Total Maximum Daily Loads and Associated Efforts in

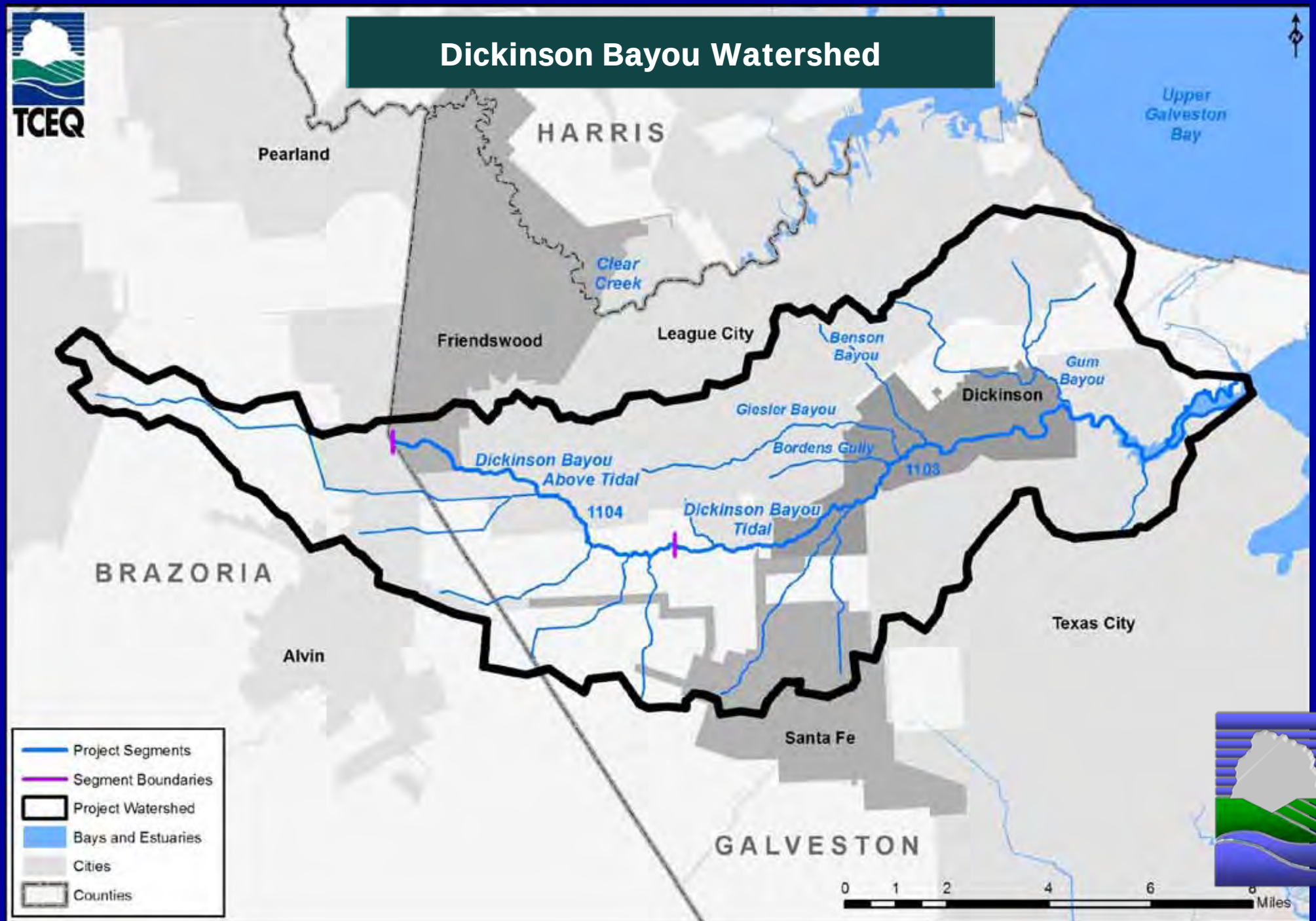
Dickinson Bayou

an Update

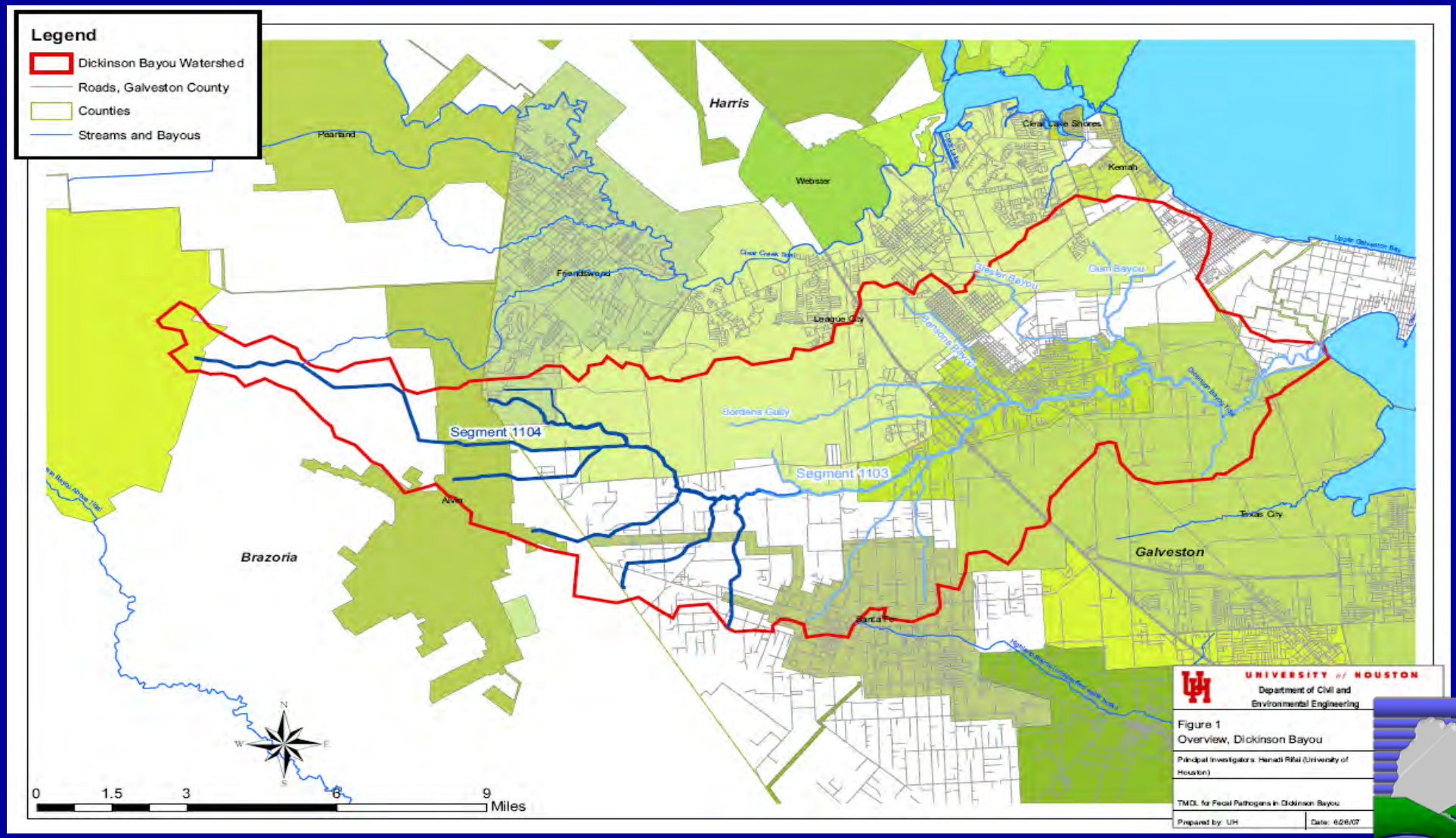
March 25, 2010

Roger M. Miranda
Texas Commission on Environmental Quality

Dickinson Bayou Watershed



Dickinson Bayou, Watershed Map



What is the Problem in Dickinson Bayou?

SegID: 1104 **Dickinson Bayou Above Tidal**
From a point 4.0 km (2.5 miles) downstream of FM 517 in Galveston County to FM 528 in Galveston County

Area		Category	Year First Listed
1104_01	*From lower segment boundary upstream to FM 517*		
	bacteria	5a	1996
	depressed dissolved oxygen	5c	2006
1104_02	*From FM 517 upstream to FM 528*		
	bacteria	5a	1996

From the 2008 Texas Clean Water Act 303(d) List

What is the problem with Dickinson Bayou?

SegID: 1103 **Dickinson Bayou Tidal**
From the confluence with Dickinson Bay 2.1 km (1.3 miles) downstream of SH 146 in Galveston County to a point 4.0 km (2.5 miles) downstream of FM 517 in Galveston County

Area		Category	Year First Listed
1103_01	*From 2.5 miles downstream of FM 517 to the Bordens Gully confluence*		
	bacteria	5a	1996
	depressed dissolved oxygen	5a	1996
1103_02	*From the Bordens Gully confluence to the Benson Bayou confluence*		
	bacteria	5a	1996
	depressed dissolved oxygen	5a	1996
1103_03	*From the Benson Bayou confluence to the confluence with Gum Bayou*		
	bacteria	5a	1996
	depressed dissolved oxygen	5a	1996

The 2008 Texas Clean Water Act 303(d) List
Dickinson Bayou Tributaries Listed

SegID: 1103A **Bensons Bayou (unclassified water body)**
From the confluence with Dickinson Bayou Tidal to 0.37 miles upstream of FM 646 in Galveston County

Area		Category	Year First Listed
1103A_01	*From confluence with Dickinson Bayou Tidal to 0.37 miles upstream of FM 646*		
	bacteria	5a	2002

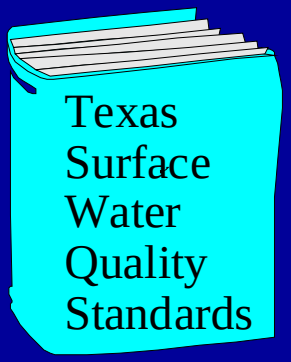
SegID: 1103B **Bordens Gully (unclassified water body)**
From confluence with Dickinson Bayou Tidal to upstream of Calder Road in Galveston County

Area		Category	Year First Listed
1103B_01	*Entire water body*		
	bacteria	5a	2002

SegID: 1103C **Geisler Bayou (unclassified water body)**
From confluence with Dickinson Bayou tidal to IH 45 in Galveston County

Area		Category	Year First Listed
1103C_01	*Entire water body*		
	bacteria	5a	2002

