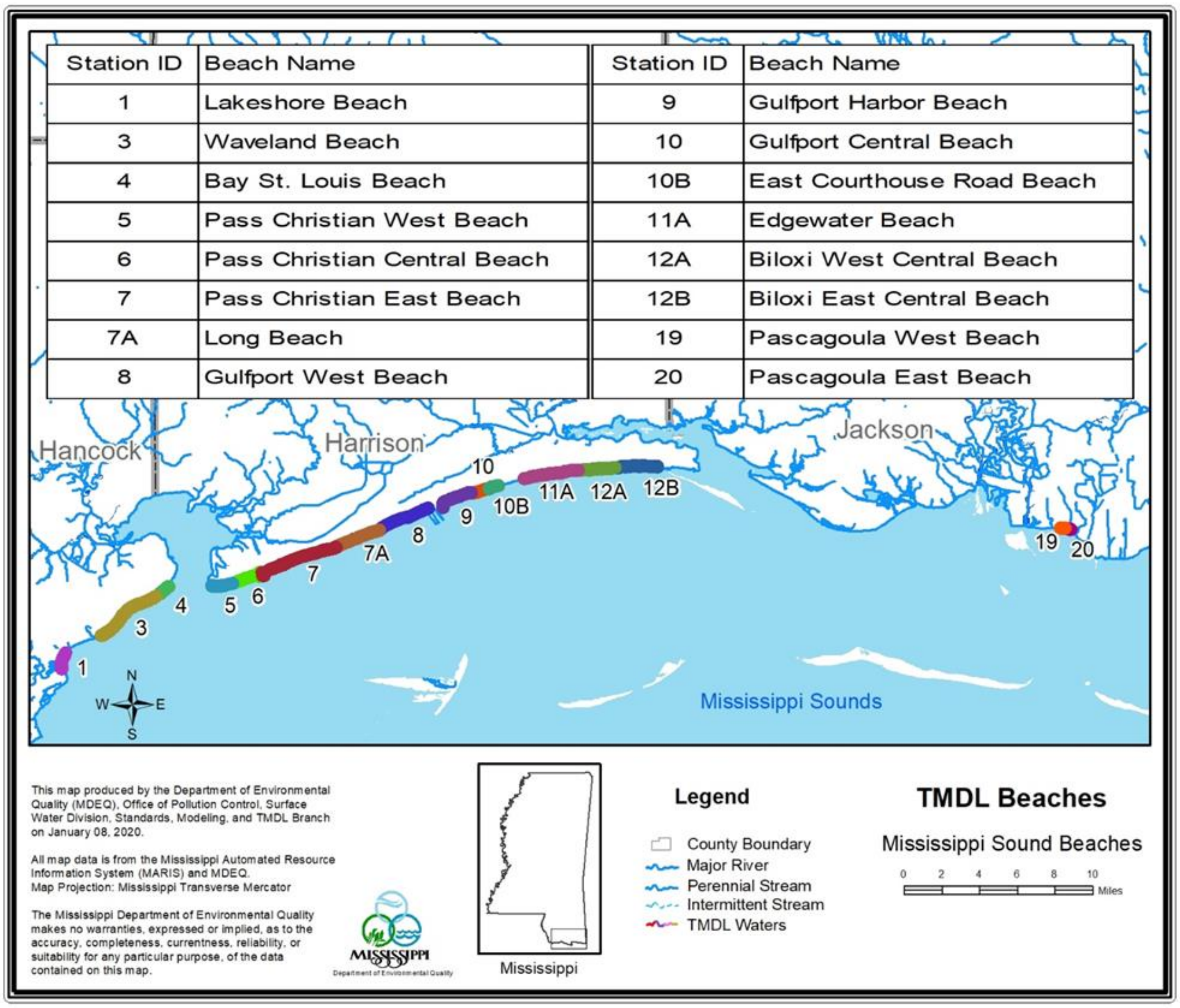
Enterococci Bacteria TMDL for Mississippi Beaches

Coastal Streams Basin
Hancock, Harrison, and Jackson Counties, Mississippi

MDEQ

TMDL FACT SHEET

This enterococci bacteria TMDL has been developed for 16 Mississippi Beach segments. These water bodies are routinely assessed as part of the Mississippi Beach Monitoring Program. Due to complexities associated with large scale open water boundaries, tidal influences, and variable storm water runoff, MDEQ applied a mass balance approach to develop the bacteria counts for these beaches. The TMDL was based on the estimated volume of water at 100 meters from the shoreline and the water quality criteria. An explicit 10% margin of safety (MOS) was used in the mass balance method to account for uncertainty. The estimated reduction recommended for the beaches range from 2% to 65%. This TMDL may be revised in the future as dynamic models of the area and additional data become available.



Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Enterococci Bacteria	Recreation	Geometric mean of 35 colony forming units (cfu) /100 ml. for enterococci bacteria in marine coastal recreation waters

Beach TMDL Information

Name	Waterbody ID	County	WLA/LA	TMDL	% Reduction
Lakeshore Beach	250114	Hancock	8.96E+10	Pathogens	23% to 63%
Location: From Silver Slipper Casino to Pointset Avenue.					
Waveland Beach	250112	Hancock	2.41E+11	Pathogens	9% to 53%
Location: From Oak Street to Favre Steet.					
Bay St. Louis Beach	250111	Hancock	5.30E+10	Pathogens	31% to 49%
Location: From Washington Street to the Culvert just north of Ramaneda Street.					
Pass Christian West Beach	250214	Harrison	3.96E+10	Pathogens	9% to 64%
Location: From Fort Henry Avenue to Elliott Street.					
Pass Christian Central Beach	250215	Harrison	1.44E+11	Pathogens	8% to 34%
Location: From Henderson Avenue to Hiern Avenue.					
Pass Christian East Beach	250211	Harrison	2.36E+11	Pathogens	15% to 63%
Location: From Espy Avenue to Hayden Street.					
Long Beach Beach	250213	Harrison	1.29E+11	Pathogens	18% to 54%
Location: From Oak Gardens Avenue to Girard Avenue.					
Gulfport West Beach	250212	Harrison	1.39E+11	Pathogens	13% to 58%
Location: From Marie Avenue to Camp Avenue.					
Gulfport Harbor Beach	250311	Harrison	1.35E+11	Pathogens	32% to 55%
Location: From 15th Street to Thornton Avenue.					
Gulfport Central Beach	250312	Harrison	4.83E+11	Pathogens	3% to 65%
Location: From Alfonso Drive to VA Main Entrance.					
East Courthouse Road Beach	250315	Harrison	7.77E+10	Pathogens	2% to 57%
Location: From VA Main Entrance to Courthouse Road.					
Edgewater Beach	250316	Hancock	1.83E+11	Pathogens	2% to 61%
Location: From Debuys Road to Edgewater Drive.					
Biloxi West Central Beach	250314	Harrison	1.32E+11	Pathogens	8% to 59%
Location: From Travia Street to I'Berville Drive.					
Biloxi East Central Beach	250317	Harrison	2.15E+11	Pathogens	31% to 64%
Location: From St Peter Street to Dukate Street.					
Pascagoula West Beach	250511	Jackson	6.87E+10	Pathogens	29% to 58%
Location: From Westwood Street to Grand Oaks.					
Pascagoula East Beach	250512	Jackson	1.04E+11	Pathogens	22% to 52%
Location: From Oliver Street to Westwood Street.					

TABLE OF CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

This enterococci bacteria Total maximum daily load (TMDL) has been developed for sixteen Mississippi Beach segments. These water bodies are routinely assessed as part of the Mississippi Beach Monitoring Program.

The Mississippi Department of Environmental Quality (MDEQ) implemented an intensive beach water quality monitoring and public notification program in 1998 through its inter-agency Beach Monitoring Task Force. Twenty-one beaches are monitored for enterococci along with several chemical parameters. If bacteria levels reach action levels, advisories are placed on the beach stating that swimming is not recommended until bacterial levels returned to safe levels. The advisories remain in place until the monitoring data indicate that the water is safe for swimming and water contact. In addition to signage, MDEQ provides public notification of beach water quality conditions through press releases as well as posting near real time information on the state's Beach Monitoring Website.

Due to complexities associated with large scale open water boundaries, tidal influences, and variable storm water runoff, MDEQ applied a mass balance approach to develop the bacteria counts for these beaches. This TMDL may be revised in the future as dynamic models of the area become available and/or additional data becomes available. Although loadings from point and nonpoint sources were not explicitly represented with a model, a source assessment was conducted. Nonpoint sources of enterococci include urban wildlife (birds) and storm water runoff. Also considered were the nonpoint sources such as failing septic systems and other direct inputs to the beach. The entire area is subject to the Mississippi Municipal Separate Storm Sewer System (MS4) General NPDES Permit. Under the MS4 permit, the storm water culverts are considered point sources. However, it is difficult to discern between point and nonpoint source allocations for the beaches. Therefore, to meet the requirements of an approvable TMDL, the Waste Load Allocation (WLA) and Load Allocation (LA) are assumed to be equal.

The seasonal and tidal variations in hydrology, climatic conditions, and watershed activities could not be represented with a mass balance approach. The TMDL was based on the estimated volume of water at 100 meters from the shoreline and the water quality criteria. An explicit 10% margin of safety (MOS) was used in the mass balance method to account for uncertainty.

Water quality data indicate exceedences of the enterococci standard in the water body. The estimated reduction recommended for the beaches range from 2% to 65%. This TMDL report recommends implementation of Best Management Practices and reengineering the storm water culverts currently discharging into the swimming waters on Mississippi's beaches to move the storm water away from the primary contact areas.

INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of the subject water bodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is enterococci bacteria. EPA recommends the use of enterococci bacteria as indicator organisms in marine waters because levels of these organisms more accurately predict illness than levels of fecal coliform (EPA, 1986). This stronger correlation may be due to the longer survival rate in marine waters for enterococci than for fecal coliform, similar to the pathogens of concern (EPA, 2004).

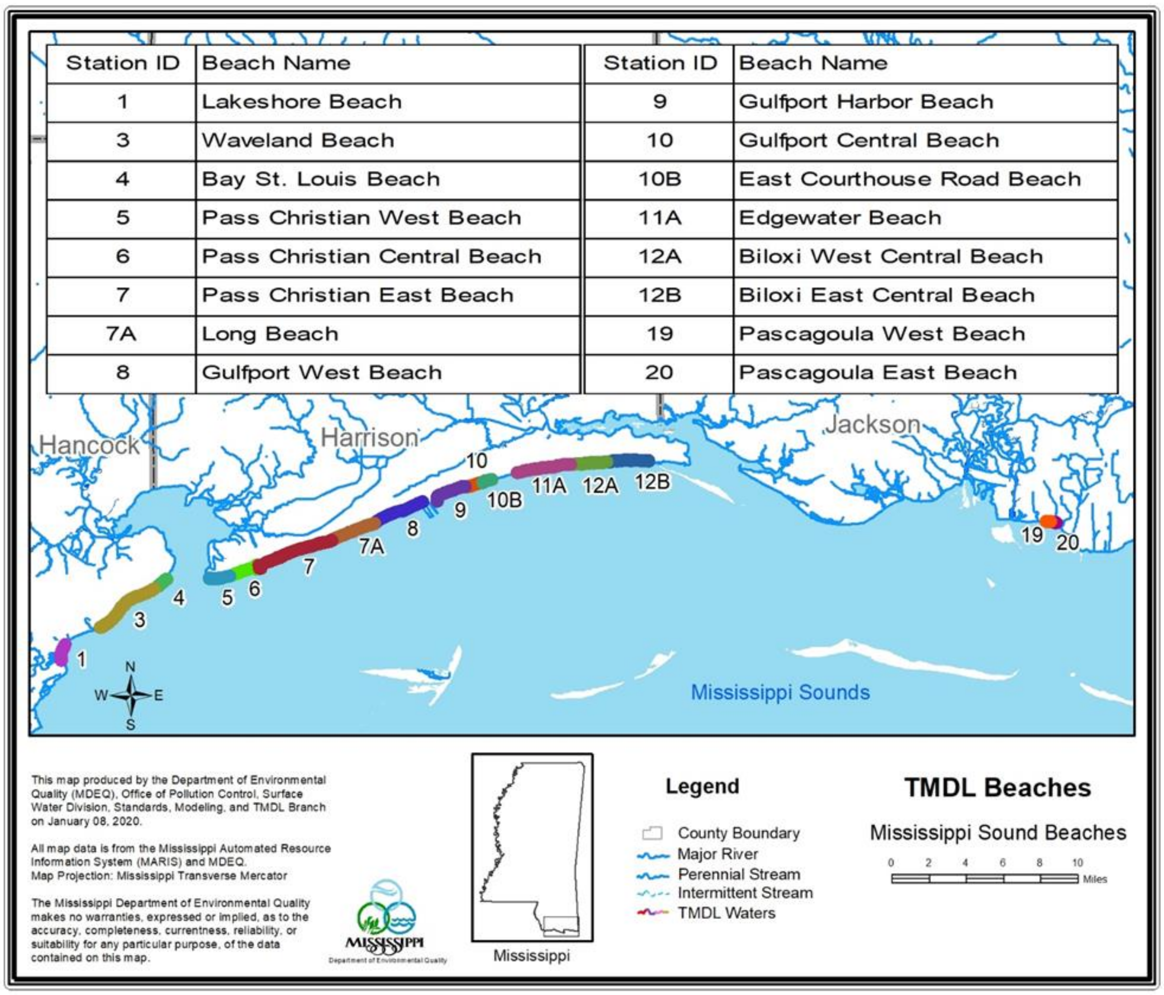


Figure 1. TMDL Beach listing Aerial View

A TMDL has been developed for Mississippi's Beaches included in Table 1. The beaches were selected based on data collected to support the Beach Monitoring Program. The data and aerial photos are included in Section 2.2.

Table 1. TMDL Waterbody ID

Name	Waterbody & Station ID	County
Lakeshore Beach	250114 -1	Hancock
Location: From Silver Slipper Casino to Pointset Avenue.		
Waveland Beach	250112 - 3	Hancock
Location: From Oak Street to Favre Street.		
Bay St. Louis Beach	250111 – 4	Hancock
Location: From Washington Street to the Culvert just north of Ramaneda Street.		
Pass Christian West Beach	250214 – 5	Harrison
Location: From Fort Henry Avenue to Elliott Street.		
Pass Christian Central Beach	250215 - 6	Harrison
Location: From Henderson Avenue to Hiern Avenue		
Pass Christian East Beach	250211 - 7	Harrison
Location: From Espy Avenue to Hayden Avenue.		
Long Beach Beach	250213 – 7A	Harrison
Location: From Oak Gardens Avenue to Girard Avenue.		
Gulfport West Beach	250212 – 8	Harrison
Location: From Marie Avenue to Camp Avenue		
Gulfport Harbor Beach	250311- 9	Harrison
Location: From 15th Street to Thornton Avenue.		
Gulfport Central Beach	250312 - 10	Harrison
Location: From Alfonso Drive to VA Main Entrance.		
East Courthouse Road Beach	250315 – 10B	Harrison
Location: From VA Main Entrance to Courthouse Road.		
Edgewater Beach	250316 – 11A	Hancock
Location: From Debuys Road to Edgewater Drive.		
Biloxi West Central Beach	250314 – 12A	Harrison
Location: From Travia Street to I'Berville Drive.		
Biloxi East Central Beach	250317 – 12B	Harrison
Location: From St Peter Street to Dukate Street.		
Pascagoula West Beach	250511 - 19	Jackson
Location: From Westwood Street to Grand Oaks.		
Pascagoula East Beach	250512 - 20	Jackson
Location: From Oliver Street to Westwood Street.		

The mass balance method is an applicable method for TMDL development with data in complex watersheds that are tidally influenced. These TMDLs were developed using a mass balance method with the federally promulgated marine recreational water quality standard and an estimated volume of water based on aerial photograph interpretation and depth soundings collected at intervals from 0 - 100 meters from the shoreline at the beaches.

Table 2. Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Enterococci Bacteria	Recreation	Geometric mean of 35 colony forming units (cfu) /100 ml. for enterococci bacteria in marine coastal recreation waters

1.2 Mississippi Beach Monitoring Program

Mississippi's Department of Environmental Quality (MDEQ) implemented an intensive beach water quality monitoring and public notification program in 1998 through its interagency Beach Monitoring Task Force. In 2005, the Mississippi Beach Monitoring Program was expanded under the BEACH Act. Currently, Mississippi has twenty-one beach monitoring sites that are monitored for enterococci and for several chemical parameters. If bacteria levels reach unsafe levels, swim advisories are placed on the beach stating that swimming is not recommended until bacteria levels return to safe levels. The advisories remain in place until the monitoring data indicates that the water is safe for swimming and water contact. A swim advisory is also in affect for 24 hours after a significant rainfall event. A significant rainfall event is defined as more than one-inch rainfall within the last 24 hours.

In 2004, MDEQ began the policy of not monitoring during significant rainfall events. From a review of the data set at the time, samples indicated an elevated enterococci bacteria count during and right after a significant rain event. This policy decision protects the public utilizing the Mississippi beaches while reducing the number of high enterococci bacteria levels collected as a result of significant rainfall.

The Mississippi Beach Monitoring Program website posts beach advisories when water samples exceed the EPA recommended levels for enterococci and after significant rainfall events. This website also provides historical beach advisories, beach locations, maps locating the sampling sites, and historical beach monitoring bacteria data. The public can view the Mississippi Beach Monitoring Program website at: http://opcgis.deq.state.ms.us/beaches/beaches.php. In addition to the website, MDEQ provides public notification of beach water quality conditions through press releases and signage posted at the beach.

Water samples from the beaches are tested for enterococci bacteria and if the bacteria levels exceed EPA recommended levels, a no swimming advisory sign is posted on the beach section. Additional water samples are tested from the site and the no swim advisory remains posted at the site until bacteria levels return to safe levels. In addition to signage, MDEQ provides public notification of beach water quality conditions through press releases as well as posting near real time information on the state's Beach Monitoring Website.

1.3 Applicable Water body Segment Use

The water use classification for the listed segments as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* regulation is Contact Recreation.

Applicable Water body Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the *Federal Register, Tuesday November 16, 2004, Part II Environmental Protection Agency, 40 CFR Part 131, Water Quality Standards for Coastal and Great Lakes Recreation Water; Final Rule.* EPA promulgated a geometric mean of 35 colony forming units (cfu) per 100ml. for enterococci in marine coastal recreation waters. There are also four single sample maximums which vary based on the intensity of use.

