

Brunswick-Glynn County Joint Water and Sewer Commission

RFP No. 18-010 Request For Proposals

Smoke and Dye Testing Services – SSI District Project No. 807 for the Brunswick-Glynn County Joint Water and Sewer Commission

Thursday, January 17, 2019

Deadline for questions is Friday, 02/08/2019, no later than 5:00 p.m. EST. Questions must be directed in writing (via e-mail) to the Purchasing Director, Pamela Drury-Crosby, email- <u>pcrosby@bgjwsc.org</u>

Responses Due by:

12:00 NOON, EST Wednesday, February 20, 2019 to:

Purchasing Division Joint Water and Sewer Commission 1703 Gloucester Street Brunswick, Georgia 31520 (912) 261-7100 Proposals should be clearly labeled as follows: "RFP No. 18-010 Smoke and Dye Testing Services – SSI District"

Submit responses in hard copy only; electronic or fax responses will not be accepted. Responses received after the deadline or at any other locations will not be accepted.

FOR COMPLETE DETAILS OF THIS SOLICITATION, please visit the BGJWSC website, utilizing the following link:

http://www.bgjwsc.org/departments/procurement/

BRUNSWICK-GLYNN COUNTY JOINT WATER AND SEWER COMMISSION

REQUEST FOR PROPOSAL 18-010 Smoke And Dye Testing Services – SSI District Project No. 807

1.0 INTRODUCTION

The Brunswick-Glynn Joint Water & Sewer Commission (JWSC) wishes to receive Requests for Proposals ("RFP") for Smoke and Dye testing services for the St. Simons Island District.

The Scope of Work for the Inflow Source Investigations shall include the following:

- Smoke testing in the following meter basins: 2034, 2065, 2002, 2011, 2063, 2013, 2046, 2008, 2005, 2017, 2039, 2023, 2052, 2030, 2047, 2048 and 2044 (see Exhibit A for cross reference listing) approximately 210,589 linear feet of sanitary sewer main pipeline. (see Exhibit A for cross reference listing) approximately 210,589 linear feet of sanitary sewer main pipeline.
- Dye Water testing for estimate of (15) dye traces and (15) dye floods.

The firms must comply with all applicable state, local and federal regulations related to the services provided to the BGJWSC. The BGJWSC reserves the right, subject to negotiation and agreement, in writing, with the selected firm, to either expand or limit the scope of services as needed. The selected firm will be required to have sufficient personnel to complete the tasks required by this scope of services. The selected firm will complete the required tasks in a timely and efficient manner. The selected firm would be expected to enter into a contract for services based upon the firm's hourly rates and an agreed-upon not to exceed amount.

The JWSC contracted with McKim & Creed, Inc., for a Flow Monitoring Study for the SSI District in 2017. The study was completed in the spring of 2018 and excerpts from the technical memorandum are included for your reference as Exhibit B. Any information shown is for reference use only, final scope of work is to be determined by the selected firm. All services performed shall be in accordance with applicable BGJWSC Standards and State EPD regulations. Firms expressing interest should be fully capable of providing the end results requested.

All proposals must be made on the proposal form included with the Contract Documents for the proposed work.

No proposer may withdraw his/her proposal for a period of ninety (90) days after the date set for the opening thereof. All proposals shall remain valid for that period of time.

The award (if an award is made) will be made as provided in the Proposal. The award shall be made to the lowest responsive and responsible bidder, provided that if the JWSC believes that the public interest will be best served by accepting other than the lowest bid, it shall have the authority to accept the proposal that will best serve the public interest.

The JWSC reserves the right to accept or reject any and all bids, alternate bids, or unit prices and/or waive any irregularities in any bid received.

Time of Completion shall be (180) one hundred eighty calendar days after issuance of the Notice to Proceed. Liquidated damages for failure to complete the work within the specified time are specified in the Contract Documents.

A certified check or corporate surety bond of not less than 10% of the amount bid for the total cost of the project must accompany each proposal.

The Contractor will be required to comply with all applicable Equal Employment Opportunity laws and regulations. All bids must cover the entire work required under this contract.

Proposers' attention is directed to the Special Provisions of the Contract Documents which require the Contractor, to whom the contract for the work is awarded, to provide at the time of executing said contract, a Contractor's Payment Bond and Bond for Faithful Performance, in the amount of 100% of the contract amount, meeting all requirements of said Contract Documents and approved by the JWSC Attorney. Additionally, all forms relevant to Insurance, Drug-Free Workplace, EEO and E-verify are to be executed at this time.

2.0 SPECIAL CONDITIONS

The selected firm shall be responsible for obtaining any additional information needed for their evaluation and design. The selected firm will be provided access to any pertinent system information in the possession of the JWSC, if available (drawdown/flow meter data, Master Plan, GIS mapping, etc.). Additional evaluation activities will be the responsibility of the selected firm. Any costs involved with additional information are the responsibility of the selected firm.

The Consultant is to complete all testing within <u>120 days</u> of receiving a signed notice to proceed. The JWSC requires that selected firm be available for bi-weekly progress meetings (either onsite at JWSC or via teleconference) with all noted deliverables by the end of the <u>180 day</u> period. Each firm's experience and qualifications will be evaluated primarily as they relate to the firm's ability to provide <u>Smoke and Dye Testing Services for the SSI District.</u>

The BGJWSC will make an award only to a responsible firm possessing the ability to perform successfully under the terms and conditions of the procurement. Consideration will be given to such matters as firm integrity, compliance with public policy, record of past performance, and financial and technical resources. This is a qualifications-based procurement of professional services whereby competitors' qualifications will be evaluated and the most qualified firm will be selected, subject to negotiation of fair and reasonable compensation.

Written proposals will be reviewed and rated by a panel of qualified BGJWSC staff members. The rating system will consist of a numerical grading system, as set forth in Section 6. The BGJWSC may or may not elect to interview any of the responding firms.

The BGJWSC has exclusive and sole discretion to determine the firm whose services will be most advantageous to the BGJWSC, and reserves the right to reject all firms. The purpose of this inquiry is to determine the interest or non-interest and the qualifications of firms in providing the professional services required. A number of firms may be asked to express their interest in regard to these services in the form of a Proposal. Following the receipt of Proposals, a certain firm or firms may be selected for further consideration.

This project is funded through JWSC rehabilitation and repair reserves and subject to availability of funds.

3.0 INFORMATION REQUESTS AND INSTRUCTIONS FOR PROPOSAL SUBMITTAL

Additional information and clarifications desired by a Proposer shall be requested from the BGJWSC in writing and if explanations are necessary, a reply shall be made in the form of an Addendum, a copy of which will be forwarded to each Proposer. Every request for such clarification shall be in writing (email) addressed to Pamela Crosby at pcrosby@bgiwsc.org. Any verbal statements regarding same by any person prior to the award shall be considered not authoritative and not binding.

Addenda issued to Proposers prior to the date of receipt of Proposals shall become a part of the RFP and Proposals shall include the work described in the Addenda. No inquiry received within five days of the date fixed for the submission of Proposals will be given consideration. Any and all such interpretations and any supplemental instructions will be in the form of written Addenda, which, if issued, shall be emailed to all prospective Proposers, not later than five days prior to the date fixed for the submission of Proposals **(no later than 12:00 noon EST on Tuesday, February 5, 2019)**.

Proposals are to be submitted with:

- A detailed description of the services provided for each phase of the project
- Proposal total anticipated not-to-exceed cost
- Time period for each phase of the project and project workflow that demonstrates actions/decision trees based on initial smoke test results
- A detailed list and fee schedule for any anticipated work not included in the proposal
- A sample package of all deliverables included for each work element (smoke testing, dye water tracing, dye water flooding and final technical memo). This should be representative of what BGJWSC will receive as documentation for the following items: testing schedule, notification communication, results spreadsheet, defect spreadsheet and final report output/technical memorandum with map and photo outputs.

All proposals shall include a completed 5.0 Proposal Summary Sheet (see attached). Please submit an original plus (4) four copies and (1) one electronic version of the proposal. Each proposal should be prepared simply and economically, providing straightforward, concise delineation of the firm's capabilities to satisfy the requirements of this RFP. Fancy binding and color displays other than those necessary are highly discouraged. Please limit responses to a total of (75) seventy-five singlesided pages. This total should include the sample of all report, map and photo outputs outlined for each service group.

Proposals are due by 12:00 noon (EST) on Wednesday, February 20, 2019. Mandatory label required on outside of envelope: "Request for Proposals 18-010 for Smoke and Dye Testing Services – SSI District – Project No. 807." Proposals are due by the time and on the date listed above. ALL LATE PROPOSALS FOR WHATEVER REASON WILL BE RETURNED UNOPENED.

4.0 SCOPE OF SERVICES

SMOKE TESTING

Service provider will conduct smoke testing of the lift station service areas exhibiting the highest levels of storm water inflow. The following identifies the tasks which will be completed during the smoke testing initiative:

- 1. Select area to be tested and develop working field maps of the area.
- 2. Field review the area selected and note on the map all "hundred block" addresses.

- 3. Distribute smoke testing notice to all homes, businesses, schools and Fire & Rescue, etc. In addition, Fire & Rescue will be notified of any proposed smoke testing activities (72) seventy two hours prior to the initiation.
- 4. During the initial field review, identify all types of businesses, specifically any doctors offices, hospitals, schools, retirement communities or any other establishment that may need special consideration and handling during the actual smoke test. Strict consideration and coordination with customers who have sensitive needs must be adhered to some of whom will not be included on any smoke testing schedule as the nature of their business, such as hospitals, is far too delicate.
- 5. (24) Twenty-four hours minimum must expire from the issuance of smoke testing notices to allow all affected to prepare for the testing or call with special exceptions, such as persons with health problems living at home, etc.
- 6. On the day of the testing, the selected portion of the study area will be identified and all street names and related hundred block addresses will be given to the fire department/emergency personnel for the area where the testing will occur. UNDER NO CIRCUMSTANCES WILL THE AREA SELECTED FOR THAT DAY'S TESTING BE MODIFIED TO INCLUDE ADDITIONAL WORK UNLESS THE FIRE DEPARTMENT/EMERGENCY RESPONSE PERSONNEL HAVE BEEN NOTIFIED FIRST. The name and ID number of the fire department person contacted will be documented on the appropriate form. The fire department/emergency personnel will be provided the exact locations and specific time frames of where and when the tests will be performed.
- 7. Multi-day scheduling with one time reporting to the fire department/emergency personnel will not be permitted.
- 8. The JWSC's Project representative will be notified on a daily basis of the same information.
- 9. Should the fire department/emergency personnel respond to the target area during the actual smoke testing, all testing will cease immediately and the Smoke Testing Team's field supervisor in charge will contact the fire unit responding to answer any questions that the fire department officer may have.
- 10. All testing activity will cease when any resident complains of smoke entering their establishment. Smoke Testing Team's field personnel will then attempt to isolate where the smoke is entering the establishment and make the occupant aware of what the problem may be. All defective plumbing found inside should be documented appropriately for future reference. The occupant will be advised to have the defect repaired by a licensed plumber.
- 11. During the actual smoke testing, Smoke Testing Team field personnel will scout the area for smoke escaping from ground sources, roof vents, storm drain structures, etc. All sources of infiltration/inflow will be photographed, measured, drawn and documented accordingly with addresses, data, and sketches. The smoke test form will identify which sewer reach is being tested by its component identification in the JWSC's GIS database. This data should be provided to the JWSC on a weekly basis at a minimum and can be accepted daily if that is preferable to the selected firm.
- 12. All defects encountered will also be recorded using a GPS receiver with subfoot accuracy. Said receiver will be compatible with JWSC GIS, and all data deliverable from units will be provided in .SHP shapefile format for continuity. The firm will have access to the JWSC's wastewater collection system GIS which will be overlaid on a digital ortho map and the R1 unit will allow the smoke test team member to see his location on the map in real time and allow for accurate recording of defects encountered. Each image taken will be geocoded to a specific location and the information will be stored electronically for future use. JWSC will be provided a link to the defect mapping and can easily monitor the smoke testing effort simply by refreshing the computer's image displayed.

It is understood that JWSC staff members may accompany service provider field staff during the smoke testing initiative to gain a better understanding of how to quantify potential inflow volumes from the smoke defects recorded and how to compare the smoke testing defect results to the previously recorded flow data.

Deliverables will include the following:

- Service provider will develop a "Smoke Testing Results" spreadsheet that identifies each pipe section tested and the results of the test, whether positive or negative.
- A separate spreadsheet; "Smoke Testing Defects" will be prepared that identifies all defects encountered during the smoke testing activity. This spreadsheet will contain a column which identifies the surface area associated with each defect, the associated inflow volume based on a one inch rainfall event at the defect and if there is a need to conduct dye water testing/flooding.

If a dye test is necessary, a service order number will be prepared for the work effort using the JWSC's Cityworks asset management system and a description provided of what personnel and equipment will be needed.

DYED WATER TRACING

Private sector dyed water testing will be conducted by introducing a small quantity of liquid dye concentrate into suspect sources such as downspouts, area drains, patio drains, window well drains, and driveway drains, and then introducing a sufficient volume of clean water to locate the source's discharge point. During each tracing, sanitary sewers, storm drains, and curb lines located downstream of the sources shall be monitored for signs of dyed water. The quantity of dye concentrate and water used will vary depending on pipe size and the quantity of flow and debris in each line section.

Deliverable will include the following:

- A report will be prepared for each location where dye water tracing was performed.
- The report will identify where the dye water was introduced and its' susceptibility for entering the wastewater collection system.
- Photos will be taken of where the dye water is introduced and where it is recorded discharging into the downstream wastewater collection system manhole.

CCTV inspection equipment may be utilized to identify exactly where the dye water is entering the wastewater collection system piping.

DYE WATER FLOODING

The Field Inspection Procedures for Dyed Water Flooding are as follows:

- A mixture of water and any approved dye coloring substance will be introduced to the identified source. Dye water team inspectors will be stationed immediately downstream on the local sanitary and storm sewer lines. Observations, whether positive or negative, will be documented appropriately. Whenever possible, the dyed water point of exit will be documented by HD closed circuit television inspection equipment.
- Prior to any testing, the appropriate JWSC staff shall be notified of the specific location of testing and what adjacent waterways may be affected when the dye water is released into the storm drainage system.

Fire hydrants used to supply the water source needed will be opened slowly and closed in the same manner. A flow restrictive device shall be used on the hydrant to prevent discoloration problems. Should the water be running cloudy or dirty after use, the fire hydrant shall be left open at a slow pace until the water clears. If long term draining is required, the Dye Water Team shall notify Fire and Rescue.

Dye water flooding results will be documented for each location where the storm drainage system is flooded. Each dye water flood report will identify the following:

- the section of wastewater gravity piping being tested
- the location(s) where the storm water system piping was isolated and flooded
- photographs of each setup
- CCTV inspection results identifying the location(s) where dye water was identified entering the wastewater collection system.

Additional documentation will include:

- Evidence of dyed water in manholes downstream from the ponding area, stream crossing, or other suspected sources where the dyed water is placed
- Time of travel from contributing source to manhole sampled, and the concentration of the dyed water

STORM WATER INFLOW ABATEMENT DESIGN

A Dye Testing Technical Memorandum will be developed upon completion of the dye tracing/flooding. This will contain recommendation of effective forms of abatement for each inflow source discovered. While defining the necessary abatement activity, note will be made as to whether said activity can be accomplished by JWSC staff in-house or will require the services of a third party contractor.

