Estimating Net Carbon Benefits of Implementing Restoration Projects in Coastal Louisiana

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Louisiana Coastal Protection and Restoration Authority

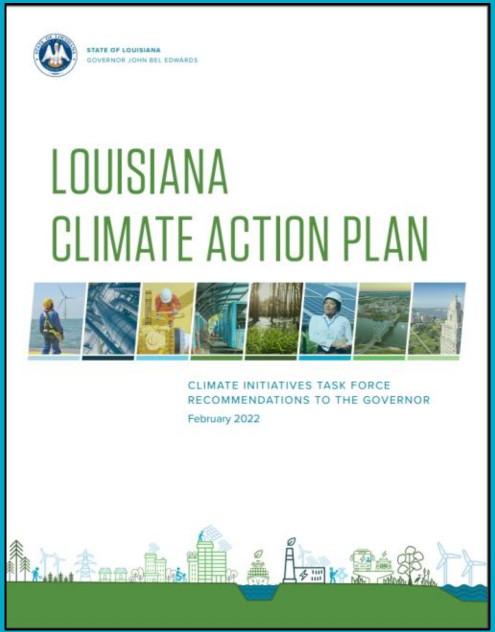
Background

2022: LA Climate Initiative Task Force Climate Action Plan identifies wetlands as avenue for reaching carbon neutrality and acquiring carbon credits

CPRA funded the Water Institute (TWI) to develop carbon benefits estimator based on scenario-based habitat distributions projected from CMP modeling.

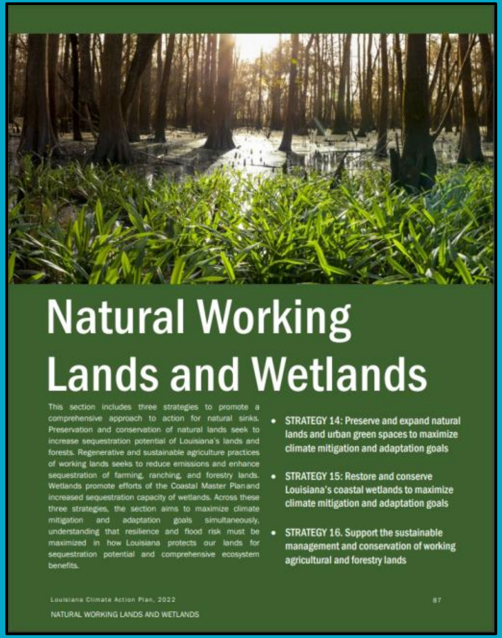
Algorithms from the carbon estimator are being incorporated into CPRA's Integrated Compartment Model (ICM) to run scenarios of Future-with and –without CMP projects to output net ecosystem carbon balance (NECB) estimates.

We can use data from the ICM model outputs to estimate the potential carbon credits earned from restoration project implementation.


STATE OF LOUISIANA
GOVERNOR JOHN BEL EDWARDS

LOUISIANA CLIMATE ACTION PLAN

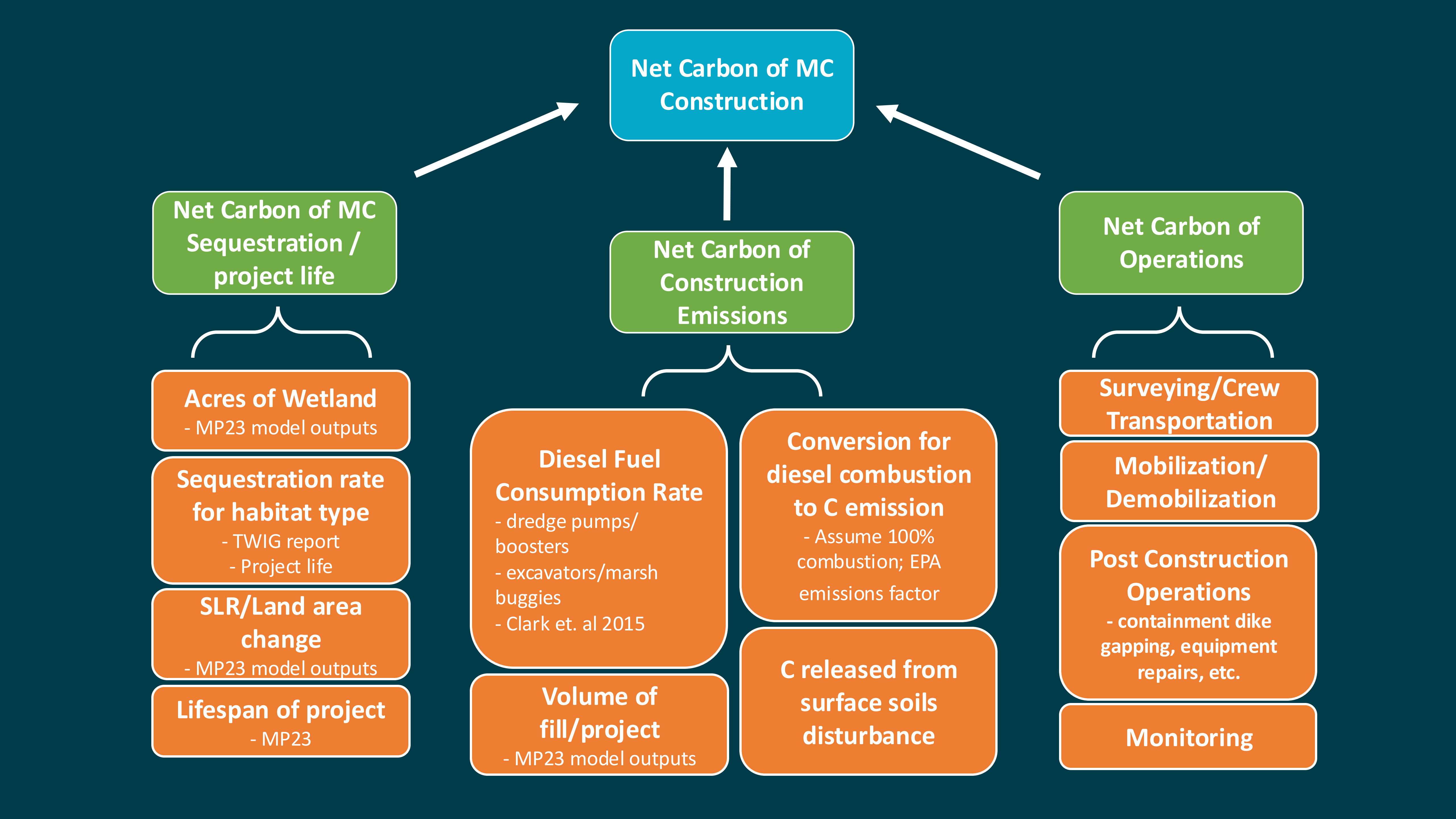
CLIMATE INITIATIVES TASK FORCE
RECOMMENDATIONS TO THE GOVERNOR
February 2022

