

# Contents

<b>Section 3</b>	<b>Infrastructure Deficiencies Affecting Economic Development, Growth and Quality of Life .....</b>	<b>3-1</b>
3.1	Introduction.....	3-1
3.2	Surface Waters and Ground Waters .....	3-1
3.2.1	Current Regulatory Issues.....	3-1
3.2.1.1	Surface Water Quality Standards.....	3-1
3.2.1.2	Filling and Dredging Water Bodies and Wetlands .....	3-3
3.2.2	Historical Surface Water Quality Impairment and TMDLs .....	3-3
3.2.2.1	Water Quality Impairments.....	3-3
3.2.2.2	TMDLs .....	3-6
3.2.3	Historical Groundwater Quantity and Quality.....	3-12
3.2.3.1	Groundwater Quantity.....	3-12
3.2.3.2	Ground Water Quality .....	3-13
3.2.4	Historical Surface Water Quality Impacts .....	3-14
3.2.5	Effect on Economic Development, Growth, and Quality of Life.....	3-17
3.2.6	Water Quality Impacts of Katrina .....	3-29
3.3	Water Supply, Treatment, and Transmission.....	3-30
3.3.1	Current Regulations .....	3-30
3.3.2	Historical Deficiencies .....	3-30
3.3.2.1	Anticipated Well Yields.....	3-30
3.3.2.2	Condition of Infrastructure.....	3-31
3.3.2.3	Operational Issues.....	3-31
3.3.2.4	Effect on Economic Development, Growth, and Quality of Life.....	3-32
3.3.2.5	Effectiveness of Existing Management Practices .....	3-32
3.3.3	Katrina-Related Impacts and Anticipated Vulnerabilities .....	3-33
3.3.4	Existing Facility and Hazard Mitigation Plans .....	3-34
3.4	Wastewater Collection, Treatment, and Disposal.....	3-36
3.4.1	Current Regulations .....	3-36
3.4.2	Historical Deficiencies .....	3-39
3.4.3	Existing Condition of Infrastructure and Operational Issues .....	3-39
3.4.4	Water Quality Impacts.....	3-46
3.4.5	Effect on Economic Development, Growth, and Quality of Life.....	3-46
3.4.6	Katrina-Related Impacts and Anticipated Vulnerabilities .....	3-47
3.4.7	Existing Facility, Recovery, and Hazard Mitigation Plans .....	3-48

3.5	Flood Control, Drainage, and Stormwater Management .....	3-50
3.5.1	Current Regulations .....	3-50
3.5.1.1	Stormwater Quality Control Regulations .....	3-50
3.5.1.2	Stormwater Design and Regulatory Compliance Manuals.....	3-52
3.5.2	Historical Deficiencies .....	3-53
3.5.2.1	Floodplain Management .....	3-54
3.5.2.2	Effect on Economic Development, Growth, and Quality of Life.....	3-54
3.5.3	Administrative and Operational Issues .....	3-55
3.5.3.1	Enforcement of Regulations.....	3-55
3.5.3.2	System Operation and Maintenance .....	3-61
3.5.3.3	Education.....	3-61
3.6	Inter-Jurisdictional Issues .....	3-61
3.6.1	Water Supply, Treatment and Distribution.....	3-61
3.6.2	Wastewater Collection and Treatment.....	3-62
3.6.3	Flood Control, Drainage and Stormwater Management .....	3-63

## Figures

Figure 3-1	Gulf Region: Water Quality Issues.....	3-16
Figure 3-2	Beach Monitoring Stations .....	3-22
Figure 3-3	Oyster Harvesting Zones.....	3-24
Figure 3-4	Gulf Region: Water Supply Infrastructure: Surge Inundation Limit .....	3-35
Figure 3-5	Wastewater Facilities for the Gulf Region .....	3-43
Figure 3-6	Mississippi Gulf Region: Drainage Basins & Watersheds .....	3-64

## Tables

Table 3-1	Infrastructure Deficiency Matrix .....	3-2
Table 3-2	Designated Uses other than “Fish and Wildlife” in the Gulf Region.....	3-4
Table 3-3	Approved TMDLs for the Gulf Region by Basin .....	3-7
Table 3-4	Pre-Katrina Water Quality Issues Within the Gulf Region.....	3-15
Table 3-5	Water Quality Issues in the USACE Sub-watershed Study Area .....	3-18
Table 3-6	Mississippi Beach Closure History.....	3-19
Table 3-7	Comparison of Historical to Post Katrina Fishery Productivity .....	3-26
Table 3-8	Change in Extent of Emergent Wetlands, 1972 to 2000.....	3-27
Table 3-9	Land Use for Hancock, Harrison and Jackson Counties.....	3-28
Table 3-10	Aggregate Pumping Capacity of Wells in the Gulf Region.....	3-31
Table 3-11	Technical Capacity Assessment Summary.....	3-31
Table 3-12	Management Capacity Assessment Summary .....	3-33
Table 3-13	Katrina-Related Impacts to Water Supply Infrastructure.....	3-33
Table 3-14	Recent Clean Water Act Compliance Actions in the Gulf Region .....	3-37
Table 3-15	Permitted Treatment Facilities within the Storm Surge Limits.....	3-40
Table 3-16	MDEQ Stormwater Phase II General Permits Applicable to the Gulf Region.....	3-51
Table 3-17	Regulated Small MS4 Permit Requirements.....	3-52
Table 3-18	Illicit Discharge Detection and Elimination Program - Progress of Stormwater Phase II Entities as of Last Annual Report .....	3-57
Table 3-19	Construction Site Ordinances - Progress of Stormwater Phase II Entities as of Last Annual Report .....	3-58
Table 3-20	Post Construction Site Ordinances - Progress of Stormwater Phase II Entities as of Last Annual Report.....	3-60
Table 3-21	Relationship between Jurisdictions and Watersheds .....	3-63

# Section 3

## Infrastructure Deficiencies Affecting Economic Development, Growth and Quality of Life

### 3.1 Introduction

The current section addresses specific deficiencies identified in the water, wastewater, and stormwater infrastructure of the Gulf Region, particularly as those deficiencies impact redevelopment and preparations for growth going forward. As discussed in Section 2 many of the systems that provided utility service in the planning area already were faced with deficiencies and other issues that impacted their service prior to Katrina. In such cases the impacts of the storm merely exacerbated existing conditions and highlighted the need to address long-standing problems associated with quality of life and continued capacity for growth.

The following subsections outline utility deficiencies and vulnerabilities that give rise to specific infrastructure needs in the six counties. In order to provide a basis for evaluating these deficiencies and needs and for prioritizing region-wide improvements, **Table 3-1** was developed for use in later sections of the Plan.

### 3.2 Surface Waters and Ground Waters

#### 3.2.1 Current Regulatory Issues

##### 3.2.1.1 Surface Water Quality Standards

Under the Clean Water Act (CWA), water quality standards are developed and adopted as part of both state and federal regulations that support the goal of “swimmable/fishable” water bodies. Such standards are intended to protect, maintain and improve the quality of the nation’s surface waters and are reviewed and modified, where necessary, every three years. The water quality standards apply to ambient waters and are used to determine effluent limits for NPDES permits. If discharges are in compliance with their respective NPDES permits and standards are still not met, then a Total Maximum Daily Load (TMDL) study is required to determine further pollutant loading reductions. Standards are established for various designated uses, including fish and wildlife, recreational use, shellfish harvesting, and public water supply.

Mississippi’s most recent water quality standards were approved by EPA on June 7, 2003, and include four major components: 1) designated uses, 2) narrative “free from” criteria, 3) numeric criteria, and 4) anti-degradation provisions. Specific water-quality standards are developed based on the designated uses. The narrative “free from” criteria include requirements such as, all surface waters shall be free from sludge, floating debris, oil and scum, color and odor producing materials, and substances that are harmful to human, animal, or aquatic life. Mississippi uses national criteria from the EPA and other scientific information to set numeric water quality criteria.

Type of Deficiency		Affected Infrastructure						Adversely Effects			
		Water Supply	Water Treatment and Distribution	Wastewater Collection and Treatment	On-site Systems and Wells	Flood Control and Drainage	Storm Water Quality Management	Tourism	Economic Development	Growth	Quality of Life
Physical Infrastructure Issues	Lack of Adequate Infrastructure	X	X	X	X	X	X	X	X	X	X
	Vulnerability of infrastructure to storm damage	X	X	X	X	X	X	X	X	X	X
	Saltwater Intrusion	X							X	X	X
	Lack of Freshwater Reservoirs	X				X		X	X	X	X
	Lack of planning for future growth	X	X	X	X	X	X	X	X	X	X
	Location of discharge points relative to shellfish beds			X	X		X		X		X
	More stringent effluent limits for impaired waters / TMDLs			X	X		X		X	X	X
	Failing Septic Tanks and Sanitary Sewer Overflows	X	X	X	X		X	X	X	X	X
	Flooding Caused by Undersized stormwater infrastructure					X			X	X	X
	Flooding Caused by encroachment into floodplains					X		X			X
	caused by inadequate control of increased imperviousness					X	X	X	X		X
	Non-storm water discharges from storm drains						X	X	X		X
	Inadequate storm drain capacity for I/I removed from sanitary sewers			X		X	X	X	X	X	X
	Lack of consistent regional infrastructure design criteria		X	X	X	X	X		X	X	X
	Low aquifer yields in areas	X							X	X	X
	Objectionable taste, odor, and color of drinking water	X	X					X	X	X	X
Lack of adequate fire protection		X						X	X	X	
Regulatory/Jurisdictional Issues	Conflicts with Environmentally Sensitive Areas	X	X	X	X	X		X	X	X	X
	Historic wetland loss					X	X		X		X
	Lack of sufficient regulatory control including zoning, storm water management, and septic tank laws				X		X		X	X	X
	Lack of coordinated governmental effort to address interjurisdictional	X	X	X	X	X	X	X	X	X	X
	Poor erosion, sediment, and construction material controls						X		X		X
	Poor stormwater management plans					X	X	X	X	X	X
Lack of regulatory oversight for well locations	X			X				X	X	X	
Resource Issues	Underfinanced utility companies	X	X	X						X	X
	Inadequately trained operating personnel	X	X	X	X	X	X				X
	Lack of dedicated stormwater funding					X	X				X

**Table 3-1 Infrastructure Deficiency Matrix**

Criteria for approximately 36 chemicals have been adopted by the state. The anti-degradation policy has been established to protect existing water quality and to upgrade or enhance the State's surface waters.<sup>1</sup>

### **3.2.1.2 Filling and Dredging Water Bodies and Wetlands**

Section 404 of the CWA regulates the discharge of dredged or fill material into U.S. waters and wetlands.<sup>2</sup> Overall, the program is intended to prevent the discharge of dredge or fill material where practical alternatives exist that cause less damage to the aquatic environment, or if U.S. waters would be significantly degraded by the discharge or dredge activity. To obtain a permit, a discharger must implement measures to avoid impacts to water bodies or to provide compensation for any unavoidable impacts.

Section 401 of the CWA, entitled "Certification and Wetlands," requires states to evaluate whether a proposed project is in compliance with water quality standards and define mitigation requirements for unavoidable impacts.

The Mississippi Coastal Zone Wetland Permits webpage directs those looking for construction permits to the USACE, Mobile District, General Permit Program.<sup>3</sup> Each permit listed in the document contains specific requirements that regulate different construction activities.

## **3.2.2 Historical Surface Water Quality Impairment and TMDLs**

### **3.2.2.1 Water Quality Impairments**

MDEQ has designated uses for receiving waters in the Gulf Region and established water quality criteria appropriate for each category. Every receiving water must, as a minimum, meet water quality criteria for fish and wildlife designated use. **Table 3-2** lists the other designated uses that MDEQ has classified for these receiving waters.

The Mississippi 2004 Section 303(d) List of Impaired Water Bodies identifies all water bodies that have use impairment due to a pollutant. Each impaired water body is required to have a total maximum daily load (TMDL) developed for constituents that exceed water quality standards. The next subsection discusses TMDLs in more detail, as well as their regulatory impact on treatment and discharge activities.

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<sup>1</sup> For water quality standards applicable to Mississippi's surface waters, see the document entitled "State of Mississippi Water Quality Criteria for Intrastate, Interstate and Coastal Waters";

<http://www.deq.state.ms.us/newweb/MDEQRegulations.nsf/RN/WPC-2>.

<sup>2</sup> <http://www.epa.gov/owow/wetlands/laws/>

<sup>3</sup> <http://www.dmr.state.ms.us/Coastal-Ecology/permitting/Mobile-District-USACE.pdf>.

<b>Waters</b>	<b>From</b>	<b>To</b>	<b>Designated Use</b>
Back Bay of Biloxi	Popps Ferry Bridge	Biloxi Bay	Recreation
Bangs Lake	Headwaters	Mississippi Sound	Shellfish Harvesting
Bayou Cumbest	Headwaters	Mississippi Sound	Shellfish Harvesting
Big Lake	Bernard Bayou	Popps Ferry Bridge	Recreation
Biloxi Bay	Headwaters/U.S. Hwy 90 Bridge	Mississippi Sound	Shellfish Harvesting
Davis Bayou	Headwaters	Biloxi Bay	Shellfish Harvesting
Graveline Bay	Headwaters	Graveline Bayou	Shellfish Harvesting
Graveline Bayou	Graveline Bay	Mississippi Sound	Shellfish Harvesting
Jourdan River	Confluence of Bacon Bayou and Catahoula Creek	St. Louis Bay	Recreation
Mallini Bayou	St. Louis Bay	St. Louis Bay	Shellfish Harvesting
Mississippi Sound	Contiguous	Mississippi Coastline	Recreation
Old Fort Bayou	Bayou Talla	Biloxi Bay	Recreation
Pass Christian Reef-off Henderson Point	Mississippi Sound	Mississippi Sound	Shellfish Harvesting
St. Louis Bay	Harrison-Hancock Counties		Shellfish Harvesting
Tchoutacabouffa River	Headwaters	Back Bay of Biloxi	Recreation
Tuxachanie Creek	Headwaters	Tchoutacabouffa River	Recreation
Wolf River	Ms. Hwy. 26	St. Louis Bay	Recreation

**Table 3-2      Designated Uses other than “Fish and Wildlife” in the Gulf Region**

### 3.2.2.2 TMDLs

A TMDL defines acceptable loads of pollutants from point and non-point sources that should allow the water body to meet requisite water quality standards established by MDEQ. MDEQ collects water quality data for Mississippi to determine which water bodies are impaired and then schedules these waters for TMDL development. MDEQ uses computer models that incorporate scientifically accepted, mathematical methods to predict how certain pollutants will behave, based on known environmental conditions, geographic information, background pollutant levels, and contributions of pollutants from point and non-point sources. The TMDL is then developed based on the information obtained from the models.

Any new discharges or changes to existing discharges into streams with established TMDLs must not increase pollutant loading above the applicable TMDL. The limits of permits for wastewater treatment facilities (WWTFs) also must not exceed the pollutant loads in the TMDLs. Growth in areas served by the WWTFs can be limited unless compliance with established TMDLs can be demonstrated. The TMDLs may also limit the discharge locations and treatment capacities of new WWTFs and the development of areas planned for service. In areas not served by central sewerage facilities, individual onsite wastewater disposal systems (IOWDS) may be utilized. Improper installation, poor site conditions or improper operation and maintenance of IOWDS could contribute to impairment, inhibiting further development in the area.

**Table 3-3** provides a list of approved TMDLs for the Gulf Region by basin from 1999 to present.

Waterbody	Waterbody ID	County	Location	USGS HUC Code	Use Impairment	Cause of Impairment	Sources of Impairment	NPDES Permitted Discharges	TMDL Status	TMDL	Final TMDL Approval Date
<b>Coastal Streams Basin</b>											
Tidewater Bayou	MS118TBM	Jackson	At Oceans Springs	3170009	Aquatic Life Support	Organic Enrichment/Low DO	Surface runoff / background concentrations	None	Approved	424 lbs/day Total BOD, 0 Toxicity Unit	March 28, 2002
Bernard Bayou segment 3	MS118BBM3	Harrison	Near Gulfport	3170009	Aquatic Life Support	Organic Enrichment/Low DO	Surface runoff / background concentrations	5	Approved	May-Oct 14,470.5 lbs/day Total BOD, Nov-Apr: 23,683.2 lbs/day Total BOD	June 29, 2001
Bernard Bayou segment 3	MS118BBM5	Harrison	Near Gulfport	3170009	Aquatic Life Support	Nutrients	Surface runoff / background concentrations	5	Approved	May-Oct 953.1 lbs/day PO <sub>4</sub> , 463.9 lbs/day NH <sub>3</sub> -N, 735.9 lbs/day NO <sub>3</sub> -N, Nov-Apr: 1,068.9 lbs/day PO <sub>4</sub> , 2,202.8 lbs/day NH <sub>3</sub> -N, 827.6 lbs/day NO <sub>3</sub> -N	June 29, 2001
Industrial Seaway	MS118BBM5	Harrison	Near Gulfport	3170009	Aquatic Life Support	Organic Enrichment/Low DO	Surface runoff / background concentrations	5	Approved	May-Oct 14,470.5 lbs/day Total BOD, Nov-Apr: 23,683.2 lbs/day Total BOD	June 29, 2001
Industrial Seaway	MS118BBM5	Harrison	Near Gulfport	3170009	Aquatic Life Support	Nutrients	Surface runoff / background concentrations	5	Approved	May-Oct 953.1 lbs/day PO <sub>4</sub> , 463.9 lbs/day NH <sub>3</sub> -N, 735.9 lbs/day NO <sub>3</sub> -N, Nov-Apr: 1,068.9 lbs/day PO <sub>4</sub> , 2,202.8 lbs/day NH <sub>3</sub> -N, 827.6 lbs/day NO <sub>3</sub> -N	June 29, 2001
Graveline Bayou	MS118GBE	Jackson	Near Camp Lamotte	3170009	Shellfishing	Fecal Coliform	Runoff from wildlife and urban development / failing septic systems and direct inputs to Graveline Bayou	0	Approved	2.80E+13 counts per day	November 4, 2005
Bayou Cumbest/Bangs Lake	MS109BCUM	Jackson	Near Orange Grove	3170009	Shellfishing	Fecal Coliform	Surface runoff / failing septic systems	0	Approved	205 colonies/100mL (dry season), 83 colonies/100mL (wet season)	May 5, 2000
Bayou Cumbest/Bangs Lake	MS109BCUM	Jackson	Near Orange Grove	3170009	Contact Recreation	Fecal Coliform	Surface runoff / failing septic systems	0	Approved	205 colonies/100mL (dry season), 83 colonies/100mL (wet season)	May 5, 2000
Bayou Cumbest	MS109BCUE	Jackson	Near Orange Grove	3170009	Secondary Contact Recreation	Fecal Coliform	Surface runoff / failing septic systems	0	Approved	205 colonies/100mL (dry season), 83 colonies/100mL (wet season)	May 5, 2000
Bangs Lake	MS109E02M	Jackson	Near Pascagoula	3170009	Shellfishing	Fecal Coliform	Surface runoff / failing septic systems	0	Approved	199 colonies/100mL (dry season), 81 colonies/100mL (wet season)	May 5, 2000
Jourdan River	MS112M1	Hancock	Near Kiln (Catahoula and Bayou Bacon to Rotten Bayou)	3170009	Contact Recreation	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	0	Approved	Summation of loads from sources listed that result in water quality standard of geometric mean of 200 counts/100mL	December 15, 2000
Jourdan River	MS115JM1	Hancock	Near Kiln (Rotten Bayou to 115J near Edwards Bayou)	3170009	Contact Recreation	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	0	Approved	Summation of loads from sources listed that result in water quality standard of geometric mean of 200 counts/100mL	December 15, 2000
Jourdan River	MS115M1	Hancock	Near Kiln (Edwards Bayou to mouth of St. Louis Bay)	3170009	Contact Recreation	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	0	Approved	Summation of loads from sources listed that result in water quality standard of geometric mean of 200 counts/100mL	December 15, 2000
St. Louis Bay	MSSTLUBAYM	Hancock and Harrison	From inland boundary to Hwy 90 bridge	3170009	Shellfishing Harvesting and Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	0	Approved	6.88E+14 MPN/15 days	July 2, 2001
St. Louis Bay Coastline	MS115CO4M	Hancock and Harrison	From Hwy 90 bridge to Jourdan River	3170009	Shellfishing Harvesting and Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	12	Approved		July 2, 2001
St. Louis Bay Coastline near Delisle	MS114CO1M	Hancock and Harrison	From Jourdan River to Wolf River	3170009	Shellfishing Harvesting and Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	12	Approved		July 2, 2001
St. Louis Bay Coastline near Pass Christian	MS118CO1M	Harrison	From Wolf River to Hwy 90 bridge	3170009	Shellfishing Harvesting and Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	12	Approved		July 2, 2001
Jourdan River	MS112M1	Hancock	Near Kiln (Catahoula Creek to Bayou Bacon)	3170009	Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	1	Approved	6.10E+13 MPN/15 days	July 2, 2001
Wolf River	MS111M1	Harrison	Near Lizana: County Road at Sellers to mouth at St. Louis Bay	3170009	Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	1	Approved	4.22E+13 MPN/15 days	July 2, 2001
Bayou Delisle	MS114DLE	Harrison	Near Delisle	3170009	Secondary Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	1	Approved		July 2, 2001
Bayou La Croix	MS115BLCE	Hancock	Near Waveland	3170009	Secondary Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	0	Approved		July 2, 2001
Edwards Bayou	MS115EBE	Hancock	At Waveland	3170009	Secondary Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	1	Approved		July 2, 2001
Joes Bayou	MS115JOBE	Hancock	Near Bay St. Louis	3170009	Secondary Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	0	Approved		July 2, 2001