The technical memorandum will include:

- The individual dye test reports including verbiage describing the necessary work which must be completed to eliminate the storm water inflow source(s)
- Projected costs for completing the work
- 11 x 17 map which identifies the sanitary and storm water features affected by the proposed I/I remediation effort

General notes will be added to the map which identifies the proposed I/I abatement scope, but no physical survey, or utility location, will be completed. For corrective measures designated as inhouse, the diagrams, sketches and notes should be sufficient for use by JWSC crews to address the inflow abatement. Outside engineering will be utilized (at the discretion and additional cost to the JWSC) for required corrections beyond the internal JWSC crew's capability.

5.0 PROPOSAL SUMMARY SHEET

ltem No.	Description	Estimated Quantity	Unit	Unit Cost
1	Mobilization and Demobilization	1	Lump Sum	\$
2	Traffic Control	1	Lump Sum	\$
3	Notification	1	Lump Sum	\$
4	Digital Database, Final Report, and Other Administrative Costs	1	Lump Sum	\$
	Unit Prices for SMOKE TESTI	NG (including a	ll work describe	ed herein):
5	Mainline	210,589	Linear Feet	\$
	Unit Prices for DYE WATER T	ESTING (includ	ing all work des	scribed herein):
6	Dye Trace	15	Each	\$
7	Dye Flood	15	Each	\$
FOTAL (Fi (Words): _ Bidders N	gures): \$			
Signature	:			
Company	Name:			
Date:				
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6.0 EVALUATION CRITERIA

The selected firm or firms must be experienced and qualified to provide the required scope of services. The firm or firms selected must have expertise related to the general Scope of Services set forth in Section 4. The following information must be submitted with the proposal on the date indicated above and in the order indicated below:

- a. Recently Completed Projects. Evidence of satisfactory performance of no less than (3) three and no more than (5) five recently completed projects of the type and nature indicated above. The projects should be within the past five (5) years and include email and phone contacts. Include email and phone contact information. (25 points possible)
- b. Project Approach, Timeline and Deliverables Package. Discuss the proposed approach to completing the needed services in the required timeline. Please detail how your firm will coordinate the project, include listing all activities, coordination of all activities with JWSC and community, plus associated timeline. A sample packet of work element documents must be submitted for evaluation as part of the proposal package. (50 points possible)
- c. Pricing. Fees required for all design, permitting, easement procurement support (if any), and services during construction will be considered. (25 points possible)
- **d.** Required Licensure. Firm must be licensed and approved for work in the State of Georgia; please include a copy of engineering license. (Pass/Fail)
- e. Professional Standing. A statement as to a professional standing including any pending controversies outstanding. If none exists, such a statement. (Pass/Fail)

<u>AFFIDAVIT</u>

This Bid is submitted to Brunswick-Glynn County Joint Water and Sewer Commission (JWSC) by the undersigned who is an authorized officer of the company and said company is licensed to do business in Georgia. Further, the undersigned is authorized to make these representations and certifies these representations are valid. The Bidder recognizes that all representations herein are binding on the Company and failure to adhere to any of these commitments, at the JWSC's option, may result in a revocation of the granted contract.

Consent is hereby given to the JWSC to contact any person or organization in order to make inquiries into legal, character, technical, financial, and other qualifications of the Bidder.

The Bidder understands that, at such time as the JWSC decides to review this Bid, additional information may be requested. Failure to supply any requested information within a reasonable time may result in the rejection of the Bid with no re-submittal rights.

The successful Bidder understands that the JWSC, after considering the legal, financial, technical, and character qualifications of the Bidder, as well as what in the JWSC's judgment may best serve the interest of its rate payers and employees, may grant a contract.

The successful Bidder understands that this bid is made without prior understanding, agreement, or connection with any corporation, firm or person submitting a bid for the same, and is in all respects fair and without collusion or fraud. I understand that collusive bidding is a violation of state and federal law and can result in fines, prison sentences, and civil damage awards.

Any contract issued will be on the basis of the Bidder's service, financial plans and arrangements being feasible and adequate to fulfill the conditions set forth in this project and the successful Bidder's response.

Company Name:			
Authorized Person:		Signature:	
	(Print/Type)		
Title:		Date:	
Address:			
Telephone:	Fax:	Email:	
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State of Georgia City of Brunswick County of Glynn

 (name of individual), solemnly swear

18-010 Smoke and Dye Testing Services – SSI District – Project No. 807

that I, nor any other person associated with me or my business, corporation or partnership, has prevented or attempted to prevent competition in the bidding or Bids of said project or from submitting a bid for this project by any means whatever.

Lastly, I swear that neither I, nor any other person associated with me or my business, Corporation or partnership has caused or induced any other bidder to withdraw his/her bid from consideration for this project. Said oath is filed in accordance with the requirements set forth in O.C.G.A. § 36-91-21 (e).

This the	day of	_2019.	
Name of Party:			
Corporate or Pa	artnership Name:		
Sworn to and su	ubscribed before me this the	day of	_2019.
NOTARY PUBL	IC:		
Name:			
My Commissior	n Expires:		
(SE/	AL)		

<u>REPRESENTATION</u>

EQUAL EMPLOYMENT OPPORTUNITY (EEO) PRACTICE:

EEO Plan: The successful Bidder will develop and implement an EEO policy that, as a minimum, will recruit, hire, train, and promote, at all levels, without regard to race, color, religion, national origin, sex, or age, except where sex or age is a bona fide occupational qualification.

EEO For Veterans/Handicapped: The successful Bidder will also provide equal employment opportunities for qualified disabled veterans, handicapped persons and veterans of the Vietnam Era.

EEO For Successful Bidder Programs: The successful Bidder, will ensure equal employment opportunity applies to all terms and conditions of employment, personnel actions, and successful Bidder-sponsored programs. Every effort shall be made to ensure that employment decisions, programs and personnel actions are non-discriminatory. That these decisions are administered on the basis of an evaluation of an employee's eligibility, performance, ability, skill and experience.

EEO Acquisitions: The successful Bidder will develop and implement a policy that will give equal opportunity to the purchase of various goods and services from small businesses and minority-owned businesses.

a. Does the Bidder have the above EEO policy in place?

- [] Yes [] No
- b. If the answer to a. above is no, will the Bidder have such a policy in place for the project?
 - [] Yes [] No

Statement of Assurance: The Bidder herein assures the JWSC that it is in compliance with Title VI & VII of the 1964 Civil Rights Act, as amended, in that it does not on the grounds of race, color, national origin, sex, age, disability, or veteran status, discriminate in any form or manner against employees or employers or applicants for employment and is in full compliance with A.D.A.

(Firm's Name	2)	
 (Authorized S	lignature)	
	/	
(Title)	(Date)	

Brunswick-Glynn County Joint Water and Sewer Commission

1703 Gloucester Street Brunswick, Georgia 31520 (912) 261-7100

INSURANCE REQUIREMENTS

The description section of your insurance certificate must read:

BGJWSC is named as an additional insured on all coverage except Workers' Compensation as per written contract. A wavier of Subrogation applies to all policies shown above as per written contract.

Insurance Requirements

Before starting and until acceptance of the Work by BGJWSC, and without further limiting its liability under the Contract, Company shall procure and maintain at its sole expense, insurance of the types and in the minimum amounts stated below:

SCHEDULE	AMOUNT
Workers' Compensation	
Georgia Statutory coverage	Statutory Limits (Workers' Compensation)
and Employer's Liability (including	\$500,000 Bodily Injury each accident
appropriate Federal Acts)	\$500,000 Bodily Injury by Disease each Employee
	\$1,000,000 Bodily Injury policy limit
Commercial General Liability	
Premises-Operations	\$1,000,000 each occurrence
Products-Completed Operations	\$2,000,000 annual aggregate for bodily injury
Contractual Liability	and property damage, combined single limit
Independent Contractors	
Broad Form Property Damage	
Explosion, Collapse and Underground	
Hazards (XCU Coverage) as appropriate	
Primary and Non Contributory	
Automobile Liability	
All autos-owned, hired,	\$1,000,000 each occurrence, combined single limit
or non-owned	
Excess or Umbrella Liability	
(This is additional coverage and limits	\$2,000,000 each occurrence and annual aggregate
above the following primary insurance:	
Employer's Liability, Commercial General	
Liability and Automobile Liability)	

Company's Commercial General Liability and Excess or Umbrella Liability policies shall be effective for two years after Work is complete. The above Indemnification provision is separate and is not limited by the type of insurance or insurance amounts stated above. The General liability shall contain a "Per Project Aggregate".

Company shall specify BGJWSC as an additional insured for all coverage except Workers' Compensation and Employer's Liability. Such insurance shall be primary and non-contributory as to any and all other insurance or self-insurance maintained by BGJWSC. Company shall include a Waiver of Subrogation on all required insurance in favor of BGJWSC, its commission members, employees, agents, successors and assigns.

Such insurance shall be written by a company or companies authorized to do business in the State of Georgia, rated at least A- VII by A M Best and satisfactory to BGJWSC. Prior to commencing any Work under this Contract, certificates evidencing the maintenance of the insurance shall be furnished to BGJWSC for approval.

CERTIFICATE OF INSURANCE

This is to certify that _____

(Insurance Company)

of ______ (Insurance Company Address)

has issued policies of insurance, as identified by a policy number to the insured name below, and that such policies are in full force and effect at this time. Furthermore, this is to certify that these policies meet the requirements described in the General Conditions of this project; and it's agreed that none of these policies will be canceled or changed so as to affect this Certificate until thirty (30) days after written notice of such cancellation or change has been delivered to:

BRUNSWICK-GLYNN COUNTY JOINT WATER AND SEWER COMMISSION

1703 GLOUCESTER STREET, BRUNSWICK, GEORGIA 31520

It is further agreed that Brunswick-Glynn County Joint Water and Sewer Commission shall be named as an additional insured on the Contractor's policy.

1.	Insured:	
2.	Project Name:	18-010 SMOKE AND DYE TESTING SERVICES – SSI DISTRICT
3.	Policy Number(s): _	
Date:		_
		(Insurance Company)
Issued	d At:	_
		(Authorized Representative)
Addre	ess:	
Note:	Please attach Certifica	ate of Insurance form to this page.

CERTIFICATE OF DRUG FREE WORKPLACE

In order to have a drug- free workplace, a business shall:

Publish a statement notifying employees that the unlawful, manufacture, distribution, dispensing, possession, or use of controlled substances is prohibited in the workplace and specifying the actions that shall be taken against employees for violation of such prohibition.

Inform employees about the dangers of drug abuse in the workplace, the business's policy of maintaining a drug-free workplace, any available drug counseling, rehabilitation, and employee assistance programs, and the penalties that may be imposed upon employees for drug abuse violations.

As a condition of working on the commodities or contractual services then under bid, the employee shall notify the employer of any conviction of, or plea of guilty or nolo contendere to, any violation of any controlled substance law of the United States or any State, for a violation occurring in the workplace no later than five (5) days after such conviction.

Impose a sanction on, or require satisfactory participation in a drug abuse assistance or rehabilitation program if such in available in the employee's community, by any employee who is so convicted.

Make a good faith effort to continue to maintain a drug-free workplace through implementation of this section.

As the person authorized to sign this statement, I certify that this firm complies fully with the above requirements.

Company Name:

Authorized Signature:

Title:

Date:

E-VERIFY CONTRACTOR AFFIDAVIT AND AGREEMENT

Georgia Security Immigration and Compliance (GSIC) Act

The Brunswick-Glynn County Joint Water and Sewer Commission and Contractor agree that compliance with the requirements of O.C.G.A. § 13-10-91 and Rule 300-10-1-.02 of the Rules of the Georgia Department of Labor are conditions of this Agreement for the physical performance of services.

By executing this affidavit, the undersigned contractor verifies its compliance with O.C.G.A. § 13-10-91, stating affirmatively that the individual, firm, or corporation which is contracting with the Brunswick- Glynn County Joint Water and Sewer Commission has registered with and is participating in the federal work authorization program known as: "E-Verify", web address <u>https://e-verify.uscis.gov/enroll/</u> operated by the United States Citizenship and Immigration Services Bureau of the United States Department of Homeland Security to verify information of newly hired employees, pursuant to the Immigration Reform and Control Act of 1986 (IRCA), P.L. 99-603], in accordance with the applicable provisions and deadlines established in O.C.G.A. § 13-10-91. The undersigned Contractor also verifies that he/she/it is using and will continue to use the federal work authorization program throughout the contract period.

The undersigned Contractor agrees that, should it employ or contract with any subcontractor(s) in connection with the physical performance of services pursuant to the contract with the Brunswick- Glynn County Joint Water and Sewer Commission, Contractor will secure from each subcontractor(s) similar verification of compliance with O.C.G.A. § 13-10-91 on the Subcontractor Affidavit provided in Rule 300-10-01-.08 or a substantially similar form. Contractor further agrees the Contractor will advise the Brunswick-Glynn County Joint Water and Sewer Commission of the hiring of a new subcontractor and will provide the Brunswick-Glynn County Joint Water and Sewer Commission with a Subcontractor Affidavit attesting to the Subcontractor's name, address, user identification number, and date of authorization to use the Federal Work Authorization Program within five (5) days of the hiring before the Subcontractor begins working on the Project. Contractor also agrees to maintain all records of such compliance for inspection by the Brunswick-Glynn County Joint Water and Sewer Commission at any time and to provide a copy of each such verification to the Brunswick-Glynn County Joint Water and Sewer Commission at the time the subcontractor(s) is retained to perform such services.

(Continued on Next Page)

E-Verify Employment Eligibility Verification User I.D. Number

Date of Authorization to Use Federal Work Authorization Program	
Name of Contractor	
Title of Authorized Officer or Agent of Contractor	
Signature and Printed Name of Authorized Officer or Agent	
Sworn to and subscribed before me this theday of	, 2019.
NOTARY PUBLIC:	
Name:	_
My Commission Expires:	
(NOTARY SEAL)	

As of the effective date of O.C.G.A. § 13-10-91, the applicable federal work authorization program is the "EEV/Basic Pilot Program" operated by the U.S. Citizenship and Immigration Services Bureau of the U.S. Department of Homeland Security, in conjunction with the Social Security Administration (SSA).

EXHIBIT A

Basin and List Station Cross-Reference Listing

RFP No. 18-010 Project No. 807 Smoke and Dye Testing Services – SSI District

Exhibit A Basin / Lift Station Cross Reference Listing				
Basin	Lift Station	Address		
2A	2034	130 Rice Mill Rd		
5B	2065	413 Kings Way		
7B	2002	120 Ocean Blvd		
8B	2002	411 Arnold Rd		
10A	2011	148-204 N Windward Dr		
10B	2063	4000 1st St		
11A	2011	3600 Windward Dr		
12B	2013/2046	115 Military Rd		
15A	2008	6 Plantation Way		
15B	2005	119 Worthing Rd		
17B	2017/2005/2039	Sea Island & Frederica Rd		
21B	2023	197 Merion		
22B	2052	122 Point Ln		
24B	2030	Rose Cottage Dr		
27B	P11602	Dunbar Creek WWTP		

EXHIBIT B

EXCERPT FROM TECHNICAL MEMORANDUM

Brunswick - Glynn County Joint Water & Sewer Commission St. Simons Island I/I Abatement Program Flow Monitoring Technical Memorandum



April, 2018



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1.0 EXECUTIVE SUMMARY

1

1.1 General Summary: In 2015 Brunswick-Glynn County Joint Water and Sewer Commission (JWSC) entered into a Consent Order with Georgia Department of Environmental Protection, (GADEP), to reduce sanitary sewer overflows, (SSOs). The Consent Order includes both mainland wastewater collection/conveyance and treatment facilities (Academy Creek & Exit 29) and St. Simon's Island, (SSI), wastewater collection/conveyance and treatment systems. In 2016 a Water and Sewer Master Plan was completed for JWSC by Applied Technology & Management and Four Waters Engineering. The results of the master plan indicated that the mainland portion of the JWSC service area will require an additional water pollution control plant (WPCP) by 2030, however, the existing SSI WPCP has adequate capacity over the next 20 years if a significant percentage of the current storm water inflow and infiltration (I/I) can be eliminated. The following table, (Table 1.1), identifies the lift station service areas that were determined to have the highest levels of I/I and the classification of need to address.