TMDL CALCULATION AND WATER QUALITY DATA ASSESSMENT

2.1 Selection of a TMDL Endpoint

One of the major components of a TMDL is the establishment of numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed water body conditions and conditions that are expected to restore designated uses. The Federal Register requires that the enterococci geometric mean of the water sample results shall not exceed 35 cfu per 100ml.

2.2 Discussion of TMDL Calculations and Water Quality Data

As stated previously, a mass balance approach was selected for this TMDL due to complexities associated with open water boundaries and tidal influences. The first step in a mass balance is to develop an estimate of the volume of water at each beach. The length of each beach was determined by measurements of aerial photographs. The width of the contact recreation area was set at 100 meters from the water's edge. Depth soundings were taken manually at three transects on each beach segment to predict a depth curve which was then used to calculate a volume of water for each beach.

Aerial photography is included which shows the extent of each beach along with the existing storm water culverts and open channel conveyances. These photographs are included to help identify the beaches and the storm water discharge locations associated with each beach.

Due to the schedule of the Mississippi Beach Monitoring Program, MDEQ has approximately 200 to 450 enterococci data points for each beach segment in this TMDL. In order to normalize this highly variable data, the geometric mean is used to inform the appropriate management action and is considered a more reliable measure (EPA, 2004).

2.2.1 Lakeshore Beach Enterococci Data

From Silver Slipper Casino to Pointset Avenue.

Beach Length (m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 years Geomean All (cfu/100ml)
1,472.04	5.69E+04	64.37	1.98E+06	35.00	1.99E+06	23% to 65%	31.63

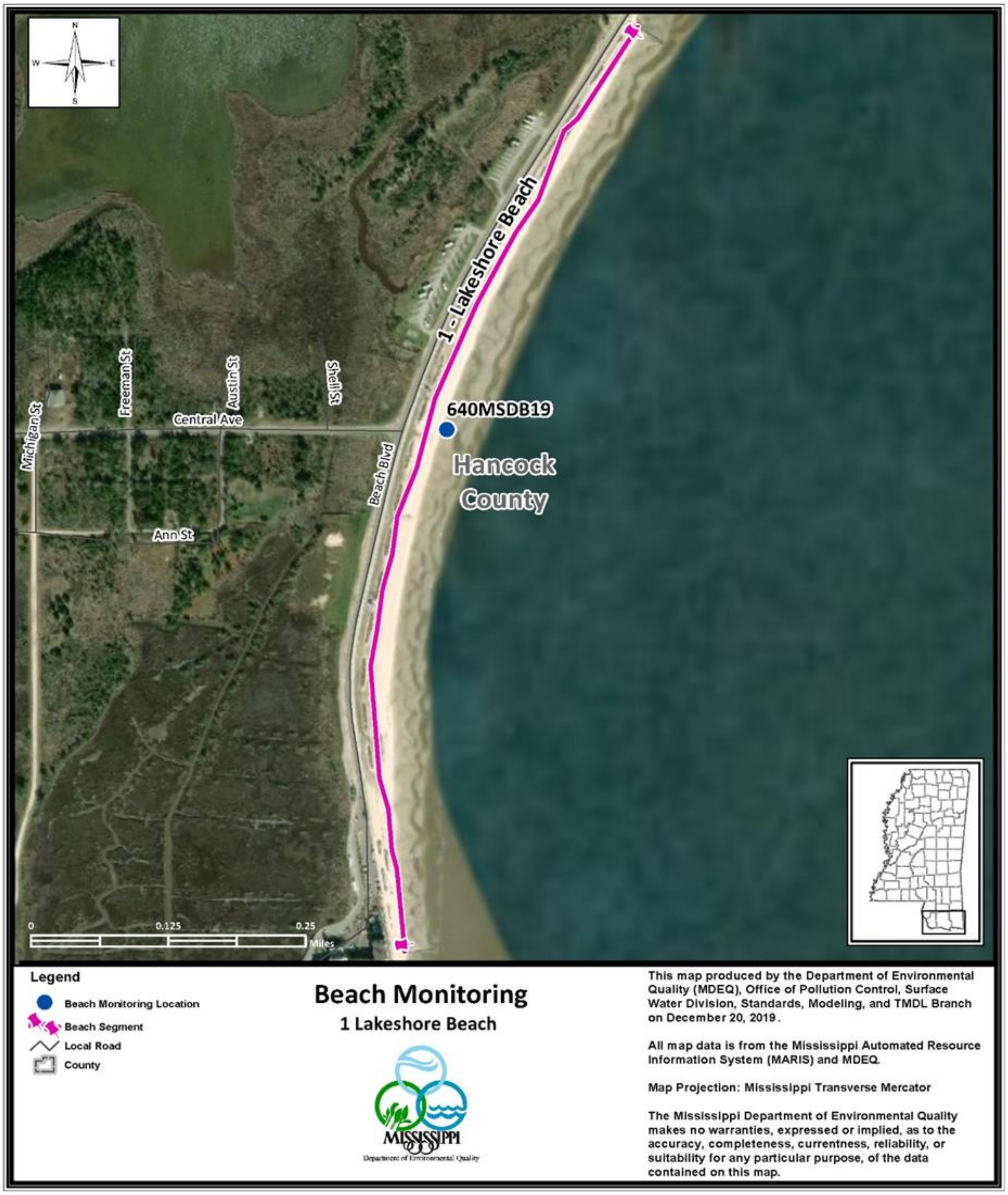


Figure 2. Lakeshore Beach Aerial View with Culverts

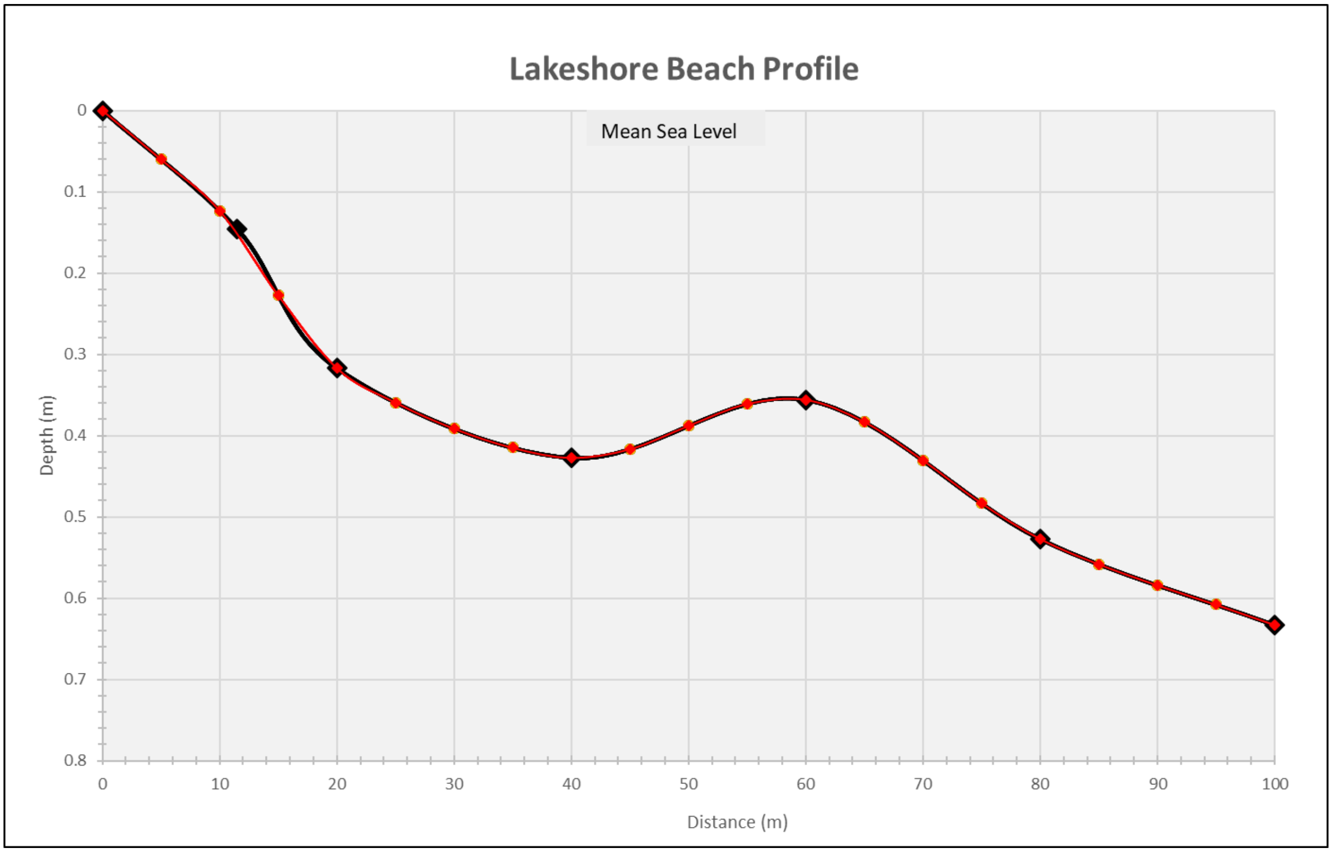


Figure 3. Lakeshore Beach Underwater Profile

2.2.2 Waveland Beach Enterococci Data

From Oak Street to Favre Street.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 years Geomean All (cfu/100ml)
5,940.0	1.53E+05	74.08	5.02E+06	35.00	5.37E+06	9% to 53%	27.60

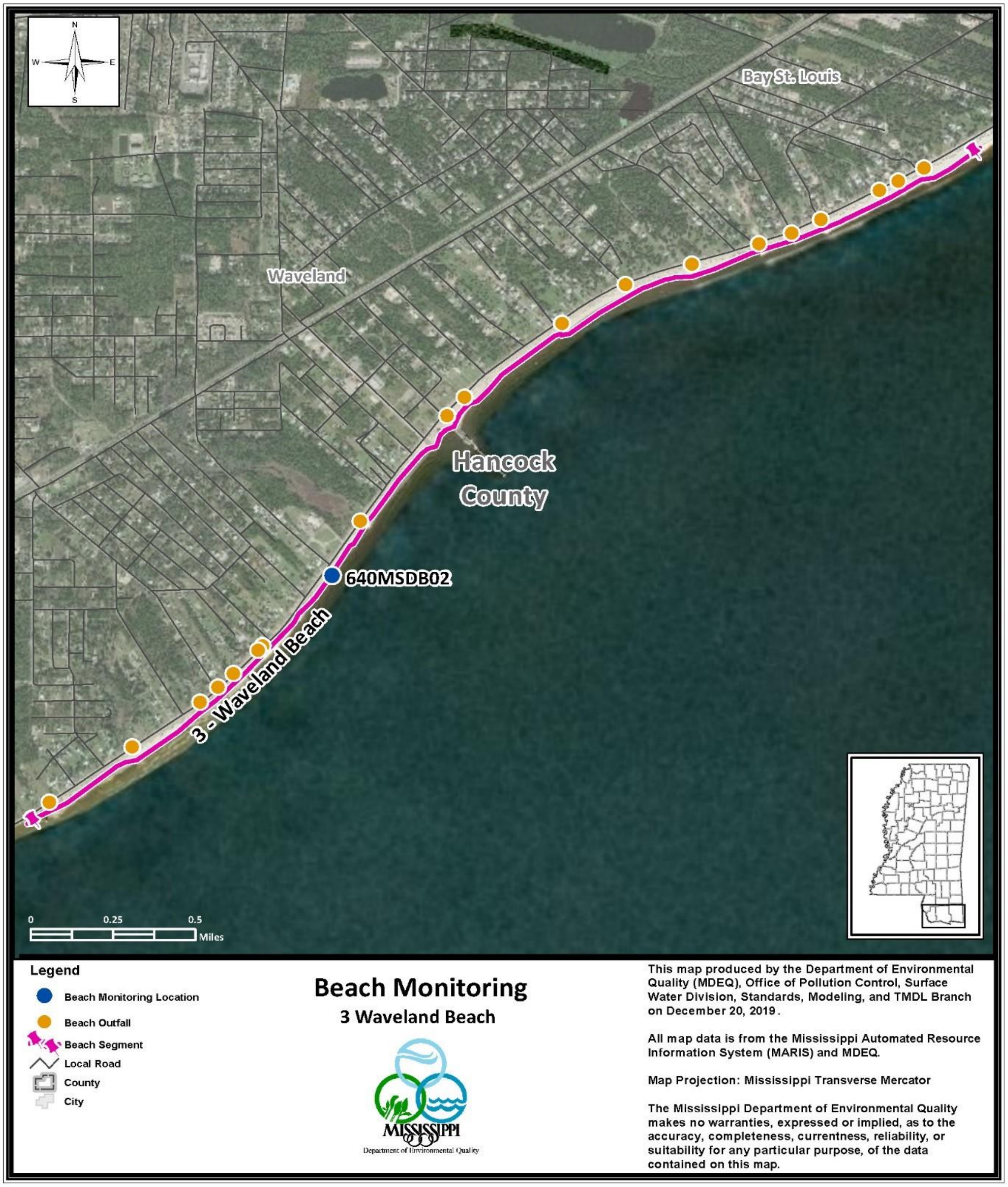


Figure 4. Waveland Beach Aerial View with Culverts

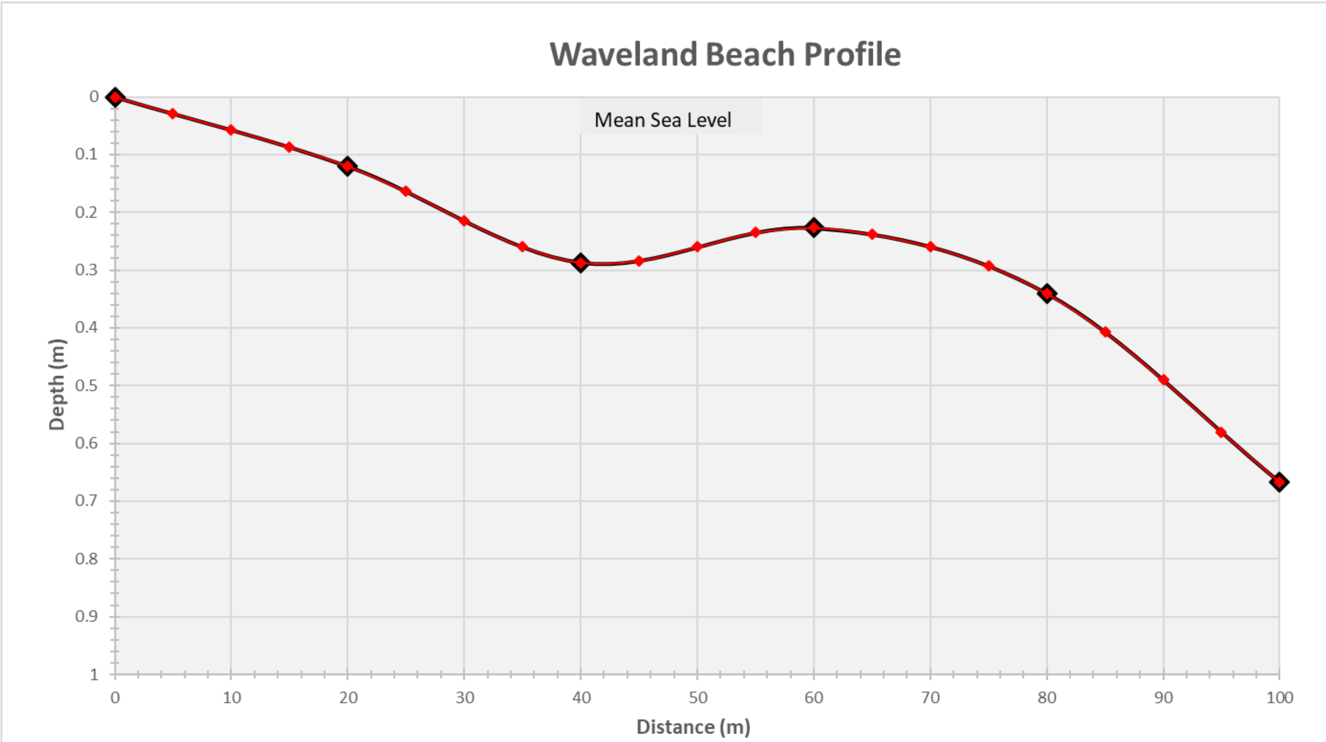


Figure 5. Waveland Beach Underwater Profile

2.2.3 Bay St. Louis Beach Enterococci Data

From Washington Street to the Culvert just north of Ramaneda Street.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 year Geomean All (cfu/100ml)
971.3	3.36E+04	69.24	9.91E+05	35.00	1.18E+06	31% to 49%	26.41