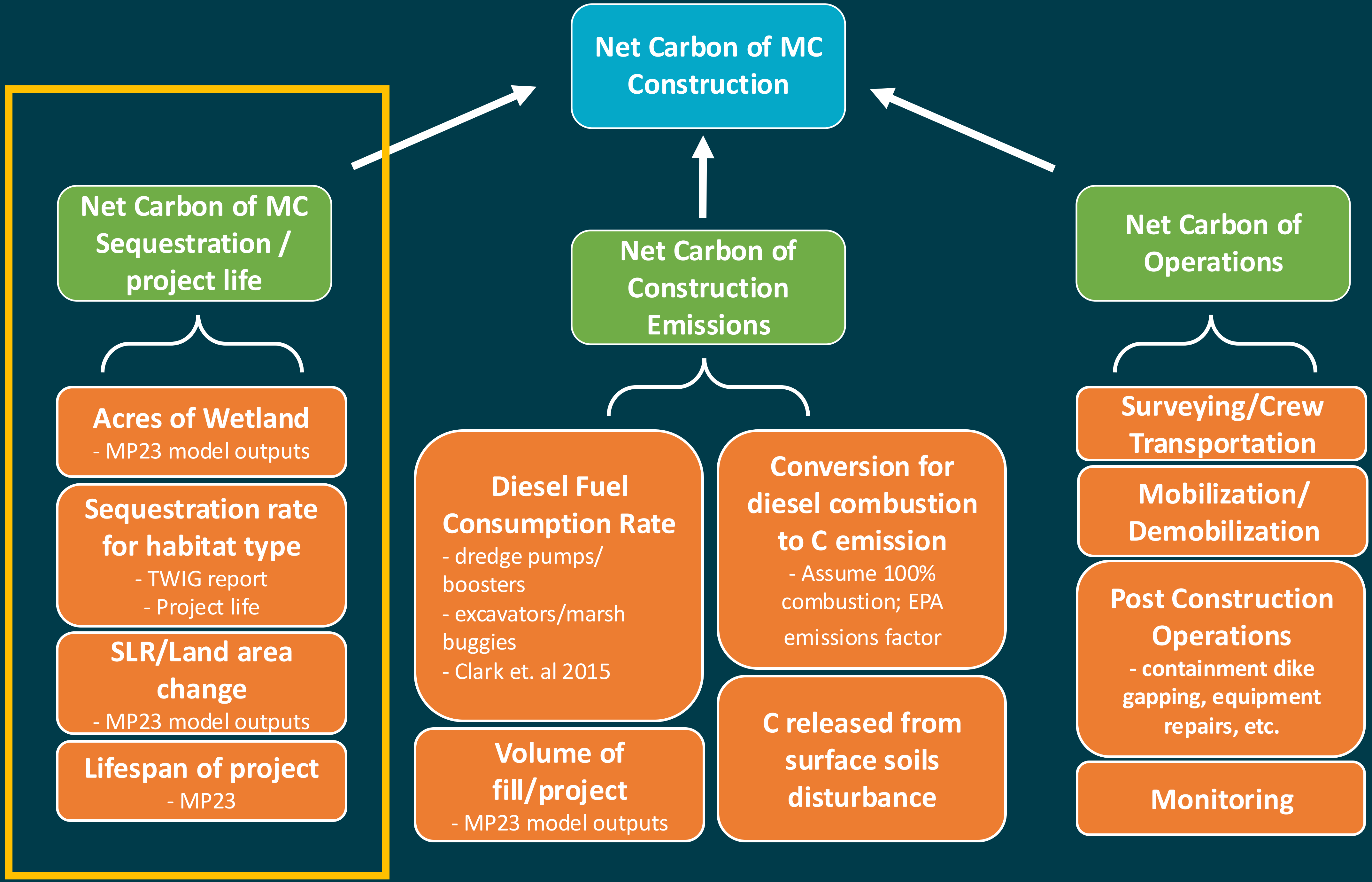

Natural Working Lands and Wetlands

This section includes three strategies to promote a comprehensive approach to action for natural sinks. Preservation and conservation of natural lands seek to increase sequestration potential of Louisiana's lands and forests. Regenerative and sustainable agriculture practices of working lands seeks to reduce emissions and enhance sequestration of farming, ranching, and forestry lands. Wetlands promote efforts of the Coastal Master Plan and increased sequestration capacity of wetlands. Across these three strategies, the section aims to maximize climate mitigation and adaptation goals simultaneously, understanding that resilience and flood risk must be maximized in how Louisiana protects our lands for sequestration potential and comprehensive ecosystem benefits.

