Coastal Engineering Technical Note

DEFINING TIDAL DATUMS

PURPOSE: To provide design guidance in the establishment and use of tidal datums in hydrographic surveys and coastal construction.

INTRODUCTION: For the design of most coastal projects, a knowledge of the tidal variations at a specific site is required since the minimum and maximum expected water levels are important design considerations. In addition, it is necessary to relate these water level fluctuations to a fixed land point of known elevation. Such a point is called a bench mark. This information is needed to design such projects as coastal protection structures (including beach fills), harbor improvements, and navigation channels.

A fixed elevation to which other elevations may be referenced is called a datum. Tidal datums are defined by a certain stage of the tide, usually Mean Sea Level (MSL), Mean Low Water (MLW), or Mean Lower Low Water (MLLW). These datums are usually tied to the National Geodetic Vertical Datum (NGVD). The Figure illustrates the relationships between common datums and various tidal elevations. Since there is no standardized tidal datum at present in the United States, care must be taken when utilizing both bathymetric (or hydrographic) charts and topographic maps to insure that all vertical values either refer to the same datum or have been adjusted to the same datum. It is also important to realize that tidal datums are *local* and should not be extended into areas having differing topographic features without substantiating measurement.

TIDE TABLES: The National Ocean Survey (NOS) maintains 50 primary tide stations at selected sites along the Atlantic Coast, Gulf Coast, and Pacific Coast including Alaska, Hawaii and Puerto Rico. Tide Tables are published yearly by NOS (see references). These tables provide predicted high and low tide levels for the primary stations and also provide a means of estimating these tidal values for a large number of secondary stations. The values which can be obtained for the secondary stations are approximate, and the cautions given in the NOS Tide Tables should be observed.

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14. ABSTRACT
For the design of most coastal projects, a knowledge of the tidal variations at a specific site is required since the minimum and maximum expected water levels are important design considerations. In addition, it is necessary to relate these water level fluctuations to a fixed land point of known elevation. Such a point is called a bench mark. This information is needed to design such projects as coastal protection structures (including beach fills), harbor improvements, and navigation channels.

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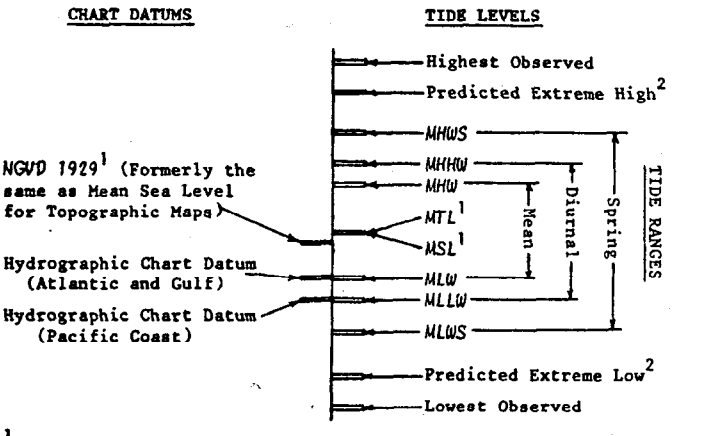

[1] The position of MSL, MTL, and NGVD, 1929 relative to each other varies with location

[2] See Harris (1981) and CETN-I-13

FIGURE - COMPARISON OF TIDE LEVELS

DEFINITIONS: Standard definitions for the tide levels shown in the Figure are given below. For more detailed definitions see Appendix A of the *Shore Protection Manual* (1977) and Harris (1981).

MHWS - *MEAN HIGH WATER SPRINGS* - The average height of the high waters occurring at spring tide.

MHHW - *MEAN HIGHER HIGH WATER* - The average height of the higher high waters of a mixed tide.

MHW - *MEAN HIGH WATER* - The average height of the high waters. Average includes all high water heights for semi-diurnal and mixed tides; includes only the higher high waters for diurnal tides. Hence, for diurnal tides, *MHW* is the same as *MHHW*.