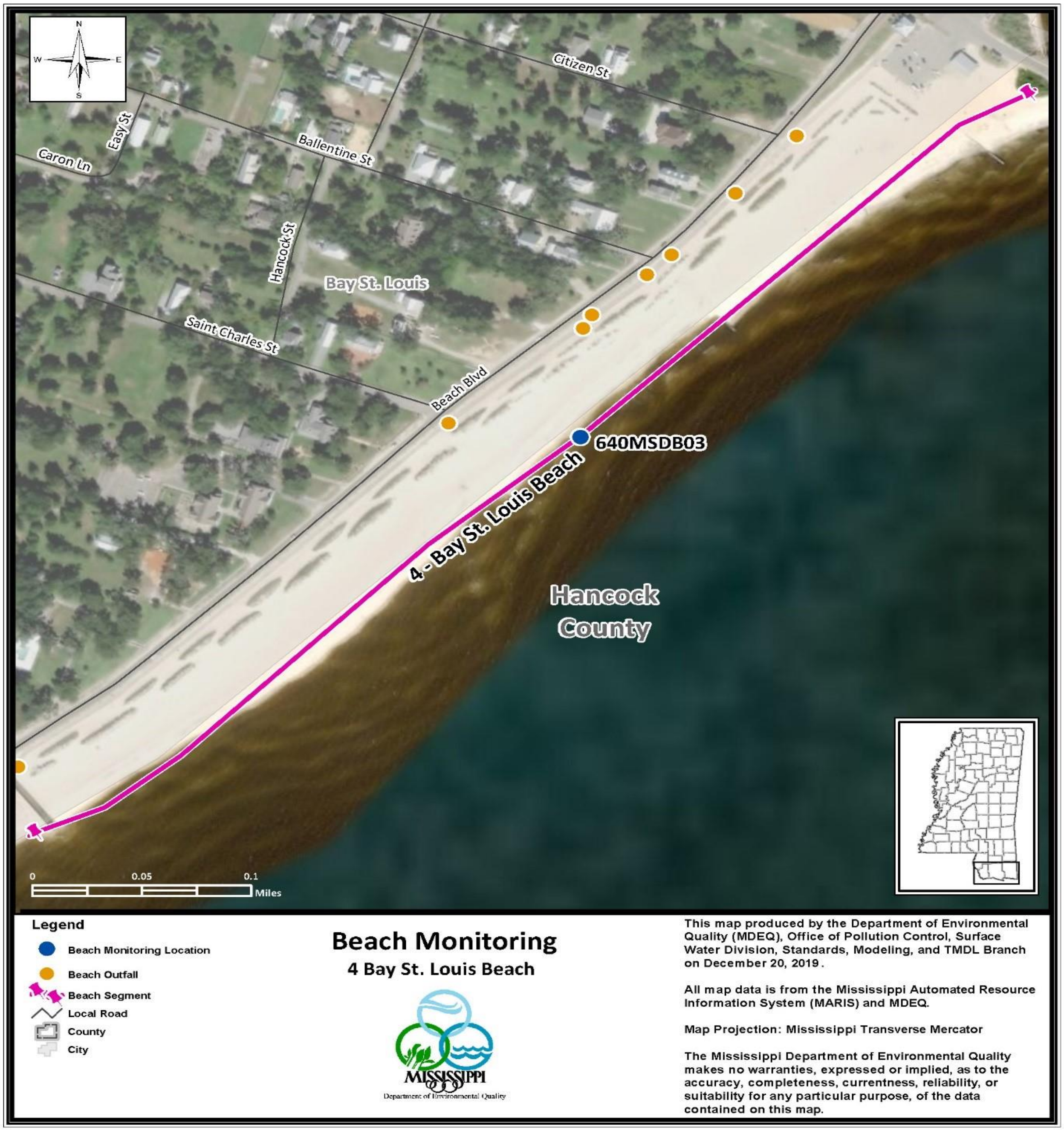


Figure 6. Bay St. Louis Beach Aerial View with Culverts

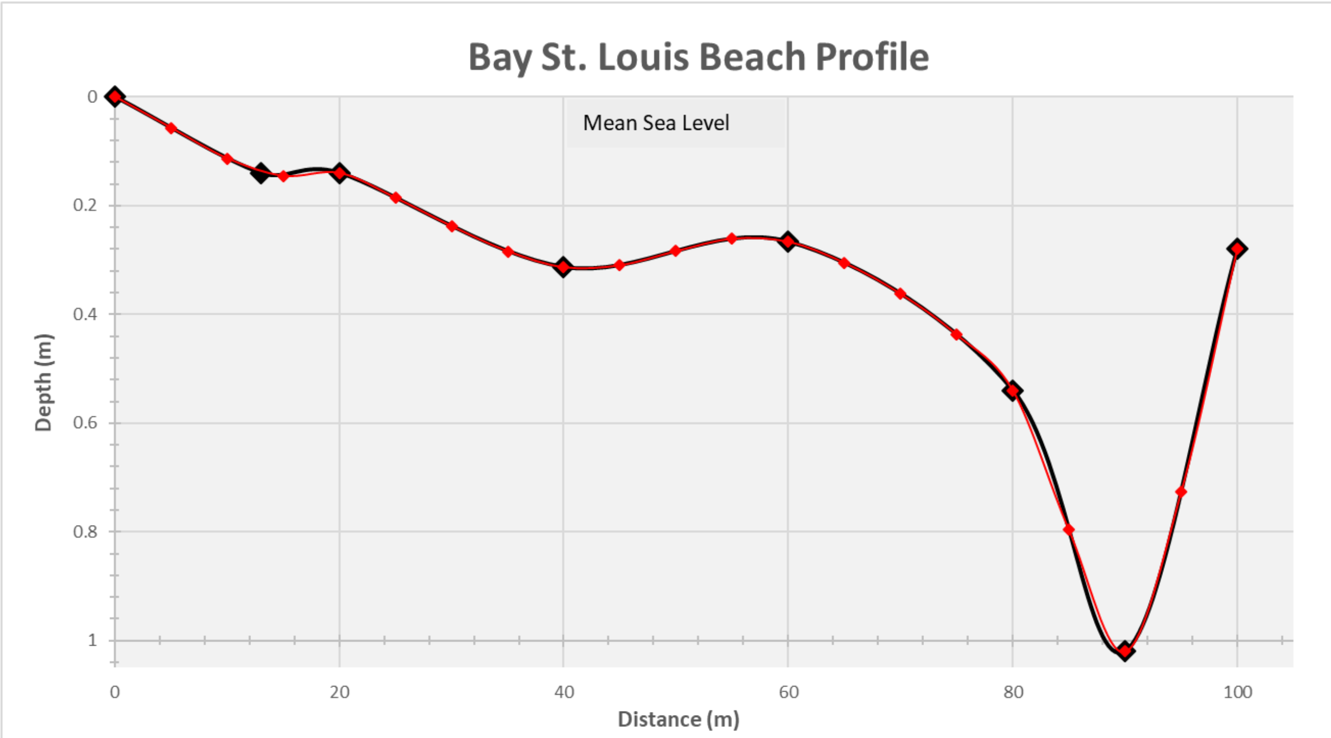


Figure 7. Bay St. Louis Beach Underwater Profile

2.2.4 Pass Christian West Beach Enterococci Data

From Fort Henry Avenue to Elliott Street.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfus per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 year Geomean All (cfu/100ml)
1,801.8	2.35E+04	97.11	1.11E+06	35.00	8.21E+05	9% to 64%	48.00

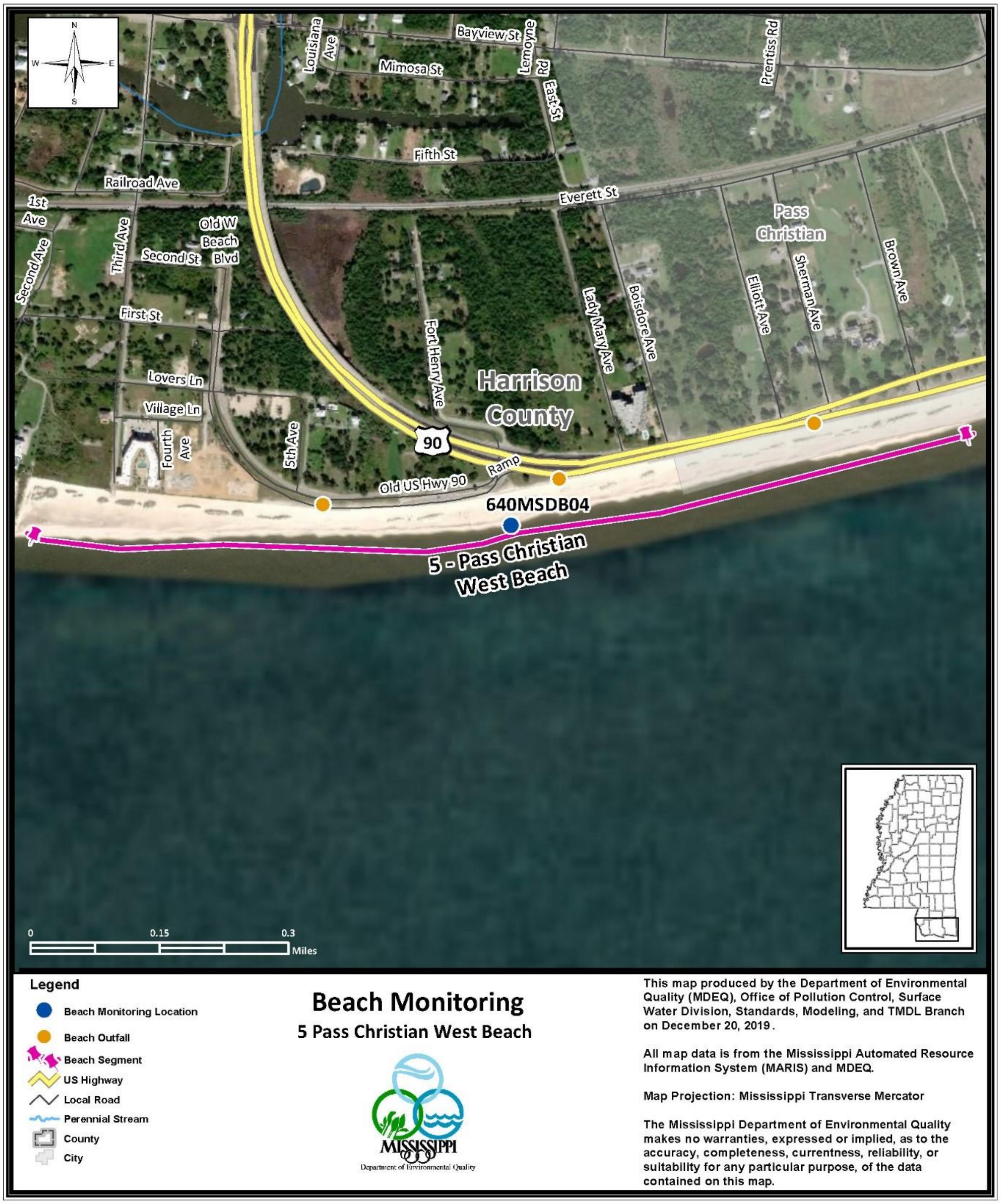


Figure 8. Pass Christian West Beach Aerial View with Culverts

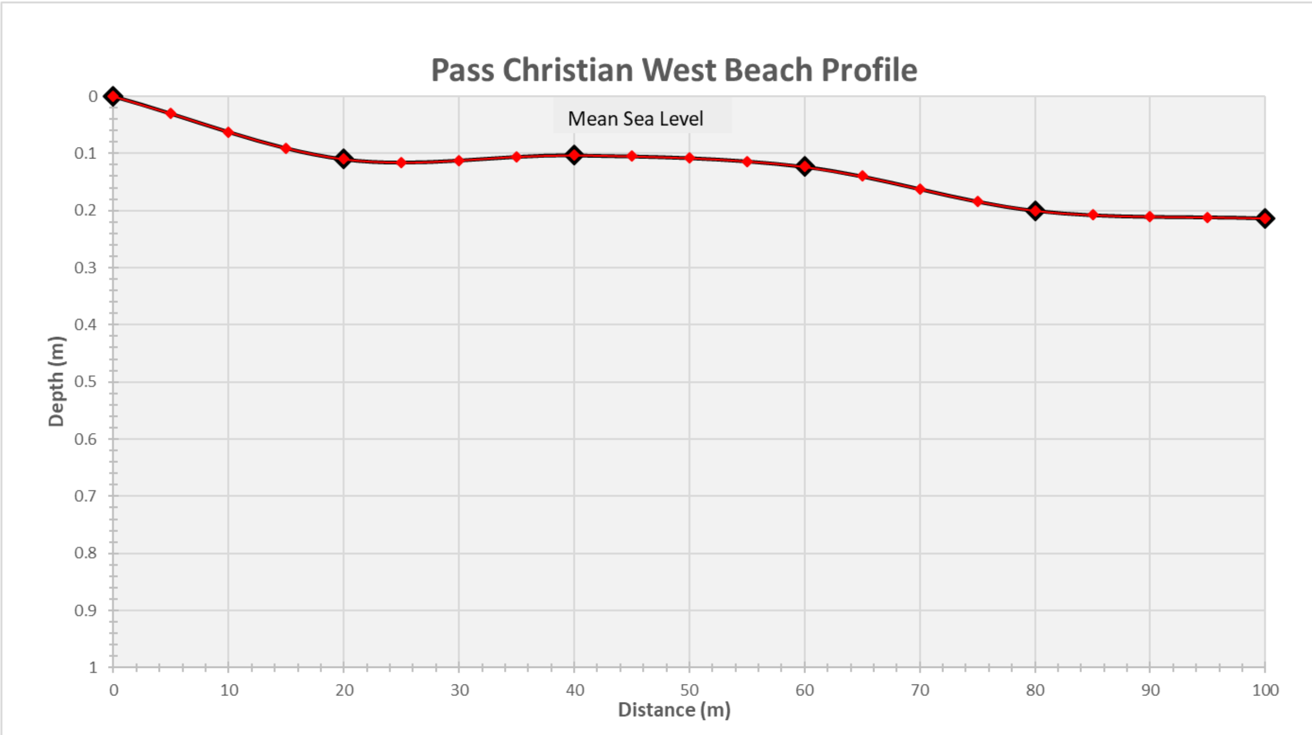


Figure 9. Pass Christian Beach Underwater Profile

2.2.5 Pass Christian Central Beach Enterococci Data

From Henderson Avenue to Hiern Avenue.

Beach Length(m)	Beach Volume (m3)	Existing Concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 Years Geomean All (cfu/100ml)
3,035.0	9.15E+04	53.13	2.05E +06	35	3.20E+06	8% to 34%	20.95

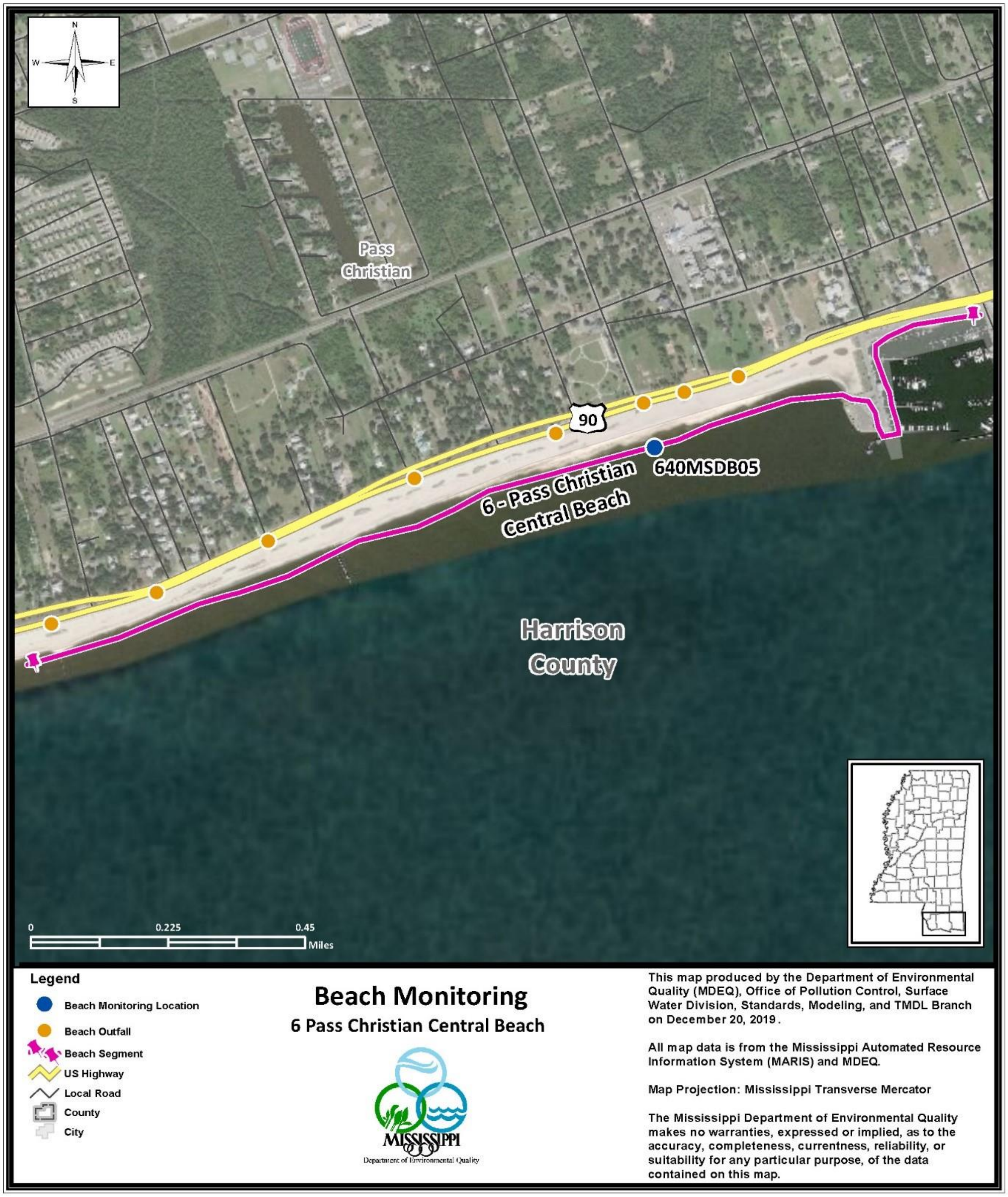


Figure 10. Pass Christain Central Beach Aerial View with Culverts

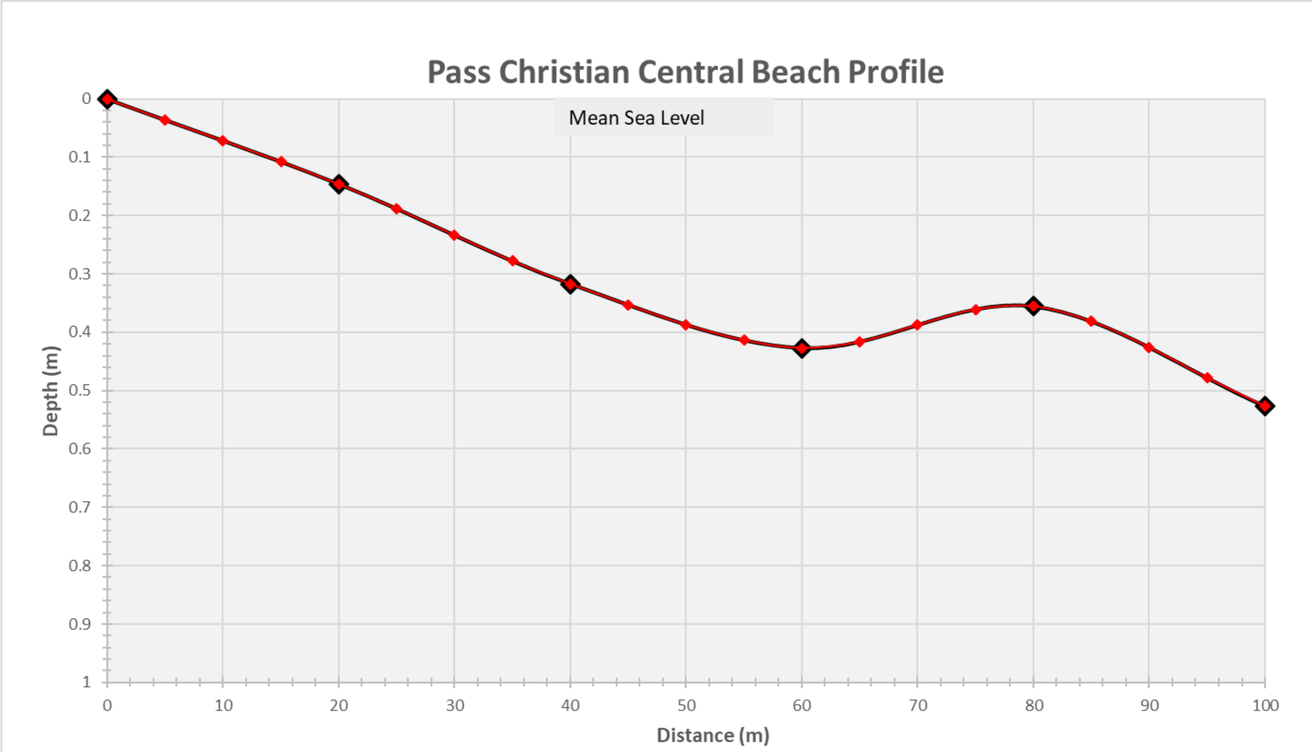


Figure 11. Pass Christian Central Beach Underwater Profile

2.2.6 Pass Christian East Beach Enterococci Data

From Espy Avenue to Hayden Avenue.