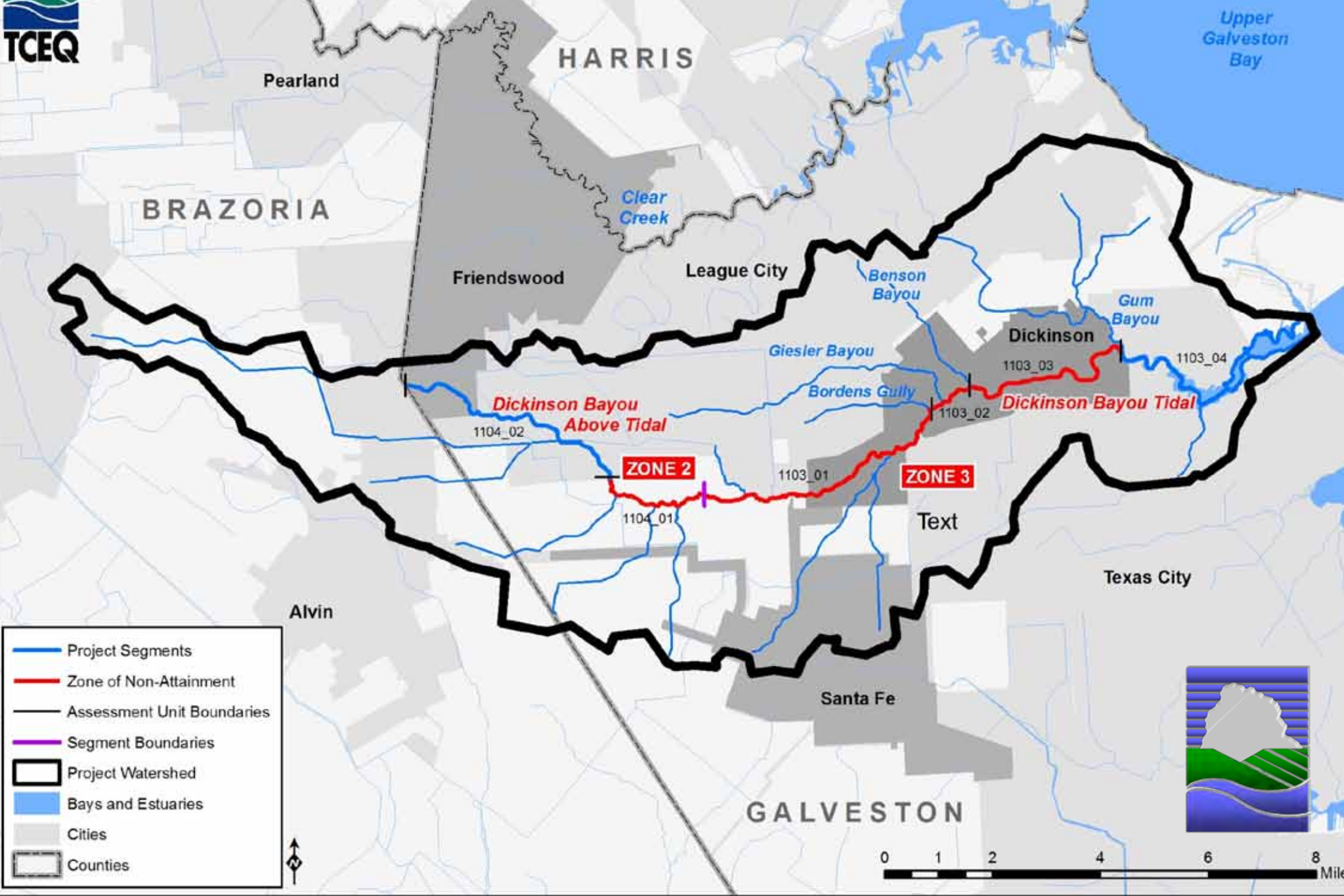
Review
Federal Clean Water Act Requirements



- Uses, Standards and Criteria
  - Aquatic Life Use
    - Designated as High in tidal segment (Segment 1103)
      (24 avg. DO = 4.0 mg/l; minimum DO = 3.0 mg/l)
    - Designated as Intermediate in segment above tidal influence (Segment 1104)
      (24 avg. DO = 4.0 mg/l; minimum DO = 3.0 mg/l)
  - Recreation (Contact Recreation in both segments)
    - Tidal (Enterococcus geometric mean = 35 CFU/100ml;
      Enterococcus single sample = 89 CFU/100ml)
    - Above Tidal (E. coli geometric mean = 126 CFU/100ml;
      E. coli single sample = 394 CFU/100ml)

Review
Federal Clean Water Act Requirements

- Assessment through monitoring
- Listing of impairments (303[d] List)
- Development and Adoption of TMDLs
- Implementation of TMDLs


TCEQ
HARRIS
Pearland
BRAZORIA
Upper Galveston Bay
Clear Creek
Friendswood
League City
Benson Bayou
Gum Bayou
Dickinson
Giesler Bayou
1103_03
1103_04
Bordens Gully
Dickinson Bayou Above Tidal
Dickinson Bayou Tidal
1104_02
1103_02
ZONE 2
1103_01
ZONE 3
1104_01
Text
Texas City
Alvin
Santa Fe
GALVESTON
Project Segments
Zone of Non-Attainment
Assessment Unit Boundaries
Segment Boundaries
Project Watershed
Bays and Estuaries
Cities
Counties
0
1
2
4
6
8
Mile

DICKINSON BAYOU WATERSHED

Dickinson Bayou, Segments

Segment	Stream Name
1103	Dickinson Bayou Tidal
1104	Dickinson Bayou Above Tidal
1103A	Bensons Bayou
1103B	Bordens Gully
1103C	Geislers Bayou
1103D	Gum Bayou

What is a Total Maximum Daily Load?

- The maximum amount of a specific pollutant that a water body can accept while meeting all applicable water quality standards (pollutant-specific assimilative capacity).

- A scientific model that:
  - determines the maximum amount (or load) of a particular pollutant
  - allocates this allowable load to point and nonpoint sources of pollution in the watershed

- A document adopted by the TCEQ which requires approval by the USEPA

What is a Total Maximum Daily Load?

$$TMDL = \Sigma\ WLA + \Sigma\ LA + MOS + FG$$

where:
TMDL = total maximum daily load
WLA = waste load allocation (point source contributions)
LA = load allocation (nonpoint source contributions)
MOS = margin of safety (implicit)
FG = Future Growth

- Estimate (calculation) of the maximum amount of a specific pollutant the water body will accept on a daily basis plus a margin of safety
- Allocation of the estimated maximum pollutant load to broad categories of sources

History of TMDL Development in Dickinson Bayou

- TMDL for Dissolved Oxygen (1103 & 1104)
  - Began in July 2001 (impairment verification in 2000)
  - Released for Public Comment in June 2008
  - Comments called for additional data collection and analysis*
  - Additional data collection and analysis are currently underway

- TMDL for Bacteria (1103, 1103A, 1103B, 1103C, 1104)
  - Began in July 2007
  - Scheduled for Public Comment in 2010
  - Tentatively Scheduled for Adoption in 2010

*TMDL not adopted in 2008

DO TMDL Conclusions

- Simulations show that the DO criteria applied to Dickinson

Conclusions (cont.)

- Additional data should be collected to assess aquatic life and determine or verify the optimum DO criteria
- Site-specific DO criteria and/or frequency of attainment of DO criteria may be developed for Dickinson Bayou (i.e., a frequency of attainment different than the current 90%)
- If necessary, a revised TMDL will be developed based on the optimum DO criteria

What remains to be done for DO TMDL?

- Complete biological and habitat sampling and assessment for Segment 1103 (at least 2 years of sampling)
- Additional Modeling (at least 1 year)
- Standards Review (no sooner than 2013)
- Adoption of revised TMDL (no sooner than 2015)

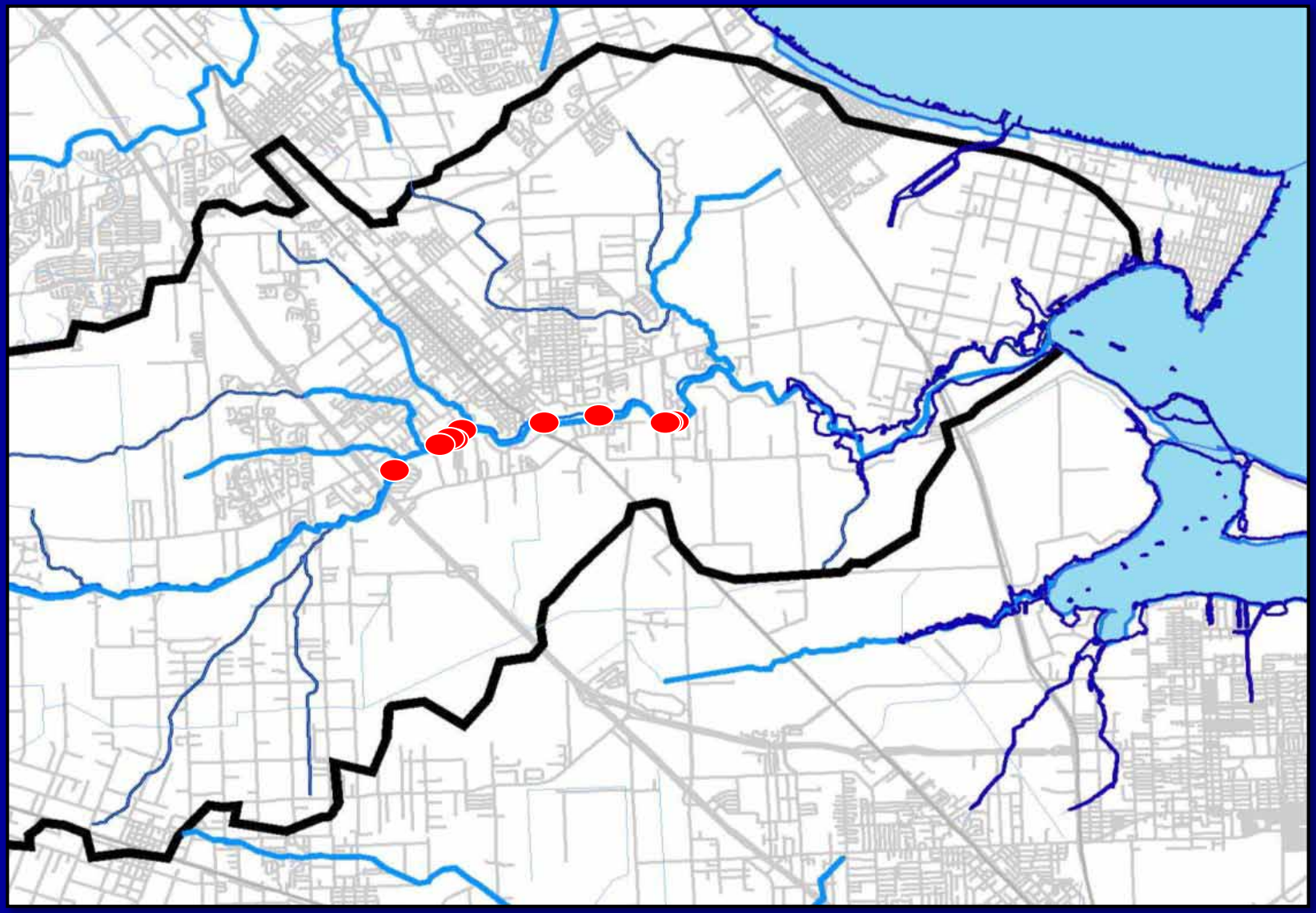
Bacteria TMDLs

In these TMDLs:

