




Bacteria TMDLs for Greens Bayou

November 6, 2008



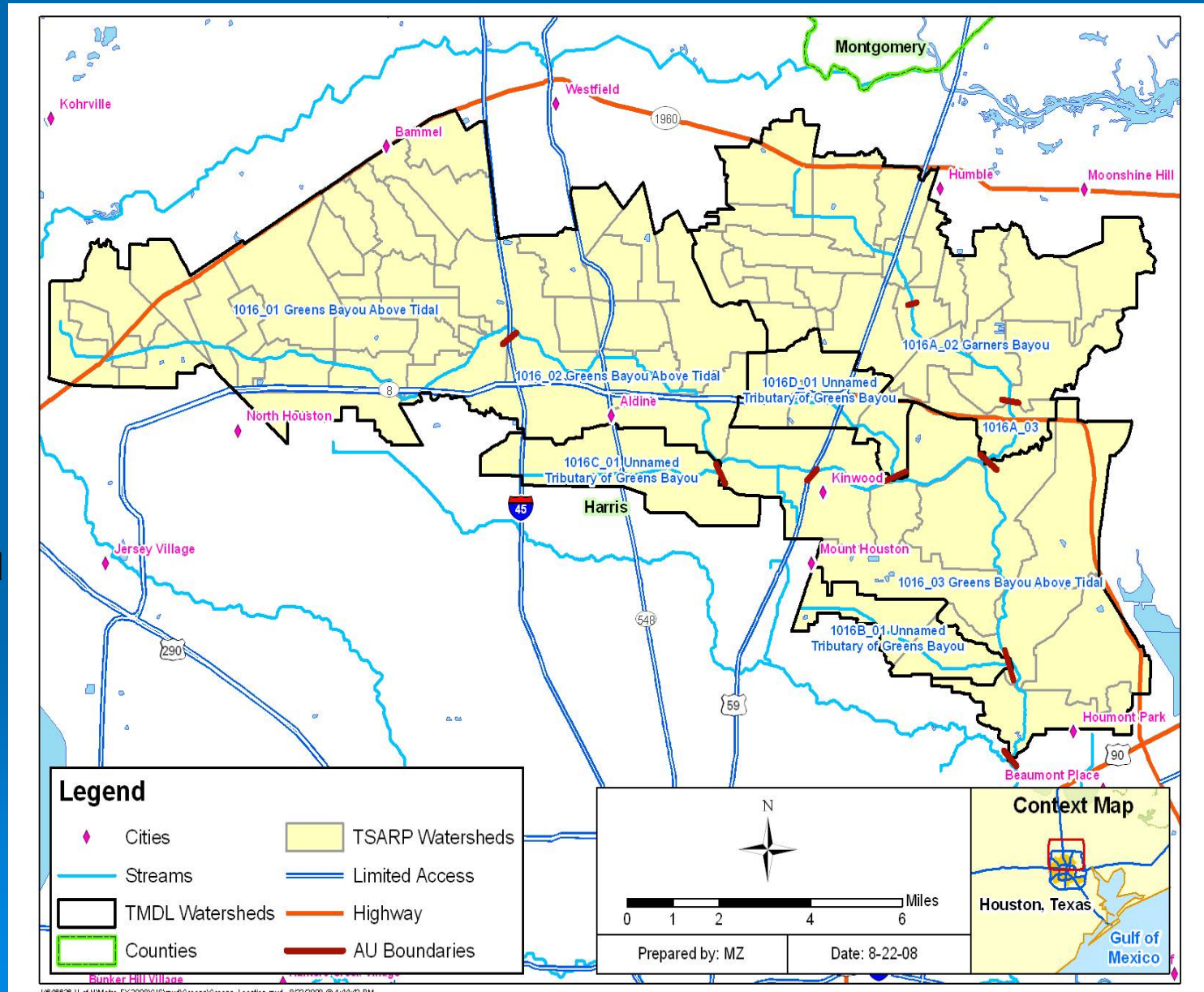
PARSONS

Outline

- **Watershed Overview**
 - **Pollutant Source Assessment**
 - **Technical Approach: Load Duration Curves**
 - **TMDL Calculations**
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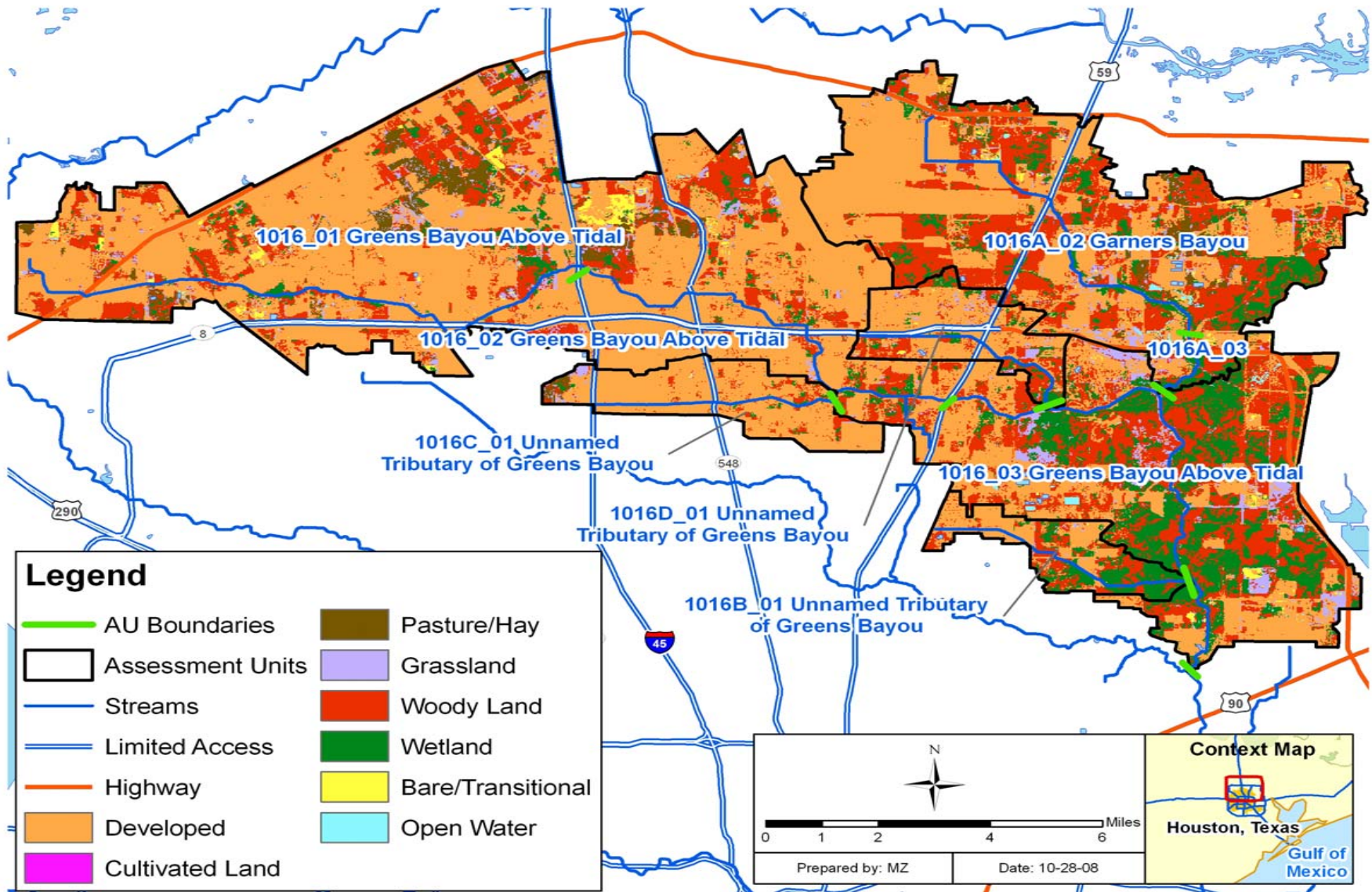
Greens Bayou Watershed

- ~140 square miles
- Located within 2 counties (Houston and Humble)
- Average Annual Rainfall 48.8 inches (NOAA 2007)



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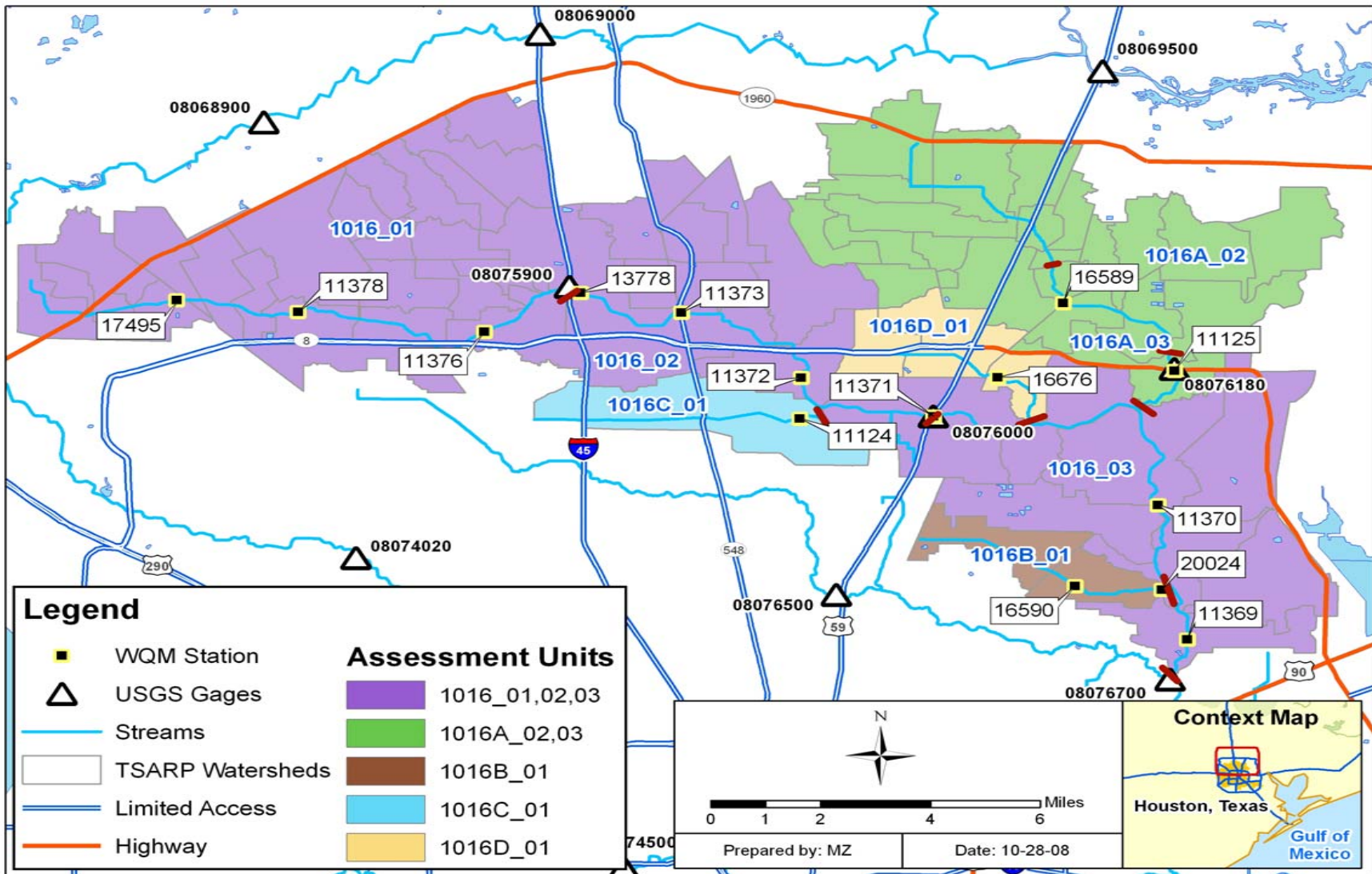
Land Use/Land Cover



303 (d) Listed Assessment Units (2008)

Segment	Water Body	Description of Assessment Unit Not Supporting Contact Recreation Use
1016_01 1016_02 1016_03	Greens Bayou Above Tidal	IH 45 to US 59
		US 59 to upstream Halls Bayou confluence
1016A_02 1016A_03	Garners Bayou	From Williams Gully confluence to confluence with Greens Bayou
1016B_01	Unnamed Tributary of Greens Bayou	Entire Stream
1016C_01	Unnamed Tributary of Greens Bayou	Entire Stream
1016D_01	Unnamed Tributary of Greens Bayou	Entire Stream