Beach Length(m)	Beach Volume (m3)	Existing Concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (col/100ml)	TMDL Load (cfu per day)	% Reduction	5 Years Geomean All (cfu/100ml)
7,275.7	1.50E+05	94.90	4.74E+06	35.00	5.24E+06	15% to 63%	30.35

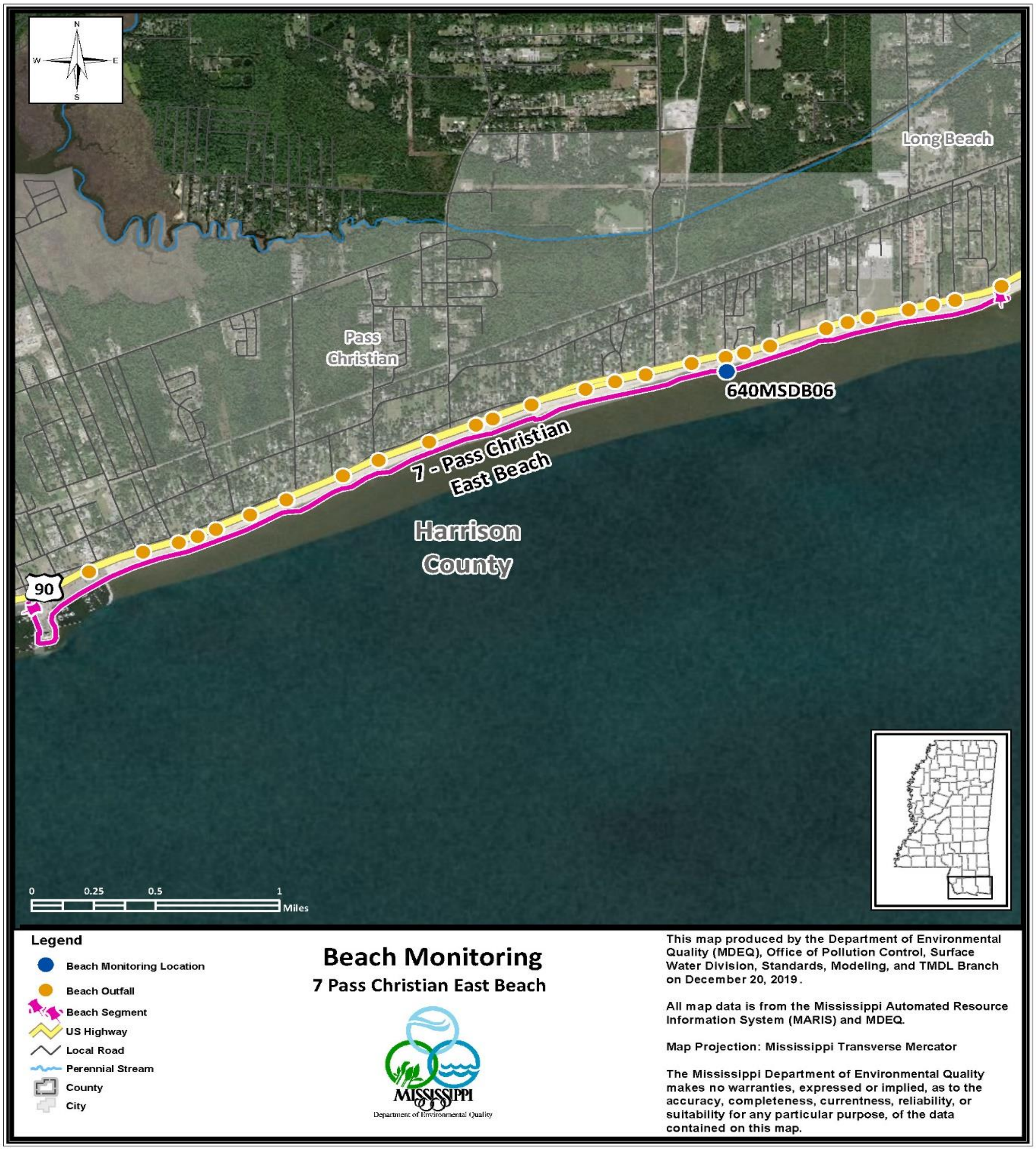


Figure 12. Pass Christain East Beach Aerial View with Culverts

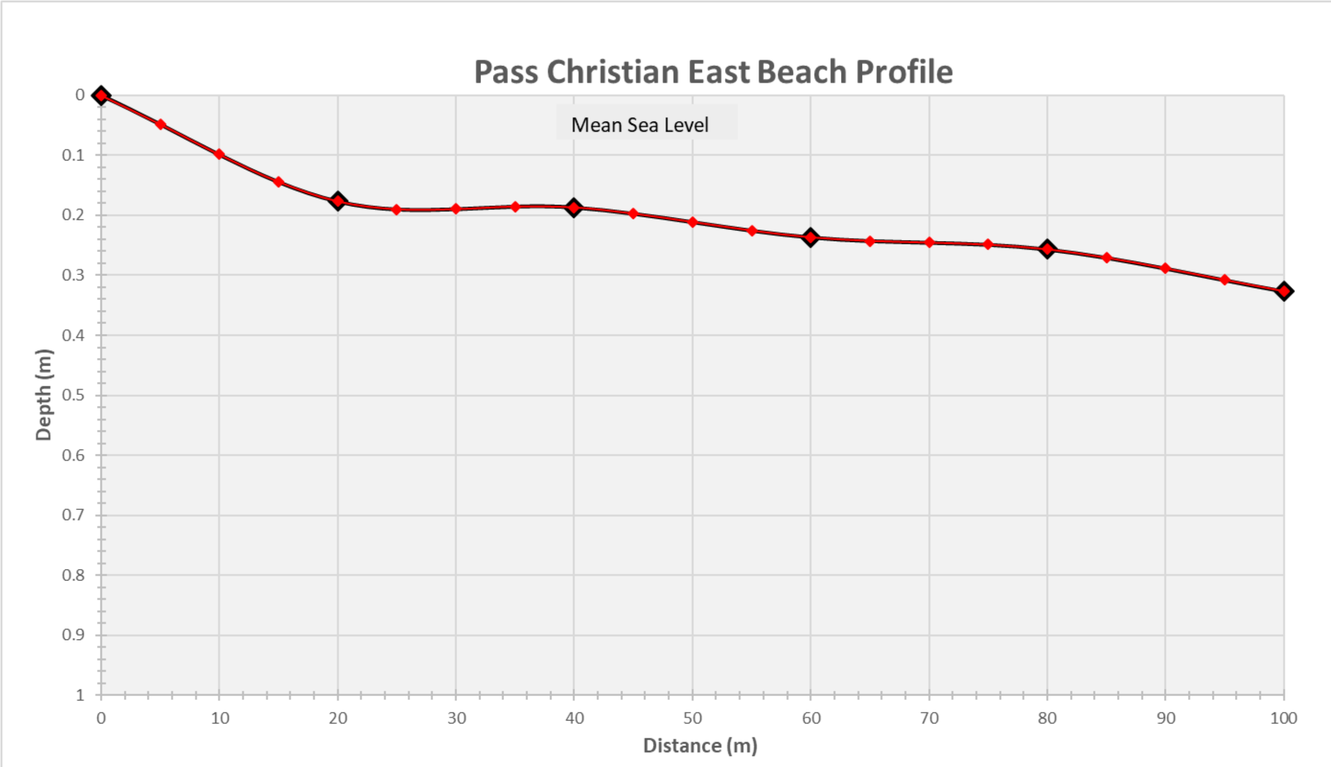


Figure 13. Pass Christian East Beach Underwater Profile

2.2.7 Long Beach Beach Enterococci Data

From Oak Gardens Avenue to Girard Avenue.

Beach Length(m)	Beach Volume (m3)	Existing Concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (col/100ml)	TMDL Load (cfu per day)	% Reduction	5 Years Geomean All (cfu/100ml)
3,994.5	8.22E+04	76.24	3.32E+06	35.00	2.88E+06	18%to54%	39.31

Figure 14. Long Beach Beach Aerial View with Culverts

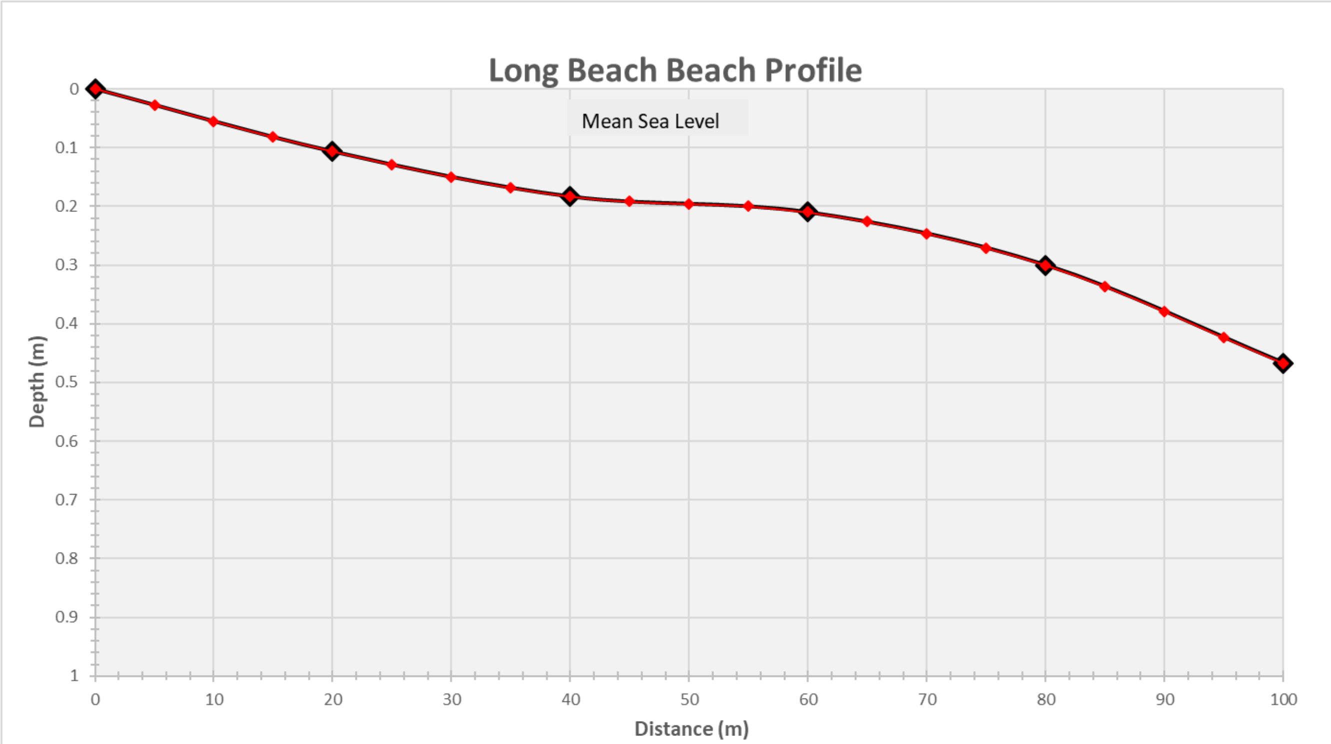


Figure 15. Long Beach Beach Underwater Profile

2.2.8 Gulfport West Beach Enterococci Data

From Marie Avenue to Camp Avenue.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 years Geomean All (cfu/100ml)
4,605.8	8.82E+04	83.04	2.72E+06	35.00	3.09E+06	13% to 58%	30.45

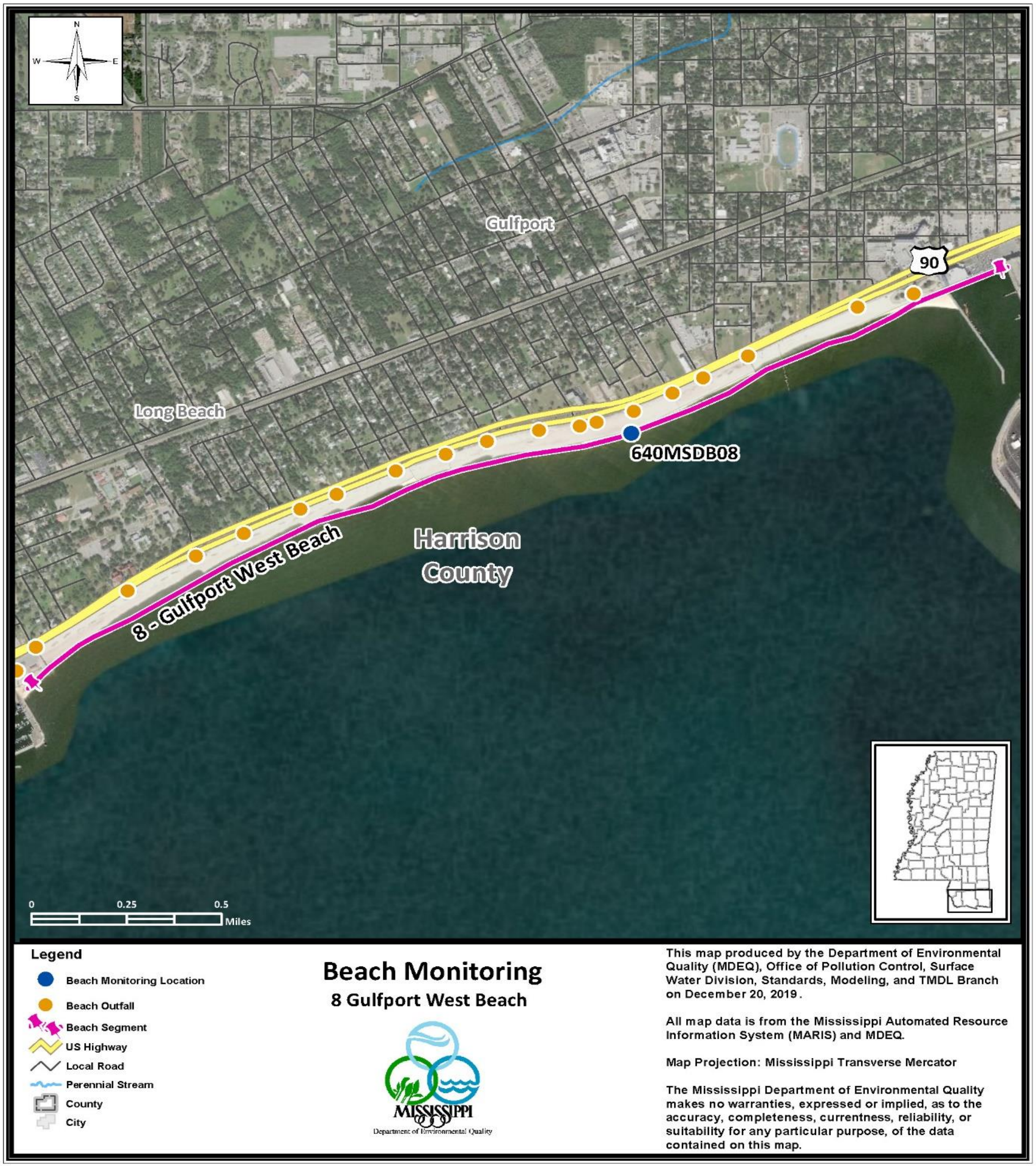


Figure 16. Gulfport West Beach Aerial View with Culverts

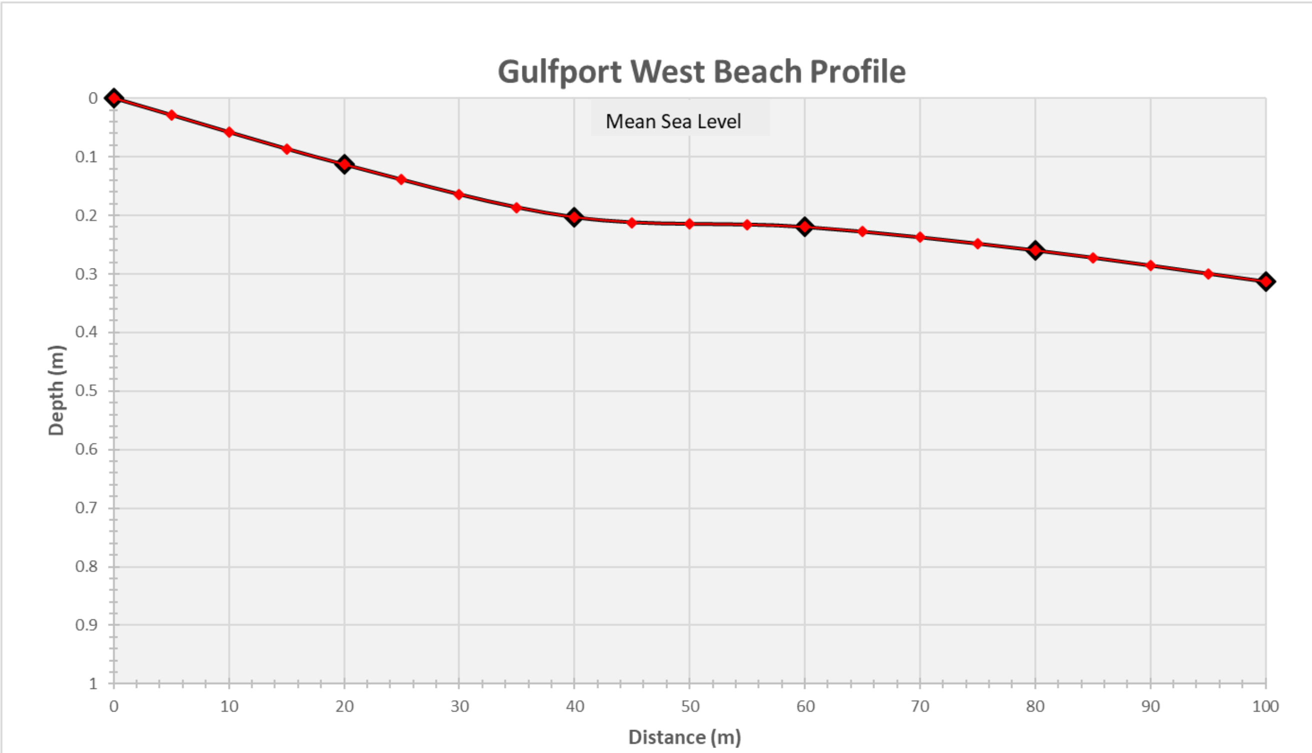


Figure 17. Gulfport West Beach Underwater Profile

2.2.9 Gulfport Harbor Beach Enterococci Data

From 15th Street to Thornton Avenue.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 years Geomean All (cfu/100ml)
2,981.7	8.58E+04	78.03	3.25E+06	35.00	3.00E+06	32% to 55%	38.62