- Historical Data Analysis
- Sampling and Analysis Plan
- Sampling

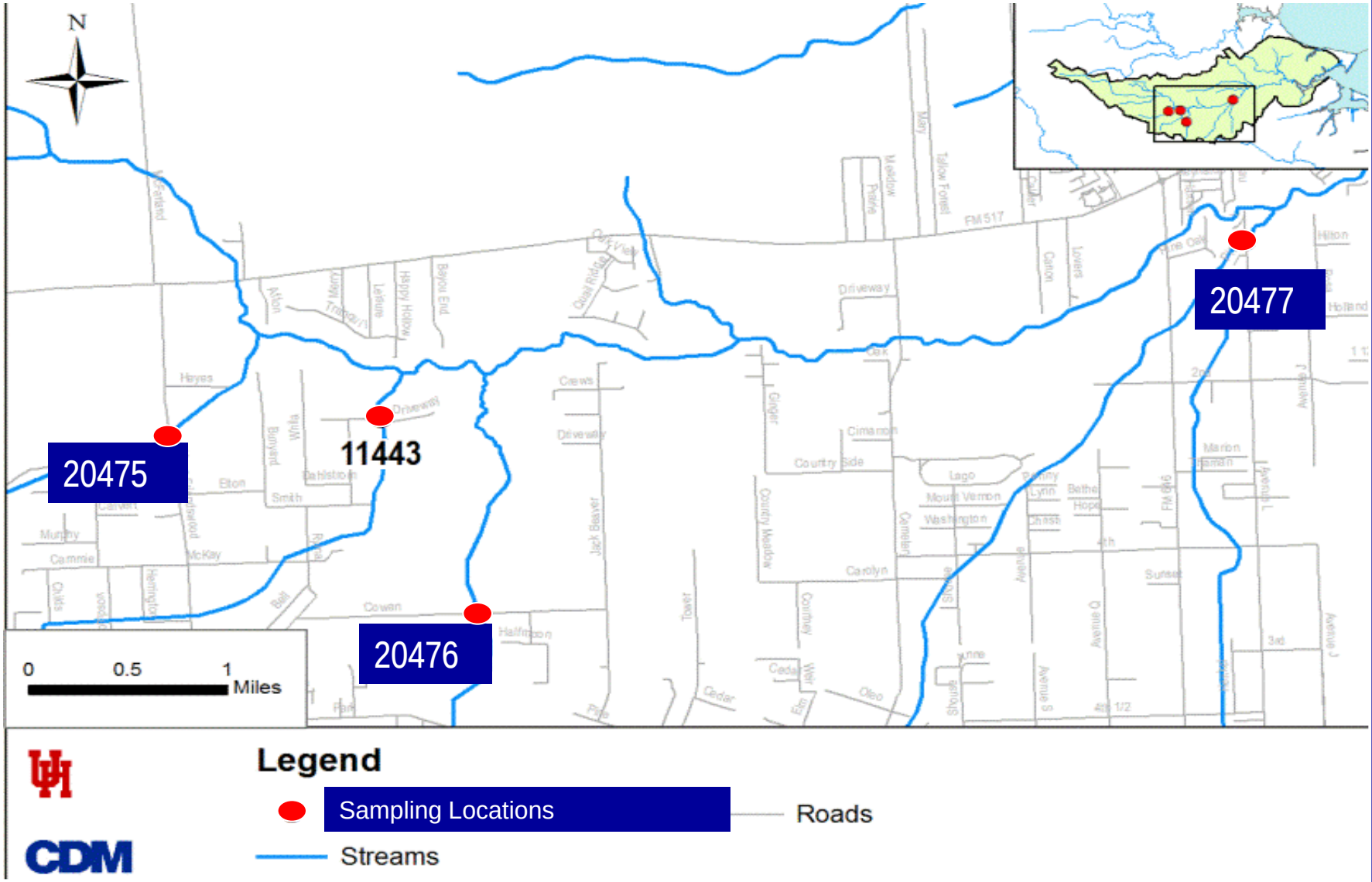
- Model development
- TMDL Allocations

Storm Pipe Sampling



Pipe location

Tributaries



Bayou Wildlife Park

Legend

- Proposed Sampling Locations
- Streams
- Roads
- Bayou Wildlife Park

In this TMDL:

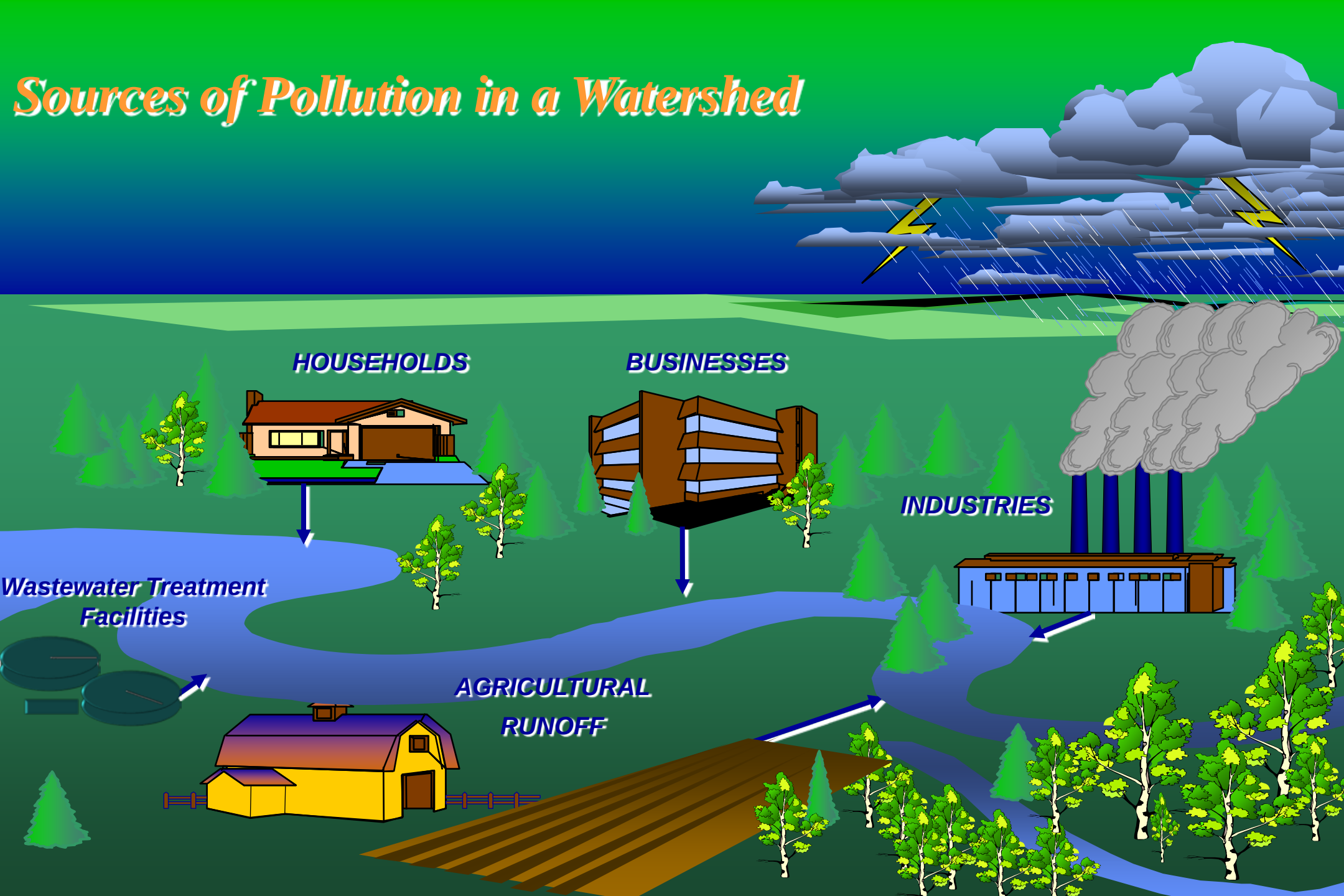
- Historical Data Analysis
- Load Allocation Methodology
- Sampling and Analysis Plan
- Quality Assurance Project Plan
- Sampling
- Model development
- TMDL Allocations

Modeling approach

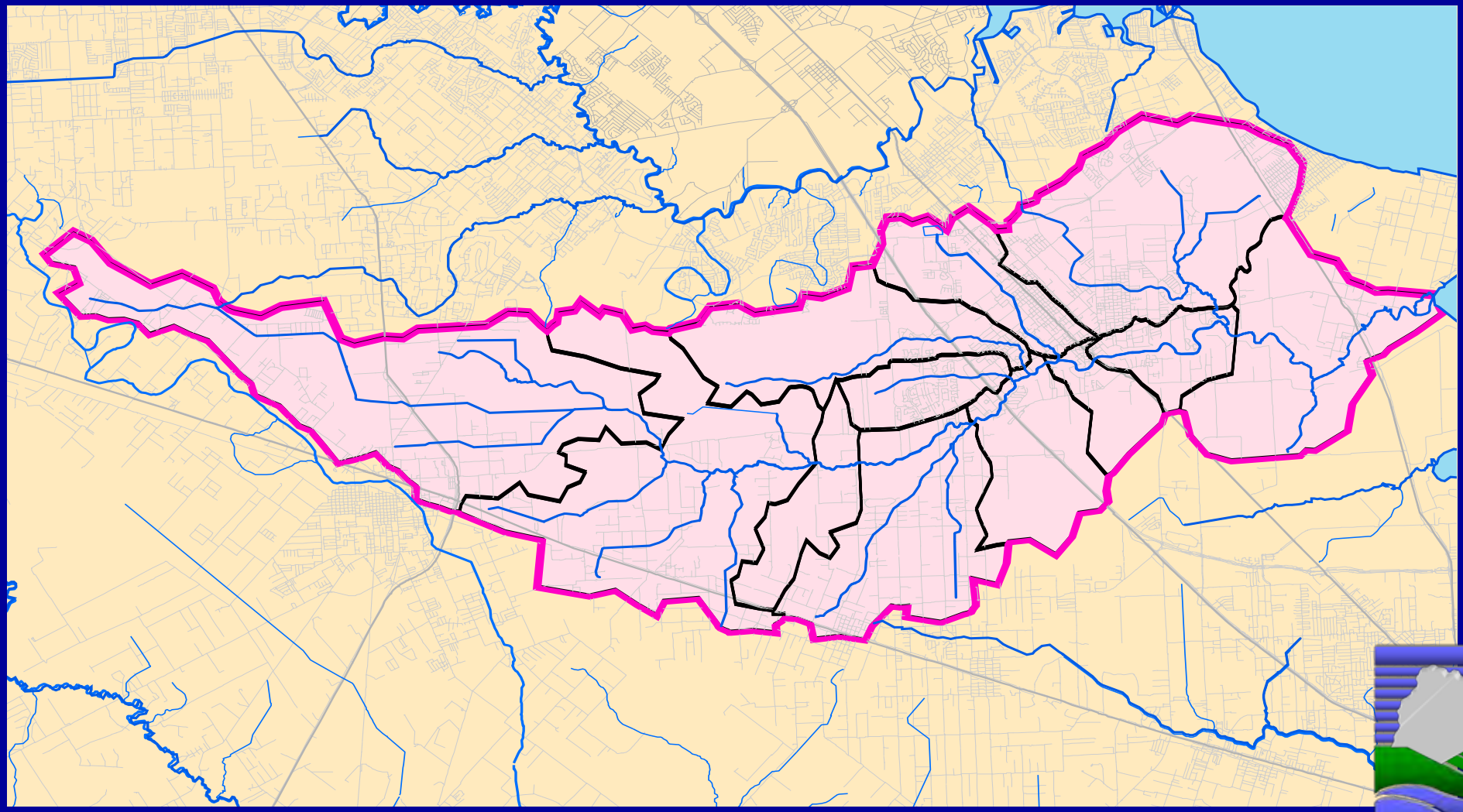
- Non-tidal Segments
  - HSPF coupled with Load Duration Curve
- Tidal Segments
  - HSPF coupled with Tidal Prism Model

