



**US Army Corps  
of Engineers** ®  
New Orleans District

# Engineering Documentation Report

## **EDR-OD-03**

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### **Mississippi River, South Pass, Head of Passes to the Gulf of Mexico**

#### **MLG to MLLW Vertical Datum Conversion**

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## **LIST OF ACRONYMS**

BHP: Mileage “Below Head of Passes” on Mississippi River

CEPD: Comprehensive Evaluation of Project Datums

CO-OPS: Center for Operational Oceanographic Products and Services

DM 10: Daymark 10 channel marker

EDR: Engineering Documentation Report

HQ-USACE: United States Army Corps of Engineers Headquarters Office

HOP: Mississippi River Head of Passes

MLG: Mean Low Gulf datum

MLLW: Mean Lower Low Water datum

MVN: Mississippi Valley Division, New Orleans District

NAVD 88: North American Vertical Datum of 1988

NGS: National Geodetic Survey

NOAA: National Oceanic and Atmospheric Administration

OPUS: Online Positioning User Service

RM: River Mile

SWP: Mississippi River, Southwest Pass

USACE: United States Army Corps of Engineers

USCG: United States Coast Guard

# 1 Introduction

The U.S. Army Corps of Engineers (USACE), New Orleans District is converting the vertical datum for all coastal navigation projects from the legacy Mean Low Gulf (MLG) terrestrial datum to the Mean Lower Low Water (MLLW) tidal datum in accordance with a 2014 USACE, memorandum from HQUSACE. This memorandum defines policy for federal navigation projects where the decision documents supporting project authorization and the project authorization in law do not reference the MLLW tidal datum.

According to the Memorandum “Navigation Projects Compliance with Vertical Datum Guidance” dated 24 October 2014:

“For federal navigation projects where the MLLW depth differs from the depths stated in the project authorization, an Engineering Documentation Report (EDR) shall be prepared in accordance with reference 1.d, paragraph 8.3 for each project and posted on a navigation home page for each district. The EDR will be of limited scope to document the datum change only.”

The Mississippi River, Gulf to Baton Rouge, Louisiana Project is authorized to (-)30 ft MLG and 450 ft width for South Pass, and (-)30 ft MLG and 600 ft width for South Pass Bar Channel. Currently, South Pass including the bar channel is maintained to (-)17.0 ft MLG.

This report documents the conversion from the legacy, unmaintained MLG datum to the National Oceanic and Atmospheric Administration (NOAA) maintained MLLW tidal datum for South Pass from the Head of Passes (HOP) to the end of the South Pass Bar Channel. This report provides details on how this relationship was determined and will be applied.

A brief description of the primary datums referenced in this report are:

- The North American Vertical Datum of 1988 (NAVD 88) is a geodetic datum that is defined and maintained by the National Geodetic Survey (NGS). This datum is typically used for surveying (in addition to design and construction) and can be related to other datums as needed, to ensure project datums are referenced as required.
- Mean Lower Low Water (MLLW) is a tidal datum that is defined and maintained by the NOAA. This tidal datum is defined as the average of the lowest of the two daily low water heights observed over the National Tidal Datum Epoch (which spans a 19-year period).
- Mean Low Gulf (MLG) is a local, legacy terrestrial datum that was originally defined relative to local mean sea level as observed in 1899 at a Biloxi, MS gage in the Gulf of Mexico. It has been used as a navigation (and construction)

reference datum in coastal waterways such as the Gulf Intracoastal Waterway (GIWW) and the coastal portion of the Mississippi River navigation channel (Reference 2).

## **2 Project Summary**

Numerous federal navigation projects for the construction, operation, and maintenance of multiple sections of the Mississippi River from Baton Rouge to New Orleans, at Southwest Pass, and at South Pass (collectively “existing projects”) were authorized in portions of the River and Harbor Act of 1875; River and Harbor Act of 1908; River and Harbor Act of 1925; and the River and Harbor Act of 1937. In 1939, a Report of the Chief of Engineers dated 25 February 1939 recommended to Congress that the existing projects: Mississippi River, Baton Rouge to New Orleans; the Mississippi River, Southwest Pass and the Mississippi River, South Pass, be modified and combined and that a project covering the Mississippi River from New Orleans to the Head of Passes be added thereto, to provide for a single project “Mississippi River, Baton Rouge to the Gulf of Mexico.”

In addition, the report recommended the deepening of specific river channels using the MLG datum to specify the channel dimensions. Thereafter, the River and Harbor Act of 1945 authorized the subject “Mississippi River, Baton Rouge to the Gulf of Mexico” Project as provided in the 25 February 1939 Chief’s Report (House Document Numbered 215, Seventy-Sixth Congress.)

