

Appendix A

Appendix A. Sample Site Descriptions for Gaineville Urban Creek Fecal Coliform, Fluorescent Whitening Agents and Microbial Source Tracking Monitoring, 2001 through 2007

Station ID	Station Description	Latitude	Longitude	Lat/Long Measurement Date	Datum	Travel Directions
ASHLEY19	Tributary to Hogtown Creek on Cumberland Circle, south of GHS. Banks are very steep.	29.66881	-82.34560	7/15/05	WGS84	From NW 16th Avenue, turn north on NW 16th Terrace, then west on NW 19th Circle (also called Cumberland Circle); left at stop sign to house #1627 and 1629; follow path on the left of house. Go down to the creek at the point that is in the middle of the duplex (may be a path). Address: 1627 NW 19th Circle.
BIV331	From SR 331 (Williston Rd) stop at single box cement culvert on the West side of the road, between Bivens Arm Nature Park and the FWC. Outfall from marsh may be stagnant or dry.	29.61649	-82.33578	7/19/05	WGS84	From University Ave and Main St. (SR 26) head South on Main St and continue to SR 331 (Williston Road). Veer to stay on SR 331 (Williston Rd). Travel about 672 feet (approx .12 mi.) from intersection. Stop at single box cement culvert on the West side of the road. Sample north of SR 331 (Williston Road) - this is east of US 441 (SW 13th St). This site is for outfall from marsh - can be stagnant or dry.
ELIZARBOR	Overgrown with vines, lots of trash.	29.65235	-82.35682	9/29/2005	NAD83	From University Avenue (SR 26) and Main Street (SR 329), head West on University Avenue (SR 26). Go north (right) on NW 23rd St. The Arboretum is on the west side of the road. Sample downstream of culvert at University Ave.
ELIZNW23	This site is approximately 10 meters upstream of the culvert at NW23rd St. The stream bank is eroded and has a narrow forested riparian buffer. The stream bottom is rocky, silt, with clay outcrops.	29.65331	-82.35664	4/26/06	WGS84	From University Avenue (SR 26) and Main Street (SR 329), head West on University Avenue (SR 26). Go north (right) on NW 23rd St. The creek crosses NW23rd st about 1/4 of a mile North of University Ave. Sample upstream of the crossing.
ELIZNW7	Herbaceous and forested riparian; driveway and lawn ~10 ft on west bank; banks are not steep; shifting sand bottom; outfall pipe just upstream of sample point. Site is located at: 2401 NW 7th Road; sample upstream of culvert.	29.65708	-82.36002	7/15/05	WGS84	From University Avenue (SR 26) at Main Street (SR 329), head West on University Avenue (SR 26). Then, turn North (right) onto NW 22nd Street and then turn west (left) on NW7th Road. Site is located at: 2401 NW 7th Road. Sample upstream of culvert.
ELIZNW7DS	Site is located downstream of the culvert at NW7th Road. Creek is braided through a wetland. There is a developed overstory and an understory. The stream bottom is sandy with lots of silt.	29.65708	-82.36002	6/8/05	WGS84	From University Avenue (SR 26) at Main Street (SR 329), head West on University Avenue (SR 26). Then, turn North (right) onto NW 22nd Street and then turn west (left) on NW7th Road. Site is located at: 2401 NW 7th Road. Sample approximately 100-200 meters downstream of culvert.
ELIZUNIV	Concrete. Can't sample in natural streambed due to fence along president's property.	29.65196	-82.35533	7/15/05	WGS84	From University Avenue (SR 26) and Main Street (SR 329), head West on University Avenue (SR 26) to just past NW 22nd St (and before SW 23rd Street. This is the 2nd stream crossing west of NW 22nd St. Sample on the south side of University Avenue, near UF President's house; sample between culvert and fence.
ELIZUNIVUS	Vegetated banks. Stream bottom sand, silt, and organics.	29.65207	-82.35430	9/29/2005	NAD83	From University Avenue (SR 26) and Main Street (SR 329), head West on University Avenue (SR 26) to just past NW 22nd St. This is the first stream crossing west of NW22nd St. Sample on the south side of University Avenue, near UF President's house.
GLENSP	Vegetated overstory and understory; banks are not steep; sand bottom. Sample downstream of sewer line.	29.67223	-82.34589	7/15/05	WGS84	From University Avenue (SR 26) and US 441 (NW 13th Street), head North on US 441 (NW 13th Street). Then, turn West (left) on NW 23rd Blvd; and go to Gaineswood Condos on south side of road, follow their signs to Recreation Center. Walk path between pool and tennis court; sample downstream of sewer line.
HOG30	Site is on the south side of CR 30 (SW 20th Avenue) on Hogtown Creek at bridge (east of SW 62nd Blvd). Banks are vertical, about 0.3m high. Stream bottom is soft sand. Staff gage is present. Flow direction is south.	29.63806	-82.39250	10/12/04	WGS84	From University Avenue (SR 26) and Main Street (SR 329), head West on University Ave (SR 26) to Saw 62nd Blvd. Turn South onto SW 62nd Blvd. and proceed to CR SW 30 (SW 20th Ave). Veer southward onto SW 20th Ave (CR SW 30). Site is on the south side of CR 30 (SW 20th Avenue) on Hogtown Creek at bridge (east of SW 62nd Blvd).
HOG30US	Site is on the North side of CR 30 (SW 20th Avenue) on Hogtown Creek at bridge (east of SW 62nd Blvd). Stream bottom is soft sand. Streambank is forested wetland. Flow direction is south.	29.63839	-82.39219	10/12/04	NAD83	From University Avenue (SR 26) and Main Street (SR 329), head West on University Ave (SR 26) to Saw 62nd Blvd. Turn South onto SW 62nd Blvd. and proceed to CR SW 30 (SW 20th Ave). Veer southward onto SW 20th Ave (CR SW 30). Site is on the north side of CR 30 (SW 20th Avenue) on Hogtown Creek at bridge (east of SW 62nd Blvd).
HOGCETRIB	This is a small trib, likely receiving roof runoff and stormwater from the apartments. It has a narrow forested buffer. There are little waterfalls you can collect samples from.	29.67434	-82.34432	8/13/07	NAD83	From University Avenue (SR 26) and NW 13th Street (US 441), head North on NW 13th St (US 441) to NW 23rd Street (Glen Springs Road). Turn West onto NW 23rd Street (Glen Springs Road). Then, turn North onto NW 16th Terrace into Creeks Edge Condos. Go west (left) at the first road. This will take you to a cluster of buildings. There is a small trib hidden by the trees running from the buildings south to Hogtown creek.
HOG EAST	Creek discharge from underground culvert; concrete at sample point	29.67748	-82.34200	7/15/05	WGS84	From University Avenue (SR 26) and Main Street (SR 329), head West on University Ave (SR 26) to NW 13th Street. Turn North onto NW 13th Street (US 441). Site is behind the old K-Mart shopping center (NW 13th Street and NW 23rd Avenue); creek discharging from underground culvert at sample point.

Appendix A. Sample Site Descriptions for Gaineville Urban Creek Fecal Coliform, Fluorescent Whitening Agents and Microbial Source Tracking Monitoring, 2001 through 2007

Station ID	Station Description	Latitude	Longitude	Lat/Long Measurement Date	Datum	Travel Directions
HOGGHSN	Developed overstory and understory; some undercut banks; sand bottom with some pebbles and organic matter.	29.67212	-82.34394	7/15/05	WGS84	From University Avenue (SR 26) and NW 13th Street (US 441), head North on NW 13th St (US 441) to NW 23rd Street (Glen Springs Road). Turn West onto NW 23rd Street (Glen Springs Road). Turn South onto NW 16th Terrace, then west on NW 22nd Circle (Hobbit's Glen). Road dead-ends at GRU LS #70 on top of steep bank (approx 38.9m southwest of lift station).
HOGGHSNASH	Site is upstream of culvert in the Ashley Creek Condo complex. The banks are steep and there is a lot of trash.	29.67081	-82.34158	4/26/06	WGS84	From University Avenue (SR 26) and NW 13th Street (US 441), head North on NW 13th St (US 441) to NW 16th Ave and Turn East. Turn North onto NW 16th Terrace, then east on NW19th Lane. Turn North into the Ashley Creek Condos and proceed east. The parking lot ends at an old stream crossing. Sample upstream.
HOGNW16	Hogtown Creek - in Ring Park, North of NW 16th Ave (between NW 18th Street and NW 20th Way). Sample 100m upstream from culvert under NW 16th Ave on Hogtown Creek. Banks are vegetated with some erosion and undercutting. Stream bottom is shifting sand with some sediment smothering. Stream flow direction is SE.	29.66703	-82.34863	10/12/04	WGS84	From University Avenue (SR 26) and NW 13th Street (US 441), head North on NW 13th St (US 441) to NW 16th Avenue. Turn West onto NW 16th Avenue. Pull in to Ring Park on the north side of NW 16th Avenue (between NW 18th Street and NW 20th Way). Sample 100m upstream from culvert under NW 16th Ave on Hogtown Creek.
HOGNW16S	Site is on NW 16th Avenue, west of NW 18th Street; sample south of NW 16th Avenue. Site is approx 91m downstream of HOGNW16. Banks are vegetated with some erosion and undercutting. Stream bottom is shifting sand with some sediment smothering. Stream flow direction is SE.	29.66658	-82.34930	7/20/05	NAD83	From University Avenue (SR 26) and NW 13th Street (US 441), head North on NW 13th St (US 441) to NW 16th Avenue. Turn West onto NW 16th Avenue and park on the side of the road. Site is on NW 16th Avenue, west of NW 18th Street; sample south of NW 16th Avenue. Site is approx 91m downstream of HOGNW16.
HOGNW19	Site is located at the wooden bridge on NW 19th Street on Hogtown Creek, and is south of NW 53rd Avenue; sample approx 6m downstream of bridge. Banks are vegetated and fairly steep (approx 9 ft.). Stream is shaded by canopy. Stream bottom is shifting sand with some large rocks. Flow is SE.	29.69785	-82.34715	7/14/05	NAD83	From University Avenue (SR 26) and NW 13th Street (US 441), head North on NW 13th St (US 441) to NW 45th Avenue. Turn West on NW 45th Avenue and go to NW 19th Street. Turn North onto NW 19th Street and go north for approx .13 miles. Site is located at the wooden bridge on NW 19th Street and is south of NW 53rd Avenue; sample approx 6m downstream of bridge.
HOGNW22	Site is located on NW 22nd Street, between NW 16th Avenue and NW 8th Avenue; sample Hogtown Creek downstream of NW 22nd Street at triple box cement culvert. Bank is steep, approx 2m high, with some vegetation and recently deposited sand. Stream bottom is soft sand. Flow direction is west.	29.66343	-82.35378	10/12/04	WGS84	From University Avenue (SR 26) and NW 13th Street (US 441), head West on W. University Ave (SR 26) to NW 22nd Street. Turn North onto NW 22nd Street and travel approx .76 miles. Site is located on NW 22nd Street, between NW 16th Avenue and NW 8th Avenue, at triple box cement culvert; sample downstream of NW 22nd Street.
HOGNW23	Site is at the Covered Bridge Apartments; sample approx 10m upstream of covered bridge. Banks are highly eroded, approx 7-8 ft high. Stream bottom is shifting sand with silt. Stream flow direction is south.	29.67483	-82.34337	10/12/04	WGS84	From University Avenue (SR 26) and NW 13th Street (US 441), head North on NW 13th St (US 441) to NW 23rd Street (Glen Springs Road). Turn West onto NW 23rd Street (Glen Springs Road). Then, turn North onto NW 16th Terrace. Site is at the Covered Bridge Apartments; sample approx 10m upstream of covered bridge.
HOGNW45	Site is located on the south side NW 45th Avenue at Hogtown Creek. Sample 1.5m downstream from double box concrete culvert. Banks are steep and vegetated; there are sandbags on the south side. Stream bottom contains shifting sands. Stream flow is west.	29.69558	-82.34520	10/12/04	WGS84	From University Avenue (SR 26) and US 441 (13th Street), head North on US 441 (NW 13th Street) to NW 45th Street. Turn West onto NW 45th Street. Site is located on the south side NW 45th Avenue at Hogtown Creek, about .4 mi. west of NW 22 Street. Sample 1.5m downstream from double box concrete culvert.
HOGNW53	This site is often dry. If possible sample downstream of NW53rd Ave. If this is too shallow you may have to sample the ponded area upstream of NW53rd Ave.	29.70299	-82.34926	8/13/07	NAD83	From University Avenue (SR 26) and NW 13th Street (US 441), head North on NW 13th St (US 441) then west on NW 53rd Avenue. Hogtown Creek is channelized here and goes under 53rd Ave approx 1/4 of a mile past NW19th St.
HOGNW8	Site is north of NW 8th Avenue on Hogtown Creek, about .4 mi. west of NW 22nd Street. Sample approx 24m upstream of culvert under NW 8th Ave. Banks are forested and not steep. Floodplain. Stream bottom is shifting sand, not much organic matter. Flow direction is south.	29.65955	-82.36065	10/12/04	WGS84	From W. University Avenue (SR 26) and Main Street (SR 329), head North on Main Street (SR 329) to NW 8th Avenue. Turn West (left) onto NW 8th Avenue (also called SR 26-A). Travel approx 2.14 mi. Site is north of NW 8th Avenue on Hogtown Creek, about .4 mi. west of NW 22nd Street. Sample approx 24m upstream of culvert under NW 8th Ave.

Appendix A. Sample Site Descriptions for Gaineville Urban Creek Fecal Coliform, Fluorescent Whitening Agents and Microbial Source Tracking Monitoring, 2001 through 2007

Station ID	Station Description	Latitude	Longitude	Lat/Long Measurement Date	Datum	Travel Directions
HOGSW2	Site is located on SW 2nd Avenue, between SW 34th Street and Newberry Road at pedestrian foot bridge by Hawaiian Village Apts on south side of SW 2nd Avenue; sample downstream of SW 2nd Avenue. Bank is high, channelized, mowed, with a small channel in the wide, flat bottom. Stream bottom has deep sand, very soft and shifting - little to no organic material. Flow direction is south.	29.65032	-82.37533	10/12/04	WGS84	From W. University Avenue (SR 26) and Main Street (SR 329), proceed West on SR 26 (University Ave) to SW 34th Street (SR 121). Site is located on SW 2nd Avenue (aka SR 26A), between SW 34th Street and Newberry Road at pedestrian foot bridge by Hawaiian Village Apts on south side of SW 2nd Avenue; sample downstream of SW 2nd Avenue.
HOGUSRAT	Herbaceous steep banks (~3 m); some undercut banks; exposed Hawthorn Group; shifting sand bottom with some pebbles. There is a house on the north bank.	29.66381	-82.35265	4/26/06	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed North on Main Street (SR 329) to NW 8th Avenue. Turn West on NW 8th Avenue and travel for 1.75 miles to NW 22nd Street. Turn North onto NW 22nd Street. Take foot trail on east side of street. A wooden pedestrian bridge on the foot trail crosses Rattlesnake Branch. The confluence with Hogtown Creek is just downstream. Walk the creek until you reach Hogtown Creek and then go upstream approximately 50 meters.
POSNW8	North of NW 8th Avenue. Sample approx 10m upstream of culvert. Banks are wooded and steep on the street side. Stream bottom is concrete. Stream flow direction is south.	29.65968	-82.36870	10/12/04	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed North on Main Street (SR 329) to NW 8th Avenue. Turn West on NW 8th Avenue and travel approx 2.66 miles to Possum Creek. Sample site is North of NW 8th Avenue before you get to NW 34th Street. Sample approx 10m upstream of culvert.
RATNW12	At intersection of NW 8th Avenue and NW 12th Street; sample at NE corner of the intersection.	29.65946	-82.33705	7/19/05	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed North on Main Street (SR 329) to NW 8th Avenue. Turn West on NW 8th Avenue and travel for .7 miles to NW 12th Street. Turn north on NW 12th Street. Sample at NE corner.
RATNW8	The banks are steep here and the channel is narrow. Sample approx 50 meters downstream of the NW8th Ave culvert.	29.65908	-82.34038	8/13/07	NAD83	From University Avenue (SR 26) and Main Street (SR 329), proceed North on Main Street (SR 329) to NW 8th Avenue. Turn West on NW 8th Avenue and travel under the NW13th St (441) bridge and then pull off to the south of the road. The creek is to the south of the road. Sample upstream of the culvert at NW8th Ave.
RATUSHOG	Sample downstream of wooden pedestrian bridge on foot trail, between NW 22nd Street and NW 18th Street. Herbaceous steep banks (~3 m); some undercut banks; exposed Hawthorn Group; shifting sand bottom with some pebbles.	29.66337	-82.35206	7/15/05	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed North on Main Street (SR 329) to NW 8th Avenue. Turn West on NW 8th Avenue and travel for 1.75 miles to NW 22nd Street. Turn North onto NW 22nd Street. Take foot trail on east side of street. Sample downstream of wooden pedestrian bridge on foot trail, between NW 22nd Street and NW 18th Street
ROSE331	Rosewood Branch - Upstream of SR 331	29 39 17.82	82 18 34.38	ACEPD FILL IN	NAD83	ACEPD FILL IN
ROSESE2	Rosewood Branch downstream of SE 2nd Avenue. Sample site is located on the Rosewood Branch downstream of SE 2nd Avenue (east of Waldo Road); approx 25m downstream of culvert. Banks are steep, undercut, and vegetated. Stream bottom is shifting sand with some concrete chunks.	29.65003	-82.30961	7/14/05	NAD83	From University Avenue (SR 26) and Main Street (SR 329), proceed East on SR 26 (University Avenue) to Williston Road and turn South onto SR 331 to SE 2nd Avenue. Turn East (left) on SE 2nd Avenue. Sample site is located on the Rosewood Branch downstream of SE 2nd Avenue (east of Waldo Road); approx 25m downstream of culvert.
ROSESE7	Site is forested with houses nearby. Lots of trash. The streambank is sand with rocks and rubble.	29.64590	-82.31270	4/25/06	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed East on SR 26 (University Avenue) to Williston Road and turn South onto SR 331 to SE 7th Avenue. Turn West (right) onto SE 7th Avenue. Pull off where the road goes over the creek (approx 1/4 of a mile from Williston Road). Sample upstream (north of road).
ROSESE9	Rosewood Branch upstream of SE 9th Street and SWB confluence. Site is located on Rosewood Branch upstream of SE 9th Street and SWB confluence; approx 30m upstream of culvert. Stream bottom is shifting sand.	29.64292	-82.31505	7/14/05	NAD83	From University Avenue (SR 26) and Main Street (SR 329), proceed East on SR 26 (University Avenue) to Williston Road and turn South onto SR 331 to SE 9th Avenue. Turn West (right) onto SE 9th Avenue. Then turn South (left) onto SE 9th Street. Site is located on Rosewood Branch upstream of SE 9th Street and SWB confluence; approx 30m upstream of culvert.
ROSEUNIV	Upstream of University Avenue. Sample on Rosewood Branch - just north of University Ave (SR 26).	29.65216	-82.30943	7/14/05	NAD83	From University Avenue (SR 26) and Main Street (SR 329), proceed West on SR 26 (University Avenue) to SW 34th Street (SR 121). Turn South (left) onto SW 34th Street (SR 121). Sample on Rosewood Branch - just north of University Ave (SR 26).
SPSTNW13	Site is to the West of NW 13th Street	29.68556	-82.33923	11/8/05	NAD83	From University Avenue (SR 26) and Main Street (SR 329), proceed West on SR 26 (University Avenue) to NW 6th Street (SR 20). Turn North (right) on NW 6th Street (SR 20). Site is to the West of NW 6th Street between NW 36th Avenue and NW 37th Avenue. Site is on Springstead Creek.

