9 1:30 (108.4); 5:30 (71.3); 21:00 (697.8)
5/10 13:00 (618.0); 21:00 (573.8)
5/11 1:00 (74.4)
5/30 2:30 (79.0)
5/31 21:00 (323.2); 22:30 (78.8); 23:00 (141.3)
The following are shallow positive depth data (9 values) beginning on 5/21 14:30
(range of 0.06 to 0.09 m; mean of 0.08 m).
Sonde probes suspected to be underwater as other parameters check out normal.
These data were not deleted:
5/21 14:30-15:30
5/31 17:30-20:00
No dissolved oxygen data or percent saturation data from 5/27 0:30 to 5/31 23:30
due to a suspected DO membrane puncture or tear and probe malfunction. All DOmg
and DOsat data, jumped from 5.7 mg and 66.3 percent to 8.0 and 96, respectively,
until reaching a peak of 34.9 mg and 348.2 percent on 5/27 3:30; thereafter
decreasing sharply until reaching values of 0.0 followed by negative values.
These data were suspect and deleted.

Inlet:
No turbidity data from 5/1 0:00 to 5/21 14:30 due to a turbidity probe malfunction (continued from 4/23 14:00).
No data collected on the following dates/times; due to a data gap. Logger did
not record data within this time range, possibly due to an overwrite of data.
5/6 2:00, 16:00-18:30
5/20 12:30
The following are episodes (67 readings) of low DOsat (range 7.8 to 58.4; mean
of 23.7 percent) and DOmg (range 0.75 to 5.56; mean of 2.26 mg/l) during several
low tide fluctuations; beginning at 5/19 1:00, that were not consistent with the
overall data record (at high tide the readings returned to the consistency of
the overall data record). These suspect data were not deleted, as we are not
absolutely sure that these values are bad.
5/19 1:00, 11:30-12:00, 13:00-13:30
5/20 0:00-2:00
5/21 13:30-14:30
5/22 1:00-3:00; 13:30-15:30
5/23 2:00-4:00, 14:30-16:30
5/24 3:00-5:00, 16:00-17:00
5/25 4:00-6:00, 17:00
5/26 5:00-6:30
5/27 6:00-7:30
5/28 7:00-8:30
5/29 8:00-9:00
5/30 9:00-10:00
5/31 10:00-10:30

June, 1998 Sampling Period
Head of Tide:
No dissolved oxygen data or percent saturation data from 6/1 0:00 through 6/28
10:30 due to a suspected DO membrane puncture or tear and probe malfunction from
the previous deployment (5/27 0:30). These data were suspect and deleted.
The following were high positive turbidity spikes that were not consistent with
the overall data record. These suspect data were not deleted, as we are not
absolutely sure that these values are bad.
6/13 1:00 (83.9)
6/16 9:30 (91.6); 10:00 (104.3); 10:30 (46.1); 11:00 (40.9); 11:30 (52.5);
12:00 (86.3); 13:00 (40.2)
The following was a "roll over" episode, with a range of high positive turbidity

spikes that were not consistent with the overall data record; although there was
a climb in turbidity values toward a high "roll over" spike on 6/13 21:00 (1758.2).
These 20 turbidity values were observed from 6/13 15:00 (44.9) continuous through 6/14 0:30 (46.6), and with a mean of 215.87 and a range from 46.6 to
1758.2 NTU. These suspect data were not deleted, as we are not absolutely sure
that these values were bad:
6/13 15:00 (44.9); 15:30 (46.5); 16:00 (51.4); 16:30 (83.1); 17:00 (158.6);
17:30 (142.8); 18:00 (132.9); 18:30 (194.0); 19:00 (127.1); 19:30 (121.1);
20:00 (99.4); 20:30 (317.0); 21:00 (1758.2); 21:30 (637.9); 22:00 (78.8);
22:30 (55.0); 23:00 (113.8); 23:30 (59.6)
6/14 0:00 (48.6); 0:30 (46.6)
There was one shallow positive depth datum on 6/30 11:00 (0.02 m). Sonde probes
suspected to be underwater as other parameters check out normal. This datum was
not deleted.
Inlet:
No data collected on the following dates/times; due to a data gap. Logger
either (1) did not record data within this time range, possibly due to an overwrite of data; or (2) did record the same data values because of an overwrite (these data were deleted).

6/3 1:00, 5:00
6/12 2:00
6/16 10:30
6/17 9:00-23:30
6/18 0:00-23:30
6/19 0:00-9:00, 14:30-15:00, 16:00-23:30
6/20 0:00-1:00, 2:30-3:00, 4:00-6:00, 7:30-10:00, 12:30-21:30
6/21 10:30-23:30
6/22 0:00-16:00

The following are episodes (139 readings) of low DOsat (range 12 to 68; mean of
30.69 percent) and DOmg (range 1.19 to 5.97; mean of 2.87 mg/l) during several
low tide fluctuations; beginning at 5/19 1:00, that were not consistent with the
overall data record (at high tide the readings returned to the consistency of
the overall data record). These suspect data were not deleted, as we are not
absolutely sure that these values are bad.

