CRMC Tidal Datum Methods

Methodology for Determining Tidal Datums

Long Term Tidal Survey for Determining Mean High Tide:

To delineate Mean High Tide to determine property boundaries, a thirty day tidal survey is required and the tide station needs to be tied to a fixed geodetic datum (NAVD 88). To establish Mean High Tide see ***CRMC Methodology for Determining Mean High Water.***

Very Short Term Tidal Survey using the Range Ration Method:

Used for estimating mean low water for dock design
Used for estimating tidal datums for habitat restoration

Procedure for Very Short Term Tide Survey using Visual Water Level Measurements:

The very short term range ratio method for determining tidal datums can be done relatively quickly (one complete tidal cycle) using inexpensive, low tech equipment. A reference datum (benchmark) and temporary tide gage must be established on the site. For very short term tidal surveys to estimate mean low water for dock design, choose a relative vertical reference datum (benchmark) that can be used for the very short term tide survey and for future reference. Both the calculated tidal datums and site bathymetry need to be tied to this relative vertical reference datum.

The next step is to establish a temporary tide station. Figure 1 shows an example of the tide gage setup. The tide gage must be set below the water level at low tide. The water level at low tide may be much lower than mean low water due to astronomical (spring tides) and meteorological (wind set down) factors. Prior to conducting the tidal survey, consult tide and weather predictions at http://tidesandcurrents.noaa.gov/nwlon.html and www.nws.noaa.gov. Very short term tidal surveys should not be conducted during stormy and high wind conditions.

Tidally restricted water bodies may have very different tidal cycles (time for maximum and minimum water levels, height of maximum and minimum water levels) than in the open ocean or unrestricted bays. Be familiar with local tidal conditions. Water level observations must be recorded every six minutes close to the maximum and minimum water levels until there is a clear pattern of rise and fall. Familiarity with local tidal conditions will save time in the long run.

After the water levels are recorded for one high and one low tide, results need to be compared to the mean values at the appropriate NOAA-NOS long term control station (Newport or Providence) to compute the tidal datums at the site. Data for simultaneous comparison and tidal datums for the long term control station can be downloaded from the National Water Level Observation Network (NWLON) at http://tidesandcurrents.noaa.gov/nwlon.html.

Equipment needed for measuring water levels:

1. Anchor post (6 foot steel fence post, existing piling or other feature that is

anchored below the water level at the lowest low tide.
2. Engineer's rod section or other pole that is calibrated to 0.01 feet. The rod must be longer than the anticipated tidal range so that both high and low tide measurements can be read.
3. Transparent stilling well such as a 3/4 inch diameter, clear plastic PVC tubing. Cover the bottom of the tube and drill a small hole (~1/16 inch) two inches from the bottom of the stilling well tube.
4. Flotation marker. The flotation marker needs to float freely in the stilling tube and be easily seen in low light. A fluorescent plastic piece works well. Before deploying, test to be sure that the marker floats and fits loosely in the tube.
5. Tide Field Measurement Record Form
6. Level

Methods for measuring water levels:

1. Set up a benchmark on the land to use for the relative vertical reference datum. The benchmark should be a stable, permanent marker. Both tidal datums and bathymetry will be tied to the reference datum. Describe the benchmark on the Tide Field Measurement Record Form.
2. Select a site for the tide gage that is visible from the benchmark.
3. Set the anchor post seaward of the anticipated low tide line. The location of the anchor post is dependant on the shoreline bathymetry. On steeply sloping shorelines the anchor post may be set a few feet seaward of the anticipated low tide line. On gently sloping shorelines the anchor post may need to be set several feet seaward of the anticipated low water line. If the staff and stilling well are set higher than the water level, the staff will need to be reset and data collection must be started from the beginning. Also be sure that the staff and stilling well extend at least two feet above the anticipated high water level. The anticipated high water level can be estimated by the height of water lines on nearby rocks or pilings. If the staff and stilling well are set lower than the high water level, the staff will need to be reset and data collection must be started from the beginning.

4 Affix the engineer's rod or other calibrated pole securely to the anchor post so that it can be seen from observation site.

5 Affix the clear plastic stilling well securely to the anchor post so that readings on the rod and flotation marker can be seen simultaneously from the observation site.

6 Set a reference elevation (from the benchmark) on the top of the anchor post.

7 Determine the rod reference reading at the top of the anchor post (or top of the rod if below the top of the anchor post). The difference (rod interval) between the rod reference reading and the flotation marker reading is then subtracted or added to the reference elevation to obtain the elevation of the water level (figure 1).