- STRATEGY 14: Preserve and expand natural lands and urban green spaces to maximize climate mitigation and adaptation goals
- STRATEGY 15: Restore and conserve Louisiana's coastal wetlands to maximize climate mitigation and adaptation goals
- STRATEGY 16. Support the sustainable management and conservation of working agricultural and forestry lands

Louisiana Climate Action Plan, 2022 87
NATURAL WORKING LANDS AND WETLANDS


Net Carbon of MC Construction
Net Carbon of MC Sequestration / project life
Net Carbon of Construction Emissions
Net Carbon of Operations
Acres of Wetland
- MP23 model outputs
Sequestration rate for habitat type
- TWIG report
- Project life
SLR/Land area change
- MP23 model outputs
Lifespan of project
- MP23
Diesel Fuel Consumption Rate
- dredge pumps/ boosters
- excavators/marsh buggies
- Clark et. al 2015
Volume of fill/project
- MP23 model outputs
Conversion for diesel combustion to C emission
- Assume 100% combustion; EPA emissions factor
C released from surface soils disturbance
Surveying/Crew Transportation
Mobilization/ Demobilization
Post Construction Operations
- containment dike gapping, equipment repairs, etc.
Monitoring



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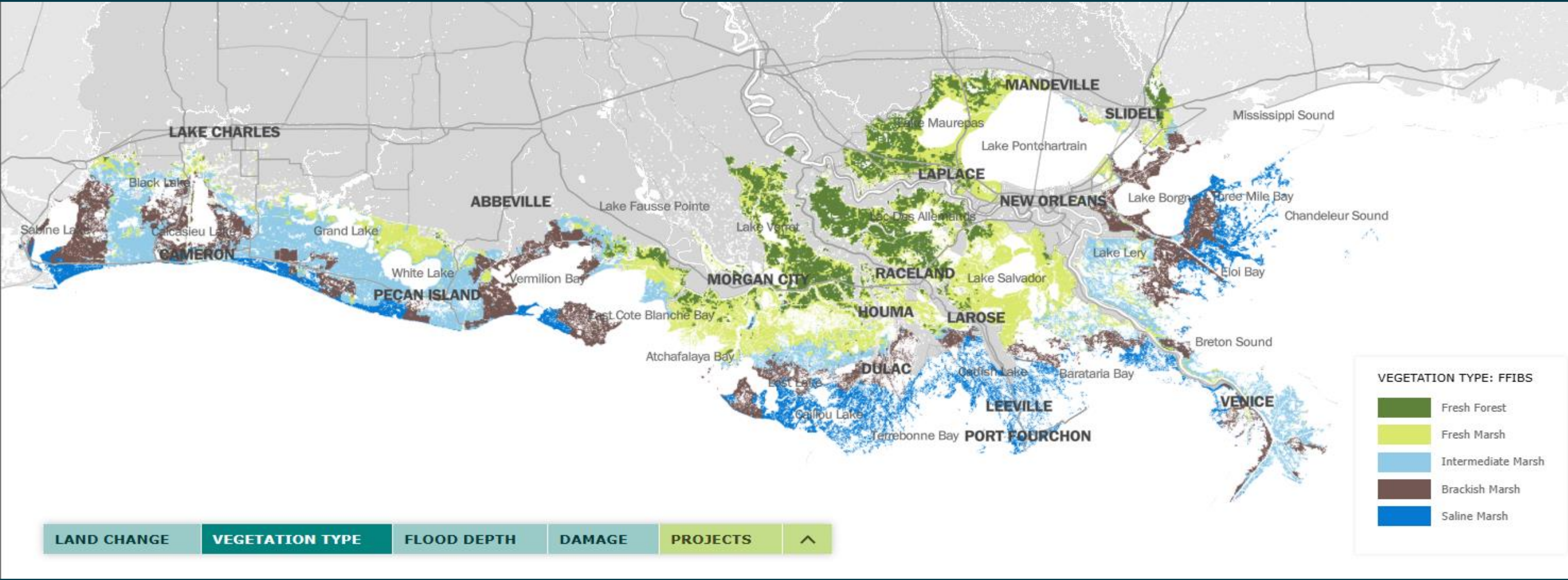
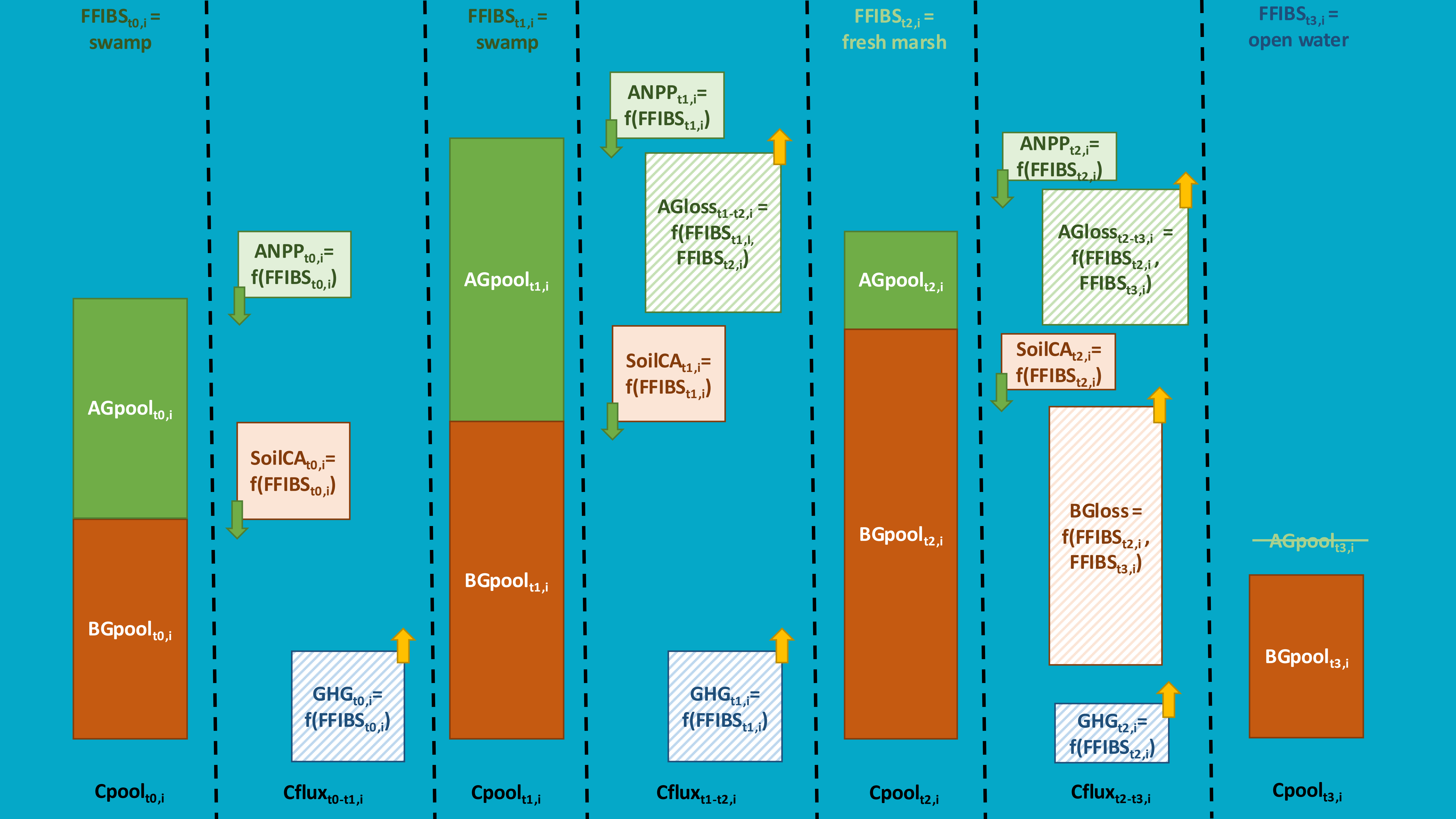
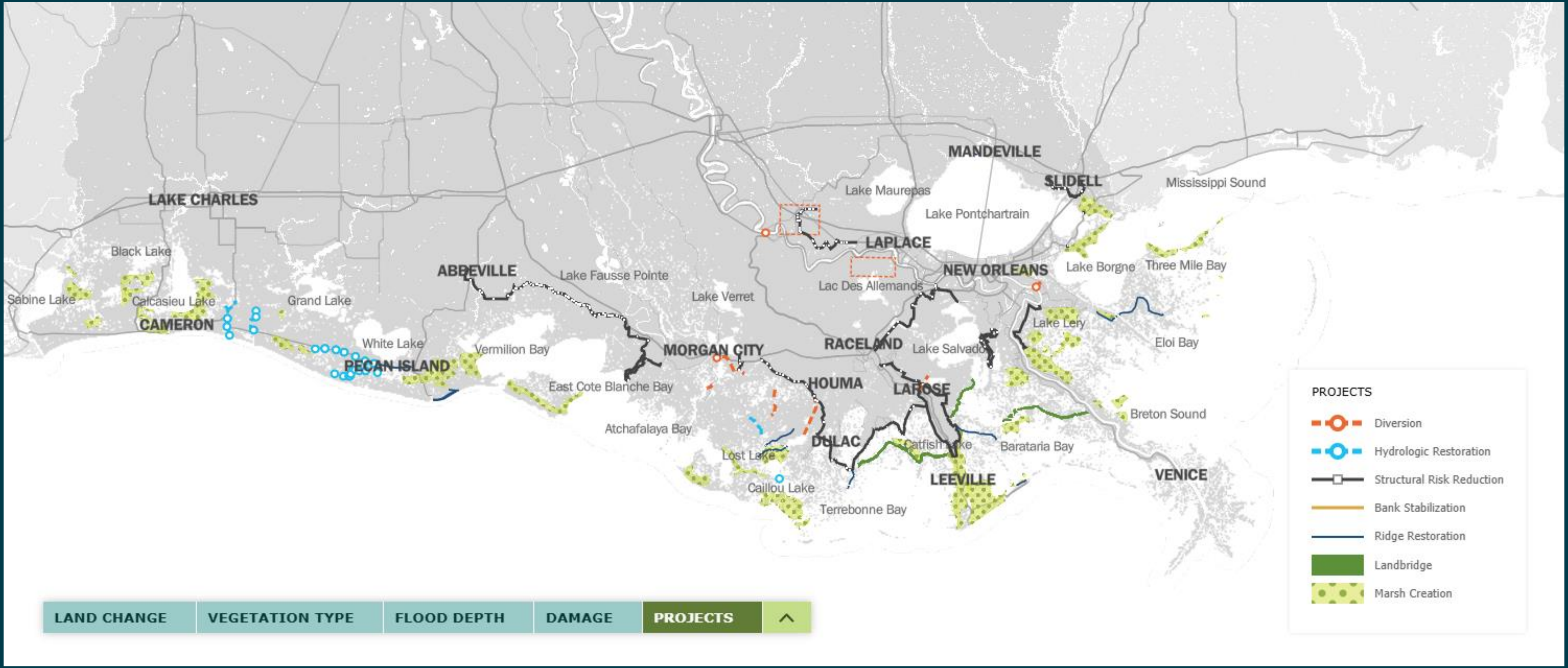
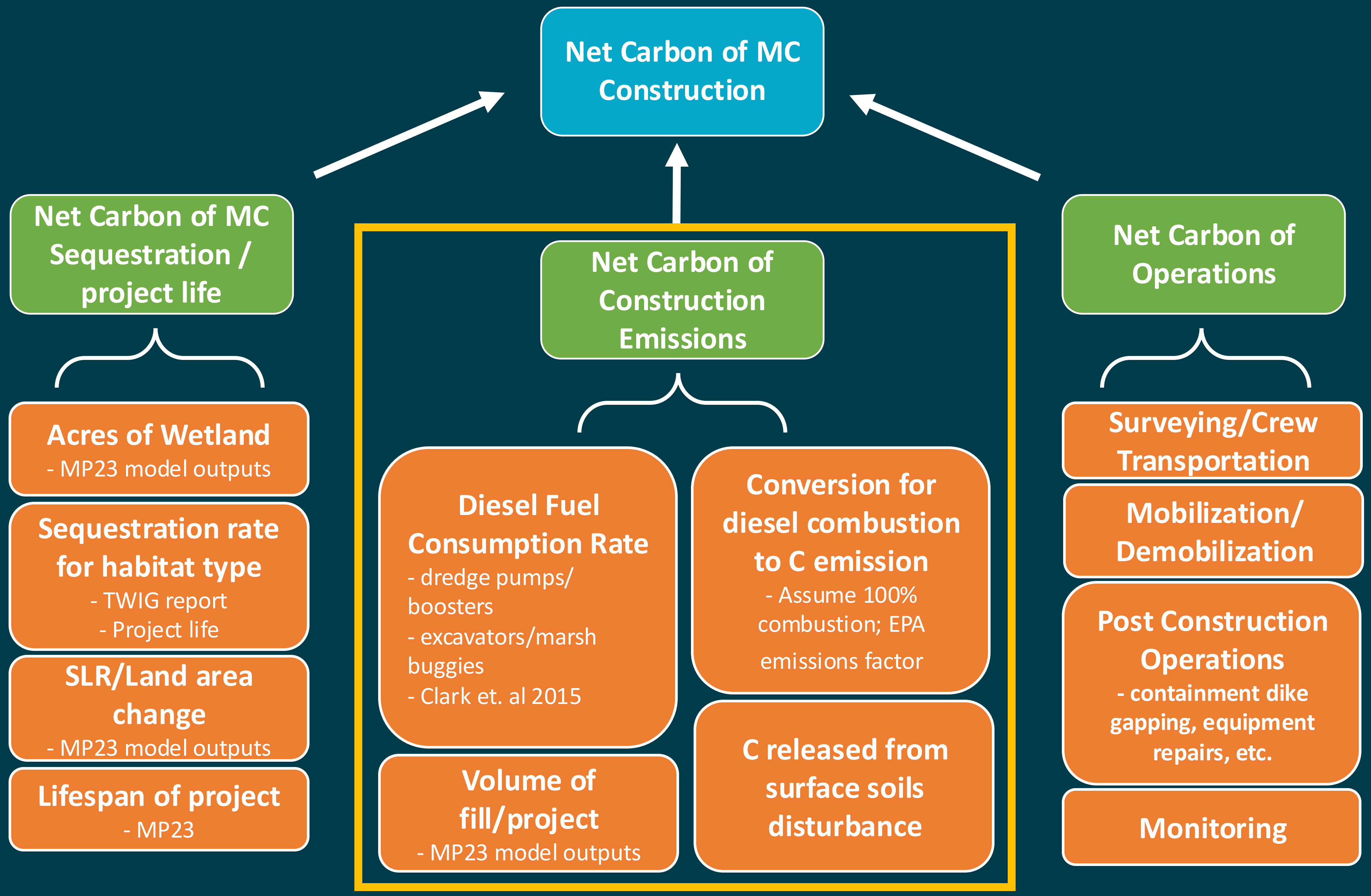
Utilizing Master Plan Modeling