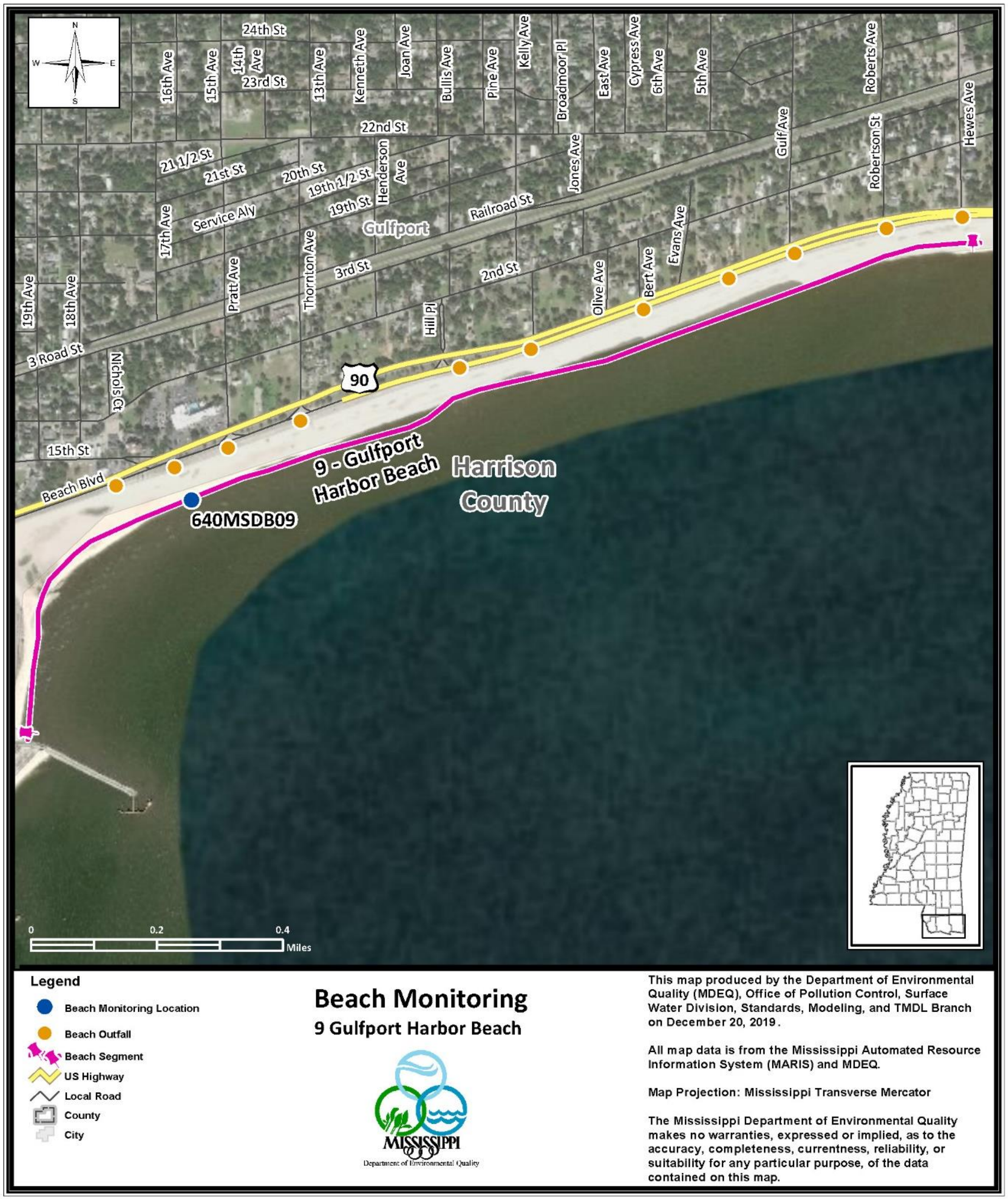


Figure 18. Gulfport Harbor Beach Aerial View with Culverts

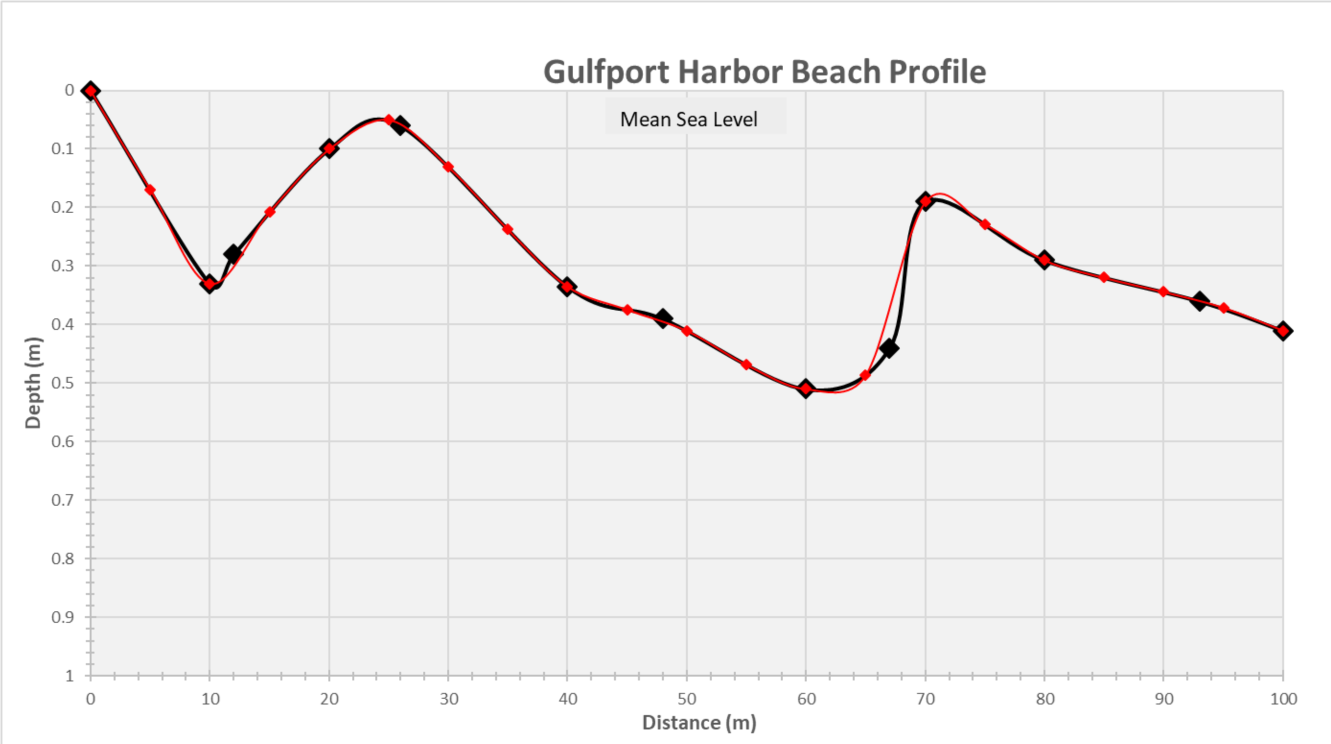


Figure 19. Gulfport Harbor Beach Underwater Profile

2.2.10 Gulfport Central Beach Enterococci Data

From Alfonso Drive to VA Main Entrance.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 years Geomean All (cfu/100ml)
1,371.1	3.06E+04	99.09	1.79E+06	35.00	1.07E+06	3% to 65%	65.67

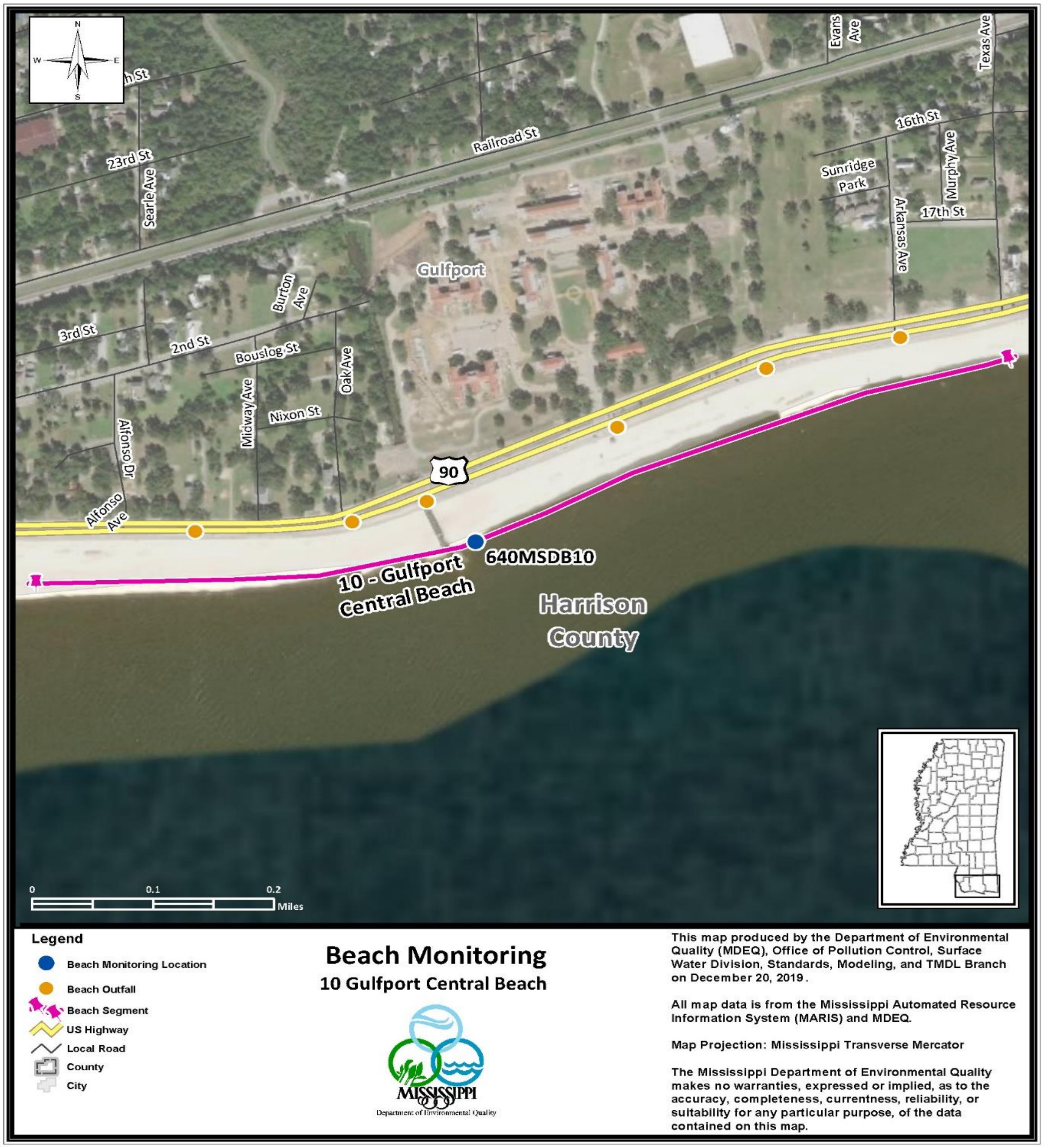


Figure 20. Gulfport Central Beach Aerial View with Culverts

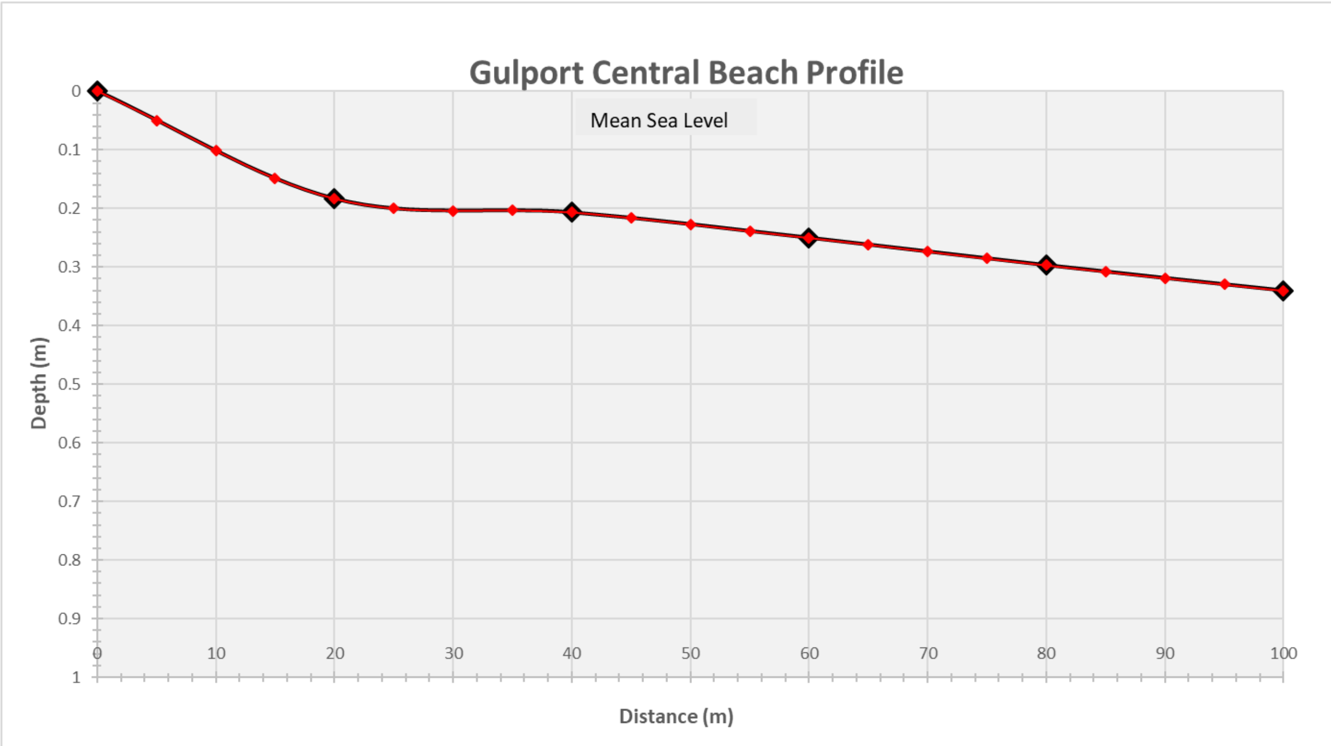


Figure 21. Gulfport Central Beach Underwater Profile

2.2.11 East Courthouse Road Beach Enterococci Data

From VA Main Entrance to Courthouse Road.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 years Geomean All (col/100ml)
853.1	4.93E+04	75.18	2.05E+06	35.00	1.73E+06	2% to 57%	51.45

