It’s the Little Things That Count:

A Review of Tidal Datums and the Possible Implications of Error on Coastal Restoration

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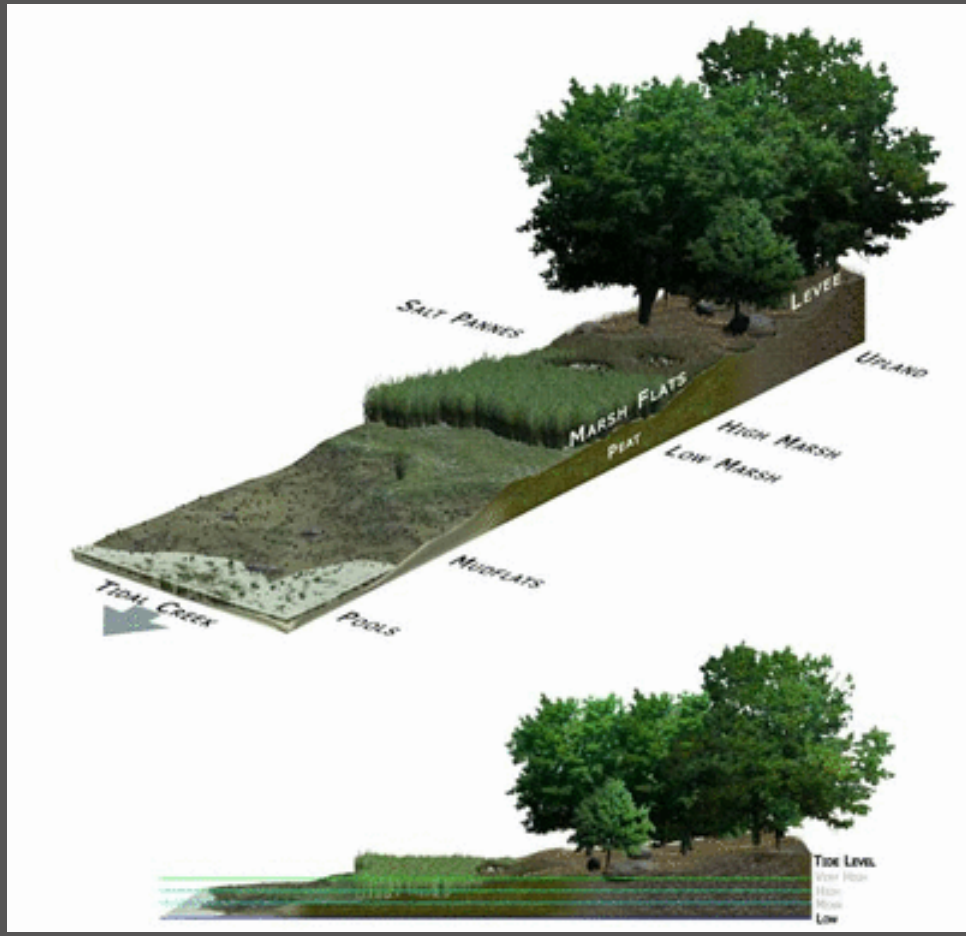
What is a Vertical Datum?

A datum is any reference system against which measurements may be made. Vertical datums are used to measure land elevations and water depths.

Why is it Important?

- Used to design coastal restoration projects.
- The relationship between geodetic datums and the local mean sea level varies by location.
- There are big differences (often >2') in the 0 reference point for each datum.
- If an incorrect assumption is made about the mapped datum, a project can be graded too high or too low.
- Using the correct or incorrect datum can have detrimental implications for successful restoration planning and implementation.



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Vertical Datum Categories

TWO PRIMARY CATEGORIES:

1) Orthometric/Geodetic Vertical Datums – based on a form of mean sea level (MSL) and are fixed references adopted as a standard geodetic datum for heights and are consistent throughout the United States.

2) Tidal Datum – standard elevation defined by a certain phase of the tide. The datum is determined from water level measurements obtained along the coast including estuaries and rivers influenced by the tide.