6/2 11:00-13:00
6/3 12:00-14:00
6/4 1:00-2:30, 12:30-15:00
6/5 1:00-3:30, 13:30-15:30
6/6 2:30-4:30, 14:30-16:30
6/7 2:30-5:00, 15:30-17:00

6/8 3:30-6:00, 16:30-17:30
6/9 4:00-6:30, 17:30-18:00
6/10 5:00-7:00, 18:00-18:30
6/11 5:30-7:30, 18:30-19:30
6/12 6:00-8:30, 19:30-20:00
6/13 7:30-9:00
6/14 19:30-22:00
6/15 7:30-10:30, 21:30-23:30
6/16 9:00-10:00, 11:00-11:30, 21:00-23:30
6/19 11:30-14:00
6/20 1:30-2:00, 3:30, 12:00
6/21 0:30-5:30

July, 1998 Sampling Period
Head of Tide: None to report.
Inlet:
Small negative turbidity values were recorded throughout the following time span: 7/1 17:30-7/31 19:30 (logging period recorded 524 anomalies), possibly due to a small calibration error. These data were not deleted.
The following are suspect DOsat and DOmg data, due to three small, negative values recorded are outside the listed range of the dissolved oxygen probe.
These suspect values were not consistent with the overall data record, and were deleted on the basis of absolute data rejection. Other parameters, the dissolved oxygen post-cal, and recalibration were good.
7/1 23:30 (-1.6 and -0.13, respectively)
7/2 0:00-0:30 (-6.1 and -0.52; -6.5 and -0.55, respectively)
No data collected on the following dates/times; due to a data gap. Logger either (1) did not record data within this time range, possibly due to an overwrite of data; or (2) did record the same data values because of an overwrite (these data were deleted).
7/5 16:30-17:30
7/6 12:00-12:30
7/8 14:30, 16:00
7/9 11:00-13:00, 14:00-15:30
7/18 2:00
7/28 16:00
The following are episodes (322 readings) of low DOsat (range 4.8 to 60.6; mean of 24.54 percent) and DOmg (range 0.39 to 5.12; mean of 2.02 mg/l) during several low tide fluctuations; beginning at 7/1 11:00, that were not consistent with the overall data record (at high tide the readings returned to the consistency of the overall data record). These suspect data were not deleted, as we are not absolutely sure that these values are bad.
7/1 11:00-12:30, 23:00
7/2 1:00, 11:00-13:30
7/3 0:00-2:00, 12:00-14:00

7/4 0:30-3:00, 13:00-15:00
7/5 1:30-3:30, 14:00-15:30
7/6 2:00-4:30, 14:30-16:30
7/7 2:30-5:00, 15:30-17:00
7/8 3:30-6:00, 17:00
7/9 4:30-6:30, 17:00-17:30
7/10 4:30-7:30, 8:30, 16:30- 18:30
7/11 5:00-8:00, 18:30-20:00
7/12 6:00-8:30, 19:30-20:00
7/13 7:30-9:00, 20:00-21:00
7/14 7:30-10:00, 19:30-22:30
7/15 8:30-11:00, 21:00-23:30
7/16 10:00-11:30, 21:30-23:30
7/17 0:00-0:30, 10:00, 11:00-12:30, 22:30-23:30
7/18 0:00-1:00, 11:00-13:30, 23:30
7/19 0:00-2:30, 4:00, 13:00-14:30
7/20 0:30-5:00, 13:00-14:00, 15:30
7/21 1:30-5:30, 14:00-16:30
7/22 2:30-5:30, 16:00-17:00
7/23 3:30-6:30
7/24 4:00-7:00, 8:30, 16:30-19:00
7/25 5:00-8:00, 17:30-19:30
7/26 5:30-8:30, 18:30-20:00
7/27 6:00-9:30, 20:30-21:00
7/28 7:00-10:00, 20:00-22:30
7/29 8:00-10:30, 20:30-23:00
7/30 8:30-11:30, 21:00-23:30
7/31 0:00, 9:30-11:00, 12:00, 22:00-23:30

August, 1998 Sampling Period
Head of Tide:
Small negative turbidity values were recorded throughout the following time
span: 8/14 6:00-8/31 23:30 (logging period recorded 312 anomalies), possibly due
to a small calibration error. These data were not deleted.
The following were episodes of high DOsat and DOmg that were not consistent with
the overall data record; from minimum values of 100.3 and 8.59 (8/9 15:00) to
maximum values of 201.2 and 15.98 (8/10 12:00). Other parameters check out
normal. These data were not deleted:
      8/4 20:30-22:30
      8/5 20:30-23:00
      8/7 12:00
      8/8 10:00-15:00
      8/9 11:30-12:30, 14:00-15:00
      8/10 10:30, 12:00-17:00
      8/11 12:30
      8/13 15:30-17:00
      8/14 16:00-18:30
      8/15 16:30-18:00
      8/16 17:30-19:00

8/19 10:00-10:30, 20:30
8/20 9:00-11:30
8/22 11:00-11:30
8/23 11:30

The following were high positive turbidity spikes that were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values are bad.

8/12 3:30 (53.3)
8/15 19:30 (40.6)
8/18 21:30 (58.4)
8/24 17:00 (131.4), 17:30 (154.1)

The following are shallow positive depth data (167 values) beginning on 8/18 3:00 (range of 0.01 to 0.049 m; mean of 0.033 m). Sonde probes suspected to be underwater as other parameters check out normal. These data were not deleted:

8/18 1:30-6:30, 9:30-18:00
8/23 18:00-19:30, 22:00-22:30
8/24 3:00-4:30, 6:30-11:00, 14:30-16:30
8/25 15:30-19:30
8/29 0:30-3:00, 5:00-14:30, 18:00-23:30
8/30 0:00-4:00, 6:00-15:30, 19:00-23:30
8/31 0:00-16:30, 19:30-23:30

Inlet:

Small negative turbidity values were recorded throughout the following time span: 8/1 3:00-8/24 11:00 (logging period recorded 551 anomalies), possibly due to a small calibration error. These data were not deleted.

The following are episodes (329 readings) of low DOsat (range 5.1 to 62.5; mean of 26.79 percent) and DOmg (range 0.42 to 5.27; mean of 2.18 mg/l) during several low tide fluctuations; beginning at 8/1 10:00, that were not consistent with the overall data record (at high tide the readings returned to the consistency of the overall data record). These suspect data were not deleted, as we are not absolutely sure that these values are bad.

