BEAUFORT COUNTY
STORMWATER MANAGEMENT UTILITY BOARD
AGENDA
Wednesday, September 30, 2015
2:00 p.m.
Beaufort Industrial Village, Building 3 Conference Room 104
Industrial Village Road, Beaufort
843.255.2805

In accordance with South Carolina Code of Laws, 1976, as amended, Section 30-4-80(d), all local media was duly notified of the time, date, place and agenda of this meeting.

1. CALL TO ORDER – 2:00 p.m.
   A. Approval of Agenda
   B. Approval of Minutes – August 26, 2015 (backup)

2. INTRODUCTIONS

3. PUBLIC COMMENT

4. REPORTS
   A. Utility Update – Eric Larson, P.E. (backup)
   B. MS4 Update - Eric Larson, P.E. (backup)
   C. Monitoring Update – Eric Larson, P.E. (backup)
   D. Stormwater Implementation Committee Report – Eric Larson, P.E. (backup)
   E. Stormwater Related Projects – Eric Larson, P.E. (backup)
   F. Upcoming Professional Contracts Report – Eric Larson, P.E. (backup)
   G. Regional Coordination – Eric Larson, P.E. (backup)
   H. Financial Report – Not provided this month
   I. Maintenance Projects Report – Not provided this month

5. UNFINISHED BUSINESS
   A. Update on the Rate Structure/ Rate Increase- Eric Larson

6. NEW BUSINESS
   A. Presentation of the D.N.R. Volume Sensitivity (Salinity) Study (backup)
   B. Presentation of the May River Watershed Sewer Master Plan by The Town of Bluffton (backup)
   C. Draft 2016 Stormwater Management Utility Board Meeting Schedule (backup)

7. PUBLIC COMMENT

8. NEXT MEETING AGENDA
   A. October 21, 2015 (backup)

9. ADJOURNMENT

Beaufort County Stormwater Management Utility Board (SWMU Board)
Meeting Minutes

August 26, 2015 at 2:00 p.m. in Beaufort Industrial Village Building #3 Conference Room
Draft 9-2-2015

Board Members		**Ex-Officio Members**	
Present	**Absent**	**Present**	**Absent**
Don Smith	Allyn Schneider	Andy Kinghorn	Van Willis
William Bruggeman		Jeremy Ritchie	
Marc Feinberg		Scott Liggett	
Larry Meisner			
Patrick Mitchell			
James Fargher			

Beaufort County Staff	**Visitors**
Eric Larson	
Eddie Bellamy	Dan Duryea, BC Solid Waste Board
Carolyn Wallace	Reed Armstrong, Coastal Conservation League
Kevin Pitts	Cynthia Bensch, County Council
Patricia Wilson	Alice Howard, County Council
Allison Coppage	Shelby Berry, Bft. Soil & Water Conservation Dist.
Thomas Keaveny	Denise Parsick, Bft. Soil & Water Conservation Dist.
James Minor, Jr.	Kate Schaefer, Coastal Conservation League
	Paul Moore, Ward Edwards

1. Meeting called to order – Don Smith

- **A.** Agenda – The board members consented to switch item (5) Unfinished Business with item (6) New Business. The agenda was approved with this change.
- **B.** July 15, 2015 Minutes - Approved.

2. Introductions – Completed.

3. Public Comment(s) – None.

4. Reports – (Mr. Eric Larson and Mr. Eddie Bellamy provided a written report and Mr. Alan Eisenman provided a copy of the June financials and they were attached to the agenda and can be accessed at http://www.bcgov.net/departments/Administrative/beaufort-county-council/boards-and-commissions/council-appointed/board-list/stormwater-management-utility-board/agendas/2015/082615.pdf)

- **A. Utility Update –** Eric Larson
  Mr. Eric Larson referred to the report he submitted with the agenda packet. He had nothing new to report.

B. Municipal Separate Storm Sewer System (MS4 Update) – Eric Larson

MS4 Permit Application – The County received a letter from SCDHEC on August 21st. Public announcement was delayed until September 1st. The effective permit date should be October 1, 2015.

C. Monitoring Update – Eric Larson

US 278 Pond Project- Mr. Kevin Pitts and Mr. Danny Polk are working together to provide preconstruction sampling as a baseline. Later sampling should result in improved water quality and volume control as a result of the project.

USCB and County MOU – Meetings with Dr. Warren (USCB) have been postponed until September. The goal is to restructure the MOU for changing monitoring needs due to Capital Improvement Projects (CIP) and MS4 requirements without having to constantly amend the MOU.

D. Stormwater Implementation Committee (SWIC) Report – Eric Larson

The focus (of the SWIC meetings) has been the Rate Study and selection of the consultant for the Storm Water Management Plan Update. Both the July 15, 2015 and August 12, 2015 meeting minutes are included in this report.

E. Stormwater Related Projects – Eric Larson

Bluffton Gateway Final Development and Island Shops Final Development Plan Review – Both of these projects are private developments of large shopping centers. Mr. Larson reviewed these plans as part of the Staff Review Team (SRT) and he does reviews for the City of Beaufort as well. One is the Wal-Mart Center by the Airport off of Sea Island Parkway. The developers for these projects are not local and they question the complexity and cost of implementing Stormwater design standards. Mr. Larson believes these issues need to be addressed when the BMP Manual is being reviewed as part of MS4.

Professional Contracts Report – Eric Larson

Utility Rate Study – Will be discussed under Old Business.

Stormwater Management Plan (Master Plan) Update –The Stormwater Implementation Committee interviewed Applied Technology Management, Center for Watershed Protection, Bowman Construction and Ward Edwards. The responses were based on qualifications. The committee's recommendation is Applied Technology Management (ATM). The committee will meet with ATM to establish a scope of work, cost of service and contract and should be ready to present a recommendation to hire ATM at the September meeting.

F. Regional Coordination - Eric Larson

Salinity Study ($25,000 Budget –County Portion) – The advisory committee is meeting on September 10th to go over the final report. SC-DNR has asked to present the findings at the September 30th Board Meeting.

Solid Waste Board Request for Support – Will be presented under New Business.

SC 170 Widening – Mr. Larry Meisner confirmed that Mr. Zinn is the same individual who made a public comment during the last board meeting. Mr. Larson reaffirmed that the County continues to meet with Mr. Zinn to resolve matters of concern to.

G. Financial Report –

The report was included in the packet and no questions were addressed.

H. Maintenance Projects Report – Eddie Bellamy

Mr. Eddie Bellamy reported that five major and twenty-three minor or routine project summaries were included in his report. Ms. Cynthia Bench questioned whether Davis Road by the new school in Bluffton was having flooding issues. Mr. Bellamy stated that he is not aware of flooding issues and the drainage is adequate. Mr. Donald Smith questioned if the recent excessive rain has caused any issues. Mr. Bellamy and Mr. Jeremy Ritchie replied that Bluffton Parkway and the area between

Masters Way and Buckwalter Parkway were experiencing flooding issues. Unclogging a storm drain resolved one issue, but staff is still trying to locate the other drainage problem.

5. **New Business –**
   A. **Public Education Briefing**- Denise Parsick - Beaufort Soil and Water Conservation District
   Ms. Denise Parsick gave a 2015 fiscal year end briefing to the Stormwater Management Utility Board Members. She provided a presentation in advance which can be viewed on the posted agenda.
   B. **Solid Waste and Recycling Board Letter for Stormwater Management Utility Board**- Dan Duryea- Solid Waste Board Chairman
   Mr. Dan Duryea referred to a letter which was included in the posted agenda. Mr. Duryea is seeking the support of the Stormwater Board to phase out drop-off convenience centers for curbside service. The Stormwater Board would like more background information and consequences of MS4 implementation before discussions continue.
   C. **Okatie West Pond Acceptance of Section 319 Grant and Recommendation to Beaufort County's Natural Resources Committee -** Eric Larson
   Mr. Larson included the 319 Grant Acceptance documents and the Recommendation Memo to the Natural Resources Committee in the posted packet. Mr. Larson explained how the grant is a 60% grant with 40% matching requirement. Federal funding totals $792,000 and the Non- Federal matching portion is $528,000. The total amount is $1,320,000.Questions about fluctuation in the project cost were answered by stating that the total Federal funding will not increase with an increased cost, however, if the project costs are lower, then Federal funding will still only pay 60% which would reduce the Federal amount paid. This project was previously approved so the board unanimously recommended the grant approval to the Natural Resources Committee.
6. **Unfinished Business –**
   A. **Update on Rate Study –** Eric Larson
   Mr. Larson advised all in attendance that the rate study information being presented is available by viewing the July 15, 2015 Stormwater Management Utility Board Meeting Video at http://beaufort.granicus.com/MediaPlayer.php?view_id=3&clip_id=2204;by visiting the Stormwater Management Utility home page and clicking on the relevant links at http://www.bcgov.net/departments/Engineering-and-Infrastructure/stormwater-management/; by watching the Natural Resources Committee Meeting on July 20, 2015 and County Council meetings on September 22, 2014, July 27, 2015, August 10, 2015 and August 24, 2015; and by watching the County Council workshop Mr. Larson presented on January 22, 2015. Mr. Larson informed the board that County Council has delayed the 3rd reading of the Stormwater Ordinance until September 14, 2015. This revised ordinance coincides with the recommended rate study model fee increase.

   Mr. Larson presented a time line of the rate study process to the board. He highlighted issues that have been brought up at public hearings and council meetings. Two key concerns addressed are:

      1. Private Citizens are concerned that their drainage issues are not being addressed. Many citizens feel that they are paying a Stormwater fee with no benefit. Mr. Larson referred to the Extent of Services which provides for publically owned infrastructure. With a fee increase, the Extent of Services could be expanded. Mr. Larson also stated that the County has experienced difficulty obtaining drainage easements from citizens to perform the necessary drainage maintenance. Without an easement, the County has no legal justification for providing the necessary maintenance.

2. The potential impact on Rural, Agriculture Use and Vacant Land parcels. County Council requested that the rate study model be adjusted to analyze a cap on five or more acres. Mr. Larson discussed the percentage of parcels that were five acres and greater and their impact on revenues. He also referred to monitoring data that suggest that vacant land does affect bacteria levels in undeveloped watershed areas. These parcels have been paying based on runoff factors and were paying an impervious percentage based on SFU. The new rate study terms this as Gross Area. His revenue analysis reflects that of the 126,000 [sic] billing accounts, 65,000 are county parcels and 3,118 meet the 5 acres or more criteria. Using this data set: **the existing** rate structure percentage of revenues is 9.66%; **Option A** percentage of revenues is 8.89%; and the recommended **option E** percentage of revenues is 5.94%. This analysis demonstrates less dependency from revenues generated by parcels five acres or greater using the recommended **option E**.

Mr. Larson also addressed an adjustment in Countywide Infrastructure (CWI) for the municipalities based on reallocation of infrastructure. Mr. Larson and County Staff met with the city and towns to go over all the maps and infrastructure calculations to fine tune the rate study model. This resulted in decreased percentages for the municipalities and an increased percentage for the County. Since the CWI is calculated to the penny and the model rounded to the whole dollar, the difference made no change in the County fee.

Mr. Larson plans on getting a simplified version of the presented information for the public. He also referred to correspondence with SCDHEC confirming time lines and fines assessed if MS4 implementation does not meet regulations such as the $37,500 per day fine. Mr. Larson said Mr. Brian Flewelling (Chairman of the Natural Resources Committee) is working on a two hour workshop prior to the Natural Resource Committee meeting on September the 8th. Mr. Larson encouraged the board to attend and support that workshop. The Stormwater Management Utility Board unanimously reaffirmed the following motions:

1. Motion to accept the rate study with the recommended option E and the rates as identified in the rate study.
2. Motion to recommend the revised Stormwater Management Utility Budget for Fiscal Year 2016.
3. Motion to acknowledge the draft ordinance and agree with the changes in the ordinance to be brought before County Council.

Mr. James Fargher questioned how individuals in Homeowner's Associations (HOAs) receive benefits from their Stormwater Credits. Mr. Larson said the HOA receives the credit. The individual is still responsible for personal Stormwater fees. Mr. Fargher feels that HOA individuals should have reduced fees due to stormwater credit compliance. Mr. Larson pointed out that the individual fee includes MS4 implementation, Capital Improvement Projects and Operation and Maintenance needs. All individuals use and benefit from public infrastructure. The utility fee would have to increase if the County maintained the HOA infrastructure.

Mr. William Bruggeman asked why five acres was the designated number for the acreage cap. Mr. Larson deferred the question to Ms. Kate Schaefer with Coastal Conservation League. Ms. Schafer explained that she understands that this rate structure decreases revenues generated from five or greater acres, however, she feels from a scientific standpoint that Gross Area or Open Space provide an ecological service. She agrees with the revision to support MS4 implementation, but she feels there should be a cap on Gross Area. She stated that five acres is forestry zoning and that seemed like a reasonable place to start. She also feels that development contributes more towards runoff factors and should be charged accordingly. She supports the revised rate structure with a five acre cap and she stated this at the public reading on August 24, 2015.

7. Public Comment(s) – Cynthia Bensch (County Council)

Ms. Bensch disagrees with putting a cap on five acres or greater. She believes that developers provide much of the fee burdens by paying impact fees and installing required infrastructure. Ms. Bensch referenced the Connecticut River Valley and how chemicals from farms ran into the Connecticut River Valley. She does not believe rural owners should receive a break while developers are penalized. Ms. Bensch is going to recommend that funding be provided by $1.5 million out of reserve funds.

Mr. Donald Smith commented that if the rate study does not pass, then capital projects and consultant studies need to be closely evaluated because MS4 requirements need to be implemented.

8. Executive Session –

"Discussion of negotiations incident to proposed contractual arrangements and proposed sale or purchase of property, the receipt of legal advice where the legal advice relates to a pending, threatened, or potential claim or other matters covered by the attorney-client privilege, settlement of legal claims, or the position of the public agency in other adversary situations involving the assertion against the agency of a claim."

Mr. Larry Meisner made a motion to proceed with Project A because (1) it is included in the Master Plan, (2) it is in the budget, and (3) after due diligence the price is determined reasonable. The motion was seconded and the board passed it unanimously.

9. Next Meeting Agenda- Approved with an amendment to 6B. (Please see attachment)

10. Meeting Adjourned.

BEAUFORT COUNTY
STORMWATER MANAGEMENT UTILITY BOARD
AGENDA
Wednesday, October 21, 2015
2:00 p.m.
Beaufort Industrial Village, Building 3 Conference Room 104
Industrial Village Road, Beaufort
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   G. Regional Coordination – Eric Larson, P.E. (backup)
   H. Financial Report (backup)
   I. Maintenance Projects Report – Eddie Bellamy (backup)

5. UNFINISHED BUSINESS
   A. Approval of Draft 2016 Stormwater Management Utility Board Meeting Schedule (backup)

6. NEW BUSINESS
   A. Overview of MS4 Implementation of Permit Year 1 (PY1)- Eric Larson (backup)

7. PUBLIC COMMENT

8. NEXT MEETING AGENDA
   A. November 18, 2015 (backup)

9. ADJOURNMENT

BEAUFORT COUNTY STORMWATER UTILITY
120 Shanklin Road
Beaufort, South Carolina 29906
Voice (843) 255-2801 Facsimile (843) 255-9478

September 30, 2015

Stormwater Manager's Report for the Stormwater Utility Board Meeting

Utility Update

1. Mr. Eric Larson has reviewed 5 projects for County Staff Review Team.
2. Stormwater fee credit application for the HHI Airport. Approved. Savings of $19,656.16 annually.
3. Rate Structure Ordinance and Rate Increase – County Council did not approve the rate increase. Staff is currently working on a balanced budget proposal for administration to cut expenses to match lower revenue projections.

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September 30, 2015

Stormwater Manager's Report for the Stormwater Utility Board Meeting

MS4 Update

1. MS4 Permit Application – DHEC Public Notice was issued August 31, 2015. The effective date of the permit will be October 1, 2015, assuming comments received by the public do not delay action by DHEC.
2. MS4 program development – Nothing new to report.
3. MS4 Staffing – The County is currently advertising for a new position, MS4 Coordinator. Hiring is pending approval of a revised operating budget.
4. Beaufort County Pond Conference – Registration is open. The date is set for October 22, 2015 at USCB Gateway campus in Bluffton.
5. Education and Outreach – Nothing new to report.

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September 30, 2015

Stormwater Manager's Report for the Stormwater Utility Board Meeting

Monitoring Update

1. USCB and County MOU for the Lab Services – Meetings to discuss possible changes to the MOU has been delayed due to workload. The goal is to meet after resolution of the rate increase, budget revisions, etc.

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September 30, 2015

Stormwater Manager's Report for the Stormwater Utility Board Meeting

Stormwater Implementation Committee (SWIC) Report

1. The SWIC meeting in September was cancelled. The SWIC meets again on October 8, 2015.

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September 30, 2015

Stormwater Manager's Report for the Stormwater Utility Board Meeting

Stormwater Related Projects

1. US 278 Retrofit Ponds ($356,000 =Budget) – The pond at Pickney Colony Park is complete. Clearing is ongoing at the first of two ponds on Barrel Landing Road. Weather has slowed progress.
2. Turtle Lane Paving on Lady's Island (Stormwater Add-On) ($8,940 Budget) – Nothing new to report.
3. Okatie West / SC 170 Widening Retrofit Land Purchase (Land Acquisition = $160,415 Budget, Design and Construction = $915,000 Budget) – Closing of the property is still pending. The CWA Section 319 grant award was accepted by County Council in the amount of $792,000. The contract with DHEC is pending. Funding for the project is subject to the budget revision.
4. SC 170 Widening Pond #8 Project (Land Acquisition = $155,694 Budget, Design and Construction = $630,840) – County Council approved the purchase in partnership with Rural and Critical Lands. Closing is pending. No schedule for construction has been established.
5. Huspah Court South Ditch Easement / Mike Zara - The County received the property owner's counteroffer. Staff has responded with yet another counteroffer. No agreement has been made at this time. Funding for the project is subject to the budget revision.
6. Bluffton Gateway Final Development Plan Review – Mr. Larson has completed review and approved the stormwater plan for the project.
7. Island Shops Final Development Plan Review – Nothing new to report.

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September 30, 2015

Stormwater Manager's Report for the Stormwater Utility Board Meeting

Professional Contracts Report

1. Utility Rate Study – See Utility Update Item #4.
2. Stormwater Management Plan (Master Plan) Update - Applied Technology and Management, Inc. (ATM) is still working on a scope of work, cost of service, and contract. Staff is not ready to recommend approval of the contract at this time.

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September 30, 2015

Stormwater Manager's Report for the Stormwater Utility Board Meeting

Regional Coordination

1. Battery Creek Pond Funded by an EPA 319 Grant ($132,609 Budget – County Portion) – On going. USACE permit for the critical land impact is still pending but should be issued in the next 45 days. All other permits are in place. The grant extension has been approved. Staff believes work can start in some of the upland areas of the project site while the remaining USACE permit is approved. Staff plans to begin advertising for bids in October, selecting and awarding through January 2016, and beginning construction in February 2016. (Lamar Taylor may also report)
2. May River Watershed Action Plan – (Jeremey Ritchie or Kim Jones may report)
   Stoney Creek Project – No update to report.
   Pine Ridge Retrofit Project – No update to report.
3. Volume Sensitivity (aka. Salinity) Study ($25,000 Budget – County Portion) - SC-DNR will present the findings at the September 30, 2015 Board meeting and the October Natural Resources Committee Meeting. A copy of the final report is included in the meeting packet.
4. Buckingham Plantation Drive Innovation District Conceptual Design Study ($25,000 Budget – SWU Portion) – Project is on hold pending funding to match the SWU portion. SWU funding for the project is subject to the budget revision.
5. SC 170 Widening – Mr. Larson continues to work with the other County staff on the project, County Council Members, and Mr. Tom Zinn (an adjacent property owner) to come to resolution on multiple issues raised by Mr. Zinn. Nothing new to report.
6. City of Beaufort Stormwater Assistance MOU – No further progress to report.
7. Factory Creek Watershed Regional Detention Basin & Academy Park Subdivision Proposal – Staff is discussing a potential Public – Private Partnership with the developer to construct a regional facility on this site. This would involve revising the current concept as defined by the 2006 Stormwater Management Plan. Participation by the County is still undecided. Funding for the project is subject to the budget revision.

NATIONAL ESTUARINE
RESEARCH RESERVE SYSTEM
SCIENCE COLLABORATIVE

Collaborative Research to Prioritize and Model the Runoff Volume Sensitivities of Tidal Headwaters

A Final Report Submitted to the

National Estuarine Research Reserve System Science Collaborative 08/13/2015

Project Start Date: September 1, 2013
Project Completion Date: June 30, 2015

Project Coordinator: Dr. Denise Sanger
Applied Science Lead: Dr. Denise Sanger
Collaboration Lead: April Turner

Submitted by: A. Tweel, D. Sanger, A. Blair, E. Montie, A. Turner, J. Leffler

Name: Denise Sanger
NERR: ACE Basin
Email: sangerd@dnr.sc.gov
Phone: 843-953-9074

This project was funded by a grant from NOAA/National Estuarine Research Reserve Science Collaborative, NOAA Grant Number NA09NOS4190153.

UNIVERSITY of NEW HAMPSHIRE

Abstract

Non-point source pollution from stormwater runoff associated with large-scale land use changes threatens the integrity of ecologically and economically valuable estuarine ecosystems. Beaufort County, SC implemented volume-based stormwater regulations on the rationale that if volume discharge is controlled, contaminant loading will also be controlled. The County seeks to identify which of their tidal creeks and what portions of the creeks are most sensitive to stormwater runoff.

Through an ongoing collaborative process with county staff and officials as well concerned citizens, four watersheds, with a fifth added for validation, of critical interest were instrumented with rain gauges and salinity sensor arrays to monitor the movement of freshwater down these systems from volume "sensitive" headwaters to volume "insensitive" downstream waters. A total of 32 sites were monitored with 791 salinity responses to rain events captured. The change in salinity was measured as the primary indicator of the volume of stormwater entering the estuarine ecosystem. Salinity was filtered using a 13.5 and 25 hour moving average to remove the tidal fluctuations observed in estuarine systems in South Carolina, thereby allowing us to isolate the stormwater impacts from tidal effects. Statistical analyses were conducted on the salinity data, rainfall, and various watershed parameters to develop predictive models. A watersheds study was conducted across all Beaufort County major watersheds to scale up the findings of this study. Stormwater runoff was also modeled with the Stormwater Runoff Modeling System (SWARM) to estimate the expected runoff based on watershed area, land cover, soils, and slope. SWARM was used to project impacts of climate change and engineered stormwater retrofits on tidal creeks.

Four major outcomes resulted from this project. First, a strong working relationship has been forged with the range of relevant Intended Users including the establishment of a Watershed Advisory Committee that has helped drive data collection, analysis, synthesis, and translation. Second, correlations between rainfall amount and salinity drop were developed in order to define volume sensitive areas, and locations within each system have been designated as more volume sensitive. Third, a ranking of all Beaufort County watersheds as either more or less volume sensitive has been made based on a range of different analyses. Fourth, best management practices (BMP) and climate change scenarios were developed for the six volume sensitive watersheds; the scenarios will enhance understanding of impacts of future conditions in Beaufort County. This information will permit Beaufort County to focus policy and stormwater management actions on the portions within a tidal creek as well as which creeks are more sensitive to stormwater inputs.

Management Problem and Context

Non-point source pollution from stormwater runoff associated with rapid coastal human population growth and large-scale land use changes threaten the integrity of ecologically and economically valuable estuarine ecosystems worldwide. Climate change is expected to exacerbate these stormwater problems (Karl et al. 2009). A portion of the ACE Basin lies within Beaufort County, South Carolina, a community very concerned about the threat of stormwater degrading its estuarine environments, a challenge that figures prominently in its Comprehensive

Plan, local media, and government affairs (Van Dolah et al. 2000, Island Packet 2001, Beaufort County 2007, Pollack and Walker Szivak 2007, Town of Bluffton 2008). This concern is also cited as a priority for the ACE Basin NERR in its 2011-2016 Management Plan and its Coastal Training Program (CTP) Strategic Plan (Maier 2010, Walker 2010). The Reserve has been actively involved with Beaufort County in addressing stormwater issues through its CTP and Stewardship activities. Beaufort County's rapid growth (83% between 1990 and 2006 and an additional 70% increase expected through 2025) makes it particularly susceptible to environmental degradation from stormwater runoff (Beaufort County 2007). The local population is particularly concerned that, in addition to runoff transporting biological and chemical contaminants, the "flashiness" of salinity changes due to stormwater influx of freshwater may negatively affect larval recruitment and survival of shellfish, crustaceans, and fish in the marshes. The health of these fishery resources is of the highest priority for local residents and rapid salinity changes are considered locally to be as much a problem as contaminants or nutrient enrichment (Barber 2008, Town of Bluffton 2008).

The County has modified its stormwater requirements to include water quantity control (runoff volume) within their Best Management Practices (BMP) manual in addition to water quality (Ahern et al. 2012). The County's rationale is that reducing the runoff of stormwater into estuaries results in fewer bacterial, nutrient, and chemical contaminants as well as less rapid salinity changes (J.R. McFee, County Engineering and Infrastructure Director, personal communication). Beaufort County has implemented some of the toughest regulations in the country, which may serve as a model for coastal communities nationally. Within specifically identified "volume sensitive" watersheds they may require that all stormwater be retained on site through a variety of Low Impact Development (LID) approaches.

Three barriers have been identified by the Intended User group which invited us to partner with them. First, a significant barrier to implementing Beaufort County's volume control plan is the lack of scientific data necessary to identify those watersheds and portions of creeks which are more sensitive to stormwater runoff. Beaufort County's stormwater standards have been contentious at times considering the financial impact to developers and property owners. Secondly, the Beaufort County recognized that it lacked the internal capacity to conduct the necessary studies. Early in 2012, the County approached the South Carolina Department of Natural Resources (SCDNR), the ACE Basin NERR, and the University of South Carolina at Beaufort (USCB) with a request to help it identify specific volume sensitive waters, based upon scientifically rigorous data, so that appropriate regulations could be applied to those areas. A five-year cooperative Memorandum of Understanding (MOU) between Beaufort County, SCDNR, USCB, and the Town of Bluffton was developed and approved by County Council with a commitment of funds to begin the process of both identifying these watersheds and assessing whether the observed salinity fluctuations (flashiness) in tidal creeks negatively affect key fishery resources. The level at which these funds were allocated represented a third significant barrier, in that it would take at least five years to obtain the desired data. This constraint on funding meant that only one or two creek systems per year could be assessed with minimal data collection. It would also mean that these critical, user-prioritized watersheds would be monitored in different years, making volume sensitivity assessments challenging. This collaborative project provides Beaufort County with the data they need in order to address policy in a timely manner.

The data will be available for incorporation into their next Stormwater Management Plan (2016-2026).

The immediate Intended Users impacted by this problem are the Beaufort County Council elected officials, the Council-appointed Stormwater Management Utility Board (SWMUB) who represent each legal jurisdiction of the County including Town of Bluffton, and the Beaufort County Stormwater Management Division professional staff, all of whom are charged with managing stormwater within Beaufort County. In addition, we established and worked throughout the project with a Watershed Advisory Committee (WAC). The WAC was comprised of SWMUB members, Beaufort County stormwater staff, and various others involved in water quality or natural resource conservation in Beaufort County. All of these entities are insistent on strong scientific justification for any major changes to stormwater policies. Coastal municipalities throughout South Carolina and the Southeast are all faced with similar challenges and are watching Beaufort County's experience with implementing strict volume control ordinances.

The barriers listed above were used to formulate, along with input from the Intended User Group, the following project questions answered by this project:

1. *Can the major watersheds in the County be prioritized based on the extent and severity of volume sensitive waters?* Working in partnership with the WAC, SCDNR and USCB monitored rainfall and salinity responses in the drainages of five watersheds of critical interest to Beaufort County. The resulting profiles have helped define how these waters respond seasonally and tidally to rain events and the extent of the impact downstream until it is attenuated. These profiles will permit Beaufort County to rank its watersheds in terms of volume sensitive areas and to focus policy and regulatory decisions on those locations that are most critical. The concurrent acquisition of data across several watersheds during the study period addresses the three barriers cited above.

2. *How will these critical volume sensitive waters respond to implementation of volume control BMPs and to possible climate change scenarios?* A partnering scientist at the National Oceanic and Atmospheric Administration, National Centers for Coastal Ocean Science (NOAA-NCCOS) Hollings Marine Laboratory (HML) has incorporated the rainfall and relevant landscape data into a stormwater runoff model called SWARM for projecting expected changes in stormwater runoff due to changing BMPs and precipitation patterns (Blair et al. 2014a, 2014b). This model has been developed specifically for the soils and topography found in coastal South Carolina. The results provide Beaufort County officials and professional staff with projections of the effect the implementation of different stormwater management policies will have on the identified volume sensitive watersheds. The model also evaluates the impacts on these watersheds of altered precipitation patterns projected by various climate change scenarios. While not necessarily required to address the three identified barriers, this component is welcomed by the Intended Users as a tool to help them evaluate possible engineered retrofits for priority watersheds. This management community has indicated an interest in designing stormwater management policies that are robust to possible future climate alterations.

The specific collaborative objectives, as defined in the proposal, were to:

1. Ensure that the publically appointed members of the Stormwater Management Utility Board thoroughly understand the research they have previously endorsed, are well informed as the project progresses, and are likely to embrace the results of the studies.
2. Engage the engineers and professional staff of the County and SWMUB for advice and assistance in additional watershed selection, specific site locations, interpretation of results, site-specific modeling modifications, synthesis of results, and translation of results for the Intended User community charged with policy development.
3. Enable community groups that routinely work with elected officials and professional staff on local environmental issues to understand and disseminate the results and analyses generated by this project.

The applied science objectives, as defined in the proposal, were to:

1. Assess the relationship between rainfall and salinity range throughout the length of tidal creeks in Beaufort County-selected watersheds in order to define what size water bodies and which particular watersheds are most volume sensitive.
2. Project the potential impacts that implementation of volume control BMPs and changing precipitation patterns might have on salinity range in priority watersheds.

Outcomes, Methods and Data

Outcomes

This study has been successful in achieving our objectives, although we have modified them in some cases based on the collaborative process. For example, the SWMUB representatives worked with us to develop a Watershed Advisory Committee (WAC) to ensure that we worked directly with all three stakeholder groups in one venue instead of engaging the groups separately as identified in our original proposal. In addition, we have also achieved additional outcomes based on questions raised by the WAC as new data were collected. For example, we did not originally plan to continue monitoring beyond a one year time period; however, the WAC suggested we try to obtain additional larger size events. The following text provides a summary of our major outcomes followed by the methods, data, and an overall project summary of the findings.

The first major outcome for the project was the establishment of a strong working relationship between the research team, Beaufort County staff, SWMUB members, environmental groups, state agency staff, and scientists. Based on feedback from these individuals, we established the WAC to help drive the project data collection, analysis, synthesis, and translation. Through a series of four facilitated and interactive workshops as well as email contact, the strength of the project was increased. This also helped to ensure that the information collected has utility for Beaufort County. The WAC understands the limitations of the data and the potential use of the information, and have asked us to present the results to the SWMUB and Beaufort County Council’s Natural Resource Committee. Over the next two months, we will first present the information associated with this final report to the WAC who will help us outline the critical information that will be most useful to the SWMUB and Natural Resource Committee.

The second major outcome for this project was the development of strong relationships between rainfall and salinity drop throughout the length of each study tidal creek and across the study creeks in WAC-selected watersheds in order to define areas where waters would be deemed more volume sensitive. This was achieved through monitoring salinity and rainfall down the length of each system via a network of 26 salinity-logging datasondes. There were six sondes deployed in each of the Okatie River, May River, and Wallace Creek watersheds, and eight placed in the bifurcated Battery Creek watershed. Each watershed was also outfitted with a weather station that included a rain gauge. The portions of each creek identified as sensitive were, inclusive of their upstream components, OK3, MR2, WC1a and WC1b, and BC2a and BC1b. The headwaters of Huspah Creek, HP2, also appeared to be very sensitive, but more data are needed to confirm this. When comparing the sensitive headwater portions across watersheds, the order of sensitivity (most to least) was found to be Huspah Creek, Okatie River, May River, Battery Creek, and Wallace Creek. The sensitivity appeared to be related to coverage of freshwater wetlands (positive), creek width (negative), coverage of estuarine wetlands (negative), and imperviousness (positive).

The third major outcome was the identification of all seventeen watersheds in Beaufort County as more or less volume sensitive. This was conducted based on the findings of the data collected and analyzed to date as well as on a watershed level assessment of the major watersheds in Beaufort County. Based on this landscape analysis, the larger coastal watersheds west and northwest of Port Royal Sound were found to be more sensitive and the small coastal watersheds east of Port Royal Sound were found to be generally less sensitive. All creeks are sensitive down to some point along their length; however, this analysis provides a perspective on which watersheds are expected to be more sensitive over more of their length. We had not originally proposed to conduct this analysis; however, we wanted to provide a broader context and better understand the potential types of watersheds in the County. Beaufort County can use this information to identify priority watersheds for consideration of stronger stormwater management requirements and in the identification of systems that warrant additional protection.

The fourth major outcome was the best management practices (BMPs) and climate change scenarios for each of the study watersheds. Beaufort County identified this as a critical component to the project. In particular, they want the scientific evidence to help decide where limited resources should be placed for mitigating the impacts from current development levels but also to understand what they might expect in the future. Ultimately, they want to keep the quality of life in Beaufort County, which for them includes healthy coastal waters and abundant natural resources.

Methods Leading to above Outcomes

Collaboration

Upon learning of funding for this project, we met with Dan Ahern (retired Beaufort County Stormwater Manager), Kim Jones (Town of Bluffton Stormwater Manager and SWMUB member), and Andy Kinghorn (SWMUB member) to discuss the proposed collaboration approach. It was decided that we would present to the SWMUB and discuss development of a technical committee. We presented the proposed project and establishment of the technical committee to the SWMUB on August 7, 2013. The SWMUB was interested in the findings of the project, and we discussed who should participate on the technical committee. This led to the establishment of the Watershed Advisory Committee (WAC) with representation from SWMUB, stormwater management professionals, natural resource or water quality managers, and active citizens. It was also requested we give a presentation to be delivered to the Beaufort County Council's Natural Resource Committee, which was conducted at their next scheduled meeting. This presentation was televised and has been shown several times on the county public affairs station.

The Watershed Advisory Committee (WAC) was established in September 2013 with the following members currently participating.

Beaufort County Watershed Advisory Committee – Stormwater Volume Sensitivities	
Dan Ahern	Retired Manager, Beaufort County Stormwater Utility
Reed Armstrong	Project Manager, South Coast Office, SC Coastal Conservation League
Russell Berry	Director, SCDHEC Environmental Quality Control Region 8
Bob Gross	Owner, Beaufort Group, LLC
Kim Jones	Director, Stormwater Management Division, Town of Bluffton
Andy Kinghorn	Member, Beaufort County Stormwater Management Utility Board
Eric Larson	Manager/Engineer, Beaufort County Stormwater Utility
Chris Marsh	Director, The LowCountry Institute
Danny Polk	Stormwater Inspector, Beaufort County Stormwater Utility
Kevin Pitts	Special Projects Manager, Beaufort County Stormwater Utility
Al Segars	Stewardship Coordinator, ACE Basin NERR
Don Smith	Chair-Beaufort County Stormwater Management Utility Board
Al Stokes	Manager, Waddell Mariculture Center
Alan Warren	Program Director, Environmental Health, USCB
ex-officio:	
Anne Blair	Project Scientist, NOAA- Hollings Marine Laboratory
John Leffler	Project Administrator, ACE Basin NERR Research Coordinator
Eric Montie	Faculty, Biology Dept., University of South Carolina – Beaufort
Robert O'Quinn, IV	Field Biologist, South Carolina Department of Natural Resources
Denise Sanger	Science Lead, South Carolina Department of Natural Resources
April Turner	Collaboration Lead, South Carolina Sea Grant Consortium
Andrew Tweel	Project Scientist, South Carolina Department of Natural Resources

Engagement of the WAC was primarily through three workshops with a fourth workshop scheduled for September 10, 2015. The first workshop was held on September 25, 2013. The focus of this workshop was largely to engage the WAC to obtain advice and assistance with the proposed study design, specifically, to identify appropriate watersheds to study, specific sites within those watersheds, and to begin discussing the modeling component and how it may benefit the study. One additional goal of this project was to ensure that the collaborative group, both the researchers and WAC, understood the project goals, and how the information generated by the project would ultimately be used. There was a thorough discussion of the project's goals, plans, and methodologies. Some of the watersheds to be studied were specified in the collaborative research MOU that pre-dated the NERRS Science Collaborative funding and were identified in the proposal. The Committee nominated and discussed additional watersheds for inclusion. SCDNR staff then surveyed and evaluated the nominated watersheds. These findings with pros and cons for each system were reported to the WAC in November via email. The WAC members considered those results and then voted on the watersheds, finally selecting two additional tidal systems, Wallace Creek and Huspah Creek for inclusion in the study. It was decided that Wallace Creek would be instrumented first with Huspah Creek being monitored if resources were available.

The second workshop was held after a significant amount of salinity data had been collected and analyzed, so that the preliminary results could be discussed, and any adjustments to methods or sites could be made. This workshop was held on September 8, 2014. Some early findings were presented, and the WAC was eager to discuss their implications and how to proceed. This process was very helpful in ensuring the development of a useful product for the group. The objectives of the September 8, 2014 workshop were to engage the WAC in facilitated discussions so that its members had a good understanding of the planned analytical approaches to the empirical data and of the structure and assumptions of the SWARM model. We also wanted to obtain advice regarding specific watershed delineation questions and site-specific modeling modifications. These discussions were designed such that the WAC members would begin to develop confidence in both the empirical analyses and the SWARM modeling approach to the extent that they would feel comfortable in making decisions based on the eventual results. A primary objective of this workshop was to get approval from the WAC of the analytical approaches to the empirical data and of the modeling methodology. This approval was forthcoming and permitted the team to move ahead with the analyses throughout the fall. In addition, the WAC raised questions about such considerations as seasonal influence and antecedent rainfall, which led to rethinking and modifying some of the empirical analyses to take these factors into account.

A third workshop was held on February 2, 2015 after a nearly a full year of data had been collected for the four main study watersheds, and considerable data analysis had been conducted. At this point there was enough data to begin the discussion about what areas could be considered volume sensitive, and where those boundaries might be delineated. With this WAC workshop, our strategy was to transfer more of the responsibility for data interpretation to the WAC with the expectation that its members would begin to accept ownership of the empirical and modeling results. The research team presented a series of representative graphs that summarized empirical and modeling results. The research team was very careful not to interpret the graphs, but just to explain how to read them. The WAC then divided into two teams and moved to separate rooms. Everyone was given three packets of graphs that related to 1) background information, 2) empirical results, and 3) modeling results, as well as a series of questions. Over the course of 90 minutes the two teams followed the questions, studied the graphs, and answered the questions to the best of their ability. Project scientists were with each team to answer specific methodological questions, but refused to interpret the graphical results with the hope that this would force the WAC members to think deeply about the results and to incorporate them into their own understanding. The teams then reconvened and, through a facilitated discussion, compared their results. Our hope was that the two groups would reach similar conclusions, and that we could identify areas where these conclusions differ. These differences then became the focus of the follow up discussion- What information do we still need? Do we need to bring in additional datasets or variables? How confident are we in these results? At the end of the workshop, the two groups rejoined and discussion addressed these and other questions. The members of the WAC asked for further monitoring to capture additional large rain events, as well as some additional analyses such as rate of change of estuarine salinity as a result of stormwater influx. We evaluated using a rate of change metric with little success in increasing the modeling performance. They also suggested that some of the monitoring sondes be withdrawn from certain locations and try to continue monitoring for large rain events. This proved very helpful to the project researchers, who followed up the workshop with a 3.5 hour meeting to consider and address all suggestions and observations developed through the WAC workshop.

We are planning an additional WAC meeting for September 10, 2015. The goal of this meeting will be to discuss this report (including the additional analyses they requested) to ensure that they can take the lead in interpretation, and to focus the discussion primarily on how they will use the results to develop new policies regarding stormwater management in the County. In addition, a second goal is to discuss how to best present the research findings and conclusions to the SWMUB and Natural Resource Committee. We believe the input received from the WAC will allow us to insure the information is translated and conveyed such that it can be used by decision makers and elected officials. We are scheduled to present to the SWMUB on September 30, 2015 and the Natural Resource Committee on October 1, 2015.

Applied Science

The geography of Beaufort County, South Carolina, is characterized by broad expanses of wetlands (43% of coastal watersheds), gently sloping topography (< 0.5 m/km in some areas), a large tidal range (2.3-2.6 m), and a dominance of soil types classified as poorly draining. In the past several decades, Beaufort County has experienced rapid population growth and the associated conversion of upland habitats to impervious surfaces, and this growth is expected to continue (Figure 1).

A variety of tidal creeks drain the upland habitats and developed areas. Excessive runoff from the proliferation of impervious surfaces has raised concern over the health of these tidal creeks. Newer housing developments have included stormwater ponds in their design as an attempt to mitigate this increase in runoff by retaining stormwater and allowing infiltration to groundwater and slower release to downstream systems.

Due to the low gradient and high tidal exchange, many of the creek systems are intertwined with watershed boundaries that are difficult to define. However, we were able to define 17 watersheds that originate near or within Beaufort County (i.e., not fed by riverine flows from beyond the coastal zone) (Figure 2). We focused on these low-lying coastal headwaters to study the varying responses to stormwater runoff and identify sensitivity thresholds.

The average size of these watersheds was 85 km^2, and five watersheds were selected to use for this volume sensitivity study. Beaufort County and the WAC-selected watersheds that were a priority area for mitigative measures and reasonably representative of other watersheds in the county, but that also represented a range of variables to help identify the dominant characteristics related to volume sensitivity. These systems were initially the Okatie River, May River, Battery Creek, and Wallace Creek, with Huspah Creek added later (Figure 3). Land use, soil types, and other geophysical characteristics of these watersheds are discussed in greater detail in the watershed study as part of this project.

In total, 26 salinity-logging datasondes were deployed in four priority watersheds of varying size, development proportions, and marine influence for at least a year to assess the variability in salinity response to stormwater input. An additional two months of data have been collected at a fifth watershed (Huspah Creek) with six datasondes, and this monitoring is ongoing with funding support from Beaufort County. Each watershed was also outfitted with a data logging rain gauge.

Sampling sites in each creek system were established from the headwaters to a downstream location that extended into what was expected to be volume “insensitive” waters. The downstream location was identified based on previously collected data provided by the South Carolina Department of Health and Environmental Control (SCDHEC) such as shellfish bed harvesting classification change (e.g., restricted to open), an indication that the system is no longer volume sensitive (Figure 4). There were six sondes deployed in each of the Okatie River, May River, and Wallace Creek watersheds, eight placed in the bifurcated Battery Creek watershed, and later six sondes placed in Huspah (Figure 3). Figure 5 shows an example of the rainfall and salinity data collected from OK1 (headwater site) and OK6 (most downstream site).

At each site, a HydroLab MS5 salinity/temperature/depth data logger was installed near the bottom of the water column to ensure that they remain submerged even during the lowest spring tides. Data sondes took measurements at 30 minute intervals. The water quality dataloggers followed QA/QC procedures similar to those employed by the NERR System-wide Monitoring Program (SWMP) to ensure the instrumentation functioned properly in the field and that all units and parameters were within the manufacturer’s recommendations (Small et al. 2010). Rain gauges were installed at a central location in each watershed, and it was assumed that this rainfall would represent rainfall for the entire watershed.

Our primary metric of volume sensitivity was the drop in salinity following a rain event (Figure 6). Although we tested and discussed other metrics, this proved to be the most useful. Measurements of time from rain event to maximum salinity drop often took several days and were confounded by additional rain events. We removed the tidal signal prior to analysis by applying the Palmetto Filter, a nested 13.5 h moving window average (MWA) and a 25 h MWA developed by Paul Conrads (USGS, 4/22/2008, personal communication), because we were interested in characterizing the salinity changes over a longer time period than a single tidal cycle (Figure 6). The salinity drop was then measured in response to each rain event using the filtered data (Figure 7).

We defined a ‘rain event’ as occurring on a day (or days) with consecutive rainfall. It was necessary to condense the half-hourly rain data into a larger unit of time because salinity drops occurred over a period of days in many cases. If rain data were analyzed at a finer resolution, it would be impossible to attribute a salinity drop to a rainfall amount. In this regard, compressing rainfall into a timescale of days, rather than hourly increments, was most appropriate given that the salinity drops also occurred over a number of days. Accordingly, consecutive days experiencing rainfall were counted as one event, with a full day of no rainfall being necessary to end an event.

Once the salinity drops for each rain event were quantified, these two variables were entered into regression models for each site with rain as the independent variable and salinity drop as the dependent variable. These relationships were tested for significance, and their slopes were studied in greater detail, with higher slopes indicating a greater salinity response, or more sensitivity, for a given rainfall event. These slopes were then used to compare between watersheds and identify differences in volume sensitivity.

These subwatershed slopes were also used to look for factors that could help explain differences in salinity drops. A number of additional watershed characteristics, such as land cover classes and watershed size, were explored using stepwise multiple polynomial regression. Variables expressing curvilinear relationships to the slope were entered as such in the model.

To further explore these salinity-rainfall relationships, a study was conducted to investigate characteristics of watersheds originating in or near Beaufort County (Figure 3). US Geological Survey (USGS) Hydrologic Unit Code (HUC)-12 watersheds served as our basis for identifying the major creek/river systems. A variety of land use/land cover, soil type, and geophysical data were collected for each watershed using ArcGIS 10. These were then compared between all of the watersheds to identify how the study watersheds compare to other watersheds not included in this study. Multiple regression was used to quantify these relationships, and to draw inferences about the sensitivity of other watersheds in Beaufort County based on similarities and differences to the five watersheds with known sensitivities.

The Stormwater Runoff Modeling System (SWARM) was used to model runoff for each of the study watersheds and sub-watersheds. SWARM is based on the long-established and widely-used runoff curve number and unit hydrograph methods of the US Department of Agriculture, National Resource Conservation Service (USDA, NRCS), and has been calibrated for the low-gradient topography of the Southeast coastal plain. The modeling system integrates land use, soil type, area, elevation, and precipitation amount and distribution to calculate runoff volume and runoff rate over time for individual storm events (Figure 8). Detailed descriptions of SWARM methods and applications are available in two publications by Blair and colleagues (2014a, 2014b).

The watersheds varied greatly in characteristics that affect runoff modeling such as area, level and type of development, and soil types. Because the watersheds differ greatly in area, our modeling provided both actual runoff volumes and rates as well as normalized results in order to remove effects of area. We used the actual output to investigate impacts of various drivers of runoff within each watershed and the normalized output to compare those impacts among the watersheds.

We modeled runoff for two different synthetic rainfalls: 1.95 inches, which is the 95th percentile 24-hour rain for the region and 4.5 inches, which is the 24-hour 2-year storm event for the general area. For the hydrographs, we also can use actual rainfall amounts and distribution recorded by rain gauges in each of the watershed.

We developed regression equations for each watershed by calculating volume from rainfalls of 0.5 inch to 5 inches using 0.5 inch intervals (Table 1). For each site watershed, these equations can predict runoff for any rainfall amount, and we used them to predict runoff for each of the rainfall amounts connected to specific drops in salinity in order to then use the predicted volumes as regressors and the salinity drop values as the response variables.

Because SWARM output showed statistical significance in predicting salinity changes, we selected the 6 subwatersheds designated as critically sensitive to stormwater runoff and used SWARM to model their responses to the implementation of a volume-control BMP scenario, two buildout scenarios, and two climate change scenarios.

For the BMP scenario, the objective was to set the watershed hydrology to one of low development. We modeled runoff using the 95th percentile rain amount of 1.95 inches and adjusted land-use categories in each watershed to reflect a development level of 9% impervious cover. Ten percent impervious cover is considered to be the threshold for stream/creek quality degradation (Schueler 1994, Holland et al. 2004, Sanger et al. 2015). The modeled volume at 9% impervious cover serves as the target for volume reduction required for current levels of development. Additionally, we adjusted land-use categories in each watershed to reflect two higher levels of development: 50% Build Out and 100% Build Out. Fifty percent Build Out is projecting additional watershed development for half of dry land not yet developed. One hundred percent Build Out projects additional watershed development for all dry land not yet developed. The difference between the low development volume and the volumes for the 3 higher development levels shows the amount of volume reduction required for each watershed to return to a low-development hydrology.

For the climate change scenarios, we based our modeling on general predictions of increasing frequency and intensity of heavy storms (Gutowski et al. 2008). Already from 1958 to 2012, the heaviest storm precipitation increased by 27% in the southeast US (Melillo et al. 2014). We compare watershed runoff using average antecedent runoff condition (ARC) to runoff from two different climate scenarios: Climate 1 and Climate 2. Both climate scenarios include a 15% increase in precipitation. Climate 1 uses semi-wet ARC and Climate 2 uses wet ARC. ARC comprises “rainfall intensity and duration, total rainfall, soil moisture conditions, cover density, state of growth, and temperature” (USDA NRCS 2004) and has a strong impact on both volume and rate of runoff.

Data Leading to Above Outcomes

Review of existing and new rainfall data

Rainfall during 2014 and 2015 compares well to rainfall data collected by Ashepoo-Combahee-Edisto Basin National Estuarine Research Reserve (ACE Basin NERR) meteorological station (station ID: ACXS1) on both monthly and annual timescales. The typical peak in rainfall occurs in the summer months, as weather patterns are dominated by late afternoon air mass thunderstorms associated with heating of the land surface (Figure 9A). Winter and spring monthly precipitation is about half that of summer patterns, but generally occurs associated with frontal systems that result in a more homogenous distribution of rainfall. April 2014 resulted in a very large rain total (221 mm) which is over three times the long term (2001-2014) average of 65 mm. Summer 2014 precipitation, which usually peaks in August, peaked in September instead, and was again above average. To date, 2015 has been a fairly average precipitation year, staying near 1 standard error (S.E) from the long-term average. On an annual basis, 2014 was the wettest year since 2001, when data collection began, for the ACE Basin NERR station (Figure 9B).

In addition to producing the most precipitation, August also experienced the shortest average time between rain events—3 days (Figure 9C). November had the least frequent rain events, averaging 7.8 days between events. Another interpretation of this data is that rain events in August were more likely to occur on wetter soils than those in November, not accounting for differences in evaporation or other seasonal effects.

Rain data collected for this study reflect the same seasonal trends as the ACE Basin NERR station. However, on a per-event basis, there tended to be fewer, larger events occurring in the fall and winter months (Figure 10A). There was good agreement between the study watershed gauges, and this agreement was stronger for the larger frontal events than the summer-pattern rain events. The vast majority of rain events captured were less than 10 mm total, with exponential decay towards the larger events (Figure 10B). The average rain event was 34 mm (1.3 in), and the maximum observed was 131 mm (5.2 in).

Coliform data

We reviewed fecal coliform data collected in Beaufort County by the SCDHEC. There was high interannual variability (Figure 11A), as well as high spatial variability. Exceedances, defined as counts in excess of 40.9 cfu/100 ml, were computed on an annual and monthly basis. On average, nearly 4% of samples collected exceed this threshold, and there was no clear relationship to precipitation totals on an annual basis; however, there may be stronger relationships if investigated at a finer temporal resolution. November data indicated the highest exceedances, and January through March were the lowest (Figure 11B). There may be a sampling bias, and we did not have the necessary information to correct for this.

For the four main study watersheds, we summarized coliform data relative to our study subwatersheds. The headwater portions of these systems generally experienced much higher coliform counts than samples collected farther downstream in the same systems (Figure 12). No headwater trend was observed in Wallace Creek, which only contains two sites compared to the nine and ten sites of the other watersheds. Wallace Creek is also the least developed of the study watersheds, and among the least developed in the County.

Salinity data

Nearly 750,000 salinity readings were collected across five watersheds comprised of 32 subwatersheds, capturing 791 salinity responses to rain events over the course of the project. These sites exhibited wide variation in almost every attribute we considered, including soil type, land-use characteristics, and geophysical setting. The average salinity for all data collected was 27.3 psu, with individual site averages ranging from 14.2 (OK1) to 32.3 (WC5).

The average rain-induced drop in tidally-filtered salinity was 2.8, with a maximum observed drop of 23 psu in the Okatie River headwater site (OK1) following a 4 day rain event in November 2014 that resulted in 128 mm of precipitation. Figure 13 shows an April 18, 2015 rain event that dropped similar amounts of rain for the primary four systems.

In terms of volume sensitivity (i.e., the response of a receiving body to an input of stormwater), we found the drop in salinity to be most informative (Figure 14). Average salinity drops for each site are shown in Figure 15. Specifically, we compared the rainfall total to the observed drop in salinity for each of the 791 site-events, and formed regression relationships for each of the 32 subwatersheds. These relationships are shown in Figures 16 through 20. Summary statistics for these regressions are shown in Table 2. The slope of these relationships (unless stated otherwise, 'slope' refers to this relationship) proved to be a useful metric for volume sensitivities—higher slopes corresponded to a greater drop in salinity for a given rain event. The greatest slope, a drop of 0.14 psu per mm rainfall, was initially observed in the headwaters of the Okatie River. Towards the end of the study, when Huspah Creek was instrumented in June 2015, much higher salinity drops were observed (slope = 0.27), suggesting even greater sensitivity to volume inputs. There were, however, only 5 events observed in the Huspah Creek headwaters versus 41 events for the Okatie River headwaters, and this relationship may change as more data are collected.

A comparison of these slopes and their standard errors is shown in Figure 21. Least squares means differences (LSD) were used to look for thresholds and significant differences in subwatershed responses to volume inputs. These LSD t-tests are presented in Table 2. It was clear early in the study that the Okatie River and May River headwater sites were quite different from Battery Creek and Wallace Creek in terms of salinity response to rain events, with slopes approximately double that of the other two creek headwaters.

The time to achieve minimum salinity following a rain event was also measured. From this we calculated the salinity drop over time of this trend (salinity drop per unit time). However, these relationships were much noisier and were not helpful in assessing volume sensitivity for these watersheds during this study period. These results are not presented.

Predictive model

The rainfall-salinity drop relationship slopes were used to compare among subwatersheds and explore a variety of land cover and geophysical characteristics that may help explain the observed sensitivity differences. A scatterplot matrix of these relationships is shown in Figure 22. Additional variables were explored, but are not shown, such as coverage of specific soil types (e.g., "poorly drained"), forested upland area, or developed land use. Huspah Creek sites, with much fewer data to support the slope relationships, are shown in grey. These sites were quite different in terms of width, distance to bay, estuarine wetland coverage, and provided a good opportunity to test previous observations and relationships.

A multiple polynomial regression was used to quantify the relationship between a subset of these independent variables and the slopes identified from the regressions of rainfall and salinity drop for each of the subwatersheds. The three lower Huspah Creek sites were excluded due to poor relationships between rainfall and salinity drop, which may be attributable to low sample size. Battery Creek 1a was also excluded due to its very small size (10% of the next closest subwatershed) that was discerned when watershed boundaries were reanalyzed using LiDAR elevation data rather than boundaries derived using more conventional means.

As can be seen in the scatterplots, some of these relationships to slope were non-linear (Figure 22). These were fit accordingly in the multiple regression. The results of this regression are shown in Figure 23 and Table 3 ($r^2 = 0.95$, $F_{(6, 21)} = 70.64$, p = <0.0001). The percent cover of freshwater wetlands (excluding water) exhibited the strongest relationship to slope, followed by creek width and estuarine wetland coverage. Percent imperviousness (a combined metric of soil and development-related imperviousness) was also significantly inversely correlated to slope. Residuals from this model followed a normal distribution (Shapiro-Wilk: p = 0.45). The root mean square error from this predictive model is 0.016 psu per mm rain.

Watershed study

Valuable comparisons were made between our 5 study watersheds and 12 other nearby watersheds (Figure 2). A wide variety of data pertaining to these watersheds were collected, including land use and land cover characteristics (Table 4), soil classifications and coverages (Table 5), and additional geophysical parameters (Table 6). These tables are color-coded to help depict variability and common attributes between the watersheds.

Broad Creek, Battery Creek, and Albergottie Creek were the three most developed watersheds. Not surprisingly, the larger watersheds toward the head of the estuary were comprised of the largest coverage of freshwater wetlands. The watersheds monitored for volume sensitivity (in bold) represent a wide range of variability for nearly all of these parameters. The addition of Huspah Creek to the monitoring database provided an even greater coverage of this variability, especially due to its low abundance of estuarine wetland and corresponding high coverage of freshwater wetland. As noted earlier, Huspah Creek also exhibited a much higher slope than any of the watersheds studied prior to its introduction.

Stepwise multiple regression was used to identify parameters best correlated to the slope values. We also included average salinity drop (the average of the observed drops for all rain events) in this analysis. Due to the low sample size (n = 5 watersheds), we tested several models ranging from simple univariate to the maximum possible given the sample size, a multiple regression of three independent variables. The results of these models are presented in Tables 7 and 8. Because the very high correlations ($r^2 = 0.999$) may be overfit due to the low sample size, we present an array of tests of increasing complexity (and increasing potential for type I error).

Variability in slopes was best explained by an inverse relationship to the coverage of estuarine wetlands (Table 7). The second most explanatory variable was a positive correlation to the coverage of soils classified as ‘very poorly drained.’ The full model also included freshwater wetland coverage.

Variability in average salinity drop was somewhat different, with area (km^2) explaining much of the variability—the larger watersheds (Okatie and May Rivers, as well as Huspah later on) tended to contain the most sensitive headwaters (Table 8). The addition of coverage of poorly drained soils further improved this model. The full model also identified creek width at mouth as a helpful independent variable. Predicted slopes and average salinity drops are shown in Table 9.

We used this suite of models to estimate headwater sensitivity of the 12 coastal watersheds not monitored for salinity sensitivity in this study. To synthesize these model results, such that the result is not dependent on a single model, but rather consistency between varied models that utilize different parameters, we selected the top (most sensitive) and bottom (least sensitive) 25% from each model. We then assigned a total score to each of the watersheds, with a value of 3, for instance, corresponding to that watershed appearing in the top 25% for 3 of the 6 models. A value of -6, for instance, would mean that all six models predicted sensitivity in the bottom 25%.

According to this classification scheme, 7 of the 17 watersheds were modeled to have sensitive headwaters. Scores within these categories, however, do not necessarily indicate more sensitivity, but rather more model confidence in the prediction. These included, in decreasing order: the Pocotaligo River (5), Euhaw Creek (4), Okatie River (3), Wright River (3), Huspah Creek (3), Tulifiny River (3), and Chechesse River (2). Six watersheds were identified as least likely to be sensitive, and these were, in order: Wallace Creek (-6), Village Creek (-5), Albergottie Creek (-3), McCalleys Creek (-3), Morgan River system (-3), and Boyd Creek system (-3). Actual estimates of sensitivity would best be determined from individual models and these are presented in Table 9.

Stormwater runoff modeling results

Table 10 provides details for major watershed characteristics related to modeling runoff. Two of the major drivers of stormwater runoff are development level and soil type. Development changes the hydrology of a watershed by creating surfaces impermeable to rain, thus causing more rainfall to be converted to runoff. Soils range from those pervious to rainfall to ones that rainfall cannot penetrate. Two watersheds in Battery Creek had the highest percentage of developed land use – BC2a with 57% and BC3a with 47%. The lowest percentage of developed land use was in Wallace Creek where the six watersheds range from 1% to 7%. The most impervious soils were found in the Okatie River with all six watersheds at 90% to 92%. May River was next with an impervious soil range of 72% to 78% for the six watersheds followed by Wallace Creek with a range of 60% to 70%. Battery Creek had the lowest proportion of impervious soils with a range of 27% to 61%. Watersheds absorb an initial amount of rainfall before runoff begins, and that amount is referred to as the initial abstraction (I_a). For the four major watersheds, the I_a ranged from 0.19 inches to 0.35 inches. Okatie River watersheds had the lowest range owing to the combination of high development and impervious soils – 0.19 inches to 0.21 inches. Wallace Creek watersheds had the highest range owing to low development and soils around 65% impervious – 0.26 inches to 0.35 inches.

We modeled runoff for all of the watersheds based on a 4.5 inch 24-hour rain event (Figures 24 and 25). Volume increased with progression from the headwaters to the final watershed outlet for each of the four main waterways as expected since each subsequent watershed had greater area than the preceding ones. Runoff for the two smaller waterways, Wallace Creek at 1944 hectares (ha) and Battery Creek at 3,229 ha, totaled 762 acre feet (af) and 1,332 af, respectively. (An acre-foot, af, is the volume of water required to cover an acre at a depth of one foot.) Runoff for the two larger systems, Okatie River at 4,859 ha and May River at 6,093 ha, totaled 2,222 af and 2,509 af, respectively.

When runoff is shown as a percentage of the rainfall that was converted to runoff, the results showed similarity for the Okatie River and Wallace Creek subwatersheds. MR1b was higher than the other May River watersheds and was also the most highly developed. BC2a was the highest of the Battery Creek watersheds and was also the most highly developed.

We constructed hydrographs for the watersheds in each of the four waterways to show runoff rate over time. As with the modeled volume, rate and time increased with progression from the headwaters to the final watershed outlet. For the Battery Creek hydrographs, the peak rate ranged from 9 cubic feet per second (cfs) and 102 cfs at the two headwater watersheds to 757 cfs at the final outlet (Figure 25). When the hydrographs were normalized to show cfs per square mile in order to remove the effect of area, BC2a had the highest peak rate followed by BC1a and then BC3a.

To project the potential impacts that implementation of volume-control BMPs and changing precipitation patterns from climate change might have on runoff volume in priority watersheds, we conducted a series of scenarios using SWARM. SWARM scenarios included: (1) pre-development scenarios to understand what volume reduction would be required in the developed watersheds to reach pre-development levels (< 9% impervious cover); (2) future development scenarios to understand the increase in volume associated with increased development levels; and (3) two climate change scenarios to understand how the predicted future weather (i.e., increased rainfall and wetter soils for periods of time) will change the runoff volume for the study watersheds.

For the BMP scenario of identifying the volume reduction amount required to match a low development (9% impervious cover) hydrology for a 95th percentile rain of 1.95 inches, three of the six volume sensitive watersheds were already below the low development level and were not considered (Table 11). For the others, BC2a needed to reduce volume from 30 af to 14 af, OK3 from 266 af to 221 af, and MR2 from 408 af to 398. BC2a had the greatest relative change.

Modeling impacts of additional development in each watershed showed the greatest relative changes for the lower developed watersheds of WC1a, WC1b, and BC1b (Table 11). At the 50% Build Out, runoff volume increased by 46%, 35%, 44%. At the 100% Build Out, volumes increased by 112%, 82%, 104%. For the higher developed watersheds of BC2a, OK3, and MR2, relative increases were lower: 23%, 11%, 20% for the 50% Build Out; 57%, 22%, 45% for the 100% Build Out. Volume increases for the larger watersheds, OK3 and MR2, were an order of magnitude greater than for the smaller ones. For all of the watersheds, the two development scenarios result in an increase in the targeted volume reduction required to achieve a 9% impervious cover hydrology.

We constructed hydrographs for the most developed small (BC2a) and large (OK3) watersheds to investigate the impact of development on the rate of runoff (Figure 26). To retrofit the watersheds to the lower development hydrology, for BC2a, the peak rate would need to decrease from 27 cfs to 12 cfs for the 1.95 inch rain and from 122 cfs to 73 cfs for the 4.5 inch rain. For OK3, the peak rate would need to decrease from 115 cfs to 97 cfs for the 1.95 inch rain and from 472 cfs to 423 cfs for the 4.5 inch rain. OK3 rates were much higher than BC2a because of the watershed's larger area – 2,296 ha compared to 288 ha; however, the relative change in rates was much greater for the smaller watershed, which could be partially explained by its more pervious soils.

The climate scenarios applied to the modeling of a 1.95 inch rain resulted in remarkably large increases in runoff volume (roughly double) for all watersheds (Table 12). For the Climate 1 scenario of a 15% increase in rainfall and a change from average to semi-wet antecedent runoff conditions, volume increases were greatest in the less developed watersheds (WC1a, WC1b, BC1b) at 108%, 106%, 107%. In the more developed watersheds (BC2a, OK3, MR2), volumes increased by 83%, 77%, 88%. For the Climate 2 scenario which included a 15% increase in rain and a change from average to wet antecedent runoff conditions, volume increases were generally double those of the Climate 1 scenario. For less developed WC1a, WC1b, BC1b, volumes increased by 223%, 212%, 222%, respectively. For more developed BC2a, OK3, MR2, the increases were 157%, 143%, 172%, respectively.

As with the BMP and development scenarios, we constructed hydrographs for the most developed small (BC2a) and large (OK3) watersheds to investigate the impact of climate on the rate of runoff (Figure 27). For BC2a at the 1.95 inch rain, the peak rate increased 93% (from 27 cfs to 52 cfs) for Climate 1 and 178% (to 75 cfs) for Climate 2. For the 4.5 inch rain, the peak rate increased 57% (from 122 cfs to 191 cfs) for Climate 1 and 95% (to 238 cfs) for Climate 2. OK3 rates were much higher than BC2a because of the watershed's larger area – 2,296 ha compared to 288 ha. For the 1.95 inch rain, the peak rate increased by 78% (from 115 cfs to 205 cfs) for Climate 1 and by 144% (to 281 cfs) for Climate 2. For the 4.5 inch rain, the peak rate increased by 49% (from 472 cfs to 705 cfs) for Climate 1 and by 78% (to 839 cfs) for Climate 2.

Data Summary and Context

The two primary study years, 2014 and 2015, proved to be good examples for studying the effects of storms. From a stormwater perspective, 2014 experienced higher than average precipitation, which provided a large number of rain events to follow as the stormwater pulse travels through each system. To date, 2015 was more reflective of an average rainfall year for this area. Together, these two years have provided a good variety of events to study.

We collected nearly 750,000 salinity readings across five watersheds, capturing nearly 800 salinity responses to rain events over the course of the project. For each rain event, we measured the salinity drop that occurred at each site. By compiling a large database of these rain events, and the response in the tidal creeks, we were able to identify areas that were volume sensitive. The most volume sensitive areas experienced the greatest salinity drop for a given rain event, and we were able to establish relationships between rainfall amount and projected salinity drop, and thus identify salinity sensitivity thresholds within each watershed.

Using feedback generated at one of our WAC workshops, we were able to delineate volume sensitive cut-points in each of the four main study watersheds. These were largely based on the slopes of the relationships between rainfall and salinity. Because each watershed responded quite differently to rain inputs, and with some watersheds being much more variable than others, there was no set threshold for what we defined as "sensitive," rather we identified salinity sensitivity thresholds based on a holistic assessment of all sites in each system. With a majority of agreement from the WAC, we identified watersheds as "sensitive," with the caveat that some of the choice in location was limited by the spatial resolution of the deployment zones—i.e., we cannot feasibly instrument every portion of a system. These watersheds were, inclusive of their upstream components, OK3, MR2, WC1a and WC1b, and BC2a and BC1b. We erred on the side of inclusion, rather than exclusion, in that if a site was transitional it was included as sensitive. For instance, the two most headwater sites in the May River, MR1a and MR1b, exhibited high sensitivity (mean slope = 0.125), yet the next site after the confluence of these two branches exhibited moderate sensitivity (slope = 0.060). Therefore, there was likely continued sensitivity beyond the first two sites, and so we included the watershed downstream, MR2. The mean of the slopes of all cut points was 0.060 psu/mm rainfall, which may serve as a general guideline based on the watersheds studied and rain events captured to date. A more objective classification of the slope breakpoints for each watershed is the least squares differences test. These results were very similar. The main distinction was that Wallace Creek, the least sensitive and least developed watershed, did not contain large enough differences in salinity drop to be statistically significant between the headwaters and downstream portions. This was likely due to the low levels of development and more pervious soils.

Expansion of the salinity monitoring into Huspah Creek proved to be worthwhile, in that it tested much of what we knew, and expanded the range of site types in the study to include more brackish salinities. Based on early results (5 rain events) salinity drops in Huspah Creek were more than twice those of the Okatie River headwaters for the same amount of rainfall.

Once we had identified volume sensitive portions of the study watersheds, we began to look for factors correlated to this sensitivity and also to model how these watersheds might respond to implementation of volume control BMPs or changing precipitation patterns associated with climate change. We used a statistical model to look for variables most closely associated with volume sensitivity. The most significant variable correlated to volume sensitivity was percent coverage of freshwater wetlands. Areas with higher percent coverage of freshwater wetlands were more likely to be volume sensitive. Two variables were inversely correlated to volume sensitivity: creek width and coverage of estuarine wetlands (salt marsh), and so volume sensitivity decreased with increases of these metrics. This was not surprising, as estuarine wetland coverage and creek widths increase toward the downstream section of these watersheds.