- Based on tidally derived surfaces of high or low water in a certain area
- Based on 19-year period* of water level averaging referred to as the *National Tidal Datum Epoch (NTDE) - Presently 1983 – 2001*

*** Certain areas, like the Gulf of Mexico, use a modified 5-year Epoch**

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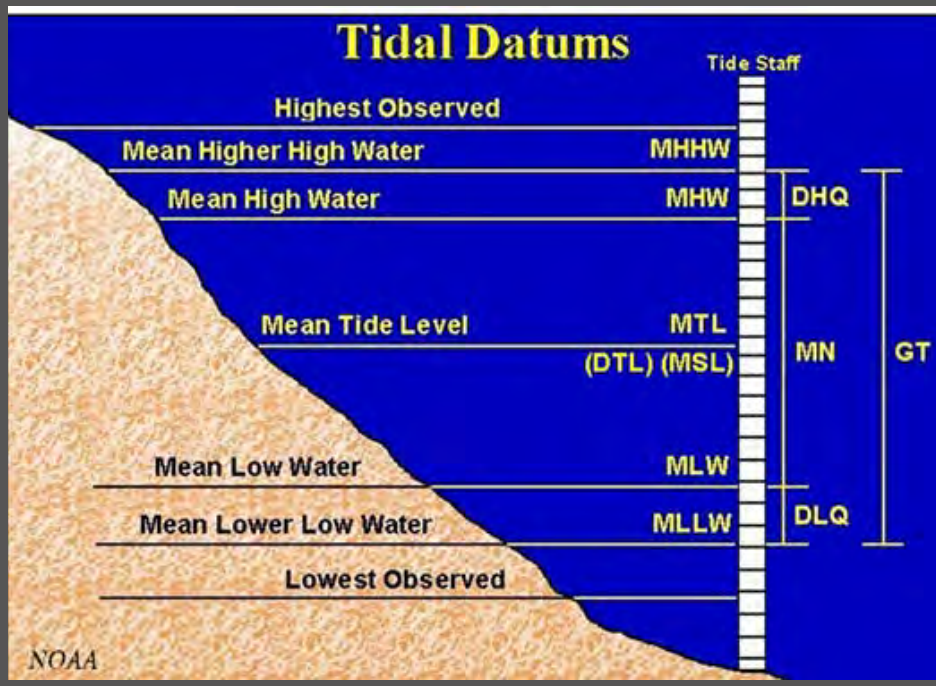
Vertical Datum Categories

COMMON GEODETIC DATUMS INCLUDE:

- **North American Datum of 1988 (NAVD 88)**
- **National Geodetic Vertical Datum of 1929 (NGVD 29)** *Recently superseded by NAVD 88 due to inconsistencies in the datum.*

COMMON TIDAL DATUMS INCLUDE:

- **Mean Low Water (MLW)** – mean of the low water heights during the current NTDE.
- **Mean Lower Low Water (MLLW)** – most typical tidal datum used - mean of each day's lower low water height during the current NTDE.
- **Mean Sea Level (MSL)** – mean of hourly water levels observed during current NTDE.
- **Also: MHHW, MHW, DTL, MTL, LAT, GT, MN, DHQ, DLQ, HWI, LWI**



More Info: http://tidesandcurrents.noaa.gov/datum_options.html
http://vdatum.noaa.gov/

