Brownsville Ship Channel/Lower Laguna Madre Updates

PRESENTED TO:
LRGVDC- WATERSHED PROTECTION PLAN ANNUAL MEETING 2022

PRESENTED BY:
CHRISTOPHER FULLER, PH.D.
RESEARCH, APPLIED TECHNOLOGY, EDUCATION, SERVICES, INC.

THURSDAY, JUNE 30, 2022 10:10-10:40 A.M.
301 W. RAILROAD ST.
WESLACO, TX 78596

Outline

- Development of Lower Laguna Madre-Brownsville Ship Channel WPP
- CMP-27 Hydrodynamic Characterization of Lower Laguna Madre
- TCEQ 319 Grant FY2023 Proposal Effort: San Martin Lake-Implementation Monitoring

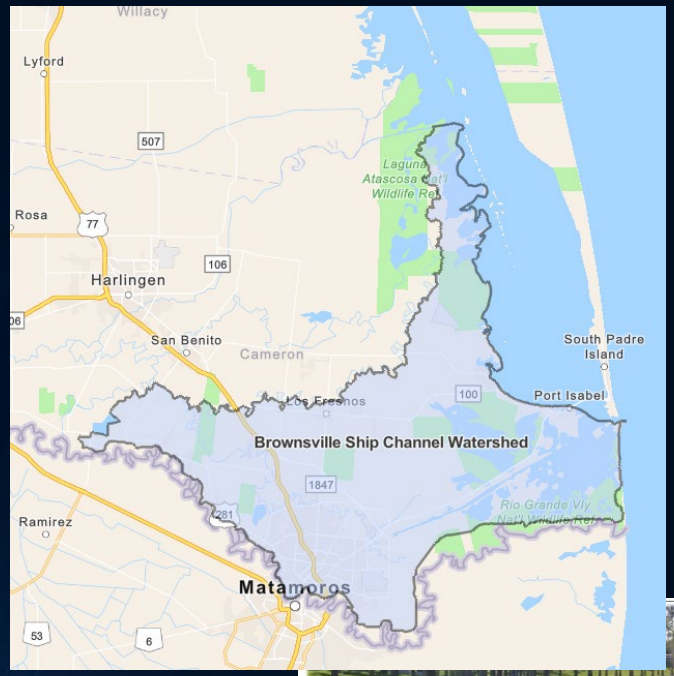
Water Quality Monitoring to Assess Pollutant Loadings in Brownsville Ship Channel Watershed

Advisory Committee:
Dr. Abdoul Oubeidillah (major advisor)
Dr. Andrew Ernest (co-major advisor)
Dr. Chu-Lin Cheng
Dr. Jungseok Ho

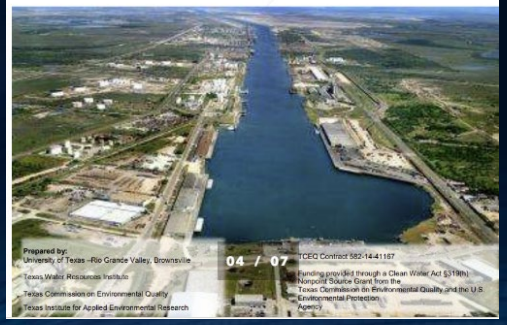
Iván René Santos Chávez
Civil Engineering Department, UTRGV

April 21st, 2022

Existing Data



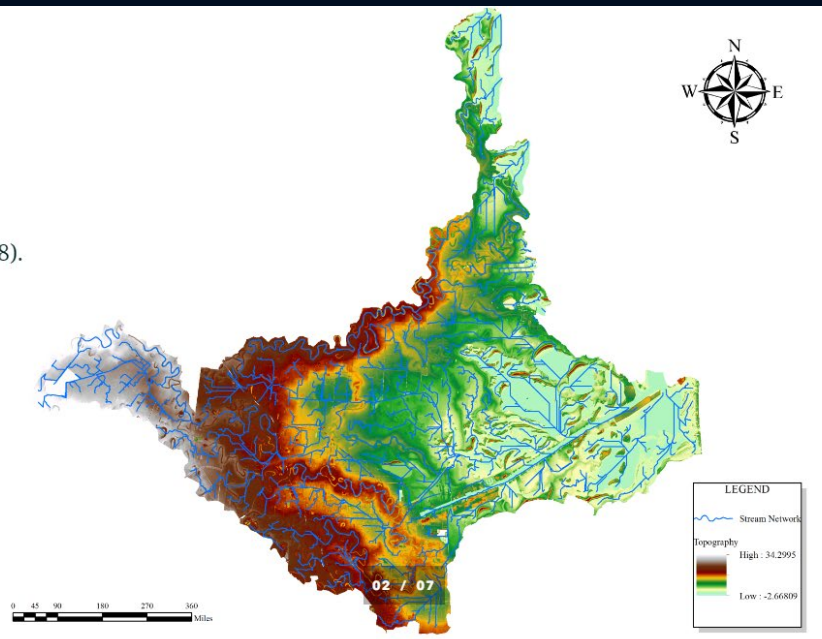
Lower Laguna Madre/
Brownsville Ship Channel
Watershed Characterization
2018

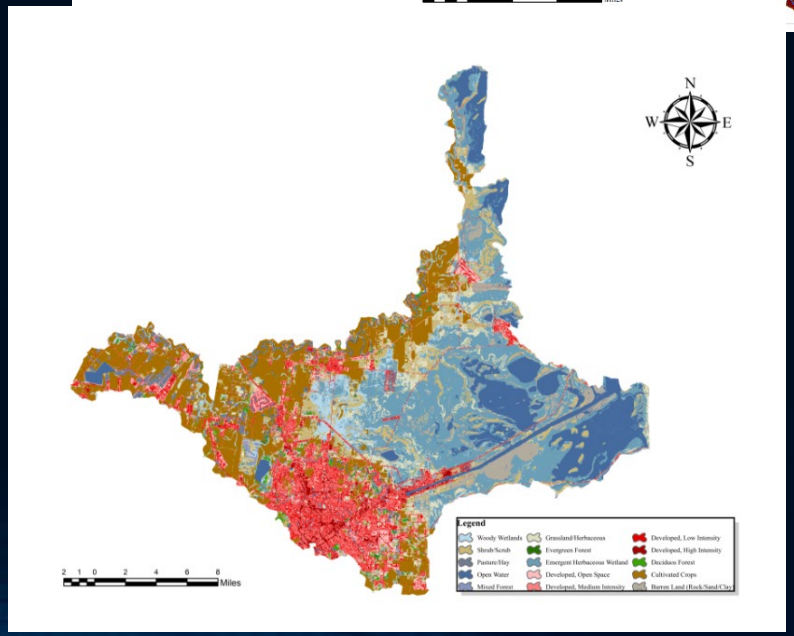


Elevation

Lidar Dataset from (USGS, 2018).

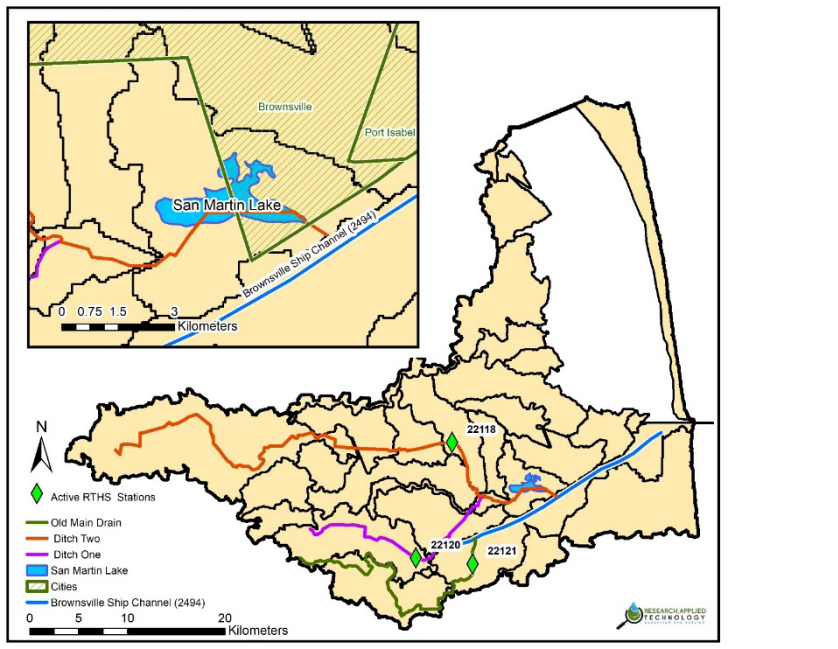
Highest elevation: 34 ft.





