Reimagining Our Stormwater Drains:
Cost Effective Restoration with Multiple Benefits

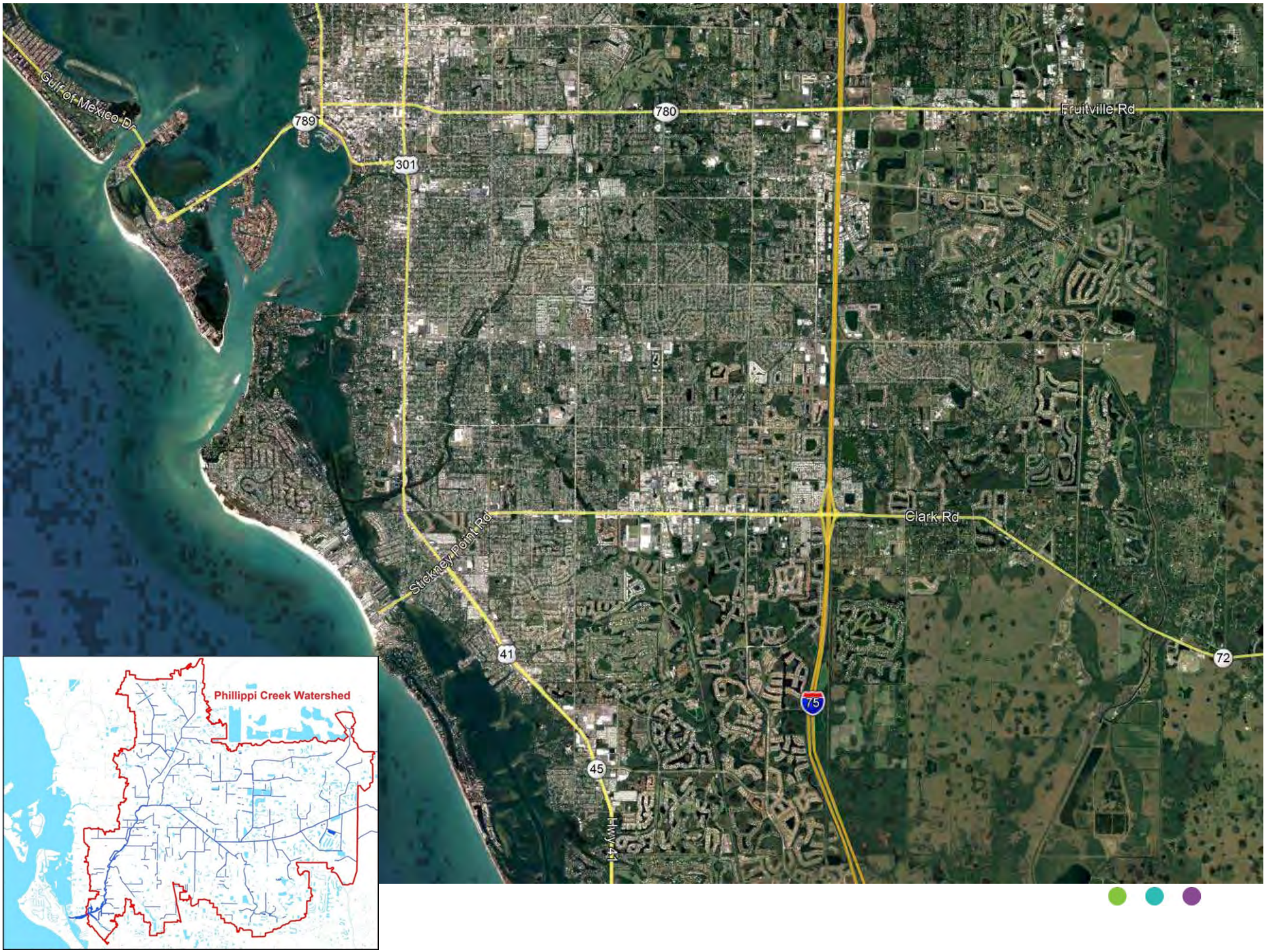
Phillippi Creek Canals

Sarasota County, Florida

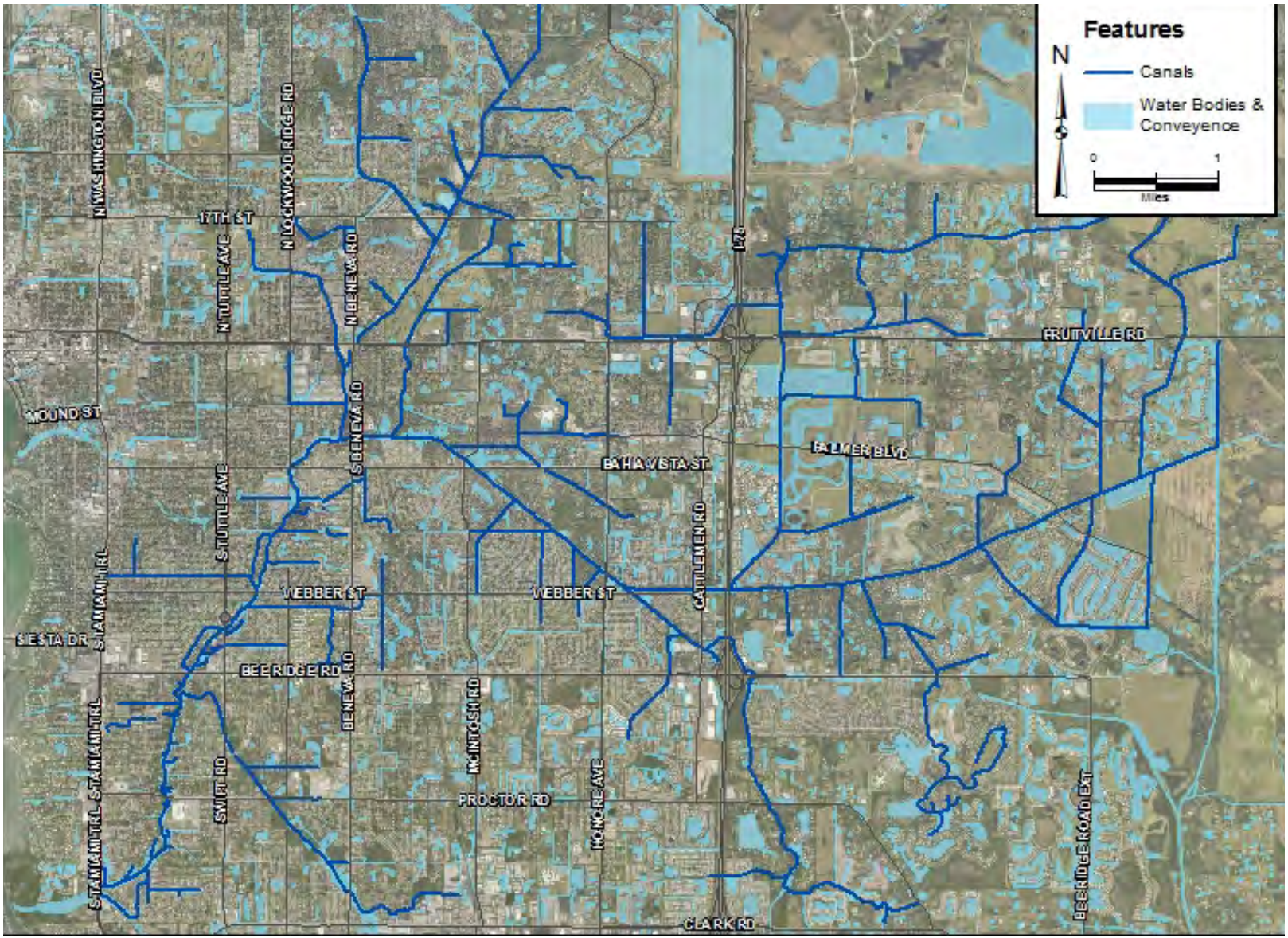
Stormwater Environmental Utility (SEU)

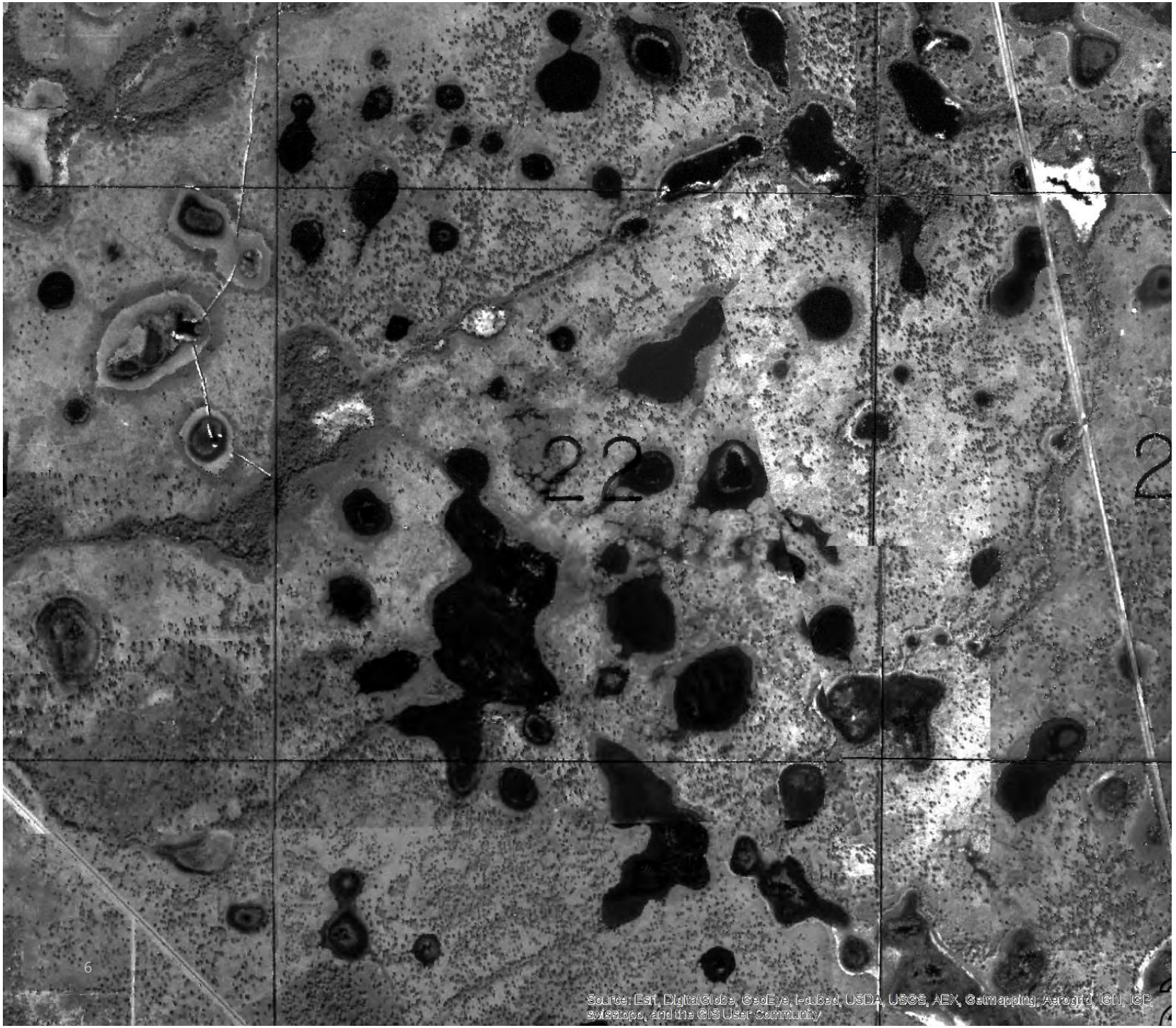
John Kiefer, PhD, PE, PWS
john.kiefer@woodplc.com

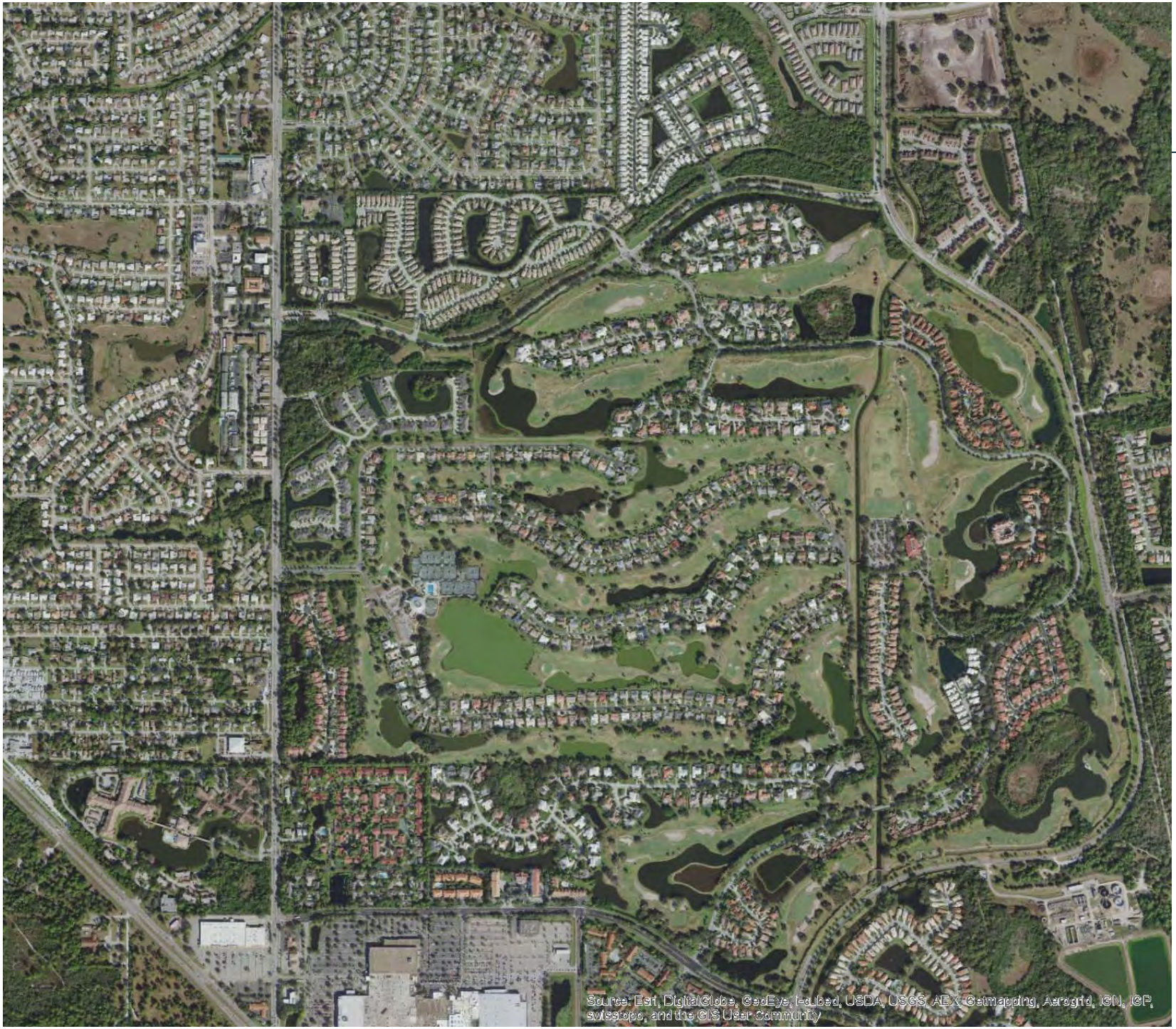
woodplc.com


Gulf of Mexico Dr
789
301
780
Fruitville Rd
Clark Rd
Stickney Point Rd
41
45
Hwy 41
75
72
Phillippi Creek Watershed