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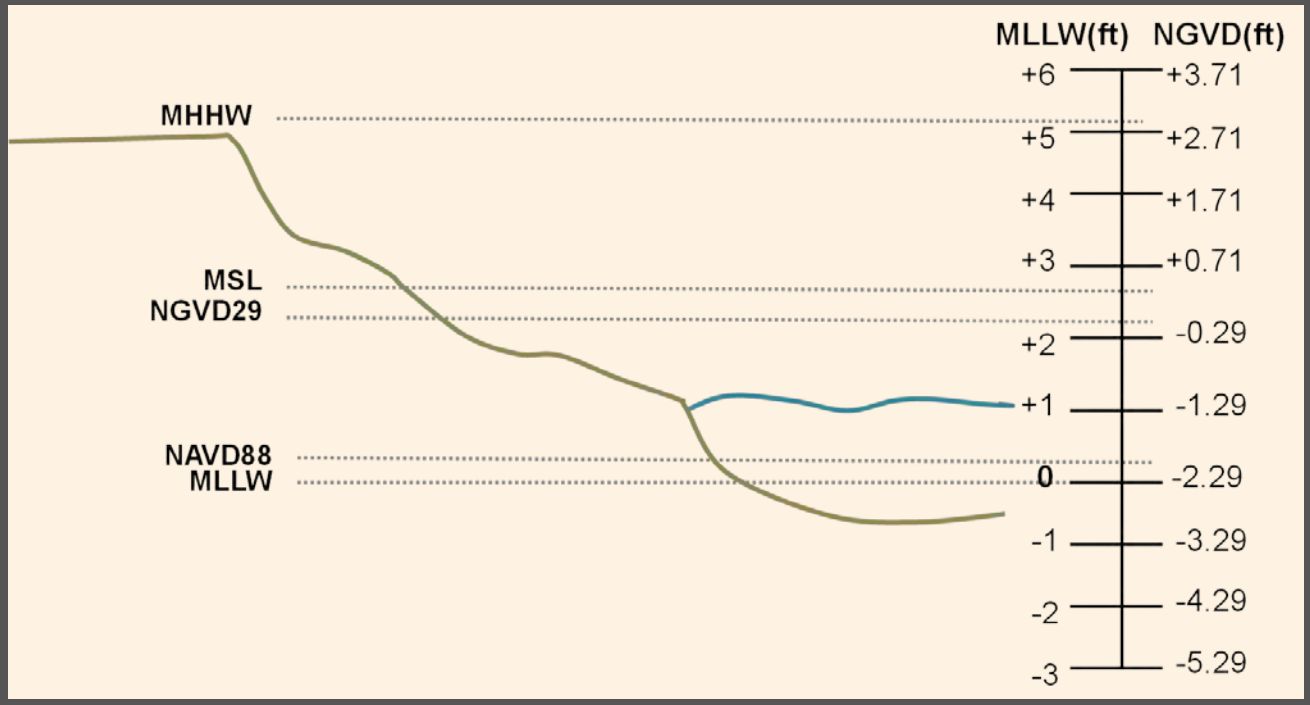
Project Highlight

3.07-acre Salt Marsh Restoration Project in Del Mar, California

- Issues receiving agency approval due to perceived lack of natural tidal inundation.
- Issues created by past misunderstanding of the vertical datums
- Overall goal to maximize the creation of three-parameter federal wetlands and establish a diverse assemblage of marsh habitats.

Salt Marsh Project Tidal Datum (MLLW and NGVD)



La Jolla, CA Tide Station #9410230 (May 2011)	MLLW	NAVD	NGVD	MSL
Conversion from MLLW	*NA*	*MLLW-0.18*	*MLLW-2.29*	*MLLW-2.73*
Highest Observed Water Level	7.651	7.471	5.361	4.921
Mean Higher High Water (MHHW)	5.330	5.150	3.040	2.600
Mean High Water (MHW)	4.600	4.420	2.310	1.870
Mean Tide Line (MTL)	2.750	2.570	0.460	0.020
Mean Sea Level (MSL)	2.730	2.550	0.440	**0.000**
National Geodetic Vertical Datum (NGVD)	2.290	2.110	**0.000**	-0.440
Mean Low Water (MLW)	0.900	0.720	-1.390	-1.830
North American Vertical Datum (NAVD)	0.180	**0.000**	-2.110	-2.550
Mean Lower Low Water (MLLW)	**0.000**	-0.180	-2.290	-2.730
Lowest Observed Water Level	-2.867	-3.047	-5.157	-5.597