South Pass, including the South Pass bar channel, extends from the Mississippi River, HOP at River Mile (RM) 0.0 to RM 14.5 Below Head of Passes (BHP). South Pass channel maintenance ends at USCG Lighted Buoy No. 3 located at the end of the bar channel.

### 3 Vertical Datum Conversion Process

The datum relationships provided in this report bring the “Mississippi River Ship Channel, Gulf to Baton Rouge” project into compliance with the requirements outlined in ER 1110-2-8160, Policies for Referencing Project Elevation Grades to Nationwide Vertical Datums, and EM 1110-2-6056, Standards and Procedures for Referencing Project Elevation Grades to Nationwide Vertical Datums. These policy documents define the requirement for referencing datums on coastal navigation projects. The following EM excerpt addresses the requirement to establish the relationship to MLLW for projects that are defined to a legacy datum, such as MLG (page 4-2):

*“USACE projects that are still defined relative to non-standard or undefined legacy datums (e.g., MLG, Gulf Mean Tide, MSL, NGVD, MLW, COEMLW, etc.) should have technically valid transforms to the NOAA MLLW chart/tidal datum for the area. In isolated cases, the legacy datum may be retained as the reference grade provided its relationship to NOAA MLLW datum is accurately defined based on current gage data at the project site. In such projects, depth data furnished to NOAA and other project users must indicate the primary reference gage, along with the tidal datum epoch period and the relationship between the legacy datum, NOAA MLLW, and NAVD 88. Legacy “Low Water” datums must be periodically updated for sea level change and regional subsidence using similar computational techniques established by NOAA for coastal waters.” (Reference 8)*

The datum relationship between MLG, MLLW, and NAVD 88 was defined in accordance with EM 1110-2-6056. This datum relationship was used to determine an MLG-MLLW conversion value. See Section 4 for the relationship and conversion value.

#### 3.1 Project Datum

The River and Harbor Act of 1945 authorized the Project, as provided in the 25 February 1939 Report of the Chief of Engineers (House Document Numbered 215, Seventy-Sixth Congress) referenced MLG as the project datum for the multiple channels within the project area, including the channel from New Orleans to the Gulf. As discussed in EM-1110-2-6056 (Reference 8), most USACE civil projects are, in effect, reference to a local vertical datum. Many local datums are based on arbitrary, unknown, or perhaps archaic origins. Most hydraulic-based river datums and MSL/MLLW tidal datums are local datums when they are not properly modeled or kept updated. Mean Low Gulf was intended to represent the low water level of the Gulf of Mexico and was defined in 1944 by New Orleans District Memorandum as being 0.78 ft below local mean sea level. At that time, mean sea level (MSL) was defined by the Sea Level Datum of 1929 (SLD 29). SLD29 was created by the US Coast and Geodetic Survey (USC&GS) as the datum to adjust all vertical control to North America. SLD 29 was believed to be a MSL datum, although MSL was not the same at each gage. Mean sea level was not developed using the same epoch or period of record at each of the gages. Each gage was, in effect, a “local mean sea level” reference datum.



However, over time, with sea level rise and other factors, SLD 29 was no longer considered a MSL datum. In 1973, the name of SLD 29 was changed to the National Geodetic Vertical Datum of 1929 (NGVD 29) because it no longer represented sea level (Reference 7). However, the assumed equivalency of NGVD 29 to MSL was predominant in both government and academic texts published well after the 1973 redefinition and MLG for this project continued to be locally interpreted as 0.78 ft below NGVD 29. The MLG datum thus became disassociated from sea level.

The relationship between reference datums is often complex given they can deviate spatially over a region, due to a variety of reasons. The relationships may also have temporal deviations due to land subsidence or uplift, sea level changes, project reconstruction, periodic readjustments to the datum origin, or to redefined points on the reference surface. This is particularly true for this project due to the magnitude of subsidence in the region. Throughout the life of the gages, periodic updates have established adjustment values for these reasons. The MVN Survey Section's Stream Gaging Unit (SGU) has maintained a gage at HOP which was referenced to MSL and MLG respectively and reset to NAVD 88 (2004.65) in 2008. This gage was updated to NAVD 88 (2009.55) in 2014. The SGU has maintained a gage at Port Eads which was referenced to MSL and MLG respectively and presumably destroyed by Hurricane Katrina in 2005. The gage was reset to NAVD 88 (OPUS) in 2011. This gage was updated to NAVD 88 (2009.55) in 2014.