Monitoring Locations

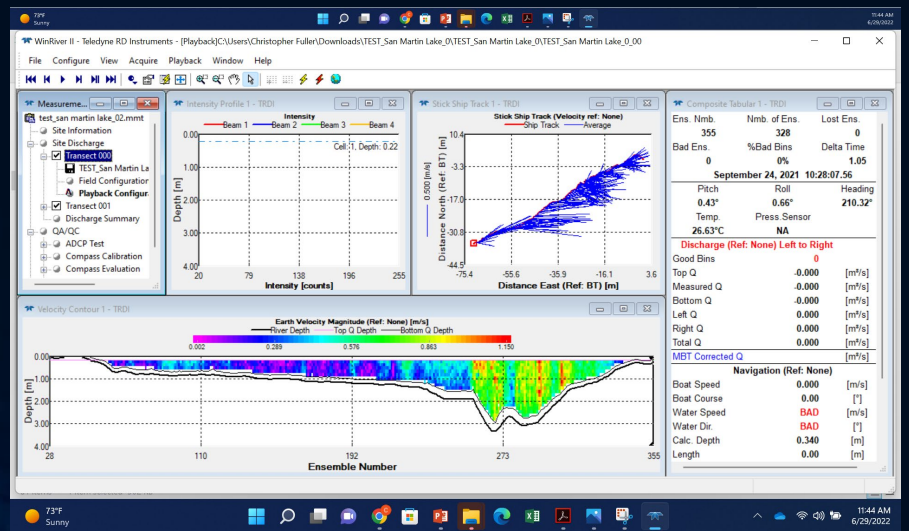
PHASE 1 MONITORING



- CCDD1 Ditch #1, #2, and Old Main Drain

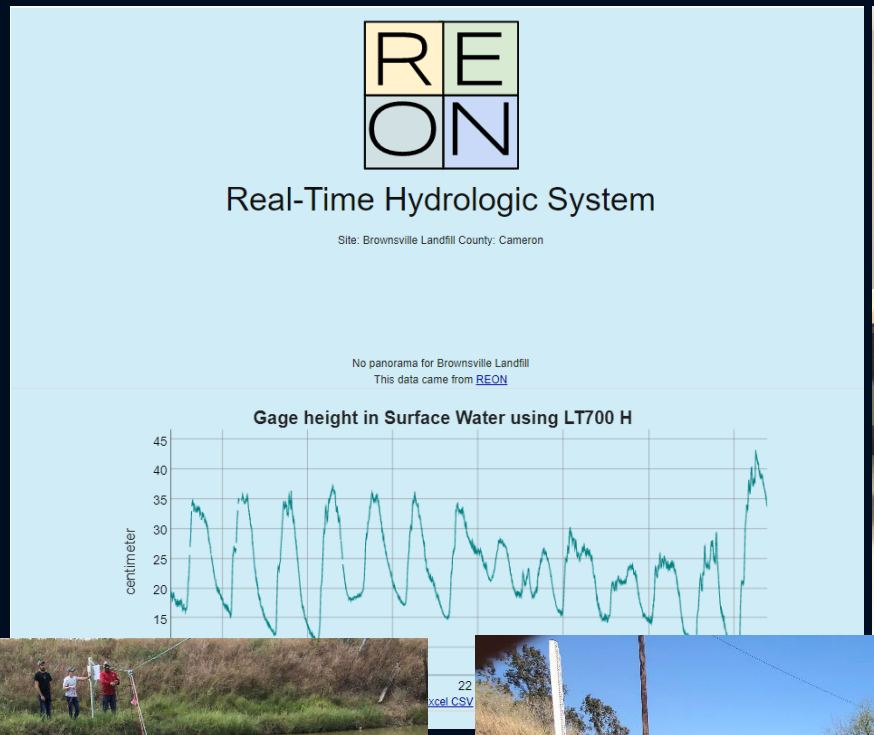
PHASE 2 MONITORING

- Expanded:
  - Real-time in-situ water quality
    - Conductivity, Dissolved Oxygen
    - to assess tidal influence as function of salinity
    - 1st sonde installed by RATES in June 2022
      - Remaining sondes to be installed this summer
  - ADCP Flow-measurement at channel linking San Martin Lake with Brownsville Ship Channel



Data Collection

- Quarterly Sampling Events
  - Water Quality
    - In-situ measurements: pH, Conductivity, dissolved oxygen
    - Grab samples- Nitrate-Nitrite, total-P, TKN, E. coli
  - Flow: ADCP
- Continuous monitoring
  - RATES RTHS
    - Stage height, water temp, wind speed/direction, barometric pressure, air temp, relative humidity
- EPA Approved Monitoring QAPP