Sarasota 2018


Features
N
Canals
Water Bodies & Conveyence
0
1
Miles
N WASHINGTON BLVD
17TH ST
N LOCKWOOD RIDGE RD
N TUTTLE AVE
N BENEVA RD
I-75
FRUITVILLE RD
WOUND ST
S BENEVA RD
BAHIA VISTA ST
PALMER BLVD
S TUTTLE AVE
CATTLEMEN RD
S TAMIAMI TRL
WEBBER ST
WEBBER ST
SIESTA DR
BEERIDGE RD
BENEVA RD
MCINTOSH RD
SWIFT RD
PROCTOR RD
MCMORE AVE
S TAMIAMI TRL
S TAMIAMI TRL
BEERIDGE ROAD EXT
CLARK RD


22
2
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community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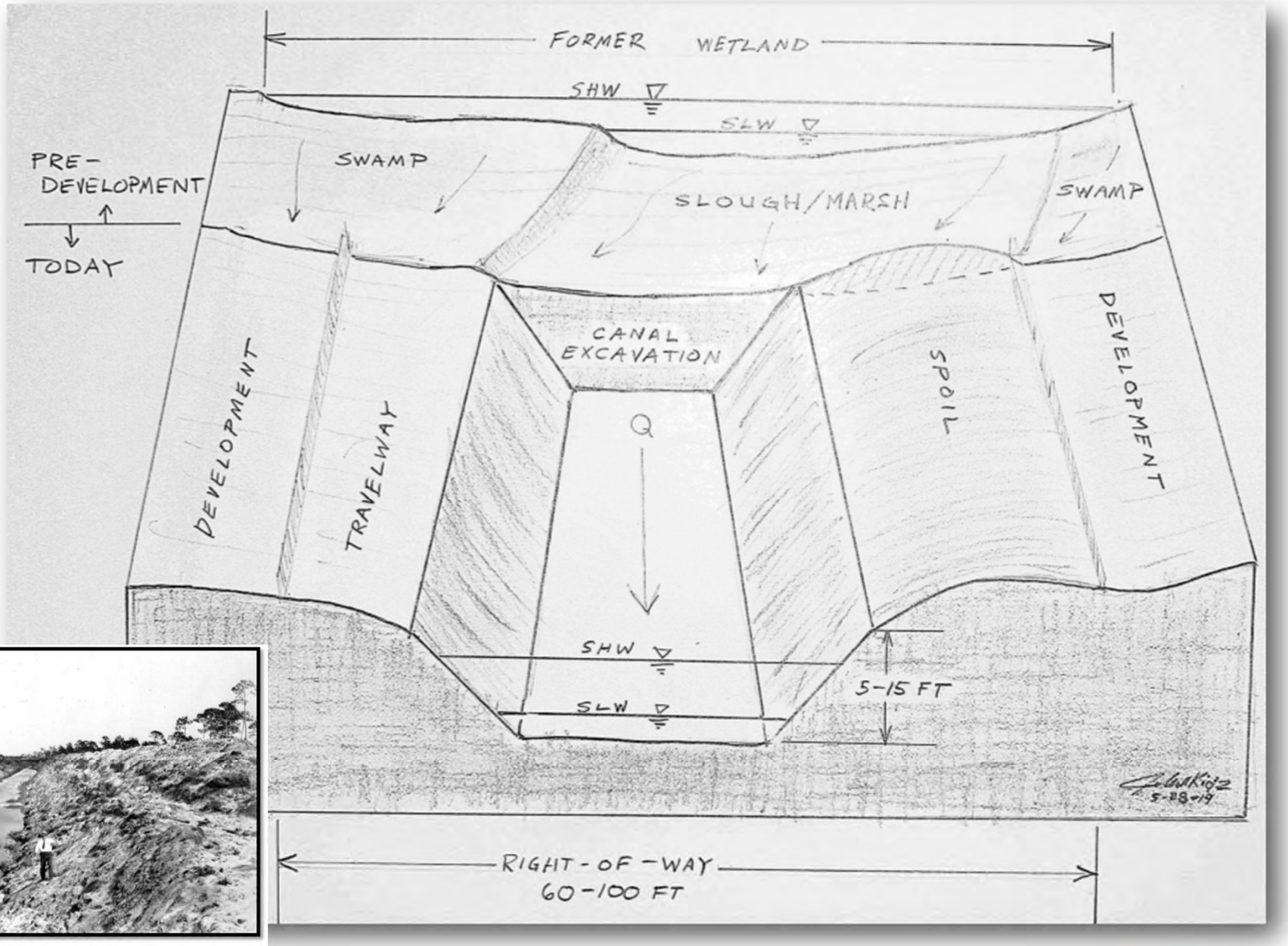
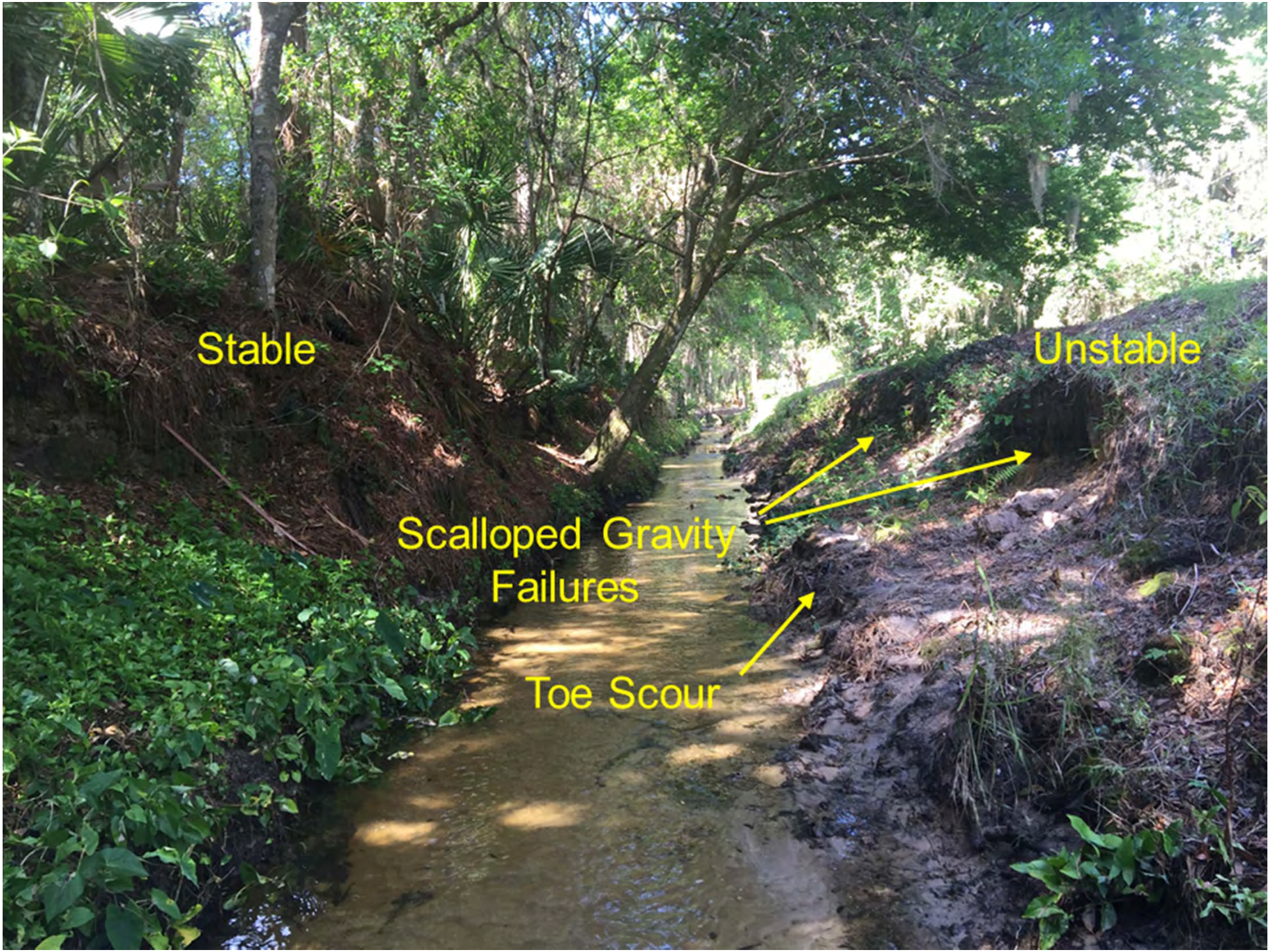


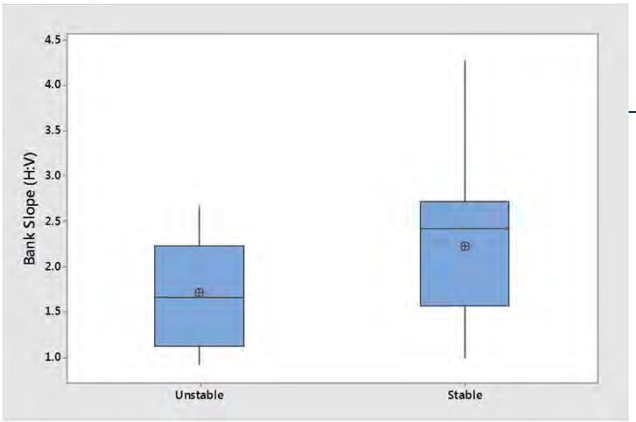
Phillippi Creek canal - east of Sarasota. 1929.

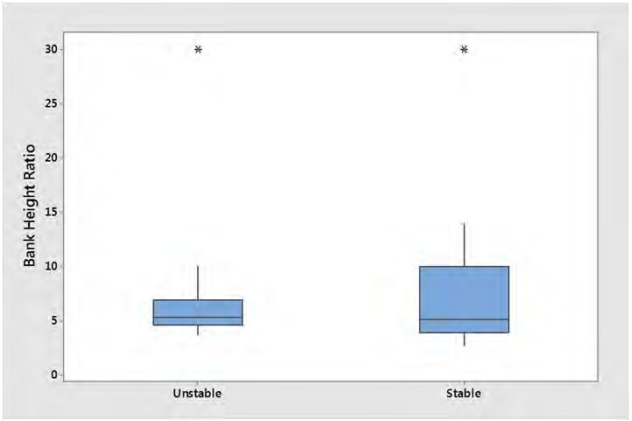
Simpson, G. G. Black & white photonegative, 4 x 5 in. State Archives of Florida, Florida Memory. <https://www.floridamemory.com/items/show/125094>

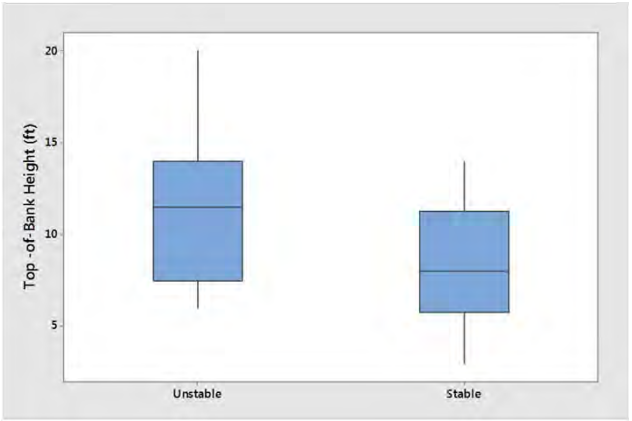
Manatee
Sarasota
North Sarasota
Beverley Terrace
Lakes
The Meadows
Sarasota
Pinecraft
Fruitville
Bellaire
Fordville
Sarasota Heights
Hyde Park
Sarasota Springs
South Trail
South Sarasota
Ridge Wood Heights
South Gate Ridge
Bee Ridge
Lake Sarasota
SIESTA KEY
Gulf Gate
Total Count of Maintenace Work Orders
1 - 9
10 - 19
20 - 29
30 - 39
40 - 49
50 - 59
> 59
Canals
N
0 2,500 5,000 Feet