Imperviousness, a combined metric we developed to account for both soil type and land-use categories, was also significantly positively correlated to volume sensitivity. We used this prediction formula to estimate changes in slope that might occur in response to changes in imperviousness. This metric weighs development that occurs on pervious soil greater than development occurring on an already impervious soil surface. We estimated the change in slope in response to an increase in 10% of the total imperviousness score for all five headwater sites, presented as *current slope (predicted slope)*: Okatie River 1: 0.13 (0.16), May River 1a: 0.12 (0.15), Battery Creek 2a: 0.06 (0.08), Wallace Creek 1a: 0.06 (0.07), Huspah Creek 1: 0.27 (0.31). A 10% increase in imperviousness would result from 10% of the remaining undeveloped upland of a pervious soil type being developed as C-CAP development class high, medium, or low intensity.

To provide a broader context for our research, we investigated other coastal watersheds within Beaufort County, and quantified a variety of land cover, soil type, and geomorphological characteristics at a coarser spatial scale than the detailed subwatershed comparisons made above. This provided an opportunity to compare our study watersheds to other watersheds we did not study, and to make inferences about their potential headwater sensitivities. This statistical modeling identified a number of variables related to volume sensitivity, and some of these varied between models. There was high covariability between these variables, and so we let stepwise regression identify the greatest correlations.

Of the 17 watersheds studied here, the models identified 7 that were likely to contain volume sensitive headwaters. In general, these tended to be in the west and northwest of Port Royal Sound, which are also the larger coastal watersheds in this area: Pocotaligo River, Euhaw Creek, Okatie River, Wright River, Huspah Creek, Tulifiny River and Chechesse River. Watersheds identified as least likely to contain sensitive headwaters were, in general, smaller and concentrated on the eastern side of Port Royal Sound. These watersheds were Wallace Creek, Village Creek, Albergottie Creek, McCalleys Creek, the Morgan River System, and the Boyd Creek System. With the exception of the Wright River and the Boyd Creek System, these are all located on the Sea Islands in the vicinity of Beaufort. The absence of the May River and Battery Creek from these lists indicates that they did not appear in the top 25% of sensitive or insensitive for any of the models. The WAC did, however, identify sensitive areas within both of these watersheds.

SWARM provided modeled runoff volume for all of the study watersheds in each of the four creek systems. This provides basic data on the percent of development, percent of impervious soils, and amount of rainfall required in order for runoff to occur under average conditions. It also provides the actual runoff modeling which allows for comparison between the watersheds of each creek system. In addition, the normalization of the runoff (both volume and rate over time) by area allows comparison among all of the watersheds, with charts and hydrographs enabling identification of any anomalies to investigate further. A regression equation for each watershed was developed to allow Beaufort County to predict the runoff volume based on any selected rainfall amount.

To project the potential impacts that implementation of volume control BMPs and changing precipitation patterns from climate change might have on runoff volume in priority watersheds, we conducted a series of scenarios using SWARM. The six headwater watersheds designated as critically sensitive to stormwater runoff were used for modeling the responses to implementation of mitigation measures in the two more-developed watersheds scenario, two volume-control BMP scenarios, and two climate change scenarios.

For the BMP scenarios, the first objective was to set the watershed hydrology to one of low development. Three of the six watersheds had levels of development lower than the targeted level (9% impervious cover). With the three more-developed watersheds, volume reduction amounts required to reach the targeted amount were calculated. The volume reduction for Battery Creek to achieve 9% impervious cover would require a 53% reduction, in comparison to the May River and Okatie River which only required a 2% and 17% reduction, respectively.

Volume reduction amounts were calculated for two higher development scenarios for all six watersheds. Volume increases for the larger watersheds, OK3 and MR2, were an order of magnitude greater than for the smaller ones. Using the current development level and the two higher levels will allow Beaufort County to have an understanding of what stormwater runoff volume changes are likely as development continues.

For the climate scenarios, we based our modeling on general predictions of increasing frequency and intensity of heavy storms. Both scenarios used an increase in rainfall, and each scenario included a wetter antecedent runoff condition. In general, the runoff volume doubled or tripled within each system for the two scenarios.

Our stormwater runoff modeling provides Beaufort County with information and insights concerning runoff in the study areas and how it will be impacted by additional development and by climate change. There is also the potential to apply SWARM to other creek systems both to calculate runoff and to predict salinity changes. However, as with all modeling, SWARM output should be viewed as an approximation of actual runoff. SWARM's validations indicate that the major drivers of runoff are captured well in the modeling system, but the results are best viewed as representative of runoff for a given rain event.

Going Forward

Although we have collected data in five watersheds in Beaufort County, there is still much that is unknown with regard to volume sensitivity. This is evidenced by our recent data collection in the Huspah Creek watershed, which varied considerably from the other watersheds studied. Had we used a regression model built on the four primary study watersheds, the large salinity drops observed in Huspah would have been grossly underpredicted. This realization confirmed that there were still a number of unknowns. We would continue to study these salinity responses, but we would use the watershed study database to identify areas where little is known with regard to volume sensitivity. Additional data collected in these relatively unstudied watersheds could then be used to validate or test the models presented here. We will discuss this with the WAC at our next meeting.

The original proposal also included a series of bioassays to assess the impact of these salinity drops on various biota of concern. Due the complexity and resources needed to complete these types of studies, this was withdrawn from the proposal. It is, however, still of interest to us and the WAC. Given additional resources we would pursue a targeted series of bioassays designed to assess the effects of stormwater runoff on estuarine organism health and survival.

Retrospective

Challenges

Overall, the project has been successful. As with other research projects, there were some challenges. The design, acquisition, and deployment process proceeded slower than anticipated. Although the official start date for the NERRS Science Collaborative grant was September 1, 2013, until the necessary forms were signed by all parties and the account was set up, it was October 22nd before we were permitted to bid out the equipment, and early December before our partner, the University of South Carolina-Beaufort received its subcontract. As a result, the sondes and rain gauges that had to be purchased did not arrive until December. By borrowing existing equipment we were able to completely outfit the Okatie River watershed and to use other sondes to survey the tidal dynamics in other watersheds. Considerable effort was made to contact dock owners in each waterway, explain the purpose and requirements of the monitoring work, and securing their cooperation in deploying monitoring sondes or weather stations from their docks. By the end of February 2014, the Okatie River, May River, Battery Creek, and Wallace Creek were fully instrumented, and we were prepared to deploy in a fifth watershed.

In Huspah Creek, technical problems with datasondes delayed full deployment until the four priority watersheds could be studied for at least one year. We experienced some significant instrumentation malfunction problems during the initial deployments, particularly in Huspah Creek starting in May 2014. Datasondes were not recording correctly, and some of these malfunctions required the instruments to be sent back for repairs. We therefore made the decision to withdraw from Huspah Creek temporarily to ensure that we had enough sondes in reserve to compensate for any malfunctions in the other watersheds.

Intended User Impact on Applied Science

Intended User collaboration was an integral component of this project and contributed greatly to its success. To ensure that our analysis was as relevant and useful as possible, we actively engaged the WAC at several points along the way, via a series of interactive workshops. This group consisted of 15 individuals representing Beaufort County stormwater staff, SWMUB members, environmental groups, state agency staff, and scientists. We presented our most recent findings and gathered group feedback as to how to proceed. Therefore, the modeling, analyses, and results were strongly driven by the interests and needs of this group. This proved an invaluable resource, as the scientific process became adaptive to the information needs of the user groups. The end result, hopefully, is that by maximizing the utility of the results to Beaufort County, local stormwater managers can make the most informed decisions.

We will continue to work with the WAC beyond the ending of this grant, in accordance with our five-year Agreement. We are planning an additional WAC meeting on September 10, 2015. The goal of this meeting will be to discuss this report (including the additional analyses they requested) to ensure that they can take the lead in interpretation, and to focus the discussion primarily on how they will use the results to develop new policies regarding stormwater management in the County. In addition, a second goal is to discuss how to best present the research findings and conclusions to the SWMUB and Natural Resource Committee. We believe the input received from the WAC will allow us to insure the information is translated and conveyed such that it can be used by decision makers and elected officials. We are scheduled to present to the SWMUB on September 30, 2015 and the Natural Resource Committee on October 1, 2015.

Budget and Resources Assessment

The budget was generally sufficient to conduct the study as proposed. We were successful at collecting over a year of data for each of the four primary study systems. A portion of the success can be attributed to the purchase of the Hydrolab datasondes at a discounted price. The project has sparked a number of additional avenues to follow which we will try and accomplish with other funding sources.

What We Know Now

There were a number of bumps in the road for this project including slow purchasing due to agency software upgrades, and the inability to test the modeling system to specific sites in Beaufort County. The slow purchasing and grant establishment were out of our control. The collection of flow data for model testing was not as successful as we originally proposed. The overall time it took to collect and process the salinity data resulted in less time to measure flow at appropriate sites (i.e., locations with no overbank flow). However, SWARM modeling has been validated prior to this study using data from other estuarine tidal creeks in South Carolina. We are currently working with Beaufort County to collect paired data in the Okatie River. The County purchased a similar instrument and we will continue to work with them to collect data at sites of interest.

Sharing Your Work with the Reserves and NOAA

This ACE Basin NERR project has applicability to many of the other coastal Reserves. We are submitting an abstract to present a poster at the 2015 NERR annual meeting to share the findings of the study with the Reserve system. We collaborated with a NOAA scientist, Anne Blair, who we hope will also provide avenues to share the information with other NOAA offices.

Anything Else?

We have been very fortunate to conduct this work with NERR Science Collaborative funding. It allowed us to provide Beaufort County with a more robust scientific dataset to use in their management decisions.

We shared the study findings through the following oral or poster presentations.

Sanger, D., J. Leffler, E. Montie, A. Blair, A. Turner, J. Brunson, G. Riekerk, and K. Pitts. Determining Volume Sensitive Waters in Beaufort County, SC Tidal Creeks. Presented at the Southeastern Estuarine Research Society annual meeting, February 13-15, 2014, Savannah, GA.

Pitts, K., D. Sanger, J. Leffler, J. Brunson, G. Riekerk, R. O'Quinn IV, E. Montie, A. Blair, and A. Turner. Determining Volume Sensitive Waters in Beaufort County, SC Tidal Creeks. Presented at the First Annual Marine Resources Division Conference, March 25-26, 2014, Charleston, SC.

Pirhalla, D., A. Blair, C. Currin, K. Holderied, E. Turner, D. Kidwell. "Impacts of Climate-related Threshold Events - Current NCCOS Research". Presented at the Climate Thresholds Workshop at Hollings Marine Laboratory August 18, 2014, Charleston, SC.

Sanger, D., J. Leffler, A. Blair, A. Tweel, and E. Montie, "Prioritizing Volume Sensitive Tidal Creek Watersheds in Beaufort County, SC". Presentation at 9th Annual Southeast Regional Stormwater Conference, October 8-10, 2014, Charleston, SC.

Tweel, A., D. Sanger, J. Leffler, E. Montie, and A. Blair, "Volume Sensitive Waters in Tidal Creeks of Beaufort County, SC". Presentation at the South Carolina Water Resources Conference, October 15-16, 2014, Columbia, SC.

Tweel, A., D. Sanger, A. Blair, and J. Leffler. "Determining Volume Sensitive Waters in Beaufort County, SC Tidal Creeks". Poster at the National Estuarine Research Reserve System Annual Meeting, November 17-21, 2014, Shepherdstown, WV.

Tweel, A., D. Sanger, A. Blair, and J. Leffler. "Determining Volume Sensitive Waters in Beaufort County, SC Tidal Creeks". Presentation at the Fifth Interagency Conference on Research in the Watersheds, March 2-5, 2015, Charleston, SC.

Tweel, A. "Determining Volume-sensitive Waters in Beaufort County Tidal Creeks". Presented at the Marine Resources Division Conference, March 18-19, 2015, Charleston, SC. Technical audience. 100 attendees.

Blair, A., D. Sanger, and S. Lovelace. "Stormwater Runoff in Watersheds: A System for Predicting Impacts of Development and Climate Change". Presentation at the Fifth Interagency Conference on Research in the Watersheds, March 2-5, 2015, Charleston, SC.

Leffler, J. "Determining Volume Sensitive Waters in Beaufort County, SC Tidal Creeks". Poster at the Fort Johnson Poster Session for Senator Sheldon Whitehouse, April 22, 2014, Charleston, SC.

References

Ahern, D., R. Wagner, and R. Klink 2012. Integrating Stormwater Runoff Quantity and Quality Requirements. North American Surface Water Quality Conference and Exposition. Aug 18-22, 2012. Denver, CO.

Barber, B.P. 2008. Town of Bluffton May River watershed monitoring program. Prepared for Town of Bluffton, Bluffton, SC. 143pp.

Beaufort County (2007). Beaufort County Comprehensive Plan. http://www.bcgov.net/ Council/ NewCouncilWeb/ComprehensivePlan/compPlan.php

Blair, A., S. Lovelace, D. Sanger, A.F. Holland, L. Vandiver, and S. White. 2014a. Exploring Impacts of Development and Climate Change on Stormwater Runoff. Hydrological Processes 28(5): 2844-2854.

Blair, A., D. Sanger, D. White, A.F. Holland, L. Vandiver, C. Bowker, and S. White. 2014b. Quantifying and Simulating Stormwater Runoff in Watersheds. Hydrological Processes 28(3): 559-569.

Gutowski W.J., G.C. Hegerl, G.J. Holland, T.R. Knutson, L.O. Mearns, R.J. Stouffer, P.J. Webster, M.F. Wehner, and F.W. Zwiers. 2008. Causes of observed changes in extremes and projections of future changes in weather and climate extremes in a changing climate. Regions of focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands. Karl T.R., G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray (eds.). A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Washington, DC.

Holland, A.F., D.M. Sanger, C.P. Gawle, S.B. Lerberg, M. Sexto Santiago, G.H.M. Riekerk, L.E. Zimmerman, and G.I. Scott. 2004. Linkages between tidal creek ecosystems and the landscape and demographic attributes of their watersheds. Journal of Experimental Marine Biology and Ecology 298:151-178.

Island Packet. 2001. Report shows importance of controlling stormwater. The Island Packet, August 15, 2001.

Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.) 2009. Global Climate Change Impacts in the United States. Cambridge University Press, New York, NY. 189 pp.

Maier, P. (ed.) 2010. Ashepoo-Combahee-Edisto (ACE) Basin National Estuarine Research Reserve Management Plan 2011-2016. South Carolina Department of Natural Resources, Charleston, SC. 142 pp.

Melillo, J.M., T.C. Richmond, and G.W. Yohe (eds.) 2014. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

Pollack, J.A. and R.W. Walker Szivak. 2007. Training Needs Assessment of Professional Decision Makers in the Coastal Counties of South Carolina. North Inlet-Winyah Bay and ACE Basin National Estuarine Research Reserve Coastal Training Programs, February 2007. 24 pp.

Sanger D., A. Blair, G. DiDonato, T. Washburn, S. Jones, G. Riekerk, E. Wirth, J. Stewart, D. White, L. Vandiver, and A.F. Holland. 2015. Impacts of Coastal Development on the Ecology and Human Well-being of Tidal Creek Ecosystems of the US Southeast. Estuaries and Coasts 38:S49-S66.

Schueler T. 1994. The importance of imperviousness. Watershed Protection Techniques 1(3): 100–111.

Small, T.D., M.R. Ide, and J.M. Keesee. 2010. CDMO NERR SWMP Data Management Manual, Version 6.3. NOAA National Estuarine Research Reserve Centralized Data Management Office, Georgetown, SC. 244 pp.

Town of Bluffton. 2008. Water Body Management Plan for the May River. http://www.townofbluffton.com/epa/waterbodyplan6.16.08.pdf

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA NRCS). 2004. National Engineering Handbook, Part 630, Chapter 10, Estimation of direct runoff from storm rainfall.

Van Dolah, R.F., D.E. Chestnut, and G.I. Scott. 2000. A Baseline Assessment of Environmental and Biological Conditions in Broad Creek and the Okatee River, Beaufort County, South Carolina. Final Report. Submitted to Beaufort County Council, Beaufort, SC. 280pp

Walker, R. (ed.) 2010. Ashepoo-Combahee-Edisto (ACE) Basin National Estuarine Research Reserve Coastal Training Program Strategic Plan. South Carolina Department of Natural Resources, Charleston, SC.

Appendix A. Figures and Tables

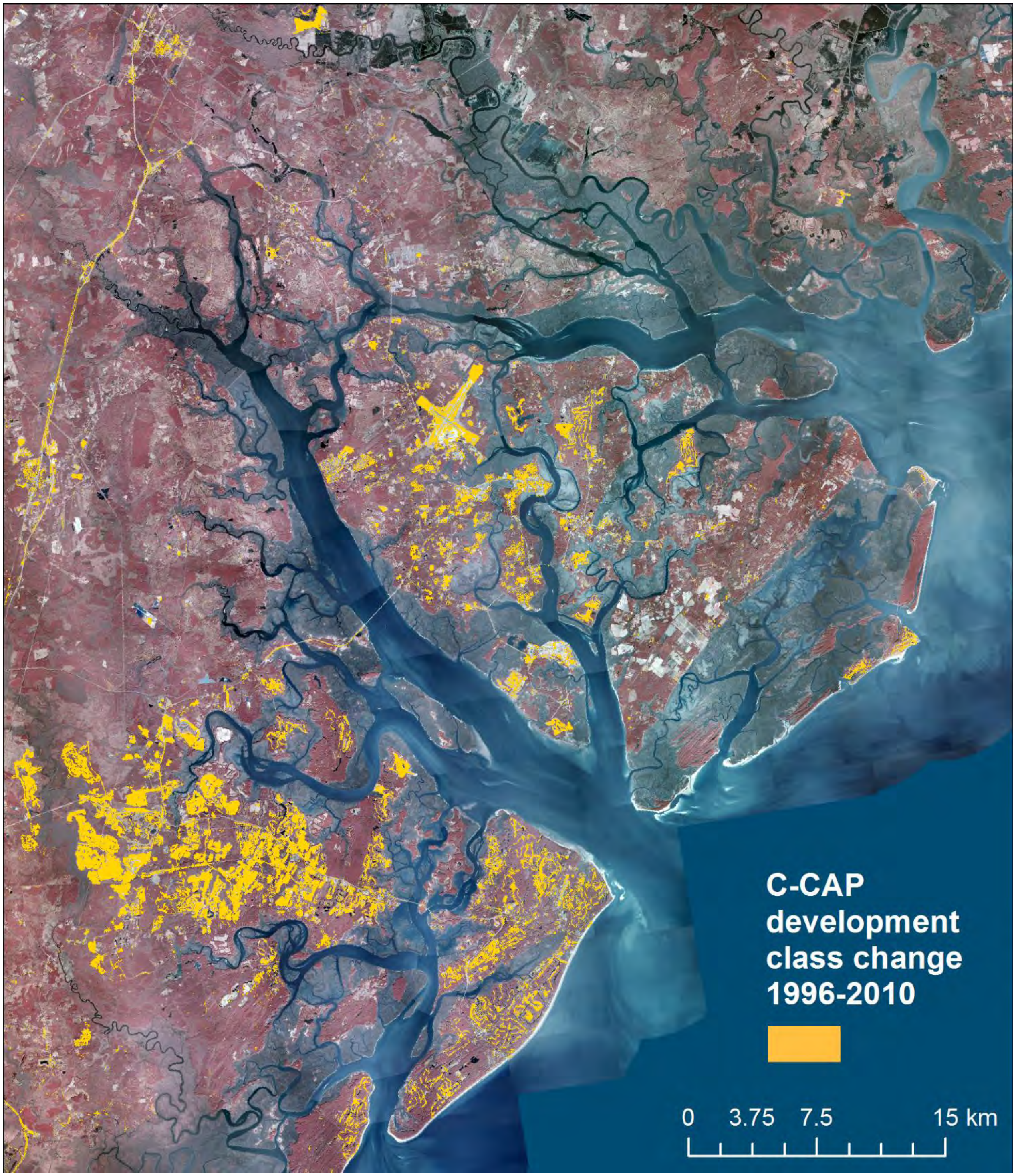


Figure 1. NOAA Coastal Change Analysis Program (C-CAP) change analysis for 1996 to 2010 in the Beaufort County area. Areas shown in yellow changed land use category from undeveloped to developed, or from a less developed category to a more developed category. Base layer is SCDNR NAPP IR 2010 image.

Figure 2. Watershed boundaries used in watershed study (yellow lines), based on USGS HUC-12 boundaries. Headwater portions of the largest watersheds were also analyzed separately (dashed lines). Base layer is USDA NAIP 2013 image.

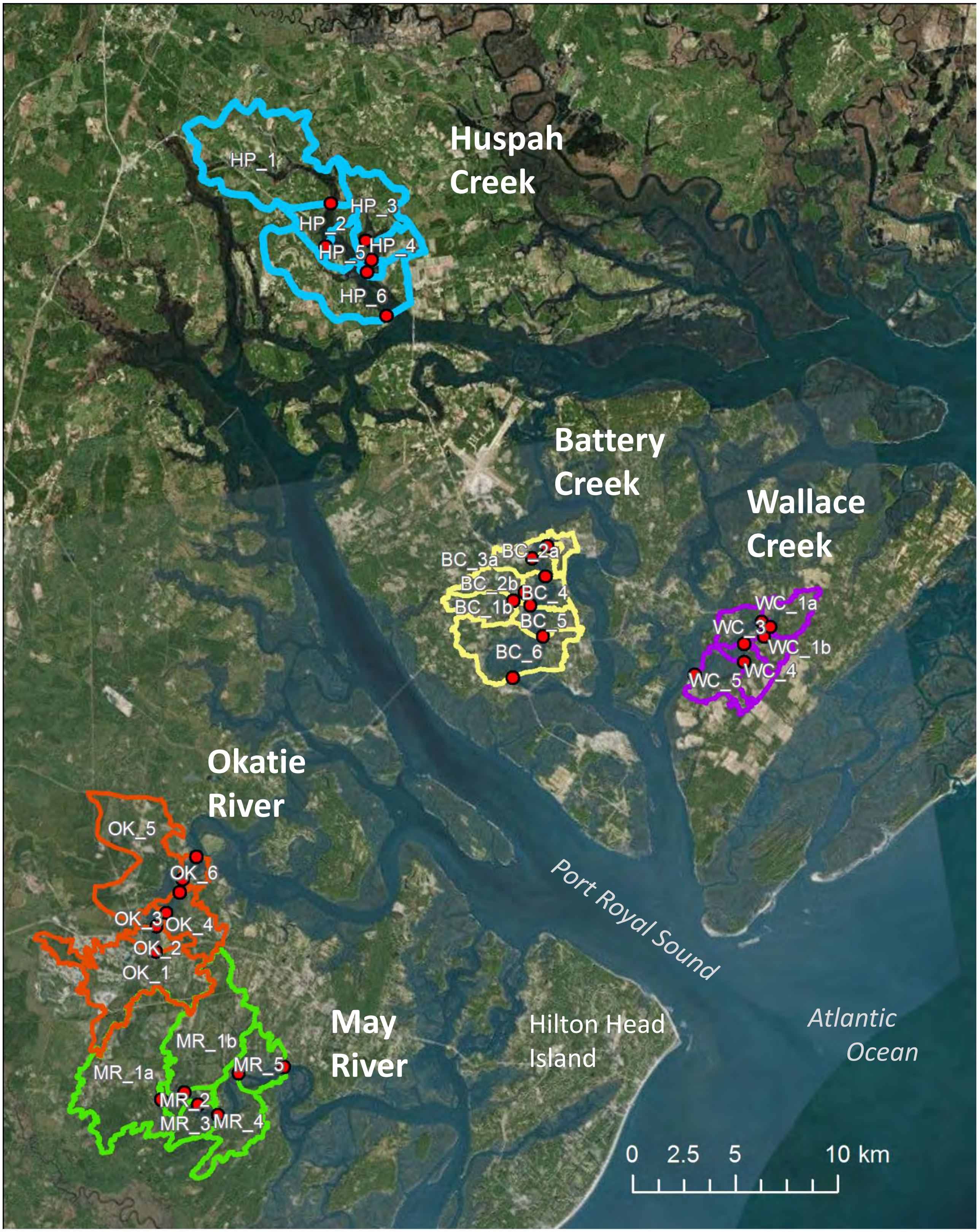


Figure 3. Aerial map of Beaufort County depicting study watersheds for Okatie River (orange), May River (green), Battery Creek (yellow), Wallace Creek (purple), and Huspah Creek (blue). Labels indicate subwatersheds and datalogger locations. WC is Wallace Creek, BC is Battery Creek, OK is Okatie River, MR is May River, HP is Huspah Creek. Base layer is USDA NAIP 2013 image.

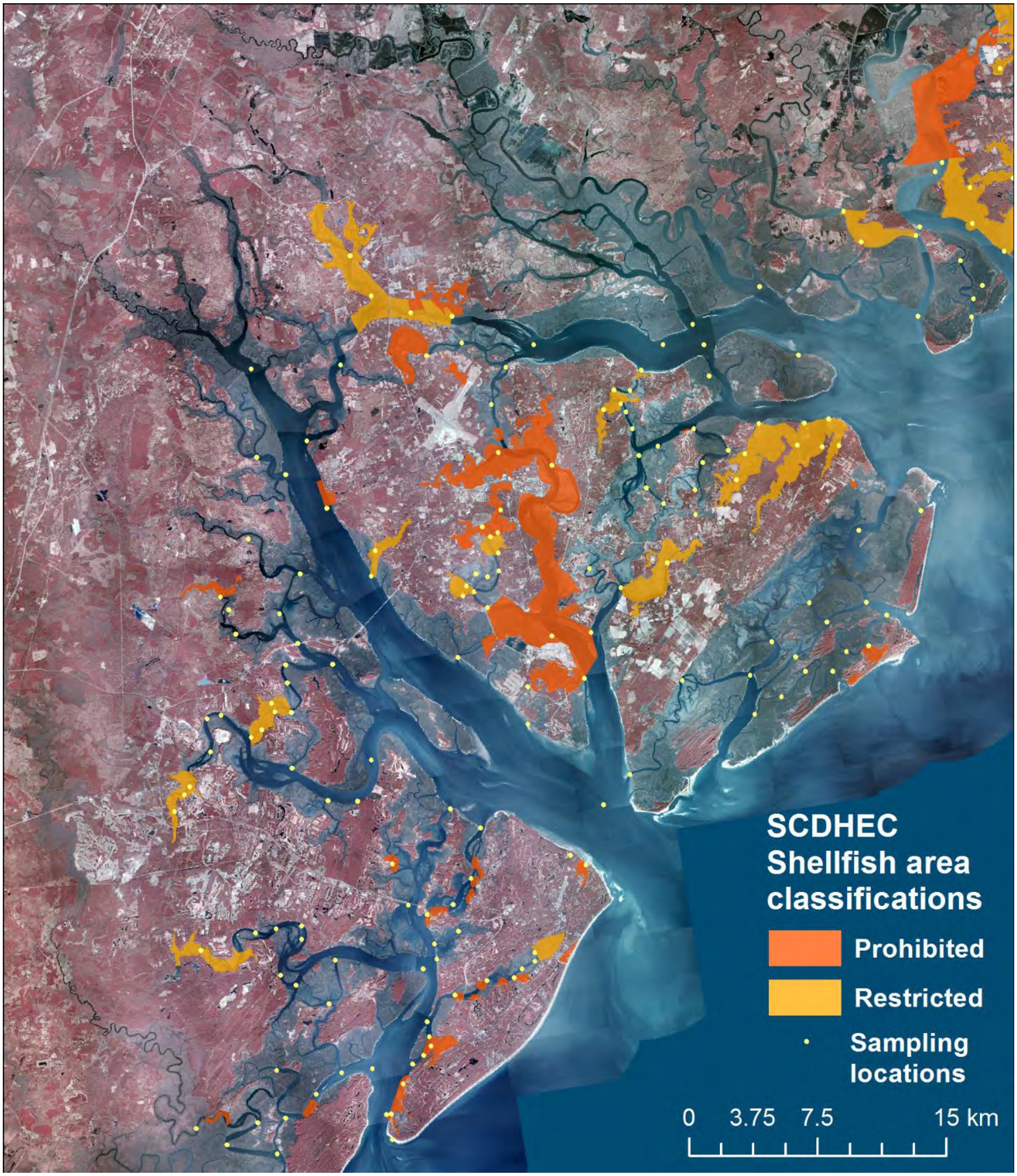


Figure 4. South Carolina Department of Health and Environmental Control (SCDHEC) shellfish zone classifications and water quality sampling locations. Headwater portions of tidal creeks are often classified as restricted or prohibited. Base layer is SCDNR NAPP IR 2010 image.

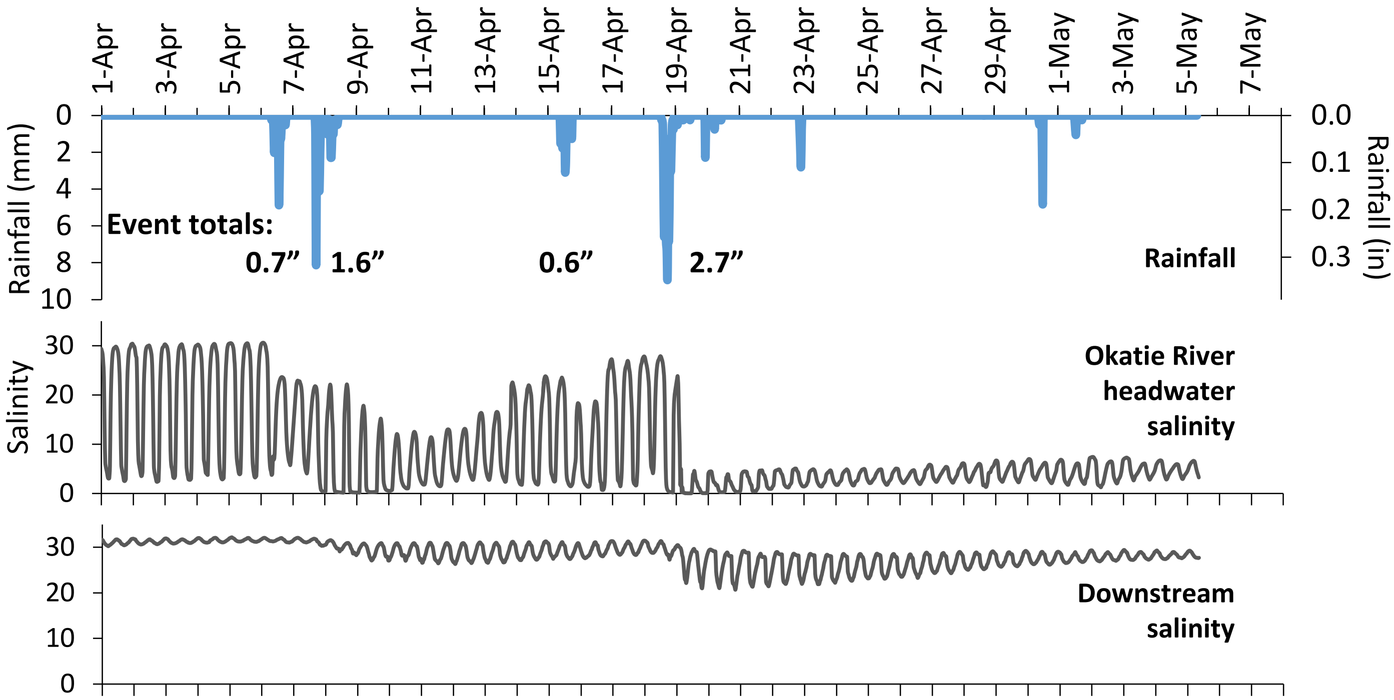


Figure 5. Example data collected from the Okatie River from April 1 to May 8, 2014. Salinity varies over the course of the two tidal cycles per day and ranges were much greater and much more influenced by rain events in the tidal creek headwaters (OK1) compared to farther downstream (OK6).

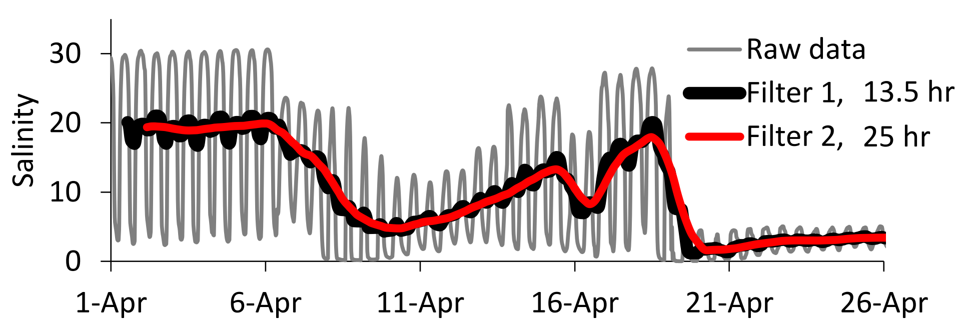


Figure 6. An example of salinity data filtered to isolate stormwater impacts from tidal effects.

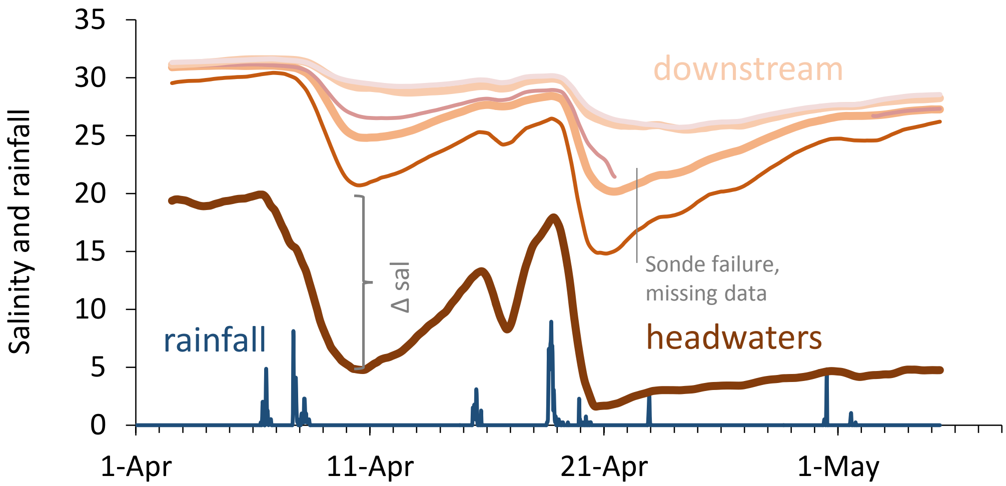


Figure 7. An example of filtered salinity data for all six Okatie River sites from two primary rain events in spring 2014. Darker colors represent more headwater sites, salinity response is dampened as the freshwater signal progresses downstream. An example of a salinity drop is brackted as Δ sal for the first rain event.

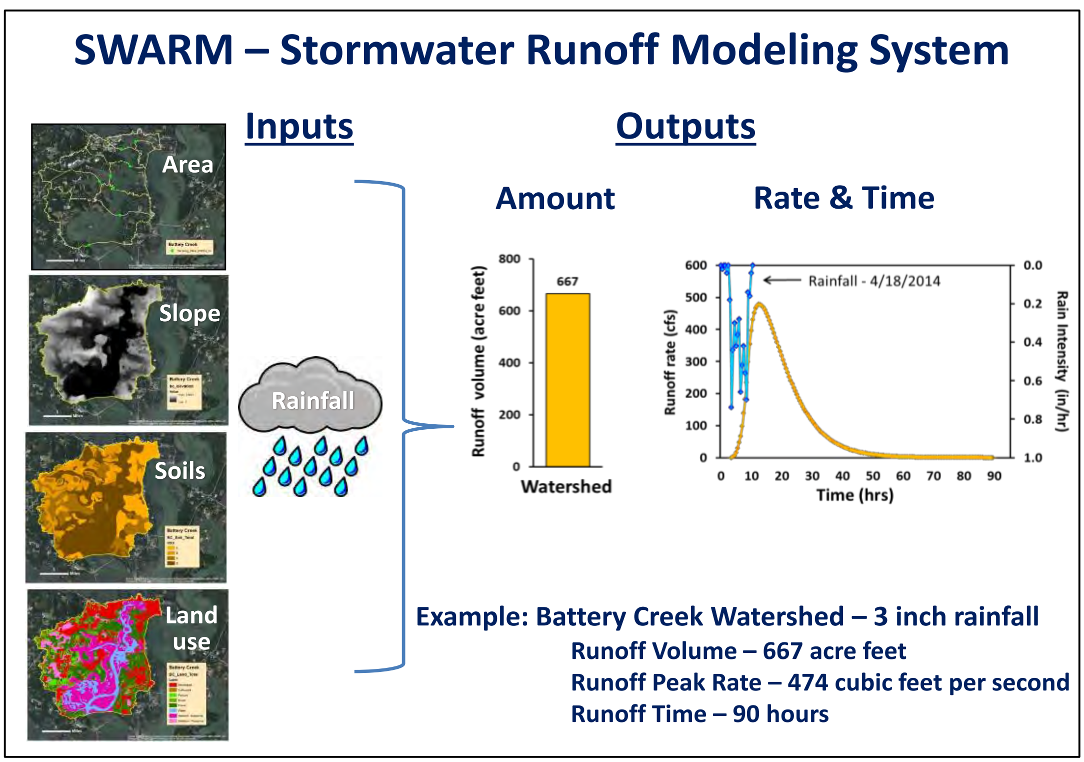


Figure 8. Diagram of general elements of SWARM. Model inputs are shown on the left. Model outputs are shown in the center and right. Specific input and output data are provided at the lower right.

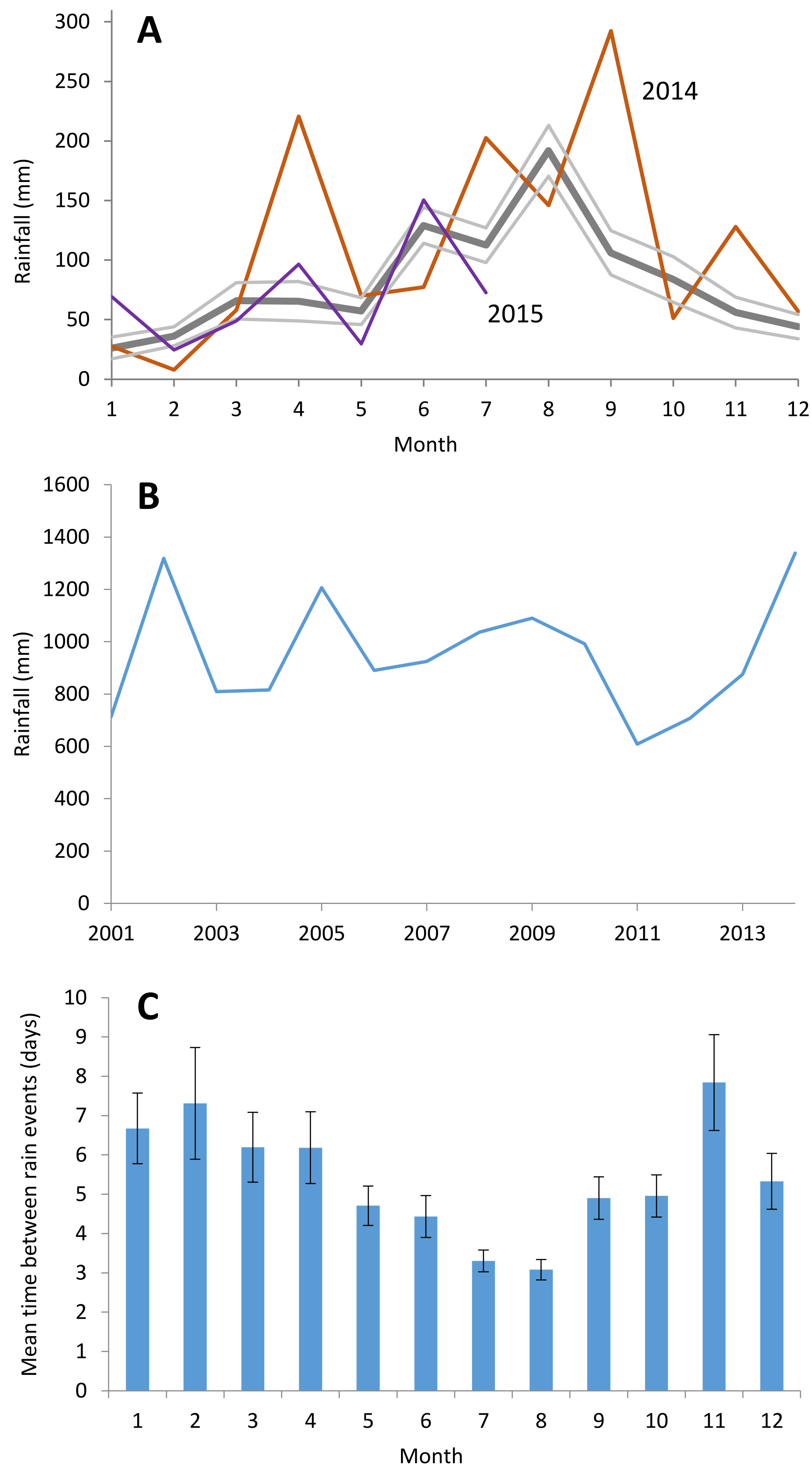


Figure 9. Summary of ACE Basin NERR meteorological data collected at Bennett's Point, South Carolina. **(A)** Mean monthly precipitation (± 1 S.E.) 2001-2014, overlain with study years 2014 and 2015. **(B)** Annual rainfall totals. **(C)** Average number of days (± 1 S.E.) between rain events for all years, by month.

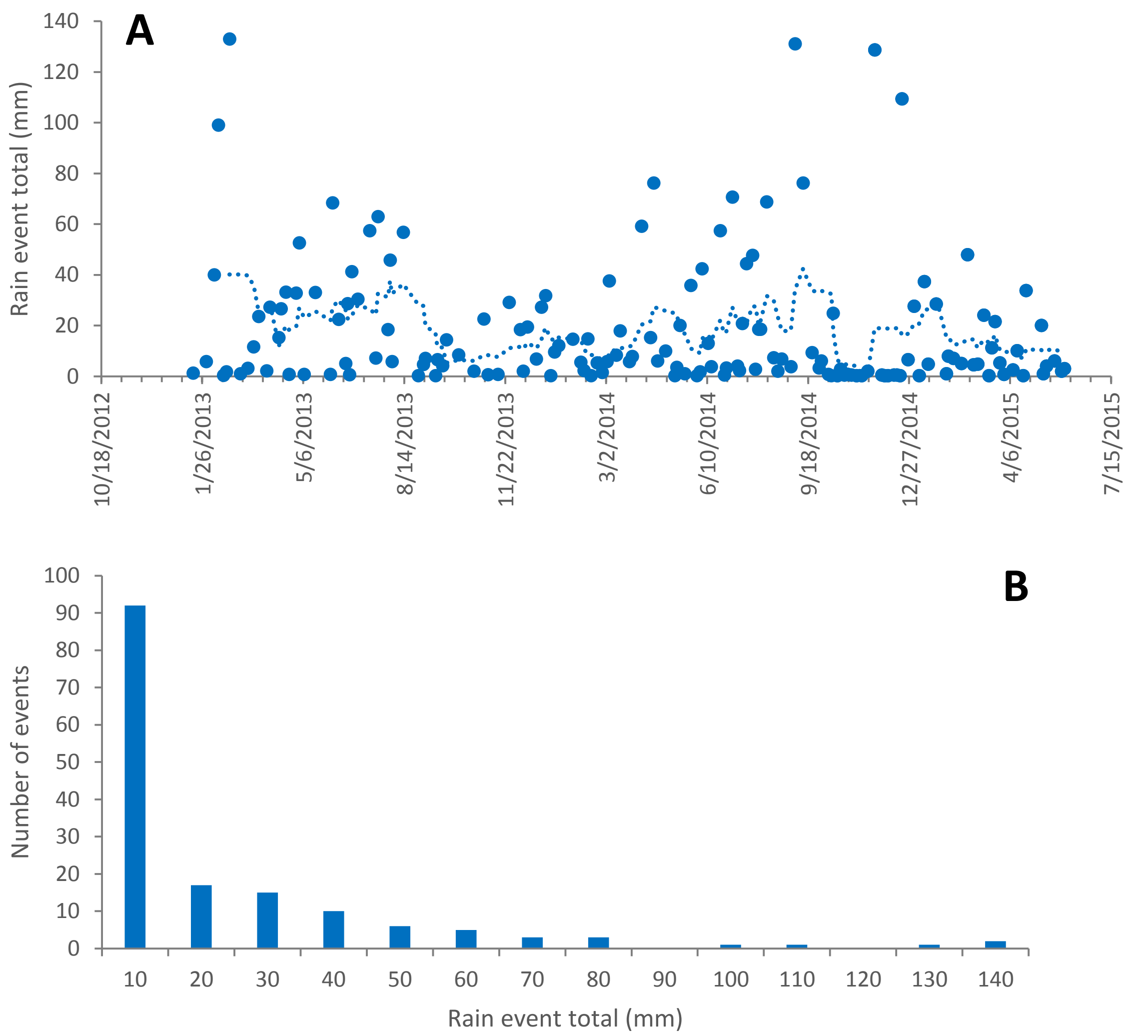


Figure 10. Summary of meteorological data collected for this study. Only data for Okatie River gauge is shown, other sites exhibit similar patterns. **(A)** Rain event totals over the course of the study, and the moving average shows periods of higher and lower rainfall. **(B)** Histogram of rain event totals by 10 mm bin.

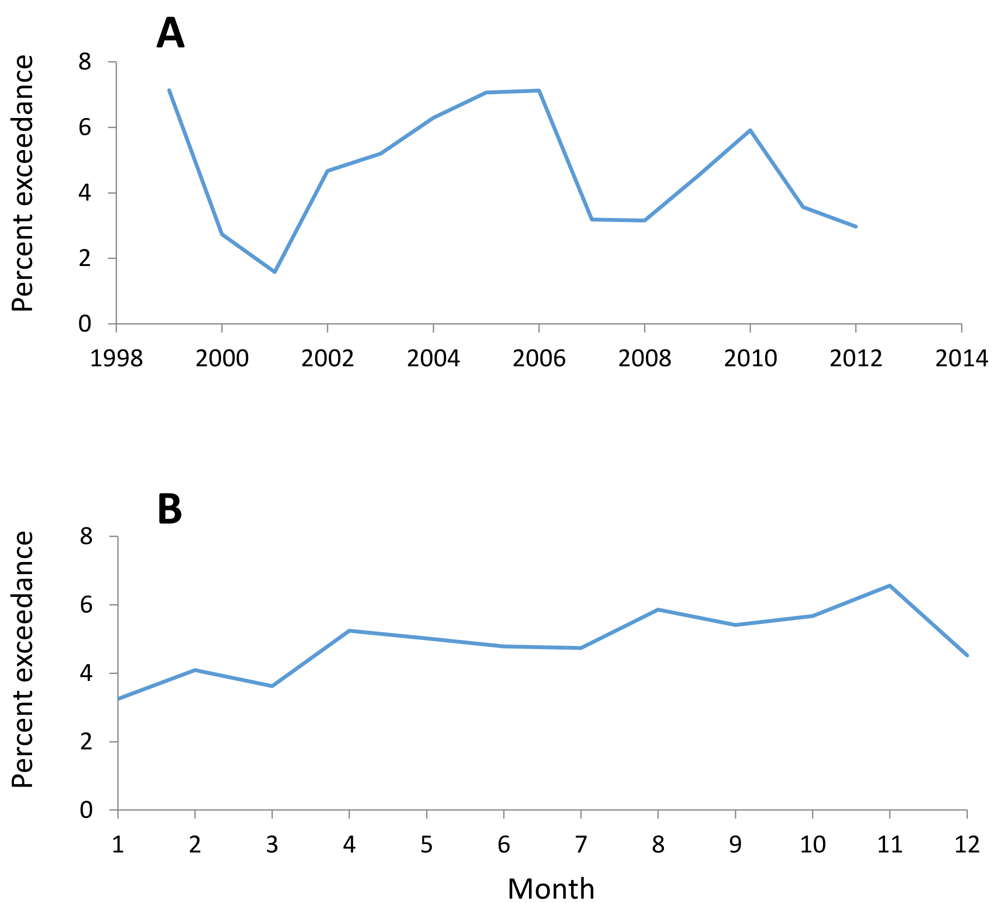


Figure 11. Summaries of SCDHEC fecal coliform water quality sample results by year **(A)** and month **(B)** for all available sample data collected in Beaufort County, South Carolina. Exceedance criteria is defined as greater than 40.9 cells/100 ml.

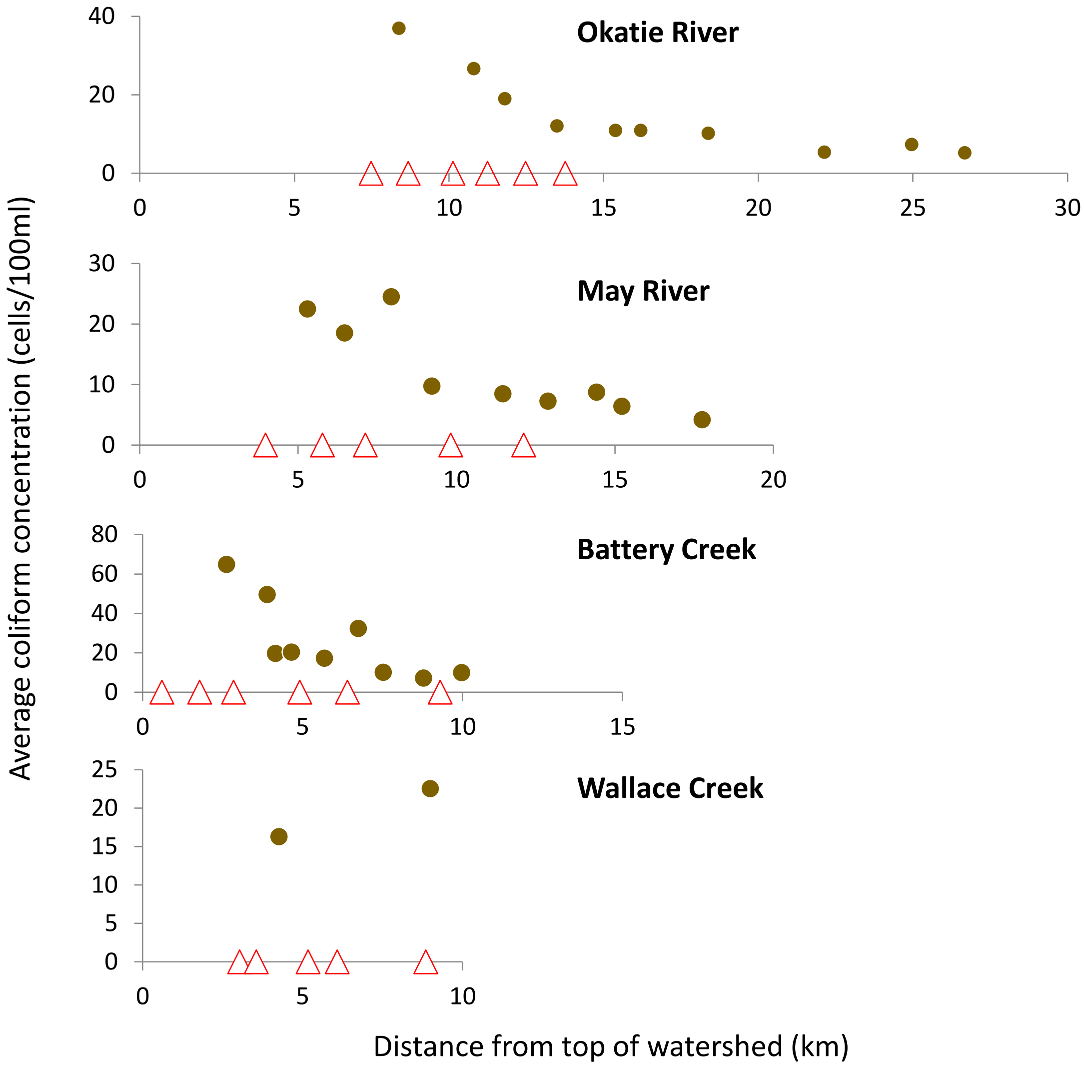
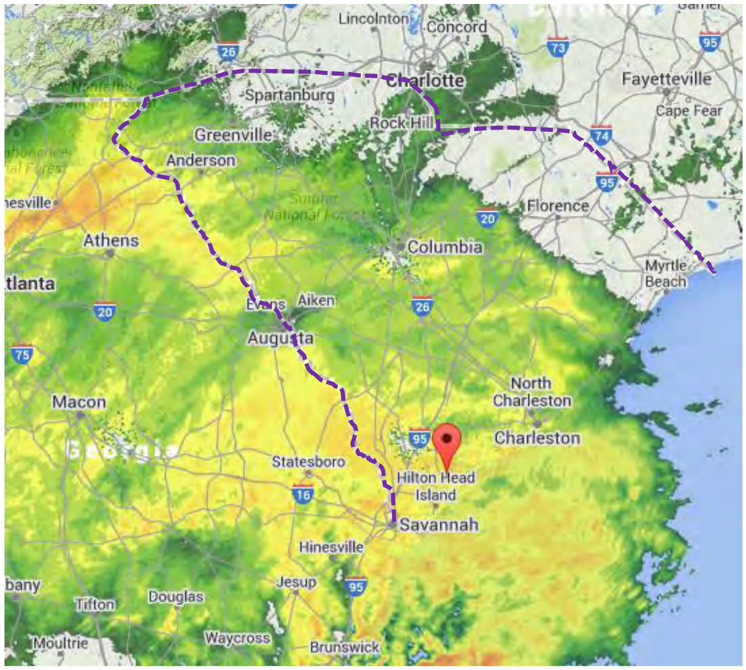


Figure 12. Summaries of SCDHEC fecal coliform water quality sample results by location within the study systems (brown) for all available data. Our study sites down the length of each creek are shown as red triangles. Note differing y-axis scales.



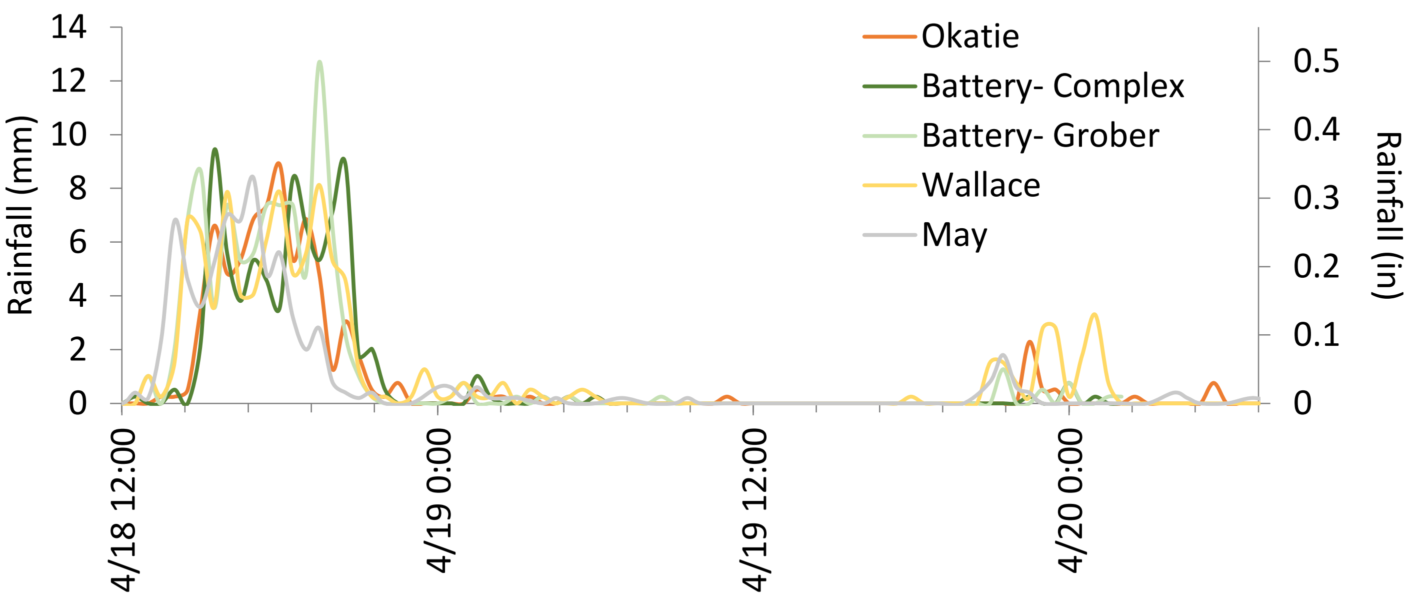


Figure 13. An example of a large rain event on April 18, 2014, showing similarities and differences between the five study rain gauges. This large rain event yielded similar rain totals and timing for all study watersheds, and was used as a case study to learn about salinity response in greater detail.

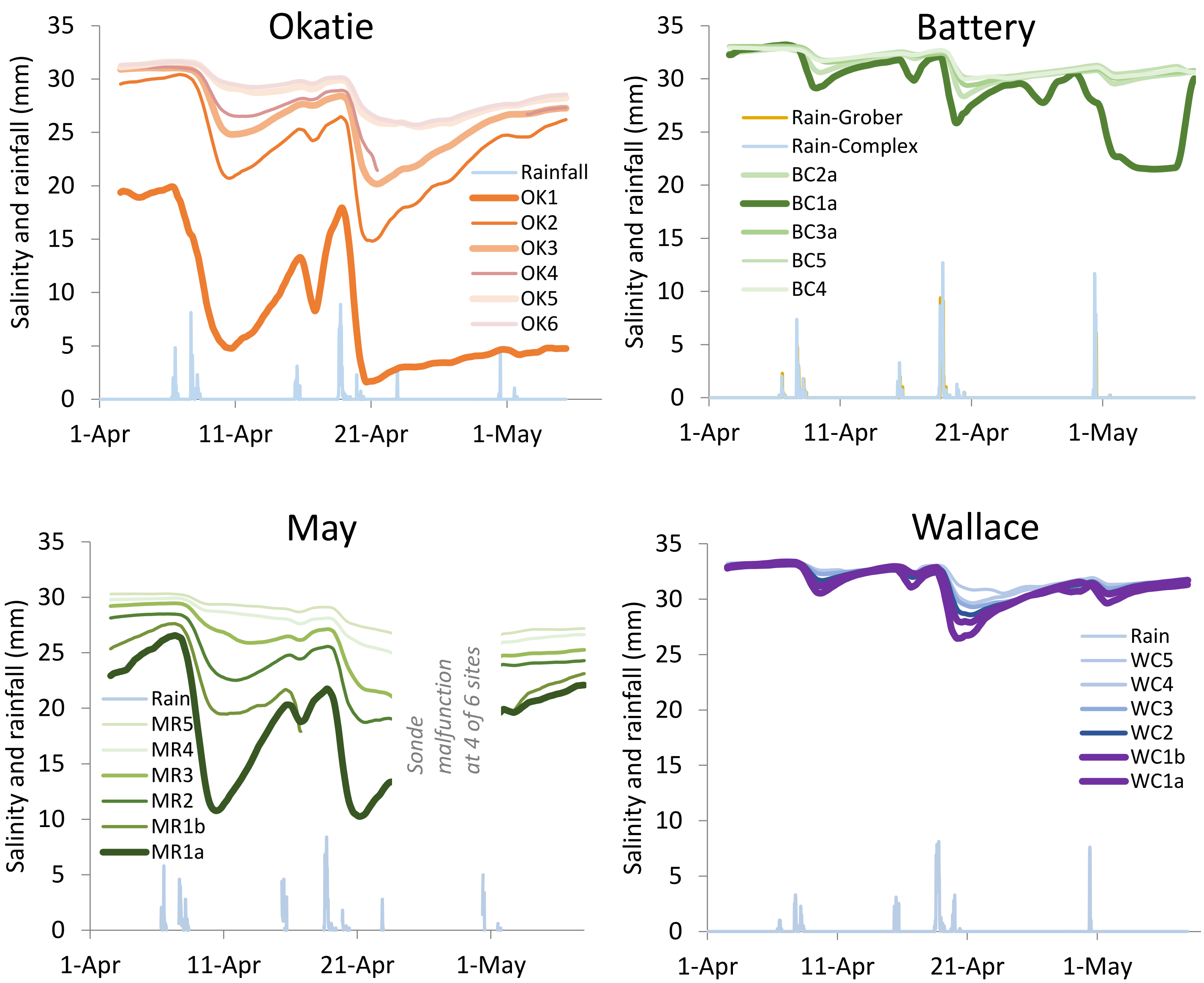


Figure 14. Examples of filtered salinity data for the four main study watersheds from two primary rain events in spring 2014. Darker colors represent more headwater sites, salinity response was dampened as the freshwater signal progressed downstream. The Okatie River and May River watersheds exhibited much larger salinity drops than Battery Creek and Wallace Creek watersheds for the same rain events.

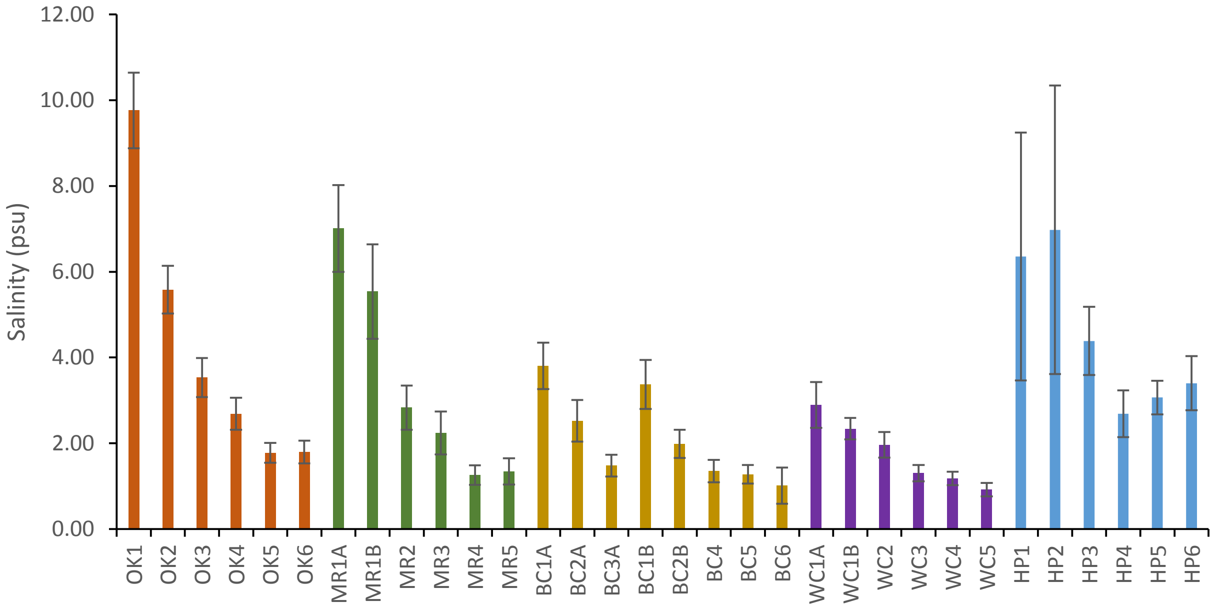


Figure 15. Average salinity drop observed at each site. Error bars represent one standard error. Average was computed across all rain events.

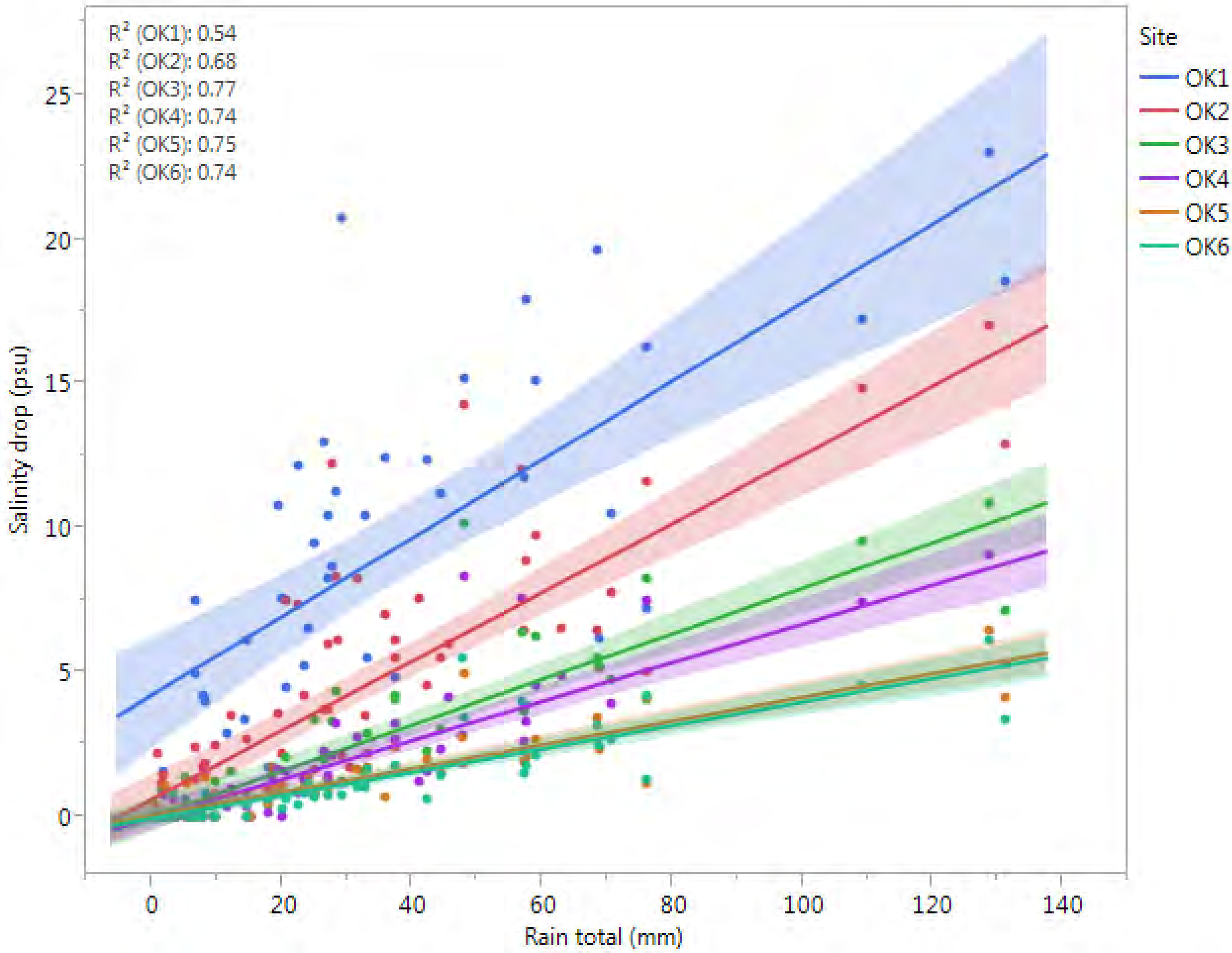


Figure 16. Relationship between rainfall total and salinity drop for the study sites in the Okatie River. The R^2 is provided for each site.