HSPF = Hydrologic Simulation Program Fortran

Sources of Pollution in a Watershed



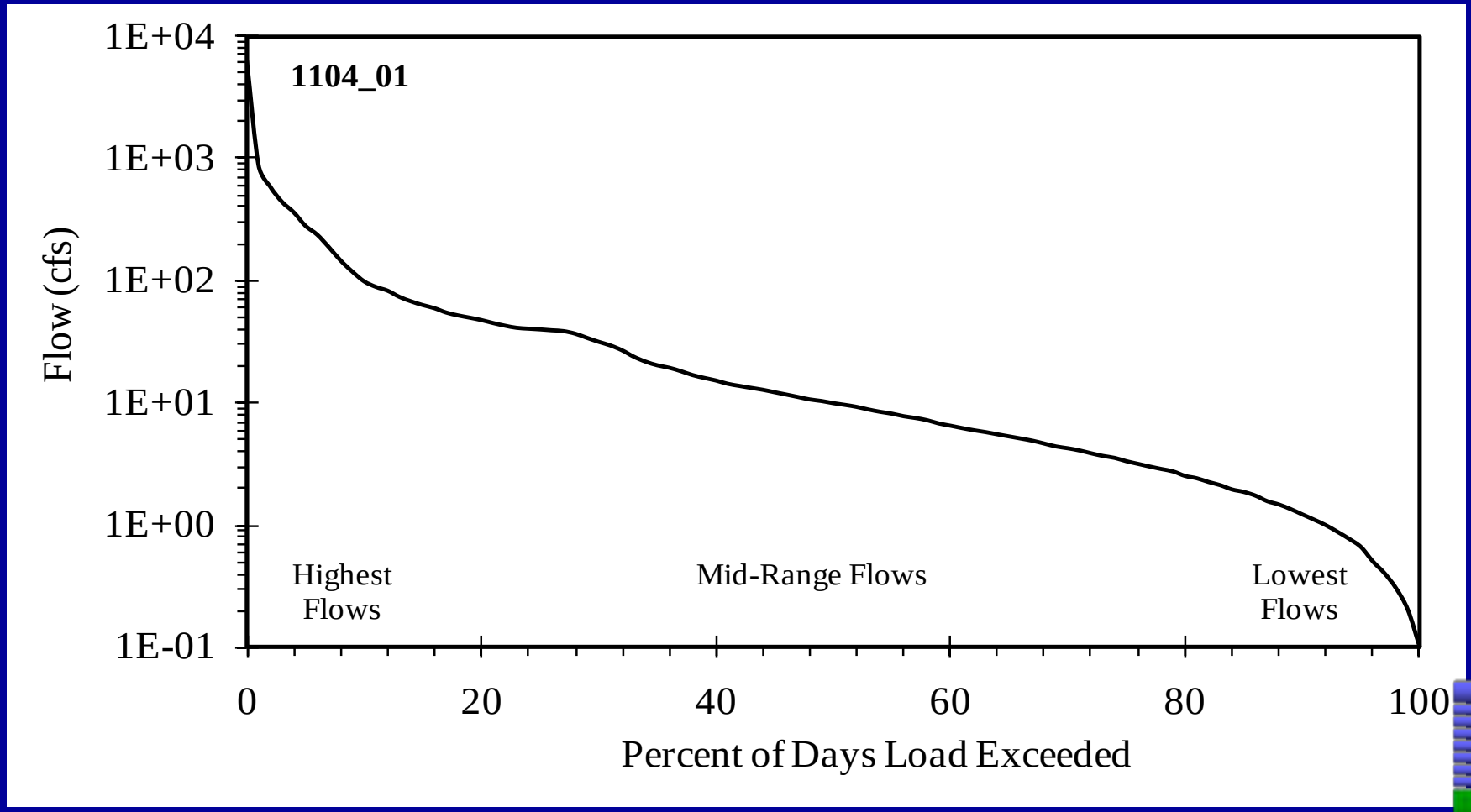
HSPF Watersheds



Load Duration Curve Approach

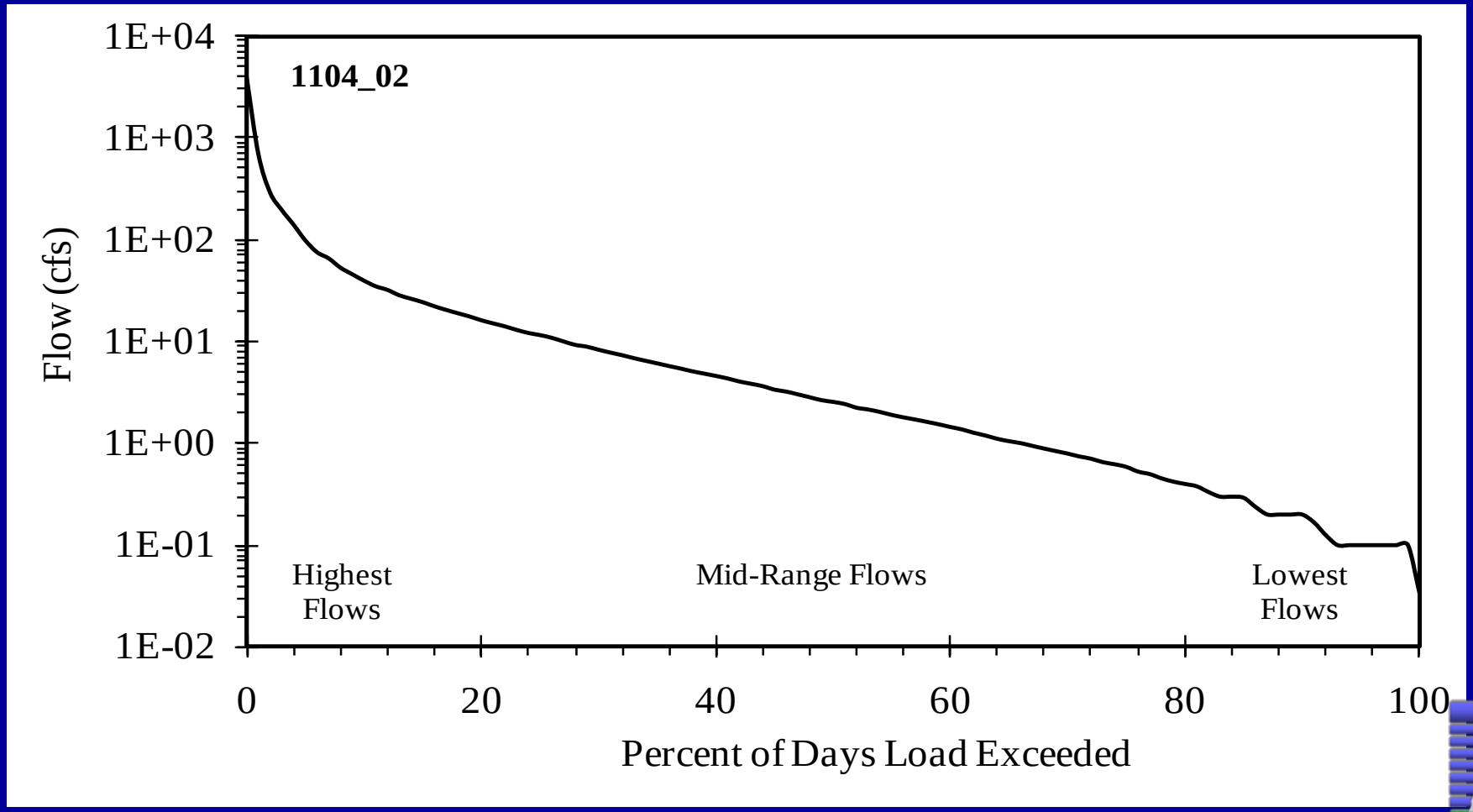
- Prepare flow duration curves (FDC) using the Hydrologic Simulation Program-Fortran (HSPF) model;
- Estimate existing indicator bacteria loading in the receiving water using ambient water quality data;
- Interpret LDCs to derive TMDL elements