Water Quality Stations

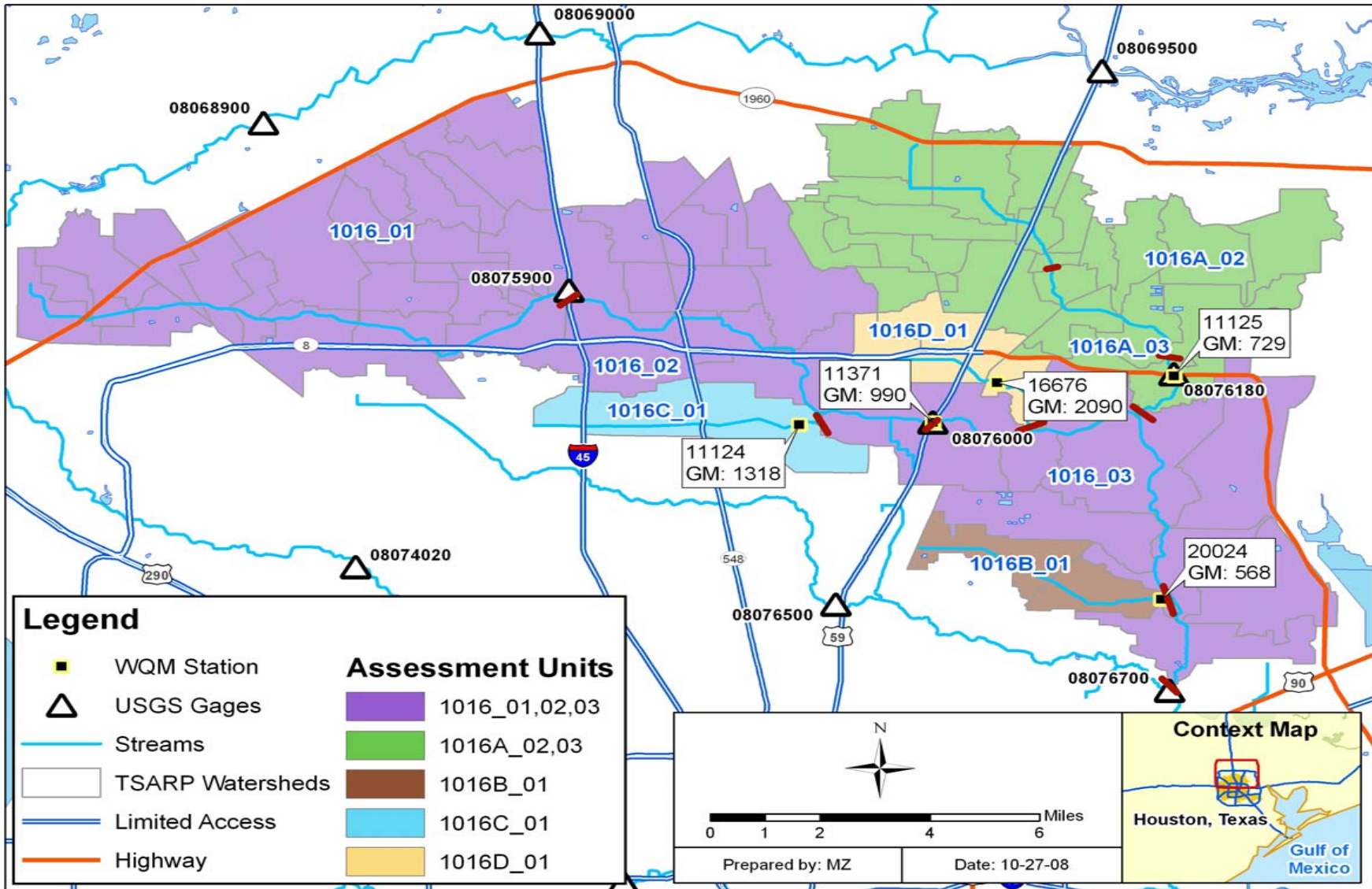


***E. coli* Data for TCEQ Stations from 1996 to 2006**

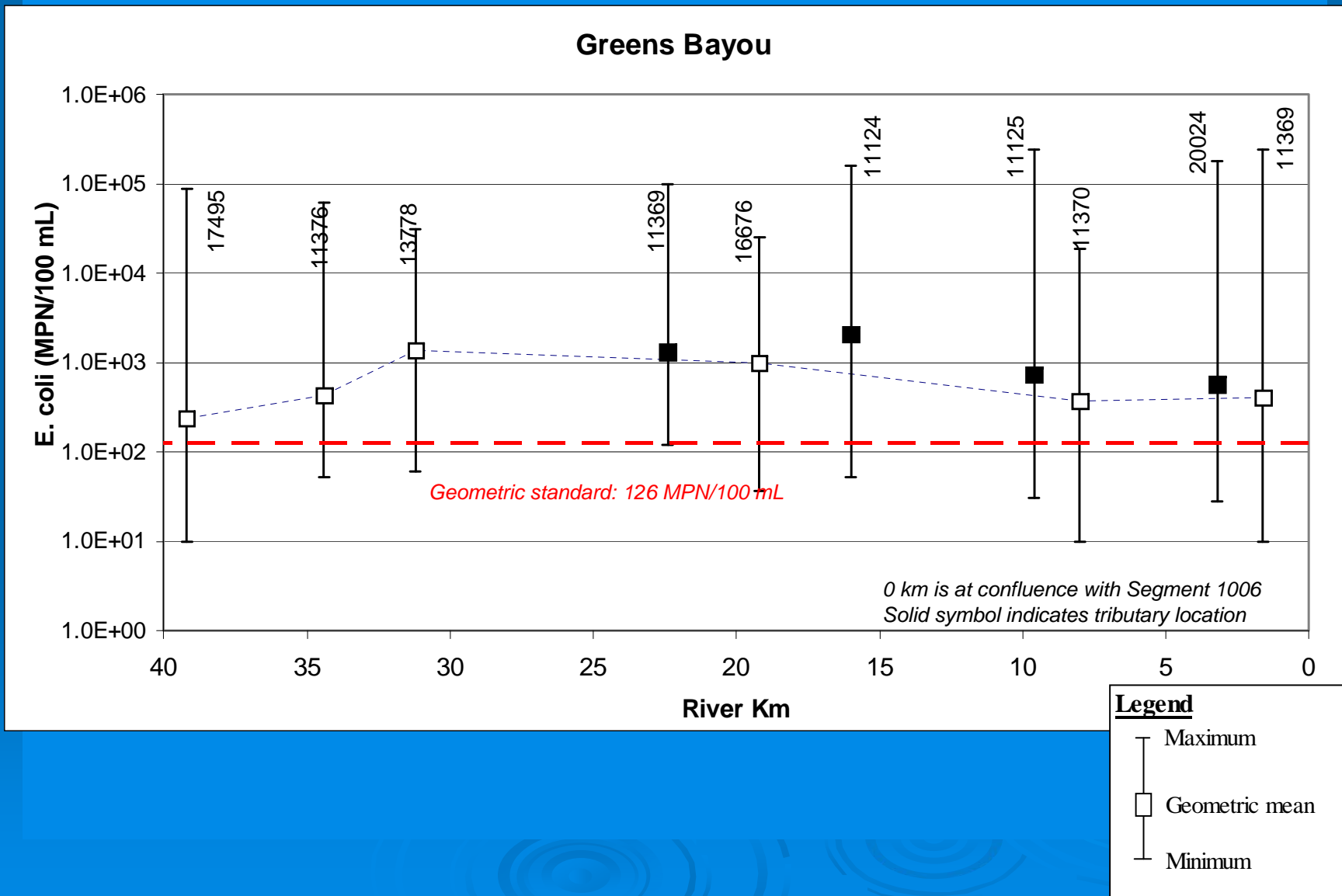
Segment	Station ID	Geometric Mean Concentration	Number of Samples	Number of Samples Exceeding Single Sample Criteria	% of Samples Exceeding
1016_02	11371	990	79	57	72%
1016_03	11369	406	88	40	45%
1016A_03	11125	729	59	34	58%
1016B_01	20024	568	18	9	50%
1016C_01	11124	1318	81	73	90%
1016D_01	16676	2090	83	67	83%

* Geometric Mean Criteria for *E. coli* is 126 MPN/100mL and Single Sample Criteria is 394 MPN/100mL

Greens Bayou *E. coli* Geomeans



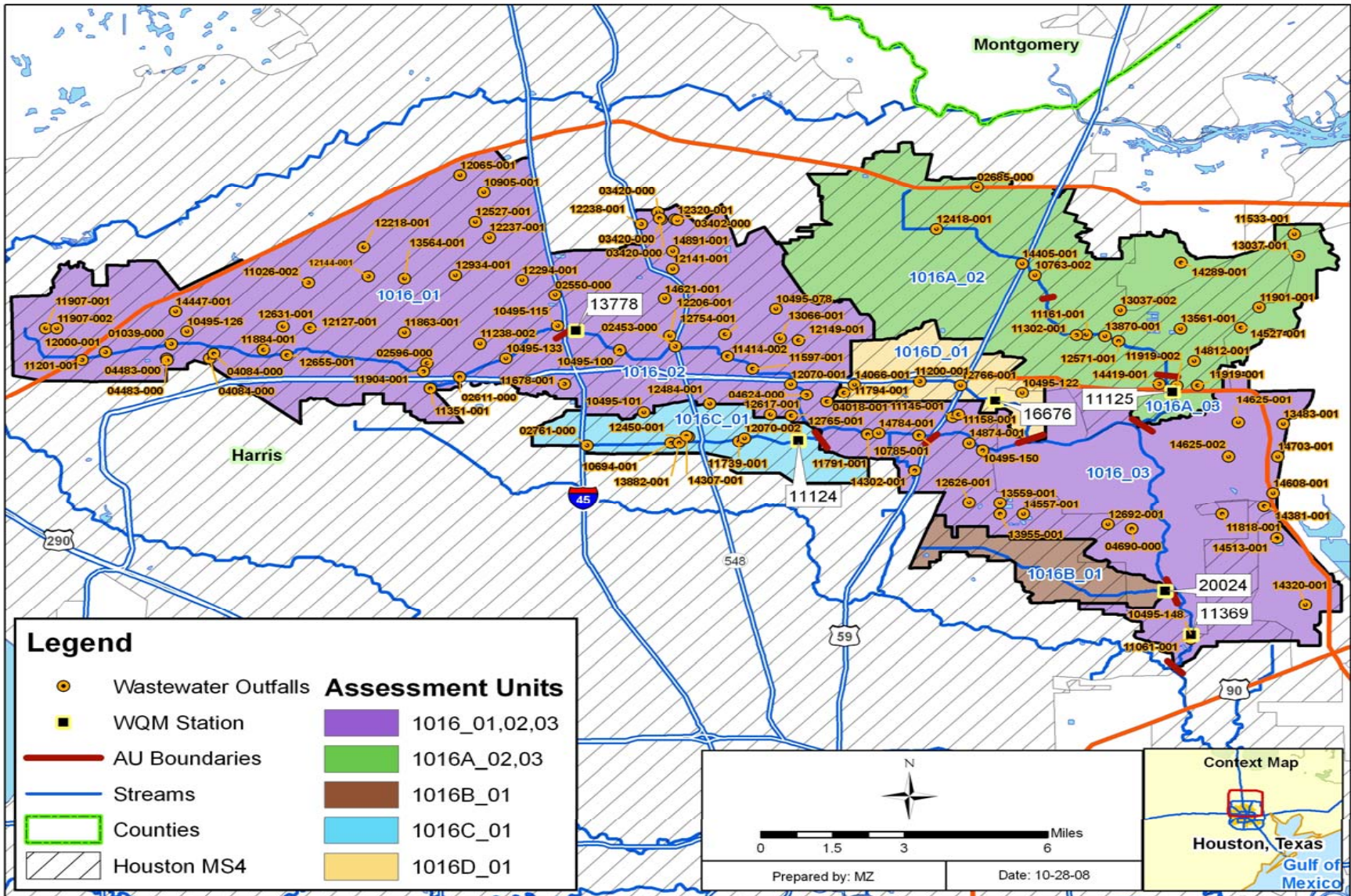
Greens Bayou *E. coli* Longitudinal Profile