Waterbody	Waterbody ID	County	Location	USGS HUC Code	Use Impairment	Cause of Impairment	Sources of Impairment	NPDES Permitted Discharges	TMDL Status	TMDL	Final TMDL Approval Date
Jourdan River	MS115M1	Hancock	Near Kiln (Edwards Bayou to mouth of St. Louis Bay)	3170009	Secondary Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	2	Approved	1.52E+14 MPN/15 days	July 2, 2001
Rotten Bayou	MS113JE	Hancock	Near Kiln	3170009	Secondary Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	1	Approved		July 2, 2001
Cutoff Bayou	MS114JE	Hancock	Near Kiln	3170009	Secondary Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	0	Approved		July 2, 2001
Jourdan River	MS115JM1	Hancock	Near Kiln (Rotten Bayou to 115J near Edwards Bayou)	3170009	Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	1	Approved	1.18E+14 MPN/15 days	July 2, 2001
Mallini Bayou	MS118MBE	Harrison	At Pass Christian	3170009	Shellfishing	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	0	Approved		July 2, 2001
Watts Bayou	MS115WBE	Hancock	Near Waveland	3170009	Secondary Contact Recreation	Fecal Coliform	Based on nonpoint sources based on runoff wildlife and livestock populations, and urban development; point sources permitted discharges	0	Approved		July 2, 2001
Heron Bayou	MS118HBE	Jackson	Near Ocean Springs	3170009	Aquatic Life Support	Sediment/Siltation	Possible contaminants such as pesticides and nutrients	0	Approved	6.68E-5 to 3.87E-4	August 30, 2005
Bayou La Croix	MS115BLCE	Hancock	Near Waveland	3170009	Aquatic Life Support	Sediment/Siltation	Possible contaminants such as pesticides and nutrients	0	Approved	7.30E-5 to 3.89E-4	August 30, 2005
Tuxachanie Creek	MS117M2	Harrison	Near Biloxi	3170009	Contact Recreation	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	1	Approved	2.12E+12 counts/30 days	February 23, 2000
Bernard Bayou and Industrial Seaway	MS118BBM3	Harrison	Segment 3, Near Gulfport from Hwy 49 to Industrial Seaway Entrance	3170009	Aquatic Life Support	Phenol	Cavenham Forest Industries is one identified NPDES permitted point source for phenol	1	Approved	0.40 lbs/day phenol	May 24, 2002
Bernard Bayou and Industrial Seaway	MS118BBM3	Harrison	Near Gulfport from Gulfport Lake to Mouth at Big Lake	3170009	Aquatic Life Support	Phenol	Cavenham Forest Industries is one identified NPDES permitted point source for phenol	1	Approved	0.40 lbs/day phenol	May 24, 2002
Bayou Casotte	MS109E04M	Jackson	At Pascagoula: County Road on West Prong to mouth of Pascagoula Bay	3170009	Aquatic Life Support	Phenol	No sources identified in watershed	7	Approved	0 gm/day	May 24, 2002
Turkey Creek	MS118BBM1	Harrison	Near Gulfport	3170009	Aquatic Life Support	Low pH	Watershed runoff / Soil Acidity / Acidic Contribution from Pine Needles	3 (1 active)	Approved		May 20, 2001
Biloxi Bay	MS118E03M	Harrison and Jackson	At Biloxi and Ocean Springs	3170009	Shellfishing	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	48	Approved	1.85E+14 MPN/15 days	January 17, 2002
Biloxi Bay	MS118E02M2	Harrison and Jackson	From Popps Ferry Bridge to New Hwy 90 Bridge	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	48	Approved	1.73E+14 MPN/15 days	January 17, 2002
Back Bay of Biloxi	MS118CO3M	Harrison	From Popps Ferry to Hwy 90 Bridge at Ocean Springs (southern coastline)	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	48	Approved	1.73E+14 MPN/15 days	January 17, 2002
Back Bay of Biloxi	MS118CO4M	Harrison	From Popps Ferry to Hwy 90 Bridge at Ocean Springs (northern coastline)	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	48	Approved	1.73E+14 MPN/15 days	January 17, 2002
Big Lake	MS118E01M	Harrison	Near Handsboro: From Mouth of Bernard Bayou-Industrial Seaway to Popps Ferry Bridge	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	21	Approved	1.24E+14 MPN/15 days	January 17, 2002
Bernard Bayou segment 2	MS118BBM2	Harrison	Near Landon: From Headwaters West of Nugent to Hwy 49	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	0	Approved	6.18E+12 MPN/15 days	January 17, 2002
Bernard Bayou segment 3	MS118BBM3	Harrison	Near Gulfport: Hwy 49 to Industrial Seaway at Entrance to Bernard Bayou	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	5	Approved	2.94E+13 MPN/15 days	January 17, 2002
Bernard Bayou segment 4	MS118BBM4	Harrison	At Gulfport in Natural Channel: From Industrial Seaway to Mouth at Big Lake	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	5	Approved	7.34E+13 MPN/15 days	January 17, 2002
Heron Bayou	MS118HBE	Jackson	Near Ocean Springs: From Headwaters to Mouth at Davis Bayou	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	0	Approved	3.16E+12 MPN/15 days	January 17, 2002
Old Fort Bayou	MS118M1	Jackson	At Ocean Springs: From Headwaters to Washington Street Bridge	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	0	Approved	1.98E+12 MPN/15 days	January 17, 2002
Tidewater Bayou	MS118TBM	Jackson	At Ocean Springs: From Headwaters to Mouth at Biloxi Bay	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	0	Approved	5.29E+12 MPN/15 days	January 17, 2002

Waterbody	Waterbody ID	County	Location	USGS HUC Code	Use Impairment	Cause of Impairment	Sources of Impairment	NPDES Permitted Discharges	TMDL Status	TMDL	Final TMDL Approval Date
Turkey Creek	MS118BBM1	Harrison	Near Gulfport: From Canal #2 to Hwy 49	3170009	Secondary Contact	Fecal Coliform	Surface runoff / 50% of failing septic tanks and all animals in the stream	2	Approved	summer: 3.61E+12 counts/30 day critical period; winter: 8.24E+12 counts/30 day critical period	July 24, 2003
Turkey Creek	MS118BBM1	Harrison	Near Gulfport: From Canal #2 to Hwy 49	3170009	Aquatic Life Support	Low pH	Watershed runoff / Soil Acidity / Acidic Contribution from Pine Needles	3 (1 active)	Approved		December 15, 2000
Bernard Bayou Segment 3 and Industrial Seaway	MS118BBM3	Harrison	Near Gulfport: From Hwy 49 to Industrial Seaway at entrance of Bernard Bayou	3170009	Aquatic Life Support	Total Toxics	No sources identified	7	Approved	1 TUc; 1 TUa	October 31, 2003
Industrial Seaway	MS118BBM5	Harrison	Near Gulfport: From Gulfport Lake to Mouth at Big Lake	3170009	Aquatic Life Support	Total Toxics	No sources identified	7	Approved	1 TUc; 1 TUa	October 31, 2003
Bay St. Louis Beach	250111	Hancock	At Bay Saint Louis From The Culvert Just North of Ramaneda Street NE to Washington St	3170009	Primary Contact (Recreation)	Pathogens			Due 04-01-19		
Bayou Casotte	MS109E04M	Jackson	At Pascagoula from County Road on West Prong to Turning Basin	3170009	Aquatic Life Support	Organic Enrichment/Low DO Unionized Ammonia			Due 04-01-19		
Bayou Cumbest	200311	Jackson	Near Orange Grove from Headwaters to Bangs Lake	3170009	Aquatic Life Support	Organic Enrichment/Low DO			Due 04-01-19		
Biloxi West Central Beach	250314	Harrison	At Biloxi from Broadwater Marina East to Acacia Avenue	3170009	Primary Contact (Recreation)	Pathogens			Due 04-01-19		
Dead Tiger Creek	MS112DT	Hancock	Near Kiln from Headwaters to Confluence with Catahoula Creek	3170009	Aquatic Life Support	Biological Impairment			Due 04-01-19		
Flat Branch	MS118F	Harrison	Near Gulfport from Headwaters to Mouth at Bernard Bayou	3170009	Aquatic Life Support	Biological Impairment			Due 04-01-19		
Gulfport Central Beach	250312	Harrison	At Gulfport from Hewes Avenue East to Texas Avenue	3170009	Primary Contact (Recreation)	Pathogens			Due 04-01-19		
Gulfport East Beach	250313	Harrison	At Gulfport from Teagarden Road East to the Eastern Side of William Carey College	3170009	Primary Contact (Recreation)	Pathogens			Due 04-01-19		
Gulfport Harbor Beach	250311	Harrison	At Gulfport from 20th Avenue East to Hewes Avenue	3170009	Primary Contact (Recreation)	Pathogens			Due 04-01-19		
Gulfport West Beach	250311	Harrison	At Gulfport from Cleveland Avenue East to 33rd Avenue	3170009	Primary Contact (Recreation)	Pathogens			Due 04-01-19		
Orphan Creek	230811	Hancock	Near Kiln from Headwaters to Mouth at Bayou Bacon	3170009	Aquatic Life Support	Biological Impairment			Due 04-01-19		
Pascagoula Beach West	250511	Jackson	At Pascagoula from Oliver Street to Westwood Street	3170009	Primary Contact (Recreation)	Pathogens			Due 04-01-19		
Pass Christian East Beach	250211	Harrison	At Pass Christian from Market Street East to Markham Drive	3170009	Primary Contact (Recreation)	Pathogens			Due 04-01-19		
Shearwater Beach	202612	Jackson	At Oceans Springs from Weeks Bayou East to Halstead Road	3170009	Primary Contact (Recreation)	Pathogens			Due 04-01-19		
Turkey Creek	MS118BBM1	Harrison	Near Long Beach from Confluence with Canal #2 to Hwy 49	3170009	Aquatic Life Support	Biological Impairment			Due 06-23-17		
Bayou Cumbest	MS109BCUE	Jackson	Near Orange Grove from Headwaters to Point Aux Chenes Bay	3170009	Aquatic Life Support	Nutrients			Due 12-31-06		
Bayou La Croix	MS115BLCE	Hancock	Near Waveland from Headwaters to Mouth at Jourdan River	3170009	Aquatic Life Support	Organic Enrichment/Low DO/Total Toxics			Due 12-31-06		
Canal Number 3	MS118BPE	Harrison	Near Pass Christian from Canal Number 2 from Turkey Creek to Mouth at Bayou Portage	3170009	Aquatic Life Support	Nutrients			Due 12-31-06		
Cutoff Bayou	MS114JE	Hancock	From Headwaters of Cutoff Bayou to Jourdan River	3170009	Aquatic Life Support	Nutrients/Organic Enrichment/Low DO			Due 12-31-06		
Heron Bayou	MS118HBE	Jackson	Near Ocean Springs from Heaadwaters to Mouth at Davis Bayou	3170009	Aquatic Life Support	Nutrients			Due 12-31-06		

Waterbody	Waterbody ID	County	Location	USGS HUC Code	Use Impairment	Cause of Impairment	Sources of Impairment	NPDES Permitted Discharges	TMDL Status	TMDL	Final TMDL Approval Date
Mallini Bayou	MS118MBE	Harrison	At Pass Christian from S. Entrance Near Hwy 49 to N. Entrance at St. Louis	3170009	Aquatic Life Support	Nutrients/Organic Enrichment/Low DO			Due 12-31-06		
Rotten Bayou	MS113JE	Hancock, Harrison	Near Kiln from Headwaters to Jourdan River	3170009	Aquatic Life Support	Nutrients/Organic Enrichment/Low DO			Due 12-31-06		
<b>Pascagoula Basin</b>											
Red Creek	MS102RE	Pearl River	Near Lumberton	3170007	Aquatic Life Support	Organic Enrichment/Low DO	Surface runoff / background concentrations	2	Approved	3,706.7 lbs/day TBODu	June 30, 2005
Red Creek	MS102RE	Pearl River	Near Lumberton	3170007	Aquatic Life Support	Nutrients	Surface runoff / background concentrations	2	Approved	58.1 to 91.3 lbs/day TP	June 30, 2005
Unnamed tributary to Clark Bayou	MS096E2	Jackson	Near Colltown	3170006	Aquatic Life Support	Organic Enrichment/Low DO	Surface runoff / background concentrations	0	Approved	0.76 lbs/day TBODu	June 2, 2005
Whiskey Creek	MS097E	George	Near Crossroads	3170006	Aquatic Life Support	Sediment/Siltation	Possible contaminants such as pesticides and nutrients	0	Approved	5.28E-3 to 1.8E-2	May 18, 2005
Bluff Creek	MS098BE	Jackson	Near Vanleave	3170006	Aquatic Life Support	Sediment/Siltation	Possible contaminants such as pesticides and nutrients	0	Approved	4.96E-3 to 1.69E-3	May 31, 2005
Lake Yazoo	MS096E04E1	Jackson	At Pascagoula	3170009	Aquatic Life Support	Phenol	Point source contributors unknown	2	Approved	0.0044 lbs/day phenol	September 30, 2004
Lake Yazoo	MS096E04E1	Jackson	At Pascagoula	3170009	Aquatic Life Support	Hydrocarbons	Point source contributors unknown	2	Approved	N/A	September 30, 2004
Lake Yazoo	MS096E04E1	Jackson	At Pascagoula	3170009	Aquatic Life Support	Total Toxics	Point source contributors unknown	2	Approved	1.00 Toxic unit	September 30, 2004
Escatawpa River Segment 1 (fresh water)	MS107M1	George and Jackson	Near Agricola: Alabama state line to Spring Creek east of Hurley	3170008	Fish Consumption	Mercury	Point source contributions / Atmospheric deposition / natural background		Approved		June 29, 2000
Escatawpa River Segment 2 (fresh water)	MS107M2	Jackson	Near Orange Grove: Spring Creek east of Hurley to I-10 Bridge	3170008	Fish Consumption	Mercury	Point source contributions / Atmospheric deposition / natural background		Approved	4.73 gm/day	June 29, 2000
Pascagoula River	MSPASRM1	George and Jackson	Near Bennedale: Leaf River and Chickasawhay River to Pascagoula River Split	3170006	Aquatic Life Support	Mercury	Point source contributions / Atmospheric deposition / natural background	17	Approved	30.3 gm/day	March 18, 2005
East Pascagoula River	MSEPASRM1	Jackson	Near Colltown: From East West Split near Barnes Lake to Escatawpa River	3170006	Aquatic Life Support	Mercury	Point source contributions / Atmospheric deposition / natural background	17	Approved	30.3 gm/day	March 18, 2005
East Pascagoula River	MSEPASRM2	Jackson	Near Pascagoula: From Escatawpa River to mouth at Mississippi Sound	3170006	Aquatic Life Support	Mercury	Point source contributions / Atmospheric deposition / natural background	17	Approved	30.3 gm/day	March 18, 2005
West Pascagoula River	MSWPASRM1	Jackson	Near Colltown: From East West Split near Barnes Lake to Mongers Creek	3170006	Aquatic Life Support	Mercury	Point source contributions / Atmospheric deposition / natural background	17	Approved	30.3 gm/day	March 18, 2005
West Pascagoula River	MSWPASRM2	Jackson	Near Vanleave: From Mongers Creek to mouth at Mississippi Sound	3170006	Aquatic Life Support	Mercury	Point source contributions / Atmospheric deposition / natural background	17	Approved	30.3 gm/day	March 18, 2005
Davis Dead River	MS096DDRE	Jackson	Near Old Americus	3170006	Aquatic Life Support	Mercury			Due 08-11-12		
East Pascagoula River	MSEPASRM2	Jackson	Near Pascagoula from Escatawpa River to Mouth at MS Sound	3170006	Aquatic Life Support	Hydrocarbons/Phenols			Due Date Not Given		
<b>Pearl River Basin</b>											
Juniper Creek	MS184JE	Pearl River	Near Millard from Headwaters to Hobolochitto Creek	3180004	Aquatic Life Support	Biological Impairment			Due 12-31-08		
Turtle Skin Creek	MS186T	Hancock	Near Santa Rosa from Headwaters to Mikes River	3180004	Aquatic Life Support	Biological Impairment			Due 06-23-17		
West Hobolochitto Creek	MS185E1	Pearl River	Near Picayune from Kennedy Creek to East Hobolochitto Creek	3180004	Secondary Contact	Pathogens			Due 12-31-08		
Mulatto Bayou Industrial Canal	MS186E1	Hancock	At Port Bienville Industrial Park from Headwaters to the Pearl River	3180004	Aquatic Life Support	Organic Enrichment/Low DO/Total Toxics			Due 12-31-08		

Waterbody	Waterbody ID	County	Location	USGS HUC Code	Use Impairment	Cause of Impairment	Sources of Impairment	NPDES Permitted Discharges	TMDL Status	TMDL	Final TMDL Approval Date
Pearl River	MSUMPRLR1E	Pearl River	Near Morgantown from Holiday Creek to Mouth at Mississippi Sound	3180004	Aquatic Life Support	Nutrients/Organic Enrichment/Low DO/Pesticides/Sediment/Siltation			Due 12-31-08		

Source: MDEQ TMDLs Mississippi 2004 Section 303(d) List of Impaired Water Bodies, and Mississippi 2006 Section 303(d) List of Impaired Water Bodies

### **3.2.3 Historical Groundwater Quantity and Quality**

#### **3.2.3.1 Groundwater Quantity**

The Gulf Region has large quantities of groundwater available for current and future potable and industrial uses. Many of these sources are relatively untapped when considering the much larger quantities that easily could be accessed.