Flow Duration Curve – 1104_01



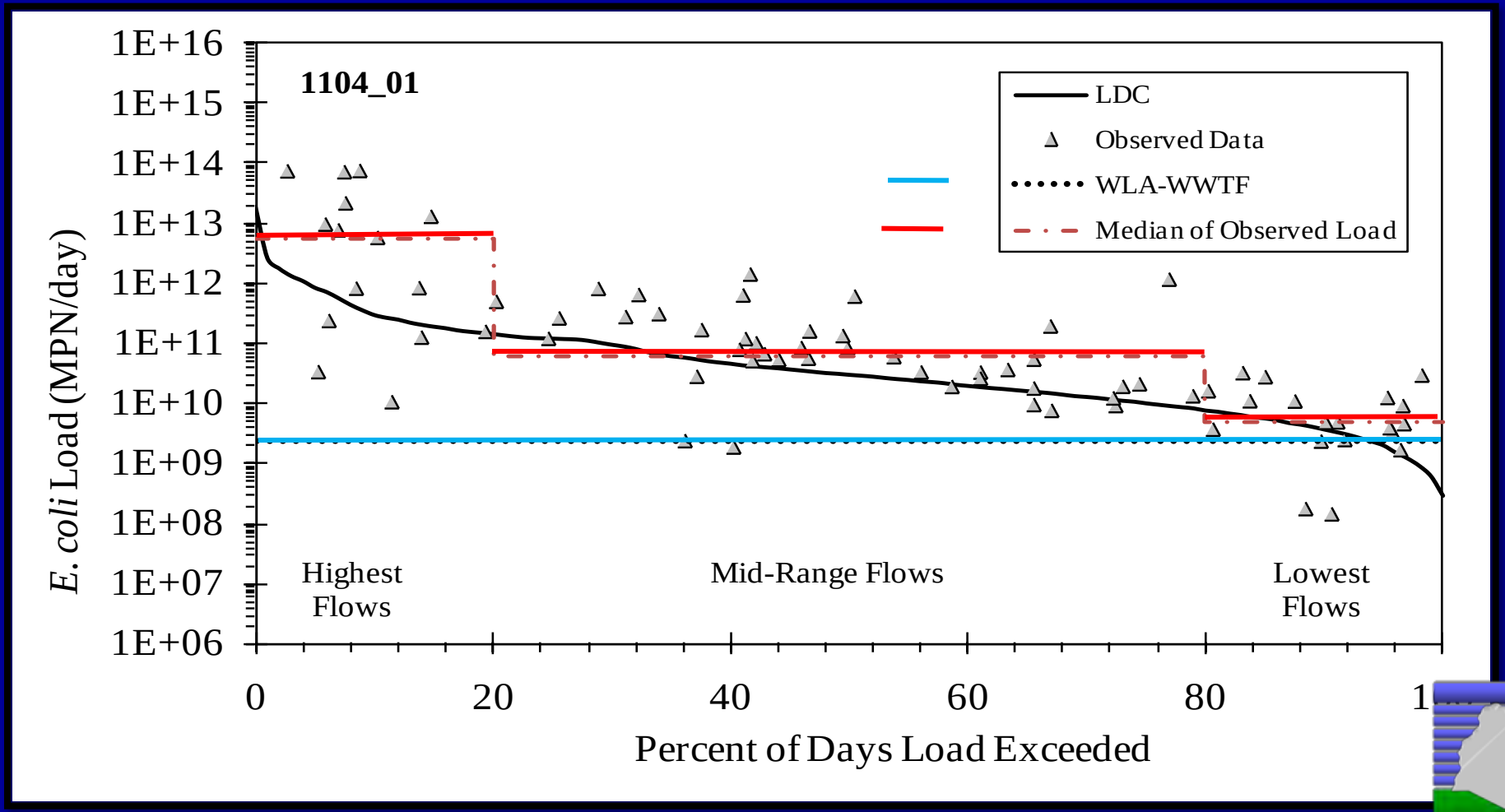
cfs - cubic feet per second

Flow Duration Curve – 1104_02



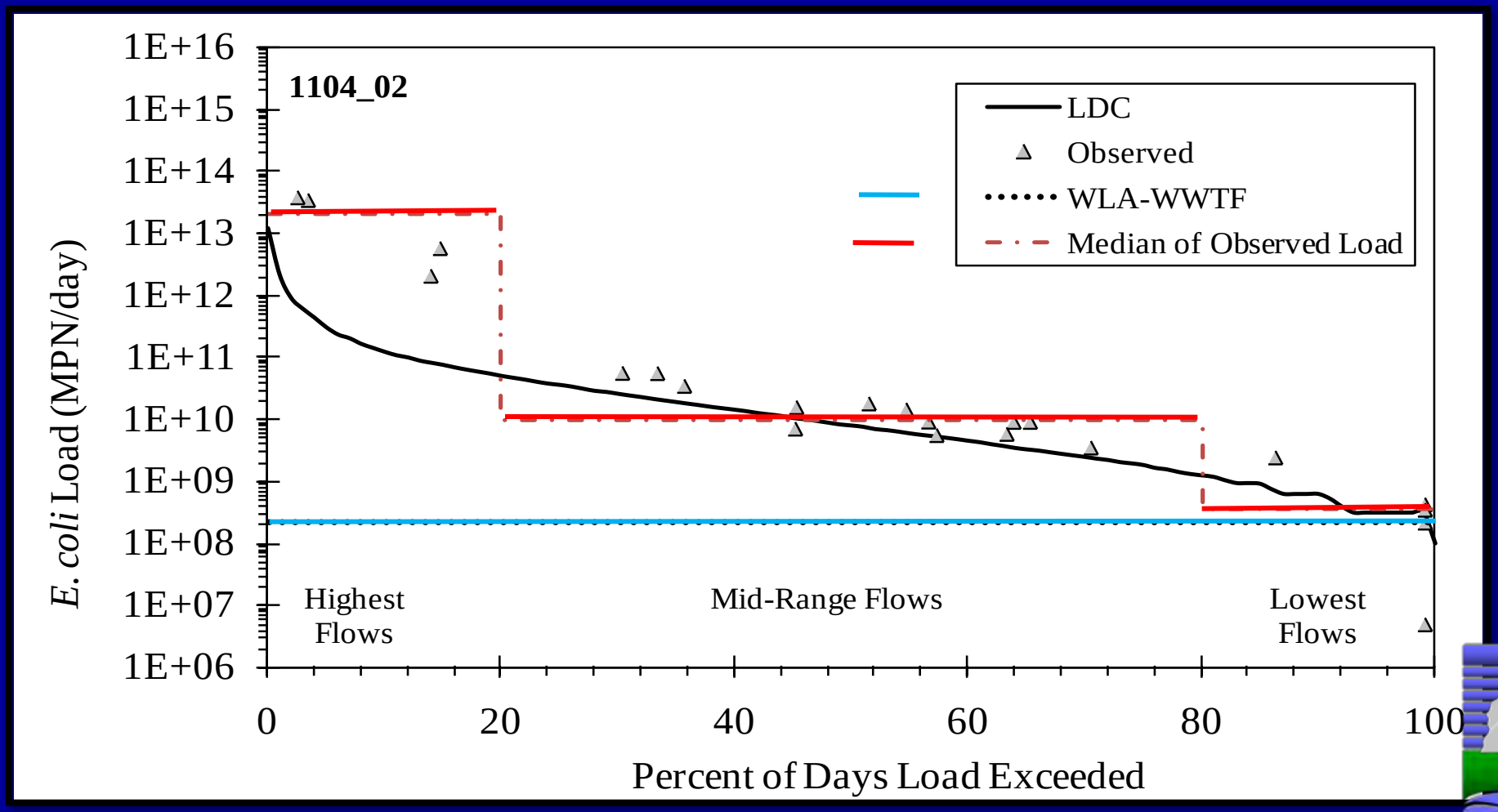
cfs - cubic feet per second

Load Duration Curve – 1104_01



MPN – most probable number, LDC – load duration curve; WLA-WWTF – wasteload allocation wastewater treatment facilities

Load Duration Curve – 1104_02



MPN – most probable number, LDC – load duration curve; WLA-WWTF – wasteload allocation for wastewater treatment facilities

Load Allocations 1104_01 (MPN/day)

Condition	0-20%	20-80%	80-100%
Median Flow (cfs)	1.15	9.85	107.53
Target Concentration	120	120	120
Existing Load, Median	4.7E+09	6.2E+10	5.7E+12
TMDL, Median	3.6E+09	3.0E+10	3.3E+11
Margin of Safety	1.8E+08	1.5E+09	1.7E+10
Load Reduction (%)	25%	51%	94%

cfs – cubic feet per second, MPN – most probable number, TMDL – total maximum daily load

Load Allocations 1104_02 (MPN/day)

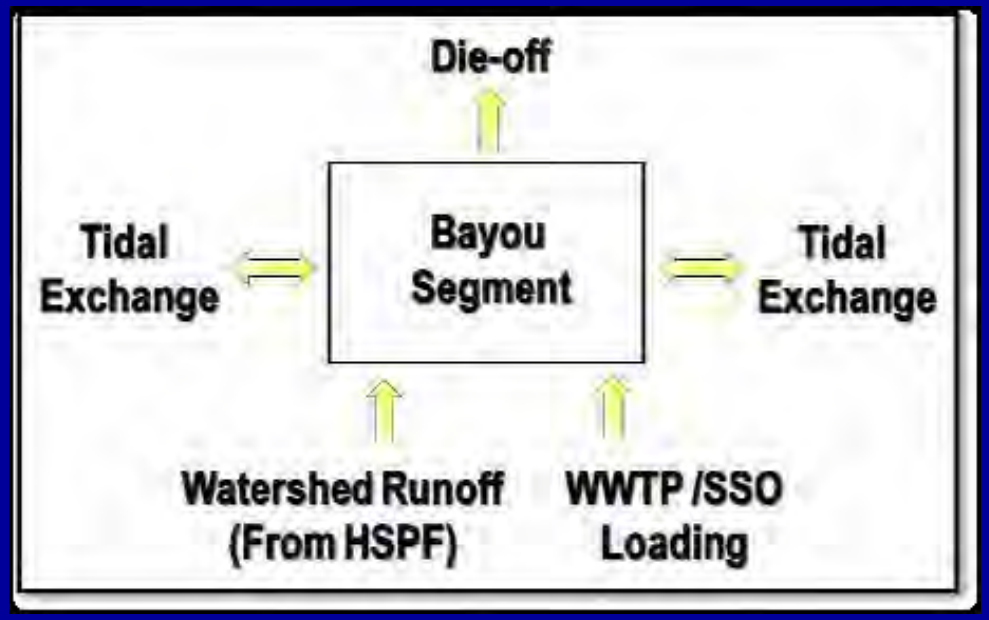
Condition	0-20%	20-80%	80-100%
Median Flow (cfs)	0.51	2.89	43.56
Target Concentration	120	120	120
Existing Load, Median	3.5E+08	9.2E+09	2.0E+13
TMDL, Median	1.6E+09	8.9E+09	1.3E+11
Margin of Safety	7.8E+07	4.5E+08	6.7E+09
Load Reduction (%)	0%	8%	99%

cfs – cubic feet per second, MPN – most probable number, TMDL – total maximum daily load

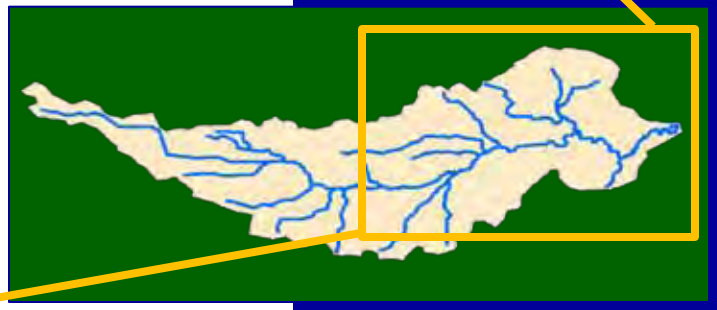
Tidal Prism/Box Modeling approach

- HSPF coupled with Tidal Prism Model
- HSPF provides:
  - Upstream boundary flows
  - Watershed build-up/wash-off process for the tidal segments
- Tidal Prism Model:
  - Simulates enterococci in the tidal portion of the watershed

