

Why Are the Bacteria Counts in My Stream Still So High?

Mollie Holland – Sarasota County
Tim Denison – Johnson Engineering



FSA 2019 Annual Conference





Bacteria Source Determination

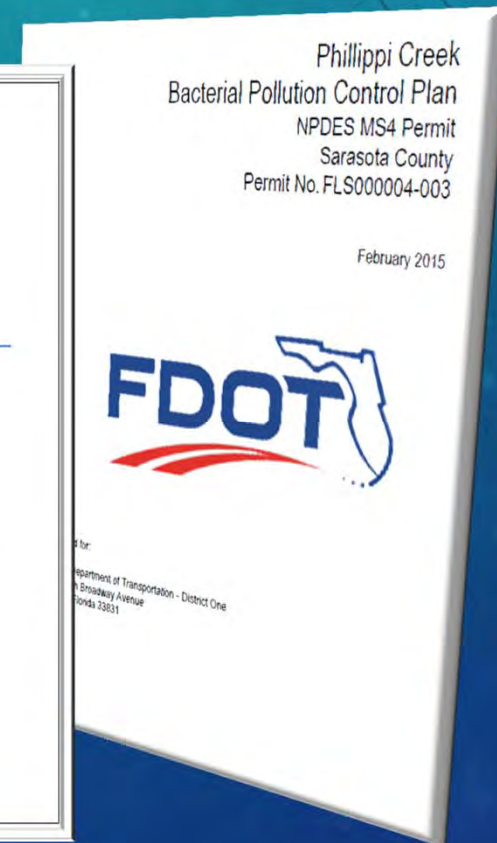
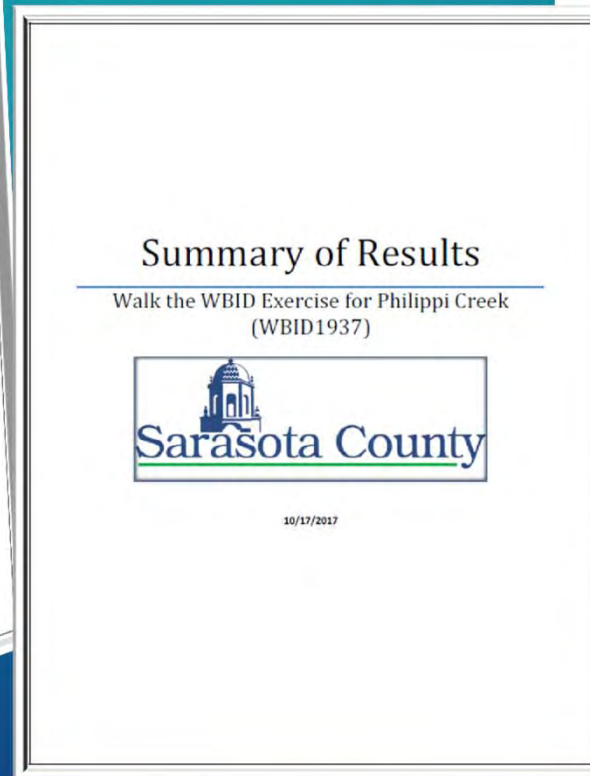
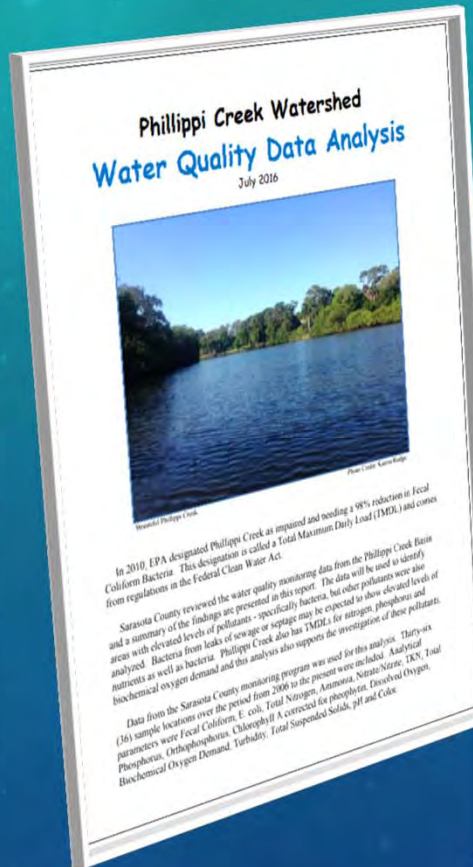
Step 1 – Review Water Quality Reports

Step 2 – Review Water Quality Data

**Step 3 – Develop and Implement a
Microbial Source Tracking Plan**

Bacteria Source Determination

Step 1 –Review Water Quality Reports



Walk the Watershed Report Review

Sarasota County Inspection/Investigation Report - Vinson Avenue Site Visit



Inspector(s):

M. Holland

Date:

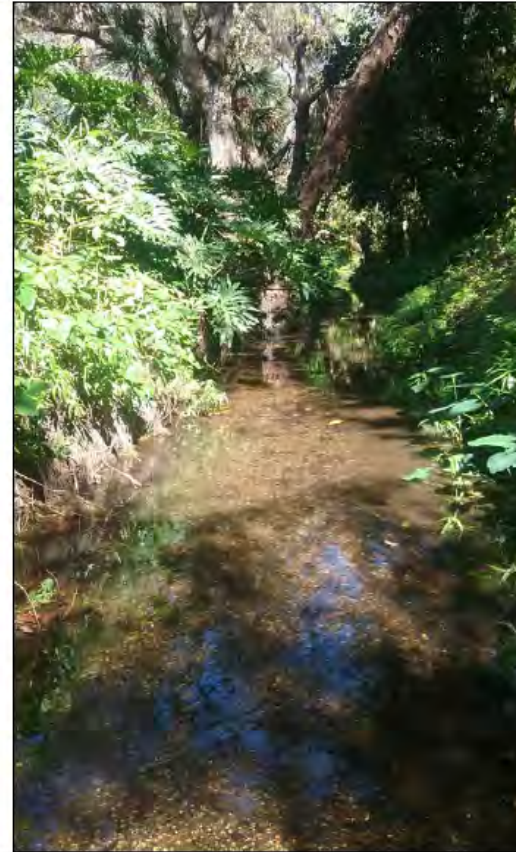
11/29/2016

Photo Location

Same as above

Comments: looking east along 4-98.1. Water is barely moving in the ditch. Lots of leaf litter in ditch. The ditch along most of the length is completely shaded. The ditch bottom is mostly sand with patches of muck deposited throughout. Some wildlife tracks (raccoon) were visible, but difficult to tell because of the leaf litter. There are a few instances where black, flexible piping comes in to the ditch. These pipes are most likely from roof drains, but it was difficult to tell.

Sarasota County Inspection/Investigation Report - Red Bug Slough At Swift and Wilkinson Site Visit



Inspector(s):

M. Holland/J. Talbott/N. Iadavia

Date:

3/1/2017

Photo Location

Same as above

Photo Direction

North

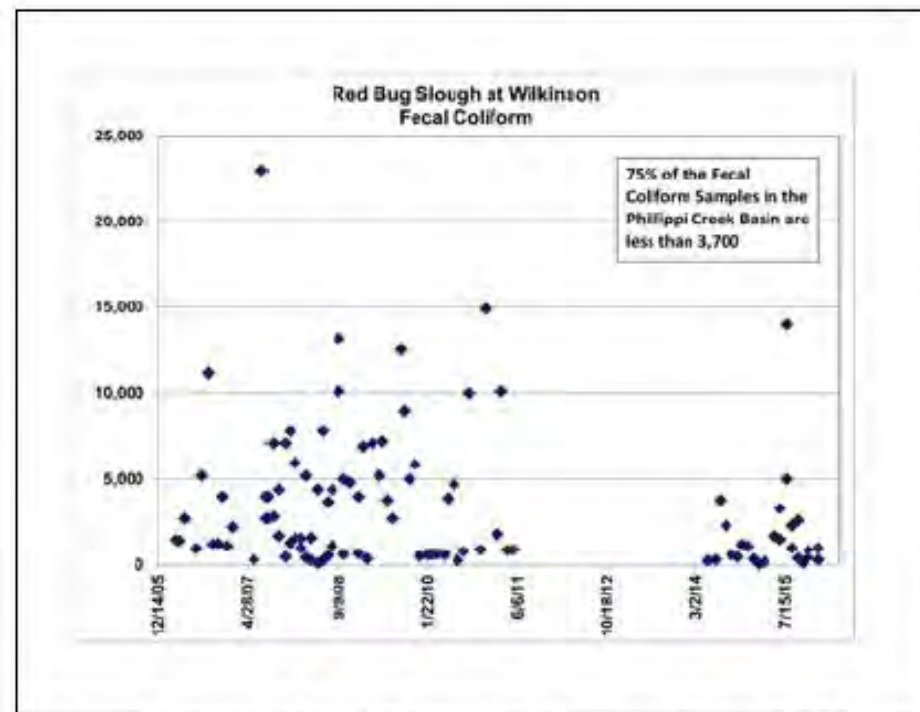
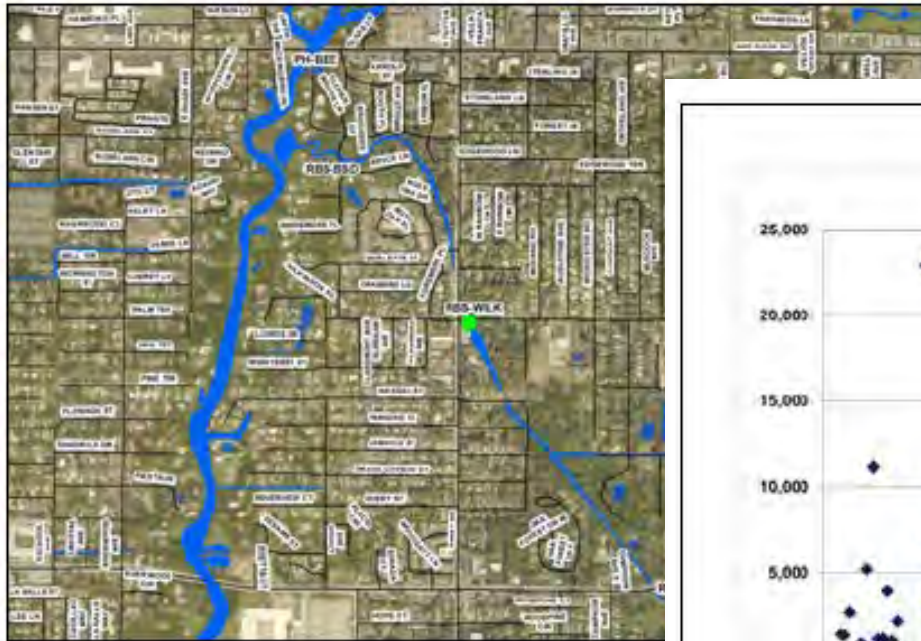
Comments: (#2) Looking further up stream. Sampling spot where E.coli is elevated is just upstream from this point, about 700 ft. The slough is mostly shaded the entire way.