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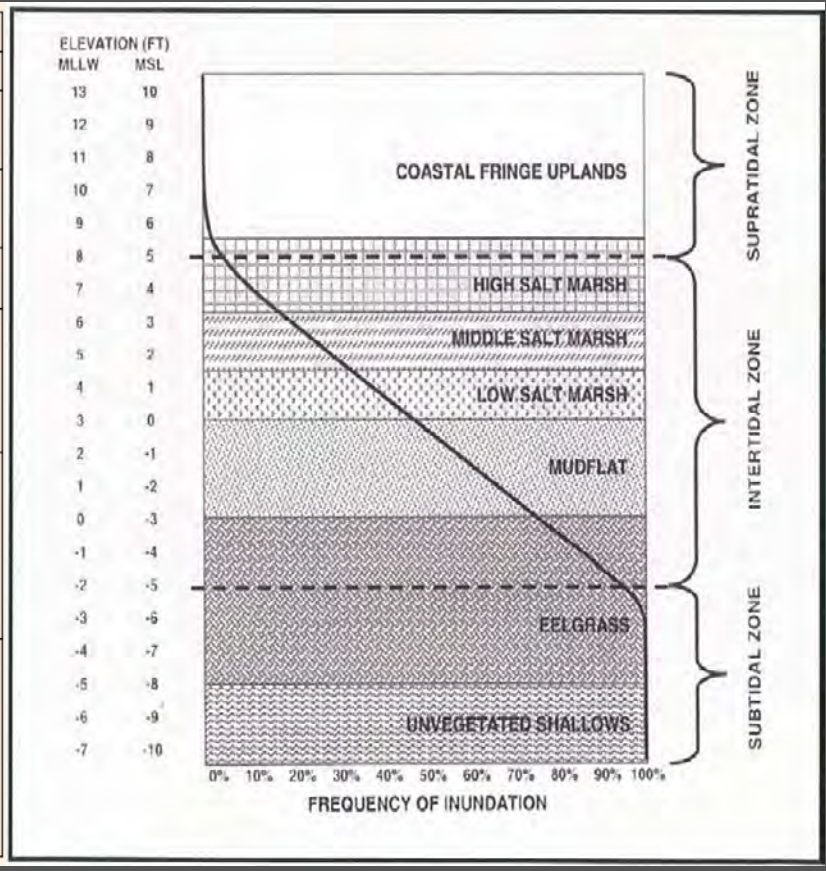
Salt Marsh Habitat Ranges

Target Habitat	NGVD (feet)[1]	MLLW (feet)[1]	Associated Floral Species
Subtidal	below -1	below +1.29	eelgrass (*Zostera marina*) or non-vegetated
Frequently Flooded Mudflat	-1 to +0.9	+1.29 to +2.28	non-vegetated
Frequently Exposed Mudflat	+0.9 to +1.3	+2.28 to +3.59	non-vegetated
Low Marsh	+1.3 to +2.2	+3.59 to +4.49	California cordgrass (*Spartina foliosa*) or non-vegetated
Mid Marsh	+2.2 to +3.8	+4.49 to +6.09	dwarf saltwort (*Salicornia bigelovii*), Pacific swampfire (*Salicornia virginica*), *marsh jaumea* (*Jaumea carnosa*), *turtleweed* (*Batis maritima*), and Parish's glasswort (*Arthrocnemum subterminale*)
High Marsh	+3.8 to +4.5	+6.09 to +6.79	Pacific swampfire, Parish's glasswort, shoregrass (*Monanthochloe littoralis*), *saltgrass* (*Distichlis spicata*), alkali heath (*Frankenia salina*), western marsh-rosemary (*Limonium californicum*), and woolly sea-blite (*Suaeda taxifolia*)
Upland Transition	above +4.5	above +6.79	California buckwheat (*Eriogonum fasciculatum*), western ragweed (*Ambrosia psilostachya*), coast goldenbush (*Isocoma menziesii*), coyote brush (*Baccharis pilularus*), bladderpod (*Cleome isomeris*), coast sunflower (*Encelia californica*), deerweed (*Lotus scoparius*), and arrow weed (*Pluchea sericea*)



Sources: Southern California Edison 2005 (San Dieguito Wetlands Restoration Project, Final Restoration Plan, November); Zedler 1977