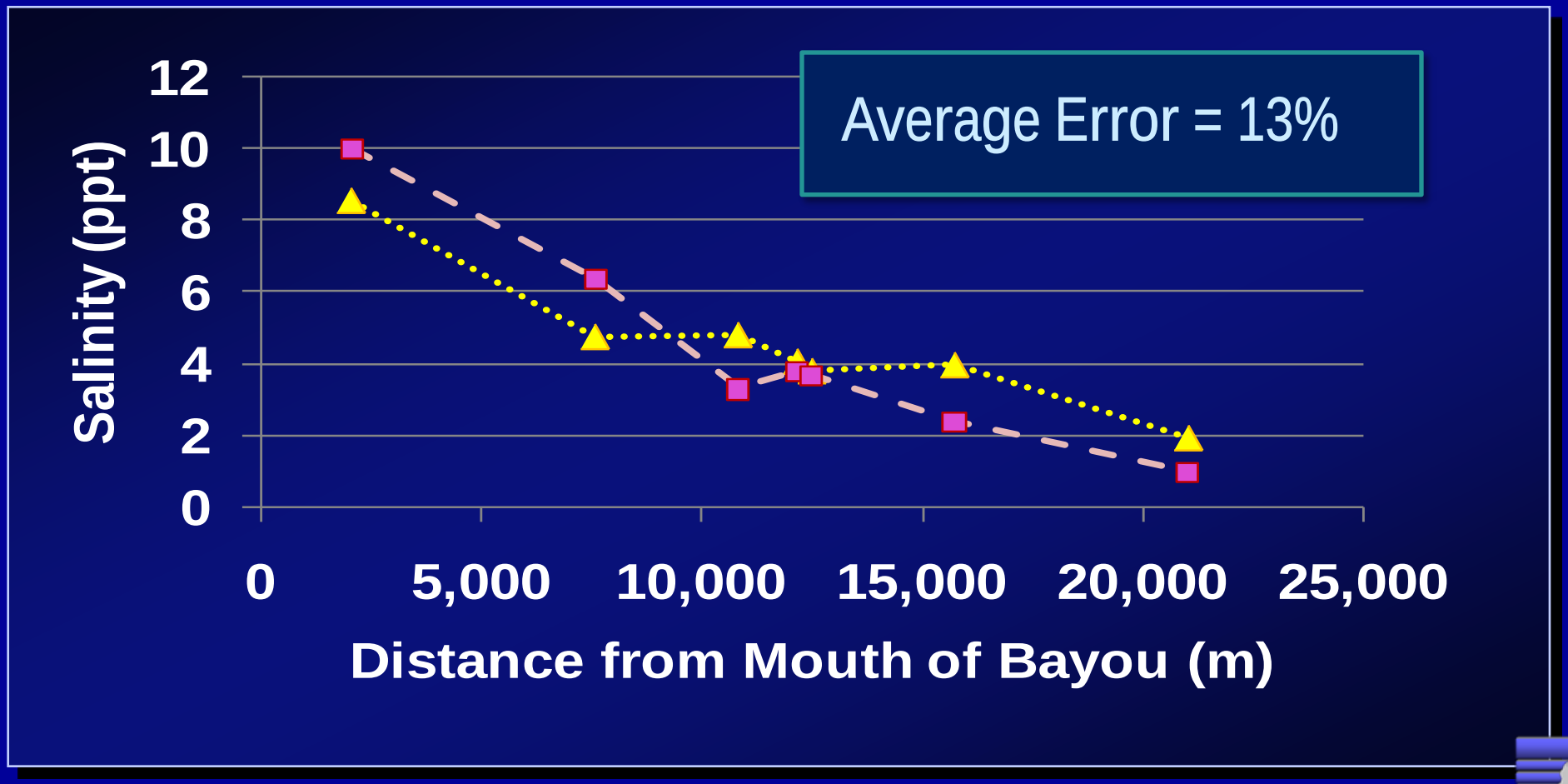
Tidal Prism/Box Modeling approach



Tidal Modeling Segmentation



Hydraulics Validated with Salinity

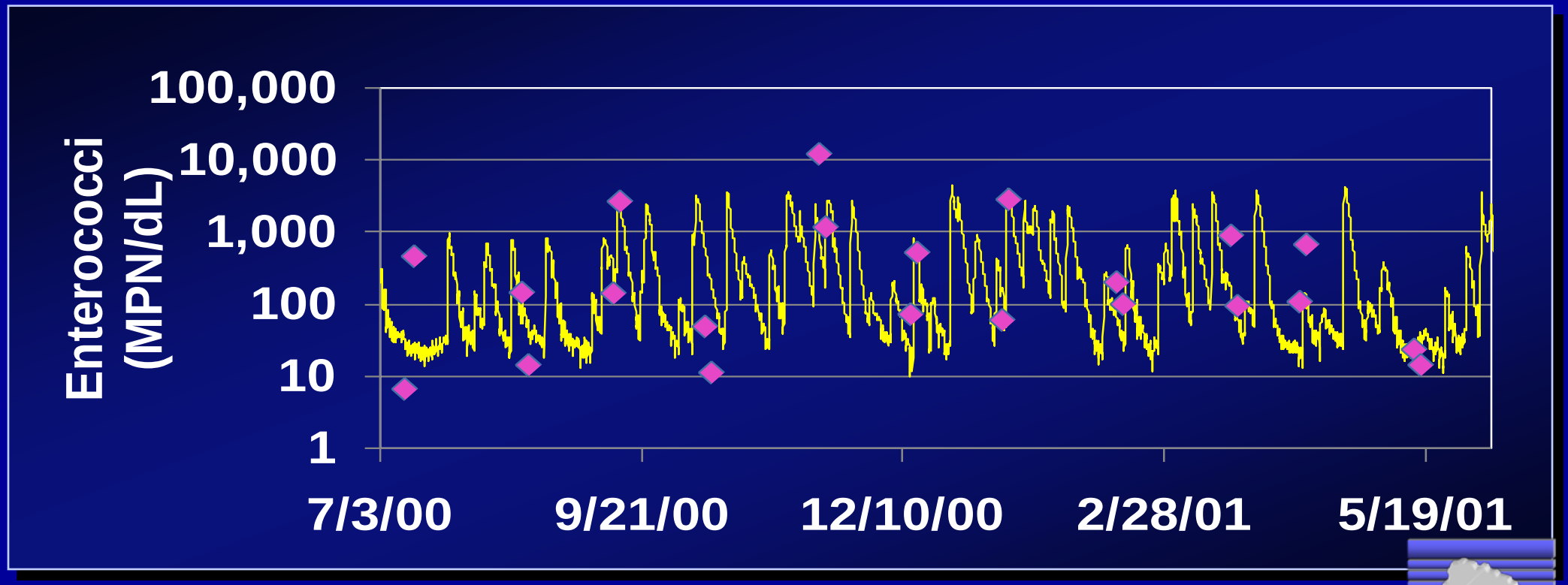


Observed Modeled

ppt - part per thousand; m - meter

Tidal Model Calibration

Reach 8, Geomean error of 15%

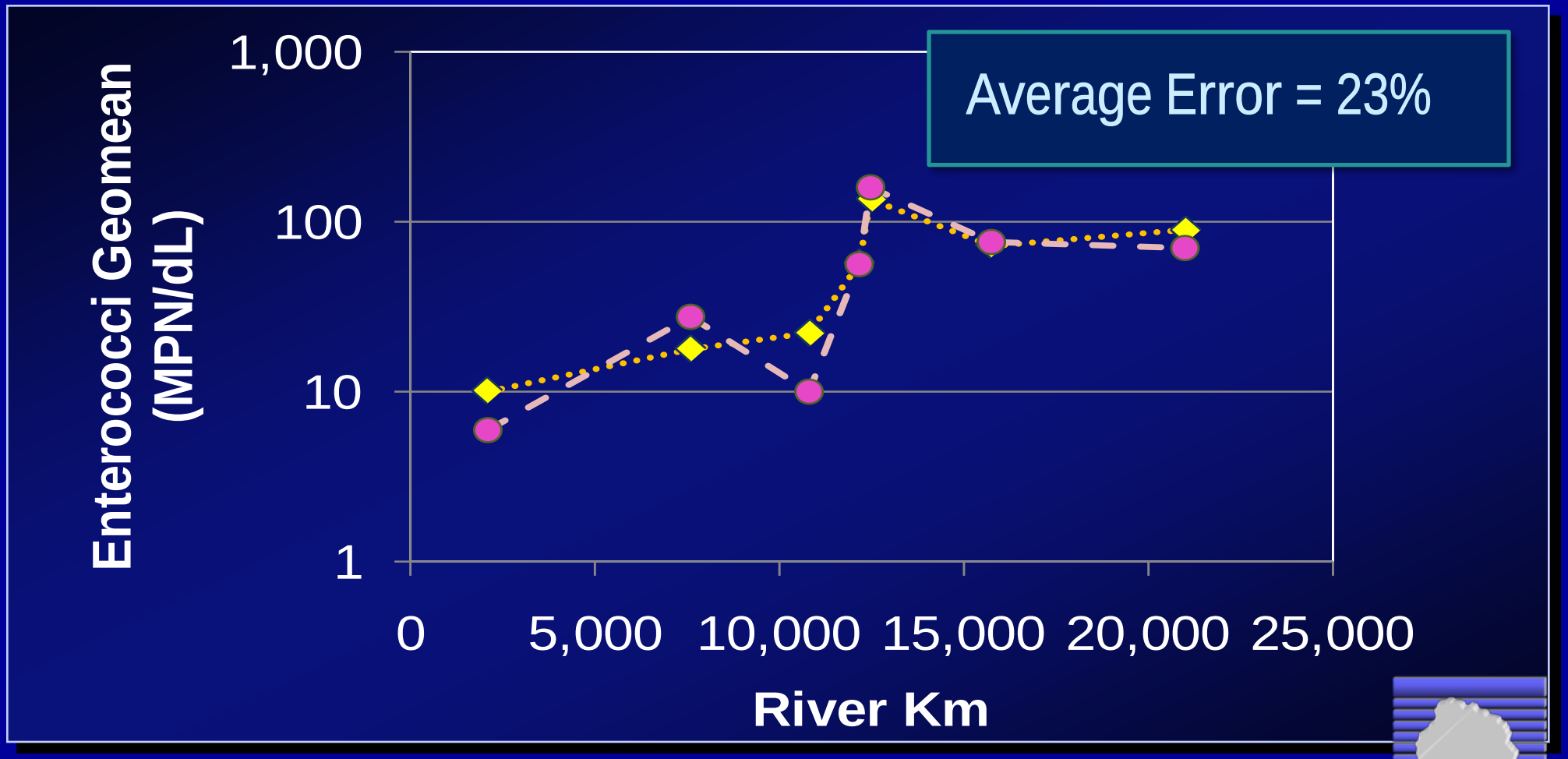


Observed

Modeled

MPN – most probable number

Longitudinal Plot – Tidal Model



Observed Modeled

MPN – most probable number; Km - kilometer

Required Reductions - Enterococci

Stream	AU	TMDL (MPN/day)	Observed Load (MPN/day)	% Reduction
Dickinson Bayou Tidal	1103_01	6.62E+10	1.4E+11	70%
	1103_02	9.21E+10	2.01E+11	87%
	1103_03	2.39E+11	6.47E+09	70%
Bensons Bayou	1103A_01	9.26E+09	3.11E+10	53%
Bordens Gully	1103B_01	1.65E+09	1.25E+10	54%
Geisler Bayou	1103C_01	4.14E+09	1.39E+10	0%

MPN – most probable number

In this TMDL:

- Historical Data Analysis
- Load Allocation Methodology
- Draft Sampling and Analysis Plan
- Quality Assurance Project Plan
- Sampling
- Model development
- TMDL Allocations

Segment 1104 – *E. coli* Allocations (MPN/day)

AU	TMDL	WLA_{WWTF}	WLA_{PSW}	LA	MOS	Future Growth
1104_01	3.2E+10	4.0E+09	1.6E+09	2.4E+10	1.5E+09	1.1E+09
1104_02	9.1E+06	1.5E+09	2.4E+09	3.4E+09	4.5E+08	1.3E+09

MPN – most probable number; AU – assessment unit, TMDL – total maximum daily load; WLA-wwtf – wasteload allocation for wastewater treatment facilities, WLA-PWS – wasteload allocation for permitted storm water; LA – load allocation; MOS – margin of safety

Segment 1103 – ENT Allocations (MPN/day)

AU	TMDL	WLA_{WWTF}	WLA_{PSW}	LA	MOS	Future Growth
1103_01	6.6E+10	0.0E+00	2.0E+10	4.3E+10	3.3E+09	0.0E+00
1103_02	9.2E+10	0.0E+00	2.6E+10	6.2+10	4.6E+09	0.0E+00
1103_03	2.4E+11	6.5E+09	6.2E+10	1.6E+11	1.2+10	1.61E+09
1103A_01	9.3E+09	0.0E+00	4.7E+09	4.1E+09	4.6E+08	0.0E+00
1103B_01	1.7E+09	0.0E+00	5.6E+08	1.0E+09	8.3E+07	0.0E+00
1103C_01	4.14E+09	0.0E+00	1.0E+09	2.9E+09	2.07E+08	0.0E+00

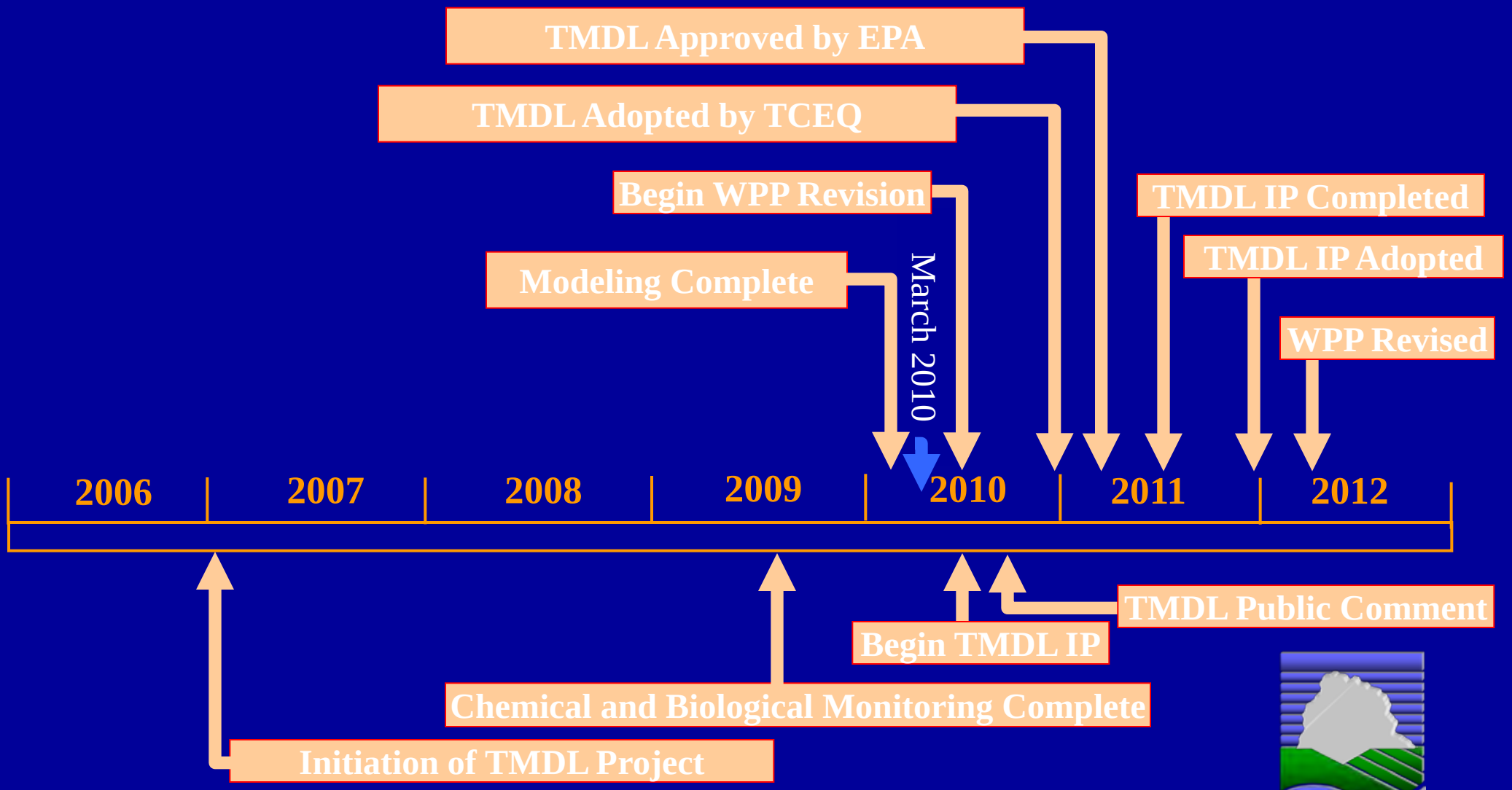
Adoption and Approval Process

1. Peer Review (2 weeks – 1 month)
2. Administrative Review (1 -3 months)
3. Release for Public Comment (1-3 months)
4. Conduct Public Meeting (1 month)
5. Prepare Response to Public Comments (1 month)
6. Schedule Adoption (1-3 months)
7. Final TCEQ Adoption (1 day)
8. Sent to EPA for approval (1 month)
9. EPA Approval (2 months)