FFIBS$_{t0,i}$ = swamp
AGpool$_{t0,i}$
BGpool$_{t0,i}$
Cpool$_{t0,i}$
ANPP$_{t0,i}$= f(FFIBS$_{t0,i}$)
SoilCA$_{t0,i}$= f(FFIBS$_{t0,i}$)
GHG$_{t0,i}$= f(FFIBS$_{t0,i}$)
Cflux$_{t0-t1,i}$
FFIBS$_{t1,i}$ = swamp
AGpool$_{t1,i}$
BGpool$_{t1,i}$
Cpool$_{t1,i}$
ANPP$_{t1,i}$= f(FFIBS$_{t1,i}$)
AGloss$_{t1-t2,i}$ = f(FFIBS$_{t1,I}$, FFIBS$_{t2,i}$)
SoilCA$_{t1,i}$= f(FFIBS$_{t1,i}$)
GHG$_{t1,i}$= f(FFIBS$_{t1,i}$)
Cflux$_{t1-t2,i}$
FFIBS$_{t2,i}$ = fresh marsh
AGpool$_{t2,i}$
BGpool$_{t2,i}$
Cpool$_{t2,i}$
ANPP$_{t2,i}$= f(FFIBS$_{t2,i}$)
AGloss$_{t2-t3,i}$ = f(FFIBS$_{t2,i}$, FFIBS$_{t3,i}$)
SoilCA$_{t2,i}$= f(FFIBS$_{t2,i}$)
BGloss = f(FFIBS$_{t2,i}$, FFIBS$_{t3,i}$)
GHG$_{t2,i}$= f(FFIBS$_{t2,i}$)
Cflux$_{t2-t3,i}$
FFIBS$_{t3,i}$ = open water
AGpool$_{t3,i}$
BGpool$_{t3,i}$
Cpool$_{t3,i}$