Appendix A. Sample Site Descriptions for Gaineville Urban Creek Fecal Coliform, Fluorescent Whitening Agents and Microbial Source Tracking Monitoring, 2001 through 2007

Station ID	Station Description	Latitude	Longitude	Lat/Long Measurement Date	Datum	Travel Directions
SWB331	Upstream of SR 331 (Williston Road) at double box cement culvert with trash screen and water lines. Site is approx 7m from culvert. Banks are steep, eroded, undercut with some aquatic vegetation. Stream bottom is soft, shifting sands. Flow is south.	29.63040	-82.32242	10/13/04	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed East on SR 26 (University Avenue) to Williston Road (SR 331) and turn South onto Williston Road (SR 331). Travel approx 1.8 miles to SWB. Site is located West of Williston Road between SE 1st Way and SW 16th Avenue Extension. Upstream of SR 331 (Williston Road) at double box cement culvert with trash screen and water lines.
SWBDPWeir	Concrete weir at the Duck Pond (concrete lined pond with sedimentation trap). North of NE 5th Avenue and between East and West branches of NE Boulevard; sample downstream of Duck Pond at weir.	29.65605	-82.31961	7/19/05	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed East on University Avenue (SR 26) to East Boulevard. Turn North onto East Boulevard for approx .3 miles to just past NE 5th Avenue. Site is located East of East Boulevard on Sweetwater Branch. North of NE 5th Avenue and between East and West branches of NE Boulevard; sample downstream of Duck Pond at weir.
SWBLF	Downstream of this site was stabilized by Gabion mattresses in 2005. The stream bed is shifting sand. The banks are eroded and there is some understory and overstory vegetation.	29.63571	-82.32257	8/13/07	NAD83	From University Avenue (SR 26) and Main Street (SR 329), proceed north on Main Street (SR 329) and then east on NE 13th Lane. This will dead end at the City of Gainesville's old landfill. You need a GRU System key to access. Keep going straight and then bear left toward the powerline crossing. Sample upstream of the crossing (where the pump around was during the restoration of this area).
SWBNE10	Concrete single box culvert east of Main Street (SR 329) beneath NE 10th Avenue. Bank is constructed (concrete), vegetation on south side. Stream bottom is sand and gravel with vegetation. Stream flow is east.	29.66107	-82.32348	10/13/04	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed North on Main Street (SR 329) to NE 10th Avenue. Turn East onto NE 10th Avenue. Sample site is on the South side of the road (before NE 10th Avenue turns into East Boulevard); concrete single box culvert east of Main Street (SR 329) beneath NE 10th Avenue. NOTE: This site is not on SWB.
SWBNE2	Sweetwater Branch - Downstream of NE 2nd Street	29 39 39.204	82 19 22.728	ACEPD FILL IN	WGS84	ACEPD FILL IN
SWBNE6	Newly restored section of creek; limerock and chert boulders line banks. North of NE 6th Avenue and between East and West branches of NE Boulevard; sample upstream of culvert at NE 6th Avenue.	29.65697	-82.31973	7/19/05	WGS94	From University Avenue (SR 26) and Main Street (SR 329), proceed North on Main Street (SR 329) to NE 6th Avenue. Turn East onto NE 6th Avenue. Site is North of NE 6th Avenue and between East and West branches of NE Boulevard; sample upstream of culvert at NE 6th Avenue.
SWBNW16	Channelized section south of NW 16th Avenue. Sample approx 40m from culvert on south side of NW 16th Ave. Stream is channelized. Banks are steep with vegetation and grass. Stream bottom is fine silt and sand with lots of organic material. Stream flow (when flowing) is south.	29.66647	-82.32578	10/13/04	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed North on Main Street (SR 329) to NW 16th Avenue. Turn West onto NW 16th Avenue and travel approx .08 miles and park (site is located between N. Main Street (SR 329) and NW 2nd Street). Site is to the South of NW 16th Avenue on SWB. Channelized section south of NW 16th Avenue. Sample approx 40m from culvert on south side of NW 16th Ave.
SWBSE1	Behind Library and Post Office at SE 1st Avenue; east of SE 3rd Street; in Sweetwater Park at Union Promenade beneath pedestrian bridge; sample upstream of concrete single box culvert. Some sand bags on bank and bottom, undercut; abundant exotic vegetation. Stream bottom is sand, gravel, vegetation. Staff gage for relative water levels only. Flow direction is south.	29.65118	-82.32059	7/19/05	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed East on University Avenue to SE 3rd Street. Turn South onto SE 3rd Street, then turn East onto SE 1st Avenue. Behind Library and Post Office at SE 1st Avenue; east of SE 3rd Street; in Sweetwater Park at Union Promenade beneath pedestrian bridge; sample upstream of single concrete box culvert.
SWBSE2	Behind Post Office at SE 2nd Avenue. Sample 6m upstream of single box culvert with baffle box. Banks are vegetated (macrophytes). Stream bottom is sandy with rocks. Flow is south.	29.64967	-82.32027	11/8/05	NAD83	From University Avenue (SR 26) and Main Street (SR 329), proceed East on University Avenue to SE 3rd Street. Turn South onto SE 3rd Street, then turn East onto SE 1st Avenue. Behind Post Office at SE 1st Avenue; east of SE 3rd Street; Behind Post Office at SE 2nd Avenue just downstream from SWBSE1 station. Sample 6m upstream of single box culvert with baffle box.
SWBSE4	Site is upstream of SE4th St (South of the FSB). There is a homeless camp upstream. N Banks are ~3m high and wooded. Stream bottom is soft sand. Flow direction is WSW.	29.63805	-82.31809	10/13/04	WGS84	From University Avenue (SR 26) and Main Street (SR 329), proceed East on University Avenue to SE 3rd Street. Turn south on SE 3rd Street. Go East at the stop sign at Depot Ave, then bear right (south). Pass the Fire Rescue building and proceed until you go over Sweetwater Baranch. Park on the west side of the road.
SWBSE8ST	This site is channelized. There is herbaceous vegetation. The streambed is shifting sand.	29.64374	-82.31653	8/13/07	NAD83	From University Avenue (SR 26) and Main Street (SR 329), proceed East on SR 26 (University Avenue) to Williston Road and turn South onto SR 331 to SE 7th Avenue. Turn West (right) onto SE 7th Avenue. Turn South on SE 8th St. Sample approximately 20 meters upstream of where the street crosses the creek.

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Station ID	Station Description	Latitude	Longitude	Lat/Long Measurement Date	Datum	Travel Directions
TUM441	Site is located west of SW 13th Street on Tumblin Creek between SW 18th Place and SW 21st Avenue. Approx 1m downstream of structure (concrete channel). Water flows through concrete channel, flowing into dredged channel with sandbars. Stream bottom is soft sand - shifting. Sand is accumulating in the concrete channel.	29.63317	-82.34058	12/14/04	WGS84	From University Avenue (SR 26) and US 441 (13th Street) turn South onto SW 13th Street (US 441) past Archer Road (SR 24). Site is located west of SW 13th Street on Tumblin Creek between SW 18th Place and SW 21st Avenue. Approx 1m downstream of structure (concrete channel end - not the triple box culvert [and not the pedestrian bridge either]).
TUM72DS	72 inch stormpipe servicing the University/13th st area. This comes in south of the stormwater park. Sample in the pool where the pipe discharges.	29.64559	-82.33274	8/13/07	NAD83	From University Avenue (SR 26) and US 441 (13th Street) turn South onto SW 13th Street (US 441). Turn East onto SW 5th Avenue. Turn South on SW7th Terrace. Park where it dead ends and follow path south. Sample in the pool where the pipe discharges.
TUMPORTERS	This site is the stormwater pipe coming in from the east just south of Depot Road.	29.64423	-82.33176	4/27/06	WGS84	From University Avenue (SR 26) and US 441 (13th Street) go east on University Ave. Go south on SW6th St until you reach Depot Ave. Pull up onto the sidewalk on the south side of Depot. The site is north of the apartments and south of Depot Ave.
TUMSW11	Steep eroding banks. Streambed rocky with rubble.	29.63952	-82.33636	8/13/07	NAD83	From University Avenue (SR 26) and US 441 (13th Street) go south on 13th Street. Go east on SW 11th Ave. At the stop sign go south on SW 11th St. Pull off at the GRU access right away before you approach PK Yonge school. The creek is behind the houses.
TUMSW5	South of SW 5th Avenue. Sample ~ 60m downstream of structure (single pipe culvert beneath SW 4th Avenue). Banks are steep and vegetated with some undercutting. Stream bottom has soft sand, rip rap, trash and debris. Flow is southeast.	29.64705	-82.33366	12/14/04	WGS84	From University Avenue (SR 26) and US 441 (13th Street) turn South onto SW 13th Street (US 441). Turn East onto SW 5th Avenue. Site is located south of SW 5th Avenue and is between SW 10th Street and SW 8th Street. Sample ~60m downstream of structure (single pipe culvert beneath SW 4th Avenue).
TUMSW9	From Depot Road, turn south on SW 9th Street; between Tumblin Creek Apartments and Tumblin Creek II Apartments; sample upstream of SW 9th Street. Steep banks, deeply incised, erosion from high stormwater flows, exposed Hawthorn Group; sand bottom with some clays.	29.64182	-82.33302	7/19/05	WGS84	From University Avenue (SR 26) and US 441 (13th Street) turn South onto SW 13th Street (US 441) to SW 9th Road. Turn East onto SW 9th Road. Turn South onto SW 9th Street. Site is located between Tumblin Creek Apartments and Tumblin Creek II Apartments; sample upstream of SW 9th Street.

NM = Not Measured; N/A = Not Applicable

At least one fecal coliform sample was collected from the following sites, but they are not routine sites and are not listed in the above list: ETUMMAIN, HATWALDON, HCRETENTION, HCWETLAND, HOGGHN16, HOGGHSNDOWN, HOGGHNUP, HOGNW30, HOGNW39, POSNW45, PP441, PPCAMP, RATNW18, RATNW22, RATT8&13, RATT@13, RATT@8, SWBNE16, SWBNE4, SWBNE7, SWBNEBLVD, SWBNW14, TUM48DI

Appendix B

Land Use Classification Legend

 Wetland forested mixed	 Tree crops	 Residential, low density - < 2 dwelling units/acre
 Freshwater marshes	 Citrus groves	 Rural residential
 Wet prairies	 Abandoned tree crops	 Low density under construction
 Emergent aquatic vegetation	 Cattle feeding operations	 Residential, medium density - 2-5 dwelling units/acre
 Mixed scrub-shrub wetland	 Poultry feeding operations	 Medium density under construction
 Rural land	 Nurseries and vineyards	 Residential, high density - 6/more dwelling units/acre
 Borrow areas	 Tree nurseries	 High density under construction
 Spoil areas	 Ornamentals	 Commercial and services
 Airports	 Specialty farms	 Oil & gas storage (except areas assoc. with industrial)
 Roads and highways (divided 4-lanes with medians)	 Horse farms	 Cemeteries
 Communications	 Dairies	 Commercial & services under construction
 Electrical power facilities	 Aquaculture	 Food processing
 Electrical power transmission lines	 Other open lands - rural	 Timber processing
 Water supply plants	 Fallow cropland	 Mineral processing
 Sewage treatment	 Herbaceous upland nonforested	 Other light industrial
 Surface water collection ponds	 Shrub and brushland	 Industrial under construction
 Pine flatwoods	 Mixed upland nonforested	 Extractive
 Longleaf pine - xeric oak	 Sand & gravel pits (must be active)	
 Upland hardwood forests	 Rock quarries	
 Xeric oak	 Institutional	
 Upland mixed coniferous/hardwood	 Military	
 Australian pine	 Golf courses	
 Coniferous pine	 Marinas & Fish Camps	
 Forest regeneration	 Parks and Zoos	
 Streams and waterways	 Community recreational facilities	
 Lakes	 Other recreational (stables, go-carts, ...)	
 Open water within a freshwater marsh / Marshy Lakes	 Open land	
 Reservoirs - pits, retention ponds, dams	 Inactive land with street pattern but no structures	
 Bay swamp (if distinct)	 Improved pastures (monocult, planted forage crops)	
 Mixed wetland hardwoods	 Unimproved pastures	
 Cabbage palm hammock	 Woodland pastures	
 Cypress	 Row crops	
 Hydric pine flatwoods	 Field crops	
	 Mixed crop	