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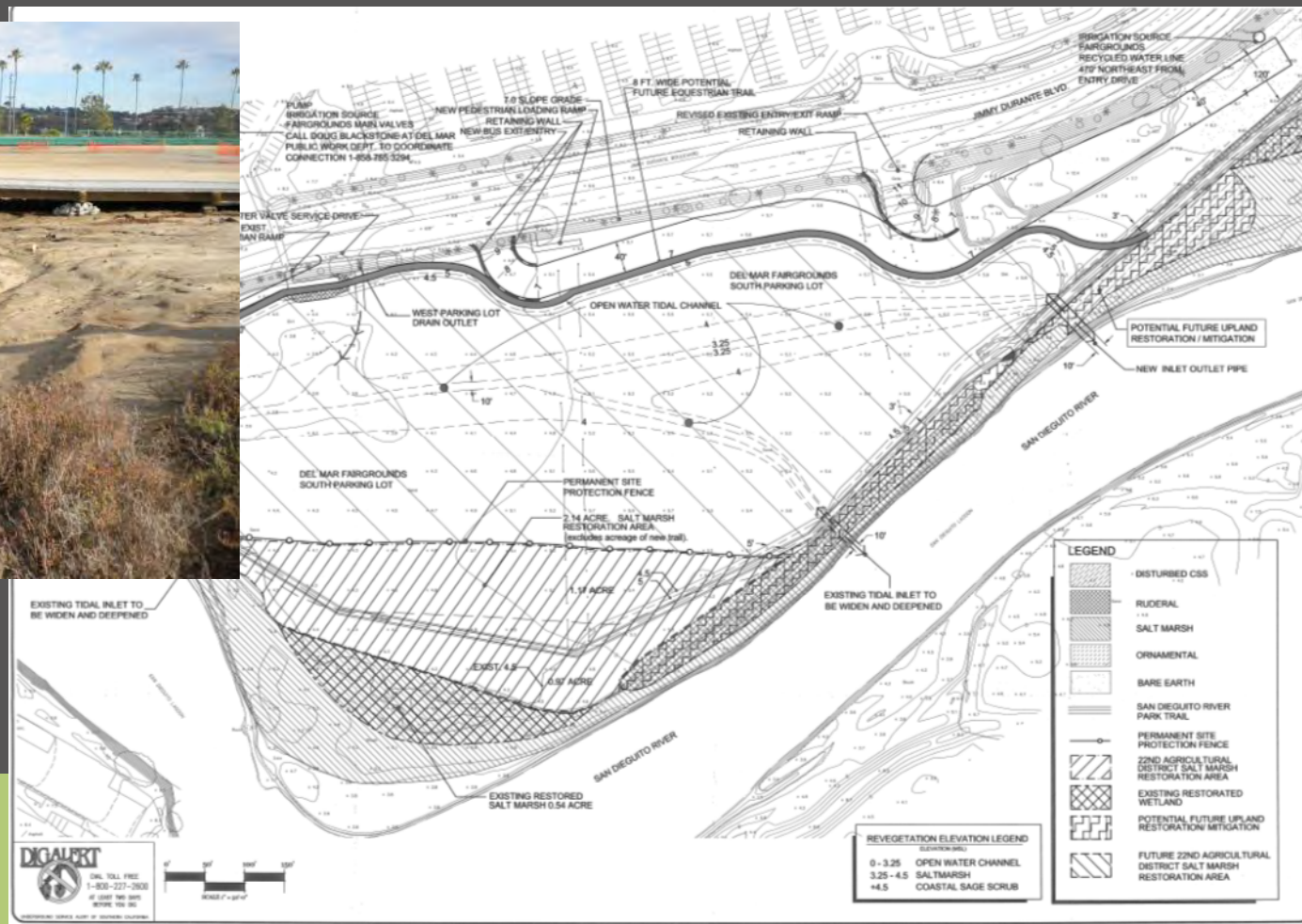
Salt Marsh Restoration Planning

- Topography file and Current Plan review
- Datum analysis
- Local restoration plan examples – San Dieguito Lagoon
- Site visit and ground-truthing



Salt Marsh Restoration Planning: Too High

- Incorrectly Assume Elevation Datum is MLLW
- Use Vegetation Ranges Associated with MLLW to Design Grading Plan
- Grade 2.29’ High Leaving Project “High and Dry”

	Mean Low Water	Mean Tide Level	Mean Higher High Water
MLLW	+0.9	+2.75	+5.33
NGVD	-1.39	+0.46	+3.04

Note Water from the San Dieguito River Enters Only at High Tides

Note Large Portion of Upland Habitat, Lack of High Marsh and Mudflat, and Complete Lack of Subtidal Habitat

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Salt Marsh Restoration Planning: Too Low

- Incorrectly Assume Elevation Datum is NGVD
- Use Vegetation Ranges Associated with NGVD to Design Grading Plan
- Grade 2.29’ Low Leaving Project “Under Water”

	Mean Low Water	Mean Tide Level	Mean Higher High Water
MLLW	+0.9	+2.75	+5.33
NGVD	-1.39	+0.46	+3.04

Note Increased Risk of Flooding Adjacent Parking Lot

Note large amount of Lower Elevation (Wetter) Habitats and Loss of Mid/High Marsh