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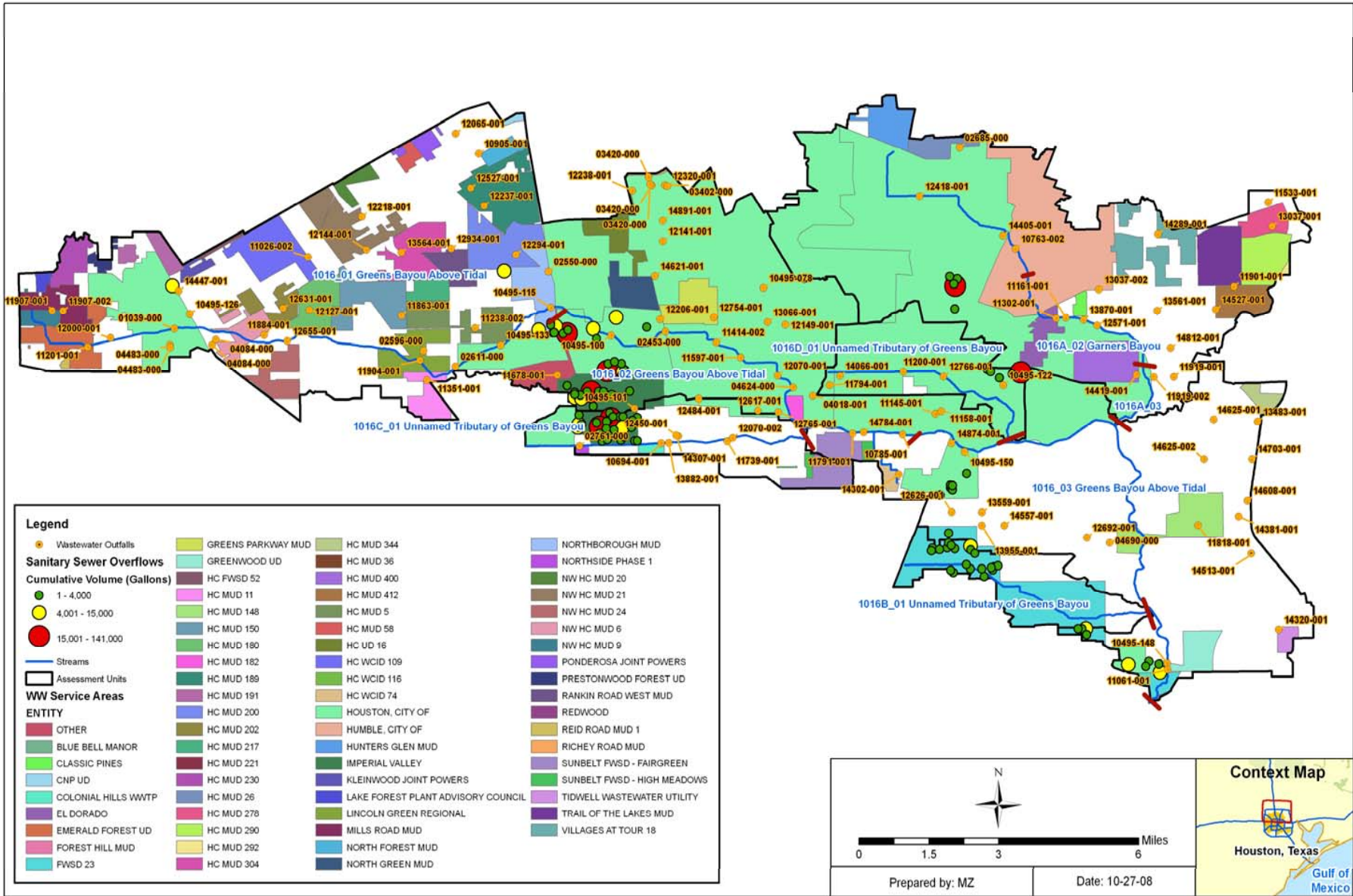
Wastewater Treatment Plants



Summary of TPDES-Permitted Facilities in the Study Area

Assessment Unit	Number of Facilities	Total Permitted Flow (MGD)	Total Average Monthly Flow (MGD)
1016	62	59.0	17.1
1016A	15	26.2	7.3
1016C	7	0.4	0.3
1016D	9	5.6	2.1

Sanitary Sewer Overflows



Permitted Stormwater For WQ0004685000

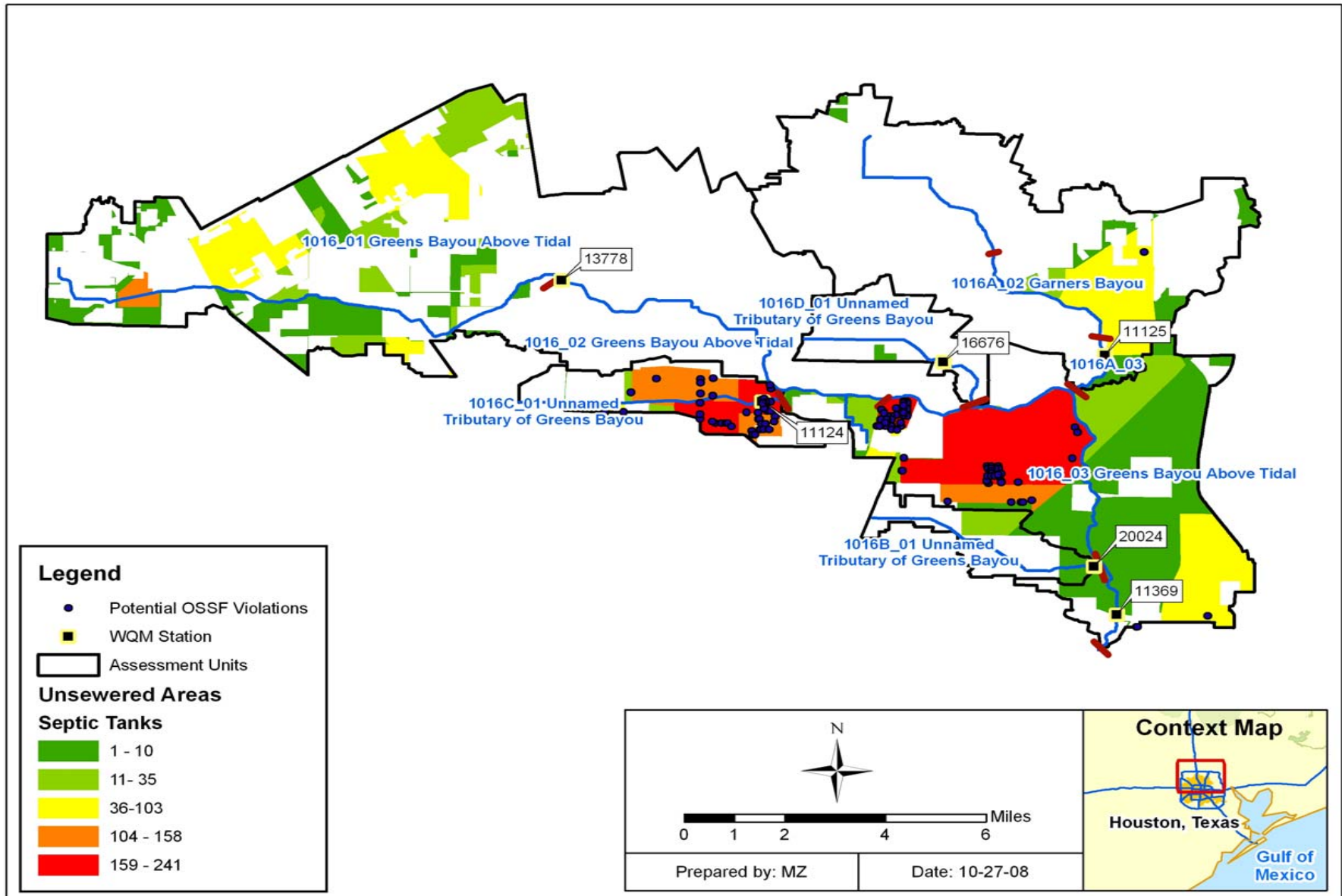
Segment	Stream Name	Total Area (acres)	Area under MS4 Permit (Acres)	Percent under MS4 Permit
1016_01 1016_02 1016_03	Greens Bayou Above Tidal	58,404	46,139	79%
1016A_02 1016A_03	Garners Bayou	21,697	18,920	87%
1016B	Unnamed Tributary of Greens Bayou	2,698	2,344	87%
1016C	Unnamed Tributary of Greens Bayou	4,043	4,043	100%
1016D	Unnamed Tributary of Greens Bayou	3,556	3,008	85%

Population Projections

Stream Name	Assessment Unit	2005	2035	Increase
Greens Bayou Above Tidal	1016_01	122,837	156,222	21%
	1016_02	48,239	87,338	45%
	1016_03	27,189	56,546	52%
Garners Bayou	1016A_02	20,226	54,531	63%
	1016A_03	3,048	6,614	54%
Unnamed Tributary of Greens Bayou	1016B_01	7,626	10,860	30%
	1016C_01	20,839	28,288	26%
	1016D_01	4,556	11,437	60%

Source: HGAC 2007

On-Site Sewage Facilities




On-Site Sewage Facilities

Assessment Unit	Stream Name	OSSF Estimate using 1990 Census Method
1016_01 1016_02 1016_03	Greens Bayou Above Tidal	1,710
1016A_02 1016A_03	Garners Bayou	128
1016B	Unnamed Tributary of Greens Bayou	26
1016C	Unnamed Tributary of Greens Bayou	1,027
1016D	Unnamed Tributary of Greens Bayou	2

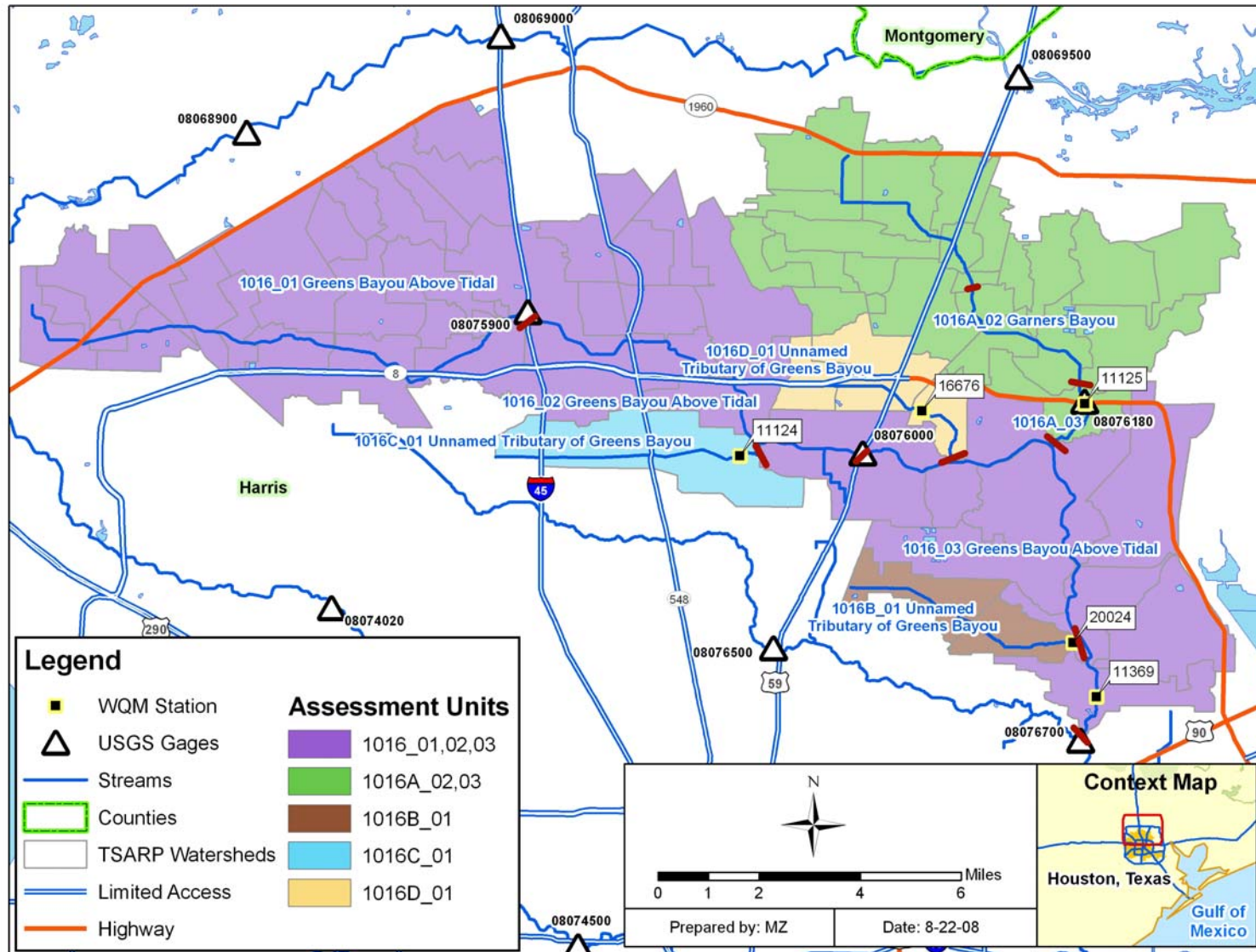
Estimated Number of Pets

Segment	Stream Name	Dogs	Cats
1016_01 1016_02 1016_03	Greens Bayou Above Tidal	57,283	33,224
1016A_02 1016A_03	Garners Bayou	9,875	11,237
1016B	Unnamed Tributary of Greens Bayou	3,515	4,000
1016C	Unnamed Tributary of Greens Bayou	3,428	3,901
1016D	Unnamed Tributary of Greens Bayou	3,915	4,455

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WQM Stations Targeted for TMDL Development