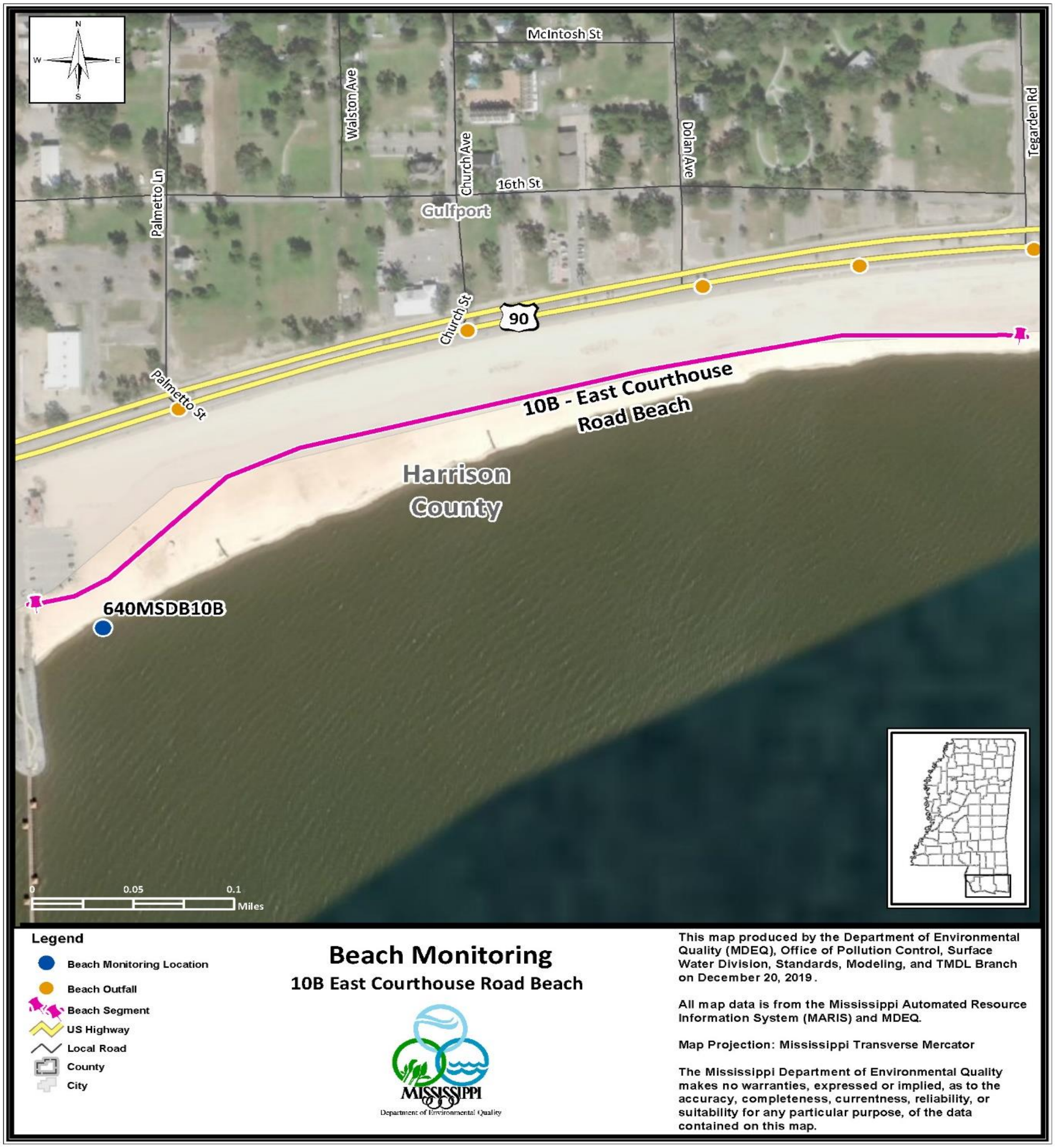


Figure 22. East Courthouse Road Beach Aerial View with Culverts

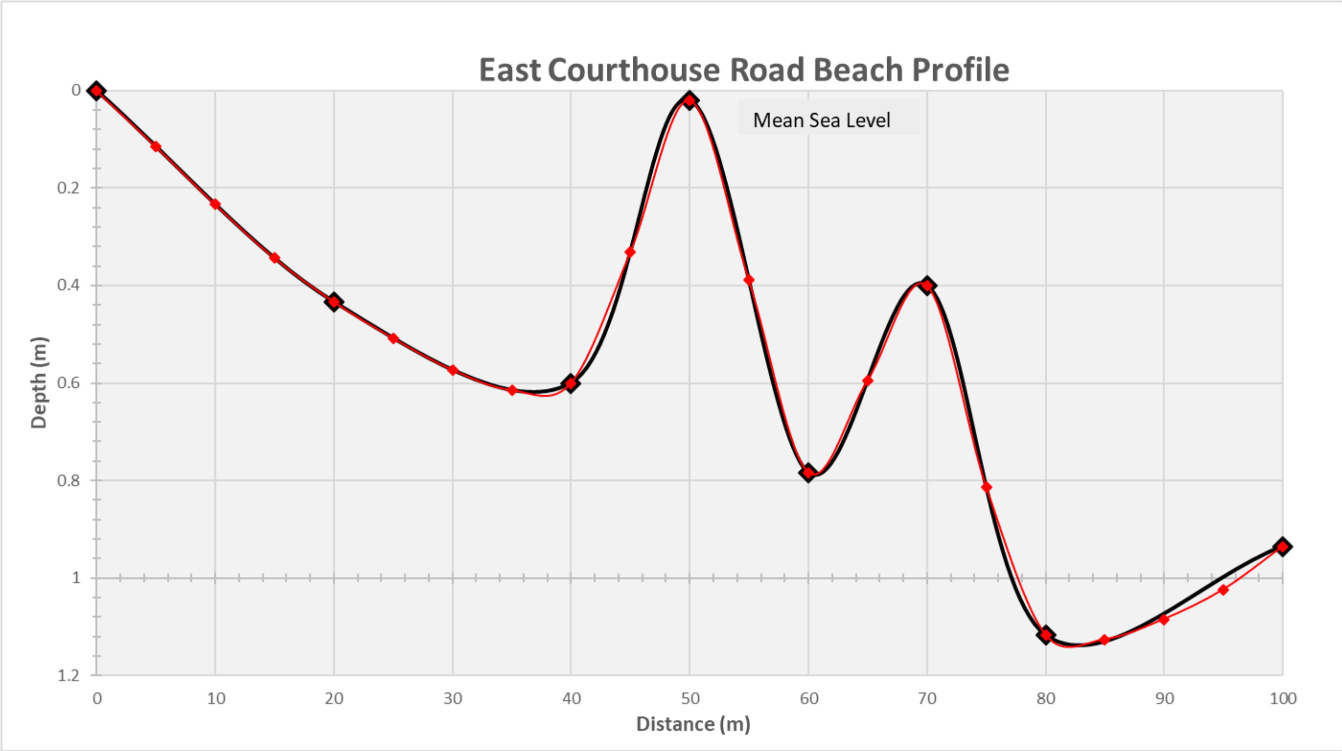


Figure 23. East Courthouse Beach Underwater Profile

2.2.12 Edgewater Beach Enterococci Data

From Debuys Road to Edgewater Drive.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 years Geomean All (cfu/100ml)
4,767.3	1.16E+05	90.44	4.62+06	35.00	4.08E+06	2% to 61%	36.02

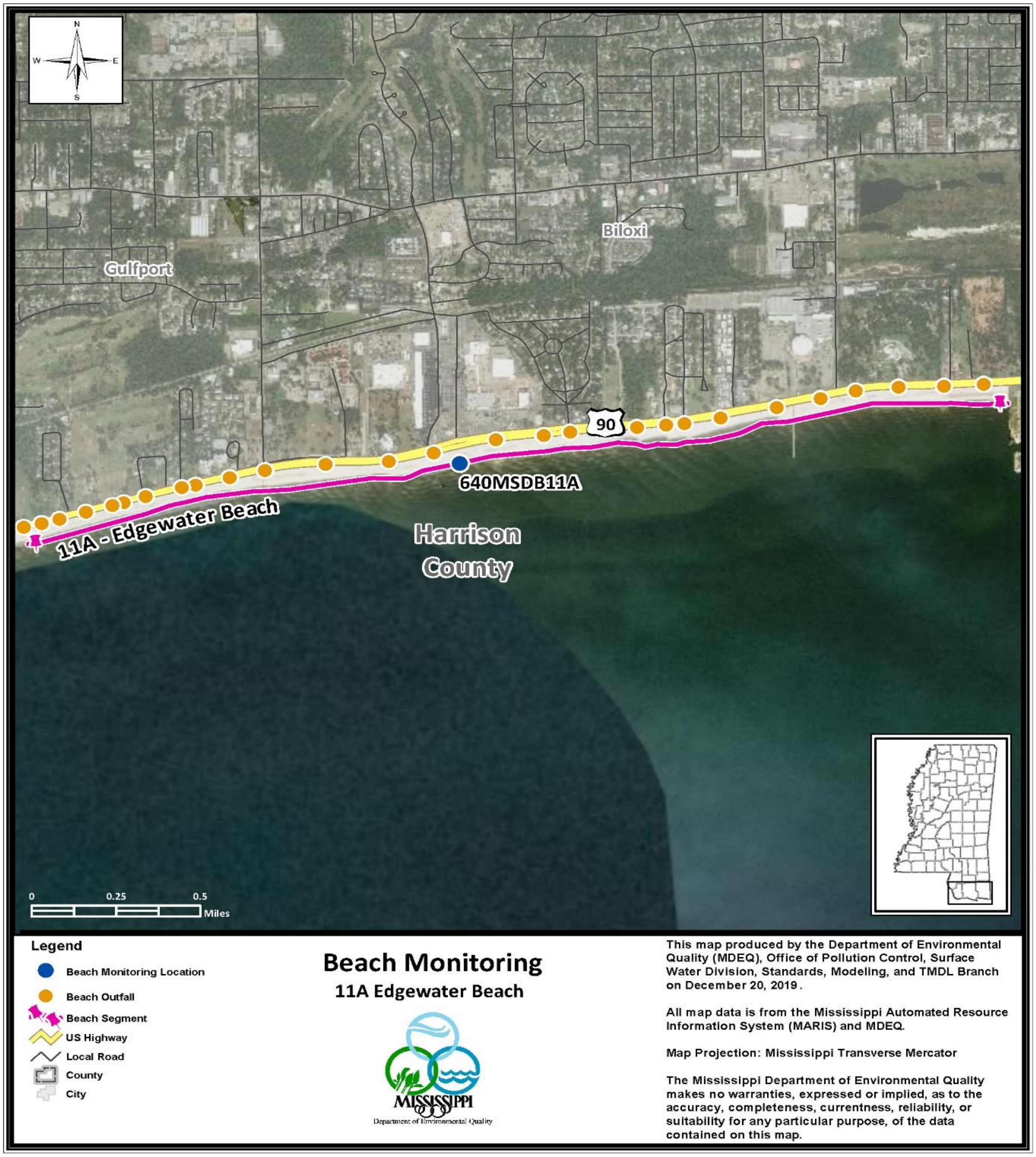


Figure 24. Edgewater Beach Aerial View with Culverts

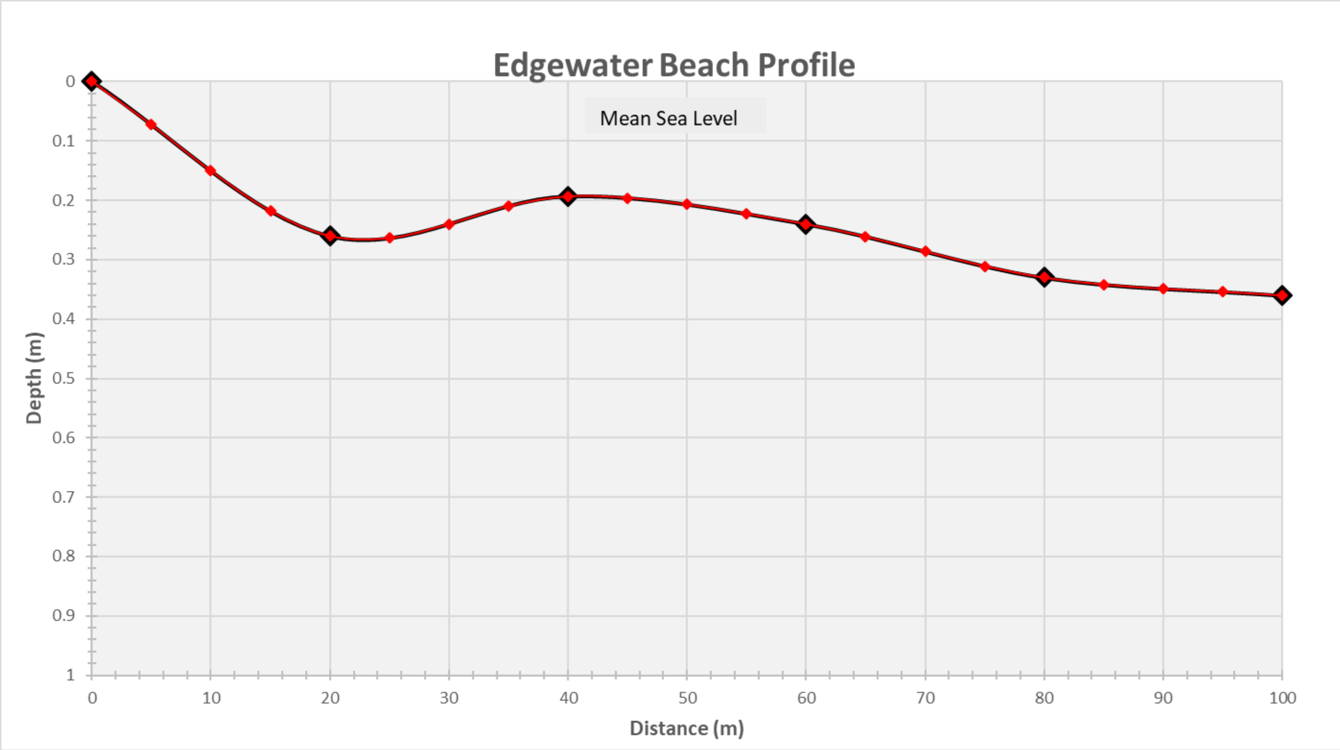


Figure 25. Edgewater Beach Underwater Profile

2.2.13 Biloxi West Central Beach Enterococci Data

From Travia Street to I'Berville Drive.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 years Geomean All (cfu/100ml)
2,917.60	8.37E+04	86.32	2.99E+06	35.00	2.93E+06	8% to 59%	42.72

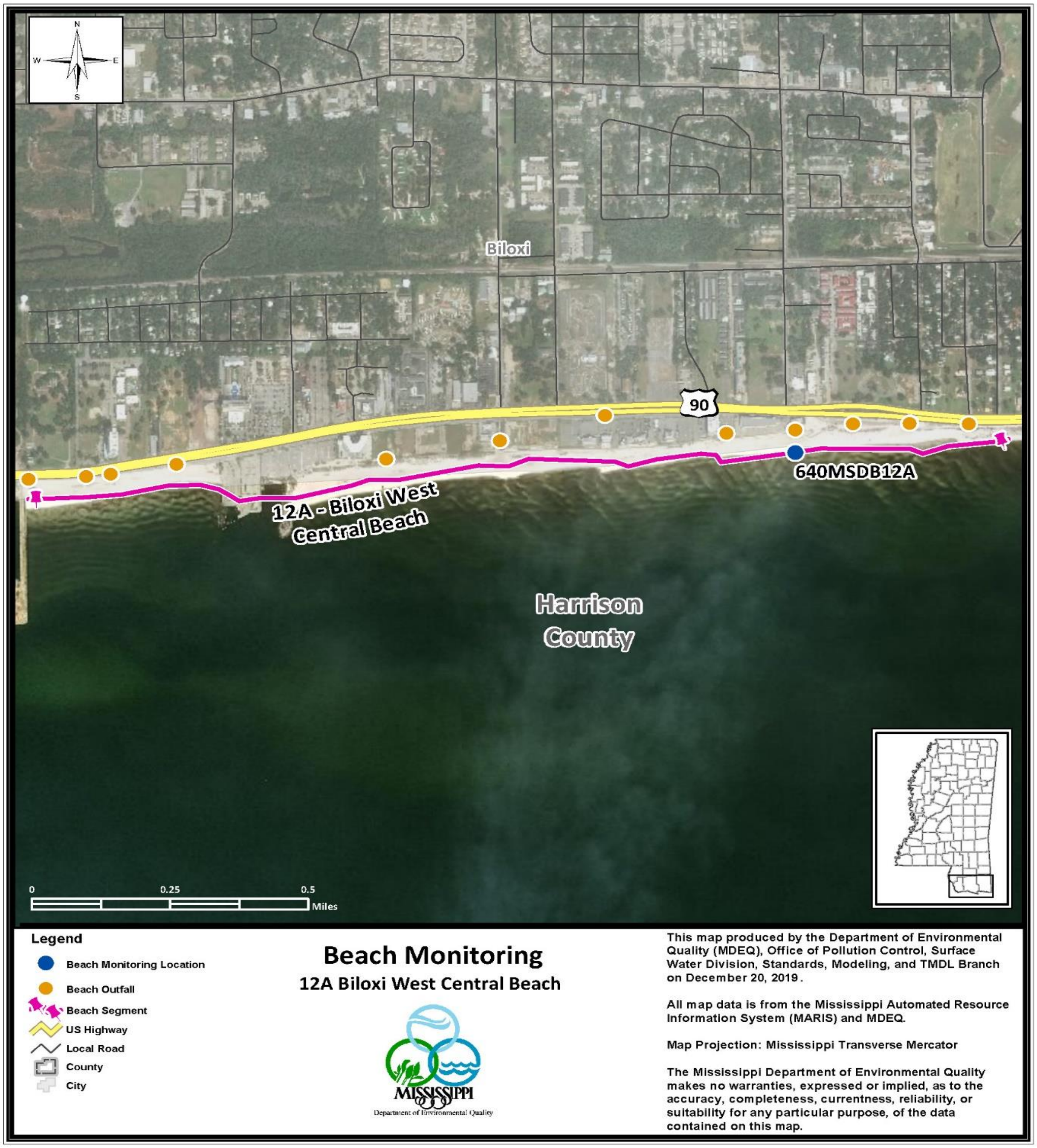


Figure 26. Biloxi West Central Beach Aerial View with Culverts

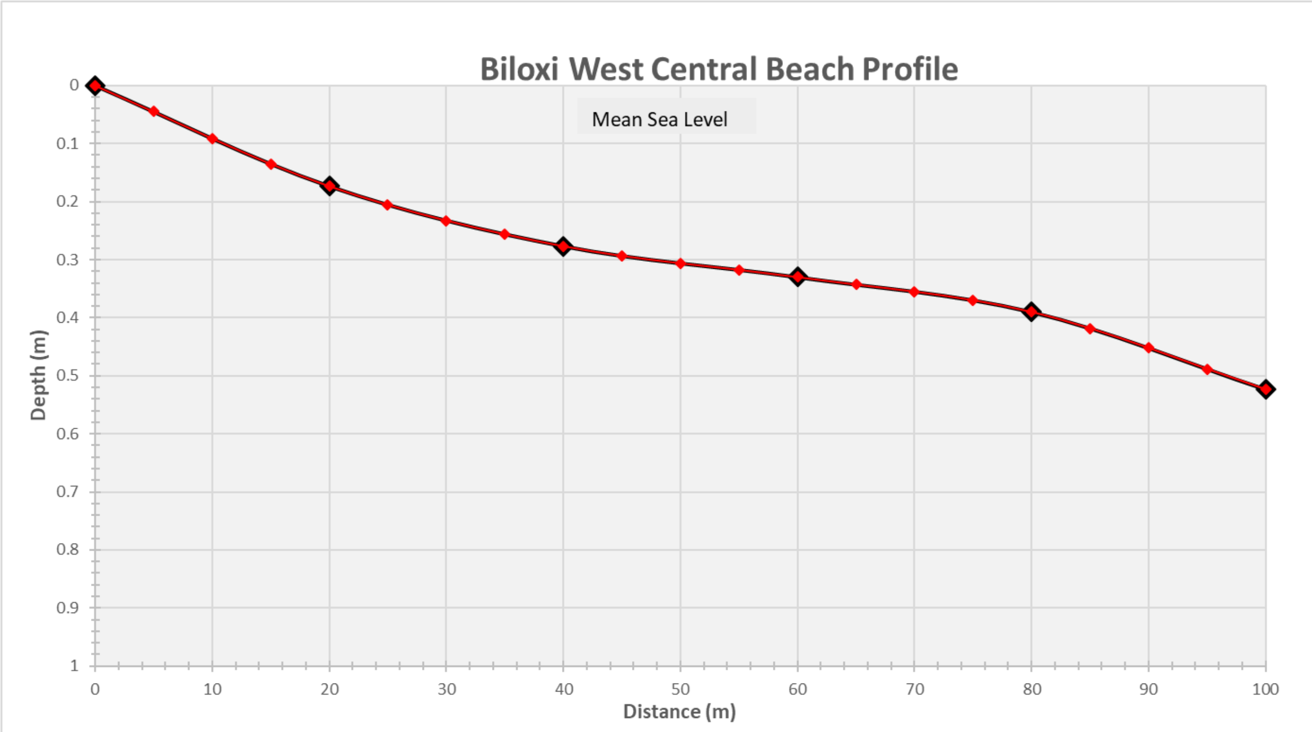


Figure 27. Biloxi West Central Beach Underwater Profile

2.2.14 Biloxi East Central Beach Enterococci Data

From St. Peter Street to Dukate Street.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfus per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 years Geomean All (cfu/100ml)
3,704.4	1.36E+05	96.84	5.65E+06	35.00	4.77E+06	31% to 64%	66.00

