



U.S. ARMY

Sabine-Neches Waterway

Regulatory Compliance Modeling for Dredge Material Placement in a Ship Channel with Eight Ocean Placement Areas

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WEDA, Houston, TX 2022



US Army Corps of Engineers

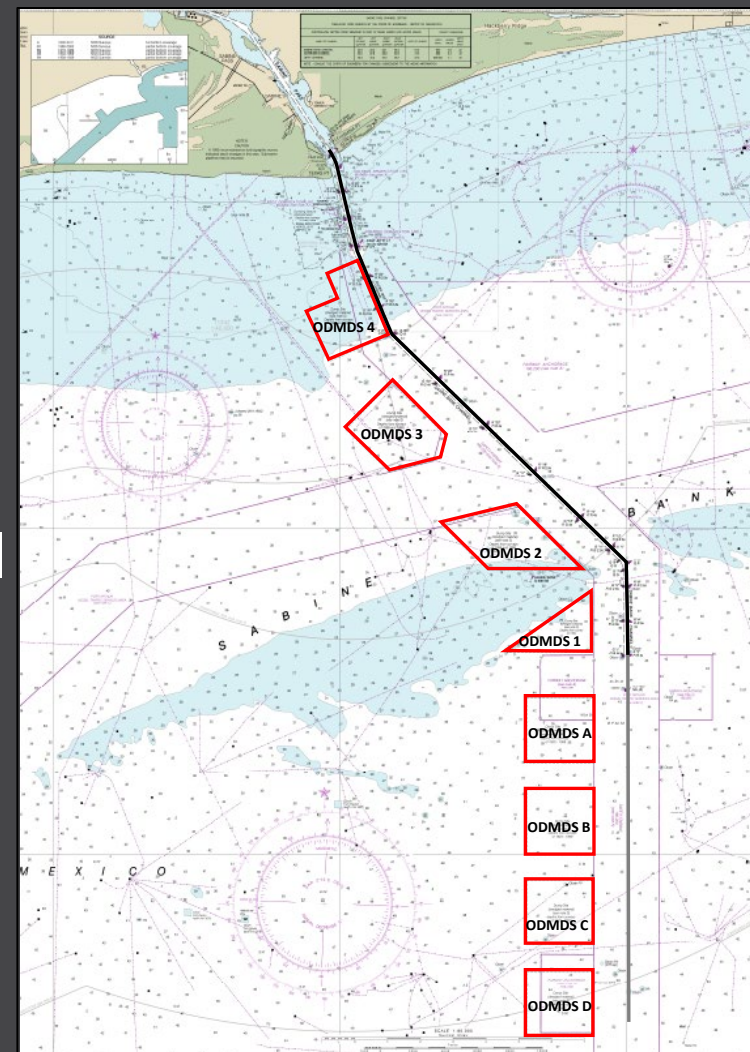


DISCOVER | DEVELOP | DELIVER

Sabine-Neches Waterway ODMDS Locations

MPRSA 103 Evaluation of New Work Dredge Materials Bound For Ocean Placement

- Evaluate elutriate chemistry and toxicity
 - ▶ COCs > WQC?
 - ▶ Toxicity?
- Determine Limiting Permissible Concentration (LPC)
- Evaluate initial mixing for each ODMDS - STFATE model
 - ▶ Is the concentration < LPC outside the ODMDS boundary?
 - ▶ Is the concentration < LPC after 4 hours?
- Determine restrictions necessary to ensure compliance?
 - ▶ Load restrictions
 - ▶ Disposal zone





Elutriate Preparation

Analytical Results

Elutriate Chemistry and Toxicity

4 Sediment Samples

SNWWNew-01, SNWWNew 02,
SNWWNew-03, SNWWNew-04

Prepare Elutriate (Standard Elutriate Test)

Elutriate Chemical Analyses

- No COCs detected at concentrations above the marine water screening criteria (TWSQS acute and EPA WQC CMC)
- Toxaphene was non-detect; DL < criteria; RL > criteria
- No WQC exceedances => no dilution/mixing required for chemical analytes

Elutriate Bioassays

- Some toxicity shown in 3 samples
- Ammonia likely cause of toxicity for some samples



Elutriate Bioassays

Bioassay Results

Elutriate Toxicity

CONFOUNDING FACTORS

Elutriate Sample	Endpoint	96-h <i>Menidia beryllina</i>	48-h <i>Americamysis bahia</i>	96-h <i>Americamysis bahia</i>	Ammonia Toxicity
SNWWNEW-01-EL NO TOXICITY	NOEC	100%	100%	100%	No
	LOEC	NA	NA	NA	
	LC50	NA	NA	NA	
SNWWNEW-02-EL NO LC50	NOEC	10%	50%	100%	LIKELY
	LOEC	50%	100%	NA	
	LC50	NA	NA	NA	
SNWWNEW-03-EL NO LC50	NOEC	50%	100%	100%	No
	LOEC	100%	NA	NA	
	LC50	NA	NA	NA	
SNWWNEW-04-EL	NOEC	10%	50%	100%	LIKELY
	LOEC	50%	100%	NA	
	LC50	82.4%	NA	NA	

New Approach to LPC determination

Part 1: Water Quality

- Determine COCs that exceeded EPA water quality criteria
- Select the COC that requires the most dilution → No WQC exceedances

Part 2: Toxicity Evaluation & Limiting Permissible Concentration

- Toxicity - elutriate bioassay tests → used to calculate required dilution
- Regulatory calculation yields a Limiting Permissible Concentration (LPC)
- LPC uses an LC50 (50% survival): $LPC = AF \times LC50$; **AF typically 0.01**
- **BUT** some of our samples did not yield LC50s → our samples had very low toxicity
- **AND** some of the toxicity was shown to be caused by ammonia; **Alternate AF = 0.05**

Q: How do we calculate the dilution without an LC50?

Part 3: Alternate LPC Determination - Negotiated with EPA

- Alternate LPC approach uses the **NOEC** (No Observed Effects Concentration)
- Rationale: limited toxicity, lack of industrial contaminant exposure for new work material
- Although never done before, ERDC provided a technically defensible case and EPA agreed to the use of the NOEC in the calculations

Bioassay Results

Elutriate Toxicity

Typical, AF = 1%
 If ammonia, AF = 5%
 If no LC50, NOEC

Sample	Endpoint	96-h <i>Menidia beryllina</i>	48-h <i>Americamysis bahia</i>	96-h <i>Americamysis bahia</i>	Ammonia Toxicity	LPC Calculation		
						LC50 x .01	LC50 x .05	NOEC
SNWWNEW-01-EL	NOEC	100%	100%	100%	No	NA	NA	NA
	LOEC	NA	NA	NA				
	LC50	NA	NA	NA				
SNWWNEW-02-EL	NOEC	10%	50%	100%	Likely	1% (D=99)	5% (D=19)	10% (D=9)
	LOEC	50%	100%	NA				
	LC50	NA	NA	NA				
SNWWNEW-03-EL	NOEC	50%	100%	100%	No	1% (D=99)	NA	50% (D=1)
	LOEC	100%	NA	NA				
	LC50	NA	NA	NA				
SNWWNEW-04-EL	NOEC	10%	50%	100%	Likely	0.824% (D=120)	4.12% (D=23.3)	NA
	LOEC	50%	100%	NA				
	LC50	82.4%	NA	NA				