USGS Gages in the Greens Bayou Watershed

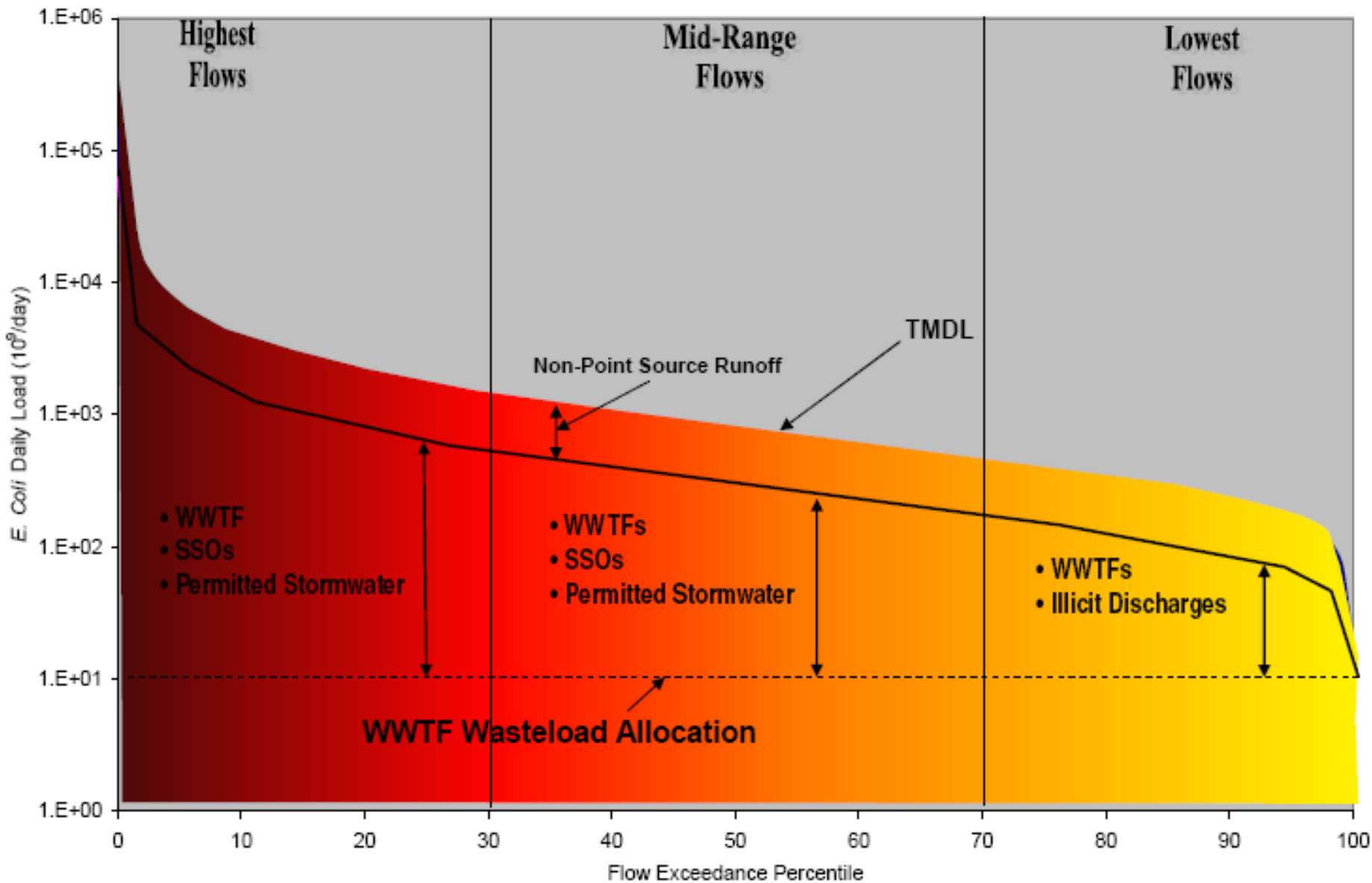
USGS Gage Number	Name	Period of Record	Data Type
8075780	Greens Bayou at Cutter Rd	12/6/2003 - Present	Gage Height (ft)
8075900	Greens Bayou at US HWY 75	8/3/1965 - Present	Discharge (cfs)
		4/17/1997 - Present	Gage Height (ft)
8076000	Greens Bayou at US 59 North of Houston	10/1/1952 - Present	Discharge (cfs)
		9/28/1952 - Present	Gage Height (ft)
8076180	Garners Bayou near Humble, TX	2/25/1986 - Present	Discharge (cfs)
		2/13/1998 - Present	Gage Height (ft)

* Highlight - USGS gage station used to project flows.

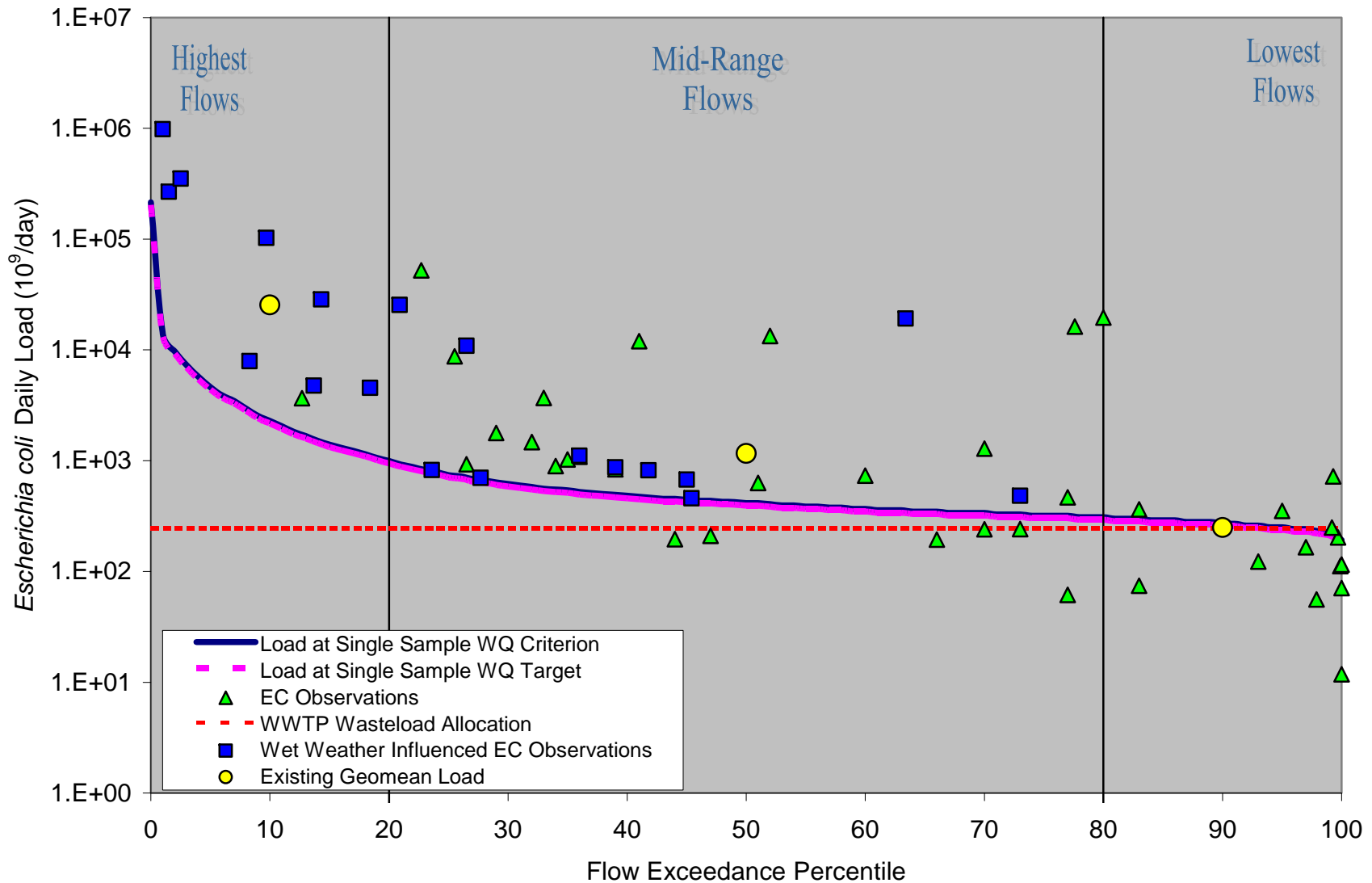
Flow Percentiles

Assessment Unit	1016_01 1016_02	1016_03	1016A_02 1016A_03	1016B_01	1016C_01	1016D_01
Watershed Area (sq. mile)	67.9	141.2	33.8	4.2	6.3	5.6
Average Annual Rainfall (inch)	49.9	50.1	47.7	53.5	51.8	48.7
Percentile	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)
0	22,300	22,474	9,400	509	3,106	442
10	237	259	55	4.87	30	7.4
20	103	123	25	1.86	11	4.8
30	64	83	19	0.97	6.0	4.0
40	50	68	16	0.66	4.2	3.7
50	43	61	14	0.49	3.2	3.3
60	38	57	13	0.38	2.5	2.9
70	35	53	12	0.29	2.0	2.7
80	32	50	11	0.22	1.6	2.4
90	28	45	10.3	0	1.2	2.0
100	20	30	8.0	0	0	0.80