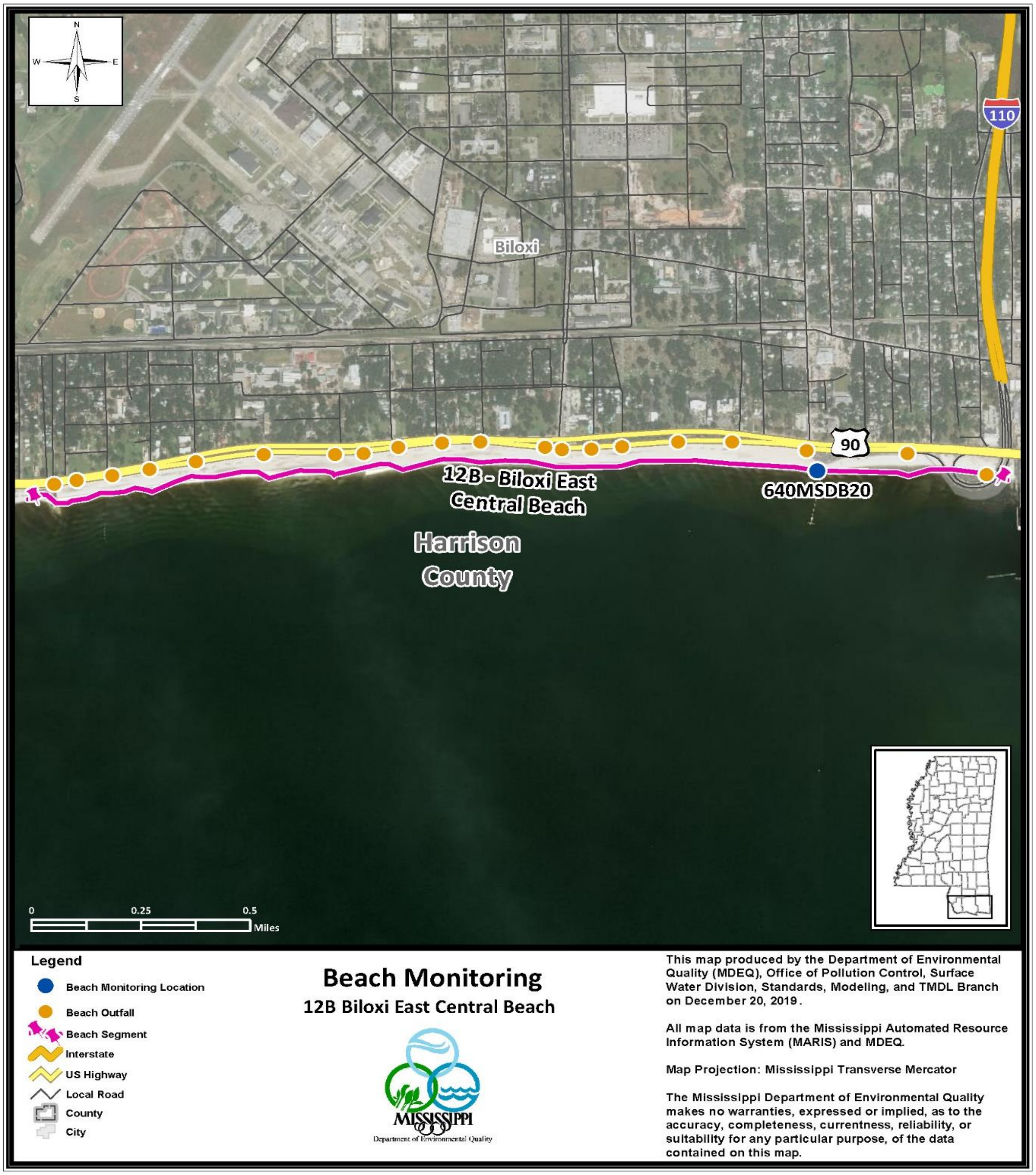


Figure 28. Biloxi East Central Beach Aerial View with Culverts

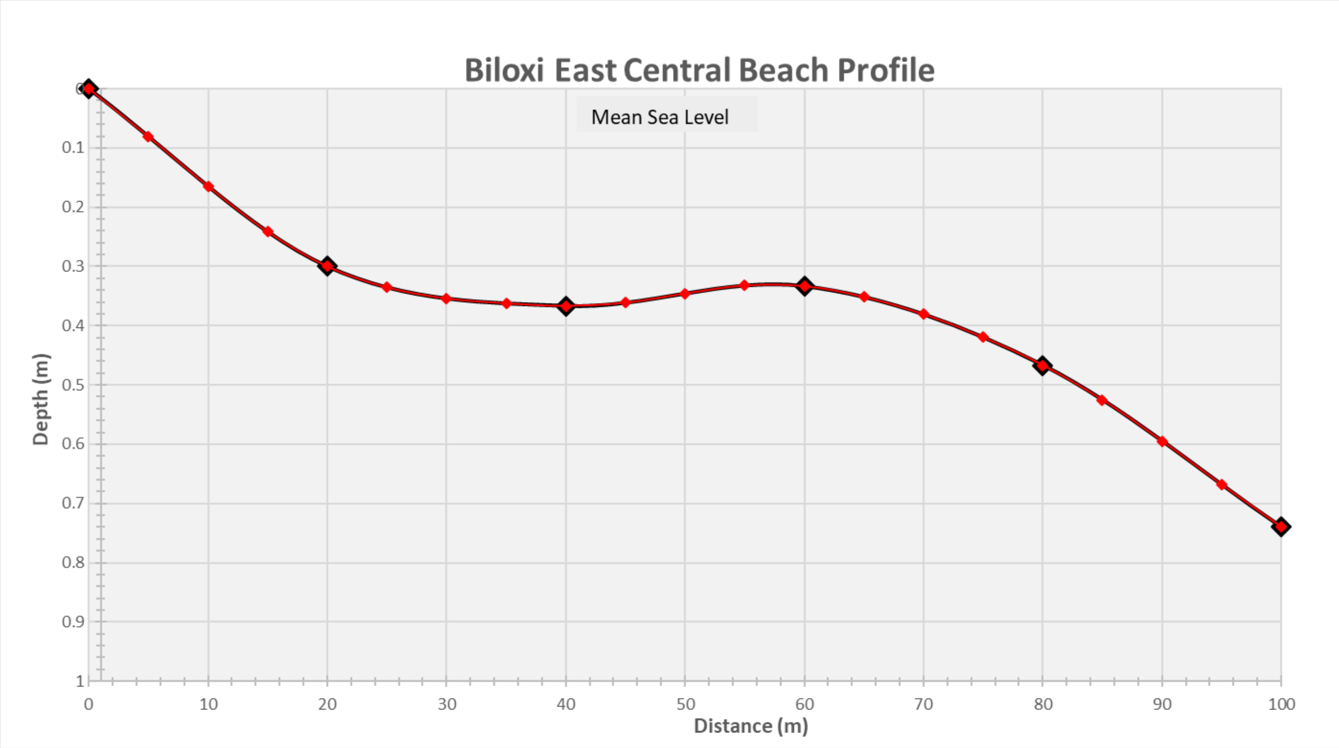


Figure 29. Biloxi East Central Underwater Profile

2.2.15 Pascagoula West Beach Enterococci Data

From Westwood Street to Grand Oaks.

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 year Geomean All (cfu/100ml)
1,897.2	9.72E+04	84.09	3.52E+06	35.00	3.40E+06	6% to 48%	31.92

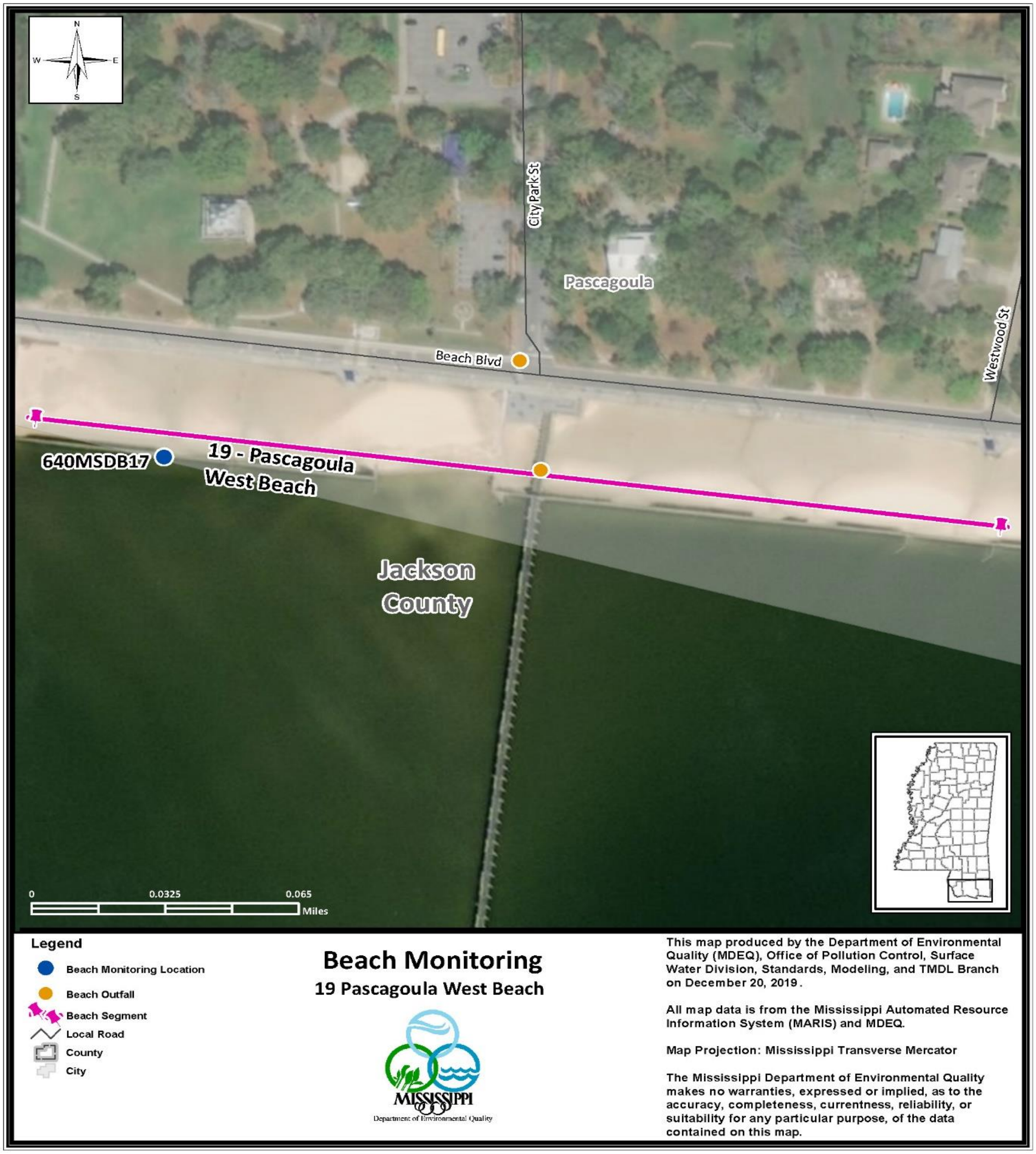


Figure 30. Pascagoula West Beach Aerial View with Culverts

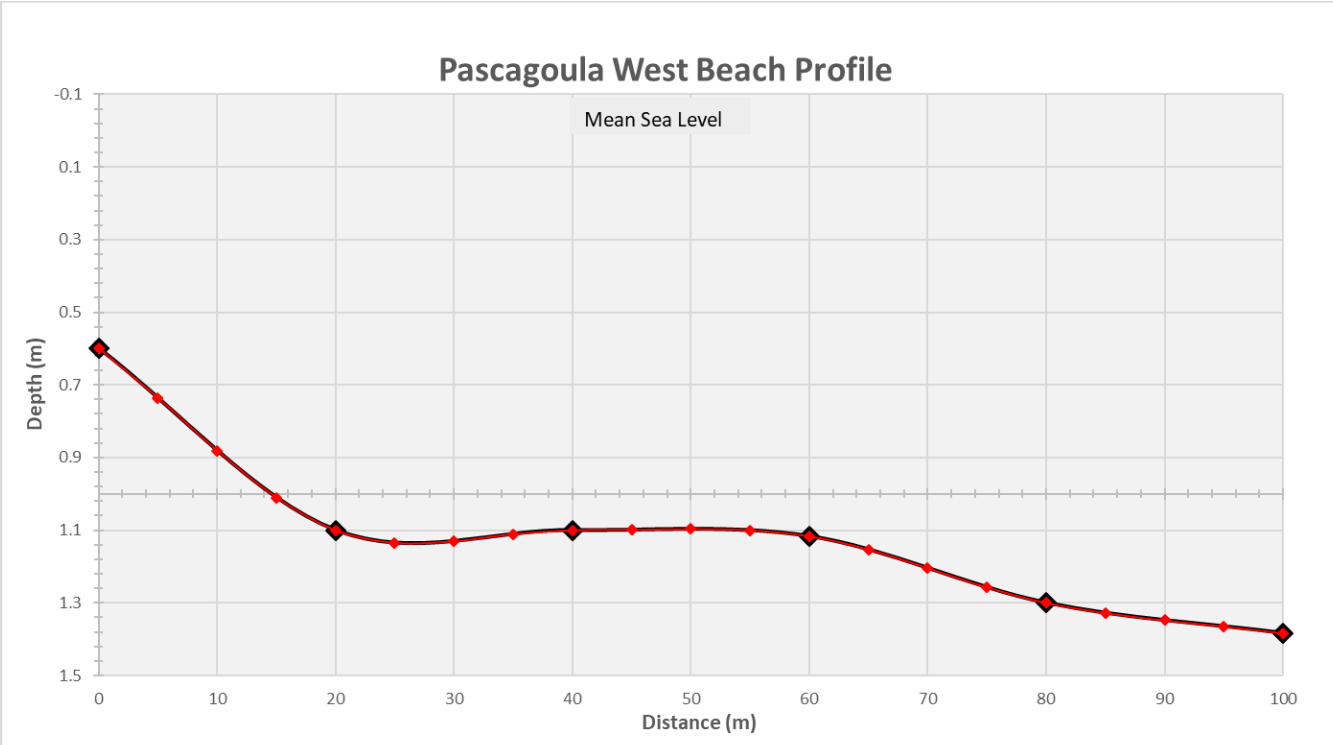


Figure 31. Pascagoula West Branch Underwater Profile

2.2.16 Pascagoula East Beach Enterococci Data

Beach Length(m)	Beach Volume (m3)	Existing concentration (cfu/100ml)	Existing Load (cfu per day)	Water Quality Standard Conc. (cfu/100ml)	TMDL Load (cfu per day)	% Reduction	5 Year Geomean All (cfu/100mL)
464.37	6.61E+04	72.79	2.02E+06	35.00	2.31E+06	22% to 52%	24.33

From Oliver Street to Westwood Street.