103 Compliance Evaluation using STFATE

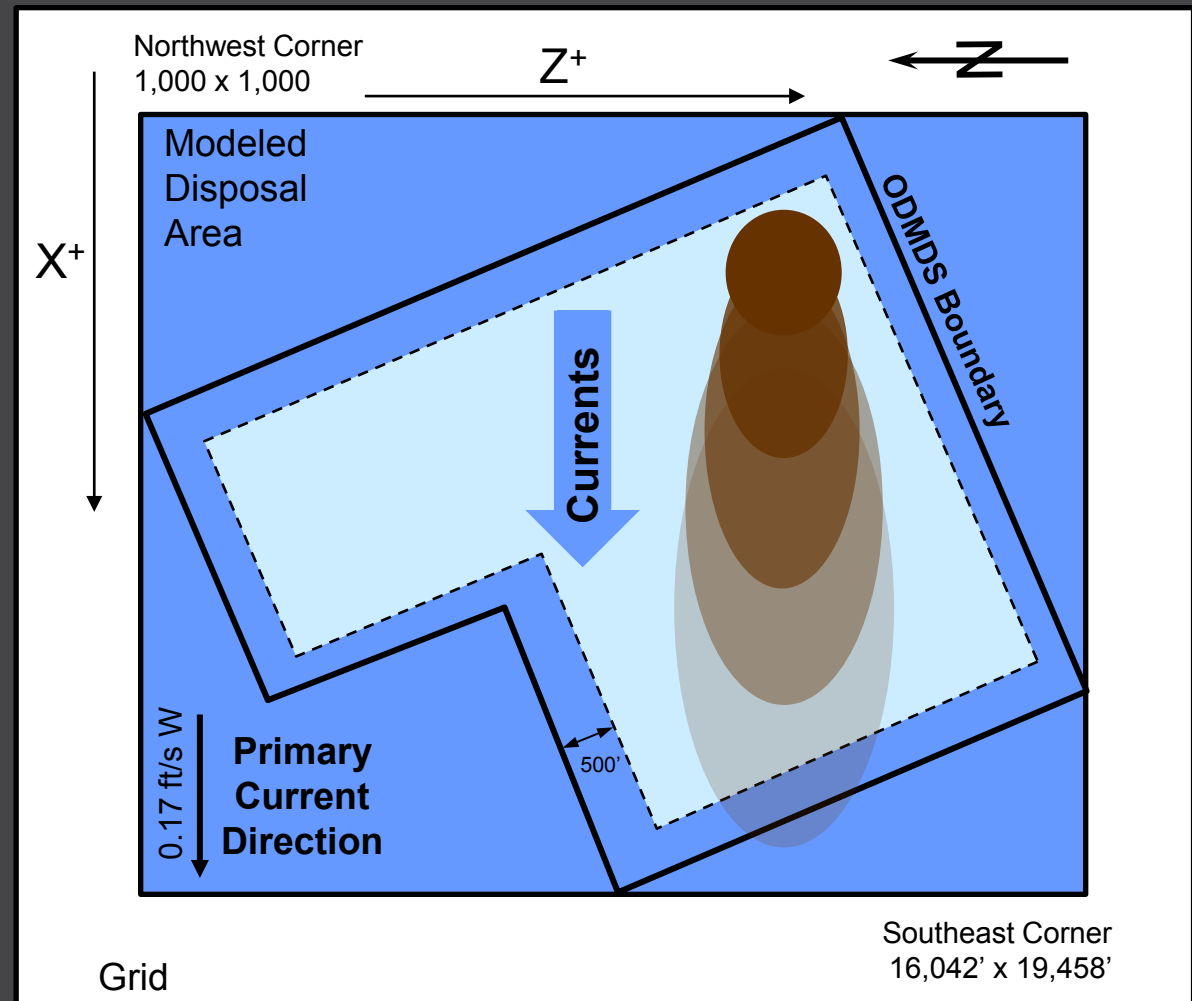
103 Regulations

- Allowances for mixing/dilution
- WQC must be met within
 - ▶ 4 hours of discharge
 - ▶ Outside ODMDS boundary (at all times)

STFATE Model

- Models mixing based on local currents and operating conditions
- Used to determine where materials need to be released to comply with dilution requirements

ODMDS 4 Disposal Map for STFATE model



STFATE Modeling

Evaluation of Mixing and Dilution

Samples

- The 3 samples that displayed toxicity

Ocean Disposal Sites

- 5 ODMDSs: ODMDSs 1-4 and ODMDS D (representing A – D)
- **Note:** for modeling purposes **assumed all samples could be placed in all ODMDSs.** However, there are restrictions as to which ODMDSs are allowed for specific materials.

Current Velocity & Direction

- Low – 0.17 ft/s
- High – 1.688 ft/s surface current; 0.388 ft/s bottom current

Disposal Operation (Load)

- Glenn Edwards (13,500 CY)
- Columbia (4,350 CY)

Volumetric Fraction

- Overflow (with & without)
- Physical characteristics (grain size distribution, Atterberg limit, and percent solids)

Sample	ODMDS	Current Condition	Toxicity Criteria	Load	Volumetric Fraction
SNWWNEW-02	ODMDS 1	Low	LPC = AF x LC50; AF = 0.01	13,500 CY	With overflow
SNWWNEW-03	ODMDS 2	High	LPC = AF x LC50; AF = 0.05	4,350 CY	No overflow
SNWWNEW-04	ODMDS 3		LPC = NOEC		
	ODMDS 4				
	ODMDS D				

= 252 STFATE Model Runs

STFATE Results

Maximum Longitudinal Distance Required from ODMDS Boundary to Meet Recommended Toxicity LPC Criterion

Worst-case results

- Maximum distance assuming no overflow
- Lower distances if assume overflow

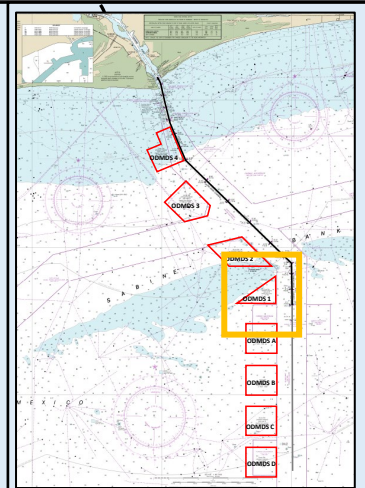
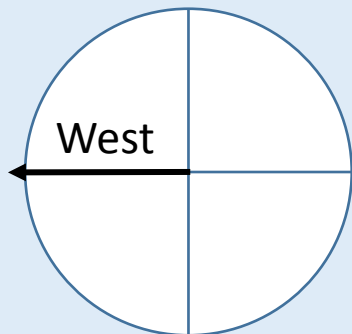
Longitudinal Distance (ft)

ODMDS	SNWWNew-01	SNWWNew-02	SNWWNew-03	SNWWNew-04
ODMDS 1	NA	1487	141	4031
ODMDS 2	NA	1360	141	3688
ODMDS 3	NA	1118	141	3250
ODMDS 4	NA	1044	141	4826
ODMDS D	NA	707	141	2693