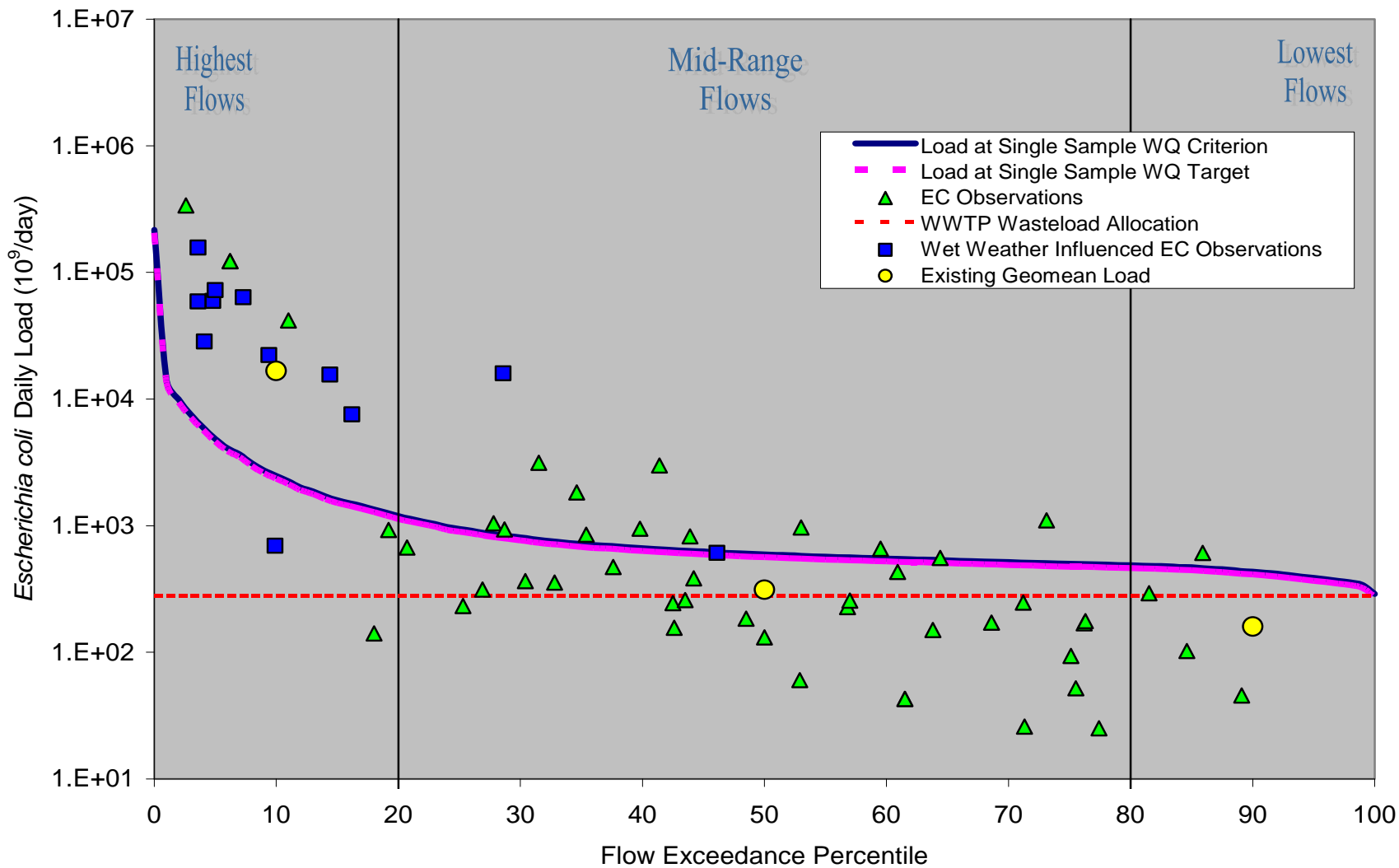
LDC Schematic



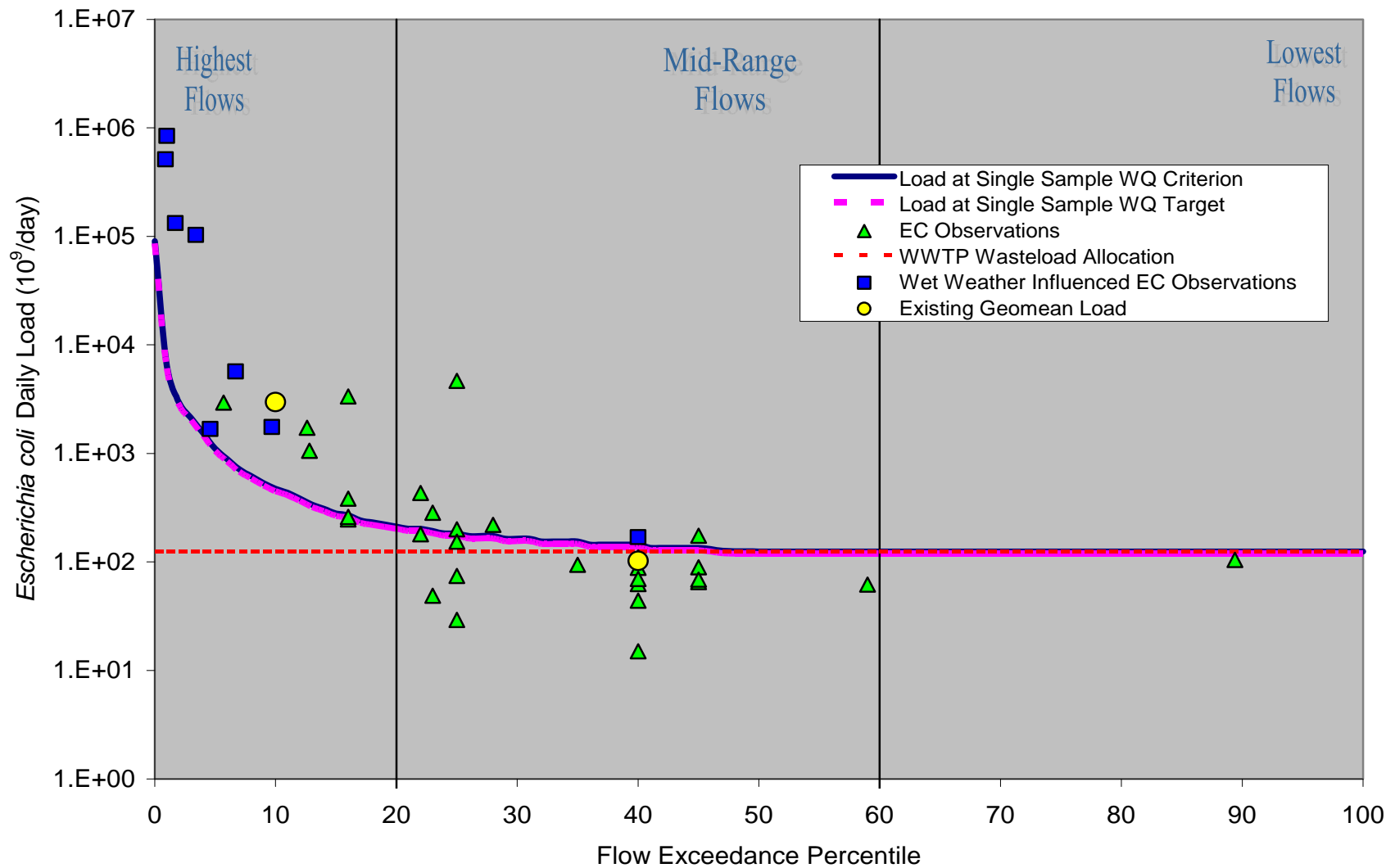
Load Duration Curve for Greens Bayou Above Tidal (1016_01, 1016_02)



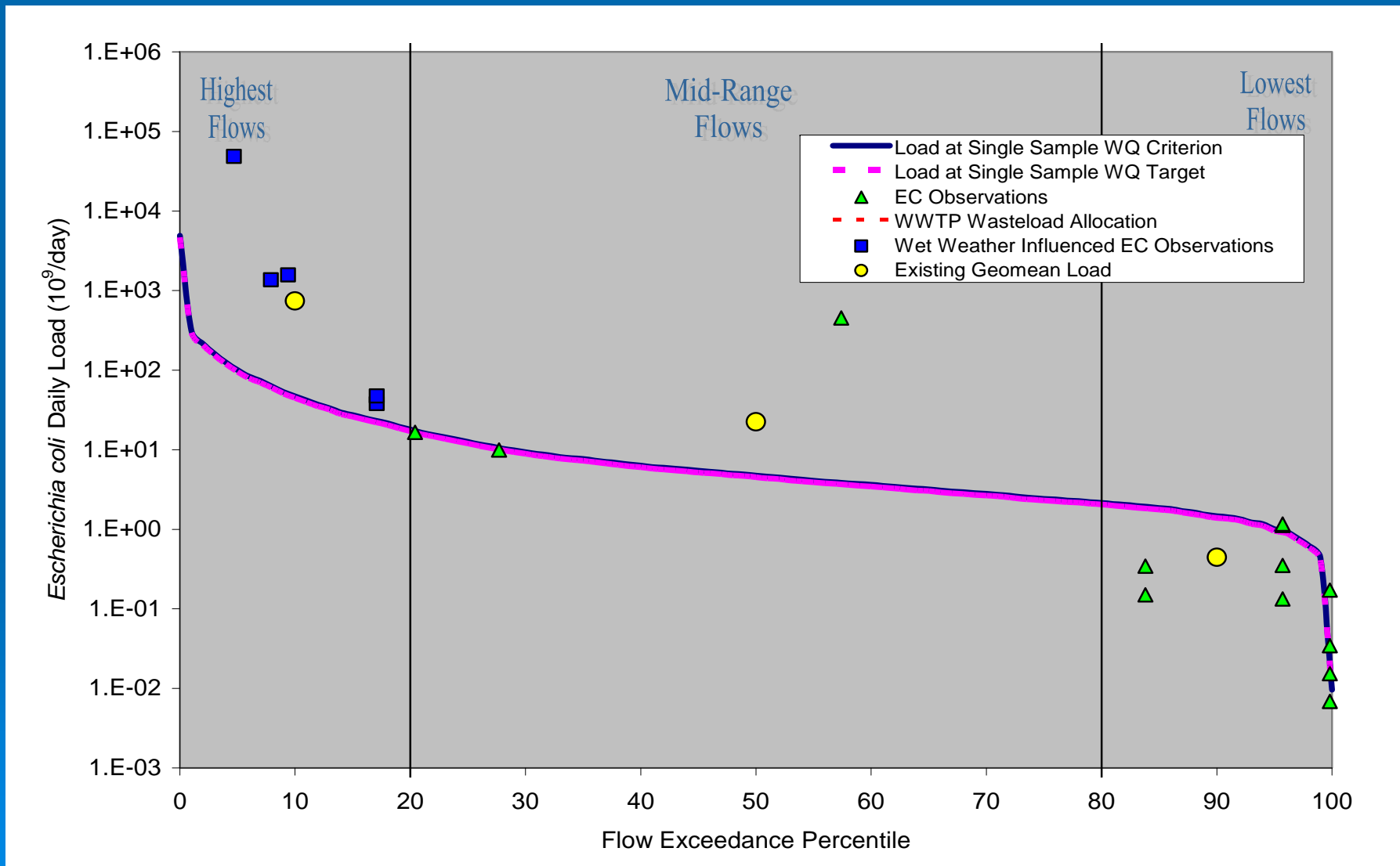
Load Duration Curve for Greens Bayou Above Tidal (1016_03)



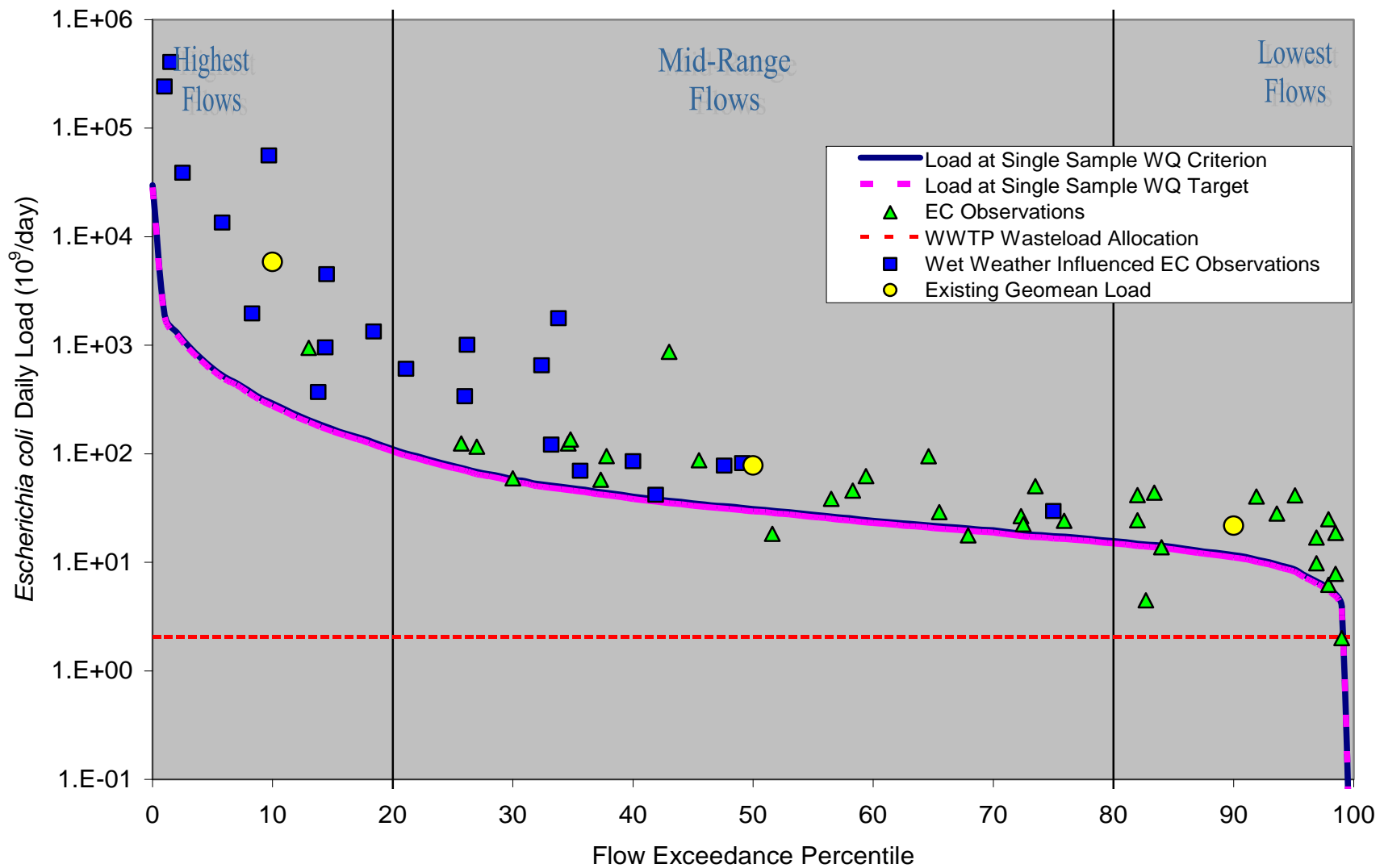
Load Duration Curve for Garner's Bayou (1016A_02, 1016A_03)