Quarterly Monitoring Results

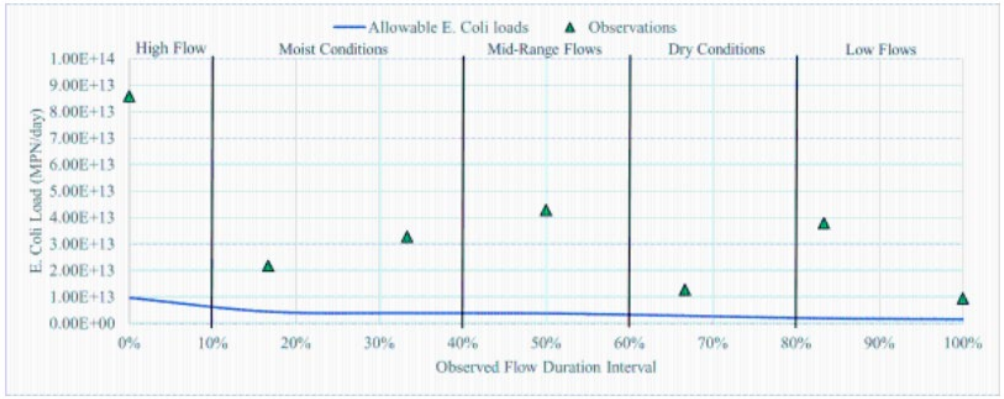
Sampling Campaign	Station ID	Date & Time (CST)	Gage height (ft)	Average Q [m3/s]	Average Flow Speed (m/s)	Water Temp [°C]	Baro. [mmHg]	SpC [µS/cm]	D.O. %	D.O. [mg/L]2	pH	E. coli	TKN	Total NO2+NO3	Total P
1st	22118	2/12/20 10:33	0.86	0.89	0.10	17.0	758.4	12128	83.6	7.72	8.20	1119.9	0.67	12	2.88
	22120	2/11/20 12:33	1.08	0.25	0.08	25.4	758.6	6808	70.9	5.68	7.50	648.8	2.19	5.82	1.80
	22121	2/12/20 12:00	0.21	0.16	0.15	18.2	758.4	6026	89.2	8.22	8.00	980.4	0.64	1.11	0.12
2nd	22118	9/28/20 14:22	1.669	0.36	0.05	26.9	764.6	15088	216.9	16.49	8.35	8.353	1.66	<0.68	0.85
	22120	9/28/20 13:46	1.237	0.30	0.11	28.0	766.0	5637	122.4	9.41	7.96	7.961	0.74	8.14	2.16
	22121	9/29/20 11:39	1.963	0.23	0.04	25.6	766.7	2236	91.7	7.44	8.06	>2419.60	1.05	<0.68	0.29
3rd	22118	3/2/21 10:23	0.65	0.27	0.10	15.5	768.2	11522	75.9	7.27	8.33	547.5	1.62	1.43	1.16
	22120	3/2/21 13:10	0.96	0.41	0.11	19.4	766.8	7253	151.1	13.57	8.52	1986.3	1.03	6.39	1.94
	22121	3/3/21 10:43	1.1	0.13	0.05	16.3	766.0	6152	73.4	7.06	7.99	>2419.6	2.02	2.34	0.14
4th	22118	4/13/21 12:58	0.9	0.15	0.03	26.5	757.6	11522	112.6	8.74	8.40	727	1.60	0.77	0.84
	22120	4/13/21 16:19	0.95	0.31	0.11	29.2	756.8	3819	178.8	13.55	8.17	816.4	0.78	7.58	3.66
	22121	4/14/21 12:23	1.3	0.55	0.14	27.8	758.7	9552	122.7	9.36	8.18	>2419.60	1.55	1.26	0.39
5th	22118	6/16/21 11:25	0.7	0.41	0.09	30.3	760.3	19431	93.6	6.55	8.12	613.1	2.45	7.11	0.81
	22120	5/25/21 13:34	1.2	0.60	0.17	30.2	761.7	4165	117.6	8.76	8.45	866.4	1.35	4.43	2.44
	22121	5/27/21 13:57	1.35	0.40	0.14	30.6	760.9	6802	137.9	10.12	8.40	1986.3	1.26	0.68	0.30
6th	22118	6/29/21 11:00	0.8	0.35	0.08	28.2	760.2	15156	85.4	6.35	8.15	1413.6	3.48	0.68	1.01
	22120	6/29/21 13:20	1	0.38	0.12	30.1	760.5	5888	102.9	7.63	7.93	>2419.6	1.45	6.86	2.20
	22121	8/18/21 11:54	1.06	0.41	0.16	31.9	759.8	18507	142.4	9.82	8.25	>2419.6	2.20	0.68	0.03
7th	22118	9/28/21 12:04	1.04	0.18	0.02	28.7	758.2	13437	132.3	9.80	8.40	<2419.60	1.73	<0.68	0.90
	22120	9/29/21 13:41	0.98	0.31	0.09	31.6	756.4	6571	121.6	8.77	8.17	980.4	0.70	10.4	1.68
	22121	10/5/21 12:20	2.7	2.09	0.80	32.0	762.1	1621	59.3	7.53	7.87	1732.9	<0.68	0.369	0.12
8th	22118														
	22120	11/16/21 13:35	0.48	0.36	0.11	28.1	762.7	6556	114.6	8.80	7.85	816.4	0.88	7.57	2.86
	22121	11/16/21 11:39	0.85	0.30	0.20	25.3	763.1	6950	110.6	9.13	7.89	1299.7	1.68	<0.68	0.20

Data is submitted routinely to TCEQ SWQM Program

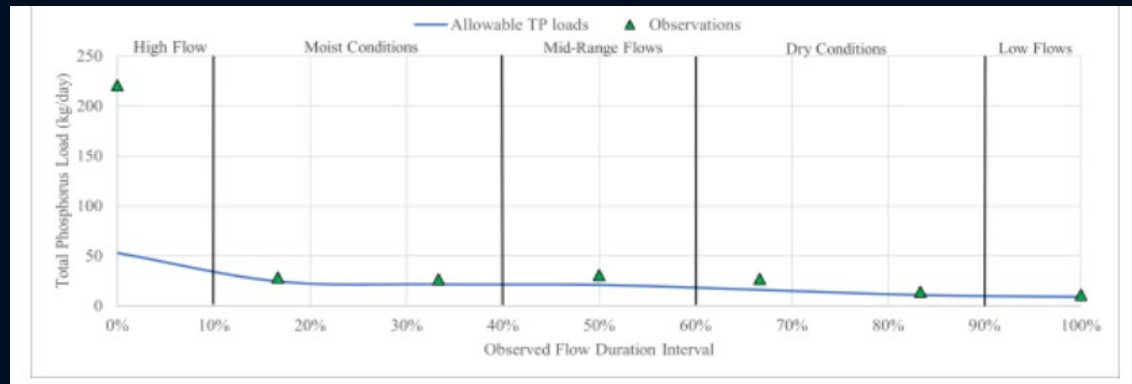
Load Duration Curves

- Maximum Allowable Daily Loads = Highest Pollutant Loading that a waterway can receive without violating water quality standards
- Function of:
  - Maximum allowable concentrations
    - *E. coli = 126 cfu/100mls*
    - *Nitrate + Nitrite = 1.95 mg/L*
    - *Total-Phoshorus= 0.69 mg/L*
    - *Total_Kjeldahl Nitrogen= 0.33 mg/L (sum of organic nitrogen, ammonia, and ammonium)*
  - Average flow rate
    - Base on 9 flow rates measured during 9 sampling events
    - Limited biased flow measurements (site accessibility has been and issue)
- $[Q]$*MAC=MADL

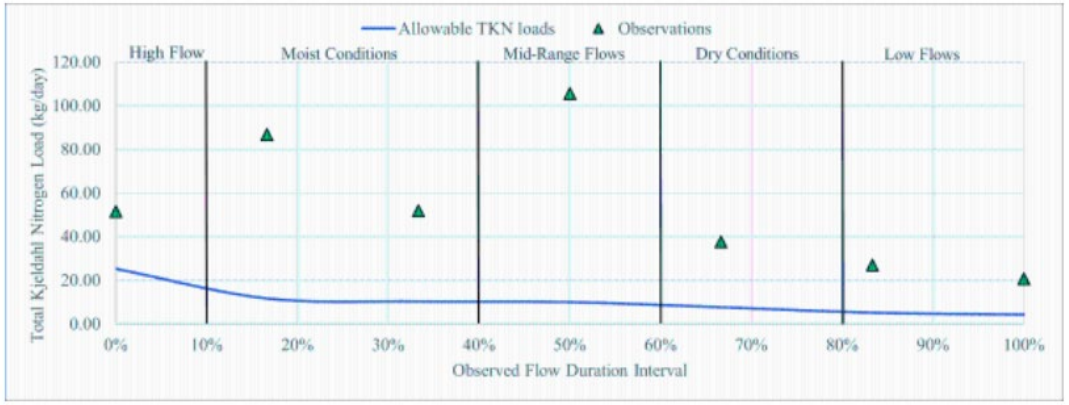
Load Duration Curves- 22118 CCDD1 Ditch #2



