D H E C
PROMOTE PROTECT PROSPER
Catherine B. Templeton, Director
Promoting and protecting the health of the public and the environment

June 19, 2013

Patricia M Allen
SAVANNAH RIVER REMEDIATION
BLDG 766-H RM 2308
Aiken, SC 29808

Re: Construction Permit No. 19673-IW
USDOE/SRS/AIKEN/H-BASIN DISCHARGE TIE-IN TO ETP TREATED WATER LINE
Aiken County

Dear Ms. Allen:

Enclosed is a SC Wastewater Construction Permit for the above referenced project. Construction is to be performed in accordance with this permit and supporting engineering report, plans, and specifications approved by this Office.

This system cannot be placed into operation until final approval is granted by the appropriate Bureau of Environmental Health Services (BEHS) Regional Office. Your Regional contact is Joshua C Yon, in the MIDLANDS REGION BEHS AIKEN. This regional office should be notified when construction begins at the following address and phone number: 206 BEAUFORT ST NE, AIKEN SC 29801-4476, 803-642-1637.

Upon completion of any construction, a letter must be submitted to the BEHS Regional Office from the registered engineer certifying that the construction has been completed in accordance with the approved plans and specifications. An inspection may then be scheduled. The BEHS Regional Office will approve the system for operation upon successful completion of this project.

Sincerely,

Melinda G Vickers
Industrial Wastewater Permitting Section
Water Facilities Permitting Division

ec: Joshua C Yon, MIDLANDS REGION BEHS AIKEN
Paul Wise, BOW Enforcement

Wastewater Construction Permit
Bureau of Water

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South Carolina Department of Health and Environmental Control

PROJECT NAME: USDOE/SRS/AIKEN/H-BASIN DISCHARGE TIE-IN TO ETP TREATED WATER LINE	COUNTY: AIKEN

PERMISSION IS HEREBY GRANTED TO: **Savannah River Remediation**
Bldg 766-H Rm 2308
Aiken SC 29808

for the construction of an upgrade to an existing wastewater treatment plant in accordance with the construction plans, specifications, engineering report and the Construction Permit Application signed by Michael B. Wood PE, Registered Professional Engineer, S.C. Registration Number: 22845.

PROJECT DESCRIPTION: Connection of piping to allow 281-8H Basin water to discharge through the Effluent Treatment Project (ETP) treated water line. Existing pumps will be used to transfer water with the addition of approximately 12 feet of 4-inch carbon steel piping, 2 feet of 6-inch carbon steel piping, 50 feet of 6-inch stainless steel piping, 20 feet of 6-inch polyethylene piping and associated backflow preventers, valves and appurtenances.

The effluent will be discharged to Upper Three Runs Creek at a daily average rate of 432,000 gallons per day.

The effluent concentrations of those constituents the wastewater treatment system is designed to remove or reduce are contained in NPDES Permit #SC0000175.

Conditions: 1. The permittee shall provide for the performance of routine collection system inspections. The inspection should include, but is not limited to, areas which require a visual observation to determine efficient operations and for which immediate corrective measures can be taken.

2. In accordance with Regulation 61-67, Standards for Wastewater Facility Construction, all wastewater treatment facilities shall be closed out within one hundred eighty (180) days when the facility is closed or the effluent disposal permit is inactivated, terminated or revoked, unless otherwise determined by the Department. Closure of wastewater treatment facilities necessitates the submittal of a closure plan and approval of the plan by the Department in accordance with R.61-82 prior to closure of any wastewater treatment unit(s).

In accepting this permit, the owner agrees to the admission of properly authorized persons at all reasonable hours for the purpose of sampling and inspection. This is a permit for construction only and does not constitute DHEC approval, temporary or otherwise, to place the system in operation. An Approval to Place in Operation is required and can be obtained following the completion of construction by contacting the AIKEN EQC OFFICE at 803-641-7670. Additional permits may be required prior to construction (e.g., Stormwater).

PERMIT NUMBER:	**19673-IW**
ISSUANCE DATE:	**June 19, 2013**
EXPIRATION DATES:	**June 19, 2015** (to begin construction) **June 19, 2016** (to obtain Approval to Place in Operation)

Jeffrey P. deBessonet, P.E., Director
Water Facilities Permitting Division

MGV

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Construction Permit Application Water/Wastewater Facilities

BUREAU OF WATER

DELEGATED REVIEW PROJECT SUBMITTAL: Yes ☐ EXPEDITED REVIEW PROGRAM SUBMITTAL: Yes ☐

SELECT ONE ➧ ☐ Water Facilities ☑ Wastewater Facilities ☐ Combined Water & Wastewater Facilities

I. **Project Name:** H-Basin Discharge Tie-In to ETP Treated Water Line **County:** Aiken

II. **Project Location** (street names, etc.): Savannah River Site, Aiken, South Carolina

III. **Project Description(s):** *Water System:* _____

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JUN 14 2013
WATER FACILITIES
PERMITTING DIVISION

Wastewater System: Connection of piping to allow discharge of 281-8H Basin water through the Effluent Treatment Project (ETP) treated water line (Construction Permit No.:18,833-IW) and the ETP diffuser (Construction Permit No.:14,379) to an Outfall (currently, the location of H-16 under NPDES Permit No.: SC0000175).

Project Type (A-Z): Water: ___ Wastewater: Z *(See instructions for the appropriate project code)*

IV. ***Initial* Owner:** [Time of Application] Name/Organization: USDOE-Owner/Savannah River Remediation(SRR) Operator

Address: Bldg 766-H Rm 2308 (Attn.: P.M. Allen) City: Aiken State: SC Zip: 29808

Phone #: (803) 208-3152 E-mail (Initial Owner): patricia.allen@srs.gov

V. ***Final* Owner:** [After Construction] Name/Organization: Same As Initial Owner Above

Address: Bldg 766-H Rm 2308 (ATTN.: P.M. Allen) City: Aiken State: SC Zip: 29808

Phone #: (803) 208-3152 E-mail (Final Owner): patricia.allen@srs.gov

VI. **Entity Responsible for Final Operation & Maintenance of System:**

Water System: Name: _____ Address: _____

City: _____ State: ___ Zip: _____ Phone #: ( ) _____ Fax #: ( ) _____

Wastewater System: Name: USDOE-Owner / SRR-Operator Address: Bldg 766-H Rm 2309; Attn. P.M. Allen

City: Aiken State: SC Zip: 29808 Phone #: (803) 208-3152 Fax #: (803) 208-1248

VII. **Engineering Firm:** Name: _____ Address: _____

City: _____ State: ___ Zip: _____ Phone #: ( ) _____ Fax #: ( ) _____

E-mail (Design Engineer): _____

VIII. **Is this project:** A) Part of a phased project? No☑ Yes☐. If Yes, Phase _____ of _____

B) A revision to a previously permitted project? No☐ Yes☑. If Yes, Permit #: 18,833-IW and 14379

Date Approved: 12/12/2003 Project name (if different): F/H-Area Effluent Treatment Project Facility

C) Submitted based on a Schedule of Compliance or Order issued by DHEC? No☑ Yes☐. Order #: _____

D) Anticipating funding by the State Revolving Fund (SRF)? No☑ Yes☐.

E) Crossing a water body (e.g., river, creek)? No☑ Yes☐. If Yes, Name of water body: _____

IX. **Are Standard Specifications approved by DHEC being used on this project?** No☑ Yes☐. If Yes:

Water: Date Approved: _____ Approved for whom: _____

Wastewater: Date Approved: _____ Approved for whom: _____

X. **Wastewater Systems:** A) Type: Domestic ☐ Process *(Industrial)* ☑ Combined *(Domestic & Process)* ☐

B) *Average Design Flow* 1. Project: 432,000 GPD 2. Treatment system: _____ GPD

C) *Sewers or Pretreatment* 1. Name of facility (e.g., POTW) treating the wastewater: _____

2. NPDES/ND Number of facility in Item #1: _____

Treatment Systems 3. Date Preliminary Engineering Report (PER) approved: _____

4. NPDES/ND application submitted? No☐ Yes☐. If Yes, Date: _____

Disposal Sites 5. Effluent Disposal Site (Description): NPDES Permit No.: SC0000175 as amended

6. Sludge Disposal Site (Description): _____

XI. **Water Systems:** Project located within city limits? No☑ Yes☐.
Public water system providing water. Name: _____ System #.: _____
New water system (including master meter)? No☑ Yes☐. If Yes, System name: _____

XII. **Type of Submittal:** Complete **Section A (Standard)** *or* **Section B (Delegated Review Program - DRP).**
A) Standard Submittal *must* include the following:
☑ 1. A transmittal letter outlining the submittal package.
☑ 2. The **original** construction permit application, properly completed, with one (1) copy.
☑ 3. Three (3) sets of signed and sealed plans and one (1) set of construction specifications. Specifications may be omitted if approved standard specifications are on file with DHEC. Four (4) sets of plans are required for a combined submittal, if the project includes a wastewater treatment facility.
☑ 4. One (1) set of the appropriate design calculations. WASTEWATER: Design flow (based on R.61-67, Appendix A), pump station calc's. and pump curve. WATER: Recent flow test from a location near the tie-on site, design calc's. indicating pressure maintained in the distribution system during max. instantaneous demand, fire flow and flushing velocities achieved. Number/types of service connections, well record form, pumping test results, etc.
☑ 5. Three (3) copies of a detailed 8½" x 11" location map, separate from the plans.
☐ 6. Two (2) copies of construction easements unless the project owner has the right of eminent domain.
☐ 7. A letter(s) from the entity supplying water and/or providing wastewater treatment stating their willingness and ability to serve the project, (state the flow, number of lots, etc.), including pretreatment permits, if applicable.
☐ 8. A letter(s) from the entity agreeing to be responsible for the operation and maintenance (O&M) of the systems.
☑ 9. Application fee enclosed $400.00. (Refer to Instructions).
☐ 10. WATER SYSTEMS: a) A letter from the local government which has potable water planning authority over the area, if applicable, in which the project is located, stating project consistency with water supply service plan for area.
b) For wells, four (4) copies of a wellhead protection area inventory.
c) For new wells, a viability demonstration is required in accordance with Regulation 61-58.1.B.(4).
Note: Other approvals may include 208 (wastewater only) and OCRM certification, and navigable waterway permitting. *To expedite the project review, the 208 and OCRM certification may be included with the project submittal.*

B) DRP submittal *must* include the following:
☐ 1. A transmittal letter, signed by the professional engineer representing the DRP entity, noting this is a DRP submittal. The letter should state that the project has been reviewed and complies with R.61-58 and/or R.61-67.
☐ 2. The **original** construction permit application, properly completed, with one (1) copy.
☐ 3. Two (2) sets of the signed and sealed plans.
☐ 4. One (1) set of the appropriate design calculations. WASTEWATER: Same information as required under Section XII.A.4. above. WATER: Same information as required under Section XII.A.4 above.
☐ 5. One (1) copy of a detailed 8½" x 11" location map, separate from the plans.
☐ 6. Two (2) copies of construction easements, unless the project owner has the right of eminent domain.
☐ 7. DHEC's Ocean and Coastal Resource Management certification (for projects in applicable counties).
☐ 8. DHEC's Water Quality permit or conditions for placement in navigable waters, and other Agency approvals.
☐ 9. WASTEWATER SYSTEMS: a) A letter of acceptance from the entity providing the treatment of the wastewater that includes the specific flow and, when applicable, the specific number of lots being accepted.
b) A letter from the organization agreeing to be responsible for the O&M of the wastewater system.
c) The 208 Plan certification from the appropriate Council of Governments (designated 208 areas), or from DHEC on the non-designated 208 areas.
☐ 10. WATER SYSTEMS: A letter from the local government which has potable water planning authority over the area, if applicable, in which the project is located, stating project consistency with water supply service plan for area.
☐ 11. Fee of $75 for water and $75 for wastewater ($150 if combined).
Note: The DRP entity should ensure that a copy of the final approved plans are returned to the design engineer.

XIII. Construction plans, material and construction specifications, the engineering report including supporting design data and calculations are herewith submitted and made a part of this application. I have placed my signature and seal on the engineering documents submitted, signifying that I accept responsibility for the design of this system, and that I have submitted a complete administrative package.

Engineer's Name (Printed): Michael B. Wood, P.E. Signature: Michael B. Wood 6.5.13
S.C. Registration Number: 22845

XIV. Prior to final approval, I will submit a statement certifying that construction is complete and in accordance with the approved plans and specifications, to the best of my knowledge, information and belief. This certification will be based upon periodic observations of construction and a final inspection for design compliance by me or a representative of this office who is under my supervision.

Engineer's Name (Printed): Andrew R. Redwood, P.E. Signature: No.20525 6/10/13
S.C. Registration Number: 20525

XV. I hereby make application for a permit to construct the project as described above. I have read this application and agree to the requirements and conditions and agree to the admission of properly authorized persons at all reasonable hours for the purpose of sampling and inspection.

ON BEHALF OF DOE, APPLICANT FOR

Owner's Name (Printed): Patricia M. Allen Signature: _____
Owner's Title: Manager ESH&QA&CA Date: 6/11/13

DHEC 1970 (March 2008)

Vickers, Melinda <vickermg@dhec.sc.gov>

Re: SRS H Retention Basin Treated Water Line Modification Permit Application (U)

1 message

keith.liner@srs.gov <keith.liner@srs.gov> Mon, Jun 10, 2013 at 1:50 PM
To: "Vickers, Melinda" <vickermg@dhec.sc.gov>
Cc: Owen.Stevens@srs.gov, stuart.stinson@srs.gov

Melinda,
Thanks so much for the input. I will get the engineers working on the changes.

Attachment 9.3, page 12, is intended to be an equipment list and is similar to your request for a list of components. Will this work for you?

The flow number is based on the maximum flow from the NPDES Permit. Please let me know if this is a problem.

Hope you are feeling better.

Have a nice day!