Appendix C

Gap Analysis Summary Table

Entity	Studies/Sampling Efforts and BMPs	Status of Implementation					
		SWBNE10	ROSESE9	HOGNW23	RATUSHOG	ELIZUNIV	TUMSW5
ACEPD	<i>Studies/Sampling Efforts</i>						
	FWAs, fecal coliform, and field parameters, 2005 (ACEPD 2008)	X	X	X	X		X
	FWAs, alternative microbial indicators, microbial source tracking, fecal coliform, and field parameter results at “hot spots”, April 2006 (ACEPD 2008)	X	X	X	X	X	X
	FWAs, microbial source tracking, fecal coliform, and flow results at “hot spots” April 2007 (ACEPD 2008)	X	X	X	X		X
	Fecal coliform data for high frequency sampling pilot on Tumblin Creek, December 2006 (ACEPD 2008)						X
	Fecal coliform data for high frequency sampling, July 2007 (ACEPD 2008)	X	X		X	X	X
	Wildlife surveys of fecal coliform “hot spot” sections of the Gainesville Urban Creeks, July and August 2007 (ACEPD 2008)		X				
	<i>Stormwater & Non-point Sources Programs</i>						
	Address requirements of the NPDES, through public outreach (e.g., WAV Program, Publication of educational material, coordinate with grassroots groups including Current Problems Inc., TV commercials, increase awareness of proper disposal of pet wastes) construction site stormwater controls, post construction stormwater controls, and good housekeeping in municipal operations						
	Implementation of IDDE Program	X	X	X	X	X	X
GRU	<i>Studies/Sampling Efforts</i>						
	Tracking and investigating microbial sources in Gainesville's urban creeks Final Report CH2M HILL, Biological Consulting Services of North Florida (2007)	X	X	X	X	X	X
	<i>Preventative Programs</i>						
	Implementation of an improved FOG Program						
	Implementation of an SSO Root Cause Program						
	Implementation of a Pop-Top Program						
	Implementation of Public Outreach and Education Programs to limit illicit connections to public and private sanitary sewer infrastructure						
	Implementation of a Manhole Monitoring Program						
	<i>WWTF and Lift Stations</i>						
	Evaluation of dry vs. wet weather flows (single events)						
	Evaluation of wet well and pump station hours of operation (SCADA)						
	Evaluation of wet well alarm level vs. max wet well level						
	Evaluation of wet well level (SCADA vs. street level)						
	Evaluate opportunities and existing operation for diverting flows during peak flow events						
	Implement time-out program at pump stations						
	Identify special issues (e.g., increased metal levels, bacteria die-off)						
	Retrofit wet wells as necessary						
	<i>Manholes</i>						
	Identify welded manholes and monitor for operational deficiency						
	Pop-Top Program						
	Fiberglass-line manholes						
	Repair (e.g., fiber glass line) as necessary and include in manhole monitoring program						
	<i>Forced Mains and Gravity Sewer Lines</i>						
	Ultra-sonic testing						
	Inspect forced main ARVs within 200' of surface waters						
	Identify cross-connections, leaks, and blockages (use smoke/dye testing and CCTV)						
	Repair valves and lines (prioritize based on size, defect, and proximity to surface waters) when necessary (e.g. trenchless repairs)						

Entity	Studies/Sampling Efforts and BMPs	Status of Implementation					
		SWBNE10	ROSESE9	HOGNW23	RATUSHOG	ELIZUNIV	TUMSW5
GRU	Investigate gravity lines contributing flows to forced mains						
	Evaluate opportunities and existing operation to increase flow carrying capacity (e.g., pipe bursting)						
	Slip line gravity mains adjacent to surface waters						
	Inspect areas where lines cross creek						
	Identify and maintain detailed GIS infrastructure database (including records of cross-connections and illicit discharges)						
ACDH	<i>Studies/Sampling Efforts</i>						
	Fecal coliform loading attributed to OSTDS in the Hogtown, Tumblin, and Sweetwater Creek Systems, in Gainesville, Florida (ACHD 2006)	X	X	X	X	X	X
	<i>OSTDS and Public Outreach and Education Programs</i>						
	Complaint-driven OSTDS Inspection Program	X	X	X	X	X	X
	Sanitary Nuisance Program	X	X	X	X	X	X
	Department of Health-sponsored certification program for haulers						
	Community-based onsite management system program in environmentally suitable areas (e.g., proper soils and distance from surface waters)						
	Education and public outreach on proper preventative maintenance procedures						
	Identification of failure areas using standard ranking protocol and determine if transition to centralized sewer system is appropriate						
	Initiation of a septic tank phase-out program						
	Identification of areas throughout the County where OSTDS are not suitable (e.g., soils, proximity to surface waters)						
	Implementation of IDDE Program						
Alachua County/City of Gainesville	<i>OSTDS-Related Ordinances</i>						
	Development/implementation of an ordinance to execute new maintenance and design requirements for environmentally sensitive areas (e.g., use of performance based systems and operating permits)						
	Development/implementation of an ordinance for a subsidized septic tank-pumping program						
	Development/implementation of an ordinance for a program in which septic tanks must be inspected when home ownership changes						
	Development/implementation of a county-wide mandatory OSTDS inspection, maintenance, and tracking program headed by the ACHD						
	Development/implementation of an ordinance to abolish the repair code to require repairs to comply with current standards						
	<i>Private Sewer infrastructure</i>						
	Development/implementation of an ordinance for regulating (permitting, inspection, enforcement) of privately owned wastewater systems (e.g., lift stations) enforced by the ACEPD						
	<i>Stormwater& Non-Point Sources</i>						
	Implementation of the NPDES Phase II MS4 program	X	X	X	X	X	X
	Digitizing and mapping of all storm sewer infrastructure	X	X	X	X	X	X
	Visual inspection for transient populations						
	Development/implementation of an ordinance to control urban camping in specific areas of the basin						
	Address requirements of the NPDES, through public outreach (e.g., WAV Program, Publication of educational material, coordinate with grassroots groups including Current Problems Inc., TV commercials, increase awareness of proper disposal of pet wastes) construction site stormwater controls, post construction stormwater controls, and good housekeeping in municipal operations						
	Implementation of IDDE Program						
	Development/implementation of an ordinance to address pet wastes (e.g., pet waste stations/removal required in specific areas)						
COG PWD	<i>Stormwater System Evaluation</i>						
	CCTV stormwater system for cross-connections to sewer						
	CCTV stormwater system for blockages (e.g., sediments and debris)						
	Routine maintenance/cleanout (box culverts, baffle boxes, and underground infrastructure (e.g., storage units)						

Entity	Studies/Sampling Efforts and BMPs	Status of Implementation					
		SWBNE10	ROSESE9	HOGNW23	RATUSHOG	ELIZUNIV	TUMSW5
COG PWD	Implementation of IDDE Program						
	Visual inspection of stormwater system (e.g., leaking manholes; evidence of wildlife living in culverts)						
	Installation of screens at outfalls to keep animals out						
	Identify and maintain detailed GIS infrastructure database (including records of cross-connections and illicit discharges)						
	Implementation of Structural BMPs						
	Filtration/dry detention with filtration						
	Infiltration/dry retention						
	Bioretention						
	Baffle boxes						
	Treatment trains						
	Implementation of Supplemental BMPs						
	Ultra-violet light disinfection						
	Ozone disinfection						
	Implementation of non-structural BMPs						
	Disconnection of impervious surfaces						
	Reduction of impervious areas						
	Restoration/enhancement of natural areas						
	Implement/Improve effectiveness of Street Sweeping Program						
	Public education and outreach programs (e.g., Storm Drain Stenciling Program)						

Appendix D

DETAILED CHARACTERISTICS OF HOT SPOTS

Hot Spot SWBNE10 sampling data (63% of sample > 1,000 CFU/100ml; 29% > 10,000 CFU/100ml)

Station	Basin	Mean	Geometric Mean	N	Minimum Obs.	Maximum Obs.	Start Date	End Date	# Exceedance	% Exceedance
SWBNE10	Sweetwater Branch	41569.47	2952.42	49	40	1300000	8/16/2000	10/16/2007	44	89.80

MST Data: total 6 of 13 (46%) positive human markers from 2005-2007 (ACEPD 2008)

Agency/Year sampled	Enteric Virus	Polyomavirus	Esp gene	Bacteroides spp.
GRU 2005	NA	NA	2/2 (slight positives)	0/2
ACEPD 2006	NA	1/2	2/2	1/2
ACEPD 2007	NA	0/1	0/1	0/1
Overall	NA	1/3	4/5	1/5

- **Sewer infrastructure (public)**
 - Area characterized by older sewer infrastructure (GRU gravity mains [VCP] installed approx 1930) and private connections (VCP and less durable material; ACEPD 2008)
- **Sewer infrastructure (private)**
 - Private sewer service areas are located just upstream at CVS and at the Gainesville Shopping Center ; a private lift station is located within the Shopping Center area
 - Grease blockage at an old Publix caused approx 4,300 gallons of sewage to be released into storm water system approx 300 meters upstream of site (June 22, 2005); correlated with levels at SWBNE10 collected on same date (108,000) and five days later (55,000)
- **Septic Systems**
 - Several septic systems are located upstream of SWBNE10 in close proximity to the stormwater collection system
- **Homeless camps**
 - A homeless camp has been reported upstream at the Rail to Trail Bike path just south of NW 16th Ave. and Near the old Publix, just south of NW 10th Ave
- **Stormwater/Sediments**
 - The creek flows underground through conveyance systems north of NW 14th Ave and reemerges just upstream of SWBNE10
 - The stormwater collection system parallels older sewer gravity mains and private service areas before surfacing at SWBNE10; possibility of cross connections?
 - A vortex box (sediment trap) is located directly upstream of SWBNE10
 - Positive trend observed between turbidity and fecal coliform levels
 - Re-growth in sediments in closed conveyance system may be an issue
 - ACEPD sediment sample collected on January 2, 2007 (fecal coliforms 15,000 CFU/100g *Enterococcus* spp. 600 CFU/100g) suggest a more recent source
- **Animals**
 - Raccoon tracks and other signs of wildlife and 3 dog walkers have been observed in areas between NW 10th Ave and University Ave

Suggested Action Items for SWBNE10

Visually inspect drop inlets for cross connections/sewage odors west of North Main St in areas near the Gainesville Shopping Center

Sample drop inlet just southwest of the NE 10th Ave and North Main St. intersection

Consider smoke/dye testing or T.V. of sewer stormwater lines at older areas near NW 2nd St. and 10th Ave

GIS layer showing areas of completed infrastructure rehabilitation would be helpful

Request DOH to inspect the septic systems at 1411 NW 2nd St. and 1627 NW 2nd St.

Perform additional sediment sampling at this station for indicator bacteria (fecal coliforms, *E. coli*, and *enterococcus* spp.)

Perform a lift station inspection at the Gainesville Shopping Center
Ensure that the vortex box directly upstream is being maintained properly

Hot Spot ROSESE9 sampling data (57% of samples > 1,000 CFU/100mL; 4% > 10,000 CFU/100ml)

Station	Basin	Mean	Geometric Mean	N	Minimum Obs.	Maximum Obs.	Start Date	End Date	# Exceedance	% Exceedance
ROSESE9	Sweetwater Branch	5252.61	1445.62	23	200	80000	4/14/2004	10/16/2007	21	91.30

MST Data: total 4 out of 11 (36%) positive human markers 2005-2007 (ACEPD 2008)

Agency/Year sampled	Enteric Virus	Polyomavirus	Esp gene	Bacteroides spp.
GRU 2005	0/2	2/2	1/2	0/2
ACEPD 2007	NA	0/1	1/1	0/1
Overall	0/2	2/3	2/3	0/3

- **Sewer infrastructure (public)**
 - o Gravity mains cross and parallel several segments of the creek upstream of station ROSESE9
- **Sewer infrastructure (private)**
 - o One identified private service area is located at the upstream extent of Rosewood Branch at a DEP owned facility; a private lift station is located within this service area
- **Septic Systems**
 - o Septic systems are located in close proximity to surface waters upstream of hotspot
 - o Significant impact area is located 930 meters upstream and in close proximity to surface waters in the area of 1106 SE 4th St.
 - o In 10/23/2006 an illegal septic system was sited in close proximity to surface waters approx 1,300 meters upstream just west of the SE 10th St. and SE 8th Ave intersection
- **Homeless camps**
 - o upstream homeless camps have been reported near headwaters of Rosewood Branch
- **Stormwater/Sediments**
 - o (80,000 CFU/100mL) occurred after rainfall (0.11 inches; 2-day total of 0.29 inches; 14-day total of 0.47 inches)
 - o Stormwater collection system cross and parallels GRU gravity mains in many areas of the creek
- **Animals**
 - o ACEPD wildlife survey observed 3 dogs, cat tracks and scat, raccoon, rodent, armadillo, bird, and possible fox tracks
 - o Dogs observed in creek bed during TIMs study

Comments

ACEPD indicated that the creek flows through low socioeconomic areas with lots of trash
Contamination observed at upstream locations of Rosewood Branch may also impact downstream locations

Suggested action items for ROSESE9

Sample drop inlet just south of sampling site and west of SE 9th St. and sample upstream of where stormwater system outfalls into creek

Sample ditch at SE 10th Terrace

Consider smoke/dye testing or T.V. sewer lines and just south of the SE 8th Avenue and SE 10th Terrace intersection and immediately adjacent to station ROSESE9

Consider T.V. of stormwater collection system in the immediate vicinity of station ROSESE9

Request DOH to inspect upstream unverified septic systems at and 1025 SE 8th Ave

Hot Spot HOGNW23 sampling data (52% of samples > 1,000 CFU/100ml; 9% > 10,000 CFU/100ml)

Station	Basin	Mean	Geometric Mean	N	Minimum Obs.	Maximum Obs.	Start Date	End Date	# Exceedance	% Exceedance
HOGNW23	Hogtown Creek	3166.53	1301.62	35	120	22000	4/11/2001	4/26/2007	29	82.86

MST Data: total 7 out of 11 (64%) positive human markers 2005-2007 (ACEPD 2008)

Agency/Year sampled	Enteric Virus	Polyomavirus	Esp gene	Bacteroides spp.
GRU 2005	2/4	N/A	3/4 (includes 1 slight positive)	NA
ACEPD 2007	NA	1/1	1/1	0/1
Overall	2/4	1/1	4/5	0/1

- **Sewer infrastructure (public)**
 - o An 18 inch slipped- lined gravity main parallels this portion of the creek from NW 23rd Ave north to NW 39th Ave
 - o Gravity mains parallel stormwater infrastructure in areas near Gainesville Mall
- **Sewer infrastructure (private)**
 - o Located downstream of a private SSO (Gainesville Mall) that spilled an unknown volume of sewage into the creek on March 6, 2002. Samples collected on the same date at station HOGNW23 showed extremely elevated levels (12,500 CFU/100mL).
 - o A private service area is located in close proximity to surface waters upstream at Country Manner apartments (2701 NW 23rd Blvd)
- **Septic Systems**
 - o Two upstream septic systems (>1,000 meter upstream) are located in close proximity to surface waters
 - o There are numerous unverified septic system and significant impact areas upstream along Springstead Creek
- **Homeless camps**
 - o One homeless camp was reported upstream on the west side of the creek just south of NW 29th Rd
- **Stormwater/Sediments**
 - o Two stormwater outfalls are located upstream at the Gainesville Mall. The northern outfall, located at station HOGEAST, crosses and parallels gravity lines.
 - o This stormwater collection system parallels and crosses gravity mains
 - o The stormwater collection system located north of NW 32nd Ave parallels sewer infrastructure and outfalls into the creek
- **Animals**
 - o ACEPD wildlife survey identified squirrel, rodent, opossum, and raccoon tracks upstream of site; a squirrel, birds, and frogs were also sited
 - o Dog and cat tracks observed during the ACEPD wildlife survey

Suggested Action items

Sample south outfall located south of Gainesville Mall

Sample north outfall that parallels gravity line at Gainesville Mall

Visually inspect drop inlets for cross connections/sewage odors that parallel sewer infrastructure in the Gainesville Mall area and in areas along NW 14th Street

Consider smoke/dye testing or T.V. of sewer lines and stormwater system in the immediate vicinity of station HOGEAST and just north of the NW 14th Street and the NW 32nd Avenue intersection

Verify that upstream sediment traps are being maintained

Sample outfall north of NW 32nd Ave

Consider sampling station SPSTNW13 (most downstream Springstead Creek station), and station HOGNW23 simultaneously to determine the impact of Springstead Creek on station HOGNW23

Hot Spot RATUSHOG sampling data (67% of samples > 1,000 CFU/100ml; 0 > 10,000 CFU/100ml)

Station	Basin	Mean	Geometric Mean	N	Minimum Obs.	Maximum Obs.	Start Date	End Date	# Exceedance	% Exceedance
RATUSHOG	Hogtown Creek	2584.83	1399.89	12	168	7900	11/3/2003	7/26/2007	9	75.00

MST Data: total 2 out of 3 (67%) positive human markers 2005-2007 (ACEPD 2008)

Agency/Year sampled	Enteric Virus	Polyomavirus	Esp gene	Bacteroides spp.
ACEPD 2007	NA	1/1	1/1	0/1

- **Sewer infrastructure (public)**
 - o An 8-inch gravity main and slipped line gravity parallel each side for almost the entire length of creek
 - o Gravity lines cross creek in several upstream locations
 - o 2003 SSO (9100 NW 18th Pl spilled 400 gallons of sewage into ditch near surface waters; sampling did not correspond with the SSO.
 - o 2003 SSO (2100 NW 11th Rd) spilled 266,000 gallons; sampling did not correspond with the SSO event.
- **Sewer infrastructure (private)**
 - o Lateral lines observed running along houses in close proximity to midstream segments of Rattlesnake Branch.
- **Septic Systems**
 - o Two “significant” OSTDS impact areas are located upstream (>550 meter upstream) at a tributary of Rattlesnake Branch
 - o Unverified septic systems are located in approx 550 meter upstream near “significant impact areas”
 - o Seepages at 2 tributaries of Rattlesnake Branch with parcels with septic systems on the end of each (ACEPD 2008)
- **Homeless camps**
 - o Transients have been reported along the upstream areas of the Creek in the vicinity of the NW 13th St and NW 8th Ave intersection
- **Stormwater/Sediments**
 - o Stormwater collection system parallels 250 meters of gravity lines along NW 11th Rd before merging with the creek. Several locations farther upstream (e.g. along NW 18th Terrace) also have stormwater collection systems that parallel sewer infrastructure and outfall into surface waters.
 - o The stormwater collection system merges with main channel at two separate locations approx 80 meters upstream of site.
 - o 4-day correlation with rainfall
- **Animals**
 - o ACEPD wildlife survey site identified squirrel, dog, and raccoon tracks upstream of site

Comments/Questions

Rattlesnake branch often has sewer odor complaints

Suggested action items for RATUSHOG

Sample the two stormwater outfalls north of NW 11th Rd

Sample seeps at the two tributaries of Rattlesnake Branch near parcels at 1920 NW 7th Place and 1902 NW 7th Place.