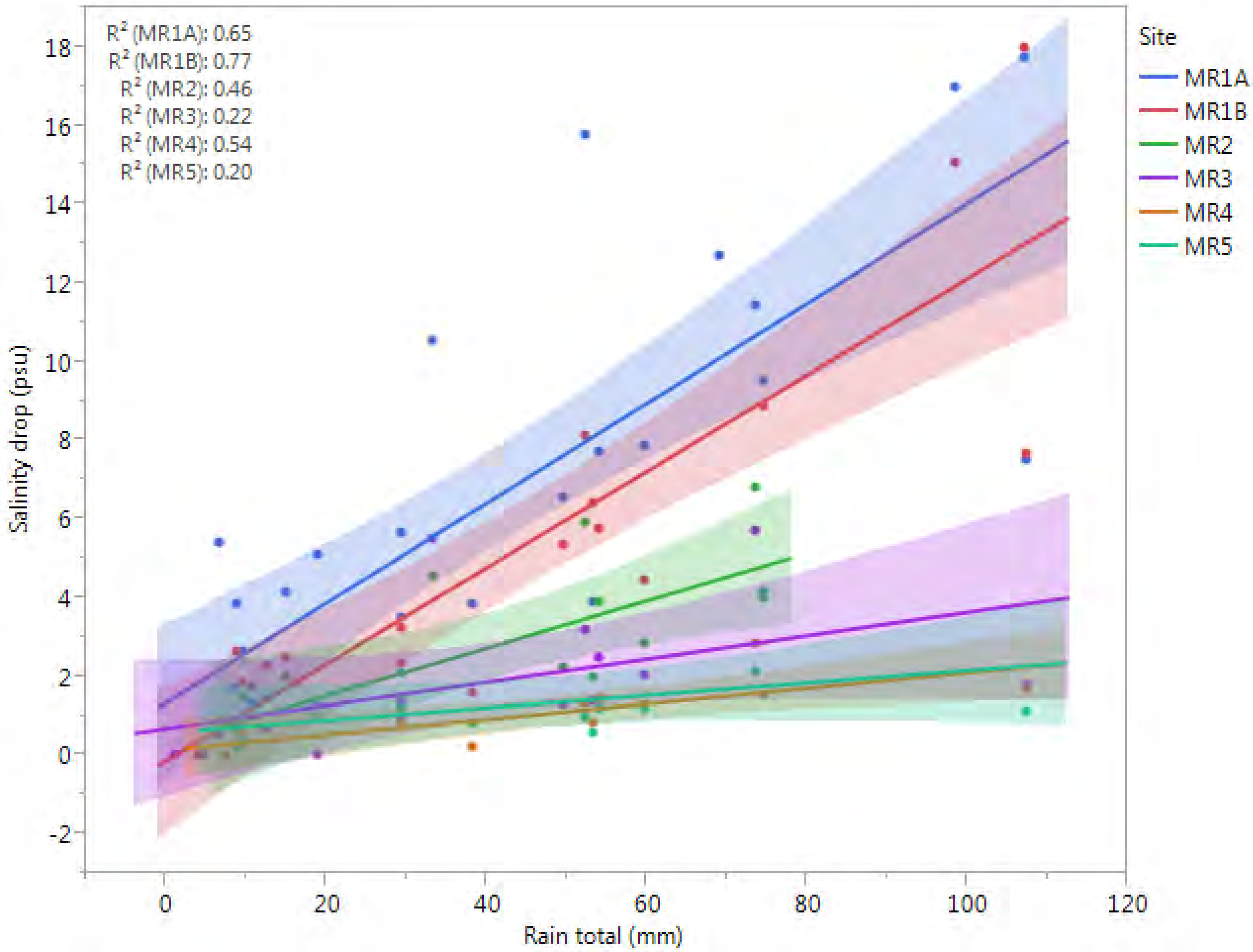


Figure 17. Relationship between rainfall total and salinity drop for the study sites in the May River. The R^2 is provided for each site.

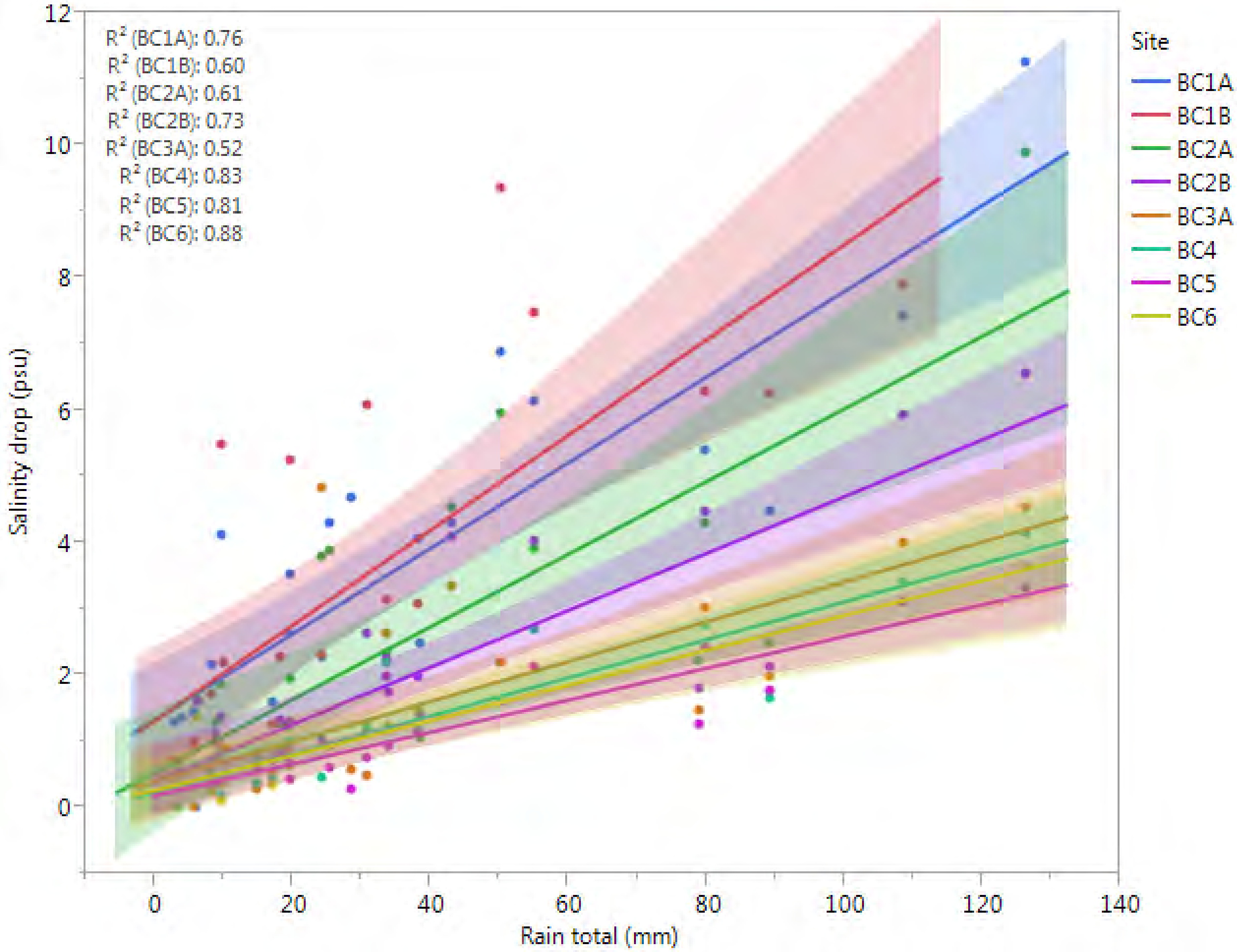


Figure 18. Relationship between rainfall total and salinity drop for the study sites in Battery Creek. The R^2 is provided for each site.

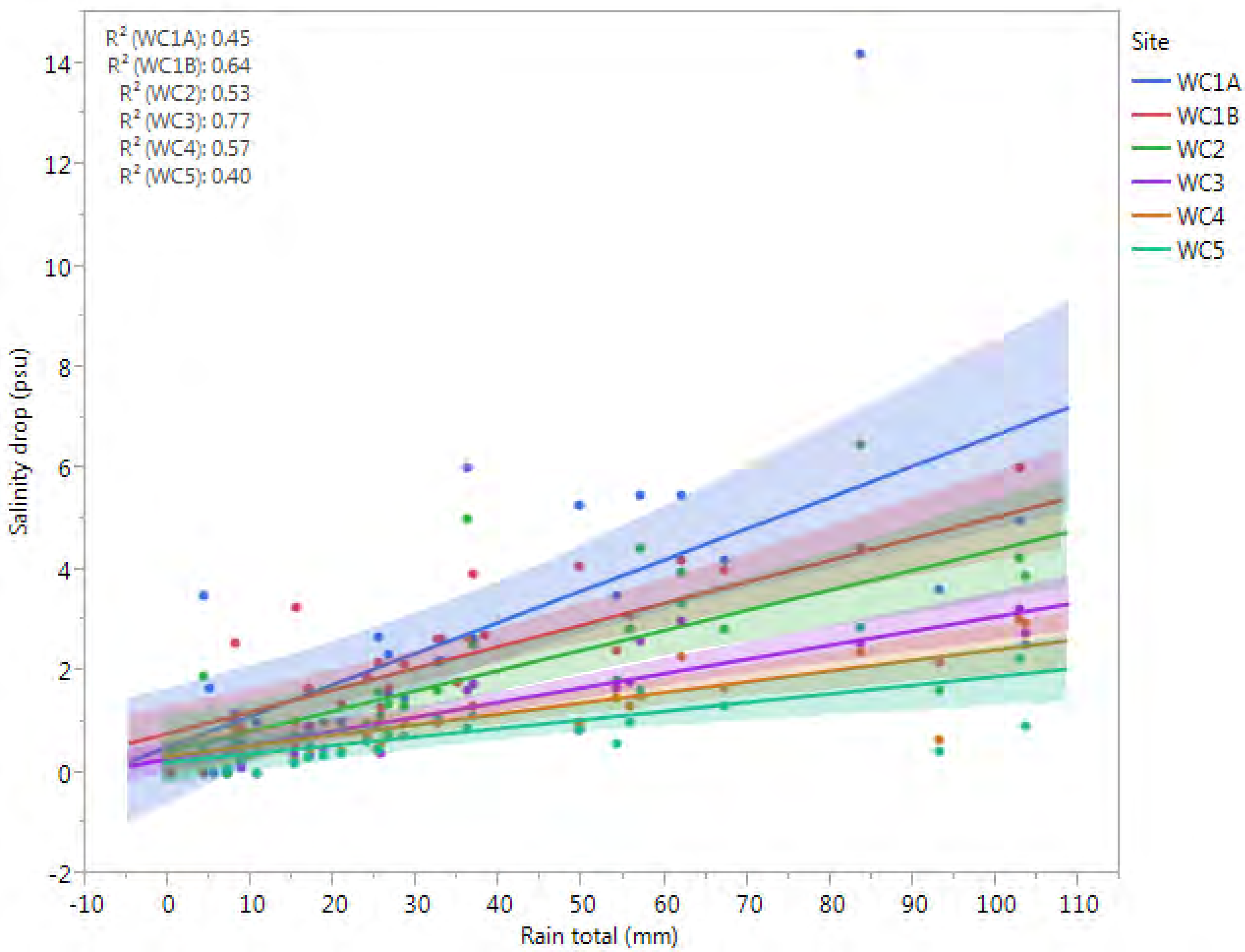


Figure 19. Relationship between rainfall total and salinity drop for the study sites in Wallace Creek. The R^2 is provided for each site.

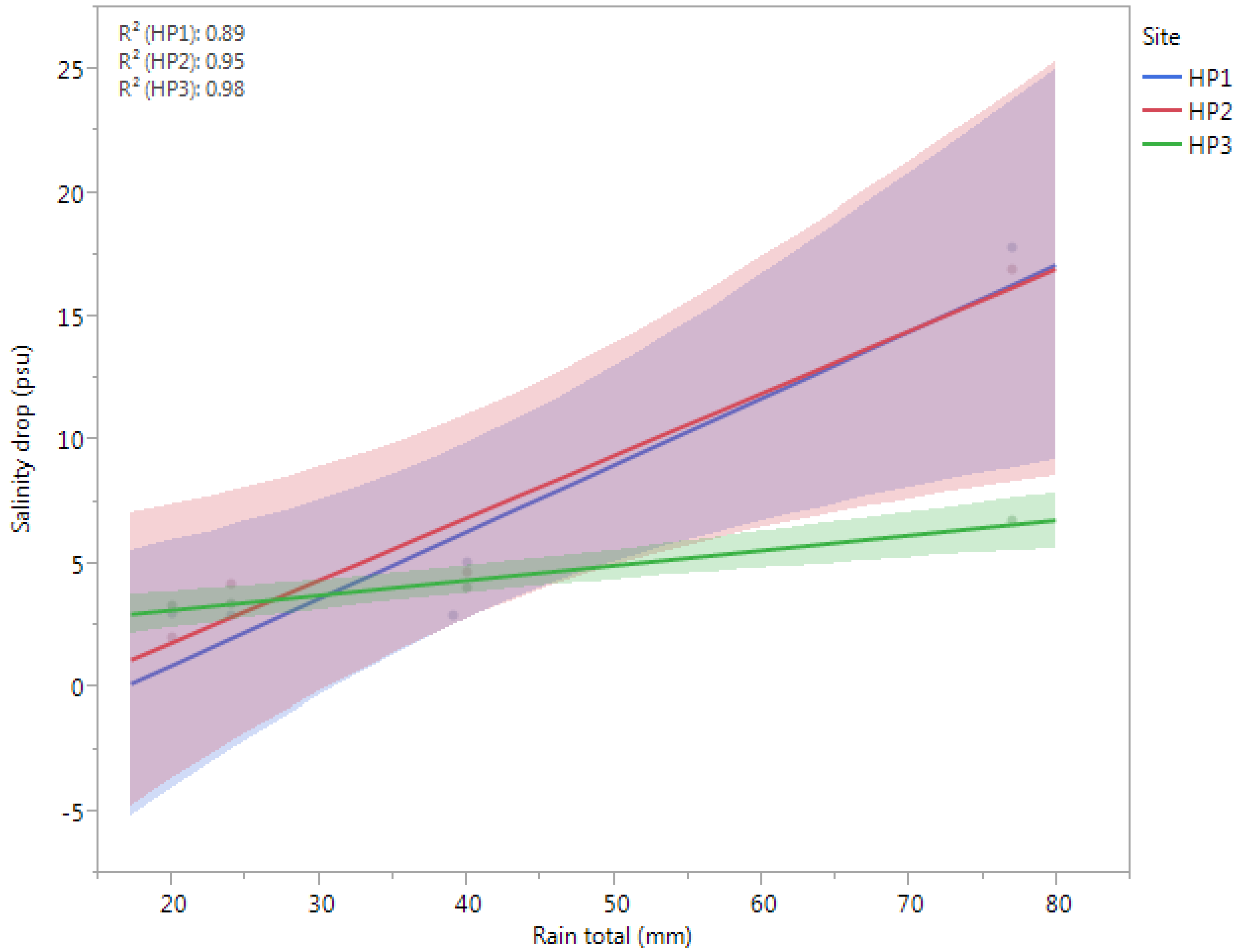


Figure 20. Relationship between rainfall total and salinity drop for the study sites in Huspah Creek. The R^2 is provided for each site. Sites HP4, HP5, and HP6 are not shown due to high p values ($p > 0.2$).

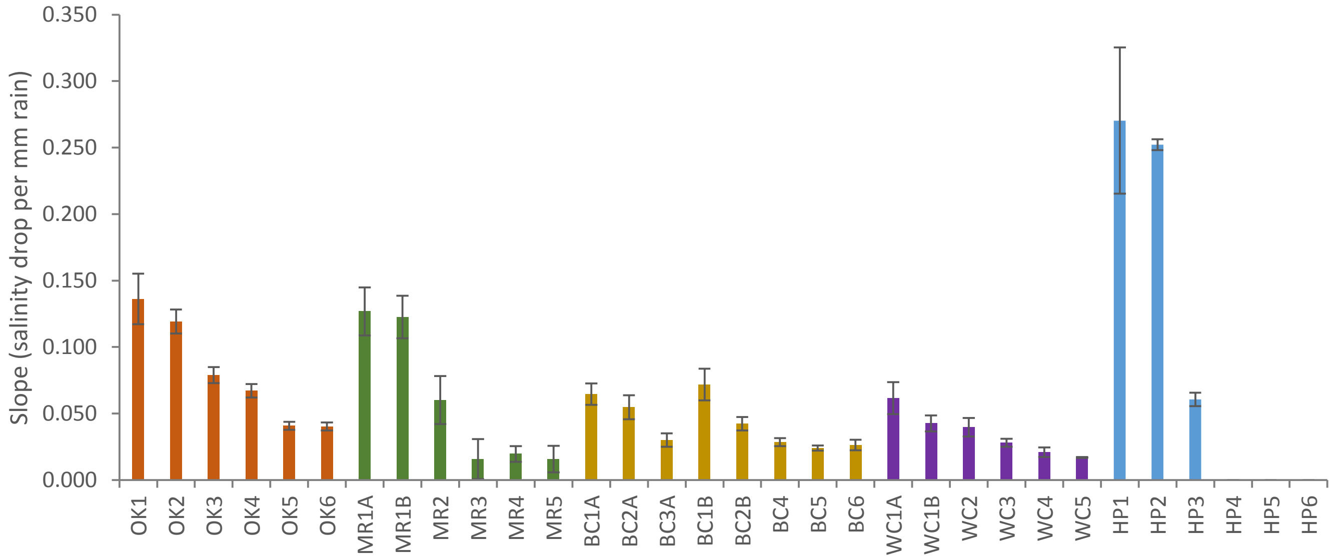


Figure 21. Slopes of equations for regressions of rain total (x) vs salinity drop (y). Huspah 4, 5, and 6 were not significant and are not shown ($p > 0.2$). All other regressions were significant except for May River 3 and 5 ($p < 0.05$).

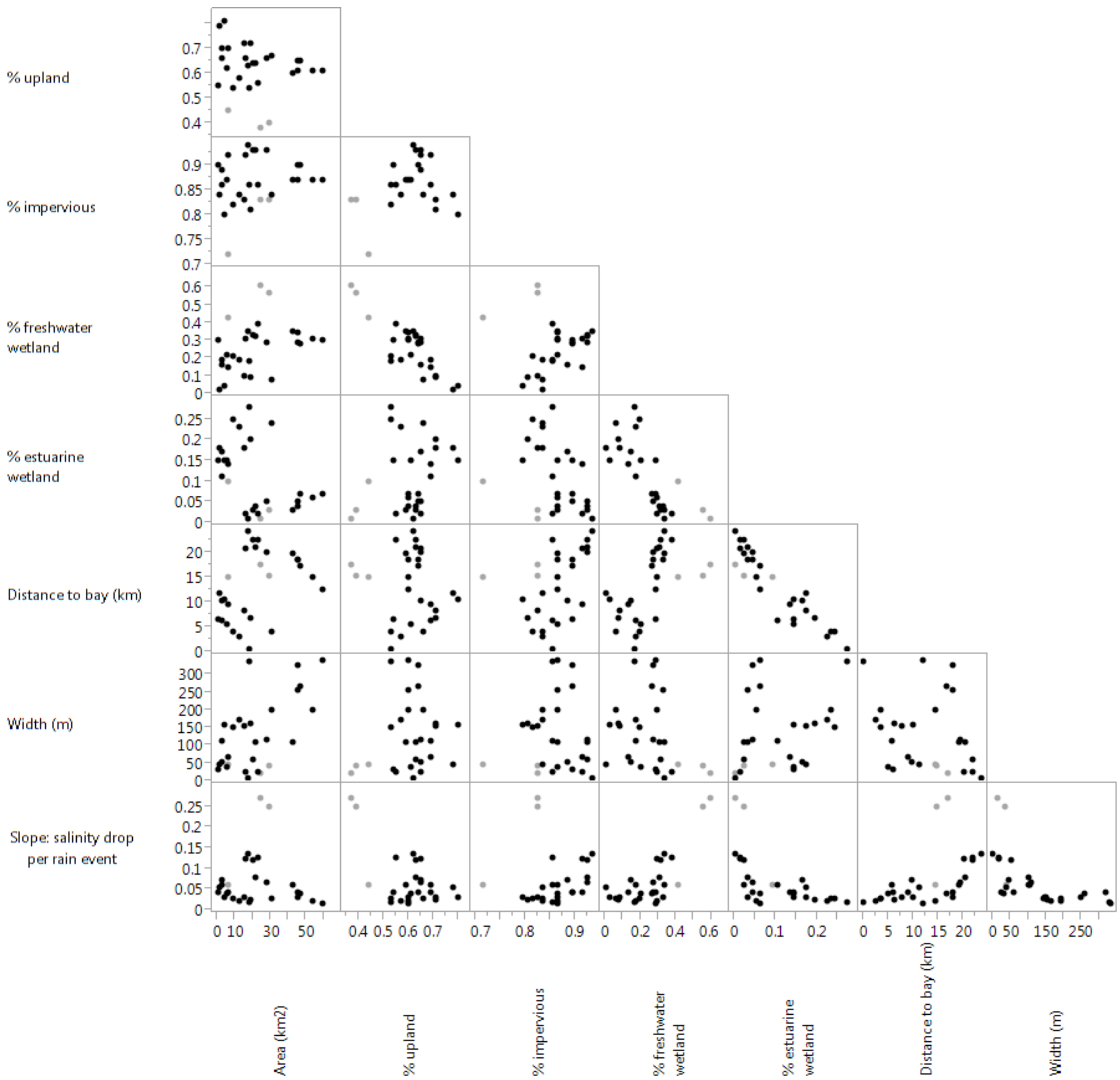


Figure 22. Scatterplot matrix of select variables used in the multivariate analysis. Huspah Creek headwater sites (HP1, HP2, HP3) appear in grey and were included in the analysis. The downstream sites exhibited no significant relationship, likely due to sparse data (max n=5 for Huspah). Variables suggesting curvilinear relationships (e.g., % saltwater wetland) were tested as such in the regression analysis.

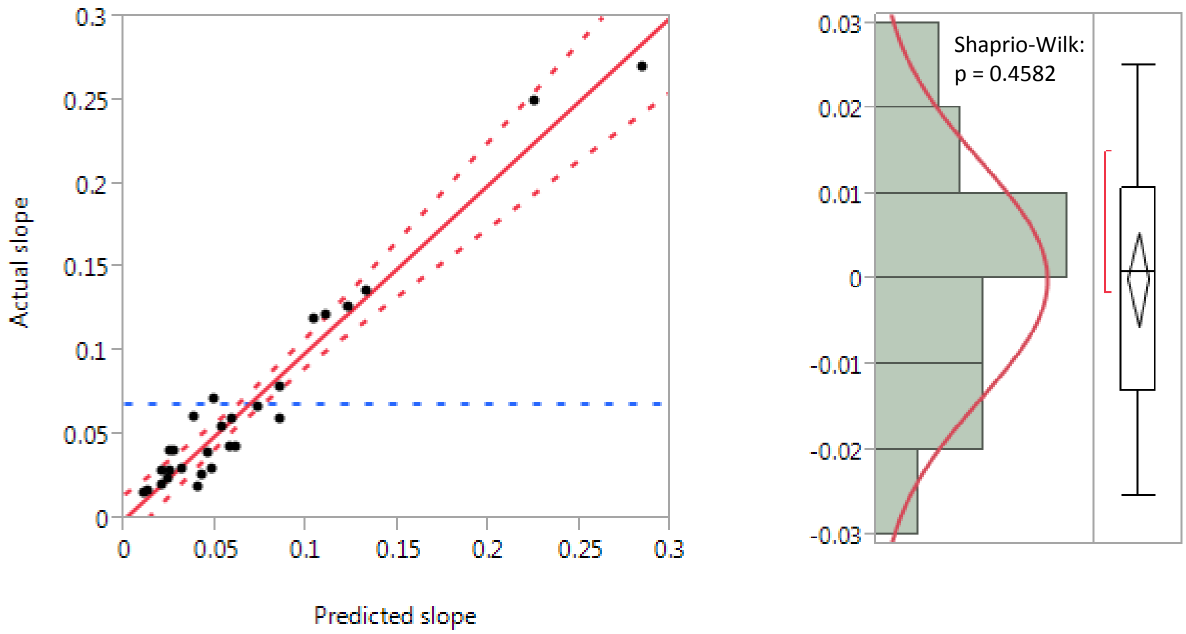


Figure 23. Model performance and normality test of residuals for best regression model to predict slope (salinity drop per mm rainfall) in study subwatersheds for each site.

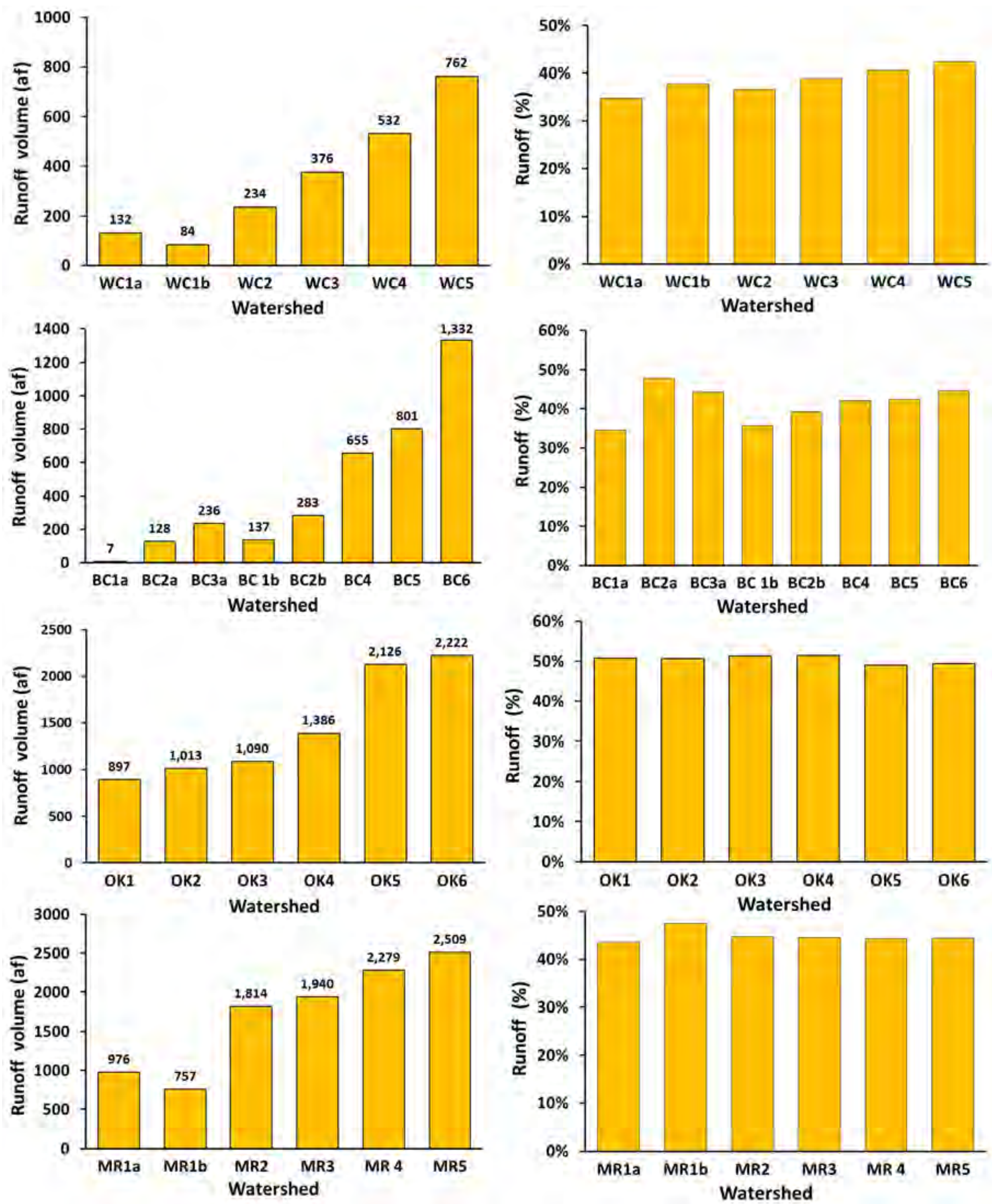


Figure 24. Runoff modeled using a 4.5 inch rain event for each of the 4 primary creek systems. Charts on the left side show output in actual volume (af is acre feet). Charts on the right side show output as a percentage of the rainfall that was converted to runoff (which removes the variance caused by area differences).

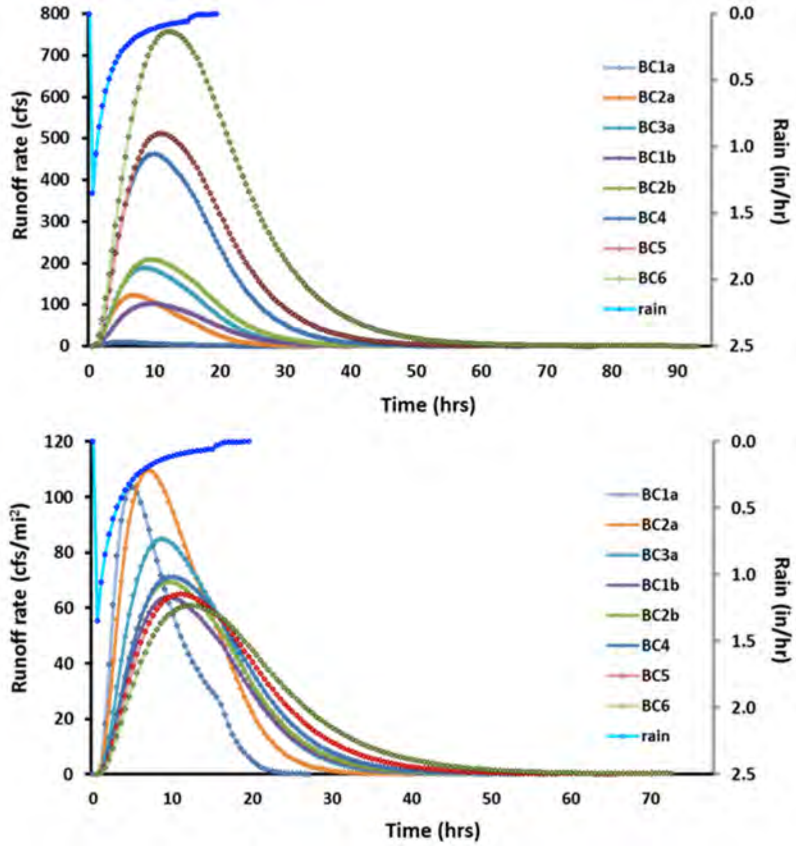


Figure 25. Hydrographs for a design 4.5 inch 24-hour rain event in each Battery Creek watershed for each site. The x-axis shows runoff time, the primary y axis shows runoff rate, and the secondary y-axis rain intensity in inches per hour. The upper chart shows the actual modeled rate in cubic feet per second (cfs). The lower chart shows a normalized rate of cfs per watershed square mile in order to remove the effect of different watershed areas. The space under each curve represents the volume of runoff.

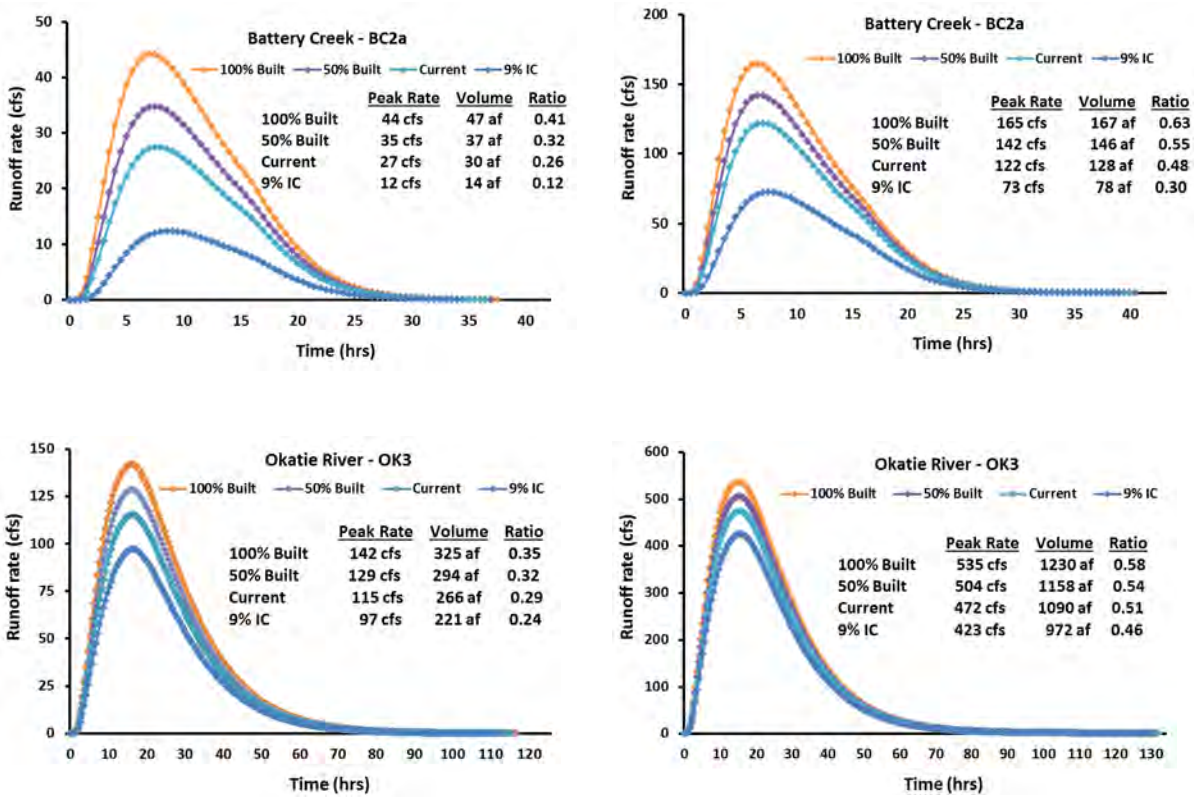


Figure 26. Development scenarios for two of the volume sensitive watersheds: BC2a (top) and OK3 (bottom). The x axis shows runoff time, and the y axis shows runoff rate. The charts on the left are modeled on a 1.95 inch 24-hour rain (95th percentile rain); the charts on the right are based on a 4.5 inch 24-hour rain (2-year storm). 100% Built is projecting additional watershed development for all of dry land not yet developed. 50% Built projects development for 50% of dry land not yet developed. Current is present watershed development. 9% IC is the percent of impervious cover reflecting the threshold of measurable environmental degradation from development. cfs is cubic feet per second, af is acre feet, hrs is hours. Peak rate is the maximum cfs for the modeled runoff. Ratio is proportion of rainfall converted to runoff. The area under each curve represents the volume of runoff.

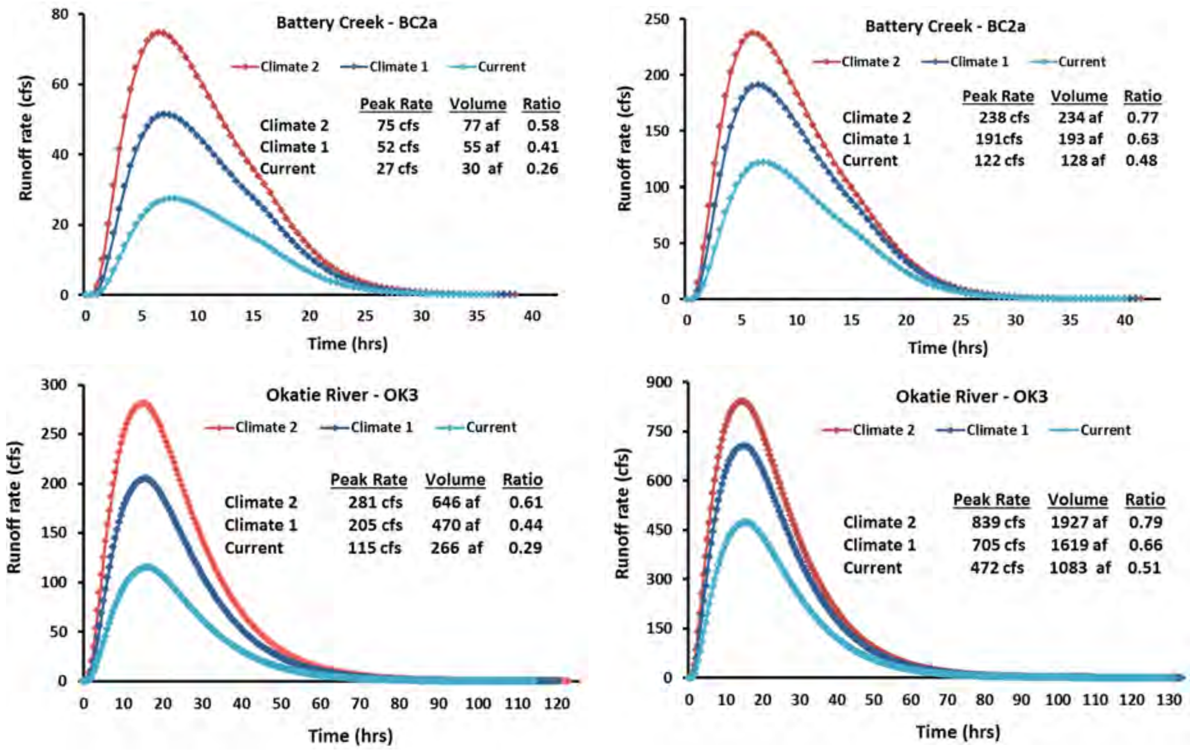


Figure 27. Climate scenarios for two of the volume sensitive watersheds: BC2a (top) and OK3 (bottom). The x axis shows runoff time, and the y axis shows runoff rate. The charts on the left are modeled on a 1.95 inch 24-hour rain (95th percentile rain); the charts on the right are based on a 4.5 inch 24-hour rain (2-year storm). Current scenario uses average antecedent runoff conditions (ARC), Climate 1 scenario uses semi-wet ARC, and Climate 2 scenario uses wet ARC. Both rainfalls are increased by 15% for the climate scenarios. cfs is cubic feet per second, af is acre feet, hrs is hours. Peak rate is the maximum cfs for the modeled runoff. Ratio is proportion of rainfall converted to runoff. The area under each curve represents the volume of runoff.

Table 1. Linear regression equations to predict runoff volume in each watershed at current development levels and with average runoff conditions. Y is runoff (acre feet), and x is rainfall amount (mm). WC is Wallace Creek, BC is Battery Creek, OK is Okatie River, MR is May River.

Watershed	Regression Equation - Volume	r^2
WC1a	$y = 0.0082 x^2 + .2678 x - 6.4477$	0.999
WC1b	$y = 0.0049 x^2 + .2107 x - 4.4992$	0.999
WC2	$y = 0.014 x^2 + .5466 x - 12.144$	0.999
WC3	$y = 0.0215 x^2 + 1.0054 x - 20.695$	0.999
WC4	$y = .0293 x^2 + 1.5625 x - 30.544$	0.999
WC5	$y = 0.0404 x^2 + 2.4311 x - 45.44$	0.999
BC1a	$y = 0.0005 x^2 + 0.0149 x - 0.3621$	0.999
BC2a	$y = 0.006 x^2 + 0.5041 x - 8.3966$	0.999
BC3a	$y = 0.012 x^2 + 0.8198 x - 14.63$	0.999
BC1b	$y = 0.0084 x^2 + 0.2978 x - 6.8798$	0.999
BC2b	$y = 0.016 x^2 + 0.7748 x - 15.739$	0.999
BC4	$y = 0.0349 x^2 + 2.0668 x - 38.851$	0.999
BC5	$y = 0.0425 x^2 + 2.5546 x - 47.755$	0.999
BC6	$y = 0.0672 x^2 + 4.6579 x - 82.831$	0.999
OK1	$y = 0.0391 x^2 + 3.8871 x - 61.48$	0.999
OK2	$y = 0.0443 x^2 + 4.3728 x - 69.403$	0.999
OK3	$y = 0.047 x^2 + 4.797 x - 75.302$	0.999
OK4	$y = 0.0595 x^2 + 6.1264 x - 95.86$	0.999
OK5	$y = 0.0967 x^2 + 8.7356 x - 142.38$	0.999
OK6	$y = 0.1003 x^2 + 9.2319 x - 149.58$	0.999
MR1a	$y = 0.0504x^2 + 3.2746x - 59.547$	0.999
MR1b	$y = 0.0357x^2 + 2.9555x - 49.536$	0.999
MR2	$y = 0.0911x^2 + 6.3921x - 113.2$	0.999
MR3	$y = 0.0979x^2 + 6.7922x - 120.72$	0.999
MR4	$y = 0.1157x^2 + 7.8925x - 141.11$	0.999
MR5	$y = 0.1268x^2 + 8.752x - 155.86$	0.999

Table 2. Salinity drop summary data and regression results for all subwatersheds monitored. Regressions compared rainfall total (mm) to observed salinity drop. Additional variables were studied, but rainfall total exhibited the greatest correlation to salinity drop.

	Salinity drop summary data				Regression: Rain total vs. salinity drop				Salinity drop:rain total
Site	Number Events	Avg. Salinity Drop	St. Dev.	St. Err.	p value	r^2	Slope	St. Err. Slope	LSD t-test
OK1	41	9.76	5.64	0.88	<0.0001	0.54	0.136	0.019	A
OK2	52	5.58	4.00	0.55	<0.0001	0.68	0.119	0.009	B
OK3	38	3.53	2.80	0.45	<0.0001	0.77	0.079	0.006	C
OK4	41	2.69	2.38	0.37	<0.0001	0.74	0.067	0.005	C
OK5	35	1.78	1.37	0.23	<0.0001	0.75	0.041	0.003	C
OK6	35	1.80	1.56	0.26	<0.0001	0.74	0.040	0.003	C
MR1A	24	7.01	4.96	1.01	<0.0001	0.65	0.127	0.018	A
MR1B	18	5.54	4.67	1.10	<0.0001	0.77	0.123	0.016	B
MR2	14	2.83	1.93	0.51	0.0077	0.46	0.060	0.018	BC
MR3	12	2.24	1.74	0.50	0.08	0.22	0.016	0.015	C
MR4	10	1.26	0.73	0.23	0.0099	0.54	0.020	0.006	C
MR5	12	1.34	1.05	0.30	0.147	0.20	0.016	0.010	C
BC1A	22	3.81	2.53	0.54	<0.0001	0.76	0.065	0.008	A
BC2A	22	2.52	2.28	0.49	<0.0001	0.61	0.055	0.009	B
BC3A	28	1.48	1.34	0.25	<0.0001	0.52	0.030	0.005	C
BC1B	23	3.37	2.73	0.57	<0.0001	0.60	0.072	0.012	A
BC2B	26	1.99	1.68	0.33	<0.0001	0.73	0.042	0.005	BC
BC4	19	1.35	1.14	0.26	<0.0001	0.83	0.029	0.003	C
BC5	19	1.28	0.94	0.22	<0.0001	0.81	0.024	0.002	C
BC6	8	1.01	1.20	0.42	0.0006	0.88	0.026	0.004	[1]
WC1A	28	2.90	2.83	0.53	<0.0001	0.45	0.062	0.012	AB
WC1B	29	2.34	1.35	0.25	<0.0001	0.64	0.043	0.006	AB
WC2	29	1.97	1.60	0.30	<0.0001	0.53	0.040	0.007	AB
WC3	24	1.31	0.93	0.19	<0.0001	0.77	0.028	0.003	A
WC4	27	1.18	0.81	0.16	<0.0001	0.57	0.021	0.004	AB
WC5	26	0.92	0.80	0.16	0.0004	0.40	0.017	0.000	B
HP1	5	6.36	6.46	2.89	0.0165	0.89	0.270	0.055	[1]
HP2	4	6.98	6.74	3.37	0.0273	0.95	0.252	0.004	[1]
HP3	4	4.39	1.59	0.79	0.0088	0.98	0.061	0.005	[1]
HP4	4	2.69	1.10	0.55	0.20	-	-	-	
HP5	3	3.07	0.68	0.39	0.75	-	-	-	
HP6	5	3.40	1.41	0.63	0.21	-	-	-	

[1] Too few events for meaningful comparison

Table 3. Model results and parameters for best regression model.

Slope = -0.0002*width – 0.29634*(% est. wet.) + 2.19439 * (% est. wet.)^2 + 0.04187*(% fr. wet.) + 1.45627*(% fr. wet.)^2 + 0.28130*(% imperviousness)

Summary		Model parameters	Estimate	t ratio	p
r^2	0.95	Intercept	-0.16248	-2.62	0.0161
RMSE	0.016	Width	-0.00020	-5.83	<0.0001
Mean	0.069	% estuarine wetlands	-0.29634	-4.12	0.0005
n	28	(% estuarine wetlands)^2	2.19439	3.47	0.0023
$F_{(6,21)}$	70.64	% freshwater wetlands	0.04187	1.01	0.3236
p	<0.0001	(% freshwater wetlands)^2	1.45627	8.70	<0.0001
		% imperviousness	0.28130	3.81	0.0010

Table 4. Summary of land use and land cover attributes for watersheds originating in or near Beaufort County, South Carolina. Bolded sections represent watersheds that were the primary focus of this study. Headwater sections are shown for select large watersheds. Color gradient depicts range from high (red) to low (green) values for each category.

	Land use and land cover % coverages				
Watershed	**Upland developed**	**Upland forest**	**Freshwater wetland**	**Estuarine wetland**	**Water**
Broad Creek	21.5	40.3	7.5	14.6	9.4
May River	9.8	29.0	17.7	20.3	15.7
May River (headwaters)	**11.4**	**34.0**	**29.6**	**5.4**	**4.5**
Okatie and Colleton Rivers	16.4	27.3	16.3	16.5	12.4
Okatie River (headwaters)	**18.7**	**25.8**	**26.8**	**6.3**	**4.5**
Wright River	0.6	12.1	32.4	40.2	5.6
Village Creek	1.2	43.6	17.3	25.2	4.9
Wallace (Capers) Creek	**2.1**	**32.6**	**16.7**	**26.1**	**7.3**
Battery Creek	**21.7**	**32.1**	**7.3**	**21.1**	**12.0**
Chechesse River	1.1	36.5	32.1	16.8	8.3
Chechesse River (headwaters)	0.7	41.5	42.9	6.1	2.5
Euhaw Creek	0.5	39.3	43.1	6.0	3.6
Albergottie Creek	22.9	25.1	15.2	17.7	5.1
Harbor River	2.9	40.7	16.6	13.1	14.0
McCalleys Creek	4.2	19.7	19.0	21.4	21.3
Huspah Creek	**1.6**	**27.1**	**40.9**	**6.9**	**11.2**
Pocotaligo River	2.2	39.7	34.8	7.2	5.4
Tulifiny River	0.9	30.4	47.2	9.6	4.4
Morgan River system	4.5	25.8	11.9	36.6	15.2
Morgan River (headwaters)	5.7	20.1	12.9	40.9	17.9
Boyd Creek system	0.3	32.4	17.2	28.1	17.7
AVERAGE	7.2	31.2	24.1	18.4	9.7

Table 5. Summary of soil classification attributes for watersheds originating in or near Beaufort County, South Carolina. Bolded sections represent watersheds that were the primary focus of this study. Headwater sections are shown for select large watersheds. Color gradient depicts range from high (red) to low (green) values for each category.

Watershed	Soil classification % coverages				
	Somewhat poor	Poor	Very poor	Poor and very poor	All poor categories
Broad Creek	18.8	22.7	19.7	42.4	61.2
May River	25.5	16.8	31.3	48.0	73.6
May River (headwaters)	**10.2**	**2.7**	**24.5**	**27.2**	**37.4**
Okatie and Colleton Rivers	19.8	25.5	26.0	51.5	71.2
Okatie River (headwaters)	**13.5**	**2.4**	**39.0**	**41.4**	**54.9**
Wright River	7.1	11.3	67.5	78.7	85.8
Village Creek	28.9	12.9	33.0	46.0	74.8
Wallace (Capers) Creek	**36.5**	**5.6**	**36.6**	**42.2**	**78.7**
Battery Creek	**30.6**	**8.5**	**28.1**	**36.6**	**67.2**
Chechesse River	7.0	33.3	30.4	63.7	70.7
Chechesse River (headwaters)	25.7	1.7	43.3	45.0	70.6
Euhaw Creek	17.5	25.6	25.9	51.5	69.0
Albergottie Creek	22.6	17.6	25.7	43.3	66.0
Harbor River	8.2	27.2	22.9	50.1	58.3
McCalleys Creek	13.3	13.4	33.7	47.1	60.4
Huspah Creek	**14.3**	**36.3**	**22.7**	**59.0**	**73.3**
Pocotaligo River	16.3	30.1	20.9	51.0	67.3
Tulifiny River	13.3	25.4	31.4	56.9	70.2
Morgan River system	15.3	11.4	42.9	54.3	69.6
Morgan River (headwaters)	8.5	16.9	10.8	27.7	36.2
Boyd Creek system	10.7	18.3	38.6	56.9	67.7
AVERAGE	17.3	17.4	31.2	48.6	65.9

Table 6. Summary of geophysical attributes for watersheds originating in or near Beaufort County, South Carolina. Bolded sections represent watersheds that were the primary focus of this study. Headwater sections are shown for select large watersheds. Color gradient depicts range from high (red) to low (green) values for each category.

	Geophysical characteristics						
Watershed	Area (km^2)	Width at mouth (m)	Perimeter (km)	Depth at mouth (m)	Elevation range (m)	Mean elevation (m)	Mean salinity (psu)
Broad Creek	68	268	44	-6	13	2	29
May River	103	615	60	-11	26	4	30
May River (headwaters)	**79**	**230**	**46**	**-4**	**47**	**4**	**30**
Okatie and Colleton Rivers	151	687	68	-11	22	4	31
Okatie River (headwaters)	**49**	**273**	**68**	**-3**	**26**	**5**	**30**
Wright River	108	317	69	-4	16	2	24
Village Creek	21	137	25	-4	11	3	27
Wallace (Capers) Creek	**19**	**109**	**31**	**-5**	**15**	**2**	**32**
Battery Creek	**32**	**132**	**33**	**-9**	**13**	**3**	**31**
Chechesse River	113	629	57	-9	47	3	30
Chechesse River (headwaters)	56	235	73	-4	24	6	26
Euhaw Creek	88	212	48	-5	32	6	31
Albergottie Creek	22	252	35	-2	17	5	32
Harbor River	8	69	17	-4	16	5	30
McCalleys Creek	16	214	26	-2	16	2	31
Huspah Creek	**63**	**306**	**46**	**-3**	**18**	4	25
Pocotaligo River	128	197	80	-1	20	4	22
Tulifiny River	39	176	53	-1	20	5	14
Morgan River system	73	514	54	-7	13	2	30
Morgan River (headwaters)	24	319	33	-8	12	1	25
Boyd Creek system	42	403	33	-6	13	2	29
AVERAGE	62	300	48	-5	21	4	28

Table 7. Series of models used to investigate relationship between slope (salinity drop per mm rainfall) and various watershed-scale variables. Due to the low sample size, the risk of overfitting increases as the number of model variables increases.

y = slope of salinity drop per rainfall mm

Summary		Model parameters	Estimate	t ratio	p
r^2	0.9422	Intercept	0.3432	10.58	0.0018
RMSE	0.024	% estuarine wetlands	-0.0117	-6.99	0.0060
Mean	0.129				
n	5				
$F_{(1, 3)}$	48.9				
p	0.006				

Summary		Model parameters	Estimate	t ratio	p
r^2	0.9918	Intercept	0.1958	4.35	0.0491
RMSE	0.011	% estuarine wetlands	-0.0178	-9.42	0.0111
Mean	0.129	% very poorly drained soils	0.0088	3.47	0.0740
n	5				
$F_{(2, 2)}$	120.45				
p	0.0082				

Summary		Model parameters	Estimate	t ratio	p
r^2	0.999	Intercept	0.1520	14.73	0.0431
RMSE	0.002	% freshwater wetlands	-0.0066	-7.45	0.0849
Mean	0.129	% estuarine wetlands	-0.0414	-12.95	0.0491
n	5	% very poorly drained soils	0.0028	10.45	0.0608
$F_{(3,1)}$	2289				
p	0.0154				

Table 8. Series of models used to investigate relationship between headwater salinity drop (averaged for all events studied) and various watershed-scale variables. Due to the low sample size, the risk of overfitting increases as the number of model variables increases.

y = average salinity drop for all events

Summary		Model parameters	Estimate	t ratio	p
r^2	0.922	Intercept	2.0125	2.73	0.0717
RMSE	0.904	Area (km^2)	0.0500	5.98	0.0094
Mean	5.694				
n	5				
$F_{(1, 3)}$	35.78				
p	0.0094				

Summary		Model parameters	Estimate	t ratio	p
r^2	0.984	Intercept	1.3901	3.00	0.0953
RMSE	0.4986	% poorly drained soils	0.0650	2.80	0.1073
Mean	5.694	Area (km^2)	0.4209	7.78	0.0161
n	5				
$F_{(2, 2)}$	62.67				
p	0.0157				

Summary		Model parameters	Estimate	t ratio	p
r^2	0.999	Intercept	1.5250	37.70	0.0169
RMSE	0.043	% poorly drained soils	0.0590	29.20	0.0218
Mean	5.694	Area (km^2)	0.0708	39.33	0.0162
n	5	Width at mouth (m)	-0.0058	-16.50	0.0385
$F_{(3,1)}$	5798				
p	0.0097				

Table 9. Model results for full three-variable models predicting headwater sensitivity as measured by slope (salinity drop per mm rainfall) and average salinity drop. All six models were tested, and the results were scored into top 25% (most sensitive) and bottom 25% (least sensitive). The total score across all models is the combined rank score. A score of -6, for instance, indicates that the bottom 25% was predicted in all 6 models, whereas a score of 3 indicates that the watershed was in the top 25% for 3 of the 6 models.

	Statistical modeling results						
Watershed	**Observed slope**	**Model estimate slope**	**% error**	**Observed average drop**	**Model estimate drop**	**% error**	**Combined 25% rank score**
Broad Creek		0.830			6.114		0
May River	**0.125**	**0.125**	**0.000**	**6.250**	**6.245**	**-0.081**	**0**
Okatie and Colleton Rivers	**0.136**	**0.134**	**-1.471**	**9.760**	**9.778**	**0.185**	**3**
Wright River		0.281			8.012		3
Village Creek		0.000			2.981		-5
Wallace (Capers) Creek	**0.050**	**0.050**	**0.000**	**2.600**	**2.604**	**0.161**	**-6**
Battery Creek	**0.065**	**0.066**	**1.538**	**3.500**	**3.550**	**1.425**	**0**
Chechesse River		0.148			7.851		2
Euhaw Creek		0.388			8.040		4
Albercottie Creek		0.083			2.671		-3
Harbor River		0.180			3.317		0
McCalleys Creek		0.142			2.196		-3
Huspah Creek	**0.270**	**0.270**	**0.000**	**6.360**	**6.357**	**-0.052**	**3**
Pocotaligo River		0.245			11.217		5
Tulifiny River		0.376			4.747		3
Morgan River system		0.000			4.384		-3
Boyd Creek system		0.023			3.277		-3

Table 10. Watershed characteristics related to stormwater runoff modeling. Dev. is Development shown as percentage of watershed area, IC is Impervious Cover, and CN is Curve Number - the higher the values the greater the runoff; I_a is Initial Abstraction and reflects the amount of rain needed for runoff to begin; HSG is Hydrologic Soil Group, and C and D are the most impervious of the soil groups.

Watershed	Area		Dev.	IC	CN		I_a (in)	HSG
	Ac	Ha		%	0.20	0.05	($CN_{0.05}$)	C+D
WC1a	1,013	410	7%	3	70.5	59.2	0.34	60%
WC1b	596	241	1%	1	72.5	61.9	0.31	70%
WC2	1,707	691	4%	2	71.8	60.9	0.32	64%
WC3	2,585	1,046	4%	2	73.2	62.8	0.30	63%
WC4	3,498	1,416	3%	2	74.3	64.3	0.28	66%
WC5	4,804	1,944	2%	1	75.3	65.8	0.26	69%
BC1a	58	23	13%	5	70.4	59.0	0.35	39%
BC2a	712	288	57%	30	78.4	70.1	0.21	27%
BC3a	1,419	574	47%	24	76.5	67.4	0.24	40%
BC1b	1,023	414	16%	8	71.1	60.0	0.33	50%
BC2b	1,924	779	25%	14	73.5	63.2	0.29	52%
BC4	4,151	1,680	30%	17	75.2	65.6	0.26	48%
BC5	5,050	2,044	30%	16	75.3	65.8	0.26	50%
BC6	7,979	3,229	24%	13	76.6	67.6	0.24	61%
OK1	4,713	1,907	44%	26	80.0	71.9	0.20	90%
OK2	5,339	2,161	42%	24	79.9	71.8	0.20	91%
OK3	5,673	2,296	40%	23	80.2	72.5	0.19	91%
OK4	7,189	2,909	41%	21	80.3	72.7	0.19	91%
OK5	11,565	4,680	33%	17	79.1	70.5	0.21	92%
OK6	12,008	4,859	32%	17	79.3	70.8	0.21	92%
MR1a	5,984	2,422	15%	8	76.0	66.7	0.25	78%
MR1b	4,253	1,721	40%	20	78.3	69.9	0.22	72%
MR2	10,819	4,378	24%	13	76.7	67.7	0.24	74%
MR3	11,616	4,701	22%	12	76.6	67.6	0.24	74%
MR4	13,732	5,557	20%	10	76.5	67.4	0.24	74%
MR5	15,056	6,093	19%	10	76.6	67.5	0.24	74%

Table 11. BMP and development scenarios for the subwatersheds in each system identified as more volume sensitive. IC is Impervious Cover, Dev. Is Developed, and CN is Curve Number – the higher the values the greater the runoff; I_a is Initial Abstraction and reflects the amount of rain needed for runoff to begin; af is acre feet; and Ratio is proportion of rainfall converted to runoff. Target Retrofit is the development level at which minimum degradation to water quality occurs. 50% Build Out is projecting additional watershed development for half of all dry land not yet developed. 100% Build Out projects for all of dry land not yet developed. Target Volume Reduction is volume of runoff required to be reduced in order to reach Target Retrofit scenario.

Watershed & Area (ha)	Development Scenario	IC	Dev.	CN 0.20	CN 0.05	I_a (in) ($CN_{0.05}$)	Runoff - 1.95" rain Volume (af)	Runoff - 1.95" rain Ratio	Target Volume Reduction (af)
WC1a	Current Development	3%	7%	71	59	0.34	26	0.16	–
410	Target Retrofit	9%	27%	74	65	0.27	33	0.20	–
	50% Build Out	16%	38%	77	68	0.24	38	0.23	5
	100% Build Out	29%	69%	83	76	0.16	55	0.34	22
WC1b	Current Development	1%	1%	72	62	0.31	17	0.18	–
241	Target Retrofit	9%	21%	76	66	0.25	21	0.22	–
	50% Build Out	18%	28%	77	68	0.23	23	0.24	2
	100% Build Out	35%	55%	82	75	0.17	31	0.32	10
BC2a	Current Development	30%	57%	78	70	0.21	30	0.26	16
288	Target Retrofit	9%	30%	67	54	0.42	14	0.12	–
	50% Build Out	35%	66%	82	75	0.16	37	0.32	23
	100% Build Out	40%	74%	86	81	0.12	47	0.41	33
BC1b	Current Development	8%	16%	71	60	0.33	27	0.16	–
414	9% Impervious Cover	9%	25%	73	62	0.30	30	0.18	–
	50% Build Out	20%	41%	77	68	0.24	39	0.23	9
	100% Build Out	32%	66%	83	76	0.16	55	0.33	25
OK3	Current Development	23%	40%	80	73	0.19	266	0.29	45
2,296	Target Retrofit	9%	25%	77	69	0.23	221	0.24	–
	50% Build Out	30%	51%	82	75	0.17	294	0.32	73
	100% Build Out	36%	63%	83	77	0.15	325	0.35	104
MR2	Current Development	13%	24%	77	68	0.24	408	0.23	10
4,378	Target Retrofit	9%	24%	76	67	0.24	398	0.23	–
	50% Build Out	23%	42%	80	72	0.19	491	0.28	93
	100% Build Out	33%	61%	83	76	0.16	592	0.34	194

Table 12. Climate scenarios for the watersheds identified as the most volume sensitive. CN is Curve Number – the higher the value the greater the runoff; I_a is Initial Abstraction and reflects the amount of rain needed for runoff to begin; af is acre feet and Ratio is proportion of rainfall converted to runoff. Current Conditions reflects average antecedent runoff conditions and 1.95 inch rain. Both Climate Scenarios increase rainfall by 15%. Climate 1 reflects semi-wet runoff conditions, and Climate 2 reflects wet runoff conditions.