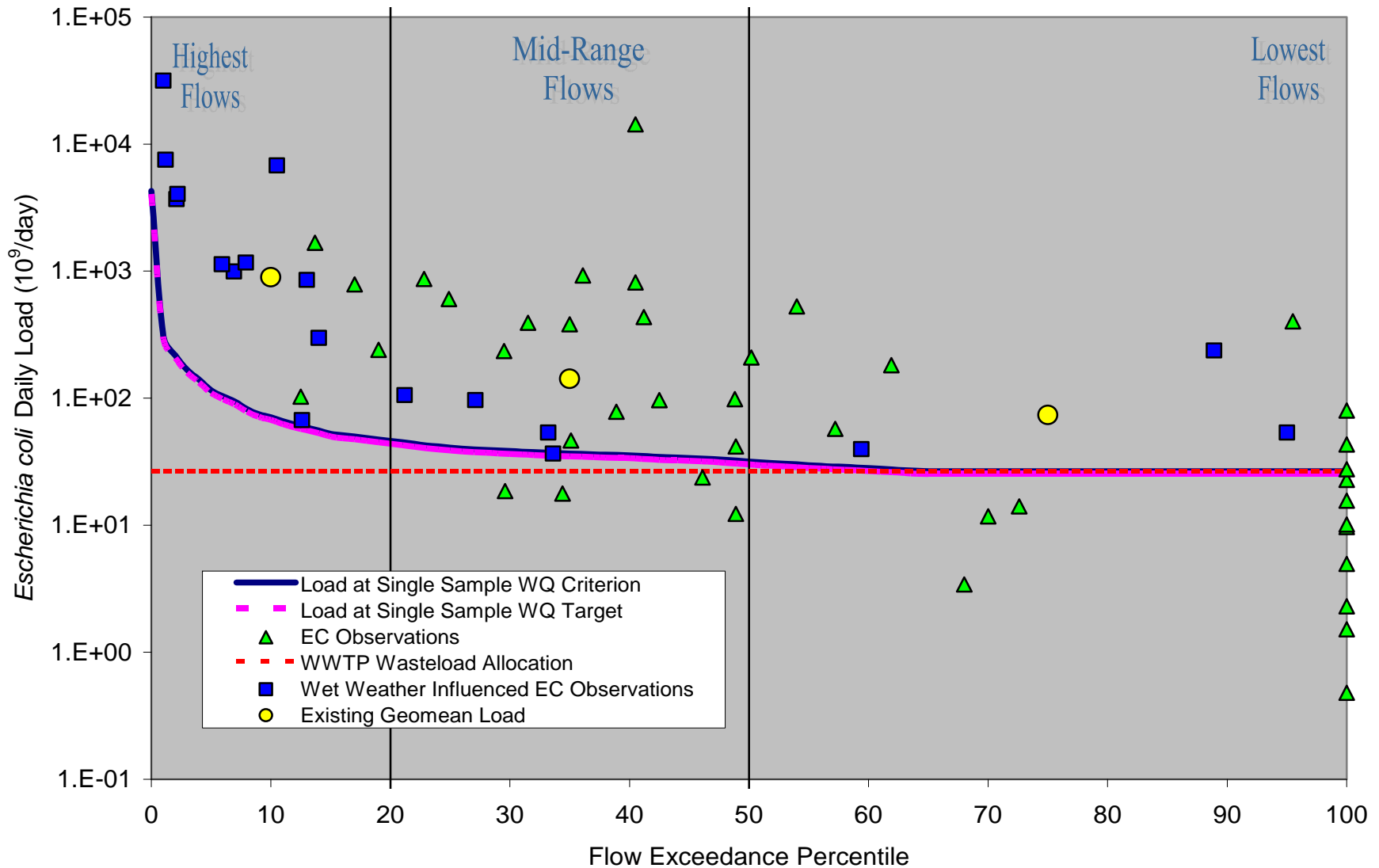
Load Duration Curve for Unnamed Tributary of Greens Bayou (1016B_01)




Load Duration Curve for Unnamed Tributary of Greens Bayou (1016C_01)



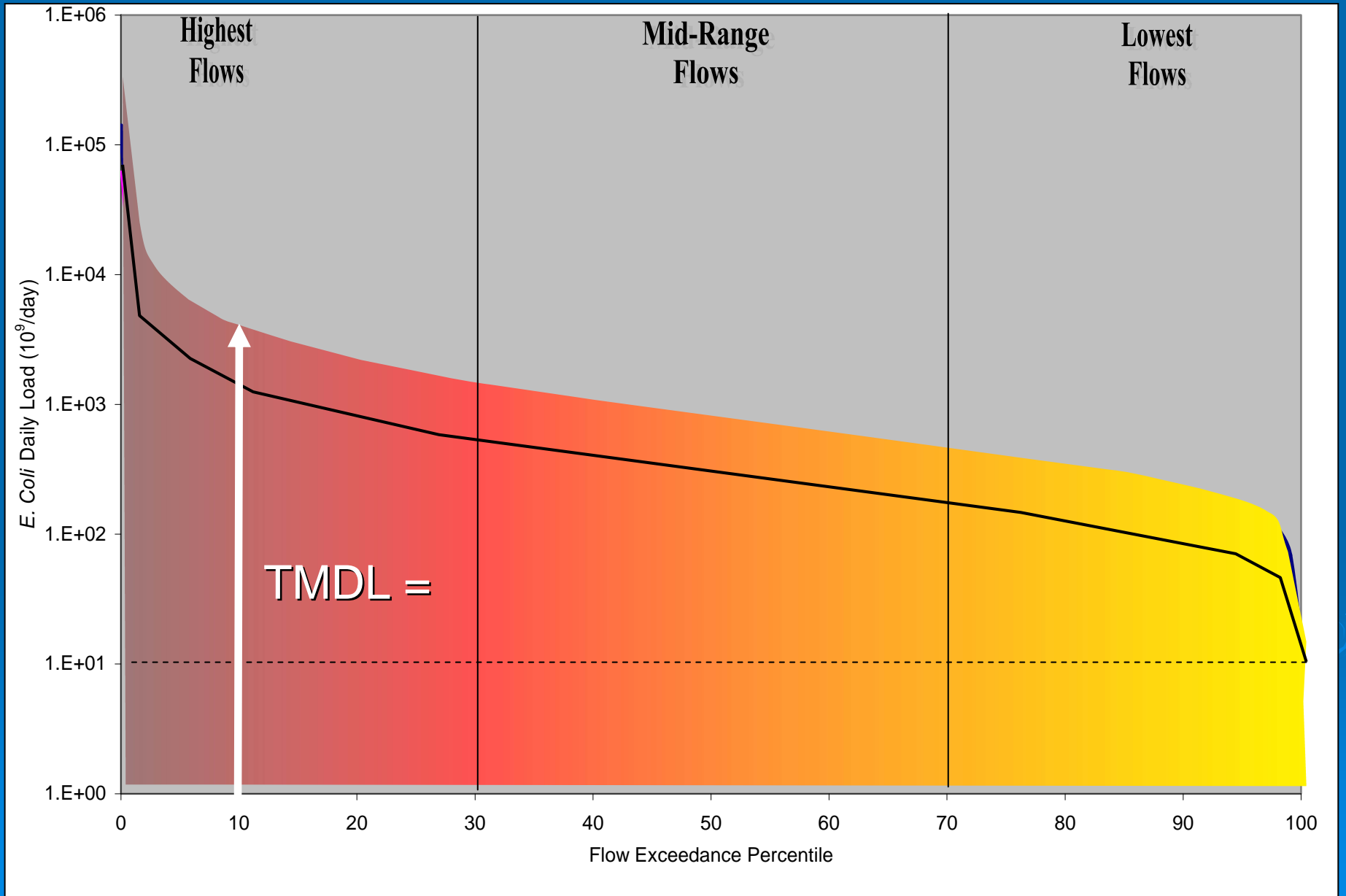
Load Duration Curve for Unnamed Tributary of Greens Bayou (1016D_01)



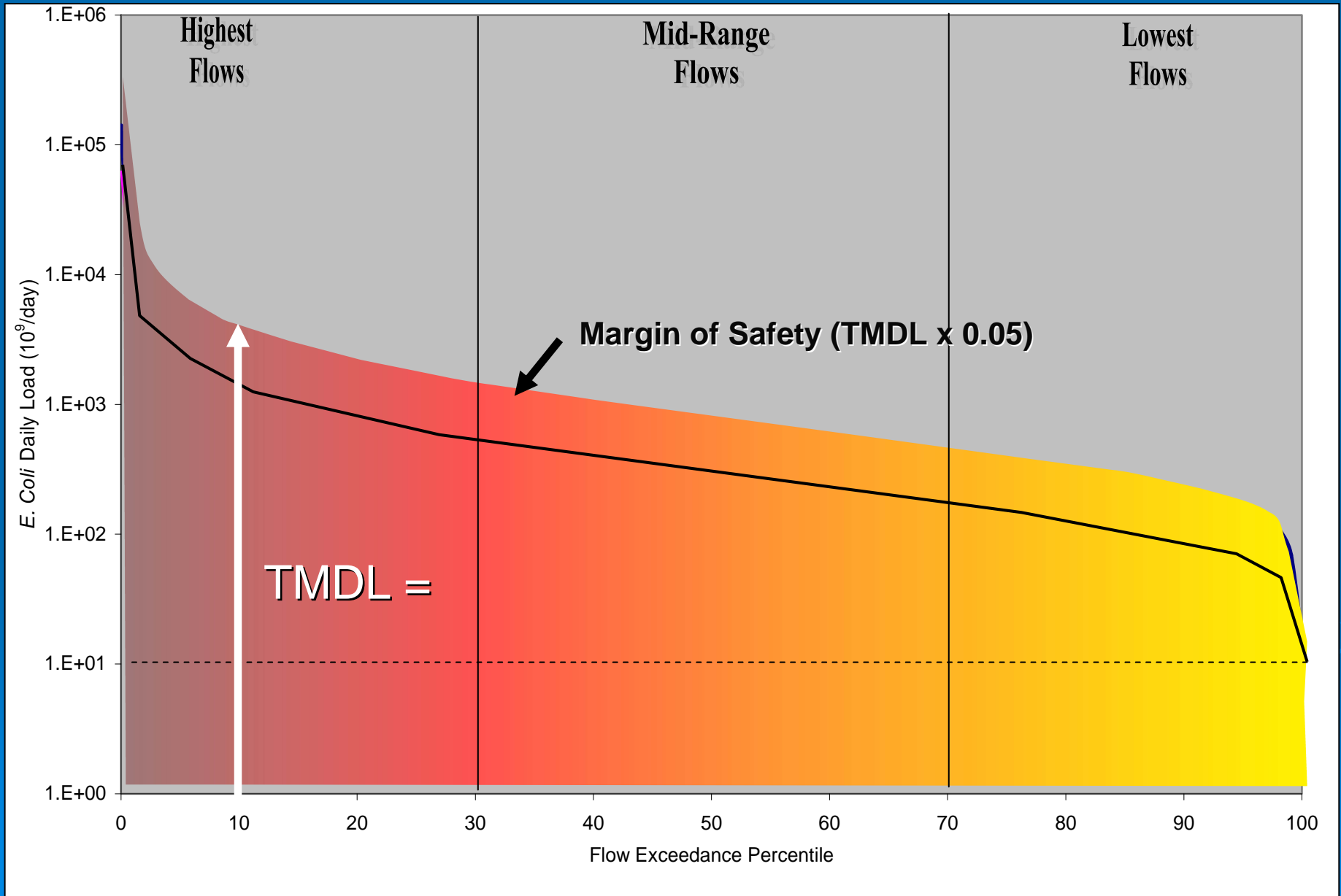
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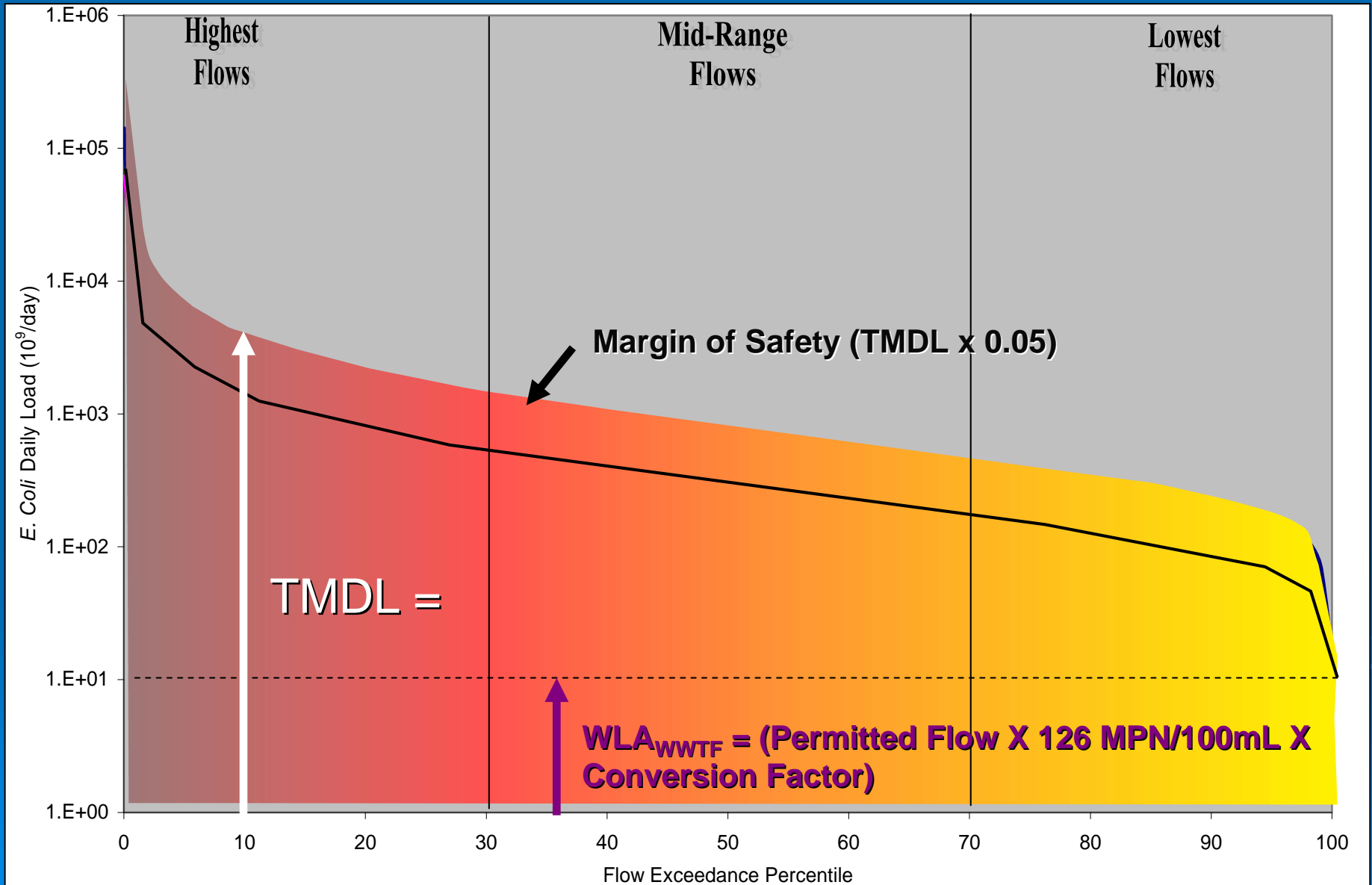
TMDL Calculations