Some common elements but no obvious sources found

Water Quality Data Analysis Report Review

Station RBS-WILK

Pollutant Hot Spot for: Fecal Coliform and Nitrate/Nitrate



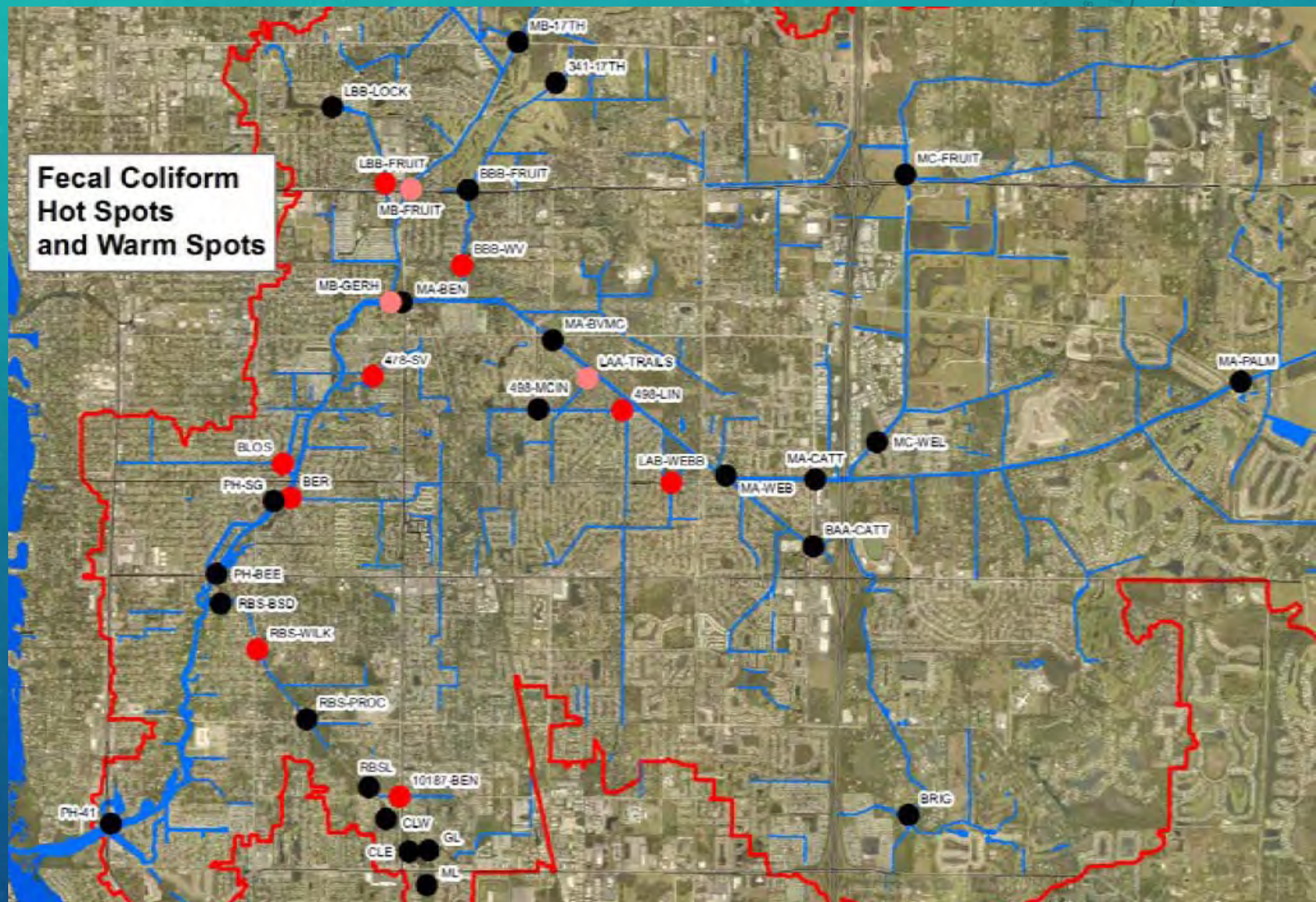
Fecal Coliform is high – 34% are over 5,000; median is 3,650.

Water Quality Data Analysis Report Review

Station	Station Location	Longitude	Latitude	Start Row	End Row	N	FC N	# FC>5000	% FC>5000	%FC Hot	FC MEDIAN	FC HOT
10187-BEN	Canal 10-187 at Beneva near Egerton	-82.497750	27.276680	2	18	17	1	1	100%		15,000	Hot
341-17TH	Canal 3-41 at 17th St. Park near Longmeadow	-82.480510	27.348400	19	74	56	56	8	14%		435	
478-SV	Canal 4-78 at Seaview near Beneva	-82.501010	27.318870	75	84	10	5	3	60%		5,100	Hot
498-LIN	Canal 4-98 at Linwood near Vinson	-82.472910	27.315530	85	255	171	114	56	49%		4,850	Hot
498-MCIN	Canal 4-98 near McIntosh & Linwood	-82.482380	27.315660	256	300	45	40	4	10%		515	
BAA-CATT	Branch AA Canal at Cattlemen near Catteridge	-82.451360	27.301970	301	434	134	115	6	5%		510	
BBB-FRUIT	Branch BB Canal at Fruitville near Bobby Jones Rd.	-82.490330	27.337630	435	532	98	92	16	17%		1,340	
BBB-WV	Branch BB Canal at Woodview	-82.490997	27.330050	533	717	185	121	23	19%		2,100	Hot
BER	Bermuda Brook North at Tanglewood near Rose	-82.510147	27.306629	718	745	28	12	4	33%		3,000	Hot
BLOS	Blossom Brook at Brink near Grove	-82.511078	27.310030	746	829	84	64	17	27%		2,650	Hot
BRIG	Canal 12-227 at Brigatta Dr.	-82.440552	27.275000	830	863	34	12	3	25%		705	
CLE	Clark Lake East near Beneva & Clark	-82.496720	27.271090	864	884	21	1	0	0%		2,600	
CLW	Clark Lake West near Beneva & Clark	-82.499280	27.274420	885	903	19	0	0				
GL	Guill Lake near Beneva & Clark	-82.494510	27.271280	904	923	20	0	0				
LAA-TRAILS	Lateral AA Canal at Trails Dr.	-82.476830	27.318750	924	1096	173	113	15	13%		1,900	Warm
LAB-WEBB	Lateral AB Canal at Webber near Mapleloft	-82.467361	27.308310	1097	1195	99	94	24	26%		3,200	Hot
LBB-FRUIT	Lateral BB Canal at Fruitville near Serena	-82.499680	27.338260	1196	1373	178	111	44	40%		3,800	Hot
LBB-LOCK	Lateral BB Canal at Lockwood Ridge	-82.505660	27.345860	1374	1449	76	65	8	12%		520	
MA-BEN	Main A Canal at Beneva	-82.497730	27.326330	1450	1459	10	10	0	0%		780	
MA-BVMC	Main A Canal at Bahia Vista & McIntosh	-82.480760	27.322550	1460	1689	230	118	10	8%		230	
MA-CATT	Main A Canal at Cattlemen near Webber	-82.451190	27.308670	1690	1796	107	80	9	11%		560	
MA-PALM	Main A Canal at Palmer & DeBrecen	-82.403313	27.318670	1797	1800	4	0	0				
MA-WEB	Main A Canal near Webber and Wood Oak	-82.461180	27.309060	1801	1827	27	8	1	13%		875	
MB-17TH	Main B Canal at 17th St near Longmeadow	-82.484820	27.352480	1828	1837	10	10	0	0%		560	
MB-FRUIT	Main B Canal at Fruitville near Beneva	-82.496810	27.337680	1838	1956	119	100	14	14%		1,260	Warm
MB-GERH	Main B at Gerhardt St.	-82.499050	27.326350	1957	2171	215	104	15	14%		1,250	Warm
MC-FRUIT	Main C Canal at Fruitville	-82.441132	27.339331	2172	2174	3	0	0				
MC-WEL	Main C Canal at Welsh near Appaloosa	-82.444267	27.312490	2175	2215	41	21	4	19%		450	
ML	Mirror Lake near Beneva & Clark	-82.494710	27.267740	2216	2244	29	10	0	0%		500	
PH-41	Phillippi Creek at US41	-82.530200	27.273860	2245	2478	234	118	10	8%		220	
PH-BEE	Phillippi Creek at Bee Ridge Road	-82.518494	27.298950	2479	2535	57	33	5	15%		670	
PH-SG	Phillippi Creek at South Gate Community Center	-82.512040	27.306270	2536	2545	10	10	1	10%		925	
RBS-BSD	Red Bug Slough at Brookside Dr.	-82.517980	27.295970	2546	2560	15	0	0				
RBSL	Red Bug Slough Lake near Beneva & Clark	-82.501250	27.277580	2561	2579	19	0	0				
RBS-PROC	Red Bug Slough at Proctor	-82.508310	27.284390	2580	2617	38	22	1	5%		445	
RBS-WILK	Red Bug Slough at Wilkinson & Swift	-82.513850	27.291380	2618	2856	239	120	41	34%	1	3,650	Hot

hot spots: fecal counts > 5,000 in at least 15% of samples

Water Quality Data Analysis Report Review



Sarasota County identified 9 fecal bacteria “hot spots”