From: "Vickers, Melinda" <vickermg@dhec.sc.gov>
To: keith.liner@srs.gov,
Cc: Owen.Stevens@srs.gov, stuart.stinson@srs.gov
Date: 06/10/2013 01:06 PM
Subject: Re: SRS H Retention Basin Treated Water Line Modification Permit Application (U)

Keith,

I got your voice mail but I have been out of the office sick for the past few days. I am working from home some today.

Crystal and I discussed your new email drawings and agreed you also need PE stamps on pages 34-41.

You have also changed or used another PE to stamp everything. This will necessitate you changing the PE on the construction permit application. The new PE needs to sign the certification statement on the permit application.

It would be helpful to me if you would summarize a list of all components being added as follows as an example:

____linear feet 6-inch carbon steel pipe
____linear feet 6-inch concrete lined pipe

___hp pump
associated valves and appurtenances

I have begun review of the project technically. Can you explain how you arrived at 432,000 gpd for the design flow? It is not clear to me from your calculations how this flow was determined.

Contact me if you have questions. I will be checking my voice mail messages and emails.

Melinda G. Vickers
Industrial Wastewater Permitting Section
Bureau of Water
SC Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
803-898-4186
803-898-4215 new FAX #

On Thu, Jun 6, 2013 at 8:27 AM, <keith.liner@srs.gov> wrote:
Melinda,
Sorry that we have not been able to connect via phone.

Attached is a Draft of the H Retention Basin Treated Water Line Modification Engineering Report. The Professional Engineer (PE) has stamped the Report. Can you please review the Draft to see if thePE's stamps meet SCDHEC's requirements?

Thanks and have a nice day!

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Vickers, Melinda <vickermg@dhec.sc.gov>

Re: DOE SRS Corrective Action Plan for Copper Exceedences

1 message

Vickers, Melinda <vickermg@dhec.sc.gov> Tue, Jun 11, 2013 at 12:59 PM
To: "Wise, Paul" <wisepf@dhec.sc.gov>
Cc: "Hughes, Jennifer R." <hughesjr@dhec.sc.gov>, "Rippy, Crystal" <rippycd@dhec.sc.gov>, "Hindman, Melanie" <hindmamh@dhec.sc.gov>

I have and am reviewing the construction permit application for the tie-in of the 281-8H basin to the H-16 outfall line (Item #7 in their letter).

I have no comments on anything else in the report.

Melinda G. Vickers
Industrial Wastewater Permitting Section
Bureau of Water
SC Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
803-898-4186
803-898-4215 new FAX #

On Tue, Jun 11, 2013 at 9:47 AM, Wise, Paul <wisepf@dhec.sc.gov> wrote:

> Please advise if you have comments on the attached CAP.
>
> Thanks - Paul
> --
> Paul F. Wise
> SCDHEC
> 2600 Bull St
> Columbia, SC 29201
> (803) 898-4181
> (803) 898-4215 (fax)
>
>

D H E C

PROMOTE PROTECT PROSPER

Catherine B. Templeton, Director

Promoting and protecting the health of the public and the environment

MEMORANDUM

April 30, 2013

TO: Joshua C Yon
MIDLANDS REGION BEHS AIKEN

FROM: Crystal D Rippy
Industrial Wastewater Permitting Section
Water Facilities Permitting Division

RE: Construction Permit Application
USDOE/ SRS/ AIKEN/ H-BASIN DISCHARGE TIE-IN TO ETP
Aiken County

Are there any problems or comments which you have on the referenced project? Copies of the application and location map are enclosed.

Please return any comments that you may have by: May 10, 2013. An e-mail response is suitable if you prefer. If you have no comments, please just note so. Thanks.

COMMENTS:

No specific Concerns

Josh Yon
Aiken EQC office

D H E C
PROMOTE PROTECT PROSPER

Vickers, Melinda <vickermg@dhec.sc.gov>

Re: H Retention Basin Treated Water Line Modification (U)

1 message

Vickers, Melinda <vickermg@dhec.sc.gov> Thu, Apr 25, 2013 at 10:58 AM
To: keith.liner@srs.gov
Cc: "Wilson, Shelly" <wilsonmd@dhec.sc.gov>, Crystal Rippy <rippycd@dhec.sc.gov>

We received the permit application and check you submitted on 4/19/13. It is being processed for completeness and entry into our system. If you have questions, contact me or Crystal Rippy.

A technical review has not yet begun.

Melinda G. Vickers
Industrial Wastewater Permitting Section
Bureau of Water
SC Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
803-898-4186
803-898-4215 new FAX #

On Fri, Apr 12, 2013 at 11:04 AM, <keith.liner@srs.gov> wrote:

> Melinda,
> Hope you are having a good week.
>
> Attached is the H Retention Basin Treated Water Line Industrial Wastewater Construction Permit Application that we discussed earlier. I have put three copies into the mail to you along with a check. Please let me know if you have any questions.
>
> Have a great day!
> Keith Liner
> 803-208-6466

D H E C
PROMOTE PROTECT PROSPER

Catherine B. Templeton, Director
Promoting and protecting the health of the public and the environment

BUREAU OF WATER

April 30, 2013

SURENDRA K GUPTA PE
US DEPT OF ENERGY SAVANNAH RIVER SITE
BLDG 766-H RM 2308
AIKEN SC 29808

Re: **USDOE/ SRS/ AIKEN/ H-BASIN DISCHARGE TIE-IN TO ETP**
Aiken County
Application Tracking # 1053243

Dear Mr. Gupta:

The Industrial Wastewater Permitting section received an engineering submittal on the above project on 04/19/2013. In accordance with R.61-30 we have reviewed your application for completeness. Based on our review, your project application package is administratively incomplete. For this reason, your project will not be in line for a technical review until you satisfy the deficiencies noted below. As a courtesy, we have logged in your project and will keep it here pending your complete response. To complete your application package, please provide the following items:

1. A SC-registered PE must sign and seal and date all plans and design drawings and the Certificate of Authorization (COA) from the engineering firm must also be affixed near the PE seal. Please resubmit these documents with the appropriate seals. Please note: Each page of design drawings or plans must include the COA and the PE seal/signature with the date regardless of whether or not they are in a bound document that is signed, sealed, dated, and affixed with the COA.

Please return the above noted items as soon as possible. Failure to submit these items will result in significant delays in the review process.

Also, please note that any land clearing activity that is being performed in relation to this project must be permitted under the State Sediment and Erosion Control Program. For more information contact Ann Clark at (803) 898-4028.

If you have any questions, please do not hesitate to contact this office at 803-898-4300.

Sincerely,

Linda S. Harrell

Linda S Harrell
Industrial Wastewater Permitting Section
Water Facilities Permitting Division

D H E C

PROMOTE PROTECT PROSPER

April 30, 2013

TO: Anne Rone McGovern – 208 Planning Contact

SUBJECT: 208 plan conformance (INFORMATION ONLY)
Recommendation NOT required

1. Project Name: USDOE/ SRS/ AIKEN/ H-BASIN DISCHARGE TIE-IN TO ETP
2. County: Aiken
3. Type of Project: WWC WWTP UPGRADE (QUALITY) -
4. Type Waste: Volume (GPD): 0
5. Disposal Method: US DOE/SAVANNAH RIVER SITE (NPDES SC0000175)
6. Consulting Engineer: US DEPT OF ENERGY SAVANNAH RIVER SITE/SURENDRA K GUPTA PE 803-725-2696
7. DHEC contact: Crystal D Rippy
   Industrial Wastewater Permitting
   Water Facilities Permitting Division
   Bureau of Water

D H E C

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control

Environmental Quality Control

Wastewater Application Fee
2600 Bull Street
Columbia, SC 29201

US DEPT OF ENERGY SAVANNAH RIVER SITE
BLDG 766-H RM 2308
AIKEN SC 29808

Invoice Date: 04/30/2013
Invoice Number: QY21782-8
Invoice Amount: $400.00
Program ID: 1053243

Department Name: BOW - DOMESTIC WW PERM
Department Contact: LINDA S HARRELL
Department Phone: 803-898-4300

Qty	Description	Unit	Extended
1.00	TS => 1MGD - Modification (no expansion)	400.00	400.00
	Total		**$400.00**

South Carolina Department of Health and Environmental Control

Facility Name: US DEPT OF ENERGY SAVANNAH RIV
Program ID: 1053243
Invoice Number: QY21782-8 Amount Due: $400.00

Amount Remitted:
$

To ensure proper credit, please return this portion of the invoice with your payment to the address below or you may go to our agency's website: WWW.SC.DHEC.GOV then click on **PAY INVOICES** under **quick links** or use the reverse side of this form for credit card payments. Please include the invoice number on your remittance. **Payment due upon receipt, past due 30 days from invoice date. Change of address and credit card payment forms are on the reverse side.**

SC DHEC
ATTN: BUREAU OF FINANCIAL MANAGEMENT
PO BOX 100103
COLUMBIA, SC 29202-3103

SUNTRUST BANK, ATLANTA GA

000005105

Savannah River Remediation LLC
PO Box 369
New Ellenton, SC 29809-0369
803-952-9677

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APR 19 2013
WATER FACILITIES
PERMITTING DIVISION

DATE	CONTROL NO.	AMOUNT
03/21/2013	000005105	$400.00

PAY Four Hundred And 00/100 Dollars

To The Order Of SOUTH CAROLINA DHEC
BUREAU OF FINANCE
2600 BULL STREET
COLUMBIA, SC 29201

Memo: _____

Jerry K. Jenson

⑈000005105⑈ ⑆061000104⑆ 1000094159182⑈

Application for Modification

Effluent Treatment Project
Industrial Wastewater Treatment
Permits #14,379-IW and 18,833-IW

H Retention Basin Treated Water Line Modification

Basin Water Discharge Tie-in to the Treated Water Line

January 2013

S C DEPT OF HEALTH & ENVIRONMENTAL CONTROL
BUREAU OF WATER
WASTEWATER FACILITIES
APPROVED FOR CONSTRUCTION
(SUBJECT TO ANY PROVISIONS WHICH MAY APPEAR IN THE CONSTRUCTION PERMIT.)
FINAL WRITTEN APPROVAL FOR OPERATION MUST BE OBTAINED FROM THIS OFFICE AFTER COMPLETION OF CONSTRUCTION.
PERMIT NO. 19673-IW DATE 6-19-13
DIRECTOR, WATER FACILITIES PERMITTING DIVISION

Savannah River Remediation
A URS COMPANY TEAMED WITH BECHTEL | CH2M HILL | BS&W | AREVA

SAVANNAH RIVER REMEDIATION LLC
[redacted]
Savannah River Site, Aiken, SC, 29808

1 **Transmittal Letter**

2 **Construction Permit Application**

3 **Location Map**

4 **Engineering Report**

5

Savannah River Remediation
A URS COMPANY TEAMED WITH BECHTEL | CH2M HILL | B&W | AREVA

SAVANNAH RIVER REMEDIATION LLC

Savannah River Site, Aiken, SC 29808

June 11, 2013

SRR-ESH-2013-00079

Ms. Melinda Vickers
South Carolina Department of Health and
Environmental Control
2600 Bull Street
Columbia, South Carolina 29201-1208

Application for Modification – F/H-Area Effluent Treatment Project Facility – Revision 1 (U)

Reference:

1. Application for Modification – F/H-Area Effluent Treatment Project Facility – Revision 0, SRR-ESH-2013-00033, M-TRT-H-00083, 4/4/13

Based on our discussions Reference 1 has been revised and is included within this modification package.

Savannah River Remediation (SRR) is planning to modify the F/H-Area Effluent Treatment Project Facility. The enclosed modification package (three copies) is being submitted for your review and approval. This package includes an engineering report, equipment list, equipment specifications, design calculations, location map, construction permit application, and fee (submitted with Reference 1). The enclosed, Application for Modification - F/H-Area Effluent Treatment Project Facility, is part of the SRS Outfall H-12 Corrective Action Plan.

Your timely review and processing of the enclosed modification package is requested.

If you have any questions, please contact Keith Liner of my staff at (803) 208-6466.

Sincerely,

Patricia M. Allen

Patricia M. Allen, Manager
Environment, Safety, Health, Quality Assurance and Contractor Assurance
Savannah River Remediation, LLC

WWW.SRREMEDIATION.COM
TEL 803.208.2877
FAX 803.208.8194

Electronic copy cc:

M.D. Wilson, SCDHEC, Columbia SC
J.R. Hughes, SCDHEC, Aiken SC

T.J. Spears, DOE, 704-S, Rm. 29
P. Giles Jr., DOE, 704-S, Rm. 39
P.C. Suggs, DOE, 704-S, Rm. 37
C.H. Pang, DOE, 704-S, Rm. 53
A.I. Watson, DOE, 730-B, Rm. 3429