The thick Miocene aquifers constitute the most reliable sources of water in the entire Gulf Region, and the aerial extent and permeability make them the largest potential source of groundwater in the State. The Citronelle aquifers overlie a large percentage of the Miocene aquifer system and are a source of recharge to them. Where the Graham Ferry Formations of Pliocene Age occur, the Graham Ferry is the uppermost aquifer of the Miocene system. The lower Miocene units consist of the Pascagoula, Hattiesburg, and Catahoula Formations. In much of the area, only the upper several hundred feet of the Miocene system have been significantly developed; and many thick aquifers remain untapped.

Studies of groundwater reserves have been conducted throughout the Gulf Region and have reached a similar conclusion, namely, that many areas possess large, virtually untapped, water resources. For example, one study reported that southward-dipping Miocene beds contain freshwater to depths of more than 3,000 feet in southwestern Pearl River and western Hancock Counties. Freshwater in Harrison County occurs to depths as great as 2,500 feet in sands of Pliocene and Miocene Age. Although most wells produce less than 1,000 gallons per minute, several of the aquifers can yield two to three times that amount to wells designed for higher production.

Although groundwater use for potable and industrial supplies in the Gulf Region has increased considerably since the 1960s, and especially during the last two decades, the geohydrology of the study area remains largely unchanged. In a study of the water resources of the Pascagoula area, including all of Jackson and George Counties, it was concluded that sufficient water is available in the area to meet requirements for future developments that may utilize large quantities of water. The same study also concluded that aquifer characteristics and available drawdown would allow about twice as much pumping of water from the Pascagoula and Graham Ferry Formations in the Pascagoula area as was being withdrawn at the time, which was approximately 21 million gallons per day.

Aquifer tests conducted in the Gulf Region and throughout Mississippi during the mid to late 20<sup>th</sup> Century and analyzed by the U.S. Geological Survey provide tangible supporting evidence to the findings noted previously. Tests results were summarized for wells completed throughout the Gulf Region planning area, with depths ranging from a minimum of 197 feet to a maximum of 1,330 feet, and measured yields ranging from about 19 gallons per minute to about 5,885 gallons per minute. Hydraulic conductivity for the investigated wells in the Gulf Region ranged from about 26 feet per day to approximately 350 feet per day.

Among forty-four aquifer tests conducted in Harrison County during a previous study, 39 were located in the southern one-third of the county. Wells were completed in the Graham Ferry Formation (28 wells), Pascagoula Formation (12 wells), and Miocene Formation (4 wells). Well depths ranged from 429 to 1,242 feet, and yield ranged from 32 to 1,100 gallons per minute. Aquifer thickness for these sites ranged from 38 to 240 feet; transmissivity ranged from 1,000 to 84,000 feet squared per day; and hydraulic conductivity ranged from 26 to 350 feet per day.

### **3.2.3.2 Ground Water Quality**

As previously stated, the Gulf Region has long been considered to have abundant potable and industrial water resources and no serious water-quality problems. The groundwater potential of the planning area is enhanced by the fact that the general quality of the water is very good, requiring little or no treatment for most potable or industrial uses.

In addition to studies of ground water availability, several investigations of water quality have been conducted by the U.S. Geological Survey in various counties of the Gulf Region. These investigations typically included conducting field measurements and collecting samples for laboratory analysis from existing water supply wells completed in the principal aquifers of the Gulf Region, including the Citronelle Aquifers and the Miocene Aquifer System. Basic characteristic parameters analyzed by these water-quality studies included water temperature, pH, specific conductance, color, total dissolved solids (TDS) concentration, chloride concentration, and the concentration of nitrite plus nitrate-nitrogen.

Although some localized variability in the data did exist, it was generally observed that water temperature ranged from about 20 degrees Celsius for shallower wells in the Citronelle Aquifers to about 30 degrees Celsius for deeper wells in the Miocene Aquifer System, with a roughly linear increase in temperature corresponding to an increase in well depth. Similarly, pH ranged from slightly acidic in the Citronelle Aquifers to slightly alkaline in the Miocene Aquifer System. Color in excess of the secondary standard level of 15 units was found in less than 5 percent of the water samples collected in Pearl River and Stone Counties, less than 10 percent of the samples collected in Harrison County, approximately 25 percent of the samples collected in George and Hancock Counties, and about 55 percent of the samples collected in Jackson County. Further, from the samples collected in Jackson County, color was observed generally to increase with depth in the Pascagoula Formation and to decrease with depth in the Graham Ferry and Hattiesburg Formations.

The determination of color represents an evaluation of a physical property and has no direct chemical significance. The color of natural water usually results from leaching of organic debris, and the recommended (secondary) limit of 15 platinum-cobalt units for color in public water supplies is based principally on aesthetic considerations. Water consistently can be treated using standard coagulation, sedimentation, and filtration processes to decrease color to substantially less than 15 platinum-cobalt units when the source water does not exceed 75 platinum-cobalt units.

The TDS concentration was observed to be in excess of secondary drinking water standards, 500 milligrams per liter, in approximately 32 percent of the samples collected in Jackson County. Samples collected in the remaining counties showed TDS concentrations below secondary standard limits. Further, chloride concentrations were found to be in excess of secondary standards in about 7 percent of samples collected in Jackson County, with samples from other counties all found to be below secondary limits for chlorides. Nitrite plus nitrate nitrogen was found to be well below secondary drinking water standard limits in samples collected from all counties.

High dissolved-solids concentrations are objectionable because of possible physiological effects, mineral taste, and economic consequences of additional water treatment. As with color, the recommended (secondary) limit of 500 milligrams per liter for dissolved solids in public water supplies is based largely on aesthetic concerns. One concern is that drinking water containing a high concentration of dissolved solids is likely to contain an excessive concentration of some specific substance that would be aesthetically objectionable. Nationally, a considerable number of supplies with dissolved-solids concentrations in excess of the 500-milligram-per-liter limit are used without any obvious ill effects. From a practical standpoint, a dissolved-solids concentration of 1,000 milligrams per liter is generally recommended as an upper limit for potable waters.

The recommended (secondary) limit of 250 milligrams per liter for chloride is based primarily on aesthetic considerations. However, on the basis of taste, there may be a large difference between detectable and objectionable chloride concentrations.

As noted above, water quality in the Gulf Region is generally good, requiring little or no additional treatment prior to domestic or industrial consumption. For those wells serving as public potable water supplies and having elevated chloride and/or color levels, additional treatment, such as reverse osmosis, may be provided to improve aesthetic quality.

### **3.2.4 Historical Surface Water Quality Impacts**

Impairments to water bodies in the Coastal Streams Basin affecting shellfish harvesting, contact recreation, and secondary recreation use are caused primarily by bacteria loadings. The bacteria loadings are primarily from non-point sources such as wildlife and urban development sources, failing septic systems and overflows from malfunctioning wastewater collection systems. Other factors of water quality impairment in the Coastal Streams Basin include low dissolved oxygen (DO)/organic enrichment, biological impairment, total toxics, and sediment/siltation.

Water-quality impairments in the Pascagoula Basin are attributed to low DO/organic enrichment, sedimentation/siltation, and total toxics. Impairment of aquatic life criteria has been observed in the Pearl River Basin, and the causes have been attributed to biological impairment, pathogens, organic enrichment/low DO, total toxics, pesticides, and sedimentation/siltation.

According to the 2006 Draft 303(d) List of Impaired Water Bodies, 20 water body segments in the Gulf Region are impaired and do not have a corresponding TMDL. This includes 23 segments in the Coastal Streams Basin, 2 segments in the Pascagoula River Basin, and 5 segments in the Pearl River Basin.

TMDLs have been completed for 43 water body segments in the planning area, including 38 segments in the Coastal Streams Basin, 4 segments in the Pascagoula River Basin, and 1 segment in the Pearl River Basin. The TMDLs were completed for impairments due to organic enrichment, low DO, total toxics, phenols, hydrocarbons, and mercury.

**Figure 3-1** presents a map of the Gulf Region illustrating reported, pre-Katrina water quality impairments and issues. **Tables 3-4 through 3-6** present the pre-Katrina water quality issues identified within the Gulf Region, based on a review of available reports and internet sites and supplemented by information provided by project stakeholders. A discussion of each water quality issue follows.

Water Quality Issue	Source of Information
Impaired water bodies caused by pollutants causing use impairments (Table 3-3)	Mississippi 2004 Section 303(d) List of Impaired Water Bodies
Beach closures due to high bacteria levels and sewage (Table 3-6)	MDEQ website (2000-Present)
Diminishing emergent wetlands with vegetation that has the capability of improving water quality (Table 3-8)	US Army Corps of Engineers, Mobile District Environmental Impact Statement
Restricted and prohibited oyster beds due to bacterial (or other) pollution (Figure 3-3)	Mississippi Department of Marine Resources
Increased impervious surface area detrimental to water quality (Table 3-9)	US Army Corps of Engineers, Mobile District Environmental Impact Statement
Wastewater and pollutant discharges along beach and waterfront	Stakeholder meetings
Bacteria in sediment of Mississippi Sound	CIAP Project, stakeholder meetings
Substandard infrastructure	Questionnaires

**Table 3-4      Pre-Katrina Water Quality Issues Within the Gulf Region**



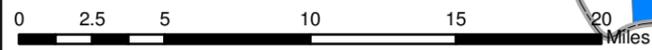
Figure 3-1  
Gulf Region: Water Quality Issues



**Legend**

- Wetlands\*
- Impaired Water Bodies
- Impaired Rivers & Streams
- Riverine Designated Uses**
  - Fish and Wildlife
  - Recreation
  - Shellfish
- Non-Riverine Designated Uses**
  - Fish and Wildlife
  - PWS - REC
  - Recreation
  - Shellfish
  - Shellfish-Recreation
- Rivers
- Intermittent / Annual Streams
- Stennis Space Center
- NASA
- City Limits
- County Boundary
- Watersheds
- BASIN**
  - Drainage Basins

SOURCE: National Wetlands Inventory  
\*NOTE: Available wetland database coverage incomplete



# MISSISSIPPI GULF REGION: Water Quality Issues

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As a result of water quality impairments caused by development along the Gulf Coast and out of a need to better characterize the cumulative impacts of projected development, the Corps of Engineers, Mobile District (USACE – Mobile) prepared an Environmental Impact Statement (EIS). The EIS evaluated the area within the three coastal counties between the coastline and two miles north of Interstate 10. **Table 3-5** summarizes the water quality issues addressed by the EIS.

### **3.2.5 Effect on Economic Development, Growth, and Quality of Life**

Water-quality impairments in the Coastal Streams Basin affect tourism, economic development and growth, and general quality of life along the Coast. Impairments impact recreation and shellfish harvesting and cause beach closures and oyster reef closures due to high bacteria levels.

#### *Water Quality Impacts on Tourism*

Poor water quality adversely affects tourism in south Mississippi. Many visitors enjoy spending time at Mississippi beaches and enjoy water related activities afforded there; however, cautionary signs posted on beaches to warn of excessive bacteria levels are a deterrent to tourists and local residents. A list of the beach postings along the coast from 2005 to the present is included in **Table 3-6** and can be found at <http://www.usm.edu/gcrl/msbeach/closehis.cgi>. Links to this site also can be found on the MDEQ webpage as well.

Beach closures typically occur due to high bacterial levels, spills, overflows, or pipe breaks. MDEQ advises the public that when a bacteria exceedence occurs, the water is not recommended for recreation until samples are deemed safe for human contact. The Beach Task Force also recommends that, during or after a significant 24-hour rainfall event, bodily contact with the waters should be avoided. The locations of 23 beach water quality monitoring stations along the Mississippi Coast are illustrated on **Figure 3-2**. Causes of beach advisories since the year 2000 include the following:

- 17 beach advisories at the time of this writing due to debris from Katrina (water-quality analysis indicated no current problems with bacteria levels);
- 22 historical beach advisories due to Katrina debris (including the beaches currently closed);
- 48 historical beach advisories due to high bacteria levels; and
- 11 historical beach advisories due to sewage spills, sewer overflows, and/or sewer line breaks.

A complete table of beach advisories, separated by sampling station, including the time period of the advisory and a description of the cause, can be seen at the website referenced previously.

Watershed	Subwatershed	HUC Code	Location	Population Level	Sewered Areas	Soils for septic tank systems	Land Cover Types	Designated Water Uses	Point source discharge permits	Mines	Dams	Nonpoint source pollution	Impaired Waters
Bay St. Louis	Bayou La Croix	3170009130	Western side Bay St. Louis	unpopulated to moderately populated	nearly all unsewered	unsuitable or poor	Wetlands or other surface waterbodies (42%), undeveloped forest (35%), and barren land (15%)		5	0	1	Erosion from forestry practices, inadequate sewage treatment and storm runoff	8
	Delisle	3170009120	North coast of Bay St. Louis		town of Delisle-municipality		Wetlands or other surface waterbodies (45%), undeveloped forest (29%)		1	1	0		8
	Lower Wolf River-Cane Creek	3170009090	Northeast Bay St. Louis		None recorded	Poor and fair to good	Undeveloped forest (51%), barren land (28%) and agriculture (16%)	Primary and secondary recreation, fish and wildlife, threatened and endangered species, commercial fishing and shellfish harvesting and	0	3	9	Improperly treated sewage and storm water runoff along Wolf River	2
	Rotten Bayou	3170009110	Northwestern side Bay St. Louis				Forest (49%), barren land (29%) and agriculture (15%)		2	2	0		1
	Upper Jourdan River	3170009100	Northwestern side Bay St. Louis	sparsely populated	No sewage collection system	Fair-to-good for proper	Forest (53%) and barren land (26%)	Primary and secondary recreation, fish and wildlife, threatened and endangered species, commercial fishing and shellfish harvesting and	1	3	17	Improperly treated sewage and storm water runoff along Jourdan River	3
	Upper Wolf River	3170009080	River, Stone and Lamar Counties				Forest (57%) and barren land (31%), less than 1% urban development		2	1	23		2
Biloxi	Biloxi River	3170009140	Northwest Biloxi Bay	sparsely populated	No sewage collection systems identified	Poor and fair to good	Forest (65%) and barren land (22%)	Secondary recreation, fish and wildlife propagation, threatened and endangered species propagation, commercial fishing and shellfish harvesting and industrial water supply	5	7	28	Improperly treated sewage and storm water runoff along the Biloxi River	3
	Turkey Creek-Old Fort Bayou	3170009160	Along Mississippi Sound, extending from Bay St. Louis to Pascagoula watershed	densely populated	More than half sewerd	Poor to fair to good	Forest (40%), urban development (23%) and barren land (15%)	Primary and secondary recreation, fish and wildlife propagation, and commercial fishing and shellfish harvesting	39	2	8	Storm water runoff	26
	Tuxachanie Creek	3170009150	North Biloxi Bay	sparsely populated		Poor to fair to good	Forest (72%) and barren land (17%)	Primary and secondary recreation, fish and wildlife propagation, threatened and endangered species propagation, commercial fishing and shellfish harvesting, and industrial	4	1	0		2

Source: US Army Corp of Engineers Environmental Impact Statement: Enhanced Evaluation of Cumulative Effects Associated With US Army Corps of Engineers Permitting Activity For Large-Scale Development in Coastal Mississippi

Date	Reason Closed
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Hancock County <u>station 02</u> (at Buccaneer State Park/Water Park, Bay St. Louis), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Hancock County <u>station 03</u> (at St. Clare Church near Vacation Lane, Bay St. Louis), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Hancock County <u>station 04</u> (at Christ Episcopal Church, Bay St. Louis), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 05</u> (at Lady Mary Avenue, Pass Christian), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 06</u> (at Church Avenue, Pass Christian), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 07</u> (at Shadow Lawn Avenue, Pass Christian), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 07A</u> (at Trautman Avenue, Long Beach), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 08</u> (at Fournier Avenue, Gulfport), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 09</u> (at Pratt Avenue, Gulfport), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 10</u> (at U.S. Naval Home/Veterans Hospital, Gulfport), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 10A</u> (at Courthouse Road west parking lot, Gulfport), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 11</u> (at Cowan/Lorraine Road, Gulfport), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 11A</u> (at Edgewater Beach across from Chevron station, Biloxi), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 12</u> (at Breakers Inn/Edgewater Mall, Biloxi), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 12A</u> (at Rodenberg Avenue, Biloxi), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 13</u> (at Chalmers Drive, Biloxi), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)

Table 3-6 Mississippi Beach Closure History

Date	Reason Closed
08/29/2005- until further notice	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Harrison County <u>station 13A</u> (at Episcopal Church of the Redeemer, Biloxi), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005-07/07/2006	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Jackson County <u>station 14</u> (at Front Beach, Ocean Springs), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005-07/07/2006	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Jackson County <u>station 15</u> (at Holcomb Blvd., Ocean Springs), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005-07/07/2006	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Jackson County <u>station 15A</u> (at Gulf Park Estates Pier, Ocean Springs), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005-07/07/2006	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Jackson County <u>station 17</u> (at St. Andrews Beach Water Tower, Ocean Springs), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005-07/07/2006	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Jackson County <u>station 19</u> (at Pascagoula Beach West, Pascagoula), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
08/29/2005-07/07/2006	Beach closure as a result of debris in the water after Hurricane Katrina at the following location: the beach area including Jackson County <u>station 20</u> (at Pascagoula Beach East, Pascagoula), closed from all areas eastward to all areas westward. (water analysis has indicated no problem with bacteria levels)
07/27/2005-07/28/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Jackson County <u>station 14</u> (at Front Beach, Ocean Springs), closed from the Ocean Springs Yacht Club eastward to Jackson Street.
07/27/2005-07/28/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Jackson County <u>station 15</u> (at Holcomb Blvd., Ocean Springs), closed from Weeks Bayou eastward to Waters Edge Drive.
07/01/2005-07/02/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 07A</u> (at Trautman Avenue, Long Beach), closed from Oak Gardens Avenue eastward to Girard Avenue.
07/01/2005-07/02/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 10</u> (at U.S. Naval Home/Veterans Hospital, Gulfport), closed from Alfonso Drive eastward to the VA Main Entrance.
07/01/2005-07/02/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 11</u> (at Cowan/Lorraine Road, Gulfport), closed from Laurel Drive eastward to Anniston Avenue.
06/30/2005-07/02/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 10A</u> (at Courthouse Road west parking lot, Gulfport), closed from the VA Main Entrance eastward to Courthouse Road.
06/09/2005-06/14/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Jackson County <u>station 19</u> (at Pascagoula Beach West, Pascagoula), closed from Oliver Street eastward to Westwood Street.
04/13/2005-04/14/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 07A</u> (at Trautman Avenue, Long Beach), closed from Oak Gardens Avenue eastward to Shelter Rock Drive.
04/13/2005-04/14/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 08</u> (at Fournier Avenue, Gulfport), closed from Marie Ave. eastward to Woodward Ave.
04/13/2005-04/14/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 09</u> (at Pratt Avenue, Gulfport), closed from 15th Street eastward to Thornton Avenue.
04/13/2005-04/15/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 10</u> (at U.S. Naval Home/Veterans Hospital, Gulfport), closed from Alfonso Drive eastward to the VA Main Entrance.