Shallow Plane Failures
Variably Stable Toe

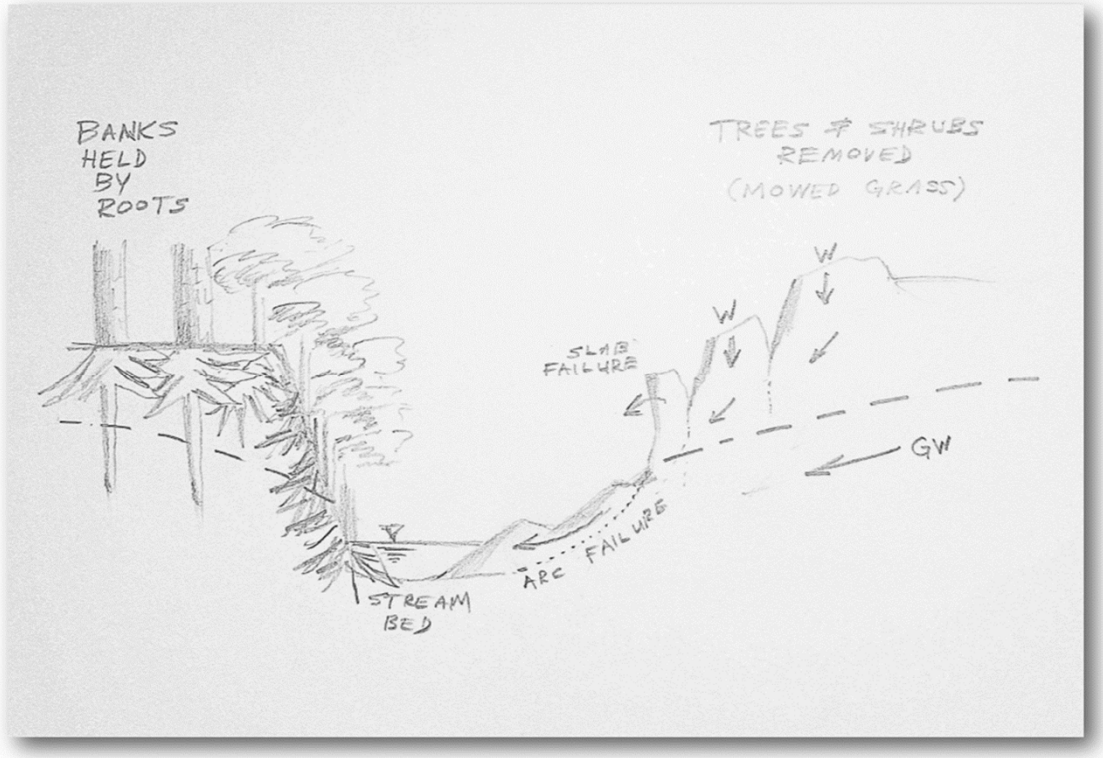

Stable
Unstable
Scalloped Gravity Failures
Toe Scour







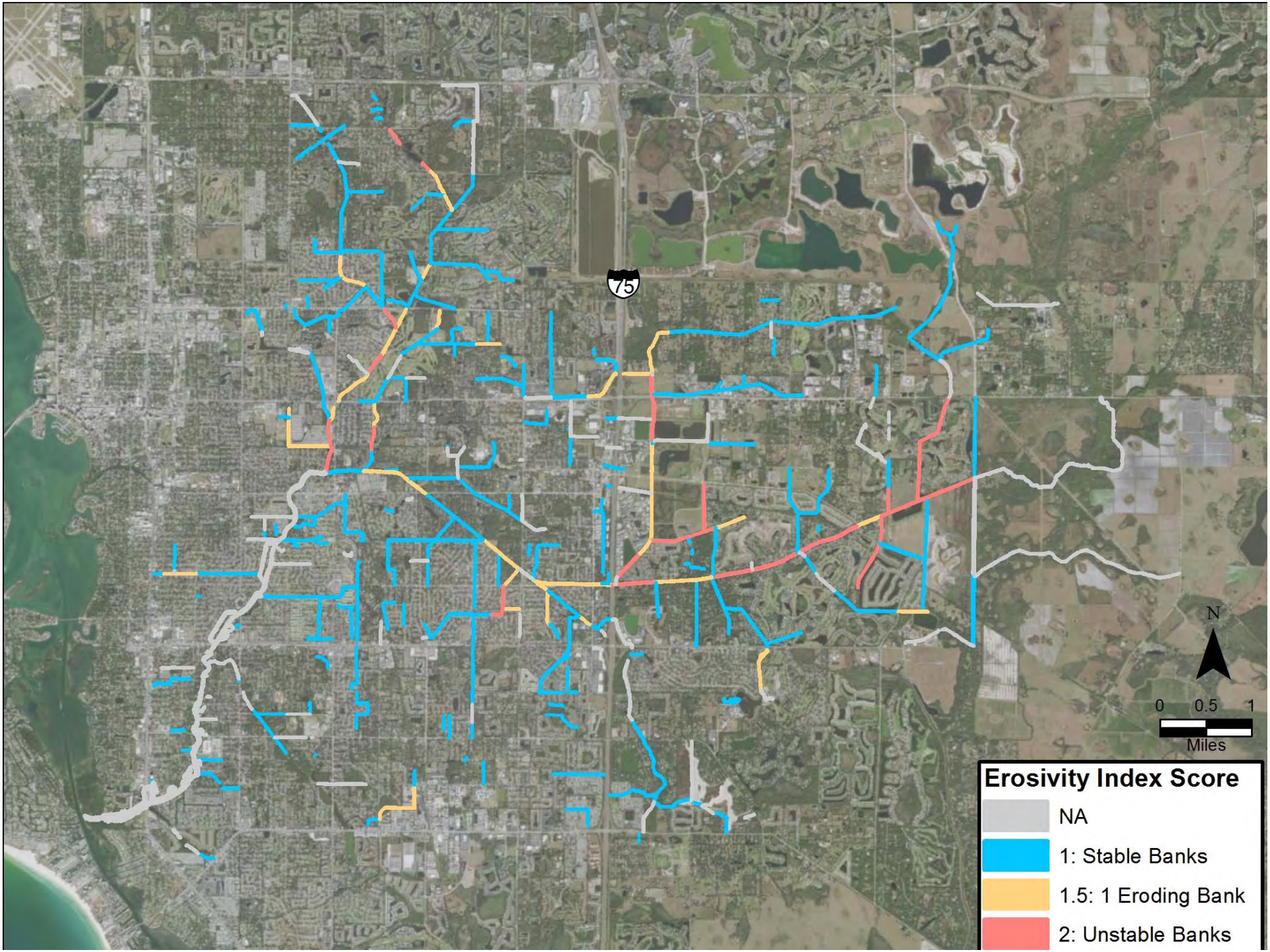
	Stable	Unstable	Total
Mowed	1	10	11
Woody	13	1	14
Total	14	11	25