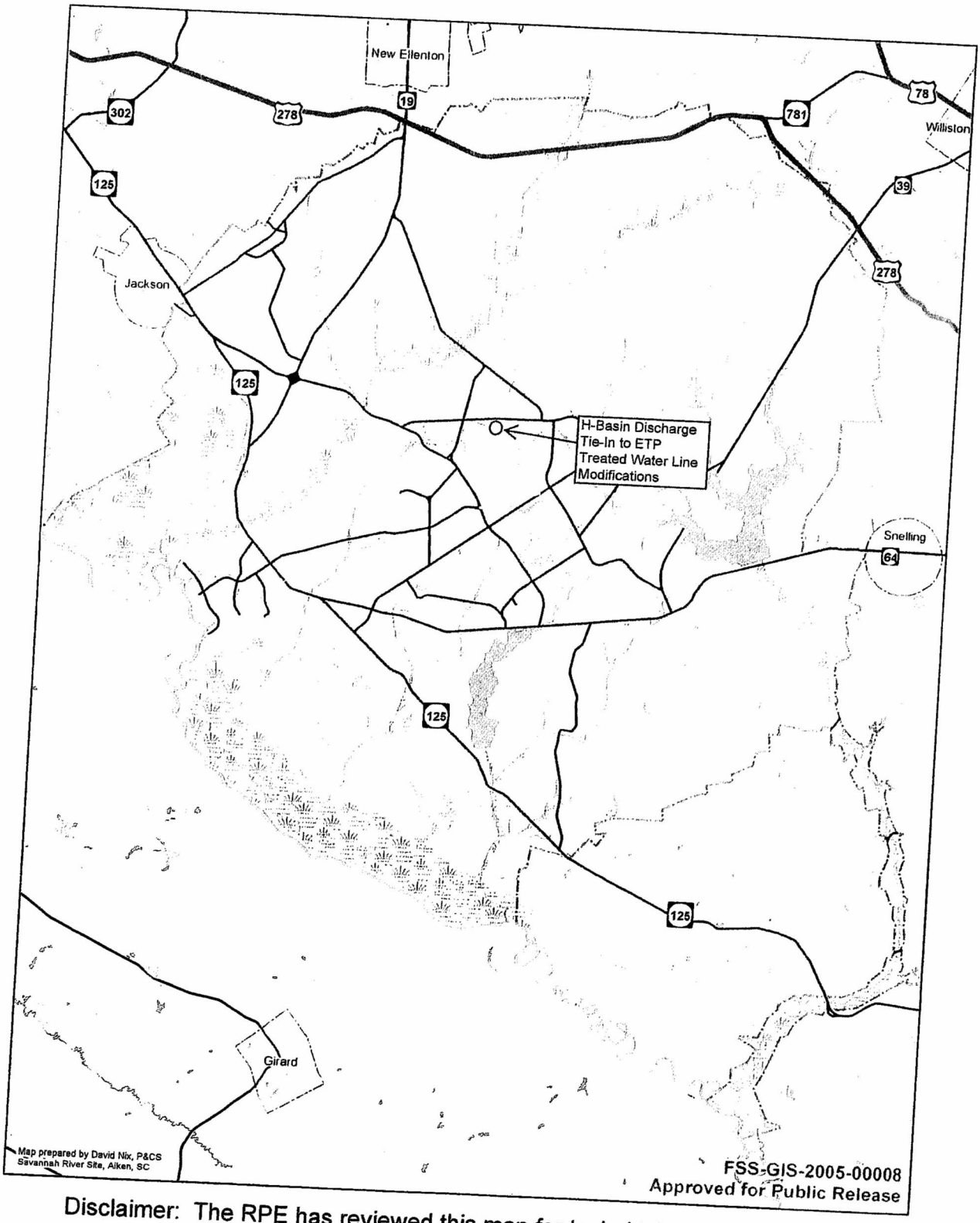
L.D. Olson, SRR, 766-H, Rm. 2407
S.A. Macvean, SRR, 766-H, Rm. 2408
K.H. Subramanian, SRR, 241-156H, Rm. 6
C.J. Winkler, SRR, 766-H, Rm. 2003
R.E. Edwards Jr., SRR, 766-H, Rm. 2404
J.E. Dickenson, SRR, 766-H, Rm. 2412
J.C. Tseng, SRR, 705-1C, Rm. 3
V.G. Dickert, SRR, 766-H, Rm. 2402
N.R. Davis, SRR, 704-56H, Rm. 103
B.A. Green, SRR, 704-56H, Rm. 164
J.E. Occhipinti, 704-56H, Rm. 119
M.T. Keefer, 704-56H, Rm. 161
C.N. Combs, 742-14G, Rm. 11
T.L. Allen, 742-14G, Rm. 4
M.B. Wood, 742-13G, Rm. 5
J.M. Suthar, 742-13G, Rm. 8
O.D. Stevens, SRR, 766-H, Rm. 2440
D.P. Skiff, SRR, 766-H, Rm. 2470
V.A. Franklin, SRR, 705-1C, Rm. 7
K.A. Hauer, SRR, 705-1C, Rm. 1
S.A. Thomas, SRR, 705-1C, Rm. 18
T.F. England, SRR, 705-1C, Rm. 17

M.A. Flora, SRNS, 730-4B, Rm. 328
K.M. Kostelnik, SRNS, 730-4B, Rm. 316
J.M. Griffith, SRNS, 730-4B. Rm. 3134
V.E. Millings III, SRNS, 730-4B, Rm. 3062

File Info:

SCDHEC, Saltstone
10666, DOE/ADM
16-1.5(a) Permanent

Location Map



Disclaimer: The RPE has reviewed this map for technical adequacy.

United States Department of Energy
Savannah River Site
Aiken, South Carolina

ENGINEERING REPORT
M-TRT-H-00083

South Carolina Department of Health and Environmental Control

H Retention Basin Treated Water Line Modification
Basin Water Discharge Tie-in to the Treated Water Line

SOUTH CAROLINA
SAVANNAH RIVER REMEDIATION, LLC
No. 3997
CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 22845
MICHAEL BRYAN WOOD
M. Wood 6.5.13

Signed: MICHAEL B. WOOD **S.C. Registration No.** 22845

S. C. DEPT. OF HEALTH & ENVIRONMENTAL CONTROL
BUREAU OF WATER
WASTEWATER FACILITIES
APPROVED FOR CONSTRUCTION
(SUBJECT TO ANY PROVISIONS WHICH MAY APPEAR IN THE CONSTRUCTION PERMIT.)
FINAL WRITTEN APPROVAL FOR OPERATION MUST BE OBTAINED FROM THIS OFFICE AFTER COMPLETION OF CONSTRUCTION.
PERMIT NO. 19673-IW DATE 6-19-13
DIRECTOR, WATER FACILITIES

DISCLAIMER

APPROVAL SHEET

APPROVED BY:

Originator — Terry L. Allen, Mechanical Engineer, PD&CS/ Design Services — 6.5.13 (Date)

Reviewer — Jagdish M. Suthar, Process / Mechanical Engineer, PD&CS/ Design Services — 6/5/13 (Date)

Reviewer — Keith R. Liner, Environmental Compliance Authority — 6/11/13 (Date)

Reviewer — Mark T. Keefer, Manager - Tank Farm Engineering — 6/6/13 (Date)

Reviewer — Brenda L. Green, Manager – Operations — 6/6/2013 (Date)

Verifier — Michael B. Wood, PE, Mechanical Lead Engineer, PD&CS/ Design Services — 6.5.13 (Date)

Project Manager — C. Neil Combs, Project Manager, PD&CS/ Projects — 6/11/13 (Date)

SUMMARY OF REVISIONS

Rev. No.	Reason for Change	Pages Affected	Issue Date
0	Initial Issue	N/A	3/27/13
1	Register Professional Engineer re-stamp in proper locations and added disclaimer.	Pages 1, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 and 23.	6/11/13

TABLE OF CONTENTS

LIST OF ACRONYMS

BWL	Basin Water Line
ER	Engineering Report
ETP	Effluent Treatment Project
IWT	Industrial Wastewater Treatment
NPDES	National Pollutant Discharge Elimination System
RPE	Registered Professional Engineer
SCR	South Carolina Regulation
SCDHEC	South Carolina Department of Health and Environmental Control
SRR	Savannah River Remediation
SRS	Savannah River Site
TWL	Treated Water Line
UTRC	Upper Three Runs Creek

1.0 ENGINEERING REPORT

This Engineering Report (ER) is being submitted pursuant to South Carolina Regulation (SCR) 61-67, *Standards for Wastewater Facility Construction* to allow discharge of the 281-8H (8H) Basin. This ER describes the location, industrial wastewater treatment processes and configuration of the proposed 8H Basin Water Tie-in to the Treated Water Line (TWL) Modification at Savannah River Site (SRS).

This modification will allow for a discharge from the 8H Basin directly to Upper Three Runs Creek (UTRC) via the existing H-16 outfall discharge pipe. An NPDES 2C application has been initiated to create a new outfall (identification to be designated later) for the 8H Basin contents that will be discharged at the H-16 discharge location. For this to be a viable option, the Effluent Treatment Project (ETP) facility is being modified to have the ability to pump the basin water to UTRC by tying into the existing TWL.

2.0 BACKGROUND INFORMATION

This ER describes a modification to the ETP facility's industrial wastewater treatment (IWT) permit number 18,833-IW and 14,379 issued by the SCDHEC. The ETP process remains unchanged, only the TWL running to the UTRC is being altered. The waste stream characterization and treatment at the ETP and the ultimate disposal of these treated wastes do not change, nor is any new equipment other than piping and fittings required to implement this modification.

3.0 LOCATION AND FACILITY LAYOUT

The ETP is located in H-Area along E Road. The existing TWL runs from the three treated water storage tanks to UTRC. The water is gravity discharged in to the creek west of the bridge. The BWL will be tied in to the TWL near the east end of the 8H Basin along E Road. The general Site location of the modification is shown in Attachment 9.1.

4.0 PROJECT DESCRIPTION

The proposed piping and equipment layout is shown in Attachment 9.2. The BWL Discharge Tie-in Modification installs:

- A section of pipe downstream of an existing gamma monitor at the pumping station with an isolation valve. See Attachments 9.2 and 9.9.
- A section of pipe from the existing lift station line to the existing TWL. This line will contain a backflow preventer with two isolation valves. See Attachments 9.2 and 9.10.
- Double isolation valves will be installed in the lift station line to prevent transfers of basin water to this process area. See Attachments 9.2 and 9.11.
- Double isolation valves will be installed in the existing TWL to prevent basin water from being transfer to the treated water storage tanks at ETP. These valves will be installed in a concrete box for ease of maintenance and inspection. See Attachments 9.2 and 9.11.

5.0 PROCESS DESCRIPTION

ETP will continue to pump the treated water through Outfall H-16 to UTRC when required. This modification makes no changes to the existing ETP process. When required, due to the accumulation of rain water run-off, the basin water will be pumped to UTRC using one of two pumps at a rate between 175 gpm and 225 gpm. This rate is similar to the existing rate of the treated water discharge. The suitability of the pumps is documented in Attachment 9.12. Between 250,000 to 320,000 gallons of water may be pumped daily, as required.

6.0 MODIFICATION DESIGN

The BWL Tie-in Modification design involves the modification of two existing water transfer lines as described above. The material specifications for the new piping and equipment to be installed by this modification are provided in Attachments 9.3 through 9.10.

7.0 OPERATIONS / MAINTENANCE

Trained Operations personnel will be required during basin water pumping, including valve operations, start-up and shutdown.

Required maintenance will be performed by trained Maintenance and E&I Mechanics assigned to the ETP or F & H Tank Farms

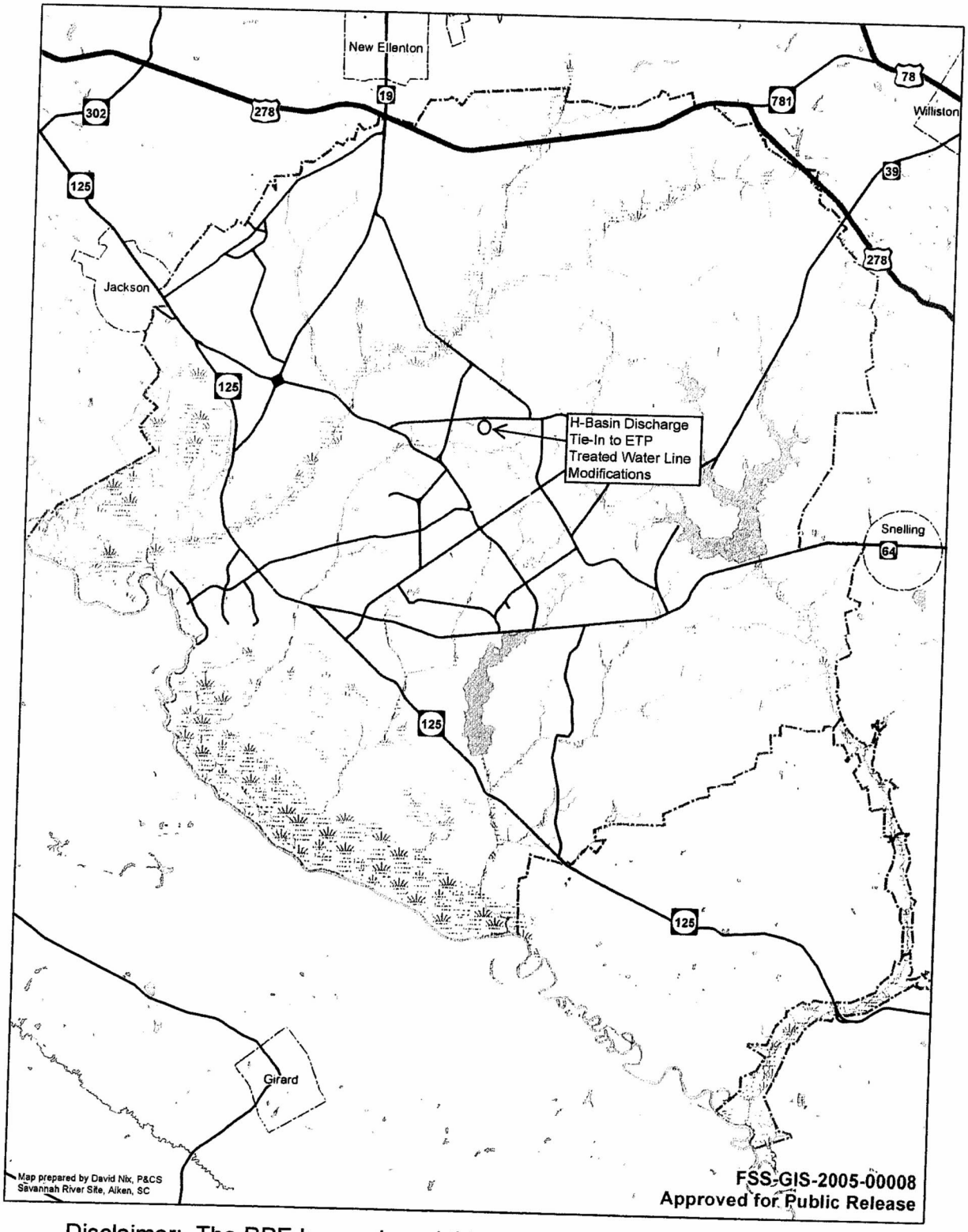
8.0 AIR EMISSIONS

This modification will not generate any air emissions.