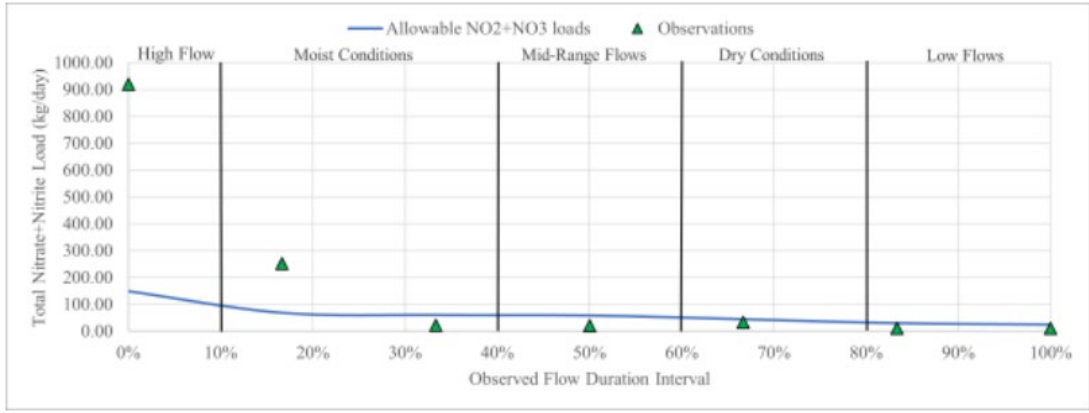
LCD of E. Coli



LDC of Total Phosphorus

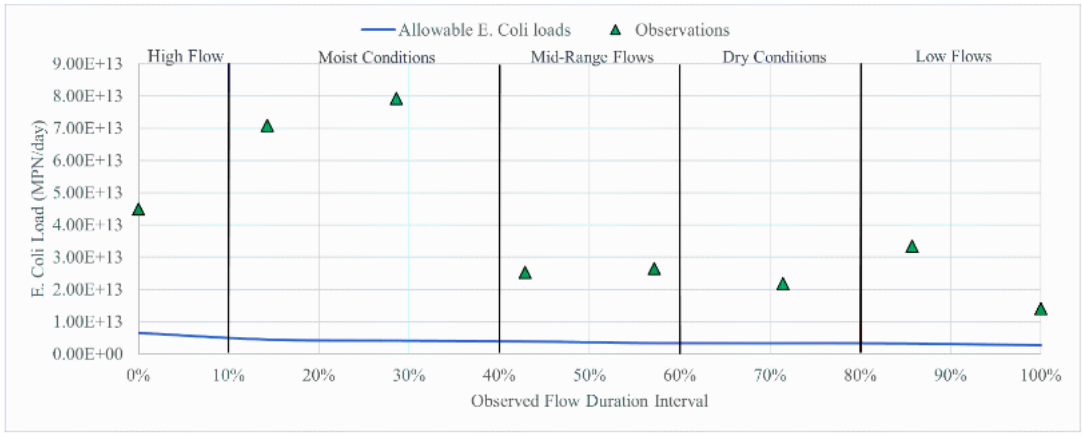


LDC of Total Kjeldahl Nitrogen

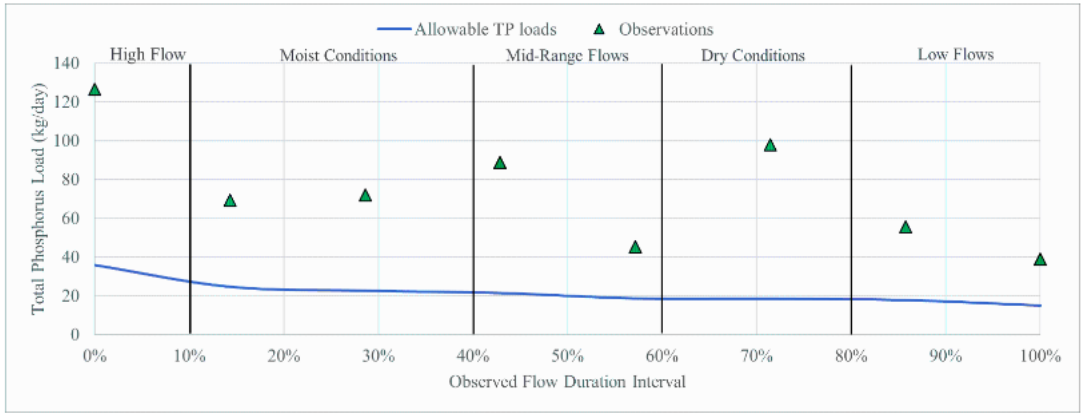


LDC of NO_2+NO_3

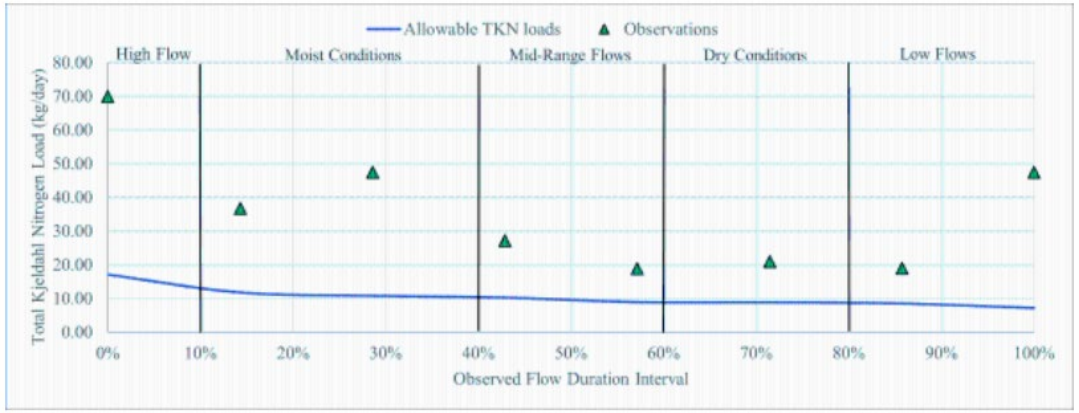
Load Duration Curves- 22120 CCDD1 Ditch #1