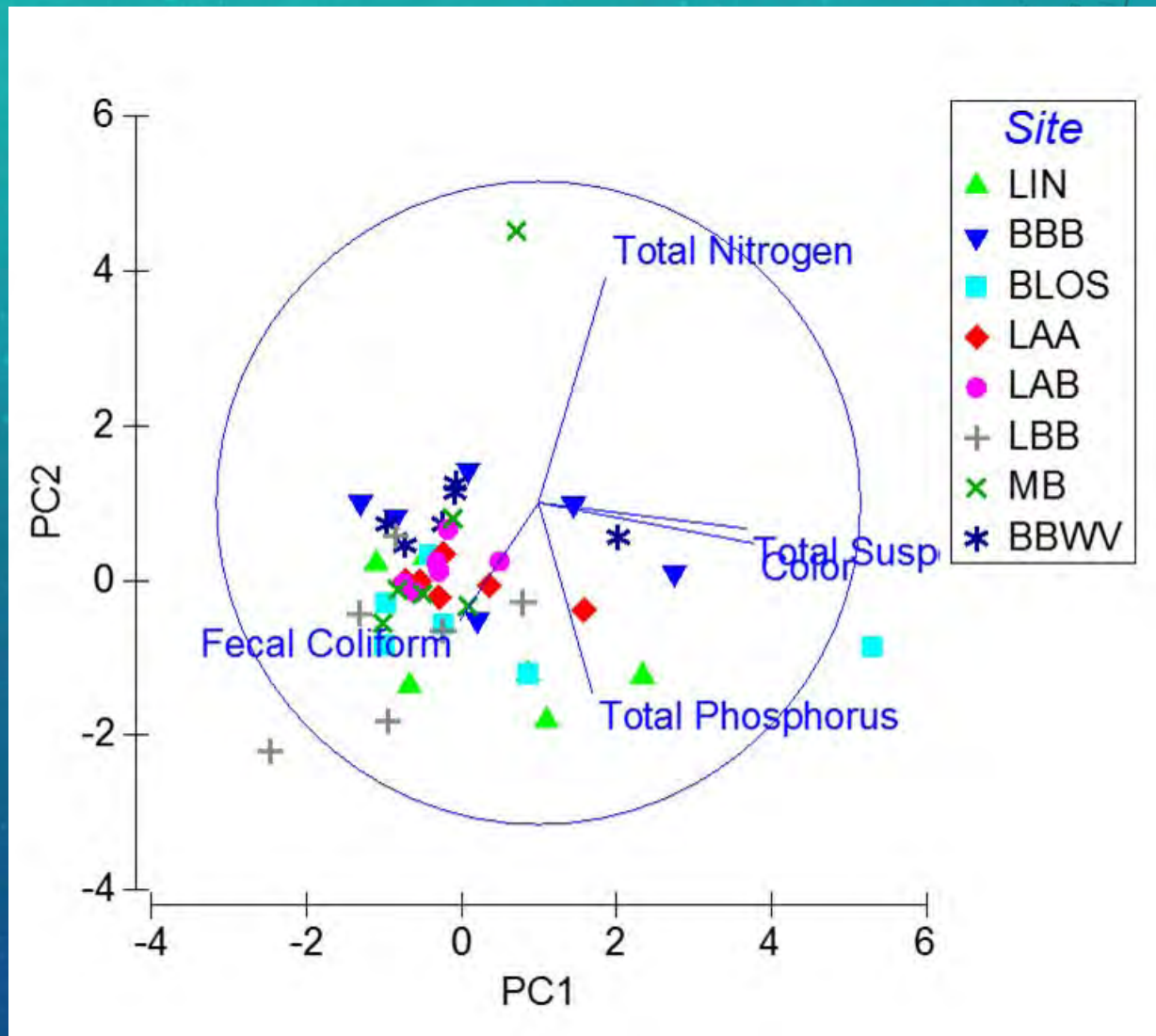
Bacteria Source Determination

Step 2 –Review Water Quality Data

	Station	Station Location	Longitude	Latitude	Start Row	End Row	N	FC N	# FC>.000	% FC>5000	%FC Hot
10-11	10187-BEN	Canal 10-187 at Beneva near Egerton	-82.497750	27.276680	2	18	17	1	1	100%	●
10-11	341-17TH	Canal 3-41 at 17th St. Park near Longmeadow	-82.480510	27.348400	19	74	56	56	8	14%	●
10-11	478-SV	Canal 4-78 at Seaview near Beneva	-82.501010	27.318870	75	84	10	5	3	60%	●
10-11	498-LIN	Canal 4-98 at Linwood near Vinson	-82.472910	27.315530	85	255	171	114	56	49%	●
10-11	498-MCIN	Canal 4-98 near McIntosh & Linwood	-82.482380	27.315660	256	300	45	40	4	10%	●
10-11	BAA-CATT	Branch AA Canal at Cattlemen near Cattleridge	-82.451360	27.301970	301	434	134	115	6	5%	●
10-11	BBB-FRUIT	Branch BB Canal at Fruitville near Bobby Jones Rd.	-82.490330	27.337630	435	532	98	92	16	17%	●
10-11	BBB-WV	Branch BB Canal at Woodview	-82.490997	27.330050	533	717	185	121	23	19%	●
10-11	BER	Bermuda brook North at Tanglewood near Rose	-82.510147	27.306629	718	745	28	12	4	53%	●
10-11	BLOS	Blossom Brook at Brink near Grove	-82.511078	27.310030	746	829	84	64	1	27%	●
10-11	BRIG	Canal 12-227 at Brigatta Dr.	-82.440552	27.275000	830	863	34	12	3	25%	●
10-11	CLC	Clark Lake East near Beneva & Clark	-82.496720	27.271090	864	884	21	1	0	0%	●
10-11	CLW	Clark Lake West near Beneva & Clark	-82.499280	27.274420	885	903	19	0	0	0%	●
10-11	GL	Gulf Lake near Beneva & Clark	-82.494510	27.271280	904	923	20	0	0	0%	●
10-11	LAA-TRAILS	Lateral AA Canal at Trails Dr.	-82.476830	27.318750	924	1096	173	113	2	13%	●
10-11	LAB-WEBB	Lateral AB Canal at Webber near Mapleloft	-82.467361	27.308310	1097	1195	99	94	2	26%	●
10-11	LBB-FRUIT	Lateral BB Canal at Fruitville near Serena	-82.499680	27.338260	1196	1373	178	111	4	40%	●
10-11	LBB-LOCK	Lateral BB Canal at Lockwood Ridge	-82.505660	27.345860	1374	1449	76	65	6	12%	●
10-11	MA-BEN	Main A Canal at Beneva	-82.497730	27.326330	1450	1459	10	10	0	0%	●
10-11	MA-BVMC	Main A Canal at Bahia Vista & McIntosh	-82.480760	27.322550	1460	1689	230	118	1	8%	●
10-11	MA-CATT	Main A Canal at Cattlemen near Webber	-82.451190	27.308670	1690	1796	107	80	9	11%	●
10-11	MA-PALM	Main A Canal at Palmer & DeBrecen	-82.403313	27.318670	1797	1800	4	0	0	0%	●
10-11	MA-WEB	Main A Canal near Webber and Wood Oak	-82.461180	27.309060	1801	1827	27	8	1	1%	●
10-11	MB-17TH	Main B Canal at 17th St near Longmeadow	-82.484820	27.352480	1828	1837	10	10	0	0%	●
10-11	MB-FRUIT	Main B Canal at Fruitville near Beneva	-82.496810	27.337680	1838	1956	119	100	1	1%	●
10-11	MB-GERH	Main B at Gerard St.	-82.499050	27.326350	1957	2171	215	104	1	1%	●
10-11	MC-FRUIT	Main C Canal at Fruitville	-82.441132	27.339331	2172	2174	3	0	0	0%	●
10-11	MC-WEL	Main C Canal at Welsh near Appaloosa	-82.444267	27.312490	2175	2215	41	21	4	19%	●
10-11	MIL	Mirror Lake near Beneva & Clark	-82.494710	27.267740	2216	2244	29	10	0	0%	●
10-11	PH-41	Phillippi Creek at US41	-82.530200	27.273860	2245	2478	234	118	1	8%	●
10-11	PH-BEE	Phillippi Creek at Bee Ridge Road	-82.518494	27.298950	2479	2536	57	33	5	15%	●
10-11	PH-SG	Phillippi Creek at South Gate Community Center	-82.512040	27.306270	2536	2545	10	10	3	10%	●
10-11	RBS-BEN	Red Bug Slough at Brookridge Dr.	-82.517980	27.295970	2546	2560	15	0	0	0%	●
10-11	RBS-CLC	Red Bug Slough Lake near Beneva & Clark	-82.501250	27.277580	2561	2579	19	0	0	0%	●
10-11	RBS-PROC	Red Bug Slough at Proctor	-82.508310	27.284390	2580	2617	38	22	3	5%	●
10-11	RBS-WILK	Red Bug Slough at Wilkinson & Swift	-82.513850	27.291380	2618	2856	239	120	41	34%	●

11 sample locations identified – 3 with data from 2006 – 2008 only

Review Water Quality Data – Principle Components



Identified weak relationship between fecal and TP

Bacteria Source Determination

What are Fecal Indicator Bacteria (FIB) ?