Watershed & Area (ha)	Climate Scenario	CN 0.20	CN 0.05	I_a (in) ($CN_{0.05}$)	Runoff - 1.95" rain Volume (af)	Runoff - 1.95" rain Ratio
WC1a	Current Conditions	71	59	0.34	26	0.16
410	Climate 1	78	70	0.22	54	0.29
	Climate 2	86	81	0.12	84	0.44
WC1b	Current Conditions	72	62	0.31	17	0.18
241	Climate 1	80	72	0.20	35	0.31
	Climate 2	87	82	0.11	53	0.48
BC2a	Current Conditions	78	70	0.21	30	0.26
288	Climate 1	84	79	0.14	55	0.41
	Climate 2	90	87	0.07	77	0.58
BC1b	Current Conditions	71	60	0.33	27	0.16
414	Climate 1	79	70	0.21	56	0.29
	Climate 2	86	81	0.12	87	0.45
OK3	Current Conditions	80	73	0.19	266	0.29
2,296	Climate 1	86	81	0.12	470	0.44
	Climate 2	91	89	0.06	646	0.61
MR2	Current Conditions	77	68	0.24	408	0.23
4,378	Climate 1	83	77	0.15	769	0.38
	Climate 2	89	86	0.08	1108	0.55

MAY RIVER WATERSHED SANITARY SEWER MASTER PLAN

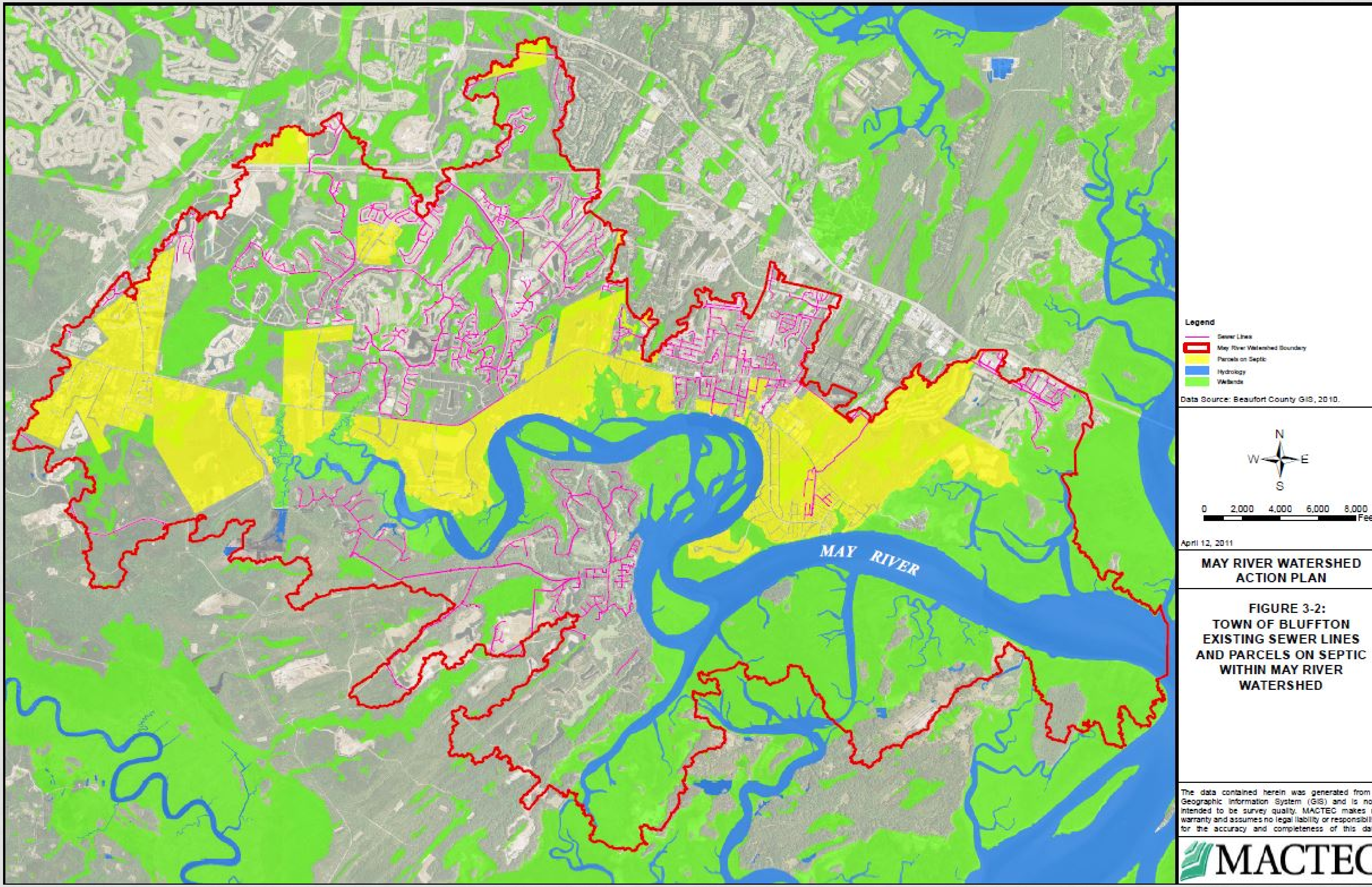
JOHN HUTCHINSON 8/26/15

May River Watershed Action Plan Background

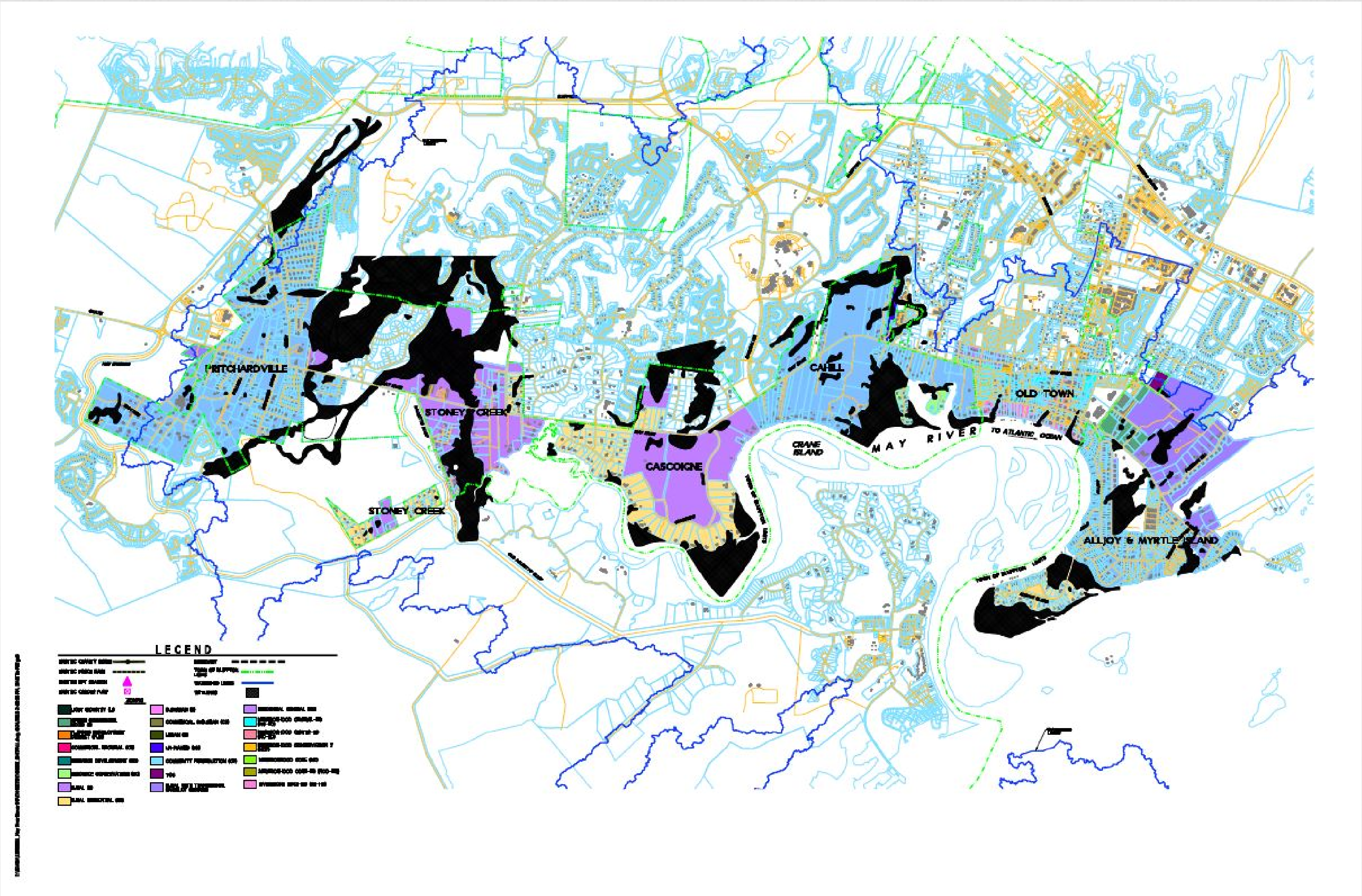
- Fast paced development
- Degradation of May River headwaters
- Primarily reactive approach in the past
- Large amounts of data collected
- Coordinated proactive campaign needed

May River Watershed Action Plan History

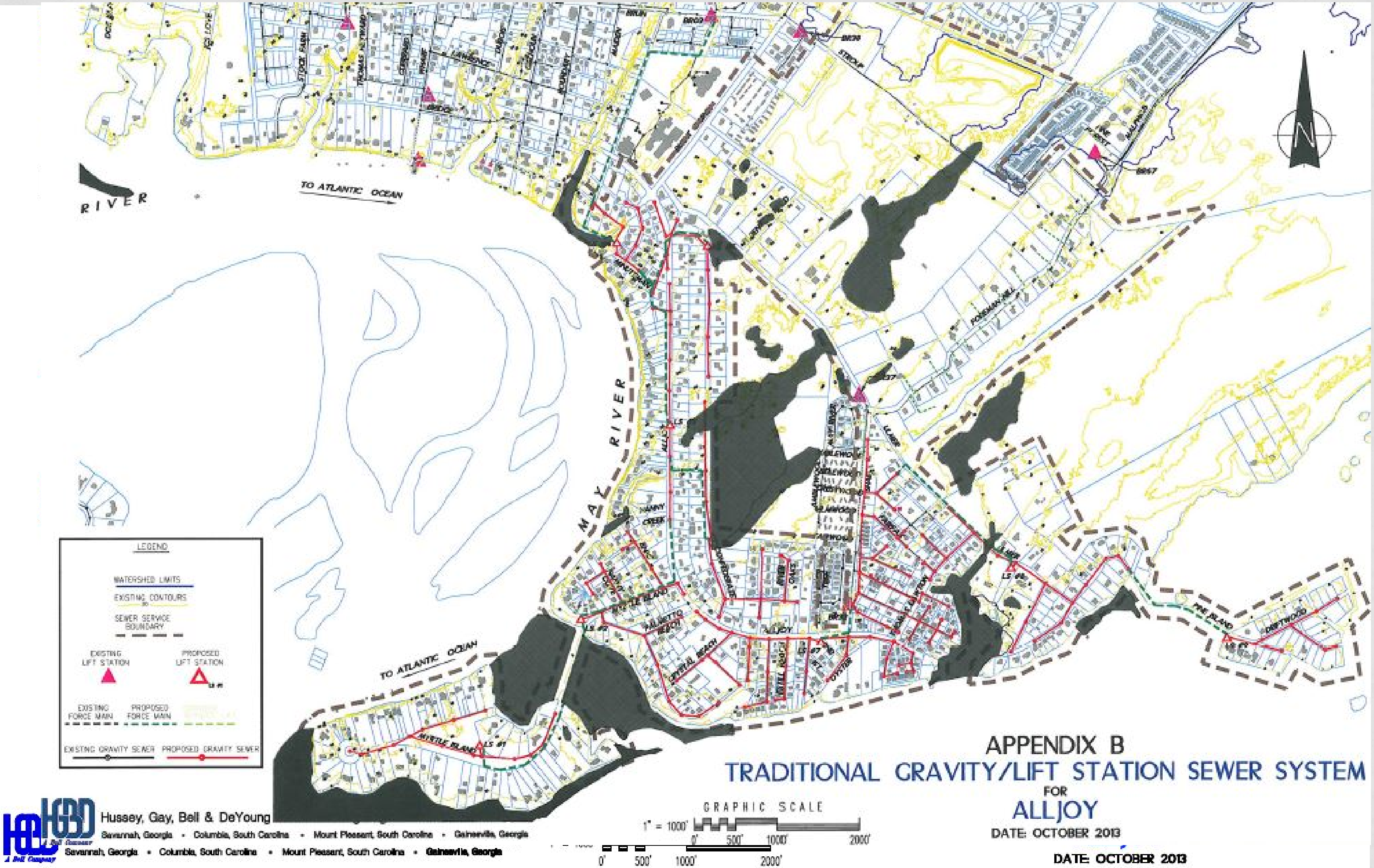
- Town Council Approved the hiring of consultant for MRWAP completion (August 10, 2010)
- Draft MRWAP released for public review and comment (July 18, 2011)
- Public review and comment period over (August 17, 2011)
- Public Workshop and Draft MRWAP presentation (October 12, 2011)
- Draft MRWAP Planning Commission Presentation (October 26, 2011)
- Town Council reviewed and approved (November 9, 2011)



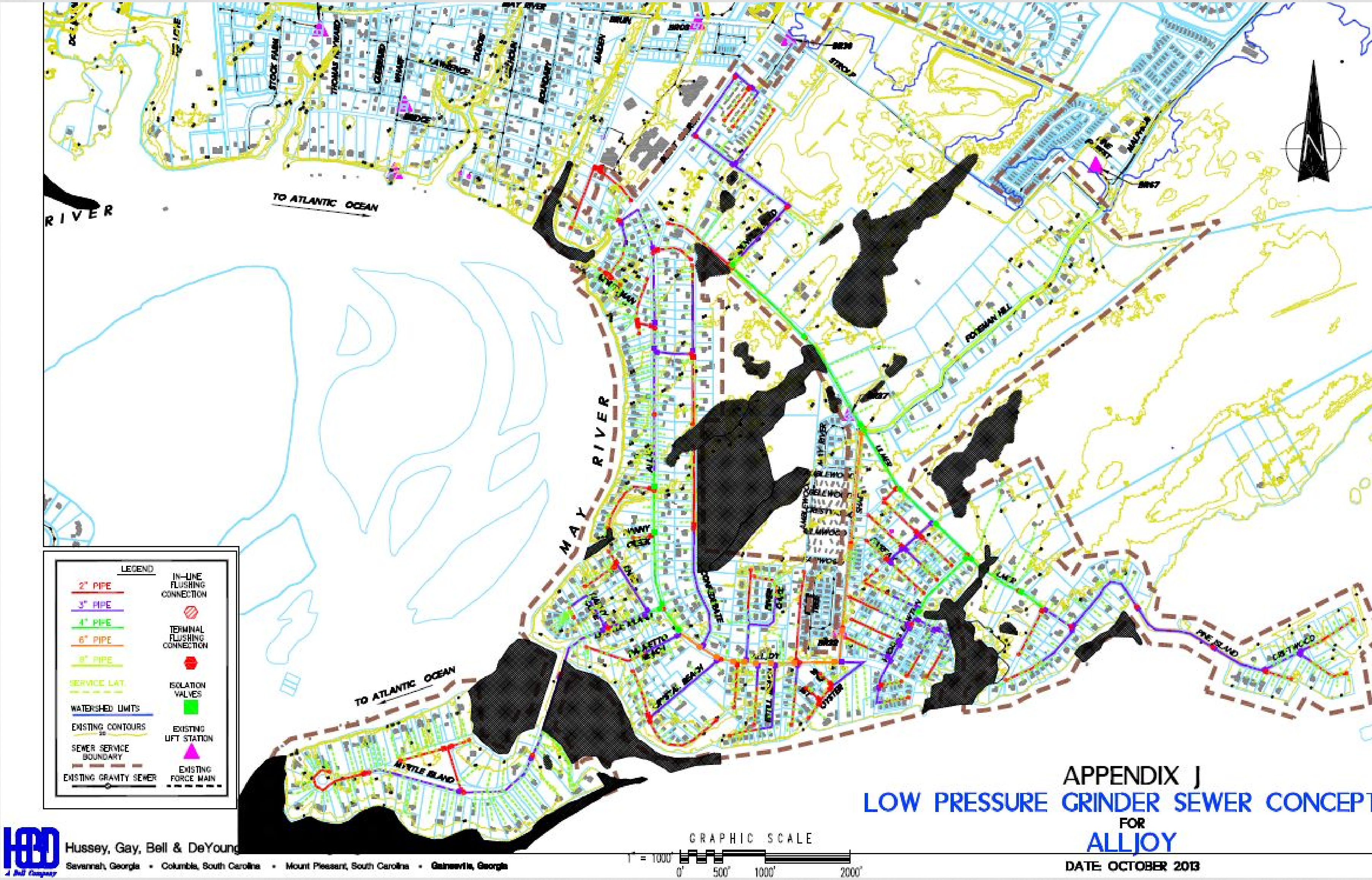
MAY RIVER
Legend
Sewer Lines
May River Watershed Boundary
Parcels on Septic
Hydrology
Wetlands
Data Source: Beaufort County GIS, 2010.
N
W
E
S
0
2,000
4,000
6,000
8,000
Feet
April 12, 2011
MAY RIVER WATERSHED ACTION PLAN
FIGURE 3-2:
TOWN OF BLUFFTON EXISTING SEWER LINES AND PARCELS ON SEPTIC WITHIN MAY RIVER WATERSHED
The data contained herein was generated from a Geographic Information System (GIS) and is not intended to be survey quality. MACTEC makes no warranty and assumes no legal liability or responsibility for the accuracy and completeness of this data.
MACTEC


PRITCHARDVILLE
STONEY CREEK
STONEY CREEK
CASCOIGNE
CAHILL
OLD TOWN
CRANE ISLAND
MAY RIVER
TO ATLANTIC OCEAN
ALLJOY & MYRTLE ISLAND
LEGEND

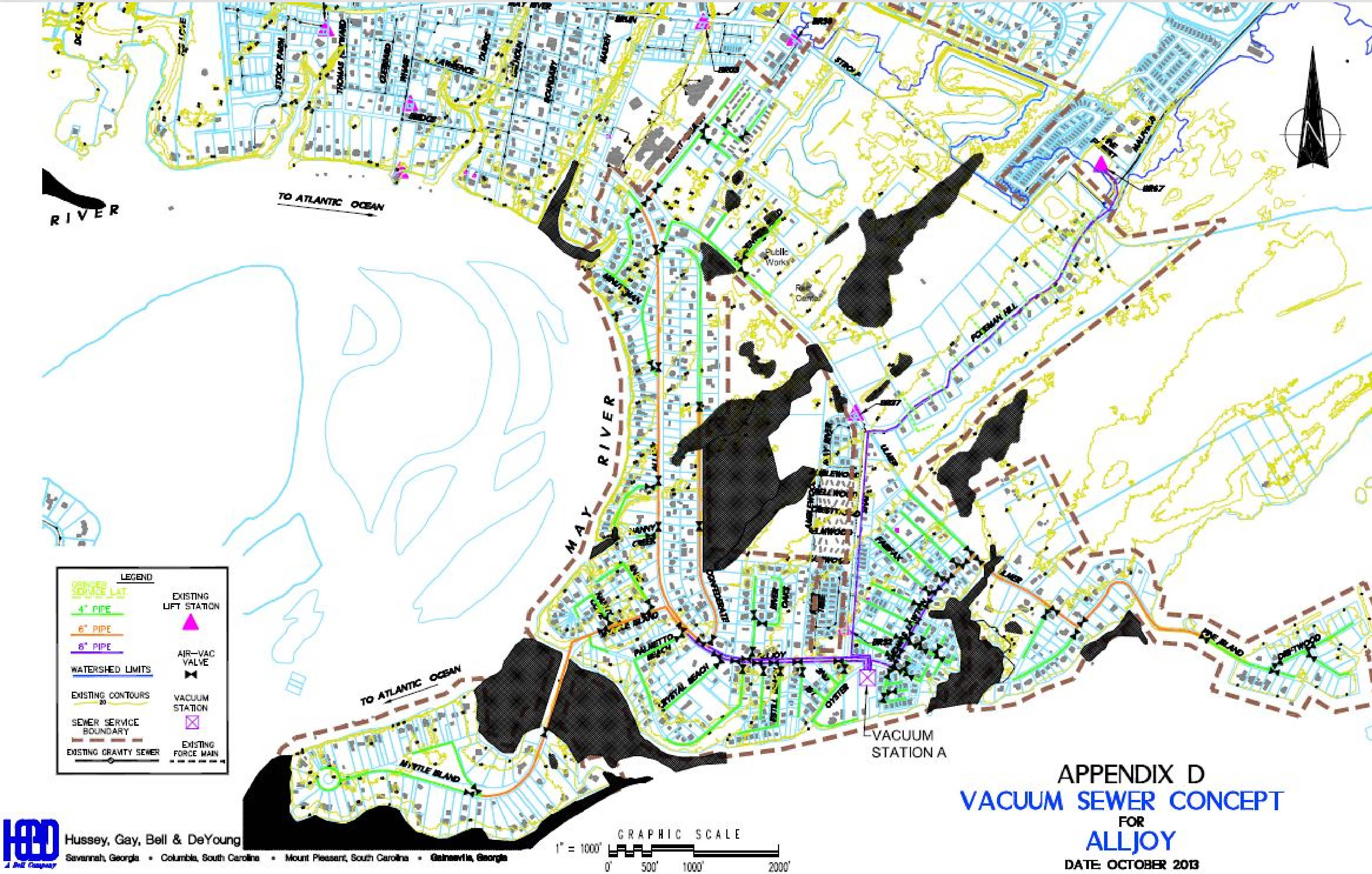
Buildout Infrastructure				
Area	No. of Existing Structures[1]	No. of Vacant Lots[2]	No. of Future Lots[3]	No. of Structures (Buildout)[4]
Old Town[7]	104	47	0	151
Alljoy	684	201	713	1,598
Cahill	99	32	10	141
Stoney Creek	150	40	10	200
Prichardville	502	100	100	702
Gascoigne	55	22	40	117
TOTAL	**1,594**	**442**	**873**	**2,909**



RIVER
TO ATLANTIC OCEAN
MAY RIVER
LEGEND
WATERSHED LIMITS
EXISTING CONTOURS
SEWER SERVICE BOUNDARY
EXISTING LIFT STATION
PROPOSED LIFT STATION
EXISTING FORCE MAIN
PROPOSED FORCE MAIN
EXISTING GRAVITY SEWER
PROPOSED GRAVITY SEWER
TO ATLANTIC OCEAN
APPENDIX B
TRADITIONAL GRAVITY/LIFT STATION SEWER SYSTEM
FOR
ALLJOY
DATE: OCTOBER 2013
GRAPHIC SCALE
1" = 1000'
0' 500' 1000' 2000'
Hussey, Gay, Bell & DeYoung
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia
0' 500' 1000' 2000'
DATE: OCTOBER 2013



APPENDIX J
LOW PRESSURE GRINDER SEWER CONCEPT
FOR
ALLJOY
DATE: OCTOBER 2013
LEGEND
2" PIPE
3" PIPE
4" PIPE
6" PIPE
8" PIPE
SERVICE LAT.
WATERSHED LIMITS
EXISTING CONTOURS
SEWER SERVICE BOUNDARY
EXISTING GRAVITY SEWER
IN-LINE FLUSHING CONNECTION
TERMINAL FLUSHING CONNECTION
ISOLATION VALVES
EXISTING LIFT STATION
EXISTING FORCE MAIN
GRAPHIC SCALE
1" = 1000'
0' 500' 1000' 2000'
TO ATLANTIC OCEAN
MAY RIVER
RIVER
MYRTLE ISLAND
PINE ISLAND
DRIFTWOOD
ALLJOY
OYSTER
Hussey, Gay, Bell & DeYoung
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

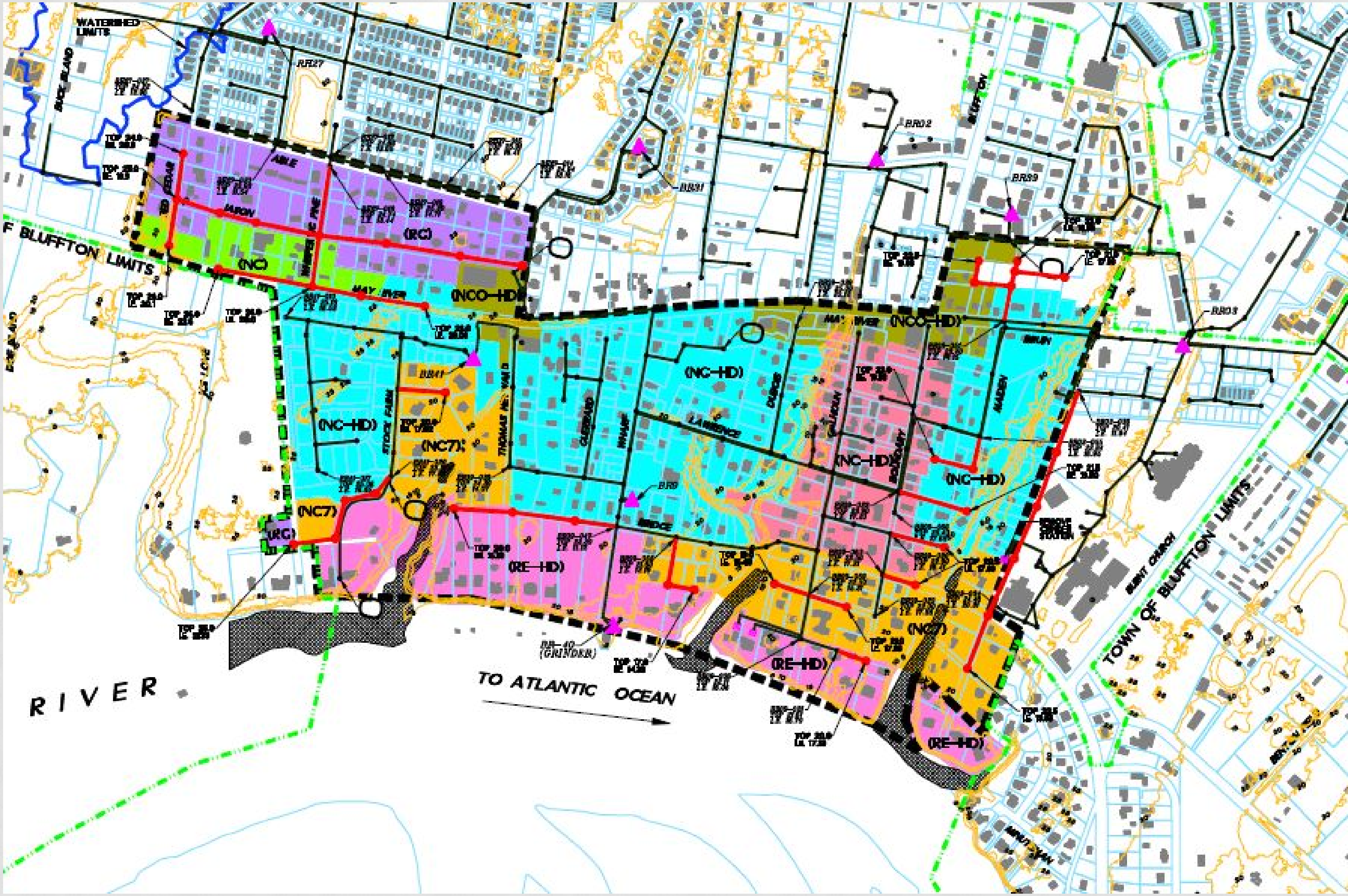

RIVER
TO ATLANTIC OCEAN
MAY RIVER
TO ATLANTIC OCEAN
Public Works
VACUUM STATION A
LEGEND
GRINDER SERVICE LAT.
4" PIPE
6" PIPE
8" PIPE
WATERSHED LIMITS
EXISTING CONTOURS
SEWER SERVICE BOUNDARY
EXISTING GRAVITY SEWER
EXISTING LIFT STATION
AIR-VAC VALVE
VACUUM STATION
EXISTING FORCE MAIN
MYRTLE ISLAND
PALMETTO BEACH
CRYSTAL BEACH
ALLJOY
OYSTER
FOREMAN HILL
DRIFTWOOD
Hussey, Gay, Bell & DeYoung
A Bell Company
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia
GRAPHIC SCALE
1" = 1000'
0' 500' 1000' 2000'
APPENDIX D
VACUUM SEWER CONCEPT
FOR
ALLJOY
DATE: OCTOBER 2013

GRAVITY SEWER EXTENSION SYSTEM BUDGET COST
ESTIMATE MAY RIVER WATERSHED SEWER MASTER PLAN -
PHASE I ALLJOY SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	8" PVC Gravity Sewer	50,000	LF	$ 26.00	$ 1,300,000.00
2	Manholes, 4' diameter, standard	180	EA	$ 3,000.00	$ 540,000.00
3	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC gravity main	300	LF	$ 150.00	$ 45,000.00
4	Insert 8-inch PVC gravity main in casing	300	LF	$ 50.00	$ 15,000.00
5	4-inch PVC force main, AWWA C900, SDR-18	14,299	LF	$ 16.00	$ 228,777.60
6	4-inch RJ PVC force main, AWWA C900, SDR-18	1,678	LF	$ 18.00	$ 30,204.00
7	4-inch DI Force Main	503	LF	$ 24.00	$ 12,081.60
8	Misc. Force Main Fittings	6,041	LBS	$ 5.00	$ 30,204.00
9	Force Main Air Release Valve and Manhole	10	EA	$ 3,000.00	$ 30,000.00
10	Core into Termination Manhole for Force Main	1	EA	$ 3,000.00	$ 3,000.00
11	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC force main	300	LF	$ 150.00	$ 45,000.00
12	Insert 8-inch PVC force main in casing	300	LF	$ 50.00	$ 15,000.00
13	New Duplex Lift Station	9	LS	$ 250,000.00	$ 2,250,000.00
14	4-inch lateral to easement or R/W line (near side)[1]	6,590	LF	$ 12.00	$ 79,080.00
15	4-inch lateral to easement or R/W line (far side)[1]	13,180	LF	$ 40.00	$ 527,200.00
16	Simplex Fiberglass Grinder Station[2]	25	EA	$ 4,572.00	$ 114,300.00
17	1-1/4" HDPE SDR9 Service Lateral[2]	1,500	LF	$ 10.00	$ 15,000.00
18	Connect Lateral to Existing Force Main[2]	25	EA	$ 2,000.00	$ 50,000.00
19	Electrical Home Connection[2]	25	EA	$ 2,500.00	$ 62,500.00
20	Clean outs	659	EA	$ 75.00	$ 49,425.00
21	Silt Fence	79,776	LF	$ 3.50	$ 279,216.00
22	Grassing (Temporary and Permanent)	22,160	SY	$ 2.00	$ 44,320.00
23	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	700	CY	$ 70.00	$ 49,000.00
24	Remove driveway surface, replace with 2" graded aggregate[3]	684	EA	$ 160.00	$ 109,440.00
25	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	33,240	SY	$ 70.00	$ 2,326,800.00
26	Decommissioning of existing septic tank[5]	684	EA	$ 500.00	$ 342,000.00
27	Traffic Control	1	JOB	Lump Sum	$ 20,000.00
28	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 516,752.89
				Subtotal	**$ 9,129,301.09**
	Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)				$ 547,758.07
				Engineering Fees (15%)	$ 1,369,395.16
				Construction Contingencies (15%)	$ 1,369,395.16
				Estimated Probable Cost	$ 12,415,849.49
				CALL **I,II, III, IV**	**$ 12,500,000.00**
No. of existing customers:					**684**
Cost per customer:					**$ 18,300.00**

Table 2: Sewer System Anticipated Cost Estimate Summary

Service Area	Type of Sewer System							
	Vacuum Sewer System	Vacuum Sewer System Per Developed Lot	Low Pressure Sewer System	Low Pressure Sewer System Per Developed Lot	Gravity Sewer System	Gravity Sewer System Per Developed Lot	Gravity/Low Pressure System Combines	Gravity/Low Pressure System Combined Per Developed Lot
Alljoy	$10,300,000	$15,100	$11,800,000	$17,300	$12,500,000	$18,300	N/A	N/A
Old Town	N/A	N/A	N/A	N/A	$2,600,000	$25,000	N/A	N/A
Cahill	$4,100,000	$41,500	$3,700,000	$37,400	N/A	N/A	N/A	N/A
Gascoigne	$3,000,000	$55,600	$2,100,000	$38,900	N/A	N/A	N/A	N/A
Stoney Creek	$4,700,000	$31,400	$4,400,000	$29,400	N/A	N/A	N/A	N/A
Pritchardville	$9,500,000	$19,000	$10,500,000	$21,000	N/A	N/A	$10,700,000	$21,400



WATERSHED LIMITS
F BLUFFTON LIMITS
ABLE
JASON
MAY RIVER
(RC)
(NC)
(NCO-HD)
(NC-HD)
(NC7)
(RG)
(RE-HD)
LAWRENCE
BRIDGE
STOCK FARM
BR41
BR9
BR-40 (GRINDER)
BR31
BR02
BR39
BR03
RR27
RIVER
TO ATLANTIC OCEAN
TOWN OF BLUFFTON LIMITS

MAY RIVER WATERSHED SEWER MASTER PLAN STUDY AND REPORT – PHASE I

FOR

BEAUFORT-JASPER WATER & SEWER AUTHORITY AND TOWN OF BLUFFTON

BEAUFORT-JASPER
WATER & SEWER
AUTHORITY

Prepared by

HGBD
A Bell Company

APRIL 2014

Hussey Gay Bell & DeYoung, Inc.
Consulting Engineers
SAVANNAH • GAINESVILLE • CHARLESTON • COLUMBIA
www.hgbd.com

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EXHIBIT 7 - Overall Sewer Service Areas

May River Watershed Sewer Master Plan Study and Report – Phase I
March 2014

EXECUTIVE SUMMARY:

Hussey, Gay, Bell & DeYoung, Inc. (HGBD) was retained by Beaufort-Jasper Water & Sewer Authority (BJWSA) and the Town of Bluffton (Town) regarding a sewer master plan for the May River Watershed. The project is a joint effort between BJWSA, the Town and Beaufort County to mitigate the usage of septic tanks which negatively impact not only public health but also ground water quality and, ultimately, the water bodies in and around the Town. The master plan is intended to provide long range planning of capital projects based on the perceived need, popular demand, benefit to the environment, public health and project cost to benefit. An analysis of the capacity of the existing sewer collection system and any necessary capacity improvements was not within the scope of the study.

This study evaluated how to determine the most economical way to extend BJWSA sewer service to six areas along the May River, from Pritchardville to Alljoy Landing, as shown on **Exhibit 7**. The six primary areas that were evaluated include:

- Pritchardville – 1,047 Acres +/-
- Stoney Creek – 747 Acres +/-
- Gascoigne Bluff – 657 Acres +/-
- Cahill – 709 Acres +/-
- Old Town – 291 Acres +/-
- Alljoy – 903 Acres +/-

The probable total budget cost for the conceptual utility infrastructure includes easement preparation and legal fees, contingency and engineering. Several sewer system alternatives and technologies were evaluated with anticipated cost estimates and conceptual layouts prepared for each area.

Sewer service in the Old Town and Alljoy areas has proven to be the most cost effective and acceptable to phasing the construction if desired.

A. BACKGROUND INFORMATION

I. PURPOSE:

Service Area Delineation

- To determine sewer service boundary area for each study area
- To delineate sewer service area and determine existing conditions (i.e. zoning, population, acreage, number of septic tanks)

Projected Sewer Flows

- To determine the number of "ready to serve" sewer connections based on the existing zoning
- To estimate the future number of sewer connections based on the existing land use and development
- To determine the current and future sewer flows for each area based on 300 gallons per day per equivalent residential unit (300 GPD/ERU)

Sewer Collection Details

- Develop a concept layout for sewer collection for the alternate system within each service area
- Develop "order of magnitude" cost estimates for sewer collection system only in each service area

Service Area Rankings

- Develop criteria for ranking each sewer service area (i.e. number of septic tanks removed, number of future sewer connections, proximity to the May River, proximity to BJWSA sewer system, public interest, sewer cost, etc.)

II. AUTHORIZATION:

This study has been completed under a contract with BJWSA for May River Watershed Sewer Master Plan – Phase I, fully executed on April 15, 2013.

III. STUDY AREA:

The service areas are defined by septic tank users within the May River Watershed Limits. These areas were divided into six (6) distinct areas, known as the following:

- Pritchardville – 1,047 Acres +/-
- Stoney Creek – 747 Acres +/-
- Gascoigne Bluff – 657 Acres +/-
- Cahill – 709 Acres +/-
- Old Town – 291 Acres +/-
- Alljoy – 903 Acres +/-

The study area limits are shown in **Exhibits 1-7**. The study area was defined based on input from BJWSA and the Town of Bluffton.

IV. ZONING:

The zoning of properties within the study area is depicted in **Exhibits 1-7**, which has been reproduced from zoning districts maps, provided by the Town of Bluffton and GIS information from BJWSA. The zoning classifications have been used to derive probable build-out wastewater flows.

B. DERIVATION OF PROJECTED FLOWS

The scope of determining current sewer flows was based the assumptions that every lot with an existing building structure contains one (1) septic tank and drain field. The buildings, parcels and zoning information were provided by BJWSA GIS Department for HGBD's use. Only "order of magnitude" estimates can be made in the absence of final development plans for the study areas in regards to future / build-out sewer flows.

The scope also included the assumption that each building equates to 300 gpd/eru. Therefore the following table outlines the number of existing, undeveloped/vacant, and build-out lots and the anticipated sewer flows:

Table 1: Buildout Sewer Flows

Area	No. of Developed Lots[1]	No. of Undeveloped/ Vacant Lots[2]	No. of Future Lots[3]	Total No. of Lots (Buildout)[4]	Average Day Demand (GPD)[5]	Peak Day Demand (GPD)[6]
Alljoy	684	201	713	1,598	479,330	1,198,326
Old Town[7]	104	47	0	151	45,300	113,250
Cahill	99	32	10	141	42,300	105,750
Gascoigne	55	22	40	116	34,800	87,000
Stoney Creek	150	40	10	200	60,000	150,000
Pritchardville	502	100	100	702	210,600	526,500
Total	**1,593**	**442**	**873**	**2,908**	**872,330**	**2,180,826**

Assumptions:

1. Assume parcels with a structure have one (1) septic tank and drain field.
2. Vacant or undeveloped lots based on existing parcels without a structure that will require a connection to the proposed sanitary sewer system once the lot is occupied.
3. Future count is based on large developable tracts of land, and assumes the tracts can be subdivided based on current zoning regulations and adjacent properties that are developable. Count determined by a proportion of developable land area (does not include wetland areas) to subdivide.
4. The number of structures at buildout conditions assumes all existing parcels with septic tank, currently vacant lots, and future lots are occupied with sanitary sewer connection.
5. Assumes 300 GPD/structure
6. Assumes 2.5 peaking factor
7. Count of current structures is based on total structures that have one (1) septic tank. Parcels currently connected to sanitary sewer system are not included.

For the basis of this report, the developed and undeveloped/vacant lot count was used for design analysis and construction cost estimating of each. However, only developed lots were used for cost estimations for the number of valve pits and/or connection points.

C. DISCUSSION OF SEWER SYSTEM IMPROVEMENT ALTERNATIVES

There are many sanitary sewer collection system alternatives available. HGBD has had previous experience with each of these alternatives. This section discusses the pros and cons of these different sewer collection system alternatives. The following alternatives were reviewed for each service area:

I. No Action

The No Action option is not the preferred option for any of the service areas as it does not remove the septic tank and drain field from the May River Watershed. However, this option could be a viable economic solution for remote and less densely populated areas such as Gascoigne or an area significantly distanced from the May River such as the northern portion of Pritchardville. The other service areas do not benefit from the No Action option.

It is recommended that a Septic Operations & Maintenance and Inspection Agreement be implemented between the property owner and the authority (i.e. Town, County, or BJWSA) if the No Action alternative is pursued. The Agreement would serve as a periodic review of the condition and function of the septic tank and drain field. At the authorities' discretion a cost for managing the inspections of the septic tanks and drain fields would be borne by the property owner.

II. Gravity Sanitary Sewer Extensions

Significant extensions of the existing gravity sewers into the service areas are not possible because of their depths, with the exception of Old Town.

Old Town has a significant amount of existing gravity sanitary sewer mains within its service area. These manholes have depths which allow for extensions of the gravity sanitary sewer mains.

Appendix A includes the gravity sanitary sewer extension system concept layout and cost estimate for Old Town.

The advantage to gravity sewer is that it is easier to phase, which makes funding smaller project over time more manageable.

III. New Traditional Gravity/Lift Station Sanitary Sewer System

A new traditional gravity sanitary sewer collection system including new lift stations and force mains is the most preferred alternative. A great benefit to this alternative is the ability to phase the installation according to available funding and the proven longevity of the system. This alternative can be implemented in all of the service areas.

However, there are factors that increase the cost and regulatory concern. Gravity sewer mains generally are installed from depths of 3-ft to 20-ft. The new system would connect to an existing gravity sewer system or if one is not present, a new lift station would be required. Due to significantly sized trees close to or within the right-of-way and private drives the depths of the gravity mains would be limited to approximately 10-ft in order to avoid extensive excavation during installation. This increases the number of new lift stations required which is a significant cost factor. Additionally, sewer mains may be installed within the roadway in order to avoid damage to tree roots. This requires single-lane access during construction, increase cost due to removal and replacement of asphalt.

This option was reviewed in detail for the Alljoy service area due to the limited number of main highways and highly dense population.

Appendix B includes the new traditional gravity/lift station sanitary sewer system concept layout and cost estimate for Alljoy.

Traditional gravity sewer collection is an option, however, it may not viable due to the cost of installation of deep sewers, replacement of existing landscape and roadways.

Additionally, service areas that have isolated subdivided neighborhoods could benefit from this alternative while the other parcels could be connected to a vacuum or low pressure grinder sewer collection system. However, if one is reviewing a service area as a whole, the anticipated construction cost would increase per customer due to the decrease in population utilizing the vacuum or low pressure grinder sewer collection system. For example, the subdivided neighbor in the northern section of Pritchardville could benefit from a traditional sanitary sewer collection system and connect to the existing BJWSA sewer infrastructure adjacent to the neighborhood. However, the cost per customer using a vacuum or low pressure grinder sewer collection system for the remainder of the Pritchardville service area would significantly increase.

IV. Vacuum Sewer System

A vacuum sewer system was reviewed with AirVac for all service areas with the exception of Old Town due to the close proximity of existing manholes capable of connecting and extending new gravity mains.

The vacuum sewer system has proven to be a good alternative solution with installations at Broad Creek Public Service District (BCPSD) and Fripp Island Public Service District.

Vacuum sewer system utilizes a valve pit package that connects and serves up to four (4) customers each; however HGBD recommends providing a two (2) valve pit package per customer, where physically possible. This gives the ability to have two (2) additional connections in the future. Only one (1) valve pit package per customer is required where homes are not in close proximity of each other.

Electrical power is not required for the valve pits. The valve pits connect to a 3-inch Schedule 40 or SDR 21 PVC vacuum service lateral which then connects to the vacuum main ranging from 4 to 8-inches buried with 3-ft of cover utilizing Schedule 40 or SDR 21 PVC. Isolation valves are installed typically at the beginning of each branch line and on the vacuum main near these branch connections. The purpose of these valves is to isolate sections of the vacuum system for troubleshooting purposes.

The vacuum mains end at the vacuum station and discharge into a steel collection tank. Once the tank reaches its capacity dry-pit sewage pumps deliver the sewage through a force main to the desired location within the existing sanitary sewer conveyance system.

A vacuum station consists of a collection tank, duplex dry-pit horizontal non-clog centrifugal pumps, vacuum pumps, emergency generator, Bio-mass odor control system for exhaust from the vacuum pumps and control panel. Stations are typically housed in a two story structure with the vacuum pumps and control panel located on the top floor and the collection tank and sewage pumps on the lower floor.

A single vacuum station is recommended for each service area serving both the existing and vacant parcels. It should be noted the proposed vacuum system capacity is adequate for the anticipated future population noted herein with the exception of Alljoy. One additional vacuum station is anticipated if the large vacant tract, located in the northern portion of Alljoy bounded by Burnt Church Road to the west, Foreman Hill Road to the east, Ulmer Road to the south and the May River Watershed limit to the north is to be developed. Upon additional developmental information for this tract a detailed analysis can be performed.

The benefits of the vacuum system include the following:

1. No power connections at each customer;
2. Isolation valves provide isolated shut-down when required for maintenance or repairs;
3. Shallow vacuum main buried cover depth;
4. Can function as a hybrid system utilizing low pressure grinder system;
5. Only one (1) vacuum station required per service area;
6. Ability to phase system within the service area

The con of the vacuum system is the high capital cost and the difficulty in phasing the system construction. This system is predominately effective in locations that have highly dense populations, high ground water tables and/or very low topography.

Appendix C includes AirVac's analysis of each service area and typical features included with the vacuum system.

Appendix D – H includes the vacuum sewer system concept layout and cost estimate for each service area with the exception of Old Town.

V. Low Pressure Grinder System

A low pressure grinder system was reviewed with E-One and ABS for all service areas with the exception of Old Town due to the close proximity of existing manholes capable of connecting and extending new gravity mains.

The low pressure grinder system has proven to be an acceptable alternative solution, with many installations throughout BJWSA's service area

Low pressure grinder systems utilize a valve pit package that connects and serves each customer. A 240 volt, single phase electrical power connection is required per valve pit. The valve pits connect to a 1-1/4-inch HDPE service lateral which then connects to the force main ranging from 2 to 8-inches buried with 3-ft of cover utilizing HDPE pipe. Isolation valves are installed typically at the beginning of each branch line and on the force main near these branch connections. The purpose of these valves is to isolate sections of the low pressure grinder system for troubleshooting purposes.

The force mains terminate at the desired existing sanitary sewer infrastructure conveyance point.

The benefits of the low pressure grinder system include the following:

1. Isolation valves provide isolated shut-down when required for maintenance or repairs;
2. Shallow force main buried cover depth;
3. Ability to phase system within the service area

The con of the low pressure grinder system is the high capital and operational cost. This system is predominately effective in locations that have highly dense populations. Additionally, there is a power connection at each customer; therefore the system is off-line during a power failure event.

Due to the large analysis package received by the vendors, **Appendix J** provides only the typical grinder pump station features, valves and appurtenances for a simplex basin grinder pump package.

Appendix K-O includes the low pressure grinder sewer system concept layout and cost estimate for each service area with the exception of Old Town.

Appendix P includes a proposed hybrid option for Pritchardville of low pressure grinders and traditional gravity sewer and force mains. This option was reviewed to look at the potential for phasing a portion of the service area that may develop more quickly near the intersection of May River Road and Gibbet Road.

D. EASEMENTS

Easements required for each service area will be determined during the design process. All of the concepts will require utility easements for the installation of the sewer system. For proposed sewers and force main shown running along arterial roads (i.e. Gibbet Road, May River Road, Old Miller Road, Palmetto Bluff, etc) it is advisable to locate them in utility easements, immediately outside the road right-of-ways. Otherwise, should these roads be widened in the future, BJWSA would be required to pay for the relocation of the utilities. However, requirements by tree ordinances and/or SCDOT may require consideration of the new infrastructure within the roadway.

E. COST ESTIMATE SUMMARY

Table 2: Sewer System Anticipated Cost Estimate Summary

Service Area	**Type of Sewer System**							
	Vacuum Sewer System	Vacuum Sewer System Per Developed Lot	Low Pressure Sewer System	Low Pressure Sewer System Per Developed Lot	Gravity Sewer System	Gravity Sewer System Per Developed Lot	Gravity/Low Pressure System Combines	Gravity/Low Pressure System Combined Per Developed Lot
Alljoy	$10,300,000	$15,100	$11,800,000	$17,300	$12,500,000	$18,300	N/A	N/A
Old Town	N/A	N/A	N/A	N/A	$2,600,000	$25,000	N/A	N/A
Cahill	$4,100,000	$41,500	$3,700,000	$37,400	N/A	N/A	N/A	N/A
Gascoigne	$3,000,000	$55,600	$2,100,000	$38,900	N/A	N/A	N/A	N/A
Stoney Creek	$4,700,000	$31,400	$4,400,000	$29,400	N/A	N/A	N/A	N/A
Pritchardville	$9,500,000	$19,000	$10,500,000	$21,000	N/A	N/A	$10,700,000	$21,400

APPENDIX A

Gravity Sanitary Sewer Extensions for Old Town Sewer Service Area

Anticipated Cost Estimate

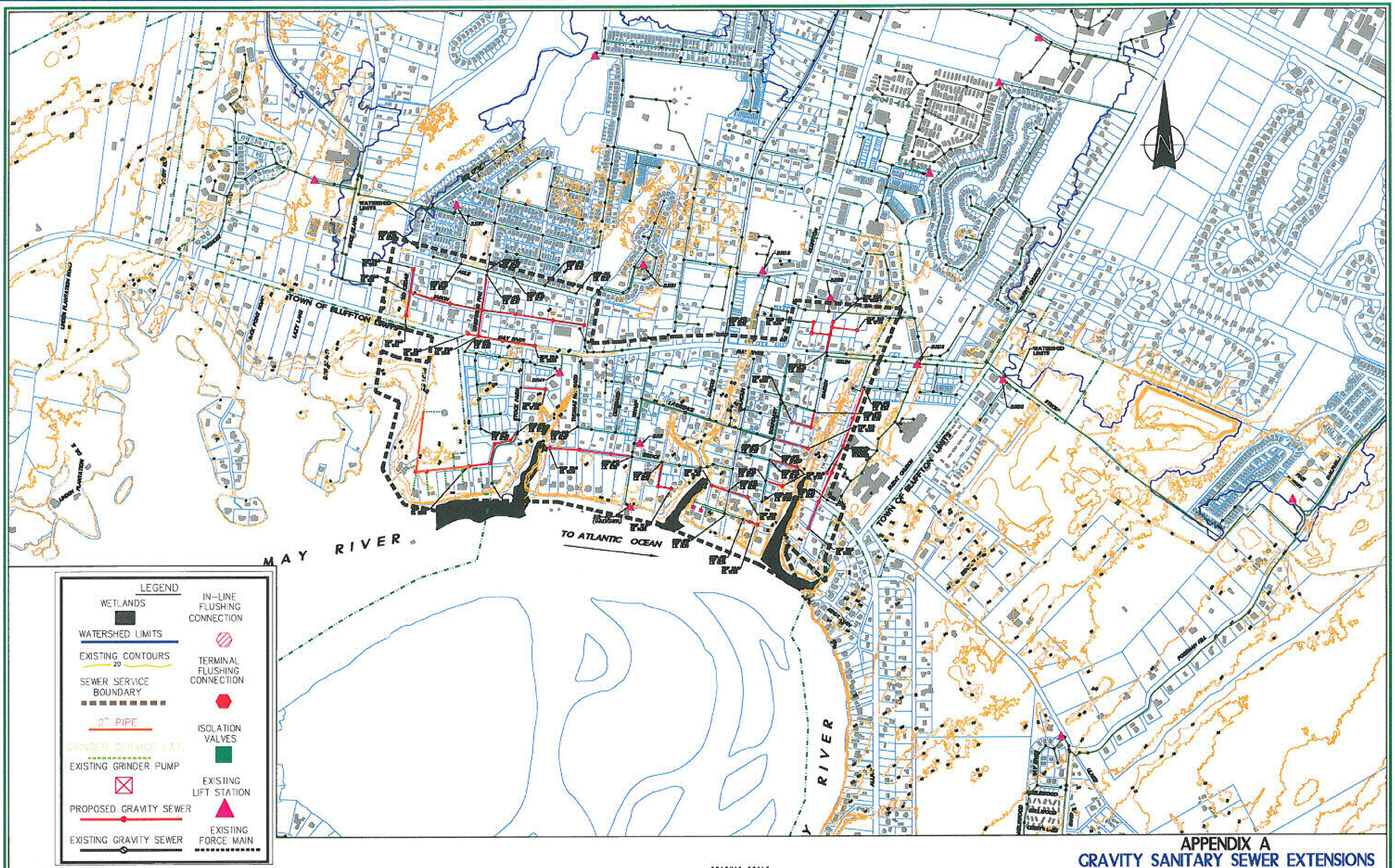
GRAVITY SEWER EXTENSION SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
OLD TOWN SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	8" PVC Gravity Sewer 4' - 8' deep	12,330	LF	$ 26.00	$ 320,580.00
2	Manholes, 4' diameter, standard, 4' - 8' deep	45	EA	$ 3,000.00	$ 135,000.00
3	Core and modify existing manhole and connect new sewer main, 4' - 8' deep	15	EA	$ 6,000.00	$ 90,000.00
4	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC gravity main	120	LF	$ 150.00	$ 18,000.00
5	Insert 8-inch PVC gravity main in casing	120	LF	$ 50.00	$ 6,000.00
6	4-inch lateral to easement or R/W line (near side)[1]	930	LF	$ 12.00	$ 11,160.00
7	4-inch lateral to easement or R/W line (far side)[1]	1,860	LF	$ 40.00	$ 74,400.00
8	Simplex Fiberglass Grinder Station[2]	11	EA	$ 4,572.00	$ 50,292.00
9	1-1/4" HDPE SDR9 Service Lateral[2]	1,876	LF	$ 10.00	$ 18,760.00
10	2" HDPE SDR11 Pipe	1,385	LF	$ 12.00	$ 16,620.00
11	Connect Lateral to Existing Force Main[2]	11	EA	$ 2,000.00	$ 22,000.00
12	Electrical Home Connection[2]	11	EA	$ 2,500.00	$ 27,500.00
13	Clean outs	93	EA	$ 75.00	$ 6,975.00
14	Silt Fence	14,796	LF	$ 3.50	$ 51,786.00
15	Grassing (Temporary and Permanent)	4,110	SY	$ 2.00	$ 8,220.00
16	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	200	CY	$ 70.00	$ 14,000.00
17	Remove driveway surface, replace with 2" graded aggregate[3]	104	EA	$ 160.00	$ 16,640.00
18	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	11,600	SY	$ 70.00	$ 812,000.00
19	Decommissioning of existing septic tank[5]	104	EA	$ 500.00	$ 52,000.00
20	Traffic Control	1	JOB	Lump Sum	$ 15,000.00
21	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 106,015.98
				Subtotal	$ 1,872,948.98
	Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)				$ 112,376.94
				Engineering Fees (15%)	$ 280,942.35
				Construction Contingencies (15%)	$ 280,942.35
				Estimated Probable Cost	$ 2,547,210.61
				CALL[I,II,III,IV]	$ 2,600,000.00
No. of existing customers:					**104**
Cost per customer:					**$ 25,000.00**

Assumptions:

1. Lateral lengths will vary.
2. Assumes price for connection to homeowner's electrical power. Cost is for what is assumed; unforeseen costs are difficult to predict for each homeowner's unique existing electrical setup.
3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways; quantity assumed. Yard and driveway restoration will vary.
4. Assumes gravity main within all roads.
5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

I: Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.
II: It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the
III: Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.
IV: Engineering Fees are for civil design services only. Fees do not include wetland mitigatoin credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton



Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

APPENDIX A
GRAVITY SANITARY SEWER EXTENSIONS
FOR
OLD TOWN SEWER SERVICE AREA
DATE: OCTOBER 2013

APPENDIX B

New Traditional Gravity / Lift Station Sanitary Sewer for Alljoy Sewer Service Area

Anticipated Cost Estimate

GRAVITY SEWER EXTENSION SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
ALLJOY SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	8" PVC Gravity Sewer	50,000	LF	$ 26.00	$ 1,300,000.00
2	Manholes, 4' diameter, standard	180	EA	$ 3,000.00	$ 540,000.00
3	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC gravity main	300	LF	$ 150.00	$ 45,000.00
4	Insert 8-inch PVC gravity main in casing	300	LF	$ 50.00	$ 15,000.00
5	4-inch PVC force main, AWWA C900, SDR-18	14,299	LF	$ 16.00	$ 228,777.60
6	4-inch RJ PVC force main, AWWA C900, SDR-18	1,678	LF	$ 18.00	$ 30,204.00
7	4-inch DI Force Main	503	LF	$ 24.00	$ 12,081.60
8	Misc. Force Main Fittings	6,041	LBS	$ 5.00	$ 30,204.00
9	Force Main Air Release Valve and Manhole	10	EA	$ 3,000.00	$ 30,000.00
10	Core into Termination Manhole for Force Main	1	EA	$ 3,000.00	$ 3,000.00
11	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC force main	300	LF	$ 150.00	$ 45,000.00
12	Insert 8-inch PVC force main in casing	300	LF	$ 50.00	$ 15,000.00
13	New Duplex Lift Station	9	LS	$ 250,000.00	$ 2,250,000.00
14	4-inch lateral to easement or R/W line (near side)[1]	6,590	LF	$ 12.00	$ 79,080.00
15	4-inch lateral to easement or R/W line (far side)[1]	13,180	LF	$ 40.00	$ 527,200.00
16	Simplex Fiberglass Grinder Station[2]	25	EA	$ 4,572.00	$ 114,300.00
17	1-1/4" HDPE SDR9 Service Lateral[2]	1,500	LF	$ 10.00	$ 15,000.00
18	Connect Lateral to Existing Force Main[2]	25	EA	$ 2,000.00	$ 50,000.00
19	Electrical Home Connection[2]	25	EA	$ 2,500.00	$ 62,500.00
20	Clean outs	659	EA	$ 75.00	$ 49,425.00
21	Silt Fence	79,776	LF	$ 3.50	$ 279,216.00
22	Grassing (Temporary and Permanent)	22,160	SY	$ 2.00	$ 44,320.00
23	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	700	CY	$ 70.00	$ 49,000.00
24	Remove driveway surface, replace with 2" graded aggregate[3]	684	EA	$ 160.00	$ 109,440.00
25	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	33,240	SY	$ 70.00	$ 2,326,800.00
26	Decommissioning of existing septic tank[5]	684	EA	$ 500.00	$ 342,000.00
27	Traffic Control	1	JOB	Lump Sum	$ 20,000.00
28	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 516,752.89
				Subtotal	$ 9,129,301.09
	Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)				$ 547,758.07
				Engineering Fees (15%)	$ 1,369,395.16
				Construction Contingencies (15%)	$ 1,369,395.16
				Estimated Probable Cost	$ 12,415,849.49
				CALL[II, III, IV]	$ 12,500,000.00
No. of existing customers:					684
Cost per customer:					$ 18,300.00

Assumptions:

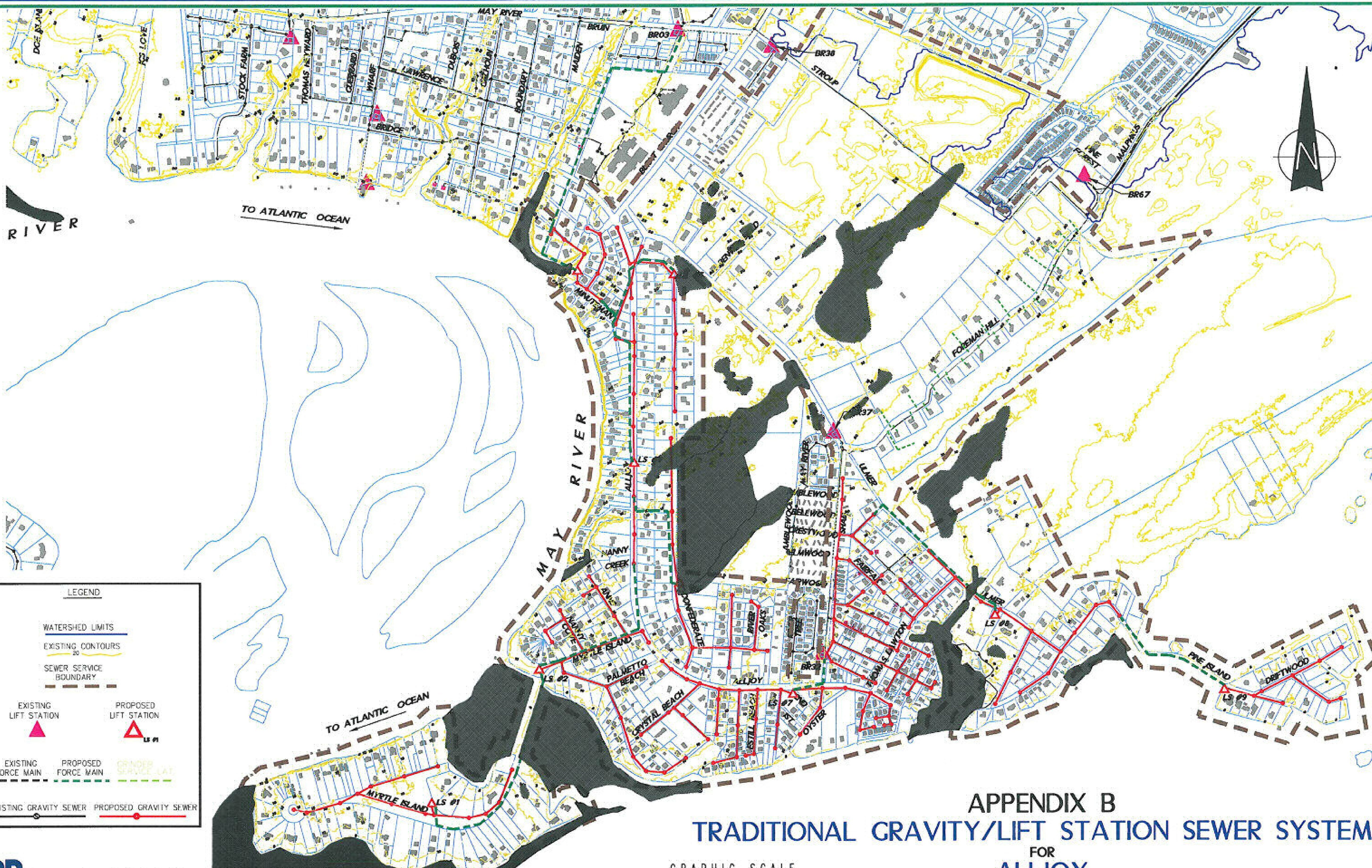
1. Lateral lengths will vary.
2. Assumes price for connection to homeowner's electrical power. Cost is for what is assumed; unforeseen costs are difficult to predict for each homeowner's unique/existing electrical setup.Grinders along Foreman Hill Road only.
3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed. Yard and driveway restoration will vary.
4. Assumes gravity & force main within portion of roads.
5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

I: Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.

II: It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

III: Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.

IV: Engineering Fees are for civil design services only. Fees do not include wetland mitigatoin credits, or other engineering discipline design required not listed herein. Easement preperation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton



Hussey, Gay, Bell & DeYoung
A Bell Company
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

GRAPHIC SCALE

1" = 1000'

0' 500' 1000' 2000'

APPENDIX B

TRADITIONAL GRAVITY/LIFT STATION SEWER SYSTEM

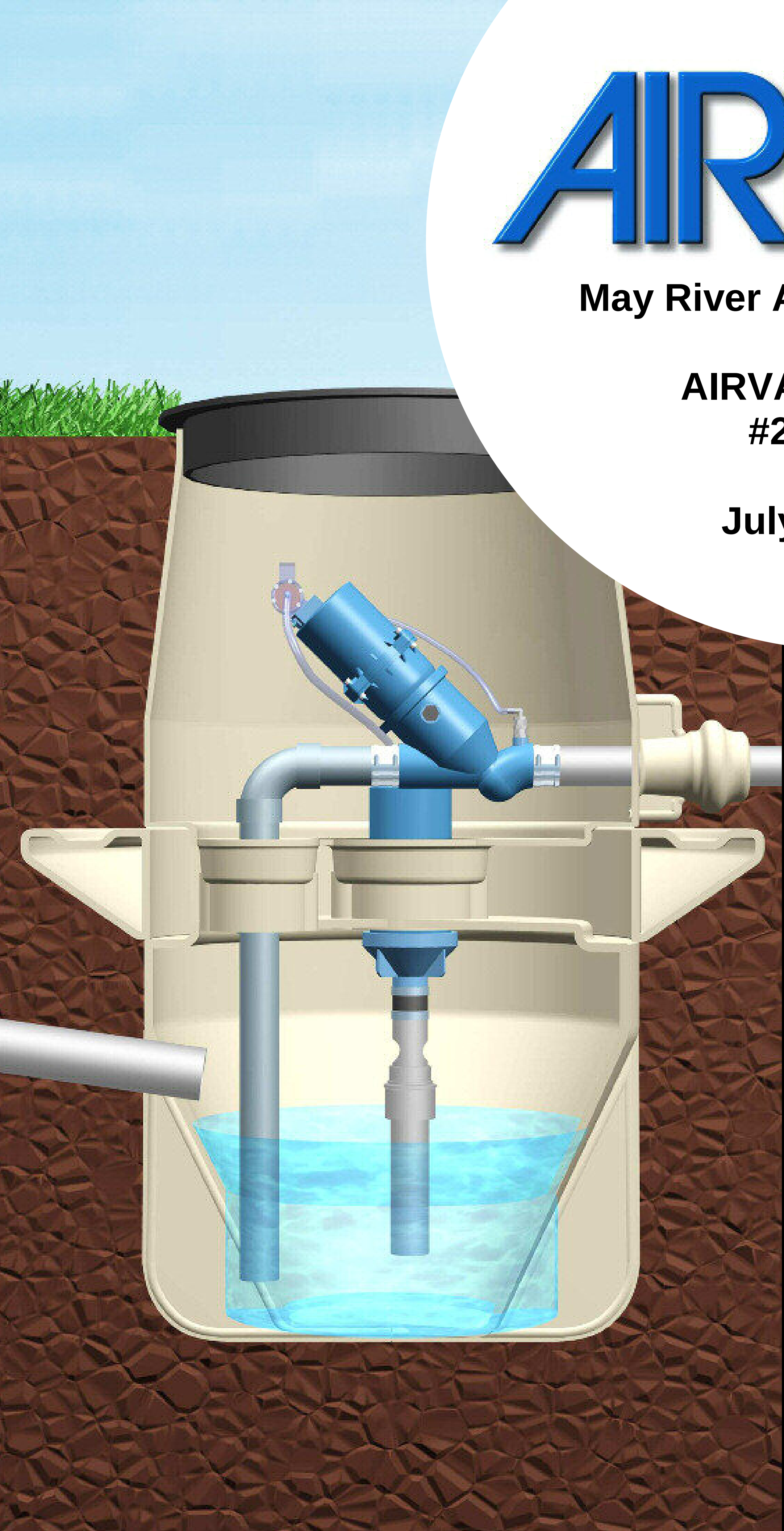
FOR

ALLJOY

DATE: OCTOBER 2013

APPENDIX C

Vacuum Sewer System Analysis and Typical Features



AIRVAC®

May River Area, Bluffton, SC

AIRVAC Estimate #2013-133

July 19, 2013

Prepared for:

Hussey, Gay, Bell & DeYoung

AIRVAC, INC.
200 Tower Drive
Suite A
Oldsmar, FL 34677
813.855.6297
813.855.9093

Corporate Office
4217 N. Old US 31
Rochester, IN 46975
574.223.3980
574.223.5566

July 19, 2013

THE WORLD LEADER IN
VACUUM SEWER TECHNOLOGY

TAMPA OFFICE
AIRVAC, INC.
200 Tower Drive, Suite A
Oldsmar, FL 34677 U.S.A.
Phone: (813) 855-6297
Fax: (813) 855-9093
Web: www.airvac.com

Justin Arnsdorff, PE
Hussey, Gay, Bell & DeYoung
Post Office Box 14247
Savannah, GA 31416
912-354-4626

RE: May River Area, Bluffton, SC
AIRVAC Project Evaluation #2013-132

Dear Mr. Arnsdorff,

Thank you for considering AIRVAC, *the world leader in vacuum sewer system technology*, for your collection needs. AIRVAC currently has more than 300 vacuum sewer systems in operation and 25 in construction or scheduled to start construction in 2013. AIRVAC vacuum sewer systems can be found in 29 states within the U.S. and an additional 600+ AIRVAC vacuum systems are in operation in 33 foreign countries.

,

A vacuum sewer system has the following advantages over other alternative wastewater collection methods:

> Vacuum sewer systems provide a superior collection system when compared to a gravity sewer system. First, the inherent tight nature of a vacuum system eliminates Infiltration/Inflow problems associated with gravity systems. Second, shallow vacuum main installation makes future connections and repairs much easier than deeply trenched gravity sewers. Finally, odors are significantly reduced since no manholes or other openings exist within a vacuum collection system.
>
> A vacuum sewer system outperforms low-pressure sewers utilizing grinder pumps. Power is only required at the vacuum station. Grinder pumps require a power source at each service connection. Standby power at the vacuum station insures uninterrupted service during power outages, whereas standby power is not practical or cost effective for each grinder pump service connection. Finally, long term Operation & Maintenance is significantly less considering grinder pumps typically must be replaced every ten years.

The purpose of this evaluation is to provide a vacuum collection system for the May River project area. An Illustrative Layout, AIRVAC Technical Report, Estimated Construction Costs, Annual O&M Costs, and Station Calculations have been prepared. A summary of costs for the vacuum collection system is shown below.

Vacuum system	Collection System	Vacuum station	**Total**
Pritchardville	2,809,570	678,000	3,487,570
Stoney Creek	970,790	590,600	1,561,390
Gascoigne	736,700	552,700	1,289,400
Cahill	989,240	588,000	1,577,240
Alljoy North	2,133,160	599,700	2,732,860
Alljoy South	3,150,340	669,100	3,819,440
Total	**10,789,800**	**3,678,100**	**14,467,900**

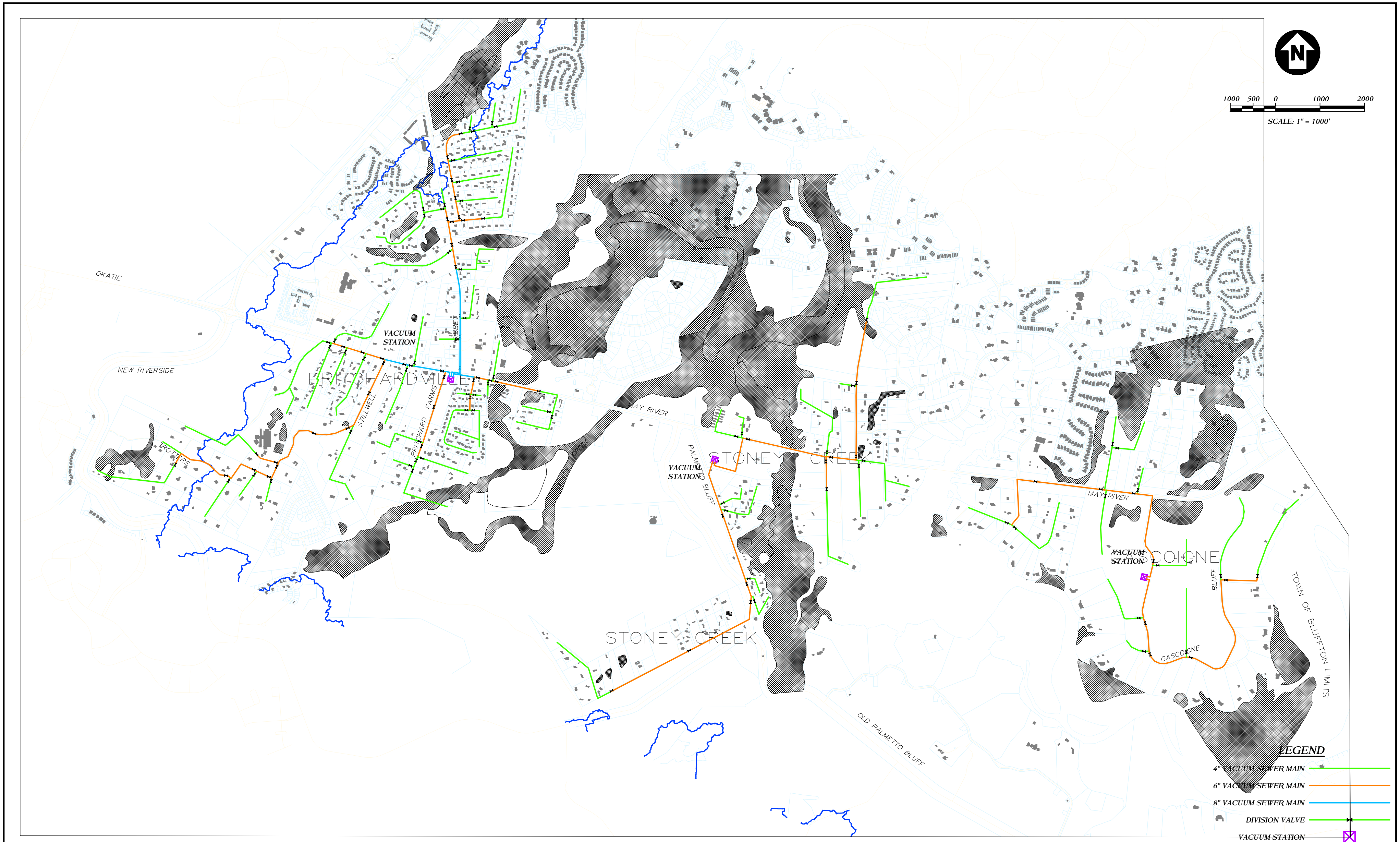
Please note that our construction costs include only the costs for the major vacuum system components. *The construction costs do not include items such as force main, final surface restoration, road borings, building hookups and other incidental costs. Nor does it include project costs such as engineering, Right-Of-Way, legal, etc.*

Again, thank you for allowing us to evaluate this project area. If there is any additional technical information you would like, please do not hesitate to call.