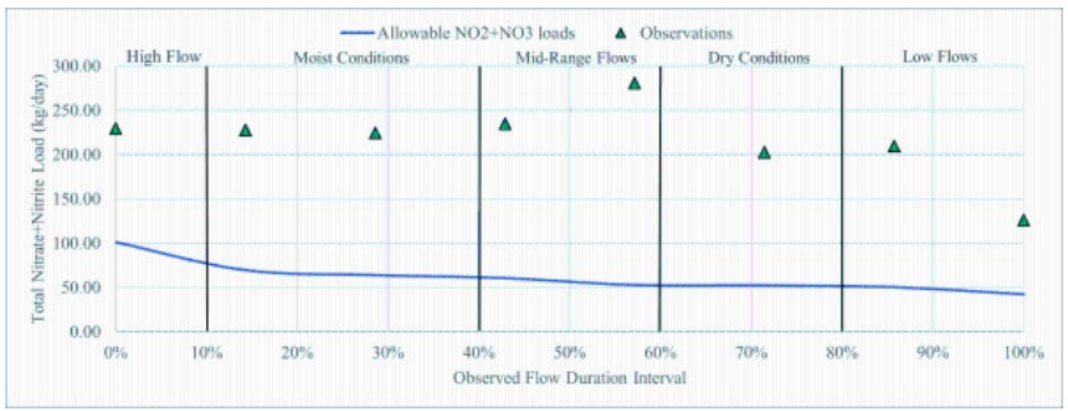
LDC for Bacteria



LDC for Total Phosphorus

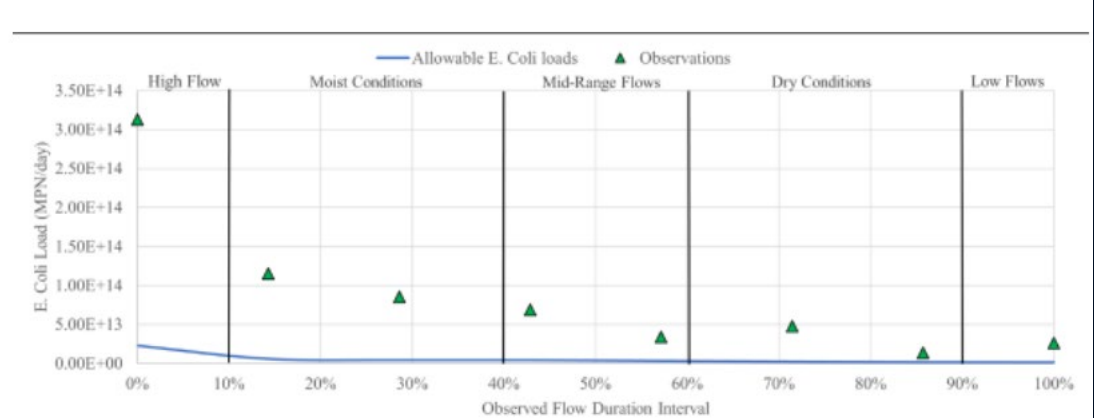


LDC for Total Kjeldahl Nitrogen

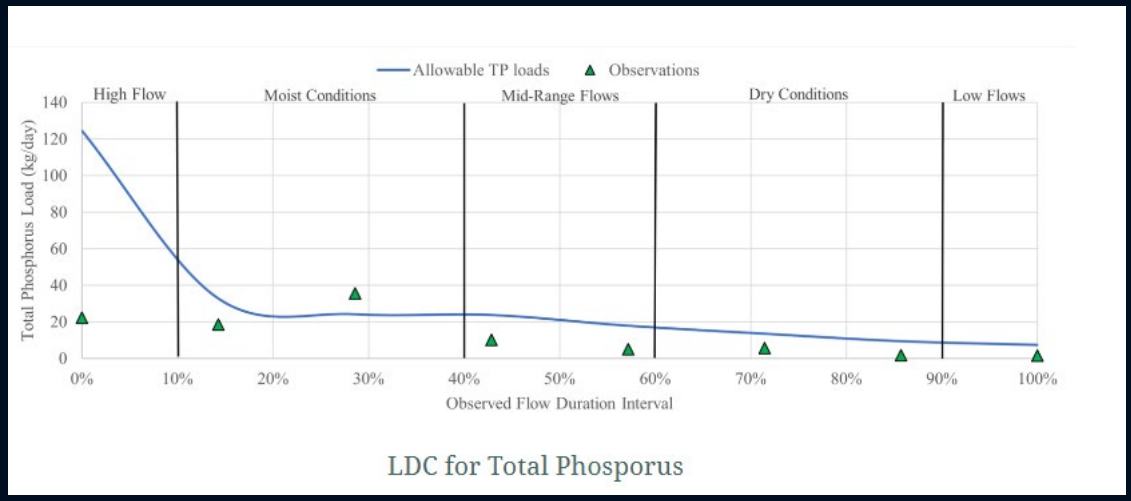


LDC for NO_2+NO_3

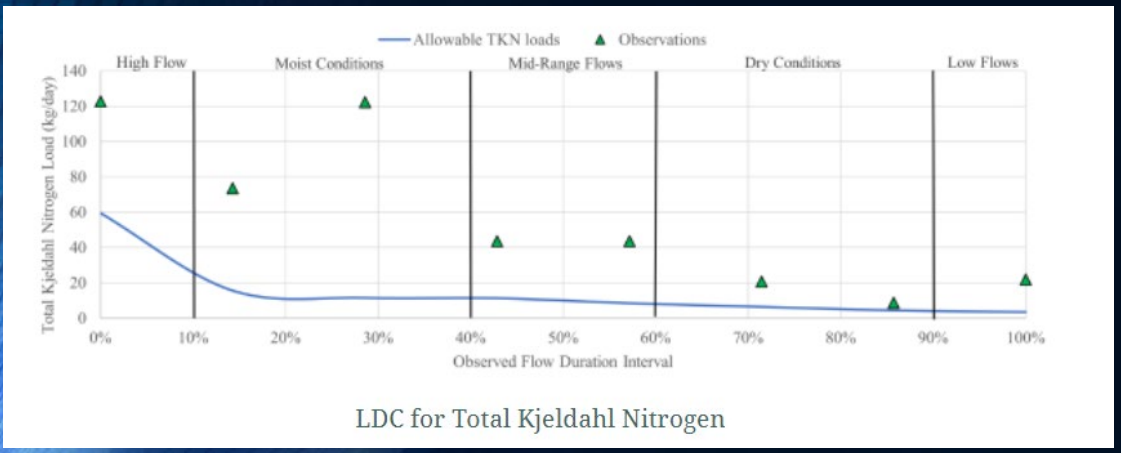
Load Duration Curves-22121- Old Main Drain