STFATE Results - Placement zones to meet WQC

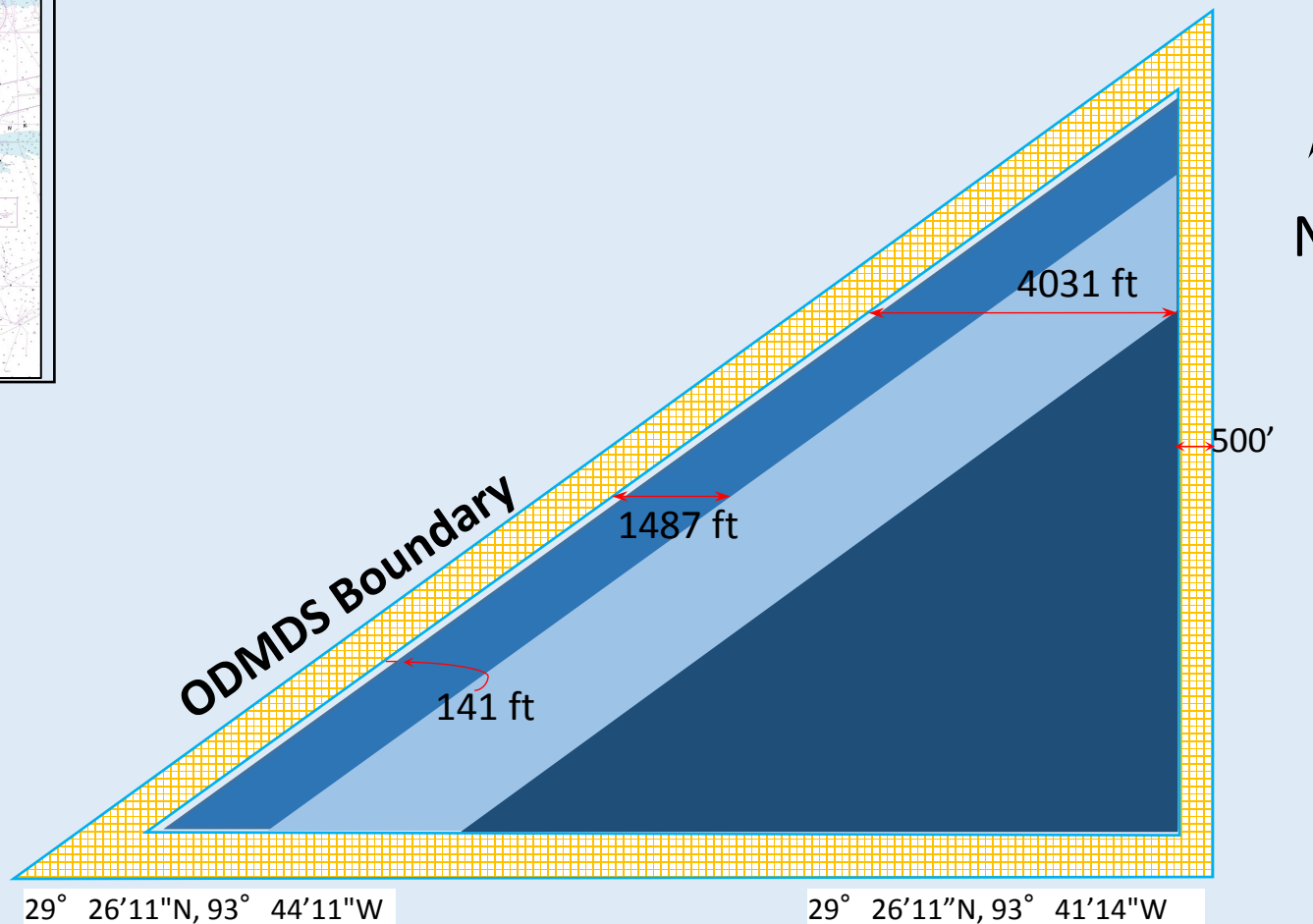
ODMDS 1 Maximum Release Zones for Each Sample, to Account for Westerly Currents

Current direction



ODMDS 1 Maximum Release Zones for Each Sample, 13,500 CY Discharge

29° 28'03"N, 93° 41'14"W



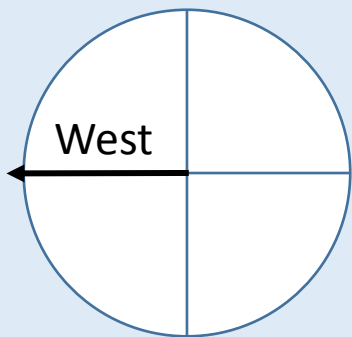
SABINE-NECHES WATERWAY ODMDS 1

- 500' buffer zone (2010 SMMP)
- 500' SNWWNew-01 release zone
- 1,487' SNWWNew-02 release zone
- 141' SNWWNew-03 release zone
- 4,031' SNWWNew-04 release zone

STFATE Results - Placement zones to meet WQC

ODMDS 2 Maximum Release Zones for Each Sample, to Account for Westerly Currents

Current direction



ODMDS 2 Maximum Release Zones for Each Sample, 13,500 CY Discharge

29° 30'41"N, 93° 43'49"W

29° 30'08"N, 93° 46'27"W

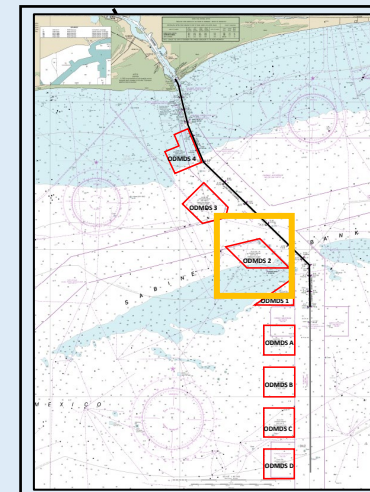
3688 ft

1360 ft

141 ft

500 ft






ODMDS Boundary



29° 28'42"N, 93° 44'49"W

29° 28'42"N, 93° 41'33"W

SABINE-NECHES WATERWAY ODMDS 2

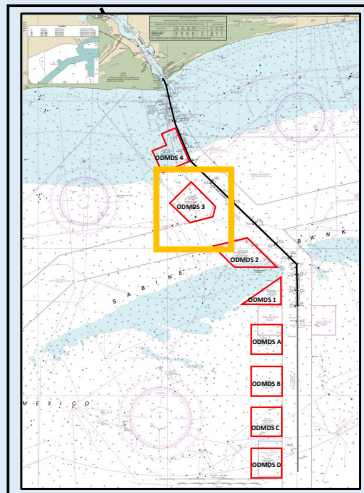
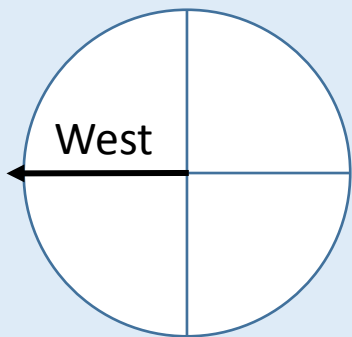
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STFATE Results - Placement zones to meet WQC