Consider performing smoke/dye testing or T.V. of sewer lines and stormwater system along NW 11th Rd and at NW 21st Terrace between NW 10th Avenue and NW 9th Avenue

Request DOH to inspect upstream unverified septic systems at 1818 NW 8th Ave and 805 NW 13th St.

Hot Spot ELIZUNIV sampling data (100% of samples > 1,000 CFU/100ml; 42% > 10,000 CFU/100ml)

Station	Basin	Mean	Geometric Mean	N	Minimum Obs.	Maximum Obs.	Start Date	End Date	# Exceedance	% Exceedance
ELIZUNIV	Hogtown Creek	9000.00	6409.38	7	1700	19750	7/15/2005	7/26/2007	7	100.00

MST Data: total of 5 out of 8 (63%) positive human markers 2005-2007 (ACEPD 2008)

Agency/Year sampled	Enteric Virus	Polyomavirus	Esp gene	Bacteroides spp.
GRU 2005	NA	NA	0/1	1/1
ACEPD 2006	NA	1/2	2/2	1/2
Overall	NA	1/2	2/3	2/3

- **Sewer infrastructure (public)**
 - o Slipped gravity line parallels the length of the creek
 - o Older wastewater infrastructure and gravity lines (installed in approx 1926) located in close proximity to the headwaters of Elizabeth Creek
 - o Older gravity lines (installed in approx 1926) parallel and cross the stormwater collection system pipes. Older infrastructure runs throughout the College Park and other neighborhoods north of University Ave–Possibility for cross connections?
- **Sewer infrastructure (private)**
 - o Retrofitted homes with apartments may have cross-connections in the student housing areas located along the length of Elizabeth Creek
- **Septic Systems**
 - o Several unverified septic tanks identified are in close proximity to the stormwater collection system near the “headwaters” in the vicinity of University Ave.
 - o Old septic tanks have been observed in surrounding area; two potential septic systems were reported upstream at the Presidents House.
- **Homeless camps**
 - o No homeless camps have been identified along Elizabeth Creek
- **Stormwater/Sediments**
 - o Extreme elevated fecal coliform levels (16,800 and 12,400 CFU/100mL following storm event (ACEPD 2008)
- **Animals**
 - o ACEPD wildlife survey identified squirrel, armadillo, bird, raccoon, dog, and cat tracks; a dog was also sited behind a fence in a yard close to the creek

Suggested action items for ELIZUNIV

Determine flow patterns of the stormwater collection system that outfall in the vicinity of this location
Sample for fecal coliforms at the drop inlet located along the most northern terminus of NW 21st Terrace
Consider performing smoke/dye testing or TV of lines in the immediate vicinity of this station at University Ave West and upstream at NW 3rd Ave.

Request FDOT to provide details of results (e.g., specific location televised, areas with cross-connections and excessive sediments) of the lines televised along West University Avenue

It is suggested that samples be collected for fecal coliforms before and immediately after high usage events (e.g., football games)

Request DOH to inspect perform field investigation on septic systems at 7 SW 23rd St, 20 SW 23rd St, and 2291 West University Ave

Hot Spot TUMSW5 sampling data (49% of samples > 1,000 CFU/100ml; 24% > 10,000 CFU/100ml)

Station	Basin	Mean	Geometric Mean	N	Minimum Obs.	Maximum Obs.	Start Date	End Date	# Exceedance	% Exceedance
TUMSW5	Tumblin Creek	5601.66	2039.74	82	10	54000	9/7/1999	10/16/2007	73	89.02

MST Data: total of 1 out of 13 (7%) positive human markers 2005-2007 (ACEPD 2008)

Agency/Year sampled	Enteric Virus	Polyomavirus	Esp gene	Bacteroides spp.
GRU 2005	0/1	0/1	0/1	0/1
ACEPD 2006	N/A	0/2	0/2	0/2
ACEPD 2007	N/A	0/1	1/1	0/1
Overall	0/1	0/4	1/4	0/4

- **Sewer infrastructure (public)**
 - Areas of Tumblin Creek from station TUMSW5 upstream to station TUM441 are characterized by exposed sewer lines
 - A sewer gravity main parallels surface waters from TUMSW5 upstream to SW 4th Ave
 - Older sewer infrastructure (gravity mains installed 1926) located upstream at SW 4th Ave and SW 2nd Ave is in close proximity to the stormwater collection system. Possibility for cross connections?
- **Sewer infrastructure (private)**
 - Located in close proximity to a private service area St. Croix Apartments (801 SW 5th Ave).
 - The private lift station has had a history of failures
- **Septic Systems**
 - A couple of unverified septic systems are located upstream of this site
 - ACEPD identified septic systems in surrounding area.
- **Homeless camps**
 - Homeless camps have been reported at a park just downstream of the site. ACEPD observed possible transients during survey (between SW 5th Ave and SW 9th St) of creek (ACEPD 2008)
- **Stormwater/Sediments**
 - The “headwaters” of Tumblin Creek primarily run underground and through culverts before reappearing at SW 2nd Ave at Shands AGH/ possible associated re-growth in the underground stormwater conveyance system?
 - Stormwater collection system parallels gravity mains along SW 5th Ave and SW 4th Ave
 - Evidence of fecal coliform levels higher during the “wet” season compared to the “dry” season (ACEPD 2008)
 - Positive trends noted between fecal coliforms concentrations and turbidity
 - Marginally significant correlation with rainfall high bacteria populations at TUMSW5 may be due to persistence in the sediments (ACEPD 2008)
- **Animals**
 - Raccoons, squirrel, dog, and armadillo tracks observed; raccoons and cats are commonly seen at this site (ACEPD, 2008). According to ACEPD cats are fed just upstream of this station.

Suggested action items for TUMSW5

Sample the junction chamber north of SW 4th Ave

Visually inspect drop inlets for cross connection/sewage odors in areas along NW 14th Street

Collect sediment samples for indicator bacteria at station location

Consider performing smoke/dye testing or T.V. of sewer lines at lines near SW 5th Ave and SW 4th Ave

Appendix E

Identification and Quantification of Human Fecal Sources in Alachua County Urban Creeks

Troy M. Scott, Ph.D. and George Lukasik, Ph.D.

BCS Laboratories, Inc., Gainesville, FL

OVERVIEW

The development of total maximum daily load (TMDL) compliance levels and the undertaking of associated risk assessment based on these calculations requires not only that the source(s) of fecal inputs into a watershed be identified but, ideally, that the relative contributions from all sources be quantified. One currently available tool, which can be used to achieve the former of these objectives, is Microbial Source Tracking technology. The evolution of source tracking technologies has included the general shift from library-dependent methods to library-independent methods. The former described methods typically utilize databases containing genotypic or phenotypic “fingerprints” from organisms from known sources to which fingerprints from unknown isolates can be compared. The latter described methods target host-specific microorganisms or genes using various molecular methods, usually polymerase chain reaction (PCR). The appropriate use and correct interpretation of MST technology has been shown to be extremely beneficial in watershed studies. This is especially true, should the investigators follow specific guidelines with regard to data collection and interpretation.

The success (or failure) of a source-tracking project lies in the types of methods employed, the specific approaches taken, and the types of analytical tools used to interpret the results.

- Specific knowledge of the watershed and potential fecal inputs is a critical component of a successful source tracking study. By concentrating only on potential inputs, the methods employed can be specifically targeted to identify these sources.
- All methods should be employed in a tiered fashion and results should be interpreted sequentially so as to implicate or eliminate potential sources one at a time.
- The sampling approach should be well planned and should be conducted during both high flow (wet) and low flow (dry) events. Care should also be taken to perform what is referred to as “targeted sampling”. Using this approach, samples are taken both upstream and downstream of potential fecal inputs. If bacterial counts are low upstream and high downstream (and source tracking data indicates a strong correlation with the suspected source(s)), then this is a strong indication that the source has been identified. Conversely, this approach can also eliminate suspected sources and redirect attention to other potential impact sites.
- End-users are encouraged to adopt a “toolbox” approach to any source tracking study. By using multiple methods that target and identify different source indicators, more comprehensive conclusions can be drawn. The most important aspect of the toolbox approach is that individual results can be confirmed and substantiated. Conclusions regarding potential inputs should NEVER

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be drawn due to the results of a single test on a single water sample. On the contrary, multiple positive results using a variety of methods are a strong indicator that the source(s) of the pollution have been identified.

- If budgetary constraints are present, end users are encouraged to conduct their source tracking studies in a piecemeal fashion. It is better to target one or two potential sources with several tests, rather than to try to pinpoint all the potential sources with more broad tests. Most source tracking projects do not produce meaningful results because too many sources of fecal pollution are targeted simultaneously. By limiting the number of potential targets, the end user can work by a process of elimination towards the likeliest sources of contamination.

METHODS

Isolation and characterization of *Enterococcus spp.* Enterococci were concentrated by membrane filtration. Filters were incubated for 24 hours on mEI agar (Difco), and processed according to the methodology outlined in USEPA Method 1600 and Scott et al. (2005).

Preparation of template DNA for PCR reactions. Filters containing enterococci (from above step) were lifted and DNA extraction was performed directly from the filter using a Qiagen Stool DNA extraction kit with slight modification (Qiagen, Inc.). Previous research in our laboratory has indicated that there is no significant bias introduced to the qPCR quantification by this culturing step. Total gene copy numbers increase, but relative ratios remain stable.

Concentration of Bacteroidetes DNA. Bacteroidetes were concentrated by membrane filtration and DNA extraction was performed directly from filter membranes using a modification of the Qiagen Stool DNA extraction kit.

Concentration of Human Derived Polyoma Virus (HPyV), DNA Extraction and Amplification. HPyVs were concentrated from 200 ml of water onto nitrocellulose filters by the methodology described in McQuaig et al. (2006). Viral particles were eluted from the filters using 3% beef extract (pH 9.3), and DNA was extracted using QIAamp DNA Blood Midi Blood Kit. The final volume of DNA eluted from the column was 90µl. A positive PCR reaction confirms the presence of human polyomaviruses in the sample, and indicates the contamination of the sample with human-derived urine material.

PCR assays. Assays for the human enterococcus, human bacteroides, and human polyomavirus assays were performed according to methodology outlined in Scott et al. (2005), Bernhard and Field (2000), and McQuaig et al. (2006), respectively. The individual characteristics of each method are outlined in Table 1.

Table 1. Characteristics of host specific molecular markers of human fecal pollution

Type of Genetic Marker	Marker Specificity	Fate in the Environment	Potential for Regrowth
Human Polyoma virus	Very highly specific	Persistence in groundwater and surface water up to 21 days. Usually indicative of recent contamination	Does not re-grow in environment due to lack of host.
Human <i>Enterococcus</i>	Very highly specific	Can persist in surface water for 10 to 21 days.	Regrowth in surface waters and sediments has been documented
<i>Bacteroides</i>	Very highly specific	Usually rapid die-off in aerobic surface waters. Can persist for up to 21 days	Will not re-grow in aerobic environments

RESULTS and DISCUSSION

Interpreting Human Molecular Marker Data for Submitted Samples

The results of the human specific DNA marker testing are summarized in Table 2. Tables 3 and 4 are supplementary tables. Table 3 depicts the presence of *Bacteroides* DNA in sediments and Table 4 summarize sites positive for at least one molecular marker of human fecal pollution, respectively. Appendix A is a map showing the sample site locations.

The results of the DNA marker analyses performed above have additional value based on qualitative interpretation by qualified staff at BCS Laboratories, Inc. Generally, there are two major conclusions that can be drawn from patterns and/or presence/absence of the DNA MST host specific markers.

- A positive result for the Human *Enterococcus* marker in the absence of any other human fecal marker should be interpreted as residual or trace fecal contamination
- The presence of the Human *Enterococcus* marker in conjunction with either the Human *Bacteroides* or Human Polyomavirus, or both, should be interpreted as a recent contamination event.

The interpretations of possible DNA marker results are summarized in Table 5. For purposes of this report, the presence of *Bacteroides* DNA in the submitted sediment samples is used to indicate the recent deposition of fecal material, regardless of source.



BCS Laboratories, Inc.

Sample Name/Type	Sampling Date	Volume analyzed	Human Enterococcus ID PCR (+/-)	Human Bacteroides ID PCR (+/-)	Human Quan. Enterococcus ID PCR (Ratio)**	Human Quan. Bacteroides ID PCR (copies/100ml)	Human Polyomavirus ID PCR (+/-)
PositiveControl	NA	NA	POSITIVE	POSITIVE	NA	NA	POSITIVE
Field Blank		NA	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE
Pos NW 16	4/25/07	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD*	NEGATIVE
Rose Univ.	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
Tum 441	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE
Tom Porters	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE
Hog NW 8	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
Hog NW 16	4/25/07	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE
RatusHog	4/25/07	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE
Eliz NW 7	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
SWB LF	4/25/07	100 ml	POSITIVE	POSITIVE	0.11%	1.25 x 10 ⁷	NEGATIVE
LFC NE 25	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
Hog GHS N	4/25/07	100 ml	POSITIVE	POSITIVE	0.23%	5.94 x 10 ⁶	NEGATIVE
Eliz Arbor	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
LHAT NB	4/25/07	100 ml	POSITIVE	POSITIVE	0.60%	2.79 x 10 ³	POSITIVE
SWB NE10	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
SWB SE8	4/25/07	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE
Pos NW 8	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
Rose SE9	4/25/07	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
HogCEtrib	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE
Tum SW 5	4/25/07	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
Hog NW 23	4/25/07	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE
Tum SW 11	4/25/07	100 ml	POSITIVE	POSITIVE	0.33%	4.65 x 10 ⁴	NEGATIVE
Pos NW36	4/25/07	100 ml	POSITIVE	POSITIVE	0.45%	7.24 x 10 ⁶	NEGATIVE
Eliz NW23	4/25/07	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
HogusRat	4/25/07	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE
Rose SE7	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
SWB331	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
LHATWaldo	4/25/07	100 ml	POSITIVE	POSITIVE	0.64%	4.9 x 10 ⁷	POSITIVE
SWB SE1	4/25/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
Rat NW8	4/25/07	100 ml	POSITIVE	POSITIVE	Below LOD	2.64 x 10 ⁶	NEGATIVE
Sewage	4/25/07	10 ml	POSITIVE	POSITIVE	1.5%	2.5 x 10 ⁸	POSITIVE
BEUpstream	8/7/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
BE Influent	8/7/07	100 ml	POSITIVE	POSITIVE	1.2%	1.6 x 10 ⁷	POSITIVE
BE Effluent	8/7/07	100 ml	POSITIVE	POSITIVE	1.1%	1.1 x 10 ⁴	POSITIVE
LHATWaldo	8/7/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
LHATArbor	8/7/07	100 ml	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE

Table 2. Results of human specific molecular marker testing on Gainesville creeks

*Limit of Detection**Ratio of 1.5% corresponds to raw sewage

Purple: Triple Positive, High Probability human fecal pollution; results conclusive; resample to confirm

Yellow: Double Positive, High to Moderate Probability human fecal pollution; results conclusive; resample to confirm

Grey: Single Positive, Low probability recent human fecal pollution or diffuse septic source, Results inconclusive; Resample to confirm

White: Triple Negative, Low probability Human Fecal pollution, Results conclusive; Resample to confirm for regulatory purposes

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Table 3. Detection of Bacteroides spp. in Sediment by Polymerase Chain Reaction as a Proxy for Recent Fecal Pollution