Sub-Basin	Low Need	Medium Need	High Need	Critical
2002		*		
2003			*	
2008	*			
2011		*		
2013			*	
2017	*			
2022	*			
2030	*			
2032				*
2038	*			
2039		*		
2042	*			
2045			*	
2053				*
WPCP				*

Table 1.1 – Lift Station Service Areas with Excessive I/I (2015)

Note: The ranking of the I/I severity was based primarily on recorded pump runtimes during significant wet weather periods. (Lift Stations 2013, 2022, 2032, 2038, 2039, 2042 & 2045 have had significant RDI/I abatement) Based on the results of the master plan, JWSC began an aggressive program aimed at reducing the I/I

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volumes and significant wet weather flow reductions have been gained at Lift Stations 2013, 2022, 2032, 2038, 2039, 2042 and 2045. JWSC then identified the need to complete a comprehensive flow/rainfall monitoring program to document the I/I reduction and to facilitate new abatement programs which will further reduce I/I. McKim & Creed was selected to perform the flow/rainfall monitoring project and the results/recommendations presented by this report identify which lift station service areas are experiencing the highest levels of groundwater infiltration and rainfall dependent inflow/infiltration, (RDI/I). The following verbiage identifies the work efforts completed as part of the project, the results of the monitoring effort and the recommended approach for identifying the sources of the extraneous clean water so that an effective remediation program can be developed.

1.2 Flow Meter Placement: The SSI Dunbar Creek WPCP service area includes approximately 546,645 linear feet of gravity sewers, ranging in size from 6-inch to 30-inch, 2,578 manholes, 146 lift stations and 254,677 linear feet of forcemain, ranging in size from 2-inch to 16-inch. In an effort to isolate the wastewater flow and identify RDI/I volumes within the service area, forty four (44) open channel flow meters, six (6) rainfall gauges and twelve (12) groundwater gauges were deployed.

When evaluating the influent piping connectivity to the Dunbar Creek WPCP it is apparent that there are two (2) primary branches; North and South. In an effort to simplify the analysis, the lift stations connected to each branch were classified based on that connectivity. See St. Simons Island Flow Meter Basin maps in Appendix A (North Branch) & Appendix B (South Branch).

1.3 Flow Monitoring Results: The flow monitoring was conducted between November 22nd, 2017 and February 22nd, 2017. From review of the flow data recorded during the monitoring period, it has been established that the average 24-hour flow at the Dunbar Creek WPCP equaled 3.368 million gallons. The average 24-hour dry weather flow was determined to be 2.845 million gallons and the lowest 24-hour flow recorded during the monitoring period occurred on January 21, 2018 when 2.67 million gallons of flow was measured entering the Dunbar Creek WPCP. This low 24-hour flow was driven primarily by dry weather patterns which helped lower the groundwater elevation, however, as several more significant rainfall events were recorded, the average 24-hour flow began to increase. The increase in flow was driven primarily by higher groundwater conditions caused by rainfall dependent infiltration and the associated increase in corresponding groundwater infiltration.

The wastewater flows received at Dunbar Creek WPCP the months of December, January, and February increased substantially as additional rainfall was recorded. The increase in overall 24-hour flow between the start of the monitoring period and the end of the monitoring period is approximately 360,000 gallons per day. Table 1.2, on the following page identifies the monthly rainfall recorded, the average daily flow recorded during the month and the increase in flow that was documented.

Time Span	Amount of Rainfall Recorded (Inches)	Average Daily Flow for Time Span (MGD)	Average Daily Increase During Time Span (Gals)
November 2018	2.59	3.15	N/A
December 2018	2.03	3.39	240,000
January 2018	3.90	3.41	20,000
February 2018	1.42	3.51	100,000

Table 1.2 – Monthly Average Daily Flow & Flow Increase After Wet Weather Periods

In an effort to effectively represent the impact of the documented wet weather events during the flow monitoring period, the hydrograph below, (Figure 1.1), was prepared.

Figure 1.1 – Total Flow Recorded at Dunbar Creek WPCP During the Monitoring Period



Total Flow Hydrograph for WPCP

As identified by the hydrograph, the projected lowest daily flow recorded at the Dunbar Creek WPCP was approximately 2.67 million gallons, which was recorded on January 21, 2018. By projecting this recorded 24-hour flow rate as the lowest daily dry weather flow, (DWF) a total base flow volume over the monitoring period is established at 250.98 million gallons; noting that the DWF includes both wastewater generated by SSI system users and groundwater infiltration, (GWI). The total volume of flow measured during the monitoring period equals 316.63 million gallons which includes DWF and RDI/I. By subtracting the calculated DWF from the total flow recorded, an RDI/I volume of 65.65 million gallons is recognized.

Approximately 9.94-inches of rainfall was recorded during the flow monitoring period. The majority of these rainfall events caused a daily increase in flow at the Dunbar Creek WPCP of more than one (1) million gallons. In an effort to project the cost of transporting and treating the extraneous clean water, a value of \$2.50 per 1,000 gallons was established. Based on this value, the cost to treat the additional 65.65 million gallons is estimated to be equal to \$164,125. It should be noted that the costs to convey the extraneous flow to the treatment facility, including additional electricity for increased pump operation at the lift stations, and additional equipment maintenance/replacement costs, caused by the excessive run-times are not included in the \$2.50 per thousand gallon cost.

It is important to realize that RDI/I includes two components; direct storm water inflow and rainfall dependent infiltration. Storm water inflow primarily enters the wastewater collection system through manhole covers, open cleanouts, improper connections to service laterals and cross connections with nearby drainage infrastructure. Rainfall dependent infiltration enters the wastewater collection system through the same piping/manhole defects which allow groundwater to enter the system. In some cases the defective piping is above the groundwater table and in other cases the affected piping and manholes are below the groundwater table. As the groundwater elevation rises, due to the rain water percolating through the soil, the constant groundwater infiltration rates are increased due to the additional hydrostatic pressure.

The following paragraphs describe the results of the RDI/I analysis undertaken and the recommendations to implement RDI/I source investigation processes that will provide the greatest impact for wet weather flow reduction.

1.4 Storm Water RDI/I Analysis Results:

Each flow meter site was given a unique letter/number combination that included identification of the branch it connects; A for North, and B for South, followed by a number which indicates proximity to the Dunbar Creek WPCP. For example, 17A indicates the meter was located on the northern force main branch and was the closest meter to the treatment facility.

The RDI/I measured during the December 6th to 9th wet weather event was the greatest recorded during the monitoring period. This event distributed an average of 2.7 inches of rainfall over the St Simons service area during a 3 day period. The tables below, (Table 1.3 & Table 1.4), depict the effect of this event for both branches/trunk lines, noting that the flow meter sites/lift stations which did not see a significant increase in flow during and after the event are not included.

Flow Meter No./Lift Station No.	Length of Gravity Sewers (Linear Feet)	Average Dry Weather Flow 72-Hrs (Gallons)	Wet Weather Flow 12/(6-9)/2017 72-Hrs (Gallons)	Calculated RDI/I (Gallons) 12/(6-9)/2017	Peaking Factor (Highest Flow Divided by Average Dry Weather Flow)
2A/2034	9,495	36,300	72,400	36,100	4
5A/2062	5,257	120,300	151,500	31,200	2.61
10A/2011	17,817	184,800	267,600	82,800	4
11A/2011	13,756	91,800	126,300	34,500	7.7
15A/2008	7,534	145,500	224,800	79,300	2.4

	Table 1.3 - No	orth Branch Intercepte	or Excessive RDI/I and	d Wet/Dry Weather	Peaking Factors
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Table 1.4 - South Branch Interceptor Excessive RDI/I and Wet/Dry Weather Peaking Factors

Flow Meter No./Lift Station No.	Length of Gravity Sewers (Linear Feet)	Average Dry Weather Flow 72-Hrs	Max Wet Weather Flow 12/(6-9)/2017 72-Hrs	Calculated RDI/I (Gallons) 12/(6-9)/2017	Peaking Factor
7B/2002	21,346	706,500	767,400	60,900	2.3
8B/2002	17,642	255,900	302,800	46,900	3.4
10B/2063	21,438	129,900	156,600	26,700	2.3
12B/Interceptor	11,658	446,100	573,900	127,800	1.3
15B/2005	14,987	279,600	384,900	105,300	8.4
17B /Interceptor	20,236	312,000	438,300	126,300	2.9
21B/2023	16,581	103,500	174,300	70,800	1.6
22B/Interceptor	4,604	442,200	531,700	89,500	6
24B/2030	12,931	280,500	308,200	27,700	1.5
26B/2047	7,330	175,200	247,300	72,100	2
27B/WPCP	7,981	603,300	744,500	171,200	1.47

Note: The thresholds utilized to establish what constitutes excessive RDI/I includes flow meter sub-basins that exceeded 100,000 gallons of RDI/I, during the 3 day period, or had a wet weather/dry weather peaking factor greater than 1.5

As identified by the tables, sixteen (16) of the forty four (44) flow meter sub-basins exhibited excessive rainfall dependent inflow/infiltration, RDI/I, during the December 3rd-9th wet weather event. These basins included five (5) on the North Branch, and eleven (11) on the South Branch. Inflow source investigations have been recommended to be completed in all of these basins.

<u>1.5 Groundwater Infiltration Analysis Results:</u>

The second groundwater analysis included evaluation of groundwater levels established using groundwater piezometers, and by use of the County's GIS to determine pipe segments which are below the groundwater table. Once the individual pipe segments that are below the groundwater table were identified for each basin, review of the minimum recorded flow rates during non-peak water usage hours was completed and the apparent groundwater infiltration for each sub-basin was calculated. Table 1.5, below, identifies the excessive apparent groundwater infiltration rates in twenty four (24) flow meter sub-basins.

North	Minimum Flow	GWI/(Inch-Diameter	GWI/(Inch-Diameter mile)	Isolated GWI % of
Branch	(Gal)	mile)	Below Groundwater	ADF
2A	9,000	626	2759	300%
5A	11,700	1417	1418	30%
12A	9,000	3275	3285	50%
14A	23,400	2820	Missing GIS Invert Data	600%
16A	6,100	1142	2596	80%
South	Minimum Flow	GWI/(Inch-Diameter	GWI/(Inch-Diameter mile)	Isolated GWI % of
Branch	(Gal)	mile)	Below Groundwater	ADF
2B	36,900	3012	4779	40%
3B	36,900	6263	9318	50%
4B	50,400	2736	3679	45%
5B	22,500	11725	11780	50%
6B	59,400	931	2248	50%
7B	107,100	3125	4500	45%
8B	28,800	964	1510	30%
9B	29,700	1664	5405	55%
10B	14,400	403	1206	50%
11B	13,500	702	13860	30%
12B	75,600	999	3614	50%
13B	51,300	725	1083	25%
15B	22,500	969	969	30%
17B	42,300	1257	2131	68%
20B	29,700	1603	4775	36%
21B	39,600	1440	2271	230%
23B	14,400	1239	1575	370%
24B	84,600	3808	4498	950%
25B	31,500	833	1557	453%

Table 1.5 - North & South Branch Sub-Basins with Excessive Groundwater Infiltration

When the minimum recorded flow rates are added together, the total equals approximately 850,300 gallons. Assuming that ninety (90) percent of the total minimum flow recorded is attributed to groundwater infiltration and the infiltration rate remains constant, an annual infiltration volume of 310.36 million gallons is established. Using the same transport and treatment cost established for the RDI/I analysis the annual cost for conveying and treating the groundwater equals \$775,900.

As identified by Table 1.5, groundwater infiltration rates for each flow meter sub-basin were presented based on using the piping footage that is determined to be below the groundwater table. It is recommended that every lift station service area/flow meter sub-basin that exceeds 2,400 gallons per inch diameter mile or has infiltration rate more than 25% of ADF, should be included in the groundwater infiltration source investigations. As outlined in the table, twenty four (24) of the forty four (44) flow meter sub-basins exceeded the established threshold. These basins included five (5) on the North Branch, and nineteen (19) on the South Branch. It should be noted that there is a significant amount of missing pipe invert data in JWSC's GIS, as such a definitive projection of the piping network below the groundwater table could not be completed.

<u>1.6 Proposed Phase 2 Scope of Services:</u>

Inflow Source Investigations - Based on the results of the temporary flow monitoring effort, it is recommended that sixteen (16) flow meter sub-basin service areas be included in the storm water inflow source investigation effort. The scope of the Phase 2 work includes conducting smoke testing of approximately 210,589 linear feet of gravity sewers and performing dye water testing at discovered apparent cross connections with the drainage system and at locations where service laterals and mainline gravity sewers are found to be defective.

The smoke testing will identify where storm water is entering the collection system and will allow for documentation of the potential inflow volume associated with each defect. Property line cleanouts found to have defective/missing caps during the smoke testing effort will be addressed using replacement cleanout plugs provided by the County. In addition, manhole covers which are found to be storm water inflow contributors will be fitted with storm water inflow abatement dishes/pans which will also be provided by the County. The installation of the cleanout plugs and inflow abatement dishes/pans while be performed concurrently with the smoke testing effort at no additional cost. Identification of significant inflow sources will necessitate the need to complete dye water testing (tracing and flooding). The dye water tracing will identify how the storm water is entering the wastewater collection system through defective service laterals, structurally impaired mainline piping and deficient collection system through cross connections with the storm water drainage system. Both dye tracing and dye flooding will include the use of CCTV inspection equipment to document where the storm water is entering the wastewater collection system.

Infiltration Source Investigations - Based on the results of the temporary flow monitoring work, it has been recommended that twenty four (24) flow meter sub-basin service areas be included in the groundwater infiltration source investigation effort. The scope of the groundwater infiltration investigations include completion of manhole inspections and night flow isolations. Manhole inspections are needed to document the groundwater infiltration flow rates at each applicable structure and the night flow isolations are needed to document the groundwater the groundwater infiltration rates for each applicable gravity sewer.

Manhole inspections will also include collection of structure attribution features and completion of individual condition assessments. The results of the manhole inspections will be utilized to prepare a prioritized rehabilitation/repair/replacement (R/R/R). The plan will be developed in a manner that

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includes mapping identifying each structure which need R/R/R related improvements and the necessary work elements that are to be provided for each structure.

The night flow isolations will be completed using pre-calibrated weir plates, or a portable liquid level/velocity sensing device. The results of the night flow isolations will be used to determine which gravity sewers require CCTV inspections to document where the excessive groundwater is entering the collection system piping so that groundwater infiltration abatement of the gravity sewers can be evaluated and the work prioritized.