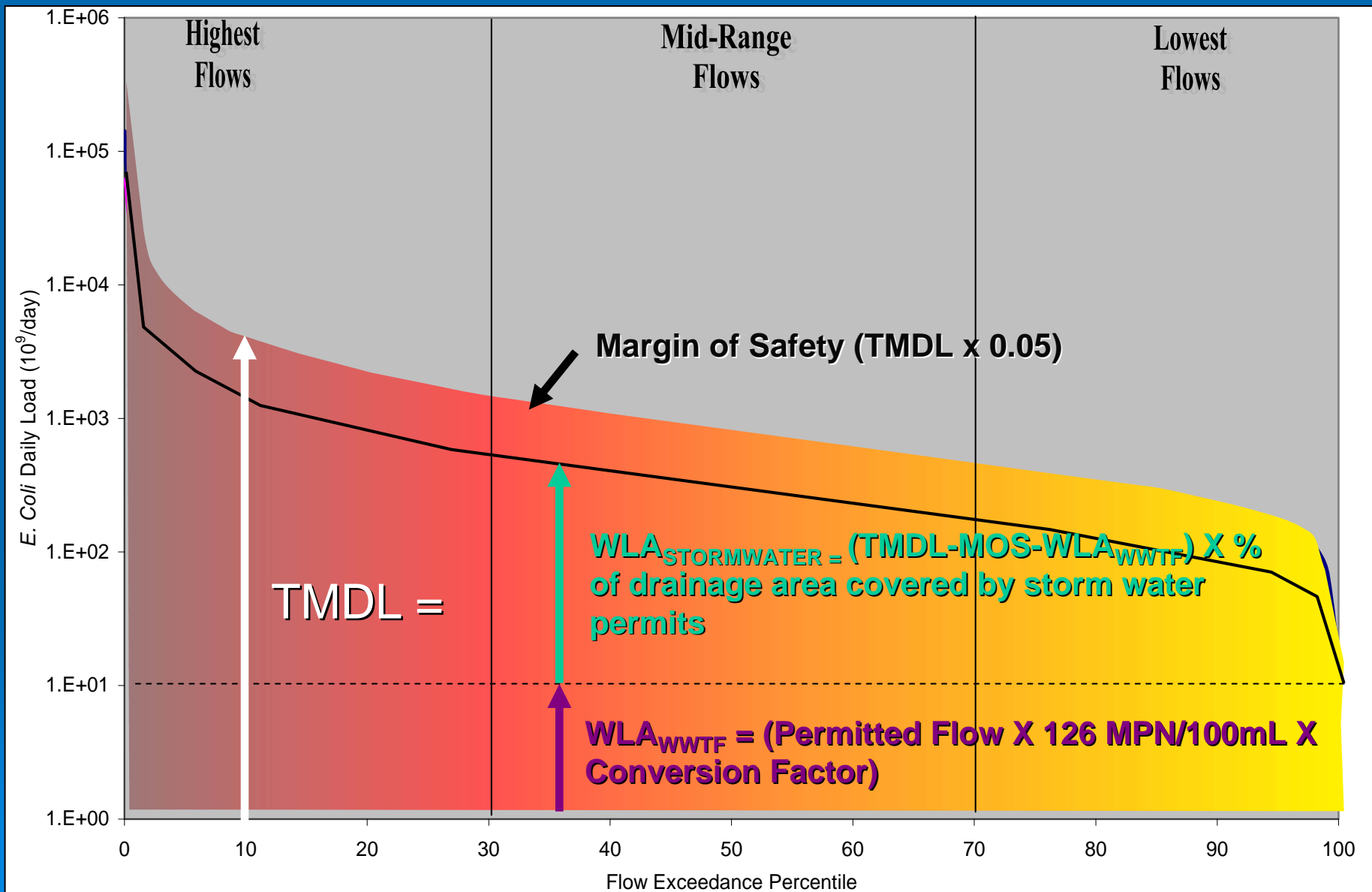
TMDL Calculations



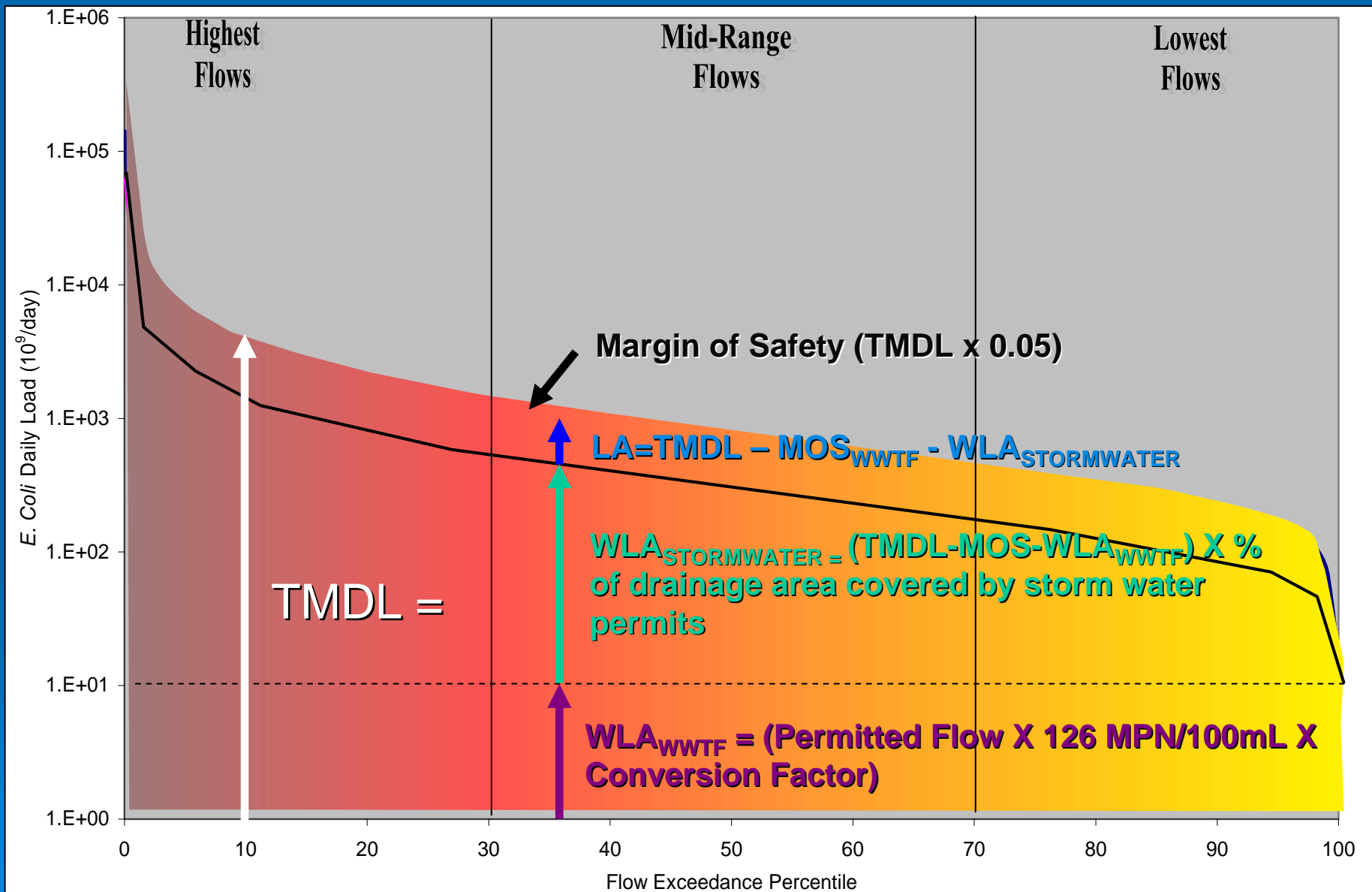
TMDL Calculations



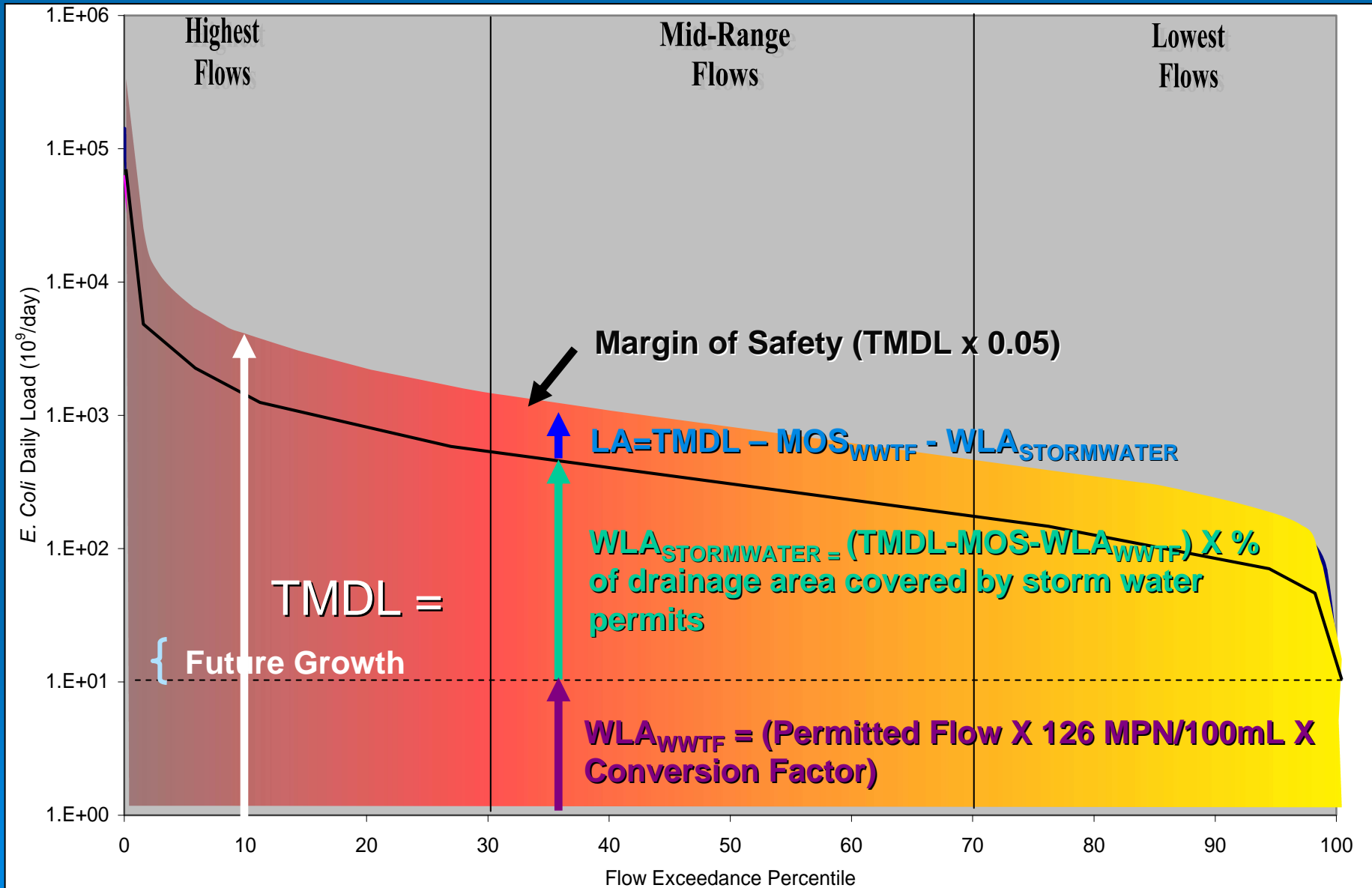
TMDL Calculations



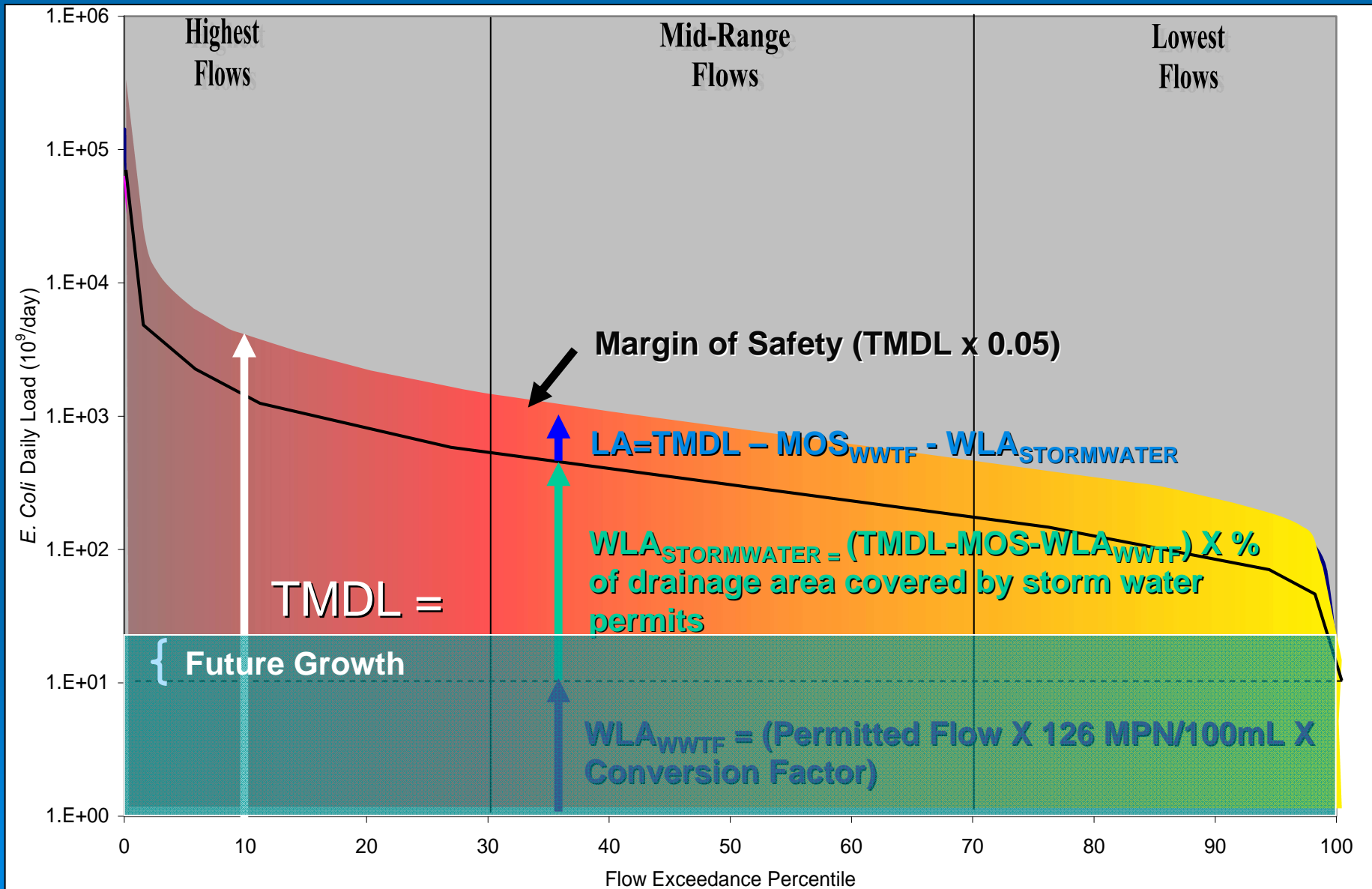
TMDL Calculations



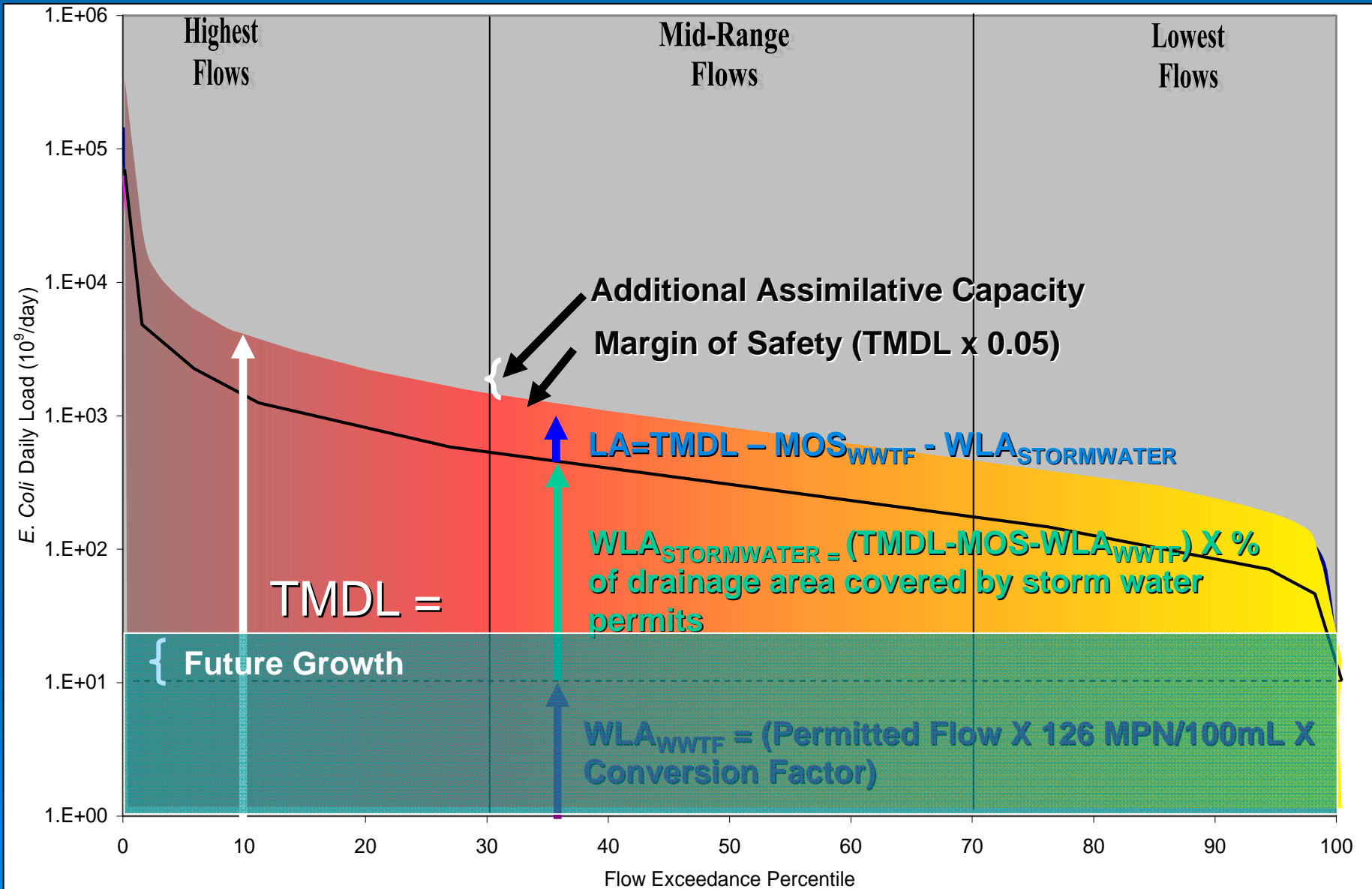
TMDL Calculations



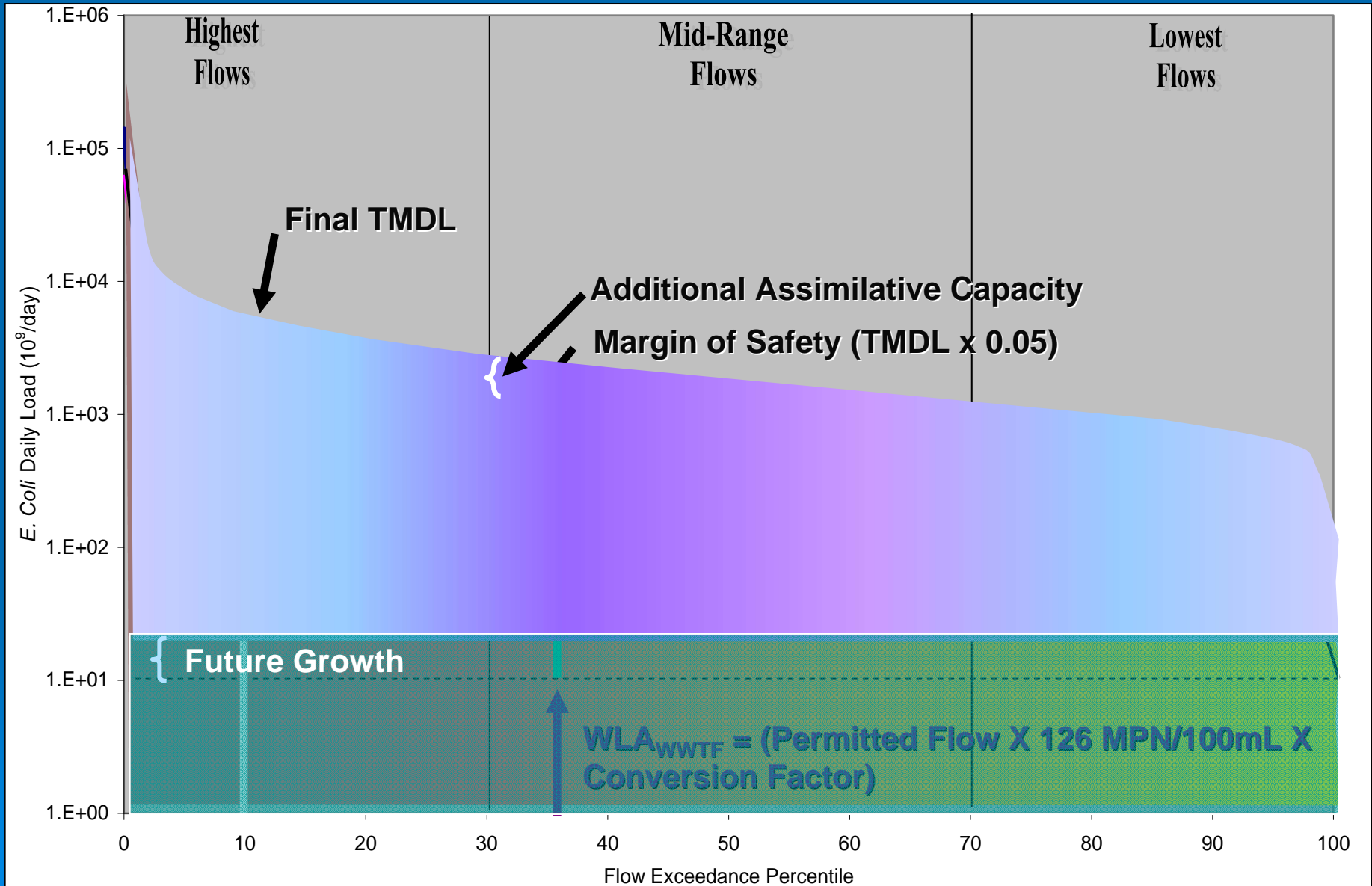
TMDL Calculations



TMDL Calculations



TMDL Calculations



Final TMDL Allocations

Assessment Unit	TMDL ^a (MPN/day)	WLA _{WWTF} ^b (MPN/day)	WLA _{MS4} (MPN/day)	LA (MPN/day)	MOS (MPN/day)
1016_01	4.18E+11	1.31E+11	2.25E+11	0	2.09E+10
1016_02	9.79E+11	2.45E+11	6.08E+11	0	4.89E+10
1016_03	1.59E+12	4.39E+11	7.23E+11	1.59E+11	7.93E+10
1016A_02	1.61E+11	5.28E+10	6.68E+10	2.75E+09	8.03E+09
1016A_03	3.16E+11	1.29E+11	8.43E+10	1.22E+10	1.58E+10
1016B_01	1.50E+10	0	1.24E+10	1.86E+09	7.51E+08
1016C_01	9.39E+10	1.78E+09	8.70E+10	0	4.70E+09
1016D_01	5.55E+10	2.66E+10	8.63E+09	1.57E+09	2.78E+09

a $WLA_{WWTF} = WLA_{WWTF} + \text{Future Growth}$

b LA includes upstream loads