Sample Name	Sample Type	Amount analyzed	General Bacteroides PCR
Positive Control	NA	POSITIVE	POSITIVE
Negative Control	NA	NEGATIVE	NEGATIVE
Pos NW 16	Sediment	10 g	POSITIVE
Rose Univ.	Sediment	10 g	POSITIVE
Tum 441	Sediment	10 g	NEGATIVE
Tom Porters	Sediment	10 g	NEGATIVE
Hog NW 8	Sediment	10 g	NEGATIVE
Hog NW 16	Sediment	10 g	POSITIVE
RatusHog	Sediment	10 g	POSITIVE
Eliz NW 7	Sediment	10 g	NEGATIVE
SWB LF	Sediment	10 g	POSITIVE
LFC NE 25	Sediment	10 g	NEGATIVE
Hog GHS N	Sediment	10 g	POSITIVE
Eliz Arbor	Sediment	10 g	NEGATIVE
LHAT NB	Sediment	10 g	POSITIVE
SWB NE10	Sediment	10 g	NEGATIVE
SWB SE8	Sediment	10 g	NEGATIVE
Pos NW 8	Sediment	10 g	NEGATIVE
Rose SE9	Sediment	10 g	POSITIVE
HogCETrib	Sediment	10 g	POSITIVE
Tum SW 5	Sediment	10 g	POSITIVE
Hog NW 23	Sediment	10 g	POSITIVE
Tum SW 11	Sediment	10 g	POSITIVE
Pos NW36	Sediment	10 g	POSITIVE
Eliz NW23	Sediment	10 g	POSITIVE
HogusRat	Sediment	10 g	POSITIVE
Rose SE7	Sediment	10 g	NEGATIVE
SWB331	Sediment	10 g	NEGATIVE
LHAT Waldo	Sediment	10 g	POSITIVE
SWB SE1	Sediment	10 g	POSITIVE
Rat NW8	Sediment	10 g	POSITIVE
Sewage	Sediment	10 g	POSITIVE

Table 4. Results of sites positive for at least one molecular indicator of human fecal pollution

Sample Name/Type	Human Enterococcus ID PCR (+/-)	Human Bacteroides ID PCR (+/-)	Human Quantitative Enterococcus ID PCR (Ratio)**	Human Quantitative Bacteroides ID PCR (copies/100ml)	Human Polyomavirus ID PCR (+/-)	Sediment General Bacteroides PCR ^{##}
Positive Control	POSITIVE	POSITIVE	NA	NA	POSITIVE	POSITIVE
Submitted Blank (-)	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE
Pos NW 16	POSITIVE	NEGATIVE	Below LOD	Below LOD*	NEGATIVE	POSITIVE
Rose Univ.	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE	POSITIVE
Hog NW 16	POSITIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE	POSITIVE
RatusHog	POSITIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE	POSITIVE
SWB LF	POSITIVE	POSITIVE	0.11%	1.25 x 10 ⁷	NEGATIVE	POSITIVE
Hog GHS N	POSITIVE	POSITIVE	0.23%	5.94 x 10 ⁶	NEGATIVE	POSITIVE
LHAT NB	POSITIVE	POSITIVE	0.60%	2.79 x 10 ³	POSITIVE	POSITIVE
SWBSE8	100 ml	POSITIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE
Rose SE9	POSITIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE	POSITIVE
Hog CE Trib	NEGATIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE	POSITIVE
Tum SW 5	POSITIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE	POSITIVE
Hog NW 23	POSITIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE	POSITIVE
Tum SW 11	POSITIVE	POSITIVE	0.33%	4.65 x 10 ⁴	NEGATIVE	POSITIVE
Pos NW36	POSITIVE	POSITIVE	0.45%	7.24 x 10 ⁶	NEGATIVE	POSITIVE
Eliz NW23	POSITIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE	POSITIVE
HogusRat	POSITIVE	NEGATIVE	Below LOD	Below LOD	POSITIVE	POSITIVE
LHAT Waldo	POSITIVE	POSITIVE	0.64%	4.9 x 10 ⁷	POSITIVE	POSITIVE
SWB SE1	NEGATIVE	NEGATIVE	Below LOD	Below LOD	NEGATIVE	POSITIVE
Rat NW8	POSITIVE	POSITIVE	Below LOD	2.64 x 10 ⁶	NEGATIVE	POSITIVE
Sewage	POSITIVE	POSITIVE	1.5%	2.5 x 10 ⁸	POSITIVE	NOT TESTED
BE Influent	POSITIVE	POSITIVE	1.2%	1.6 x 10 ⁷	POSITIVE	NOT TESTED
BE Effluent	POSITIVE	POSITIVE	1.1%	1.1 x 10 ⁴	POSITIVE	NOT TESTED

**Ratio of 1.5% corresponds to raw sewage

Purple: Triple Positive, High Probability human fecal pollution; results conclusive; resample to confirm

Yellow: Double Positive, High to Moderate Probability human fecal pollution; results conclusive; resample to confirm

Grey: Single Positive, Low probability recent human fecal pollution or diffuse septic source, Results inconclusive; Resample to confirm

^{##}General *Bacteroides* marker indicates the presence of fecal pollution, regardless of host, and serves as an indicator of recent fecal deposition

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Table 5. Possible signature patterns of human specific molecular markers and interpretation

Category	Polyoma Virus	Enterococcus	Bacteroides	Characteristics of the Signature		
				Strength Human Signature	Recent or Residual Source	Other
Triple Positive	Positive	Positive	Positive	Very strong positive	Recent	
	Positive	Negative	Positive	Very strong positive	Recent	Possible septic tanks
Double Positive	Positive	Positive	Negative	Very strong positive	Residual	
	Negative	Positive	Positive	Strong positive	Recent	Strong signature based on realistic method sensitivity
	Positive	Negative	Negative	Moderate positive	Residual	No evidence of human fecal contamination
Single Positive	Negative	Positive	Negative	Weak positive	Residual	Low evidence of human fecal contamination; Resample
	Negative	Negative	Positive	Weak/moderate positive	Recent	Possible septic tanks; Resample
No Positive	Negative	Negative	Negative	Very strong negative	No recent human source/impact	

Interpreting Human Polyoma Virus results

The human polyomaviruses (HPyVs), JCV and BKV, have similarly structured genomes that show 75% homology. The prevalence of these viruses in the human population is worldwide. Serological studies have shown 60-90% of adults harbor antibodies against human polyomaviruses (HPyVs). A symptomless primary infection occurs during childhood; following which, the viruses establish latent infections in the renal tissue and can persist indefinitely. Asymptomatic viruria can occur occasionally or continuously in infected individuals. Disease is normally associated when the host's immune system becomes suppressed by conditions such as AIDS. In general, polyomaviruses have a low morbidity, latency, and symptom-less reactivation. Approximately one million viral particles can be shed in one milliliter of urine from a healthy individual.

In this study we use human-specific polyomaviruses (HPyVs) as an indicator of human fecal pollution. HPyVs are ubiquitous throughout the human population. They are secreted in the urine in high titers and mostly cause asymptomatic infections. Infected individuals shed viruses throughout their life span.

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We have developed and optimized a rapid and sensitive method to concentrate and extract DNA of HPyVs from environmental water samples (McQuaig et al.; 2007). Primers specific for the conserved T-antigen of both JCV and BKV are used in a nested PCR reaction to detect HPyVs. The method is able to detect as little as one microliter of raw sewage added to 100-ml of water.

The detection of the presence of Human polyoma viruses in a water sample indicates the direct contamination of the water sample by a human waste source. This could be either direct contamination (urination) or impact by faulty septic or sewage systems. Though the persistence of the marker has not been documented in studies, our studies and field trials have indicated that it does not persist for extended periods in tropical climates. The presence of this marker in conjunction with the human enterococcus marker indicates a high correlation with human derived sewage contamination. Whereas, the presence of this marker in the absence of the human enterococcus marker, indicates a high septic system impact.

Interpreting Human Enterococcus Quantification Results

While the presence/absence molecular methods provide valuable, rapid information as to the sources of fecal pollution in a water system, they offer no information regarding relative contributions to a watershed impacted by multiple sources. This difficulty can be addressed through the use of real time quantitative PCR (qPCR). This is a valuable tool that can be used to quantify the amount of DNA in a water sample but its use is limited by a satisfactory means of data interpretation. *Specifically, if the number of gene copy numbers of a specific molecular marker can be quantified in an environmental sample, what does this number mean?* We have approached this question by establishing relative ratios of a host specific gene marker to generic gene markers present in specific bacteria from different host sources. If the fecal pollution present in a watercourse is from a single source, the relative ratios of the specific and generic gene markers should be similar to that seen in the host source. In this project we used a highly sensitive and specific quantitative PCR assay to collect information on the temporal and spatial distribution, as well as relative abundance of specific and generic targets present in specific fecal sources. This information was then used to establish baselines to which unknown samples can be compared. While this approach could conceivably be applied to any molecular target, this study used the Enterococcal Surface Protein gene as a proxy for human fecal contamination (Scott et al., 2005).

The logic behind this approach relies on several assumptions: First, assuming that the total copy number of human specific markers is relatively constant in sewage influent and that the total bacterial populations in sewage influent are relatively constant; the ratio of human marker to total population should be a relatively fixed value. Second, this ratio should be affected predictably by factors such as dilution and inflow of background bacteria from non-target hosts. Specifically, ratios will not be affected as total volume of the system increases but absolute bacterial levels remain the same. Likewise, relative ratios will decrease when background bacterial levels increase but levels of host specific marker remains the same. This approach should also work within systems in which dilution and influx of non-target bacteria occur concurrently. Thus, we have a test that quantifies the total

number of ***bacteria*** (*Ent. Faecium*) that originate from human sources and not an absolute quantification of total human fecal pollution in a system. It is important to make this distinction as it defines the method by quantifying a subset of indicator microorganisms present in sewage, not the sewage itself. This approach should prove useful for calculation of Total Maximum Daily Loads (TMDLs).

Final Interpretation of Human Molecular Marker Data for Submitted Samples

Of the submitted samples, all sites that initially draw concern are depicted in Table 4. Of these, the sites outlined in yellow and purple are of the most concern and are the most likely to have received the impact of human fecal pollution. Based on the interpretation scheme depicted in Table 5, the following sites are likely to have received a recent human fecal contamination event prior to sampling: SWB LF, Hog GHS N, LHAT NB, Tum SW 11, Pos NW36, LHAT Waldo, and Rat NW8.

The remaining flagged sites, Hog NW 16, Rat Vs Hog, Hog NW 23, Hog vs Rat, and SWBSE8 likely contain human fecal material; however, the contamination event probably occurred at a some time long prior to sampling.

Overall, the LHAT NB and LHAT Waldo sites show the most significant human signature and these results are corroborated by the quantitative data shown below.

Final Interpretation of Quantitative Human Enterococcus and Human Bacteroides Data

The final interpretation of the human Enterococcus quantitative assay is inherently difficult due to the high background of enterococci found in the creek system. For the Human Bacteroides Quantitative data, seven sites show significant levels of recent human input and directly mirror the results of the presence/absence data for human fecal pollution: SWB LF, Hog GHS N, LHAT NB, SWBSE8, Tum SW 11, Pos NW36, LHAT Waldo, and Rat NW8.

Overall, “LHAT NB” and “LHAT Waldo” warrant further investigation due to the high ratio of human marker to total enterococci observed in these samples as well as the quantifiable presence of the human Bacteroides marker. Also of significance are the sites that contained both markers in quantifiable numbers (SWB LF, Hog GHS N, Tum SW 11, and Pos NW36) although it is difficult to assign a priority level to these sites due to the small number of samples collected.

Summary and Conclusions

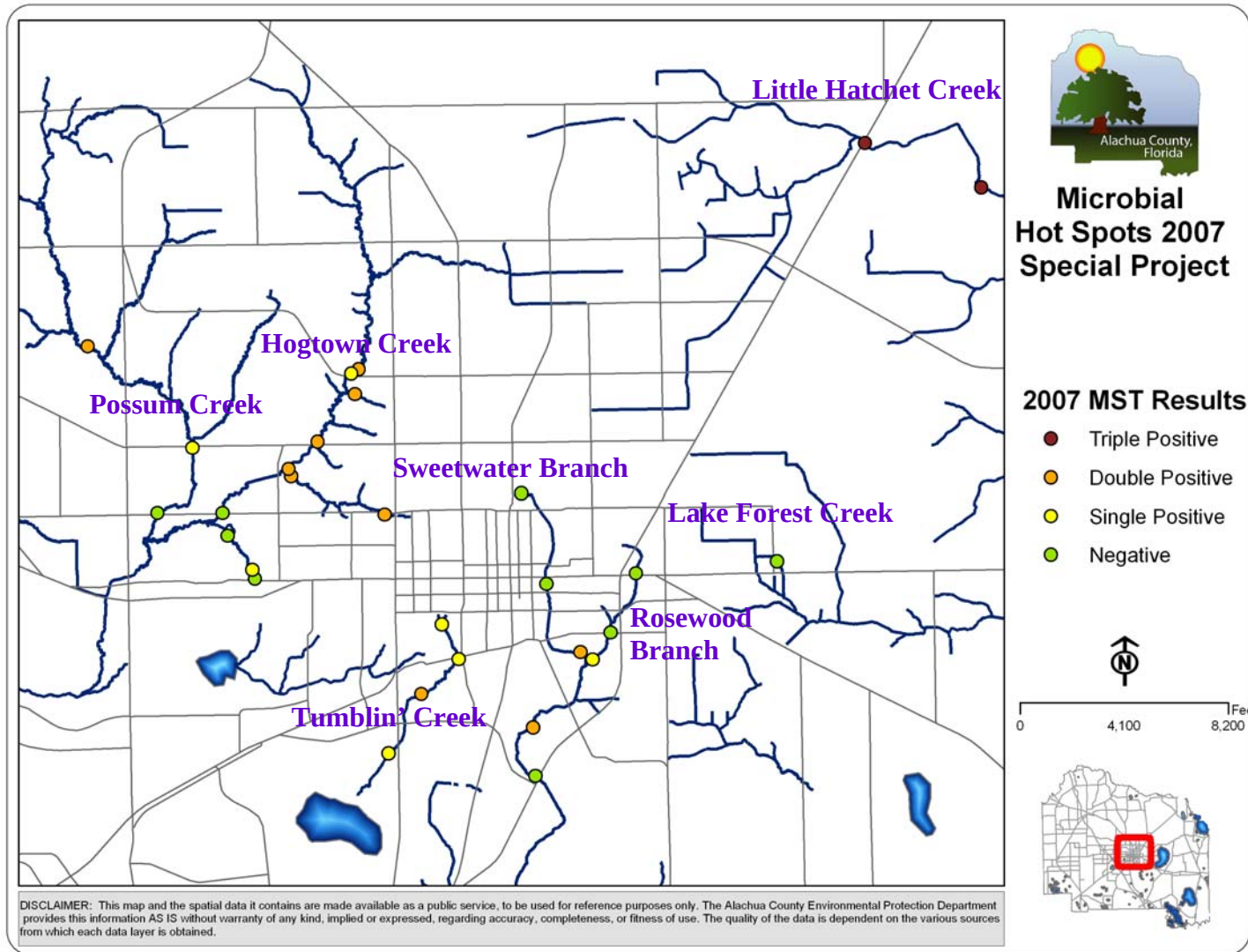
- **Three molecular markers of human fecal pollution (*Ent. faecium* esp gene, Human specific 16S rDNA sequence in *Bacteroides* spp., and Human polyomavirus) were used as a proxy for the presence of human fecal contamination in Alachua County creeks.**



- In general, all markers are highly specific for human fecal pollution. The highest sensitivity is achieved with the *esp* marker.
- None of the markers persist in the environment for extended periods of time. The average maximum retention time of each marker is approximately 21 days. The *esp* marker is particularly useful for detecting domestic sewage and its occurrence in septic systems is sporadic. Therefore, the presence of either human *Bacteroides* or polyomavirus in the absence of *esp* would be an indicator of septic tank impact.
- Sites that are negative for human markers but positive for General *Bacteroides* in the sediments should be considered sites of recent fecal deposition (nonhuman).
- For samples collected on 8/7/07, two sites (BE influent, BE effluent) were positive for all three markers of human fecal pollution.
- More interestingly, the sample collected from just upstream (BE upstream) contained indicator levels several orders of magnitude greater than BE effluent (data not shown) but contained no markers of human fecal pollution.
- The Alachua County creeks system contains high levels of bacterial indicators of fecal pollution. The use of more specific, molecular assays enables the targeting of “hot spots” and areas of interest in order to direct more appropriate focus on sites that can be remediated (i.e. sites impacted by human fecal pollution)



Appendix



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Appendix F

Appendix X1la. Tumblin Creek Microbial Source Tracking and Septic Tank Survey Results and Interpretations by Sample Site