ODMDS 3 Maximum Release Zones for Each Sample, to Account for Westerly Currents

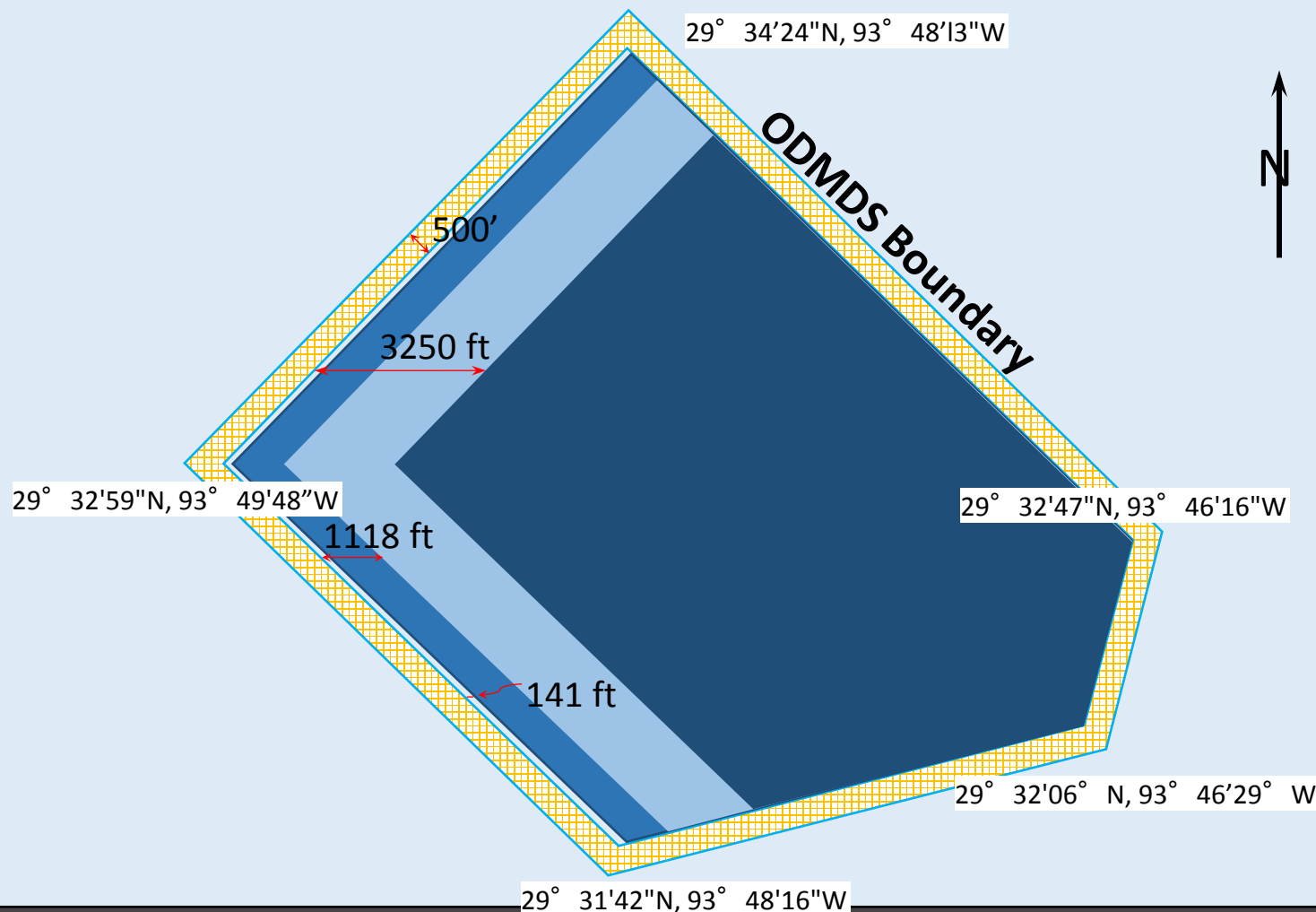
ODMDS 3 Maximum Release Zones for Each Sample, 13,500 CY Discharge

Current direction



SABINE-NECHES WATERWAY ODMDS 3

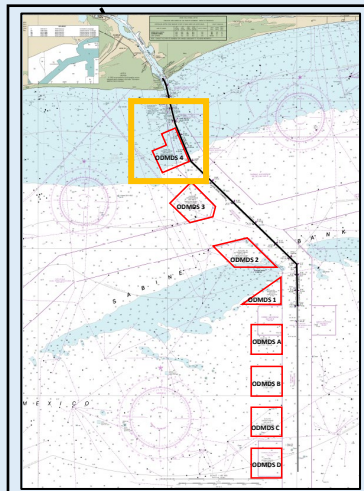
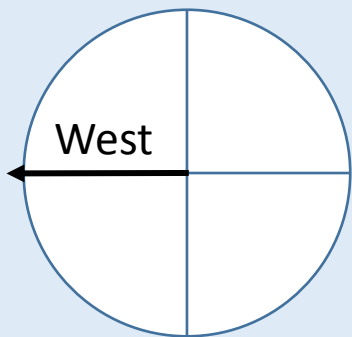
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-  3,250' SNWWNew-04 release zone



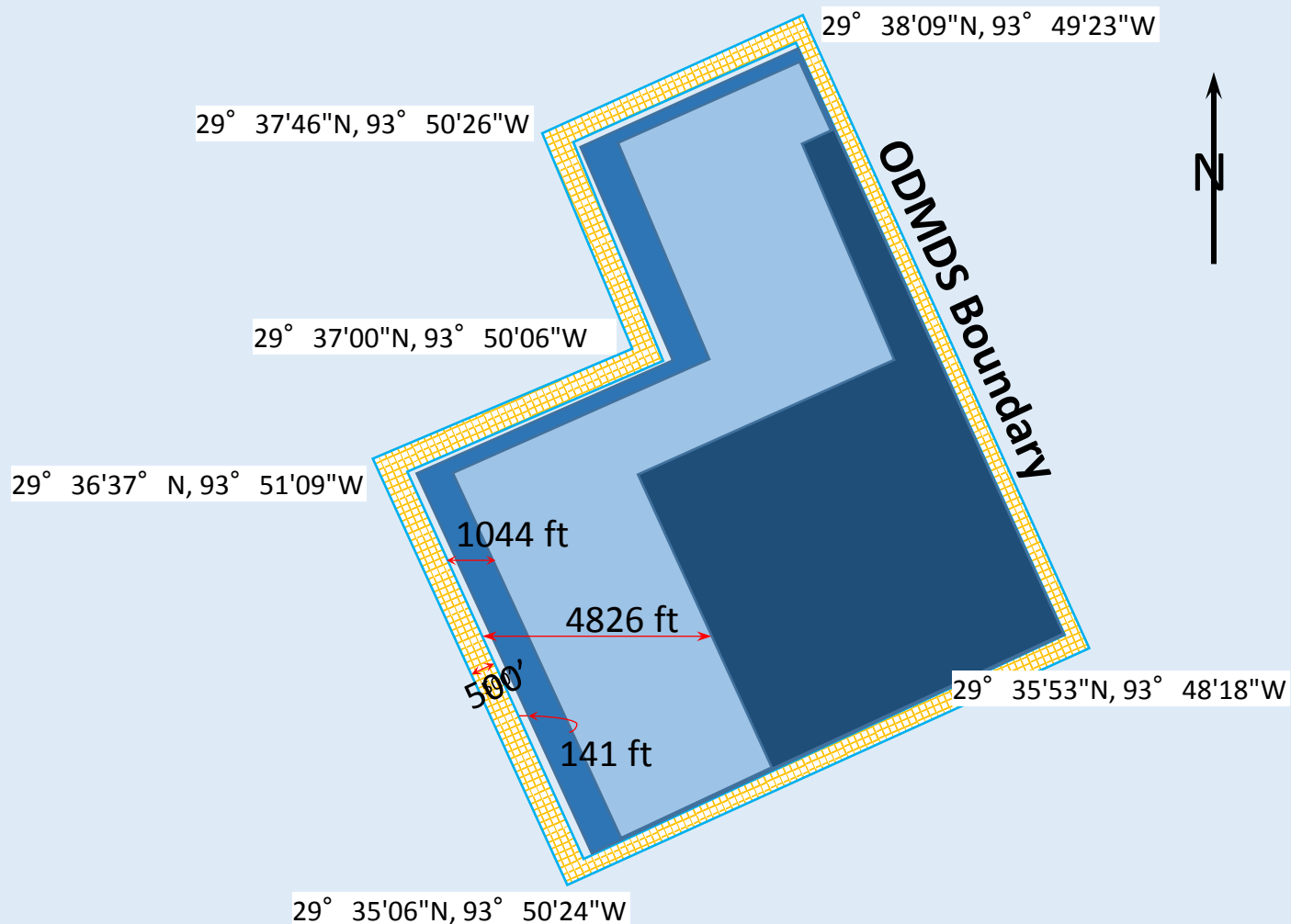
STFATE Results - Placement zones to meet WQC