<u>1.7 Storm Water Inflow & Groundwater Infiltration Source Location Program Scope:</u></u>

In summary, the first phase of the project has been completed and recommendations to transition into additional activities are provided below:

Phase 2 - Complete smoke testing and dye testing of sixteen (16) flow meter sub-basins (210,589 LF)

<u>Phase 3</u> - Complete manhole inspections of twenty four (24) flow meter sub-basins (1,668 Manholes) & Complete night flow isolations of twenty four (24) flow meter sub-basins (1,668 Isolations)

Once the Phase 2 and Phase 3 activities have been completed a Technical Memorandum will be prepared which identifies the recommended scope of storm water inflow and groundwater infiltration abatement. This document will provide recommendations and include cost opinions for completing the following initiative:

- Storm Water Inflow Abatement Recommendations Elimination of Cross Connections and Necessary Pipe Repair/Rehabilitation/Replacement
- Groundwater Infiltration Abatement CCTV Inspection/Manhole Repair/Rehabilitation Recommendations

<u>Storm Water Inflow Abatement:</u> Recommendations to complete storm water inflow abatement will be based on the results of dye water tracing and flooding program and will utilize the CCTV inspection data, which will be captured during the dye testing, to determine the best method for eliminating the discovered deficient piping and cross-connection(s). Digital orthographic-photo mapping with a storm water and wastewater collection system piping overlay will be utilized to identify the approach recommended to achieve inflow abatement. In addition, 11x17 maps which identify the sanitary and storm water features affected by the proposed I/I remediation effort will be provided. General notes will be added to the maps to identify the proposed I/I abatement scope, but no physical survey, or utility location, will be completed. The diagrams, sketches and notes will be sufficient for use by JWSC maintenance crews to address the inflow abatement.

<u>Groundwater Infiltration Abatement Recommendations Manhole Inspections:</u> Utilizing the results of the manhole inspections digital orthographic mapping will be prepared that identifies the location of each structure in a flow meter sub-basin that requires repair. The proposed scope for the necessary repair/rehabilitation (R/R) will be presented for each sub-basin in a tabular format. Individual tables will be presented on the flow meter sub-basin maps that depict the necessary improvements.

<u>Groundwater Infiltration CCTV Inspections:</u> Utilizing the results of the night flow isolations the gravity piping with groundwater infiltration rates that exceed pre-established thresholds will be recommended for CCTV inspections. CCTV inspections can be completed by either JWSC, or McKim & Creed.

It is envisioned that the Phase 2 storm water inflow source identification will begin in September of 2018 and will be completed over a two (2) month period and the Phase 3 infiltration source investigations will begin in December of 2018 and be completed over a three (3) month period. Once the Final Technical Memorandums have been reviewed by JWSC, McKim & Creed will be available to provide any necessary support services required to develop a prioritized repair, rehabilitation and replacement program.

2.0 PROJECT BACKGROUND

2.1 Phase 1 – Flow Monitoring:

The SSI Dunbar Creek WPCP service area includes approximately 546,645 linear feet of gravity sewers, ranging in size from 6-inch to 30-inch, 2,578 manholes, 146 lift stations and 254,677 linear feet of forcemain, ranging in size from 2-inch to 16-inch. In an effort to isolate the wastewater flow and identify RDI/I volumes within the individual lift station basins forty four (44) open channel flow meters, six (6) rainfall gauges and twelve (12) groundwater gauges were deployed.

When evaluating the influent piping connectivity to the Dunbar Creek WPCP it is apparent that there are two (2) primary branches; North and South. In an effort to simplify the analysis, the lift stations connected to each branch were classified based on that connectivity. See St. Simons Island Flow Meter Basin maps in Appendix A (North Branch) & Appendix B (South Branch).

The table below and on the following page (Table 2.1) identify the locations where the flow monitoring equipment was deployed within the Dunbar Creek WPCP sewer service areas during Phase 1.

Lift Station Service Area	Meter ID	Address	MH Number
20350000	1A	185 Rice Mill	20350010
P29601	1B	Sea Island Golf Course	P29601
20340000	2A	130 Rice Mill Rd	20340010
20010000	2B	118 Florence St	20010290
2060000	3A	35 Stillwater	20600010
20090000	3B	193 Kings Way	20090290
20380000	4A	102 W Point Rd	20380000
20090000	4B	193 Ashantilly Ave	20090010
20620000	5A	119 Marsh's Edge Ln	P84618
20650000	5B	413 Kings Way	20650010
20420000	6A	298 Stevens Rd	20420010
20010000	6B	413 Lord Ave	20010020
20540000	7A	354 N. Harrington Rd	20540000
20020000	7B	120 Ocean Blvd.	20020230
20320000	8A	5615 Frederica Rd	20320350
20020000	8B	411 Arnold Rd	20020420
20450000	9A	102 Village Creek way	20320030
20020000	9B	1219 Ocean Blvd	20020050

Table 2.1 – Flow Meter Location Description Table

Lift Station Service Area	Meter ID	Address	MH Number
20110000	10A	148-204 N Windward Dr.	20450000
20630000	10B	4000 1st St.	20630020
20110000	11A	300 Windward Dr.	20110020
20130000	11B	1059 Demere Rd.	20030390
20250000	12A	23 Dunbar Creek Point	20110200
20130000 & 20460000	12B	115 Military Rd	20030190
20220000	13A	225 Dunbarton Dr.	20250010
20030000	13B	90 Stewart Ave	20030020
20220011	14A	101 Colonial Dr.	20220011
20032780	14B	103 Taylor Ln	20032780
20080000	15A	6 Plantation Way	2WTP0230
20050020	15B	119 Worthing Rd.	20050020
20080000	16A	200 Atlantic Dr.	20080000
2WTP0320	16B	109 Worthing Rd.	2WTP0320
2WTP0200	17A	Sixth Ave	2WTP0200
20170000, 20050000,2039000	17B	Sealand & Frederica Rd	2WTP0130
P2645	18B	620 Sea Island Rd.	2WTP0090
20290000	19B	134 Pine Valley	2WTP0250
P12577 & 20240000	20B	127 St. Andrews	20230220
20230000	21B	197 Merion	20230350
20520000	22B	122 Point Lane	20230020
20230000, P9685, 20510000	23B	1007 Lewis Lane	20520010
20300000	24B	915 Rose Cottage Rd	20300150
P36816, P8402, P11922	25B	1065 Brockinton Dr.	20300010
20470000, 20480000, 20470000	26B	101 Davison Ln	20300090
20440000, P11602	27B	515 Pine St	20470010

As part of the scope of services for this project McKim & Creed provided monthly reporting for various recorded flow conditions and performed data analysis to predict the associated groundwater infiltration and storm water inflow levels. The reporting was also utilized to rank each sub-basin based on the severity of RDI/I. The following flow conditions were established for each sub-basin.

- ✤ ADF, Average Daily Flow
- ← *ABF*, *Average Base Flow*, *established during periods of dry weather*.
- ← ASF, Average Daily Sanitary Sewer Flow, determined by calculation

O ASF = ABF - GWI

- ← GWI, Non-Rainfall Groundwater Infiltration, estimated by analysis of early morning flows when the sanitary sewer contribution is very low.
- MSF, Minimum Sanitary Flow, by calculation, MSF = 0.12*ASF.

- ✓ MBF, Minimum Base Flow, by calculation, MBF = MSF + GWI.
- ✓ Ratio of MBF/ABF.
- ✓ Ratio of GWI/ABF.
- ← Rainfall Amount and Intensity.
- Rainfall Dependent Infiltration/Inflow, (RDI/I), directly resulting from rainfall.
 o RDI/I = Total Flow Volume ABF
- ← *Peak RDI/I, maximum difference between the ABF and Total Flow hydrographs.*
- ← PHF, Peak Hour Flow
- ✓ Peaking Factor = PHF/ADF
- ← Peak 15-minute Flow Depth
- 👻 Peak 15-minute Flow Velocity
- 👻 Peak 15-minute Flow Volume
- 👻 Current Full Pipe Capacity
- 👻 Total Monthly Flow
- ← Ratio of GWI/Inch-Diameter Miles of Upstream Contributing Sewer Mains for each meter basin. (See Appendix C for All Monthly Reports Generated for Each Flow Meter Sub-basin)

The Average Base Flow, ABF, was established for each lift station service area/flow meter sub-basin using four (4) dry weather 24-hour recorded flows. These flows were then averaged to create the 24-hour ABF which was used for comparison of 24-hour recorded flows during periods of significant wet weather. In an effort to simplify the overall hydraulic analysis, the individual flow meter sub-basin discharge volumes were compiled for both dry and wet weather periods, and contributing flow from upstream flow meter sub-basins were subtracted to determine the total rainfall dependent inflow/infiltration, RDI/I, of each flow meter sub-basin. Figure 2.1 below depicts the hydrograph that was developed for the flow meter site in Sub-basin 11A (Lift Station 2011).

Figure 2.1 – Average Dry Weather/Wet Weather Flow Schematic



The Flow Balance Schematic on the following page, Figure 2.2, is an example of the methodology utilized to isolate flow meter sub-Flow basin flow. Balance Schematics were prepared for each significant rainfall event and the referenced example depicts the flow characteristics recorded during the three day event on December 6th to 9th recorded at all flow meter sub-basins. The wet weather flow balance schematics for each significant rainfall event have been provided in Appendix D.




It should be noted that 4.54 mgd of flow that was recorded at the Dunbar Creek WPCP headworks including flow from both branches; North, and South. It should also be noted that the daily flow rate recorded prior to the three day event, on December 6th-9th, was 2.71 mgd and that the recorded daily flow at the WPCP remained over 3 mgd for approximately 3 days.

In order to ensure the flow data recorded during each wet weather event was accurate, and repeatable, a scattergraph was developed for each monitoring location. The scattergraph plots the total 24-hour wet weather volume recorded, vertical axis, against the total rainfall recorded during the 24-hour period, horizontal axis, for each rainfall event. A regression line is then plotted between the points and the variance, distance of the points from the line, indicates the quality of the data. The closer the points are to the line indicates higher quality data and the better predictability of total expected RDI/I volume for any return rainfall frequency. It is important to note that there are several variables that effect the correlation of increased flow to recorded rainfall. Those variables include the following:

- Changes in Groundwater Elevation
- Magnitude and Duration of each Wet Weather Event (A 2-inch rainfall event occurring over a 10-hour period will have less impact on the collection system then a 2-inch rainfall recorded over a 2-hour period)

The scattergraph below, Figure 2.3, was presented in the November/December 2017/2018 Monthly Flow Monitoring Report, and represents the recorded rainfall and flow for three (3) wet weather events experienced during the first month of flow monitoring.



Date	Flow (MGD)	Rainfall (IN)	R ² Value
11/(21-22)/2017	0.1082	0.75	
11/(23-24)/2017	0.1041	0.32	0.98
12/(6-9)/2017*	0.1985	2.45	

*Note: 2.45 inches of rainfall is cumulative total for three days rain event and flow used for scattergraph is calculated using formula below:

Event Flow = Average Base Flow + Total rainfall induced volume

When reviewing the regression line, there appears to be a good correlation between the effects of the recorded rainfall events, however, it should be noted that in some cases a significant variance can be encountered during rainfall events that cause flooding, as inflow defect locations that were not affected by non-flooding events are now active due to the increase water elevation. This variance is also attributed the interaction between surface runoff, soil classification and groundwater elevation. The changing antecedent moist condition of the soil substrate provides the greatest variance in runoff and

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Figure 2.3 – Example Scattergraph

RDI/I volumes, as in many cases a significant percent of the initial rainfall of any event is absorbed into the non-impervious ground surface. As the moisture content of the absorbing surface increases the groundwater table rises and rainfall dependent infiltration rates escalate. The storm water runoff rate is also increased and the potential for direct inflow has an immediate correlation with the degree of ponding/flooding of impervious surface and surcharge of the storm water conveyance system. Another contributing factor to the predictability of RDI/I volumes, based on return rainfall magnitude, is the duration and immediate intensity of the rainfall event; as higher intensities over shorter time durations typically cause a greater RDI/I impact.

2.2 Phase 1 – Rainfall Monitoring:

As previously described six (6) rainfall gauges were deployed as part of the Phase 1 effort. The table below identifies the locations where the rainfall monitoring equipment was deployed within the Dunbar Creek WPCP sewer service area during Phase 1.

Rainfall Gauge Number	Flow Meter Service Area/LS	Location
Rainfall Gauge Number 1	1A/LS 2035	185 Rice Mill Road
Rainfall Gauge Number 2	4A/LS 2038	102 West Point Road
Rainfall Gauge Number 3	27B/Dunbar Creek WPCP	517 Pine Street
Rainfall Gauge Number 4	15B & 16B/LS 2005	119 Worthing Road
Rainfall Gauge Number 5	10B/LS 2063	4000 1 st Street
Rainfall Gauge Number 6	4B/LS 2009	193 Ashantilly Road

Table 2.2 – Rainfall Gauge Locations

The rainfall gauges were maintained for the duration of the flow monitoring effort and the data collected was utilized to determine the RDI/I volumes for each flow meter service area and to develop the previously described scattergraphs. The rainfall gauge which was closest to each flow meter site was used to perform the wet weather impact analysis.

2.3 Phase 1 – Groundwater Monitoring:

As previously described twelve (12) groundwater gauges were deployed as part of the Phase 1 effort. The gauges were installed at the beginning of the flow monitoring period and the groundwater levels were recorded on a weekly basis. The table on the following page, Table 2.3, identifies the locations where the groundwater monitoring devices were deployed within the Dunbar Creek WPCP sewer service area during Phase 1.

Groundwater Gauge Number	Groundwater Gauge Location	Depth from MH Rim to
	(Flow Meter Service Area)	Gauge - Groundwater Level
Groundwater Gauge Number 1	Lift Station 2034 (2A)	15.1'-18"-60"
Groundwater Gauge Number 2	206 Lorah Lane (4A)	6.0-11"-32"
Groundwater Gauge Number 3	Lift Station 2062 (5A)	13.3'-17''-60''
Groundwater Gauge Number 4	Lift Station 2042 (6A)	12.2'-18''-60''
Groundwater Gauge Number 5	Lift Station 2011 (10A)	11.4'-18''-16''
Groundwater Gauge Number 6	Lift Station 2025 (12A)	8.1'-17''-1''
Groundwater Gauge Number 7	Lift Station 2005 (15B)	11.1'-12''-59''
Groundwater Gauge Number 8	197 Merion Drive (21B)	14.1'-17''-3''
Groundwater Gauge Number 9	1065 Brockinton Dr.(25B)	15.2'-18''-60''
Groundwater Gauge Number 10	Dunbar Creek WPCP	8.6'-18''-0''
Groundwater Gauge Number 11	115 Military Street (12B)	8.1'-11"-0"
Groundwater Gauge Number 12	Lift Station 2009 (4B)	11.8'-17''-52''

Table 2.3 – Groundwater Gauge Locations

The recorded groundwater levels were used to establish the maximum groundwater elevation at each monitoring location. JWSC's GIS data was used to determine the actual elevation of each groundwater gauge; manhole rim elevation minus the depth of the gauge. The maximum groundwater elevations were then compared to the gravity piping inverts, pipes adjacent to the monitoring location, to determine which sections of the collection system piping could be contributing groundwater infiltration. By comparison of non-peak water usage hourly flow, gained form the flow meters, allowed for the establishment of projected groundwater infiltration rates for each flow meter service area. The results of that analysis are discussed further in Section 4 of the Technical Memorandum. The following section of the Technical Memorandum, Section 3, addresses the results of the storm water inflow and groundwater infiltration analysis completed for each flow meter sub-basin.

3.0 ASSESSMENT OF THE FLOW MONITORING RESULTS

The flow monitoring sites in the Dunbar Creek WPCP sewer service area included forty four (44) flow meter sites. The Flow Meter Location Maps in Appendix A & B; North Branch & South Branch, identifies where each flow meter was located and the limits of each drainage area/lift station service area. As previously described each flow meter site was classified based on its' location along the two (2) primary wastewater conveyance branches. Individual flow meter sub-basin maps have been provided in Appendix E for the North Branch, and Appendix F for the South Branch. The following describes the specific flow characteristics of each flow meter sub-basin.