### 3.2 Methodology for Establishing Conversion Value

The CEPD Final Report, dated July 2015, defined a MLLW-MLG calibration value of 3.5 ft for the Southwest Pass (SWP). EDR-OD-01, November 2016, defined the NAVD 88 (2009.55/OPUS), MLLW (2007-2011) and MLG relationships for the SWP gages including the HOP Gage (01545). The relationship values were based on the then-current NAVD 88 (2009.55)-MLLW (2007-2011) relationship and the 3.5 ft MLLW-MLG calibration value. Datum relationships for the HOP Gage were updated in May 2020 based on MLLW (2012-2016).

In 2021, MLLW (2012-2016) was calculated at the Port Eads Gage (01850) using the Monthly Mean Simultaneous Comparison method. This method uses the *Tidal Analysis Datum Calculator* developed by NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) in which local gage readings over a period of time are compared to gage readings at a control station where tidal ranges are known.

Using the *Tidal Analysis Datum Calculator*, a MLLW value was calculated for Port Eads based on comparison to the NOAA Grand Isle Station (Station 8761724). The comparison was based on gage readings at Port Eads taken at a one-hour interval for two years from September 2017 to August 2019.

Datum analysis of the calculated MLLW (2012-2016) and the legacy MLG value at Port Eads determined that the MLLW-MLG calibration value of 3.5 ft used at HOP was also valid at Port Eads.

MLLW, and subsequently MLG, is determined to be a constant slope from HOP to Port Eads, resulting in an interpolated value for MLLW at the Daymark 10 (DM 10) Gage (01840) located at RM 5.9 BHP. Further analysis determined that the MLLW value and the dependent MLG value would be held as constant (level) from Port Eads to the end of the South Pass Bar Channel at RM 14.5 BHP. See Map 1 for the relative locations of the South Pass gages.

The MLLW and NAVD 88 datum relationships have been and will continue to be periodically updated to incorporate future sea level rise and local subsidence, as well as other factors that may affect these datums (i.e., geoid models, epoch updates).

Of note, these periodic updates will not change the MLG to MLLW conversion value. This value will remain constant, which will allow dredging templates to rise over time along with MLLW (due to sea level rise).



<p><b>Legend</b></p> <ul style="list-style-type: none"> <li>Gages</li> <li>South Pass</li> </ul>	<p><b>Location Map</b></p>	<p>U.S. ARMY CORPS OF ENGINEERS NEW ORLEANS DISTRICT</p>	
<p><b>SOUTH PASS GAGES FROM HEAD OF PASSES TO THE GULF OF MEXICO</b></p> <p>Updated On 07/02/2021</p>			

EGIS Map ID No. EGIS -21-

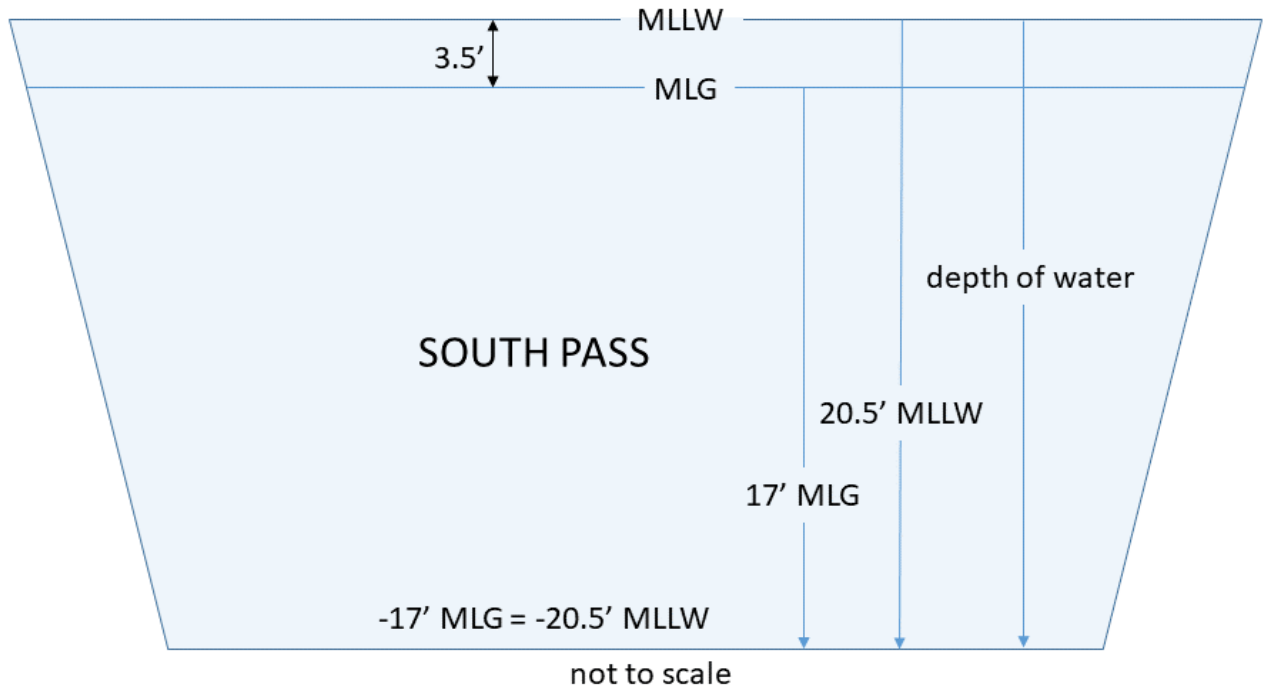
**MAP 1- South Pass Gages from Head of Passes to the Gulf of Mexico**