Source	Results	TUMSW1	TUMSW5	TUMDEPOT	TUMSW9	TUMPKYonge			TUMSW11			TUM441
GRU 2005	Enteric Virus polyomavirus esp gene Bacteroides spp.		Negative Negative Negative Negative	Negative Positive Positive Positive	Negative Positive Positive Positive	Negative Positive	Negative Positive Positive Positive	Negative Positive Positive Positive	Negative Positive Positive Positive	Negative Positive Positive Negative		
	TIMS Report interpretation		No evidence of human	Very Strong Human, Recent	Very Strong Human, Recent		Weak Human, Residual	Very Strong Human, Recent	Very Strong Human, Recent	Strong Human, Residual	Strong Human, Residual	
	Additional Interpretation by ACEPD			Non-septic	Non-septic	Septic	Non-septic	Non-septic	Non-septic	Non-septic	Non-septic	
ACHD 2006	Septic Survey					1 Significant upstream PK Yonge			1 Significant upstream of TUMSW11			
ACEPD 2006	polyomavirus Bacteroides spp. esp gene Interpretation	Negative Negative Negative Non-human	Negative Negative Negative Non-human	Negative Negative Negative Non-human								
ACEPD 2007	polyomavirus Bacteroides spp. esp gene Interpretation		Negative Negative Positive Weak Human, Residual, Non-septic	Positive Negative Negative Moderate Positive, Residual, Septic					Negative Positive Positive Strong Human, Recent, Non-septic			Positive Negative Negative Moderate Positive, Residual, Septic
Total Positive MST Results		0 out of 6 (0%)	1 out of 13 (7%)	4 out of 7 (57%)	3 out of 4 (75%)	5 out of 10 (50%)			9 out of 15 (60%)			1 out of 3 (33%)
Overall Source Hypothesis		Non-human	Non-human	Wastewater/ Septic	Wastewater	Wastewater/Septic			Wastewater			Septic

Appendix XIIb. Sweetwater Branch Microbial Source Tracking and Septic Tank Survey Results and Interpretations by Sample Site

Source	Results	SWBNE10		SWBSE1	SWBDepot	SWBSE8ST		SWBLF		SWB331
GRU 2005	Enteric Virus polyomavirus				Negative	Negative	Negative	Negative		
	esp gene	Slight Positive	Slight Positive	Positive	Positive	Positive	Slight Positive	Negative	Negative	Negative
	Bacteroides spp.	Negative	Negative	Positive	Positive	Negative	Negative	Moderate	Negative	Negative
	TIMS Report interpretation	Little evidence of human	Little evidence of human		Very Strong Human, Recent	Strong Human, Residual	Human, Residual, no evidence of human	No evidence of human		
	Additional Interpretation by ACEPD	Possible Non-septic	Possible Non-septic	Non-septic	Non-septic	Possible Non-septic	Septic		Non-human	
ACHD 2006	Septic Survey							7 Significant upstream of SWBLF		
ACEPD 2006	polyomavirus Bacteroides spp. esp gene	Positive Positive Positive	Negative Negative Positive							
	Interpretation	Very Strong Human, Recent, Non-septic	Weak Human, Residual, Non-septic							
ACEPD 2007	polyomavirus Bacteroides spp. esp gene	Negative Negative Negative	Negative Negative Negative			Positive Negative Positive	Negative Positive Positive		Negative Negative Negative	
	Interpretation	Non-human	Non-human			Very Strong Human, Residual, Non-septic	Strong Human, Recent, Non-septic		Non-human	
Total Positive MST Results		6 out of 13 (46%)		2 out of 5 (40%)	3 out of 4 (75%)	5 out of 11 (45%)		2 out of 9 (22%)		0 out of 3 (0%)
Overall Source Hypothesis		Wastewater		Wastewater/Transient Population	Wastewater	Wastewater/Septic		Wastewater/Transient Population		Non-human

Appendix XIIc. Rosewood Branch Microbial Source Tracking and Septic Tank Survey Results and Interpretations by Sample Site

Source	Results	ROSEUNIV	ROSE331	ROSESE7	ROSESE9
GRU 2005	Enteric Virus polyomavirus <i>esp</i> gene <i>Bacteroides</i> spp. TIMS Report interpretation Additional Interpretation by ACEPD		Negative Negative Positive Positive Positive Positive Negative Negative Strong Strong Human, Human, Residual Residual Non-septic Non-septic		Negative Negative Positive Positive Negative Positive Negative Negative Moderate Strong Human, Human, Residual Residual Possible Non-septic Septic
ACHD 2006	Septic Survey		1 Significant upstream		
ACEPD 2006	polyomavirus <i>Bacteroides</i> spp. <i>esp</i> gene Interpretation				
ACEPD 2007	polyomavirus <i>Bacteroides</i> spp. <i>esp</i> gene Interpretation	Negative Negative Negative Non-human		Negative Negative Negative Non-human	Negative Negative Positive Non-septic
Total Positive MST Results		0 out of 3 (0%)	4 out of 8 (50%)	0 out of 3 (0%)	4 out of 11 (36%)
Overall Source Hypothesis		Non-human	Wastewater	Non-human	Wastewater

Appendix XIId. Hogtown Creek Microbial Source Tracking and Septic Tank Survey Results and Interpretations by Sample Site

Source	Results	HOGNW53	HOGNW39	HOGNW23	HOGCETRIB	HOGGHSNASH	HOGGHSN	HOGNW16	HOGUSRAT	HOGNW8
GRU 2005	Enteric Virus polyomavirus	Negative Positive	Negative Negative	Positive Negative Positive Negative				Negative Negative Negative Negative Negative Positive	Negative Negative Positive Positive	
	esp gene	Negative	Positive	Positive Slight Positive Negative Positive				Negative Positive Negative	Positive Positive	
	Bacteroides spp.	Negative	Negative					Negative Positive Positive	Positive Positive	
	TIMS Report interpretation	Moderate Human, Residual, No evidence of human	Weak Human, Residual, Little evidence of human					No Strong Strong evidence Human, Human, of human Recent Recent	Very Very Strong Strong Human, Human, Recent Recent	
	Additional Interpretation by ACEPD	Possible Septic	Non-septic	Non-septic Non-septic Non-septic Non-human				Non-human Non-septic Possible Septic	Non-septic Non-septic	
ACHD 2006	Septic Survey		Between HOGNW53 and HOGNW39 - 9 significant, 3 no-access, 3 minor	Between HOGNW39 and HOGNW23 - 1 significant				Between HOGNW23 and HOGNW16 - 1 significant, 2 significant just downstream of HOGNW16 on HOGNW16S Trib		
ACEPD 2006	polyomavirus Bacteroides spp. esp gene Interpretation					Negative Negative Negative Negative Non-human Non-human				
ACEPD 2007	polyomavirus Bacteroides spp. esp gene Interpretation			Positive Negative Positive Very Strong Human, Residual, Non-septic	Positive Negative Negative Moderate Human, Residual		Negative Positive Positive Strong Human, Recent, Non-Septic	Positive Negative Positive Very Strong Human, Residual, Non-septic	Positive Negative Positive Strong Human, Recent, Non-Septic	Negative Negative Negative No Human Sources
Total Positive MST Results		1/4 (25%)	1/4 (25%)	7/11 (64%)	1/3 (33%)	0/6 (0%)	2/3 (67%)	6/15 (40%)	8/11 (73%)	0/3 (0%)
Overall Source Hypothesis		Little Human Impact	Little Human Impact	Wastewater	Private Wastewater Collection System	No Human Sources	Wastewater	Wastewater and/or Septic	Wastewater	No Human Sources

Appendix XIIe. Possum Creek Microbial Source Tracking and Septic Tank Survey Results and Interpretations by Sample Site

Source	Results	POSNW53	POSNW36DR	MIDPOS	POSNW16			POSNW8
GRU 2005	Enteric Virus	Negative	Negative	Negative	Negative	Negative	Negative	Negative
	polyomavirus	Negative	Negative	Negative	Positive	Negative	Negative	Positive
	esp gene	Negative	Negative	Negative	Slight	Negative	Negative	Positive
	Bacteroides spp.	Negative	Negative	Negative	Positive			
	TIMS Report interpretation	No evidence of human	No evidence of human	No evidence of human	Negative	Negative	Negative	Negative
	Additional Interpretation by ACEPD				Strong Human, Residual	No evidence of human	No evidence of human	Strong Human, Residual
					Possible Non-septic			Non-septic
ACEPD 2007	polyomavirus		Negative		Negative			Negative
	Bacteroides spp.		Positive		Negative			Negative
	esp gene		Positive		Positive			Negative
	Interpretation		Strong human, Recent, Non-septic		Weak Human, Residual, Non-septic			Non-human
Total Positive MST Results		0 out of 4 (0%)	2 out of 7 (29%)	0 out of 4 (0%)	3 out of 15 (20%)			2 out of 7 (29%)
Overall Source Hypothesis		Non-human	Wastewater/Non-human	Non-human	Wastewater/Non-human			Wastewater/Non-human

Appendix XII.f. Rattlesnake Branch Microbial Source Tracking and Septic Tank Survey Results and Interpretations by Sample Site

Source	Results	RATNW8	MIDRATUS	MIDRAT	RATUSHOG
GRU 2005	Enteric Virus polyomavirus esp gene <i>Bacteroides</i> spp. TIMS Report interpretation Additional Interpretation by ACEPD		Negative Positive Positive Positive Very Strong Human, Recent Non-septic	Negative Positive Positive Negative Strong Human, Residual Non-septic	
ACHD 2006	Septic Survey		2 Significant		
ACEPD 2007	polyomavirus <i>Bacteroides</i> spp. esp gene Interpretation	Negative Positive Positive Strong Human, Recent, Non- septic			Positive Negative Positive Very Strong Human, Residual, Non- septic
Total Positive MST Results		2 out of 3 (67%)	5 out of 8 (63%)		2 out of 3 (67%)
Overall Source Hypothesis		Wastewater	Wastewater		Wastewater

Appendix XIIg. Elizabeth Creek Microbial Source Tracking and Septic Tank Survey Results and Interpretations by Sample Site

Source	Results	ELIZUNIV		ELIZARBOR		ELIZNW23	ELIZNW7DS
GRU 2005	Enteric Virus polyomavirus <i>esp</i> gene <i>Bacteroides</i> spp.	Negative Positive		Negative Positive Positive Positive	Negative Positive Positive Positive		
	TIMS Report interpretation	Possible Septic		Very Strong Human, Recent	Very Strong Human, Recent		
	Additional Interpretation by ACEPD	Possible Septic		Non-septic	Non-septic		
ACHD 2006	Septic Survey	0 Significant, 0 Minor, and 0 no access parcels					
ACEPD 2006	polyomavirus <i>Bacteroides</i> spp. <i>esp</i> gene Interpretation	Negative Positive Positive Strong Human, Recent, Non-septic	Positive Negative Positive Very Strong Human, Residual, Non-septic	Negative Negative Negative Non-human			
ACEPD 2007	polyomavirus <i>Bacteroides</i> spp. <i>esp</i> gene Interpretation			Negative Negative Negative Non-human	Negative Negative Positive Weak human, Residual, Non-septic	Negative Negative Negative Non-human	
Total Positive MST Results		5 out of 8 (63%)		6 out of 14 (43%)		1 out of 3 (33%)	0 out of 3 (0%)
Overall Source Hypothesis		Wastewater and/or septic		Wastewater (source may have been eliminated)		Wastewater	Non-human

Appendix G

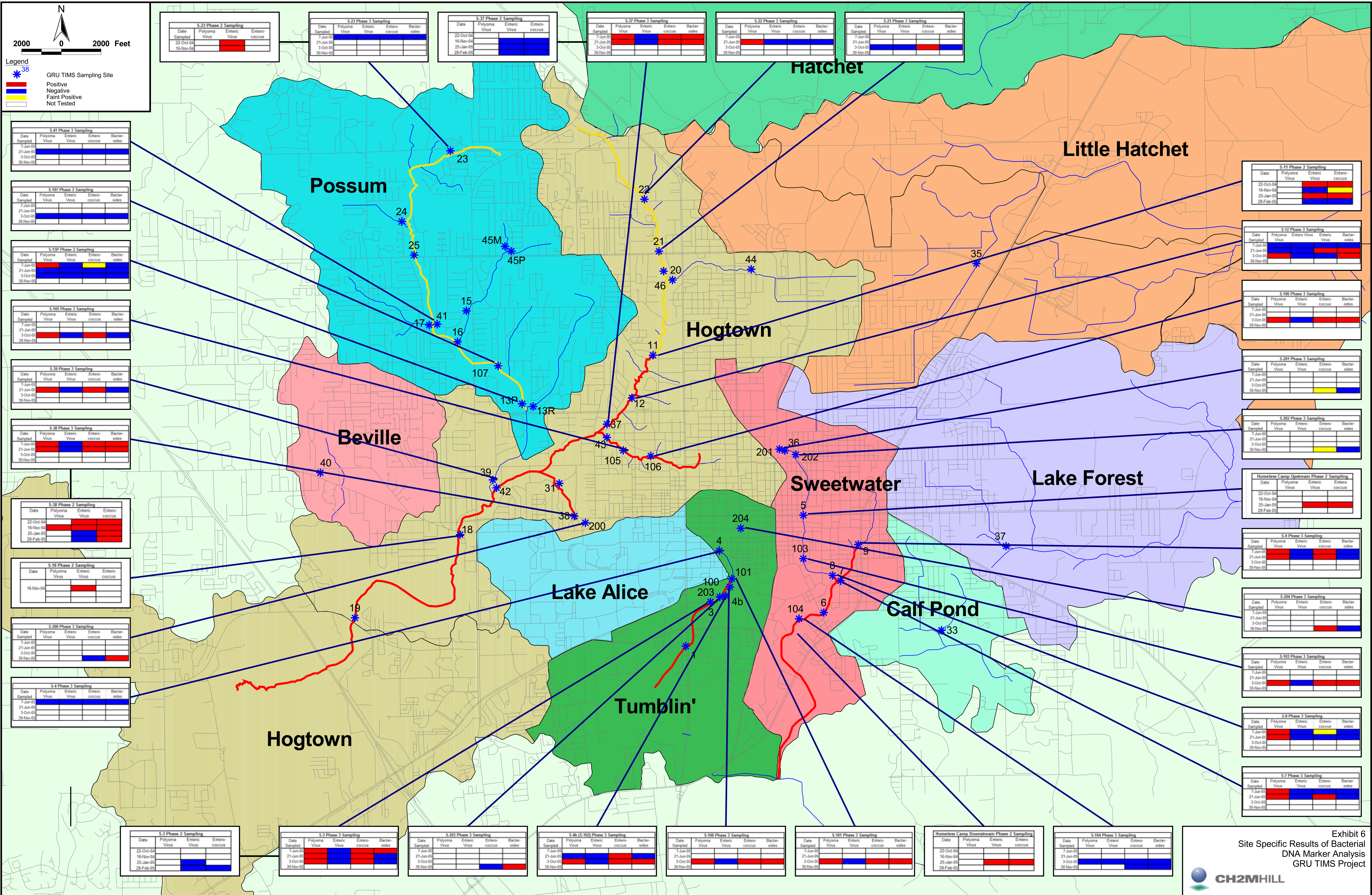
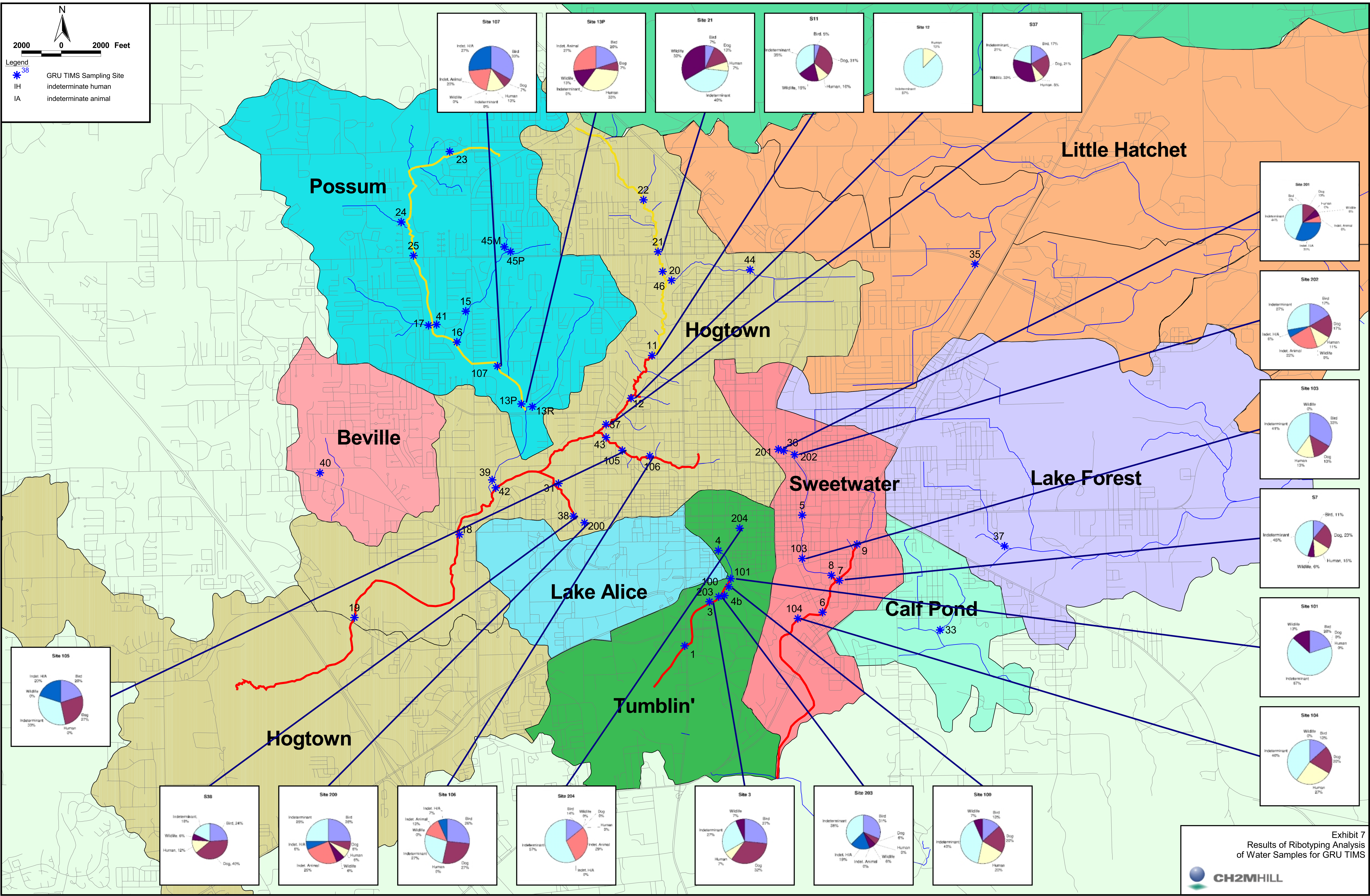