3.1 North Branch Flow Meter Sub-basins:

Flow Meter Sub-Basin Site 1A:



The flow meter in this sub-basin was deployed on November 7th, 2017 and remained in place until February 22nd, 2018 completing the Phase I monitoring period. The flow meter was installed in the 8-inch effluent pipe of the Lift Station 2035 wetwell located at 185 Rice Mill Rd . Sub-Basin 1A has geographical area coverage of 0.3951 sq. miles. The gravity sanitary sewer in Sub-Basin 1A includes 12,080 linear feet of gravity piping ranging from 8 to 10inch in diameter. The adjacent hydrograph depicts the average dry weather flow conditions recorded during the monitoring period.

Total Average Daily Dry Weather Flow measured at Flow Meter Site 1A is approximately 48,000 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 1,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 0.3285 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping equals 130 gallons. Because of the low groundwater infiltration rates, this sub-basin has not been recommended to be included in the groundwater infiltration source investigation program.



Flow Meter Sub-Basin Site 2A:

Flow Meter Site Site_2A (LS 2034) Average Dry Daily Flow - December 1 - 4, 2017



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th -9th rainfall event. The total rainfall that was recorded during the event was above 2.42 inches over a 3 day period and the total flow recorded during this event was gallons. 144,000 approximately Approximately 5,900 gallons of RDI/I was calculated. Several other rainfall events were also analyzed, but none caused significant RDI/I contribution. Hence, it is not recommended to include this lift station service area in the storm water inflow source identification program.

The flow meter in this Sub-Basin was deployed on November 8, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in 8-inch effluent pipe of the manhole located at the 130 Rice Mill Rd. Sub-Basin 2A has a geographical area coverage of 0.2896 sq. miles. The gravity sanitary sewer in Sub-Basin 2A includes 9,495 linear feet of 8-inch The adjacent hydrograph piping. depicts dry weather flow conditions recorded during the monitoring period.

Total Average Daily Dry Weather Flow measured at Flow Meter Site 2A is approximately 60,100 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 10,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 3.285 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 2,759 gallons. The 2A Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th -9th rainfall event. The total rainfall recorded during the event was 2.62 inches over a 3 day period and the total flow recorded during this event was approximately 222,300 gallons. The total isolated flow recorded was 72,400 gallons. approximately Approximately 36,100 gallons of isolated RDI/I was established. Several rainfall events were other also analyzed, most of them also had

significant RDI/I contribution. After reviewing the hydrograph it is evident that both storm water inflow and rainfall derived infiltration is significant in this sub-basin and peak hourly wet weather flow to dry hourly flow exceeds a ratio of 2 to 1. For this reason it is recommended to include this lift station service area in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 3A:



The flow meter in this Sub-Basin was deployed on November 10, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 8-inch influent pipe of the Lift Station 2060 wetwell located at the 35 Stillwater Road. Sub-Basin 3A has geographical area coverage of 0.1611 sq. miles. The gravity sanitary sewer in Sub-Basin 3A includes 7,022 linear feet of 6-inch and 8-inch piping. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total

Average Daily Dry Weather Flow measured at Flow Meter 3A is approximately 7,800 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 1,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 0.3285 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 228

gallons. Because of the low groundwater infiltration rates, this sub-basin has not been recommended to be included in the groundwater infiltration source investigation program.



identification program.

Flow Meter Sub-Basin Site 4A:



Flow Meter Site Site_4A Average Dry Daily Flow - December 1 - 4, 2017 The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th -9th rainfall event. The total rainfall recorded during the event was 2.92 inches over a period and the total flow 3 dav recorded during this event was approximately 18,900 gallons. During event there was no this RDI/I identified. Several other rainfall events were also analyzed and none showed any significant RDI/I. For this reason it is not recommended to include this basin in the storm water inflow source

The flow meter in this Sub-Basin was deployed on November 8, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in 8-inch influent pipe of the Lift Station 2036 wetwell located at the 102 West Point Rd. Sub-Basin 4A has geographical area coverage of 0.3271 sq. miles. Sub-Basin 4A has 15,330 linear feet of gravity sewers ranging from 6-inch to 8-inch. The adjacent hydrograph depicts the dry weather flow conditions recorded during the monitoring period. The

total Average Daily Dry Weather Flow measured at Flow Meter 4A is approximately 1,800 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 100 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 0.365 gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 7 gallons. Because of the low groundwater infiltration rates, this sub-basin has not been recommended to be included in the groundwater infiltration source investigation program.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th -9th rainfall event. The total rainfall recorded during event was 2.96 inches over a 3 day period and the total flow recorded during this event was approximately 7,800 gallons. Approximately 2,400 gallons of RDI/I was identified entering the collection system. Several other rainfall events were also analyzed and during each event no significant RDI/I levels were recorded. This basin didn't show any significant increase in the flow. For

this reason it is not been recommended in the storm water inflow source identification program.



4.3.2 Flow Metering Sub-Basin Site 5A:

The flow meter in this Sub-Basin was deployed on November 11th, 2017 and remained in place until February 22nd, 2018 completing the Phase I monitoring period. The flow meter was installed in the 10-inch influent pipe of a manhole located at the 119 Marsh's Edge Lane. Sub-Basin 5A has geographical area coverage of 0.0693 sq. miles. Sub-Basin 5A has 5,257 linear feet of gravity sewer ranging in size from 8-inch to 10-The adjacent hydrograph inch. depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry

Weather Flow measured at Flow Meter 5A is approximately 40,100 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 13,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 4.27 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping equals 1,418 gallons. Although this basin has a low calculated groundwater infiltration level, the percentage of infiltration exceeds 25% of the average dry weather 24-hour flow. As such, this sub-basin has been recommended to be included in the groundwater infiltration source investigation program.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th to 9th rainfall event. The total rainfall recorded during the event was 2.96 inches over a 3 day period and the total flow recorded during this event was approximately 151,500 gallons. Approximately 31,200 gallons of the total flow was identified as RDI/I. The wet weather hourly peak flow was more than 2.6 times the hourly dry weather flow. For this reason it is recommended to include this lift

station service area in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 6A:



The flow meter in this Sub-Basin was deployed on November 8th, 2017 and remained in place until February 22nd, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 8-inch effluent pipe of a manhole located at 298 Stevens Road. Sub-Basin 6A has geographical area coverage of 0.1222 sq. miles. Sub-Basin 6A has 9,381 linear feet of gravity sewer all being 8inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 6A is

approximately 17,000 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 1,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 0.3285 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 63 gallons. Because of the low groundwater infiltration rates, this sub-basin has not been recommended to be included in the groundwater infiltration source investigation program.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.96 inches over a 3 day period and the total flow recorded during this event was approximately 64,900 gallons. Approximately 13,900 gallons of the total volume was determined to be RDI/I. Several other rainfall events were also analyzed and during each event no significant RDI/I levels were recorded. For this reason it is not recommended to include this service

area in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 7A:



The flow meter in this Sub-Basin was deployed on November 8th, 2017 and remained in place until February 22nd, 2018 completing the Phase I monitoring period. The flow meter was installed in 8-inch influent pipe of the wetwell at 354 N. Harrington Rd. Sub-Basin 7A has geographical area coverage of 0.1069 sq. miles. The flow meter sub-basin has 6,723 linear feet of gravity sewer ranging from 6-8-inch. The inch to adjacent hydrograph depicts the dry weather flow conditions recorded during the November monitoring period. The total Average Daily Dry Weather

Flow measured at Flow Meter 7A for the Phase I monitoring period is approximately 3,500 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 111 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 0.0365 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 10 gallons. Because of the low groundwater infiltration rates, this sub-basin has not been recommended to be included in the groundwater infiltration source investigation program.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded at site 7A during this event was 2.96-inches over a 3 day period and the total flow recorded during this event was approximately 20,000 gallons. Approximately 9,500 gallons of the total flow was identified as RDI/I. Several other rainfall events were also analyzed and during each event no significant RDI/I levels were recorded. As such, this basin was not recommended to include this lift

station service area in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 8A:

The flow meter in this Sub-Basin was deployed on November 8th, 2017 and remained in place until February 22nd, 2018 completing the Phase I monitoring period. The flow meter was installed in 12-inch influent pipe of a manhole at 5615 Frederica Road. Sub-Basin 8A has geographical area coverage of 0.0733 sq. miles. The flow meter sub-basin has 17,386 linear feet of gravity sewer ranging from 8-inch to 12-inch. The Total Average Daily Dry Weather Flow measured from this meter is approximately 32,500 gallons. It is important to realize that the minimum flow rate recorded

during typical non-water usage hours is approximately 6,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 1.97 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 187 gallons. Because of the low groundwater infiltration rate, this sub-basin has not been recommended to be included in the groundwater infiltration source investigation program.



recommended for storm water investigation.

Flow Meter Sub-Basin Site 9A:



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded at site 8A during the event was 2.96inches over a 3 day period and the total flow recorded during this event was approximately 115,000 gallons. Approximately 17,500 gallons of the total flow was identified as RDI/I. Several other rainfall events were also analyzed and during each event no significant RDI/I levels were recorded. As such, the 8A service area is not

The flow meter in this Sub-Basin was deployed on November 8th, 2017 and remained in place until February 22nd, 2018 completing the Phase Ι monitoring period. The flow meter was installed in 12-inch influent pipe of a manhole located at 102 Village Sub-Basin 9A Creek Way. has geographical area coverage of 0.2441 sq. miles. The flow meter sub-basin has 5,577 linear feet of gravity sewer ranging from 6-inch to 8-inch. The Total Average Daily Dry Weather Flow measured from this meter is approximately 9,100 gallons. It is

important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 1,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 0.3285 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 107 gallons. Because of the low groundwater infiltration rate, this sub-basin has not been recommended to be included in the groundwater infiltration source investigation program.



area is not recommended for storm water investigation.





The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded at site 9A during the December 6th -9th event was 2.59-inches over a 3 day period and the total flow recorded during this event was approximately 27,700 gallons. Approximately 400 gallons of the total flow was identified as RDI/I. Several other rainfall events were also analyzed and during each event no significant RDI/I levels were recorded. As such, this service

The flow meter in this Sub-Basin was deployed on November 11, 2017 and remained in place until February 22, 2018 completing the Phase 1 monitoring period. The flow meter was installed in an 8-inch influent pipe to a manhole located at 204 N Windward Drive. The service are includes the northern portion of the wastewater collection system served by Lift Station 2011. Sub-Basin 10A has geographical area coverage of 0.0714 sq. miles. Sub-Basin 10A has 17,817 linear feet of gravity sewer ranging from 8-inch to 10-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during

the monitoring period. The total Average Daily Dry Weather Flow measured at Flow Meter 10A is approximately 61,600 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 7,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 2.299 million gallons per year. Groundwater infiltration rates calculated during the wet season equaled 391 gallons per inch diameter per mile. Due to the lower infiltration rates, the 10A Service Area has not been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th - 9th rainfall event. The total rainfall recorded during the December 6th - 9th event was 2.54 inch over a 3 day period and the total flow recorded during this event was approximately 267,600 gallons. Approximately 82,800 gallons of the total flow was identified as RDI/I. While the overall RDI/I volume recorded during the December 6th -9th event equaled approximately 44 percent of the daily

dry weather flow. The wet weather hourly peak flow was almost 4 times the hourly dry weather flow. For this reason it is recommended to include this lift station service area in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 11A:

The flow meter in this Sub-Basin was deployed on November 7, 2017 remained in place until and February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 8-inch influent pipe of manhole located at 300 Windward Drive. The service are includes the southern portion of the wastewater collection system served by Lift Station 2011. Sub-Basin 11A has geographical area coverage of 0.2444 sq. miles. Sub-Basin 11A has 13,756 linear of gravity sewer ranging from 6-inch to 12-inch. The adjacent hydrograph

depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 11A is approximately 30,600 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 6,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 1.97 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 260 gallons. Due to the lower infiltration rates the 11A Service Area has not been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather and wet weather flow that was recorded during the December 6th – 9th rainfall event. The total rainfall recorded during the event was 2.54 inch over a 3 day period and the total flow recorded during this event was 126,300 approximately gallons. Approximately 34,500 gallons of RDI/I was calculated. Several other rainfall events were also analyzed and significant RDI/I was identified during each of those rainfall periods. While the overall RDI/I volume recorded during the December 6th

percent of the daily dry weather flow and the wet weather hourly peak flow was 7.7 times the hourly dry weather flow. For this reason it is recommended to include this lift station service area in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 12A:

-9th event equaled approximately 37 The flow meter in this Sub-Basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 10-inch discharge pipe of manhole located at 23 Dunbar Creek Point. Sub-Basin 12A has geographical area coverage of 0.231 sq. miles. Sub-Basin 12A has 1,814 linear feet of 8-inch gravity sewer. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 12A is approximately 26,000

gallons per day. It is important to realize that the minimum flow rate recorded during typical nonwater usage hours is approximately 10,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 3.285 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 3,285 gallons. The 12A Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th – 9th rainfall event. The total rainfall recorded during this event was 2.5 inches over a 3 day period and the total flow recorded during this event was approximately 87,300 gallons. Approximately 9,300 gallons of RDI/I was calculated. Several other rainfall events were also analyzed but none showed and significant increase in the flow. For this reason it is not recommended to include this lift

station service area in the storm water inflow source identification program.



1.00 2.00

Time (hours)

12/2/2017

Flow Meter Sub-Basin Site 13A:

Avg. Dry Daily Flow (r

The flow meter in this Sub-Basin was deployed on November 8, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 8-inch discharge pipe of the manhole located at 225 Dunbarton Drive. Sub-Basin 13A has geographical area coverage of 0.02294 sq. miles. Sub-Basin 13A has 9,849 linear feet of gravity sewer ranging from 6-inch to 10-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average

Daily Dry Weather Flow measured at flow meter 13A is approximately 101,500 gallons per day. As this site is not hydraulically independent, the flow had to be isolated and the Isolated Average Daily Dry Weather Flow is approximately 75,500 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 6,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 1.971 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 542 gallons. Due to the lower infiltration rate the 13A Service Area has not been recommended to be included in the groundwater infiltration source investigation work effort.

12/4/2017

12/3/2017



The adjacent hydrograph depicts the average dry weather 24-hour flow and wet weather flow that was recorded during the December 6th -9th rainfall event. The total rainfall recorded during this event was 2.5 inches over a 3 day period and the total flow recorded during this event was approximately 317,700 gallons and the total isolated flow recorded during this event was 230,400 gallons. Approximately 3,900 gallons of isolated RDI/I was calculated. Several other rainfall events were also analyzed none and showed any

significant RDI/I. For this reason it is not recommended to include this lift station service area in the storm water inflow source identification program.



Flow Metering Sub-Basin Site 14A:

The flow meter in this Sub-Basin was deployed on November 11, 2017 and remained in place until February 22, 2018. The flow meter was installed in 8inch effluent pipe of the manhole located at 101 Colonial Drive. Sub-Basin 14A has geographical area coverage of 0.1495 sq. miles. Sub-Basin 14A has 5477 linear feet of 8-inch gravity sewer. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 14A is approximately 119,600 gallons per day. As this site is not

hydraulically independent, the flow had to be isolated and the Isolated Daily Dry Weather Flow is approximately 27,400 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 26,000 gallons per day for the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 8.541 million gallons per year. Groundwater infiltration rates calculated during the wet season equaled 2,820 gallons per inch diameter per mile. The 14A Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during this event was 2.54 inches over a 3 day period and the total flow recorded during this event was approximately 488,900 gallons and the isolated flow recorded during this was approximately 95,000 event gallons. Approximately 12,800 gallons of the total flow was identified as RDI/I. Several other rainfall events were also analyzed and each event had a similar wet weather response.

The overall RDI/I volume recorded during the December 6th-9th event was less than 15 percent of the daily dry weather flow. For this reason it is not recommended to include this lift station service area in the storm water inflow source identification program.