## 4 Datum Conversion

This section reports the actual conversion from MLG to MLLW for South Pass. The MLG to MLLW conversion value has been defined as:

$$0.0 \text{ ft MLLW} = 3.5 \text{ ft MLG}$$

**FIGURE 1**  
**Datum Conversion Definition Sketch**



This conversion value of 3.5 feet will be used to define MLG for this area, by directly referencing MLLW and add 3.5 feet to determine MLG. This conversion value has been determined by referencing the Modified National Tidal Datum Epoch of 2012-2016 and will be held with future updates to MLLW. This conversion value is discussed further in Section 3.2 of this report and in EDR-OD-01, Revision 2.

## 4.1 Datum Offsets for South Pass Gages

Table 1 provides the datum offsets at the gages that are currently used by USACE New Orleans District, Operations Division to maintain South Pass. In 2014, both the HOP and Port Eads gages were set to NAVD 88 (2009.55), and in 2021, the Gage 01840 was established on the local daymark, DM 10 and set to NAVD 88 (2009.55). Measurements from HOP and Port Eads in June 2018 show changes in the gage relationships to NAVD 88 (2009.55), which are shown below.

**TABLE 1-** Datum Offsets Relative to NAVD88 (2009.55)

Datum Offsets to NAVD 88 (2009.55)					
Gage ID	Gage Name	NAVD 88 (2009.55)	Gage Datum	MLLW (2012-2016)	MLG
01545	Mississippi River at Head of Passes	0.00'	0.15'	-0.32'	3.18'
01840	South Pass at DM 10	0.00'	0.00'	0.00'	3.50'
01850	South Pass at Port Eads	0.00'	0.34'	0.34'	3.84'

**NOTE:** MLLW is referenced to the 2012-2016 modified tidal datum epoch.  
NAVD 88 is referenced to 2009.55 epoch and the values determined using GEOID 12B.