ODMDS 4 Maximum Release Zones for Each Sample, to Account for Westerly Currents






Current direction



ODMDS 4 Maximum Release Zones for Each Sample, 13,500 CY Discharge



SABINE-NECHES WATERWAY ODMDS 4

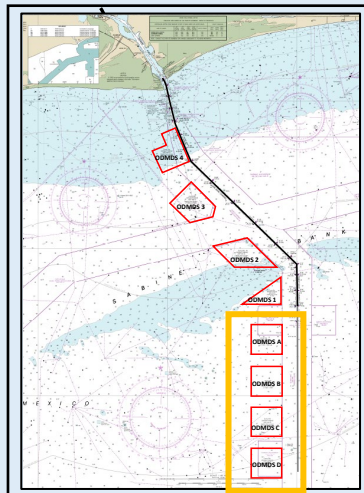
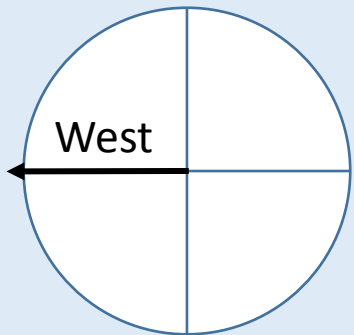
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STFATE Results - Placement zones to meet WQC

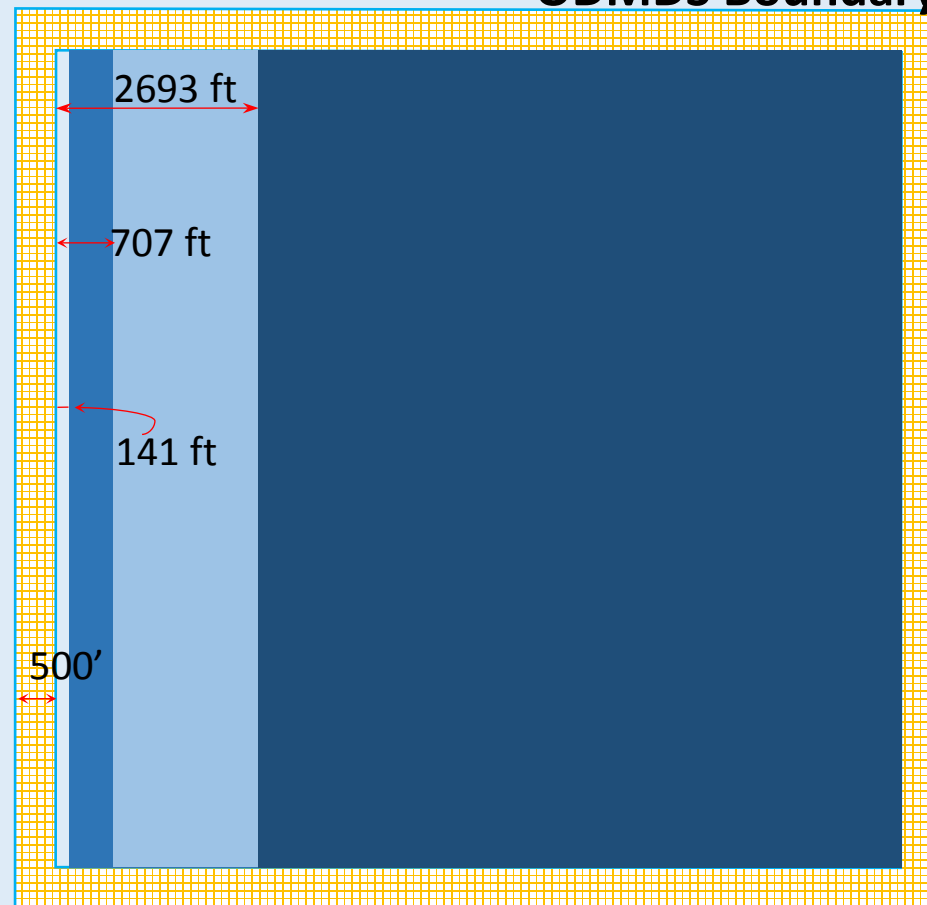
ODMDSs A - D Maximum Release Zones for Each Sample, to Account for Westerly Currents

ODMDSs A - D Maximum Release Zones for Each Sample, 13,500 CY Discharge






Current direction



ODMDS Boundary



SABINE-NECHES WATERWAY ODMDSs A - D

-  500' buffer zone (2010 SMMP)
-  500' SNWWNew-01 release zone
-  707' SNWWNew-02 release zone
-  141' SNWWNew-03 release zone
-  2,693' SNWWNew-04 release zone

Predominant Currents

Predominant Current Direction by Month

Current Data

- Data for Buoy Station 42051 - TABS Buoy R, 2010 - 2019
- SW to NW 61%
- NE to SE 24%
- Median current magnitude was 0.52 ft/s

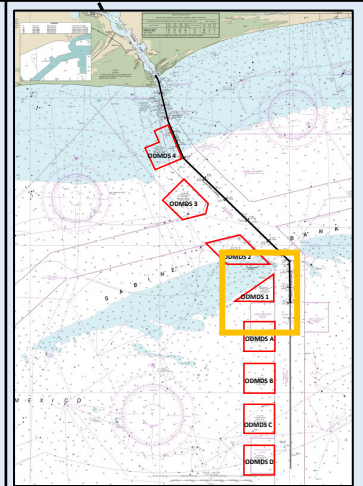
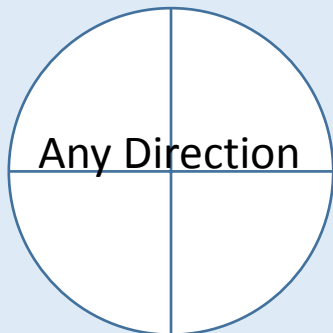
Month	Degrees ¹	Direction
Jan	249	WSW
Feb	254	WSW
Mar	254	WSW
Apr	251	WSW
May	246	WSW
Jun	206	SSW
Jul	102	ESE
Aug	125	SE
Sep	252	WSW
Oct	251	WSW
Nov	257	WSW
Dec	254	WSW