- Have many possible sources
 - High risk (human sewage)
 - Moderate risk (cattle)
 - Low risk (wildlife, pets, decaying vegetation)
- May be present when pathogens are absent
- May be absent when pathogens are present

Class III Bacteria Water Quality Standards

Fecal Coliform (old standard)

- Not to exceed 400 cfu / 100 ml in *10% of the samples*
- Nor exceed 800 cfu / 100 ml on any one day

E. Coli (fresh)

- Not to exceed 410 cfu / 100 ml in *10% of the samples*

Enterococcus (marine)

- Not to exceed 130 cfu / 100 ml in *10% of the samples*

Bacteria Source Determination

Step 3 – Develop and Implement a Microbial Source Tracking Plan



Fecal Indicator Bacteria and Nutrient

- Fecal Coliform, E. Coli, Total Phosphorus



Personal Care Products

- Acetaminophen (pain reliever)
- Sucralose (artificial sweetener)



Quantitative PCR

- Extract and amplify bacteria DNA
- Compare to Human (HF 183), Dog, Bird

Develop and Implement a Microbial Source Tracking Plan

- Three sampling events
- Phased approach with 3 sets of samples each
 - Fecal Coiform, E. Coli and Total Phosphorus
 - Acetaminophen and Sucralose
 - DNA comparison to Human, Dog, and Bird
- If Fecal Coliform > 800 then analyze for other parameters

ANALYTICAL TEST REPORT
THESE RESULTS MEET NELAC STANDARDS

Submission Number : 18030560

Johnson Engineering, Inc.
2122 Johnson Street
Fort Myers, FL 33901
Tim Denison

Project Name : PHILLIPPI
Date Received : 03/13/2018
Time Received : 1530

TP > 049

Submission Number: 18030560
Sample Number: 001
Sample Description: 478-SV

Fecal > 800
E. coli > 410

Parameter	Result	Units	MDL	PQL	Procedure
TOTAL PHOSPHORUS AS P	0.007	MG/L	0.008	0.032	365.3
FECAL COLIFORM	880 #	#/100 ML	10	10	SM9222D
E. COLI BY IDEXX QUANTITRAY	1918	#/100 ML	10	10	SM9223B

Submission Number: 18030560
Sample Number: 002
Sample Description: BLOS

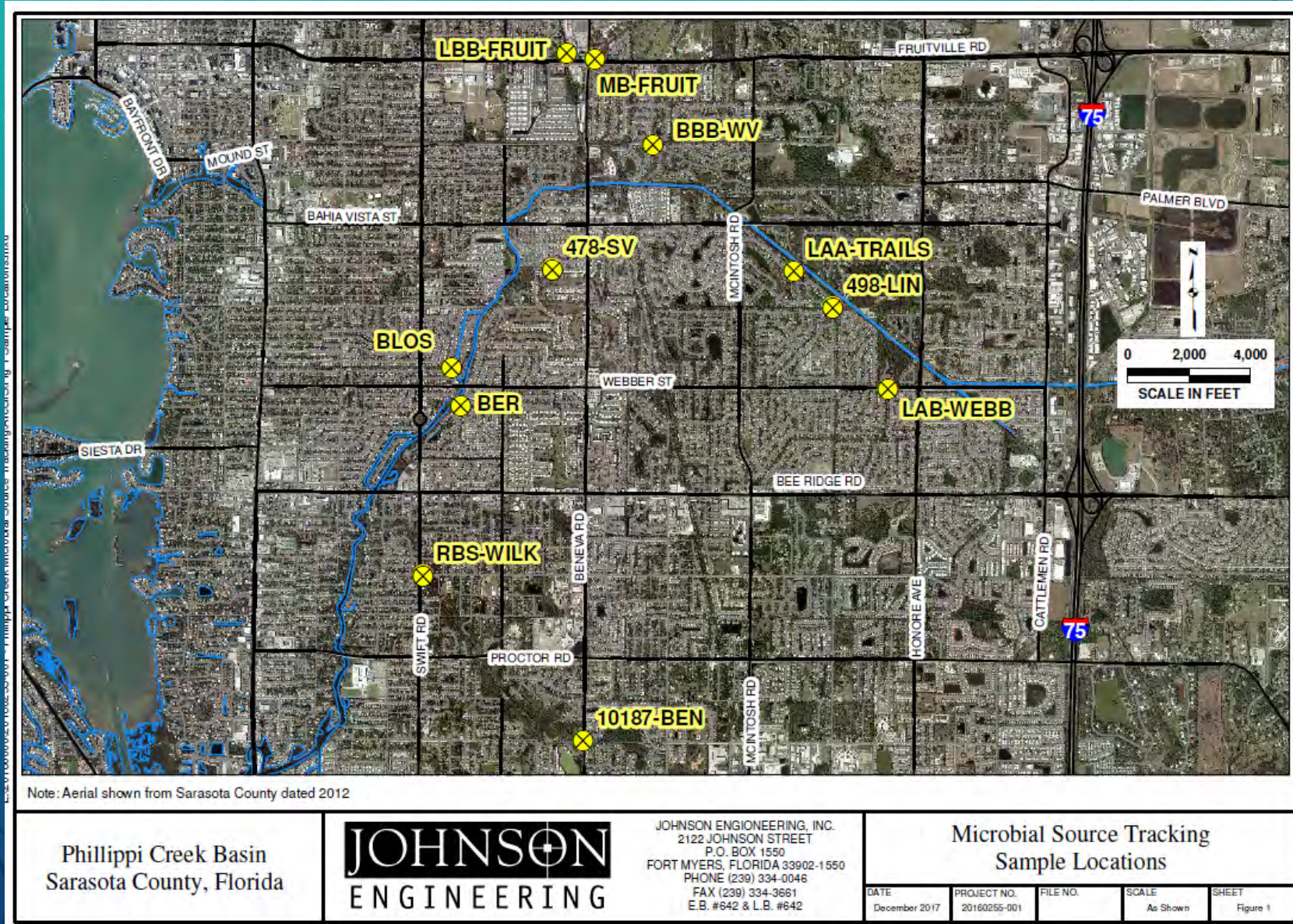
0.575

Parameter	Result	Units	MDL	PQL	Procedure
TOTAL PHOSPHORUS AS P	0.007	MG/L	0.008	0.032	365.3
FECAL COLIFORM	280	#/100 ML	10	10	SM9222D
E. COLI BY IDEXX QUANTITRAY	275	#/100 ML	10	10	SM9223B

Submission Number: 18030560
Sample Number: 003
Sample Description: BER

Parameter	Result	Units	MDL	PQL	Procedure
TOTAL PHOSPHORUS AS P	0.007	MG/L	0.008	0.032	365.3
FECAL COLIFORM	2400	#/100 ML	10	10	SM9222D
E. COLI BY IDEXX QUANTITRAY	2723	#/100 ML	10	10	SM9223B