Exhibit 6
Site Specific Results of Bacterial
DNA Marker Analysis
GRU TIMS Project





Appendix H

APPENDIX H. GRU OPERATIONS AND MAINTENANCE PROGRAMS

I. GRU Wastewater Treatment and Collection Systems Overview

GRU Wastewater Treatment

The city of Gainesville's wastewater treatment facilities consist of the Kanapaha Water Reclamation Facility (KWRF) and the Main Street Water Reclamation Facility (MSWRF), which are permitted by the Florida Department of Environmental Protection at combined capacity of 22.4 million gallons per day (mgd). KWRF provides advanced wastewater treatment to incoming wastewater that meets Primary and Secondary Federal Drinking Water Standards. MSWRF also provides advanced treatment, and meets Class III surface water standards. MSWRF was upgraded to advanced treatment in 1990 at a cost of \$16 million. KWRF was expanded by 5 mgd to 15 mgd in 2003 at a cost of \$13.92 million. KWRF and MSWRF have an Operations and Maintenance Budget of \$1.96 million for fiscal year (FY) 2007. **Figure H-1** shows aerial photographs of the KWRF and MSWRF.

Figure H-1. Aerial photographs of the GRU Kanapaha Water Reclamation Facility and Main Street Water Reclamation Facility

KWRF



MSWRF



GRU Wastewater Collection System

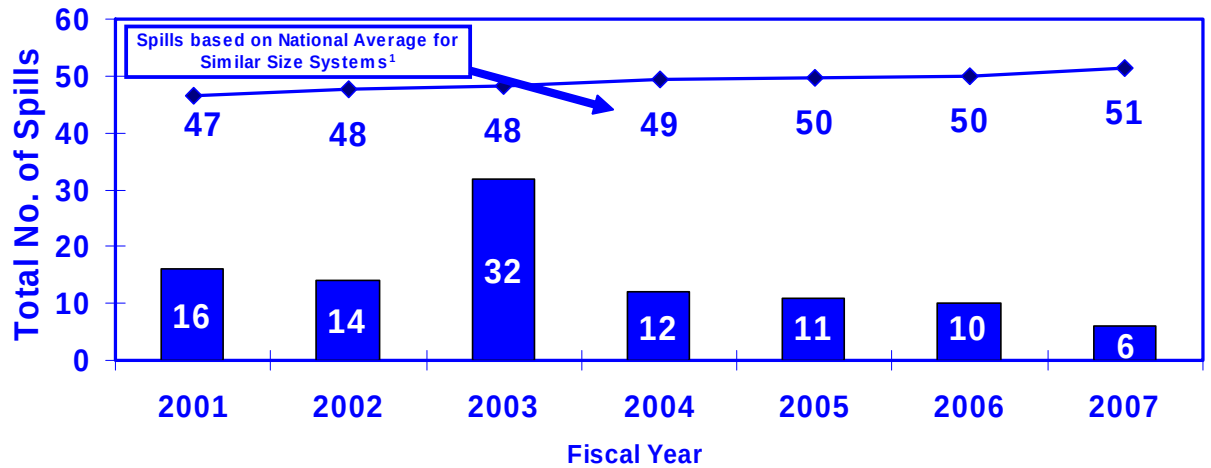
The city of Gainesville's wastewater collection system piping consists of 127 miles of force main where wastewater is conveyed under pressure by pumping stations, and 578 miles of gravity main where the wastewater flows by gravity; for a total of 705 miles of piping. The wastewater collection system also includes 160 lift stations (pumping stations) with 13,888 manholes, and covers a service

Figure H-2. GRU major wastewater collection facilities



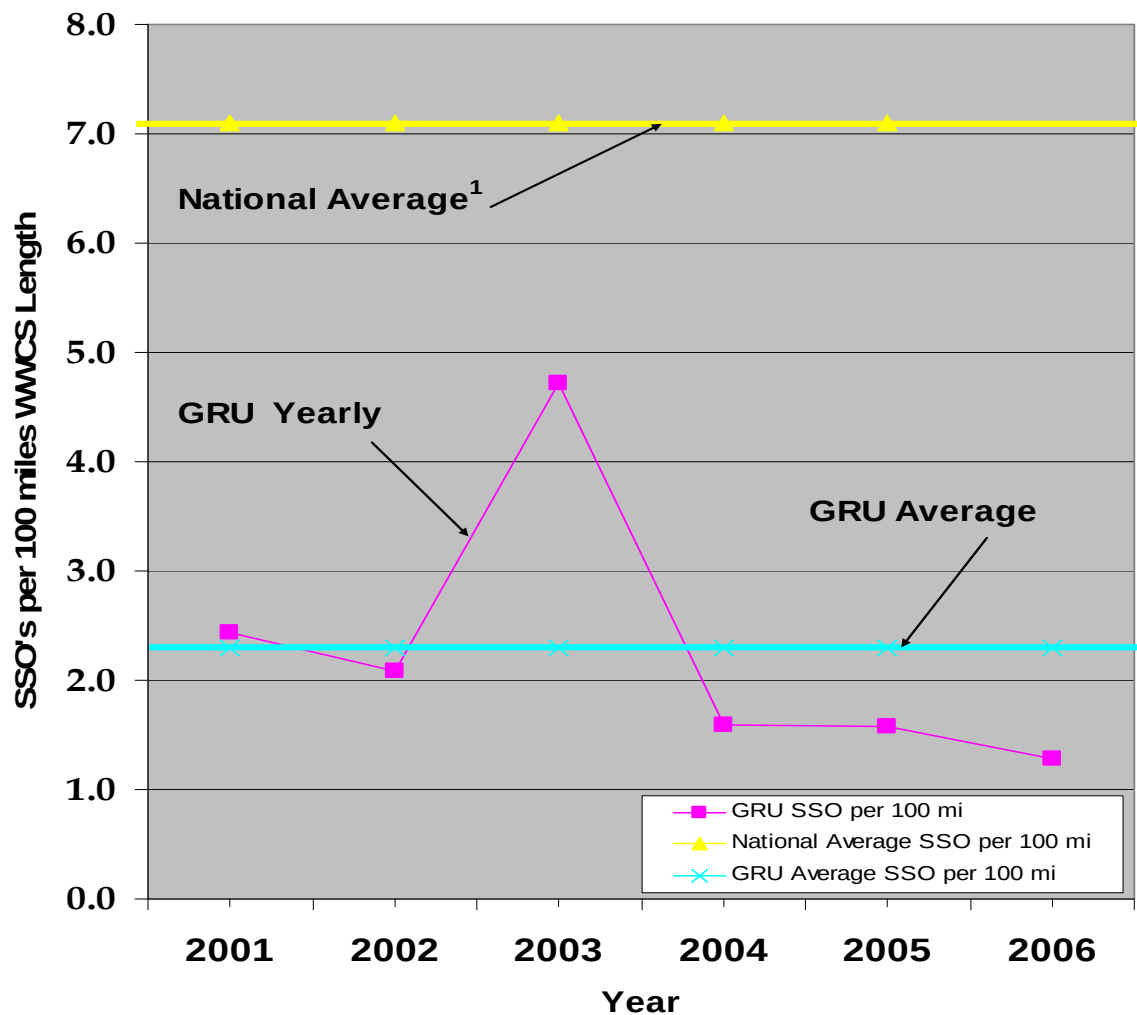
In 2006, GRU systems conveyed and treated over 5.5 billion gallons of wastewater (99.999% efficiency based on volume), and maintained a spill rate of less than 25% of the national average in 2004, 2005, and 2006 (See **Figures H-3** and **H-4**). The national average of 7.1 spills/100 miles of collection system is based on a national survey of comparable utilities conducted by the Water Environment Research Foundation.¹ GRU's average spill rate from 2001 through 2006 was 2.3 spills/100 miles.

Figure H-3. GRU wastewater system performance—Total number of GRU spills, 2001–06, compared with projected national average per 100 miles wastewater collection system spills



¹Source: "Effective Practices for Sanitary Sewer and Collection System Operations and Maintenance"
Water Environment Research Federation (June 2003)

Figure H-4. GRU wastewater system performance compared with national averages—SSO's per 100 miles of collection system length, 2001–06



II. GRU Wastewater Collection System Integrity Programs and Projects

GRU's integrity programs and projects continuously protect the public and the urban creeks from wastewater release from the publicly owned and operated wastewater collection system. These programs and projects include the following:

- *Closed-Circuit TV Inspection/Repair and Cleaning,*
- *Infiltration & Inflow (I&I) Testing,*
- *Sliplining of Gravity Mains Adjacent to Urban Creeks,*
- *Force Main Integrity Testing,*

- *GIS Asset Management System – Mapping and Targeted Maintenance,*
- *Plan Review and New Development Inspection – Redundancy, Oversizing, and New Standard Practices to Improve Reliability,*
- *Annual Water/Wastewater Engineering Operation and Maintenance Services, and*
- *Wastewater Spill Prevention Programs.*

The following is a more detailed description of each of these efforts.

Closed-Circuit TV Inspection/Repair and Cleaning

GRU has an ongoing closed-circuit TV inspection/repair and cleaning program, and added a new closed-circuit TV unit (truck and crew) in FY 2006. Crews clean gravity mains with high-pressure water jets prior to closed-circuit TV inspection. As the crews inspect the lines, they log any deficiencies that may inhibit the pipe's performance. A closed-circuit TV/sealing (grout) unit (truck and crew) follows the inspection to make repairs to damaged pipelines as needed. If necessary, additional crews are dispatched to repair the pipe by sliplining techniques or by utilizing some other appropriate repair method to restore the pipeline to optimum condition. GRU has the ability to make joint repairs and sliplining repairs for the pipe diameters up to 12 inches immediately. This eliminates the time and expense of procuring outside contractors to perform the work. **Figure H-5** shows the components of the closed-circuit TV unit.

Figure H-5. Closed-circuit TV unit components

Closed-Circuit TV Inspection Crew and Equipment

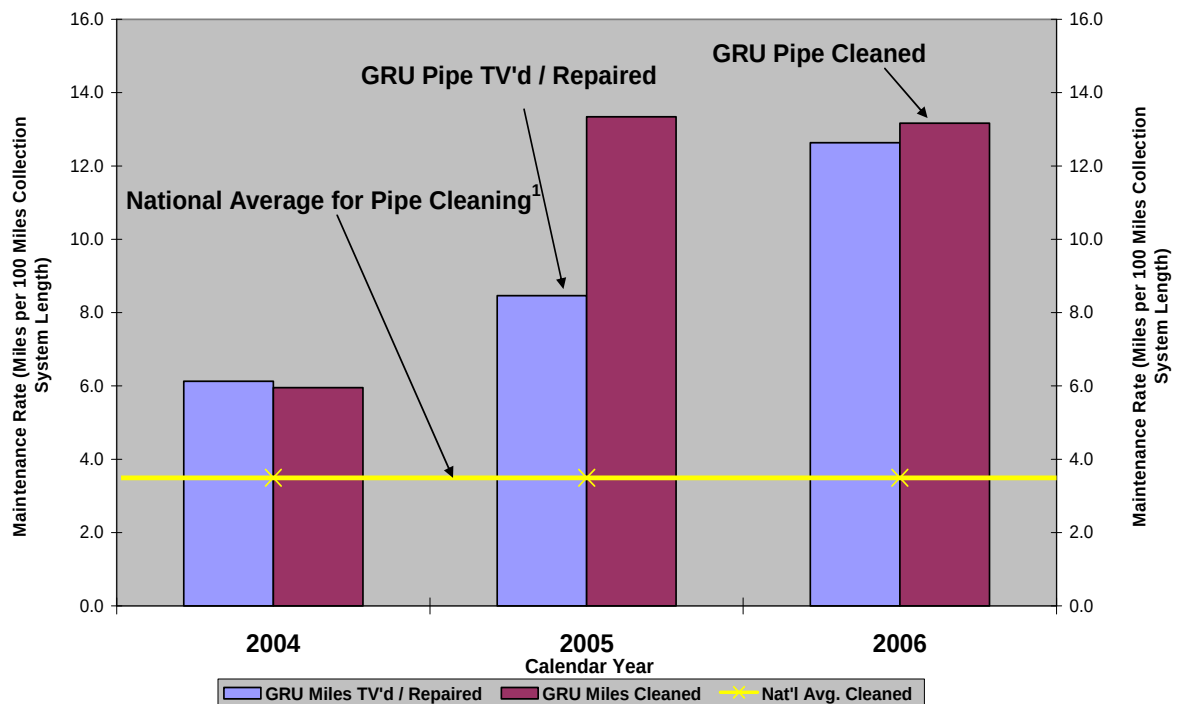


Closed-Circuit TV Inspection Camera



Figure H-6, a bar graph, compares GRU's maintenance rate with the national average.

Figure H-6. GRU wastewater collection system maintenance rate compared with the national average



Infiltration & Inflow Testing

GRU's I&I program goal is to prevent all nonwastewater flows from entering the wastewater collection system. Infiltration is water that flows into the wastewater collection system via cracks and joints that are not completely sealed in the pipe system. Inflow is water that flows directly into the wastewater collection system—for example, through manhole lids, broken cleanouts, or direct illicit connections. Both I&I can have significant impacts on wastewater collection system capacity. Eliminating I&I is a key component of wastewater collection system preventative maintenance.

As part of the I&I elimination program, GRU's crews utilize a number of techniques, including smoke testing, closed-circuit TV inspection, and dye testing, to find potential locations where I&I can occur. **Figure H-7** shows the areas that have been tested since January 2001. In August 2003, GRU commenced with Phase 3, where the focus was on the urban creek areas.

If collection system defects are found, crews immediately repair each defect in the collection system area before moving on the next designated test area. **Figure H-8** shows the use of smoke testing to find sources of I&I, some of the illicit connections that exist. GRU has tested over 71% of its wastewater collection system since January 2001, with the urban creek areas covered in Phase 3 of the project during 2003, 2004, and 2005. GRU has spent \$2.8 million since 2001 on I&I and has budgeted \$1.36 million to continue this effort for the 2007 to 2012 budget period.