9.0 ATTACHMENTS

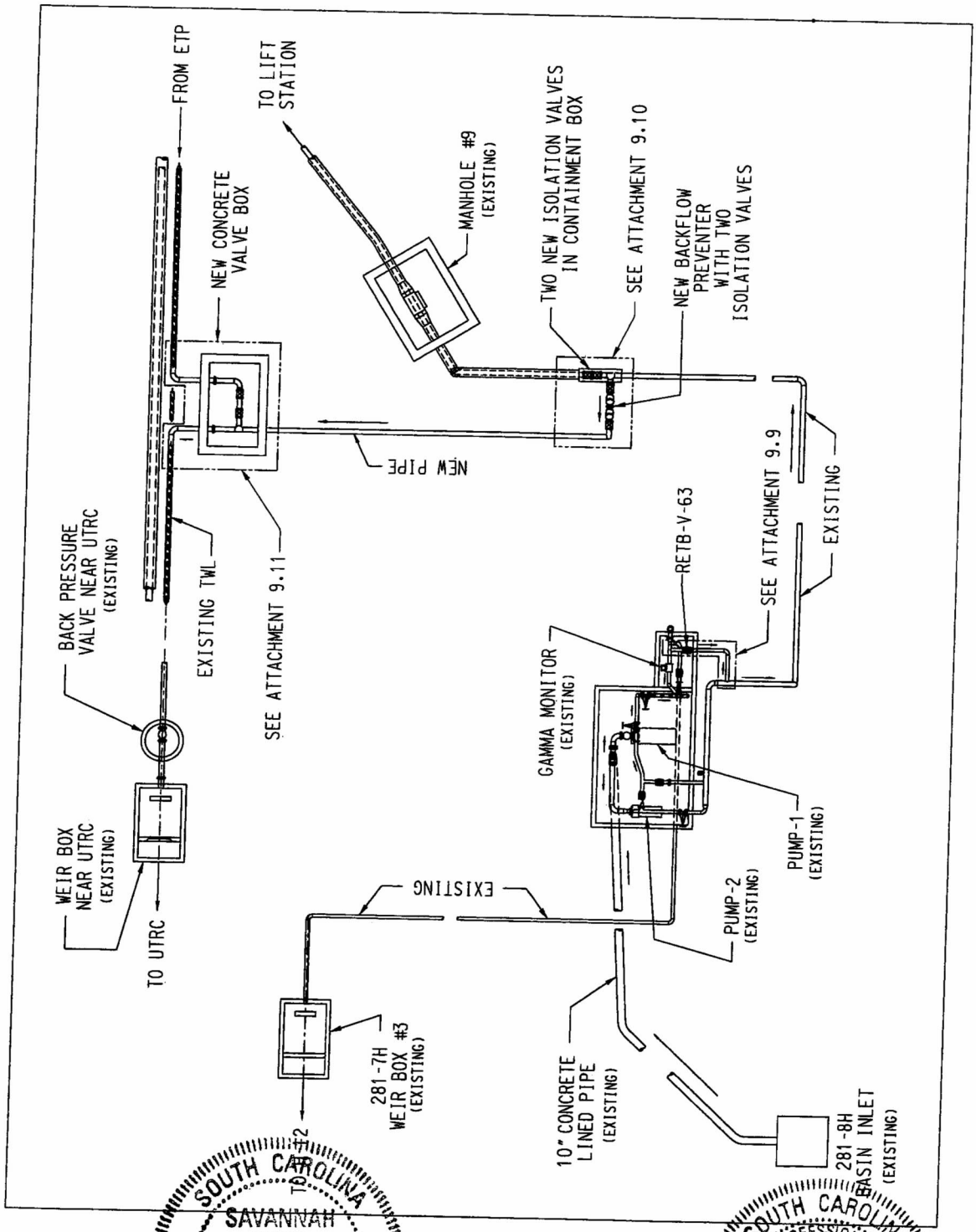
9.1 Location Map
9.2 Basin Water Line Tie-in Modification Overview
9.3 Equipment List and Piping Specification
9.4 Piping Specification 101 for New Pipe
9.5 Piping Specification 200 for New Pipe
9.6 Piping Specification 502 for New Pipe
9.7 Watts Double Check Valve Assembly
9.8 Flow Isolation Ball Valves
9.9 Pipe Tie-In at Pump Pad for New BWL
9.10 New Backflow Preventer and Lift Station Isolation Valves
9.11 New Concrete Valve Box and TWL Isolation Valves
9.12 M-CLC-H-03203, Revision 1, Basin Water-Treated Water Piping System

Attachment 9.1
General Location Map



Disclaimer: The RPE has reviewed this map for technical adequacy.

Attachment 9.2
Basin Waste Line Tie-In Modification Overview

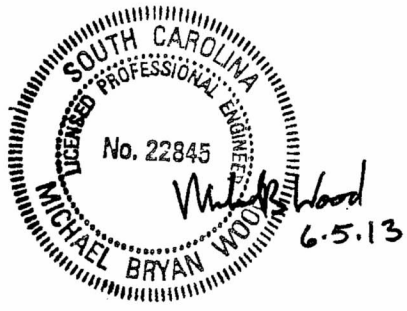


SOUTH CAROLINA
SAVANNAH RIVER REMEDIATION, LLC
No. 3887
CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 22845
MICHAEL BRYAN WOOD
6.5.13

Attachment 9.3
Equipment List and Piping Specifications

Item	Description	Type, Size, Capacity	Quantity	Specification
1	Pipe	Carbon Steel, 4 inch	≈12 feet	Pipe Specification PS101B (Attachment 9.4)
2	Pipe	Carbon Steel, 6 inch	≈2 feet	Pipe Specification PS101B (Attachment 9.4)
3	Pipe	Stainless Steel, 6 inch	≈50 feet	Pipe Specification PS200C (Attachment 9.5)
4	Pipe	Polyethylene, 6 inch	≈20 feet	Pipe Specification PS502F (Attachment 9.6)
5	Backflow Preventer with Gate Valves	Carbon Steel, 6 inch	1	Watts – 709-OSY or equivalent (Attachment 9.7)
6	Ball Valve for Metal Valve Box	Carbon Steel, 6 inch	2	Cam-Tite or equivalent (Attachment 9.8)
7	Ball Valve for Concrete Valve Box	Stainless Steel, 6 inch	2	Cam-Tite or equivalent (Attachment 9.8)



Attachment 9.4
Piping Specification PS101

SRS Engineering Practices Manual	Manual : WSRC-IM-95-58	
APPLICATION OF ASME B31.3	GUIDE NO: 15060-G APPENDIX A	PAGE 47
	DATE: 10/1/2011	REVISION: 7
	ESB TECH COMMITTEE: Piping and Valves	

APPENDIX A
Piping Specifications

Piping Specification PS101 — Page 1 of 1

Design Parameters

P-Spec	PS101(A, B, C, D)						
Design Pressure (psig)	285	260	230	200	170	140	125
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	430	390	345	300	270	245	220
Maximum Test Pressure (psig)	820						

Calculation Reference:	M-CLC-G-00231
Code of Reference:	B31.3 - 2010
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	Class 150
External Pressure Rating:	Note 20

General Notes

Refer to General Notes 1-12, 61

Allowable Pipe Materials

Component	NPS	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10M	ASTM A53	B	ERW – Type E/Seamless
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	NPS	¼	½	¾	1	1½	2	2½	3	4	6	8	10	12	14	16	18	20	24
A	0.000	Schedule	40	40	40	40	40	40	40	40	40	40	40	40	40	30	30	20	20	20
B	0.031	Schedule	40	40	40	40	40	40	40	40	40	40	40	40	40	30	30	30	30	30
C	0.063	Schedule	80	40	40	40	40	40	40	40	[illegible]	[illegible]	40	40	40	30	30	20	20	20
D	0.125	Schedule	-	XXS	160	160	160	80	80	80	40	40	40	40	40	30	30	20	20	20

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	NPS	¼	½	¾	1	1¼	1½	2	2½	3	4
A	0.000	Schedule	80	80	80	80	80	[illegible]				
B	0.031	Schedule	80	80	80	80	80	[illegible]				
C	0.063	Schedule	-	80	80	80	80	80	80	80	80	40
D	0.125	Schedule	-	XXS	160	160	160	160	160	80	80	

To be used for above grade pipe.

Fittings

Component	NPS	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	Class 2000, Class 3000	ASME B16.11	ASTM A105	WP	Use Class 3000 for PS101-D; see Note 61
Socket-Weld Fittings	¼ - 2	Class 2000, Class 3000	ASME B16.11	ASTM A105	WP	Use Class 6000 for PS101-D
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	NPS	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 150	ASME B16.5	ASTM A105	N/A	
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Blind Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size (in)	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B7-HH	See General Note 12
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	2H-HH	

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SOUTH CAROLINA PROFESSIONAL ENGINEER LICENSED No. 22845 MICHAEL BRYAN WOOD 6.5.13

Attachment 9.5
Piping Specification PS200 for New Pipe

SRS Engineering Practices Manual	Manual : WSRC-IM-95-58	
APPLICATION OF ASME B31.3	GUIDE NO: 15060-G APPENDIX A	PAGE 53
	DATE: 10/1/2011	REVISION: 7
	ESB TECH COMMITTEE: Piping and Valves	

APPENDIX A
Piping Specifications

Piping Specification PS200 — Page 1 of 1

Design Parameters

P-Spec	PS200(A, B, C, D)						
Design Pressure (psig)	230	195	175	160	145	140	125
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-425	-425	-425	-425	-425	-425	-425
Minimum Test Pressure (psig)	345	295	265	255	245	250	230
Maximum Test Pressure (psig)	440 for NPS ≤ 6, 360 for NPS > 6						

Calculation Reference:	M-CLC-G-00231
Code of Reference:	B31.3 - 2010
Fluid Service:	Normal
Material:	Stainless Steel (304L)
Pressure Rating:	Class 150
External Pressure Rating:	Note 20

General Notes

Refer to General Notes 1-4, 6-13, 59-61

Allowable Pipe Materials

Component	NPS	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.19	ASTM A312	TP304L	Welded
Piping	¼ - 24	Schedule Tables	ASME B36.19	ASTM A312	TP304L	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	NPS	¼	⅜	½	¾	1	1½	2	2½	3	4	6	8	10	12	14	16	18	20	24
A	0.00	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S
B	0.03	Schedule	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	10S	-	-	-	-
C	0.05	Schedule	40S	40S	10S	40S	10S	10S	10S	10S	10S	40S	40S	10S	10S	10S	10S	-	-	-	-
D	0.08	Schedule	80S	80S	80S	80S	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S	-	-	-	-	-

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	NPS	¼	⅜	½	¾	1	1½	2	2½	3	4
A	0.00	Schedule	40S	40S	40S	40S	40S	40S	40S	40S	40S	40S
B	0.03	Schedule	80S	80S	40S	40S	40S	40S	40S	40S	40S	40S
C	0.05	Schedule	80S	80S	80S	80S	80S	80S	80S	40S	40S	40S
D	0.08	Schedule	-	-	-	-	-	80S	80S	80S	80S	80S

To be used for above and below grade pipe.

Fittings

Component	NPS	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	Class 2000	ASME B16.11	ASTM A182	F304L	See Note 61
Threaded Fittings	¼ - 4	Class 150	MSS SP-114	MSS SP-114	304L	
Socket-Weld Fittings	¼ - 2	Class 3000	ASME B16.11	ASTM A182	F304L	
Socket-Weld Fittings	¼ - 2	Class 150	MSS SP-114	MSS SP-114	304L	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A403	WP304L	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A403	WP304L	

Flanges

Component	NPS	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 4	Class 150	ASME B16.5	ASTM A182	F304L	
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A182	F304L	
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A182	F304L	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A182	F304L	
Blind Flange	½ - 24	Class 150	ASME B16.5	ASTM A182	F304L	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	Min Temperature - 20°F. Notes 10, 59 and 60.
Backup Flange	½ - 24	Class 150	ASME B16.42	ASTM A395	N/A	Min Temp. - 20°F. Notes 10, 59, and 60.

Mechanical Fasteners

Component	Size (in)	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B8 Cl. 2-HH	Min Temperature - 325°F, Notes 12 and 60.
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	8F-HH	Notes 59 and 60.

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6.5.13

Attachment 9.6
Piping Specification PS502

SRS Engineering Practices Manual	Manual : WSRC-IM-95-58	
APPLICATION OF ASME B31.3	GUIDE NO: 15060-G APPENDIX A	PAGE 88
	DATE: 10/1/2011	REVISION: 7
	ESB TECH COMMITTEE: Piping and Valves	

APPENDIX A
Piping Specifications

Piping Specification PS502 — Page 1 of 1

Design Parameters

P-Spec	PS502 (A, B, C, D, E, F, G)						
Design Pressure (psig)	200	193	160	128	110	100	80
Design Temperature (°F)	73	73	73	73	73	73	73
Minimum Temperature (°F)	0	0	0	0	0	0	0
Minimum Test Pressure (psig)	300	290	240	190	165	150	120
Maximum Test Pressure (psig)	385	320	265	215	185	165	135

Calculation Reference:	M-CLC-G-00231
Code of Reference:	B31.3, 2010
Fluid Service:	Normal
Material:	Polyethylene (PE)
Pressure Rating:	200 psi
External Pressure Rating:	N/A

General Notes

Refer to General Notes 1-4, 8-12, 33-35, 37, 38.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	½ - 12	Design Parameters	ASTM D3035	ASTM D3035	PE3408	Note 35
Piping	½ - 12	Design Parameters	ASTM D2513	ASTM D3035	PE3408	Note 35
Tubing	¼ - 1¾	Design Parameters	ASTM D2513	ASTM D3035	PE3408	Note 35
Tubing	½ - 2	Design Parameters	ASTM D2737	ASTM D3035	PE3408	Note 35

Required DR Schedules for Pipe

P-Spec	Corrosion Allowance	Design Pressure at 73°	Pipe Size	½	¾	1	1 ½	2	2½	3	4	6	8	10	12
A	0.00	200	DR	9	9	9	9	9	9	9	9	9	9	9	9
B	0.00	193	DR	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
C	0.00	160	DR	11	11	11	11	11	11	11	11	11	11	11	11
D	0.00	128	DR	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
E	0.00	110	DR	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5
F	0.00	100	DR	17	17	17	17	17	17	17	17	17	17	17	17
G	0.00	80	DR	21	21	21	21	21	21	21	21	21	21	21	21

Required DR Schedules for Tube

P-Spec	Corrosion Allowance	Design Pressure at 73°	Pipe Size	¼	⅜	½	⅝	¾	1	1¼	1½	1¾	2
A	0.00	200	DR	9	9	9	9	9	9	9	9	9	9
B	0.00	193	DR	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
C	0.00	160	DR	11	11	11	11	11	11	11	11	11	11
D	0.00	128	DR	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
E	0.00	110	DR	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5
F	0.00	100	DR	17	17	17	17	17	17	17	17	17	17
G	0.00	80	DR	21	21	21	21	21	21	21	21	21	21

To be used for tie-in to existing TRW pipe.