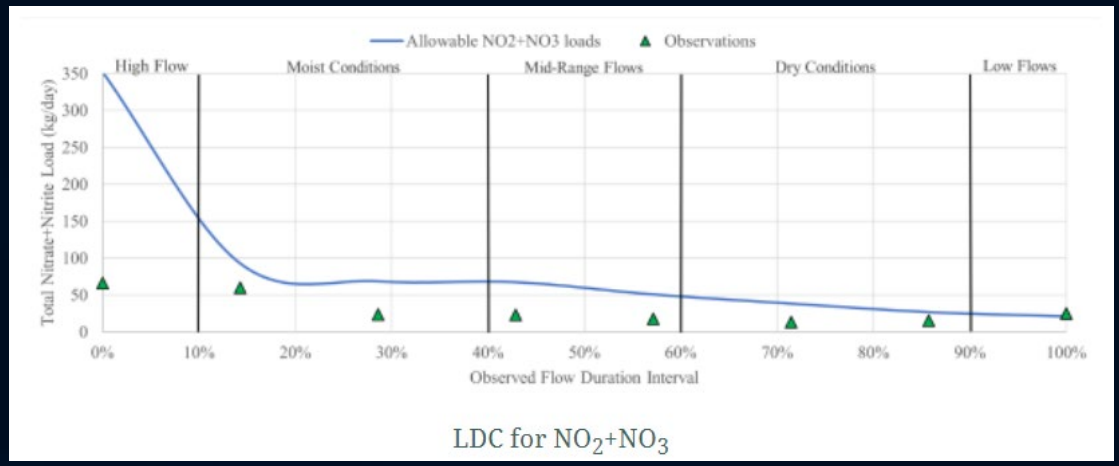
LDC for E. Coli



LDC for Total Phosporus



LDC for Total Kjeldahl Nitrogen



LDC for NO_2+NO_3

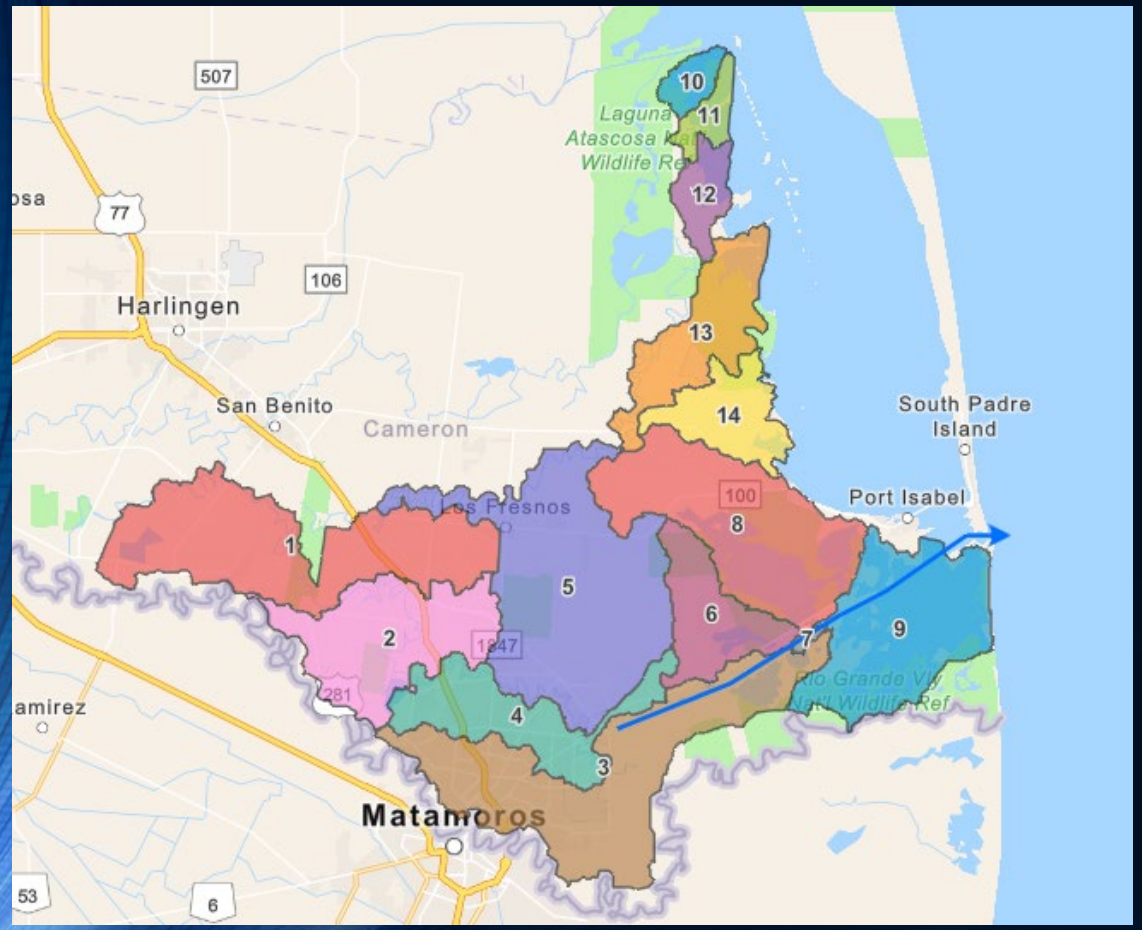
Required Load Reductions to Meet WQS

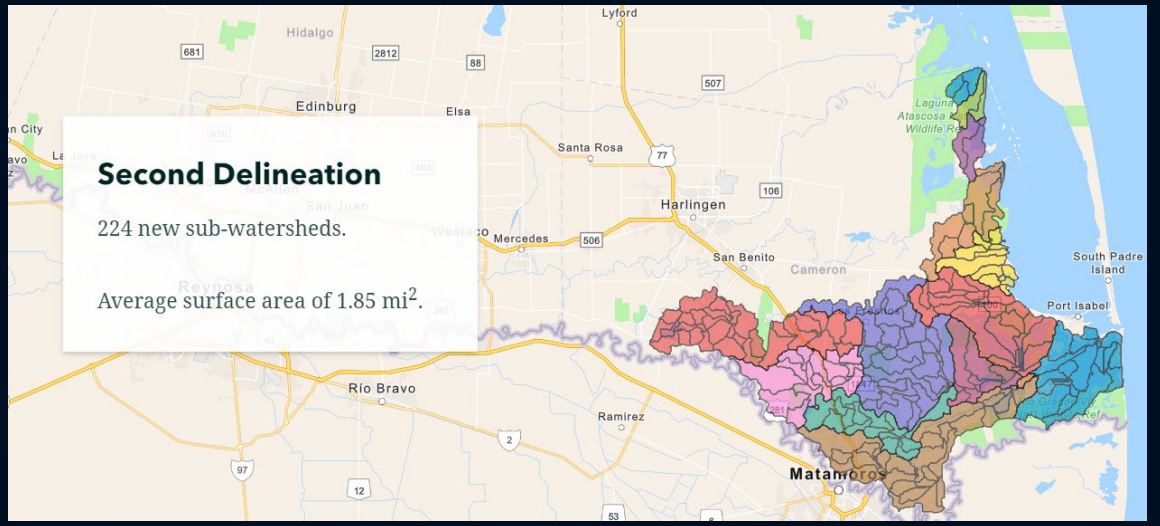
TKN Reductions				
Station	Hydrologic Condition Class	Target Load ($\frac{kg}{day}$)	Daily Load observed ($\frac{kg}{day}$)	Load Reduction Required ($\frac{kg}{day}$)
22118 (Ditch No. 2)	High Flows	25.29	51.50	26.21
	Moist Conditions	11.69	86.79	75.10
	Moist Conditions	10.32	51.92	41.60
	Mid-Range Flows	10.01	105.59	95.57
	Dry Conditions	7.66	37.62	29.95
	Dry Conditions	5.16	27.05	21.89
	Low Flows	4.28	20.74	16.46
22120 (Ditch No. 1)	High Flows	17.11	69.98	52.88
	Moist Conditions	11.77	36.73	24.96
	Moist Conditions	10.80	47.47	36.66
	Mid-Range Flows	10.24	27.17	16.94
	Mid-Range Flows	8.91	18.80	9.89
	Dry Conditions	8.83	20.94	12.12
	Dry Conditions	8.50	18.95	10.45
	Low Flows	7.16	47.49	40.34
22121 (Old Main Drain Ditch)	High Flows	59.59	122.79	63.20
	Moist Conditions	15.68	73.66	57.97
	Moist Conditions	11.61	122.42	110.81
	Mid-Range Flows	11.40	43.55	32.14
	Mid-Range Flows	8.59	43.73	35.14
	Dry Conditions	6.50	20.68	14.18
	Dry Conditions	4.53	8.74	4.20
	Low Flows	3.57	21.85	18.28

Priority Ranking of Required Load Reduction

1. E. coli and TKN reductions required in all 3 waterways and flow conditions.
2. Total-Phosphors reductions required in Ditch 1 and 2 for all flow conditions. OMD exceeded permissible loads in only 1 instance
3. Nitrate and Nitrite- required in Ditch #1 for all flow condition.