8/1 10:00-12:30, 22:30-23:30
8/2 0:00-02:00, 10:30-13:00, 23:30
8/3 0:00-03:00, 11:30-14:00
8/4 0:30-03:30, 12:30-14:30
8/5 1:00-4:30, 13:30-16:00
8/6 2:00-5:30, 14:00-16:30
8/7 2:30-6:00, 15:00-17:30
8/8 3:30-7:00, 16:00-18:30
8/9 4:00-7:30, 16:30-19:00
8/10 5:00-8:00, 17:30-20:00
8/11 6:00-8:30, 18:30-21:00
8/12 7:00-9:30, 19:00-22:00
8/13 7:30-10:30, 20:00-23:00

8/14 8:30-11:30, 21:00-23:30
8/15 0:00, 9:30-12:00, 22:00-23:30
8/16 0:00-1:30, 10:30-13:30, 23:00-23:30
8/17 0:00-2:30
8/18 0:30-4:00, 12:30-16:30
8/19 1:00-6:30, 13:00-17:00
8/20 1:30-7:30, 14:00-17:30, 23:30
8/21 0:00, 2:00-7:30, 15:30-18:30
8/22 3:00-8:30, 17:00-19:00
8/23 4:00-8:00, 18:00-19:30
8/24 5:00-8:30

No data collected on 8/14 2:00; due to a data gap. Logger did not record data within this time range, possibly due to an overwrite of data.

No data collected from 8/24 11:30 to 8/31 23:30 due to a telemetry malfunction, including a telemetry battery crash.

September, 1998 Sampling Period

Head of Tide:

Small negative turbidity values were recorded throughout the following time span: 9/1 0:00-9/28 0:00 (logging period recorded 238 anomalies), possibly due to a small calibration error. These data were not deleted.

The following are shallow positive depth data (606 values) beginning on 9/1 0:00 (range of 0.00 to 0.09 m; mean of 0.04 m). Sonde probes suspected to be underwater as other parameters check out normal. These data were not deleted:

9/1 0:00-17:00, 20:30-23:30
9/2 0:00-7:00, 8:00-12:30, 18:00, 22:00
9/3 5:30-7:00, 10:00-18:30, 23:30-23:30
9/4 0:00-8:00, 11:00-13:30
9/5 0:00-1:30, 3:30, 4:30-8:30, 12:00-20:30
9/6 1:00-7:30
9/8 23:00
9/10 0:00, 17:00-23:30
9/11 0:00-1:00, 4:30-13:00, 17:30-23:30
9/12 0:00, 2:00, 5:30, 18:30, 22:00-23:30
9/13 0:00-3:00, 6:30-15:00, 19:30-23:30
9/14 0:00-4:00, 7:30-16:00, 20:30-23:30
9/15 0:00-5:30, 8:30-17:30, 21:00-23:30
9/16 0:00-7:00, 9:00-12:30, 14:00-18:30
9/17 0:00, 1:00-7:30, 10:30-19:30, 23:30
9/18 0:00-1:00, 15:30-20:00
9/19 0:00-9:00, 12:00-21:00
9/20 0:30-9:30, 13:00-21:30
9/21 1:30-10:00, 13:30
9/22 17:30-23:00
9/23 2:30-11:00, 14:30-18:00
9/25 12:30, 16:00-23:30
9/26 0:00-1:30, 3:30-13:00, 16:00-23:30
9/27 0:00-4:00, 16:30-17:00

The following are shallow negative depth data (269 values) beginning on 9/2
13:00 (range of -0.11 to -0.01; mean of -.05 m). Sonde probes suspected to be
underwater as other parameters check out normal. These data were not deleted.
9/2 13:00-17:30, 22:30-23:30
9/3 0:00-5:00
9/4 14:00-19:30
9/5 2:00-3:00, 4:00, 8:00-9:00
9/6 13:00-21:00
9/7 2:00-9:30, 14:30-22:00
9/8 3:30-10:30, 15:30-22:30
9/9 4:00-11:00, 16:30-23:30
9/10 4:30-12:00
9/12 0:30-1:30, 6:00-14:00, 19:00-21:30
9/21 14:00-22:00
9/22 2:00-10:30, 14:30-17:00
9/27 4:30-14:00, 17:30-23:30
9/28 0:00
There were two high positive turbidity spikes on 9/7 1:30 (295.9) and 9/13 1:00
(96.5) that were not consistent with the overall data record. These suspect
data were not deleted, as we are not absolutely sure that these values are bad.
Inlet:
No data from 9/1 0:00 to 9/21 13:30 due to a telemetry malfunction, including a
telemetry battery crash (continued from the crash observed beginning on 8/24
11:00).
Small negative turbidity values were recorded throughout the following time
span: 9/21 14:00-9/30 23:00 (logging period recorded 377 anomalies), possibly
due to a small calibration error. These data were not deleted.
The following are episodes (129 readings) of low DOsat (range 0.8 to 58.2; mean
of 32.2 percent) and DOmg (range 0.1 to 4.9; mean of 2.7 mg/l) during several
low tide fluctuations; beginning at 9/21 15:30, that were not consistent with
the overall data record (at high tide the readings returned to the consistency
of the overall data record). These suspect data were not deleted, as we are not
absolutely sure that these values are bad.
9/21 15:30-18:30
9/22 3:30-7:30, 16:00-19:00
9/23 4:00-7:30, 16:30-20:00
9/24 4:30-8:30, 18:00-20:30
9/25 6:30-9:00, 18:00-21:30
9/26 6:30-10:00, 18:30-22:00

9/27 19:30-22:30
9/28 7:30-11:30, 20:00-21:30, 23:30
9/29 0:00-1:30, 8:00-12:30, 21:30-23:30
9/30 0:00-0:30, 11:30, 22:00-23:30
The following are suspect DOsat and DOmg data, due to three small, negative values recorded are outside the listed range of the dissolved oxygen probe.
These suspect values were not consistent with the overall data record, and were deleted on the basis of absolute data rejection. Other parameters, the dissolved oxygen post-cal, and recalibration were good.
9/28 22:00 (-0.6 and -0.05, respectively), 22:30 (-3.8 and -0.31 respectively), 23:00 (-4.0 and -0.33 respectively)
No data collected on the following dates/times; due to a data gap. Logger did not record data within this time range, possibly due to an overwrite of data.