**Table 3-6 Mississippi Beach Closure History (Continued)**

Date	Reason Closed
04/13/2005-04/14/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 10A</u> (at Courthouse Road west parking lot, Gulfport), closed from the VA Main Entrance eastward to Courthouse Road.
04/13/2005-04/14/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 11A</u> (at Edgewater Beach across from Chevron station, Biloxi), closed from Eisenhower Dr. eastward to the traffic light at O'Charleys.
04/13/2005-04/14/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Jackson County <u>station 15A</u> (at Gulf Park Estates Pier, Ocean Springs), closed from the beach area west of the Gulf Park Estates pier eastward to the beach area east of the pier.
03/05/2005-03/07/2005	Beach closure as a result of high bacteria levels at the following location: the beach area including Harrison County <u>station 07A</u> (at Trautman Avenue, Long Beach), closed from West Avenue eastward to Shelter Rock Drive.
02/09/2005-02/11/2005	Beach closure as a result of a cracked sewer line leaking into Bayou Chico <i>near</i> the following location: the beach area including Jackson County <u>station 19</u> (at Pascagoula Beach West, Pascagoula), closed from West Pascagoula Beach eastward to East Pascagoula Beach. (includes station 20 area)
02/09/2005-02/11/2005	Beach closure as a result of a cracked sewer line leaking into Bayou Chico <i>near</i> the following location: the beach area including Jackson County <u>station 20</u> (at Pascagoula Beach East, Pascagoula), closed from West Pascagoula Beach eastward to East Pascagoula Beach. (includes station 19 area)
01/21/2005-02/11/2005	Beach closure as a result of a sewer spill <i>near</i> the following location: the beach area including Harrison County <u>station 10</u> (at U.S. Naval Home/Veterans Hospital, Gulfport), closed from Hewes Avenue eastward to Courthouse Road. (includes station 10A area)
01/21/2005-02/11/2005	Beach closure as a result of a sewer spill <i>near</i> the following location: the beach area including Harrison County <u>station 10A</u> (at Courthouse Road west parking lot, Gulfport), closed from Hewes Avenue eastward to Courthouse Road. (includes station 10 area)

**Table 3-6      Mississippi Beach Closure History  
(Continued)**

***Water Quality Impacts on Economic Development***

The presence of impaired water bodies can have adverse effects on economic development within a particular area. Locating new sites for development can be significantly hindered if suitable conditions do not exist for disposal of properly treated wastewater. One of the most significant examples of such detriment to economic development along the Gulf Coast relates to the seafood industry.

The economy of the Gulf Coast is heavily dependent on the seafood industry. Poor bacterial water quality affects oyster beds and can be attributed largely to runoff from failing septic tanks, agricultural areas, overflows from wastewater collection systems, and other sources, especially during rainfall events. These impacts are particularly acute in oyster reefs, as oysters concentrate the pollutants in the water. The Mississippi Department of Marine Resources (DMR) manages 17 natural oyster reefs. Approximately 97 percent of the commercially harvested oyster reefs are located in the western part of Mississippi Sound and concentrated south of Pass Christian, including the Pass Marianne, Telegraph, and Pass Christian reefs. The reefs are located in these areas due to the favorable salinity conditions that result from the flow of fresh water into Mississippi Sound from the Pearl River.



**Figure 3-2**  
**Beach Monitoring Stations**

**Legend**

- ◆ Beach Monitoring Stations
- Stormwater Pipes
- Intermittent / Annual Streams
- Rivers
- Gulf of Mexico
- Impaired Rivers & Streams
- ▨ Impaired Water Bodies
- Railroads
- State Highway
- U.S. Highway
- Interstate Highway
- ▨ Stennis Space Center
- ▨ NASA
- ▨ City Limits
- ▨ County Boundary

SOURCE: DMR

0 2.5 5 10 15 20 Miles

# MISSISSIPPI GULF REGION: Water Quality Impacts on Tourism - Beach Monitoring Stations

**MSEG**  
MISSISSIPPI ENGINEERING GROUP, INC.  
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The DMR adopted Ordinance No. 1.014 on April 19, 1999, as a water-quality standard for shellfish activities. The state water-quality standards for shellfish growing areas related to bacteria are the strictest of all state bacteria standards for water quality, including the bacteria standard for swimming. The DMR has designated four levels of use for a shellfish growing area for the oyster season, including:

- ***Approved:*** Defined as waters where the bacteriological quality of every sampling station does not exceed a fecal coliform median or geometric mean fecal coliform most probable number (MPN) of 14 per 100 ml; and not more than 10 percent of the samples exceed an MPN of 43 for a 5-tube decimal dilution test or an MPN of 49 per 100 ml for a 3-tube decimal dilution test. A shellfishing area can be closed when the above stated limits are not met or upon the occurrence of a predetermined level of precipitation within any consecutive 24-hour period. The area remains closed until such time that microbiological analysis of two consecutive samples separated by a 48-hour period from each station in the area meets the above-stated minimum level for approval.
- ***Conditionally Approved:*** Defined as waters that meet approved area criteria for a predictable period. The period is conditional upon established performance standards specified in a management plan.
- ***Restricted:*** Defined as waters from which shellfish may be harvested only if permitted and subjected to a suitable and effective purification process as determined and permitted by the Mississippi Commission on Marine Resources.
- ***Prohibited:*** Defined as waters that are prohibited for harvest of shellfish for any purpose except depletion. A prohibited shellfish growing area is a closed area for the harvesting of shellfish at all times.

Areas currently conforming to these four levels of approval for oyster harvesting along the Gulf Coast can be seen in **Figure 3-3**, along with oyster bed locations.

As a result of Hurricane Katrina, the mortality of oyster reefs on the Gulf Coast comprised approximately 90 to 95 percent of the legal size (3-inch) oysters immediately following the storm. However, due to a good spat (juvenile oysters) after the storm, the reefs have been recovering. The DMR anticipates that most of their reefs will be open to harvest provided there are suitable growing conditions, such as temperature and salinity over the next two years.



Figure 3-3  
Oyster Harvesting Zones

**Legend**

- Stormwater Pipes
- Oyster Reefs
- Oyster Zones**
- approved
- conditionally approved
- restricted
- prohibited
- unclassified
- Rivers
- ▨ Impaired Water Bodies
- Railroads
- State Highway
- U.S. Highway
- Interstate Highway
- ▨ Stennis Space Center
- ▨ NASA
- ▨ City Limits
- ▨ County Boundary

SOURCE: DMR



# MISSISSIPPI GULF REGION: Oyster Harvesting Zones



**Table 3-7** summarizes preliminary information provided by a survey of a small portion of Mississippi's licensed harvesters and seafood dealers following Katrina. The information was reported in the DMR "Coastal Markers Newsletter" from Fall 2005<sup>4</sup>. Information such as the total number of commercial shrimp, oysters, crab, and finfish vessels beached, sunk, damaged, or lost is still in the process of being finalized.

Wetlands provide a vital role in improving water quality by acting as a natural filter for water as it enters a receiving water body; and, in this function, they are vital to providing habitat necessary to support the south Mississippi seafood industry. **Table 3-8** quantifies the loss of wetlands from 1972 through 2000 in the coastal counties (source: USACE - Mobile) from various sources of degradation.

Marshes are impacted by bulkheading, channelization, and changes in upstream drainage patterns caused by commercial and residential developments that also limit buffering/filtering capacities. Approximately 7.3 percent of marsh loss occurred from the early 1950s to 1978. Prior to Hurricane Katrina, the area covered by seagrasses was estimated to be approximately 3,000 acres in the Mississippi Sound, having declined 40 to 50 percent since 1969. It was reported in the DMR's Fall 2005 newsletter that as much as 60 to 90 percent of seagrasses were damaged or had disappeared (based on gross estimates) as a result of Katrina. Impacts from dredge-and-fill activities from shoreline development have also contributed to declining water quality, impacting estuarine habitat<sup>5</sup>.

#### ***Water Quality Impacts from Stormwater Related to Growth***

Urban growth and development results in an increase of impervious surfaces within a given area; in turn, this increases stormwater runoff, which can cause localized flooding, transport of sediments and pollutants, and increased stream pollution. From 1972 to 2000, impervious surfaces increased by 57.5 percent throughout the three coastal counties, as summarized in **Table 3-9**. Each urban community along the coast is required by MDEQ to develop post-construction stormwater regulations in order to comply with Municipal Separate Storm Sewer System (MS4) stormwater discharge permit requirements on urban runoff. These regulations include combinations of structural and non-structural measures to control the flow and pollutant-related impacts of increased stormwater runoff. As redevelopment occurs within the Gulf Region impacts from stormwater will only increase.

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<sup>4</sup> Mississippi Department of Marine Resources, "Coastal Markers Newsletter," Vol. 9, Issue 2 (Fall 2005).

<sup>5</sup> U.S. Army Corps of Engineers, Mobile District, *Final Environmental Statement – Enhanced Evaluation of Cumulative Effects Associated with US Army Corps of Engineers Permitting Activity For Large-Scale Development in Coastal Mississippi*, August 2005 (Volume I), pp. 4-196.

Impacts of Katrina	Fishery Production during 2004-2005 Season
<b>Oysters:</b>	
Approximately 35 percent of oyster fleet lost	180 commercial dredging licenses issued
About 90 to 95 percent oyster mortality occurred on commercial reefs	60 commercial tonging licenses and 44 recreational oyster licenses sold
	56 non-resident tonging licenses and 32 non-resident dredging licenses sold
	12-month average catch was 2.6 million pounds of meat valuing at \$5.6 million
	Total economic output (harvesting, processing, distribution) \$34 million per year
<b>Shrimp:</b>	
Approximately 10 to 20 percent of shrimping fleet destroyed, and 40 to 50 percent were damaged (many were able to move boats to locations anticipated out of harm's way)	673 resident and 262 non-resident commercial shrimp licenses issued
All shrimp dealers and processing facilities received damage (from water damage to complete demolition)	Dockside value of shrimp fishery in 2004 was \$26.5 million
Supporting infrastructure such as docks, ice-houses, fuel depots, and processing facilities were severely damaged	Five-year Annual average of \$30.3 million makes it the number one value of all seafood harvested
	Landings in 2004 were 18.1 million pounds with a 5-year average of 16.6 million pounds
	Total economic output (harvesting, processing, distribution) \$437 million per year
<b>Crabs:</b>	
Several fisherman were able to remove their traps from water prior to the hurricane, but lost them to tidal surge	189 resident and 22 non-resident commercial crab licenses issued annually
Preliminary estimates of trap loss ranged between 75 to 85 percent	Crab harvesters landed 865,000 pounds of blue crabs with dockside value of \$705,000 in 2004
Preliminary assessment of crab vessel damages was 10 to 20 percent destroyed and 40 to 50 percent damaged to various degrees	Five-year average of 797,000 pounds and \$642,000
	Total economic input (harvesting, processing, distribution) \$5 million per year
<b>Finfish:</b>	
Not reported	A 12-month annual average catch based on landings from 2000-2004 was 3.6 million pounds, value of \$1.2 million
Not reported	Total economic output (harvesting, processing, distribution) \$46 million per year
<b>Menhaden:</b>	
Protein menhaden plant in Jackson County operating prior to the hurricane was severely impacted, flooded with several feet of water	A 12-month annual average catch based on landings from 2000-2004 was 185 million pounds, value of \$11.5 million
During 12-month period, production losses in revenue for the Moss Point facility is estimated to be \$24.5 million	

Table 3-7 Comparison of Historical to Post Katrina Fishery Productivity

## Change in Extent of Emergent Wetlands, 1972 to 2000

(Acres in Thousands, Rounded to Nearest 1,000)

	<b>Emergent Wetlands</b>		
	<b>1972– 1992</b>	<b>1992–2000</b>	<b>Ratio<sup>1</sup></b>
Hancock County	-3.0	-4.2	1.4
Harrison County	-1.8	-1.8	1.0
Jackson County	-5.5	-10.8	2.0
 <i><b>County Total</b></i>			
Bay St. Louis Watershed	-1.4	-4.2	3.0
Biloxi Bay Watershed	-1.9	-3.1	1.6
 <i><b>Watershed Total</b></i>			
Coastal Study Area	-3.7	-6.1	1.6
Coastal Study Area Change as % of Watershed Total:	113.3%	83.5%	0.7

<sup>1</sup> “Ratio” is the size of the 1992–2000 loss (gain) relative to the 1972–1992 (gain). Ratios more than 1.0 indicate a 1992–2000 rate higher than the 1972–1992 rate.

Source: U.S. Army Corps of Engineers Mobile District

**Table 3-8      Change in Extent of Emergent Wetlands, 1972 to 2000**

## Coastal Mississippi Land Use - Coastal Counties

	1972	% Total 1972	1992	% Total 1992	% Change 1972-1992	2000	% Total 2000	% Change 1992-2000	% Change 1972-2000
<b>Land Use - General</b>									
Developed	59,682	5.2%	81,400	7.1%	36.4%	90,203	7.9%	10.8%	51.1%
- Impervious	26,896		36,516		35.8%	42,367		16.0%	57.5%
Natural	1,017,639	87.9%	937,865	81.8%	-7.8%	940,687	82.1%	0.3%	-7.6%
Agricultural	68,062	5.9%	115,376	10.1%	69.5%	101,725	8.9%	-11.8%	49.5%
Inland Fresh Water	12,577	1.1%	12,577	1.1%		12,577	1.1%	0.0%	0.0%
Subtotals	1,157,960	100.0%	1,147,218	100.0%		1,145,192	100.0%		
Surface Water/Other	497,064		507,806			509,833			
<b>TOTAL Acres</b>	<b>1,655,024</b>		<b>1,655,024</b>			<b>1,655,024</b>			
<b>Land Use - Detailed</b>									
Medium-Density Urban Land	34,923	3.0%	47,898	4.2%	37.2%	50,170	4.4%	4.7%	43.7%
High-Density Urban Land	13,695	1.2%	18,223	1.6%	33.1%	24,572	2.1%	34.8%	79.4%
Transportation	11,064	1.0%	15,278	1.3%	38.1%	15,461	1.4%	1.2%	39.7%
Cropland/Pasture/Grassland	68,062	5.9%	115,376	10.1%	69.5%	101,725	8.9%	-11.8%	49.5%
Deciduous/Mixed Bottomland									
Forest/Swamp	262,916	22.7%	299,391	26.1%	13.9%	295,602	25.8%	-1.3%	12.4%
Coniferous Forest/Savanna	595,885	51.5%	385,631	33.6%	-35.3%	352,510	30.8%	-8.6%	-40.8%
Scrub-Shrub/Cutover/Barren	75,872	6.6%	180,221	15.7%	137.5%	236,848	20.7%	31.4%	212.2%
Emergent Wetland	82,966	7.2%	72,622	6.3%	-12.5%	55,726	4.9%	-23.3%	-32.8%
Inland Fresh Water	12,577	1.1%	12,577	1.1%	0.0%	12,577	1.1%	0.0%	0.0%
Subtotals	1,157,960	100.0%	1,147,218	100.0%		1,145,192	100.0%		
Surface Water/Other	497,064		507,806			509,833			
<b>TOTAL Acres</b>	<b>1,655,024</b>		<b>1,655,024</b>			<b>1,655,024</b>			

Source: U.S. Army Corps of Engineers Mobile District

**Table 3-9 Land Use for Hancock, Harrison and Jackson Counties**

### 3.2.6 Water Quality Impacts of Katrina

The U.S. Environmental Protection Agency (EPA), in a joint effort with MDEQ, performed a water-quality study of bays in coastal Mississippi after Hurricanes Katrina and Rita, on September 26-30, 2005. Sediment and water-quality data were obtained from 39 sampling sites on Bangs Lake, Bayou Cassotte, Pascagoula and West Pascagoula Rivers, the Back Bay of Biloxi, St. Louis Bay, and Pearl River. The results will be useful as a basis for additional studies to assess water, sediment, and shellfish/fish conditions in the four major bay systems that were a part of the study. Following are the major conclusions of the study.

- Pollutant concentrations fall within EPA's National Oceanic Water Quality Criteria for surface water and the National Oceanic and Atmospheric Administration (NOAA) effect levels for sediment.
- Dissolved oxygen concentrations were above Mississippi's minimum criteria in 37 of the 39 surface water sampling locations.
- Bacteriological densities were less than EPA's *enterococci* criteria for coastal waters.
- Algal growth in the Back Bay of Biloxi and in Bayou Cassotte exceeded 5 mg/l.
- Dioxin concentrations in five sediment samples were well below the EPA screening value for residential soils.
- Overall, there were few water-quality criteria exceeded during the study period.