Watershed Delineation



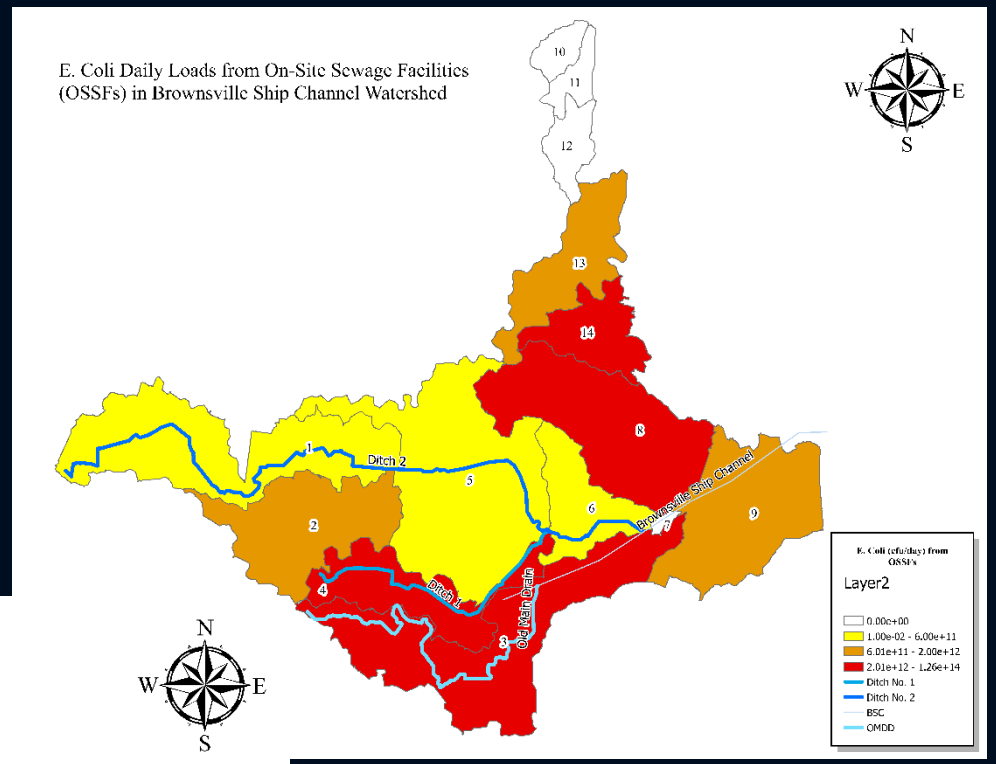


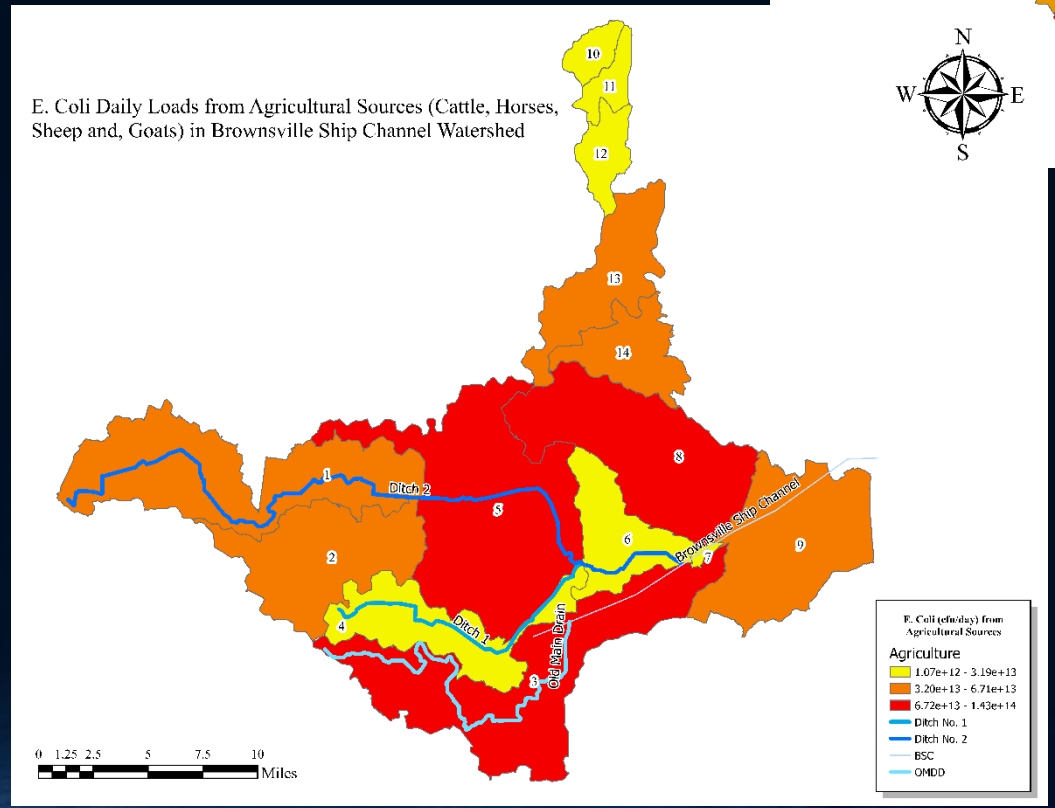
Spatially Explicit Load Calculation Tool

- Model to predict E. coli loads based on land uses, population densities (e.g. humans, animal species), and soil types.
  - Worst case scenario
  - Species specific data may be derived estimates (e.g. state wide average for specific land type).
  - Considers both point source and non-source
    - Point Sources = OSFF, WWTF, Concentrated Animal Feeding Operations
    - Non-Point Sources = Cattle, Sheep/Goats, Feral Hog, Horses, Deer
  - Note: Model does not consider all possible sources (e.g. birds, coons, etc.)

SELECT Results

- Ditch #2- E. coli loads from NPS especially cattle, dogs, and feral hogs
- Ditch #1- E. coli loads primarily of WWTF and OSSF, both point sources
- Old Main Drain- E. coli loads from a cattle and OSSFs
- Results can be applied in the development of BMPs





Tidal Prism Modeling

- Project drains are tidally influenced
- Additional modeling required to differentiate up-land and tidal flows in these system
  - Drainage Area Ratio is a function of:
    - Stream flow salinity is zero (Not applicable)
    - Stream segment is completely mixed (Not applicable)
    - Salinity and flow data at monitoring location (applicable)
  - Tidal Prism is another model that can be applied to simulate a conservative water quality parameter (Salinity) is function of:
    - *Basin topography/bathymetry (Available for existing data)*
    - *Can be applied to estimate relative contributions of fresh and salt water inflows in a basin*
      - *Steady state assumption*
      - *Applies continuous salinity (i.e. conductivity measurement and stage height)*
    - *Tidal Prism simulations are pending*

Development of LLM-BSC WPP: Project Status

- 20 Field Data Collection Events
  - 9 completed to date
  - 11 to be completed by years end
- TCEQ to conduct data collection audit- July 11-15
  - Will be onsite
- Final Report- end of the year

TGLO Coastal Management Program (CMP)-27

- Lower Laguna Madre Hydrodynamic Characterization
- Project Type: Project of Special Merit
  - Large in Scope of Work and/or Regional Project
  - No Match Requirement
- Project Lead: Cameron County
  - Augusto Sanchez Gonzalez
- Proposal developed in collaboration with TWDB and USACE
- Total Budget: $852,254
- Sub Contract: Expected in Days
- Project Duration: 24 months

NSF: SRF RN: Shared Destinies: Hydro-social infrastructures for community involvement and sustainability in fragmented border regions

- Project Lead: University of Texas at El Paso
- Project Partners:
  - UTRGV
  - University of California San Diego
  - RATES
- Scope of Work: Explore impact of cross-border water issue
  - Surveys- 1st round distributed in June 2022
  - Workshops: 2 work shops will be held in each of targeted cross border region
    - San Diego/Tijuana; El Paso/Juarez; LRGV/Matamoras-Reynosa
- Goal: Developed of proposal for full-blown study

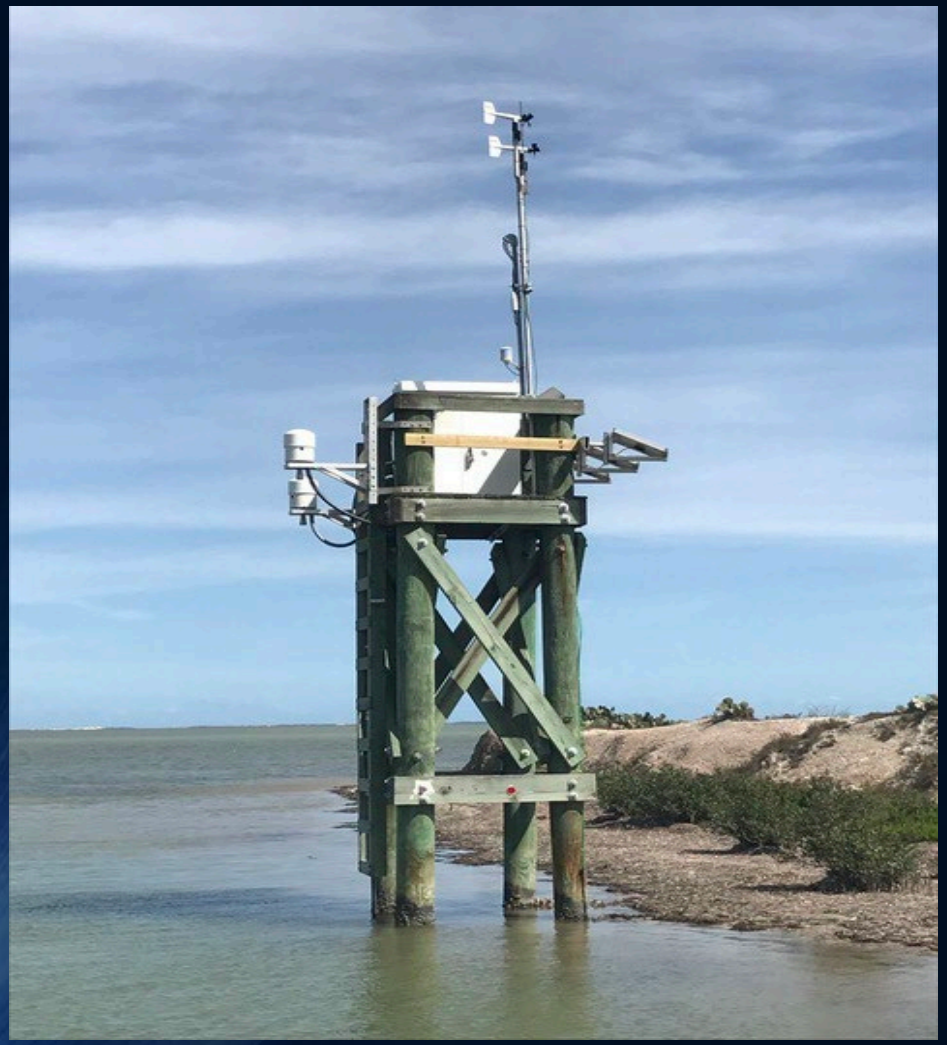
CMP-27 PSM Lower Laguna Madre Hydrodynamic Characterization