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Butt Fusion Fittings	¼ - 12	See Note 38	ASTM D3261	ASTM D1248	P34 (PE3408)	
Solvent Welded Fittings (Pipe)	¼ - 4	See Note 38	ASTM D2683	ASTM D1248	P34 (PE3408)	Type III, Class B or C Note A
Solvent Welded Fittings (Pipe)	¼ - 1¼	See Note 38	ASTM D2683	ASTM D1248	P34 (PE3408)	Type III, Class B or C Note A

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Backup Flange	½ - 12	Class 150	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - ⅞	N/A	ASME B18.2.1	ASTM A307	Grade A	See Note 12.
Nuts	½ - ⅞	N/A	ASME B18.2.2	ASTM A563	Grade B	

A. Electrofusion in accordance with ASTM F1055 or AWWA C906.

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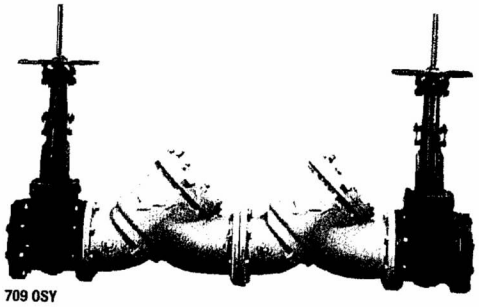
Attachment 9.7
(Page 1 of 2)
Watts Double Check Valve Assembly
With Gate Valves

ES-709L

Series 709
Double Check Valve Assemblies

Sizes: 2½" – 10" (65 – 250mm)

Series 709 Double Check Valve Assemblies are designed to prevent the reverse flow of polluted water from entering into the potable water system. This series can be applied, where approved by the local authority having jurisdiction, on non-health hazard installations. Series 709 features a modular check design concept to facilitate easy maintenance. Check with local jurisdictional authority as to installation requirements.



709 OSY

Features

- Replaceable bronze seats
- Maximum flow at low pressure drop
- Design simplicity for easy maintenance
- No special tools required for servicing
- Captured spring assemblies for safety
- Approved for vertical flow up installation

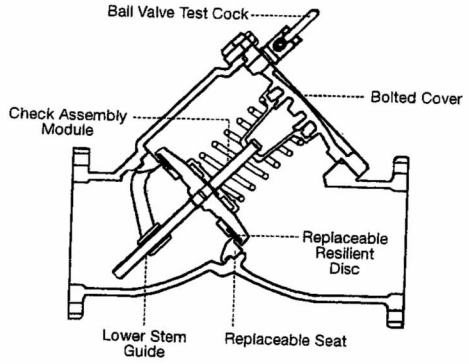
Models

Suffix:

NRS – non-rising stem resilient seated gate valves
OSY – UL/FM outside stem and yoke resilient seated gate valves
S-FDA – FDA epoxy coated strainer
BB – bronze body - 2½" – 3" (64 – 76mm)
QT – quarter-turn ball valves
QT-FDA – FDA epoxy coated ball valve shutoffs
LF – without shutoff valves

Specifications

A Double Check Valve Assembly shall be installed at referenced cross-connections to prevent the backflow of polluted water into the potable water supply. The cross-connections shall be determined by local inspection authority for use where a high hazard situation does not exist. Valve shall feature modular check assemblies with center stem guiding. Each check module shall have a captured spring and be accessible through a bolted cover plate. Seats shall be replaceable without special tools. It shall be a complete assembly including tight-closing resilient seated shutoff valves, test cocks, and a strainer is recommended. The assembly shall meet the requirements of ASSE No. 1015; AWWA C510-92; CSA B64.5 and UL Classified File No. EX3185. Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California. Assembly shall be a Watts Regulator Company Series 709.



Check Assembly Module

Series 709 features a modular design concept which facilitates complete maintenance and assembly by retaining the spring load. Also, the first and second check module are identical and can be interchanged.

***IMPORTANT:** INQUIRE WITH GOVERNING AUTHORITIES FOR LOCAL INSTALLATION REQUIREMENTS*

Now Available
WattsBox Insulated Enclosures.
For more information, send for literature ES-WB.

Disclaimer: The RPE has reviewed this product cut sheet for technical adequacy.

Attachment 9.7
(Page 2 of 2)
Watts Double Check Valve Assembly
With Gate Valves

Materials
Check Valve Bodies: Epoxy coated cast iron
Seats: Bronze

Pressure — Temperature
Temperatures Range: 33°F – 110°F (0.5°C – 43°C) continuous, 140°F (60°C) intermittent
Maximum Working Pressure: 175psi (12.1 bar)

Standards
AWWA C510-92
IAPMO PA 31
USC Manual for Cross-Connection Control, 8th Edition

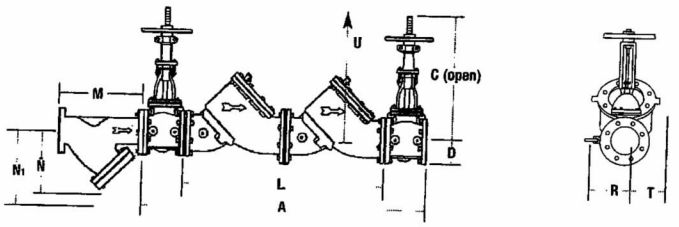
Approvals
1015 864.5

Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California. Sizes 4" – 10" (100 – 250mm) approved horizontal and vertical "flow up". Size 2½" and 3" (65 – 80mm) approved horizontal only.

Factory Mutual approved 4" – 10" (80 – 250mm) vertical "flow up" with OSY gate valves only.

Note: Model "S" not listed

Dimensions — Weights



RETB-V-67, RETB-V-68, RETB-V-69, & RETB-V-70, respectively

Size to be used.

SIZE (DN)		DIMENSIONS															
		A		C (OSY)		C (NRS)		D		L		U*		M		N	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
2½	65	39⅜	1000	16⅜	416	9⅜	238	3½	89	24⅛	613	11	279	10	254	6½	165
3	80	40⅜	1025	18⅞	479	10¼	260	3¾	95	24⅛	613	14	356	10⅛	257	7	178
4	100	41¼	1048	20¼	514	12⅜	314	4¼	114	24⅛	613	14	356	10⅛	257	8¼	210
6	150	62⅞	1597	30⅛	765	16	406	5½	140	41⅝	1057	16	406	18½	470	13½	343
8	200	77	1956	37¼	946	19¼	489	6¼	159	63	1600	21	533	21½	546	16¼	413
10	250	90	2286	45¾	1162	23¹³⁄₁₆	605	8	203	64	1626	25	635	26	660	18½	470

SIZE (DN)		DIMENSIONS								WEIGHT						STRAINER	
		N1†		R		R❖		T		NRS		OSY		QT		Weight	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kgs.	lbs.	kgs.	lbs.	kgs.	lbs.	kgs.
2½	65	10	254	4	102	16	406	3	76	167	76	170	77	154	70	28	13
3	80	10	254	5	127	16	406	3	76	167	76	170	77	162	73	34	15
4	100	12	305	6	152	18⅛	460	4	102	303	137	308	140	278	126	56	25
6	150	20	508	11	279	26	660	7½	191	627	284	707	321	611	277	122	55
8	200	22¾	578	11⅞	302	11⅞	302	9	229	1201	545	1693	768	1413	641	247	112
10	250	28	711	12½	318	12½	318	10¼	260	2003	909	2073	940	2466	1119	370	168

† - Dimension required for screen removal. ❖Quarter-turn (QT) valve dimensions.
*Service clearance for check assembly from center.

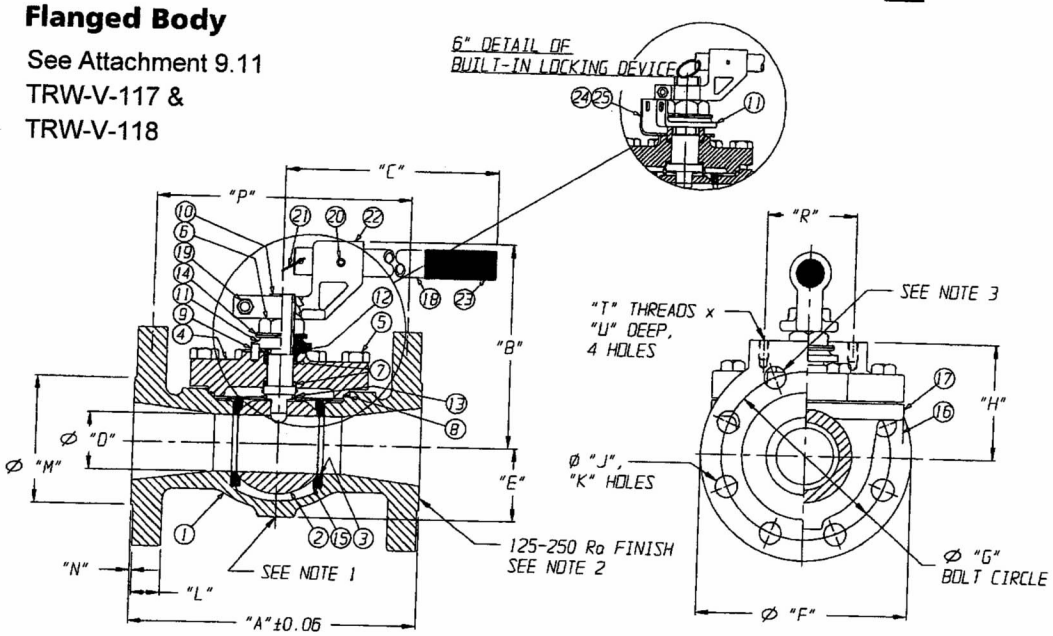
Disclaimer: The RPE has reviewed this product cut sheet for technical adequacy.

Attachment 9.8
(Page 1 of 2)
Flow Isolation Ball Valves

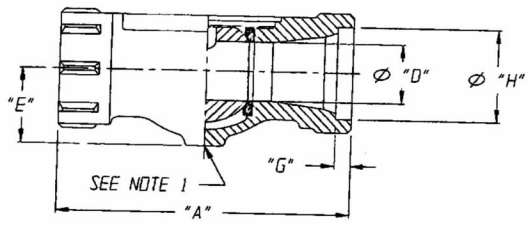
Dimensions, Weights, & Parts Lists 3", 4" and 6" Valves

Flanged Body

See Attachment 9.11
TRW-V-117 &
TRW-V-118



Socket Weld & Threaded Body

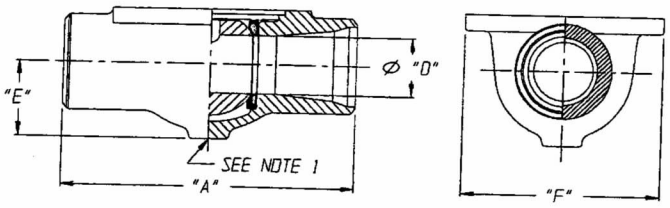


NOTE:

1. ***Body boss can be drilled, tapped, and plugged.***
2. ***End machining meets ANSI B16.5 for flanged ends.***
3. ***Top two flanged bolt holes on 3" & 4" 150 lb. class valves are drilled and tapped 5/8"-11 UNC class 2B. Top two flanged bolt holes on 4" 300# Class valves are drilled and tapped 3/4"-10 UNC class 2B.***
4. ***The design meets ANSI B16.34, MSS-SP 72 and ANSI B16.10.***
5. ***Valve is shown in the open position. Clockwise rotation of stem closes the valve.***

Butt Weld Body

See Attachment 9.10 - RETB-V-65 & RETB-V-66



22 Item 6. 6" Buttweld End, Carbon Steel WCB Valve, 316SST Ball & Stem, Std. Cover, UHMW PE Seat, UHMP Stem Seal & Gasket.

Item 7. 6" ANSI Class 150# Flanged Stainless Steel Valve, 316SST Ball & Stem, Std. Cover, UHMW PE Seat, UHMP Stem Seal & Gasket.

Disclaimer: The RPE has reviewed this product cut sheet for technical adequacy.

Attachment 9.8
(Page 2 of 2)
Flow Isolation Ball Valves

Compliance With National Standards

Cam-Tite Ball Valves are designed to the following ANSI specifications:

ANSI B2.1	Pipe Threads
ANSI B16.5	Flanges and Flanged Fittings
ANSI B16.11	Socketweld and Threaded Fittings
ANSI B16.25	Buttweld Ends
ANSI B16.34*	Flanged, Threaded and Weld End Valves
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping

*Compliance to ANSI B16.34 is dependent on the materials of construction selected and the testing specified for each application. Consult the factory for further details.