The U.S. Geological Survey (USGS) collected data following Katrina throughout September and October of 2005; and, in a joint effort with MDEQ, they monitored various water quality sampling locations along the Gulf Coast to determine the effects of the hurricane on surface water. Water samples were collected weekly, over a five-week period, at 31 estuarine tributary sites and 13 beach monitoring sites in Hancock, Harrison, and Jackson Counties. The primary constituent that was analyzed was *enterococci*, an indicator of the presence of pathogen concentration. Evaluation of the data concluded that approximately 14 percent of *enterococci* densities were less than the detection limit, and approximately 81 percent were lower than EPA's criteria for the protection of public health.

Samples collected at inland fresh water sites were analyzed for constituents such as nutrients, trace metals, pesticides, wastewater compounds, volatile organic compounds and non-organic compounds. The conclusions were that most observations were below available state and federal water quality criteria for Mississippi streams; and, overall, there was no systematic post-Katrina contamination in the streams that were sampled.

## 3.3 Water Supply, Treatment, and Transmission

### 3.3.1 Current Regulations

Public water supplies in the United States are regulated by the EPA through authority of the Safe Drinking Water Act of 1974, amended in 1996. In Mississippi, compliance is enforced by the Mississippi State Department of Health (MSDH). These regulations are defined in the *Recommended Minimum Design Criteria for Mississippi Public Water Systems*, produced by the MSDH, Division of Water Supply.

Drinking Water Regulations are classified as either primary or secondary standards. National Primary Drinking Water Regulations (NPDWRs, or primary standards) are legally enforceable standards that apply to public water systems and are intended to protect public health by limiting the levels of specific contaminants in drinking water. Such contaminants are broadly classified into six categories, including:

- Disinfectants,
- Disinfection Byproducts,
- Inorganic Chemicals,
- Microorganisms,
- Organic Chemicals, and
- Radionuclides.

Unlike primary standards, National Secondary Drinking Water Regulations (NSDWRs, or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects, such as skin or tooth discoloration, or aesthetic effects, such as taste, odor, or color. While states do have the option to adopt the secondary standards as enforceable standards, Mississippi has not yet done so.

Current listings of both Primary and Secondary National Drinking Water Regulations may be found on the EPA web site at (<http://www.epa.gov/safewater/mcl.html>).

### 3.3.2 Historical Deficiencies

#### 3.3.2.1 Anticipated Well Yields

Table 3-10 summarizes the aggregate pumping capacity of operating public water supply wells monitored by MSDH in the Gulf Region.

County	Total Well Capacity (gpm)
George	3,738
Hancock	21,068
Harrison	92,607
Pearl River	14,718
Jackson	39,732
Stone	5,704

**Table 3-10 Aggregate Pumping Capacity of Wells in the Gulf Region**

### 3.3.2.2 Condition of Infrastructure

MSDH conducts an annual evaluation of the public water supplies in the state, rating their performance in three distinct areas including technical capacity, management capacity, and financial capacity. These Capacity Assessments rate the systems on a scale of zero through five, with five being the highest possible rating. The Technical Capacity Assessments take into account issues such as pressure problems, water losses, records of storage tank cleanings and inspections, system maintenance, and system overloads. **Table 3-11** presents a summary of the most recent technical capacity ratings of the monitored potable water service providers in the Gulf Region.

County	Public Water System Technical Capacity Rating					
	Less than 1	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0
George	0	0	1	1	2	3
Hancock	0	1	6	3	1	8
Harrison	0	3	9	13	21	12
Jackson	1	6	9	15	8	10
Pearl River	1	0	1	2	6	5
Stone	0	0	1	3	1	3

**Table 3-11 Technical Capacity Assessment Summary**

### 3.3.2.3 Operational Issues

Operational issues within the public water systems of the Gulf Region may be attributed generally to the condition of supply and distribution infrastructure. For example, if a system experiences loss of storage, then the customers of that system will suffer from decreased water pressure and, in some cases, a decrease in the quantity of water available for consumption. Failure of other components in the water supply, treatment, and distribution system utilized by a potable water service provider would yield a similar impact to customers.

A component of the technical capacity assessment, presented previously, reviews the general condition of each potable water system. Therefore, the summary in **Table 3-11** may be referenced as a general indication of potable water supply systems in the Gulf Region experiencing operational issues. In this manner, those systems

receiving higher ratings would be considered to have fewer operational issues than those systems receiving lower ratings.

#### **3.3.2.4 Effect on Economic Development, Growth, and Quality of Life**

The availability of safe, aesthetically pleasing potable water in sufficient quantity is a key component of economic development. The overwhelming majority of public water supply systems monitored by MSDH operate in compliance with regulatory requirements. However, the regulatory requirements do not address aspects that would tend to make the potable water aesthetically unpleasing.

When considering aesthetic aspects, the predominant issue is the presence of organic color. While some level of organic color is present in the water supplies of each county in the Gulf Region, levels well in excess of Secondary Drinking Water Standards have been documented in Jackson County. Water systems in Hancock County also have documented levels of organic color in excess of Secondary Drinking Water Standards. The presence of observable levels of organic color in the potable water distribution system creates the perception that water is unsafe for consumption, even though the water may comply with applicable regulatory requirements.

Growth is also influenced by the availability of water in adequate quantities. MSDH monitors the capacity of each public water supply to insure adequate water is available to serve customers. The capacity of a water system is based on available supply and storage within the system, in comparison to typical per-capita rates of consumption. When a water system reaches its design capacity, no additional customers may be connected to the system until the capacity is increased. The City of Poplarville is presently under a moratorium issued by MSDH that will not allow any additional connections to the existing water supply, because the system has reached its design capacity. Similarly, the Kiln community is voluntarily disallowing additional connection to the existing water supply, because the system is very near design capacity.

#### **3.3.2.5 Effectiveness of Existing Management Practices**

MSDH monitors the management practices of public water service providers on an annual basis as a component of its public water system capacity assessment. The Management Capacity Assessments take into consideration issues such as records maintenance, written policies and procedures, water system violations, long range improvement plans, and emergency strategies. As with the Technical Capacity Assessment discussed previously, providers are rated on a scale of 0 to 5, with 5 representing the highest possible rating. **Table 3-12** presents a summary of the most recent management capacity assessment ratings of the monitored potable water service providers in the Gulf Region.

County	Public Water System Management Capacity Rating					
	Less than 1	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0
George	0	0	0	2	2	3
Hancock	0	1	4	3	4	7
Harrison	0	3	4	16	17	19
Jackson	0	5	10	12	12	10
Pearl River	1	0	0	0	3	9
Stone	0	1	2	3	1	1

**Table 3-12 Management Capacity Assessment Summary**

### 3.3.3 Katrina-Related Impacts and Anticipated Vulnerabilities

Table 3-13 summarizes the water supply infrastructure in the planning area damaged and destroyed by Hurricane Katrina.

County	Quantity of Reports Noting Infrastructure Damage or Destruction			
	Water Supply Wells	Water Storage Tanks	Water Treatment Facilities	Generators
George	No Records Available	No Records Available	No Records Available	No Records Available
Hancock	14	14	13	2
Harrison	21	12	12	2
Jackson	25	21	21	0
Pearl River	0	6	6	5
Stone	0	0	0	0

**Table 3-13 Katrina-Related Impacts to Water Supply Infrastructure**

The areas of the Gulf Region considered vulnerable to storm damage are shown in **Figure 3-4**. As this figure illustrates, water supply infrastructure along the coastline and in low-lying areas north was impacted primarily as a result of the storm surge.

“Absolute protection” is an idealized goal when considering storm proofing of critical infrastructure, and achieving such a level of protection is impractical for many reasons. The level of protection selected for critical infrastructure must weigh the derived benefits and associated costs. Summarized below are factors that were considered in evaluating storm protection alternatives for Gulf Region water supply and distribution infrastructure.

- When possible, water supply sources (e.g., well fields) may be centralized and sited above the limits of storm surge.
- Vent pipes on water supply wells should be set higher than the localized projected storm surge elevation in order to mitigate the potential for inundation of the well.

- Water supply well pumps should be capable of operation when a loss of primary electrical power occurs. Such capability may be achieved through alternate electrical generation equipment or mechanical pump operating equipment.
- Ground-based water storage tanks located below storm surge elevation need to be filled to reduce buoyant forces in the event of a flood.
- Potable water treatment facilities should be sited above local storm surge elevations.
- New construction should meet building standards that address development in hurricane-prone areas.
- Control equipment should be situated in waterproof buildings or rooms, if located in flood-prone areas.
- Alternate operation control sites or portable control capabilities should be prepared in the event operation control facilities are damaged or destroyed.
- As much of the infrastructure as possible should be located underground in order to reduce damage from storm surge or debris removal.

### **3.3.4 Existing Facility and Hazard Mitigation Plans**

Facility plans generally are prepared by utility providers to address alternatives for meeting existing and projected needs, and include evaluation of the cost-effectiveness of alternatives, a recommended plan, an environmental assessment of the recommendations, and descriptions of existing facilities, proposed facilities, costs, and schedules. Such plans are required by funding agencies to ensure that grant and loan funds will be utilized effectively. Existing facility plans for utility systems within the Gulf Region were obtained from MDEQ, MSDH, consulting engineers, and the utilities themselves. The plans were examined to determine pre-Katrina conditions of facilities, as well as expected trends and planned improvements. The recommendations contained in the current Plan were, in many cases, based on recommendations originally proposed in these existing facility plans.

Hazard mitigation plans are developed to assess risks from disasters and to outline strategies to minimize those risks. Hancock, Harrison, Jackson and Pearl River Counties, as well as some individual municipalities, had plans prior to Katrina; and several entities have updated their plans based on recent experiences. No privately owned utilities were known to have hazard mitigation plans. Available plans were obtained and reviewed; and, in each case, only cursory mention was made of utility infrastructure, including water supply and distribution. One explanation is that public utilities are not regulated directly by Mississippi Emergency Management Agency (MEMA) or the Federal Emergency Management Agency (FEMA), the entities responsible for management of disaster relief and prevention programs.



## **3.4 Wastewater Collection, Treatment, and Disposal**

As municipalities, private utility companies, and authorities begin to repair and/or replace utilities damaged by Katrina, they must address a myriad of issues. Similarly, new local or regional utilities will be required to undergo review and approval by local, state, and perhaps federal agencies depending on the size and type of infrastructure that might be installed and their impacts on the communities and surrounding environments they affect. During discussions with utility stakeholders, many issues were explored that would have an impact on the construction and/or operation of wastewater infrastructure in the region. Issues were divided into four categories, including regulatory, operational, financial, and administrative.

### **3.4.1 Current Regulations**

Environmental review is required for projects that have the potential to impact the environment, and the extent of review depends on the degree of expected impact(s) and on appropriate environmental regulations. Such regulations could range from minimum impact, such as adding equipment to an existing facility, to greater impact such as locating a large facility in a wetland or other environmentally sensitive area. At a minimum, new wastewater treatment facilities, or those planned for capacity expansion, will undergo a review and approval process for an NPDES permit. This review will include a waste-load allocation and review of receiving waters. Where facilities are proposed to discharge into impaired waters, an evaluation must be done to insure that the discharge does not cause or contribute to the impairment; and, where a TMDL has been completed, the discharge must comply with the requirements of the TMDL.

In the past, several collection systems operated by municipalities and county authorities in the Gulf Region have been cited for violating the Clean Water Act. These collection systems have experienced frequent overflows or bypasses caused by lack of proper operation and maintenance or by collection systems operating above capacity or in a deteriorated condition. Since 2001, the EPA has issued six Consent Agreements and Consent Orders for Compliance, three Administrative Orders, and four Notices of Violation. Violators are required to develop operation, maintenance, and rehabilitation programs to prevent future violations. A summary of compliance actions in the Gulf Region is provided in **Table 3-14**.

Order No.	Date	Name of Violator	County	NPDES Permit No.	Type of Action	Document Received
2001-069	June 5, 2001	City of Ocean Springs	Jackson		Consent Agreement and Consent Order for Compliance	Y
2001-028	March 26, 2001	Gautier Utility District	Jackson		Consent Agreement and Consent Order for Compliance	Y
2001-070	September 28, 2001	City of Moss Point	Jackson		Consent Agreement and Consent Order for Compliance	Y
CWA-04-2002-4750	December 4, 2001	City of Pascagoula	Jackson		Consent Agreement and Consent Order for Compliance	Y
CWA-04-2003-4765	October 18, 2002	Diamondhead Water & Sewer District	Hancock	MS0046078	Consent Agreement and Consent Order for Compliance	Y
CWA-04-2002-4769	September 9, 2002	City of Pass Christian	Harrison		Consent Agreement and Consent Order for Compliance	Y
CWA-04-004-4814	July 16, 2004	City of Biloxi	Harrison		Administrative Order	Y
CWA-04-2004-4815	July 27, 2004	City of Bay St. Louis	Hancock		Administrative Order	Y
CWA-04-2005-4768	April 8, 2005	City of Gulfport	Harrison		Administrative Order	Y
		Mississippi Gulf Coast Regional Wastewater Authority	Jackson		Closure Letter	N
		West Jackson County Utility District	Jackson		Closure Letter	N
		Southern Regional Wastewater Management District	Hancock		Closure Letter	N
		Harrison County Wastewater and Solid Waste Management District	Harrison		Notice of Violation	N
		City of D'Iberville	Harrison		Notice of Violation	N
		City of Waveland	Hancock		Notice of Violation	N
		City of Bay St. Louis	Hancock		Notice of Violation	N

Note: Source, Brad Ammons, EPA Region IV

**Table 3-14 Recent Clean Water Act Compliance Actions in the Gulf Region**

Following are lists of federal and state agencies, county utility authorities, municipalities and utility districts that may have regulations, sewer use ordinances or other specific requirements that should be considered as alternatives are developed for the Plan.

Federal Agency

Environmental Protection Agency - Region 4  
Environmental Protection Agency Gulf of Mexico Program  
Federal Emergency Management Agency  
Department of Housing and Urban Development  
U.S. Army Corps of Engineers, Mobile District (USACE - Mobile)

State Agency

Mississippi Department of Environmental Quality  
Mississippi State Department of Health  
Mississippi Development Authority  
Mississippi Public Service Commission  
Mississippi Public Utilities Staff  
Mississippi Department of Marine Resources

Utility Authorities/Municipalities

George County Utility Authority	City of Long Beach
Hancock County Utility Authority	City of Lucedale
Harrison County Utility Authority	City of Moss Point
Jackson County Utility Authority	City of Pascagoula
Pearl River County Utility Authority	City of Pass Christian
Stone County Utility Authority	City of Picayune
City of Bay St. Louis	City of Poplarville
City of Biloxi	City of Ocean Springs
City of D'Iberville	City of Waveland
City of Gautier	City of Wiggins
City of Gulfport	

Utility Districts

Diamondhead Water and Sewer District  
East Central Harrison County Public Utility District  
Escatawpa Utility District  
Gautier Utility District  
Hancock County Water and Sewer District  
Harrison County Development Commission  
Helena Utility District  
Henderson Point/Pass Christian Isles Water 7 Sewer District  
Jackson County Port Authority

Utility Districts (Continued)

Kiln Water and Fire Protection District  
Pearlington Water & Sewer District  
West Harrison County Water & Sewer District  
West Jackson County Utility District

### **3.4.2 Historical Deficiencies**

Deficiencies in existing wastewater treatment and collection systems continue to plague local and regional authorities throughout the Gulf Region. Hurricane Katrina further complicated pre-existing conditions by damaging critical systems, decreasing system capacities or, in some cases, rendering them completely inoperable. In addition, population concentrations are changing, resulting in excess capacity in some areas and insufficient capacity in others. Katrina also was responsible for depleting existing manpower resources, widening the void of properly trained personnel to maintain and operate existing facilities.

Historically, treatment deficiencies have included lack of capacity to handle daily flow due to insufficient or non-operating process units. Collection systems have had an array of problems, with the most prevalent being infiltration and inflow (I/I) where stormwater would enter leaking or damaged service clean outs, lines, and manholes, causing a surge in flow during wet-weather events. Aging facilities and continued use of old and inefficient technologies have added to capacity loss and inability for utilities to meet growing customer demands.

Since most of the Gulf Region is sparsely developed, many residents in rural areas utilize individual onsite wastewater disposal systems (IOWDS) to meet their service needs. Due largely to incompatible soil conditions, high levels of groundwater, and poor or lacking system maintenance, many of these systems continue to fail, polluting streams and wetlands and creating environmental hazards and poor water quality. Local municipalities continue to look to incorporate new developments, as well as existing unsewered areas, into their treatment systems but lack either the financial ability or adequate incentives to proceed.

### **3.4.3 Existing Condition of Infrastructure and Operational Issues**

The storm surge from Hurricane Katrina caused the greatest destruction south of Interstate 10 where 16 of the municipal wastewater treatment plants addressed in this Plan are located. As a consequence, wastewater services for residents and businesses along the coast were reduced to minimal levels or eliminated completely. Following immediately hereafter, in **Table 3-15**, is a list of permitted treatment facilities located inside the surge limits. Thereafter, in **Figure 3-5**, is a depiction of the general location of wastewater facilities along the Gulf Coast and an approximation of the storm surge limits from Katrina.