**TABLE 2-** Datum Offsets Relative to Gage Datum

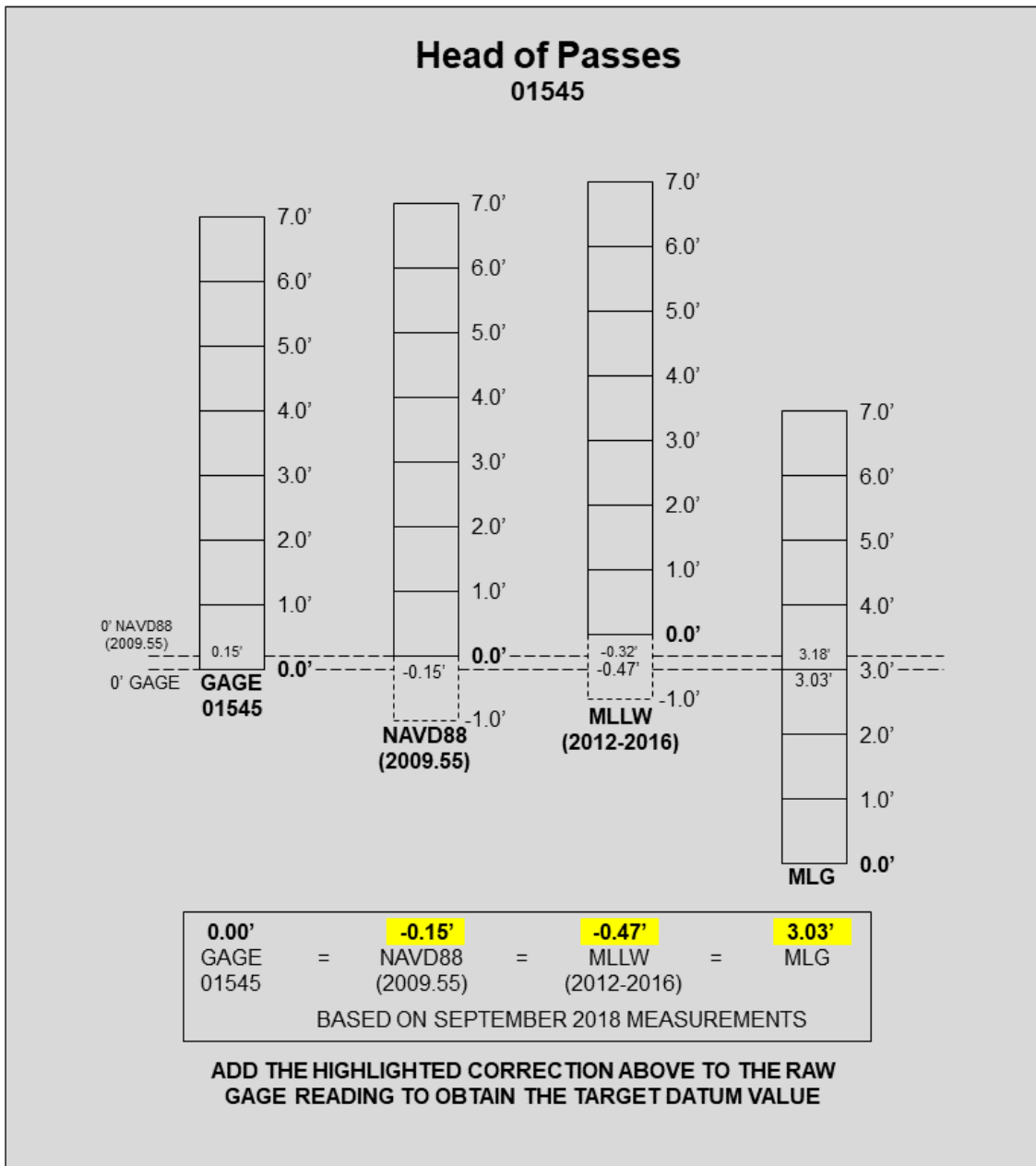
Datum Offsets to Gage Datum					
Gage ID	Gage Name	Gage Datum	NAVD 88 (2009.55)	MLLW (2012-2016)	MLG
01545	Mississippi River at Head of Passes	0.00'	- 0.15'	- 0.47'	3.03'
01840	South Pass at DM 10	0.00'	0.00'	0.00'	3.50'
01850	South Pass at Port Eads	0.00'	- 0.34'	0.00'	3.50'

**NOTE:** MLLW is referenced to the 2012-2016 modified tidal datum epoch.  
NAVD 88 is referenced to 2009.55 epoch and the values determined using GEOID 12B.

## 4.2 Datum Offsets for Gage 01545

Figure 2 shows the datum relationships that were determined for USACE Gage 01545 via the Southwest Pass Engineering Documentation Report, Revision 2 (EDR-OD-01). The NAVD 88 - MLG and NAVD 88 - MLLW relationships are valid as of 30 September 2018.