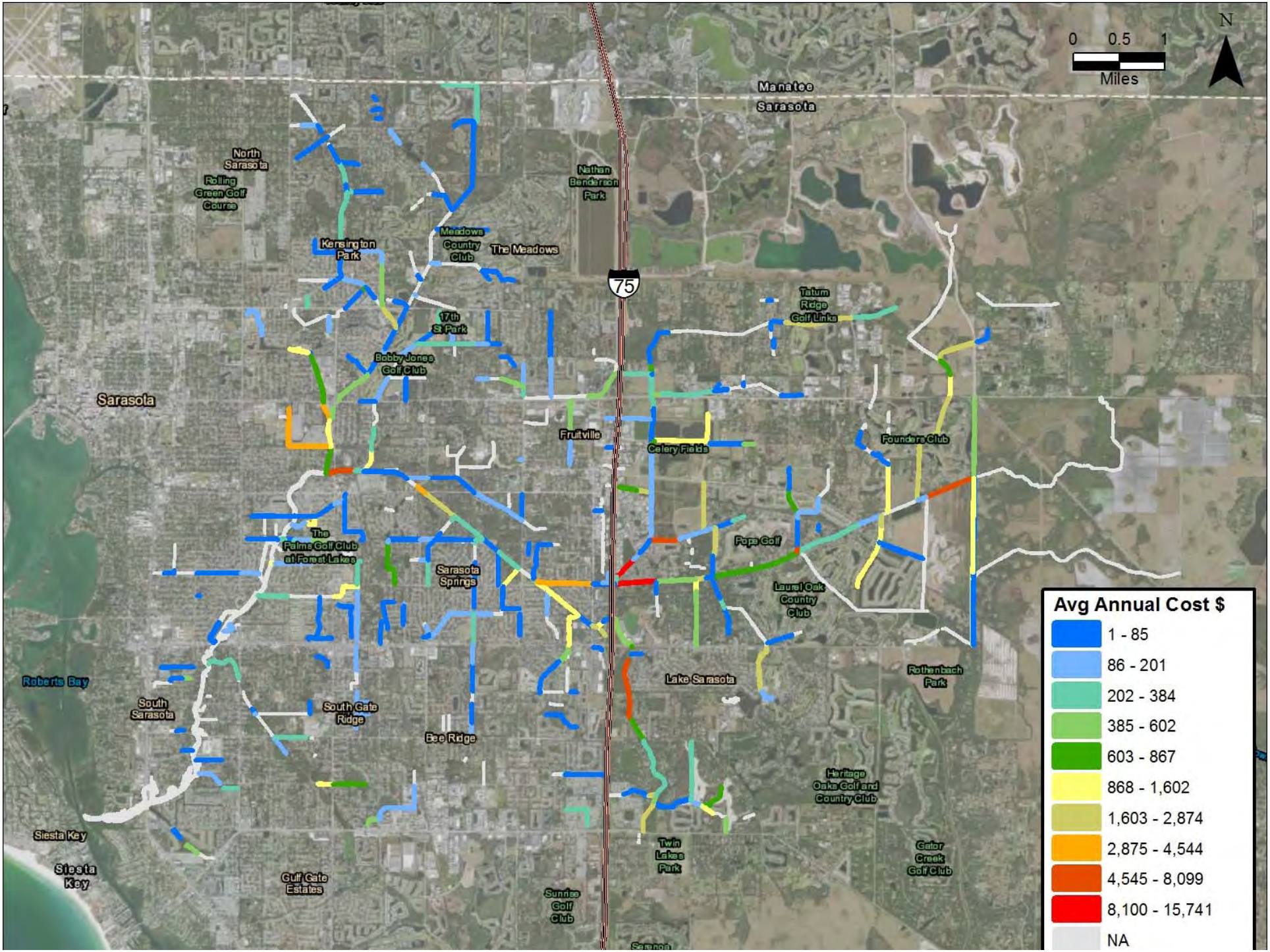


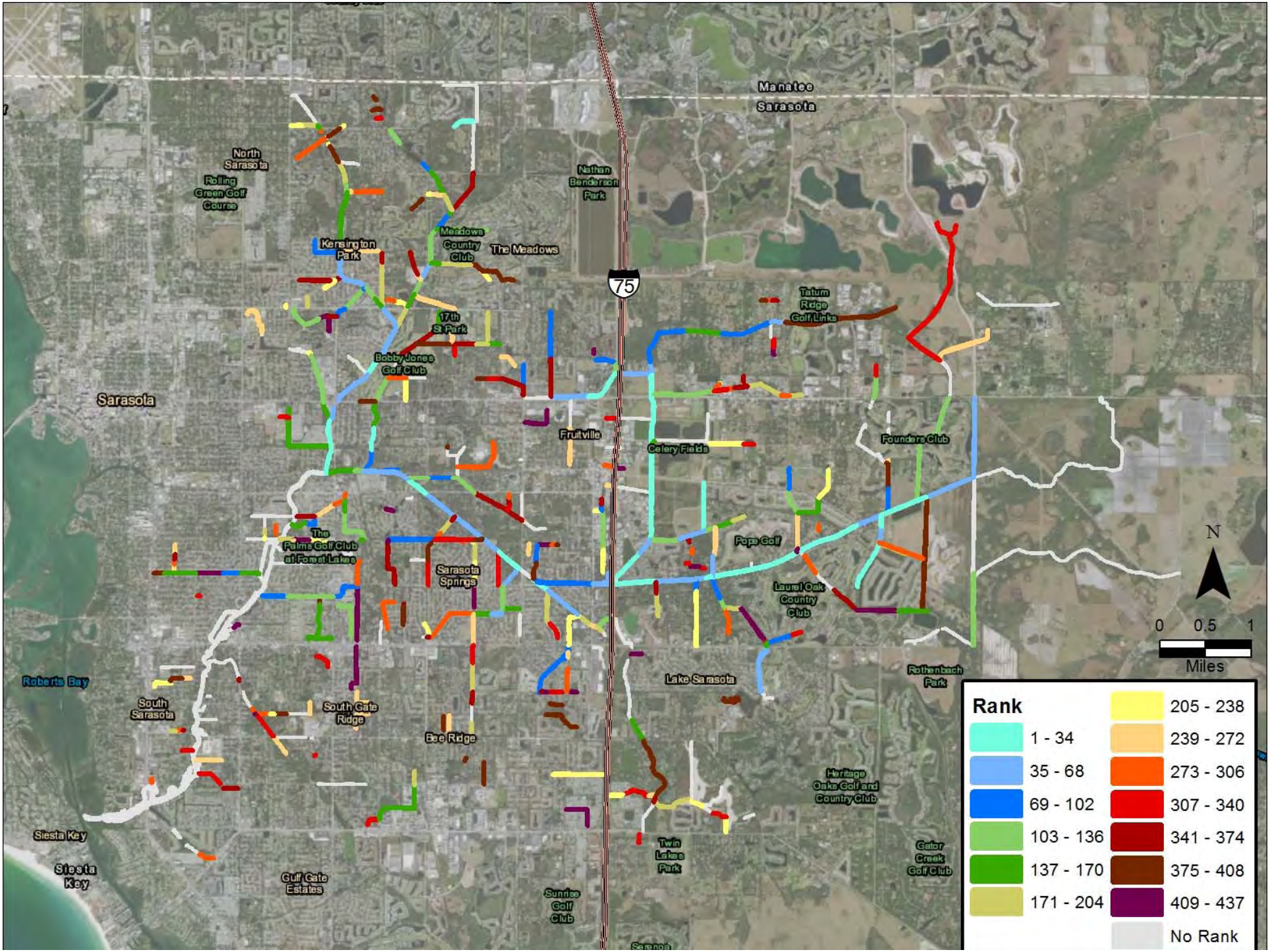

Uniform water depth over soft sand bed

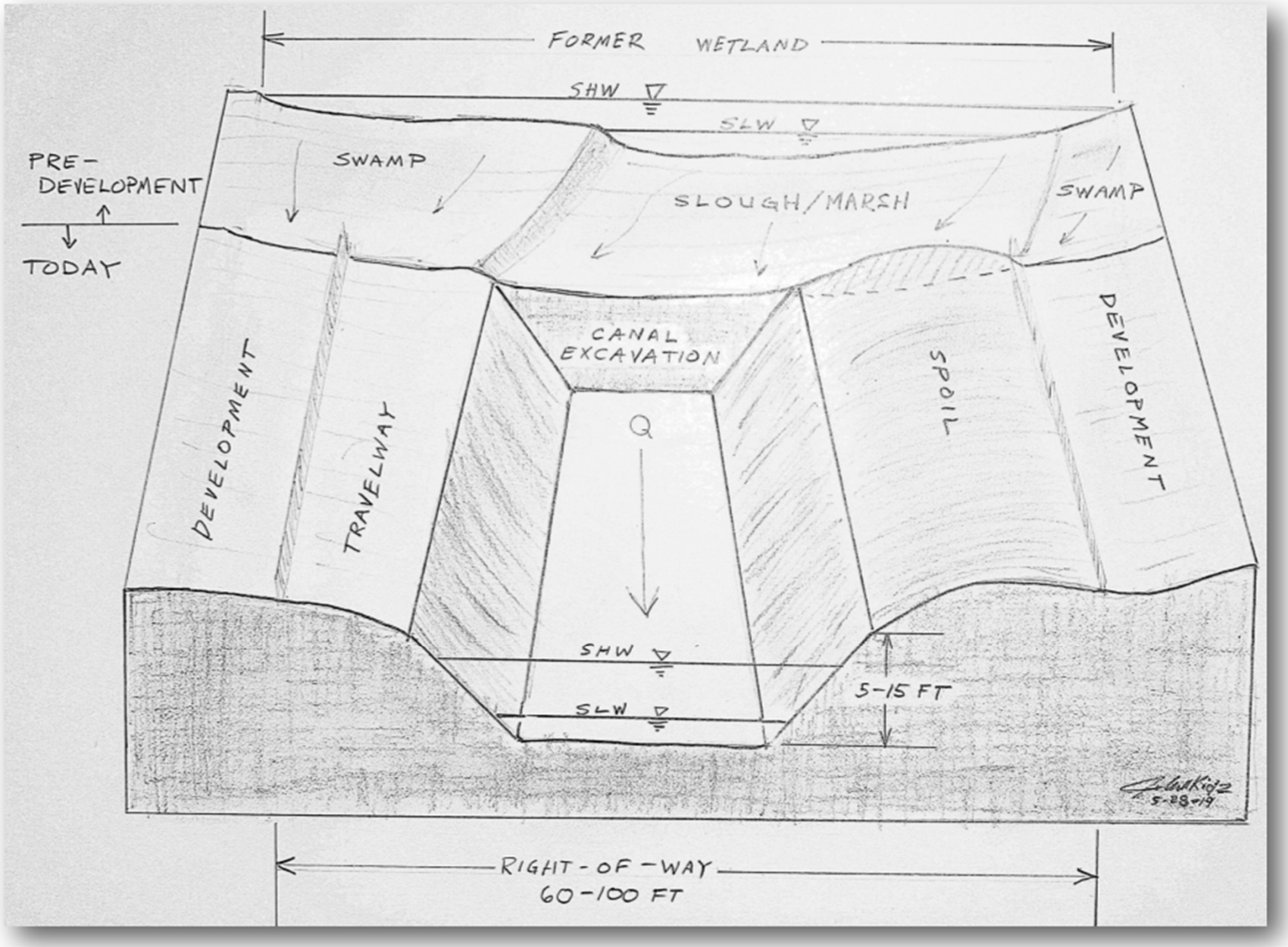

Leading edge of sediment plume moving downstream

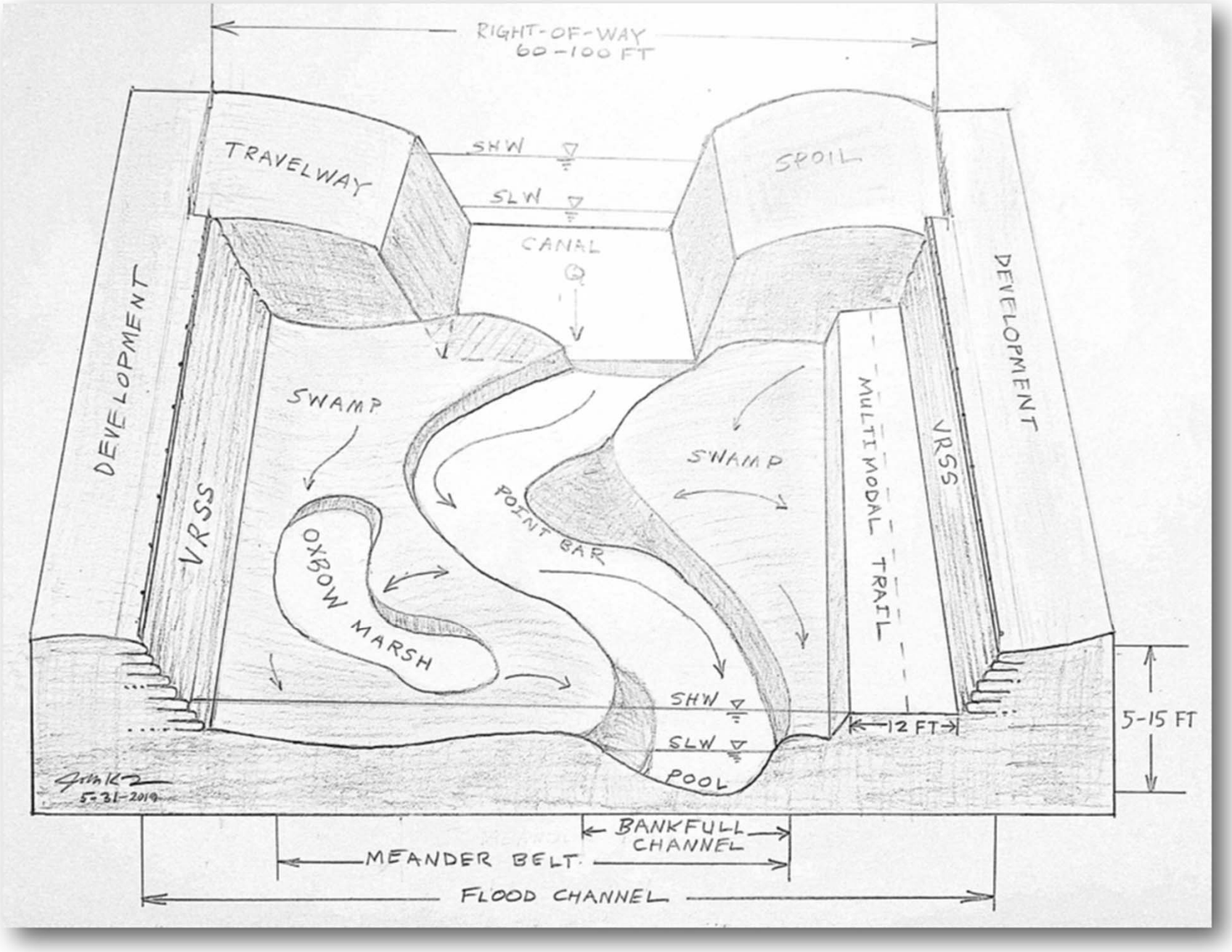

emotion
AdvantEdge

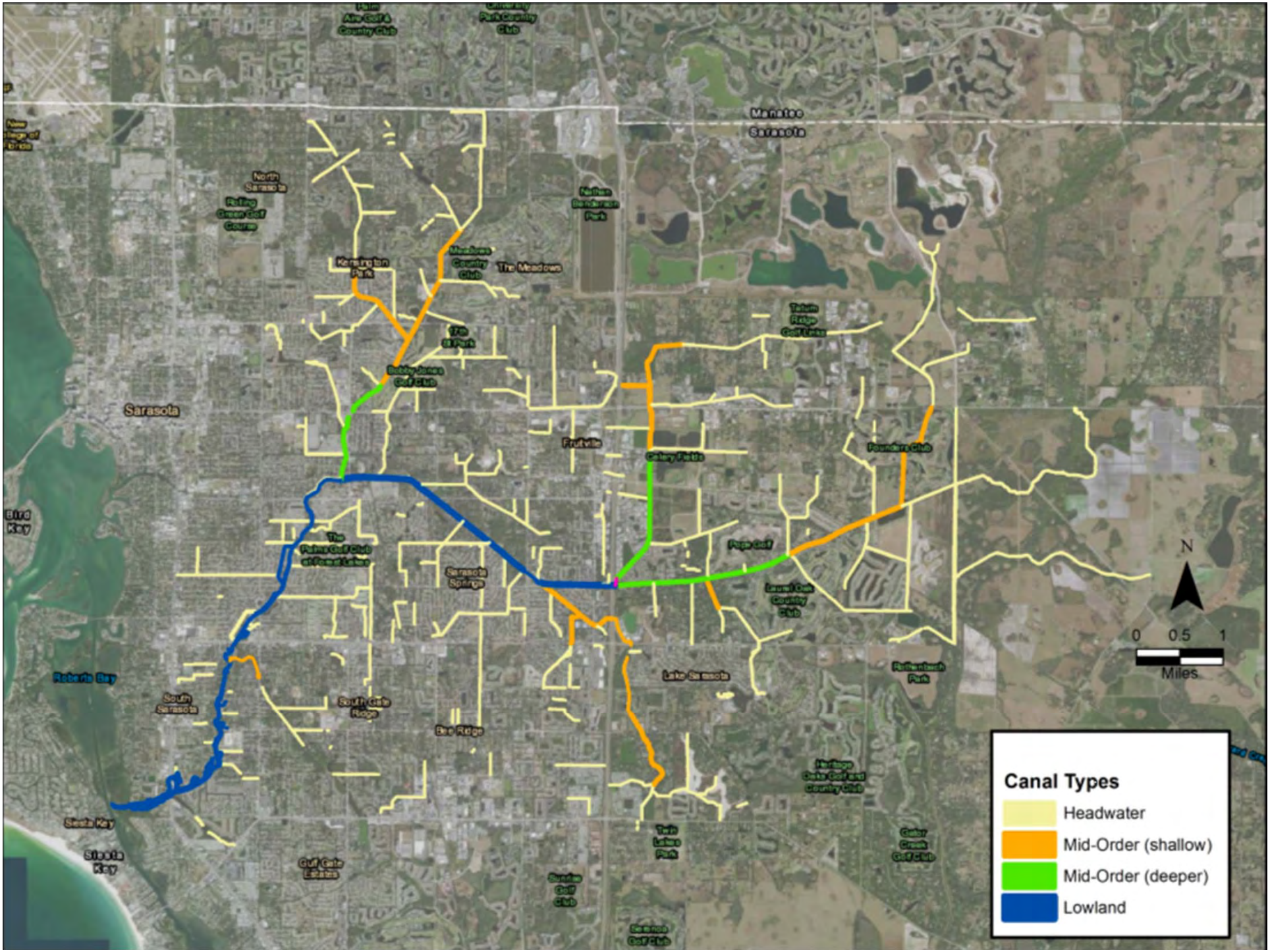

75
N
0 0.5 1
Miles
Erosivity Index Score
NA
1: Stable Banks
1.5: 1 Eroding Bank
2: Unstable Banks


0 0.5 1
Miles
N
Manatee
Sarasota
North Sarasota
Rolling Green Golf Course
Nathan Benderson Park
Meadows Country Club
The Meadows
Kensington Park
75
Tatum Ridge Golf Links
17th St Park
Bobby Jones Golf Club
Sarasota
Fruitville
Celery Fields
Founders Club
The Palms Golf Club at Forest Lakes
Sarasota Springs
Pope Golf
Laurel Oak Country Club
Roberts Bay
South Sarasota
South Gate Ridge
Bee Ridge
Lake Sarasota
Rothenbach Park
Heritage Oaks Golf and Country Club
Siesta Key
Siesta Key
Gulf Gate Estates
Twin Lakes Park
Gator Creek Golf Club
Sunrise Golf Club
Avg Annual Cost $
1 - 85
86 - 201
202 - 384
385 - 602
603 - 867
868 - 1,602
1,603 - 2,874
2,875 - 4,544
4,545 - 8,099
8,100 - 15,741
NA


Manatee
Sarasota
North Sarasota
Rolling Green Golf Course
Nathan Benderson Park
Kensington Park
Meadows Country Club
The Meadows
75
Tatum Ridge Golf Links
17th St Park
Bobby Jones Golf Club
Sarasota
Fruitville
Celery Fields
Founders Club
The Palms Golf Club at Forest Lakes
Sarasota Springs
Pope Golf
Laurel Oak Country Club
N
0 0.5 1
Miles
Roberts Bay
South Sarasota
South Gate Ridge
Bee Ridge
Lake Sarasota
Rothenbach Park
Heritage Oaks Golf and Country Club
Siesta Key
Siesta Key
Gulf Gate Estates
Twin Lakes Park
Gator Creek Golf Club
Sunrise Golf Club
Rank
1 - 34
35 - 68
69 - 102
103 - 136
137 - 170
171 - 204
205 - 238
239 - 272
273 - 306
307 - 340
341 - 374
375 - 408
409 - 437
No Rank


FORMER WETLAND
SHW
SLW
PRE-DEVELOPMENT
TODAY
SWAMP
SLOUGH/MARSH
SWAMP
DEVELOPMENT
TRAVELWAY
CANAL EXCAVATION
Q
SPOIL
DEVELOPMENT
SHW
SLW
5-15 FT
5-28-19
RIGHT-OF-WAY
60-100 FT

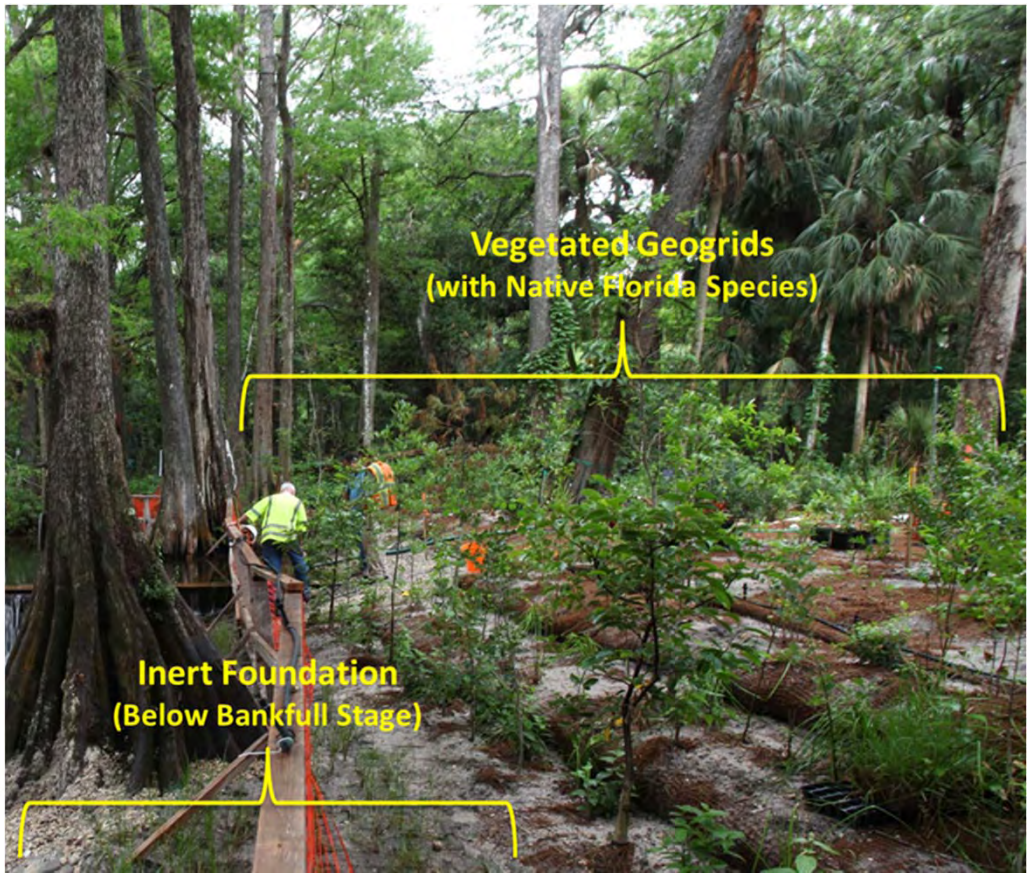

RIGHT-OF-WAY
60-100 FT
TRAVELWAY
SHW
SLW
CANAL
Q
SPOIL
DEVELOPMENT
VRSS
SWAMP
OXBOW MARSH
POINT BAR
SWAMP
MULTI MODAL TRAIL
VRSS
DEVELOPMENT
SHW
SLW
POOL
12 FT
5-15 FT
5-31-2019
BANKFULL CHANNEL
MEANDER BELT
FLOOD CHANNEL

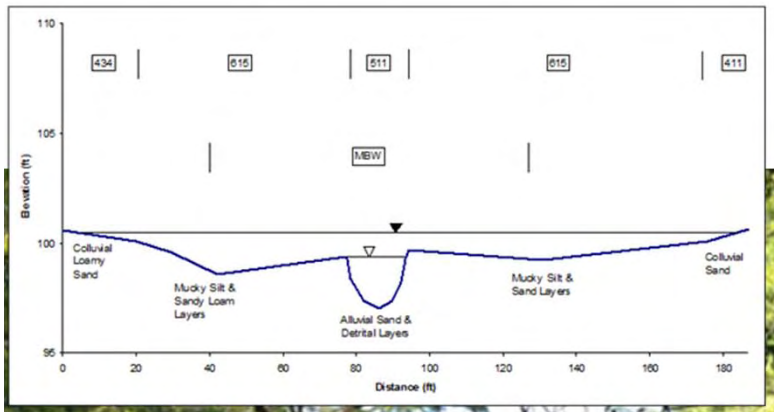

Manatee
Sarasota
Sarasota
Bird Key
Siesta Key
Siesta Key
Roberts Bay
Lake Sarasota
Fruitville
Celery Fields
Pope Golf
Laurel Oak Country Club
Founders Club
Tatum Ridge Golf Links
The Meadows
Meadows Country Club
Bobby Jones Golf Club
Kensington Park
North Sarasota Rolling Greens Golf Course
Nathan Benderson Park
The Palms Golf Club at Forest Lakes
Sarasota Springs
South Gate Ridge
Bee Ridge
Gulf Gate Estates
Twin Lakes Park
Cedar Creek Golf Club
Rothenbach Park
Heritage Oaks Golf and Country Club
Serenoa Golf Club
Riverview Golf Club
N
0 0.5 1
Miles
Canal Types
Headwater
Mid-Order (shallow)
Mid-Order (deeper)
Lowland