<u>Permit</u>	<u>Facility Name</u>
MS0001481	Chevron Products Company, Pascagoula Refinery
MS0001520	Reichhold Inc, Gulfport
MS0001562	R Fournier and Sons Seafood Inc
MS0001759	Weems Brothers Seafood Company
MS0001791	First Chemical Corporation
MS0002020	Ashco
MS0002674	International Paper Company, Moss Point Mill
MS0002861	C F Gollott and Son Seafood Inc
MS0002925	Mississippi Power Company, Plant Jack Watson
MS0002950	Omega Protein, Inc.
MS0003069	Northrop Grumman Ship Systems Inc
MS0003115	Mississippi Phosphates Corporation
MS0020249	Mississippi Gulf Coast Regional Wastewater Authority, Pascagoula POTW
MS0021521	Mississippi Gulf Coast Regional Wastewater Authority, Escatawpa
MS0021865	Total Environmental Solutions Inc, Discovery Bay Subdivision
MS0021881	Total Environmental Solutions Inc, Oak Harbor Subdivision
MS0022799	Pass Christian Public School District, DeLisle Elementary School
MS0022870	Total Environmental Solutions Inc, Jourdan River Shores
MS0023159	Harrison County Wastewater and Solid Waste Management Authority, East Biloxi POTW
MS0023345	Harrison County Wastewater and Solid Waste Management Authority, Gulfport POTW
MS0027294	DuPont DeLisle Facility
MS0027537	Bernard Bayou Industrial District
MS0027847	Southern Regional Wastewater Management District, Waveland POTW
MS0028720	Woodland Park Mobile Home Village
MS0028967	Hancock County Schools, Charles B Murphy Elementary School
MS0030198	Port Bienville Industrial Park
MS0030333	Harrison County Wastewater and Solid Waste Management Authority, West Biloxi POTW
MS0031020	Stennis Air Industrial Park
MS0033375	Kwik Kar Wash
MS0034410	U Wash M Carwash
MS0034436	Harrison County Wastewater and Solid Waste Management Authority, Eagle Point POTW
MS0034924	Spee-D Wash Carwash
MS0035131	Five Star Recreational Vehicle Park
MS0035637	Gulf City Fisheries
MS0035769	MDOT, Interstate 10, Rest Area, Jackson
MS0035866	Rain R Shine Washateria

**Table 3-15 Permitted Treatment Facilities within the Storm Surge Limits**

<u>Permit</u>	<u>Facility Name</u>
MS0036315	Seymour and Sons Seafood Inc
MS0036820	Orange Lake Elementary
<u>Permit</u>	<u>Facility Name</u>
MS0036994	GE Plastics
MS0037001	Ocean Springs Seafood Company Inc
MS0037028	C J Davis Slaughterhouse Inc
MS0037656	R. A. Lesso Seafood Company Inc
MS0039276	Gulf Pride Enterprises Inc
MS0039594	Mazalea Travel Park
MS0040142	Golden Gulf Coast Packing Company Inc
MS0041629	KOA Kamp Ground, Jackson
MS0042218	CAL Services LLC, Country Living Mobile Home Village
MS0042269	Finicky Pet Food Incorporated
MS0042340	Harrison County Wastewater and Solid Waste Management District, D'Iberville POTW
MS0042897	Dolans Trailer Park
MS0043010	Mississippi Gulf Coast Regional Wastewater Authority, Gautier POTW
MS0043141	Harrison County Wastewater and Solid Waste Management Authority, Long Beach and Pass Christian
MS0043214	Sunrise Haven Mobile Home Park
MS0044580	Cavenham Forest Industries Inc
MS0045004	Custom Pack Inc
MS0045136	Tiny Tots Day Care Center
MS0045519	Gulf Coast Prestress Company, Inc
MS0045772	Munro Petroleum and Terminal Corporation
MS0045926	Aquaculture Corporation of America Inc
MS0046078	Diamondhead Water Sewer District
MS0046230	Tennessee Gas Pipeline Company, Bay St Louis Compressor Station Number 530
MS0046515	Calgon Carbon Corporation
MS0046752	GULF COAST COMMUNITY ACTION AG
MS0047201	The Pantry Inc
MS0047520	Ole Biloxi Seafood Company
MS0047597	Gollott Brothers Seafood Company Inc
MS0048445	Colle Towing Company
MS0050717	Oaklawn Mobile Home Park
MS0050911	Magic River Resort

**Table 3-15 Permitted Treatment Facilities within the Storm Surge Limits  
(Continued)**

<u>Permit</u>	<u>Facility Name</u>
MS0051756	Harrison County Wastewater and Solid Waste Management Authority, Gulfport POTW, North
MS0052027	Eaglebrook Inc
MS0052159	Parkers Landing Recreational Vehicle Park
MS0052167	Roberts Seafood
MS0052230	Jigs Fish Camp
MS0052400	David Gollott Seafood Inc
MS0052485	Wellman of Mississippi Inc

**Table 3-15 Permitted Treatment Facilities within the Storm Surge Limits (Continued)**

For purposes of damage assessment, wastewater systems were separated into two categories:

- Wastewater treatment facilities that might include cast in-place concrete structures for preliminary screening, primary and secondary treatments, and ancillary buildings for administration, storage, laboratory, instrumentation, and power distribution/generating facilities; and
- Wastewater collection and conveyance systems that would include buried piping for collection, house connections, interceptor lines, lift stations and force mains.

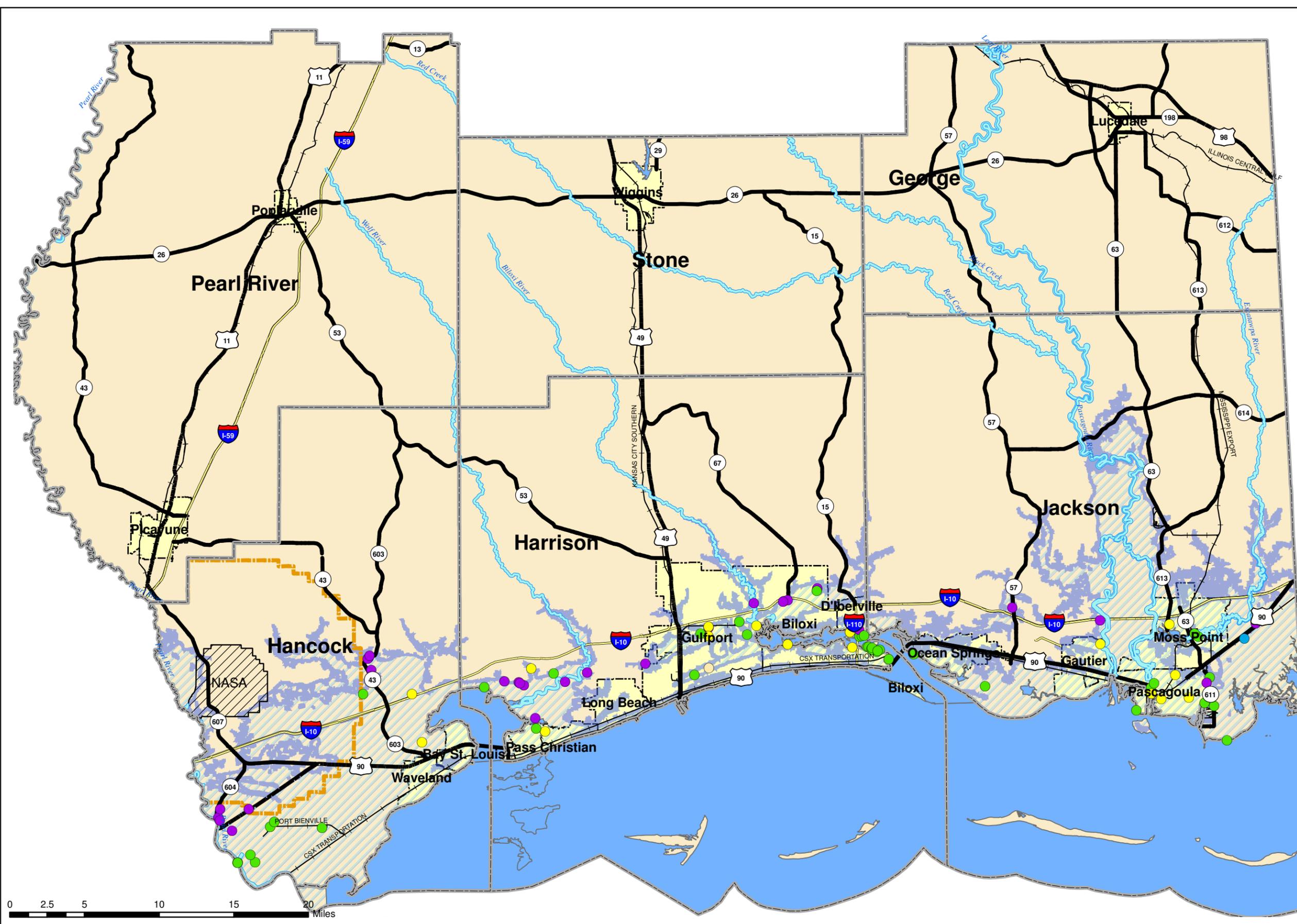
Damages to the treatment facilities could include:

- Flooding of buildings, electrical and instrumentation equipment and process units;
- Wind damage to roofing, structural components, and security fencing; and
- Storm surge damage to buffer landscaping, roadway erosion and undermining of pipe embedment.

Damages to collection/conveyance infrastructure could include:

- Storm erosion resulting in eroded or damaged sewer lines;
- Downed trees from high winds, which up-root shallow service connections and collection lines; and
- Flooded electrical and control equipment in lift stations.

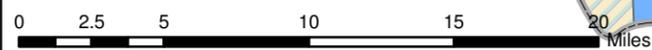
Damage to municipal wastewater facilities located in George, Pearl River and Stone Counties was minimal by comparison to that occurring in the coastal counties. Specific damages to facilities in Harrison, Hancock and Jackson Counties, as reported by the respective utility authorities, are described hereafter.



**Figure 3-5**  
**Wastewater Facilities for**  
**the Gulf Region**

**Legend**

- Domestic/Commercial
- Federal
- Industrial
- Municipal
- No Discharge
- Pretreatment
- Rivers
- Interstate Highway
- State Highway
- U.S. Highway
- Railroads
- County Boundary
- City Limits
- Stennis Space Center
- NASA
- Surge Inundation Limit



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**GULF REGION - WASTEWATER TREATMENT FACILITIES WITHIN SURGE LIMITS**

### *Jackson County*

#### Pascagoula/Moss Point Wastewater Treatment Facility (WWTF)

- Plant was hit with storm surge exceeding six feet causing severe damage to almost all of its operations.
- Electrical equipment, including main switch gear, emergency generator, motor control centers, control panels, instrumentation, conduit and wiring were flooded.
- Influent pumping, grit removal, clarifiers, return and waste pumping systems, chlorination/dechlorination units, plant reuse water system, digester aeration, solids thickener and digested solids pumping were destroyed.
- Free-standing buildings at the site were flooded with damage caused by high winds to roofing and structural components.

#### Escatawpa WWTF

- Facility received a four-foot storm surge.
- Most of the electrical equipment was damaged.
- Almost all of the process equipment was heavily damaged or destroyed.
- Operations/maintenance building roof received massive wind damage.

#### West Jackson County WWTF

- Facility has an aerated lagoon with spray irrigation and artificial wetland. Levees around the lagoon cells were severely damaged by wave action generated by the hurricane winds, and the soils under the levee liner sloughed and structurally weakened the levees.
- Baffle curtain and some of the directional aerators were destroyed.
- Main equipment storage building sustained heavy wind damage.

#### Gautier WWTF

- Facility received medium wind damage to main control building and minor roof damage to dewatering building.
- Minor damage from storm surge flooding.
- Various electrical components located in lower elevations and some underground wiring were damaged.

#### Lift Stations

- Fifteen of twenty-one existing lift stations received moderate to heavy damage, primarily from flooding caused by the storm surge.
- Two of the major stations experienced water levels above their roofs.
- In general, lift stations received flood damage to pumps, motors, motor controls, electrical generators, wiring, flow monitoring, and instrumentation equipment.

- In some cases wind caused damage to building roofs, wall siding and flashing, and security fencing.

### *Harrison County*

#### Keegan Bayou WWTF

- Facility was almost entirely submerged and sustained some wind damage.
- All motor control center (MCC) and control panels were flooded.
- Influent pump station including supervisory control and data acquisition (SCADA) and level control, along with the effluent pump station, plant water pump station, and grit removal pump system were destroyed.
- Chlorine and sulfur dioxide systems were severely damaged.
- Aeration blower system and two diesel generators were flooded.
- Minor wind damage was sustained to the building roof and edge flashing.

#### D'Iberville WWTF

- Facility was submerged resulting in the loss of all electrical and control systems.
- Belt filter press was lost.
- Minimal wind damage to roofing system.

#### West Biloxi WWTF

- Damage to facility was minimal.
- Influent pump station control panel and system were slightly damaged.
- No roof damage, however, there are some concerns regarding cracks found in one of the older buildings.

#### South Gulfport WWTF

- High storm surge flooded this facility resulting in severe damage to the influent pump station system, return and waste pump stations and controls for primary sludge and secondary clarifiers.
- Belt filter presses and generators were submerged and damaged.
- Buildings flooded but no known roof damage.

#### North Gulfport WWTF

- Not damaged by Katrina.

#### Long Beach/Pass Christian WWTF

- Facility heavily damaged with loss of all electrical and control systems.
- Control center building, chlorination/dechlorination and metering systems were destroyed.

### ***Hancock County***

#### **Waveland WWTF**

- Facility was submerged under a six-foot storm surge with severe wind damage to above ground facilities.
- Greatest damage occurred to flooded electrical systems.
- Specific damages included loss of eight influent and four effluent pump stations, grit removal pumping systems, aeration/blower systems, centrifuge with controls, nine flow meters, three automatic valves, pond liner, lab equipment, maintenance equipment, tools, on-site vehicles, eight samplers, stored motors, air compressors, and welding machines.
- Main administration building sustained wall cracks, as well as damage to internal and external appurtenances and loss of office equipment due to flooding.

Although most municipal wastewater treatment facilities in the six-county region were inoperable after the storm, staff immediately began to make repairs. With the assistance of MDEQ, EPA, and the USACE, all but two facilities were operational by September 12, 2005, and all were operational by October 31, 2005.

### **3.4.4 Water Quality Impacts**

Improperly treated discharge from wastewater treatment plants and failing individual onsite disposal systems (IOWDS) adversely affect the waters of the Gulf Region. Pollutants dumped into rivers, streams, wetlands, and coastal waterways continue to affect water quality, hindering growth in the residential, industrial, and tourism sectors.

### **3.4.5 Effect on Economic Development, Growth, and Quality of Life**

Tourism historically has been a major source of revenue for the Gulf Coast. Prior to Katrina, the total number of statewide jobs associated with tourism was estimated at 126,500.<sup>6</sup> Total tourism expenditures for fiscal year 2005 (July 2004 through June 2005) topped \$6 billion, with \$479 million collected in state tax revenues. Tourist services and attractions included lodging, gaming, water sports, entertainment, food service, transportation related industries, sight seeing, and retail markets. Prior to Katrina, negative impacts on tourism and quality of life included temporary beach closures along the coast and internal waterways due to high bacteria levels and sewage spills. Insufficient or inadequate treatment facilities further impaired opportunities for growth in the area.

Katrina destroyed many coastal casinos and hotels as well as the local support industry. The impact to tourism and quality of life has been monumental. Adequate infrastructure must be provided to ensure continued growth in the tourism industry.

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<sup>6</sup> [www.visitmississippi.org/resources/tourism\\_partners.asp](http://www.visitmississippi.org/resources/tourism_partners.asp), "Key Indicators FY 2005"

### **3.4.6 Katrina-Related Impacts and Anticipated Vulnerabilities**

Much of the costs for Katrina-related repairs to existing wastewater facilities were supplemented by FEMA. Standard practice was for FEMA representatives to assist applicants (municipalities, districts, authorities) with preparing project worksheets (PWs) that served as applications for repair costs. As of June 1, 2006, wastewater system providers had filed 145 PWs with FEMA; and the total estimate of the damages for the Gulf Region came to nearly \$137,285,000.

#### *Wastewater Collection Systems*

In general, collection systems (lines and pump stations) are buried and usually are protected from damage caused by hurricanes. Collection system damages caused by Katrina primarily included the following:

- Loss of electrical power, causing control systems and/or pump stations to shut down;
- Wind and water damage to exposed station structures and equipment;
- Accumulation of sediment in smaller diameter collection lines;
- Broken lines caused by storm erosion and up-rooted trees; and
- Exposed service connections where houses were washed away.

#### *Wastewater Treatment Facilities*

In areas where high winds and flooding were most prevalent, major damage occurred to plant buildings, mechanical equipment, and electrical and control systems. Reinforced concrete plant structures did not sustain severe damage but required a substantial level of cleaning and debris removal.

An impact more difficult to quantify, but equal in importance to actual physical plant damage, is the financial effect of the decreased labor force, due to the fact that many workers in the public utility industry have not returned to their jobs. Whether loss of personnel is related to forced relocation or organizational layoffs, the loss of qualified and experienced personnel represents a significant problem to normalizing and preparing for future operation and maintenance programs.

#### *System Facilities Vulnerable to Future Storm Damage*

The vulnerability of infrastructure facilities to future hurricanes depends largely on geographic location and, in some cases, standards to which new and rebuilt facilities are installed. Treatment plants and pump stations located within the limits of potential storm surges will continue to be vulnerable to flooding and wind damage. Special measures should be taken to raise electrical equipment above anticipated flood levels or install waterproofed (submersible type) equipment where feasible. Providing backup equipment such as stand-alone power generators should be considered for areas and systems where the need for post-event service is deemed critical. Such backup equipment must be stored in locations that are not vulnerable to damage from storms.

Although buried sewer lines and force mains are generally not as susceptible to hurricane damage, system vulnerabilities do exist for areas located in proximity to stormwater drainage systems and along the coast. Intense storm surge and stormwater runoff can cause erosion of underlying lines and eventual failure. Similarly, where lines are buried in shallow alignments located in forested areas, high winds may uproot trees, damaging lines that have become encompassed in their root balls.

### **3.4.7 Existing Facility, Recovery, and Hazard Mitigation Plans**

When intense storms and natural disasters such as Katrina occur, it becomes imperative for communities, and local, state, and federal agencies to work together in order to provide for general public safety and to ensure timely recovery. An important component for ensuring utility operation and recovery is the level of hazard mitigation applied to offset potential storm damage. FEMA provides for some hazard mitigation plan (HMP) funding through 44 CFR 201 and 206 regulations. However, in the shadow of Katrina, communities at large have begun giving greater attention to mitigation as a whole. Mitigation planning should involve several types of efforts, examples of which follow:

- Recognition of natural and man-made disasters or hazards that potentially affect public services;
- Actions aimed at significantly reducing the risk of loss of life and bodily injury, damaged economy, and destruction of natural and cultural resources;
- Increasing public awareness of potential risks;
- Developing plans and training regimens for municipal and agency coordination and response; and
- Establishing networks for partnering with local, state and federal agencies.

Weather-related disasters that historically have caused damage to personal, private and public properties include the following:

- Hurricanes and tropical coastal storms resulting in:
  - Damage from high winds, including flying debris;
  - Storm surge flooding;
  - Heavy rainfall and inland flooding; and
  - Land subsidence and erosion;
- Thunderstorms and high-wind storms that result in:
  - Flooding;
  - Damage from high winds including, flying debris;

- Lighting strikes; and
- Hail damage;
- Tornadoes that cause:
  - Damage from high winds and flying debris; and
  - Hail damage;
- Winter ice storms, which result in:
  - Ice accumulation;
  - Damage to exposed utility lines; and
  - Downed trees and utility services.

Hancock, Harrison, Jackson, and Pearl River Counties developed mitigation plans for specific treatment facilities, which were published prior to or immediately following Katrina. No plans have been provided for Stone or George Counties. Mitigation measures included in the plans reviewed were general in nature and included such things as elevating and/or waterproofing electrical equipment and controls, and providing backup power for critical facilities. Since Katrina, a more regional approach likely will be considered utilizing suggested mitigation where appropriate. Following are available documents obtained during preparation of this Plan.