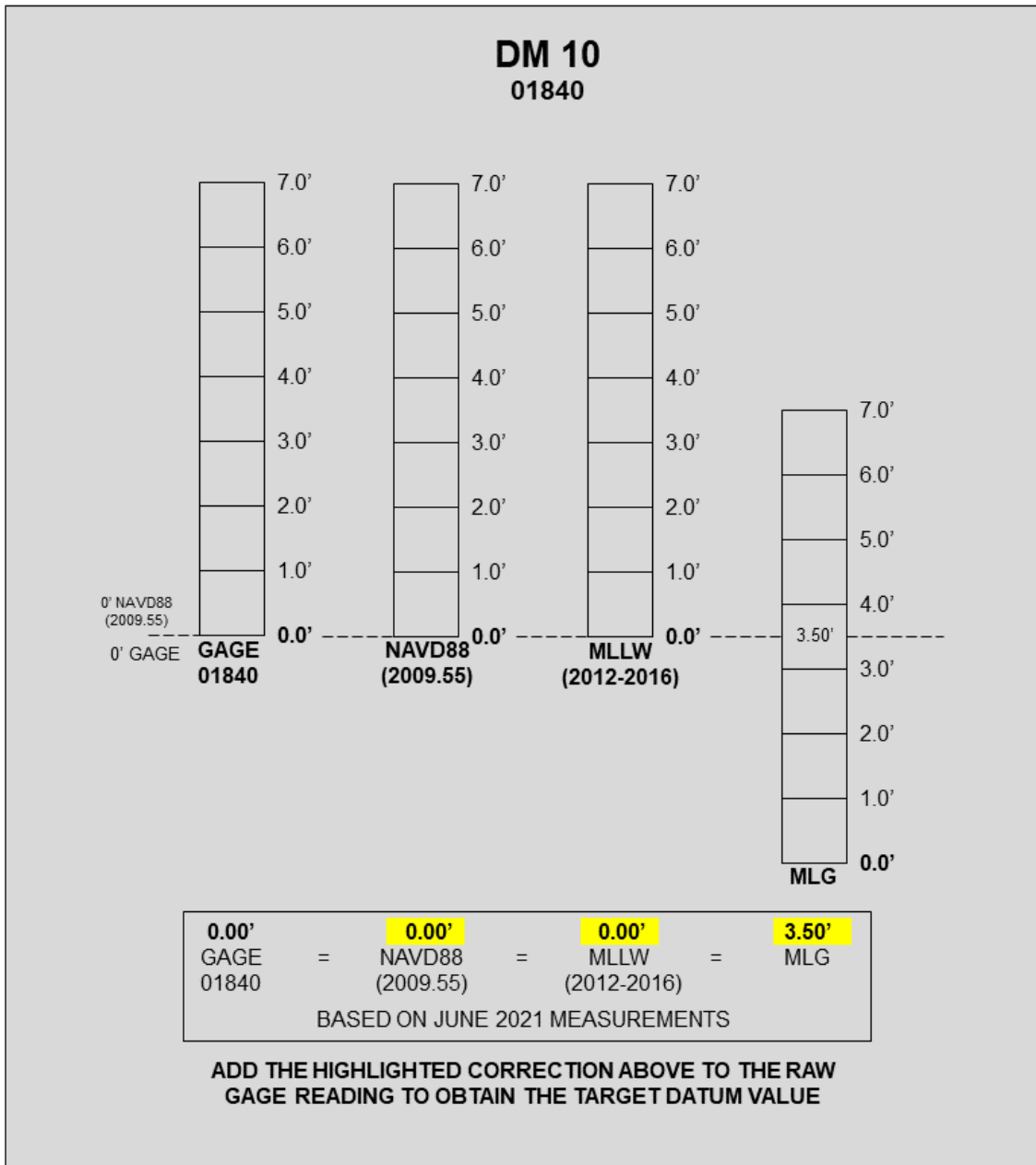
**FIGURE 2**  
**Datum Offsets for USACE Gage 01545**



### 4.3 Datum Offsets for Gage 01840

Figure 3 shows the datum relationships that were determined for USACE gage 01840. The NAVD 88 - MLG and NAVD 88 - MLLW relationships are valid as of June 2021.