Develop and Implement a Microbial Source Tracking Plan

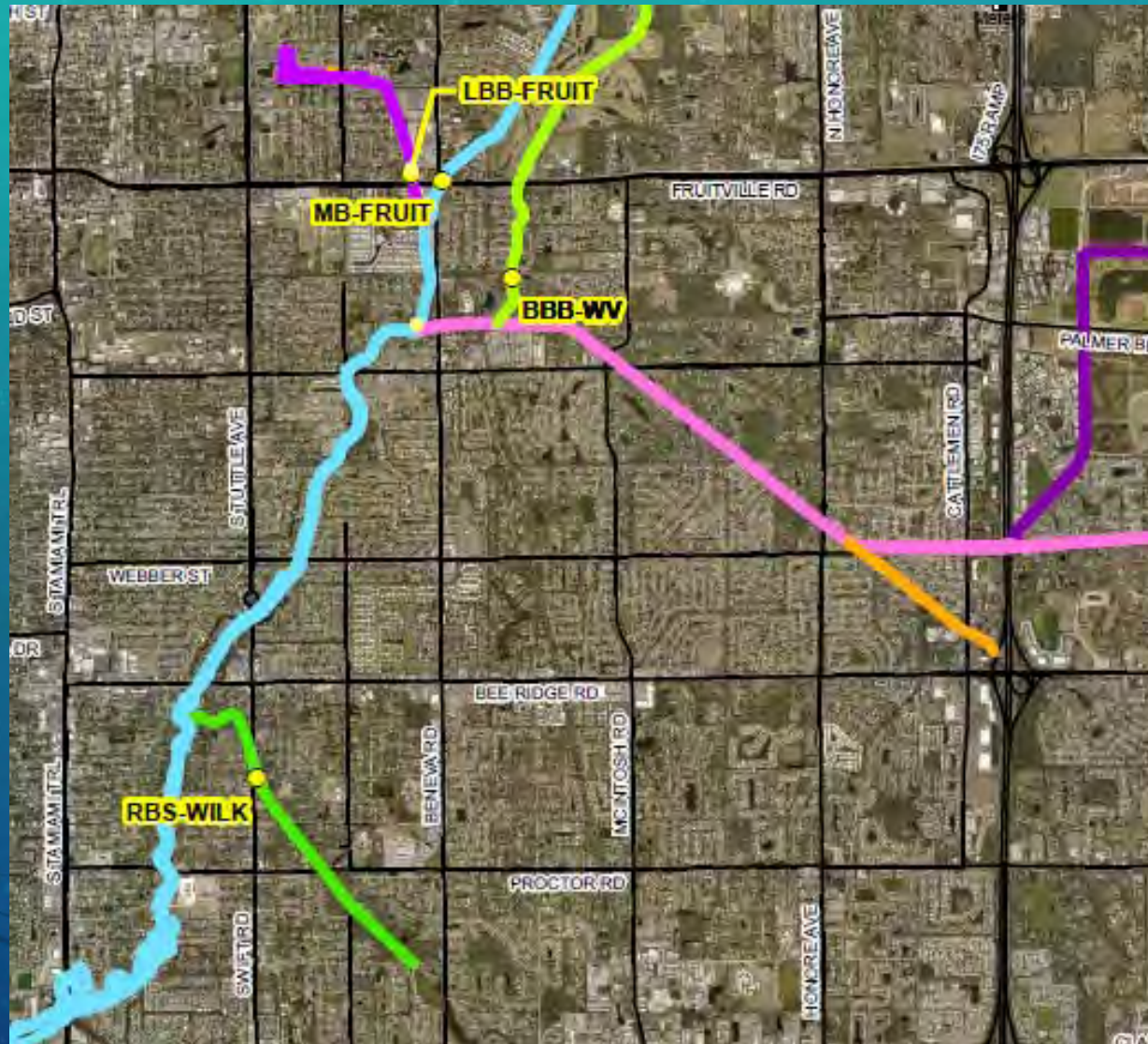


Develop and Implement a Microbial Source Tracking Plan



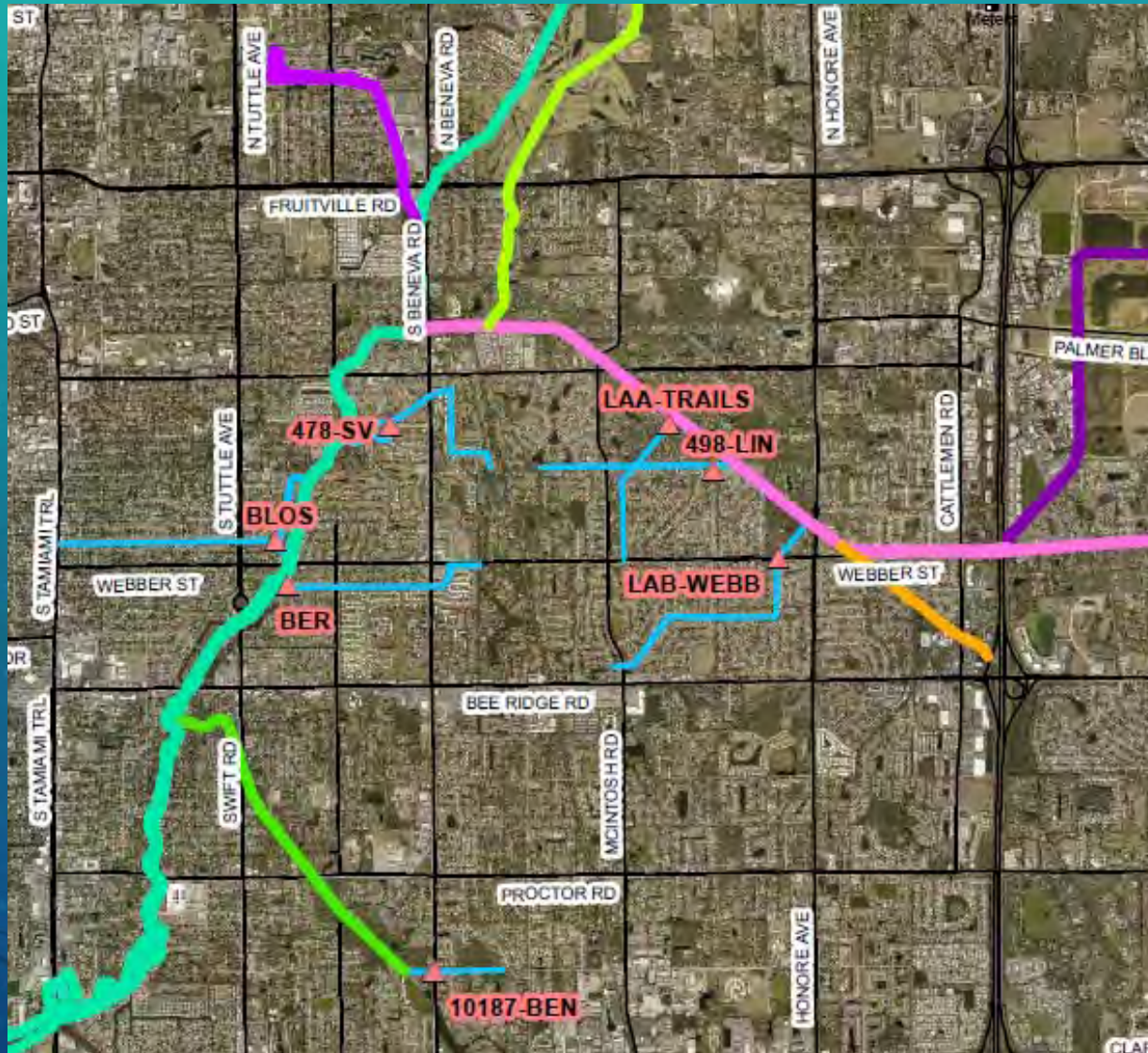
Phillippi Creek
Flow Directions

Develop and Implement a Microbial Source Tracking Plan



Major Tributary
Sample Locations

Develop and Implement a Microbial Source Tracking Plan



Minor Tributary
Sample Locations

Sampling Event #1

March 13th & 15th 2018

- Flow with no rainfall (baseline)
- Collected from 10 of 11 sites (too shallow at 498-LIN)
- 6 samples with fecal > 800
- 1 (LBB-FRUIT) > 5,000
- Acetamin. & sucralose (0 of 6)
- Bird – 5 of 6 samples
- Dog – 4 of 6 samples
- Human – 2 of 6 samples



Sampling Event #2

March 21st 2018

- Flow after 0.4" of rain
- Collected from all 11 sites
- 6 samples with fecal > 800
- 1 (LBB-FRUIT) > 5,000
- 3 more with E. Coli > 410
- Acetamin. & sucralose (0 of 6)
- Bird – 8 of 9 samples
- Dog – 7 of 9 samples
- Human – 4 of 9 samples



Sampling Event #3

April 16th 2018

- Flow after 1.0" of rain
- Collected from all 11 sites
- 11 samples with fecal > 800
- 498-LIN = 20,000
- LBB-FRUIT = 4,500
- 3 highest fecal/E. Coli analyzed for Acetamin. & sucralose
- Acetaminophen (0 of 3)
- Sucralose (2 of 3)
- Bird – 10 of 11 samples (10187-BEN = 25,100)
- Dog – 9 of 11 samples
- Human – 6 of 11 samples



Bacteria and Total Phosphorus (mean concentrations)