#### *Hancock County*

- Hazard Mitigation and Flood Protection Plan, Waveland, Mississippi, published August 2005
- Bay St. Louis Hazard Mitigation Plan, City of Bay St. Louis, Mississippi, published May 2005

The Waveland wastewater treatment facility serves both Waveland and Bay St. Louis and is listed as a critical plant in the Waveland mitigation plan. While suggested improvements to the stormwater drainage system can offer some flood protection, they would do little to protect the plant from a storm surge similar to that of Katrina, which submerged the entire facility. Considering the potential magnitude of the occurrence of a similar storm, relocation of the facility would be an option.

#### *Harrison County*

- Amendment to Harrison County Hazard Mitigation and Flood Protection Plan, published May 2005
- City of D'Iberville Hazard Mitigation Plan 2006-2011, published February 2006
- Hazard Mitigation and Flood Protection Plan, Long Beach, Mississippi, published February 2006

Mitigation plans for Harrison County facilities were intended to meet basic regulatory compliance with state and federal requirements. Treatment plants are permitted to

and operated by the Harrison County Wastewater and Solid Waste Management Authority. These facilities are listed as critical facilities. Again, the Katrina storm surge submerged the facilities; therefore, relocation would be an option.

### *Jackson County*

- Jackson County Multi-jurisdictional Hazard Mitigation Plan, Jackson County, Mississippi, published November 2005
- Ocean Springs Hazard Mitigation Plan, Ocean Springs, Mississippi, published August 2005
- City of Pascagoula Updated Hazard Mitigation Plan, Pascagoula, Mississippi, published December 2005

### *Pearl River Counties*

- Addendum and Update of the Pearl River County, Mississippi, Hazard Mitigation and Flood Protection Plan, published August 2005

Buried piping generally is not as susceptible to storm-related damage as are above-ground components. Damage to buried facilities typically is the result of trees and poles being uprooted by high winds; broken house connections or clean outs where homes are severely damaged or moved as a result of flooding or surge; or damages to lines where erosion from storm runoff undermines pipe bedding.

Exposed aboveground structures and appurtenances can be vulnerable to high winds and flooding. Electrical and control equipment can also be flooded by storm surge. Mitigation might include elevating and/or waterproofing electrical equipment and providing backup power generation for critical facilities.

## **3.5 Flood Control, Drainage, and Stormwater Management**

### **3.5.1 Current Regulations**

Numerous regulations and design criteria govern the management of stormwater. Discussed hereafter are pertinent regulations and supporting design criteria and guidance manuals commonly used by communities in the Gulf Region.

#### **3.5.1.1 Stormwater Quality Control Regulations**

The Office of Pollution Control (OPC) at MDEQ is responsible for administering NPDES stormwater general permits in Mississippi. The permits require a Stormwater Management Plan (SWMP) or Stormwater Pollution Prevention Plan (SWPPP) to be developed and implemented in accordance with the Clean Water Act. **Table 3-16** lists the criteria for the applicable stormwater permits:

Permit	Criteria
Mississippi Small Municipal Separate Storm Sewer System (MS4)	Municipally-owned storm sewer systems, local jurisdictions, State departments of transportation, universities, local sewer districts, hospitals, military bases and prisons not regulated under Phase 1 Stormwater Program
Large Construction Stormwater (MSR10)	Construction activities greater than or equal to 5 acres
Small Construction Stormwater (MSR15)	Construction activities greater than or equal to 1 acre and less than 5 acres
Baseline Stormwater Permit for Industrial Activities (MSR00)	Industrial activities exposed to stormwater as described in 122.26(b)(14)

**Table 3-16 MDEQ Stormwater Phase II General Permits Applicable to the Gulf Region**

***Stormwater Permits for MS4s***

The Mississippi Stormwater Phase II General Permit for MS4s requires each entity to submit a Notice of Intent (NOI) to discharge stormwater under the general permit, along with a stormwater management plan (SWMP) outlining how the entity proposes to comply with permit conditions. The permit requires the SWMP to include basic requirements for Best Management Practices (BMPs) that address the six minimum control measures. **Table 3-17** outlines the basic requirements that must be met under an entity’s Stormwater Phase II Program.

The Stormwater Phase II Permit requirements apply to eleven coastal cities (Bay St. Louis, Waveland, Biloxi, D’Iberville, Gulfport, Long Beach, Pass Christian, Gautier, Ocean Springs, Pascagoula, and Moss Point), three coastal counties (Hancock, Harrison and Jackson), MDOT in the three coastal counties, and two military installations (Keesler Air Force Base and the Naval Construction Battalion Center). Among the coastal counties, Hancock County has implemented a county-wide permit compliance program.

***Permit Requirements for Individual Construction Projects***

In addition to municipal regulations, large construction activities in Mississippi must submit a Notice of Intent (NOI) prior to construction and a Stormwater Pollution Prevention Plan (SWPPP) to be prepared and kept on-site under the terms of MDEQ’s General NPDES Permit for Stormwater Discharges from Construction Activities. Requirements for Small Construction General Permits are similar, except that there are no required submittals to MDEQ, unless specifically requested.<sup>7</sup> Large construction activities are considered to be five acres or greater while small construction activities fall between one and five acres. A construction site SWPPP must comply with all local stormwater ordinances, address erosion and sediment

<sup>7</sup> For permit requirements see [http://www.deq.state.ms.us/MDEQ.nsf/page/epd\\_epdgeneral?OpenDocument](http://www.deq.state.ms.us/MDEQ.nsf/page/epd_epdgeneral?OpenDocument).

control, and describe post-construction BMPs. In addition, large-construction SWPPPs must be approved by MDEQ.

<b>Storm Water Phase II Program - Six Minimum Control Measures</b>	
<b>Regulated Small MS4 Permit Requirements</b>	
<b>1.0 Public Education and Outreach</b>	
	Public Education Program
	Distribution Materials Describing Stormwater Impacts and Pollution Reduction Actions
<b>2.0 Public Involvement and Participation</b>	
	Comply with State/Local Public Notice Requirements
<b>3.0 Illicit Discharge Detection and Elimination</b>	
	Develop Storm Sewer Map of Outfalls and Names of Receiving Streams
	Prohibit Illicit Discharges into MS4 System (Ordinances and Enforcement)
	Implement Plan to Detect and Address Illicit Discharges and Illegal Dumping
	Inform Public of Hazards Associated with Illegal Discharges and Improper Disposal
<b>4.0 Construction Site Stormwater Runoff Control</b>	
	Develop, Implement, and Enforce Storm Water Pollution Program for All Construction Activities $\geq 1$ Acre < 5 Acres
	Use Ordinance to Control Erosion and Sedimentation and Other Waste On Site
	Requirements for Site Owners/Operators to Implement Appropriate BMPs
	Pre-Construction Review of Site Plans
	Procedures to Receive/Consider Public Input
	Regular Inspections During Construction
	Penalties to Ensure Compliance
<b>5.0 Post-construction Stormwater Management in Areas of New Development and Redevelopment</b>	
	Address Storm Water Runoff from New Development and Redevelopment Disturbing One Acre or Greater
	Include Plan to Implement Site-Appropriate, Cost Effective Structural and Non-Structural BMPs
	Ensure Long Term Operation and Maintenance of BMPs
	Ensure Controls in Place Preventing or Minimizing Water Quality Impacts
<b>6.0 Pollution Prevention and Good Housekeeping</b>	
	Develop and Implement Cost-Effective O&M Program Preventing/Reducing Pollutant Runoff from Municipal Operations
	Park and Open Space Maintenance
	Street, Parking Lot and Fleet Maintenance
	Building Maintenance
	Stormwater System Maintenance
	Include Local Government Employee Training

**Table 3-17 Regulated Small MS4 Permit Requirements**

*MDOT Requirements for Stormwater Discharges from Construction Activities*

MDOT is also required to develop, implement and enforce programs to reduce pollutants in stormwater runoff from construction activities. Their guidelines can be found in Chapter Four of the MDOT Phase II Stormwater Guidance Manual (Draft 11/06/02), located on the MDEQ website.<sup>8</sup>

**3.5.1.2 Stormwater Design and Regulatory Compliance Manuals**

Several state and/or federal agencies have prepared design and/or regulatory compliance manuals in support of their regulatory requirements. Pertinent criteria in these manuals that affect stormwater management systems in the Gulf Region are summarized hereafter.

<sup>8</sup> The MDOT requirements can be found at GoMDOT.com and at the MDEQ site at: [http://www.deq.state.ms.us/MDEQ.nsf/pdf/epd\\_MDOTPhaseIIStormWaterGuidanceManualDraft/\\$File/25General.pdf?OpenElement](http://www.deq.state.ms.us/MDEQ.nsf/pdf/epd_MDOTPhaseIIStormWaterGuidanceManualDraft/$File/25General.pdf?OpenElement)

### ***Mississippi Department of Transportation Design Manual***

Drainage criteria and procedures for highway related drainage design are included in Chapter Seven of the MDOT Design Manual. This manual governs drainage design for state highway projects, and is also used by many local jurisdictions throughout the state. MDOT requires that all drainage design follow AASHTO procedures and specifications.

### ***MDMR Stormwater Management Toolbox***

The Mississippi Department of Marine Resources (DMR) Comprehensive Resources Management Plan (CRMP) established the Stormwater Management Toolbox to assist coastal counties and cities with the development and implementation of their stormwater management programs. The Toolbox provides a template for managing stormwater runoff and incorporating best-management practices to protect the environment from potential impacts related to construction and development. The Toolbox can be found at DMR's website.<sup>9</sup>

The designated Phase II municipalities along the Gulf Coast used this Toolbox to serve as rationale for the selection of applicable BMPs. They also used model ordinances in the toolbox to develop ordinances for their jurisdictions, as necessary, to comply with the six minimum control measures.

### ***MDEQ's Planning and Design Manual for the Control of Erosion, Sediment & Stormwater***

The Planning and Design Manual provides guidance for the control of erosion, sediment and stormwater from non-point sources and for the preparation of stormwater control plans. The manual provides structural and vegetative Best Management Practices (BMPs) for temporary and permanent erosion, sediment and stormwater control due to construction activities as mentioned under the DMR Toolbox. The manual also provides methods of determining the hydrology and design procedures when using the erosion control practices.<sup>10</sup>

### ***MDEQ's Guidance Manual for Preparing a SWPPP***

MDEQ's Guidance Manual for preparing a SWPPP can be found on their website.<sup>11</sup> This Guidance Manual divides the process into six parts: 1) collect site information, 2) choose controls, 3) prepare SWPPP, 4) apply for permit coverage, 5) implement controls, and 6) stabilize site and terminate coverage.

## **3.5.2 Historical Deficiencies**

The historical deficiencies of drainage systems within the Gulf Region vary greatly but are focused mainly around 1) insufficient capacity to prevent frequent flooding of structures, roadways, and property and 2) historical encroachment into floodplains.

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<sup>9</sup> <http://www.dmr.state.ms.us/CoastalEcology/Storm/Stormwater-Mgt-toolbox.htm>

<sup>10</sup> This manual can be purchased from MDEQ or found at <http://abe.msstate.edu/csd/p-dm>.

<sup>11</sup> [http://www.deq.state.ms.us/MDEQ.nsf/pdf/epd\\_conguidman/\\$File/ConstructionGM.pdf?OpenElement](http://www.deq.state.ms.us/MDEQ.nsf/pdf/epd_conguidman/$File/ConstructionGM.pdf?OpenElement)

### **3.5.2.1 Floodplain Management**

Many general problems within the Gulf Region can be improved with proper floodplain management through local regulation, acquisition and/or protection of repetitive flood loss properties and large, regional detention /conveyance projects. These types of deficiencies are more general and focus on minimizing future regional flooding. Unlike most drainage systems with inadequate capacity, these issues cannot be fixed by a focused construction project and may not show any immediate changes. These issues often affect entire areas such as cities, counties or drainage basins.

Many floodplain management issues identified were regulatory and meant to apply to all future construction and rebuilding. These include flood proofing buildings and infrastructure through higher floor and control elevations. For more recent structures, these may apply to non-damaged facilities as well.

Structure buyouts are one option for floodplain management and were recommended by previous studies in several areas within the Gulf Region. Such buyouts entail identifying the repetitive flood loss properties, purchasing them from their owners for mitigation, and either restoring the property to its natural state or utilizing it as a regional detention facility or as a regional spillway. Large buyout opportunities exist in Harrison, Hancock, Jackson, George, and Pearl River Counties.

Regional detention/conveyance projects also were recommended for flood control in some instances by previous studies, but high costs and property requirements may make them inefficient in many areas. In areas where water is needed for public water supply, a detention area may be recommended for flood control as well as water supply storage.

### **3.5.2.2 Effect on Economic Development, Growth, and Quality of Life**

Impaired drainage infrastructure causes local flooding during high intensity rain events. Local flooding damages properties, homes and businesses and often limits roadway access to these areas. Such damages diminish property values and damage building contents, creating real and perceived barriers to economic development and tourism in the impacted area.

High-intensity rain events are very common in southern Mississippi and vary in their duration. Short-duration (one hour or less), high-intensity events can often cause temporary flooding in deficient areas and limit neighborhood and road access. Events located closer to the coast have a greater effect on tourism, and events in less populated areas surrounding arterial roads may have greater impacts on storm evacuation routes.

Developers looking to create large subdivisions may be able to incorporate detention areas to minimize flooding; however, individual homeowners do not often have this option. Structure buyouts minimize the number of flooded structures as well as decrease the flooding in surrounding areas. Regional detention facilities allow for an

increase in growth by providing flood control for entire areas and have the potential to provide water supply, as well.

### **3.5.3 Administrative and Operational Issues**

State NPDES Permits and Federal Regulations require local jurisdictions in the coastal counties to implement stormwater management programs, which include such components as enforcement of regulations, system operation and maintenance, and education. While not governed by NPDES permits, jurisdictions within the three inland counties of the Gulf Region also conduct stormwater management programs with similar program elements. Following is a discussion of the administrative and operational issues pertinent to the stormwater management programs of these jurisdictions as well as the new County Utility Authorities.

#### **3.5.3.1 Enforcement of Regulations**

Each Stormwater Phase II entity in the Gulf Region has indicated that new regulations and regulatory enforcement programs are needed for stormwater control. Regulations are the backbone of minimum control measures to provide Illicit Discharge Detection and Elimination, Construction Site Stormwater Runoff Control, and Post-Construction Stormwater Management in Areas of New Development.

##### *Illicit Discharge Detection and Elimination*

Each community subject to NPDES stormwater permits is required to implement an Illicit Discharge Identification and Elimination Program, supported by an ordinance or other regulatory mechanism, to effectively prohibit the discharge of materials other than stormwater into the municipal separate storm sewer system (MS4). **Table 3-18** summarizes the compliance status of each regulated community as reported in their 2005 annual compliance reports. The following compliance status was reported:

- All jurisdictions have enacted or are in the process of enacting ordinances to require use of individual, onsite wastewater disposal systems (IOWDS) approved by either MSDH or a professional engineer.
- The ordinance also requires follow-up by an MSDH officer to ensure proper installation prior to the issuance of a certificate of occupancy.
- State Law dictates that if access to a central treatment system is available, IOWDS will not be approved.
- MDEQ requires approval from either a local MSDH office or professional engineer before a construction stormwater permit can be issued for related wastewater disposal systems.

The problems that are evident with the current practices and requirements are related primarily to lack of local requirements for IOWDS. The high failure rate of existing IOWDS typically was found to be due to lack of homeowner maintenance and the lack of state or local programs requiring maintenance or inspection. Additionally,

and even with state requirements for approval, IOWDS facilities reportedly were installed in unsuitable locations.

The Stormwater Phase II entities participate in voluntary sanitary sewer collection system audits of compliance status under the EPA Management, Operation and Maintenance (MOM) Program in an attempt to eliminate Sanitary Sewer Overflows (SSOs) from their municipal sewer systems. Most Stormwater Phase II entities have adopted, or are in the process of adopting, an Illicit Discharge Ordinance to effectively outlaw illicit discharges.

#### ***Construction Site Stormwater Runoff Control***

Each community is required to implement a construction-site runoff control program, supported by an ordinance or other regulatory mechanism, to control the discharge of pollutants from construction sites. **Table 3-19** summarizes the compliance status of each community as reported in their 2005 annual compliance reports. In general, community erosion and sediment controls must comply with the standards set by MDEQ's "Planning and Design Manual for the Control of Erosion, Sediment & Stormwater," or in a recognized design manual appropriate for Mississippi such as "Stormwater Pollution Prevention Plan (SWPPP) Guidance Manual for Construction Activities." The erosion and sediment controls at a minimum must include vegetative practices, structural practices and post-construction control measures.