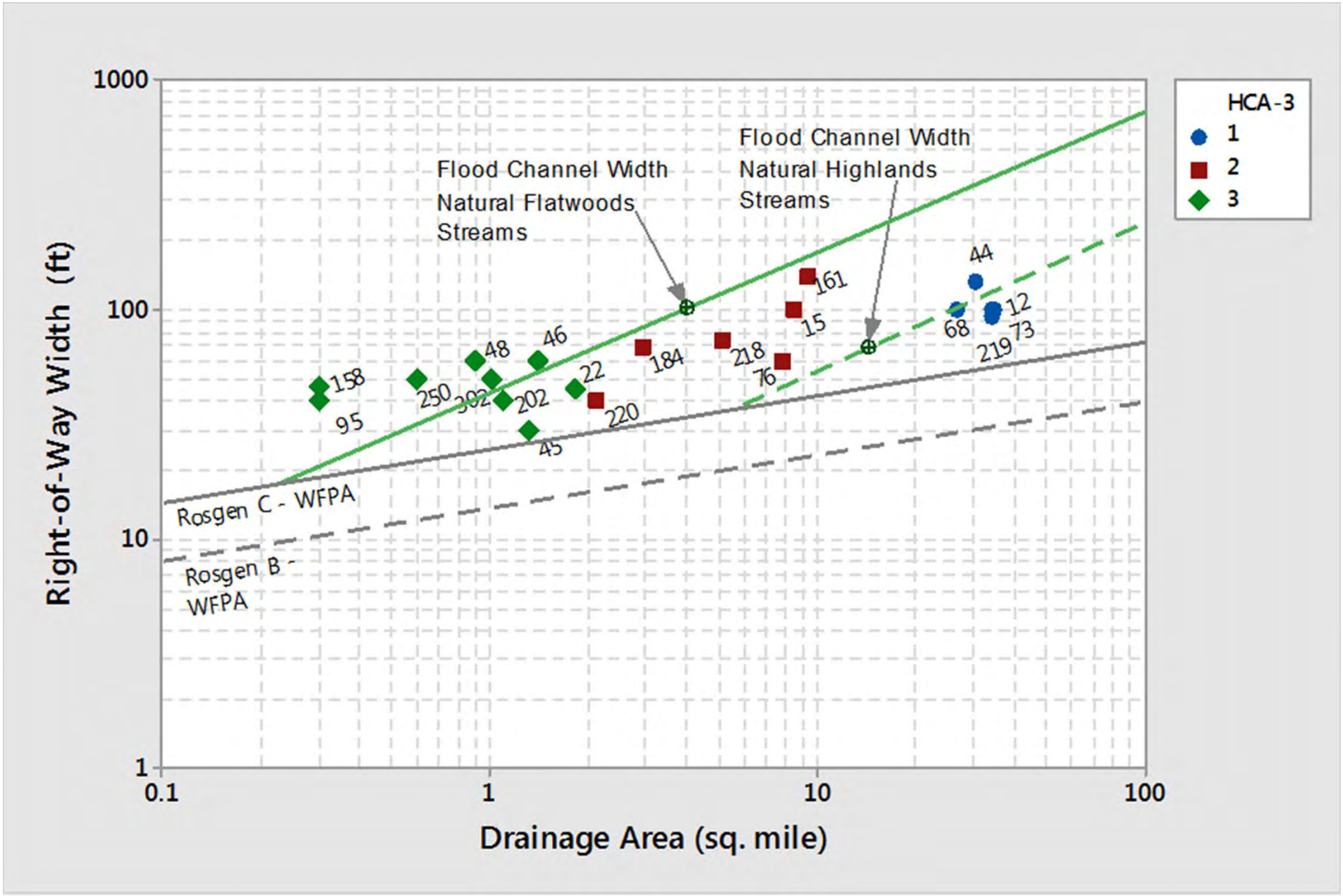
i. Photo credit: http://gabion1.co.uk/river-bank-protection/

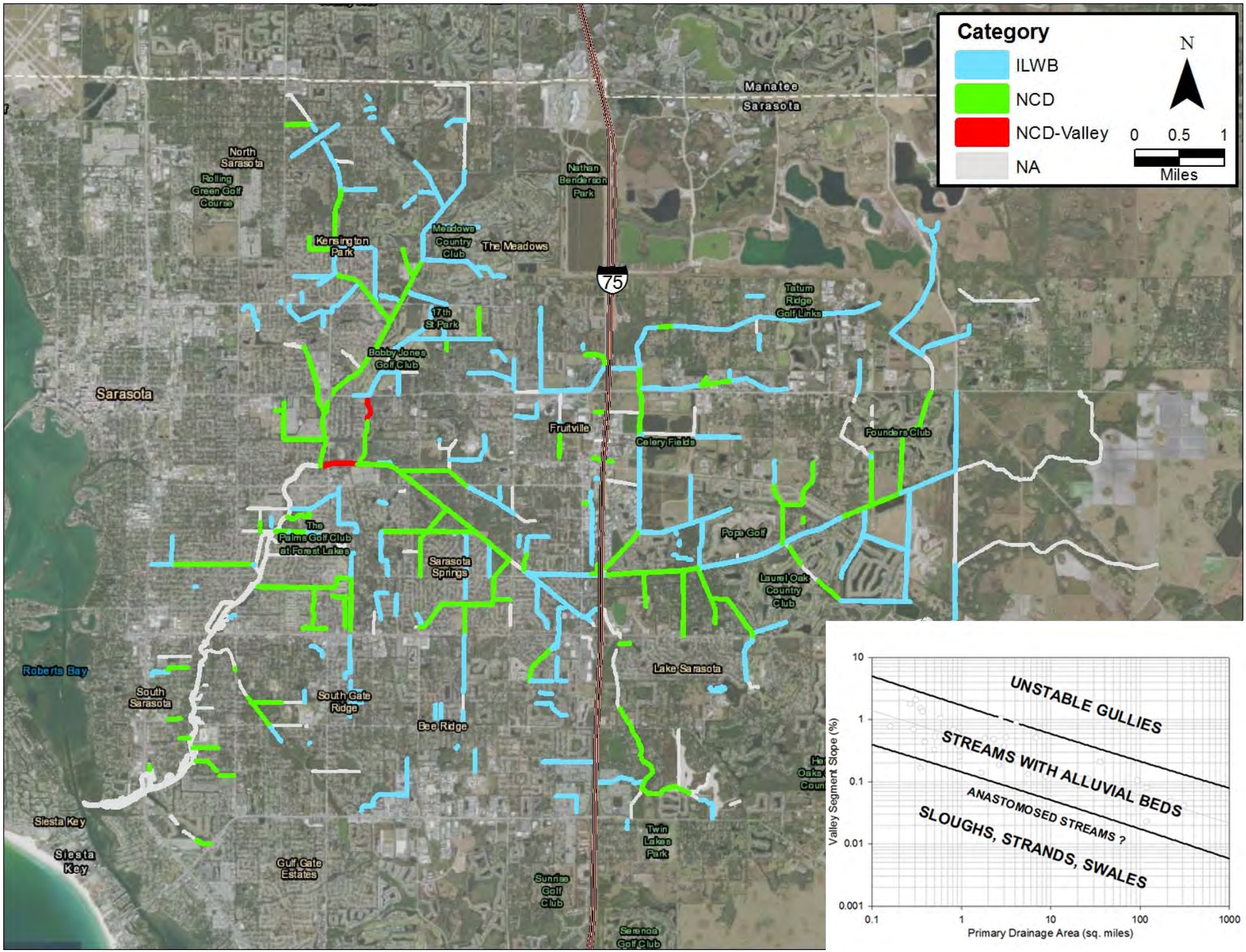
VRSS

Photo credit: Tensar Corp.

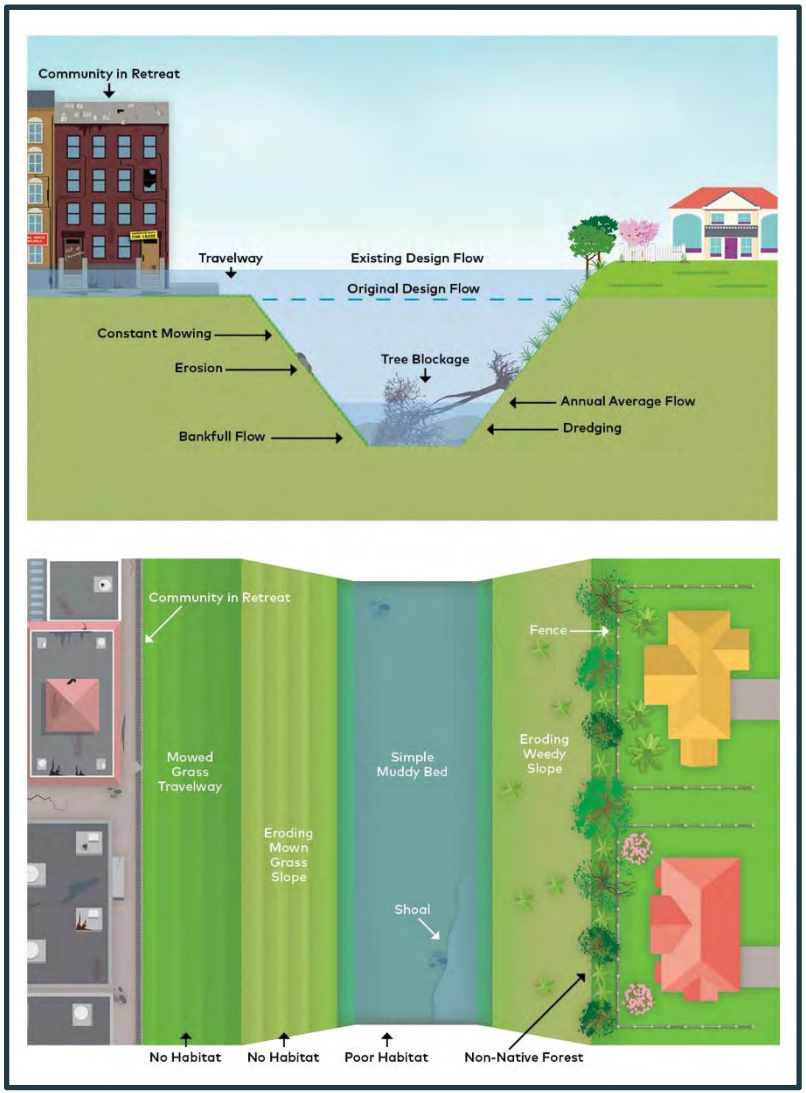


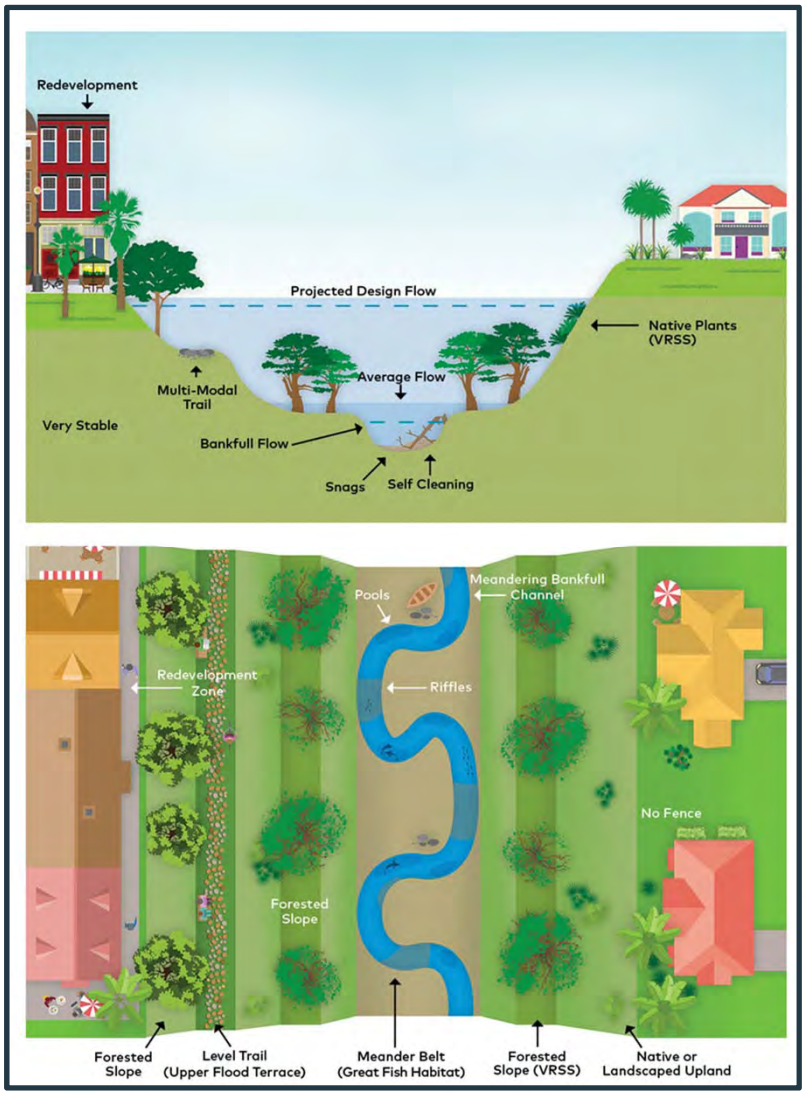

434
616
611
615
411
MBW
Elevation (ft)
110
105
100
95
0
20
40
60
80
100
120
140
160
180
Distance (ft)
Colluvial Loamy Sand
Mucky Silt & Sandy Loam Layers
Alluvial Sand & Detrital Layers
Mucky Silt & Sand Layers
Colluvial Sand


Right-of-Way Width (ft)
1000
100
10
1
0.1
1
10
100
Drainage Area (sq. mile)
HCA-3
1
2
3
Flood Channel Width
Natural Flatwoods
Streams
Flood Channel Width
Natural Highlands
Streams
Rosgen C - WFPA
Rosgen B - WFPA
158
95
250
48
46
202
22
184
220
45
218
76
161
15
44
68
12
219
73


Category
ILWB
NCD
NCD-Valley
NA
N
0 0.5 1
Miles
Manatee
Sarasota
North Sarasota
Rolling Green Golf Course
Nathan Benderson Park
Kensington Park
Meadows Country Club
The Meadows
75
Tatum Ridge Golf Links
17th St Park
Bobby Jones Golf Club
Sarasota
Fruitville
Celery Fields
Founders Club
The Palms Golf Club at Forest Lakes
Sarasota Springs
Pope Golf
Laurel Oak Country Club
Roberts Bay
South Sarasota
South Gate Ridge
Bee Ridge
Lake Sarasota
Siesta Key
Siesta Key
Gulf Gate Estates
Sunrise Golf Club
Twin Lakes Park
Serenoa Golf Club
UNSTABLE GULLIES
STREAMS WITH ALLUVIAL BEDS
ANASTOMOSED STREAMS ?
SLOUGHS, STRANDS, SWALES
Valley Segment Slope (%)
10
1
0.1
0.01
0.001
0.1
1
10
100
1000
Primary Drainage Area (sq. miles)

Drainage Ditch Conversion to Multi-Stage Channel





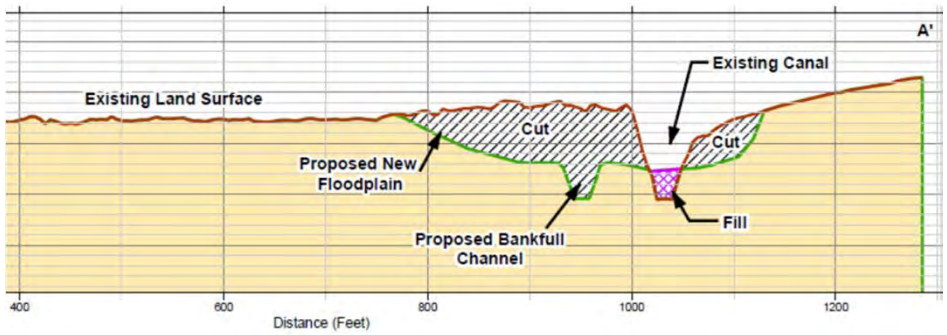
Year 0. Edwards Bottomlands, Starke FL.
(Drainage Area = 25 sq. mi.)