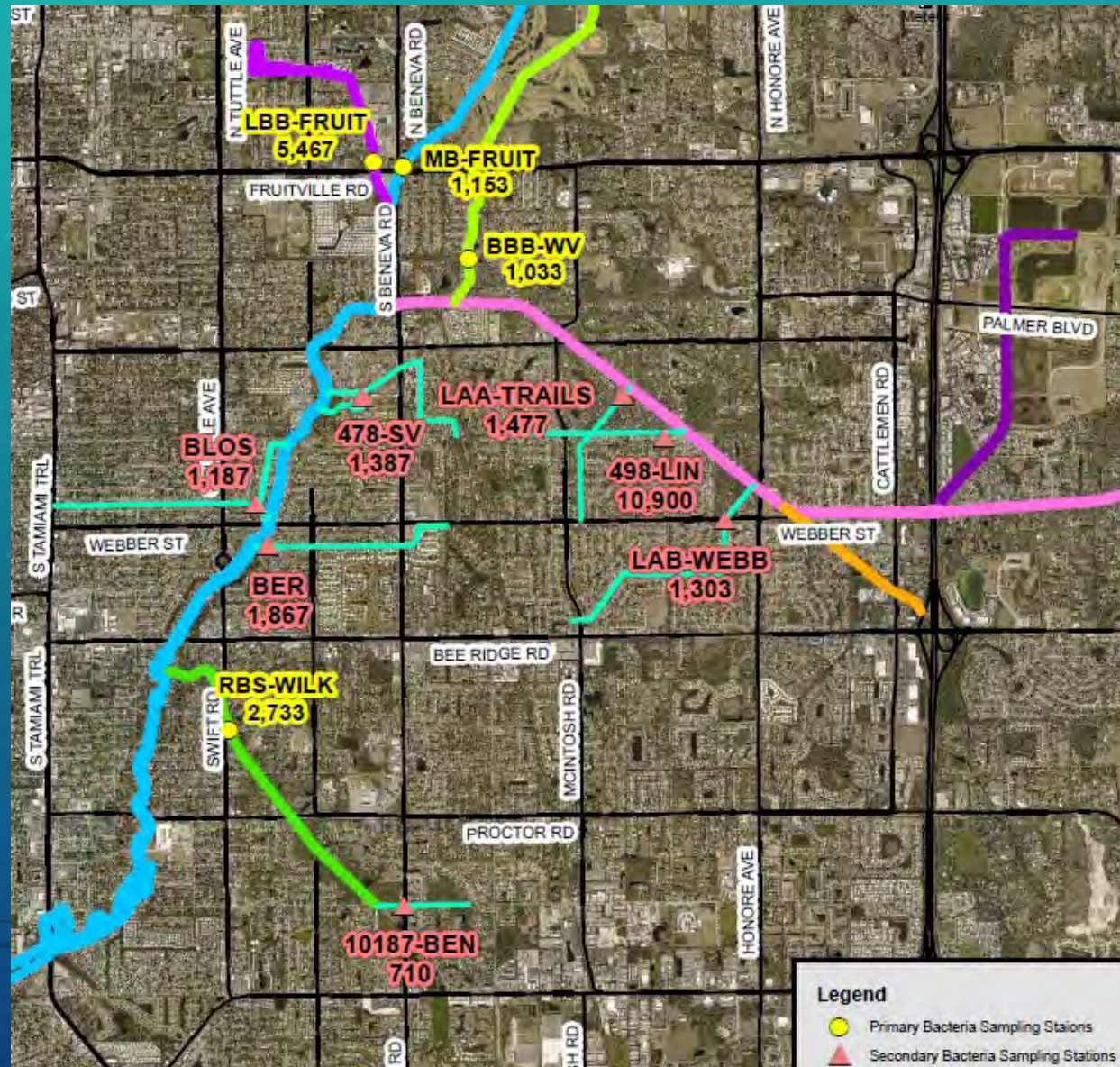
Fecal (counts per 100 ml)		E Coli (counts per 100 ml)		Total Phosphorus (mg/l)	
Sample ID	Mean	Sample ID	Mean	Sample ID	Mean
LBB-FRUIT	5,467	LBB-FRUIT	5,841	LBB-FRUIT	0.79
MB-FRUIT	1,153	MB-FRUIT	1,249	MB-FRUIT	0.46
478-SV	1,387	478-SV	2,528	478-SV	0.22
BLOS	1,181	BLOS	413	BLOS	0.53
BER	1,867	BER	4,361	BER	0.20
RBS-WILK	2,733	RBS-WILK	4,205	RBS-WILK	0.26
10187-BEN	710	10187-BEN	1,305	10187-BEN	0.30
BBB-WV	1,033	BBB-WV	1,558	BBB-WV	0.39
LAA-TRAILS	1,477	LAA-TRAILS	1,596	LAA-TRAILS	0.23
498-LIN	10,900	498-LIN	14,995	498-LIN	0.54
LAB-WEBB	1,303	LAB-WEBB	1,602	LAB-WEBB	0.41
Brown = Fecal > 800*		Brown = E. coli > 410**		Yellow = > 0.49***	
Red = Fecal > 5,000		Red = E. coli > 4,000			

LBB-FRUIT and 498-LIN highest Fecal Coliform

BER and RBS-WILK also had high E. Coli

Total Phosphorus values < twice annual threshold

Fecal Coliform (mean concentrations)

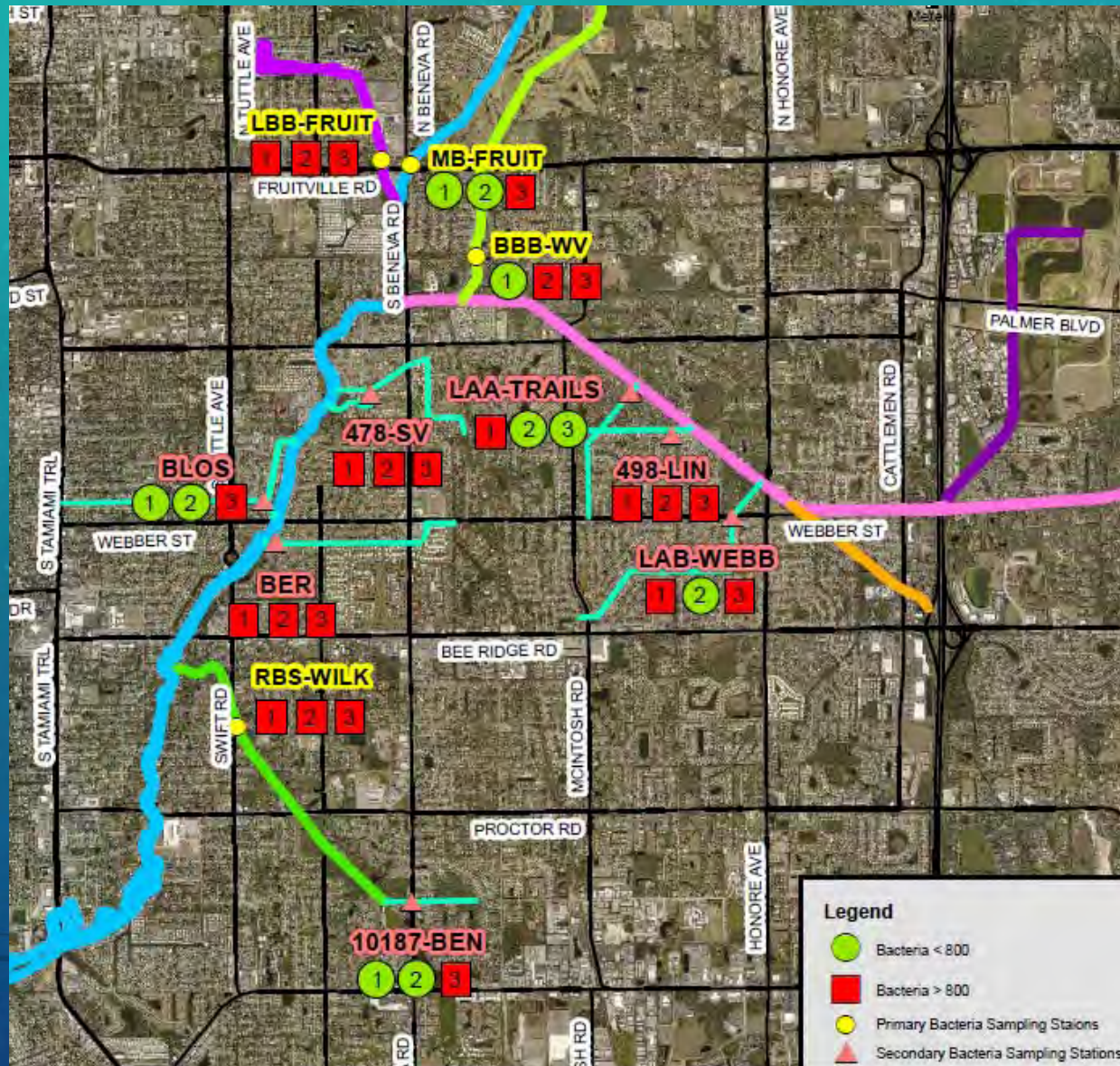


- All locations above > 800 except 10187-BEN
- Highest counts at LBB-FRUIT (major tributary) and 498-LIN (minor tributary)

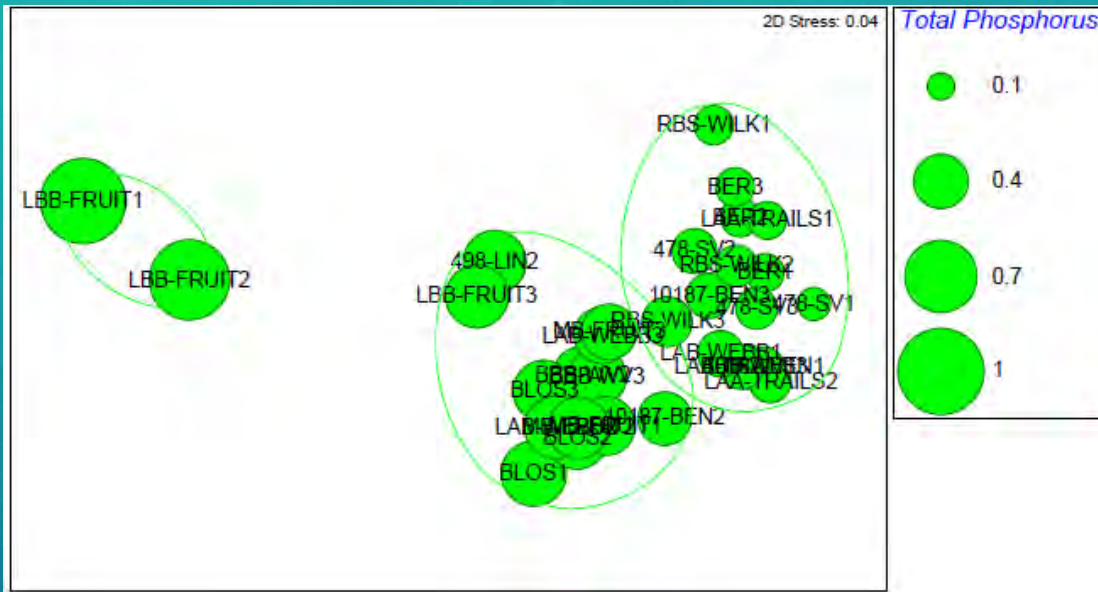
Fecal Coliform vs Rainfall (per sample event)