Low end estimate 8-9 months

High end estimate 15 months

Draft Schedule



http://www.tceq.state.tx.us/implementation/water/tmdl/17-dickinson.html

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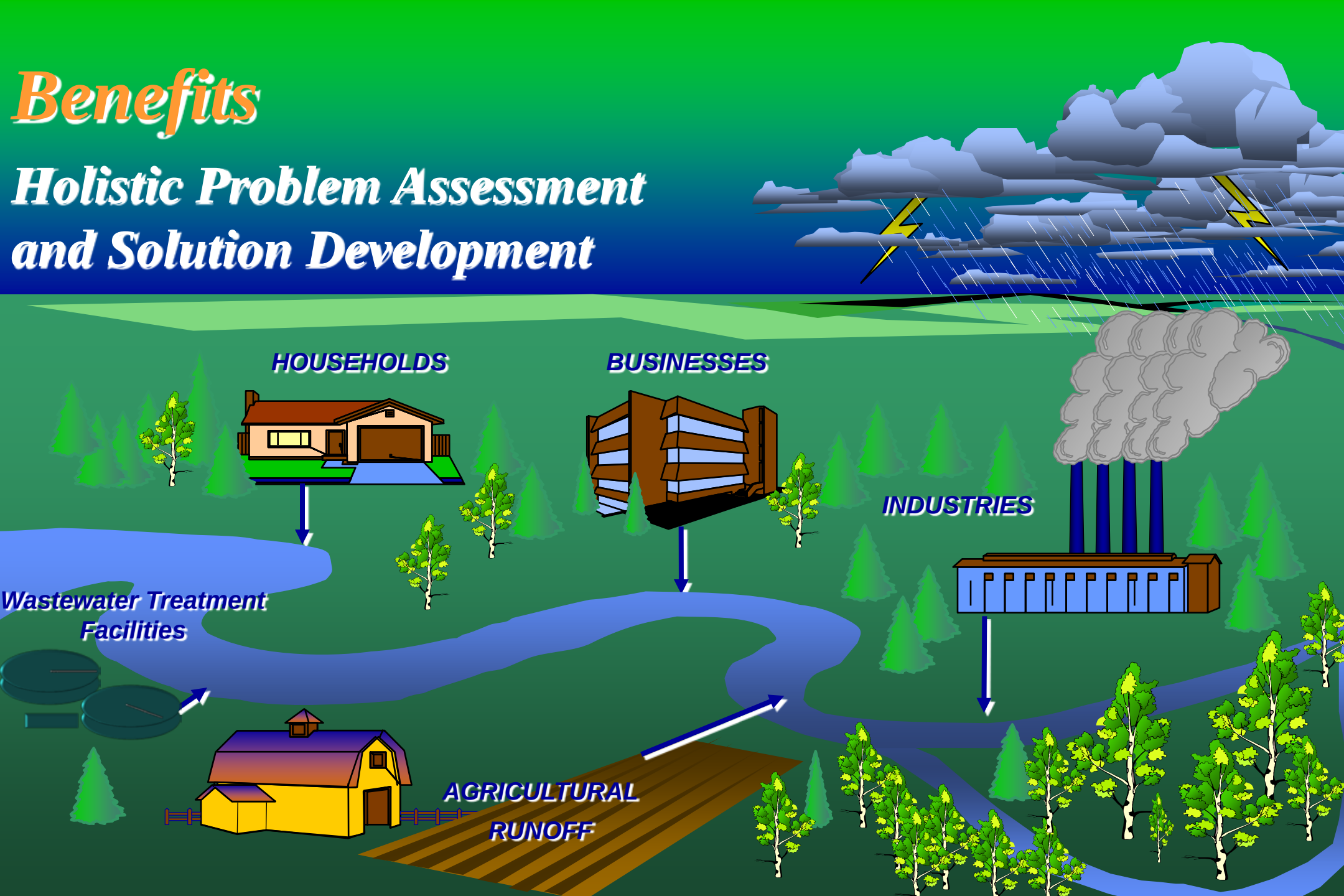
Due to time constraints, the following portion of the presentation was not presented at the April 25th meeting

Two Kinds of Watershed Restoration Plans

- Watershed Protection Plans (WPPs)
- TMDL Implementation Plans (I-Plans)
- Both have the same goal — improving water quality in rivers, lakes, or bays
- I-Plans are remedial actions for impaired waters; WPPs may be either remedial or preventive
- I-Plans are based on total maximum daily loads; WPPs may use TMDLs or other measurable goals for water quality

Benefits

Holistic Problem Assessment and Solution Development



TMDL Process

303(d) List Category 5a

Initiate TMDL Projects for Impaired Waters

TMDL Allocation Report

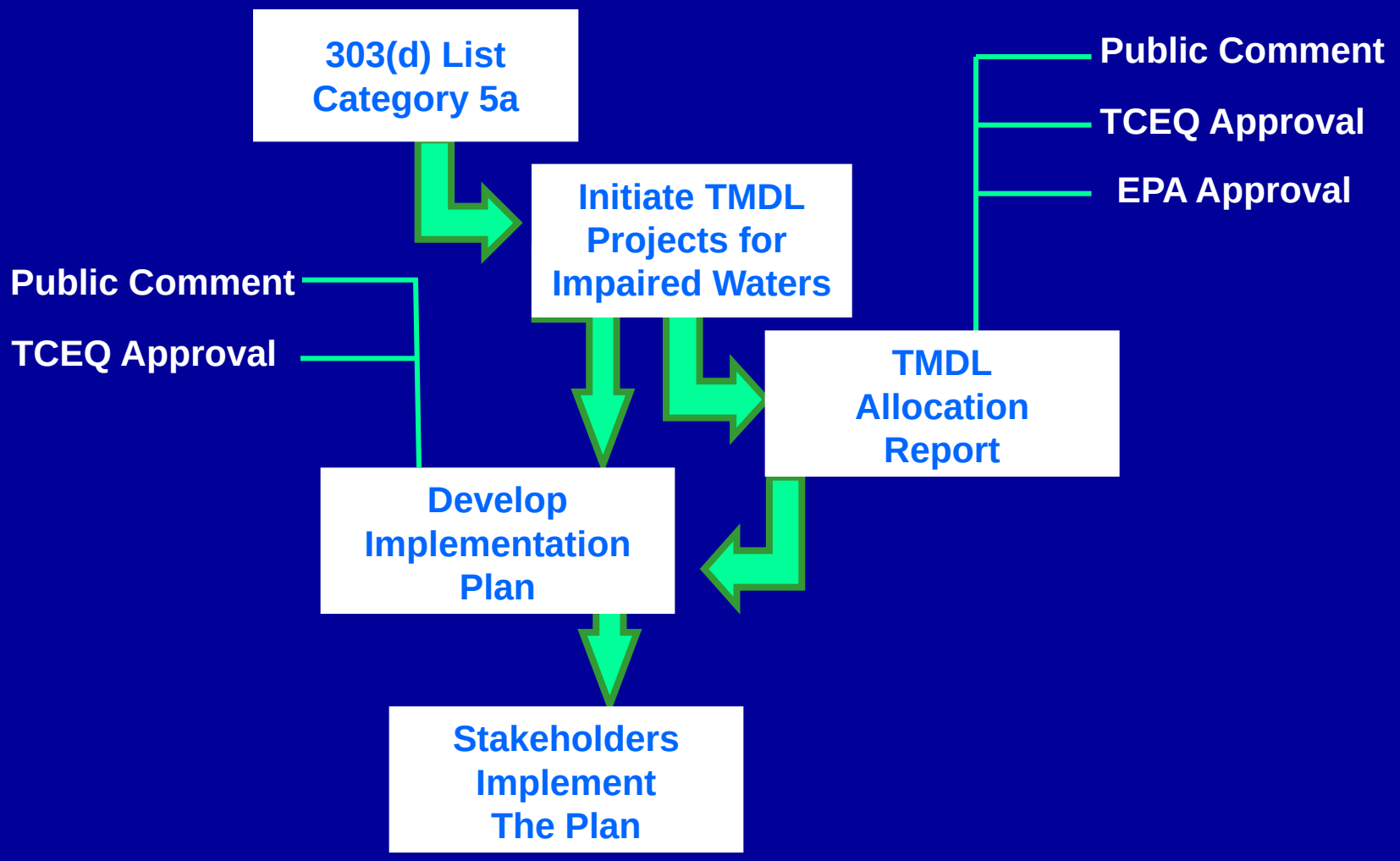
- Public Comment
- TCEQ Approval
- EPA Approval

Develop Implementation Plan

- Public Comment
- TCEQ Approval

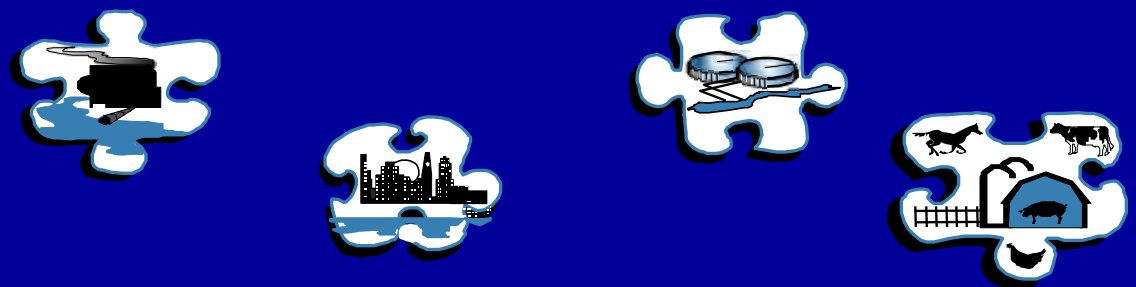
Stakeholders Implement The Plan

Dickinson Bayou TMDL Process



What Are WPPs and TMDL IPs?

- Watershed protection plans and TMDL I-Plans:
  - Define actions needed to reduce pollution and restore water quality
  - Include voluntary actions for water quality restoration (IPs also include regulatory actions)
  - Are developed in cooperation with regional and local stakeholders
- Are based on the best available scientific methods and tools.



Implementing TMDLs

- Implementation plans are collaborative efforts and involve a wide variety of stakeholders.
  - Citizens, watershed interest groups
  - State, local, and federal agencies
  - Regulated organizations
- Control actions for point source discharges; management measures for nonpoint source
- Often, plans are phased-in based on progress in achieving water quality improvement.
- Water quality improvement may take years.
- Follow-up monitoring is crucial.

IP Control Actions

- Point source TMDL allocations affect permits
  - New, amended, or renewed permitted loads must be consistent with the TMDL allocation.
  - TCEQ may initiate amendments to impose new limits, or may impose them with routine renewals or amendments.
  - Permitted loading from existing facilities may be substantially reduced.
  - New facilities may be required to meet more stringent effluent limits.

Control Actions (continued)

- Point source TMDL allocations affect permits:
  - In some cases or areas, storm water permits may receive new or more stringent limits consistent with TMDL allocations.
  - Permittees may no longer be eligible for general permits.
  - Additional monitoring and reporting requirements may be needed.
  - Permittees may have the opportunity to negotiate effluent trading agreements in order to meet net load limit for watershed.

Management Measures

- Nonpoint source TMDL allocations may result in implementation of best management practices (BMPs):
  - Managing runoff:
    Detention basins, filter strips, infiltration basins, porous pavement, retention ponds, swales
  - Decreasing pollutants in runoff:
    Spill prevention and control, source controls (OSTs), education
- Management is an iterative process.