¹The direction the current is flowing toward, 0-360 degrees; 360 is due north

STFATE Results - Placement zones to meet WQC

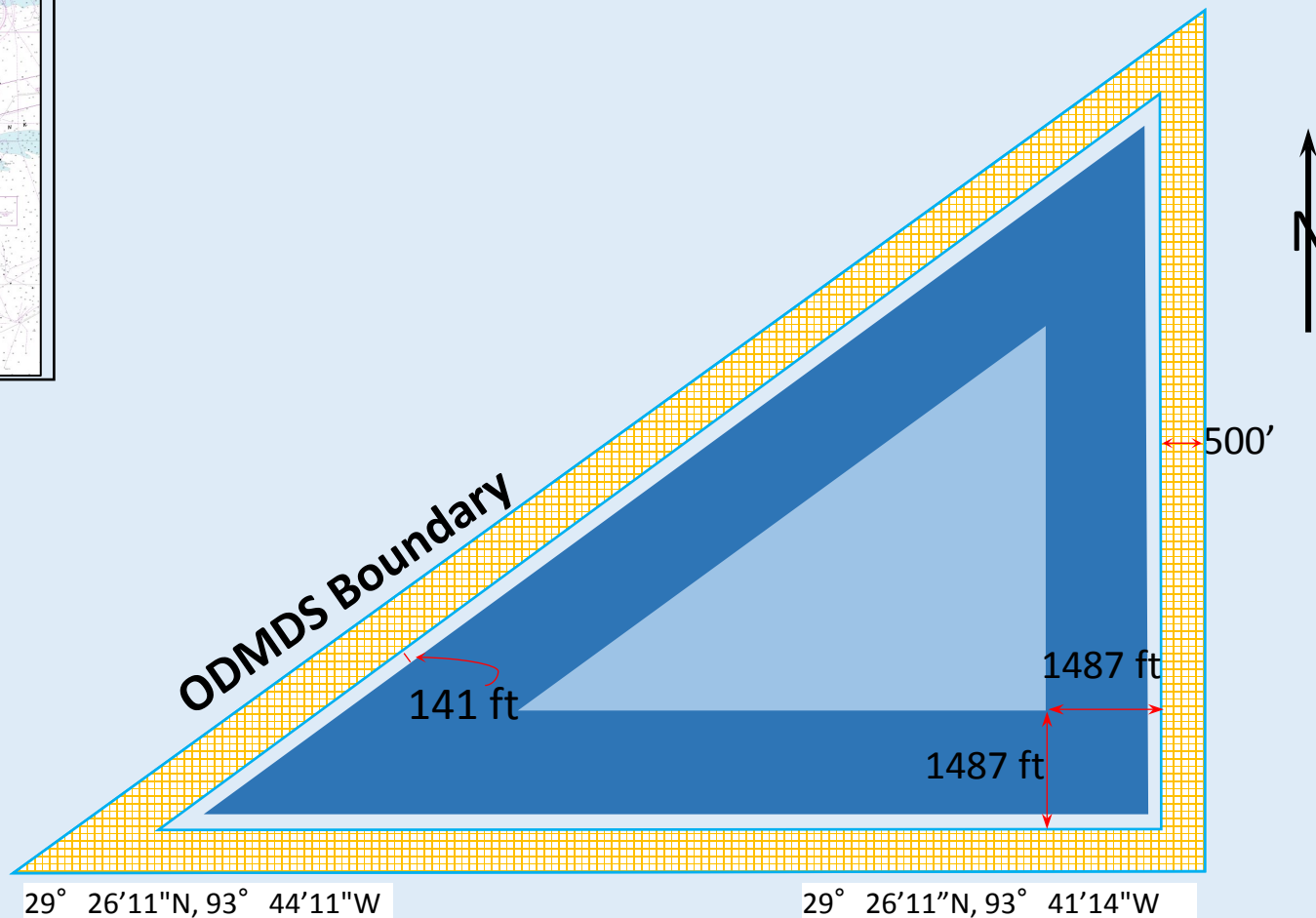
ODMDS 1 Maximum Release Zones for Each Sample, to Account for ANY Currents

Current direction








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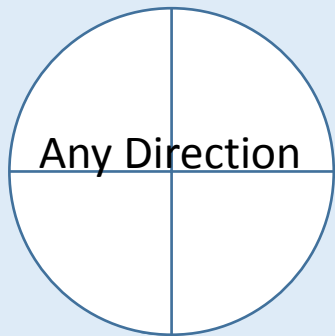
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(not possible)

STFATE Results - Placement zones to meet WQC

ODMDS 2 Maximum Release Zones for Each Sample, to Account for ANY Currents

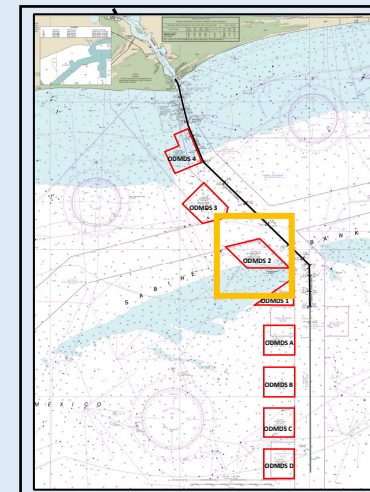
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




ODMDS 2 Maximum Release Zones for Each Sample, 13,500 CY Discharge

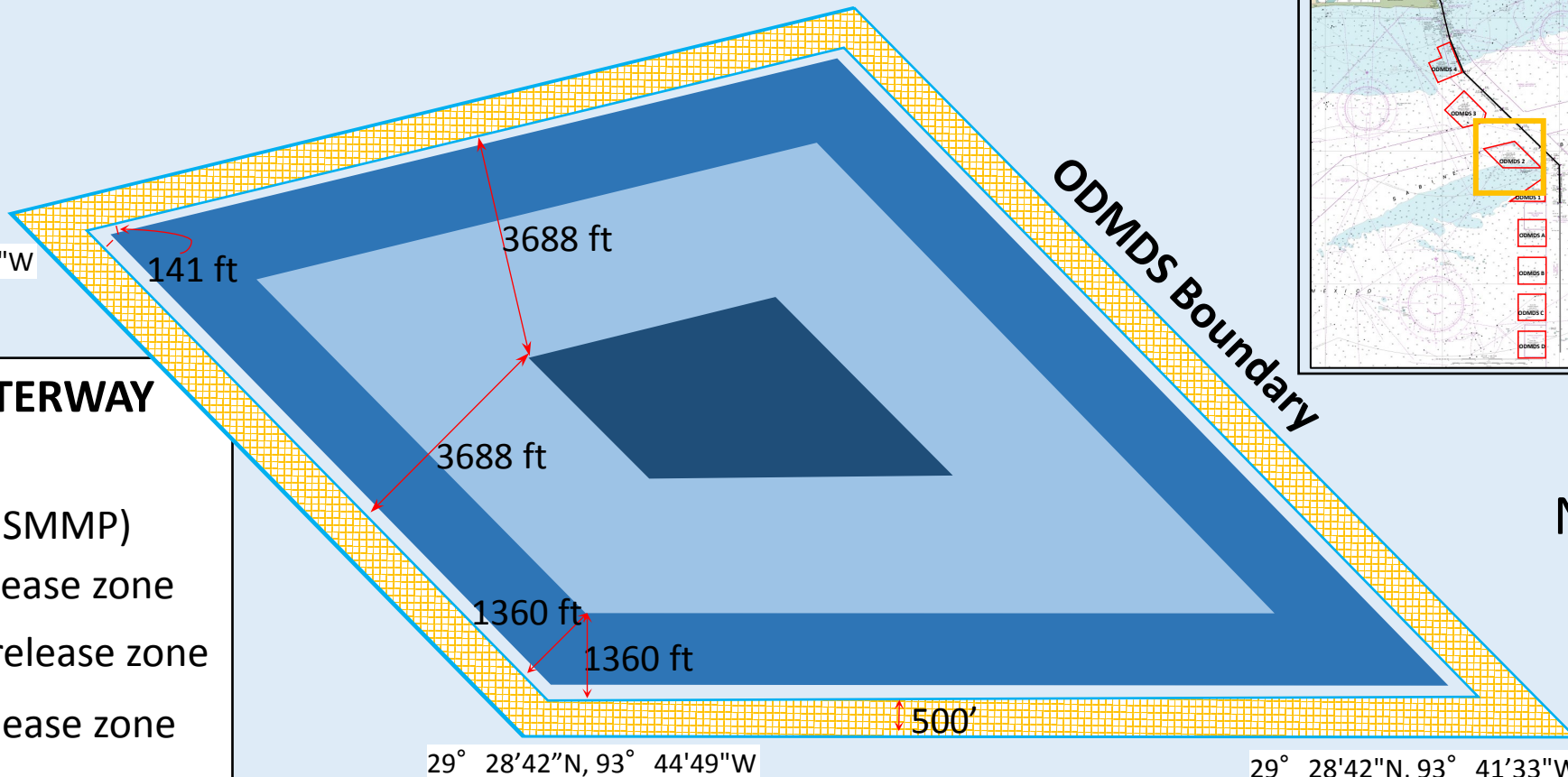
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ODMDS Boundary