9/24 11:30-13:00
9/29 3:30

October, 1998 Sampling Period
Head of Tide:
There were suspect data (all parameters) beginning on 10/9 1:00 through 10/12 14:30 due to a powerful storm event (strong winds, heavy rain, flooding, coastal erosion along with astronomical high tides). All parameters returned to normal except for DO mg/l and DO percent saturation that seemed to flatline over 100 percent for the remainder of the month. This suspect data was not deleted, as post calibrations checked out normal. (The full description from the NCDC website of this storm event is listed in Section 12).

The following were several continuous "roll over" episodes, with a range of high positive turbidity spikes that were not consistent with the overall data record.
Beginning on 10/10 8:30 and continuing through 10/12 14:00, these 108 turbidity anomalies (range from 2.6 to 2007.5; with seven values >1000 plus two values >2000, and a mean of 322.78) were observed climbing to the "roll over" readings of >1000 NTU and then falling back down to the overall data record before immediately increasing to these large positive values . These suspect data were not deleted, as we are not absolutely sure that these values were bad:
10/10 8:30-10/12 14:00

The following are shallow negative depth data (14 values) beginning on 10/1
10:00 (range of -0.007 to -0.05 m; mean of -.036 m). Sonde probes suspected to
be underwater as other parameters check out normal. These data were not deleted:
10/1 10:00-16:30
The following are shallow positive depth data (43 values) beginning on 10/1
17:00 (range of 0.00 to 0.095 m; mean of 0.04 m). Sonde probes suspected to be
underwater as other parameters check out normal. These data were not deleted:
10/1 17:00-18:30, 21:30-23:30
10/2 0:00-7:30, 10:00-18:30

Inlet:
Small negative turbidity values were recorded throughout the following time
span: 10/1 2:00-10/31 23:30 (logging period recorded 916 anomalies), possibly
due to a small calibration error. These data were not deleted.
The following are 16 suspect DOsat and DOmg data, due to small, negative values
recorded are outside the listed range of the dissolved oxygen probe. These
suspect values were not consistent with the overall data record, and were
deleted on the basis of absolute data rejection. Other parameters, the
dissolved oxygen post-cal, and recalibration were good.
10/2 0:30, 1:30-2:00
10/3 1:30
10/4 2:00-4:00
10/5 3:00-4:30
10/24 19:30-20:30
The following are episodes (454 readings) of low DOsat (range 0.7 to 55.7; mean
of 14.03 percent) and DOmg (range 0.06 to 5.21; mean of 1.33 mg/l) during
several low tide fluctuations; beginning at 10/1 0:00, that were not consistent
with the overall data record (at high tide the readings returned to the
consistency of the overall data record). These suspect data were not deleted,
as we are not absolutely sure that these values are bad.
10/1 0:00-1:30, 20:30, 22:00-23:30
10/2 0:00-1:00, 2:30, 8:30, 12:30-15:00, 23:00-23:30
10/3 0:00-1:00, 2:00-3:30, 13:00-15:30, 23:00-23:30
10/4 0:00-1:30, 4:30, 14:00-16:30
10/5 2:30, 5:00, 15:00-17:30
10/6 3:30-6:00, 15:30-18:30
10/7 4:00-7:00, 16:30-19:00
10/8 5:30-7:30, 17:30-20:00
10/9 4:30-8:00, 18:30-21:00
10/10 7:00-9:30, 19:00
10/11 8:00-10:30, 20:00-23:30

10/12 9:00-11:30, 21:00-23:30
10/13 0:00-0:30, 10:00-13:00, 22:00-23:30
10/14 0:00-1:30, 11:00-14:00, 23:00-23:30
10/15 0:00-2:30, 11:30-15:00, 23:30
10/16 0:00-3:30, 12:30-16:00
10/17 1:00-4:30, 13:00-16:30
10/18 1:30-5:00, 14:00-17:30
10/19 2:30-6:00, 14:00-18:00
10/20 3:00-6:30, 14:30-18:30
10/21 3:30-7:00, 15:30-19:30
10/22 4:00-7:30, 16:00-20:00
10/23 5:00-8:00, 16:30-20:30
10/24 5:30-9:00, 17:30-19:00, 21:00-21:30
10/25 3:30-9:30, 17:30-22:00
10/26 6:00-10:00, 18:00-23:00
10/27 7:00-11:00, 19:30-23:30
10/28 0:00, 8:00-12:00, 20:30-23:30
10/29 0:00-0:30, 8:00-13:00, 20:30, 21:30-23:30
10/30 0:00-1:30, 9:00-14:00, 21:30, 22:30-23:30
10/31 0:00-2:30, 9:30-15:00, 23:30
The following was a high positive turbidity spike that was not consistent with
the overall data record. This suspect datum was not deleted, as we are not
absolutely sure that this value is bad.
10/5 14:00 (47.5)

November, 1998 Sampling Period
Head of Tide:
The following was a "roll over" episode, with a range of three high positive
turbidity spikes >1000 NTU that were not consistent with the overall data
record; and there was no climb in turbidity values toward three high "roll over"
spikes. These 6 turbidity values were observed from 11/2 15:00 (1088.5)
continuous through 11/2 17:30 (87.6), and with a mean of 919.9 and a range from
87.6 to 1976.4 NTU. These suspect data were not deleted, as we are not
absolutely sure that these values
were bad:
11/2 15:00:00 (1088.5)
11/2 15:30:00 (719.9)
11/2 16:00:00 (631.1)
11/2 16:30:00 (1976.4)
11/2 17:00:00 (1016.1)
11/2 17:30:00 (87.6)
There were three high positive turbidity spikes on 11/2 18:30 (140.0), 20:30
(255.1), and 21:00 (119.7) that were not consistent with the overall data
record. These suspect data were not deleted, as we are not absolutely sure that
these values are bad.
Inlet:

Small negative turbidity values were recorded throughout the following time
span: 11/1 3:30-11/19 12:30 (logging period recorded 637 anomalies), possibly
due to a small calibration error. These data were not deleted.
The following are episodes (246 readings) of low DOsat (range 0.4 to 52.8; mean
of 7.843 percent) and DOmg (range 0.04 to 5.26; mean of 0.781 mg/l) during
several low tide fluctuations; beginning at 11/1 0:00, that were not consistent
with the overall data record (at high tide the readings returned to the
consistency of the overall data record). These suspect data were
not deleted, as we are not absolutely sure that these values are bad.
11/1 0:00-3:00, 12:00-15:30
11/2 0:30-4:00, 13:00-16:30
11/3 2:00-4:30, 14:00-17:00
11/4 3:00-5:30, 15:00-18:00
11/5 3:30-6:00, 16:00-19:00
11/6 4:30-7:00, 17:00-20:00
11/7 5:30-8:00, 17:30-21:00
11/8 6:30-8:30, 18:30-22:00
11/9 7:30-9:30, 20:00-23:30
11/10 8:30-11:00, 21:00-23:30
11/11 22:00-23:30
11/12 0:00-1:00, 11:00-13:00, 22:30-23:30
11/13 0:00-2:00, 11:00-14:30, 23:30
11/14 0:00-3:00, 12:00-15:30
11/15 0:30-3:30, 13:00-16:00
11/16 1:00-4:30, 11:30, 13:30-17:00
11/17 2:00-5:00, 14:00-17:30
11/18 2:30-5:30, 14:30-18:30
11/19 3:30-6:00

December, 1998 Sampling Period
Head of Tide:
The following are shallow positive depth data (32 values) beginning on 12/7
10:00 (range of 0.002 to 0.098 m; mean of 0.056 m). Sonde probes suspected to
be underwater as other parameters check out normal. These data were not
deleted:
12/7 8:30-12:00
12/17 14:00-16:30
12/22 4:30-10:00
12/29 22:00-23:30
12/30 0:00-1:00, 11:30, 15:00-19:30
The following are shallow negative depth data (16 values) beginning on 12/30
1:30 (range of -0.046 to -0.004 m; mean of -.026 m). Sonde probes suspected to
be underwater as other parameters check out normal. These data were not
deleted:
12/30 1:30-6:00, 12:00-14:30

Inlet:
Small negative turbidity values were recorded throughout the following time span: 12/4 23:00-12/31 10:00 (logging period recorded 392 anomalies), possibly due to a small calibration error. These data were not deleted.
The following were shallow negative depth data where there is suspect that sonde was out of the water (possibly due to ice in the holding tube); due to specific conductivity and salinity data. All data were suspect and deleted.
12/6 19:00-20:30
12/7 7:30
12/9 22:00-22:30
12/31 1:30-2:00, 3:00-4:00
The following were shallow positive depth data where there is suspect that sonde was out of the water (possibly due to ice in the holding tube); due to specific conductivity and salinity data. All data were suspect and deleted.
12/5 4:30-6:30; 17:00-20:00
12/6 5:30-7:30; 18:00-18:30
12/7 19:00-21:30
12/8 20:30-22:00
12/9 21:30
12/10 23:00
12/18 15:30-18:00;
12/19 17:30
12/20 5:30; 17:30-18:30
12/21 18:00-19:30
12/22 18:00-21:30
12/23 6:30-8:30; 19:00-21:00
12/24 21:00
12/25 8:30-10:00; 21:00-22:30
12/26 23:00
12/27 11:00-11:30; 23:00-23:30
12/28 0:00-0:30; 12:00-13:00
12/29 0:00-1:30
12/31 2:30; 14:00-17:00; 21:30-23:30
The following are 5 suspect DOsat and DOmg data, due to small, negative values recorded are outside the listed range of the dissolved oxygen probe. These suspect values were not consistent with the overall data record, and were deleted on the basis of absolute data rejection. Other parameters, the dissolved oxygen post-cal, and recalibration were good.

12/14 23:00
12/15 0:00, 23:30
12/16 0:00-0:30

The following are episodes (518 readings) of low DOsat (range 1.7 to 49.9; mean of 28.9 percent) and DOmg (range 0.17 to 5.78; mean of 3.11 mg/l) during several