Implementing Master Plan Projects

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Dike Construction

Equation 1: $Dike_{Mob} = \sum((\text{vessel days})*(\text{fuel volume/vessel day})*(\text{fuel-type carbon conversion}))_{vessel}$

Equation 2: $Dike_{Build} = \sum((\text{vehicle days})*(\text{fuel volume/vehicle day})*(\text{fuel-type carbon conversion}))_{vehicle}$

Equation 3: $Dike = Dike_{Mob} + Dike_{Build}$

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Dredge Operation

Equation 4: $Dredge_{Mob} = \sum((\text{vessel days}) * (\text{fuel volume/vessel day}) * (\text{fuel-type carbon conversion}))_{vessel}$

Equation 5: $Dredge_{Dig} = (\sum((\text{vessel days}) * (\text{fuel volume/vessel day}) * (\text{fuel-type carbon conversion}))_{vessel}) + ((\#\text{boosters}) * (\text{booster days}) * (\text{fuel volume/booster day}) * (\text{fuel-type carbon conversion}))$

Equation 6: $Dredge = Dredge_{Mob} + Dredge_{Dig}$

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Material Placement

Equation 7: $Place_{Mob} = \sum((\text{vessel days})*(\text{fuel volume/vessel day})*(\text{fuel-type carbon conversion}))_{vessel}$

Equation 8: $Place_{Build} = \sum((\text{vehicle days})*(\text{fuel volume/vehicle day})*(\text{fuel-type carbon conversion}))_{vehicle}$

Equation 9: $Place = Place_{Mob} + Place_{Build}$

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Equation 9: $Place = Place_{Mob} + Place_{Build}$

Equation 10: $Project = Dike + Dredging + Place$

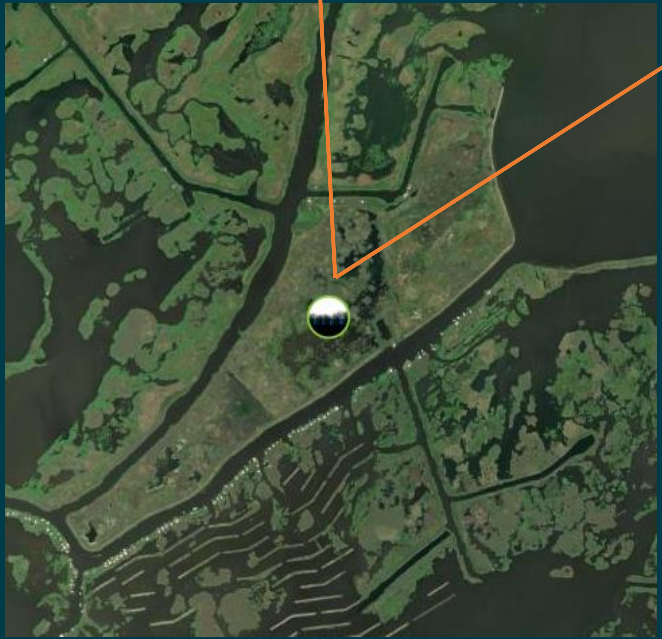
1st order accounting

Diesel Consumption Rate			
TE-138	Dredging (18")	0.22	**gal/yd^3**
	Dike	1.24	**gal/LF**
BA-171	Dredging (30")	0.17	**gal/yd^3**
PO-75	Dredging (30")	0.09	**gal/yd^3**

Diesel Combustion Rate
10.21 kg CO2 / gal

Carbon Emissions Rate			
TE-138	Dredging (18")	2.26	**kg CO2/ yd^3 sed**
	Dike	12.63	**kg CO2/ yd^3 sed**
BA-171	Dredging (30")	1.72	**kg CO2/ yd^3 sed**
PO-75	Dredging (30")	0.91	**kg CO2/ yd^3 sed**