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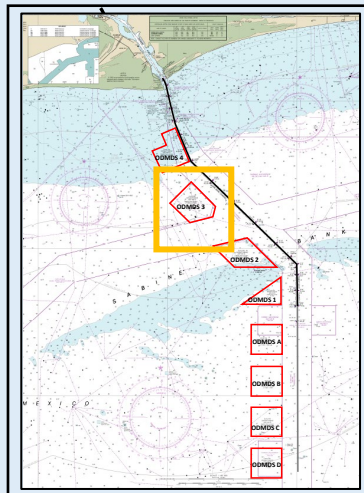
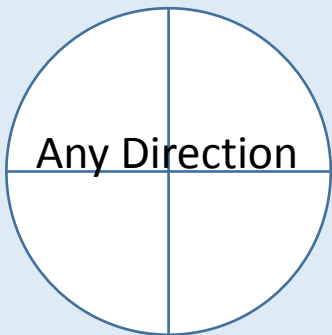
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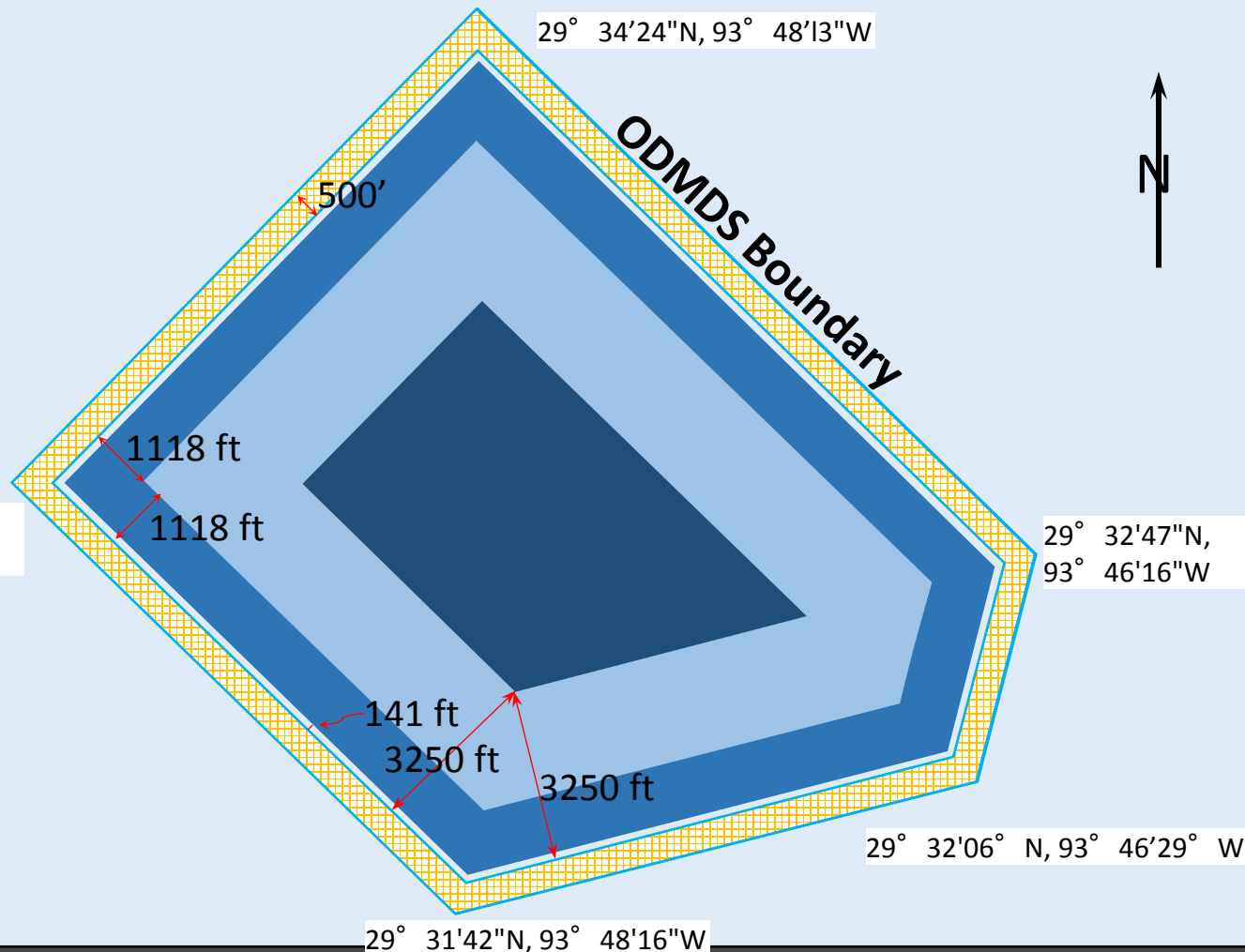
STFATE Results - Placement zones to meet WQC

ODMDS 3 Maximum Release Zones for Each Sample, to Account for ANY Currents






Current direction



ODMDS 3 Maximum Release Zones for Each Sample, 13,500 CY Discharge



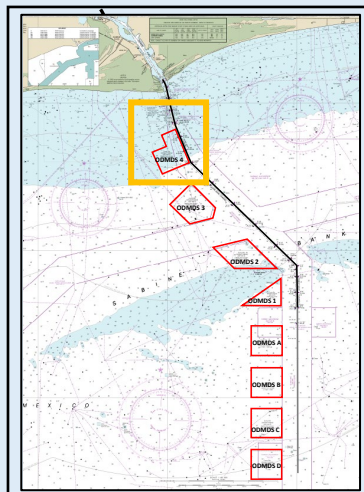
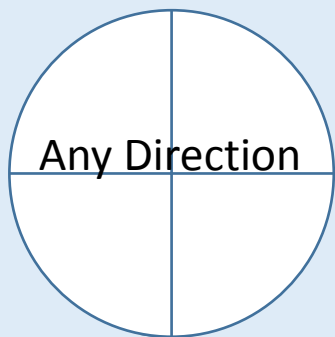
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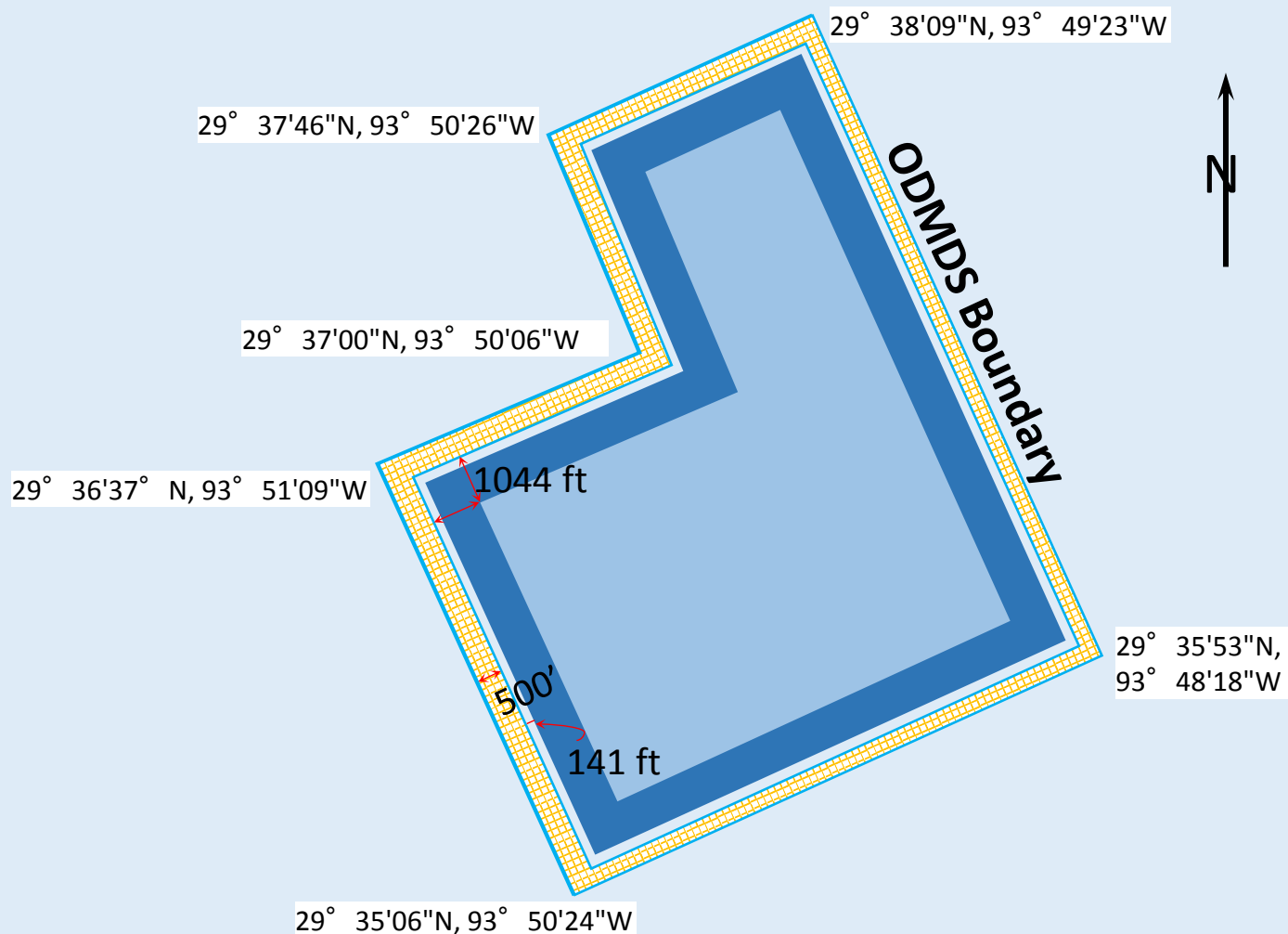
STFATE Results - Placement zones to meet WQC