low tide fluctuations; beginning at 11/1 0:00, that were not consistent with the
overall data record (at high tide the readings returned to the consistency of
the overall data record). These suspect data were not deleted, as we are not
absolutely sure that these values are bad.
12/5 3:00-4:00; 7:00-8:30; 15:30-16:00; 21:30
12/6 4:00-4:30; 9:00-9:30; 16:30; 22:00-22:30
12/7 5:00-5:30; 9:30-10:00; 17:30; 23:00-23:30
12/8 5:30-6:30; 7:30; 10:30-11:30; 18:00-18:30; 23:30
12/9 0:00-0:30; 6:30-7:30; 11:30-12:00; 19:00-20:00
12/10 0:00-1:30; 7:00-8:30; 11:00-14:00; 19:30-23:30
12/11 0:00-2:30; 8:00-15:30; 19:30-23:30
12/12 0:00-4:00; 8:30-16:30; 20:30-23:30
12/13 0:00-5:00; 9:30-17:30; 21:30-23:30
12/14 0:00-5:30; 10:30-18:30; 22:00-23:30
12/15 0:30-6:30; 11:00-19:30; 23:00
12/16 1:00-7:00; 12:00-19:30
12/17 0:00-7:00; 13:00-20:00
12/18 1:00-7:30; 13:30-15:00; 19:00-21:00
12/19 2:00-8:30; 14:30-17:00; 19:00-21:00
12/20 2:30-4:30; 7:00-9:00; 15:00-17:00; 20:00-22:00
12/21 3:00-6:00; 7:00-10:00; 15:30-17:00; 21:00-22:30
12/22 4:30-6:00; 7:30-9:30; 16:30-17:30; 22:00-23:30
12/23 4:30-6:00; 9:00-11:00; 17:30-18:30; 22:00-23:30
12/24 5:30-11:30; 18:00-20:30; 22:00-23:30
12/25 0:00-0:30; 6:00-8:00; 10:30-13:00; 18:30-20:30
12/26 0:00-1:30; 7:00-13:30; 19:30-21:30
12/27 0:30-2:30; 8:00-10:30; 13:00-15:00; 20:00-21:30
12/28 2:00-3:30; 9:30-10:30; 15:00-16:00; 21:30-22:30
12/29 3:00-4:00; 10:30-11:30; 16:00-16:30; 17:30
12/30 23:30
12/31 0:00; 6:00
The following are shallow negative depth data (4 values) beginning on 12/7 6:30
(range of -0.125 to -0.018 m; mean of -.081 m). Sonde probes suspected to be
underwater as other parameters check out normal. These data were not deleted:
12/7 6:30-7:00, 8:00
12/31 4:30
The following are shallow positive depth data (31 values) beginning on 12/4
19:30 (range of 0.006 to 0.099 m; mean of 0.064 m). Sonde probes suspected to
be underwater as other parameters check out normal. These data were not deleted:
12/4 19:30
12/5 7:00; 16:30
12/6 17:30
12/7 8:30; 18:30
12/8 20:00
12/10 22:30-23:00

12/13 0:30-1:00
12/15 14:30-15:30
12/16 3:00-3:30; 15:00-16:00
12/17 16:00
12/19 17:30-18:00
12/26 22:00-22:30; 23:30
12/28 23:30
12/29 13:00-14:00
12/31 1:00; 13:30
There following were 18 high positive turbidity spikes (range 45-380 NTU; mean
116.5) that were not consistent with the overall data record. These suspect
data were not deleted, as we are not absolutely sure that these values are bad.
12/4 19:30 (125.6); 20:00 (75.9)
12/5 3:30 (71.9); 4:00 (61.7); 7:00 (66.4); 7:30 (61.7); 8:00 (53.8); 16:00
(54.6); 16:30 (49.8); 20:30 (50.4); 21:00 (51.3)
12/6 4:30 (47.7); 5:00 (45.0)
12/23 9:00 (79.5)
12/31 4:30 (307.8); 17:30 (380.0); 18:00 (313.0); 18:30 (200.0)
No data collected on the following dates/times; due to a data gap. Logger did
not record data within this time range, possibly due to an overwrite of data.
12/23 16:30-17:00
12/29 16:30-23:30
12/30 0:00-16:00, 17:00

11. Missing data:

January, 1998 Sampling Period
Head of Tide: No data in January; sonde not deployed until April.
Inlet:
No data from 1/21 12:00 to 1/29 11:00 due to downtime for calibration, maintenance and downloading.
No pH data from 1/13 15:30 to 1/21 11:30 due to a pH probe crash.

February, 1998 Sampling Period
Head of Tide: No data in February; sonde not deployed until April.
Inlet: No missing data.

March, 1998 Sampling Period
Head of Tide: No data in March; sonde not deployed until April.
Inlet:
No data from 3/4 14:30 to 3/16 10:00 due to downtime for calibration, maintenance and downloading; and for getting the YSI telemetry unit set up (see
Research Methods) [The YSI telemetry unit at the inlet site (IN) began reading
on 3/16/98 at 10:30:00].

DO deleted from 3/16 10:30 to 11:00; first few records are low compared to rest
the rest of deployment. Membrane may have still been settling.

April, 1998 Sampling Period
Head of Tide:
No data on 4/1 0:00 to 4/1 12:30; this was the first logger deployment (4/1 at
13:00) at this site for 1998.
Inlet:
No data on 4/18 1:00-2:00; due to a data gap. Logger did not record data within
this time range, possibly due to an overwrite of data.
No data from 4/23 7:30-13:30 due to downtime for calibration, maintenance and
downloading.
No turbidity data from 4/23 14:00 to 4/30 23:30 due to a turbidity probe malfunction.

May, 1998 Sampling Period
Head of Tide:
No data from 5/11 1:30 to 5/19 13:30 due to downtime for calibration, maintenance and downloading.
No dissolved oxygen data or percent saturation data from 5/27 0:30 to 5/31 23:30
due to a suspected DO membrane puncture or tear and probe malfunction.
Inlet:
No turbidity data from 5/1 0:00 to 5/21 14:30 due to a turbidity probe malfunction (continued from 4/23 14:00).
No data collected on the following dates/times; due to a data gap. Logger did
not record data within this time range, possibly due to an overwrite of data.
5/6 2:00, 16:00-18:30
5/20 12:30
No missing data due to downtime for calibration, maintenance and downloading.
Deployed extra calibrated sonde within a non-collection time of existing sonde
(replaced sonde on 5/21 15:00).

June, 1998 Sampling Period
Head of Tide:
No dissolved oxygen data or percent saturation data from 6/1 0:00 through 6/28
10:30 due to a suspected DO membrane puncture or tear and probe malfunction from
the previous deployment (5/27 0:30).
No data from 6/28 11:00 to 6/30 11:00 due to downtime for calibration, maintenance and downloading.
Inlet:
No data collected on the following dates/times; due to a data gap. Logger
either (1) did not record data within this time range, possibly due to an

overwrite of data; or (2) did record the same data values because of an overwrite (these data were deleted).
6/3 1:00, 5:00
6/12 2:00
6/16 10:30
6/17 9:00-23:30
6/18 0:00-23:30
6/19 0:00-9:00, 14:30-15:00, 16:00-23:30
6/20 0:00-1:00, 2:30-3:00, 4:00-6:00, 7:30-10:00, 12:30-21:30
6/21 10:30-23:30
6/22 0:00-16:00
No data from 6/22 16:30 to 6/30 23:30 due to downtime for calibration, maintenance and downloading.