All standard Cam-Tite Ball Valves are tested and tagged in accordance with the following specifications:

MSS-SP-25	Marking System for Valves
MSS-SP-72	Ball Valves for General Service

In addition, Cam-Tite Ball Valves can be furnished in accordance with the special requirements of the
following specifications:

ANSI B31.3	Category M Service
API 598	Valve Inspection and Testing
API 607	Firetesting for Soft Seated Quarter Turn Valves
Chlorine Institute Pamphlet 6	Ball Valves for Dry Chlorine Service
NACE Standard MR01-75	Materials for Oilfield Equipment

Material Standards

All Cam-Tite body and bonnet castings are in accordance with one of the following standards:

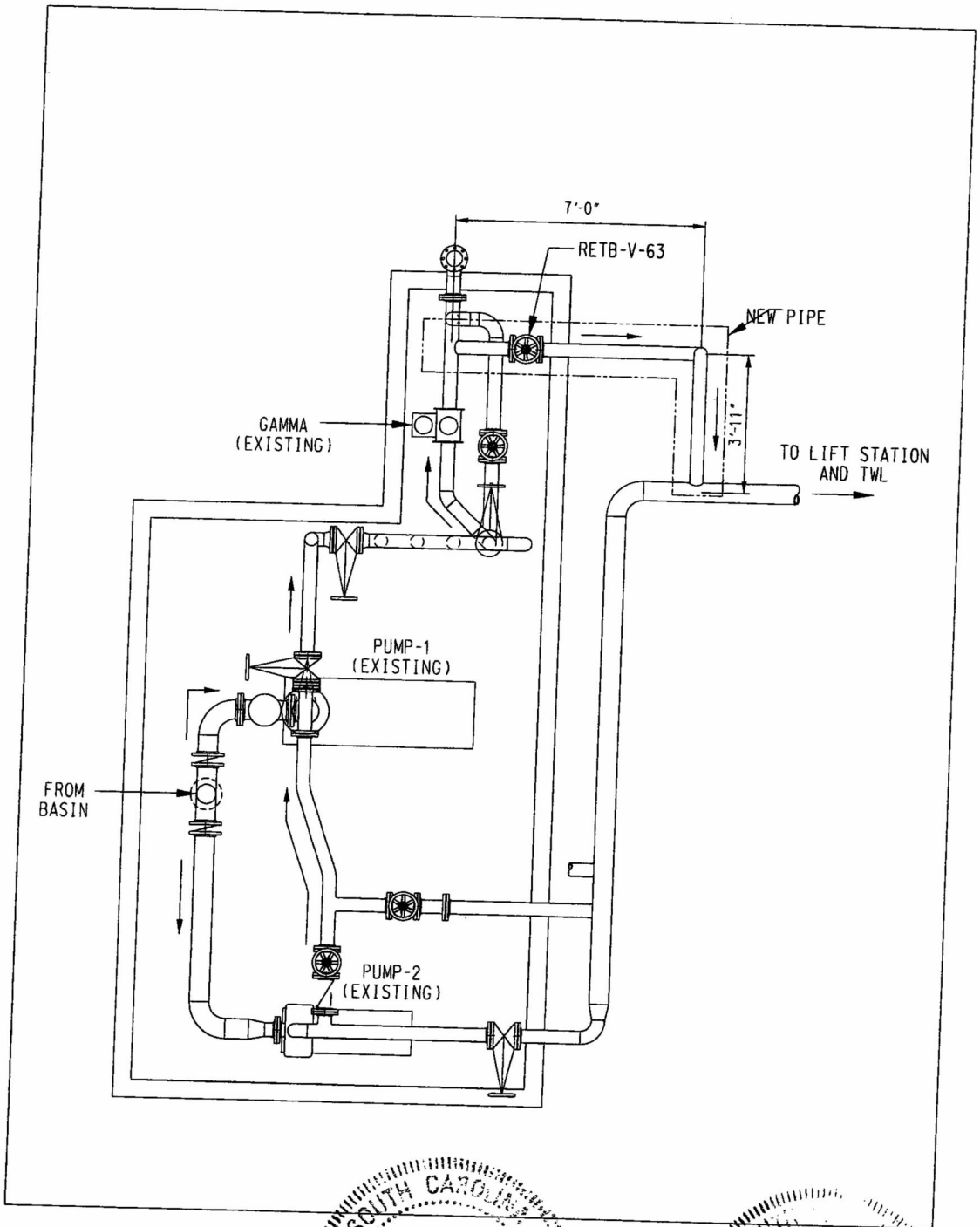
Carbon Steel	ASTM A216 GR WCB
Carbon Steel (Low Temperature)	ASTM A352 GR LCB
Carbon Steel (Low Temperature)	ASTM A352 GR LC-1
316 Stainless Steel	ASTM A351 GR CF8M
316 L Stainless Steel	ASTM A351 GR CF3M
Alloy 20	ASTM A351 GR CN7M
Monel	ASTM A494 GR M-35-1
Hastelloy C	ASTM A494 GRs CW-6M or CW-2M
Inconel	ASTM A494 GR CY-40
Nickel	ASTM A494 GR CZ-100
Titanium	ASTM B367 GR C3

All standard Cam-Tite Ball Valve cover bolting is in accordance with the following standards:

Carbon Steel	ASTM A193 GR B7
Stainless Steel	ASTM A193 GR B8

Certified Material Test Reports (CMTRs) can be supplied on the above materials. Contact Engineered Valves for additional information on materials not listed.

Attachment 9.9
Pipe Tie-In at Pump Pad for New BWL

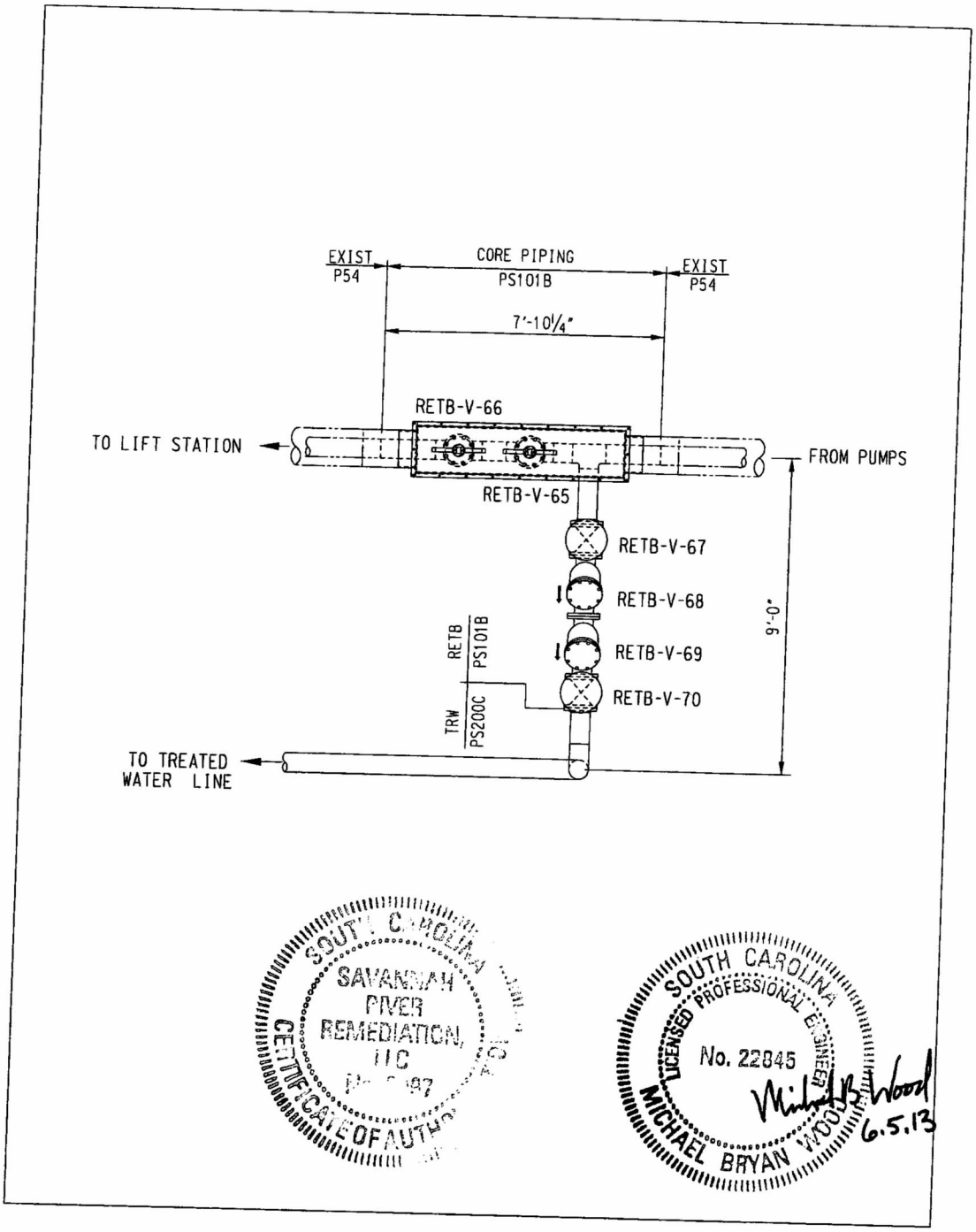


SOUTH CAROLINA
SAVANNAH RIVER REMEDIATION, LLC
No. 3997
CERTIFICATE OF AUTHORIZATION

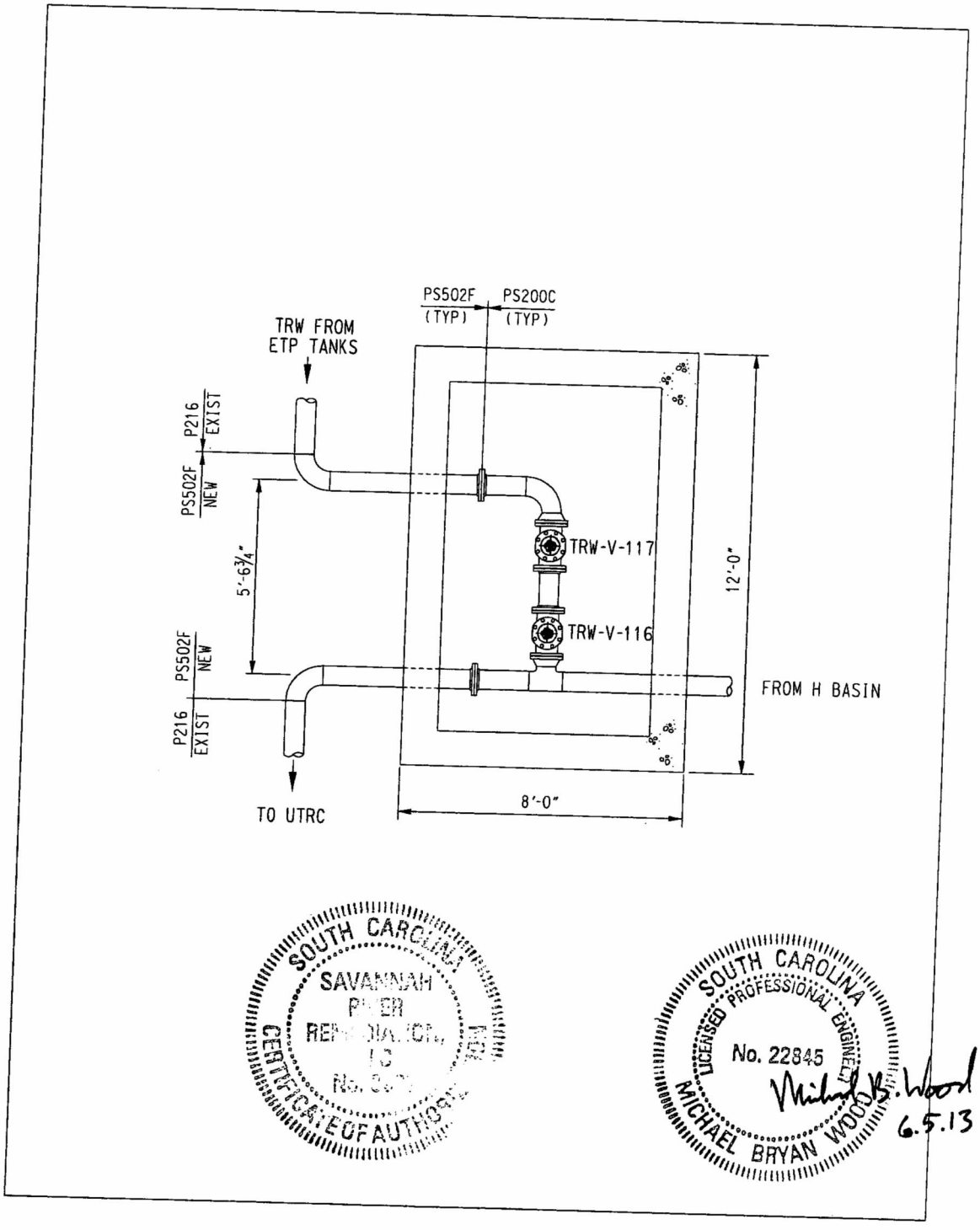
SOUTH
LICENSED PROFESSIONAL
No. 2284
MICHAEL BRYAN

6.5.13

Attachment 9.10
New Backflow Preventer and Lift Station Isolation Valves



Attachment 9.11
New Concrete Valve Box and TWL Isolation Valves



Attachment 9.12

BEST AVAILABLE

UNCLASSIFIED

CALCULATION COVER SHEET

1

Calculation Number:	Revision:	Functional Classification:	Project:
M-CLC-H-03203	1	PS	N/A

Title: Basin Water-Treated Water Piping System

Calculation Type: Type 1-Confirmed

Computer Program and Version/Release No: N/A

Purpose and Objective:

Purpose: Apply accepted computational methods to determine the system head requirement for pumping Basin Water to Upper Three Runs Creek (UTRC).
Objective: Verify that the existing pumps are capable of pumping the Basin Water to UTRC. If not, select a suitable pump to meet the performance requirements of Reference 5.