ODMDS 4 Maximum Release Zones for Each Sample, to Account for ANY Currents






Current direction



ODMDS 4 Maximum Release Zones for Each Sample, 13,500 CY Discharge



SABINE-NECHES WATERWAY ODMDS 4

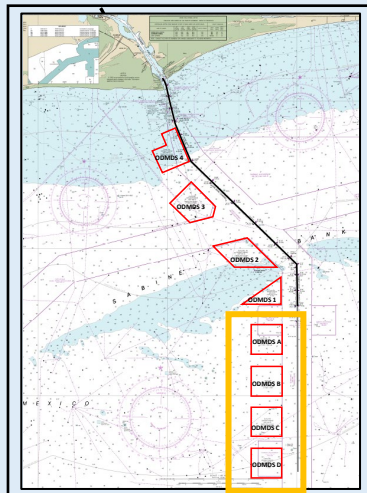
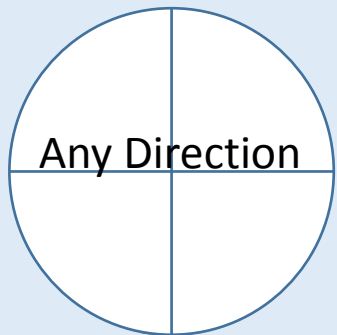
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STFATE Results - Placement zones to meet WQC

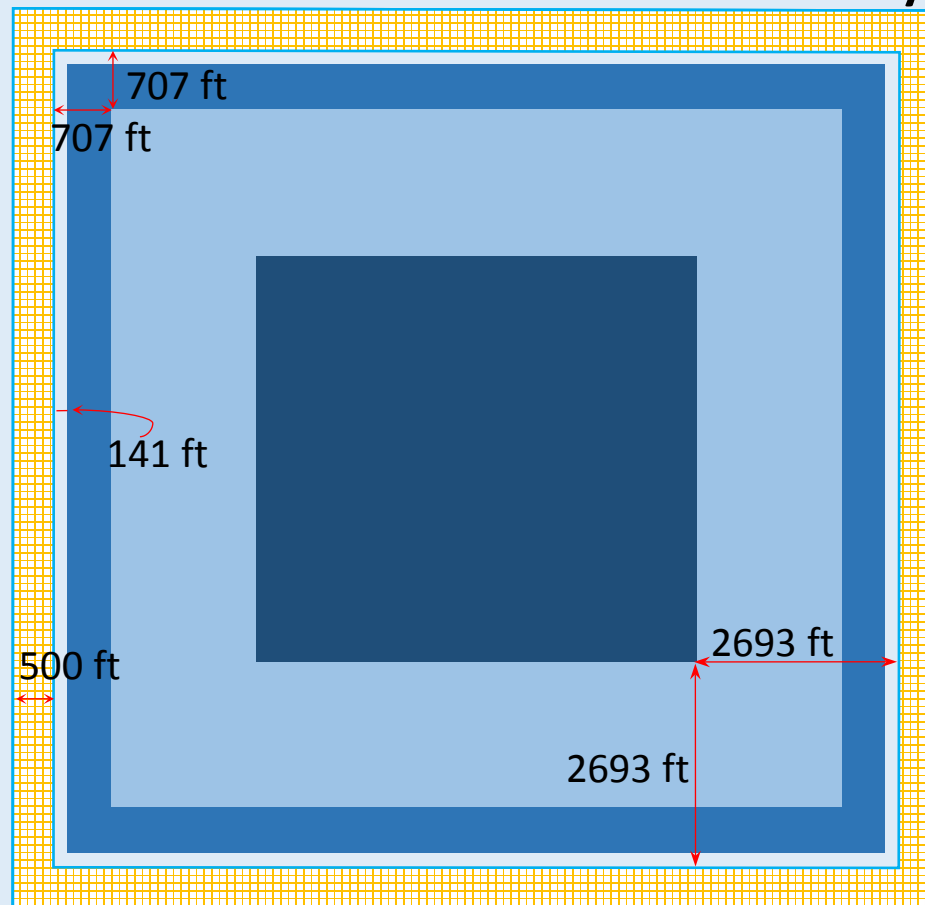
ODMDSs A - D Maximum Release Zones for Each Sample, to Account for Westerly Currents

ODMDSs A - D Maximum Release Zones for Each Sample, 13,500 CY Discharge






Current direction



ODMDS Boundary



SABINE-NECHES WATERWAY ODMDSs A - D

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-  2,693' SNWWNew-04 release zone

Summary

STFATE MODELING WAS PERFORMED TO DETERMINE HOW SNWW DREDGED MATERIALS CAN BE PLACED WITHIN THE 8 ODMDS TO MAINTAIN REGULATORY COMPLIANCE

- Mixing and dilution needed due to elutriate toxicity
- Approach to determine LPC developed cooperatively with EPA R6
- STFATE modeling demonstrated discharge restrictions
 - ▶ Restricted zones for each ODMDS based on sediment regime and seasonal currents
- Results used to develop operational guidance

Acknowledgements

- **ERDC Project Team** (authors, team leads and their teams):
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Tuan Nguyen and Paul Schroeder
- **USACE Galveston District**
- **Sabine Neches Navigation District**
- **EPA Region 6 Ocean Dumping Program**

QUESTIONS???