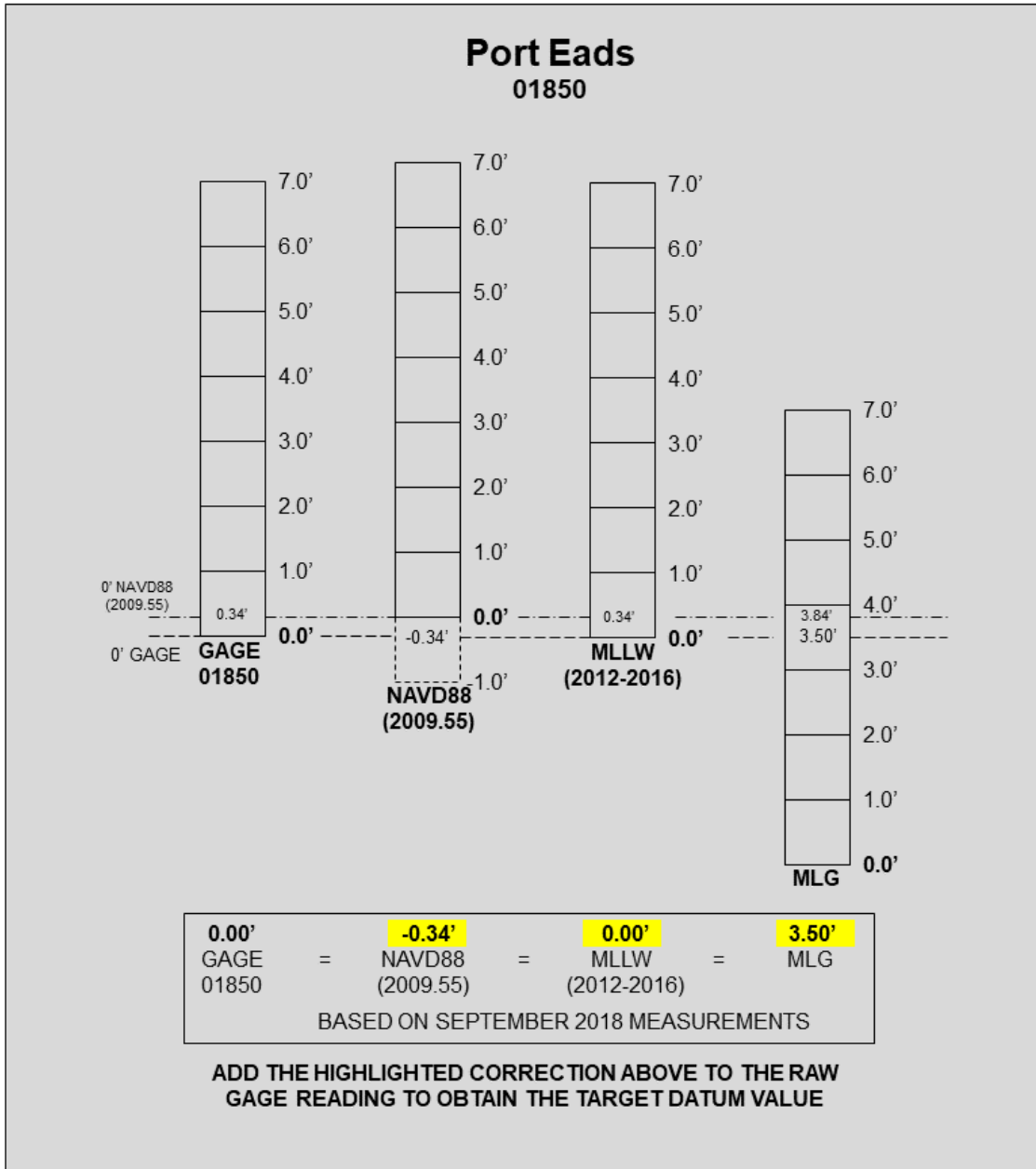
**FIGURE 3**  
**Datum Offsets for USACE Gage 01840**



#### 4.4 Datum Offsets for Gage 01850

Figure 4 shows the datum relationships that were determined for USACE gage 01850. The NAVD 88 - MLG and NAVD 88 - MLLW relationships are valid as of 30 September 2018.

**FIGURE 4**  
**Datum Offsets for USACE Gage 01850**

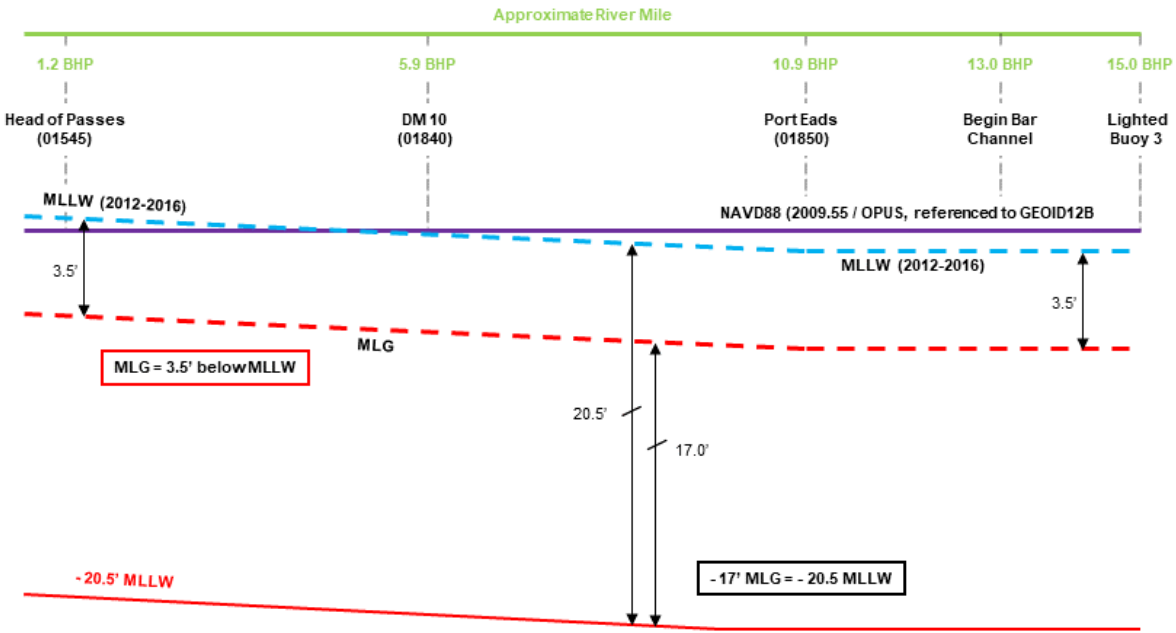




#### 4.5 Datum Offset Chart

The following chart (Figure 5) shows the MLG/MLLW/NAVD datum offsets for South Pass gages from HOP to the Gulf of Mexico.