Sincerely,

John Young
AIRVAC Tampa Office

Copy: AIRVAC – Tampa
AIRVAC – Rochester



AIRVAC®

VACUUM SEWER SYSTEMS

AIRVAC, INC
P.O. BOX 528, 4217 N. OLD U.S. 31, ROCHESTER, INDIANA 46975 U.S.A.
TELEPHONE (574) 223-3980
FAX (574) 223-5566

AIRVAC ESTIMATE #2013-133

The Viable Alternative©

NO.	REVISIONS	DATE

TITLE	MAY RIVER AREA, BLUFFTON, SC PRELIMINARY VACUUM COLLECTION SYSTEM LAYOUT		
CLIENT	HUSSEY, GAY, BELL & DeYOUNG		
DRAWN BY J.YOUNG	DATE 07-19-2013	SCALE 1" = 1000'	DRAWING NO. 1 OF 2
DESIGNED BY J.YOUNG	COPYRIGHT© AIRVAC®		

LEGEND

- 4" VACUUM SEWER MAIN
- 6" VACUUM SEWER MAIN
- 8" VACUUM SEWER MAIN
- DIVISION VALVE
- VACUUM STATION

AIRVAC®

VACUUM SEWER SYSTEMS

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TELEPHONE (574) 223-3980
FAX (574) 223-5566

AIRVAC ESTIMATE #2013-133

The Viable Alternative©

NO.	REVISIONS	DATE

TITLE: MAY RIVER AREA, BLUFFTON, SC
PRELIMINARY VACUUM COLLECTION SYSTEM LAYOUT

CLIENT: HUSSEY, GAY, BELL & DeYOUNG

DRAWN BY	DATE	SCALE	DRAWING NO.
J.YOUNG	07-19-2013	1" = 1000'	2 OF 2
DESIGNED BY J.YOUNG	COPYRIGHT© AIRVAC©		

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ESTIMATED CONSTRUCTION COSTS

PRITCHARDVILLE VACUUM STATION
702 Service Connections

PRITCHARDVILLE, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

INSTALLED COST-COLLECTION SYSTEM

Quantity		Description	@	Unit Price	Total Price
4,730	lf	8" Vacuum Main	@	19.00 /lf	89,870
17,320	lf	6" Vacuum Main	@	16.00 /lf	277,120
49,520	lf	4" Vacuum Main	@	13.00 /lf	643,760
7,020	lf	3" Service Lateral	@	6.00 /lf	42,120
6	ea	8" Isolation Valve	@	1,800.00 /ea	10,800
29	ea	6" Isolation Valve	@	1,500.00 /ea	43,500
44	ea	4" Isolation Valve	@	1,200.00 /ea	52,800
351	ea	AIRVAC 6.0' - 2 pc Hybrid Valve Pit	@	4,600.00 /ea	1,614,600
1	set	Special Tools	@	5,000.00 /set	5,000
1	set	Spare Parts	@	6,000.00 /set	6,000
1	ea	Trailer Mounted Vacuum Pump	@	24,000.00 /ea	24,000
				COLLECTION SYSTEM COST	**$2,809,570**

INSTALLED COST-STANDARD VACUUM STATION

AIRVAC Standard Skid Model 3D-30	266,500
Standard Skid Upgrades	0
Equipment Installation	13,500
Wiring/Piping, etc.	48,000
Vacuum Station Building	300,000
Emergency Generator	25,000
Odor Control: Bio-Mass Filter Bed	25,000
VACUUM STATION COST	**$678,000**
TOTAL INSTALLED COSTS	**$3,487,570**
Number of Connections	702
Cost per Connection	$4,968

This is not a firm quote but rather is an estimate of the magnitude of the major construction costs. Passing time, market conditions and design variables will affect the costs shown. We encourage you to thoroughly review the AIRVAC Pricing Report

AIRVAC®

ESTIMATED CONSTRUCTION COSTS

STONEY CREEK VACUUM STATION
200 Service Connections

STONEY CREEK, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

INSTALLED COST-COLLECTION SYSTEM

Quantity		Description	@	Unit Price	Total Price
15,010	lf	6" Vacuum Main	@	16.00 /lf	240,160
16,810	lf	4" Vacuum Main	@	13.00 /lf	218,530
2,000	lf	3" Service Lateral	@	6.00 /lf	12,000
9	ea	6" Isolation Valve	@	1,500.00 /ea	13,500
13	ea	4" Isolation Valve	@	1,200.00 /ea	15,600
100	ea	AIRVAC 6.0' - 2 pc Hybrid Valve Pit	@	4,600.00 /ea	460,000
1	set	Special Tools	@	5,000.00 /set	5,000
1	set	Spare Parts	@	6,000.00 /set	6,000
				COLLECTION SYSTEM COST	**$970,790**

INSTALLED COST-STANDARD VACUUM STATION

AIRVAC Standard Skid Model 2D-15	217,700
Standard Skid Upgrades	0
Equipment Installation	11,000
Wiring/Piping, etc.	41,900
Vacuum Station Building	275,000
Emergency Generator	25,000
Odor Control: Bio-Mass Filter Bed	20,000
VACUUM STATION COST	**$590,600**
TOTAL INSTALLED COSTS	**$1,561,390**
Number of Connections	200
Cost per Connection	$7,807

This is not a firm quote but rather is an estimate of the magnitude of the major construction costs. Passing time, market conditions and design variables will affect the costs shown. We encourage you to thoroughly review the AIRVAC Pricing Report

AIRVAC®

ESTIMATED CONSTRUCTION COSTS

GASCOIGNE, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

GASCOIGNE VACUUM STATION
117 Service Connections

INSTALLED COST-COLLECTION SYSTEM

Quantity		Description	@	Unit Price		Total Price
12,700	lf	6" Vacuum Main	@	16.00	/lf	203,200
16,740	lf	4" Vacuum Main	@	13.00	/lf	217,620
1,180	lf	3" Service Lateral	@	6.00	/lf	7,080
8	ea	6" Isolation Valve	@	1,500.00	/ea	12,000
12	ea	4" Isolation Valve	@	1,200.00	/ea	14,400
59	ea	AIRVAC 6.0' - 2 pc Hybrid Valve Pit	@	4,600.00	/ea	271,400
1	set	Special Tools	@	5,000.00	/set	5,000
1	set	Spare Parts	@	6,000.00	/set	6,000
				COLLECTION SYSTEM COST		**$736,700**

INSTALLED COST-STANDARD VACUUM STATION

AIRVAC Standard Skid Model 3B-10	204,300
Standard Skid Upgrades	0
Equipment Installation	13,500
Wiring/Piping, etc.	39,900
Vacuum Station Building	250,000
Emergency Generator	20,000
Odor Control: Bio-Mass Filter Bed	25,000
VACUUM STATION COST	**$552,700**
TOTAL INSTALLED COSTS	**$1,289,400**
Number of Connections	117
Cost per Connection	$11,021

This is not a firm quote but rather is an estimate of the magnitude of the major construction costs. Passing time, market conditions and design variables will affect the costs shown. We encourage you to thoroughly review the AIRVAC Pricing Report

AIRVAC®

CAHILL, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

ESTIMATED CONSTRUCTION COSTS

CAHILL VACUUM STATION
155 Service Connections

INSTALLED COST-COLLECTION SYSTEM

Quantity	Description	@	Unit Price	Total Price
12,770 lf	6" Vacuum Main	@	16.00 /lf	204,320
27,220 lf	4" Vacuum Main	@	13.00 /lf	353,860
1,560 lf	3" Service Lateral	@	6.00 /lf	9,360
17 ea	6" Isolation Valve	@	1,500.00 /ea	25,500
22 ea	4" Isolation Valve	@	1,200.00 /ea	26,400
78 ea	AIRVAC 6.0' - 2 pc Hybrid Valve Pit	@	4,600.00 /ea	358,800
1 set	Special Tools	@	5,000.00 /set	5,000
1 set	Spare Parts	@	6,000.00 /set	6,000
			COLLECTION SYSTEM COST	**$989,240**

INSTALLED COST-STANDARD VACUUM STATION

AIRVAC Standard Skid Model 2D-10	215,100
Standard Skid Upgrades	0
Equipment Installation	11,000
Wiring/Piping, etc.	41,900
Vacuum Station Building	275,000
Emergency Generator	25,000
Odor Control: Bio-Mass Filter Bed	20,000
VACUUM STATION COST	**$588,000**
TOTAL INSTALLED COSTS	**$1,577,240**
Number of Connections	155
Cost per Connection	$10,176

This is not a firm quote but rather is an estimate of the magnitude of the major construction costs. Passing time, market conditions and design variables will affect the costs shown. We encourage you to thoroughly review the AIRVAC Pricing Report

AIRVAC®

ESTIMATED CONSTRUCTION COSTS

ALLJOY NORTH VACUUM STATION
713 Service Connections

ALLJOY NORTH, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

INSTALLED COST-COLLECTION SYSTEM

Quantity		Description	@	Unit Price	Total Price
3,620	lf	8" Vacuum Main	@	19.00 /lf	68,780
5,270	lf	6" Vacuum Main	@	16.00 /lf	84,320
17,440	lf	4" Vacuum Main	@	13.00 /lf	226,720
7,140	lf	3" Service Lateral	@	6.00 /lf	42,840
6	ea	8" Isolation Valve	@	1,800.00 /ea	10,800
11	ea	6" Isolation Valve	@	1,500.00 /ea	16,500
25	ea	4" Isolation Valve	@	1,200.00 /ea	30,000
357	ea	AIRVAC 6.0' - 2 pc Hybrid Valve Pit	@	4,600.00 /ea	1,642,200
1	set	Special Tools	@	5,000.00 /set	5,000
1	set	Spare Parts	@	6,000.00 /set	6,000
				COLLECTION SYSTEM COST	**$2,133,160**

INSTALLED COST-STANDARD VACUUM STATION

AIRVAC Standard Skid Model 2D-35	226,800
Standard Skid Upgrades	0
Equipment Installation	11,000
Wiring/Piping, etc.	41,900
Vacuum Station Building	275,000
Emergency Generator	25,000
Odor Control: Bio-Mass Filter Bed	20,000
VACUUM STATION COST	**$599,700**
TOTAL INSTALLED COSTS	**$2,732,860**
Number of Connections	713
Cost per Connection	$3,833

This is not a firm quote but rather is an estimate of the magnitude of the major construction costs. Passing time, market conditions and design variables will affect the costs shown. We encourage you to thoroughly review the AIRVAC Pricing Report

AIRVAC®

ESTIMATED CONSTRUCTION COSTS

ALLJOY SOUTH, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

ALLJOY SOUTH VACUUM STATION
885 Service Connections

INSTALLED COST-COLLECTION SYSTEM

Quantity		Description	@	Unit Price	Total Price
5,900	lf	8" Vacuum Main	@	19.00 /lf	112,100
16,370	lf	6" Vacuum Main	@	16.00 /lf	261,920
43,220	lf	4" Vacuum Main	@	13.00 /lf	561,860
8,860	lf	3" Service Lateral	@	6.00 /lf	53,160
13	ea	8" Isolation Valve	@	1,800.00 /ea	23,400
17	ea	6" Isolation Valve	@	1,500.00 /ea	25,500
53	ea	4" Isolation Valve	@	1,200.00 /ea	63,600
443	ea	AIRVAC 6.0' - 2 pc Hybrid Valve Pit	@	4,600.00 /ea	2,037,800
1	set	Special Tools	@	5,000.00 /set	5,000
1	set	Spare Parts	@	6,000.00 /set	6,000
				COLLECTION SYSTEM COST	**$3,150,340**

INSTALLED COST-STANDARD VACUUM STATION

AIRVAC Standard Skid Model 3D-40	257,600
Standard Skid Upgrades	0
Equipment Installation	13,500
Wiring/Piping, etc.	48,000
Vacuum Station Building	300,000
Emergency Generator	25,000
Odor Control: Bio-Mass Filter Bed	25,000
VACUUM STATION COST	**$669,100**
TOTAL INSTALLED COSTS	**$3,819,440**
Number of Connections	885
Cost per Connection	$4,316

This is not a firm quote but rather is an estimate of the magnitude of the major construction costs. Passing time, market conditions and design variables will affect the costs shown. We encourage you to thoroughly review the AIRVAC Pricing Report

EXPLANATION OF CONSTRUCTION COSTS
May River Area, Bluffton, SC

BASIS OF PRICING

Design requirements and construction conditions on each project are unique; therefore, costs are project specific. Many factors affect construction costs; for example, material surpluses or shortages, prevailing wage rates (depending on funding sources), local bidding climate, time of year, and integrity soundness of the overall system design. Funding and regulatory requirements also play a role in overall construction costs, to the extent that imposed regulations may positively or negatively impact costs. Because of the many variables, actual costs will vary. However, the following information will provide guidelines to adjust costs as necessary.

VACUUM MAINS

The piping network connects the individual valve pits to the collection tank at the vacuum station. The vacuum main is a PVC thermoplastic pipe Schedule 40 or SDR 21 PVC pipe, with SDR 21 recommended. To reduce expansion and contraction induced stresses, a flexible elastic joint ("rubber ring" joint) pipe is recommended. The pipe manufacturer requires the "Reiber Style" gasket for the pipe to be certified for vacuum use.

Unit prices for vacuum mains are site specific and vary widely from project to project and geographic location. Conditions such as rock, unstable soil, and groundwater have a large effect on installed prices. Experience has shown that the installed cost of vacuum mains falls somewhere between gravity and pressure main pricing; typically, closer to force main pricing than gravity main.

For the purposes of this project, we assumed the installed cost of the 6" vacuum main will be similar to that of other projects in the area.

3" SERVICE LATERAL

The 3" service lateral is a Schedule 40 or SDR 21 PVC pipe that connects the 3" AIRVAC interface valve to the branch or main line. The length of the service lateral will vary depending on the location of the valve pit or buffer tank in relation to the vacuum main or branch line.

ISOLATION VALVES

Isolation valves are typically found at the beginning of each branch line and on the vacuum main near these branch connections. The purpose of these valves is to isolate sections of the vacuum system for troubleshooting purposes. While both plug and resilient-wedge gate valves have been used, AIRVAC recommends the resilient-wedge gate valves.

AIRVAC VALVE PIT PACKAGE

The AIRVAC valve pit package consists of a 3" AIRVAC interface valve, polyethylene plastic pit, cast iron cover w/ frame, in-sump breather, and sump. The valve pit package is H20 traffic-rated and can serve up to four properties or a peak flow of 3 gpm. The most common arrangement is a single valve pit package serving two properties.

As with vacuum mains, installed prices may vary widely from project to project according to site conditions. Installation costs include furnishing the valve pit, setting, excavation, bedding, backfill, compaction, vacuum testing, and surface restoration. Installed costs for the valve pit have been based on similar completed AIRVAC projects.

<u>SPECIAL TOOLS AND SPARE PARTS</u>

AIRVAC supplied materials and tools needed for installation and maintenance of the system.

<u>TRAILER MOUNTED VACUUM PUMP</u>

The trailer mounted vacuum pump (TMVP) is an AIRVAC supplied portable unit that aids in the mandatory vacuum main testing during construction. The TMVP consists of a two wheeled trailer, 200 cfm vacuum pump, 18 hp gasoline engine, 30 gallon collection tank, control panel, and chart recorder.

<u>VACUUM STATION</u>

Vacuum station costs include an AIRVAC skid which is typically housed in a two story structure with the vacuum pumps and control panel located on the top floor and the collection tank and sewage pumps on the lower floor. A backup generator has been recommended to ensure continued operation during power failures. Also included is a Bio-mass odor control system for exhaust from the vacuum pumps. AIRVAC skid component details are shown below.

Collection Tank – Mild steel, internally and externally epoxy coated tank with a designed working pressure of 20 in. Hg vacuum and tested to 28 in. HG vacuum.

Sewage Pumps – Duplicate Dry-pit, horizontal, non-clog centrifugal pumps each capable of pumping the design peak flow.

Vacuum Pumps – Multiple sliding-vane type vacuum pumps capable of an ultimate vacuum range of 29" Hg and offer efficient air-delivery-to-horsepower ratios.

Control Panel - Typical electrical controls include, vacuum switches with stainless bellows, liquid level controls suitable for sanitary sewage, motor starters with overload, automatic alternators for pump cycling, hour run meters, a solid state telephone alarm system, and a seven day circular vacuum chart recorder.

Each AIRVAC skid is unique. The final price for the skid is dependent on the size and configuration of the equipment as well as any optional equipment desired by the owner/engineer. The price range shown above assumes the standard AIRVAC skid is used. Optional items such as stainless steel tanks, stainless steel deck plates, PLC logic, special sewage pumps, UL labels, etc. may add 25% or more to the above figures. In addition, vacuum station building costs may vary widely, depending on the utility, planning, zoning requirements and aesthetics. **Please contact your AIRVAC Regional Manager for a specific summary of components and options.**

OTHER COSTS NOT INCLUDED IN THE AIRVAC COST BREAKDOWN

The Construction Cost sheet does not include items such as mobilization, final surface restoration, homeowner hookups and other incidental costs. All labor to install AIRVAC materials and other items will be supplied by the contractor. AIRVAC's Construction Cost sheet does not include any project costs such as engineering, Right-Of-Way, legal, etc.

AIRVAC SUPPLIED MATERIAL

Shown below is the expected year 2013 material cost range for the various products offered by AIRVAC. Final pricing will be determined after final plans and specifications are completed.

ITEMS SUPPLIED BY AIRVAC	PRICE RANGE
AIRVAC valve pit	$ 3,300 - $ 3,600/ea
Buffer tank kit	$ 1,900 - $ 3,800/ea
Special tools	$ 4,100 - $ 5,700/set
Trailer mounted vacuum pump	$ 21,000 - $ 26,000/ea
AIRVAC skid	$ 185,000 - $ 420,000/ea
Field services	$ 2,700 - $ 3,000/wk

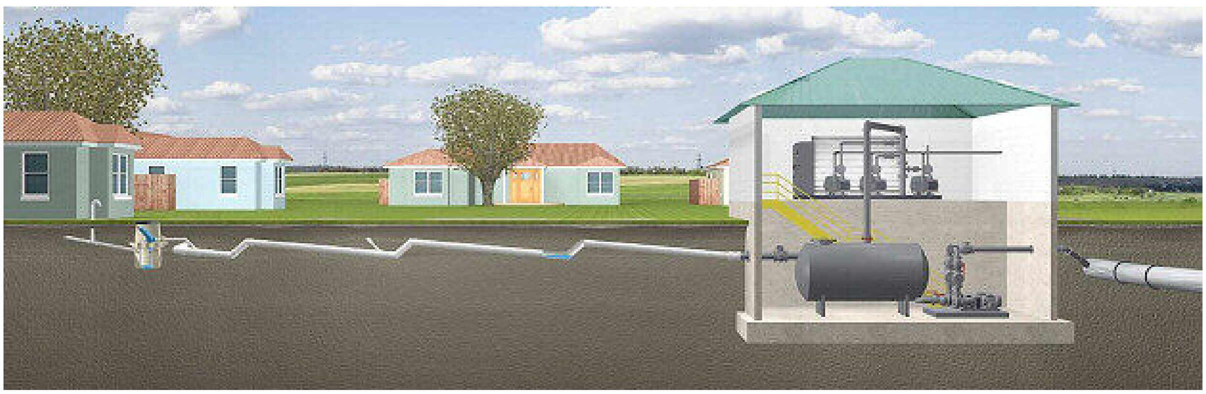
The AIRVAC prices above do not include installation. In order to provide installed prices, bid documents from similar completed AIRVAC projects have been used as a reference.

TECHNICAL REPORT
May River Area, Bluffton, SC

INTRODUCTION

A vacuum sewer system is a mechanized method of transporting wastewater. Differential air pressure creates flow rather than gravity or pressure. Essentially, a vacuum sewer system is a negative pressure sewer system.

Vacuum sewer systems require a vacuum station similar to a gravity lift station or pumping station. Unlike a lift station, vacuum pumps maintain vacuum on the collection mains. To maintain this vacuum, a valve at each sewage input point seals the system. The valve opens automatically when a given quantity of sewage accumulates in a collection sump. This valve is entirely pneumatic in its control and operation. Differential pressure between local atmospheric pressure and the vacuum pressure provides the thrust needed for liquid transportation.



GENERAL PROJECT SUMMARY

The proposed collection system requires six vacuum stations. Wastewater will enter the vacuum system through AIRVAC valve pit packages. From the vacuum stations a force main will carry the wastewater to the ultimate point of discharge.

CONNECTIONS

A vacuum collection system typically collects wastewater from many different sources. Sources include residential, commercial, industrial, institutional, and recreational areas. The May River Area vacuum sewer system has been designed to collect wastewater from 3,429 residential and small commercial customers.

Connections

Vacuum system	Connections
Pritchardville	702
Stoney Creek	200
Gascoigne	117
Cahill	155
Alljoy North	713
Alljoy South	885
Total	**2,772**

BASIS OF DESIGN

Determining wastewater flow rates is a fundamental step in the conceptual design of a vacuum collection system. Reliable data for existing and projected flow rates affect the hydraulic characteristics and sizing of the vacuum collection system components. Flow rates from residential, commercial, industrial, institutional, and recreational areas must be established before the collection system can be accurately designed.

Extraneous flow into the collection system from infiltration and inflow is not included in the flow rates. By its very nature, a vacuum sewer system is tight leaving no chance of infiltration or inflow, unless a break occurs. A break or small leak would be detected by an increase in vacuum pump run time and would be isolated and repaired.

All of the major vacuum system components are sized according to peak flow, expressed in gallons per minute (gpm). Flow rates have been determined by 100 gallons per capita, 3 persons per service connection, and a peak factor of 2.5. In order to properly size a vacuum station and collection system peak flow rates have been used. A summary of the design flows for each system is shown below.

Flow rates

Vacuum system	Connections	Average daily flow (gpd)	Peak flow (gpm)
Pritchardville	702	210,600	366
Stoney Creek	200	60,000	104
Gascoigne	117	35,100	61
Cahill	155	46,500	81
Alljoy North	713	213,900	371
Alljoy South	885	265,500	461
Total	**2772**	**831,600**	**1444**

AIRVAC VALVE PIT PACKAGE

The vacuum sewer system requires a normally closed vacuum/gravity interface valve at each entry point to seal the lines in order to maintain vacuum. The interface valve opens when a predetermined amount of sewage accumulates in the collecting sump. The resulting differential pressure between atmosphere and vacuum becomes the driving force that propels the sewage towards the vacuum station.

The valve pit, with two internal chambers, provides the vacuum/gravity interface. The upper chamber houses the AIRVAC Three Inch Valve. The bottom chamber or collecting sump allows a connecting point for the gravity sewer. These two chambers are sealed from each other.

The valve pit is typically located in the right-of-way between property lines and is able to withstand traffic loads. Up to four separate building sewers can connect to a valve pit, each at 90 degrees of one another. However, this is rarely done as property line considerations, lot depths, and elevation differences may render this impractical. For purposes of this estimate we have provided a valve pit ratio of 2 connections per valve pit. A summary of valve pit packages is shown below.

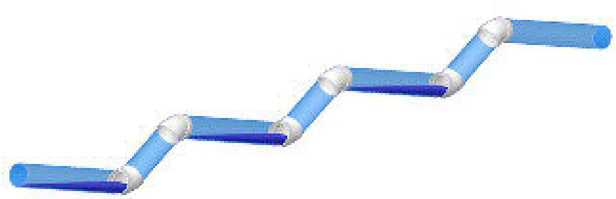
AIRVAC valve pit packages

Vacuum system	Connections	Valve pit packages
Pritchardville	702	351
Stoney Creek	200	100
Gascoigne	117	59
Cahill	155	78
Alljoy North	713	357
Alljoy South	885	443
Total	**2772**	**1388**

VACUUM MAIN

Each AIRVAC 3” interface valve is connected to the vacuum collection system by a 3” service lateral. Differential air pressure (7-10 psi) propels the sewage into the vacuum collection system. Turbulence disintegrates the solids and mixes them with the air and liquid to form aerobic foam, which scours the pipeline, preventing blockage.

The 3” service lateral connects to a branch or main line. Unlike gravity sewers that must be laid with enough slope to create a scouring velocity, the vacuum lines are only slightly sloped (0.2%) toward the vacuum station since vacuum provides adequate velocity.



The vacuum mains are installed with a saw tooth profile to minimize burial depth. When the vacuum line exceeds the minimal cover by a foot or more, inserting two 45-degree fittings and a short section of pipe creates a lift back to minimum cover.

Division valves are installed in the branch or main lines to allow portions of the piping system to be isolated for troubleshooting and maintenance.

FORCE MAIN

Once the wastewater is collected in the vacuum station it is discharged to the ultimate point of disposal through a force main. Force main costs are not included in our construction costs; however, discharge pump costs are.

VACUUM STATION

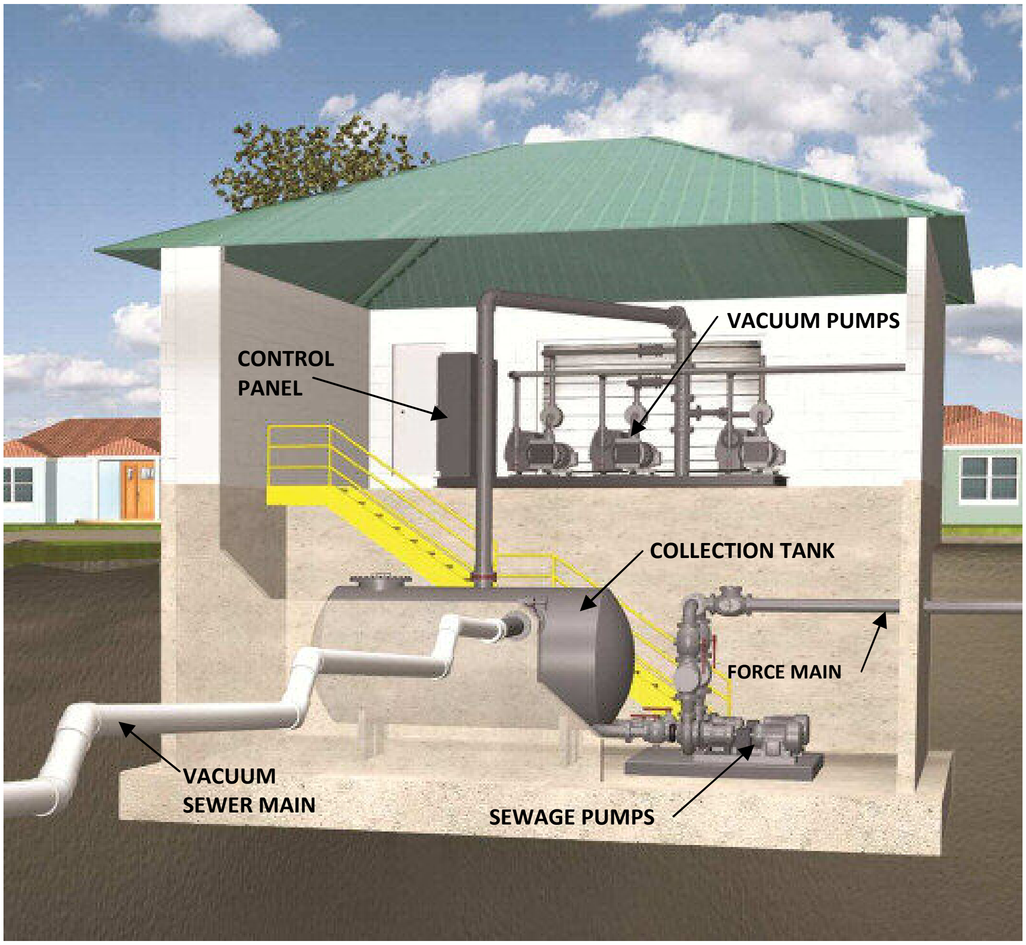
The vacuum station is the heart of the vacuum collection system. The machinery installed is similar to that of a conventional sewage pumping station or lift station, except vacuum is applied to the wetwell (collection tank) that is sealed. Major components include a collection tank, sewage pumps, vacuum pumps, and a control panel.

Most modern vacuum systems utilize factory pre-fabricated collection stations mounted on skids for ease of installation. This allows the skid to be lifted into the building and connected to the incoming vacuum mains and the outgoing force or gravity main. The AIRVAC skid models chosen for the May River Area project are as follows.

Preliminary vacuum station components

Vacuum System	Vacuum pumps (cfm)	Sewage pumps (gpm)	Collection tank (gal)
Pritchardville	3-455	2-370	1-3,000
Stoney Creek	2-455	2-135	1-1,500
Gascoigne	3-170	2-65	1-1,000
Cahill	2-455	2-85	1-1,000
Alljoy North	2-455	2-375	1-3,500
Alljoy South	3-455	2-465	1-4,000

The AIRVAC Skid is typically housed in a two story structure with the vacuum pumps and control panel located on the top floor and the collection tank and sewage pumps on the lower floor. Since the systems require only one source of power, many systems utilize existing portable generators for emergency power; others have permanently installed backup generators.



OPERATION & MAINTENANCE COSTS

Enclosed is an estimate of the annual Operational & Maintenance costs (O&M) for this project. The O&M costs have been based on the 1991 United States Environmental Protection Agency (EPA), publication number EPA/625/1-91/024, *The Manual For Alternative Wastewater Collection Systems* and the 2008 Water Environment Federation (WEF) *Alternative Sewer Systems, 2nd ed.; Manual of Practice No. FD-12.*

FIELD SERVICES

The correct installation of a vacuum sewer system is critical to its success and AIRVAC field services help to ensure proper installation. The Field Service Representative can also provide immediate resolution to unforeseen construction difficulties as well as provide advice on whether “lifts” can be added or deleted. This helps minimize contractor downtime resulting in fewer change orders.

Three levels of field service support are offered. The first level is full-time field services. A trained Field Service Representative is on site from the beginning of installation and every day until the job is complete and the system is in operation. This option ensures the highest level of system performance. The second level is half-time field services. A trained Field Representative is on site 50 percent of the time. The third and final level is part-time field services. A trained Field Representative is on site during selected critical stages of the construction phase. One option should be included in the project budget.

AIRVAC®

PRITCHARDVILLE, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

OPERATION AND MAINTENANCE

PRITCHARDVILLE VACUUM STATION
702 Service Connections

LABOR (INCREMENTAL)

Item	Labor effort		Quantity		Annual Labor
Vacuum Station	300 hrs/yr/station	x	1 station	=	300 hrs/yr
Piping	60 hrs/yr/system	x	1 system	=	60 hrs/yr
Valves	1.75 hrs/yr/valve	x	351 valves	=	614 hrs/yr
					974 hrs/yr
				x	$25 /hr
					$24,350 /yr
				ROUND TO:	**$24,400 /yr**

VACUUM STATION POWER CONSUMPTION

Item	Unit cost		Conn		Duration		Annual Power
Flat rate	$100.00 /mo	x	1 station	x	12 mo	=	$1,200 /yr
Consumption	$1.85 /mo/conn	x	702 /mo/conn	x	12 mo	=	$15,584 /yr
							$16,784
						ROUND TO:	**$16,800 /yr**

EQUIPMENT RENEWAL AND REPLACEMENT

Item	Renewal/Replacement cost		Renewal/Replacement interval		Quantity		Annual R&R
Vacuum Station							
Vacuum Pumps	$23,280 /ea	/	15 years	x	3 pumps	=	$4,656 /yr
Sewage Pumps	$18,720 /ea	/	15 years	x	2 pumps	=	$2,496 /yr
Collection Tank	$32,500 /ea	/	30 years	x	1 ea	=	$1,083 /yr
Control Panel	$17,979 /ea	/	20 years	x	1 ea	=	$899 /yr
Misc. Equip	$2,000 /ea	/	15 years	x	1 ea	=	$133 /yr
							$9,268 /yr
						ROUND TO:	**$9,300 /yr**
Vacuum Valves (renewal)							
Vacuum Valves	$40.00 /ea	/	15 years	x	351 valves	=	$936 /yr
Controller	$40.00 /ea	/	10 years	x	351 valves	=	$1,404 /yr
Misc. Parts	$20.00 /ea	/	10 years	x	351 valves	=	$702 /yr
							$3,042 /yr
						ROUND TO:	**$3,100 /yr**

SUMMARY

Labor	$24,400 /yr
Power	$16,800 /yr
Equipment Replacement (Station)	$9,300 /yr
Equipment Renewal (Valves)	$3,100 /yr
	$53,600 /yr
Number of Connections	702
Cost per Connection	$76 /yr/conn

Based on the 1991 EPA, publication number EPA/625/1-91/024, The Manual For Alternative Wastewater Collection Systems
and the 2008 WEF Alternative Sewer Systems, 2nd ed.; Manual of Practice No. FD-12.

AIRVAC®

STONEY CREEK, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

OPERATION AND MAINTENANCE

STONEY CREEK VACUUM STATION
200 Service Connections

LABOR (INCREMENTAL)

Item	Labor effort		Quantity		Annual Labor
Vacuum Station	300 hrs/yr/station	x	1 station	=	300 hrs/yr
Piping	60 hrs/yr/system	x	1 system	=	60 hrs/yr
Valves	1.75 hrs/yr/valve	x	100 valves	=	175 hrs/yr
					535 hrs/yr
				x	$25 /hr
					$13,375 /yr
				ROUND TO:	**$13,400 /yr**

VACUUM STATION POWER CONSUMPTION

Item	Unit cost		Conn		Duration		Annual Power
Flat rate	$100.00 /mo	x	1 station	x	12 mo	=	$1,200 /yr
Consumption	$3.30 /mo/conn	x	200 /mo/conn	x	12 mo	=	$7,920 /yr
							$9,120
						ROUND TO:	**$9,200 /yr**

EQUIPMENT RENEWAL AND REPLACEMENT

Item	Renewal/Replacement cost		Renewal/Replacement interval		Quantity		Annual R&R
Vacuum Station							
Vacuum Pumps	$23,320 /ea	/	15 years	x	2 pumps	=	$3,109 /yr
Sewage Pumps	$13,910 /ea	/	15 years	x	2 pumps	=	$1,855 /yr
Collection Tank	$24,700 /ea	/	30 years	x	1 ea	=	$823 /yr
Control Panel	$15,961 /ea	/	20 years	x	1 ea	=	$798 /yr
Misc. Equip	$2,000 /ea	/	15 years	x	1 ea	=	$133 /yr
							$6,719 /yr
						ROUND TO:	**$6,800 /yr**
Vacuum Valves (renewal)							
Vacuum Valves	$40.00 /ea	/	15 years	x	100 valves	=	$267 /yr
Controller	$40.00 /ea	/	10 years	x	100 valves	=	$400 /yr
Misc. Parts	$20.00 /ea	/	10 years	x	100 valves	=	$200 /yr
							$867 /yr
						ROUND TO:	**$900 /yr**

SUMMARY

Labor	$13,400 /yr
Power	$9,200 /yr
Equipment Replacement (Station)	$6,800 /yr
Equipment Renewal (Valves)	$900 /yr
	$30,300 /yr
Number of Connections	200
Cost per Connection	$152 /yr/conn

Based on the 1991 EPA, publication number EPA/625/1-91/024, The Manual For Alternative Wastewater Collection Systems and the 2008 WEF Alternative Sewer Systems, 2nd ed.; Manual of Practice No. FD-12.

AIRVAC®

GASCOIGNE, MAY RIVER AREA, SC

Estimate #2013-133

July 22, 2013

Hussey, Gay, Bell & DeYoung

OPERATION AND MAINTENANCE

GASCOIGNE VACUUM STATION

117 Service Connections

LABOR (INCREMENTAL)

Item	Labor effort		Quantity		Annual Labor
Vacuum Station	300 hrs/yr/station	x	1 station	=	300 hrs/yr
Piping	60 hrs/yr/system	x	1 system	=	60 hrs/yr
Valves	1.75 hrs/yr/valve	x	59 valves	=	103 hrs/yr
					463 hrs/yr
				x	$25 /hr
					$11,575 /yr
			ROUND TO:		**$11,600 /yr**

VACUUM STATION POWER CONSUMPTION

Item	Unit cost		Conn		Duration		Annual Power
Flat rate	$100.00 /mo	x	1 station	x	12 mo	=	$1,200 /yr
Consumption	$5.85 /mo/conn	x	117 /mo/conn	x	12 mo	=	$8,213 /yr
							$9,413
					ROUND TO:		**$9,500 /yr**

EQUIPMENT RENEWAL AND REPLACEMENT

Item	Renewal/Replacement cost		Renewal/Replacement interval		Quantity		Annual R&R
Vacuum Station							
Vacuum Pumps	$12,880 /ea	/	15 years	x	3 pumps	=	$2,576 /yr
Sewage Pumps	$13,910 /ea	/	15 years	x	2 pumps	=	$1,855 /yr
Collection Tank	$22,100 /ea	/	30 years	x	1 ea	=	$737 /yr
Control Panel	$16,548 /ea	/	20 years	x	1 ea	=	$827 /yr
Misc. Equip	$2,000 /ea	/	15 years	x	1 ea	=	$133 /yr
							$6,128 /yr
					ROUND TO:		**$6,200 /yr**
Vacuum Valves (renewal)							
Vacuum Valves	$40.00 /ea	/	15 years	x	59 valves	=	$157 /yr
Controller	$40.00 /ea	/	10 years	x	59 valves	=	$236 /yr
Misc. Parts	$20.00 /ea	/	10 years	x	59 valves	=	$118 /yr
							$511 /yr
					ROUND TO:		**$600 /yr**

SUMMARY

Labor	$11,600 /yr
Power	$9,500 /yr
Equipment Replacement (Station)	$6,200 /yr
Equipment Renewal (Valves)	$600 /yr
	$27,900 /yr
Number of Connections	117
Cost per Connection	$238 /yr/conn

Based on the 1991 EPA, publication number EPA/625/1-91/024, The Manual For Alternative Wastewater Collection Systems and the 2008 WEF Alternative Sewer Systems, 2nd ed.; Manual of Practice No. FD-12.

AIRVAC®

CAHILL, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

OPERATION AND MAINTENANCE

CAHILL VACUUM STATION
155 Service Connections

LABOR (INCREMENTAL)

Item	Labor effort		Quantity		Annual Labor
Vacuum Station	300 hrs/yr/station	x	1 station	=	300 hrs/yr
Piping	60 hrs/yr/system	x	1 system	=	60 hrs/yr
Valves	1.75 hrs/yr/valve	x	78 valves	=	137 hrs/yr
					497 hrs/yr
				x	$25 /hr
					$12,425 /yr
				ROUND TO:	**$12,500 /yr**

VACUUM STATION POWER CONSUMPTION

Item	Unit cost		Conn		Duration		Annual Power
Flat rate	$100.00 /mo	x	1 station	x	12 mo	=	$1,200 /yr
Consumption	$4.25 /mo/conn	x	155 /mo/conn	x	12 mo	=	$7,905 /yr
							$9,105
						ROUND TO:	**$9,200 /yr**

EQUIPMENT RENEWAL AND REPLACEMENT

Item	Renewal/Replacement cost		Renewal/Replacement interval		Quantity		Annual R&R
Vacuum Station							
Vacuum Pumps	$23,320 /ea	/	15 years	x	2 pumps	=	$3,109 /yr
Sewage Pumps	$13,910 /ea	/	15 years	x	2 pumps	=	$1,855 /yr
Collection Tank	$22,100 /ea	/	30 years	x	1 ea	=	$737 /yr
Control Panel	$15,961 /ea	/	20 years	x	1 ea	=	$798 /yr
Misc. Equip	$2,000 /ea	/	15 years	x	1 ea	=	$133 /yr
							$6,632 /yr
						ROUND TO:	**$6,700 /yr**
Vacuum Valves (renewal)							
Vacuum Valves	$40.00 /ea	/	15 years	x	78 valves	=	$208 /yr
Controller	$40.00 /ea	/	10 years	x	78 valves	=	$312 /yr
Misc. Parts	$20.00 /ea	/	10 years	x	78 valves	=	$156 /yr
							$676 /yr
						ROUND TO:	**$700 /yr**

SUMMARY

Labor	$12,500 /yr
Power	$9,200 /yr
Equipment Replacement (Station)	$6,700 /yr
Equipment Renewal (Valves)	$700 /yr
	$29,100 /yr
Number of Connections	155
Cost per Connection	$188 /yr/conn

Based on the 1991 EPA, publication number EPA/625/1-91/024, The Manual For Alternative Wastewater Collection Systems and the 2008 WEF Alternative Sewer Systems, 2nd ed.; Manual of Practice No. FD-12.

AIRVAC®

OPERATION AND MAINTENANCE

ALLJOY NORTH VACUUM STATION
713 Service Connections

ALLJOY NORTH, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

LABOR (INCREMENTAL)

Item	Labor effort		Quantity		Annual Labor
Vacuum Station	300 hrs/yr/station	x	1 station	=	300 hrs/yr
Piping	60 hrs/yr/system	x	1 system	=	60 hrs/yr
Valves	1.75 hrs/yr/valve	x	357 valves	=	625 hrs/yr
					985 hrs/yr
				x	$25 /hr
					$24,625 /yr
				ROUND TO:	**$24,700 /yr**

VACUUM STATION POWER CONSUMPTION

Item	Unit cost		Conn		Duration		Annual Power
Flat rate	$100.00 /mo	x	1 station	x	12 mo	=	$1,200 /yr
Consumption	$0.95 /mo/conn	x	713 /mo/conn	x	12 mo	=	$8,128 /yr
							$9,328
						ROUND TO:	**$9,400 /yr**

EQUIPMENT RENEWAL AND REPLACEMENT

Item	Renewal/Replacement cost		Renewal/Replacement interval		Quantity		Annual R&R
Vacuum Station							
Vacuum Pumps	$23,320 /ea	/	15 years	x	2 pumps	=	$3,109 /yr
Sewage Pumps	$13,910 /ea	/	15 years	x	2 pumps	=	$1,855 /yr
Collection Tank	$33,800 /ea	/	30 years	x	1 ea	=	$1,127 /yr
Control Panel	$15,961 /ea	/	20 years	x	1 ea	=	$798 /yr
Misc. Equip	$2,000 /ea	/	15 years	x	1 ea	=	$133 /yr
							$7,022 /yr
						ROUND TO:	**$7,100 /yr**
Vacuum Valves (renewal)							
Vacuum Valves	$40.00 /ea	/	15 years	x	357 valves	=	$952 /yr
Controller	$40.00 /ea	/	10 years	x	357 valves	=	$1,428 /yr
Misc. Parts	$20.00 /ea	/	10 years	x	357 valves	=	$714 /yr
							$3,094 /yr
						ROUND TO:	**$3,100 /yr**

SUMMARY

Labor	$24,700 /yr
Power	$9,400 /yr
Equipment Replacement (Station)	$7,100 /yr
Equipment Renewal (Valves)	$3,100 /yr
	$44,300 /yr
Number of Connections	713
Cost per Connection	$62 /yr/conn

Based on the 1991 EPA, publication number EPA/625/1-91/024, The Manual For Alternative Wastewater Collection Systems and the 2008 WEF Alternative Sewer Systems, 2nd ed.; Manual of Practice No. FD-12.

AIRVAC®

ALLJOY SOUTH, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

OPERATION AND MAINTENANCE

ALLJOY SOUTH VACUUM STATION
885 Service Connections

LABOR (INCREMENTAL)

Item	Labor effort		Quantity		Annual Labor
Vacuum Station	300 hrs/yr/station	x	1 station	=	300 hrs/yr
Piping	60 hrs/yr/system	x	1 system	=	60 hrs/yr
Valves	1.75 hrs/yr/valve	x	443 valves	=	775 hrs/yr
					1135 hrs/yr
				x	$25 /hr
					$28,375 /yr
			ROUND TO:		**$28,400 /yr**

VACUUM STATION POWER CONSUMPTION

Item	Unit cost		Conn		Duration		Annual Power
Flat rate	$100.00 /mo	x	1 station	x	12 mo	=	$1,200 /yr
Consumption	$1.20 /mo/conn	x	885 /mo/conn	x	12 mo	=	$12,744 /yr
							$13,944
					ROUND TO:		**$14,000 /yr**

EQUIPMENT RENEWAL AND REPLACEMENT

Item	Renewal/Replacement cost		Renewal/Replacement interval		Quantity		Annual R&R
Vacuum Station							
Vacuum Pumps	$23,280 /ea	/	15 years	x	3 pumps	=	$4,656 /yr
Sewage Pumps	$13,910 /ea	/	15 years	x	2 pumps	=	$1,855 /yr
Collection Tank	$34,500 /ea	/	30 years	x	1 ea	=	$1,150 /yr
Control Panel	$17,329 /ea	/	20 years	x	1 ea	=	$866 /yr
Misc. Equip	$2,000 /ea	/	15 years	x	1 ea	=	$133 /yr
							$8,660 /yr
					ROUND TO:		**$8,700 /yr**
Vacuum Valves (renewal)							
Vacuum Valves	$40.00 /ea	/	15 years	x	443 valves	=	$1,181 /yr
Controller	$40.00 /ea	/	10 years	x	443 valves	=	$1,772 /yr
Misc. Parts	$20.00 /ea	/	10 years	x	443 valves	=	$886 /yr
							$3,839 /yr
					ROUND TO:		**$3,900 /yr**

SUMMARY

Labor	$28,400 /yr
Power	$14,000 /yr
Equipment Replacement (Station)	$8,700 /yr
Equipment Renewal (Valves)	$3,900 /yr
	$55,000 /yr
Number of Connections	885
Cost per Connection	$62 /yr/conn

Based on the 1991 EPA, publication number EPA/625/1-91/024, The Manual For Alternative Wastewater Collection Systems and the 2008 WEF Alternative Sewer Systems, 2nd ed.; Manual of Practice No. FD-12.

AIRVAC®

PRITCHARDVILLE, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

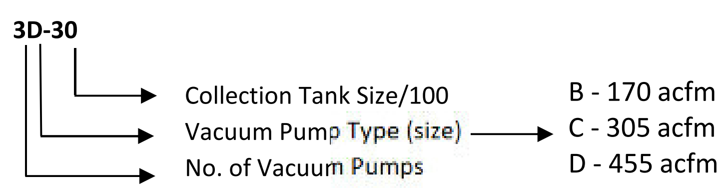
VACUUM STATION CALCULATIONS

PRITCHARDVILLE VACUUM STATION

702 Service Connections

DESIGN FLOWS				
Number of Connections		702		
Growth factor	x	1.00		
Per capita flow	x	100	gpd	
Persons/connection	x	3.00		
Peak factor	x	2.50		
Peak flow	=	366	gpm	
Other peak flow	+	0	gpm	
Total peak flow		**366**	**gpm**	**Qmax**
Average flow		146	gpm	Qa
Minimum flow		73	gpm	Qmin
SEWAGE PUMPS				
Sewage pump capacity		**370**	**gpm**	**Qdp (SELECTED DISCHARGE PUMP)**
Estimated TDH		80	ft	
Pump efficiency		50%		
Motor efficiency		85%		
Estimate BHP		17.59	hp	
Selected HP		**30**	**hp**	
COLLECTION TANK				
Operating volume		879	gal	Vo
Tank volume required		3,000	gal	
Selected tank volume		**3,000**	**gal**	**Vct**
VACUUM PUMPS				
Longest Line		10,000	lf	
"A" factor		8		
Volume of pipe		73,490	gal	Vp
Vacuum pump capacity required		390	cfm	
System pump down time		2.53	min	t
Selected vacuum pumps	**3**	**455**	**acfm**	**Qvp (SELECTED VACUUM PUMP)**
		25	**hp**	

SKID MODEL



AIRVAC®

STONEY CREEK, MAY RIVER AREA, SC

Estimate #2013-133

July 22, 2013

Hussey, Gay, Bell & DeYoung

VACUUM STATION CALCULATIONS

STONEY CREEK VACUUM STATION

200 Service Connections

DESIGN FLOWS

Number of Connections		200		
Growth factor	x	1.00		
Per capita flow	x	100	gpd	
Persons/connection	x	3.00		
Peak factor	x	2.50		
Peak flow	=	104	gpm	
Other peak flow	+	0	gpm	
Total peak flow		**104**	**gpm**	**Qmax**
Average flow		42	gpm	Qa
Minimum flow		21	gpm	Qmin

SEWAGE PUMPS

Sewage pump capacity	**105**	**gpm**	**Qdp (SELECTED DISCHARGE PUMP)**
Estimated TDH	80	ft	
Pump efficiency	50%		
Motor efficiency	85%		
Estimate BHP	4.99	hp	
Selected HP	**10**	**hp**	

COLLECTION TANK

Operating volume	252	gal	Vo
Tank volume required	1,200	gal	
Selected tank volume	**1,500**	**gal**	**Vct**

VACUUM PUMPS

Longest Line		9,200	lf	
"A" factor		8		
Volume of pipe		34,180	gal	Vp
Vacuum pump capacity required		111	cfm	
System pump down time		2.38	min	t
Selected vacuum pumps	**2**	**455**	**acfm**	**Qvp (SELECTED VACUUM PUMP)**
		25	**hp**	

SKID MODEL

2D-15

Collection Tank Size/100

Vacuum Pump Type (size) → B - 170 acfm; C - 305 acfm; D - 455 acfm

No. of Vacuum Pumps

AIRVAC®

GASCOIGNE, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

VACUUM STATION CALCULATIONS

GASCOIGNE VACUUM STATION

117 Service Connections

DESIGN FLOWS				
Number of Connections		117		
Growth factor	x	1.00		
Per capita flow	x	100	gpd	
Persons/connection	x	3.00		
Peak factor	x	2.50		
Peak flow	=	61	gpm	
Other peak flow	+	0	gpm	
Total peak flow		**61**	**gpm**	**Qmax**
Average flow		24	gpm	Qa
Minimum flow		12	gpm	Qmin

SEWAGE PUMPS				
Sewage pump capacity		**65**	**gpm**	**Qdp (SELECTED DISCHARGE PUMP)**
Estimated TDH		80	ft	
Pump efficiency		50%		
Motor efficiency		85%		
Estimate BHP		3.09	hp	
Selected HP		**10**	**hp**	

COLLECTION TANK				
Operating volume		147	gal	Vo
Tank volume required		1,000	gal	
Selected tank volume		**1,000**	**gal**	**Vct**

VACUUM PUMPS				
Longest Line		8,500	lf	
"A" factor		8		
Volume of pipe		30,410	gal	Vp
Vacuum pump capacity required		65	cfm	
System pump down time		2.80	min	t
Selected vacuum pumps	**3**	**170**	**acfm**	**Qvp (SELECTED VACUUM PUMP)**
		10	**hp**	

SKID MODEL

3B-10

Collection Tank Size/100
Vacuum Pump Type (size) → B - 170 acfm; C - 305 acfm; D - 455 acfm
No. of Vacuum Pumps

AIRVAC®

VACUUM STATION CALCULATIONS

CAHILL VACUUM STATION

155 Service Connections

CAHILL, MAY RIVER AREA, SC

Estimate #2013-133

July 22, 2013

Hussey, Gay, Bell & DeYoung

DESIGN FLOWS				
Number of Connections		155		
Growth factor	x	1.00		
Per capita flow	x	100	gpd	
Persons/connection	x	3.00		
Peak factor	x	2.50		
Peak flow	=	81	gpm	
Other peak flow	+	0	gpm	
Total peak flow		**81**	**gpm**	**Qmax**
Average flow		32	gpm	Qa
Minimum flow		16	gpm	Qmin

SEWAGE PUMPS				
Sewage pump capacity		**85**	**gpm**	**Qdp (SELECTED DISCHARGE PUMP)**
Estimated TDH		80	ft	
Pump efficiency		50%		
Motor efficiency		85%		
Estimate BHP		4.04	hp	
Selected HP		**10**	**hp**	

COLLECTION TANK				
Operating volume		195	gal	Vo
Tank volume required		1,000	gal	
Selected tank volume		**1,000**	**gal**	**Vct**

VACUUM PUMPS				
Longest Line		7,000	lf	
"A" factor		7		
Volume of pipe		37,760	gal	Vp
Vacuum pump capacity required		76	cfm	
System pump down time		2.57	min	t
Selected vacuum pumps	**2**	**455**	**acfm**	**Qvp (SELECTED VACUUM PUMP)**
		25	**hp**	

SKID MODEL

2D-10

→ Collection Tank Size/100

→ Vacuum Pump Type (size) → B - 170 acfm, C - 305 acfm, D - 455 acfm

→ No. of Vacuum Pumps

AIRVAC®

VACUUM STATION CALCULATIONS

ALLJOY NORTH VACUUM STATION

713 Service Connections

ALLJOY NORTH, MAY RIVER AREA, SC

Estimate #2013-133

July 22, 2013

Hussey, Gay, Bell & DeYoung

DESIGN FLOWS				
Number of Connections		713		
Growth factor	x	1.00		
Per capita flow	x	100	gpd	
Persons/connection	x	3.00		
Peak factor	x	2.50		
Peak flow	=	371	gpm	
Other peak flow	+	0	gpm	
Total peak flow		**371**	**gpm**	**Qmax**
Average flow		148	gpm	Qa
Minimum flow		74	gpm	Qmin

SEWAGE PUMPS				
Sewage pump capacity		**375**	**gpm**	**Qdp (SELECTED DISCHARGE PUMP)**
Estimated TDH		80	ft	
Pump efficiency		50%		
Motor efficiency		85%		
Estimate BHP		17.83	hp	
Selected HP		**10**	**hp**	

COLLECTION TANK				
Operating volume		891	gal	Vo
Tank volume required		3,100	gal	
Selected tank volume		**3,500**	**gal**	**Vct**

VACUUM PUMPS				
Longest Line		5,700	lf	
"A" factor		7		
Volume of pipe		31,420	gal	Vp
Vacuum pump capacity required		346	cfm	
System pump down time		2.33	min	t
Selected vacuum pumps	**2**	**455**	**acfm**	**Qvp (SELECTED VACUUM PUMP)**
		25	**hp**	

SKID MODEL

2D-35

Collection Tank Size/100

Vacuum Pump Type (size)

No. of Vacuum Pumps

B - 170 acfm

C - 305 acfm

D - 455 acfm

AIRVAC®

ALLJOY SOUTH, MAY RIVER AREA, SC
Estimate #2013-133
July 22, 2013
Hussey, Gay, Bell & DeYoung

VACUUM STATION CALCULATIONS

ALLJOY SOUTH VACUUM STATION

885 Service Connections

DESIGN FLOWS

Number of Connections		885		
Growth factor	x	1.00		
Per capita flow	x	100	gpd	
Persons/connection	x	3.00		
Peak factor	x	2.50		
Peak flow	=	461	gpm	
Other peak flow	+	0	gpm	
Total peak flow		**461**	**gpm**	**Qmax**
Average flow		184	gpm	Qa
Minimum flow		92	gpm	Qmin

SEWAGE PUMPS

Sewage pump capacity		**465**	**gpm**	**Qdp (SELECTED DISCHARGE PUMP)**
Estimated TDH		80	ft	
Pump efficiency		50%		
Motor efficiency		85%		
Estimate BHP		22.10	hp	
Selected HP		**10**	**hp**	

COLLECTION TANK

Operating volume		1,107	gal	Vo
Tank volume required		3,700	gal	
Selected tank volume		**4,000**	**gal**	**Vct**

VACUUM PUMPS

Longest Line		9,800	lf	
"A" factor		8		
Volume of pipe		71,510	gal	Vp
Vacuum pump capacity required		492	cfm	
System pump down time		2.50	min	t
Selected vacuum pumps	**3**	**455**	**acfm**	**Qvp (SELECTED VACUUM PUMP)**
		25	**hp**	

SKID MODEL

3D-40

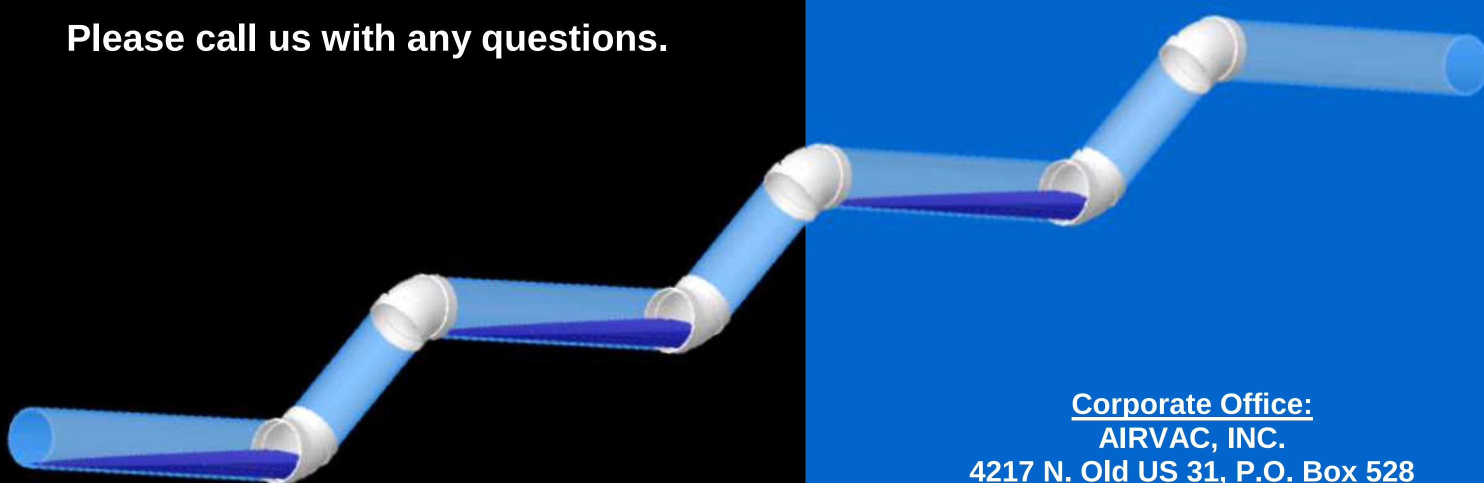
Collection Tank Size/100
Vacuum Pump Type (size) → B - 170 acfm
C - 305 acfm
D - 455 acfm
No. of Vacuum Pumps

AIRVAC

The World Leader in Vacuum Sewer Technology

AIRVAC prides itself on the ability to deliver a broad range of services from planning, design, and engineering support to inspection, training and contractor services. We focus our efforts on developing full-service, long-term customer relationships.

Please call us with any questions.



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Rochester, IN 46975
Phone: 574.223.3980
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AIRVAC®

VACUUM SEWER SYSTEMS

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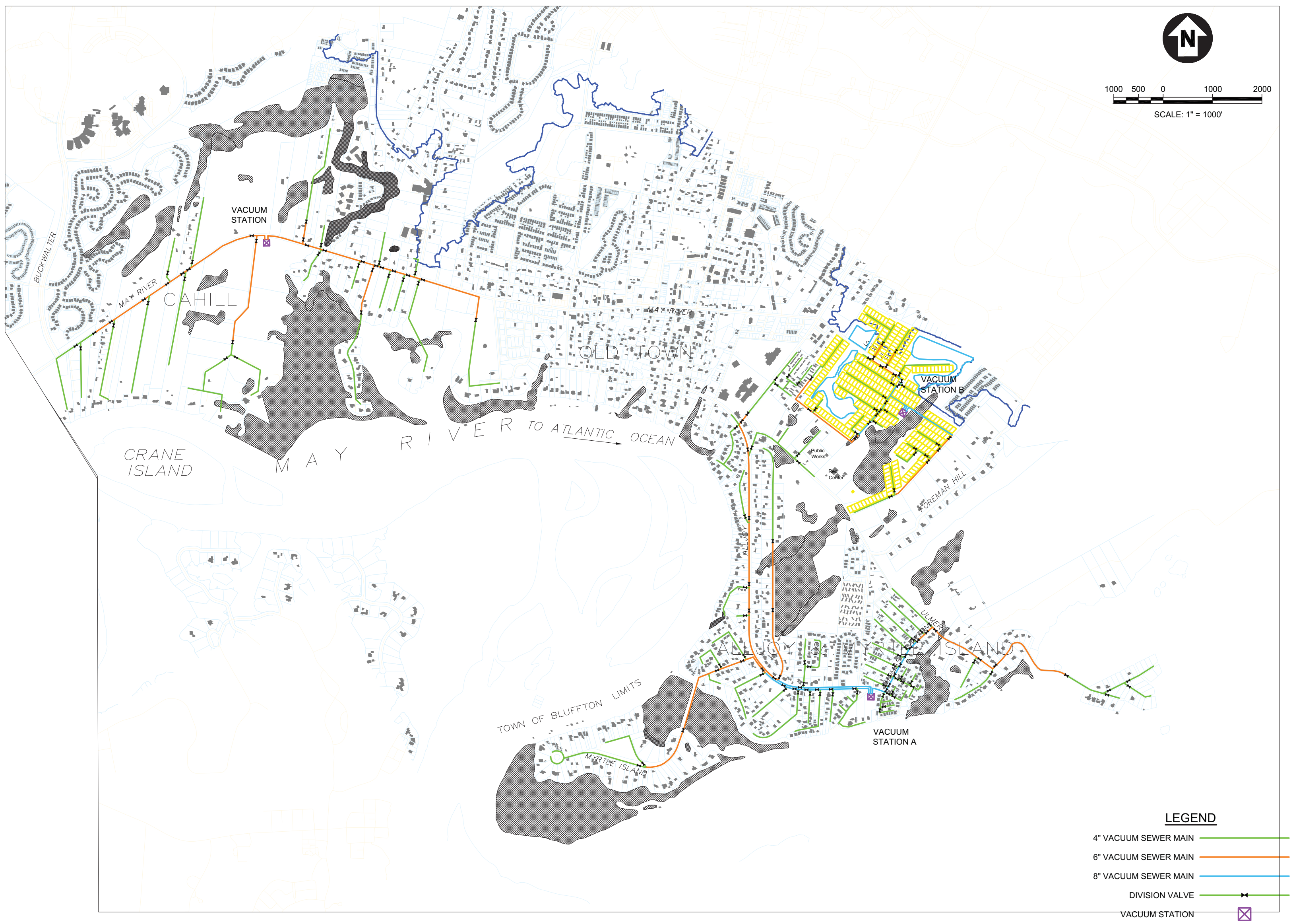
TELEPHONE (574) 223-3980
FAX (574) 223-5566

AIRVAC ESTIMATE #2013-133

The Viable Alternative®

NO.	REVISIONS	DATE

TITLE	MAY RIVER AREA, BLUFFTON, SC PRELIMINARY VACUUM COLLECTION SYSTEM LAYOUT		
CLIENT	HUSSEY, GAY, BELL & DeYOUNG		
DRAWN BY J.YOUNG	DATE 07-19-2013	SCALE 1" = 1000'	DRAWING NO. 1 OF 2
DESIGNED BY J.YOUNG	COPYRIGHT® AIRVAC®		



AIRVAC®

VACUUM SEWER SYSTEMS

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TELEPHONE (574) 223-3980
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AIRVAC ESTIMATE #2013-133

The Viable Alternative®

NO.	REVISIONS	DATE

TITLE	MAY RIVER AREA, BLUFFTON, SC PRELIMINARY VACUUM COLLECTION SYSTEM LAYOUT		
CLIENT	HUSSEY, GAY, BELL & DeYOUNG		
DRAWN BY J.YOUNG	DATE 07-19-2013	SCALE 1" = 1000'	DRAWING NO. 2 OF 2
DESIGNED BY J.YOUNG	COPYRIGHT® AIRVAC®		

Appendix D

Vacuum Sewer Concept for Alljoy Sewer Service Area

Anticipated Cost Estimate

VACUUM SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
ALLJOY SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	4-inch Vacuum Main, SDR 21 PVC with Profile Lifts	17,380	LF	$ 19.00	$ 330,220.00
2	6-inch Vacuum Main, SDR 21 PVC with Profile Lifts	5,210	LF	$ 23.00	$ 119,830.00
3	8-inch Vacuum Main, SDR 21 PVC with Profile Lifts	3,620	LF	$ 27.00	$ 97,740.00
4	4-inch Resilent-Wedge Gate/Isolation Service Valve	45	EA	$ 1,710.00	$ 76,950.00
5	6-inch Resilent-Wedge Gate/Isolation Service Valve	30	EA	$ 2,130.00	$ 63,900.00
6	8-inch Resilent-Wedge Gate Isolation Service Valve	6	EA	$ 2,560.00	$ 15,360.00
7	3-inch Service Lateral, SDR 21 PVC	9,885	LF	$ 9.00	$ 88,965.00
8	Misc. Vacuum Fittings	26,330	LBS	$ 1.00	$ 26,330.00
9	Jack & Bore 8-inch steel casing (0.5" wall thickness) for 4-inch PVC vacuum main	60	LF	$ 100.00	$ 6,000.00
10	Jack & Bore 12-inch steel casing (0.5" wall thickness) for 6-inch PVC vacuum main	60	LF	$ 120.00	$ 7,200.00
11	Insert 4-inch PVC vacuum main in casing	60	LF	$ 30.00	$ 1,800.00
12	Insert 6-inch PVC vacuum main in casing	60	LF	$ 40.00	$ 2,400.00
13	6' deep - 2 Piece Hybrid Valve Pit Package (H20 traffic rated)[1]	494	EA	$ 5,400.00	$ 2,668,950.00
14	Vacuum Sewer Tools	1	EA	$ 5,850.00	$ 5,850.00
15	Spare Parts	1	EA	$ 7,020.00	$ 7,020.00
16	Trailer Mounted Vacuum Pump	1	EA	$ 28,080.00	$ 28,080.00
17	Standard Vacuum Station[2]	1	EA	$ 701,650.00	$ 701,650.00
18	Simplex HDPE Grinder Station[8]	25	EA	$ 8,600.00	$ 215,000.00
19	1-1/4" HDPE SDR9 Service Lateral[8]	1,500	LF	$ 9.00	$ 13,500.00
20	Connect Lateral to Existing Force Main[8]	25	EA	$ 2,000.00	$ 50,000.00
21	Electrical Home Connection[9]	25	EA	$ 2,500.00	$ 62,500.00
22	Silt Fence	31,452	LF	$ 3.50	$ 110,082.00
23	Grassing (Temporary and Permanent)	11,513	SY	$ 2.00	$ 23,026.67
24	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	400	CY	$ 70.00	$ 28,000.00
25	Remove driveway surface, replace with 2" graded aggregate[3]	684	EA	$ 160.00	$ 109,440.00
26	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	8,700	SY	$ 70.00	$ 609,000.00
27	Decommissioning of existing septic tank[5]	684	EA	$ 500.00	$ 342,000.00
28	Connection of Vacuum System to home owner's existing system[6]	684	EA	$ 1,500.00	$ 1,026,000.00
29	8-inch PVC force main, AWWA C900, SDR-18[7]	7,232	LF	$ 18.00	$ 130,167.00
30	8-inch RJ PVC force main, AWWA C900, SDR-18	845	LF	$ 24.00	$ 20,280.00
31	8-inch DI Force Main	254	LF	$ 28.00	$ 7,098.00
32	Misc. Force Main Fittings	3,042	LBS	$ 5.00	$ 15,210.00
33	Force Main Air Release Valve and Manhole	5	EA	$ 3,000.00	$ 15,000.00
34	Core into Termination Manhole for Force Main	1	EA	$ 3,000.00	$ 3,000.00
35	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC force main	120	LF	$ 150.00	$ 18,000.00
36	Insert 8-inch PVC force main in casing	120	LF	$ 50.00	$ 6,000.00
37	Vacuum Manufacturer Field Services	2	Week	$ 3,000.00	$ 6,000.00
38	Traffic Control	1	JOB	Lump Sum	$ 20,000.00
39	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 424,700.00
				Subtotal	$ 7,502,248.67
				Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)	$ 450,134.92
				Engineering Fees (15%)	$ 1,125,337.30
				Construction Contingencies (15%)	$ 1,125,337.30
				Estimated Probable Cost	$ 10,203,058.19
				CALL[I, II, III, IV]	$ 10,300,000.00
No. of existing customers:					684
Cost per customer:					$ 15,100.00

Assumptions:

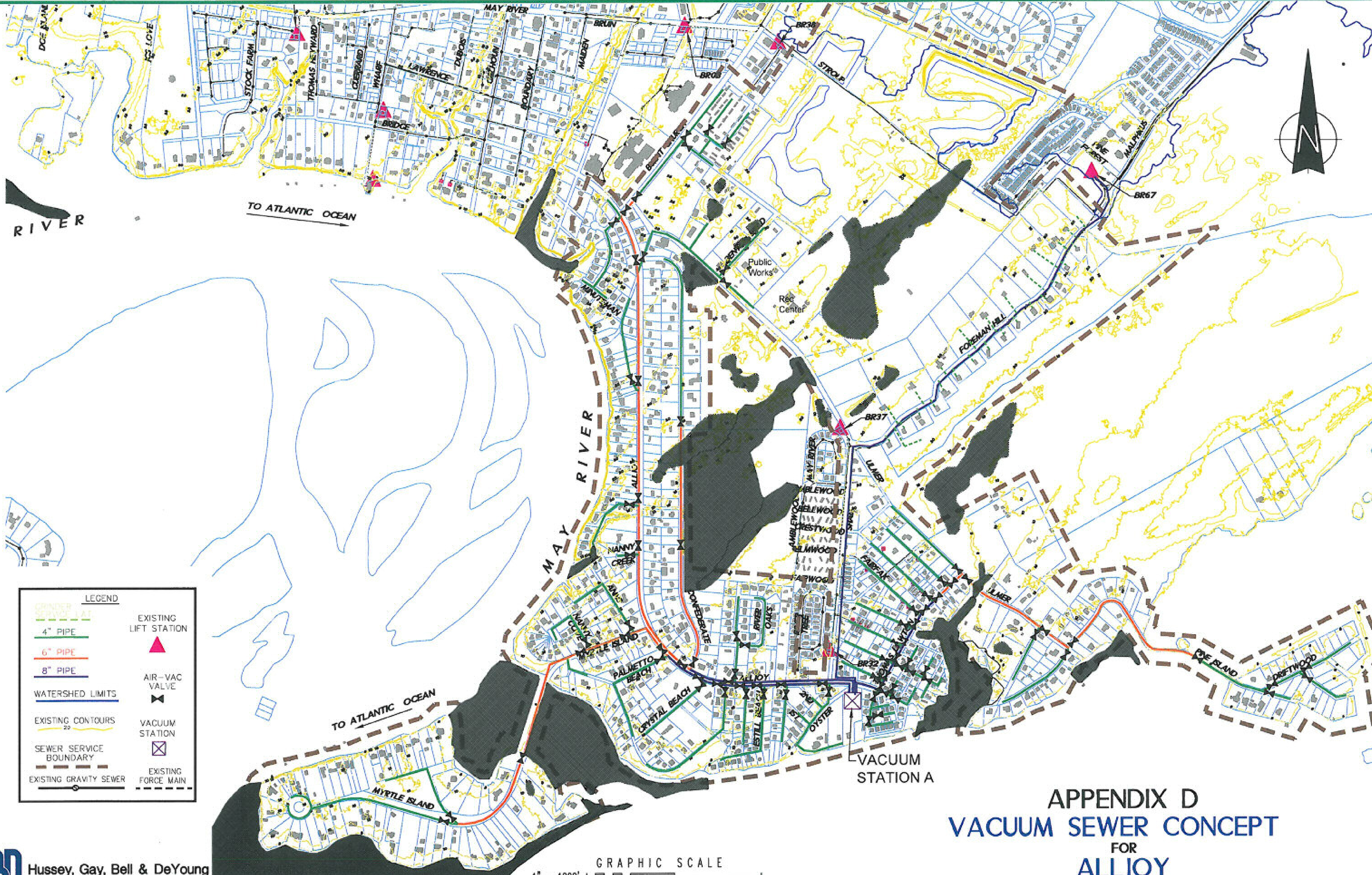
1. Assumes 50% of the homes can physically share Valve Pit Package at 2:1. Quantity based on existing lots only.

2. Standard Vacuum Station includes AirVAc Standard Skid Model 2D-35, equipment installation, wiring/piping/etc., vacuum station building, emergency generator, odor control bio-mass filter bed, collection tank, duplex sewage pumps, vacuum pumps, control panel. Optional equipment, building design and controls will effect the total cost of the Station.
3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.
4. Assumes force main within portions of roadway.
5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6. Cost assumes locating each home owner's drain line, cap line to septic tank and run sewer lateral to valve pit. Lateral lengths will vary. Yard and driveway restoration will vary.