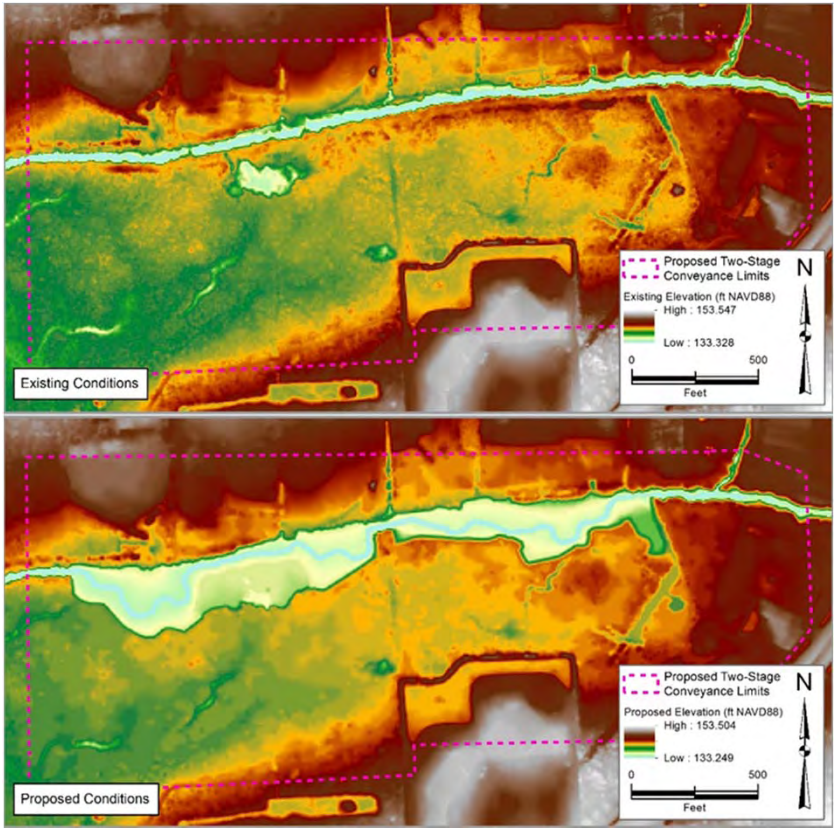
Year 3. Doe Branch 5, Hardee Co. FL.
(Drainage Area = <1 sq. mi.)

Year 12. Maron Run, Polk Co. FL.
(Drainage Area = 3 sq. mi.)

Year 25. Hickey Branch, Hardee Co. FL.
(Drainage Area = 2 sq. mi.)

Three-Stage Channel – Edwards Bottomlands





Water Quality Benefits - Chesapeake Bay TMDL Stream Restoration Protocols

- P1: Bank stabilization
- P2: Hyporheic exchange during baseflow
- P3: Floodplain reconnection
- P4: Dry RSC – Provides add-on reductions downstream of untreated impervious surface

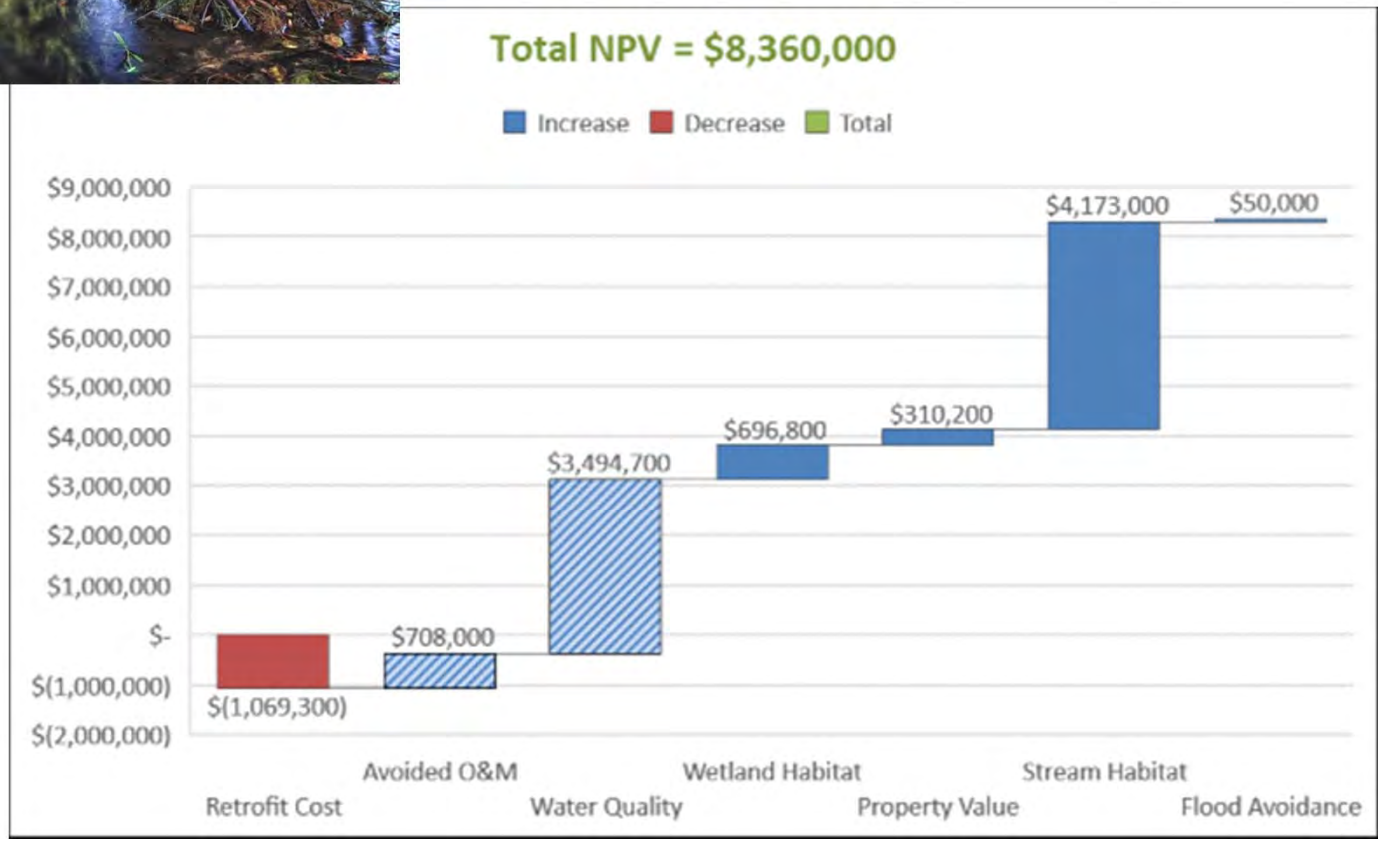
	Mechanism		Effect on Nutrient Cycling		Ecosystem Response to Nutrient Addition	Ecosystem Stability
	Retention	Biological Activity	Rate of Recycling	Distance Between Spiral Loops		
A.	HIGH	HIGH	FAST	SHORT	CONSERVATIVE (b>E)	HIGH
B.	HIGH	LOW	SLOW	SHORT	STORING (b>E)	HIGH
C.	LOW	HIGH	FAST	LONG	INTERMEDIATELY CONSERVATIVE <A but > D	LOW
D.	LOW	LOW	SLOW	LONG	EXPORTING (I=E)	LOW

From Minshall et al (1983) Ecological Society of America

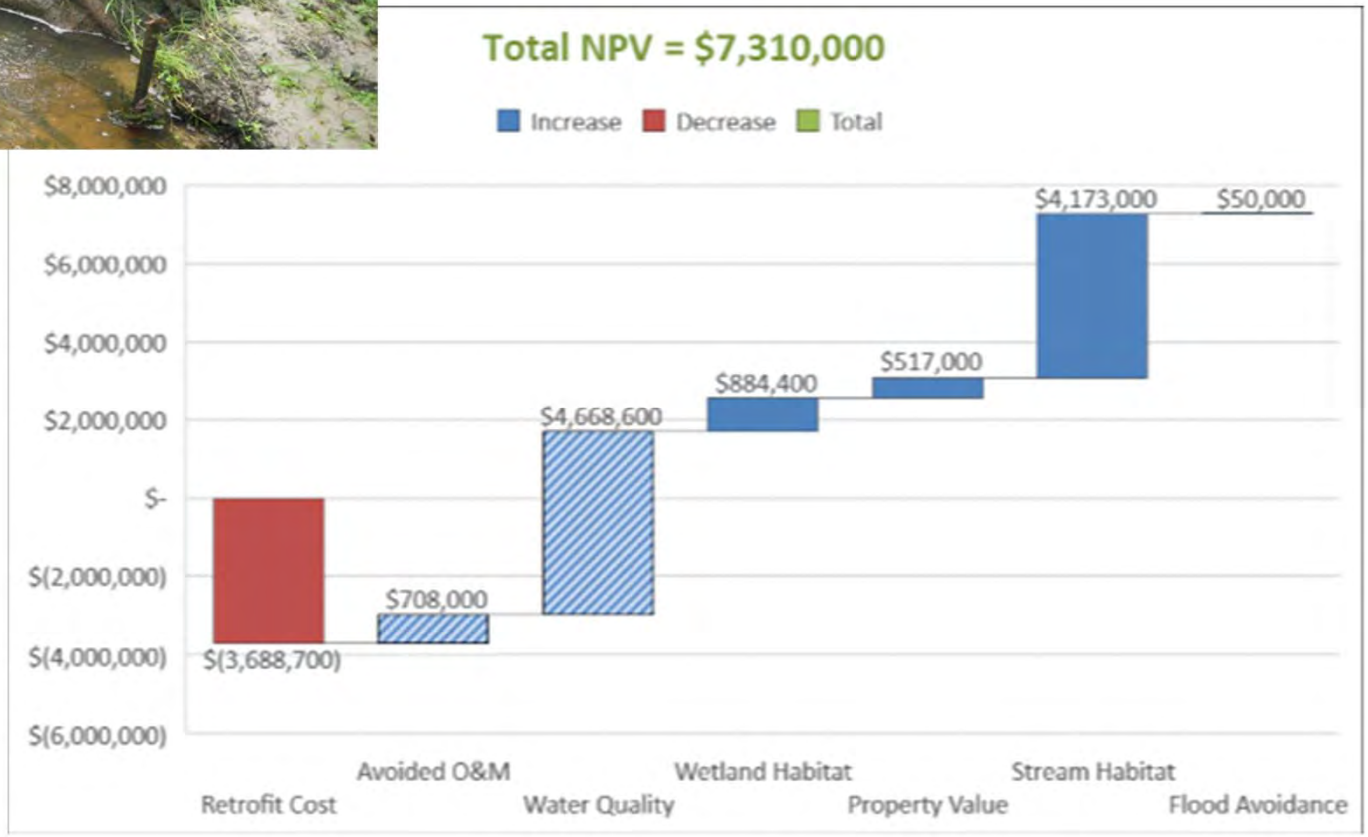
Phillip Canal Restoration – Estimated Nitrogen Reduction

TN Removed (lb TN/yr/mile)				
Stream Category	**P1 - Erosion**	**P2 - Hyporheic**	**P3 - Floodplain**	**Total**
Headwater (<2 SM)	51	539	62	652
Mid-Order (2-20 SM)	51	742	79	872
Lowland (>20 SM)	51	1011	103	1165

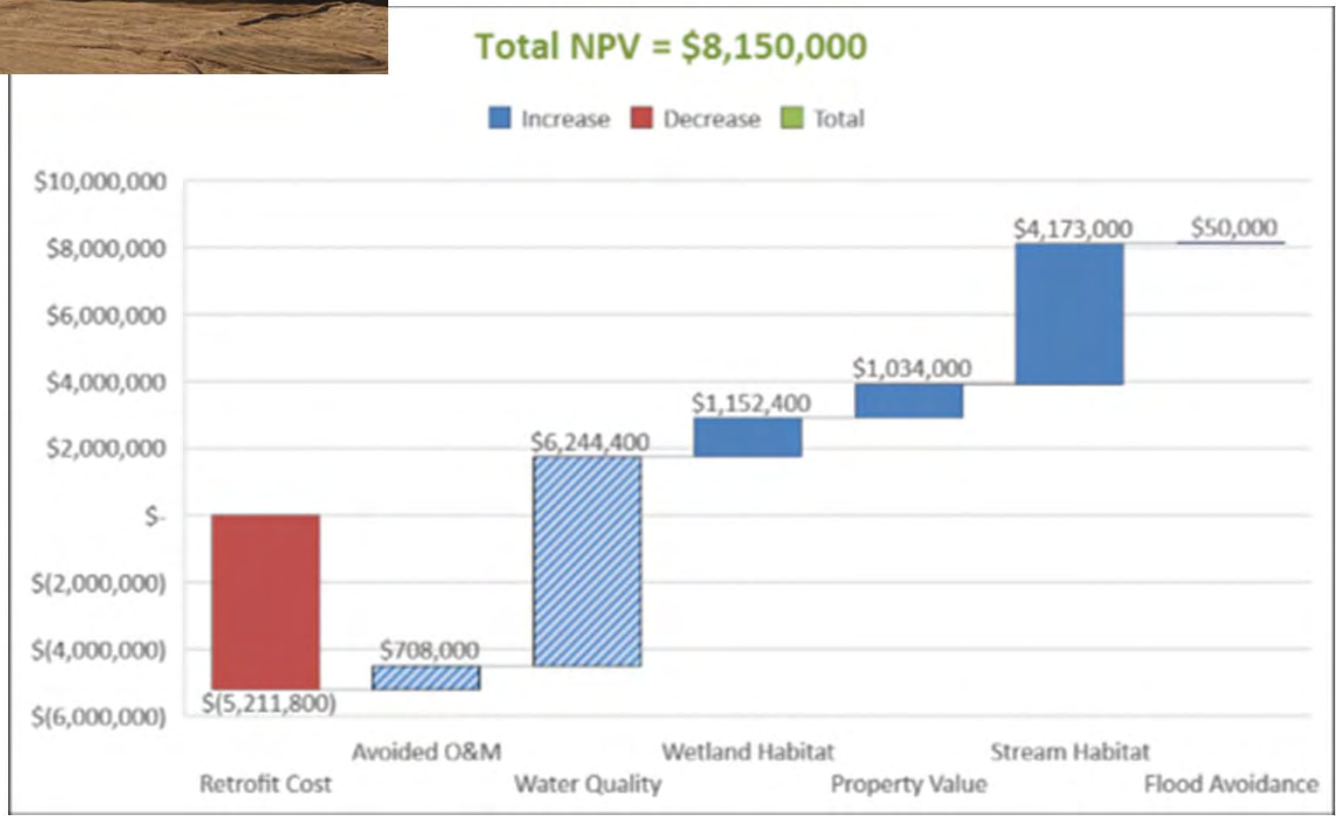
Convert Headwater Canal to Natural Channel System, 1 mile