Figure H-7. GRU sewer system I&I elimination program
(Colored and shaded areas represent the designated wastewater collection system tested areas in the TMDL listed Hogtown, Sweetwater, and Tumblin' Creek basins—as shown in the graph, all of GRU's wastewater collection system in these urban creeks areas has been tested)

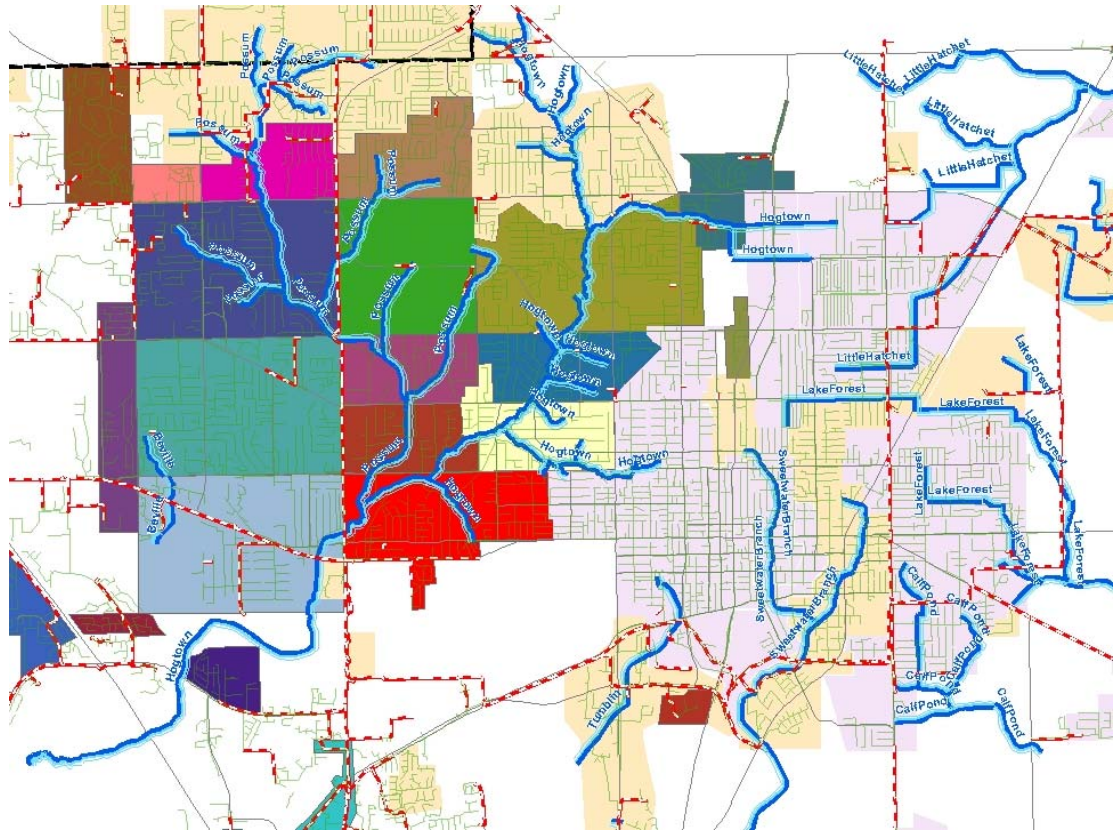


Figure H-8. Smoke testing used to find I&I

Broken Cleanout



Broken Service Lateral



Illegal Connections to GRU Wastewater Collection System: Apartment Rain Gutter



Illegal Connections to GRU Wastewater Collection System: Stormwater Retention Pond



Sliplining of Gravity Mains Adjacent to Urban Creeks

GRU utilizes sliplining technology to rehabilitate the wastewater gravity mains throughout its collection system. Sliplining pipelines protects the urban creeks by minimizing the possibility of wastewater leakage; essentially, old pipe is replaced with new pipe. The sliplining of gravity sewer interceptor tributary small-diameter lines adjacent to creeks is ongoing. GRU sliplining projects totaled \$4.7 million as of 2006, and the projected budget for continuing these efforts is \$681,000 over the 2007–12 budget period.

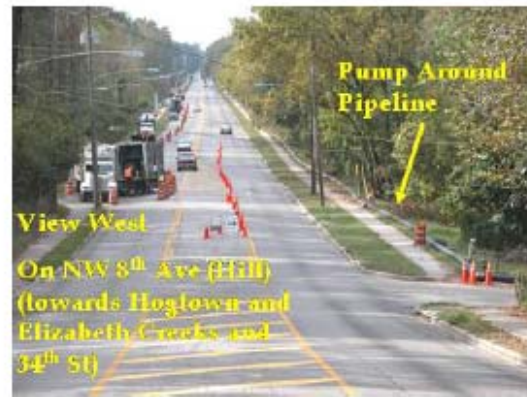
The Insituform® process is the most widely used trenchless method (sliplining) for restoring the structural integrity of gravity mains that can not be restored cost-effectively through digging an open trench. It has been proven in pipes with a wide range of shapes and in diameters of up to nine feet (2.75 meters). In the Insituform® process, a resin-impregnated Insituform® tube is installed into an existing pipe. This process results in a seamless, jointless "pipe-within-a-pipe" with a smooth, continuous inner surface which usually increases flow capacity. Typically installations are completed in a single day, using robotic methods to restore active connections from within the line.

Since the collection system provides 24-hour-per-day service, crews construct "pump arounds" to isolate GRU wastewater collection system lines for cleaning and sliplining. Pump around pipelines are typically assembled using high-density polyethylene (HDPE) where sections are fusion welded to form a continuous pipe. Pumps are set up, attached to a common manifold, and then operated to pump wastewater "around" the work area section to a manhole downgradient where wastewater continues gravity flow. After a pump around is established, the pipe is typically cleaned with a jet truck cleaning crew. Then, a closed-circuit television (CCTV) crew records and documents the wastewater collection system gravity line. If tuberculation (corrosion) is found, the pipe is then cleared of the corrosion with a hydraulic chain cutter tool.

To verify that the pipe is properly prepared, the pipe is pressure cleaned and CCTV'd before the sliplining work is performed. Once the pipe is prepared, a polyethylene resin impregnated tube is placed inside the pipe and heated water cures the resin, creating a new pipe within the old pipe, with the installation of the tube typically taking a few hours. The cured pipe is then cut at manholes and laterals are cut open, completing the work to install a new cast-in-place pipe.

Figure H-9 shows the installation sequence for a Hogtown Creek sliplining project. The sliplining process typically restores the hydraulic and structural integrity of the older pipe to that of a new pipe. While sliplining is an expensive technology, it is less invasive than open trench construction along the urban creek corridors.

Figure H-9. Installation sequence of a Hogtown Creek sliplining project
Pump Around (Hogtown Creek Basin)





Sliplining Pipe Installation



Sliplined Pipe in Manhole

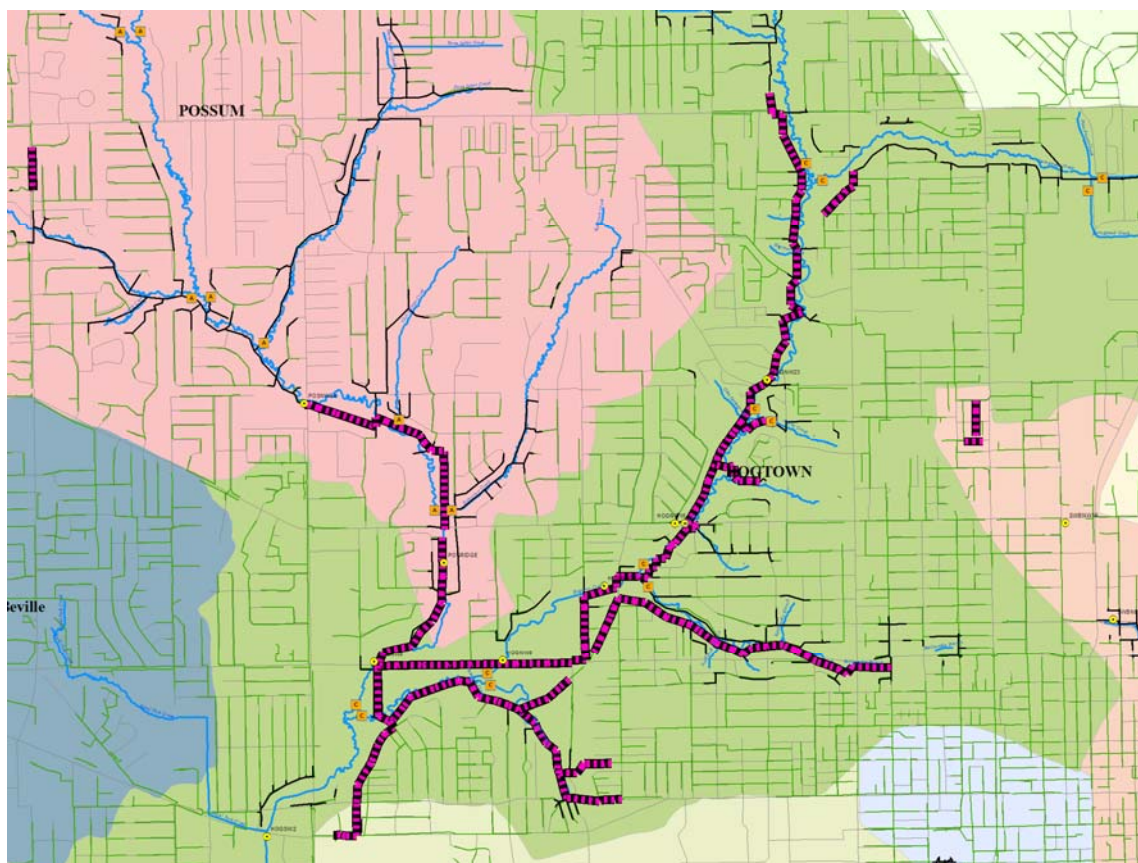


Finished Pipe in Manhole



Figure H-10 shows GRU major gravity mains adjacent to Hogtown Creek and its tributaries that have been sliplined since 1994.

Figure H-10. GRU sliplined major gravity mains adjacent to Hogtown Creek and tributaries



Force Main Integrity Testing

GRU staff have identified more than 25 miles of major force mains that were constructed with ductile iron or cast iron, and are 16 inches in diameter and larger, for inspection and wall thickness testing. A comprehensive program was developed and initiated to test the wall thickness of the 10 major force mains at 48 locations, perform pressure monitoring at 6 strategic locations within the force main system, and inspect 52 air release valves.

Nearly 1,700 pipe wall thickness test measurements have been collected to assess the overall condition of GRU's major force mains. The following conclusions can be made from this effort:

- *GRU's major force mains appear to be in relatively good condition based on the pipe wall thickness and system operating pressure data collected,*
- *No significant loss of pipe wall material was noted for the 10 major force main systems,*
- *Major force mains operate at relatively low pressures and pressure surges do not appear to be detrimental to the system in considering the bursting strength of measured pipe wall thicknesses, and*
- *Air release valves that are not operating to specifications are to be replaced as part of a multiyear rehabilitation program.*

Figure H-11 shows engineers and crews performing pipe wall thickness testing after accessing the pipeline.

Figure H-11. GRU engineers and crews performing pipe wall thickness testing



GRU has initiated a program to test second-tier force main systems that have piping diameters of 14 inches or smaller. As of January 2007, 6 of the 15 miles of force mains have been identified and tested. In addition, GRU has adopted a Standard Operating Procedure (SOP) that requires pipe wall thickness testing prior to all taps (connections) to existing force mains, to ensure quality taps to the force main and to minimize the risk of failure resulting in released wastewater.

GIS Asset Management System – Mapping and Targeted Maintenance

GIS facilities mapping involves efforts associated with incorporating developer and GRU installed wastewater and reclaimed water systems into a GIS database format, including a creek crossing pipeline assessment project that logged the GRU wastewater system creek crossings and is being used for assessment of the infrastructure for targeted maintenance. The GIS-based software system also stores mapping information and facility-specific information such as age, material, maintenance history, and adjacent utilities. It also incorporates new developments into the mapping system and reduces construction accidents due to increased accuracy in the location of underground utilities.

Plan Review and New Development Inspection – Redundancy, Oversizing, and New Standard Practices To Improve Reliability

All new construction requires a plan review process for compliance with all GRU design and construction standards. GRU's requirements exceed industry standards in such areas as improved manhole connection methods, pipe materials and utility crossings (casings), and wastewater collection system oversizing and redundancy. All of these requirements improve the reliability of GRU's wastewater collection system. Inspections are performed during and after the completion of construction projects to ensure compliance with construction standards. In addition, before GRU accepts any new gravity wastewater infrastructure for ownership and maintenance, it is inspected with closed-circuit TV cameras, flushed, smoked tested, and repaired as necessary. For force main systems, it is standard practice to pressure test all new systems before they are put into service.

Annual Water/Wastewater Engineering Department Operation and Maintenance Services for Initiating and Adminstrating the Capital Budget

GRU's executes a five-year scheduling system for initiating and administering wastewater capital projects, at an annual operation and maintenance cost of about \$650,000. GRU has budgeted \$70 million in capital improvements to the wastewater collection and treatment system over the 2007–11 budget cycle. Projects are timed and prioritized to ensure that facilities are available in a timely manner to meet demands as needed. The major areas of capital improvements include the following:

WASTEWATER TREATMENT FACILITIES – This budget category consists of projects associated with expansion, improvement, renewal, and replacement at the Kanapaha and Main Street Water Reclamation Facilities. Projects in the capital budget category include reclaimed water systems; pumping and facility effluent discharge; disinfection; process and efficiency studies and projects; digestion and biosolids management; emergency generation; capacity analysis and future planning; tertiary filter rehabilitation; electrical control systems replacement; process monitoring equipment; transfer pump station evaluation; grit drying facilities; and operator interface software systemwide upgrades.

LIFT STATIONS – Work in this capital budget category is associated with improvements; renewal and replacement required to maintain the existing lift stations in a reliable and efficient operating condition, including control cabinet replacement; wetwell and piping rehabilitation, replacement, and oversizing; valve and flow diversion upgrades; pump and motor drive system replacements; retrofits of control communication hardware; emergency portable and permanent generators for power outages to help prevent and/or minimize wastewater releases; communication system frequency conversion; maintenance facility expansion; storage and pumping capacity increases; motor soft start replacements; and float ball replacements.

WASTEWATER COLLECTION SYSTEM – This budget category includes wastewater collection system gravity and force main extensions, oversizing, rehabilitation, replacement, and removal to accommodate present and future customers and developments; modification of force main systems to establish redundancy and rerouting options; deepening of gravity mains; manhole rehabilitation or replacement; purchasing of software to analyze gravity sewer and force main systems; a gravity system capacity analysis study; and installation and replacement of wastewater service laterals and cleanouts to new and existing customers that are not associated with new developments.

GRU is working with an independent consultant to evaluate its wastewater collection system integrity programs. The goal of this effort is to increase the reliability of the wastewater collection system by assessing GRU's wastewater collection system procedures and compare them against standard industry practices. Recommendations will be provided for modifying GRU existing procedures, or if necessary, suggestions will be provided for new procedures to achieve the goal of increased reliability.

Specific Examples of Major Capital Projects, Equipment Utilized, and Work Performed

This section provides examples of recent capital improvement projects to illustrate the types of work performed on GRU's wastewater collection and treatment system.

Figure H-12 shows the force main replacement on NW 34th Street; this provides an example of a major capital project and the equipment methods utilized to complete a project of this scale. Approximately \$4.2 million was spent to replace 10,730 feet of force main piping.

Figure H-12. Force main replacement on NW 34th Street

HDPE Butt Welder Creates Contiguous Force Main Pipe Onsite



Pipe Assembly and Installation near 34th Street



Trench Boxes Installed and Jack and Bore Method Utilized to Install Pipe Casing under Utility Conflicts such as Roads, Gas Lines, and the Stormwater Sewer System



***Directional Boring Method Utilized to Install Piping Casing under
Utility Conflicts such as NW 34th Street***



***Tie In of New Pipe to Existing Pipe Utilizing Trench Box, Tapping
Tool, Valve Assemblies and Excavation***



Final Steps in Pipeline Installation



Lift Station 10 Renovation

This capital project replaced the existing pumps, controls, and mechanical equipment. The antiquated station was converted from a Yeomans wetwell/drywell station to a more efficient Flygt submersible station with upgraded controls, variable frequency drives, and mechanical appurtenances.

The existing above-ground structure was also demolished. The total cost of the project was \$1.4 million. **Figure H-13** shows the project being carried out.

Figure H-13. LS 10 renovation

Lift Station before Renovation



Lift Station during Renovation with Demolition and External Pumping



Renovated Receiving Manhole, Wetwell, Drywell, and Completed Lift Station



Wastewater Spill Prevention Programs

To further reduce releases from the wastewater collection system to the environment, GRU has implemented an aggressive pretreatment program focused on commercial grease control. The program includes two inspectors who conduct inspections on all food service establishments. In addition, GRU has implemented a campaign focused on residential grease control. As part of the public outreach campaign, staff distributed 5,000 grease trappers; presented at local schools; distributed press releases where local media assisted in getting information out to the public; and provided spill prevention information in the GRU customer bulletin.

Wastewater Collection System Performance Monitoring

GRU funded a Bacterial Source Tracking (BST) at a cost of \$325,000. The study is examining the DNA of fecal coliform to determine whether their source is animal or human in origin. Local stakeholders will use the study results in developing practical indicators for future monitoring and implement appropriate strategies to reduce bacteria in Gainesville's urban creeks. Section 5.4.3 explains this project and the techniques utilized in depth.

References

Water Environment Research Federation . June 2003. Effective practices for sanitary sewer and collection system operations and maintenance.