Flow Metering Sub-Basin Site 15A:



The flow meter in this Sub-Basin was deployed on November 7, 2017 and remained in place until February 22, 2018. The flow meter was installed in 8-inch effluent pipe of the manhole located at 6 Plantation Way. Sub-Basin 15A has geographical area coverage of 0.0874 sq. miles. Sub-Basin 15A has 7,534 linear feet of gravity sewer ranging from 8-inch to 10-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 15A is approximately 48,500 gallons per day.

It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 11,000 gallons per day for the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 3.613 million gallons per year. Groundwater infiltration rates calculated during the wet season equaled 889 gallons per inch diameter per mile. Due to very low infiltration rates the 15A Service Area has not been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th - 9th rainfall event. The total rainfall recorded during the December 6th-9th event was 2.54 inches over a 3 day period and the total flow during recorded this event was gallons. approximately 224,800 Approximately 79,300 gallons of the total flow was identified as RDI/I. Several other rainfall events were also analyzed and each event had a similar wet weather response. The overall RDI/I volume recorded during the December 6th-9th

event equaled approximately 54 percent of the daily dry weather flow and the wet weather hourly peak flow was a little more than 2.4 times the hourly dry weather flow. For this reason it is recommended to include this lift station service area in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 16A:



The flow meter in this Sub-Basin was deployed on November 8, 2017 and remained in place until February 22, 2018. The flow meter was installed in the 19-inch influent pipe of a manhole located at 200 Atlantic Drive. Sub-Basin 16A has geographical area coverage of 0.1153 sq. miles. Sub-Basin 16A has 1,889 linear feet of gravity sewer ranging in size from 8-inch to 18inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 16A is approximately 457,400 gallons per day. As this site is not hydraulically independent, the flow

had to be isolated. The isolated Daily Dry Weather Flow recorded was 13,400 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 6,777 gallons per day for the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 2.226 million gallons per year. Groundwater infiltration rates calculated during the wet season equaled 2,596 gallons per inch diameter per mile. The 16A Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during this event was 2.54 inches over a 3 day period and the total flow recorded during this event was approximately 1,815,500 gallons and the total isolated recorded flow was approximately 35,400 gallons. There was no RDI/I recorded during this event. Several other rainfall events were also analyzed and each event had a similar wet weather response. For this reason it is

not recommended to include this lift station service area in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 17A:

The flow meter in this sub-basin was deployed on November 8, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 18-inch effluent pipe of the manhole located at the intersection of Pine Street and Sixth Avenue. Sub-Basin 17A has geographical area coverage of 0.0205 sq. miles. Sub-Basin 17A has 15,904 linear feet of gravity sewer ranging from 6inch 18-inch. to The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at

flow meter 17A is approximately 582,700 gallons per day. As this site is not hydraulically independent, the flow had to be isolated. The isolated average daily dry weather flow approximately equals 23,800 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 5,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 1.642 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 238 gallons. Due to very low infiltration rates the 17A Service Area has not been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 24-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during this event was above 2.54 inches over a 3 day period and the total flow recorded during this event was approximately 2,208,800 gallons. As this site is not hydraulically independent, the flow had to be isolated. The isolated wet weather flow during this event was equal to 75,600 gallons. Approximately 4,200 gallons of isolated RDI/I was calculated. The overall RDI/I volume recorded during this event

equaled approximately 5 percent of the daily dry weather flow. For this reason it is not recommended to include this service area in the storm water inflow source identification program.

3.2. South Branch Flow Meter Sub-basins:

Flow Meter Sub-Basin Site 1B:



The flow meter in this sub-basin was deployed on November 10, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 8-inch influent pipe of the wetwell of a private lift station (P29601) located at Sea Island Sub-Basin Golf Course. 1B has geographical area coverage of 0.095 sq. miles. Sub-Basin 1B has 2,596 linear feet of The 8-inch gravity sewer. adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow

meter 1B is approximately 4,000 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 800 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 0.292 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 4 gallons. Due to extremely low infiltration rates this service area has not been recommended to be included in the groundwater infiltration source investigation work effort.



the storm water inflow source identification program.

Flow Meter Sub-Basin Site 2B:



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the December 6th-9th event was 1.70 inches over a 3 day period and the total flow recorded during this event was approximately 14,200 gallons. Approximately 2,200 gallons of RDI/I was identified. Several other rainfall events were also analyzed and each had a similar wet weather response. For this reason it is recommended not to include this lift station service area in

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 10-inch influent pipe of the manhole located at 118 Florence Street (LS 2001). Sub-Basin 2B has geographical area coverage of 0.077 sq. miles. Sub-Basin 2B has 7,613 linear feet of gravity sewer ranging from 6-inch to 10-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather

Flow measured at flow meter 2B is approximately 124,800 gallons per day. As this site is not hydraulically independent, the flow had to be isolated. The isolated Average Daily Dry Weather Flow measured at this flowmeter was 120,800 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 41,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 12.468 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 4,779 gallons. The 2B service area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the December 6th-9th event was 1.74 inches over a 3 day period and the total flow recorded during this event was approximately 381,300 gallons. As this site is not hydraulically independent, the flow had to be isolated. The isolated wet weather flow during this event was 366,800 equal to gallons. Approximately 4,400 gallons of isolated RDI/I was identified. Several

other rainfall events were also analyzed and all had a similar wet weather response. The overall RDI/I volume recorded during the December 6th -9th event equaled a little more than 0.1 percent of the daily dry weather flow. For this reason it is not recommended to include this lift station service area in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 3B:



The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 8-inch influent pipe of the manhole located at 193 Kings Way (LS 2009). Sub-Basin 3B has geographical area coverage of 0.0979 sq. miles. Sub-Basin 3B has 3,352 linear feet of 8-inch gravity sewer. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow

meter 3B is approximately 68,700 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 41,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 14.96 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 9,318 gallons. The 3B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during this event was 1.70 inches over a 3 day period and the total flow recorded during this event was approximately 212,300 gallons. Approximately 6,200 gallons of RDI/I was identified. Several other rainfall events were also analyzed and each had a similar wet weather response. The overall RDI/I volume recorded during the December 6th-9th event equaled a little more than 3

percent of the daily dry weather flow. For this reason it is not recommended to include this lift station service area in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 4B:

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 8-inch influent pipe of the manhole located at 193 Ashantilly Avenue (LS 2009). Sub-Basin 4B has geographical area coverage of 0.1276 sq. miles. Sub-Basin 4B has 11,010 linear feet of gravity sewer ranging from 8-inch to 10-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at

flow meter 4B is approximately 117,100 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 56,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 18.396 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 3679 gallons. The 4B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the December 6th-9th event was 1.70 inches over a 3 day period and the total flow recorded during this event was approximately 368,100 gallons. Approximately 16,800 gallons of RDI/I was identified. Several other rainfall events were also analyzed and each had a similar wet weather response. The overall RDI/I volume recorded

during the December 6th- 9th event equaled a little more than 4 percent of the daily dry weather flow. For this reason it is not recommended to include this lift station service area in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 5B:



The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 8-inch effluent pipe of the manhole located at 413 Kings Way (LS 2065). Sub-Basin 5B has geographical area coverage of 0.0057 sq. miles. Sub-Basin 5B has 1,267 linear feet of 8-inch gravity sewer. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow

meter 5B is approximately 66,700 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 25,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 8.21 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 11,780 gallons. The 5B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th- 9th rainfall event. The total rainfall recorded during this event was 1.71 inches over a 3 day period and the total flow recorded during this event was approximately 229,600 gallons. Approximately 29,500 gallons of RDI/I was identified. Several other rainfall events were also analyzed and each had a similar wet weather response. The overall RDI/I volume recorded during the December 6th-9th

percent of the daily dry weather flow. For this reason it not is recommended to include this lift station service area in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 6B:



The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 18, 2018 completing the Phase I monitoring period. The flow meter was installed in the 12-inch effluent pipe of the manhole located at 413 Lord Ave (LS 2001). Sub-Basin 6B has geographical area coverage of 0.3531 sq. miles. Sub-Basin 6B has 39,100 linear feet of 6-inch to 12-inch gravity sewer. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 6B is

approximately 366,500 gallons per day. As this service area is not hydraulically independent, and the flow needs to be isolated. The isolated Average Daily Dry Weather Flow measured at this manhole is 114,000 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 66,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 21.68 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 2,248 gallons. Though the infiltration rate is lower than the recommended rate of 2,400 gallons but the percentage of infiltration to the Average Dry Weather Flow is 50%. The 6B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th- 9th rainfall event. The total rainfall recorded during this event was 1.74 inches over a 3 day period and the total flow recorded during this event was approximately 1,155,100 gallons. As this site is not hydraulically independent, the flow had to be isolated. The isolated wet weather flow during this event was equal to 345,100 gallons. Approximately 3,100 gallons of isolated RDI/I was identified. Several other rainfall events were also

analyzed and each had a similar wet weather response. The overall RDI/I volume recorded during the December 6th-9th event equaled a little more than 0.8 percent of the daily dry weather flow. For this reason it is not recommended to include this lift station service area in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 7B:



The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 15-inch influent pipe of manhole located at 120 Ocean Blvd (LS 2002). Sub-Basin 7B has geographical area coverage of 0.2052 sq. mile. Sub-Basin 7B has 21,346 linear feet of 6-inch to 15sewer. The inch gravity adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at

flow meter 7B is approximately 235,500 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 119,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 39.09 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 4,500 gallons. The 7B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the December 6th-9th event was 2.22 inches over a 3 day period and the total flow recorded during this event was approximately 767,400 gallons. Approximately 60,900 gallons RDI/I was identified. The overall RDI/I volume recorded during the December 6th-9th event equaled a little more than 8 percent of the daily dry weather flow and the wet weather hourly peak flow

was a little more than 2.3 times the hourly dry weather flow. For this reason it is recommended to include this lift station service area in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 8B:

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 15-inch effluent pipe of the manhole located at 411 Arnold Road (LS 2002). Sub-Basin 8B has geographical area coverage of 0.175 sq. miles. Sub-Basin 8B has 17,642 linear feet of gravity sewer ranging in size from 8-inch to 15inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow

measured at flow meter 8B is approximately 85,300 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 32,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 10.51 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 1,510 gallons. Although the infiltration rate is lower than the specified rate of 2,400 gallons, the overall percentage of infiltration is more than 30 percent. As such, the 8B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during this event was 2.22 inches over a 3 day period and the total flow recorded during this event was approximately 302,800 gallons. Approximately 16,000 gallons RDI/I was identified. The overall RDI/I volume recorded during the December 6th-9th event equaled a little more than 18 percent of the daily dry weather flow and the wet weather hourly peak flow was a little more

than 3.4 times the hourly dry weather flow. For this reason it is recommended to include this lift station service area in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 9B:

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 15-inch influent pipe of the manhole located at 1219 Ocean Blvd (LS 2002). Sub-Basin 9B has geographical area coverage of 0.0884 sq. mile. Sub-Basin 9B has 9058 feet of gravity sewer ranging in size from 6-inch to 15-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average

Daily Dry Weather Flow measured at flow meter 9B is approximately 82,200 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 33,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 10.84 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 5,405 gallons. Therefore, the 9B Service Area has been recommended to be included in the groundwater infiltration work effort.



water inflow source identification program.

Flow Meter Sub-Basin Site 10B:



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the December 6th-9th event was 2.22 inches over a 3 day period and the total flow recorded during this event was approximately gallons. 261,400 Approximately 14,000 gallons RDI/I was identified. Several other events were analyzed but none showed any significant RDI/I. For this reason it is not recommended to include this lift station service area in the storm

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 15-inch influent pipe of manhole located at 4000 1st Street (LS 2063). Sub-Basin 10B has geographical area coverage of 0.2113 sq. mile. Sub-Basin 10B has 21,434 linear feet of gravity piping with pipe size ranging from 6-inch to 15-The adjacent hydrograph inch. depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry

Weather Flow measured at flow meter 10B is approximately 43,300 gallons per day. It is important to realize that the minimum isolated flow rate recorded during typical non-water usage hours is approximately 16,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 5.26 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 1206 gallons. Although the infiltration rate is lower than the specified rate of 2,400 gallons, the percentage of infiltration is greater than 50 percent of the average daily dry weather flow. As such, the 10B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.22 inches over a 3 day period and the total flow recorded during this event was approximately 156,600 gallons. Approximately 26,700 gallons of RDI/I was calculated. The overall RDI/I volume recorded during the December 6th-9th event equaled a little more than 20 percent of the daily dry weather flow and the wet weather hourly peak flow was a little more than 2.3 times

the hourly dry weather flow. For this reason it is recommended to include this service area in the storm water inflow source identification program.





The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 12-inch effluent pipe of the manhole located at 1059 Demere Road. Sub-Basin 11B has geographical area coverage of 0.1569 sq. mile. Sub-Basin 11B has 11,658 linear feet of gravity piping with pipe size ranging from 6-inch to 12-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total isolated Average Daily Dry

Weather Flow measured at flow meter 11B is approximately 50,400 gallons per day. It is important to realize that the minimum non-isolated flow rate recorded during typical non-water usage hours is approximately 15,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 4.92 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 13,860 gallons. As such, the 11B Service Area has been recommended to be included in the groundwater infiltration work effort.



Flow Meter Sub-Basin Site 12B:

Average Dry Daily Flow - December 1 - 4, 2017 2.200 Average Dry Daily Volume = 1,136,700 gallons Isolated = 148,700 gallons 2 000 1.800 1.600 1.400 1.000 -low 0.800 0.600 0.400 0.200 0.000 5.00 °° 100° 1,10° 120° P 200 Q.0 .8 °°° Time (hours) - Avg. Dry Daily Flow (mgd) 12/1/2017

Flow Meter Site Site_12B

The adjacent hydrograph depicts the average dry weather 72- hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.22 inches over a 3 day period and the total flow recorded during this event was approximately 145,700 gallons. There was no significant RDI/I identified during this event. Several other events were also analyzed and all had similar effect. For this reason it is not recommended to include this lift station service area in the storm water inflow source identification program.

The flow meter in this sub-basin was installed on November 6, 2017 and remained in place until February 22, completing 2018 the Phase Ι monitoring period. The flow meter was installed in the 28-inch effluent pipe of the manhole located at intersection of Armstrong Street and Military Road (155 Military Road). Sub-Basin 12B has geographical area coverage of 0.4215 sq. miles. Sub-Basin 12B has 37,695 linear feet of gravity sewer ranging in size from 4-inch to The adjacent hydrograph 28-inch. depicts dry weather flow conditions recorded during the monitoring

period. The total Average Daily Dry Weather Flow measured at flow meter 12B is approximately 1,136,700 gallons day and the total Average Isolated Daily Dry Weather Flow measured at flow meter 12B is approximately 148,700 gallons per day. It is important to realize that the minimum isolated flow rate recorded during typical isolated non-water usage hours is approximately 84,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 27.59 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 3,614 gallons. The 12B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hrs flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.2 inches over a 3 day period and the total flow recorded during this event was approximately 3,743,900 gallons and the total isolated flow was 573,900 gallons. Approximately 127,800 gallons of isolated RDI/I was identified. The overall RDI/I volume recorded during the December 6th-9th event equaled a

little more than 28 percent of the daily dry weather flow and the wet weather hourly peak flow. For this reason it is recommended to include this lift station service area in the storm water inflow source identification program.