Convert Mid-Order Canal to Natural Channel System, 1 mile



Convert Lowland Canal to Natural Channel System, 1 mile

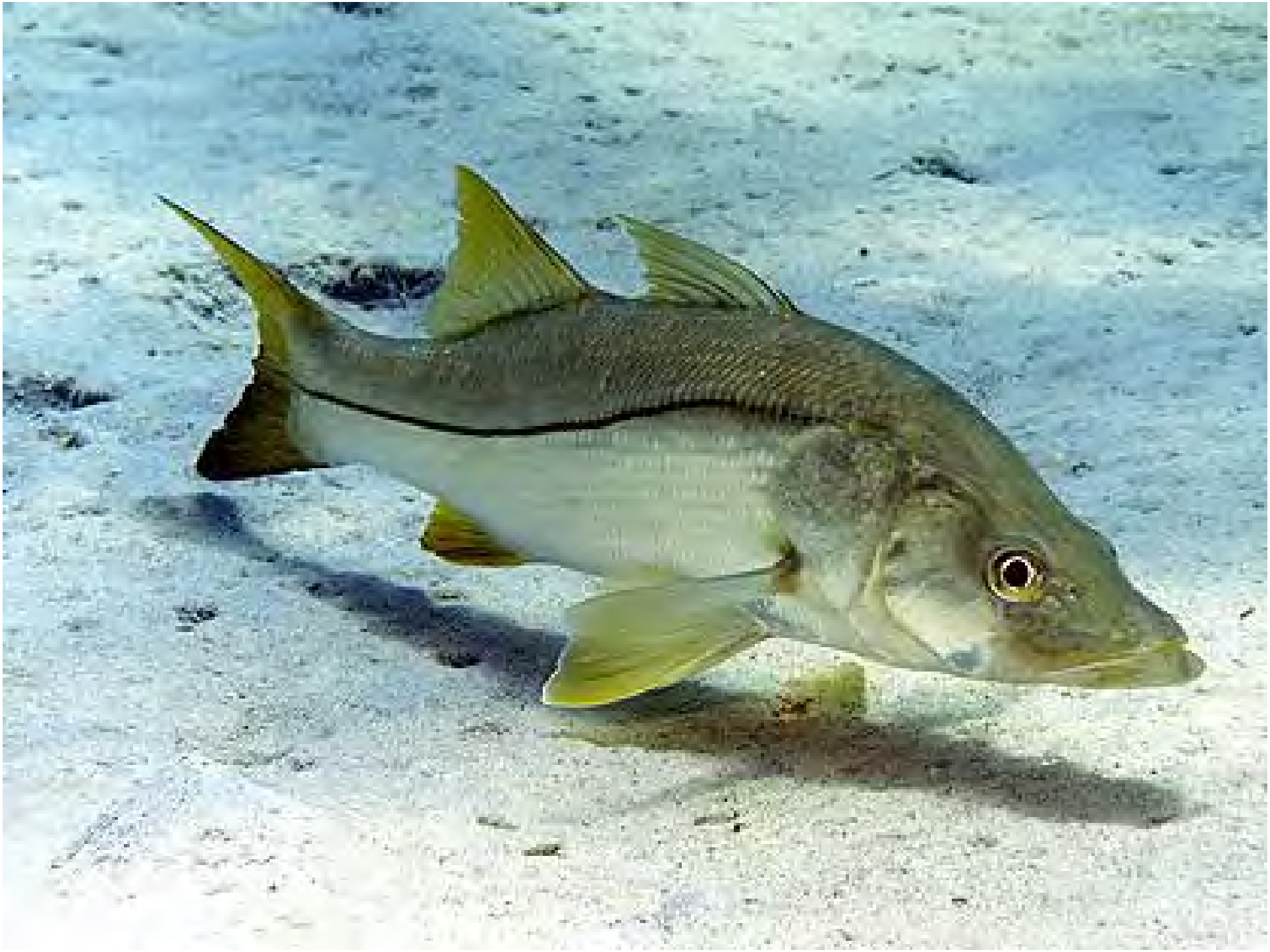


Capital Investment

Retrofit Scenario	Position	Mean Capital	Capital Range	
			Worst Case	Best Case
Turf over VRSS	HW	$ (724,800)	$ (942,240)	$ (507,360)
Forest over VRSS	HW	$ (731,900)	$ (951,470)	$ (512,330)
Stream Restoration	HW	$ (1,069,300)	$ (1,390,090)	$ (748,510)
VRSS - Whole Bank	HW	$ (1,194,300)	$ (1,552,590)	$ (836,010)
Riprap	HW	$ (1,256,700)	$ (1,633,710)	$ (879,690)
Articulated Block	HW	$ (1,432,900)	$ (1,862,770)	$ (1,003,030)
Gabion	HW	$ (2,371,300)	$ (3,082,690)	$ (1,659,910)
Turf over VRSS	MO	$ (1,539,300)	$ (2,001,090)	$ (1,077,510)
Forest over VRSS	MO	$ (1,548,000)	$ (2,012,400)	$ (1,083,600)
VRSS - Whole Bank	MO	$ (2,509,400)	$ (3,262,220)	$ (1,756,580)
Stream Restoration	MO	$ (3,688,700)	$ (4,795,310)	$ (2,582,090)
Riprap	MO	$ (4,063,000)	$ (5,281,900)	$ (2,844,100)
Gabion	MO	$ (4,063,200)	$ (5,282,160)	$ (2,844,240)
Articulated Block	MO	$ (4,591,700)	$ (5,969,210)	$ (3,214,190)
Turf over VRSS	LL	$ (1,576,100)	$ (2,048,930)	$ (1,103,270)
Forest over VRSS	LL	$ (2,179,200)	$ (2,832,960)	$ (1,525,440)
VRSS - Whole Bank	LL	$ (2,428,000)	$ (3,156,400)	$ (1,699,600)
Gabion	LL	$ (3,914,500)	$ (5,088,850)	$ (2,740,150)
Riprap	LL	$ (4,591,700)	$ (5,969,210)	$ (3,214,190)
Stream Restoration	LL	$ (5,211,800)	$ (6,775,340)	$ (3,648,260)
Articulated Block	LL	$ (6,448,700)	$ (8,383,310)	$ (4,514,090)

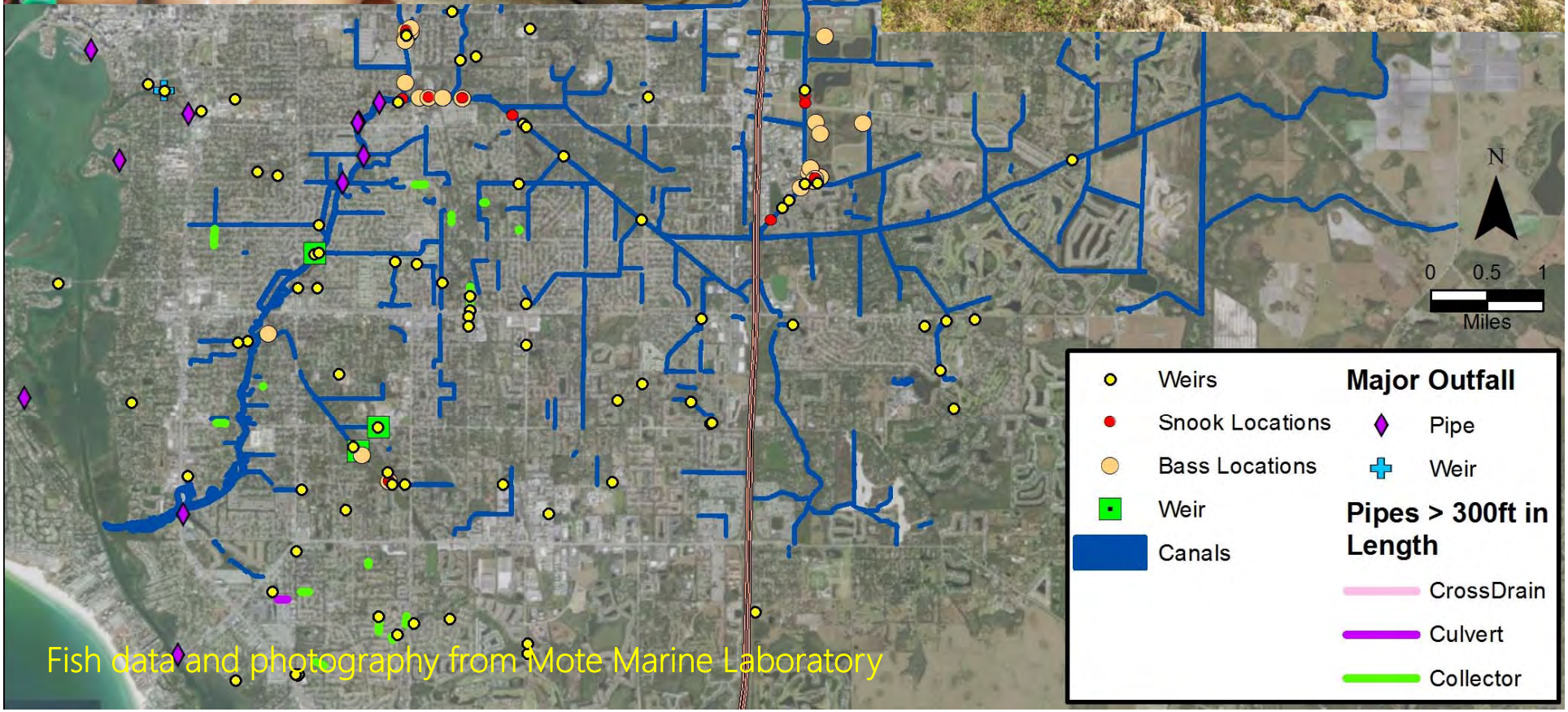
Triple Bottom Line

Retrofit Scenario	Position	Mean NPV	NPV Range	
			Worst Case	Best Case
Stream Restoration	HW	$ 8,363,400	$ 3,146,160	$ 11,749,000
Stream Restoration	LL	$ 8,150,000	$ (636,440)	$ 13,957,080
Stream Restoration	MO	$ 7,312,300	$ 421,690	$ 11,954,210
Forest over VRSS	HW	$ 408,100	$ (381,470)	$ 969,670
Turf over VRSS	LL	$ 249,000	$ (1,482,780)	$ 1,269,360
Turf over VRSS	HW	$ 61,200	$ (549,240)	$ 514,440
Forest over VRSS	MO	$ 100	$ (1,411,550)	$ 928,930
Forest over VRSS	LL	$ (100)	$ (2,089,810)	$ 1,307,390
VRSS - Whole Bank	HW	$ (54,300)	$ (982,590)	$ 945,990
VRSS - Whole Bank	LL	$ (248,900)	$ (2,413,250)	$ 1,433,230
Turf over VRSS	MO	$ (345,200)	$ (1,577,240)	$ 474,820
Riprap	HW	$ (357,300)	$ (1,184,010)	$ 289,530
Articulated Block	HW	$ (533,500)	$ (1,413,070)	$ 166,190
VRSS - Whole Bank	MO	$ (961,300)	$ (2,661,370)	$ 555,950
Gabion	HW	$ (1,471,900)	$ (2,632,990)	$ (490,690)
Gabion	LL	$ (3,015,100)	$ (4,639,150)	$ (1,570,930)
Riprap	MO	$ (3,163,600)	$ (4,832,200)	$ (1,674,880)
Gabion	MO	$ (3,163,800)	$ (4,832,460)	$ (1,675,020)
Riprap	LL	$ (3,692,300)	$ (5,519,510)	$ (2,044,970)
Articulated Block	MO	$ (3,692,300)	$ (5,519,510)	$ (2,044,970)
Articulated Block	LL	$ (5,549,300)	$ (7,933,610)	$ (3,344,870)