Management Measures

TMDL and IP provide increased incentives to implement BMPs

Assistance
- Financial (319, SRF)
- Technical
- Public Education

Re-evaluate BMP
- Effectiveness
- Incentives

Not Good

Assess
- Evaluate progress toward IP goals

Good

TMDL and IP provide increased accountability for BMP effectiveness and implementation
- Monitoring
- Modeling
- Tracking

IP Goal Met

Standards Met

Use Restored

Implementing TMDLs

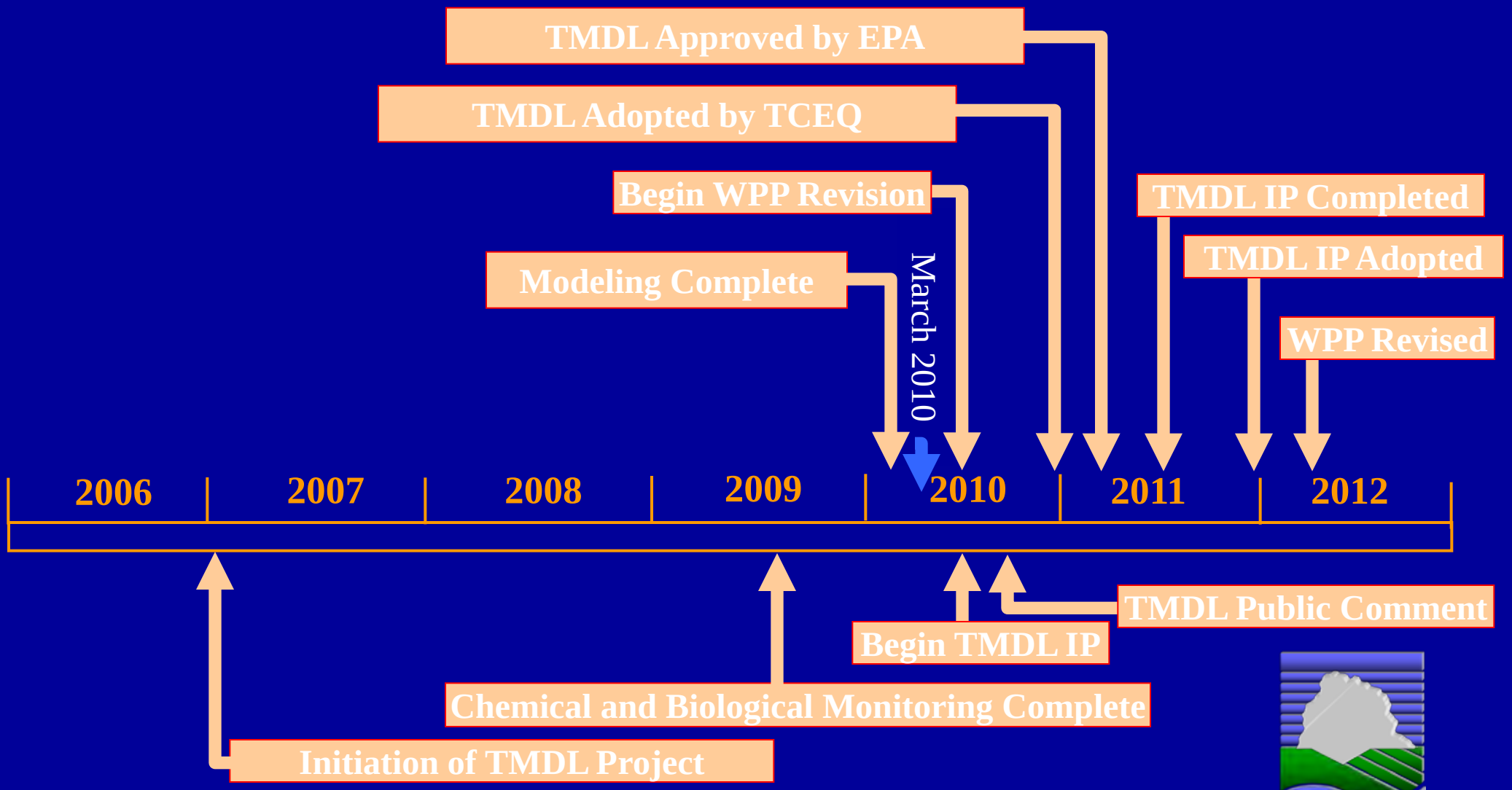
- I-Plans are complete for 54 pollutants or adverse conditions in 33 water bodies.
- As of January 2010, the program had restored:
  - 311 stream miles for fishing, aquatic life, and general uses
  - 19,247 reservoir acres as sources of drinking water
  - 12 bay/estuary square miles for aquatic life

For Dickinson Bayou…

- Implementation of WPP Measures
- Adoption and Approval of Bacteria TMDLs
- Completion and Approval of Bacteria TMDLIP
- Revision of WPP document
- Completion of Biological and Habitat Assessment
- Determination of Optimum DO Criteria and Standards Review
- Revision of Draft DO TMDL*
- Adoption and Approval of DO TMDL*

*If Observed DO < Optimum Criteria

Draft Schedule



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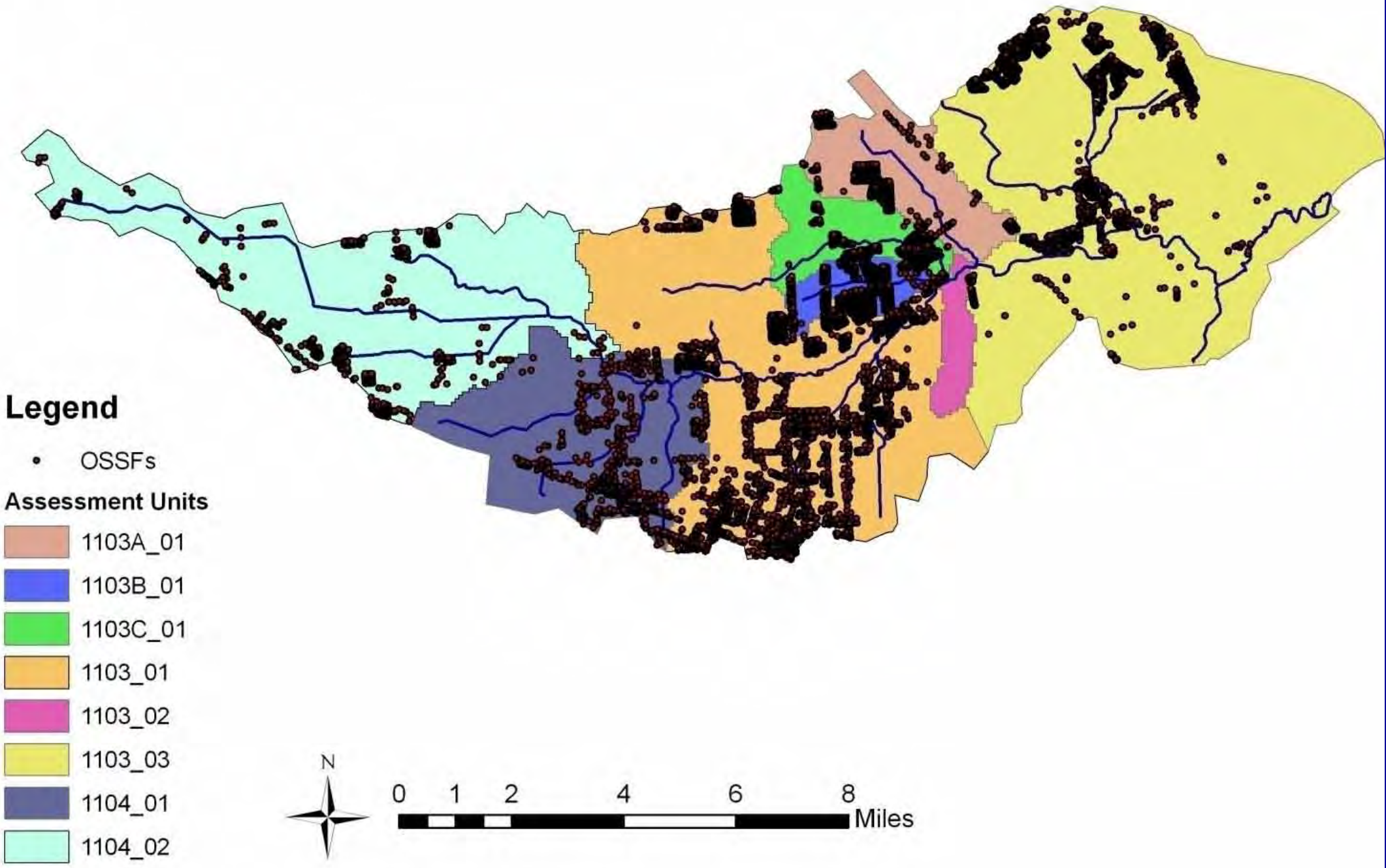
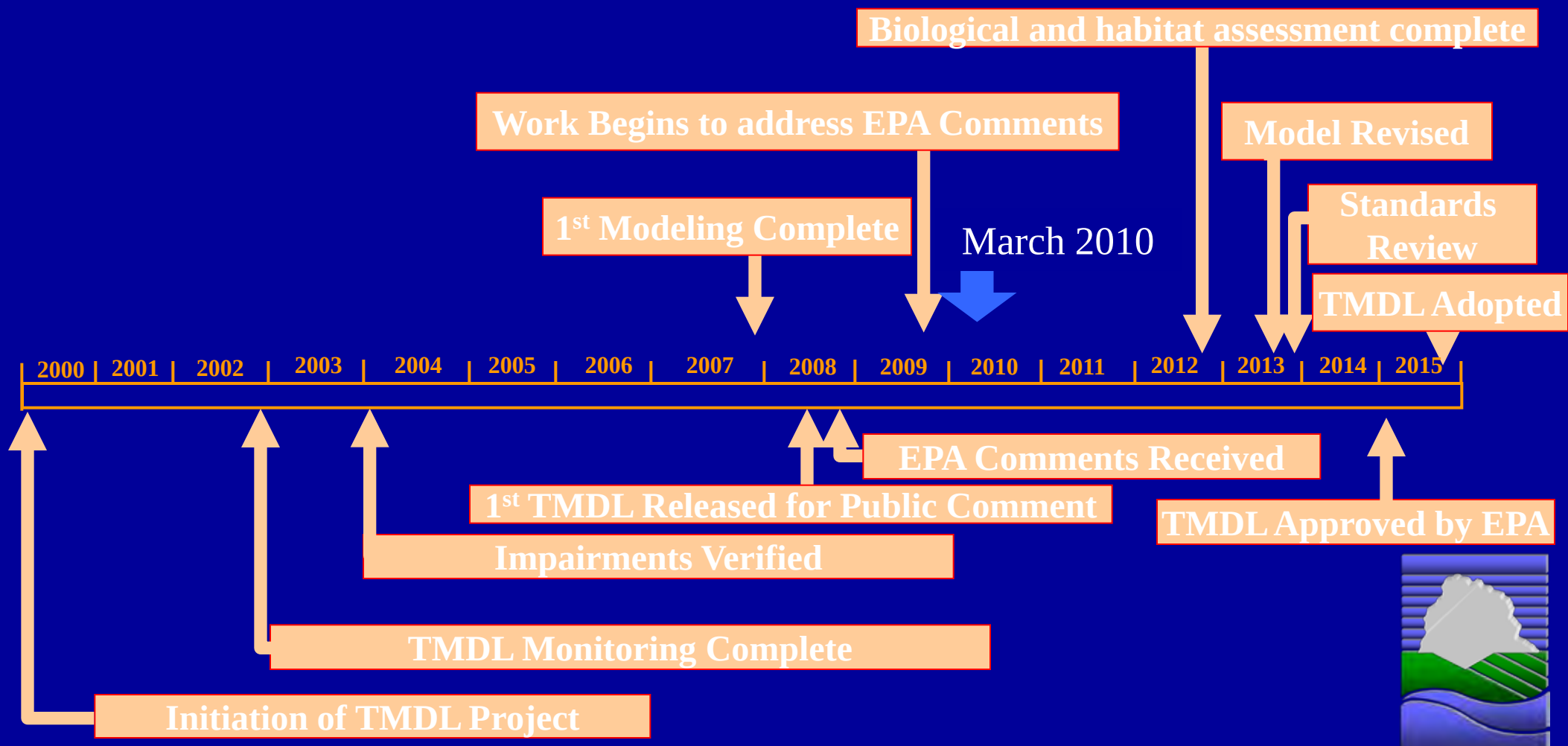

Legend
OSSFs
Assessment Units
1103A_01
1103B_01
1103C_01
1103_01
1103_02
1103_03
1104_01
1104_02
N
0 1 2 4 6 8
Miles

Contact Recreation Standards

Indicator Bacteria	Geometric Mean Concentration	Not to Exceed Concentration
Fecal Coliform (cfu/dL)	200	400
E. coli (MPN/dL)	126	394
Enterococci (MPN/dL)	35	89

cfu--colony forming unit, MPN -- most probable number

Draft Schedule DO