TE-138 Lake Decade MC



Dike	MT/LF	0.01
	LF	34301
	TOTAL	1,022.56
Dredge	MT/CY	0.002
	CY	2,250,454.00
	TOTAL	5,075.67
Construction CO2 Emissions		**6,098 MT**

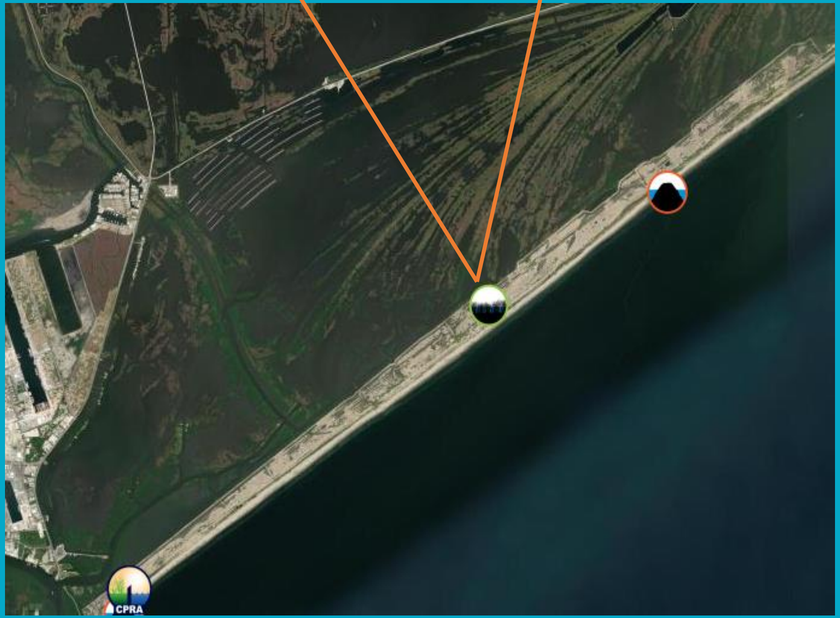
\+

Marsh Class:	Intermediate	
Project Acres:	473	acres
Surface Soil C:	-3,350	MT

=

1st ORDER PROJECT NET C		
Net C	2748	MT

BA-171 Caminada Back Barrier Headlands



Dike	MT/LF	-
	LF	-
	TOTAL	-
Dredge	MT/CY	0.0017
	CY	2,151,196.00
	TOTAL	3,705.89
Construction CO2 Emissions		**3,706 MT**

+

Marsh Class:	Saline	
Project Acres:	928	acres
Surface Soil C:	-8,516	MT

=

1st ORDER PROJECT NET C		
Net C	-4,810	MT

PO-75 LaBranche East MC

Dike	MT/LF	-
	LF	-
	TOTAL	-
Dredge	MT/CY	0.0009
	CY	6,658,106.00
	TOTAL	6,028
Construction CO_2 Emissions		**6,028 MT**