7. Assumes new force main discharges to LS - BR67
8. Grinders along Foreman Hill Road only
9. Assumes price for connection to homeowner's electrical power. Cost is for what is assumed; unforeseen costs are difficult to predict for each homeowner's unique existing electrical setup.
I: Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.
II: It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

III: Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.
IV: Engineering Fees are for civil design services only. Fees do not include wetland mitigatoin credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton



APPENDIX D
VACUUM SEWER CONCEPT
FOR
ALLJOY
DATE: OCTOBER 2013

Hussey, Gay, Bell & DeYoung
A Bell Company
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

Appendix E

Vacuum Sewer Concept for Cahill Sewer Service Area

Anticipated Cost Estimate

VACUUM SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
CAHILL SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price		Total Cost	
1	4-inch Vacuum Main, SDR 21 PVC with Profile Lifts	25,101	LF	$	16.00	$	401,616.00
2	6-inch Vacuum Main, SDR 21 PVC with Profile Lifts	11,470	LF	$	19.00	$	217,930.00
3	4-inch Resilent-Wedge Gate Isolation Service Valve	20	EA	$	1,410.00	$	28,200.00
4	6-inch Resilent-Wedge Gate/Isolation Service Valve	17	EA	$	1,760.00	$	29,920.00
5	3-inch Service Lateral, SDR 21 PVC	1,485	LF	$	8.00	$	11,880.00
6	Misc. Vacuum Fittings	37,471	LBS	$	1.00	$	37,471.00
7	Jack & Bore 8-inch steel casing (0.5" wall thickness) for 4-inch PVC vacuum main	600	LF	$	100.00	$	60,000.00
8	Jack & Bore 12-inch steel casing (0.5" wall thickness) for 6-inch PVC vacuum main	300	LF	$	120.00	$	36,000.00
9	Insert 4-inch PVC vacuum main in casing	600	LF	$	30.00	$	18,000.00
10	Insert 6-inch PVC vacuum main in casing	300	LF	$	40.00	$	12,000.00
11	6' deep - 2 Piece Hybrid Valve Pit Package (H20 traffic rated)[1]	74	EA	$	5,400.00	$	400,950.00
12	Vacuum Sewer Tools	1	EA	$	5,850.00	$	5,850.00
13	Spare Parts	1	EA	$	7,020.00	$	7,020.00
14	Trailer Mounted Vacuum Pump	1	EA	$	28,080.00	$	28,080.00
15	Standard Vacuum Station[2]	1	EA	$	687,960.00	$	687,960.00
16	Silt Fence	43,885	LF	$	3.50	$	153,598.20
17	Grassing (Temporary and Permanent)	13,670	SY	$	2.00	$	27,340.67
18	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	500	CY	$	70.00	$	35,000.00
19	Remove driveway surface, replace with 2" graded aggregate[3]	99	EA	$	160.00	$	15,840.00
20	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	3,450	SY	$	70.00	$	241,500.00
21	Decommissioning of existing septic tank[5]	99	EA	$	500.00	$	49,500.00
22	Connection of Vacuum System to home owner's existing system[6]	99	EA	$	1,500.00	$	148,500.00
23	8-inch PVC force main, AWWA C900, SDR-18[7]	3,855	LF	$	18.00	$	69,390.00
24	8-inch RJ PVC force main, AWWA C900, SDR-18	450	LF	$	24.00	$	10,800.00
25	8-inch DI Force Main	135	LF	$	28.00	$	3,780.00
26	Misc. Force Main Fittings	1,620	LBS	$	5.00	$	8,100.00
27	Force Main Air Release Valve and Manhole	5	EA	$	3,000.00	$	15,000.00
28	Core into Termination Manhole for Force Main	1	EA	$	3,000.00	$	3,000.00
29	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC force main	60	LF	$	150.00	$	9,000.00
30	Insert 8-inch PVC force main in casing	60	LF	$	50.00	$	3,000.00
31	Vacuum Manufacturer Field Services	2	Week	$	3,000.00	$	6,000.00
32	Traffic Control	1	JOB	Lump Sum		$	20,000.00
33	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum		$	168,200.00
					Subtotal	$	2,970,425.87
					Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)	$	178,225.55
					Engineering Fees (15%)	$	445,563.88
					Construction Contingencies (15%)	$	445,563.88
					Estimated Probable Cost	$	4,039,779.18
					CALL[I, II, III, IV]	$	4,100,000.00
No. of existing customers:							99
Cost per customer:						$	41,500.00

Assumptions:

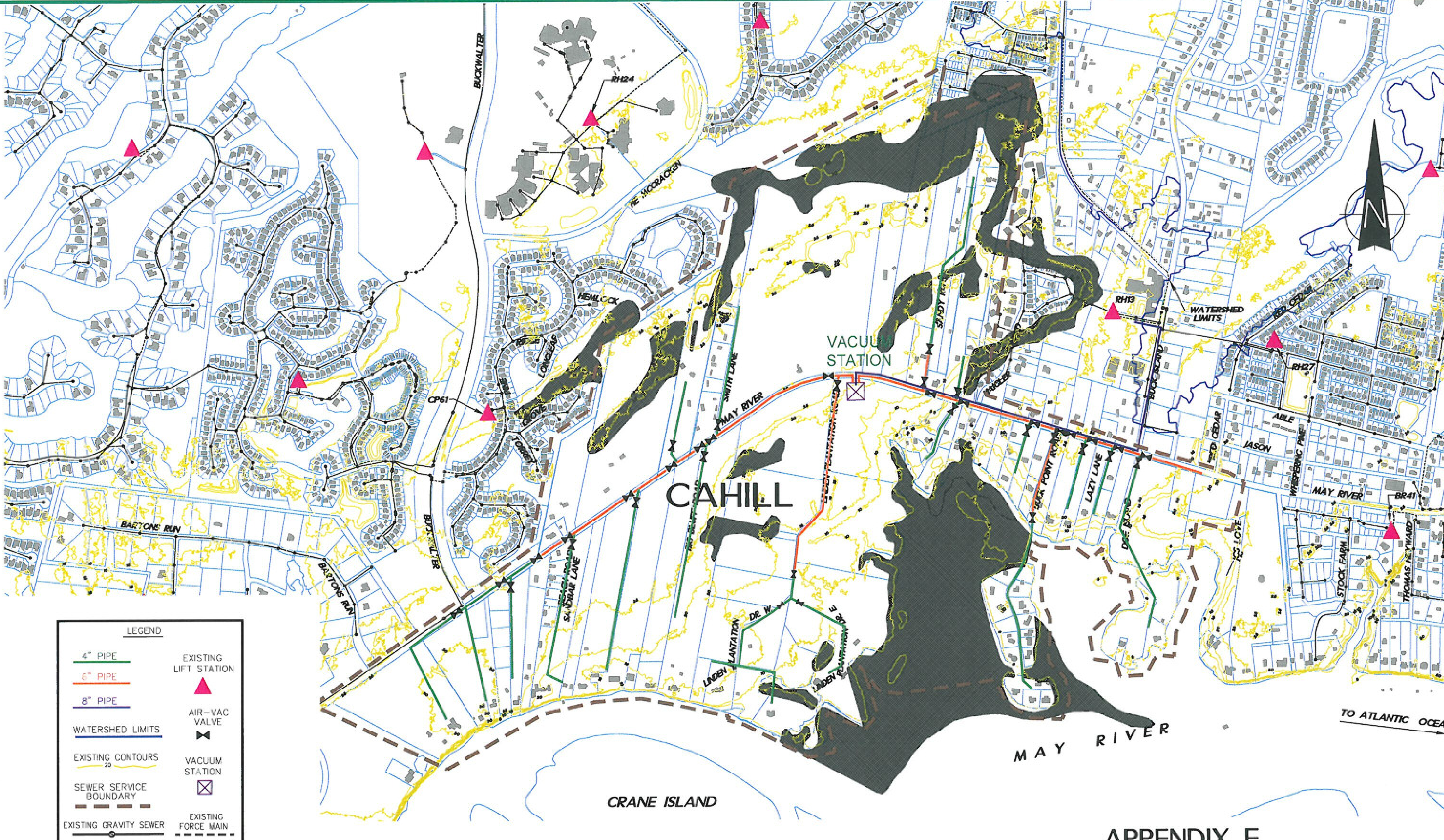
1. Assumes 50% of the homes can physically share Valve Pit Package at 2:1. Quantity based on existing lots only.

2. Standard Vacuum Station includes AirVAc Standard Skid Model 2D-10, equipment installation, wiring, piping/etc., vacuum station building, emergency generator, odor control bio-mass filter bed, collection tank, duplex sewage pumps, vacuum pumps, control panel. Optional equipment, building design and controls will effect the total cost of the Station.
3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.
4. Assumes force main within portions of roadway.
5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6. Cost assumes locating each home owner's drain line, cap line to septic tank and run sewer lateral to valve pit. Lateral lengths will vary. Yard and driveway restoration will vary.

7. Assumes new force main discharges to LS - RH13
I: Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.
II: It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

III: Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.
IV. Engineering Fees are for civil design services only. Fees do not include wetland mitigatoin credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton



APPENDIX E
VACUUM SEWER CONCEPT
FOR
CAHILL
DATE: OCTOBER 2013

GRAPHIC SCALE
1" = 1000'
0' 500' 1000' 2000'

HGBD A Bell Company
Hussey, Gay, Bell & DeYoung - Consulting Engineers
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

Appendix F

Vacuum Sewer Concept for Gascoigne Sewer Service Area

Anticipated Cost Estimate

VACUUM SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
G SCOIGNE SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	4-inch Vacuum Main, SDR 21 PVC with Profile Lifts	18,995	LF	$ 19.00	$ 360,905.00
2	6-inch Vacuum Main, SDR 21 PVC with Profile Lifts	10,494	LF	$ 23.00	$ 241,362.00
3	4-inch Resilent-Wedge Gate/Isolation Service Valve	12	EA	$ 1,710.00	$ 20,520.00
4	6-inch Resilent-Wedge Gate/Isolation Service Valve	8	EA	$ 2,130.00	$ 17,040.00
5	3-inch Service Lateral, SDR 21 PVC	810	LF	$ 9.00	$ 7,290.00
6	Misc. Vacuum Fittings	29,729	LBS	$ 1.00	$ 29,729.00
7	Jack & Bore 12-inch steel casing (0.5" wall thickness) for 6-inch PVC vacuum main	120	LF	$ 120.00	$ 14,400.00
8	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC vacuum main	120	LF	$ 150.00	$ 18,000.00
9	Insert 4-inch PVC vacuum main in casing	120	LF	$ 30.00	$ 3,600.00
10	Insert 6-inch PVC vacuum main in casing	120	LF	$ 40.00	$ 4,800.00
11	6' deep - 2 Piece Hybrid Valve Pit Package (H20 traffic rated)[1]	41	EA	$ 5,400.00	$ 218,700.00
12	Vacuum Sewer Tools	1	EA	$ 5,850.00	$ 5,850.00
13	Spare Parts	1	EA	$ 7,020.00	$ 7,020.00
14	Trailer Mounted Vacuum Pump	1	EA	$ 28,080.00	$ 28,080.00
15	Standard Vacuum Station[2]	1	EA	$ 646,660.00	$ 646,660.00
16	Silt Fence	35,387	LF	$ 3.50	$ 123,853.80
17	Grassing (Temporary and Permanent)	10,488	SY	$ 2.00	$ 20,976.00
18	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	400	CY	$ 70.00	$ 28,000.00
19	Remove driveway surface, replace with 2" graded aggregate[3]	54	EA	$ 160.00	$ 8,640.00
20	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	750	SY	$ 70.00	$ 52,500.00
21	Decommissioning of existing septic tank[5]	54	EA	$ 500.00	$ 27,000.00
22	Connection of Vacuum System to home owner's existings stem[6]	54	EA	$ 1,500.00	$ 81,000.00
23	8-inch PVC force main, AWWA C900, SDR-18[7]	1,710	LF	$ 18.00	$ 30,788.10
24	8-inch RJ PVC force main, AWWA C900, SDR-18	204	LF	$ 24.00	$ 4,884.00
25	8-inch DI Force Main	61	LF	$ 28.00	$ 1,709.40
26	Misc. Force Main Fittings	733	LBS	$ 5.00	$ 3,663.00
27	Force Main Air Release Valve and Manhole	5	EA	$ 3,000.00	$ 15,000.00
28	Core into Termination Manhole for Force Main	1	EA	$ 3,000.00	$ 3,000.00
29	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC force main	60	LF	$ 150.00	$ 9,000.00
30	Insert 8-inch PVC force main in casing	60	LF	$ 50.00	$ 3,000.00
31	Vacuum Manufacturer Field Services	2	Week	$ 3,000.00	$ 6,000.00
32	Traffic Control	1	JOB	Lump Sum	$ 30,000.00
33	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 123,800.00
				Subtotal	$ 2,186,770.10
				Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)	$ 131,206.22
				Engineering Fees (15%)	$ 328,015.55
				Construction Contingencies (15%)	$ 328,015.55
				Estimated Probable Cost	$ 2,974,007.61
				CALL[I,II,III,IV]	$ 3,000,000.00
No. of existing customers:					54
Cost per customer:					$ 55,600.00

Assumptions

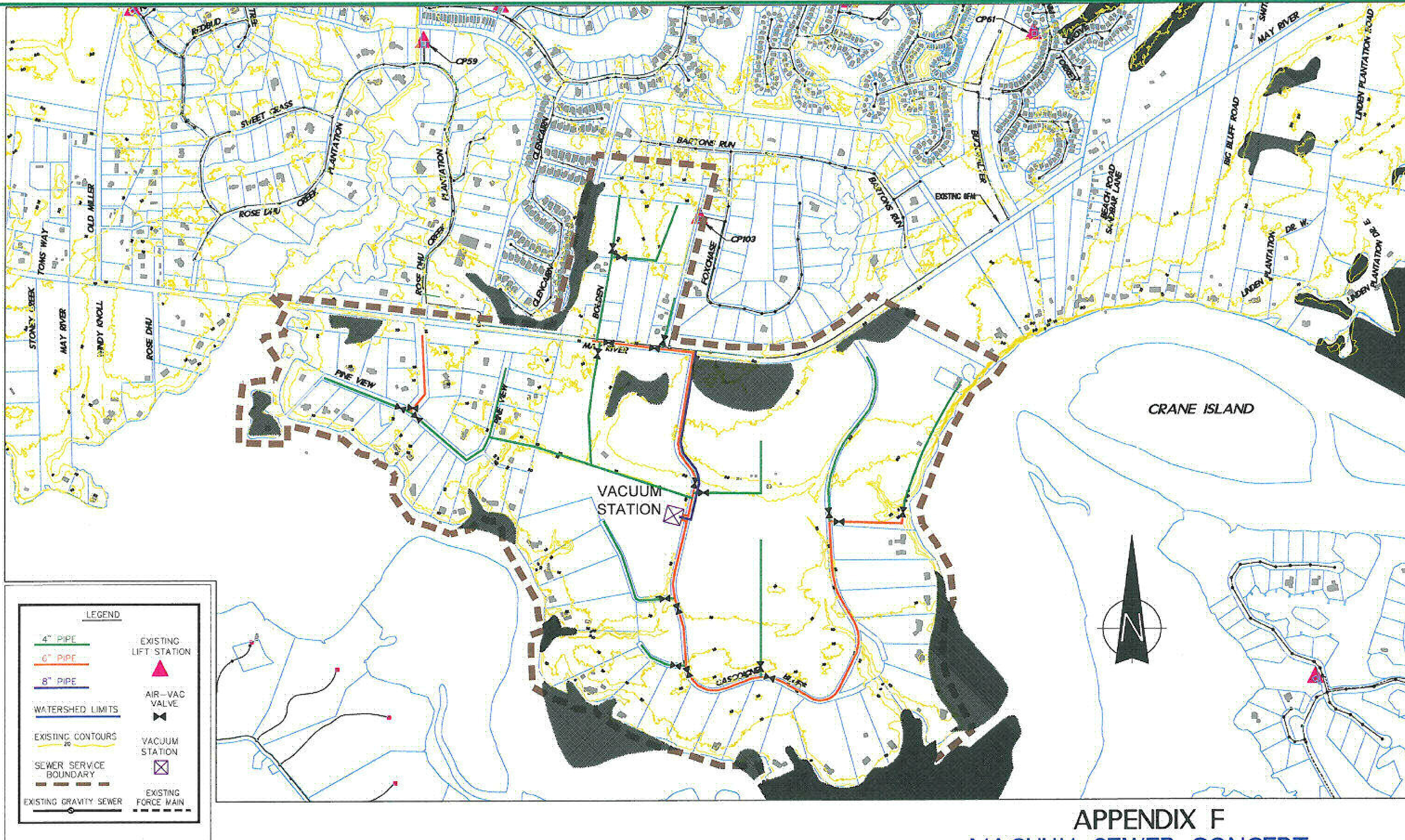
1. Assumes 50% of the homes can physically share Valve Pit Package at 2:1. Quantity based on existing lots only

2. Standard Vacuum Station includes AirVAc Standard Skid Model 30-10, equipment installation, wiring/piping/etc., vacuum station building, emergency generator, odor control bio-mass filter bed, collection tank, duplex sewage pumps, vacuum pumps, control panel. Optional equipment, building design and controls will effect the total cost of the Station
3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.
4. Assumes force main within portions of roadway.
5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc

6. Cost assumes locating each home owner's drain line, cap line to septic tank and run sewer lateral to valve pit. Lateral lengths will vary. Yard and driveway restoration will vary.

7. Assumes new force main manifolds to existing 8-inch force main along May River Road
I. Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure
II. It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

III. Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.
IV. Engineering Fees are for civil design services only. Fees do not include wetland mitigation credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton



APPENDIX F

VACUUM SEWER CONCEPT

FOR

GASCOIGNE

DATE: OCTOBER 2013

GRAPHIC SCALE

1" = 1000'

0' 500' 1000' 2000'

HGBD A Bell Company

Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

Appendix G

Vacuum Sewer Concept for Stoney Creek Sewer Service Area

Anticipated Cost Estimate

VACUUM SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
STONEY CREEK SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	4-inch Vacuum Main, SDR 21 PVC with Profile Lifts	16,810	LF	$ 19.00	$ 319,390.00
2	6-inch Vacuum Main, SDR 21 PVC with Profile Lifts	14,710	LF	$ 23.00	$ 338,330.00
3	4-inch Resilent-Wedge Gate/Isolation Service Valve	13	EA	$ 1,710.00	$ 22,230.00
4	6-inch Resilent-Wedge Gate Isolation Service Valve	9	EA	$ 2,130.00	$ 19,170.00
5	3-inch Service Lateral, SDR 21 PVC	2,700	LF	$ 9.00	$ 24,300.00
6	Misc. Vacuum Fittings	31,820	LBS	$ 1.00	$ 31,820.00
7	Jack & Bore 12-inch steel casing (0.5" wall thickness) for 6-inch PVC vacuum main	300	LF	$ 120.00	$ 36,000.00
8	Insert 6-inch PVC vacuum main in casing	300	LF	$ 40.00	$ 12,000.00
9	6' deep - 2 Piece Hybrid Valve Pit Package (H20 traffic rated)[1]	135	EA	$ 5,400.00	$ 729,000.00
10	Vacuum Sewer Tools	1	EA	$ 5,850.00	$ 5,850.00
11	Spare Parts	1	EA	$ 7,020.00	$ 7,020.00
12	Trailer Mounted Vacuum Pump	1	EA	$ 28,080.00	$ 28,080.00
13	Standard Vacuum Station[2]	1	EA	$ 691,010.00	$ 691,010.00
14	Silt Fence	37,824	LF	$ 3.50	$ 132,384.00
15	Grassing (Temporary and Permanent)	12,767	SY	$ 2.00	$ 25,533.33
16	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	400	CY	$ 70.00	$ 28,000.00
17	Remove driveway surface, replace with 2' graded aggregate[3]	150	EA	$ 160.00	$ 24,000.00
18	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	3,825	SY	$ 70.00	$ 267,750.00
19	Decommissioning of existing septic tank[5]	150	EA	$ 500.00	$ 75,000.00
20	Connection of Vacuum System to home owner's existing system[6]	150	EA	$ 1,500.00	$ 225,000.00
21	8-inch PVC force main, AWWA C900, SDR-18[7]	5,883	LF	$ 18.00	$ 105,894.00
22	8-inch RJ PVC force main, AWWA C900, SDR-18	690	LF	$ 24.00	$ 16,560.00
23	8-inch DI Force Main	207	LF	$ 28.00	$ 5,796.00
24	Misc. Force Main Fittings	2,484	LBS	$ 5.00	$ 12,420.00
25	Force Main Air Release Valve and Manhole	5	EA	$ 3,000.00	$ 15,000.00
26	Core into Termination Manhole for Force Main	1	EA	$ 3,000.00	$ 3,000.00
27	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC force main	120	LF	$ 150.00	$ 18,000.00
28	Insert 8-inch PVC force main in casing	120	LF	$ 50.00	$ 6,000.00
29	Vacuum Manufacturer Field Services	2	Week	$ 3,000.00	$ 6,000.00
30	Traffic Control	1	JOB	Lump Sum	$ 20,000.00
31	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, Insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 195,100.00
				Subtotal	$ 3,445,637.33
				Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)	$ 206,738.24
				Engineering Fees (15%)	$ 516,845.60
				Construction Contingencies (15%)	$ 516,845.60
				Estimated Probable Cost	$ 4,686,066.77
				CALL[I, II, III, IV]	$ 4,700,000.00
No. of existing customers:					150
Cost per customer:					$ 31,400.00

Assumptions:

1. Assumes 10% of the homes can physically share Valve Pit Package at 2:1. Quantity based on existing lots only.

2. Standard Vacuum Station includes AirVAc Standard Skid Model 2D-15, equipment installation, wiring/piping/etc., vacuum station building, emergency generator, odor control bio-mass filter bed, collection tank, duplex sewage pumps, vacuum pumps, control panel. Optional equipment, building design and controls will effect the total cost of the Station.

3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.

4. Assumes force main within portions of roadway.

5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6. Cost assumes locating each home owner's drain line, cap line to septic tank and run sewer lateral to valve pit. Lateral lengths will vary. Yard and driveway restoration will vary.

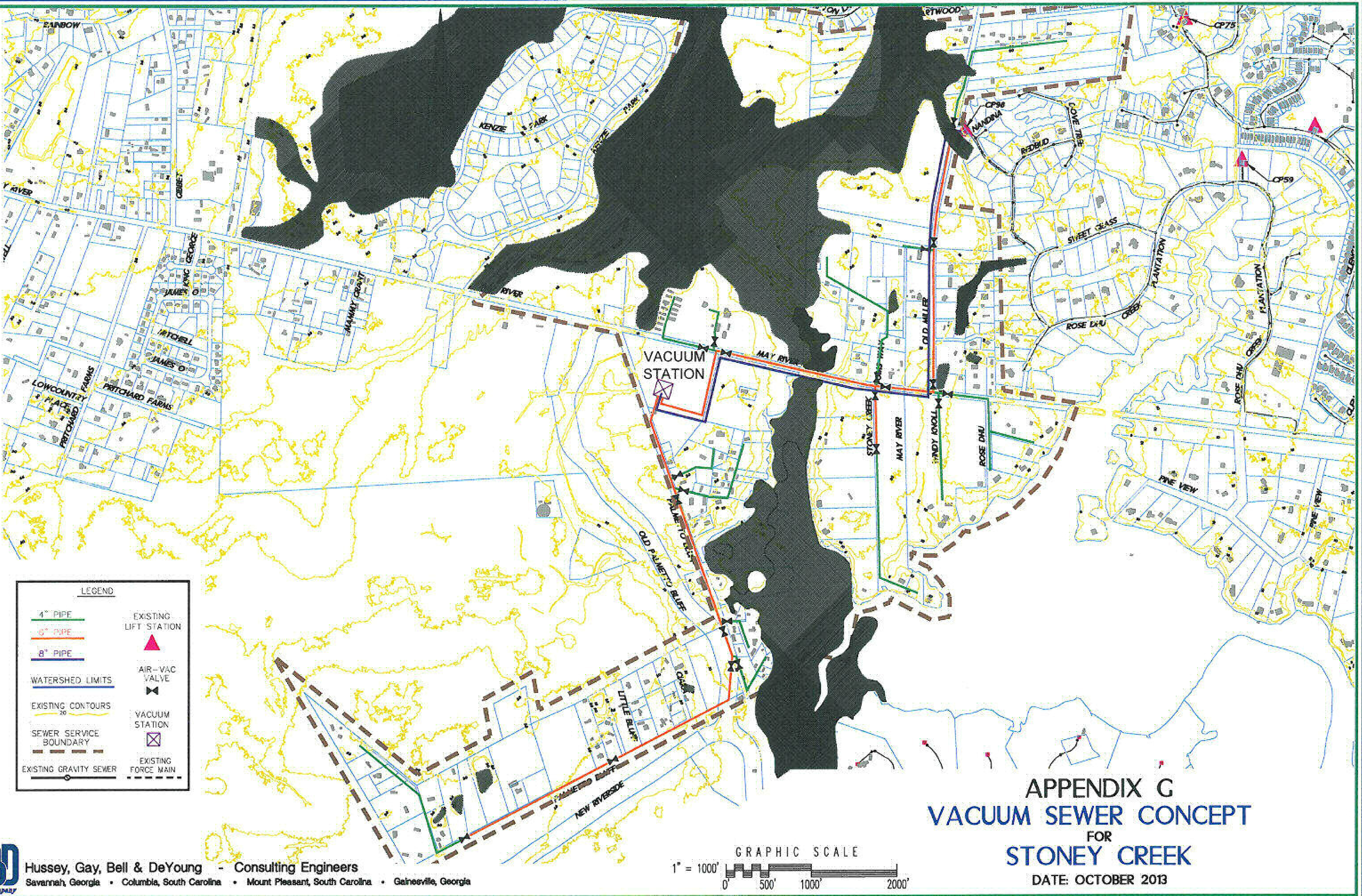
7. Assumes new force main discharges to LS - CP98

I: Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.

II: It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

III: Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.

IV: Engineering Fees are for civil design services only. Fees do not include wetland mitigatoin credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton



APPENDIX G
VACUUM SEWER CONCEPT
FOR
STONEY CREEK
DATE: OCTOBER 2013

HGBD A Bell Company

Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

Appendix H

Vacuum Sewer Concept for Pritchardville Sewer Service Area

Anticipated Cost Estimate

VACUUM SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
PRITCHARDVILLE SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	4-inch Vacuum Main, SDR 21 PVC with Profile Lifts	49,160	LF	$ 19.00	$ 934,040.00
2	6-inch Vacuum Main, SDR 21 PVC with Profile Lifts	17,080	LF	$ 23.00	$ 392,840.00
3	8-inch Vacuum Main, SDR 21 PVC with Profile Lifts	4,550	LF	$ 27.00	$ 122,850.00
4	4-inch Resilent-Wedge Gate/Isolation Service Valve	45	EA	$ 1,710.00	$ 76,950.00
5	6-inch Resilent-Wedge Gate/Isolation Service Valve	30	EA	$ 2,130.00	$ 63,900.00
6	8-inch Resilent-Wedge Gate/Isolation Service Valve	6	EA	$ 2,560.00	$ 15,360.00
7	3-inch Service Lateral, SDR 21 PVC	7,530	LF	$ 9.00	$ 67,770.00
8	Misc. Vacuum Fittings	71,570	LBS	$ 1.00	$ 71,570.00
9	Jack & Bore 8-inch steel casing (0.5" wall thickness) for 4-inch PVC vacuum main	360	LF	$ 100.00	$ 36,000.00
10	Jack & Bore 12-inch steel casing (0.5" wall thickness) for 6-inch PVC vacuum main	240	LF	$ 120.00	$ 28,800.00
11	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC vacuum main	180	LF	$ 150.00	$ 27,000.00
12	Insert 4-inch PVC vacuum main in casing	360	LF	$ 30.00	$ 10,800.00
13	Insert 6-inch PVC vacuum main in casing	240	LF	$ 40.00	$ 9,600.00
14	Insert 8-inch PVC vacuum main in casing	180	LF	$ 50.00	$ 9,000.00
15	6' deep - 2 Piece Hybrid Valve Pit Package (H20 traffic rated)[1]	377	EA	$ 5,400.00	$ 2,033,100.00
16	Vacuum Sewer Tools	1	EA	$ 5,850.00	$ 5,850.00
17	Spare Parts	1	EA	$ 7,020.00	$ 7,020.00
18	Trailer Mounted Vacuum Pump	1	EA	$ 28,080.00	$ 28,080.00
19	Standard Vacuum Station[2]	1	EA	$ 793,260.00	$ 793,260.00
20	Silt Fence	84,948	LF	$ 3.50	$ 297,318.00
21	Grassing (Temporary and Permanent)	25,343	SY	$ 2.00	$ 50,686.67
22	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	800	CY	$ 70.00	$ 56,000.00
23	Remove driveway surface, replace with 2" graded aggregate[3]	502	EA	$ 160.00	$ 80,320.00
24	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	2,865	SY	$ 70.00	$ 200,550.00
25	Decommissioning of existing septic tank[5]	502	EA	$ 500.00	$ 251,000.00
26	Connection of Vacuum System to home owner's existing system[6]	502	EA	$ 1,500.00	$ 753,000.00
27	8-inch PVC force main, AWWA C900, SDR-18[7]	4,551	LF	$ 18.00	$ 81,918.00
28	8-inch RJ PVC force main, AWWA C900, SDR-18	530	LF	$ 24.00	$ 12,720.00
29	8-inch DI Force Main	159	LF	$ 28.00	$ 4,452.00
30	Misc. Force Main Fittings	1,908	LBS	$ 5.00	$ 9,540.00
31	Force Main Air Release Valve and Manhole	5	EA	$ 3,000.00	$ 15,000.00
32	Core into Termination Manhole for Force Main	1	EA	$ 3,000.00	$ 3,000.00
33	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC force main	60	LF	$ 150.00	$ 9,000.00
34	Insert 8-inch PVC force main in casing	60	LF	$ 50.00	$ 3,000.00
35	Vacuum Manufacturer Field Services	2	Week	$ 3,000.00	$ 6,000.00
36	Traffic Control	1	JOB	Lump Sum	$ 20,000.00
37	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 395,300.00
				Subtotal	$ 6,982,594.67
				Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)	$ 418,955.68
				Engineering Fees (15%)	$ 1,047,389.20
				Construction Contingencies (15%)	$ 1,047,389.20
				Estimated Probable Cost	$ 9,496,328.75
				CALL[I, II, III, IV]	$ 9,500,000.00
No. of existing customers:					502
Cost per customer:					$ 19,000.00

Assumptions:

1. Assumes 50% of the homes can physically share Valve Pit Package at 2:1. Quantity based on existing lots only.

2. Standard Vacuum Station includes AirVAc Standard Skid Model 3D-30, equipment installation, wiring/piping/etc., acuum station building, emergency generator, odor control bio-mass filter bed, collection tank, duplex sewage pumps, vacuum pumps, control panel. Optional equipment, building design and controls will effect the total cost of the Station.
3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.
4. Assumes vacuum main and/or force main within portions of roadway
5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6. Cost assumes locating each home owner's drain line, cap line to septic tank and run sewer lateral to valve pit, Lateral lengths will vary. Yard and driveway restoration will vary.

7. Assumes new force main discharges to LS - CP128
I: Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.
II: It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

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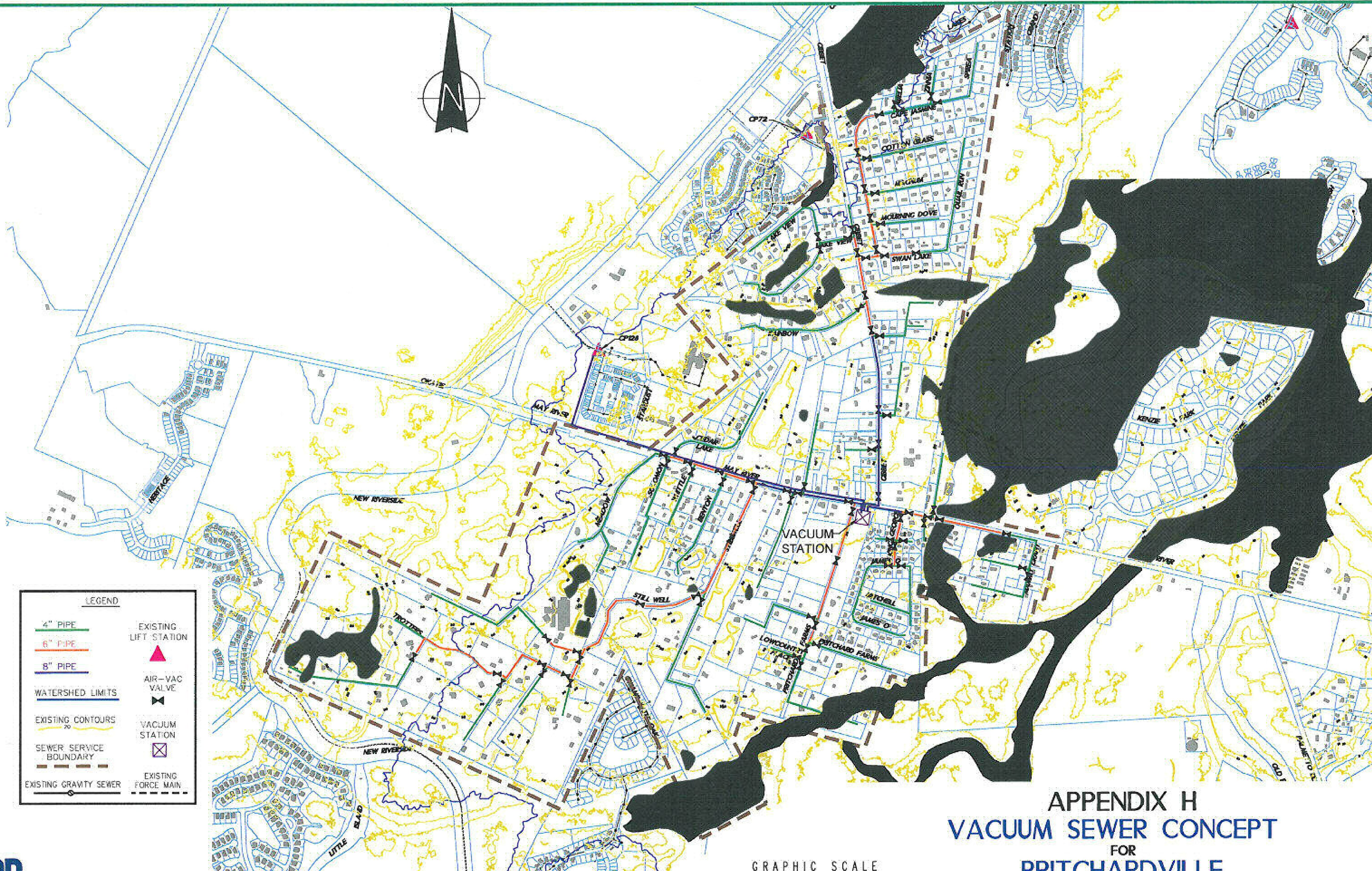


APPENDIX H

VACUUM SEWER CONCEPT

FOR

PRITCHARDVILLE

DATE: OCTOBER 2013

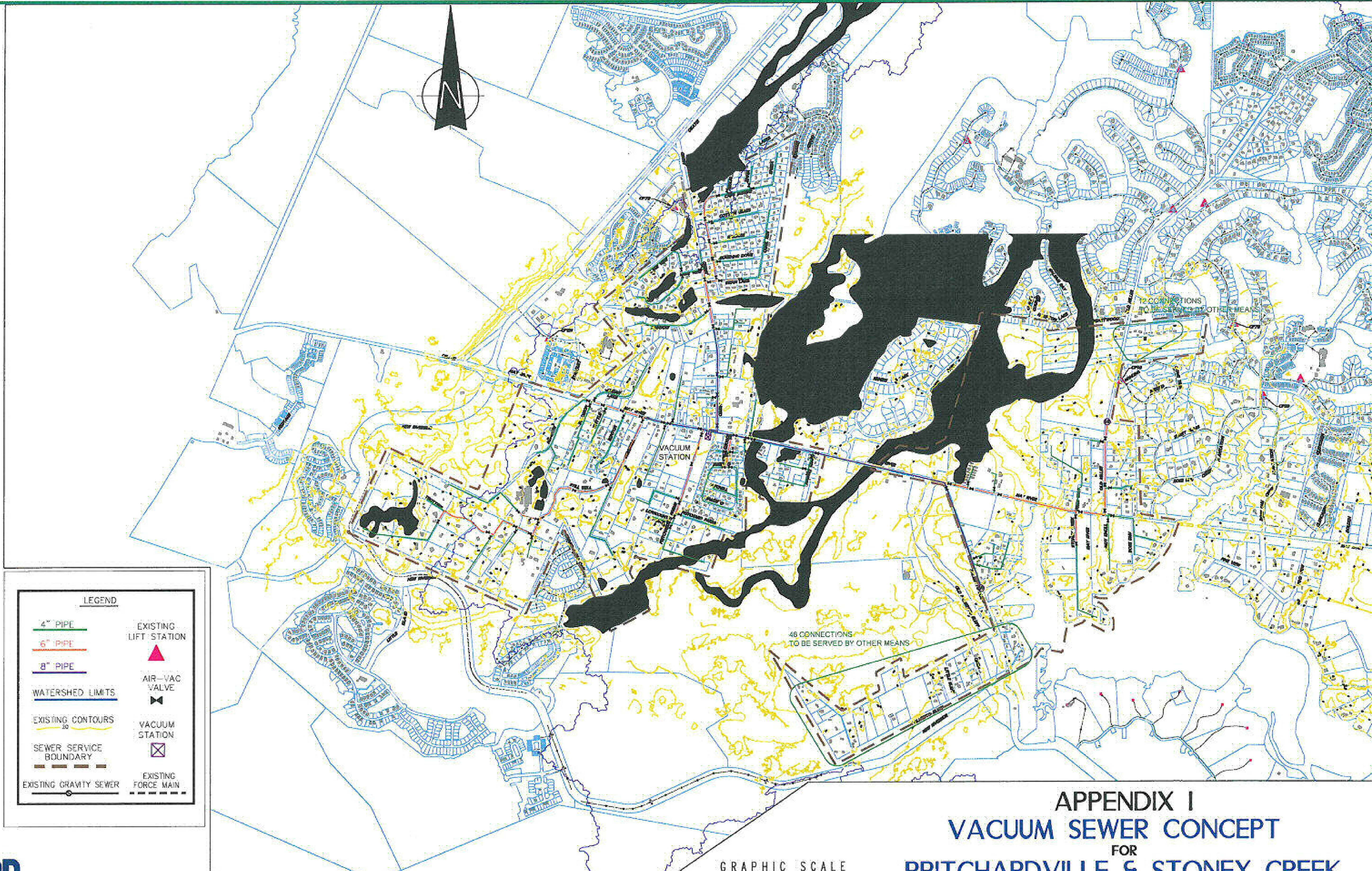
HGBD
A Bell Company

Hussey, Gay, Bell & DeYoung - Consulting Engineers
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

GRAPHIC SCALE
1" = 1200'
0' 600' 1200' 2400'

Appendix I

Vacuum Sewer Concept for Pritchardville and Stoney Creek Sewer Service Area - Combined



APPENDIX I
VACUUM SEWER CONCEPT
FOR
PRITCHARDVILLE & STONEY CREEK
DATE: OCTOBER 2013

HGBD A Bell Company

Hussey, Gay, Bell & DeYoung - Consulting Engineers
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

Appendix J

Low Pressure Grinder Sewer System
Typical Features

PETE DUTY & ASSOCIATES, INC.
1121 Drayton Street • Newberry, South Carolina 29108 • (803) 276-3211 • Fax (803) 276-3212

SUBMITTAL LETTER

March 11, 2013

To: Bobby Lee @ Terry Lee Contracting
From: Joe Desroches @ Pete Duty & Associates, Inc.
Re: BJWSA - Sanchez Residence - Simplex Basin Package

Pete Duty & Associates, Inc. is pleased to submit the following equipment for your approval:

(1) Simplex Fiberglass Basin Grinder Pump Package To Include:

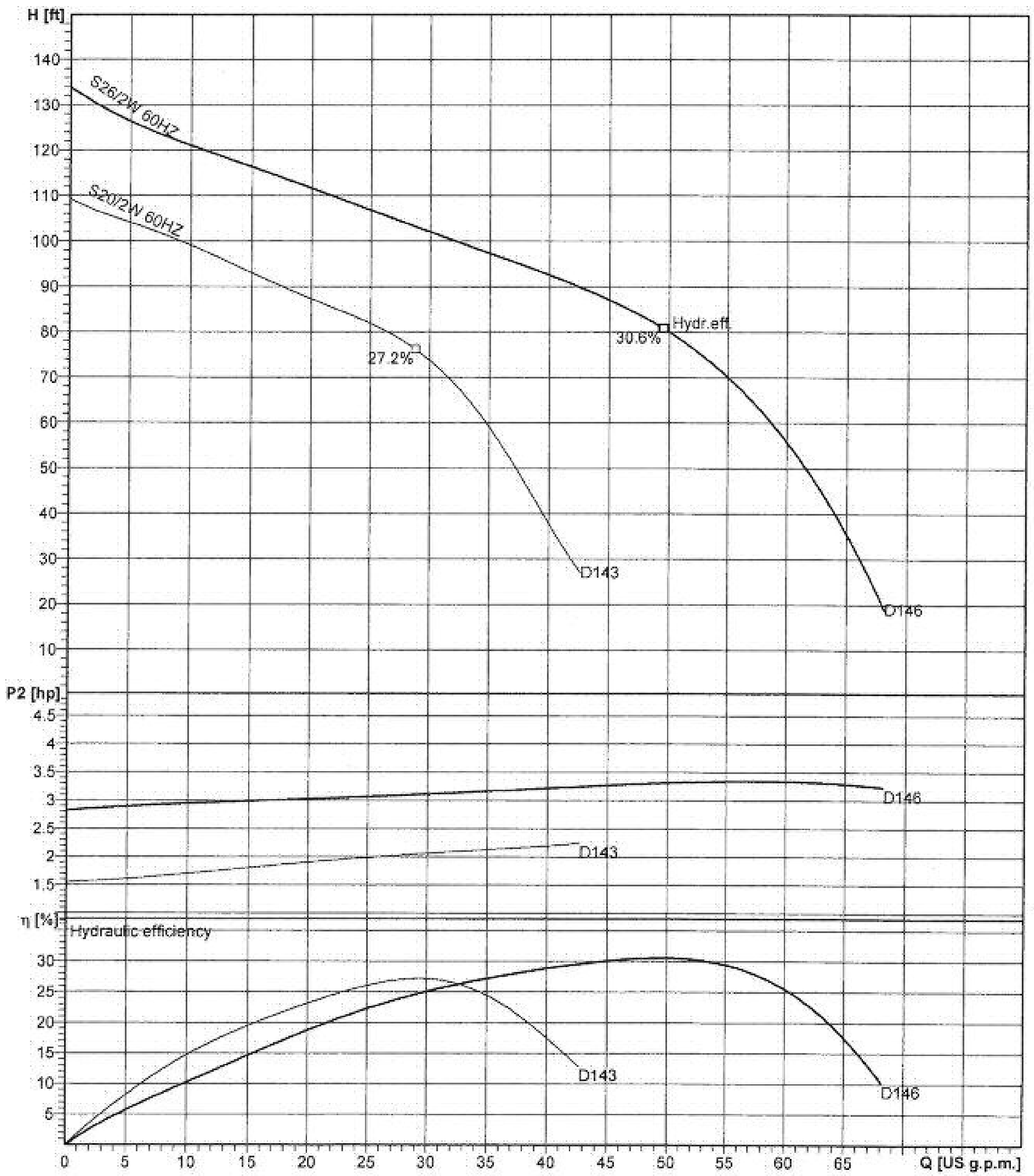
- (1) 30" x 60" Fiberglass Basin To Include All Internal 2" Piping, Fittings, 4" Inlet Gasket, Fiberglass Bolt Down Lid, Check Valve True Union Ball Valve, & 2" X 6" SS Nipple (Shipped Loose)
- (1) ABS Piranha S-20/2W Grinder Pump, 230 Volt, Single Phase w/ 30' Power Cable
- (1) Guide Rail Assembly (Installed In Basin)
- (1) Upper Guide Bracket 316 Stainless Steel (Installed In Basin)
- (1) 2" 316 SS - Schedule 40 Guide Rail Pipe (Installed In Basin)
- (1) ABS Simplex Control Panel
- (3) Anchor Mini Floats w/ 30' Cables
- (1) 3/16" Lifting Chain Type 316 SS w/ Shackle
- (1) Cable Bracket - SS
- (1) Meter Box

If you have any questions, or need additional information, please feel free to contact me.

Cordially,

Joe Desroches

abs	Pump performance curves PIRANHA S W 60 HZ			Curve number Reference curve PIRANHA S W
Both pumps selected			Discharge G1¼"	Frequency 60 Hz
Density 62.428 lb/ft³	Viscosity 0.000016813 ft²/s	Testnorm Hydraulic Institute	Rated speed 3520 rpm	Date 2013-08-18
Flow 49.6 US g.p.m.	Head 80.7 ft	Rated power 3.31 hp	Hydraulic efficiency 30.6 %	NPSH



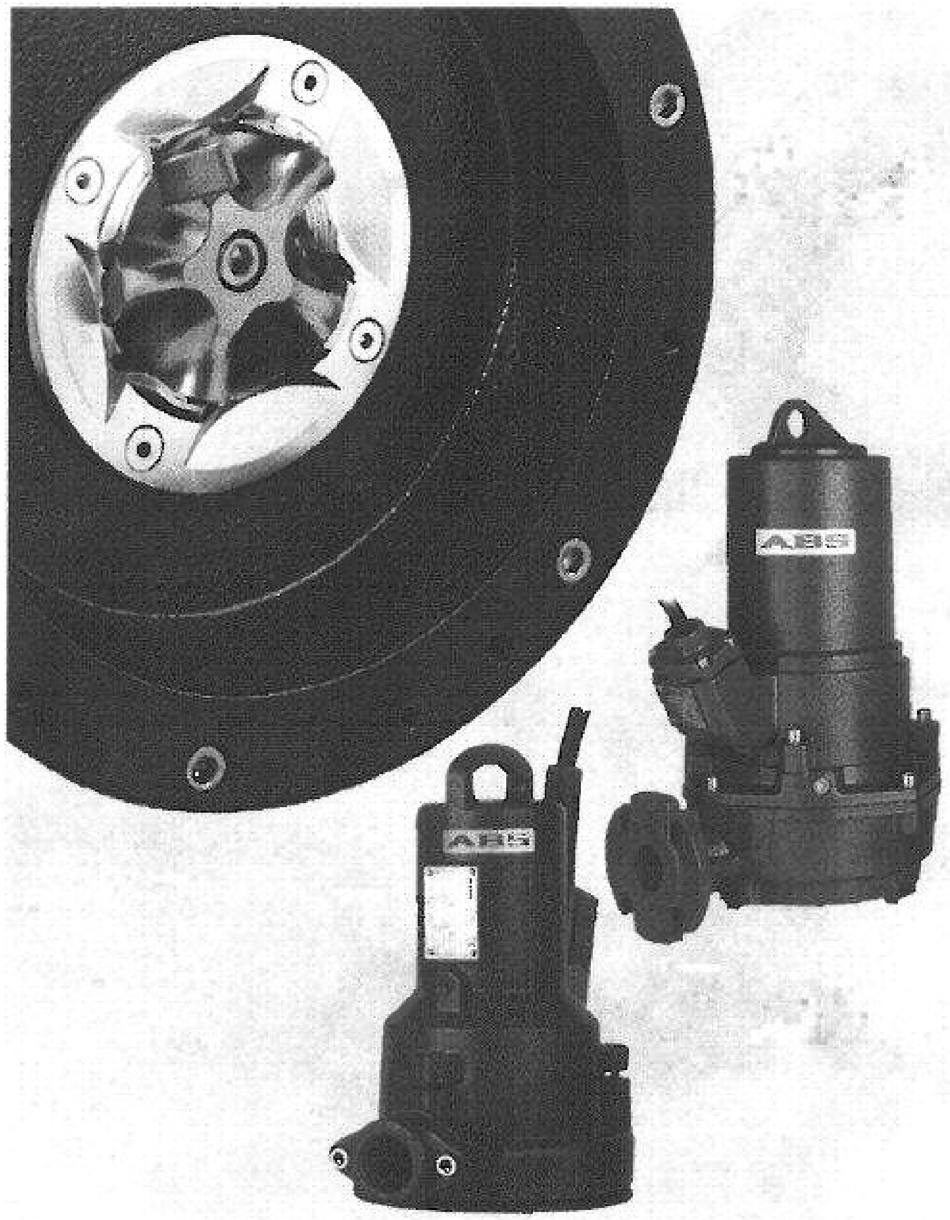
Impeller size	N° of vanes	Impeller	Solid size	Revision 2010-09-28
5.75 inch	4	Macerator		

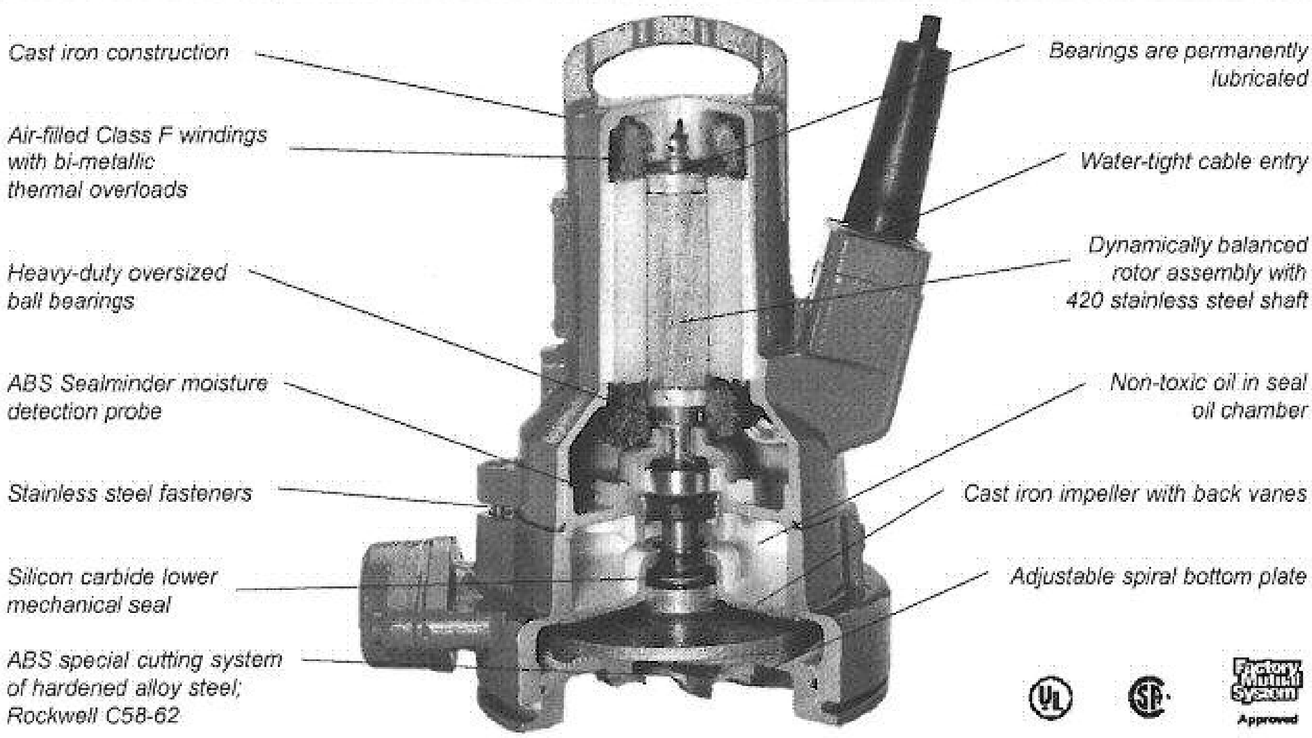
ABSEL PRO 1.7.2 / 2007-02-07

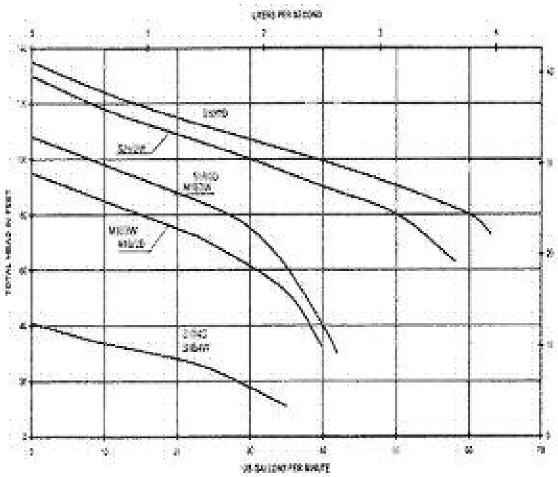
ABS
COST-EFFECTIVE PUMPING

"S" Series models to 4 horsepower and "M" Series to 16 horsepower grinder pumps

- Superior cutter and non-clog action
- Ball bearing construction for extended life
- Unique Sealminder safety-check system
- Complete packaged pump systems with control panels
- FM approved, explosion proof models available
- Thermal protection for all models
- Cast iron construction
- Air-filled motor
- 1 1/4" & 2" discharge
- Non-toxic environmentally friendly oil in seal chamber
- Four pole version available for low-flow applications
- Models available in single and three phase
- "S" Series is UL approved for electrical safety
- All models are CSA approved for electrical safety







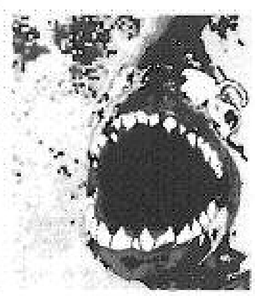
Consult an authorized ABS representative when selecting Piranha pumps for low head applications.

Accessories

- Standard guide rail assembly
- Ball check guide rail assembly
- Vertical pedestal base
- Horizontal pedestal base
- ABS manufactured control panel — designed to enhance the operation and reliability of the pump

Sealminder – safety check system

Piranha pumps are equipped with a Sealminder probe in the oil chamber. Should the lower seal leak, allowing water into the oil chamber, the probe activates a warning light or audible alarm. This gives advanced warning allowing for the repair of the pump seal before water enters the motor.



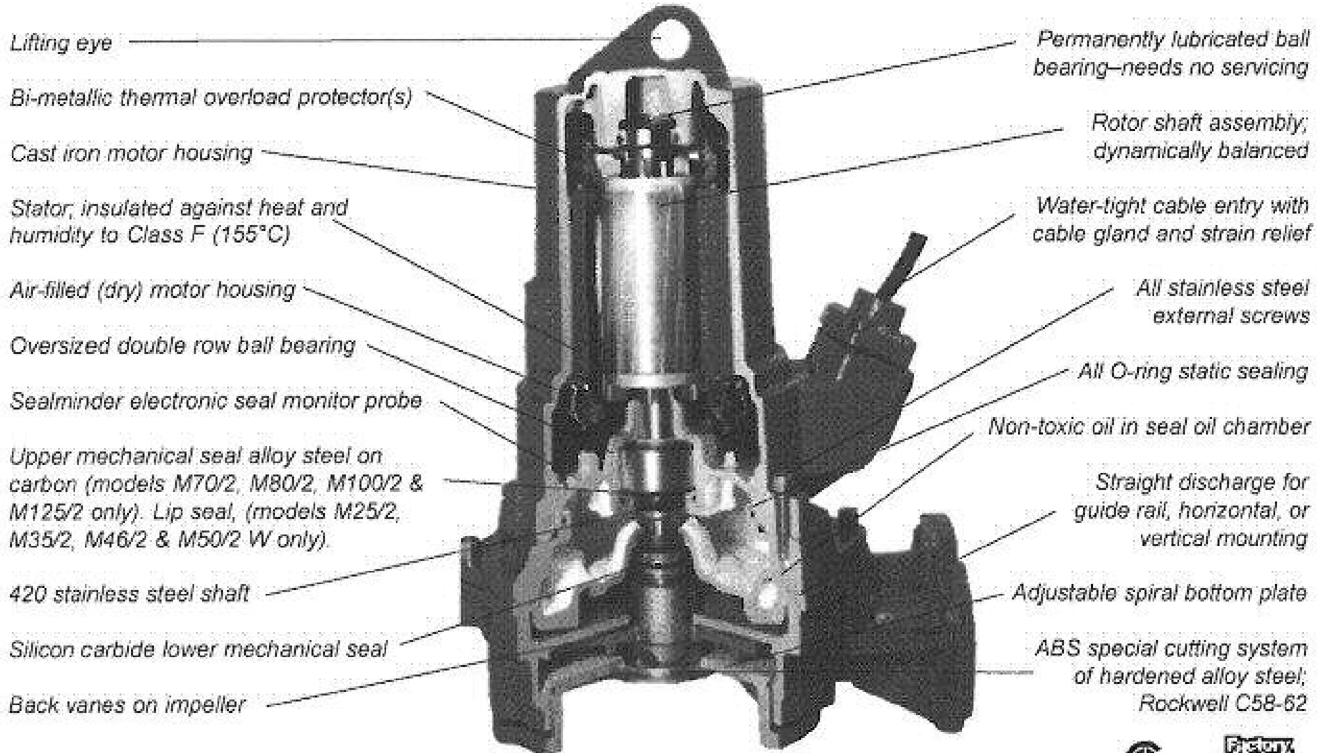
The Piranha

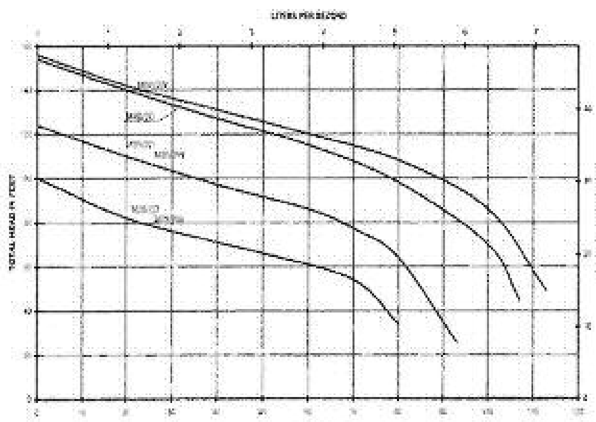
The shredding rotor and ring of the Piranha System ensures efficient operation in sewage containing solids, and allows blockage-free pumping. Good reasons for being named after the voracious South American fish.

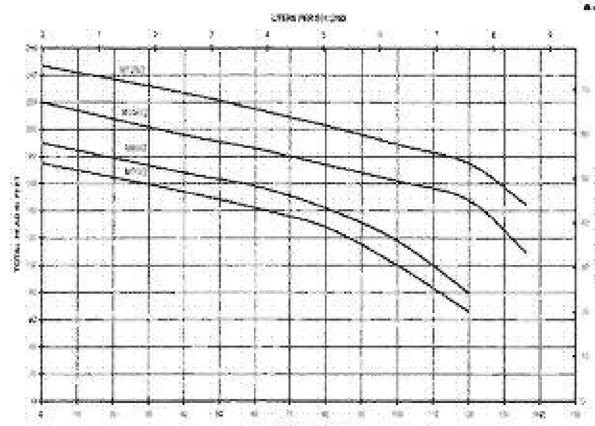
Specifications

Model	S10-4W	S10-4D	S16-2W	S16-2D	S18-2W	S18-2D	S26-2W	S30-2D
Voltage	230	230,460 575	230	230,460 575	230	230,460 575	230	230,460 575
Full Load Amps	6.5	5.2,2.6 2.1	9.2	6.6,3.3 2.6	10.8	7.2,3.6 2.9	13.7	11.5,5 4.4
Phase	1	3	1	3	1	3	1	3
RPM	1750	1750	3450	3450	3450	3450	3450	3450
HP	1.3	1.3	2.1	2.1	2.4	2.4	3.5	4.0
Standard Cable (ft.)	30	30	30	30	30	30	30	30
Discharge (inches)	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
Height (inches)	14	14	14	14	14	14	14 1/2	14 1/2
Weight (lbs.)	70	70	70	70	71	71	88	88

Specifications are subject to change without notice.







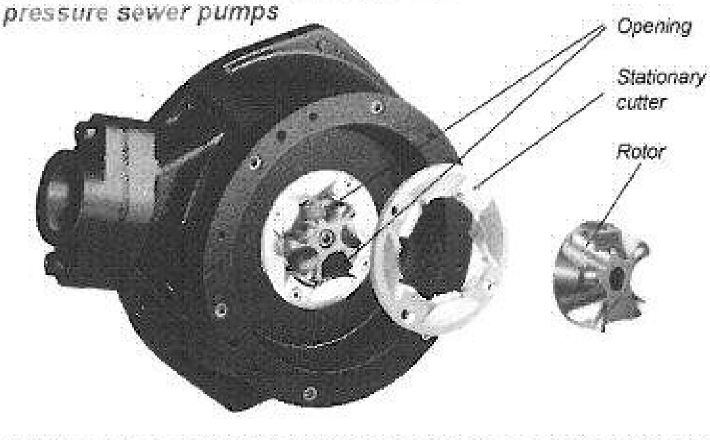
Consult an authorized ABS representative when selecting Piranha pumps for low head applications.

Specifications

Model	M25/2		M35/2		M46/2	M50/2W	M70/2	M80/2	M100/2	M125/2D
Phase	1	3	1	3	1	1	3	3	3	3
Voltage	230	230 460 575	230	230 460 575	230 460 575	230	230 460 575	230 460 575	230 460 575	230 460 575
Full Load Amps	16.6	9.4 4.7 6.8	24	12.2 6.1 4.9	15.4 7.7 6.2	29.3	23.2 11.6 9.3	26.2 13.1 10.5	34 17 13.6	42.5 21.3 17
RPM	3450	3450	3450	3450	3450	3450	3450	3450	3450	3450
HP	3.4	3.4	4.7	4.7	6.2	6.7	9.4	10.7	13.4	16
Standard Cable (ft.)	30	30	30	30	30	30	30	30	30	30
Discharge (inches)	1¼	1¼	1¼	1¼	1¼	1¼	2	2	2	2

Specifications are subject to change without notice.

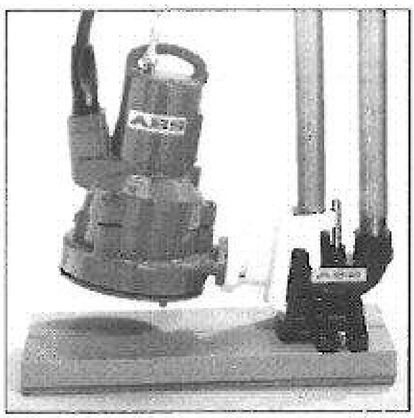
The most effective cutting system for pressure sewer pumps



The ABS cutter system features a totally different concept in grinder pump design. The ABS design consists of a lobed rotor cutter attached to a centrifugal impeller. A stationary cutting element is fastened to the ABS spiral bottom plate. The lobed rotor turns in the stationary cutter. The stationary cutter is designed with a wave form. The number of waves is one less than the number of lobes on the rotor. This causes an opening to be formed between the rotor and stationary cutter. The normal pumping action of the impeller causes water and solids to flow into the cutting elements. As the solids are sheared into small particles, they are pumped by the impeller into the discharge pipe. Should any of the finely cut particles try to wedge between the impeller and bottom plate, the outward threaded spiral grooves will move them to the discharge.

Applications

ABS Piranha grinder pumps move sewage and wastewater at high velocity through contour piping. Recommended for individual or groups of homes, motels, industrial complexes, shopping centers, schools, and many other applications requiring pressure sewer systems.



Residential Grinder Pump System

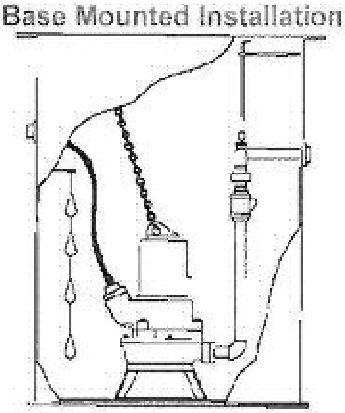
The Piranha S16/2 is available as a completely packaged simplex or duplex system. It is designed for residential and small industrial sewage or sump applications. The pump is recommended for homes in isolated or mountainous areas, and for dewatering of dwellings located in inland protected areas where septic tanks are not permitted. The system includes a basin, chain, pump, cover, check valve, discharge pipe, control box and float switches.

Guide Rail Installation

For those installations where the ABS Piranha grinder pump must be installed in a deep sump, a guide rail system is available. The ABS guide rail system allows connection of the pump to the discharge pipe by gravity. The pumps are lowered by chain down a single 2" guide rail. As the pump is lowered into position, an angled slot in the pump bracket contacts a straightening vane which squares the pump with the mating flange of the guide rail base.

For routine inspection, the pump can be easily lifted by the chain. Personnel need not enter the wet well for

Base Mounted Installation



Distributed by:

ABS

COST-EFFECTIVE PUMPING

ABS reserves the right to alter specifications due to technical developments.

Corporate Office:
ABS Pumps Inc.
140 Pond View Drive
Meriden, CT 06450
(203) 238-2700
FAX (203) 238-0738

Regional Offices:
ABS Pumps Inc.
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Sanford, FL 32771
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FAX (407) 330-3404

Odell's Pump & Motor Service
1650 Bell Ave., Ste. 140
Sacramento, CA 95838
(916) 925-8508
FAX (916) 925-3914

CH&E Pumps
3849 N. Palmer Street
Milwaukee, WI 53212
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FAX (414) 964-0677

ABS Pumps Corp.
1215 Meyerside Drive
Unit #7
Mississauga, Ontario
Canada L5T 1H3
(905) 670-4677
FAX (905) 670-3709

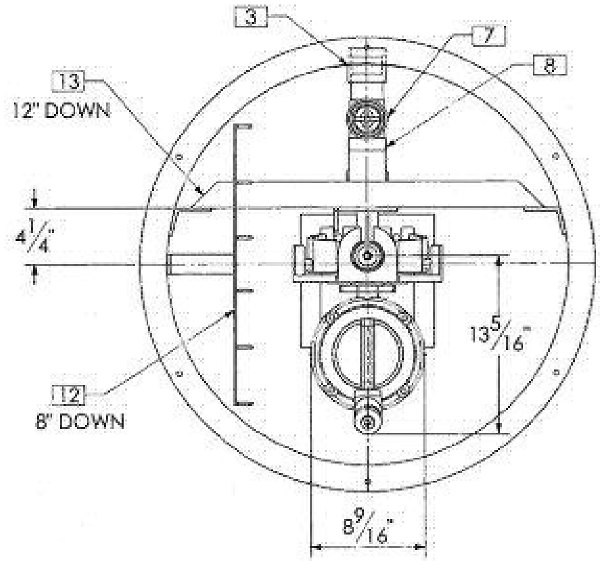
Agents and distributors
ABS has sales and service representation in more than 100 countries the world over.