The flow meter in this sub-basin was deployed on November 6, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 8-inch effluent pipe of the manhole located at 90 Stewart Street (LS 2003). Sub-Basin 13B has geographical area coverage of 0.4992 sq. miles. Sub-Basin 13B has 37,589 linear feet of gravity sewer ranging from 4-inch to 28-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average

Daily Dry Weather Flow measured at flow meter 13B is approximately 1,392,900 gallons per day and total isolated Average Daily Dry weather flow is approximately 247,700 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 57,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 18.72 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 1083 gallons. The infiltration rate is greater than 25 percent of the average dry weather daily flow. As such, the 13B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during this event was 2.45 inches over a 3 day period and the total flow recorded during this event was approximately 4,564,900 gallons and the total recorded flow after isolation was approximately 794,000 Approximately 50,900 gallons. of isolated RDI/I gallons was identified, several other events were also analyzed and none showed any significant RDI/I. For this reason it is

not recommended to include this lift station service area in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 14B:



The 14B flow meter was installed on November 6, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 8- inch effluent pipe of the manhole located at 103 Taylor Lane 2003). Sub-Basin 14B (LS has geographical area coverage of 0.0246 sq. miles. Sub-Basin 14B has 2,906 linear feet of 8-inch gravity sewer. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 14B is

approximately 8,500 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 4,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 1.31 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 2,195 gallons. The 14B Service Area has not been recommended to be included in the groundwater infiltration source investigation work effort.



source identification program.

Flow Meter Sub-Basin Site 15B:



The adjacent hydrograph depicts the average dry weather 24-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.45 inches over a 3 day period and the total flow recorded during this event was approximately 27,000 gallons. Approximately 1,500 gallons of isolated RDI/I was identified. Several other rainfall events were also analyzed and each had a similar wet weather response. For this reason the 14B Sub-basin is not recommended to be included in the storm water inflow

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 8-inch influent pipe of manhole located at 119 Worthing Road (2003). Sub-Basin 15B has geographical area coverage of 0.190 sq. miles. Sub-Basin 15B has 15,276 linear feet of gravity sewer ranging in size from 6-inch to 12-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather

Flow measured at flow meter 15B is approximately 93,200 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 25,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 8.21 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 969 gallons. The infiltration rate is greater than 30 percent percentage of average daily dry weather flow. As such, the 15B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during this event was 2.45 inches over a 3 day period and the total flow during recorded this event was 384,900 gallons. approximately Approximately 105,300 gallons RDI/I were calculated. Several other rainfall events were also analyzed and each had a similar wet weather response. The overall RDI/I volume recorded during

the December 6th- 9th event equaled a little more than 37 percent of the daily dry weather flow and the wet weather hourly peak flow was a little more than 8.4 times the hourly dry weather flow. For this reason the 15B Sub-basin has been recommended to be included in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 16B:



The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018. The flow meter was installed in the 8-inch influent pipe in the Lift Station 2005 wetwell. Sub-Basin 16B has geographical area coverage of 0.0925 sq. mile. Sub-Basin 16B has 7,238 linear feet of 8-inch gravity sewer. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 16B is approximately 10,500 gallons per day. It is important to realize that the minimum flow rate

recorded during typical non-water usage hours is approximately 2,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 0.657 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 163 gallons. Due to lower groundwater infiltration rates the 16B Service Area has not been recommended to be included in the groundwater infiltration source investigation work effort.


source identification program.

Flow Meter Sub-Basin Site 17B:



The adjacent hydrograph depicts the average dry weather 24-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.45 inches over a 3 day period and the total flow recorded during this event was approximately 32,900 gallons. Approximately 1,400 gallons RDI/I was calculated. Several other rainfall events were also analyzed and each had a similar wet weather response. For this reason the 16B sub-basin has been recommended to be not included in the storm water inflow

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 18-inch influent pipe of a manhole located at the intersection of Sea Island Road & Frederica Road. Sub-Basin 17B has geographical area coverage of 0.3407 sq. mile. Sub-Basin 17B has 20,236 linear feet of gravity sewer ranging in size from 8-inch to 18-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The

total Average Daily Dry Weather Flow measured at flow meter 17B is approximately 104,000 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 47,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 15.44 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 2,131 gallons. The infiltration rate is approximately 65 percent of the average daily dry weather flow. As such, the 17B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.45 inches over a 3 day period and the total flow recorded during this event was approximately 438,300 gallons. Approximately 126,300 gallons of RDI/I was identified. The overall RDI/I volume recorded during the December 6th-9th event equaled a little more than 40 percent of the daily dry weather flow and the wet weather hourly peak flow was a little more than 2.9 times

the hourly dry weather flow. The 17B sub-basin has been recommended to be included in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 18B:

The flow meter in this sub-basin was deployed on November 6, 2017 and remained in place until February 22, 2018. The flow meter was installed in the 28-inch discharge pipe of the manhole located at 620 Sea Island Road. Sub-Basin 18B has geographical area coverage of 0.0557 sq. mile, however, includes the flow generated from Sea Island as well. Sub-Basin 18B has 5,250 linear feet of gravity sewer ranging in size from 8-inch to 28-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The

total Average Daily Dry Weather Flow measured at flow meter 18B is approximately 1,605,500 gallons per day and the Isolated Average Daily Dry Weather flow is approximately 108,900 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 5,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 1.64 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 446 gallons. Due to the lower infiltration rate the 18B Service Area has not been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.45 inches over a 3 day period and the total flow recorded during this event was approximately 5,343,700 gallons and the isolated total flow recorded was approximately 361,000 gallons. Approximately 34,300 gallons of isolated RDI/I was identified. Several other rainfall events were also analyzed and each had a similar wet weather response. As such, the

18B Sub-basin and Sea Island have not been recommended to be included in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 19B:



The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018. The flow meter was installed in the 8-inch influent pipe of the manhole located at 134 Pine Valley. Sub-Basin 19B has geographical area coverage of 0.2094 sq. mile. Sub-Basin 19B has 13,623 linear feet of 8inch gravity sewer. The adjacent hydrograph depicts dry weather flow conditions recorded during the period. monitoring The total Average Daily Dry Weather Flow measured at flow meter 19B is approximately 20,400 gallons per

day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 4,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 1.31 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 185 gallons. Therefore, the 19B Service Area has not been recommended to be included in the groundwater infiltration work effort.





Flow Meter Sub-Basin Site 20B:

Average Dry Daily Flow - Dece r 1 - 4, 2017 0.300 Average Dry Daily Volume = 111,700 gallon 0.270 0.240 0.210 0.180 **b** 0.150 ⁶ 0.120 0.090 0.060 0.030 0.000 ×2:00 200 .0¹⁰ .1¹⁰ 12^{.6} Time (hours) Avg. Dry Daily Flow (mgd

Flow Meter Site Site_20B

The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 1.7 inches over a 3 day period and the total flow recorded during this event was approximately 64,900 gallons. Approximately 3,700 gallons RDI/I were calculated. Several other rainfall events were also analyzed and each had a similar wet weather response. The 19B Sub-basin has not been recommended to be included in the storm water inflow source

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 10-inch influent pipe of manhole located at 127 the St. Andrews Road. Sub-Basin 20B has geographical area coverage of 0.1721 sq. mile. Sub-Basin 20B has 12,204 linear feet of gravity sewer ranging in size from 8-inch to 10-inch. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow

measured at flow meter 20B is approximately 111,700 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 33,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 10.84 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 4,775 gallons. As such, the 20B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



identification program.

Flow Meter Sub-Basin Site 21B:



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 1.70 inches over a 3 day period and the total flow recorded during this event was approximately 337,900 gallons. Approximately 2,800 gallons of RDI/I was identified. Several other events were also analyzed and none showed any significant RDI/I. as such, the 20B Sub-basin has not been recommended to be included in the inflow storm water source

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, completing the 2018 Phase I monitoring period. The flow meter was installed in the 12-inch influent pipe of a manhole located at 197 Merion Road. Sub-Basin 21B has geographical area coverage of 0.264 sq. mile. Sub-Basin 21B has 16,581 linear feet of gravity sewer ranging in size from 6-inch to 15-inch. The adjacent hydrograph below depicts dry weather flow conditions during the recorded monitoring period. The total Average Daily Dry

Weather Flow measured at flow meter 21B is approximately 188,900 gallons per day and the total isolated Daily Dry Weather Flow is approximately 56,800 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 44,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 14.45 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 2271 gallons. The infiltration rate is is more than 230 percent of the average daily dry weather flow. As such, the 21B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 1.70 inches over a 3 day period and the total flow recorded during this event approximately was 642,900 gallons and the isolated total flow recorded is approximately 240,100 gallons. Approximately 69,700 gallons of isolated RDI/I was identified. The overall RDI/I volume recorded during the December 6th-9th event equaled

more than 29 percent of the daily dry weather flow and the wet weather hourly peak flow was more than 1.6 times the hourly dry weather flow. As such, the 21B Sun-basin has been recommended to be included in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 22B:

The flow meter in this sub-basin was deployed on November 7, 2018 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 8-inch influent pipe of the manhole located at 122 Point Lane (LS Sub-Basin 2052). 22B has geographical area coverage of 0.0776 sq. mile. Sub-Basin 22B has 4,604 linear feet of 8-inch gravity sewer. The depicts hydrograph adjacent dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow

measured at flow meter 22B is approximately 147,400 gallons per day. It should be noted that there was no minimum flow rate recorded during typical non-water usage hours during the month of November. This is due to the current operating levels at Lift Station 2052. The collection system surcharges to approximately 10-inches at the manhole where the flow meter was installed before the pump is activated. As such, there is not a free discharge into the lift station wetwell and the minimum recorded flow rate is equal to zero.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 1.70 inches over a 3 day period and the total flow recorded during this event was approximately 531,700 gallons. 89,500 Approximately gallons of isolated RDI/I was identified. The overall RDI/I volume recorded during the December 6th-9th event equaled a little more than 20 percent of the daily dry weather flow and the wet weather

hourly peak flow was a little more than 6 times the hourly dry weather flow. The 22B Sub-basin has been recommended to be included in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 23B:



The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, completing the Phase 2018 Ι monitoring period. The flow meter was installed in the 10-inch influent pipe of the manhole located at 1007 Lewis Lane. Sub-Basin 23B has geographical area coverage of 0.352 sq. mile. Sub-Basin 23B has 6,969 linear feet of gravity sewer ranging in size from 8-inch to 10-inch. The adjacent hydrograph below depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow

measured at flow meter 23B is approximately 354,500 gallons per day and the total Isolated Daily Dry Weather Flow measured is approximately 18,200 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 16,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 5.25 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 1,575 gallons. The infiltration rate is more than 370 percent of the average dry weather flow. As such, the 23B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.45 inches over a 3 day period and the total flow recorded during this event was approximately 1,234,900 gallons and the total isolated flow recorded during this event was approximately 60,300 gallons. Approximately 5,700 gallons isolated RDI/I was identified. of Several other events also were analyzed but none showed any significant RDI/I. Therefore, the 23B

Sub-basin has not been recommended to be included in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 24B:



The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase Ι monitoring period. The flow meter was installed in the 15-inch influent pipe of the manhole located at 915 Rose Cottage Road. Sub-Basin 24B has geographical area coverage of 0.4127 sq. mile. Sub-Basin 24B has 12,931 linear feet of gravity sewer ranging in size from 8-inch to 15-inch. The adjacent hydrograph below depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow

measured at flow meter 24B is approximately 448,000 gallons per day and the total Isolated Average Daily Dry Weather Flow measured is approximately 93,500 gallons. It is important to realize that the minimum isolated flow rate recorded during typical non-water usage hours is approximately 77,500 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 30.87 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 4,498 gallons. As such, the 24B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.45 inches over a 3 days period and the total flow recorded during this event was approximately 1,543,100 gallons and the total isolated flow recorded during this event was 308,200 approximately gallons. Approximately 27,700 gallons of isolated RDI/I was identified. The overall RDI/I volume recorded during the December 6th-9th event equaled more than 9 percent of the daily dry weather

flow and the wet weather hourly peak flow was more than 1.5 times the hourly dry weather flow. The 24B Sub-basin has been recommended to be included in the storm water inflow source identification program.

Flow Meter Sub-Basin Site 25B:



The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 12-inch influent pipe of the manhole located at 1065 Brockinton Drive. Subhas geographical area Basin 25B coverage of 0.274 sq. mile. Sub-Basin 25B has 24,285 linear feet of gravity sewer ranging in size from 6-inch to 12inch. The adjacent hydrograph below depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather

Flow measured at flow meter 25B is approximately 104,100 gallons per day. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 35,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 11.49 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 1,557 gallons. The infiltration rate is more than 43 percent of the average daily dry weather flow. As such, the 25B Service Area has been recommended to be included in the groundwater infiltration source investigation work effort.



the storm water inflow source identification program.

Flow Meter Sub-Basin Site 26B:



The adjacent hydrograph depicts the average dry weather 72-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.45 inches over a 3-day period and the total flow recorded during this event was approximately 324,900 gallons. Approximately 12,600 gallons of isolated RDI/I was identified. Several other events were also analyzed and none showed any significant RDI/I. As such, the 25B Sub-basin has not been recommended to be included in

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 8-inch influent pipe of the Lift Station 2047 wetwell located at 101 Davison Lane. Sub-Basin 26B has geographical area coverage of 0.192 sq. mile. Sub-Basin 26B has 7,330 linear feet of 8-inch gravity sewer. The adjacent hydrograph depicts dry weather flow conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at

flow meter 26B is approximately 58,400 gallons per day. It should be noted that there was no minimum flow recorded during typical non-water usage hours during the month of November. This is due to the current operating levels at Lift Station 2052. The collection system surcharges to approximately 8-inches at the manhole where the flow meter was installed before the pump is activated. As such, there is not a free discharge into the lift station wetwell and the minimum recorded flow rate is equal to zero. As such, the 26B Sub-basin has not been recommended to be included in the storm water inflow source identification program.



The adjacent hydrograph depicts the average dry weather 24-hour flow and wet weather flow that recorded was during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.45 inches over a 3 day period and the total flow recorded during this event was approximately 247,300 gallons. Approximately 72,100 gallons of RDI/I was identified. The overall RDI/I volume recorded during the December 6th-9th event equaled more than 41 percent of the daily dry weather flow and the wet

weather hourly peak flow was more than 2 times the hourly dry weather flow. Therefore, the 26B Subbasin has been recommended to be included in the storm water inflow source identification program.



Flow Meter Sub-Basin Site 27B:

The flow meter in this sub-basin was deployed on November 7, 2017 and remained in place until February 22, 2018 completing the Phase I monitoring period. The flow meter was installed in the 30inch influent pipe of the manhole across from the Dunbar Creek WPCP headworks located at 515 Pine Street. Sub-Basin 27B has geographical area coverage of 0.2751 sq. mile. Sub-Basin 27B has 7,981 linear feet of gravity sewer ranging in size from 6-inch to 30inch. The adjacent hydrograph depicts dry weather flow

conditions recorded during the monitoring period. The total Average Daily Dry Weather Flow measured at flow meter 27B is approximately 2,417,100 gallons per day and the total Isolated Average Daily Dry Weather Flow measured is approximately 201,100 gallons. It is important to realize that the minimum flow rate recorded during typical non-water usage hours is approximately 24,000 gallons per day during the month of November. Assuming that 90% of the minimum flow rate is due to groundwater infiltration this equates to approximately 7.88 million gallons per year. Groundwater infiltration rates calculated per inch diameter per mile of piping is 1,910 gallons. As such, the 27B

Service Area has not been recommended to be included in the groundwater infiltration source investigation work effort.