Event 1 0.0 inch
Event 2 0.4 inch
Event 3 1.0 inch

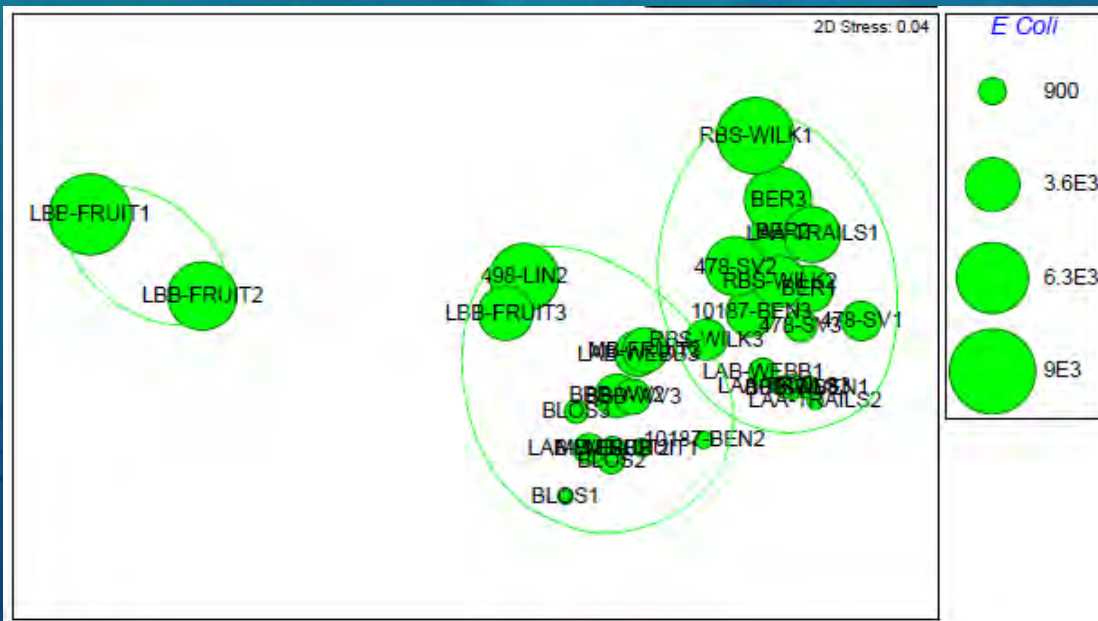
Green < 800
Red > 800



Multidimensional Scaling (MDS)



Normalized Total Phosphorus compared to Fecal Coliform and E. Coli.



Normalized E. Coli compared to Fecal Coliform and Total Phosphorus

Sucralose and Acetaminophen (max concentrations)



No hits > 0.5
ug/L MDL



2 hits > 0.625
ug/L MDL

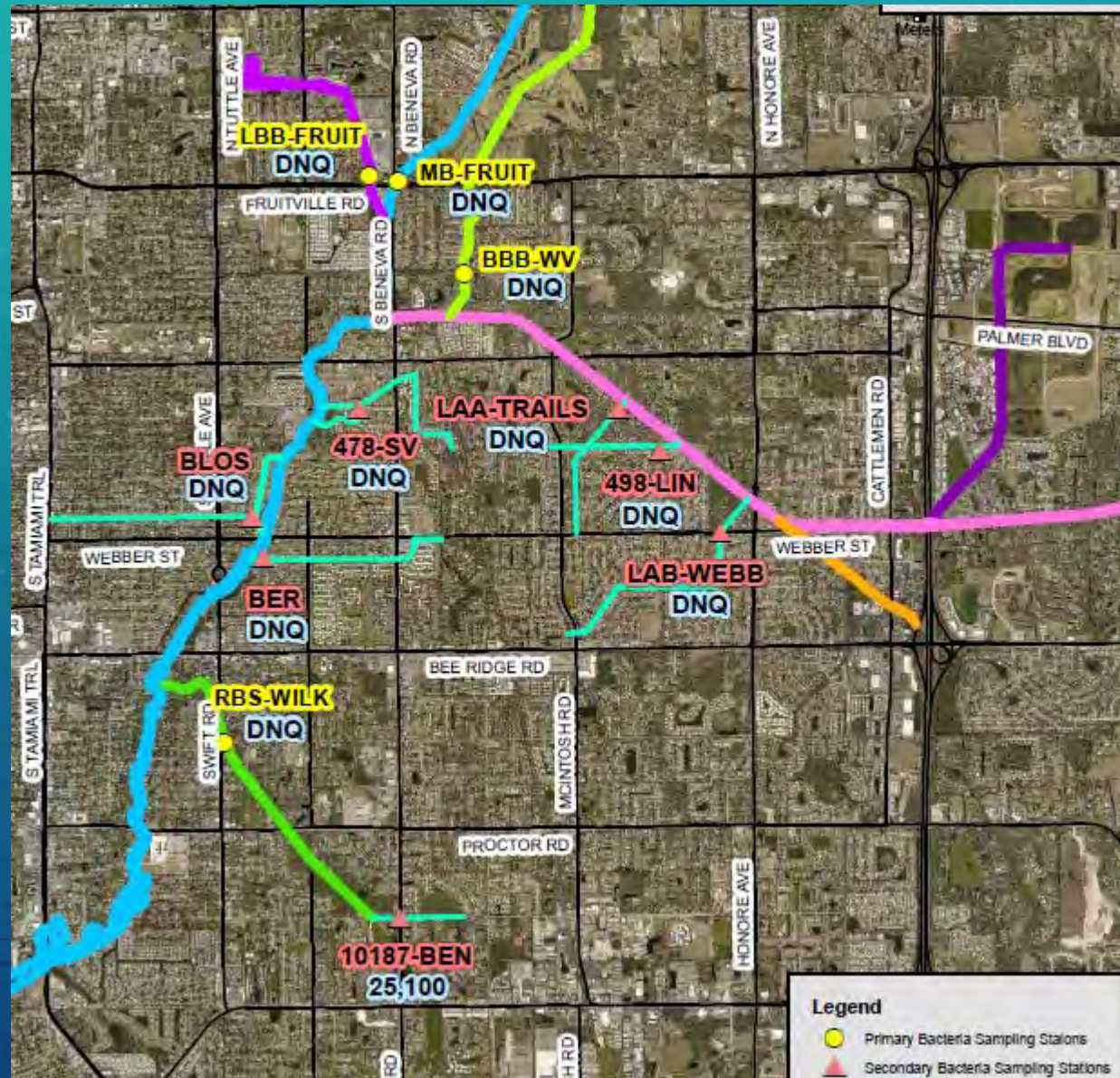
Sample ID	Max Concentration	
	Sucralose (ug/l)	Acetaminophen (ug/l)
LBB-FRUIT	1.29	ND
MB-FRUIT		
478-SV	ND	ND
BLOS		
BER	0.690 i	ND
RBS-WILK	ND	ND
10187-BEN		
BBB-WV	ND	ND
LAA-TRAILS	ND	ND
498-LIN	ND	ND
LAB-WEBB	ND	ND
Yellow = Sucralose i-Qualified		
Orange = Sucralose w/o "Q"		

DNA Analysis (max copies per 100 ml)

Max	Bird	Dog	Human
LBB-FRUIT	DNQ	4,500	300
MB-FRUIT	DNQ	248	DNQ
478-SV	DNQ	1,000	349
BLOS	DNQ	1,270	963
BER	DNQ	ND	DNQ
RBS-WILK	DNQ	466	ND
10187-BEN	25,100	554	253
BBB-WV	DNQ	304	517
LAA-TRAILS	DNQ	3,250	DNQ
498-LIN	DNQ	227	ND
LAB-WEBB	DNQ	ND	ND
ND = Not Detected			
DNQ = Detected Not Quantified			