Summary of Conclusion:

The currently installed pumps, RETB-P-1 and RETB-P-2 are capable of pumping the basin water at the required range of 175 – 225 gpm.
To meet the flow rate requirement, the discharge flow rate of RETB-P-1 must be throttled to approximate 225 gpm with a manual valve.
Pump 2, RETB-P-2, is capable of pumping the basin water at a flow rate of approximately 175 gpm.
A double check valve assembly is required to prevent the draining of treated water back into the basin.

"This document has been verified, including evaluation against questions a-m of E7, 2.60, Section 5.2.1.1"

Originator: ALLEN, TERRY L **Date:** 4/9/2013

Verifier/Checker: GAUTHIER, HAROLD P **Date:** 4/9/2013

Discipline: MECHANICAL

Verification/Checking Method: Design Check (GS/PS only)

Contributing Reviewers:	Org/Dept	Date:
N/A		4/9/2013
N/A		4/9/2013
N/A		4/9/2013
N/A		4/9/2013
N/A		4/9/2013

Design Authority: N/A **Date:** 4/9/2013

USQ Required?: NO

Responsible Manager: WOOD, MICHAEL BRYAN **Date:** 4/10/2013

DCRO: N/A **Date:** 4/10/2013 **Guidance / Exemption:**

UNCLASSIFIED - Does Not Contain Unclassified Controlled Nuclear Information

SOUTH CAROLINA PROFESSIONAL ENGINEER LICENSED No. 22845 MICHAEL BRYAN WOOD

Michael B. Wood 6.5.13

Attachment 9.12

Calculation Continuation Sheet

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Attachment 9.12

Calculation Continuation Sheet

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1. References

General

1. Flow of Fluids through Valves, Fittings and Pipe, Technical Paper No. 410; Crane Co., 1988, Reprinted 03/06.
2. Pump Characteristics and Applications, Volk, M. W., Marcel Dekker, Inc., 1996.
3. Handbook of Tables for Applied Engineering Science, Second Edition, Bolz, Ray E. and Tuve, George L.
4. Handbook of Polyethylene Pipe, Second Edition, Chapter 6 – Design of PE Piping Systems, Table 2-1, Plastic Pipe Institute.
5. MT-EPT-2012-00002, Rev. 0, 281-8H Retention Basin Tie into the Treated Water Line.
6. Swamee PK, Jain AK, Explicit Equations for Pipe-Flow Problems, Journal Hydraulics Division of ASCE 1976; 102(5): 657–64.
7. ASTM F714-12, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter. (Note: Used IPS based on archived DuPont Specification 4482-P216 flange requirement.)

SRS Piping and Instrumentation Diagrams (P&IDs)

8. M-M6-H-9427, Rev.13, Effluent Treatment Facility, H Area Pump Pit, Retention Basin System, Piping and Instrument Drawing.
9. M-M6-H-9592, Rev. 4, Effluent Treatment Facility, Treated Water Transfer Pumps, Treated Water System, Piping and Instrument Drawing.
10. M-M6-H-9593, Rev. 2, Effluent Treatment Facility, Treated Water System, Piping and Instrument.

SRS Blue Print Files (BPF)

11. BPF211919, Self-Priming Mark II Durcopumps Group II (H281-100.1 / W239022)
12. BPF216672, Durco Mark III Pumps 2K 4x3US-10H, Sheets 1, 5 and 13 (H824-170-10 / W725794)

SRS Drawings

13. D186318, Rev. 27, Basins 200 F-H, Piping Details, Details, Process.
14. D186319, Rev. 37, Basins 200 F-H, Piping Details, Details, Process & Concrete.
15. D186320, Rev. 30, Basins 200 F, Piping Details, Details, Power.
16. D186325, Rev. 5, Basins 200 F-H, Piping Details, Details, Process.
17. D186328, Rev. 3, Basins 200 F-H, Piping Details, Details, Process.
18. W238897, Rev. 39, Bldg. 281-8, -9 & -10H, Contaminated Water Control, Plot Plan, Civil.
19. W238973, Rev. 23, Bldg. 281-8F & H, Contaminated Waste Control, Inlet Structure & Sump, Concrete.
20. W238978, Rev. 3, Bldg. 281-9H, Contaminated Water Control, Pump & Valve Pad, Concrete.
21. W239022, Rev. 65, Bldg. 281-9H, Contaminated Water Control, Pump Station Equip. & Piping Arrg't., Process.
22. W814332, Rev. 60, Basins – 200-H, Piping Plan, Bldg. 281-9H, Piping Arrg't., Process.

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23. W816264, Rev. 36, Area 811-F, Collection & Storage Facility OSUG Piping Profile, Sheet 1, Power.
24. W816265, Rev. 24, Area 811-F, Collection & Storage Facility OSUG Piping Profile, Sheet 2, Power.
25. W816266, Rev. 21, Area 811-F, Collection & Storage Facility OSUG Piping Profile, Sheet 3, Power.
26. W816267, Rev. 11, Area 811-F, Collection & Storage Facility OSUG Piping Profile, Sheet 4, Power.
27. W816268, Rev. 12, Area 811-F, Collection & Storage Facility OSUG Piping Profile, Sheet 5, Power.
28. W816269, Rev. 36, Area 811-F, Collection & Storage Facility OSUG Piping Profile, Sheet 6, Power.
29. W816270, Rev. 19, Area 811-H, Collection & Storage Facility OSUG Piping Profile, Sheet 1, Power.
30. W816271, Rev. 22, Area 811-H, Collection & Storage Facility OSUG Piping Profile, Sheet 2, Power.
31. W816272, Rev. 20, Area 811-H, Collection & Storage Facility OSUG Piping Profile, Sheet 3, Power.
32. W816273, Rev. 26, Area 811-H, Collection & Storage Facility OSUG Piping Profile, Sheet 4, Power.
33. W816274, Rev. 56, Area 811-H, Collection & Storage Facility OSUG Piping Profile, Sheet 5, Power.

2. Open Items

None.

3. Introduction

R1 The new NPDES Permit for SRS will have zinc discharge limits at Outfall H-12 that will be difficult for SRR to meet. Per agreement with SCDHEC, SRR will reroute the flow from 281-8H to the discharge treated water line from ETP that leads to Outfall H-16 at Upper Three Runs Creek (UTRC). The Facility desires to use the existing pump(s) to pump the water basin to UTRC. Originally, the pumps were not designed for this application. This calculation determines if the pump(s) are adequate or must they be replaced.

4. Input Data

1. Transfer pump target flow rate range is approximately 175 – 225 gpm, (Ref. 1.5).

5. Assumptions

1. Fluid Characteristics for Basin Water is assumed to be water.
2. Pressure head (h_P) and Velocity head (h_V) are not considered in this calculation
3. All 66.6' radius bends are considered straight pipe.
4. Full port valves are used.
5. The backflow preventer as listed in Attachment 2 with an assumed head loss of approximately 3 psi (≈ 12.7 ft).

Attachment 9.12

Calculation Continuation Sheet

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6. Analysis Method and Calculation

This calculation uses the following methodology:

1. Establish the proposed piping arrangement using general arrangement and layout drawings.
2. Determine total head loss (h_L) for the piping system as follows:
   - Determine flow through capacity range (Q).
   - Calculate Reynolds Number (R_e)
   - Determine Friction factor (f).
   - Calculate resistance coefficient (K).
   - Calculate pressure head loss (h_L) for the piping system.
3. Determine the maximum elevation head difference between the lowest basin water level and the discharge elevation at the Weir Box (h_S).
4. Develop system head requirements for the Basin Water System. (This includes elevation head minus system head loss. ($h_S - h_L$)
5. Plot the pump performance parameters obtained from references 1.11 and 1.12.
6. Evaluate the Basin Water to Upper Three Runs Creek System head requirements for the piping system with respect to pump performance, to determine the flow delivering capability of the existing Retention Basin pumps.

Pipe Route

The evaluated pipe route is shown schematically in Figure 1. Figure 2 shows the significant elevation changes of the piping from ETP to the UTRC. The overall flow path that was analyzed by this calculation is shown in Figure 3. The flow path was divided into nine segments; pipe size/type and by pump. Figures 4 through 8 show the nine pipe segments. The lengths of pipe are based on the drawings listed. Some of the lengths were scaled because a dimension could not be calculated. Table 1, Basin Water to Upper Three Runs Creek System Piping and Components, tabulates the lengths of each segment and the number of valves, elbows, tee, and etc. in each section. Table 2 contains the key elevations used in calculating the system curve.

Table 3 contains the pipe length and fitting tabulation of the calculation. There are nine segments that are categorized by the pipe size or the pump to be evaluated.

Segment Description

1 From Basin Inlet to 10" x 6" reducer below pad (Figures 4 and 6).

2 From 10" x 6" reducer below pad to inlet of RETB-P-2 (Figures 5 and 6).

3 From outlet of RETB-P-2 to tee above RETB-P-1 (Figures 5 and 6).

4 From tee above RETB-P-1 through radiation monitor to tee on line 4302 (Figures 5 and 6).

5 From 10" x 6" reducer below pad to inlet of RETB-P-1 (Figures 5 and 6).

6 From outlet of RETB-P-1 to tee above RETB-P-1 (Figures 5 and 6).

7 From tee on line 4302 to AG/UG connection to the underground PE pipe (Figures 7 and 8).

8 The PE piping starting just below grade to the tie-in to the treated water line (Figures 7 and 8).

9 The treated water line to the weir box at UTRC (Figures 7 and 8).

Attachment 9.12

Calculation Continuation Sheet

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Table 1
Piping and Fluid Data

Friction Factors (f_T) (Ref. 1.1)

8 to 10-inch NPS Pipe	0.014
6-inch NPS Pipe	0.015
4-inch NPS Pipe	0.017

Absolute roughness (ε) pipe (Ref. 1.1):

Carbon Steel Pipe – CSP	0.00015 ft
Concrete Lined Pipe – CLP	0.01 ft

Absolute roughness (ε) pipe (Ref. 1.4):

Polyethylene pipe – PE	0.000005 ft

Pipe Data	OD	ID	
10-inch 40S CLP - in.	10.750	9.520	(Ref. 1.1)
10-inch 40S Pipe - in.	10.750	10.020	(Ref. 1.1)
6-inch 40S Pipe - in.	6.625	6.065	(Ref. 1.1)
6-inch PE Pipe - in.	6.625	5.845	(Ref. 1.7)
4-inch 40S Pipe - in.	4.500	4.026	(Ref. 1.1)

Fluid Properties (Ref. 1.3)

	μ (cP)	SG	ρ (lbm/ft^3)
Water @ 68°F / 20°C	1.004	1.0	62.38

Table 2
Elevation Head for Flow Delivery Points

10" Sump suction elevation	254.05 ft
Min basin level elevation	259.50 ft
Max basin level elevation	270.00 ft
Max basin operating elevation	266.00 ft
Pump P-2 suction elevation (170-10)	271.90 ft
Pump P-1 suction elevation (EP-100H)	271.90 ft
4" Pipe Elevation Line - 4302 (max)	275.33 ft
6" Pipe Elevation Line - 4302 (max)	275.53 ft
High Point elevation	284.75 ft
Max elevation (estimated)	297.00 ft
Discharge elevation	131.75 ft

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Table 3
Segment Pipe Lengths, Fittings and Valves Tabulation

Pipe Segment				
Segment 1 - 10" Sch 40S, CLP	Total	W238897	W238978	W239022
Pipe (ft)	280.88	268.92		11.96
90° Standard Elbow	1			1
45° Standard Elbow	2	2		
Entrance, sharp edged	1	1		
Reducer 10x6	1			1
Segment 2 - 6-inch CSP Sch 40S - P-2	Total	W239022	W814332	& Figures 5 & 6
Pipe (ft)	12.41	4.31	8.09	
Butterfly Valve	1		1	
90° Standard Elbow	1		1	
Standard Tee, FTB	1		1	
Reducer 6x4	1		1	
Segment 3 - 4-inch CSP Sch 40S - P-2	Total	W814332	& Figures 5 & 6	
Pipe (ft)	13.86	13.86		
Enlarger 4x3	1	1		
Gate Valve	1	1		
Swing Check Valve (flanged)	1	1		
90° Standard Elbow	1	1		
45° Standard Elbow	2	2		
Standard Tee, FTR	2	2		
Standard Tee, FTB	1	1		
Segment 4 - 6-inch CSP Sch 40S	Total	W814332	& Figures 5 & 6	
Pipe (ft)	33.49	33.49		
Gate Valve	4	4		
90° Standard Elbow	5	5		
45° Standard Elbow	1	1		
Standard Tee, FTB	3	3		
Segment 5 - 6-inch Sch 40S - P-1	Total	W239022	W814332	& Figures 5 & 6
Pipe (ft)	6.74	4.31	2.43	
Butterfly Valve	1		1	
90° Standard Elbow	1		1	
Tee, FTB	3		3	

Attachment 9.12
Calculation Continuation Sheet

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Table 3
Segment Pipe Lengths, Fittings and Valves Tabulation
(continued)

Segment 6 - 4-inch CSP Sch 40S - P-1	Total	W814332	& Figures 5 & 6	
Pipe (ft)	2.77	2.77		
Gate Valve	1	1		
Standard Tee, FTB	1	1		
Segment 7 - 6-inch CSP Sch 40S	Total	W814332	& Figures 7 & 8	
Pipe (ft)	257.24	257.24		
90° Standard Elbow	2	2		
Standard Tee, FTB	3	3		
Backflow Preventer	1	1		
Segment 8 - 6-inch PE Sch 40S	Total	W814332	& Figures 7 & 8	
Pipe (ft)	48.17	48.17		
90° Standard Elbow	1	1		
Standard Tee, FTB	1	1		
Segment 9 - 6-inch PE Sch 40S	Total	W816274		
Pipe (ft)	762.69	762.69		
Segment 9 - 6-inch PE Sch 40S	Total	W816273		
Pipe (ft)	1500.00	1500.00		
Segment 9 - 6-inch PE Sch 40S	Total	W816272		
Pipe (ft)	1500.00	1500.00		
Segment 9 - 6-inch PE Sch 40S	Total	W816271		
Pipe (ft)	1500.00	1500.00		
Segment 9 - 6-inch PE Sch 40S	Total	W816270		
Pipe (ft)	1500.00	1500.00		
Segment 9 - 6-inch PE Sch 40S	Total	W816269		
Pipe (ft)	1500.00	1500.00		
Segment 9 - 6-inch PE Sch 40S	Total	W816268		
Pipe (ft)	1400.00	1400.00		
Segment 9 - 6-inch PE Sch 40S	Total	W816267		
Pipe (ft)	1500.00	1500.00		

Attachment 9.12
Calculation Continuation Sheet

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Table 3
Segment Pipe Lengths, Fittings and Valves Tabulation
(continued)

Segment 9 - 6-inch PE Sch 40S	Total	W816266	
Pipe (ft)	1500.00	1500.00	
Segment 9 - 6-inch PE Sch 40S	Total	W816265	
Pipe (ft)	1400.00	1400.00	
Segment 9 - 6-inch PE Sch 40S	Total	W816264	D186328
Pipe (ft)	965.00	965.00	
Back Pressure Valve	1	1	

Computation

The following information establishes the methodology and formulas used to determine the head losses due to fluid flow through the piping system.