- Scope of Work
  - Data Collection
    - Continuous monitoring hydrodynamic and water quality (CTD)
    - Quarterly Monitoring- Research Vessel Surveys
      - Hydrodynamic measurements (ADCP)
      - CTD cast (characterize water column structures/ hydrodynamic)
  - Modeling
    - Applied in hydrodynamic modeling developments by multiple agencies
      - TWDB (fresh water in flows/ oil spill trajectory)
      - TGLO (oil spill trajectory)
      - USACE (storm surge forecasting)
      - TCEQ (NPS pollutant transport and fate modeling)

Continuous Monitoring Campaign

- Six proposed monitoring locations
  - Will leverage existing infrastructure (where possible)
    - NOAA CO-OPS
  - Installation of two (2) Real-Time-Hydrologic-System stations at two SWQM monitoring locations
    - Continuous monitoring
    - Expanded capacity (ADCP and CTD), to enable characterization of tidal influences

NOAA/CO-OPS

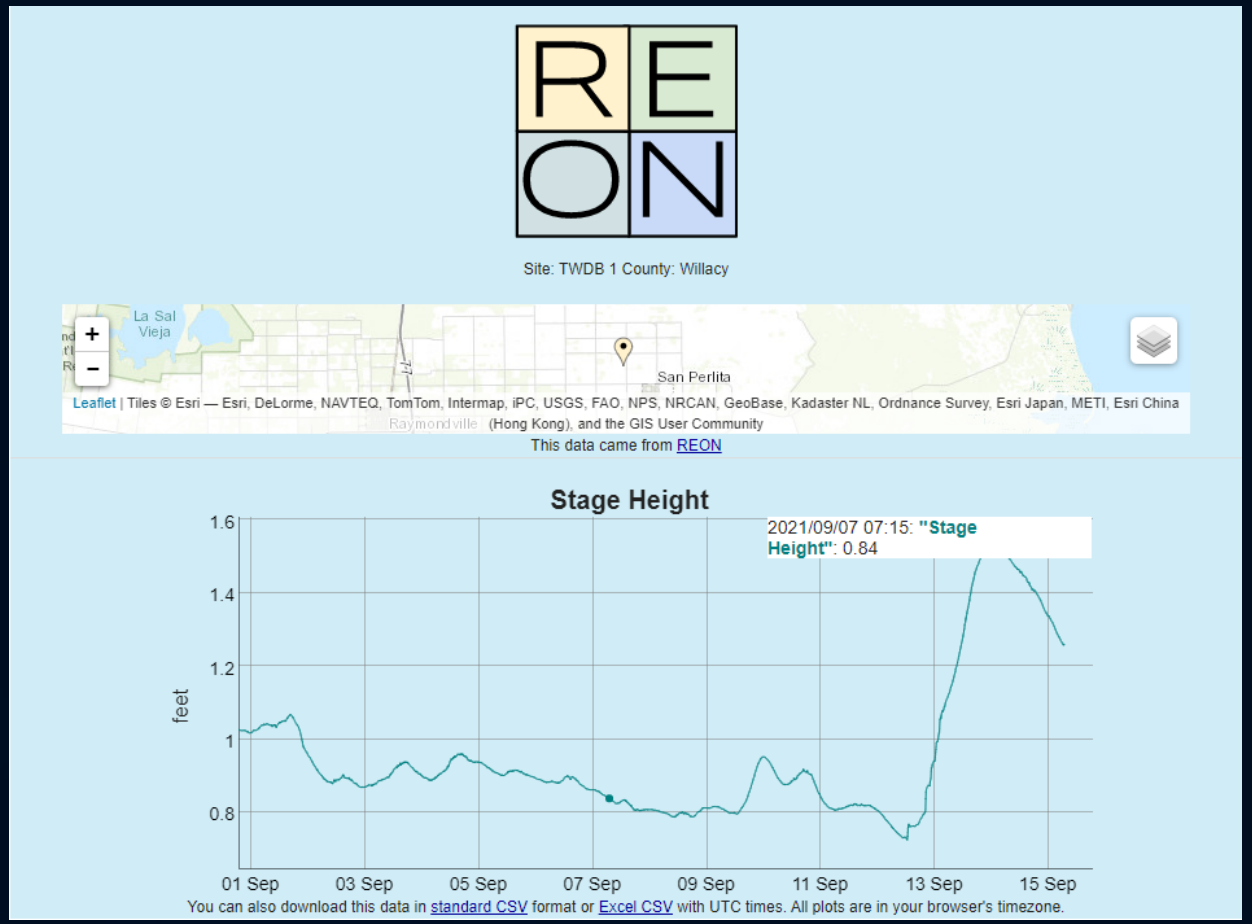


Realitos Peninsula

SPI Brazos Santiago

Andrew Ernest, RATES CEO; Javier Guerrero, Project Development Officer; Chris Fuller, LRGV Watershed Coordinator

Real-Time-Hydrologic Systems



TCEQ-CWA Section 319 FY2023 Proposal

San Martin Lake-Implementation Monitoring

- San Martin Lake- important estuary of LLM-BSC system
- Vulnerable to eutrophication
- Receives inflows from CCD1- Ditch 1 and 2
  - WWPP Development work indicate excessive nutrient and bacterial loads
- Project will involve:
  - RTHS monitoring and quarterly data collection events
    - Establish baseline conditions for San Martin Lake
      - Evaluation of up-stream BMPs
    - Extended monitoring parameters (Bacteria source tracking
- Outreach events to promote implementation voluntary non-structural BMPs
  - BMPs to target NPS contaminant source in source water sheds
- Project partners-
  - RATES, Cameron County, Texas Sea Grant, others TBD
- Project Duration
  - 36 months
- Proposal Due Date: July 15, 2022

The End

TCEQ Section 319: Solicitation No. 582-21-23333

- Characterization of Northern and Central Lower Rio Grande Valley (LRGV) Watersheds: Phase II
- Project Lead: RATES
- Budget:
  - Total: $225,000
    - Federal: $135,000
    - Match: $90,000
      - Lower Rio Grande Valley-TPDES Stormwater Tasks Force
      - Cameron County Texas
- Contract Execution: September 2022

Project Scope

- Extend Phase I Lower Rio Grande Valley-North and Central Watershed Characterization (UTRGV)
  - Provide combination of continuous and event based monitoring (modeled after LLM-BSC WPP)
    - RTHS- stream monitoring
      - Leverages 3 monitoring stations commissioned by TWDB-FWF
        - Raymondville Drain
        - Hidalgo-Willacy Main Drain
        - USIBWC North Floodway
    - Quarterly- water quality and hydrodynamic measurements
      - DO, Water Temp, Conductivity, pH, Nitrate/Nitrite, Total Phosphorus, TKN, and *E. coli*
      - ADCP discharge transects, flow measurements to develop discharge rating curves as a function of stage height

North and Central Monitoring Stations