Salt Marsh Restoration Plan: Just Right

- Project Success = Proper Tidal Hydrology + Mix of Salt Marsh Communities
- Must Know Correct Elevation Datum Used in Survey and Corresponding Habitat Elevation Ranges
- Not Using the Same Elevation Datum for Grading and Habitat Planning Can Result in Project Failure

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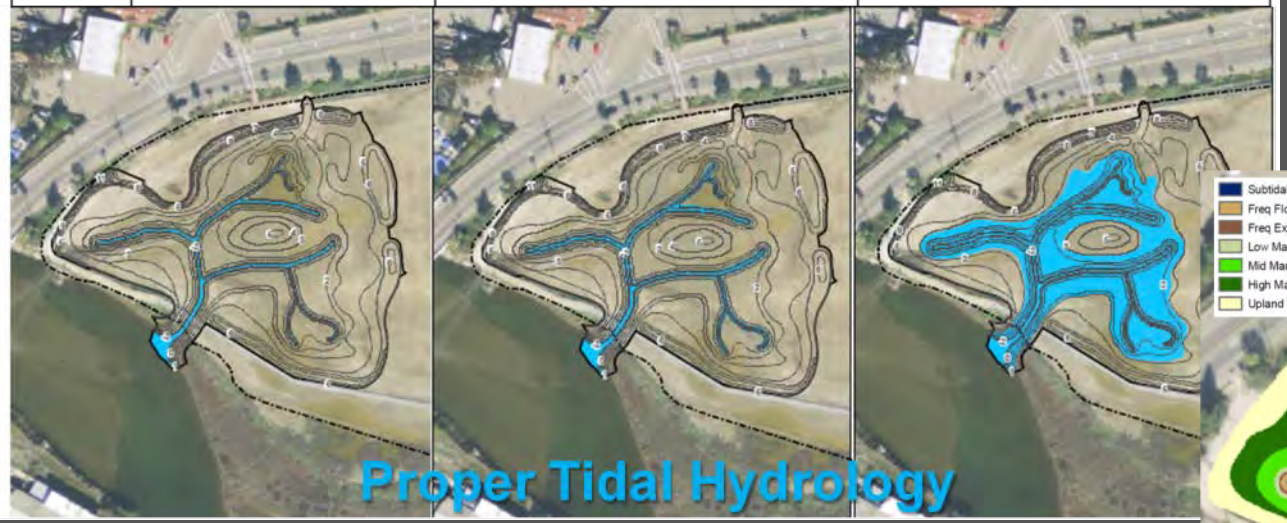
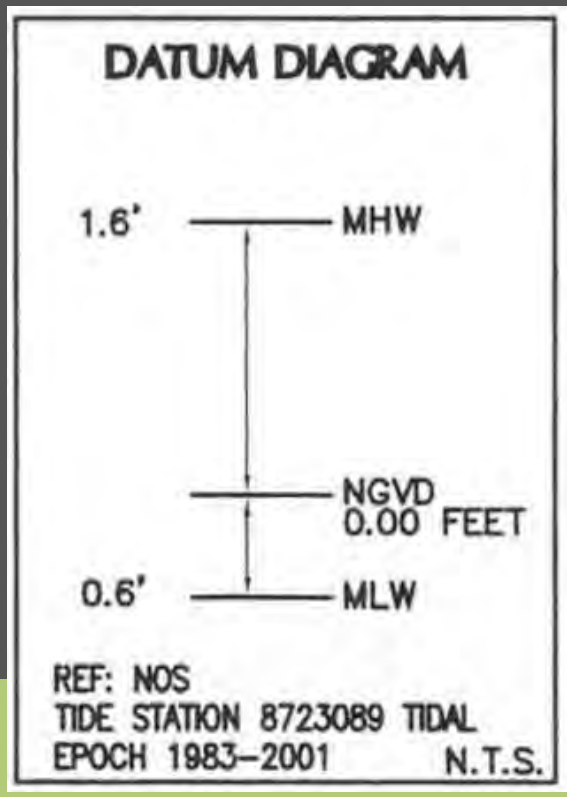


Solutions and Best Practices

- Check that horizontal and vertical datums are listed on topographic survey. If not available, or outdated, a new survey is needed.
- Request that the surveyor display the difference between the datums on the survey map (as shown below).
- Ground-truth survey data with a field visit, prior to design.
- Know your results/expectations!



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Questions?