MTL - *MEAN TIDE LEVEL* - A plane midway between mean high water and mean low water. Not necessarily equal to Mean Sea Level.

MSL - *MEAN SEA LEVEL* - The average height of the sea for all stages of the tide. Usually determined from hourly readings.

MLW - *MEAN LOW WATER* - The average height of the low waters. Average includes all low water heights for semi-diurnal and mixed tides; includes only lower low waters for diurnal tides. Hence, for diurnal tides, *MLW* is the same as *MLLW*.

MLLW - *MEAN LOWER LOW WATER* - The average height of the lower low waters of a mixed tide.

MLWS - *MEAN LOW WATER SPRINGS* - The average height of the low waters occurring at spring tide.

NGVD - *NATIONAL GEODETIC VERTICAL DATUM* - A fixed reference adopted as a standard geodetic datum for heights. The datum was derived for land surveys from a general adjustment of the first-order level nets of the U.S. and Canada. The year indicates the time of the last general adjustment. The NGVD is fixed and does not take into account the changing stands of sea level. The relationship between the geodetic datum and local MSL is not consistent from one location to another. For these reasons the NGVD of 1929 is not the same as Mean Sea Level.

Any of the tide levels defined above (with the exception of MTL) can be a tidal datum if the average is taken over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations.

SOURCES OF TIDAL DATUM INFORMATION: The primary source of tidal datum information is NOS. You may write this agency at: National Oceanic and Atmospheric Administration, National Ocean Survey, Distribution Division (C44), Riverdale, MD 20840 or call NOS at (301) 436-6990. NOS can provide index maps of tidal datum bench marks and lists of the established references between the NGVD of 1929 (where available) and the local tidal datum on a state-by-state basis. Bench mark sheets can be obtained for all the primary and some of the secondary stations listed in the Tide Tables. A typical tidal bench mark sheet for a specific location gives the following information (see CETN-I-14).

-location (latitude and longitude to nearest 0.1 of a minute) of the tide station;
-a description of several nearby surveying bench marks, their locations, and their elevation above the tidal datum (i.e. MLW or MLLW);
-the time length of tidal record used in establishing the tidal datum;
-the elevation of: highest recorded (or estimated) tide, MHW (or MHHW), MTL, NGVD (if available), MLW (or MLLW), and lowest recorded (or estimated) tide level.

Often Corps offices have established survey bench marks which have been referenced to existing NOS tidal bench marks or to the NGVD. When these exist, they may be used as tidal bench marks by determining their elevation with respect to the local tidal datum.

A third source of tidal information is local educational institutions which engage in marine studies. These institutions sometime collect tidal information independently of NOS.

SETTING OF A DATUM: There may be situations where an accurate tidal datum is required, but not available. When the time and cost-benefit allow, it is possible to establish a datum by collecting at least 3 months of good, continuous data from a tide gage and comparing it with data from nearly primary or secondary stations. A detailed description of this procedure is given by Miles (1980).

CAUTIONS: Most tidal information is collected in bays and rivers. In many cases these values are applied to the adjacent open coast. However, there may be situations where the tidal range in the bay differs from the range in the open ocean. Depending on the geometry of the bay and the friction losses in the inlet, the range in the bay may be either greater or smaller than the tidal range on the open coast. Before using tidal information for a specific site other than that of the tide station, the coastal engineer should investigate these possibilities (see CETN-IV-2).

The NGVD of 1929 is a permanently fixed surface to which tidal datums are usually referenced. While the general trend toward rising sea level relative to the land is usually not significant, tidal datums are sometimes adjusted to reflect this trend. Therefore, for maximum accuracy, always use the most up-to-date elevation of the tidal datum with respect to NGVD.

Linear interpolation of any tidal datums, extreme tidal values, or tidal ranges between stations listed in the Tide Tables is not recommended due to the large variations which can occur in these parameters over a short distance of coastline. When it is necessary to interpolate, use the best available data along with any obtainable local knowledge.

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