8 Start recording water level measurements approximately one hour before estimated time for minimum and maximum water level. Observations must be read every six minutes until peak high/low water is clearly recorded. The observations must continue until the tide amplitude has changed at least 0.20

feet from peak high/low water. Record the time and rod reading in the appropriate columns on the Tide Field Measurement Record form.

9 Complete the Tide Field Measurement Record form. Determine the high and low water levels for the subordinate site.

10 Recheck the reference elevation (from the benchmark) on the top of the anchor post.

Computing tidal datums from tidal observations:
A vertical datum is called a tidal datum when it is defined by a certain phase of the tides. Tidal datums are derived from measurements recorded over a 19 year period. Specific 19-year periods are defined by NOAA as a **National Tidal Datum Epoch (NTDE)** and tidal datums must be specified with regard to a NTDE. For example, mean high water at Newport, RI is the average of all high tides between 1983 and 2001. Because it is impractical to record 19 years of data at every location, shorter tidal records can be compared to the long term tide stations to determine tidal datums at a particular site. The long term tide station is referred to as the **control station (c)** and the very short term tide station is the **short term station (s)**. The following describes the vertical datums that need to be calculated at the short term station.

Mean High Water (MHW) is a tidal datum determined from the arithmetic mean of the high water heights observed each tidal day.

Mean Low Water (MLW) is a tidal datum determined from the arithmetic mean of the low water heights observed each tidal day.

Mean Tide Level (MTL) is a tidal datum which is determined from the average of the MHW and MLW tidal datum elevations.

Mean Range of Tide (Mn) is the difference in elevation between the tidal datums of MHW and MLW.

Before computing the tidal datums for the site download the water levels from the appropriate NOS tide gage (control station) at http://tidesandcurrents.noaa.gov/nwlon.html for the same time period that water levels were recorded at the subordinate station. The default time is GMT. Be sure to check the box for local time before downloading. Also download tidal datums for the latest National Tidal Datum Epoch from the benchmark sheets for the appropriate tide station. Newport tidal datums are listed below.

Tidal datums at NEWPORT, NARRAGANSETT BAY based on:

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

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

HIGHEST OBSERVED WATER LEVEL (09/21/1938)	=	4.056 (13.30 ft)
MEAN HIGHER HIGH WATER (MHHW)	=	1.174 (3.85 ft)
MEAN HIGH WATER (MHW)	=	1.099 (3.60 ft)
NORTH AMERICAN VERTICAL DATUM-1988 (NAVD)	=	0.622 (2.04 ft)
MEAN TIDE LEVEL (MTL)	=	0.571 (1.87 ft)
MEAN SEA LEVEL (MSL)	=	0.529 (1.74 ft)
MEAN LOW WATER (MLW)	=	0.042 (0.14 ft)
MEAN LOWER LOW WATER (MLLW)	=	0.000 (0.00 ft)
LOWEST OBSERVED WATER LEVEL (02/03/1976)	=	-0.943 (-3.09 ft)

Formulas and Computations:

1. Compare the differences in MTL between the short-term and the control station for a simultaneous time period.

$$\mathbf{MTL_s - MTL_c = MTL_{difference.}}$$

This difference is then applied to the accepted NTDE value for MTL at the long-term control station ($_{MTLacc}$) to compute the equivalent long term value at the short-term station.

$$\mathbf{MTL_{difference} + MTL_{acc} = MTL_{acs}}$$

2. The accepted mean range of tide at the short-term station (Mn_{acs}) then must be determined. This is computed by forming a range ratio between the ranges of tide at the short-term and the control station for simultaneous time period.

$$\mathbf{Mn_s / Mn_c = Mn_{ratio}}$$

This ratio is then applied to the accepted NDTE value for Mn at the long-term control station (Mn_{acc}) to compute the equivalent long-term value at the short-term station.

$$\mathbf{Mn_{ratio} \times Mn_{acc} = Mn_{acs}}$$

3. The accepted datum of Mean High Water at the short-term station (MHW_{acs}) is then computed by first subtracting 1/2 of the value of the accepted Mean Range (from step 2)at the short-term station from the Mean Tide Level at the short-term station (from step 1) to get MLW_{acs} and then adding the Mn_{acs} to the MLW_{acs} to get MHW_{acs}:

$$\mathbf{MLW_{acs} = MTL_{acs} - 1/2\ Mn_{acs}}$$

$$\mathbf{MHW_{acs} = MLW_{acs} + Mn_{acs}}$$

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For additional information on tides and tidal datum computations go to the following websites:

http://tidesandcurrents.noaa.gov/publications/Computational_Techniques_for_Tidal_Datums_handbook.pdf

http://tidesandcurrents.noaa.gov/pub.html

http://tidesandcurrents.noaa.gov/publications/tidal_datums_and_their_applications.pdf