July, 1998 Sampling Period
Head of Tide: No missing data.
Inlet:
No data on 7/1 0:00 to 10:30 due to downtime for calibration, maintenance and
downloading.
The following are suspect DOsat and DOmg data, due to three small, negative
values recorded are outside the listed range of the dissolved oxygen probe.
These suspect values were not consistent with the overall data record, and were
deleted on the basis of absolute data rejection.
7/1 23:30
7/2 0:00-0:30
No data collected on the following dates/times; due to a data gap. Logger
either (1) did not record data within this time range, possibly due to an overwrite of data; or (2) did record the same data values because of an overwrite (these data were deleted).
7/5 16:30-17:30
7/6 12:00-12:30
7/8 14:30, 16:00
7/9 11:00-13:00, 14:00-15:30
7/18 2:00
7/28 16:00

August, 1998 Sampling Period
Head of Tide:
No data on 8/14 5:00 due to downtime for calibration, maintenance and downloading.
Inlet:
No data on 8/17 11:00 to 17:30 due to downtime for calibration, maintenance and
downloading.
No data collected on 8/14 2:00; due to a data gap. Logger did not record data
within this time range, possibly due to an overwrite of data.
No data collected from 8/24 11:30 to 8/31 23:30 due to a telemetry malfunction,

including a telemetry battery crash.

September, 1998 Sampling Period
Head of Tide:
No data from 9/28 0:30 to 9/30 23:30 due to downtime for calibration, maintenance and downloading.
Inlet:
No data from 9/1 0:00 to 9/21 13:30 due to a telemetry malfunction, including a
telemetry battery crash (continued from the crash observed beginning on 8/24
11:00).
No data collected on the following dates/times; due to a data gap. Logger did
not record data within this time range, possibly due to an overwrite of data.
9/24 11:30-13:00
9/29 3:30
The following are suspect DOsat and DOmg data, due to three small, negative
values recorded are outside the listed range of the dissolved oxygen probe.
These suspect values were not consistent with the overall data record, and were
deleted on the basis of absolute data rejection.
9/28 22:00-23:00

October, 1998 Sampling Period
Head of Tide:
No data from 10/1 0:00 to 10/1 9:30 due to downtime for calibration, maintenance
and downloading.
Inlet:
No data on 10/5 13:30 due to downtime for calibration, maintenance and downloading.
The following are 16 suspect DOsat and DOmg data, due to small, negative values
recorded are outside the listed range of the dissolved oxygen probe. These
suspect values were not consistent with the overall data record, and were
deleted on the basis of absolute data rejection10/2 0:30
10/2 1:30
10/2 2:00
10/3 1:30
10/4 2:00
10/4 2:30
10/4 3:00
10/4 3:30
10/4 4:00
10/5 3:00
10/5 3:30
10/5 4:00
10/5 4:30
10/24 19:30

10/24 20:00
10/24 20:30

November, 1998 Sampling Period
Head of Tide:
No data from 11/15 1:30 to 11/30 23:30 due to downtime for calibration, maintenance and downloading.
Inlet:
No data from 11/19 13:00 to 11/30 23:30 due to downtime for calibration, maintenance and downloading.

December, 1998 Sampling Period
Head of Tide:
No data from 12/1 0:00 to 12/2 14:30 due to downtime for calibration, maintenance and downloading.
No data from 12/31 11:30 to 23:30. This datalogger was pulled for the year
(winter months) to prevent ice damage.
Inlet:
No data from 12/1 0:00 to 12/4 19:00 due to downtime for calibration, maintenance and downloading.
The following were shallow negative depth data where there is suspect that sonde
was out of the water (possibly due to ice in the holding tube); due to specific
conductivity and salinity data. All data were suspect and deleted.
12/6 19:00-20:30
12/7 7:30
12/9 22:00-22:30
12/31 1:30-2:00, 3:00-4:00
The following were shallow positive depth data where there is suspect that sonde
was out of the water (possibly due to ice in the holding tube); due to specific
conductivity and salinity data. All data were suspect and deleted.
12/5 4:30-6:30; 17:00-20:00
12/6 5:30-7:30; 18:00-18:30
12/7 19:00-21:30
12/8 20:30-22:00
12/9 21:30
12/10 23:00
12/18 15:30-18:00;
12/19 17:30
12/20 5:30; 17:30-18:30
12/21 18:00-19:30
12/22 18:00-21:30
12/23 6:30-8:30; 19:00-21:00
12/24 21:00
12/25 8:30-10:00; 21:00-22:30
12/26 23:00
12/27 11:00-11:30; 23:00-23:30
12/28 0:00-0:30; 12:00-13:00
12/29 0:00-1:30
12/31 2:30; 14:00-17:00; 21:30-23:30

The following are 5 suspect DOsat and DOmg data, due to small, negative values
recorded are outside the listed range of the dissolved oxygen probe. These
suspect values were not consistent with the overall data record, and were deleted on the basis of absolute data rejection. Other parameters, the dissolved oxygen post-cal, and recalibration were good.