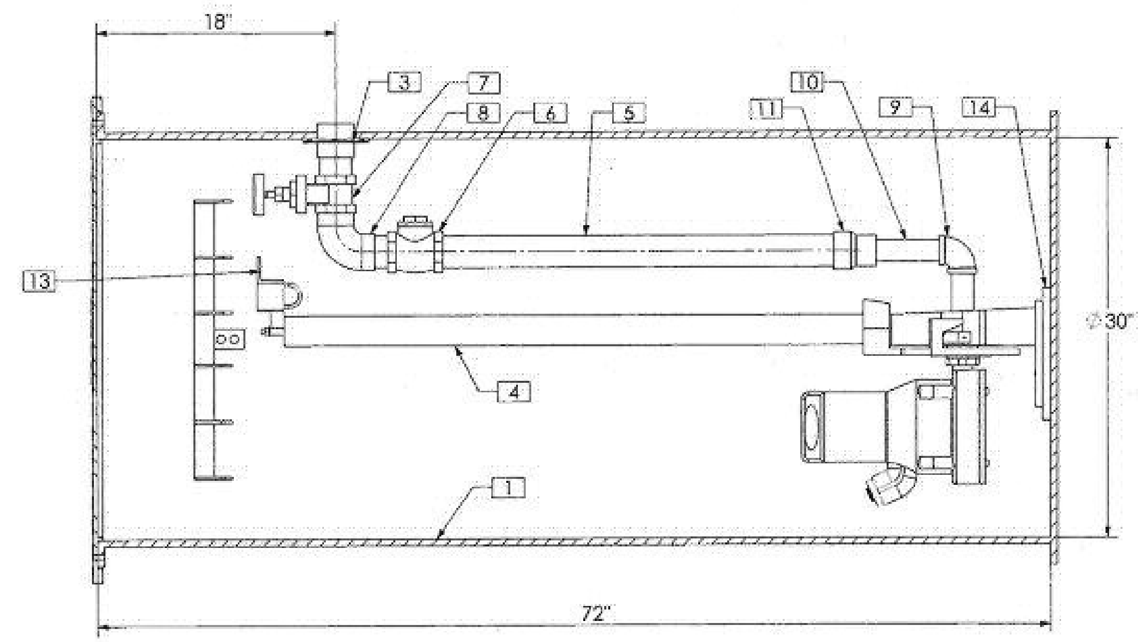
www.abspumpsusa.com

ABS is a company in the Cardo Group

MP 15M 4/03

WET WELL
O.D. = 34"
B.C. = 32 1/2"
I.D. = 30"





O.D. = OUTER DIAMETER
B.C. = BOLT CIRCLE
I.D. = INNER DIAMETER
C.A. = CLEAR ACCESS

TOPP INDUSTRIES INCORPORATED

PUMP: ABS S16

228786

12549-7-NS

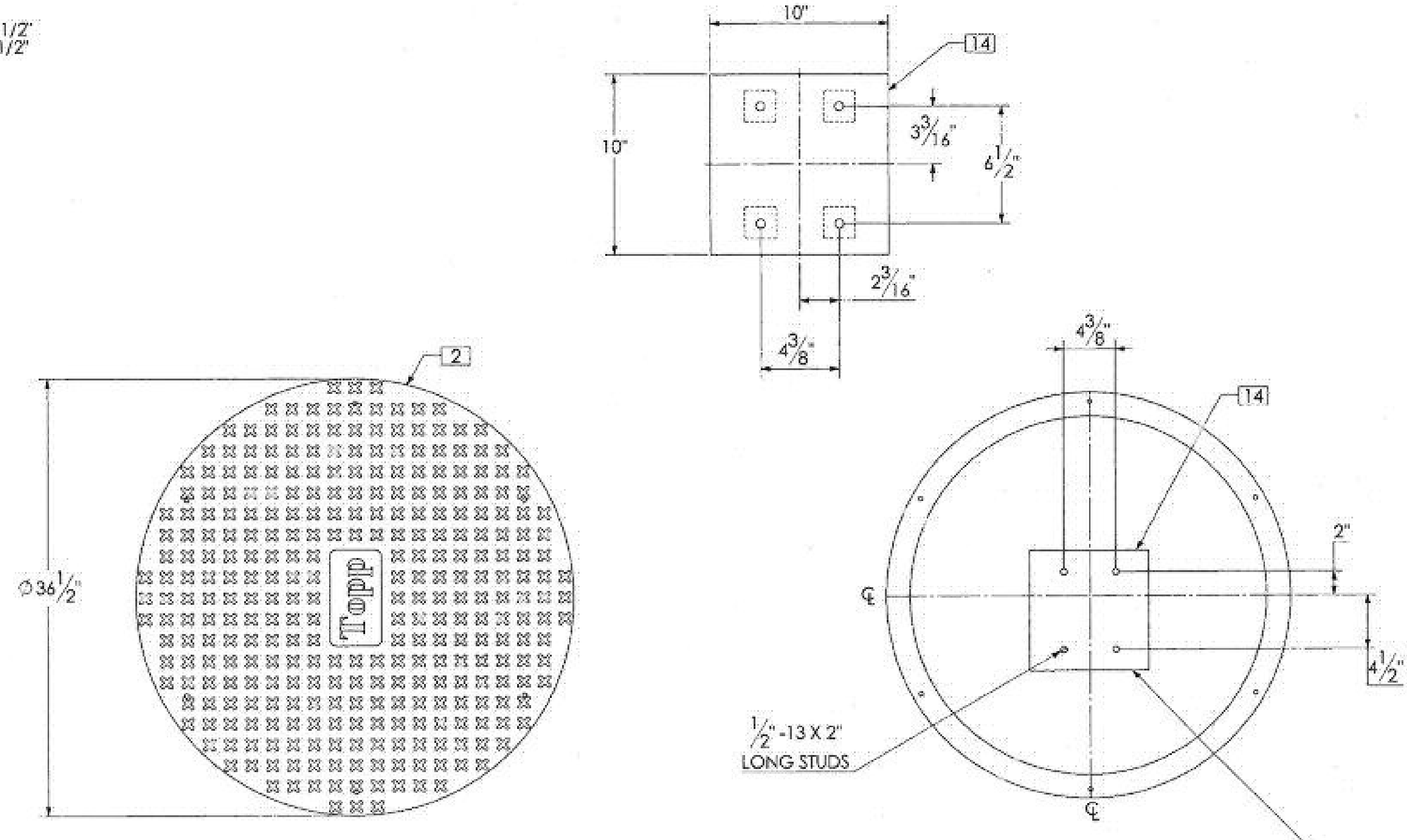
TAG: NEWBERRY STOCK

PETE DUTY & ASSOCIATES, INC.

228786 A

A2

WET WELL
COVER
O.D. = 36 1/2"
B.C. = 32 1/2"
I.D. = 30"



NOTE: A MINIMUM OF 5/8" THICK FOR THE CHOPPED STUD PLATE. TO BE GLUED ON TOP OF THE BOTTOM BOARD. W/ 1/8" TO 1/4" BEAD OF GLUE SHOWING AROUND ALL SIDES OF PAD.

O.D. = OUTER DIAMETER
B.C. = BOLT CIRCLE
I.D. = INNER DIAMETER
C.A. = CLEAR ACCESS

TOPP

PUMP: ABS S16
228786 | 12549-7-NS
TAG: NEWBERRY STOCK
PETE DUTY & ASSOCIATES, INC.
228786 B A2

ITEM NO.	PART NUMBER	BILL OF MATERIAL DESCRIPTION	QTY.
1	FB30X72F-SS	30" X 72" FG BASIN, W/FG ANTI-FLOAT, W/SIMPLEX STUDS	6
2	C30WFNST	SOLID NON-SKID FG COVER W/TOPP LOGO FOR 30" BASIN	6
3	C200S30	2" SS THREADED NPT COUPLING	6
4	13-0105	2" 304 STAINLESS STEEL PIPE	40 FT
5	14-0105	2" SCH80 PVC PIPE	40 FT
6	16-0102	2" BRASS THREADED SWING CHECK VALVE	6
7	16-0302	2" BRASS THREADED GATE VALVE	6
8	14-0218	2" SCH80 PVC 90 DEG. ELBOW (SW)	6
9	13-0202	1¼" STAINLESS STEEL 90° ELBOW	6
10	13-0103	1 1/4" 304 STAINLESS STEEL PIPE NIPPLE	6 FT
11	14-5035	2" X 1 1/4" SCH80 PVC THREADED REDUCING COUPLING	6
12	SSFBH621	STAINLESS STEEL FLOAT BRACKET W/(6) HOOKS	6
13	228786 UGBALUM30	UPPER ALUMINUM GUIDERAIL BRACE FOR 30" BASIN	6
14	ABS 4 BOLT PUMP PAD	CHOPPED STUD PLATE (MINIMUM OF 5/8" THICK)	6

		ITEMS SHIPPED LOOSE	
	C200S30	2" SS THREADED NPT COUPLING - ELECTRICAL	6
	H403FG3672	4" FG HUB FOR 36" & UP	6
	H400R	4" RUBBER GROMMET HUB	6

		CUSTOMER SUPPLIED MATERIAL	
		4-BOLT ABS BASE ELBOWS	6
		S.S. UPPER GUIDERAIL BRACKETS	6

TOPP INDUSTRIES INCORPORATED

PUMP: ABS S16

228786 | 12549-7-NS

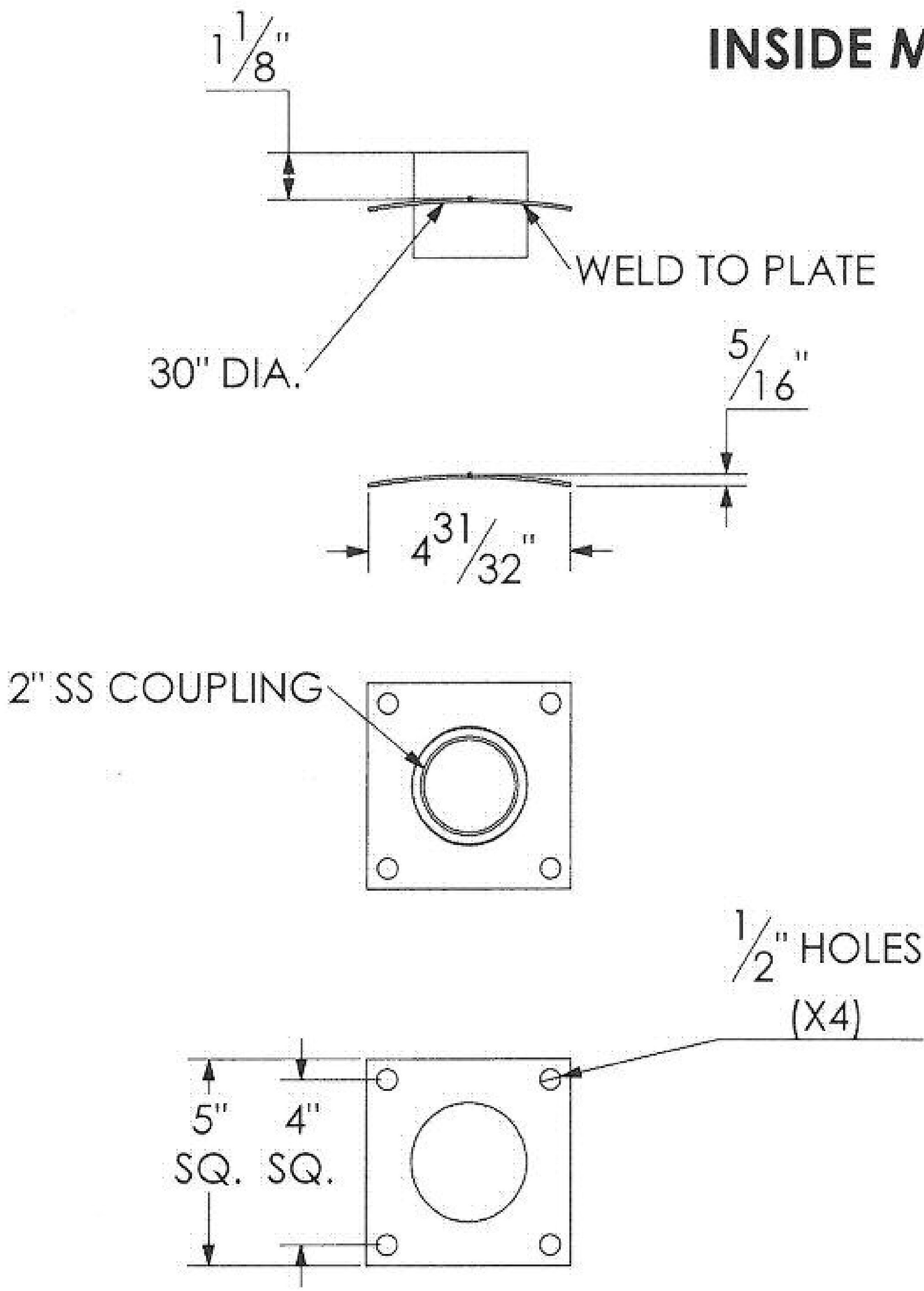
TAG: NEWBERRY STOCK

PETE DUTY & ASSOCIATES, INC.

228786 C

A2

INSIDE MOUNT



C200S30

2" SS COUPLING WELDED IN
14 GA. S.S. PLATE

CUSTOMER:

PUMP & DISCONNECT

PO:	SO:	
MATERIAL:		

PROPRIETARY AND CONFIDENTIAL

DRAWN	gh	DATE: 12/23/2011
CHECKED		
ENG APPR.		

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

MATERIAL:

REF:

SIZE A DWG. NO. 228786 01

WEIGHT:

SHEET 4 OF 4

We know how water works

Warranty

ABS ONE YEAR PRODUCT WARRANTY - PERMANENT TYPE INSTALLATION
Piranha, AS, Scavenger, RCP, & Robusta Series Pumps; Mixers; Aerators; Control Panels

ABS Pumps Inc. warrants its new products (excluding replacement parts) used in a permanent installation to be free from defects in workmanship and materials, covering parts and labor, for a period of twelve (12) months from the date of installation, or eighteen (18) months from the date of shipment to original end customer, whichever occurs first. Proof of installation/startup date or purchase/shipment date will be required to support a warranty claim.

Any product used in a portable application will be subject to the 6 month portable dewatering warranty.

Control panel warranty is effective only if control installation and wiring meets all applicable articles of the National Electrical Code at time of installation and if start-up is done by an authorized ABS agent.

Start-up reports and electrical system schematics may be required to support warranty claims and will be required for all claims on pumps of 30 Horsepower and greater. All protection features (such as moisture sensors, bearing monitors, and thermal overloads) incorporated in the product must be connected and operable to validate the warranty. Warranty effective only if ABS supplied or authorized cables and control panels are used.

ABS's sole obligation under this warranty shall be to make repairs and replace parts when necessary on products that have been returned to ABS, prepaid, or to an ABS authorized service facility and found to be defective. Products repaired under this warranty will be returned with freight prepaid. All returns must have prior authorization from ABS. ABS product must be repaired by an authorized ABS repair facility in order to support the warranty. Explosion Proof (Agency Approved) pumps must be repaired at an ABS authorized service center in order to keep the Explosion Proof rating.

ABS shall not be liable for any special, indirect, consequential damages, or profit loss of any kind. Major components not manufactured by the Company are covered by the original manufacturer's warranty in lieu of this warranty. ABS will not be held responsible for travel expenses, rented (replacement) equipment, pump removal fees, installation fees, outside contractors fees, or unauthorized repair shop expenses. Damage due to normal wear or failure beyond "defect in workmanship" is not covered. The warranty does not cover damage caused by a defective power supply or improper electrical protection.

ABS neither assumes nor authorizes any person or other company to assume for it, any other obligation in connection with the sale of its equipment. Any enlargement or modification of this warranty by a Representative or other Sales Agent is their exclusive responsibility.

This warranty is not transferable and shall extend only to the original end user. It shall not apply to any products that have been repaired or altered without ABS's consent. It does not apply to products that have been subject to misuse, accident, neglect, installation damage, or have been used for pumping liquids other than what it was designed for.

NO OTHER WARRANTIES EXPRESS OR IMPLIED, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WILL APPLY.

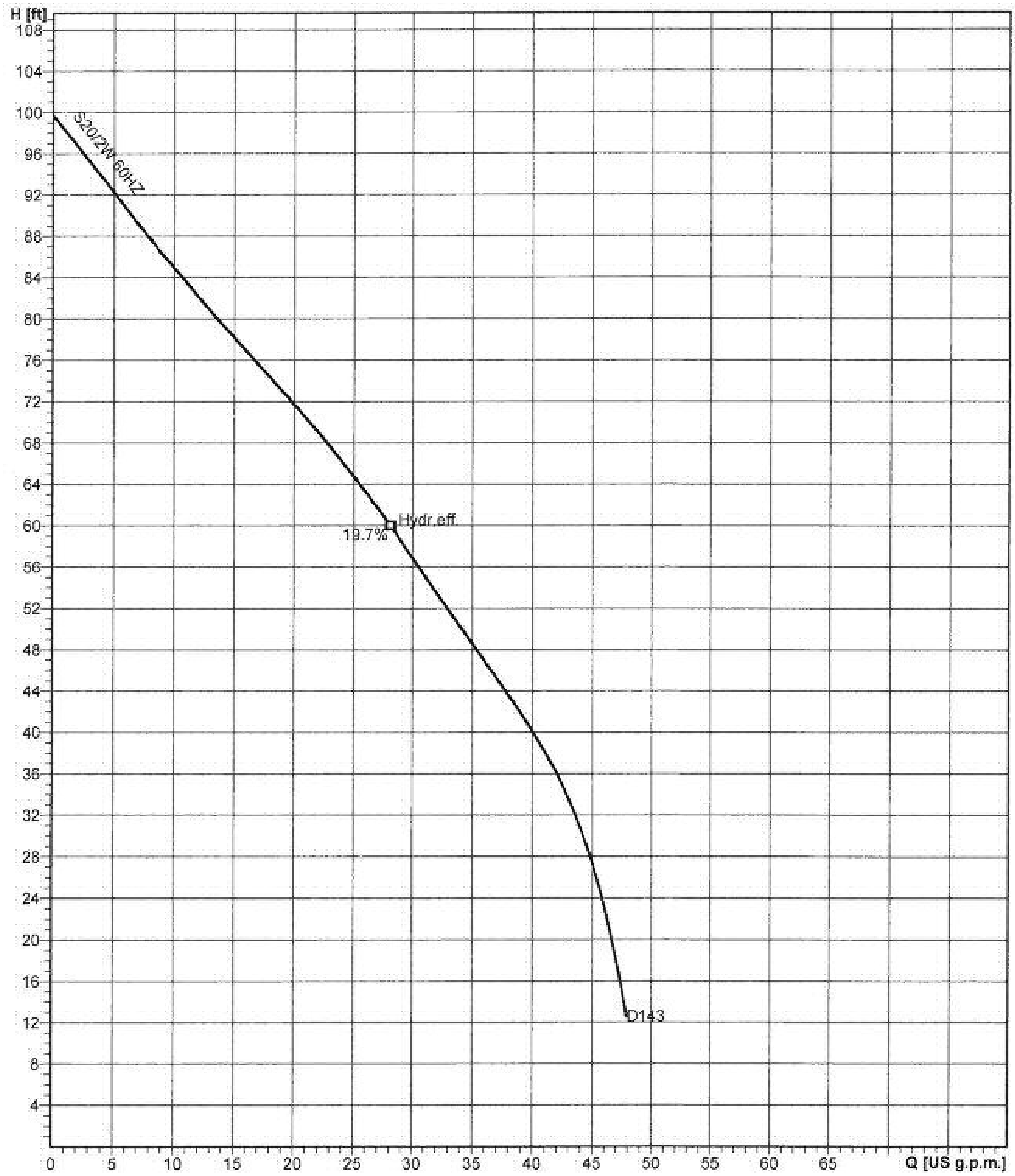
85066034

Issued 7/18/03
Revised 8/22/2005, 10/17/2006, 12/14/06

abs

Pump performance curves
PIR S20/2W 60 HZ

				Curve number
				Reference curve PIR S20/2W
			Discharge G1¼"	Frequency 60 Hz
Density 62.428 lb/ft³	Viscosity 0.000016813 ft²/s	Testnorm Hydraulic Institute	Rated speed 3520..3345 rpm	Date 2007-01-26
Flow	Head	Rated power	Hydraulic efficiency	NPSH



Impeller size	N° of vanes	Impeller	Solid size	Revision 2006-06-16
5.625"	4	Macerator		

ABSEL PRO 1.7.1 / 2005-03-17

GENERAL

Furnish and install one Model S20/2W **ABS Piranha** Grinder Pump(s) to deliver a maximum head of 93 feet of head at 2 USGPM or maximum flow of 42 USGPM against a total head of 20 feet. The motor shall be 2.0 HP, 3450 RPM connected for operation on a 230 volt, 60 HZ, single phase service. The motor shall be an integral part of the pumping unit. The pump discharge shall be 1 ¼". The grinder unit shall be capable of shearing and reducing to a fine slurry all material normally found in domestic and commercial sewage such as sanitary napkins, disposable diapers, cloth diapers, wash rags, wood, plastic, etc. The slurry shall be capable of freely passing through a 1 ¼" piping system including check and gate valves.

GRINDER PUMP CONSTRUCTION & OPERATION

The pump shall be of the centrifugal type with a lobed rotating cutter mounted on the pump shaft directly against the impeller. The stationary cutter shall be mounted in an adjustable spiral grooved bottom plate. The lobed rotating cutter rotates in the stationary cutter which utilizes a wave form. The stationary cutter shall have slots to facilitate better flow. The stationary cutter shall have one less wave than the rotating cutter has lobes. This differential creates a small opening between the cutting elements. The normal pumping action forces the flow though these small openings, shredding the solids into a slurry. The bottom plate shall be cast with grooves threading outward from the center opening of the plate to the outer diameter. The impeller shall be a multiple vane centrifugal type. Should any of the finely cut particles wedge between the impeller and bottom plate, the outward threaded spiral grooves will shear and direct them towards the discharge.

The cutter material shall be similar to an ANSI 440C stainless steel with the addition of cobalt, vanadium, and molybdenum for superior abrasion resistance and a hardness of 58-62 Rockwell C. The common pump and motor shaft shall be 420 stainless steel supported on the impeller end by a heavy duty single row ball bearing. The opposite end of the shaft is supported on a sealed single row ball bearing. The cutting elements and impeller shall be designed to keep the overhung load distance to a minimum. All fasteners shall be 304 stainless steel.

Shaft Seals: Each pump shall be equipped with two (2) seals. The lower seal (pump side) shall be of the mechanical type with silicon carbide faces. The upper seal shall be a lip type seal. The seals shall be separated by an oil chamber providing cooling and lubrication of the seals, and a barrier between the pumped fluid, and the dry motor chamber.

Seal Failure Warning System: An electric probe shall be provided in the oil chamber to detect the presence of water in the oil. A solid-state device mounted in the pump control panel enclosure shall send a low voltage, low amperage signal to the probe. If water enters the oil chamber in sufficient quantity to warrant concern, the probe shall activate a warning light in the control panel.

MOTOR CONSTRUCTION

The motor shall be of submersible type rated for 2.0 HP at 3450 RPM. The full load current shall not exceed 10.8 amps at 230 volts. Motors shall be of the capacitor start capacitor run type for high starting and running torque. The motor shall be air-filled and shall have Class "F" insulation. The rotor and stator shall be enclosed in a cast iron outer housing. Bi-metallic thermal switches shall be imbedded in the windings to sense high temperature. The rating of the switch shall be 130°C +/- 5°C. The control circuit shall be connected through the bi-metallic switches so the motor is shut down should a high temperature condition exist. The switches shall be self-resetting when the motor cools. Power cable shall be rated for explosion proof environment.

APPROVALS

The ABS Piranha S16/2W pump shall be UL and CSA approved. The complete basin package including the control panel shall be UL approved.

STANDARD & EXPLOSION PROOF

MOTOR SPECIFICATIONS

Motor Design	NEMA design B, squirrel cage induction, air filled
Motor Type	Enclosed submersible
Insulation Class	Class F, rated at 279° F (155° C)
Motor Protection	Oil Chamber Moisture Detector, bimetallic switches embedded in each phase for thermal overload protection. Installer must conform to N.E.C. standards, 1990 Ed. Art. 430.
Bimetallic Temp Trip	234° F ± 9° (130° C ± 5° C)
Service Factor	1.0
Voltage Tolerance	± 10% from nominal
Approvals	UL, CSA (FM available as option)

MOTOR DATA, 60Hz

Model	Phase	Output Power bhp	Volts	Full Load Amps	Locked Rotor Amps	NEMA Code Letter	Power Factor 100% Load	Motor Efficiency 100% Load	Pole/ Speed (rpm)
S20/2W*	1	2.0	208	11.9	32.5	A	0.99	73.1	2/3450
S20/2W*	1	2.0	230	10.8	29.4	A	0.99	73.1	2/3450
S20/2	3	2.0	208	8.0	42.6	G	0.84	74.5	2/3450
S20/2	3	2.0	230	7.2	38.5	G	0.84	74.5	2/3450
S20/2	3	2.0	460	3.6	19.2	G	0.84	74.5	2/3450
S20/2	3	2.0	575	2.9	15.4	G	0.84	74.5	2/3450

*Requires external start kit mounted in the control panel

MATERIALS of CONSTRUCTION

Motor Housing	Cast Iron ASTM A48 Class 30
Cable Cap	Cast Iron ASTM A48 Class 30
Volute	Cast Iron ASTM A48 Class 30
Oil Chamber	Cast Iron ASTM A48 Class 30
External Hardware	AISI 304 Stainless Steel
O-Rings	Buna-N
Motor Shaft	AISI 420 Stainless Steel
Cutter Disc Assembly	Chrome Molybdenum Cobalt Tool Steel 58-62 Rockwell "C"
Upper Bearing	Single row ball bearing.
Lower Bearing(s)	Single row ball bearing.
Upper Shaft Seal	Buna N Lip Seal
Lower Shaft Seal	Silicon Carbide
Impeller	Cast Iron, Open Multi-vane

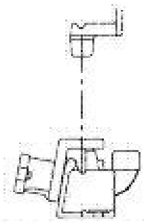
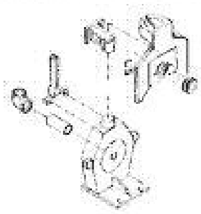
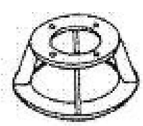
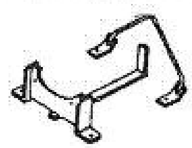
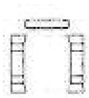
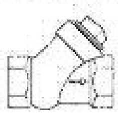
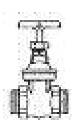
DIMENSIONS, WEIGHT, AND MISC.

Pump weight (lb.)	81
Pump weight (lb.) (explosion proof)	82
Maximum submergence (feet)	33
Discharge size, standard	1¼ Inch
Discharge thread type	Female NPT
Maximum temp. of pumped fluid	72° F (40° C)

CABLE SPECIFICATIONS

MODEL	POWER CABLE Quantity, Type	LENGTH, Feet
S20/2W	14/7 Type SOW-A	32
S20/2D	14/7 Type SOW-A	32

Power cable suitable for all standard voltages listed in "MOTOR DATA" section.

		Part Number	Description
Standard Guide Rail Assembly		62320674	S10/4, S16/2, S18/2, S26/2W, S30/2D
		62320674	M35/2, M46/2, M50/2W
		62320660	M80/2, M100/2, M120/2
Heavy Duty Guide Rail Assembly		62320501	S10/4, S16/2, S20/2, S26/2W, S30/2D
		62320501	M35/2, M46/2, M50/2W
		62320018	M80/2, M100/2, M120/2
Ball Check Guide Rail Assembly		62320536	S10/4, S16/2, S18/2, S26/2W, S30/2D
		62320538	M35/2, M46/2
		62320539	M50/2W
Vertical Pedestal Base		4182037Y	S10/4, S16/2, S18/2, S26/2W, S30/2D
		61906003	M35/2, M46/2, M50/2W
		61906007	M80/2, M100/2, M120/2
Horizontal Cradle Base w/ Lifting Bail		61906001	S10/4, S16/2, S18/2
		61906002	S26/2, S30/2
		61906005	M35/2, M46/2
		61906006	M50/2W, M80/2, M100/2, M120/2
Horizontal Swing Check Valve		1405125	1 ¼"
		1404127	2"
		1404128	3"
Vertical Ball Check Valve		6140525	1¼"
		6140526	2"
		6140527	3"
Shut Off Valve, Gate		1404125	1¼"
		1404150	1½"
		1404145	2"

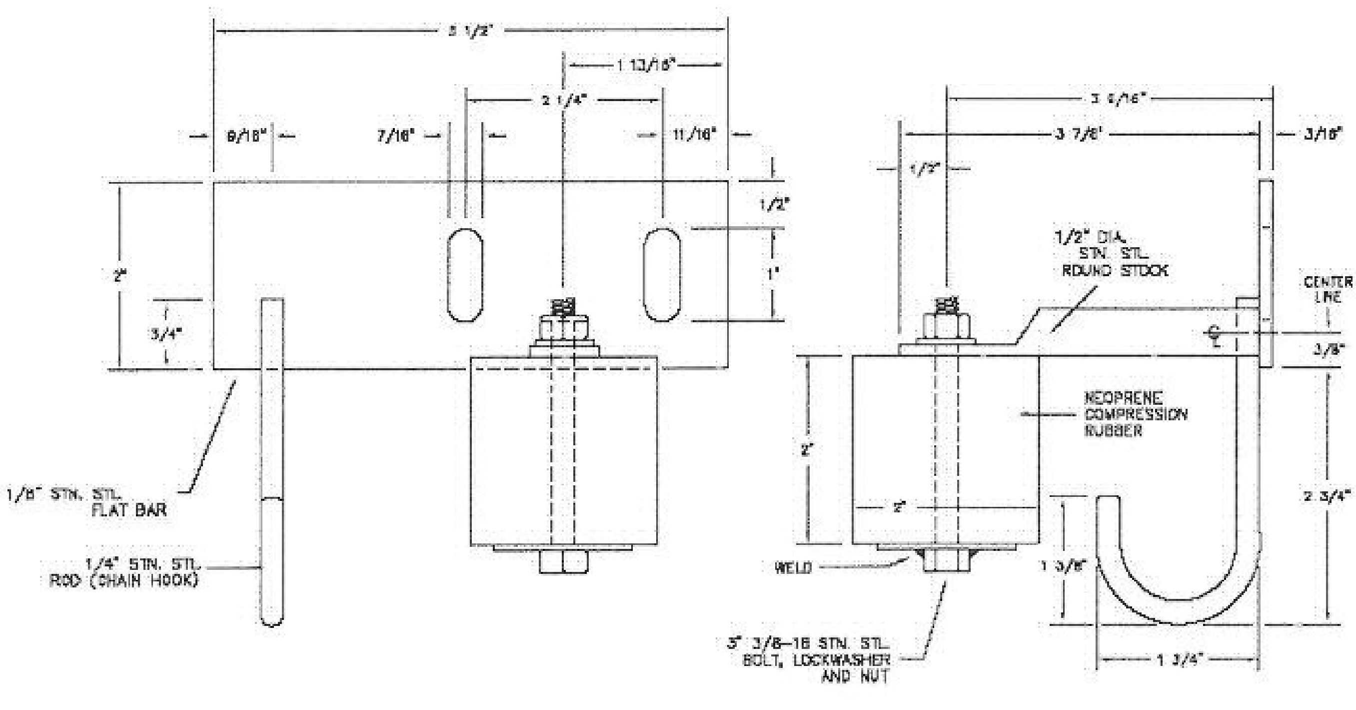
STAINLESS STEEL UPPER GUIDE
SINGLE RAIL ASSEMBLY

A.S.T.M. A276-03, Standard specification for stainless steel bars and shapes.

Type 316 chromium-nickel stainless steel with molybdenum added to increase corrosion resistance and mechanical properties at elevated temperatures. It also resists the corrosive effects of sulfates, phosphates, and other salts as well as sulfuric, sulfurous, and phosphoric.

Nominal Composition Percentages % : C=0.08, Mn=2.00, Si=1.00, Cr=16.0-18.0, Ni=10.0-14.0, P=0.045, S=0.03

NOTES: 1.)ABS Stainless Steel fabricated products are made using a combination of ARC / MIG welding. A 40 ton press for making holes. The edges and ends are ground for safety.



S.E. REGIONAL WAREHOUSE:

ABS PUMPS, INC.
111 MARITIME DRIVE
SANFORD, FLORIDA 32771
PH. (800)323-1731 / (407)330-3456 / FAX.(407)330-3404

www.abspumps.com

SUBMITTAL DATA
STAINLESS STEEL GUIDE RAIL

abs
We know how water works

ISSUED: 07/06/06

[ ] Engineer [ ] APPROVED

[ ] CUSTOMER [ ] REJECTED

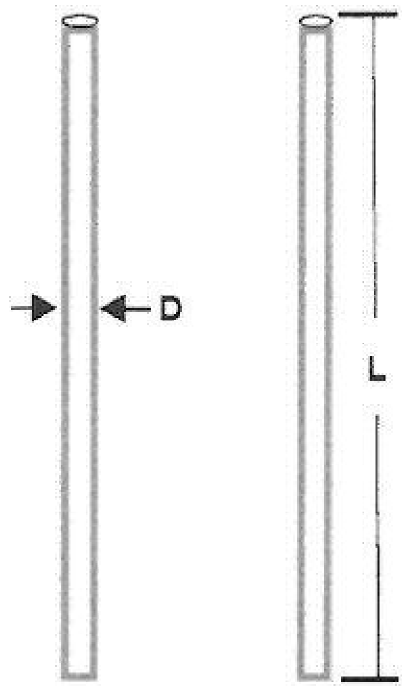
A.S.T.M. A778 - 01, WELDED UNANNEALED AUSTENITIC STAINLESS STEEL TUBULAR PRODUCTS

The guide rail provided for this project will be in the proper diameter and length as specified by the design engineer. It will be as follows:

Diameter(in), Material Type	Length, ft
2" Dia,Type 316SS - 9388 (per ft.)	20.0ea

A S T M Chemical Requirements

	304	316
Elements	S30403	S31603
(C) Carbon, max	0.030	0.030
(Mn) Manganese, max	2.00	2.00
(P) Phosphorus, max	0.045	0.045
(S) Sulfur, max	0.030	0.030
(Si) Silicon	1.00	1.00
(Ni) Nickel	8.00-13.00	10.00-14.00
(Cr) Chromium	18.00-20.00	16.00-18.00
(Mo) Molybdenum	0.00	2.00
(N) Nitrogen	0.10	0.10



ASTM Tensile Requirements

Grade	Tensile Strength min. ksi (Mpa)	Yield Strength min. ksi (Mpa)	Elong. In 2" min. %
304	70 (485)	25 (170)	40
316	70 (485)	25 (170)	40

Laboratory Testing

Test	ASTM	United
Passivation test per MIL-STD 753B	Not Required	Required

Mechanical Testing Test

Test	ASTM	United
Flare	Not Required	Required
Flatten	Required	Required
Reverse Bend	Not Required	Required
Eddy Current	Not Required	Required
Transverse Tension	Required	Required

Product Marking

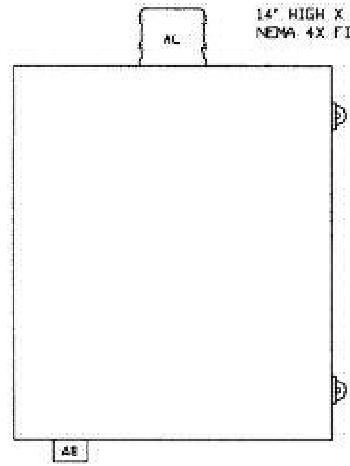
Each length will have man. Name or Brand, specified size, heat number, spec. number, grade and "HT-O" to indicate no heat treatment. For small diameter tubes and pieces under 3', the information will be placed on a tag securely under the bundle.

S.E REGIONAL WAREHOUSE:

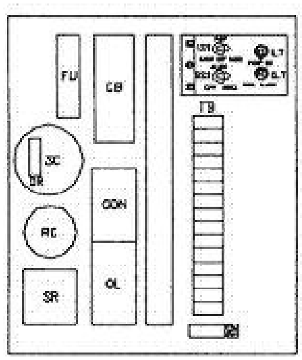
www.abspumps.com

ABS PUMPS, INC.
111 MARITIME DRIVE
SANFORD, FLORIDA ,32771
PH (800) 323-1731 / (407) 330-3456 / (407) 330-3404

14" HIGH X 12" WIDE X 6" DEEP
NEMA 4X FIBERGLASS ENCLOSURE

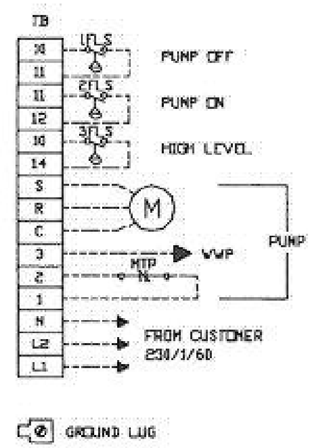


OUTER DOOR



BACKPLATE

FIELD CONNECTIONS



NOTES
1. C TERMINAL IS WIRED TO COMMON ON MOTOR. R TERMINAL IS WIRED TO RUN WINDING ON MOTOR. S TERMINAL IS WIRED TO START WINDING ON MOTOR. WWP IS WATER SENSING PROBE IN MOTOR. MTP IS THERMAL CONTACT IN MOTOR.

LEGEND

AB — ALARM BUZZER
AH — ALARM HORN
AL — ALARM LIGHT
ALT — ALTERNATOR
AM — AMMETER
ASW — AMMETER SWITCH
CAP — CAPACITOR
CB — CIRCUIT BREAKER
CON — CONTACTOR
CR — CONTROL RELAY
CT — CURRENT TRANSFORMER
CV — GFI DUPLEX RECEPTACLE
DI — DIODE
DISC — DISCONNECT SWITCH
DR — DISCHARGE RESISTOR
DSW — DOOR INTERLOCK SWITCH
ETM — ELAPSED TIME METER
FL — FLASHER
FLS — FLOAT SWITCH
FU — FUSE
GEN — GENERATOR RECEPTACLE
GFI — GROUND FAULT INTERRUPTER
HTR — HEATER
ISR — INTRINSICALLY SAFE RELAY
LA — LIGHTNING ARRESTOR
LT — PILOT LIGHT
M — MOTOR STARTER
MCB — MAIN CIRCUIT BREAKER
MCP — MOTOR CIRCUIT PROTECTOR
OL — OVERLOAD
PB — PUSHBUTTON
PM — PHASE/POWER MONITOR
RC — RUN CAPACITOR
SC — START CAPACITOR
SH — SPACE HEATER
SR — START RELAY
SS — SELECTOR SWITCH
T — TRANSFORMER
TAS — TEMPERATURE ACTUATED SWITCH
TB — TERMINAL BLOCK
TC — TIME CLOCK
TDM — TIME DELAY MODULE
TM — THERMISTOR SENSOR RELAY
TS — TRANSFER SWITCH
VM — VOLTMETER
WSD — WATER SENSING DEVICE
WWP — WATER WARNING PROBE

CAD FILE#08766046
SHEET 2 OF 2

REV	MADE BY / CHKD BY	DATE	CHANGE

ABS

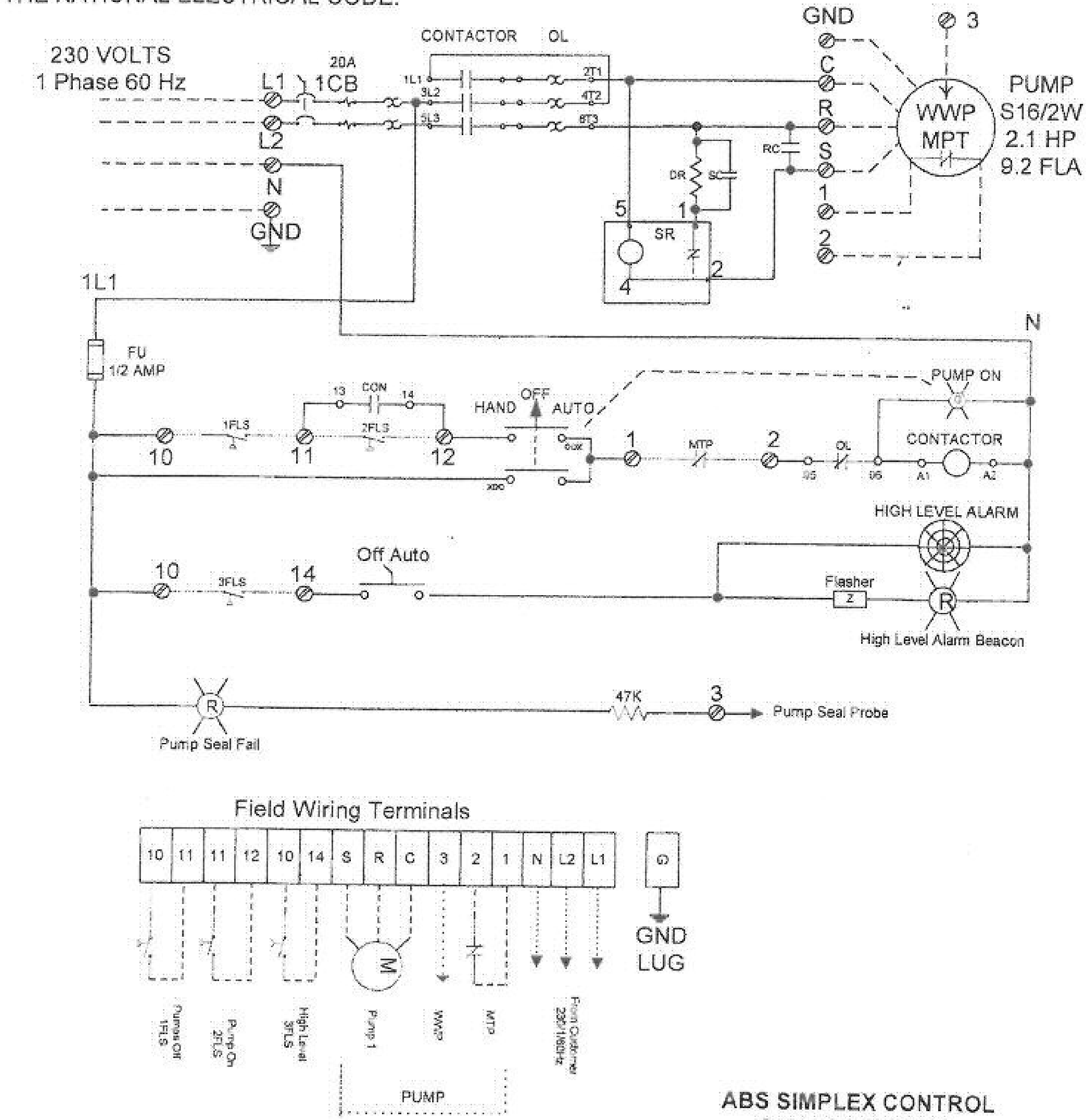
DESCRIPTION
SIMPLEX CONTROL
PIRANHA 230/1/60

DTV 3/6/98

DWG NO. 08766046

CAUTION
THIS CONTROLLER DOES NOT CONTAIN A MAIN DISCONNECT SWITCH. A UL LISTED DISCONNECT SWITCH MUST BE INSTALLED AHEAD OF THIS CONTROLLER IN ACCORDANCE WITH THE N.E.C.

GROUND IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE.



ABS SIMPLEX CONTROL
PIRANHA 230/1/60
Dwg D008766046-C

anchor scientific inc.
Box 378, Long Lake, MN 55356 / 612-473-7115 / FAX 612-473-6092

mini·float®
Form 2500-D

mini·float®

DESCRIPTION

Mini-floats are pilot duty devices designed for small diameter sumps and places where space is a determining factor in the selection of a level control device. Mini-floats control the function of motor load devices, such as contactors, motor starters, and power relays, to automatically cycle a pump or pumps. They can also be used for alarm signaling devices. Two Mini-Floats are needed for a one-pump operation; three for a two-pump operation.

SPECIFICATIONS

Cable .... 18-2 SJO W/A
Housing .... Polypropylene
Clamp .... Adjustable 1"-4"
(Only on Type P models)
Temperature Rating .... 60° C.

MODELS

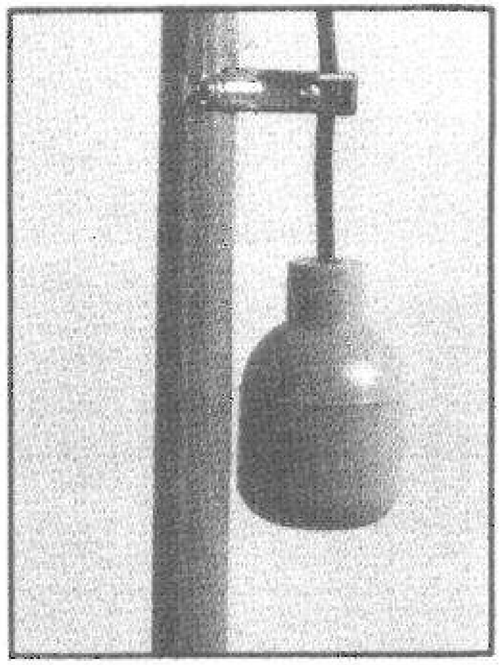
Mini-Floats are available in a combination of mounting styles, cable lengths, and circuit configurations. Mounting styles are shown at right: pipe mounted (Type P), and suspended (Type S). 10, 15, and 25-foot cable lengths are standard, but other lengths can be special ordered. Electrical configurations must be specificied; normally open, (NO), for pump out applications and normally closed, (NC), for pump in applications.

EXAMPLE:

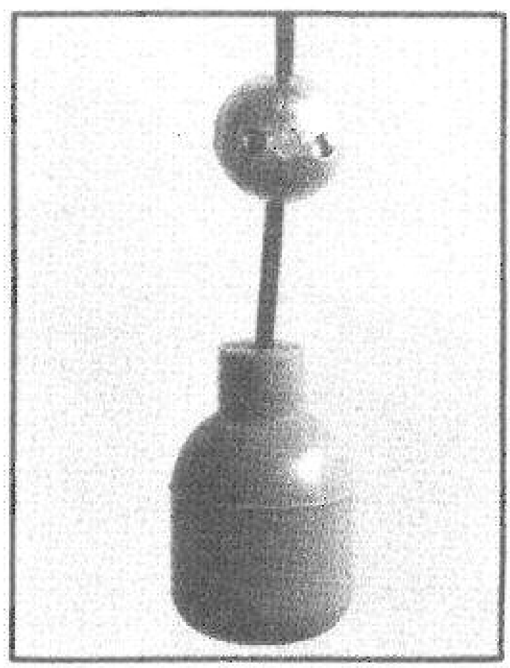
P	M	10	NO
Mounting Style	Mini-Float	Cable Length	Electrical Configuration

ELECTRICAL CONFIGURATION	CABLE LENGTH	SUSPENDED TYPE 'S' MODEL NO.	PIPE MOUNTED TYPE 'P' MODEL NO.
NORMALLY OPEN	10	S M 10 NO	P M 10 NO
	15	S M 15 NO	P M 15 NO
	20	S M 20 NO	P M 20 NO
	25	S M 25 NO	P M 25 NO
	30	S M 30 NO	P M 30 NO
NORMALLY CLOSED	10	S M 10 NC	P M 10 NC
	15	S M 15 NC	P M 15 NC
	20	S M 20 NC	P M 20 NC
	25	S M 25 NC	P M 25 NC
	30	S M 30 NC	P M 30 NC

MOUNTING STYLES

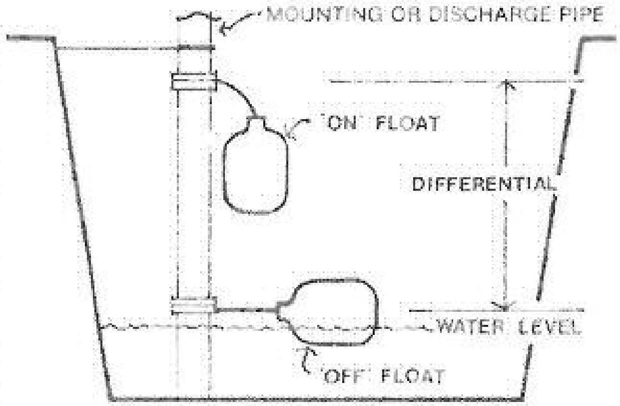


TYPE P - M



TYPE S - M

TYPICAL INSTALLATION



General Comments

1) Never work in the sump with the power on.

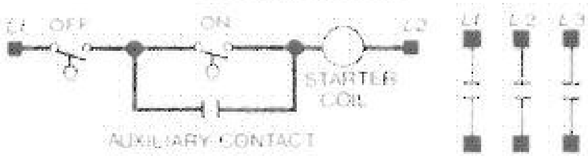
2) Attach the Type P Mini-Floats to the mounting pipe or the pump discharge pipe. The 'off' float should be below the 'on' float in a 'pump out' application.

3) Arrange the Mini-Floats so they do not tangle or hang up.

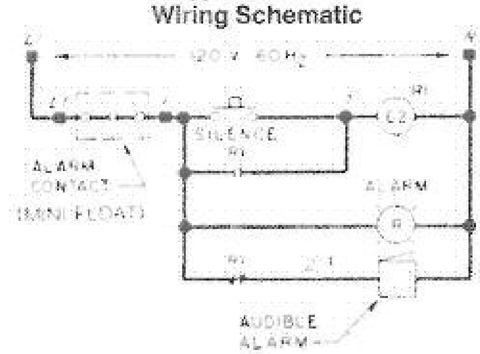
4) Thread the cable strap through the buckle with the ratchet pawl; cinch up tight; thread excess strapping through outer buckle slot.

5) Measuring the difference between mounting points gives the 'pump down' differential.

Typical Simplex Wiring Schematic



Typical Alarm Wiring Schematic



SPECIFICATIONS

Cable - 16-2 SJO W/A 34 × 41 strand. 90°C.
DIAMETER .30

Float - Polypropylene.

Clamp - Stainless Steel.

UL Listed Ind. Con. Eq.
125 VA @ 115 VAC

Component Switch Rating 4.5A @ 120V., Res.
2.2A @ 230V., Res.

Temperature Rating - 60 C.

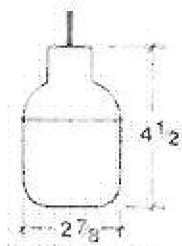
Normally Open - Blue Housing
Normally Closed - Red Housing

ELECTRICAL CONFIGURATION	CABLE LENGTH	SUSPENDED TYPE 'S' MODEL NO.	PIPE MOUNTED TYPE 'P' MODEL NO.
NORMALLY OPEN	10	S M 10 NO	P M 10 NO
	15	S M 15 NO	P M 15 NO
	20	S M 20 NO	P M 20 NO
	25	S M 25 NO	P M 25 NO
	30	S M 30 NO	P M 30 NO
NORMALLY CLOSED	10	S M 10 NC	P M 10 NC
	15	S M 15 NC	P M 15 NC
	20	S M 20 NC	P M 20 NC
	25	S M 25 NC	P M 25 NC
	30	S M 30 NC	P M 30 NC

SUBMITTAL APPROVAL

NAME

DATE

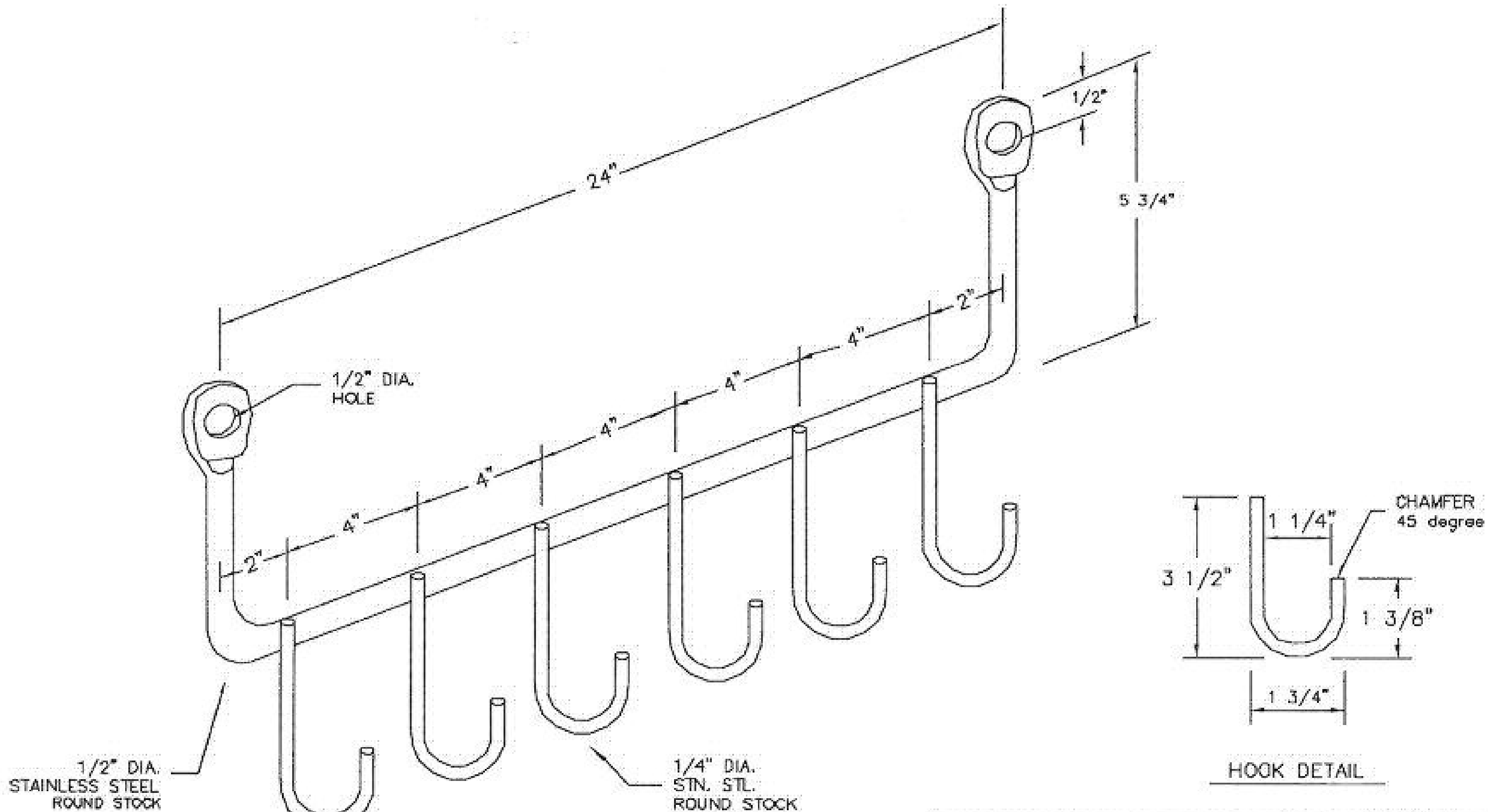


Float Dimensions

* Important Notes - Mini-floats are pilot duty devices. They cannot be used to directly power pump motors. Also, do not use Mini-Floats in gasoline or other combustibles. These devices can be used with intrinsically safe relays for some hazardous locations. See Sec. 500 of NEC.

This product contains mercury. Dispose of in accordance with Local, State and Federal Regulations so that mercury does not contaminate the environment.

DWN BY PD	DATE 7-17-80	anchor scientific inc.
CKD BY JTP	DATE 7-20-80	
APPD BY JTP	DATE 7-20	Typical installation and specification data for Mini-Floats
PROJECT NAME Mini-Float		DWG NO 2510-B
FACTORY ORDER NO		



ABS PUMPS – FLORIDA

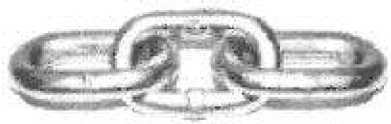
FLOAT HANGER
FOR DUPLEX PUMP SYSTEM
PN# 4149365

				APP'D	DWN BY JCP	DWG NO. ES-FLTHGR1
REV	DATE	DESCRIPTION	BY	APP'D	DATE	SHT. NO. 1 of 1

ABS COST-EFFECTIVE PUMPING	STAINLESS STEEL CHAIN	ISSUED 6/03	SECTION A	PAGE 1

SUBMITTAL DATA:

[ ]ENGINEER [ ]APPROVED
[ ]CUSTOMER [ ]REJECTED



[ ] **Type 304** welded steel chain is a general purpose, rustproof product for ordinary wastewater applications not requiring high strength or extremely corrosive environments.

[x] **Type 316** welded steel chain is a rugged, highly corrosion resistant stainless used in chemical, water, and wastewater plants worldwide.

CHAIN LENGTH:

[ ]1' [ ]1.5' [ ]2' [ ]3' [ ]4' [ ]5' [ ]6' [ ]7' [ ]8' [ ]9' [ ]10' [ ]11' [ ]12' [ ]13' [ ]14' [ ]15'
[ ]16' [ ]18' [ ]20' [ ]22' [ ]24' [ ]25' [ ]26' [ ]28' [ ]30' [ ]Other____'

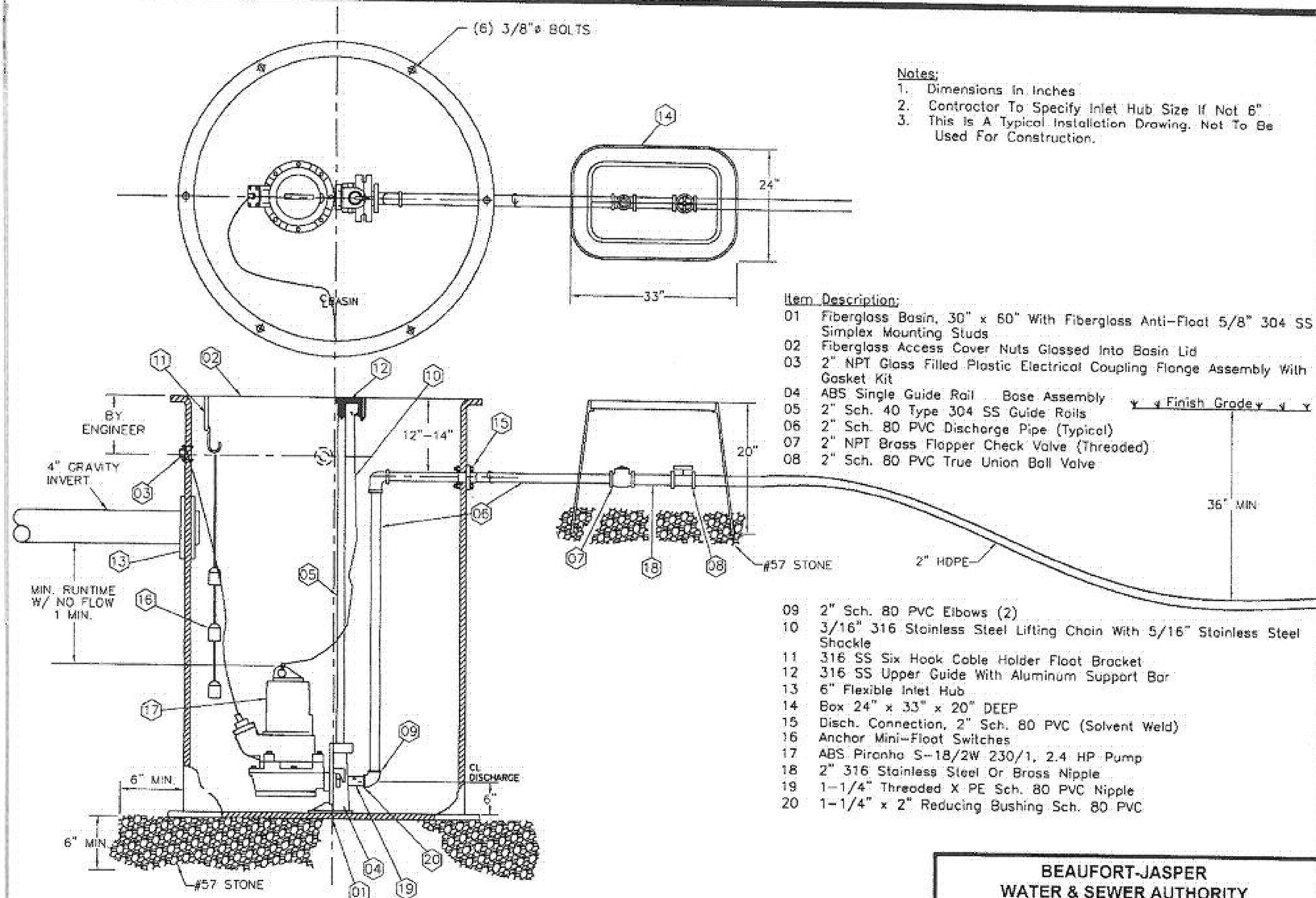
TRADE SIZE - INCHES -	WORKING LOAD LIMIT (lbs.)	- MATERIAL DIA.	- INSIDE LGTH.	- INSIDE WIDTH -	WT./100'FT
3/16"	1,150	.217	.980	.300	38 #
1/4"	1,860	.275	1.240	.380	61 #
5/16"	2,425	.330	1.290	.440	84 #
3/8"	3,800	.394	1.380	.550	140 #
1/2"	6,425	.512	1.790	.720	234 #
5/8"	9,725	.630	2.200	.790	358 #
3/4"	15,175	.787	2.760	.980	551 #

DO NOT USE FOR OVERHEAD LIFTING

S.E. REGIONAL WAREHOUSE:

ABS PUMPS, INC.
111 MARITIME DRIVE
SANFORD, FLORIDA 32771
PH. (800)323-1731 / (407)330-3456 / FAX.(407)330-3404

www.abspumps.com



Notes:
1. Dimensions In Inches
2. Contractor To Specify Inlet Hub Size If Not 6"
3. This Is A Typical Installation Drawing. Not To Be Used For Construction.

Item	Description:
01	Fiberglass Basin, 30" x 60" With Fiberglass Anti-Float 5/8" 304 SS Simplex Mounting Studs
02	Fiberglass Access Cover Nuts Glassed Into Basin Lid
03	2" NPT Glass Filled Plastic Electrical Coupling Flange Assembly With Gasket Kit
04	ABS Single Guide Rail Base Assembly
05	2" Sch. 40 Type 304 SS Guide Rails
06	2" Sch. 80 PVC Discharge Pipe (Typical)
07	2" NPT Brass Flapper Check Valve (Threaded)
08	2" Sch. 80 PVC True Union Ball Valve
09	2" Sch. 80 PVC Elbows (2)
10	3/16" 316 Stainless Steel Lifting Chain With 5/16" Stainless Steel Shackle
11	316 SS Six Hook Cable Holder Float Bracket
12	316 SS Upper Guide With Aluminum Support Bar
13	6" Flexible Inlet Hub
14	Box 24" x 33" x 20" DEEP
15	Disch. Connection, 2" Sch. 80 PVC (Solvent Weld)
16	Anchor Mini-Float Switches
17	ABS Piranha S-18/2W 230/1, 2.4 HP Pump
18	2" 316 Stainless Steel Or Brass Nipple
19	1-1/4" Threaded X PE Sch. 80 PVC Nipple
20	1-1/4" x 2" Reducing Bushing Sch. 80 PVC

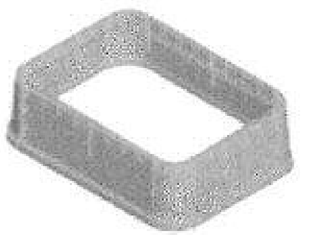
BEAUFORT-JASPER WATER & SEWER AUTHORITY

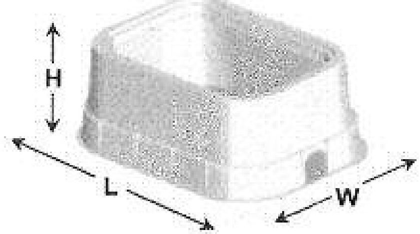
PS SIMPLEX GRINDER

DATE: 07/12/07	DRAWN BY: TIA	DRAWING #: S 22
SCALE: NTS	APPROVED BY: ERS	

Bjwsa-pdc\engineering\Brian\Specs\2007\Sewer\S22 SmplxG02.dwg, 6/12/2007 11:43:57 AM

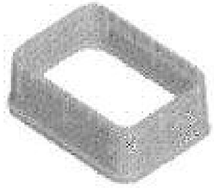
Jumbo Valve Box with Lid — 6" or 12" Height

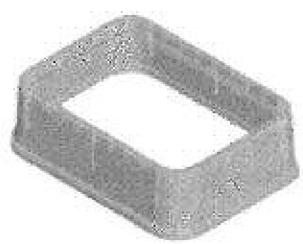




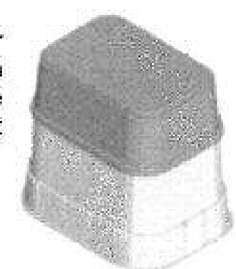
Product #	Description	Height	UPC Code	Dimensions (inches) L	W	H	Weight Each (Lbs.)
0622 VB	6" **Black** Jumbo Valve Box w/**Green** Lid	6"	96942708418	22.0	16.0	6.0	10.0
0622VBS	6" **Black** Jumbo Valve Box w/**Sand** Lid	6"	96942710107	22.0	16.0	6.0	10.0
0622VBGG	6" **Green** Jumbo Valve Box w/**Green** Lid	6"	96942710183	22.0	16.0	6.0	10.0
0622VBSS	6" **Sand** Jumbo Valve Box w/**Sand** Lid	6"	96942710114	22.0	16.0	6.0	10.0
1222VB	12" **Black** Jumbo Valve Box w/**Green** Lid	12"	96942708395	22.0	16.0	12.0	14.6
1222VBS	12" **Black** Jumbo Valve Box w/**Sand** Lid	12"	96942710077	22.0	16.0	12.0	14.6
1222VBGG	12" **Green** Jumbo Valve Box w/**Green** Lid	12"	96942710169	22.0	16.0	12.0	14.6
1222VBSS	12" **Sand** Jumbo Valve Box w/**Sand** Lid	12"	96942710084	22.0	16.0	12.0	14.6

Risers for 12" Valve Boxes





1212 Riser used with 1222 Valve Box



Product #	Description	UPC Code	Dimensions (inches) L	W	H	Weight Each (Lbs.)	Package Quantity
0618VBR	6" **Black** Riser for 12" **Standard** Valve Box	96942708388	18.0	12.0	6.0	4.0	4
0618VBRG	6" **Green** Riser for 12" **Standard** Valve Box	96942710152	18.0	12.0	6.0	4.0	4
0618VBRS	6" **Sand** Riser for 12" **Standard** Valve Box	96942710060	18.0	12.0	6.0	4.0	4
1222VBRB	6" **Black** Riser for 12" **Jumbo** Valve Box	96942708401	22.0	16.0	6.0	6.0	1
1222VBRG	6" **Green** Riser for 12" **Jumbo** Valve Box	96942710176	22.0	16.0	6.0	6.0	1
1222VBRS	6" **Sand** Riser for 12" **Jumbo** Valve Box	96942710091	22.0	16.0	6.0	6.0	1

Appendix K

Low Pressure Grinder Sewer Concept for Alljoy Sewer Service Area

Anticipated Cost Estimate

LOW PRESSURE GRINDER SEWER SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
ALLJOY SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	1-1/4" HDPE SDR29 Pipe	92,900	LF	$ 10.00	$ 929,000.00
2	2" HDPE SDR11 Pipe	27,900	LF	$ 12.00	$ 334,800.00
3	3" HDPE SDR11 Pipe	30,200	LF	$ 14.00	$ 422,800.00
4	4" HDPE SDR11 Pipe	8,900	LF	$ 16.00	$ 142,400.00
5	6" HDPE SDR11 Pipe	4,800	LF	$ 22.00	$ 105,600.00
6	8" HDPE SDR11 Pipe	2,980	LF	$ 29.00	$ 86,420.00
7	2" Isolation Valve	38	EA	$ 370.00	$ 14,060.00
8	3" Isolation Valve	51	EA	$ 619.00	$ 31,569.00
9	4" Isolation Valve	15	EA	$ 758.00	$ 11,370.00
10	6" Isolation Valve	11	EA	$ 1,472.00	$ 16,192.00
11	8" Isolation Valve	3	EA	$ 2,146.00	$ 6,438.00
12	Terminal Flushing Connection (Clean-out)	55	EA	$ 1,054.00	$ 57,970.00
13	In-Line Flushing Connection (Clean-out)	38	EA	$ 1,195.00	$ 45,410.00
14	Force Main Air Release Valve and Manhole	17	EA	$ 3,000.00	$ 50,304.00
15	Lateral Kits[1]	684	EA	$ 258.00	$ 176,472.00
16	Simplex Fiberglass Grinder Station[2]	684	EA	$ 4,572.00	$ 3,127,248.00
17	Misc. Vacuum Fittings				
	2" x 1-1/4" EF Saddle	410	EA	$ 84.00	$ 34,440.00
	3" x 1-1/4" EF Saddle	321	EA	$ 90.00	$ 28,890.00
	4" x 1-1/4" EF Saddle	57	EA	$ 90.00	$ 5,130.00
	6" x 1-1/4" EF Saddle	54	EA	$ 98.00	$ 5,292.00
	8" x 1-1/4" EF Saddle	28	EA	$ 192.00	$ 5,376.00
	2" x 3" Reducer	42	EA	$ 32.00	$ 1,344.00
	2" Tee	7	EA	$ 44.00	$ 308.00
	3" Tee	18	EA	$ 51.00	$ 918.00
	4" Tee	9	EA	$ 78.00	$ 702.00
	6" Tee	10	EA	$ 232.00	$ 2,320.00
	3" W_ye	3	EA	$ 381.00	$ 1,143.00
	3" x 4" Reducer	6	EA	$ 34.00	$ 204.00
	6" x 3" Reducer	9	EA	$ 92.00	$ 828.00
	6" x 4" Reducer	2	EA	$ 92.00	$ 184.00
	4" x 2" Reducer	6	EA	$ 34.00	$ 204.00
	8" x 6" Reducer	1	EA	$ 174.00	$ 174.00
	8" x 4" Reducer	2	EA	$ 236.00	$ 472.00
	3" Cross	2	EA	$ 510.00	$ 1,020.00
	8" Cross	1	EA	$ 1,092.00	$ 1,092.00
18	Silt Fence	89,736	LF	$ 3.50	$ 314,076.00
19	Grassing (Temporary and Permanent)	24,927	SY	$ 2.00	$ 49,853.33
20	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	800	CY	$ 70.00	$ 56,000.00
21	Remove driveway surface, replace with 2" graded aggregate[3]	201	EA	$ 160.00	$ 32,160.00
22	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	18,695	SY	$ 70.00	$ 1,308,650.00
23	Decommissioning of existing septic tank[5]	201	EA	$ 500.00	$ 100,500.00
24	Connection of Grinder Pump Station to home owner's existing system[6]	201	EA	$ 2,000.00	$ 402,000.00
25	8-inch Fusible PVC force main, AWWA C900, DR-18 installed by HDD	1,000	LF	$ 150.00	$ 150,000.00
26	Force Main Air Release Valve and Manhole	5	EA	$ 3,000.00	$ 15,000.00
27	Core into Termination Manhole for Force Main[3]	2	EA	$ 3,000.00	$ 6,000.00
28	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch HDPE force main	120	LF	$ 150.00	$ 18,000.00
29	Insert 8-inch HDPE force main in casing	120	LF	$ 50.00	$ 6,000.00
30	Traffic Control	1	JOB	Lump Sum	$ 20,000.00
31	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 487,600.00
				Subtotal	$ 8,613,933.33
	Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)				$ 516,836.00
				Engineering Fees (15%)	$ 1,292,090.00
				Construction Contingencies (15%)	$ 1,292,090.00
				Estimated Probable Cost	$ 11,714,949.33
				CALL[I, II, III, IV]	$ 11,800,000.00
No. of existing customers:					684
Cost per customer:					$ 17,300.00

Assumptions:

1. Lateral kit includes one (1) 1-1/4" HDPE check valve and one (1) 1-1/4" HDPE ball valve installed in the discharge line between the pump station and the discharge point to protect the pump station from high pressures of the force main.