**FIGURE 5**  
**Datum Offset Chart**



Due to regional subsidence and global sea-level rise, the elevations of the referenced benchmarks and the tidal datum values at the referenced gages (as well as the datum relationships) are time dependent and subject to change. Therefore, the information contained in this report shall be updated on a regular basis and/or as new information becomes available.

## **5 Future updates to MLLW-NAVD 88**

The MLLW-NAVD 88 datum offsets defined in this report are time dependent and will have to be regularly verified/updated. The EM 1110-2-6065 indicates that the periodic reassessments of controlling elevations and datum relationships should be performed at least every five years.

These reassessments will not change the MLLW-MLG conversion value; only changing the MLLW-NAVD 88 relationships that will be used to define MLLW for the South Pass navigation channel from the HOP to the end of the South Pass Bar Channel at RM 14.5 BHP.

It is anticipated that in 2023, NOAA will publish an updated National Tidal Datum Epoch for the period of observations from 2017 to 2021, which will require an update of the South Pass MLLW-NAVD 88 relationship and a corresponding update of the relationship to MLG.

## **6 Summary**

This conversion value is considered absolute and documents current practices. It will not be redefined for South Pass. However, the relationship between MLLW and NAVD 88 will need to be periodically updated to incorporate the future sea level rise and local subsidence.

Dredging design templates and other associated documents shall be updated to directly reference and utilize MLLW depths, and the relationship to MLG shall be included as a note. Providing the MLG relationship will allow users to relate these project documents back to authorization language as needed.

## REFERENCES

1. Comprehensive Evaluation of Project Datums (CEPD) Final Report – Appendix 1, Mississippi River Ship Channel, Gulf to Baton Rouge. Date: 18 December 2013. Updated: 10 July 2015.
2. Mississippi River Baton Rouge to the Gulf of Mexico, Planning Report, New Orleans, Louisiana, District Office, Corps of Engineers, Department of the Army, January 1954, January 1955, and January 1956.
3. River & Harbors Act March 1915, Chapter 142, Section 5. 1644 Laws Relating to Improvement of Rivers and Harbors.
4. Report of the Chief of Engineers U. S. Army 1939, Part I, Volume I, House Document No.488, Part I, 76<sup>th</sup> Congress, 2<sup>nd</sup> Session.
5. USACE, 1999. ER 1110-2-1150: Engineering and Design for Civil Work Projects, 31 August 1999.
6. USACE, 2007. EC 1110-2-6065: Engineering and Design, Comprehensive Evaluation of Project Datums, Guidance for a Comprehensive Evaluation of Vertical Datums on Flood Control, Shore Protection, Hurricane Protection, and Navigation Projects, 1 July 2007.
7. USACE, 2009. EC 1110-2-6070: Engineering and Design, Comprehensive Evaluation of Project Datums, Guidance for a Comprehensive Evaluation of Vertical Datums on Flood Control, Shore Protection, Hurricane Protection, and Navigation Projects, 1 July 2009.
8. USACE, 2010. EM 1110-2-6056: Engineering and Design, Standards and Procedures for Referencing Project Elevation Grades to Nationwide Vertical Datums, 31 December 2010.
9. USACE, 2014. Navigation Project Compliance with Vertical Datum Guidance. Memorandum from HQ USACE. Dated 24 October 2014.
10. ER 1110-2-8160, Policies for Referencing Project Elevation Grades to Nationwide Vertical Datums
11. Tidal Analysis Datum Calculator developed by NOAA's Center for Operational Oceanographic Products and Services (CO-OPS).  
<https://access.co-ops.nos.noaa.gov/datumcalc/>
12. NOAA, 2014. NOAA Technical Report NOS CO-OPS 068, Implementation of Procedures for Computation of Tidal Datums in Areas with Anomalous Trends in Relative Mean Sea Level

13. South Pass Engineering Documentation Report (EDR-OD-01), Revision 2,  
26 February 2021

All related supporting documentation may be found in the MVN ProjectWise server at:

pw:\\PWINT-CPC.EIS.DS.USACE.ARMY.MIL:CEMVN01\Documents\Civil  
Works\MRBRTOG - Mississippi River - Baton Rouge to the Gulf of Mexico\South  
Pass\Engineering Documentation Report\