The adjacent hydrograph depicts the average dry weather 24-hour flow and wet weather flow that was recorded during the December 6th-9th rainfall event. The total rainfall recorded during the event was 2.54 inches over a 3 day period and the total flow recorded during this event was approximately 8,233,400 gallons and the total isolated flow recorded during this event was approximately 774,500 Approximately gallons. 171,200 gallons of isolated RDI/I was identified. The overall RDI/I volume recorded during the December 6th-9th event equaled a little more than 28

percent of the daily dry weather flow and the wet weather hourly peak flow was a little more than 1.47 times the hourly dry weather flow. As such, the 27B Sub-basin has been recommended to be included in the storm water inflow source identification program.

4.0 SUMMARY OF THE FLOW MONITORING RESULTS:

4.1 Summary of I/I Analysis Results:

From review of the flow data recorded during the monitoring period, it has been established that the average 24-hour flow at the Dunbar Creek WPCP equaled 3.368 million gallons. The average 24-hour dry weather flow was determined to be 2.845 million gallons and the lowest 24-hour flow recorded during the monitoring period occurred on January 21, 2018 when 2.670 million gallons of flow were measured entering the Dunbar Creek WPCP. This low 24-hour flow was driven primarily by dry weather patterns which helped lower the groundwater elevation, however, as several more significant rainfall events were recorded the average 24-hour flow began to increase. The increase in flow was driven primarily by higher groundwater conditions caused by rainfall dependent infiltration and the associated increase in corresponding groundwater infiltration.

As described previously the wastewater flows received at Dunbar Creek WPCP during the months of December, January, and February increased substantially as additional rainfall was recorded. The increase in overall 24-hour flow between the start of the monitoring period and the end of the monitoring period is approximately 360,000 gallons per day. Table 1.2, on the following page identifies the monthly rainfall recorded, the average daily flow recorded during the month and the increase in flow that was documented.

Time Span	Amount of Rainfall Recorded (Inches)	Average Daily Flow for Time Span (MGD)	Average Daily Increase During Time Span (Gals)
November 2018	2.59	3.15	N/A
December 2018	2.03	3.39	240,000
January 2018	3.90	3.41	20,000
February 2018	1.42	3.51	100,000

Table 4.1 – Monthly Average Daily Flow & Flow Increase After Wet Weather Periods

In an effort to effectively represent the impact of the documented wet weather events during the flow monitoring period, the hydrograph on the following page, (Figure 4.1), was prepared.





As identified by the hydrograph the projected lowest daily flow recorded at the Dunbar Creek WPCP was approximately 2.67 million gallons, which was recorded on January 21, 2018. By projecting this recorded 24-hour flow rate as the lowest daily dry weather flow, (DWF) a total base flow volume over the monitoring period is established at 250.98 million gallons; noting that the DWF includes both wastewater generated by SSI system users and groundwater infiltration, (GWI). The total volume of flow measured during the monitoring period equals 316.63 million gallons which includes DWF and RDI/I. By subtracting the calculated DWF from the total flow recorded an RDI/I volume of 65.65 million gallons is recognized.

As presented previously, approximately 9.94-inches of rainfall was recorded during the flow monitoring period. The majority of these rainfall events caused a daily increase in flow at the Dunbar Creek WPCP of more than one (1) million gallons. In an effort to project the cost of transporting and treating the extraneous clean water a value of \$2.50 per 1,000 gallons was established. Based on this value, the cost to treat the additional 65.65 million gallons is estimated to be equal to \$164,125. It should be noted that the costs to convey the extraneous flow to the treatment facility, including additional electricity for increased pump operation at the lift stations, and additional equipment maintenance/replacement costs, caused by the excessive run-times are not included in the \$2.50 per thousand gallon cost. The average annual rainfall recorded in Brunswick is equal to approximately 49-

inches. If the measured RDI/I identified during the study period, based on 8.5-inches of rainfall, is annualized, using an average rainfall of 49-inches, the expected annual RDI/I is projected to equal 323.63 million gallons with annual cost of \$809,075 to transport and treat.

It is important to realize that RDI/I includes two components; direct storm water inflow and rainfall dependent infiltration. Storm water inflow primarily enters the wastewater collection system through manhole covers, open cleanouts, improper connections to service laterals and cross connections with nearby drainage infrastructure. Rainfall dependent infiltration enters the wastewater collection system through the same piping/manhole defects which allow groundwater to enter the system. In some cases the defective piping is above the groundwater table and in other cases the affected piping and manholes are below the groundwater table and as the groundwater elevation rises, due to the rain water percolating through the soil, the constant groundwater infiltration rates are increased due to the additional hydrostatic pressure.

4.2 Storm Water Inflow & Rainfall Dependent Infiltration Analysis

The largest contribution of RDI/I in the Dunbar Creek WPCP service area, was generated in Flow Meter Sub-basins 27B, 17B, 12B, 15B, 22B, 26B, 21B, 15A and 10A. The adjacent pie-chart depicts the measured RDI/I volumes for each flow meter subbasin during the December 6th-9th rainfall event. As previously described the 27B, 17B, 12B, 15B, 22B, 26B, 21B, 15A and 10A recorded Service Areas the highest levels of RDI/I. These contributed service areas approximately 77.9 percent of the total RDI/I recorded during the event. It should be noted that in addition to evaluating the RDI/I

% RDI/I Contribution for December 6th - 9th Rainfall Event



recorded volumes an analysis of the peak hourly wet weather flow was also conducted. While it makes sense that the largest drainage areas contributed the greatest volumes of RDI/I it is important to realize that when comparing RDI/I in the smaller lift station service areas the focus is on how much did the flow increase during the wet weather period compared to average dry weather flow rates. By comparing the peak wet weather hourly flow rate to the dry weather hourly flow rate the lift station service areas which are most prone to excessive pump run-times can be easily established. While the overall RDI/I volume may not be as glaring as the RDI/I levels in larger drainage basins the primary concern is the potential for SSOs to occur if the wet weather event's magnitude and duration are extended. Tables 4.2 and 4.3 depict the maximum RDI/I levels and peak wet weather hourly flow

versus average dry hourly flow ratios, for the flow meter sub-basins/lift station service areas with excessive RDI/I.

Flow Meter No./Lift Station No.	Length of Gravity Sewers (Linear Feet)	Average Dry Weather Flow 72-Hrs (Gallons)	Wet Weather Flow 12/(6-9)/2017 72-Hrs (Gallons)	Calculated RDI/I (Gallons) 12/(6-9)/2017	Peaking Factor (Highest Flow Divided by Average Dry Weather Flow)
2A/2034	9,495	36,300	72,400	36,100	4
5A/2062	5,257	120,300	151,500	31,200	2.61
10A/2011	17,817	184,800	267,600	82,800	4
11A/2011	13,756	91,800	126,300	34,500	7.7
15A/2008	7,534	145,500	224,800	79,300	2.4

Table 4.2 - North Branch Interceptor Excessive RDI/I and Wet/Dry Weather Peaking Factors

Table 4.3 - South Branch Interceptor Excessive RDI/I and Wet/Dry Weather Peaking Factors

Flow Meter No./Lift Station No.	Length of Gravity Sewers (Linear Feet)	Average Dry Weather Flow 72-Hrs	Max Wet Weather Flow 12/(6-9)/2017 72-Hrs	Calculated RDI/I (Gallons) 12/(6-9)/2017	Peaking Factor(Highest Flow Divided by Average Dry Weather Flow)
7B/2002	21,346	706,500	767,400	60,900	2.3
8B/2002	17,642	255,900	302,800	46,900	3.4
10B/2063	21,438	129,900	156,600	26,700	2.3
12B/Interceptor	11,658	446,100	573,900	127,800	1.3
15B/2005	14,987	279,600	384,900	105,300	8.4
17B /Interceptor	20,236	312,000	438,300	126,300	2.9
21B/2023	16,581	103,500	174,300	70,800	1.6
22B/Interceptor	4,604	442,200	531,700	89,500	6
24B/2030	12,931	280,500	308,200	27,700	1.5
26B/2047	7,330	175,200	247,300	72,100	2
27B/WPCP	7,981	603,300	744,500	171,200	1.47

It is important to note that unlike determination of excessive groundwater infiltration flow rates, which are analyzed based on a linear function (gallons of infiltration per inch diameter per mile of gravity piping), evaluation of storm water inflow is point source; the number of defects which are allowing storm water to enter the wastewater collection system could be as few as one. In an effort to establish a defendable threshold for allowable storm water inflow the following criteria were developed.

- If the storm water inflow volume exceeded 100,000 gallons during the December 6th-9th rainfall event the lift station/flow meter service area should be included in the storm water inflow source investigations
- If the peak hourly wet weather flow rate exceeded the average dry weather hourly flow rate by a magnitude of one and a half (1.5) the lift station/flow meter service area should be included in the storm water inflow source investigations.

As identified by the tables sixteen (16) of the forty four (44) flow meter sub-basins exhibited excessive RDI/I, exceeded wet weather flow volume/wet weather peak hourly flow rate threshold, during the December 6th-9th wet weather event. These basins included eleven (11) on the South Branch and five (5) on the North Branch. Inflow source investigations have been recommended to be completed in all of these basins.

<u>4.3 Groundwater Infiltration Analysis Results:</u>

The groundwater analysis included evaluation of groundwater levels established using groundwater piezometers, and by use of the County's GIS to determine pipe segments which are below the groundwater table, (See Groundwater Infiltration Maps in Appendix G & Appendix H). Once the individual pipe segments that are below the groundwater table were established for each basin, review of the minimum recorded flow rates during non-peak water usage hours was completed and the apparent groundwater infiltration for each sub-basin was calculated. Table 4.4 identifies the excessive apparent groundwater infiltration rates in twenty four (24) flow meter sub-basins.

North Branch	Minimum Flow (Gal)	GWI/(Inch-Diameter mile)	GWI/(Inch-Diameter mile) Below Groundwater	Isolated GWI % of ADF
2A	9,000	626	2759	300%
5A	11,700	1417	1418	30%
12A	9,000	3275	3285	50%
14A	23,400	2820	Missing GIS Invert Data	600%
16A	6,100	1142	2596	80%
South Branch	Minimum Flow (Gal)	GWI/(Inch-Diameter mile)	GWI/(Inch-Diameter mile) Below Groundwater	Isolated GWI % of ADF
2 B	36,900	3012	4779	40%
3B	36,900	6263	9318	50%
4B	50,400	2736	3679	45%
5B	22,500	11725	11780	50%
6B	59,400	931	2248	50%
7B	107,100	3125	4500	45%
8B	28,800	964	1510	30%
9B	29,700	1664	5405	55%
10B	14,400	403	1206	50%
11B	13,500	702	13860	30%
12B	75,600	999	3614	50%
13B	51,300	725	1083	25%
15B	22,500	969	969	30%
17B	42,300	1257	2131	68%
20B	29,700	1603	4775	36%
21B	39,600	1440	2271	230%
23B	14,400	1239	1575	370%
24B	84,600	3808	4498	950%
25B	31,500	833	1557	453%

Table 4.4 - North & South Branch Sub-Basins with Excessive Groundwater Infiltration Flow Rates

When the minimum recorded flow rates are added together the total equals approximately 850,300 gallons. If it assumed that ninety (90) percent of the total minimum flow recorded is attributed to groundwater infiltration and the infiltration rate remains constant an annual infiltration volume of 310.36 million gallons is established. Using the same transport and treatment cost established for the RDI/I analysis the annual cost for conveying and treating the groundwater equals \$775,900.

As identified by Table 4.4, groundwater infiltration rates for each flow meter sub-basin were presented based on using the piping footage that is believed to be below the groundwater table; see groundwater infiltration maps in Appendix G and Appendix H. It is recommended that every lift station service area/flow meter sub-basin that exceeds 2,400 gallons per inch diameter mile or has infiltration rate more than 25% of ADF, should be included in the groundwater infiltration source investigations. As identified by the table twenty four (24) of the forty four (44) flow meter sub-basins exceeded the

established threshold. These basins included five (5) on the North Branch, and nineteen (19) on the South Branch. It should be noted that there is a significant amount of missing pipe invert data in JWSC's GIS, as such a definitive projection of the piping network below the groundwater table could not be completed.

5.0 I/I SOURCE IDENTIFICATION RECOMMENDATIONS

5.1 Storm Water Inflow & Groundwater Infiltration Source Location Program Scope:

In summary, the first phase of the project has been completed and recommendations to transition into additional activities have been provided. Those recommendations include the following:

Phase 2 - Complete smoke testing and dye testing of sixteen (16) flow meter sub-basins (210,589 LF)

<u>Phase 3</u> - Complete manhole inspections of twenty four (24) flow meter sub-basins (1,668 Manholes) & Complete night flow isolations of twenty four (24) flow meter sub-basins (1,668 Isolations)

Once the Phase 2 and Phase 3 activities have been completed a Technical Memorandum will be prepared which identifies the recommended scope of storm water inflow and groundwater infiltration abatement. This document will provide recommendations and include cost opinions for completing the following initiative:

- Storm Water Inflow Abatement Recommendations Elimination of Cross Connections and Necessary Pipe Repair/Rehabilitation/Replacement
- Groundwater Infiltration Abatement CCTV Inspection/Manhole Repair/Rehabilitation Recommendations

<u>Storm Water Inflow Abatement:</u> Recommendations to complete storm water inflow abatement will be based on the results of dye water tracing and flooding program and will utilize the CCTV inspection data, which will be captured during the dye testing, to determine the best method for eliminating the discovered deficient piping and cross-connection(s). Digital orthographic-photo mapping with a storm water and wastewater collection system piping overlay will be utilized to identify the approach recommended to achieve inflow abatement. In addition, 11x17 maps which identify the sanitary and storm water features affected by the proposed I/I remediation effort will be provided. General notes will be added to the maps to identify the proposed I/I abatement scope, but no physical survey, or utility location, will be completed. The diagrams, sketches and notes will be sufficient for use by JWSC maintenance crews to address the inflow abatement.

<u>Groundwater Infiltration Abatement Recommendations Manhole Inspections:</u> Utilizing the results of the manhole inspections digital orthographic mapping will be prepared that identifies the location of each structure in a flow meter sub-basin that requires repair. The proposed scope for the necessary repair/rehabilitation (R/R) will be presented for each sub-basin in a tabular format. Individual tables will be presented on the flow meter sub-basin maps that depict the necessary improvements.

<u>Groundwater Infiltration CCTV Inspections:</u> Utilizing the results of the night flow isolations the gravity piping with groundwater infiltration rates that exceed pre-established thresholds will be recommended for CCTV inspections. CCTV inspections can be completed by either JWSC, or McKim & Creed.

5.2 Summary of Phase 2 and Phase 3 Recommendations:

Depending on available funding the infiltration source investigation program can be completed over multiple years on a prioritized basis. While the inflow source investigations will yield the greatest flow reduction value, based on gallons removed versus cost of removal, the infiltration source investigations will allow JWSC the ability to develop a phased CIP to address infiltration removal. The following identifies the actual scope of Phase 2 and Phase 3 and the projected cost to complete each phase.

Phase 2 - Inflow Source Investigations:

- 1. Smoke Testing of the Following Meter Basins 2A, 5A, 7B, 8B, 10A, 10B, 11A, 12B, 15A, 15B, 17B, 21B, 22B, 24B, 26B & 27B 210,589 LF
- 2. Dye Water Testing Assume 15 Dye Traces and 15 Dye Floods
- 3. Report Preparation

Phase 3 - Infiltration Source Investigations:

- Perform Manhole Inspections in the Following Basins 2A, 2B, 3B, 4B, 5A, 5B, 6B, 7B, 8B, 9B, 10B, 11B, 12A, 12B, 13B, 14A, 15B, 16A, 17B, 20B, 21B, 23B, 24B, 25B
 Total No. of Manholes Flow Meter Basins
- 2. Perform Night Flow Isolations in all Flow Meter Basins Recommended for Manhole Inspections
- 3. Report Preparation