12/14 23:00
12/15 0:00, 23:30
12/16 0:00-0:30

No data collected on the following dates/times; due to a data gap. Logger did
not record data within this time range, possibly due to an overwrite of data.
12/23 16:30-17:00
12/29 16:30-23:30
12/30 0:00-16:00, 17:00

12. Other Remarks/Notes:

•*The YSI telemetry unit at the inlet site (IN) began reading on 3/16/98 at
10:30:00. Before this date/time (from Wells NERR 1997 Metadata):
The inlet site (IN) deployment methods changed starting on 12/19/97 at 10:30.
The YSI telemetry unit was installed to this site. A 23 foot, 4 inch diameter
high grade PVC tube was installed against a dock piling. Four steel flat bars
with bolts were used to attach this 23 foot PVC tube against the dock piling. A
3 by 1.5 inch PVC transducer was glued on the inside bottom of the PVC tube to
allow the sonde to sit exactly 1.0 meter (3.28 ft) off the bottom. Several
vertical holes, representative of the sonde guard, were cut out the circumference near the bottom of the PVC pipe to allow water flow to the probes.
An "L" shaped steel bar with two end-holes is placed through two created slits
about a half of foot from the top of the PVC tube. A stainless steel wire
(1/16") is attached to the sonde bail using two stainless steel clips; and to
one end of the "L" shaped steel bar for sonde deployment and retrieval. A
marine lock is attached through the other end of the "L" shaped steel bar to
hold the bar, wire, and sonde in place and for security. A PVC threaded cap
screws in to the threaded top of the PVC tube, also for security. A hole was

created in the PVC cap to allow the sonde to hook up with the telemetry unit
using the 50 foot cable. The collection of data parameters at the inlet (IN)
site are slightly different then at the head of tide (HT) site, due to
the telemetry unit installation. This is explained in the Wells 1998 metadata
[BELOW], as we didn't actually begin the telemetry unit data collection until
1998; we just installed the new 23 foot PVC tube (see YSI's Eco-Watch Users
Guide). Thus, the actual data parameter collection from 12/19/97 10:30 to
12/31/97 23:30 was the same as prior to that. Two to four week variable
sampling periods were chosen due to limitations created by the life of the
dissolved oxygen membrane and probe fouling. Battery power is not needed
anymore within the sonde itself (although, battery power is needed during
calibrations and downloading) at the time of deployment at this site because of
the telemetry unit's solar batter power. Measurements of temperature, specific
conductivity, salinity, percent saturation, dissolved oxygen, depth, pH, and
turbidity are recorded at 30 minute intervals throughout the deployment period.
Time, date, and battery voltage are no longer programmed to be recorded by the
sonde, since these parameters are already programmed with the Eco-Watch Program
(see YSI's Eco-Watch Users Guide).

•There were significant rain storms during the June HT deployment; which could
be the reason for the observed high turbidity
values.

•With our extra data sonde, we have been reducing the amount of time of missing
data from calibrations and maintenance for all sites. Some months have no
missing data from the use of this extra sonde.

•There were suspect data at the head of tide site (HT) of (all parameters)
beginning on 10/9 1:00 through 10/12 14:30 due to a powerful storm event (strong
winds, heavy rain, flooding, coastal erosion along with astronomical
high tides). All parameters returned to normal except for DO mg/l and DO
percent saturation that seemed to flatline over 100 percent for the remainder of
the month. This suspect data was not deleted, as post calibrations checked out
normal.

The following is a full description from the NCDC website of this storm event:

This page dynamically generated 14 Sep 2001 from:
http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~storms
Please send questions or comments about this system to rray@ncdc.noaa.gov
Please see the NCDC Contact Page if you have questions or comments.

Event Record Details

Event:Flood State:Maine
Begin Date:10 Oct 1998, 10:00:00 AM EST Map of Counties
Begin Location:Countywide County:York
End Date:11 Oct 1998, 12:00:00 PM EST
End Location:Countywide
Magnitude:0
Fatalities:0
Injuries:0
Property Damage:$ 225.0K
Crop Damage:$ 0.0

Description:
A moist southeast flow from the Atlantic developed ahead of an intensifying low pressure center off the mid-Atlantic coast on Friday, October 9 and caused heavy rain to spread over southern Maine during the day. The low moved slowly northeastward during the 10th and 11th, then gradually moved east of the area on the 12th. The storm caused strong winds, heavy rain, flooding, and coastal erosion in parts of southern Maine. The southeasterly flow ahead of the storm combined with its slow movement brought a persistent flow of moisture laden air from the Atlantic into the southwestern part of the state. The heavy precipitation caused rivers, streams, and low areas to flood during the day Saturday, October 10. In addition to the heavy rainfall, high winds caused large and powerful wind driven waves, which, in combination with astronomically high tides, caused erosion along sections of the coast. Rainfall amounts during the period in Cumberland and York Counties ranged from about 5 inches in extreme southwestern York County and northwestern York and Cumberland Counties to more than 10 inches in coastal sections of Cumberland County. South Portland Pubic Works reported 11.89 inches of precipitation at South Portland High School during the four-day period. The heavy rainfall caused numerous small

rivers and
streams in Cumberland and York Counties to flood roadways. Many roads were
closed due to the flood waters and/or the damage caused by the flood waters.
In Freeport, a 90 foot long, 14 foot diameter steel culvert located where Mill
Creek flows beneath Flying Creek Road was damaged. The Presumpscot River was
above flood stage from about 12:30 pm Saturday through about 9:30 pm Sunday
evening. The Presumpscot River crested at about 20.88 feet at about 9 pm
Saturday evening, just under 6 feet above the 15 foot flood stage. In
Kennebunk, the combination of astronomically high tides and the large waves
generated by the storm undermined 230 feet of seawall. The concrete and steel
wall slid forward and dropped onto the beach, allowing washout under Great
Hill Road and loss of the sidewalk. Both Cumberland and York Counties were
declared federal
disaster areas by the President, making them eligible for federal aid. Strong
winds, rough seas, and high astronomical tides caused several boats in the
mid-coast region to break from their moorings. In Rockland, a 20-foot sailboat
and a 25-foot sailboat grounded on rocks. At the southern end of Owls Head, a
35 foot boat used for urchin diving was destroyed when it hit the rocks.