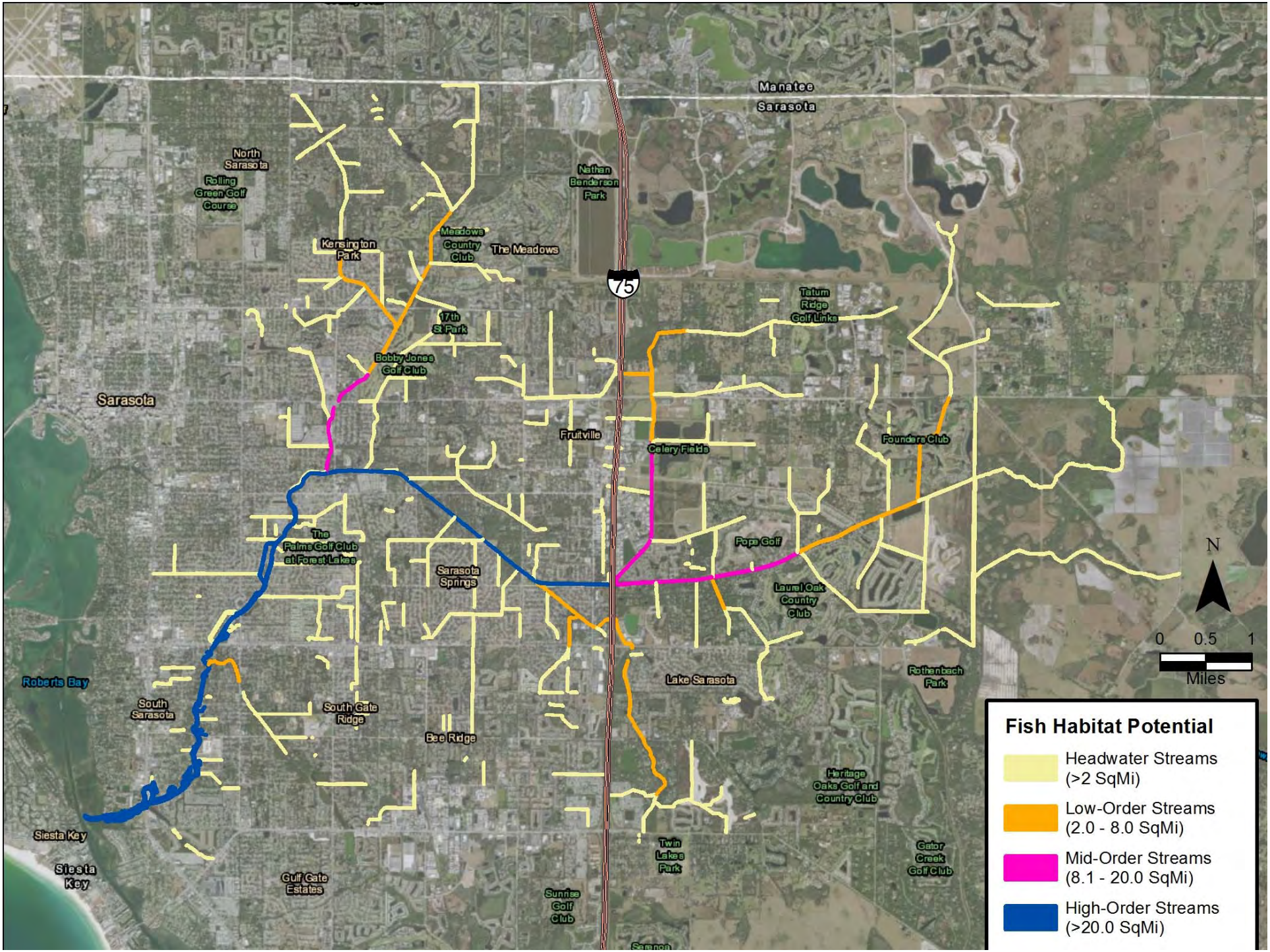


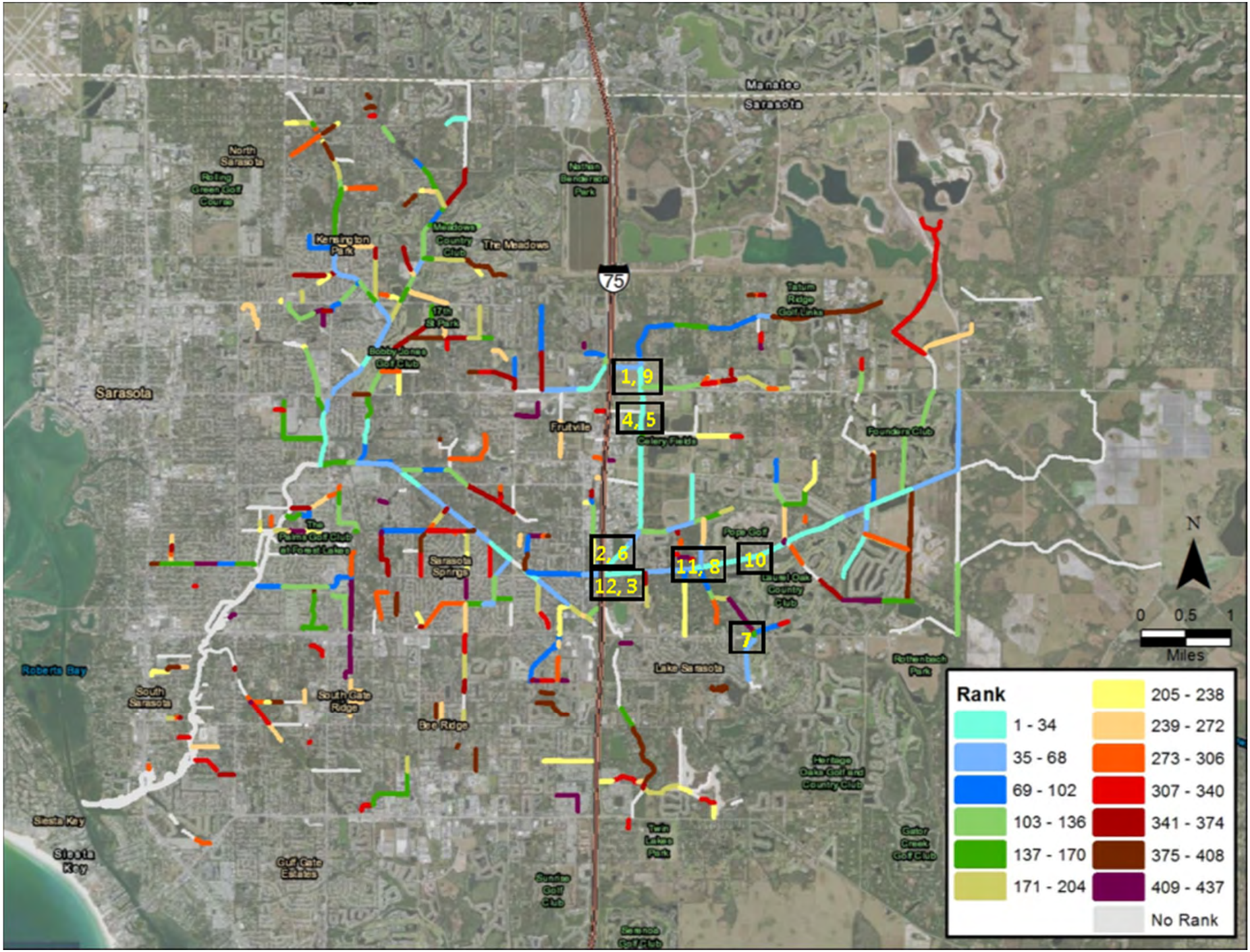
PHILLIPPI CREEK

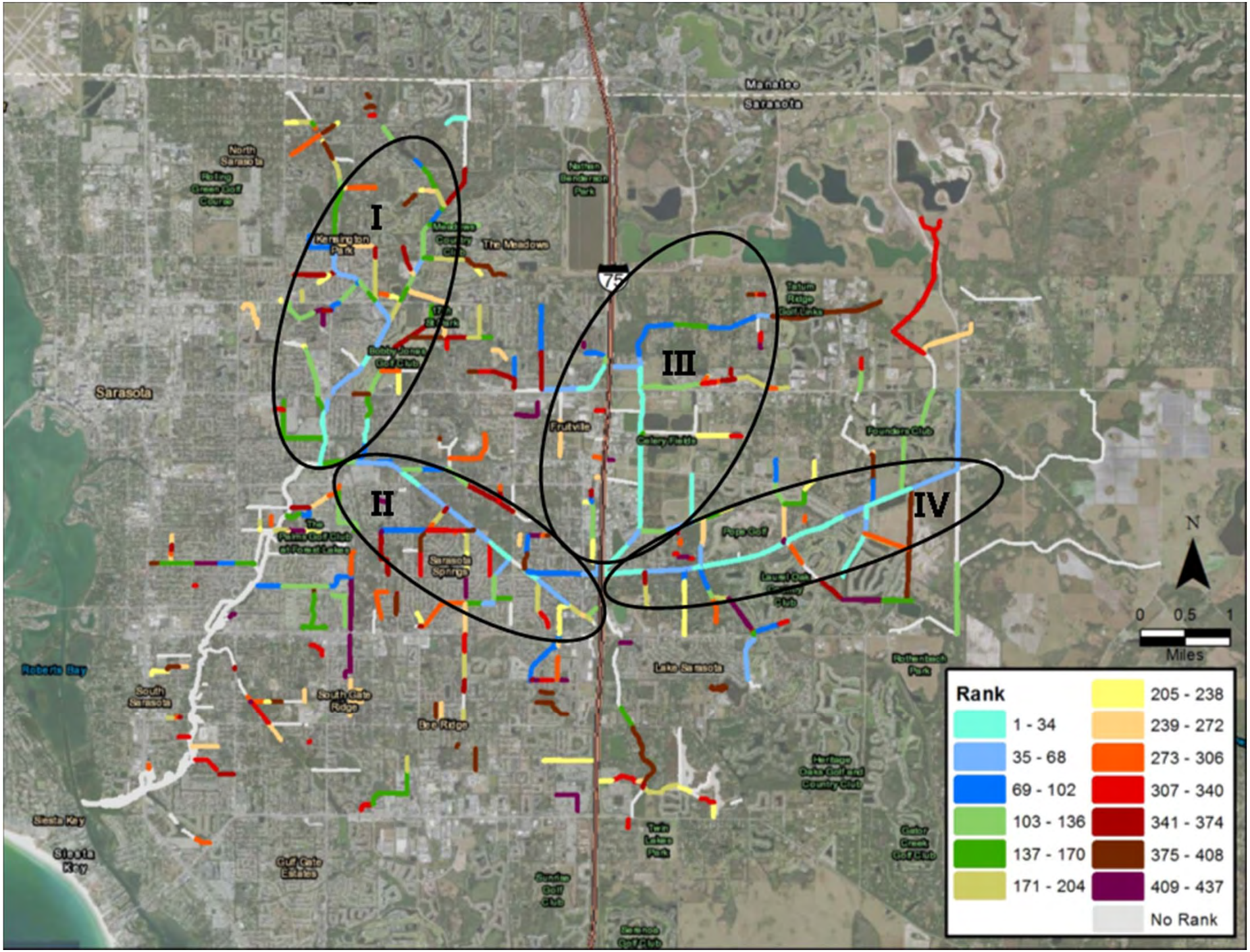
Protect our Creek!

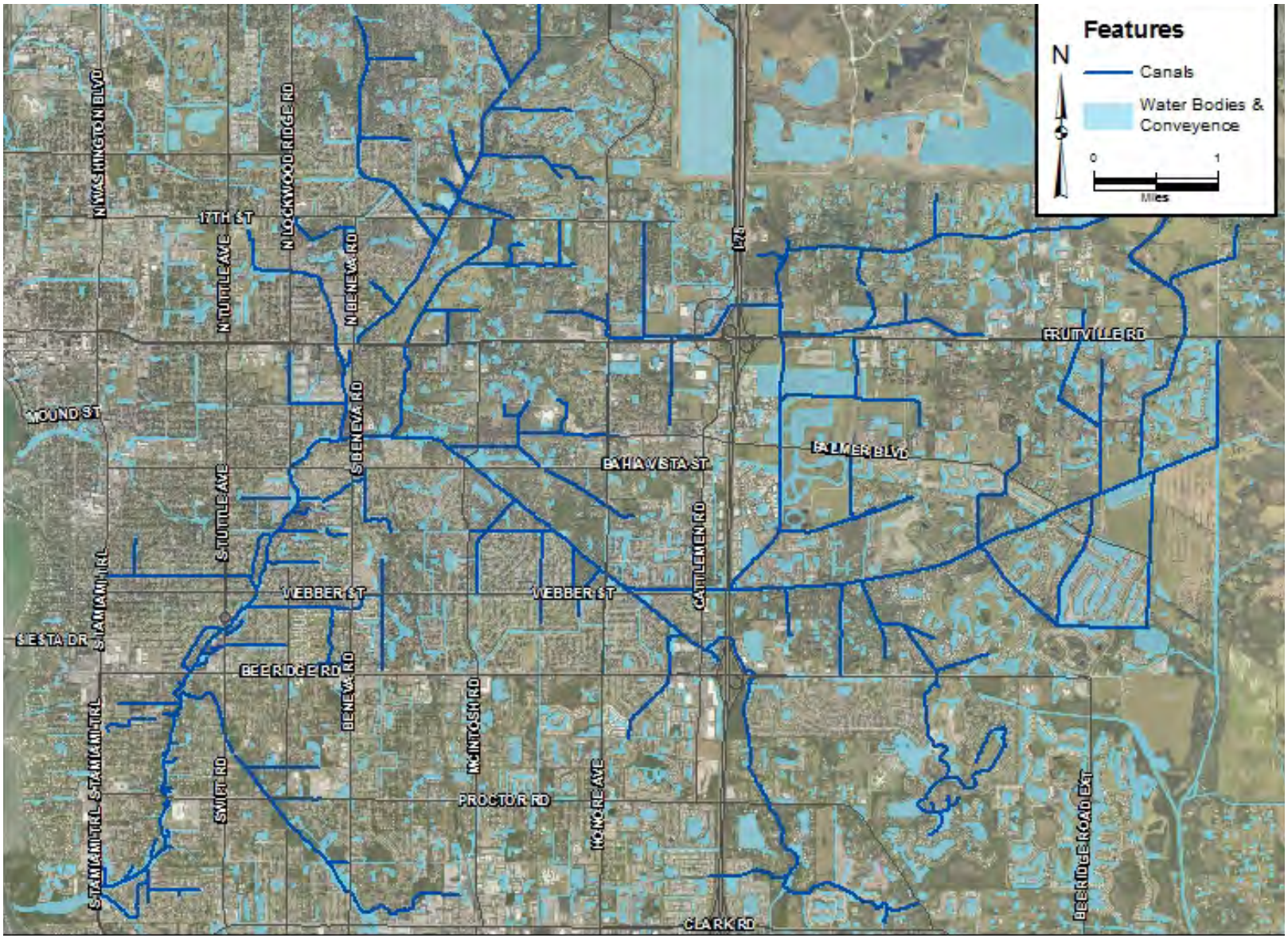


Fish data and photography from Mote Marine Laboratory


Manatee
Sarasota
North Sarasota
Rolling Green Golf Course
Nathan Benderson Park
Meadows Country Club
The Meadows
Kensington Park
75
Tatum Ridge Golf Links
17th St Park
Bobby Jones Golf Club
Sarasota
Fruitville
Celery Fields
Founders Club
The Palms Golf Club at Forest Lakes
Sarasota Springs
Pope Golf
Laurel Oak Country Club
N
0 0.5 1
Miles
Roberts Bay
South Sarasota
South Gate Ridge
Bee Ridge
Lake Sarasota
Rothenbach Park
Heritage Oaks Golf and Country Club
Siesta Key
Siesta Key
Gulf Gate Estates
Twin Lakes Park
Gator Creek Golf Club
Sunrise Golf Club
Fish Habitat Potential
Headwater Streams (>2 SqMi)
Low-Order Streams (2.0 - 8.0 SqMi)
Mid-Order Streams (8.1 - 20.0 SqMi)
High-Order Streams (>20.0 SqMi)


Manatee
Sarasota
North Sarasota
Rolling Green Golf Course
Nathan Benderson Park
Kensington Park
Meadows Country Club
The Meadows
75
Tatum Ridge Golf Links
17th St Park
Bobby Jones Golf Club
Sarasota
1, 9
4, 5
Fruitville
Celery Fields
Founders Club
The Palms Golf Club at Forest Lakes
Sarasota Springs
2, 6
12, 3
11, 8
10
Pope Golf
Laurel Oak Country Club
7
N
0 0.5 1
Miles
Roberts Bay
South Sarasota
South Gate Ridge
Bee Ridge
Lake Sarasota
Rothenbach Park
Heritage Oaks Golf and Country Club
Siesta Key
Siesta Key
Gulf Gate Estates
Sunrise Golf Club
Twin Lakes Park
Gator Creek Golf Club
Rank
1 - 34
35 - 68
69 - 102
103 - 136
137 - 170
171 - 204
205 - 238
239 - 272
273 - 306
307 - 340
341 - 374
375 - 408
409 - 437
No Rank


I
II
III
IV
Manatee
Sarasota
North Sarasota
Rolling Green Golf Course
Kensington Park
Meadows Country Club
The Meadows
Nathan Benderson Park
75
Tatum Ridge Golf Links
Bobby Jones Golf Club
Sarasota
Fruitville
Celery Fields
Founders Club
The Palms Golf Club at Forest Lakes
Sarasota Springs
Pope Golf
Laurel Oak Country Club
Roberts Bay
South Sarasota
South Gate Ridge
Bee Ridge
Lake Sarasota
Rothenbach Park
Heritage Oaks Golf and Country Club
Siesta Key
Siesta Key
Gulf Gate Estates
Twin Lakes Park
Gator Creek Golf Club
Riverview Golf Club
Riverview Golf Club
N
0 0.5 1
Miles
Rank
1 - 34
35 - 68
69 - 102
103 - 136
137 - 170
171 - 204
205 - 238
239 - 272
273 - 306
307 - 340
341 - 374
375 - 408
409 - 437
No Rank


Features
N
Canals
Water Bodies & Conveyence
0
1
Miles
N WASHINGTON BLVD
17TH ST
N LOCKWOOD RIDGE RD
N TUTTLE AVE
N BENEVA RD
I-75
FRUITVILLE RD
WOUND ST
S BENEVA RD
BAHIA VISTA ST
PALMER BLVD
S TUTTLE AVE
CATTLEMEN RD
S TAMIAMI TRL
WEBBER ST
WEBBER ST
SIESTA DR
BEERIDGE RD
BENEVA RD
MCINTOSH RD
SWIFT RD
PROCTOR RD
MCMORE AVE
S TAMIAMI TRL
S TAMIAMI TRL
BEERIDGE ROAD EXT
CLARK RD

Florida Canal Improvements

John Kiefer, PhD, PE, PWS
863-944-6987
john.kiefer@woodplc.com