+

Marsh Class:	Saline	
Project Acres:	473	acres
Surface Soil C:	-10,036	MT

=

1st ORDER PROJECT NET C		
Net C	-4,008	MT

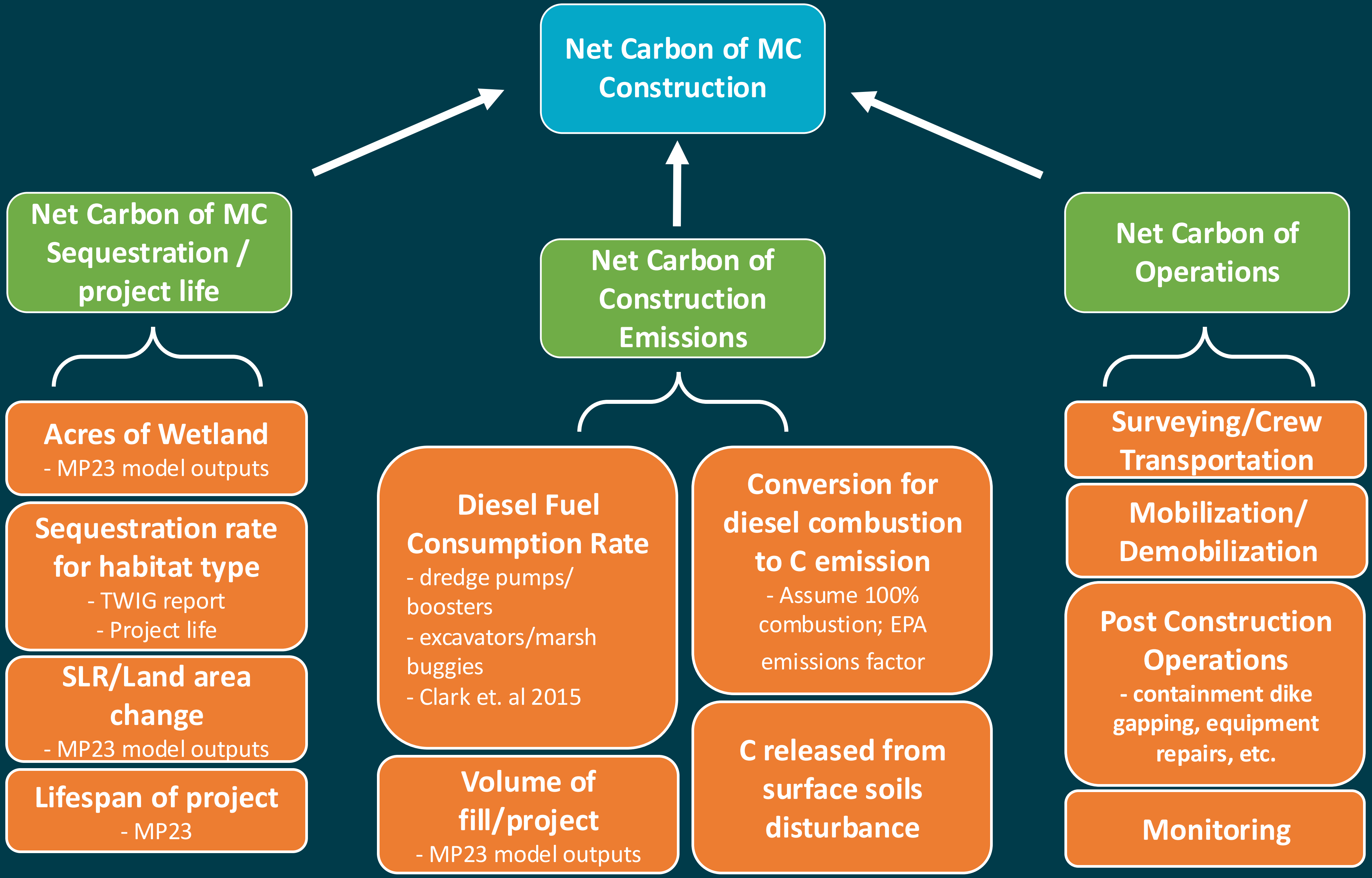
Conclusions

- Potential for some marsh creation projects to generate carbon credits

- Estimating carbon emissions from project construction require tedious accounting of diesel consumption

- Other considerations play large role in diesel consumption
  - Larger polygons + consistent dredge operations = ↑ efficiency = ↓ emmissions
  - Source material
  - Pump distance

- Current data sets are enough for 1st order estimates, but may not be sufficient for accreditation – need clarification from accreditors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Conceptual Carbon Budget Model for the ICM

Carbon budget for an ICM wetland pixel* *i*, from year *t* to *t+1*

Above-ground carbon pool, $AGpool_{t,i}$ [tonnes CO_{2e}]:

$$AGpool_{t+1,i} = AGpool_{t,i} + ANPP_{t,i}\,\Delta t + AGloss_{t\text{-}t+1,i}$$

Below-ground carbon pool in top 1-m of soil, $BGpool_{t,i}$ [tonnes CO_{2e}]:

$$BGpool_{t+1,i} = BGpool_{t,i} + SoilAC_{t,i}\,\Delta t + BGloss_{t\text{-}t+1,i}$$

** Note that this is currently a carbon budget solely for wetland pixels – there is currently no framework for handling carbon in water bodies. Nor is there any mechanism for carbon flux from soil to water; all fluxes are currently assumed to be atmospheric.*

Carbon flux from an ICM wetland pixel *i*, between years *t* and *t+1*

Net carbon flux, $Cflux_{t\text{-}t+1,i}$ [tonnes CO_{2e} / yr]:

Sign convention for flux equation is positive values are emitted *into* atmosphere.

$$Cflux_{t\text{-}t+1,i} = GHGflux_{t,i} + [\,GHGchange_{t\text{-}t+1,i} - (AGpool_{t+1,i} - AGpool_{t,i}) - (BGpool_{t+1,i} - BGpool_{t,i})\,]/\Delta t$$

Lookup variables based on vegetation cover (FFIBS) of ICM wetland pixel, *i*

Above-ground net primary productivity rate, $ANPP_{t,i}$ [tonnes CO_{2e} / yr]:

$$ANPP_{t,i} = f(FFIBS_{t,i})$$

Above-ground biomass loss due to vegetative cover change between years *t* and *t+1*, $AGloss_{t\text{-}t+1,i}$ [tonnes CO_{2e}]:

$$AGloss_{t\text{-}t+1,i} = f(FFIBS_{t,i}, FFIBS_{t+1,i})$$

example of AGloss would be the biomass loss when swamp forest dies and leaves ghost trees behind

Below-ground soil carbon accumulation rate, $SoilAC_{t,i}$ [tonnes CO_{2e} / yr]:

$$SoilAC_{t,i} = f(FFIBS_{t,i})$$

Below-ground carbon loss due to vegetative cover change between years *t* and *t+1*, $BGloss_{t\text{-}t+1,i}$ [tonnes CO_{2e}]:

$$BGloss_{t\text{-}t+1,i} = f(FFIBS_{t,i}, FFIBS_{t+1,i})$$

Greenhouse gas emissions rate from wetland processes for year *t*, $GHGflux_{t,i}$ [tonnes CO_{2e} / yr]:

$$GHGflux_{t,i} = f(FFIBS_{t,i})$$

Greenhouse gas emissions from land/cover change processes from year *t* to *t+1*, $GHGchange_{t\text{-}t+1,i}$ [tonnes CO_{2e}]:

$$GHGchange_{t\text{-}t+1,i} = f(FFIBS_{t,i}, FFIBS_{t+1,i})$$

example of GHGchange would be the GHG emissions from project construction (e.g., diesel for dredging)