Best Management Practice	Jackson County	Moss Point	Gautier	Pascagoula	Hancock County	Bay St. Louis	Waveland	Harrison	Long Beach	Biloxi	Pass Christian	Gulfport	Ocean Springs	D'Iberville
<b>Develop Inspection and Enforcement Program</b>	Ordinance to be formalized in 2006	Discussed in Illicit Discharge Identification and Elimination Meeting 9/9/04	Progress Discussed in Illicit Discharge Identification and Elimination Meeting 9/9/04	Progress Discussed in Illicit Discharge Identification and Elimination Meeting 9/9/04	Special Enforcement Officer to Investigate Complaints	No Septic Tanks in City	Not Applicable with Waveland	Not Available	Progress Discussed in Illicit Discharge Identification and Elimination Meeting 9/9/04	Progress Discussed in Illicit Discharge Identification and Elimination Meeting 9/9/04	Progress Discussed in Illicit Discharge Identification and Elimination Meeting 9/9/04	In Process of Developing Program based on the Illicit Discharge Ordinance	Progress Discussed in Illicit Discharge Identification and Elimination Meeting 9/9/04	Compliance
<b>Participate in EPA's Management, Operation, and Maintenance (MOM) Program or other Self Inspection Programs</b>	In Process of Implementing the Self Inspection Program	Participates in EPA MOM Program	Participates in EPA MOM Program	Participates in EPA MOM Program	Participates in EPA MOM Program	Participates in EPA MOM Program	Participates in EPA MOM Program	Not Available	Participates in EPA MOM Program	Participates in EPA MOM Program	Participates in EPA MOM Program	Participates in EPA MOM Program	Participates in EPA MOM Program	Compliance
<b>Create Ordinance to Allow Inspections and Penalize Violations</b>	Illicit Discharge Ordinance adopted October 25, 2004	Ordinance adopted on 12/14/04	Ordinance to be adopted 1st Quarter of 2005	Ordinances Regulating Sewer Use in Place	Ordinance adopted in 12/2004	Ordinance: Unlawful to Dump Sewage in Bay; Illegal to Construct or Maintain Septic Tanks in the City	Ordinance in Place to Require Sanitary Sewer Hookup	Not Available	Ordinance to be adopted 1st Quarter of 2005	Ordinances are in the Process of Being Reviewed	Ordinance to be adopted 1st Quarter of 2005	Illicit Discharge Ordinance in Development with Guidance of a Model Ordinance (Missouri DNR)	Ordinance to be adopted 2nd Quarter of 2005	Compliance
<b>Create Ordinance for Construction Plan Review and Construction Site Inspection in Ordinance to Assure Proper Sewer and Storm Drain Connections)</b>	Developing Detailed Plan in the Process	City adopted SWPPP on 12/14/04	Already Conducts Construction Site Plan Reviews	Ordinance for Drainage Control and Erosion Prevention in Place	Current Policy Requires Inspection and MDH/MDEQ approval prior to Occupancy Certificate	No Septic Tanks in City	No New Septic Tanks in the City	Not Available	Process is Being Refined, but Long Beach has a Review Process	Site Plan Reviews are Done as an Articles 4 and 14 of the Land Development Ordinance (LDO)	Reviewing Construction Plans for Proper Sewer and Storm Drainage	A Process is in Place and will be Revised and Added to the Illicit Discharge Ordinance	Process in Development	Compliance

Best Management Practice	Jackson County	Moss Point	Gautier	Pascagoula	Hancock County	Bay St. Louis	Waveland	Harrison	Long Beach	Biloxi	Pass Christian	Gulfport	Ocean Springs	D'Iberville
<b>Continue Current Construction Practices (silt fence, retention ponds)</b>	Now Required in Ordinance	Compliance	Compliance	Landscaping Ordinance in Place Requiring 10% of Lot Area to be Green Space	Not Available	Not Available	Not Available	Not Available	Compliance	Site Plan Reviews are Done as an Articles 4 and 14 of the LDO	Currently Monitoring and Reviewing Site Plans	Promotes Practices and All Developments in City Require 10% Pervious Area	Compliance	Compliance
<b>Develop standards for Erosion and Sediment Control</b>	Will Use MDEQ's Design Manual, Field Manual, and Toolbox	Will Use MDEQ's Design Manual, Field Manual, and Toolbox	Will Use MDEQ's Design Manual, Field Manual, and Toolbox	Will Use MDEQ's Design Manual, Field Manual, and Toolbox	Ordinance Currently Being Enforced	Ordinance Currently Being Enforced	Ordinance Currently Being Enforced	Not Available	Will Use MDEQ's Design Manual, Field Manual, and Toolbox	Will Use MDEQ's Design Manual, Field Manual, and Toolbox	Will Use MDEQ's Design Manual, Field Manual, and Toolbox	Compliance Achieved Previous Annual Report	Will Use MDEQ's Design Manual, Field Manual, and Toolbox	Compliance
<b>Construction Site Erosion and Sediment Control Ordinance</b>	Ordinance Amendments were adopted on October 25, 2004	Compliance	Ordinance to be amended 2005	Not Available	Ordinance Currently Being Enforced	Ordinance Currently Being Enforced	Ordinance Currently Being Enforced	Not Available	New Land Development Code to be Adopted in 2006	Erosion and Sediment Control Ordinance Already Exists	New Land Development Code Will Be Adopted in 2006	Ordinance Adopted 1/18/2005	Ordinance No. 14-2000 Exists for Requiring and Providing Penalties for Violations	Compliance
<b>Develop Program to Require ESC Plan for one to five acres</b>	County is in Process of Developing Program	Will be Required SWPPP (building permit)	ESC Plan to be Required in Ordinance Amendments	Ordinance for Drainage Control and Erosion Prevention in Place	Not Available	Not Available	Not Available	Not Available	City is Refining to Coincide with New Ordinance to be Passed in 2005	Erosion and Sediment Control Plans are Required as part of the Site Plan Review Process	Requires Contractors to Submit BMPs	Program Defined in Ordinance and is in Place	Will Continue its Current Practice	Compliance
<b>Construction Site Inspections</b>	Program in Development	Program in Development	Will Begin to Incorporate in Year 3	Program in Development	Inspections for BMPs Conducted-Normal Code Enforcement Inspections	Inspections for BMPs Conducted-Normal Code Enforcement Inspections	Inspections for BMPs Conducted-Normal Code Enforcement Inspections	Not Available	Program in Development	City Engineering Inspectors are Assigned Subdivisions During Construction and Ensure the Erosion Control Plan is Being Followed	Program in Development	A Schedule is Set in Ordinance and is Being Incorporated with Inspection Schedule in Building Code Services	Program in Development	Compliance

In the development of standards and guidance for erosion and sediment control at construction sites greater than one acre, the entities all plan to use MDEQ's "Planning and Design Manual for the Control of Erosion, Sediment & Stormwater," the Field Manual, and MDMR/CRMP's "Mississippi Gulf Coast Stormwater Runoff Management Toolbox" to achieve compliance.

#### ***Post-Construction Stormwater Management in Areas of New Development***

Each community is required to implement a post-construction stormwater management program, supported by an ordinance or other regulatory mechanism, to control the discharge of pollutants from sites after construction is complete. These programs should include appropriate land-use controls, requirements to construct structural stormwater quality-control facilities, and binding long-term maintenance and funding requirements. **Table 3-20** summarizes the post-construction compliance status of each community as reported in their 2005 annual compliance reports.

Municipal post-construction stormwater management programs are supported by land-use measures such as stream and wetland protection zones, design criteria for permanent structural controls and designated responsibility for maintenance of control measures. All the entities reviewed either have a stormwater management ordinance in place or were enacting amendments to their existing stormwater regulations during 2005.

#### ***U.S. Army Corps of Engineers, Mobile District's Environmental Impact Statement***

The U.S. Army Corps Mobile District (USACE - Mobile) developed an "Environmental Impact Statement (EIS) for the Enhanced Evaluation of Cumulative Effects Associated with U.S. Army Corps of Engineers Permitting Activity for Large-Scale Development in Coastal Mississippi" in August of 2005. The purpose of this EIS was for the Corps to develop a consistent methodology in evaluating the cumulative effects to the environment of large-scale development projects that need a Corps permit. The affected jurisdictions include Hancock County, Harrison County and western Jackson County, Mississippi. The EIS evaluates different scenarios and regulatory structures over a twenty-year period, to determine whether future Corps permit decisions should rely on the results of trends analysis for the evaluations. A no-action alternative also was evaluated and was used as the baseline for the proposed action. The EIS would require the Corps to continue to evaluate the permits as it has in the past, and the cumulative effects analysis would be done on an "ad hoc basis."

The EIS recommends Regional Conservation Practices (RCPs) to reduce the cumulative impacts from development, mainly environmental and socioeconomic effects associated with land use. The recommended RCPs include only general land-use recommendations that suggest adopting BMPs and implementation through permit conditions.

Best Management Practice	Jackson County	Moss Point	Gautier	Pascagoula	Hancock County	Bay St. Louis	Waveland	Harrison County	Long Beach	Biloxi	Pass Christian	Gulfport	Ocean Springs	D'Iberville
<b>Continue Current Practices Requiring Post-construction Runoff to Equal Pre-construction Runoff and Promote Greener Practices (vegetative practices)</b>	Ordinance now requires BMP's	Continue to Enforce Landscape Ordinances	Continue to Enforce Landscape Ordinances	Continue to Enforce Landscape Ordinances	Not Available	Not Available	Not Available	Not Available	Enforcing Existing Ordinance While in Process of Creating New LDO Code	Continue to Enforce Landscape Ordinances	Enforcing Existing Ordinance While in Process of Creating New LDO Code	Continually Promotes Practices and All Developments Require 10% Pervious Area	Continue to Enforce Landscape Ordinances	Compliance
<b>Ordinance to Require Submittal and Review of Storm water Master Plan</b>	Ordinances were adopted on October 25, 2004	Amendments will be Adopted in 2005	Ordinance Drafted to be Adopted 1st Quarter of 2005	Amendments will be Adopted 2005	Ordinance adopted 12/2004 and Being Enforced	Ordinance adopted 12/2004 and Being Enforced	Ordinance adopted 12/2004 and Being Enforced	Not Available	Ordinance Drafted to be Adopted 1st Quarter of 2005	Submittal of Storm water Management Plans are required as part of the LDO and the Manual	City to Amend Their Storm water Ordinance in 1st Quarter of 2005	Ordinance Adopted 1/18/2005	Already Required in City Ordinance	Ordinance Passed by the City Council
<b>Storm water Runoff Management Standards for Post Construction</b>	Will Use MDEQ's Design Manual, Field Manual, and Toolbox	Ordinance to Require Developer/Owner Responsible in Amendments	City Already Requires Post Construction Storm water Management Plans	Obtained Post Construction Standards and plans to Use MDEQ's Planning and Design Manual	Not Available	Not Available	Not Available	Not Available	Obtained Post Construction Standards and plans to Use MDEQ's Planning and Design Manual	Obtained Post Construction Standards and plans to Use MDEQ's Planning and Design Manual	Obtained Post Construction Standards and plans to Use MDEQ's Planning and Design Manual	Guidance Manual with Standards and BMPs is in the Process of Being Developed	Obtained Post Construction Standards and plans to Use MDEQ's Planning and Design Manual	Compliance
<b>Storm water Inspections</b>	SWPPP for all municipal facilities was approved	Obtained Post Construction Standards and plans to Use MDEQ's Planning and Design Manual	City has Obtained Existing Post Construction Standards	Program in Development	Policy Developed to Review Site Plans and BMPs Prior to Permit Issue	Policy Developed to Review Site Plans and BMPs Prior to Permit Issue	Policy Developed to Review Site Plans and BMPs Prior to Permit Issue	Not Available	Program in Development	Program in Development	Program in Development	Inspection Program in the Process of Being Developed	Program in Development	Compliance

The Corps has the authority to implement the following RCPs to reduce anticipated cumulative effects on water resources of large-scale development:

- Implement riparian buffer requirements for stream and wetland protection; and
- Implement Low-Impact Development (LID) measures to reduce peak storm flows by creating wetlands, detention ponds, or bioretention cells.

In addition, the Corps suggested that other federal, state, and local agencies and private entities incorporate RCPs and/or other mitigation measures in their regulations.

### **3.5.3.2 System Operation and Maintenance**

Stormwater systems require regular maintenance to operate effectively; and, in general, an effective operations-and-maintenance program involves the following components:

- Inspection
- Cleaning
- Repair
- Rehabilitation and Renewal

### **3.5.3.3 Education**

Effective public education is the foundation of an effective stormwater management program. This requires informing residents, visitors and businesses of their stormwater management responsibilities and building support for community stormwater management programs. Public education and participation is a required element of the stormwater quality management programs mandated by NPDES permits and is integral to an orderly evacuation and response to major flooding events.

## **3.6 Inter-Jurisdictional Issues**

### **3.6.1 Water Supply, Treatment and Distribution**

As discussed in earlier sections of the Plan, groundwater aquifers provide the primary source for potable water supply across the Gulf Region. These aquifers obviously transcend political boundaries; consequently, issues affecting any particular aquifer have the potential to impact multiple entities and users. Conversely, the actions of individual users or withdrawers of groundwater, for instance water utilities, associations, or even municipalities, have the potential to impact other users.

As discussed previously, a water supply provider distributes water within an area prescribed by its Certificate of Public Convenience and Necessity, obtained from the Mississippi Public Service Commission. Exceptions to this are incorporated municipalities, which are allowed to provide potable water service up to one mile

beyond their boundaries of incorporation. However, incorporated municipalities providing potable water service beyond this distance are required to obtain a Certificate as well. Overall, the existing water supply and distribution infrastructure is limited to the primary area of service of the providing entity. There are very few points of interconnection between adjacent service providers to provide redundancy in times of need; consequently, little “regional” infrastructure exists in the Gulf Region.

A primary goal of regional water supply infrastructure should be to augment systems low in available capacity and to provide capacity to areas currently unserved by existing systems. Secondly, regional infrastructure should incorporate a program of aquifer-wide management of the groundwater resources that provide the primary source for many of the individual systems within the region. This provides added assurance that the ground water supply will remain viable for many years to come. Finally, a goal of regionalization should be the interconnection, where practicable, of individual water supply networks throughout the region.

### **3.6.2 Wastewater Collection and Treatment**

**Figure 3-6** provides a visual depiction of the natural drainage basins, county, and municipal boundaries located in the study area. As can be readily observed, the topographical/hydrological drainage basins are not restricted by political boundaries. The Wolf River originates in Pearl River County near Poplarville, runs through Harrison County, and ultimately discharges into St. Louis Bay near Pass Christian. Likewise, the Biloxi River originates in Stone County and flows through Harrison County, before discharging into Back Bay. The largest drainage basin is the Pascagoula River Basin. The Pascagoula originates at the confluence of the Leaf and Chickasawhay Rivers in northern George County and flows through George and Jackson Counties, before it discharges into the Gulf between Gautier and Pascagoula. For practical purposes, development of regional wastewater systems should evolve along these same basin features in order to take advantage of the natural terrain and topographic relief. Sewer lines that follow streams and rivers typically are the most cost-effective means of transportation of wastewater.

**Figure 3-6** also illustrates municipal boundaries and certificated areas, relative to wastewater infrastructure. Larger populated areas generally are served by municipal systems; however, there are numerous private and rural systems with wastewater infrastructure. Before Katrina, there were over fifty entities that operated individual wastewater systems in the planning area. As a rule, larger non-municipal certificated areas lie outside City limits; however, on a more limited basis, some certificated areas skirt municipal boundaries, serving areas both inside and outside city limits, while other certificated areas are completely encompassed inside municipal boundaries.

It is apparent that much development and location of wastewater infrastructure has occurred without regard to natural topography or regional planning. Rather, as development has increased, localized systems have been created to serve immediate needs. The continued development of unsewered areas also points to a lack of

regional planning. The need for a central or regional authority to plan and provide guidance for better management of these isolated wastewater activities within the Gulf Region is apparent.

### 3.6.3 Flood Control, Drainage and Stormwater Management

Stormwater flows within watersheds that seldom follow jurisdictional boundaries, as **Figure 3-6** illustrates. **Table 3-21** summarizes the relationship between political jurisdictions and watersheds, defined by 12-digit hydrologic unit codes (HUCs). Each HUC is composed of numerous catchments that also may transcend jurisdictional boundaries, further complicating stormwater management. In addition, drainage patterns may be altered somewhat as land is developed, particularly in relatively flat areas like the Gulf Coast. Drainage improvements sometimes cut off drainage from adjacent jurisdictions, which in turn causes flooding problems.

	HUC 0318000					HUC 0317000																				
	Pearl River					Coastal Streams								Pascagoula River												
	5	5	5	5	5	9	9	9	9	9	9	9	9	9	3	3	5	6	6	6	7	7	7	8	8	
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	1	1	1	1	1	
	8	8	8	8	8	0	1	1	1	1	1	1	1	1	7	0	9	9	9	9	0	0	0	0	0	
	0	3	4	5	6	9	0	1	2	3	4	5	6	7	8	2	6	4	6	7	8	1	2	3	7	8
George County																										
o Lucedale																		X								
o Unincorporated Areas															X	X	X	X			X		X	X		
Hancock County																										
o Bay St. Louis													X													
o Waveland													X													
o Unincorporated Areas				X		X	X	X	X	X	X	X														
Harrison County																										
o Biloxi												X	X	X												
o D'Iberville													X	X												
o Gulfport													X	X												
o Long Beach														X												
o Pass Christian														X												
o Unincorporated Areas						X	X		X	X		X	X	X												
Jackson County																										
o Gautier														X						X						
o Moss Point						X											X							X		
o Ocean Springs														X												
o Pascagoula						X											X		X							
o Unincorporated Areas						X								X			X		X			X	X	X		
Pearl River County																										
o Picayune			X	X	X																					
o Poplarville			X	X		X																				
o Unincorporated Areas	X	X	X	X	X	X	X	X															X			
Stone County																										
o Wiggins																							X			
o Unincorporated Areas						X						X	X								X	X	X			

**Table 3-21 Relationship between Jurisdictions and Watersheds**



Figure 3-6  
Gulf Region: Drainage Basins & Watersheds

**Legend**

- Gulf of Mexico
- Rivers
- Intermittent / Annual Streams
- Stennis Space Center
- NASA
- City Limits
- County Boundary
- Watersheds (HUCs)
- Drainage Basins



# MISSISSIPPI GULF REGION: Drainage Basins & Watersheds



Watersheds that cross jurisdictional boundaries present numerous significant issues for stormwater planning and management. Some of those are summarized hereafter.

- Development within an upstream jurisdiction increases impervious area and/or concentrates flow, increasing flooding in a downstream jurisdiction.
- Drainage constraints within a downstream jurisdiction may create a backwater extending into an upstream jurisdiction and increasing flooding.
- Detention basins in an upstream jurisdiction may not compensate for increased stormwater volumes associated with additional impervious area, releasing flows at predevelopment rates over an extended period of time, changing the timing and duration of stream hydrographs, and increasing downstream peak flows, causing flooding.
- Adjoining communities within a watershed often have different stormwater design criteria. This can create the potential for infrastructure to be smaller downstream than upstream, causing flooding, confusion, and additional review time for development plan submittals.
- Differences in pollutant loading may not be recognized between various communities within a watershed, causing confusion and inequities in complying with stormwater permits and TMDL limits.
- Stormwater discharged into the Mississippi Sound along the beaches is conveyed through systems owned and operated by municipalities and then discharged through outfalls of the county beach districts. Any improvements or modifications must be coordinated by all these entities.
- No formal mechanism exists for performing drainage improvements that cross jurisdictional boundaries, often creating significant barriers to project implementation when the project impacts and benefits are not equal between the jurisdictions.

For example, one chronic flooding problem associated with interjurisdictional drainage is the 27.3 square mile Turkey Creek/Canal 1, 2 and 3 drainage area. Canals 1, 2 and 3 receive runoff from approximately 70 percent of Long Beach as well as large areas of unincorporated Harrison County north of Long Beach. Complex flow patterns and steady urbanization have caused increased flooding within the low lying floodplain<sup>12</sup>. Low ground elevations, tidal backwaters, and limited capacity contribute to inadequate drainage for new development largely occurring outside the City. Hurricane Katrina deposited large quantities of sediment and debris within these canals and in the local drainage system, further limiting drainage system capacity. An inter-jurisdictional solution to this flooding problem is needed. The project recommended by the USACE – Mobile is designed largely to restore drainage capacity to pre-Katrina levels, and is considered to only be a “starting point” for a more comprehensive drainage solution.

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<sup>12</sup> U.S. Army Corps of Engineers, Mobile District, *Environmental Assessment – Mississippi Coastal Improvements Program (MSCIP), Near Term Improvements, Hancock, Harrison, and Jackson Counties, Mississippi*, May 2006 (Draft), p. 34.