2. Grinder station includes a simplex fiberglass station complete with grinder pump, basin, rails, control panel, floats; cables, meter box. Quantity based on existing and vacant lots only

3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.

4. Assumes force main within portions of roadway.

5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6. Cost assumes locating each home owner's drain line, cap line to septic tank, run sewer lateral to valve pit, electrical connection to homeowner. Note unit price is an estimate, lateral lengths, yard and driveway restoration and conditions & unique circumstances of electrical supply and its location will vary the cost for each homeowner.

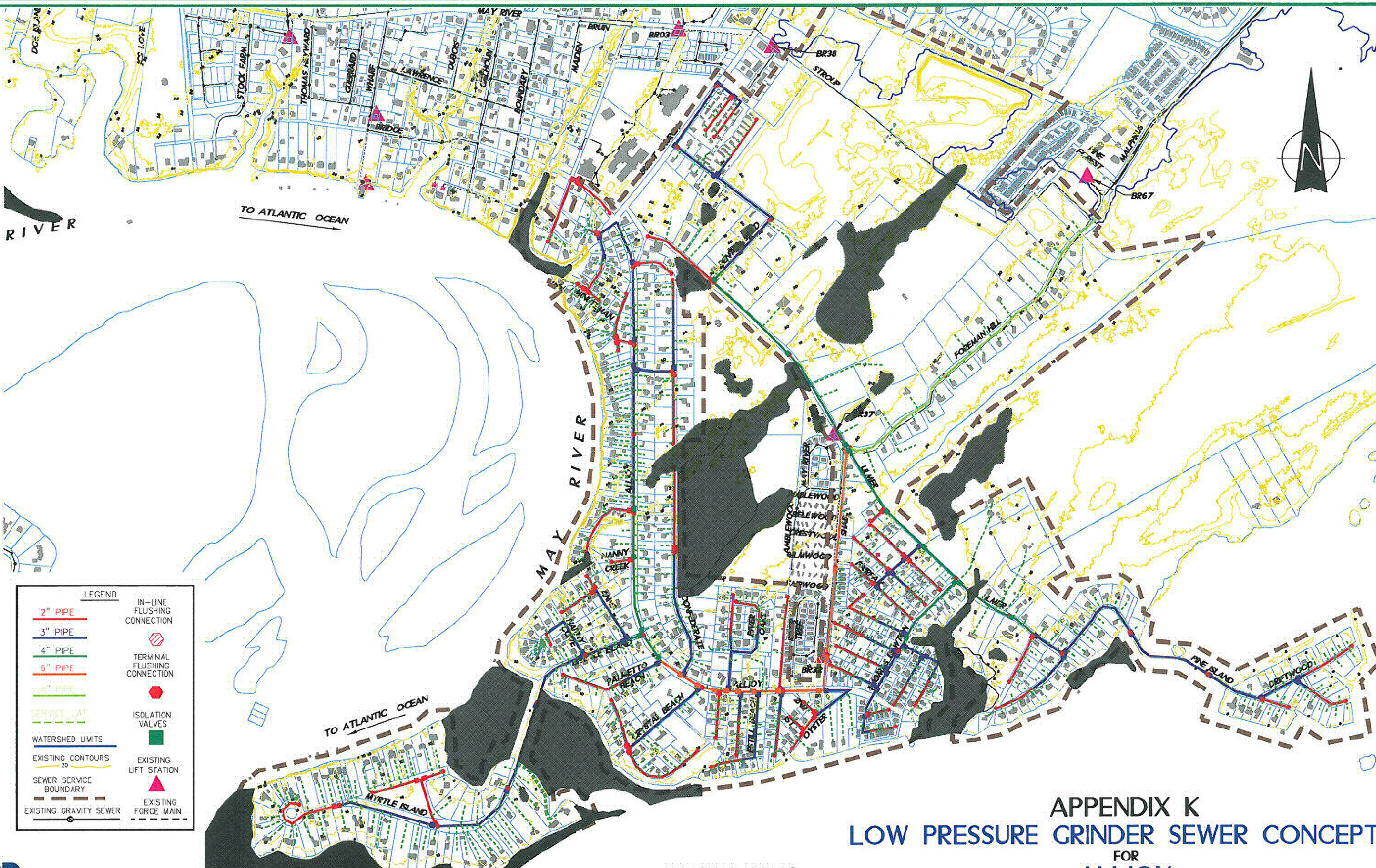
7. Assumes new force main discharges to MH03-034 & LS - BR67

I. Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.

II. It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competative bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

III. Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.

IV. Engineering Fees are for civil design services only. Fees do not include wetland mitigation credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton



APPENDIX K
LOW PRESSURE GRINDER SEWER CONCEPT
FOR
ALLJOY
DATE: OCTOBER 2013

HGBD A Bell Company

Hussey, Gay, Bell & DeYoung

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

Appendix L

Low Pressure Grinder Sewer Concept for Cahill Sewer Service Area

Anticipated Cost Estimate

LOW PRESSURE GRINDER SEWER SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
CAHILL SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	1-1/4" HDPE SDR29 Pipe	42,235	LF	$ 10.00	$ 422,350.00
2	1-1/2" HDPE SDR11 Pipe	3,200	LF	$ 10.00	$ 32,000.00
3	2" HDPE SDR11 Pipe	14,637	LF	$ 12.00	$ 175,644.00
4	3" HDPE SDR11 Pipe	3,700	LF	$ 14.00	$ 51,800.00
5	4" HDPE SDR11 Pipe	8,100	LF	$ 16.00	$ 129,600.00
6	2" Isolation Valve	21	EA	$ 370.00	$ 7,770.00
7	3" Isolation Valve	12	EA	$ 619.00	$ 7,428.00
8	4" Isolation Valve	6	EA	$ 758.00	$ 4,548.00
9	Terminal Flushing Connection (Clean-out)	15	EA	$ 1,054.00	$ 15,810.00
10	In-Line Flushing Connection (Clean-out)	21	EA	$ 1,195.00	$ 25,095.00
11	Force Main Air Release Valve and Manhole	7	EA	$ 3,000.00	$ 21,561.60
12	Lateral Kits[1]	99	EA	$ 258.00	$ 25,542.00
13	Simplex Fiberglass Grinder Station[2]	99	EA	$ 4,572.00	$ 452,628.00
14	Misc. Vacuum Fittings				
	1-1/2" x 1-1/4" EF Saddle	12	EA	$ 84.00	$ 1,008.00
	2" x 1-1/4" EF Saddle	82	EA	$ 84.00	$ 6,888.00
	3" x 1-1/4" EF Saddle	37	EA	$ 90.00	$ 3,330.00
	4" x 1-1/4" EF Saddle	18	EA	$ 90.00	$ 1,620.00
	2" x 3" Reducer	7	EA	$ 32.00	$ 224.00
	1-1/2" x 2" Reducer	3	EA	$ 29.00	$ 87.00
	2" Tee	4	EA	$ 44.00	$ 176.00
	3" Tee	4	EA	$ 51.00	$ 204.00
	4" Tee	6	EA	$ 78.00	$ 468.00
	3" Wye	1	EA	$ 381.00	$ 381.00
	2" Wye	1	EA	$ 338.00	$ 338.00
	3" x 4" Reducer	2	EA	$ 34.00	$ 68.00
	4" x 2" Reducer	6	EA	$ 34.00	$ 204.00
15	Silt Fence	31,724	LF	$ 3.50	$ 111,035.40
16	Grassing (Temporary and Permanent)	8,812	SY	$ 2.00	$ 17,624.67
17	Remove unsuitable material, dispose offsite, replace with crushed stone or sae fill material[3]	300	CY	$ 70.00	$ 21,000.00
18	Remove driveway surface, replace with 2" graded aggregate[3]	99	EA	$ 160.00	$ 15,840.00
19	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	1,322	SY	$ 70.00	$ 92,529.50
20	Decommissioning of existing septic tank[5]	99	EA	$ 500.00	$ 49,500.00
21	Connection of Grinder Pump Station to home owner's existing system[6]	99	EA	$ 2,000.00	$ 198,000.00
22	2-inch HDPD SDR11 Pipe installed by HDD	2,300	LF	$ 50.00	$ 115,000.00
23	3-inch HDPD SDR11 Pipe installed by HDD	5,600	LF	$ 60.00	$ 336,000.00
24	4-inch HDPD SDR11 Pipe installed by HDD	1,600	LF	$ 80.00	$ 128,000.00
25	Force Main Air Release Valve and Manhole	5	EA	$ 3,000.00	$ 15,000.00
26	Core into Termination Manhole for Force Main[7]	1	EA	$ 3,000.00	$ 3,000.00
27	Traffic Control	1	JOB	Lump Sum	$ 20,000.00
28	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 150,600.00
				Subtotal	$ 2,659,902.17
				Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)	$ 159,594.13
				Engineering Fees (15%)	$ 398,985.33
				Construction Contingencies (15%)	$ 398,985.33
				Estimated Probable Cost	$ 3,617,466.95
				CALL[I,II,III,IV]	$ 3,700,000.00
No. of existing customers:					99
Cost per customer:					$ 37,400.00

Assumptions:

1 Lateral kit includes one (1) 1-1/4" HDPE check valve and one (1) 1-1/4" HDPE ball valve installed in the discharge line between the pump station and the discharge point to protect the pump station from high pressures of the force main.

2 Grinder station includes a simplex fiberglass station complete with grinder pump, basin, rails, control panel, floats, cables, meter box. Quantity based on existing and vacant lots only

3 Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.

4 Assumes force main within portions of roadway

5 Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6 Cost assumes locating each home owner's drain line, cap line to septic tank, run sewer lateral to valve pit, electrical connection to homeowner. Note unit price is an estimate, lateral lengths, yard and driveway restoration and conditions & unique circumstances of electrical supply and its location will vary the cost for each homeowner.

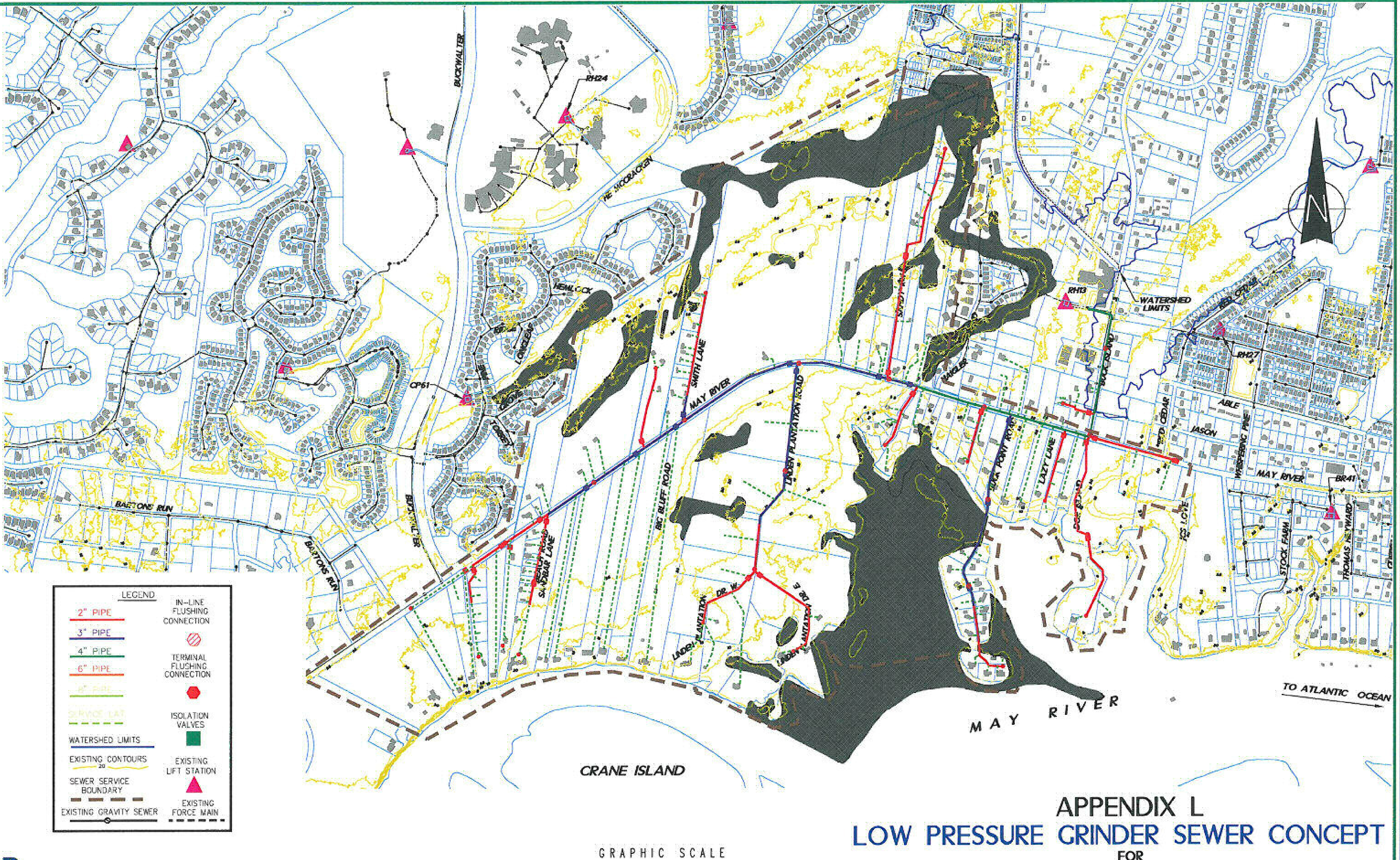
7 Assumes new force main discharges to LS - RH13

I Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure

II It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer

III Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.

IV Engineering Fees are for civil design services only. Fees do not include wetland mitigation credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton



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APPENDIX L

LOW PRESSURE GRINDER SEWER CONCEPT

FOR

CAHILL

DATE: OCTOBER 2013

Appendix M

Low Pressure Grinder Sewer Concept for Gascoigne Sewer Service Area

Anticipated Cost Estimate

LOW PRESSURE GRINDER SEWER SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE 1
GASCOIGNE SEWER SERVICE AREA
October 4, 2013

Item No	Description	Estimated Quantity	Units	Unit Price		Total Cost	
1	1-1/4" HDPE SDR29 Pipe	29,100	LF	$	10.00	$	291,000.00
2	1-1/2" HDPE SDR11 Pipe	1,700	LF	$	10.00	$	17,000.00
3	2" HDPE SDR11 Pipe	6,470	LF	$	12.00	$	77,640.00
4	3" HDPE SDR11 Pipe	5,755	LF	$	14.00	$	80,570.00
5	2" Isolation Valve	5	EA	$	370.00	$	1,850.00
6	3" Isolation Valve	16	EA	$	619.00	$	9,904.00
7	Terminal Flushing Connection (Clean-out)	8	EA	$	1,054.00	$	8,432.00
8	In-Line Flushing Connection (Clean-out)	14	EA	$	1,195.00	$	16,730.00
9	Force Main Air Release Valve and Manhole	4	EA	$	3,000.00	$	12,907.50
10	Lateral Kits[1]	54	EA	$	258.00	$	13,932.00
11	Simplex Fiberglass Grinder Station[2]	54	EA	$	4,572.00	$	246,888.00
12	Misc. Vacuum Fittings						
	1-1/2" x 1-1/4" EF Saddle	3	EA	$	84.00	$	252.00
	2" x 1-1/4" EF Saddle	43	EA	$	84.00	$	3,612.00
	3" x 1-1/4" EF Saddle	43	EA	$	90.00	$	3,870.00
	2" x 3" Reducer	8	EA	$	32.00	$	256.00
	1-1/2" x 2" Reducer	1	EA	$	29.00	$	29.00
	2" Tee	2	EA	$	44.00	$	88.00
	3" Tee	4	EA	$	51.00	$	204.00
13	Silt Fence	14,670	LF	$	3.50	$	51,345.00
14	Grassing (Temporary and Permanent)	4,075	SY	$	2.00	$	8,150.00
15	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	200	CY	$	70.00	$	14,000.00
16	Remove driveway surface, replace with 2" graded aggregate[3]	54	EA	$	160.00	$	8,640.00
17	Remove and replace 5' of asphaltic road surface over trenches, 3" compacted thickness[4]	611	SY	$	70.00	$	42,787.50
18	Decommissioning of existing septic tank[5]	54	EA	$	500.00	$	27,000.00
19	Connection of Grinder Pump Station to home owner's existing system[6]	54	EA	$	2,000.00	$	108,000.00
20	2-inch HDPD SDR11 Pipe installed by HDD	1,500	LF	$	50.00	$	75,000.00
21	3-inch HDPD SDR11 Pipe installed by HDD	4,800	LF	$	60.00	$	288,000.00
22	Grinder Force Main Manifold[7]	6	EA	$	500.00	$	3,000.00
23	Traffic Control	1	JOB	Lump Sum		$	20,000.00
24	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum		$	85,900.00
					Subtotal	$	1,516,987.00
					Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)	$	91,019.22
					Engineering Fees (15%)	$	227,548.05
					Construction Contingencies (15%)	$	227,548.05
					Estimated Probable Cost	$	2,063,102.32
					CALL[I,II,III,IV]	**$**	**2,100,000.00**
No. of existing customers:							**54**
Cost per customer:						**$**	**38,900.00**

Assumptions

1. Lateral kit includes one (1) 1-1/4" HDPE check valve and one (1) 1-1/4" HDPE ball valve installed in the discharge line between the pump station and the discharge point to protect the pump station from high pressures of the force main.

2. Grinder station includes a simplex fiberglass station complete with grinder pump, basin, rails, control panel, floats, cables, meter box. Quantity based on existing and vacant lots only.

3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.

4. Assumes force main within portions of roadway.

5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6. Cost assumes locating each home owner's drain line, cap line to septic tank, run sewer lateral to valve pit, electrical connection to homeowner. Note unit price is an estimate, lateral lengths, yard and driveway restoration and conditions & unique circumstances of electrical supply and its location will vary the cost for each homeowner.

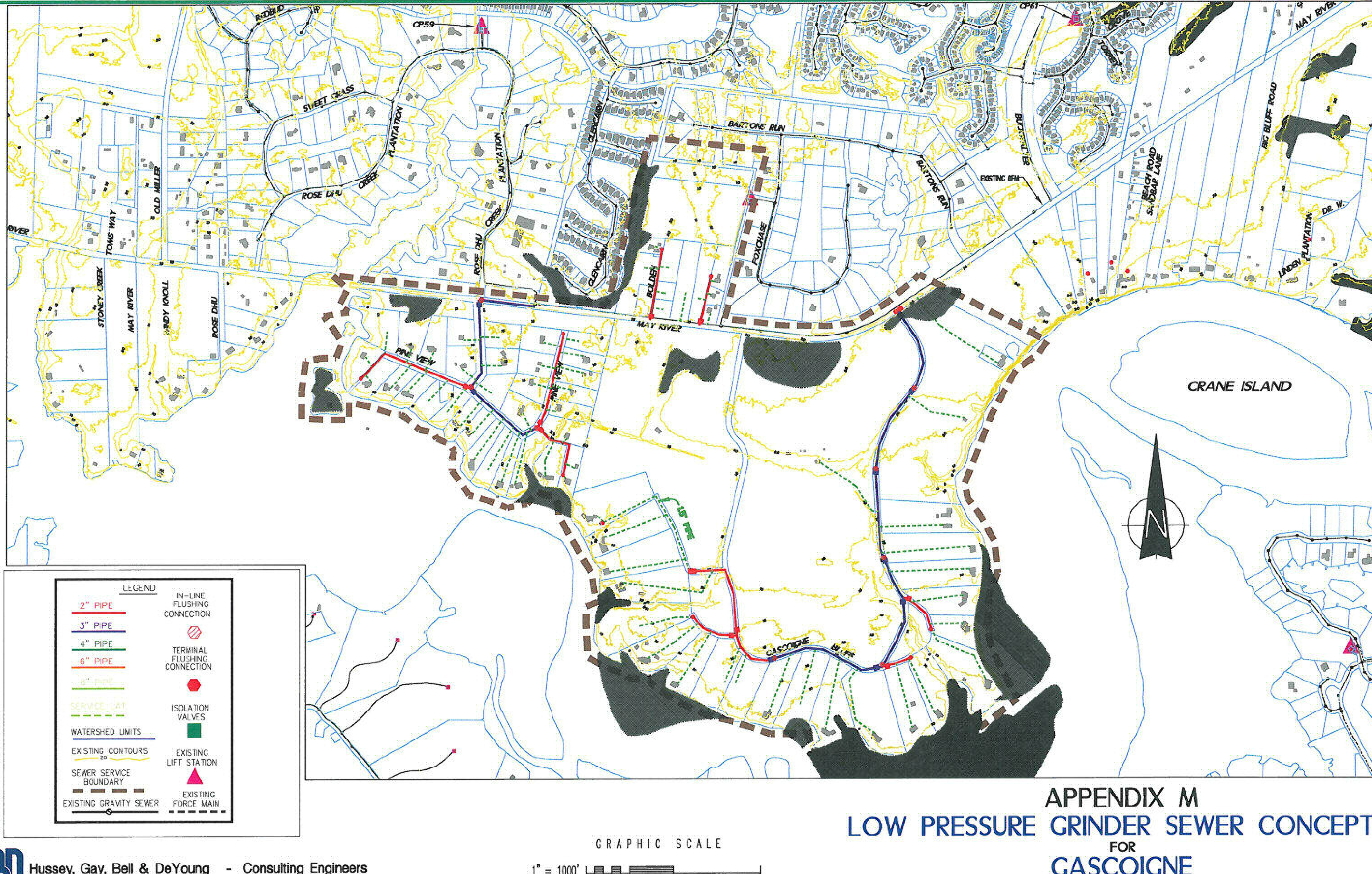
7. Assumes grinders connect to existing 8-inch FM along May River Road.

I. Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.

II. It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

III. Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.

IV. Engineering Fees are for civil design services only. Fees do not include wetland mitigatoin credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton



APPENDIX M
LOW PRESSURE GRINDER SEWER CONCEPT
FOR
GASCOIGNE
DATE: OCTOBER 2013

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Appendix N

Low Pressure Grinder Sewer Concept for Stoney Creek Sewer Service Area

Anticipated Cost Estimate

LOW PRESSURE GRINDER SEWER SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
STONEY CREEK SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	1-1/4" HDPE SDR29 Pipe	24,100	LF	$ 10.00	$ 241,000.00
2	1-1/2" HDPE SDR11 Pipe	900	LF	$ 10.00	$ 9,000.00
3	2" HDPE SDR11 Pipe	16,050	LF	$ 12.00	$ 192,600.00
4	3" HDPE SDR11 Pipe	6,045	LF	$ 14.00	$ 84,630.00
5	2" Isolation Valve	21	EA	$ 370.00	$ 7,770.00
6	3" Isolation Valve	12	EA	$ 619.00	$ 7,428.00
7	4" Isolation Valve	7	EA	$ 758.00	$ 5,306.00
8	6" Isolation Valve	4	EA	$ 1,472.00	$ 5,888.00
9	Terminal Flushing Connection (Clean-out)	20	EA	$ 1,054.00	$ 21,080.00
10	In-Line Flushing Connection (Clean-out)	23	EA	$ 1,195.00	$ 27,485.00
11	Force Main Air Release Valve and Manhole	5	EA	$ 3,000.00	$ 14,128.50
12	Lateral Kits[1]	150	EA	$ 258.00	$ 38,700.00
13	Simplex Fiberglass Grinder Station[2]	150	EA	$ 4,572.00	$ 685,800.00
14	Misc. Vacuum Fittings				
	1-1/2" x 1-1/4" EF Saddle	3	EA	$ 84.00	$ 252.00
	2" x 1-1/4" EF Saddle	108	EA	$ 84.00	$ 9,072.00
	3" x 1-1/4" EF Saddle	39	EA	$ 90.00	$ 3,510.00
	4" x 1-1 ." EF Saddle	14	EA	$ 90.00	$ 1,260.00
	6" x 1-1/4" EF Saddle	2	EA	$ 98.00	$ 196.00
	2" x 3" Reducer	11	EA	$ 32.00	$ 352.00
	1-1/2" x 2" Reducer	1	EA	$ 29.00	$ 29.00
	2" Tee	3	EA	$ 44.00	$ 132.00
	3" Tee	5	EA	$ 51.00	$ 255.00
	4" Tee	10	EA	$ 78.00	$ 780.00
	6" Tee	2	EA	$ 232.00	$ 464.00
	3" W .	1	EA	$ 381.00	$ 381.00
	2" W .	0	EA	$ 338.00	$ -
	3" x 4" Reducer	4	EA	$ 34.00	$ 136.00
	6" x 3" Reducer	1	EA	$ 92.00	$ 92.00
	6" x 4" Reducer	1	EA	$ 92.00	$ 92.00
	4" x 2" Reducer	8	EA	$ 34.00	$ 272.00
15	Silt Fence	26,514	LF	$ 3.50	$ 92,799.00
16	Grassing (Temporary and Permanent)	7,365	SY	$ 2.00	$ 14,730.00
17	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	300	CY	$ 70.00	$ 21,000.00
18	Remove drive. .y surface, replace with 2" graded aggregate[3]	150	EA	$ 160.00	$ 24,000.00
19	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	1,105	SY	$ 70.00	$ 77,332.50
20	Decommissioning of existing septic tank[5]	150	EA	$ 500.00	$ 75,000.00
21	Connection of Grinder Pump Station to home owner's existing system[6]	150	EA	$ 2,000.00	$ 300,000.00
22	2-inch HDPD SDR11 Pipe installed by HDD	150	LF	$ 50.00	$ 7,500.00
23	3-inch HDPD SDR11 Pipe installed by HDD	3455	LF	$ 60.00	$ 207,300.00
24	4-inch HDPD SDR11 Pipe installed by HDD	6865	LF	$ 80.00	$ 549,200.00
25	6-inch HDPD SDR11 Pipe installed by HDD	2000	LF	$ 120.00	$ 240,000.00
26	Force Main Air Release Valve and Manhole	5	EA	$ 3,000.00	$ 15,000.00
27	Core into Termination Manhole for Force Main[7]	1	EA	$ 3,000.00	$ 3,000.00
28	Jack & Bore 8-inch steel casing (0.5" wall thickness) for 4-inch HDPE force main	60	LF	$ 100.00	$ 6,000.00
29	Insert 4-inch HDPE force main in casing	60	LF	$ 40.00	$ 2,400.00
30	Traffic Control	1	JOB	Lump Sum	$ 20,000.00
31	Grading, spreading disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 180,900.00
	Subtotal				$ 3,194,252.00
	Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)				$ 191,655.12
	Engineering Fees (15%)				$ 479,137.80
	Construction Contingencies (15%)				$ 479,137.80
	Estimated Probable Cost				$ 4,344,182.72
	CALL[I, II, III, IV]				$ 4,400,000.00
No. of existing customers:					150
Cost per customer:					$ 29,400.00

Assumptions:

1. Lateral kit includes one (1) 1-1/4" HDPE check valve and one (1) 1-1/4" HDPE ball valve installed in the discharge line between the pump station and the discharge point to protect the pump station from high pressures of the force main.

2. Grinder station includes a simplex fiberglass station complete with grinder pump, basin, rails, control panel, floots, cables, meter box. Quantity based on existing and vacant lots only

3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.

4. Assumes force main within portions of roadway.

5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees b. EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6. Cost assumes locating each home owner's drain line, cap line to septic tank, run sewer lateral to valve pit, electrical connection to homeowner. Note unit price is an estimate, lateral lengths, ; ard and driveway r. storation and conditions & unique circumstances of electrical supply and its location will . ary the cost for each homeowner.

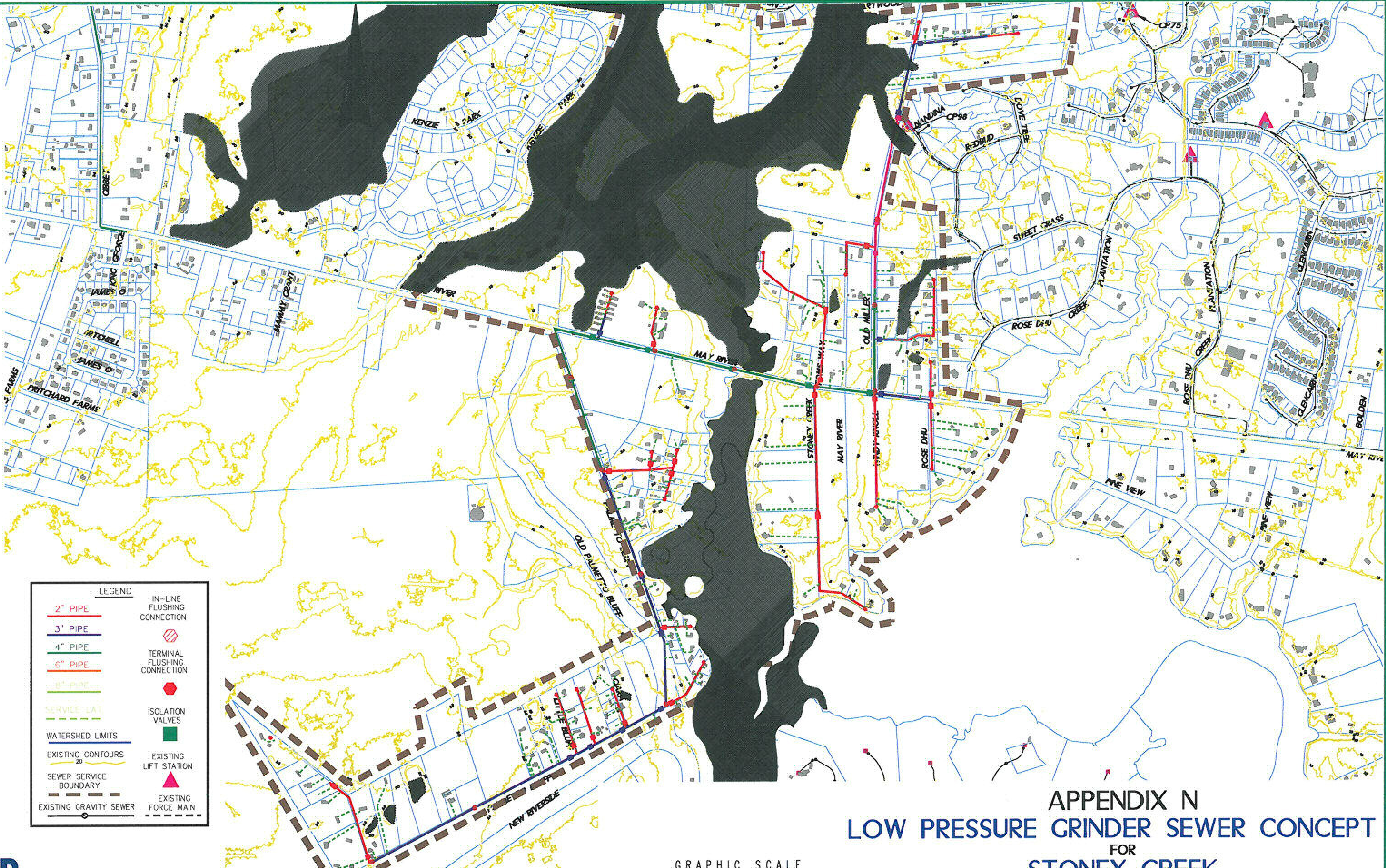
7. Assumes new force main discharges to LS - CP98.

I. Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.

II. It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

III. Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.

IV. Engineering Fees are for civil design services only. Fees do not include wetland mitigatoin credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJ. SA & Town of Bluffton



APPENDIX N
LOW PRESSURE GRINDER SEWER CONCEPT
FOR
STONEY CREEK
DATE: OCTOBER 2013

GRAPHIC SCALE
1" = 1000'
0' 500' 1000' 2000'

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Appendix O

Low Pressure Grinder Sewer Concept for Pritchardville Sewer Service Area

Anticipated Cost Estimate

LOW PRESSURE GRINDER SEWER SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
PRITCHARDVILLE SEWER SERVICE AREA
October 4, 2013

Item No.	Description	Estimated Quantity	Units	Unit Price	Total Cost
1	1-1/4" HDPE SDR29 Pipe	72,900	LF	$ 10.00	$ 729,000.00
3	2" HDPE SDR11 Pipe	39,620	LF	$ 12.00	$ 475,440.00
4	3" HDPE SDR11 Pipe	27,220	LF	$ 14.00	$ 381,080.00
5	4" HDPE SDR11 Pipe	400	LF	$ 16.00	$ 6,400.00
6	2" Isolation Valve	29	EA	$ 370.00	$ 10,730.00
7	3" Isolation Valve	37	EA	$ 619.00	$ 22,903.00
8	4" Isolation Valve	5	EA	$ 758.00	$ 3,790.00
9	6" Isolation Valve	4	EA	$ 1,472.00	$ 5,888.00
10	Terminal Flushing Connection (Clean-out)	45	EA	$ 1,054.00	$ 47,430.00
11	In-Line Flushing Connection (Clean-out)	35	EA	$ 1,195.00	$ 41,825.00
12	Force Main Air Release Valve and Manhole	14	EA	$ 3,000.00	$ 42,042.00
13	Lateral Kits[1]	502	EA	$ 258.00	$ 129,516.00
14	Simplex Fiberglass Grinder Station[2]	502	EA	$ 4,572.00	$ 2,295,144.00
15	Misc. Vacuum Fittings				
	2" x 1-1/4" EF Saddle	303	EA	$ 84.00	$ 25,452.00
	3" x 1-1/4" EF Saddle	199	EA	$ 90.00	$ 17,910.00
	4" x 1-1/4" EF Saddle	30	EA	$ 90.00	$ 2,700.00
	6" x 1-1/4" EF Saddle	20	EA	$ 98.00	$ 1,960.00
	2" x 3" Reducer	37	EA	$ 32.00	$ 1,184.00
	2" Tee	4	EA	$ 44.00	$ 176.00
	3" Tee	20	EA	$ 51.00	$ 1,020.00
	4" Tee	5	EA	$ 78.00	$ 390.00
	6" Tee	10	EA	$ 232.00	$ 2,320.00
	3" Wye	2	EA	$ 381.00	$ 762.00
	2" Wy	1	EA	$ 338.00	$ 338.00
	3" x 4" Reducer	4	EA	$ 34.00	$ 136.00
	6" x 3" Reducer	10	EA	$ 92.00	$ 920.00
	6" x 4" Reducer	1	EA	$ 92.00	$ 92.00
	4" x 2" Reducer	2	EA	$ 34.00	$ 68.00
	3" Cross	1	EA	$ 510.00	$ 510.00
16	Silt Fence	80,688	LF	$ 3.50	$ 282,408.00
17	Grassing (Temporary and Permanent)	22,413	SY	$ 2.00	$ 44,826.67
18	Remo e unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	700	CY	$ 70.00	$ 49,000.00
19	Remove driveway surface, replace with 2" graded aggregate[3]	502	EA	$ 160.00	$ 80,320.00
20	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	3,362	SY	$ 70.00	$ 235,340.00
21	Decommissioning of existing septic tank[5]	502	EA	$ 500.00	$ 251,000.00
22	Connection of Grinder Pump Station to home owner's existing system[6]	502	EA	$ 2,000.00	$ 1,004,000.00
23	2-inch HDPD SDR11 Pipe installed by HDD	180	LF	$ 60.00	$ 10,800.00
24	3-inch HDPD SDR11 Pipe installed by HDD	3,980	LF	$ 60.00	$ 238,800.00
25	4-inch HDPD SDR11 Pipe installed by HDD	3,400	LF	$ 80.00	$ 272,000.00
26	6-inch HDPD SDR11 Pipe installed by HDD	4,000	LF	$ 120.00	$ 480,000.00
27	Force Main Air Release Valve and Manhole	5	EA	$ 3,000.00	$ 15,000.00
28	Core into Termination Manhole for Force Main[7]	1	EA	$ 3,000.00	$ 3,000.00
29	Traffic Control	1	JOB	Lump Sum	$ 20,000.00
30	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB	Lump Sum	$ 434,100.00
				Subtotal	$ 7,667,720.67
				Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)	$ 460,063.24
				Engineering Fees (15%)	$ 1,150,158.10
				Construction Contingencies (15%)	$ 1,150,158.10
				Estimated Probable Cost	$ 10,428,100.11
				CALL[I,II,III,IV]	$ **10,500,000.00**
No. of existing customers:					**502**
Cost per customer:					$ **21,000.00**

Assumptions

1. Lateral kit includes one (1) 1-1/4" HDPE check valve and one (1) 1-1/4" HDPE ball valve installed in the discharge line between the pump station and the discharge point to protect the pump station from high pressures of the force main.

2. Grinder station includes a simplex fiberglass station complete with grinder pump, basin, rails, control panel, floats, cables, meter box. Quantity based on existing and vacant lots only.

3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.

4. Assumes force main within portions of roadway.

5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6. Cost assumes locating each home owner's drain line, cap line to septic tank, run sewer lateral to valve pit, electrical connection to homeowner. Note unit price is an estimate, lateral lengths, yard and driveway restoration and conditions & unique circumstances of electrical supply and its location will vary the cost for each homeowner.

7. Assumes new force main discharges to LS - CP128

I. Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.

II. It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any Statement of Probable Construction Cost or other cost estimates or evaluations prepared by the Engineer.

III. Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.

IV. Engineering Fees are for civil design services only. Fees do not include wetland mitigatoin credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton

APPENDIX O
LOW PRESSURE GRINDER SEWER CONCEPT
FOR
PRITCHARDVILLE
DATE: OCTOBER 2013

GRAPHIC SCALE
1" = 1200' 0' 600' 1200' 2400'

HGBD A Bell Company
Hussey, Gay, Bell & DeYoung - Consulting Engineers
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

Appendix P

Gravity, Low Pressure Grinder and Force Main Sewer Concept for Pritchardville Sewer Service Area

Anticipated Cost Estimate

GRAVITY, LOW PRESSURE GRINDER, & FORCE MAIN SEWER SYSTEM BUDGET COST ESTIMATE
MAY RIVER WATERSHED SEWER MASTER PLAN - PHASE I
PRITCHARDVILLE SEWER SERVICE AREA
April 1, 2014

Item No.	Description	Estimated Quantity	Units		Unit Price		Total Cost
1	1-1/4" HDPE SDR29 Pipe	38,200	LF	$	10.00	$	382,000.00
2	2" HDPE SDR11 Pipe	29,700	LF	$	12.00	$	356,400.00
3	3" HDPE SDR11 Pipe	18,200	LF	$	14.00	$	254,800.00
4	4" HDPE SDR11 Pipe	300	LF	$	16.00	$	4,800.00
5	2" Isolation Valve	24	EA	$	370.00	$	8,880.00
6	3" Isolation Valve	16	EA	$	619.00	$	9,904.00
7	Terminal Flushing Connection (Clean-out)	29	EA	$	1,054.00	$	30,566.00
8	In-Line Flushing Connection (Clean-out)	11	EA	$	1,195.00	$	13,145.00
9	Force Main Air Release Valve and Manhole	10	EA	$	3,000.00	$	30,000.00
10	Lateral Kits[1]	266	EA	$	258.00	$	68,628.00
11	Simplex Fiberglass Grinder Station[2]	266	EA	$	4,572.00	$	1,216,152.00
12	Misc. Vacuum Fittings						
	2" x 1-1/4" EF Saddle	160	EA	$	84.00	$	13,440.00
	3" x 1-1/4" EF Saddle	106	EA	$	90.00	$	9,540.00
	4" x 1-1/4" EF Saddle	16	EA	$	90.00	$	1,440.00
	6" x 1-1/4" EF Saddle	10	EA	$	98.00	$	980.00
	2" x 3" Reducer	20	EA	$	32.00	$	640.00
	2" Tee	2	EA	$	44.00	$	88.00
	3" Tee	10	EA	$	51.00	$	510.00
	4" Tee	2	EA	$	78.00	$	156.00
	6" Tee	5	EA	$	232.00	$	1,160.00
	3" Wye	2	EA	$	381.00	$	762.00
	2" Wy	1	EA	$	338.00	$	338.00
	3" x 4" Reducer	2	EA	$	34.00	$	68.00
	6" x 3" Reducer	5	EA	$	92.00	$	460.00
	6" x 4" Reducer	1	EA	$	92.00	$	92.00
	4" x 2" Reducer	2	EA	$	34.00	$	68.00
	3" Cross	1	EA	$	510.00	$	510.00
13	8" PVC Gravity Sewer	32,000	LF	$	26.00	$	832,000.00
14	Manholes, 4' diameter, standard	104	EA	$	3,000.00	$	312,000.00
15	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC gravity main	300	LF	$	150.00	$	45,000.00
16	Insert 8-inch PVC gravity main in casing	300	LF	$	50.00	$	15,000.00
17	4-inch RJ PVC force main, AWWA C900, SDR-18	900	LF	$	18.00	$	16,200.00
18	8-inch PVC force main, AWWA C900, SDR-18	4,400	LF	$	22.00	$	96,800.00
19	8-inch RJ PVC force main, AWWA C900, SDR-18	3,000	LF	$	26.00	$	78,000.00
20	Misc. Force Main Fittings	3,000	LBS	$	5.00	$	15,000.00
21	Jack & Bore 18-inch steel casing (0.5" wall thickness) for 8-inch PVC force main	300	LF	$	150.00	$	45,000.00
22	Insert 8-inch PVC force main in casing	300	LF	$	50.00	$	15,000.00
23	New Duplex Lift Station	2	LS	$	250,000.00	$	500,000.00
24	4-inch lateral to easement or R/W line (near side)[7]	15,000	LF	$	12.00	$	180,000.00
25	4-inch lateral to easement or R/W line (far side)[7]	21,000	LF	$	40.00	$	840,000.00
26	Clean outs	502	EA	$	75.00	$	37,650.00
27	Silt Fence	106,200	LF	$	3.50	$	371,700.00
28	Grassing (Temporary and Permanent)	29,500	SY	$	2.00	$	59,000.00
29	Remove unsuitable material, dispose offsite, replace with crushed stone or site fill material[3]	900	CY	$	70.00	$	63,000.00
30	Remove driveway surface, replace with 2" graded aggregate[3]	502	EA	$	160.00	$	80,320.00
31	Remove and replace 3' of asphaltic road surface over trenches, 3" compacted thickness[4]	9,640	SY	$	70.00	$	674,800.00
32	Decommissioning of existing septic tank[5]	266	EA	$	500.00	$	133,000.00
33	Connection of Grinder Pump Station to home owner's existing system[6]	266	EA	$	2,000.00	$	532,000.00
34	Core into Termination Manhole for Force Main	10	EA	$	3,000.00	$	30,000.00
35	Traffic Control	1	JOB		Lump Sum	$	20,000.00
36	Grading, spreading/disposal excess excavated material, remove and replace monuments, tree protection, mobilization, clean-up, insurance, bonds and other miscellaneous items not specifically listed but necessary for a complete job (6% of all)	1	JOB		Lump Sum	$	443,900.00
					Subtotal	$	7,840,897.00
	Easement Preparation, Appraisals, Legal Fees and Value of the Easements (6%)					$	470,453.82
					Engineering Fees (15%)	$	1,176,134.55
					Construction Contingencies (15%)	$	1,176,134.55
					Estimated Probable Cost	$	10,663,619.92
					CALL[I, II, III, IV]	$	**10,700,000.00**

Assumptions:

1. Lateral kit includes one (1) 1-1/4" HDPE check valve and one (1) 1-1/4" HDPE ball valve installed in the discharge line between the pump station and the discharge point to protect the pump station from high pressures of the force main.

2. Grinder station includes a simplex fiberglass station complete with grinder pump, basin, rails, control panel, floats; cables, meter box. Quantity based on existing and vacant lots only.

3. Remove and replace unsuitable material: quantity assumed, remove and replace driveways: quantity assumed.

4. Assumes force main and sewer main within portions of roadway.

5. Cost includes removing contents and fill tank with sand and abandon drain-fields in place. Cost does not include any environmental permitting fees by EPA, DHEC or any other agencies for the decommissioning of septic tanks, drain fields, etc.

6. Cost assumes locating each home owner's drain line, cap line to septic tank, run sewer lateral to valve pit, electrical connection to homeowner. Note unit price is an estimate, lateral lengths, yard and driveway restoration and conditions & unique circumstances of electrical supply and its location will vary the cost for each homeowner.

7. Lateral lengths will vary.

I: Pricing does not include rehabilitation or capacity upgrades to the existing sewer infrastructure.

II: It is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment, over the Contractor's methods of determining bid prices, or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from any

III: Costs are based on 2013 estimated costs. Inflation factors need to be applied for awards after 2014.

IV: Engineering Fees are for civil design services only. Fees do not include wetland mitigatoin credits, or other engineering discipline design required not listed herein. Easement preparation, appraisals, legal fees and value of the easements at 6% based on input from BJWSA & Town of Bluffton

APPENDIX P

GRAVITY, LOW PRESSURE GRINDER, & FORCE MAIN SEWER CONCEPT

FOR

PRITCHARDVILLE

DATE: MARCH 2014

HGBD
A Bell Company

Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

Exhibit 1

Alljoy Sewer Service Area

Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

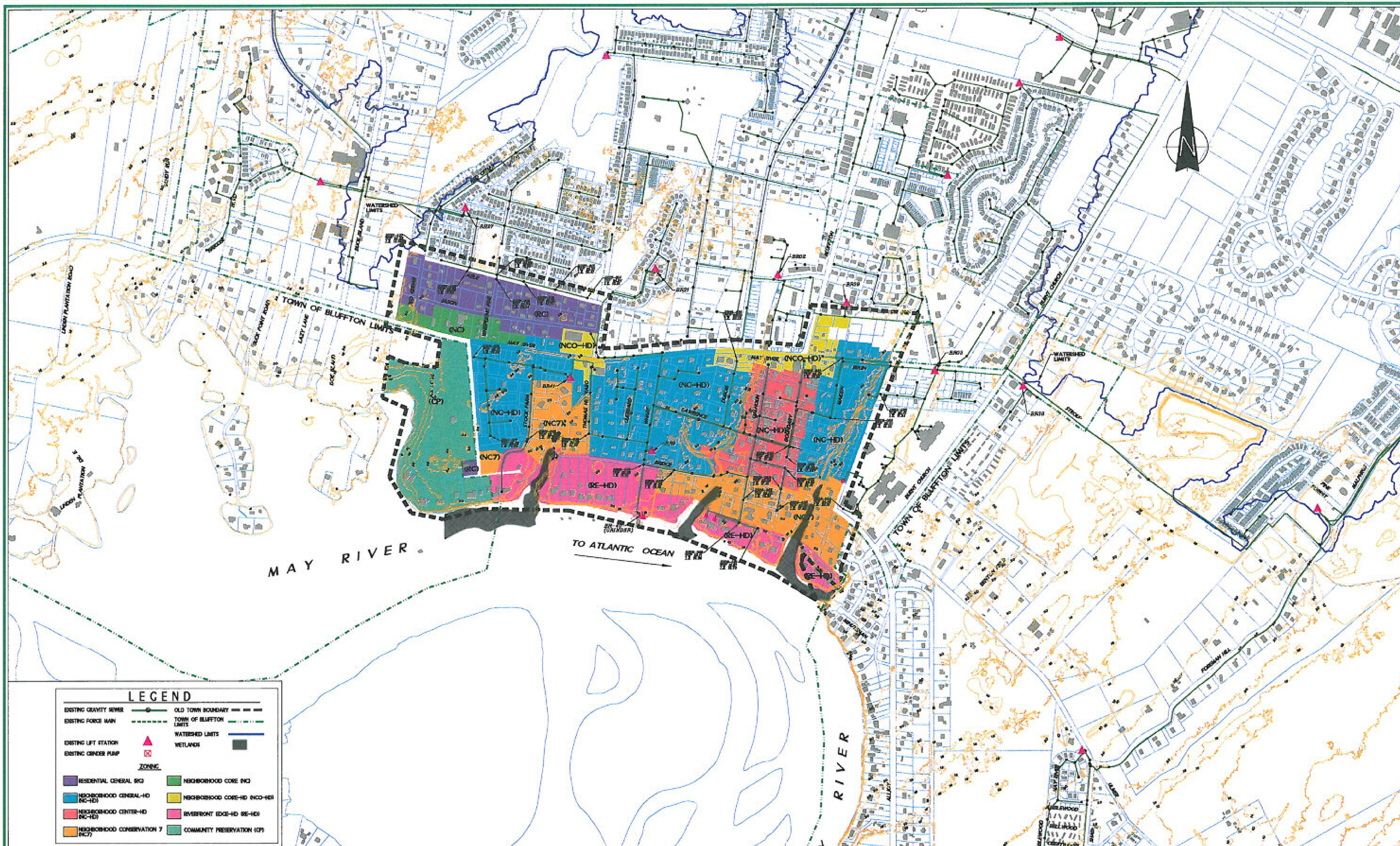
EXHIBIT 1

ALLJOY SEWER SERVICE AREA

DATE: OCTOBER 2013

Exhibit 2

Old Town Sewer Service Area



Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

GRAPHIC SCALE

1" = 500'

0 250' 500' 750' 1000' 1250' 2500'

EXHIBIT 2

OLD TOWN SEWER SERVICE AREA

DATE: OCTOBER 2013

Exhibit 3

Cahill Sewer Service Area

GRAPHIC SCALE

1" = 500'

0' 250' 500' 750' 1000' 1250' 2500'

EXHIBIT 3

CAHILL SEWER SERVICE AREA

Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

DATE: OCTOBER 2013

Exhibit 4

Gascoigne Sewer Service Area

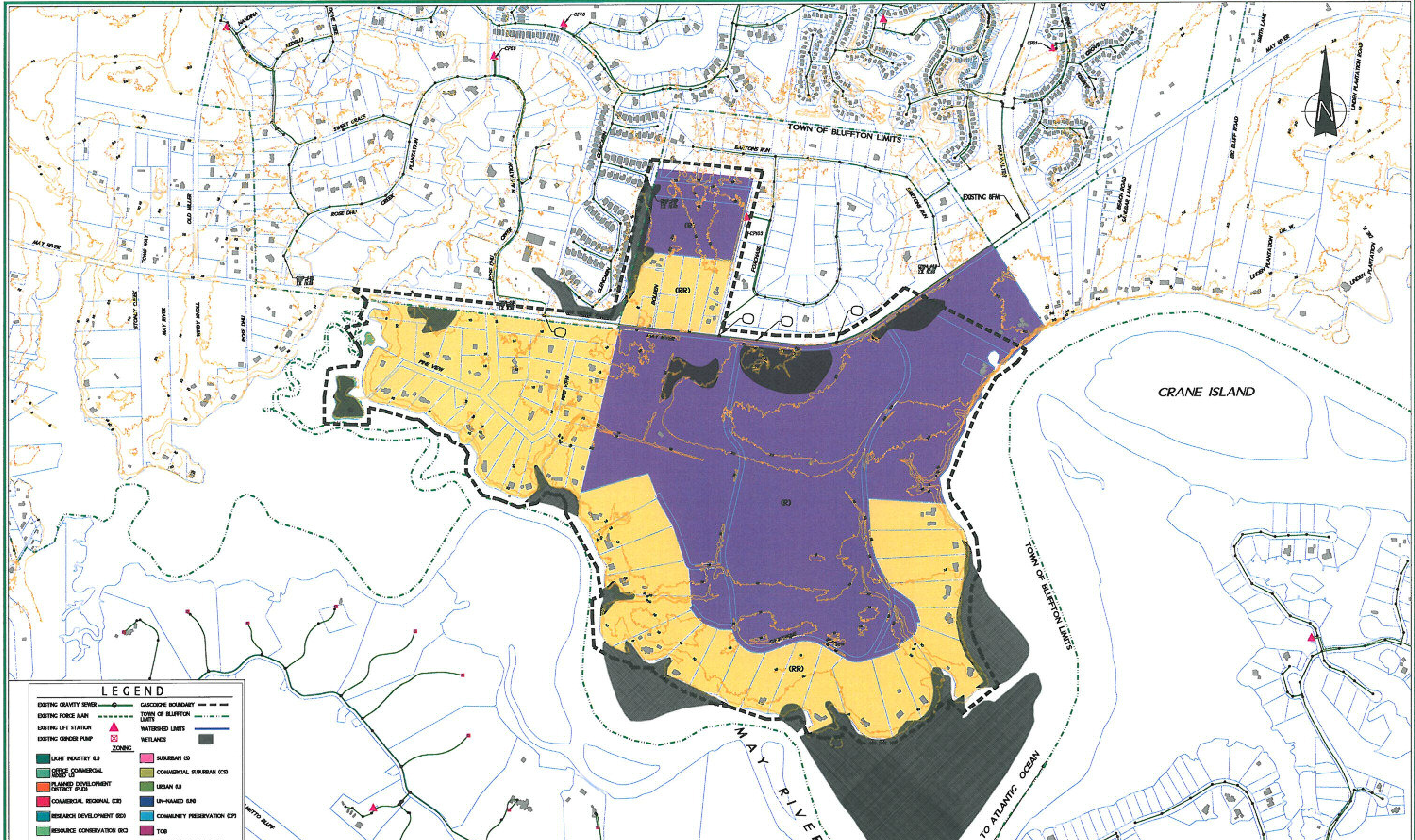


EXHIBIT 4
GASCOIGNE SEWER SERVICE AREA

Hussey, Gay, Bell & DeYoung - Consulting Engineers
Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

GRAPHIC SCALE
1" = 500'
0 250' 500' 750' 1000' 1250' 2500'

DATE: OCTOBER 2013

Exhibit 5

Stoney Creek Sewer Service Area

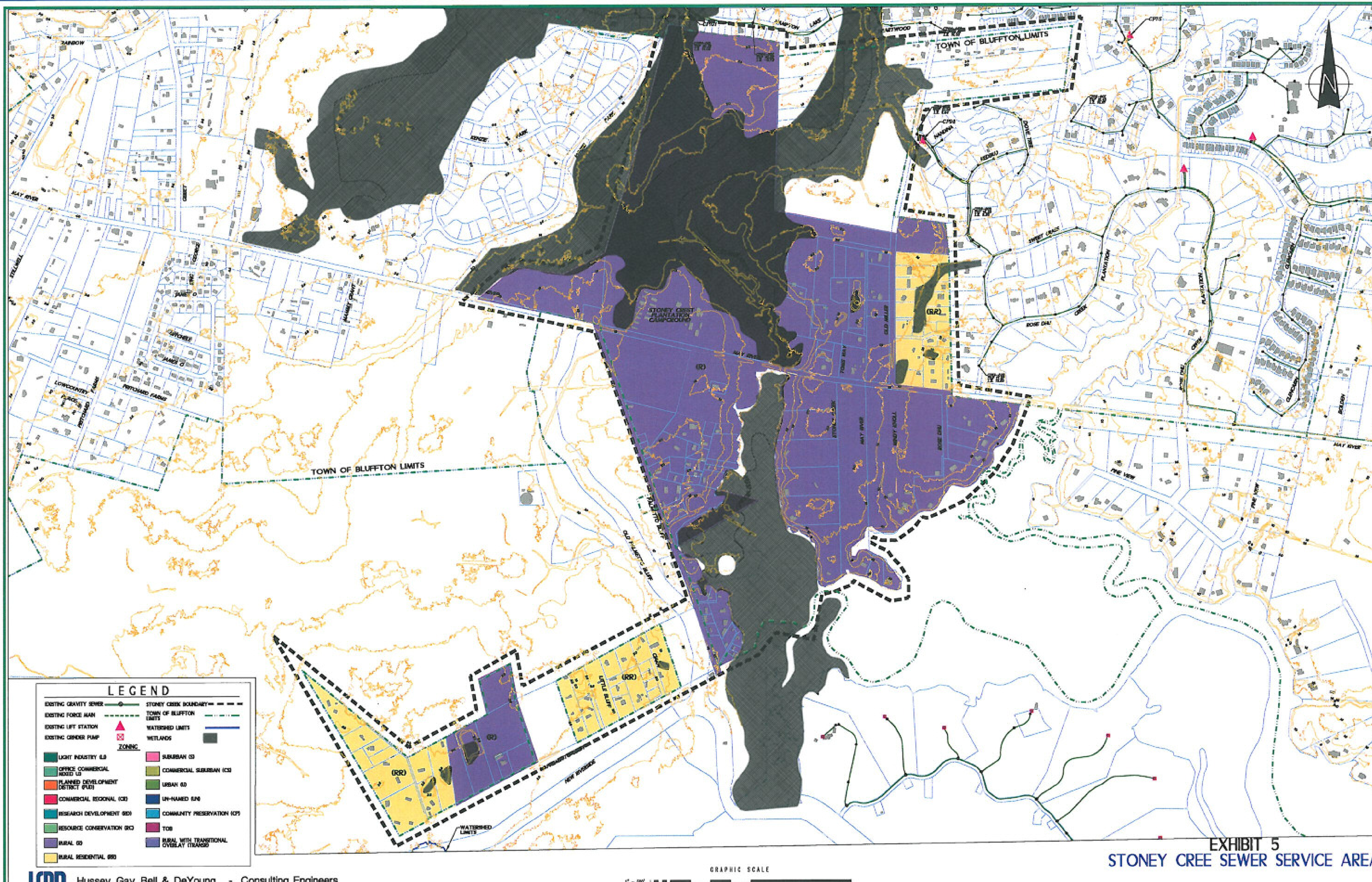


EXHIBIT 5

STONEY CREE SEWER SERVICE AREA

Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

DATE: OCTOBER 2013

Exhibit 6

Pritchardville Sewer Service Area

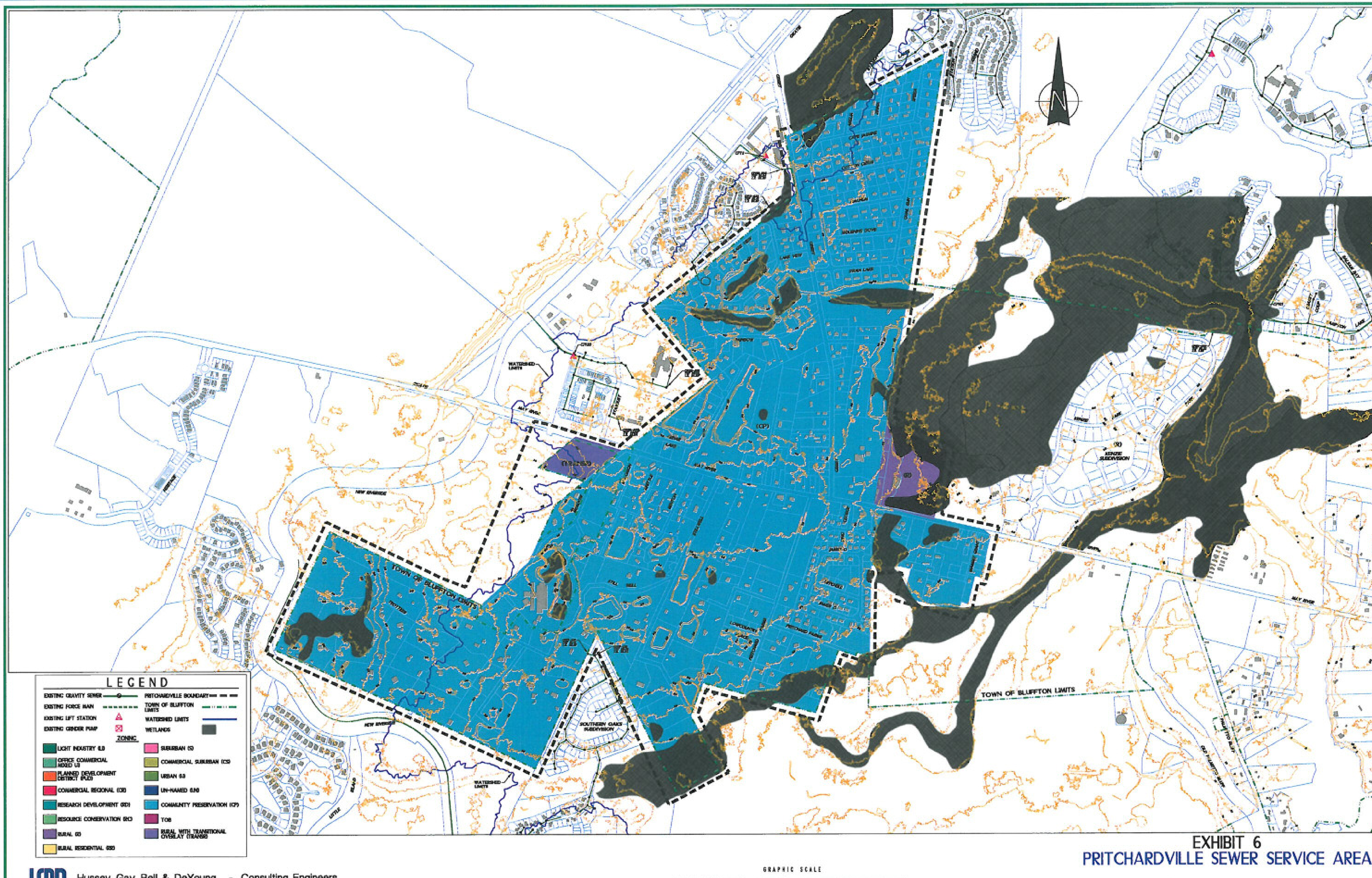


EXHIBIT 6
PRITCHARDVILLE SEWER SERVICE AREA

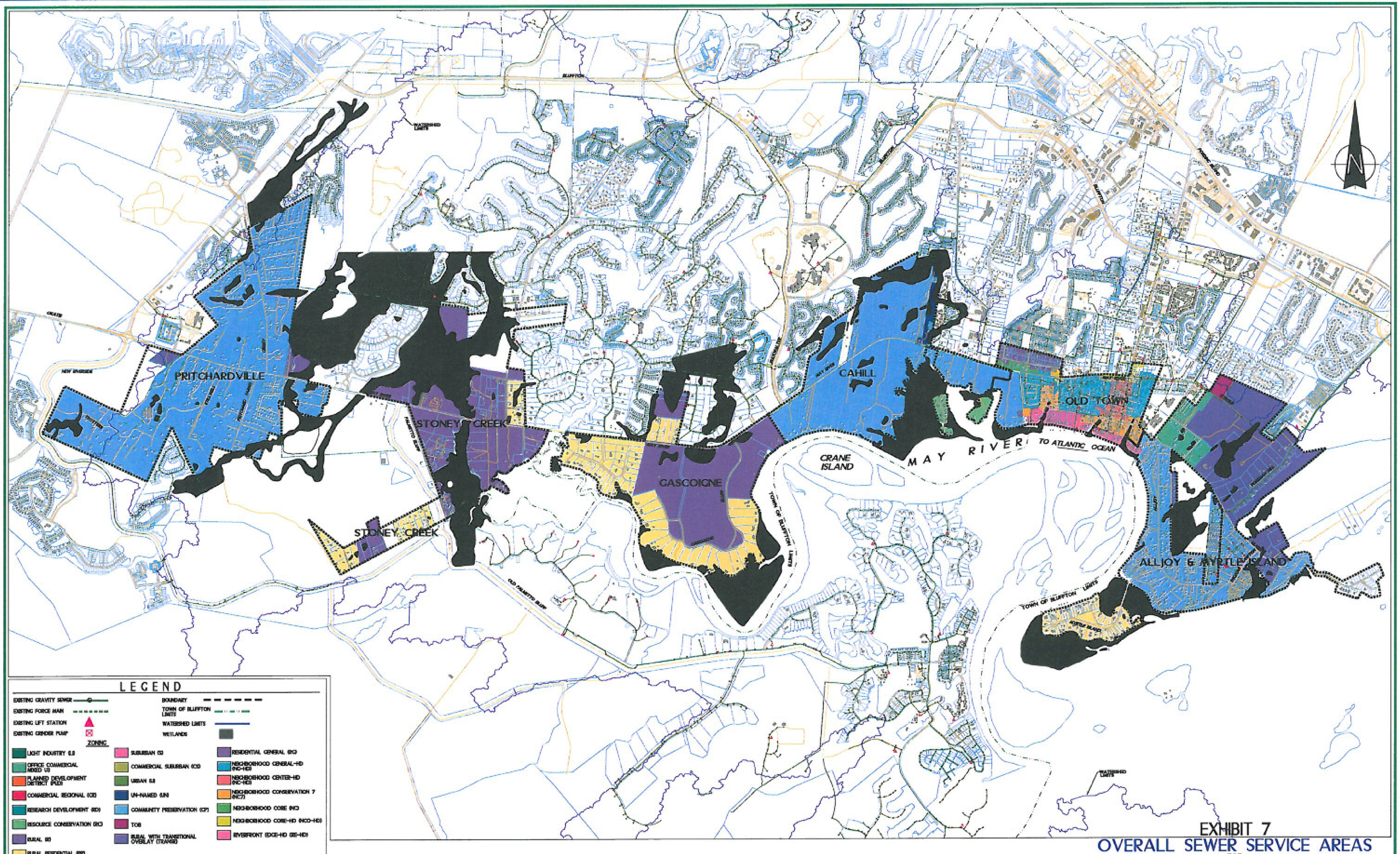
Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

DATE: OCTOBER 2013

Exhibit 7

Overall Sewer Service Area



Hussey, Gay, Bell & DeYoung - Consulting Engineers

Savannah, Georgia • Columbia, South Carolina • Mount Pleasant, South Carolina • Gainesville, Georgia

GRAPHIC SCALE

1" = 1500'

0' 750' 1500' 2250' 3000' 3750' 7500'

EXHIBIT 7

OVERALL SEWER SERVICE AREAS

FOR

MAY RIVER WATERSHED

MASTER PLAN – PHASE 1

DATE: OCTOBER 2013

2016

Stormwater Management Utility Board

Date	**Time**	**Location**
January 27, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC
February 24, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC
March 23, 2016	2:00 p.m.	Administration Building, Executive Conference Room 100 Ribaut Road, Beaufort, SC
April 27, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC
May 25, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC
July 27, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC
August 24, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC
September 28, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC
October 26, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC
November 23, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC
December 14, 2016	2:00 p.m.	Beaufort Industrial Village, Building 3 Conference Room 104 Industrial Village Road, Beaufort, SC

BEAUFORT COUNTY
STORMWATER MANAGEMENT UTILITY BOARD
AGENDA
Wednesday, October 21, 2015
2:00 p.m.
Beaufort Industrial Village, Building 3 Conference Room 104
Industrial Village Road, Beaufort
843.255.2805

In accordance with South Carolina Code of Laws, 1976, as amended, Section 30-4-80(d), all local media was duly notified of the time, date, place and agenda of this meeting.

1. CALL TO ORDER – 2:00 p.m.
   A. Approval of Agenda
   B. Approval of Minutes – September 30, 2015 (backup)

2. INTRODUCTIONS

3. PUBLIC COMMENT

4. REPORTS
   A. Utility Update – Eric Larson, P.E. (backup)
   B. MS4 Update - Eric Larson, P.E. (backup)
   C. Monitoring Update – Eric Larson, P.E. (backup)
   D. Stormwater Implementation Committee Report – Eric Larson, P.E. (backup)
   E. Stormwater Related Projects – Eric Larson, P.E. (backup)
   F. Upcoming Professional Contracts Report – Eric Larson, P.E. (backup)
   G. Regional Coordination – Eric Larson, P.E. (backup)
   H. Financial Report (backup)
   I. Maintenance Projects Report – Eddie Bellamy (backup)

5. UNFINISHED BUSINESS
   A. Approval of Draft 2016 Stormwater Management Utility Board Meeting Schedule (backup)

6. NEW BUSINESS
   A. Overview of MS4 Implementation of Permit Year 1 (PY1)- Eric Larson (backup)

7. PUBLIC COMMENT

8. NEXT MEETING AGENDA
   A. November 18, 2015 (backup)

9. ADJOURNMENT

The County Channel