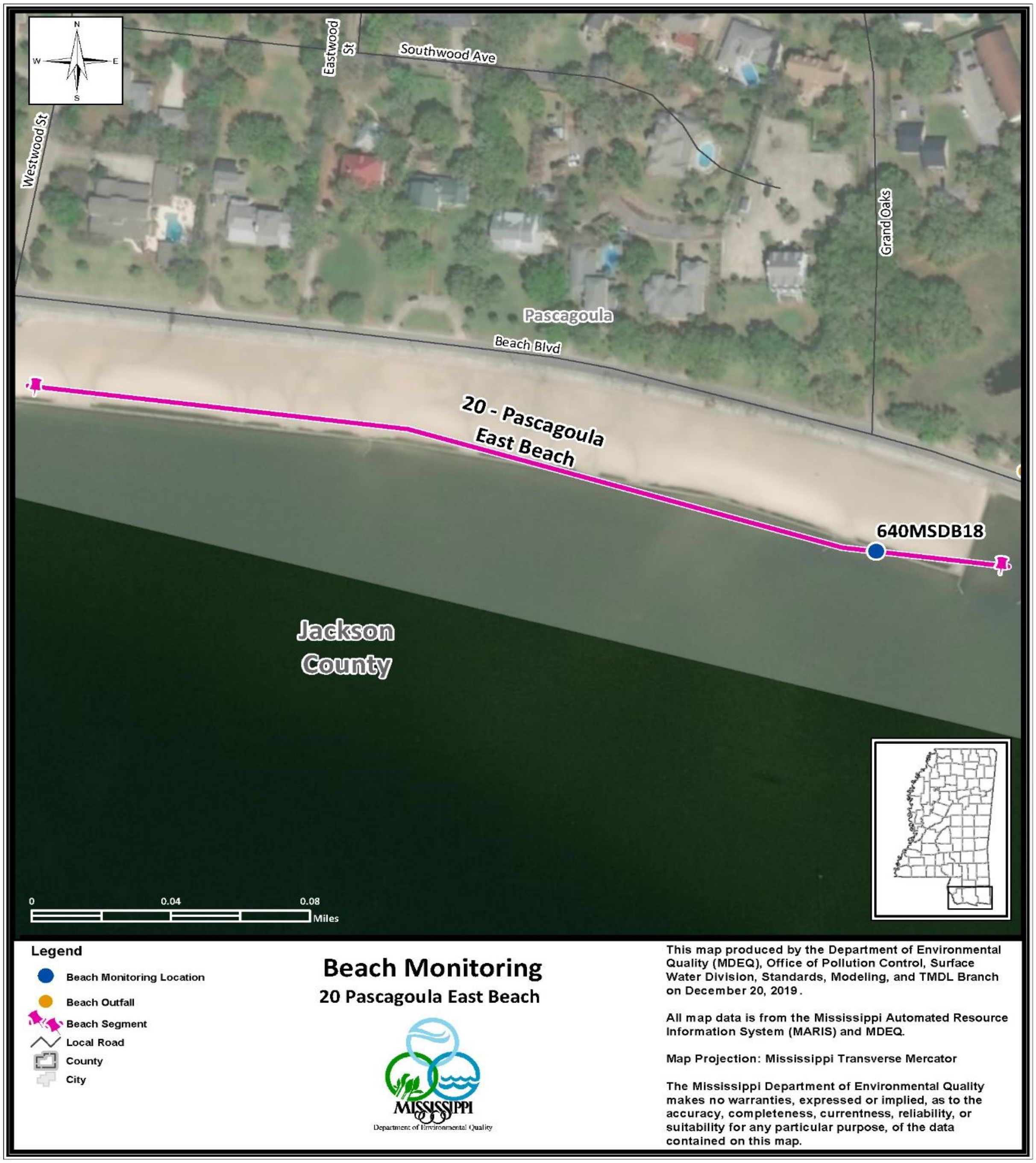


Figure 32. Pascagoula East Beach Aerial View with Culverts

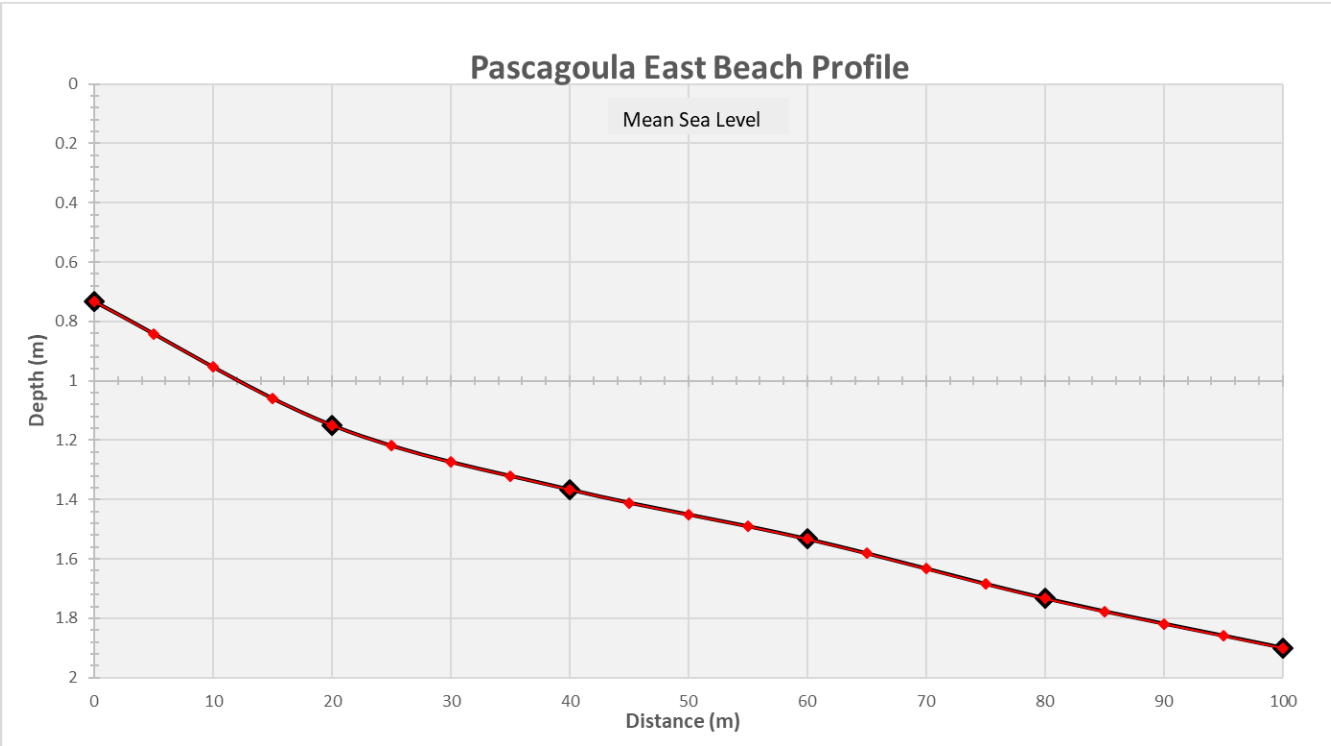


Figure 33. Pascagoula East Branch Underwater Profile

Figure 34. Concrete Seawall at Pascagoula Beach and Remnants of Pier destroyed by Hurricane Katrina

2.3 Review of Enterococci Data

Table 3 provides geometric means of enterococci bacteria levels at sixteen Mississippi beaches from 2014 through 2018. Sampling is conducted on a seasonal basis rather than annual with more intensive sampling occurring during the contact season (May through October). The geometric means that are above the 35 cfu /100 ml. are shown in red in Table 3 below. The geomean of all data collected during 5 year data window has been added for reference.

Table 3. Enterococci Geometric Mean Values by Beach and Year

Beach	Non-Contact 2013-2014	Contact 2014	Non-Contact 2014-2015	Contact 2015	Non-Contact 2015-2016	Contact 2016	Non-Contact 2016-2017	Contact 2017	Non-Contact 2017-2018	Contact 2018	Geomean All
Lakeshore Beach	14.29	14.46	12.166	7.24	64.37	100.96	58.03	13.51	44.65	27.11	31.63
Waveland Beach	24.09	7.64	11.36	7.24	74.07	55.69	69.87	20.26	47.27	27.56	27.60
Bay St. Louis Beach	24.78	8.02	12.37	14.20	51.07	52.93	69.24	24.60	31.54	22.35	26.41
Pass Christian West Beach	79.72	11.15	44.19	18.02	81.58	70.87	126.16	39.86	97.11	34.97	48.00
Pass Christian Central Beach	7.10	8.83	5.58	14.53	17.50	53.13	38.14	27.76	17.31	53.17	20.95
Pass Christian East Beach	13.30	12.77	6.48	18.17	23.86	94.89	28.05	52.03	48.06	41.30	30.35
Long Beach Beach	19.10	27.28	6.86	26.79	42.70	76.23	47.10	50.90	69.39	58.85	39.31
Gulfport West Beach	12.41	13.39	13.87	12.18	41.04	83.04	34.43	53.38	22.36	40.31	30.45
Gulfport Harbor Beach	17.07	18.65	25.71	19.48	51.25	75.84	46.11	78.02	34.91	43.55	38.62
Gulfport Central Beach	36.18	36.01	25.12	36.63	77.75	120.47	113.89	99.09	77.20	67.77	65.67
East Courthouse Road Beach	41.72	13.05	22.57	35.78	40.35	75.18	49.33	61.32	51.12	81.07	51.45
Edgewater Beach	18.82	9.21	12.27	16.58	35.58	90.43	44.74	82.10	28.02	76.32	36.02
Biloxi West Central Beach	17.11	10.81	8.42	15.84	22.01	86.31	37.94	82.94	31.40	58.96	42.72
Biloxi East Central Beach	24.97	16.24	24.24	31.34	25.90	96.83	66.22	58.18	34.32	50.48	66.00
Pascagoula West Beach	10.14	7.55	4.78	6.21	49.18	84.08	75.66	59.37	25.96	56.20	30.01
Pascagoula East Beach	4.88	5.19	4.70	5.30	45.15	47.97	72.78	46.15	16.09	66.47	24.33

SOURCE ASSESSMENT

Under the CWA, sources are broadly classified as either point or nonpoint sources. Under 40 CFR §122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Point sources can be described by two broad categories: 1) NPDES regulated municipal and industrial wastewater treatment plants (WWTPs) and 2) NPDES regulated industrial activities (which include construction activities) and municipal storm water discharges (Municipal Separate Storm Sewer Systems [MS4s]). For the purposes of this TMDL, all sources of enterococci loading are regulated by NPDES permits through either individual permits or the MS4 general permit.

3.1 Assessment of Point Sources

The three coastal counties have MS4 permits which regulate, among other things, the storm water culverts and open conveyances to the beaches. The location for each of these culverts is shown in the aerial photography in the preceeding section.

Figure 35. Typical Storm water Culvert discharging on the Beach

3.2 Assessment of Nonpoint Sources

There are other potential nonpoint sources of enterococci bacteria for the beaches, including:

- Failing septic systems
- Wildlife Direct Inputs
- Urban development
- Failed waste water infrastructure

3.2.1 Failing Septic Systems

Septic systems have a potential to deliver enterococci bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat wastewater and dispose of the water through a series of underground field lines or the use of a drip or spray irrigation system. These systems can fail when the field lines are broken, or when the underground substrate is clogged or flooded. A failing septic system's discharge can reach the surface, where it becomes available for wash-off into the environment. Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, treatment systems are occasionally bypassed entirely resulting in transport directly to open water or other conveyance to the beaches.

Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are in wide use in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems may not receive the maintenance needed for proper, long-term operation including the required disinfection to properly operate. When this expense is ignored, the water does not receive adequate disinfection prior to release.

Septic systems have an impact on nonpoint source enterococci impairment in the Coastal Basin. The best management practices needed to reduce this pollutant load need to prioritize eliminating septic tank failures and improving maintenance and proper use of individual onsite treatment systems.

3.2.2 Wildlife

Not all wildlife contributes to the enterococci load in these water bodies. Small mammals and birds, including pets, are the most prevalent contributors. No effort was made in the TMDL to distinguish between the human and animal sources. This should be re-evaluated as sampling and analytical resources become available.

3.2.3 Urban Development and Other Direct Inputs

Other direct inputs of enterococci bacteria to the beaches include illicit discharges, human recreation, and leaking sewer collection lines. Urban areas front the majority of these beach areas. Enterococci bacteria contributions from urban areas come from storm water runoff and runoff contribution from improper disposal of sewage, lift station malfunctions, sewer line breaks, or other failures of wastewater infrastructure.

MASS BALANCE PROCEDURE

Establishing the relationship between the instream water quality target and the source loading is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions.

4.1 Modeling Framework Selection

A mass balance approach was used to calculate the TMDLs for the beaches. This method of analysis was selected because the nature of the water body precluded the use of more complex methods. The mass balance approach utilizes the conservation of mass principle. Loads are calculated by multiplying the enterococci concentration in the water body by a volume of water. The principle of the conservation of mass allows for the addition and subtraction of those loads to determine the appropriate numbers necessary for the TMDL and its components.

4.2 Calculation of Allowable Load

For each beach the volume of water was estimated for the mass balance calculation. Staff gathered soundings, or the depth in meters of the water body at three transects in each beach segment. These depths were then averaged to estimate the depth gradient of each beach. The depth gradient estimation was calculated using an excel spreadsheet formula that interpolated the depth between the sounding points. The resulting depth gradients were used to calculate the volume of water out to 100 meters for each beach. Given the small tidal elevation range and the minimal gradient of the beach segments, tidal variations in volume were assumed to be negligible. The enterococci loads were calculated using the following relationship:

Load (cfu/day) = [**Concentration** (cfu/100 ml)] * [**Volume at 100 meters from shoreline** (m^3/day)] * (Conversion Factor)

where (Conversion Factor) = 1,000,000 ml/m^3

4.3 Calculation of Existing Load

For the calculation of the existing load, highest and lowest exceedances of all seasonal geometric means within the 5-year data window was calculated. The percent reductions reported in the TMDL are based on the difference between the existing load and the water quality standard to calculate the reductions needed at each beach.

ALLOCATION

A TMDL includes a Waste Load Allocation (WLA) for point sources, a Load Allocation (LA) for nonpoint sources, and a margin of safety (MOS).

5.1 Wasteload and Load Allocations

The storm water culverts are considered point sources under the MS4 NPDES permit. However, there is no way to quantify or characterize the distinction between the point and nonpoint source allocations for the beaches coming from the stormwater culverts. Therefore, to meet the requirements of an approvable TMDL, the WLA and LA will be divided equally from the TMDL minus the MOS.

5.2 Incorporation of a Margin of Safety (MOS)

The two types of MOS development are to implicitly incorporate the MOS using conservative assumptions or to explicitly specify a portion of the total TMDL as the MOS. For these beaches, the MOS has been set at 10% of the total load.

5.3 Calculation of the TMDL

The TMDLs were calculated based on the following equation:

TMDL = WLA + LA + MOS

where WLA is the Waste Load Allocation, LA is the Load Allocation, and MOS is the Margin of Safety.

WLA = NPDES Permitted Discharges (MS4 Storm Water)

LA = Surface Runoff + Other Direct Inputs

MOS = 10% explicit

The TMDLs were calculated based on the estimated volume of water in each beach within 100 meters and an enterococci concentration of 35 cfu/100ml. The difference between the existing geometric mean and the target (35 cfu/100ml.) is given in Table 4 as a percent reduction range for each beach.

Table 4. Enterococci TMDL Components for Each Beach

Beach Name	WLA (cfu per day)	LA (cfu per day)	MOS (cfu per day)	Total TMDL (cfu per day)	TMDL Percent Reduction
Lakeshore Beach	8.96E+10	8.96E+10	1.99E+10	1.99E+11	23% to 65%
Waveland Beach	2.41E+11	2.41E+11	5.37E+10	5.37E+11	9% to 53%
Bay St. Louis Beach	5.30E+10	5.30E+10	1.18E+10	1.18E+11	31% to 49%
Pass Christian West Beach	3.69E+10	3.69E+10	8.21E+09	8.21E+10	9% to 64%
Pass Christian Central Beach	1.44E+11	1.44E+11	3.20E10	3.20E+11	8% to 34%
Pass Christian Each Beach	2.36E+11	2.36E+11	5.24E+10	5.24E+11	15% to 63%
Long Beach Beach	1.29E+11	1.29E+11	2.88E+10	2.88E+11	18% to 54%
Gulfport West Beach	1.39E+11	1.39E+11	3.09E+10	3.09E+11	13% to 58%
Gulfport Harbor Beach	1.35E+11	1.35E+11	3.00E+10	3.00E+11	32% to 55%
Gulfport Central Beach	4.83E+10	4.83E+10	1.07E+10	1.07E+11	3% to 65%
East Courthouse road Beach	7.77E+10	7.77E+10	1.73E+10	1.73E+11	2% to 57%
Edgewater Beach	1.83E+11	1.83E+11	4.08E+10	4.08E+11	2% to 61%
Biloxi West Central Beach	1.32E+11	1.32E+11	2.93E+10	2.93E+11	8% to 59%
Biloxi East Central Beach	2.15E+11	2.15E+11	4.77E+10	4.77E+11	31% to 64%
Pascagoula West Beach	6.87E+10	6.87E+10	1.53E+10	1.53E+11	29% to 58%
Pascagoula east Beach	1.04E+11	1.04E+11	2.31E+10	2.31E+11	22% to 52%

5.4 Seasonality

While beach use is somewhat seasonal, the standard is the same for both contact and non-contact seasons. Therefore, this TMDL is appropriate for all seasons.

CONCLUSION

Primary contact recreation waters, such as those listed in this TMDL, are not appropriate for receiving treated effluent and discharges to them will not be considered. MDEQ recommends implementation of both structural and non-structural Best Management Practices (BMPs) to reduce enterococci bacteria in the recreational waters along Mississippi's Coast. These should include identification of and repairs to wastewater collection system leaks as well as reengineering of the storm water culverts discharging into the primary water contact areas on the beaches.

6.1 Future Monitoring

Mississippi's Beaches will receive ongoing monitoring to report water quality for recreational activities in the future. MDEQ will continue to encourage Best Management Practices to improve water quality and the environment. As additional information becomes available, this TMDL may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in land use within the watershed. In some cases, additional water quality data may indicate that no exceedances exist.

6.2 Public Participation

This TMDL will be published for a 30-day public notice published in the statewide newspaper and a newspaper on the Mississippi Coast. The public will be given an opportunity to review the TMDL and submit comments. MDEQ also distributes all TMDLs to those members of the public who have requested to be included on a TMDL email list. Anyone wishing to be included on the TMDL email list should contact Shawn Clark at sclark@mdeq.ms.gov. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public meeting. All written comments received during the public notice period and at any public meeting become a part of the record of this TMDL. All comments will be considered in the ultimate completion of this TMDL for submission of this TMDL to EPA Region 4 for final approval.

REFERENCES

Federal Register, Tuesday, November 16, 2004. Part II Environmental Protection Agency. 40 CFR Part 131, Water Quality Standards for Coastal and Great Lakes Recreation Waters; Final Rule.

Horner, 1992. Water Quality Criteria/Pollutant Loading Estimation/Treatment Effectiveness Estimation. In R.W. Beck and Associates. Covington Master Drainage Plan. King County Surface Water Management Division, Seattle, WA.

Horsley & Whitten, Inc. 1996. Identification and Evaluation of Nutrient Bacterial Loadings to Maquoit Bay, Brunswick, and Freeport, Maine. Casco Bay Estuary Project.

Jackson County, Mississippi Website. http://www.co.jackson.ms.us/JCHome_page.htm

Lee, C.C.. 1998. *Environmental Engineering Dictionary*. 3rd Edition. Government Institutes, Inc., Rockville, Maryland.

Metccalf and Eddy. 1991. *Wastewater Engineering: Treatment, Disposal, Reuse*. 3rd Edition. McGraw-Hill, Inc., New York.

MDEQ. 2001. *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification.* Office of Pollution Control.

MDEQ. 2002. *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Office of Pollution Control.

MDEQ. 2002. *Mississippi List of Water Bodies, Pursuant to Section 303(d) of the Clean Water Act*. Office of Pollution Control.

MDEQ. 2000. *Mississippi 2000 Water Quality Assessment, Pursuant to Section 305(b) of the Clean Water Act. Pascagoula River Supplement*. Office of Pollution Control.

NCSU. 1994. *Livestock Manure Production and Characterization in North Carolina*, North Carolina Cooperative Extension Service, North Carolina State University (NCSU) College of Agriculture and Life Sciences, Raleigh, January 1994.

National Shellfish Sanitation Program. 1999. *Model Ordinance,* Interstate Shellfish Sanitation Conference.

NOAA. 2001. *NOAA Electronic Navigational Charts Direct to GIS*. Office of Coast Survey, Silver Spring, MD, http://nauticalcharts.noaa.gov/csdl/ctp/encdirect_new.htm

Sheely. 2002. *Load Duration Curves: Development and Application to Data Analysis for Streams in the Yazoo River Basin, MS*. Special Project, Summer 2002, Jackson Engineering Graduate Program.

USDA. 2004. *2002 Census of Agriculture*. U.S. Department of Agriculture, National Agricultural Statistics Service, Washington, D.C.

US Department of Commerce. 2001. *Tidal Datums and their Applications*. National Oceanic and Atmospheric Administration, NOAA Special Publication NOS CO-OPS 1.

USEPA. 1998. *Better Assessment Science Integrating Point and Nonpoint Sources, BASINS, Version 2.0 User's Manual*. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

USEPA. 2004. *Water Quality Standards for Coastal and Great Lakes Recreational Waters; Final Rule.* U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

USM. 2002. *Mississippi Tide, Sun, Moon Information Glossary*. Gulf Coast Research Laboratory, Ocean Springs, MS. http://www.usm.edu/gcrl/MStide/tideglos.htm