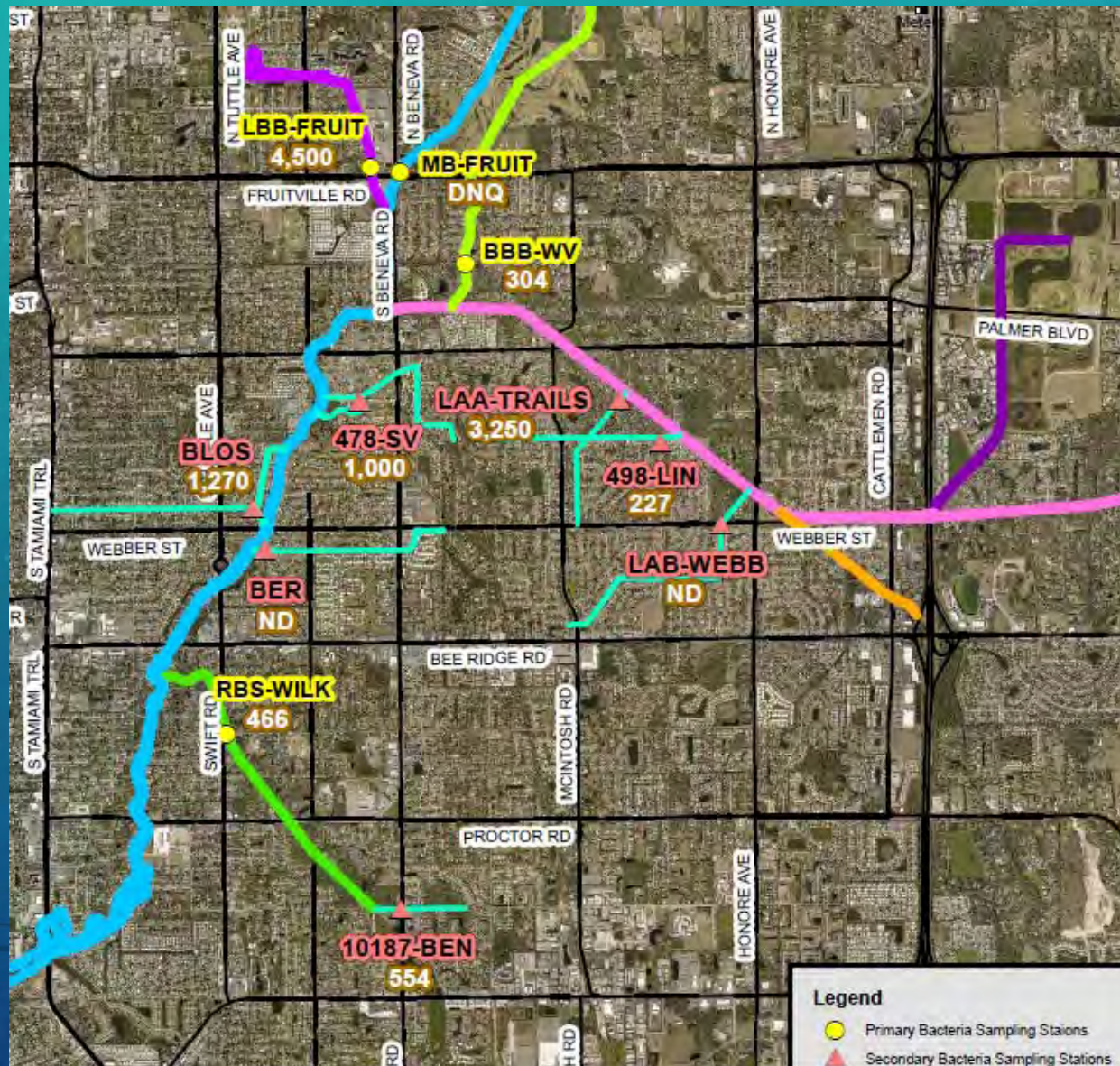
Very low bird bacteria detected at all sites except once
 Low to moderate dog bacteria detected at 9 of 11 sites
 Very low to low human bacteria detected at 8 of 11 sites

DNA Analysis – Birds (max count per site)



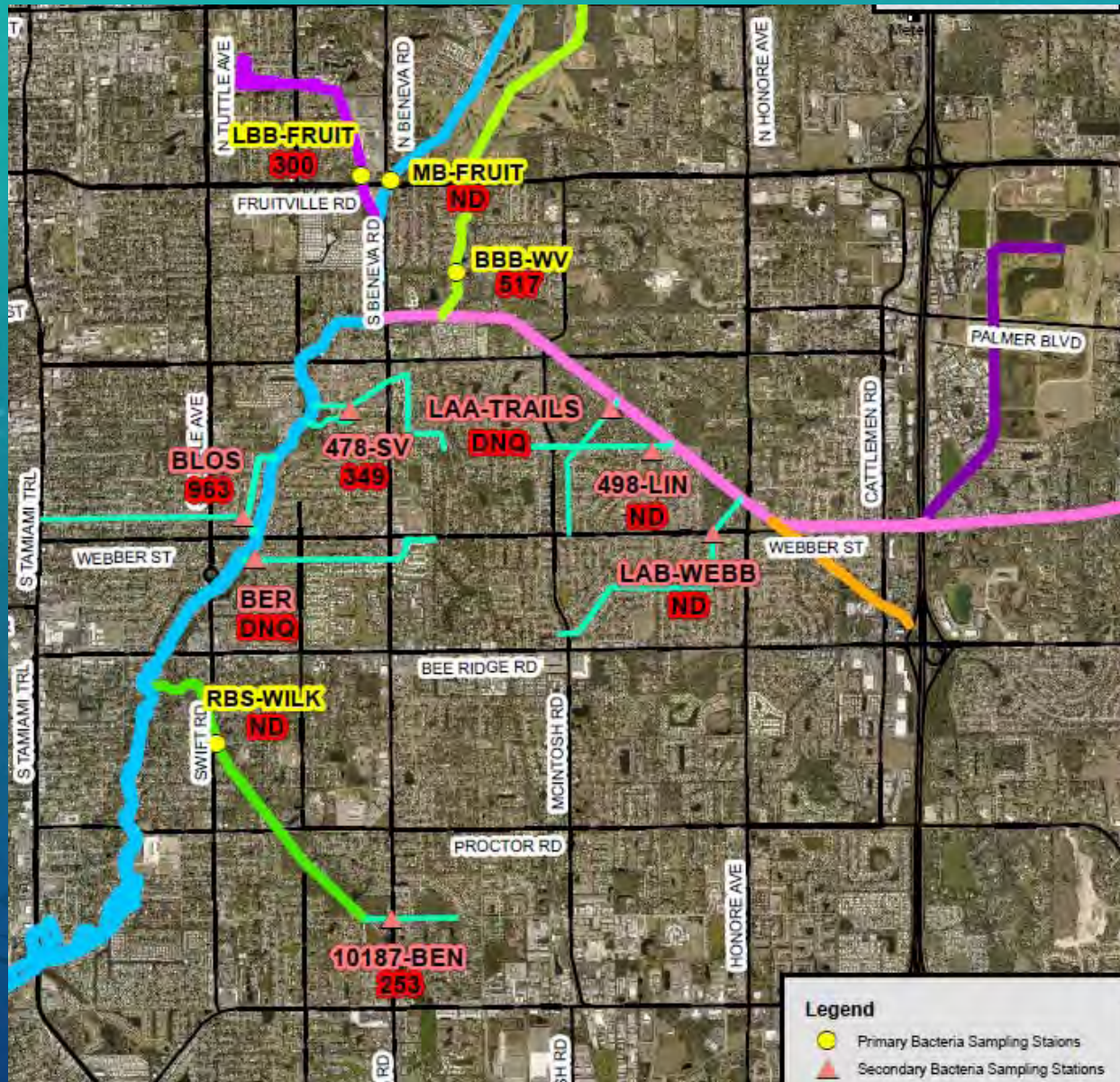
- All locations had hits too low to qualify (DNQ)
- Moderate hit in one sample at 10187-BEN near where flocks of birds sited

DNA Analysis – Dogs (max count per site)



- Hits along all major tributaries
- Highest counts at LBB-FRUIT
- Hits along all minor tributaries except BER and LAB-WEBB (Not Detected)

DNA Analysis – Humans (max count per site)

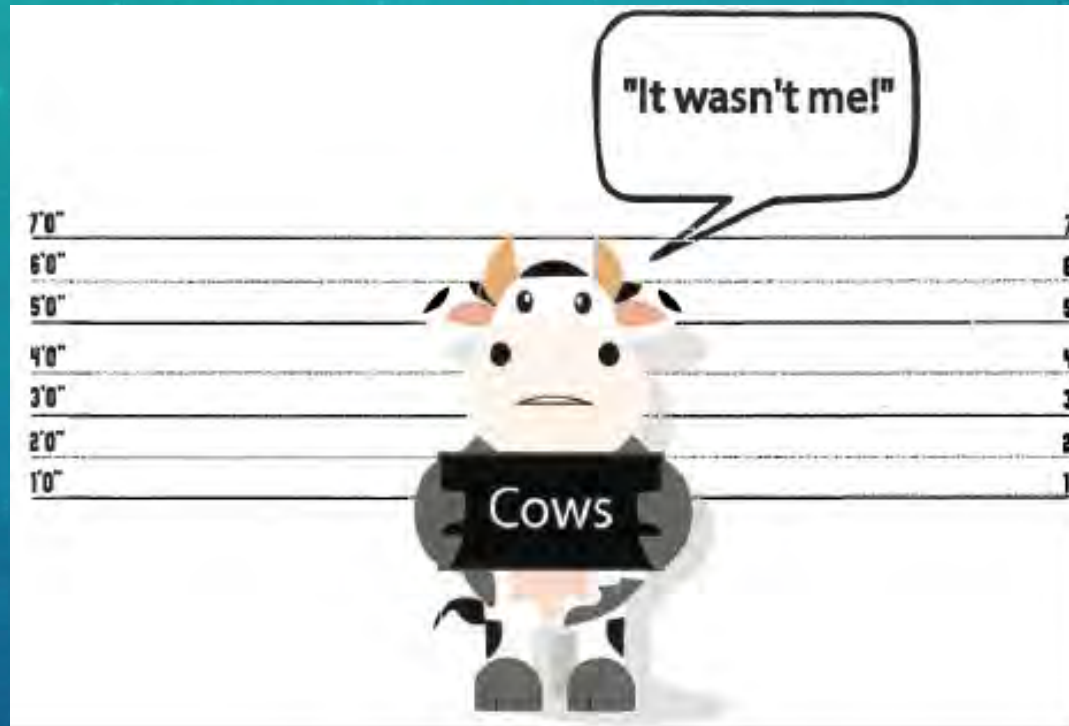


- Major tributary hits at LBB-FRUIT and BBB-WV
- Minor tributary hits at BLOS, 478-SV and 10187-BEN
- DNQ at BER and LAA-TRAILS
- ND at MB-FRUIT, RBS-WILK, 498-LIN and LAB-WEBB

Conclusions and Recommendations

- ✓ Fecal and E. Coli bacteria do not correlate with human bacteria
- ✓ LBB-FRUIT has high bacteria and has human influence (along with other sources)
- ✓ 498-LIN has high bacteria but no human influence (may be from raccoons or decaying leaves)
- ✓ Acetaminophen and Sucralose too difficult to detect
- ✓ Total Phosphorus levels not highly elevated
- ✓ Focus on where human influence is suspected
- ✓ Focus on major tributaries

Questions?



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