The system head curve will be based on the fluid characteristics of water as defined in Table 1. Determination of the system head curve will use the methods and equations contained in References 1, 2, and 3. The flow rate range was evaluated from 50 to 550 gpm, in 50 gpm increments. Microsoft Excel was used to generate spreadsheets and charts of the results. The system head curve is the sum of elevation head (h_S) and friction losses (h_L).

Elevation head (h_S), feet, is based on the elevation differences between the minimum liquid level of the basin and the discharge elevation at UTRC.

NOTE: A complete list of nomenclature, i.e., symbols, for this calculation is presented in Attachment 3.

Straight pipe friction losses (h_L), feet, will be calculated by the following equations.

$h_L = 0.1863 (f L v^2 / d)$ (Ref. 1.1, Eq. 3-5)

Where:

$v = q / A$ (Ref. 1.1, Eq. 1-1)

$f = 0.25 / [\text{Log}_{10} (\varepsilon / 3.7 d + 5.7 / R_e^{0.9})]^2$ (Ref. 1.8)
Range of validity – $(5x10^3 \leq Re \leq 1x10^7)$ and $(1x10^{-6} \leq \varepsilon/D \leq 5x10^{-2})$

$R_e = 50.6 (Q \rho / d \mu)$ (Ref. 1.1, Eq. 3-3)

Fittings and components frictional losses will be determined using the following equation. Note: Modified to include summation all fitting and component *K* values.

$h_L = 0.00259 (Q^2 / d^4) \Sigma K$ (Ref. 1.1, Eq. 3-14)

The *K* values for various fittings will be determined using the methods of Reference 1, pages 3-4 and A-26 through A-29.

Attachment 9.12

Calculation Continuation Sheet

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NOTE: The calculated value for *f* will be used instead of f_T for all fittings, since the flow is not fully turbulent for the targeted flow rate.

Butterfly valve
$K = 45\ f_T$ (Ref. 1.1, A-28)

Ball valve ($\beta = 1$)
$K = 3\ f_T$ (Ref. 1.1, A-28)

Gate valve ($\beta = 1$)
$K = 8\ f_T$ (Ref. 1.1, A-27)

Swing Gate valve, flanged ($\beta = 1$)
$K = 50\ f_T$ (Ref. 1.1, A-27)

90° Standard Elbow
$K = 30\ f_T$ (Ref. 1.1, A-29)

45° Standard Elbow
$K = 16\ f_T$ (Ref. 1.1, A-29)

Tee, flow thru run (Standard Tee)
$K = 20\ f_T$ (Ref. 1.1, A-29)

Tee, flow thru branch (Standard Tee)
$K = 60\ f_T$ (Ref. 1.1, A-29)

K values for pipe entrance and exit are 0.5 and 1.0, respectfully. (Ref. 1.1, A-29)

For conservatism, the resistance to flow for reducers and enlargers is as follows:

Reducers
$K = (1 - d_1^2/d_2^2)^2$ (Ref. 1.1, Eq. 2-9)

Enlargers
$K = 0.5\ (1 - d_1^2/d_2^2)$ (Ref. 1.1, Eq. 2-9)

To verify that the existing and/or selected motor for the pump is adequate, the following equation is used to estimate the required brake horsepower:

$BHP = Q\ h\ S / 3960\ \eta$ (Ref. 1.2, Eq. 15)

7. Analysis Results

The system head requirements for the Basin Water to UTRC System for the two pumps are tabulated in attachment 4. The results are graphically presented in Figures 9 and 10 for comparison.

Pump RETB-P-1 has a 40 hp motor. Based on the pump-system curve at a flow rate of 350 gpm the motor efficiency (η) is approximately 0.50 (Ref. 1.11). Therefore, the required brake horse power required is:

BHP = 350 * 158 * 1 / 3960 * 0.50
BHP = 28

Attachment 9.12

Calculation Continuation Sheet

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Pump RETB-P-2 has a 7.5 hp motor. Based on the pump-system curve at a flow rate of 175 gpm the motor efficiency (η) is approximately 0.50 (Ref. 1.12). Therefore, the required brake horse power required is:

BHP = 175 * 55 * 1 / 3960 * 0.50
BHP = 4.9

A backflow preventer (BFP) is required based on the tie-in point elevation to the TWL. By inspection of Figure 2, without the BFP, water would flow into the basin if the isolation valves are not closed.

8. Conclusions

Figure 9 shows the system-pump-bhp curves for the transfer route using RETB-P-1. From the data presented, it can be concluded:

- The operating point for this system is approximately 350 gpm.
- The existing motor will provide the necessary brake horse power for the above flow rate.
- When RETB-P-1 is used, flow will must be throttled using a discharge valve to meet the flow rate requirement range of 175 to 225 gpm (Input 4.2)

Figure 10 shows the system-pump-bhp curves for the transfer route using RETB-P-2.

- The operating point for this system is approximately 175 gpm.
- The existing motor will provide the necessary brake horse power for the above flow rate.

Based on the profile of the Treated Water Line in Figure 2, a back flow preventer is required to prevent the draining of treated water back into the basin.

Attachment 9.12

Calculation Continuation Sheet

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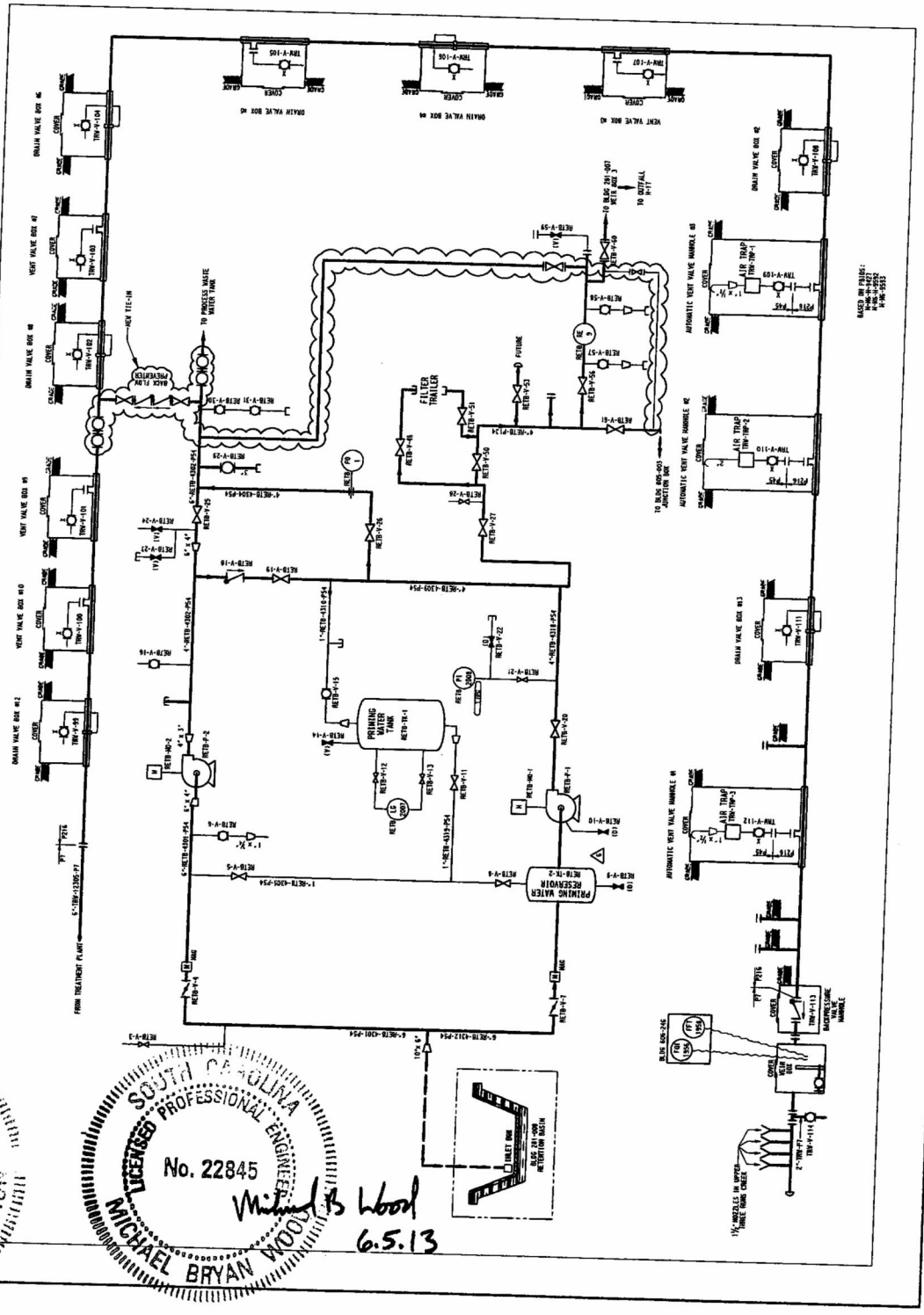
Figure 1
Proposed P&ID for Basin Water Tie-in to the Treated Water Line



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MICHAEL BRYAN WOOD

Michael B Wood
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Attachment 9.12

Calculation Continuation Sheet

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Figure 2
Treated Water Line Profile

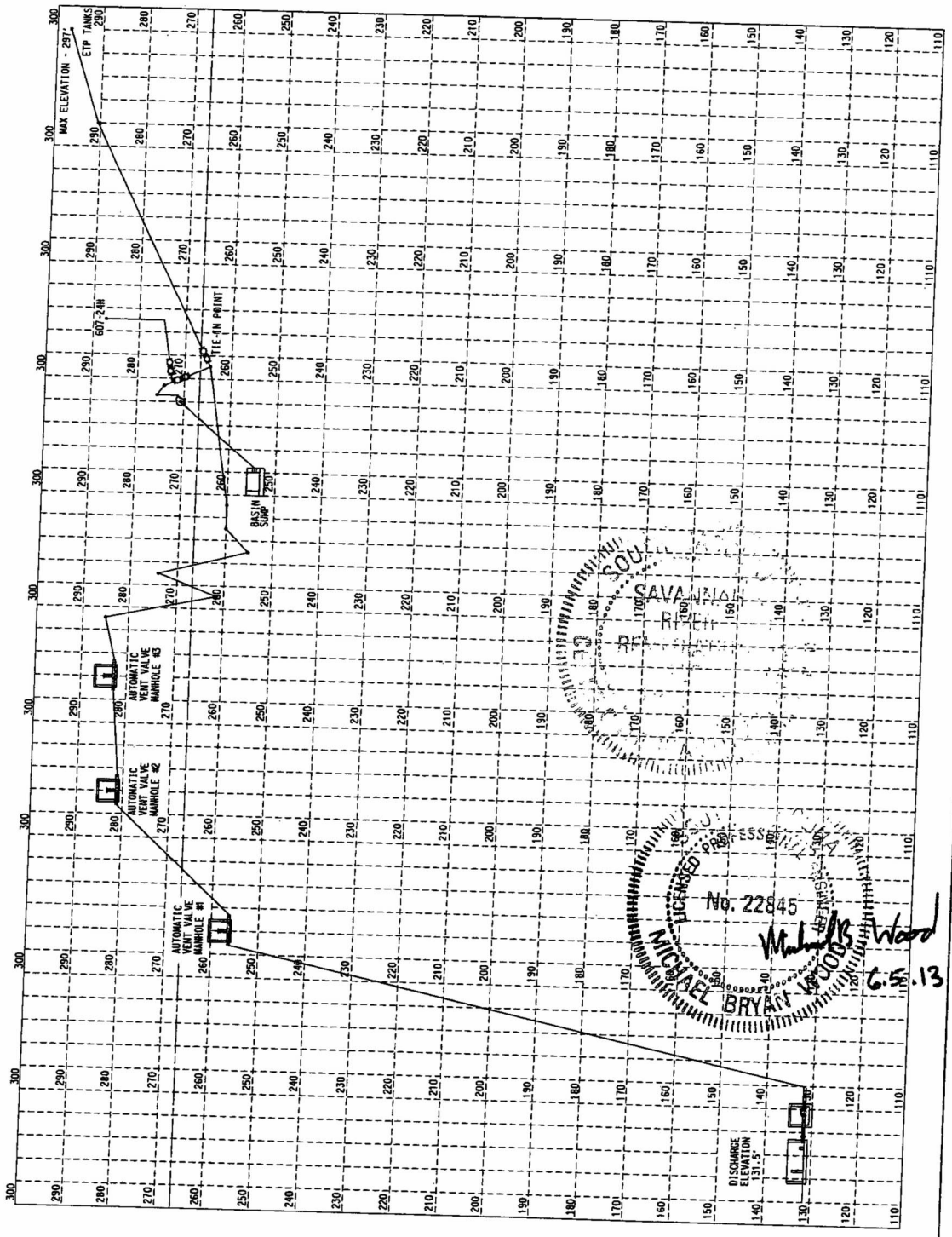

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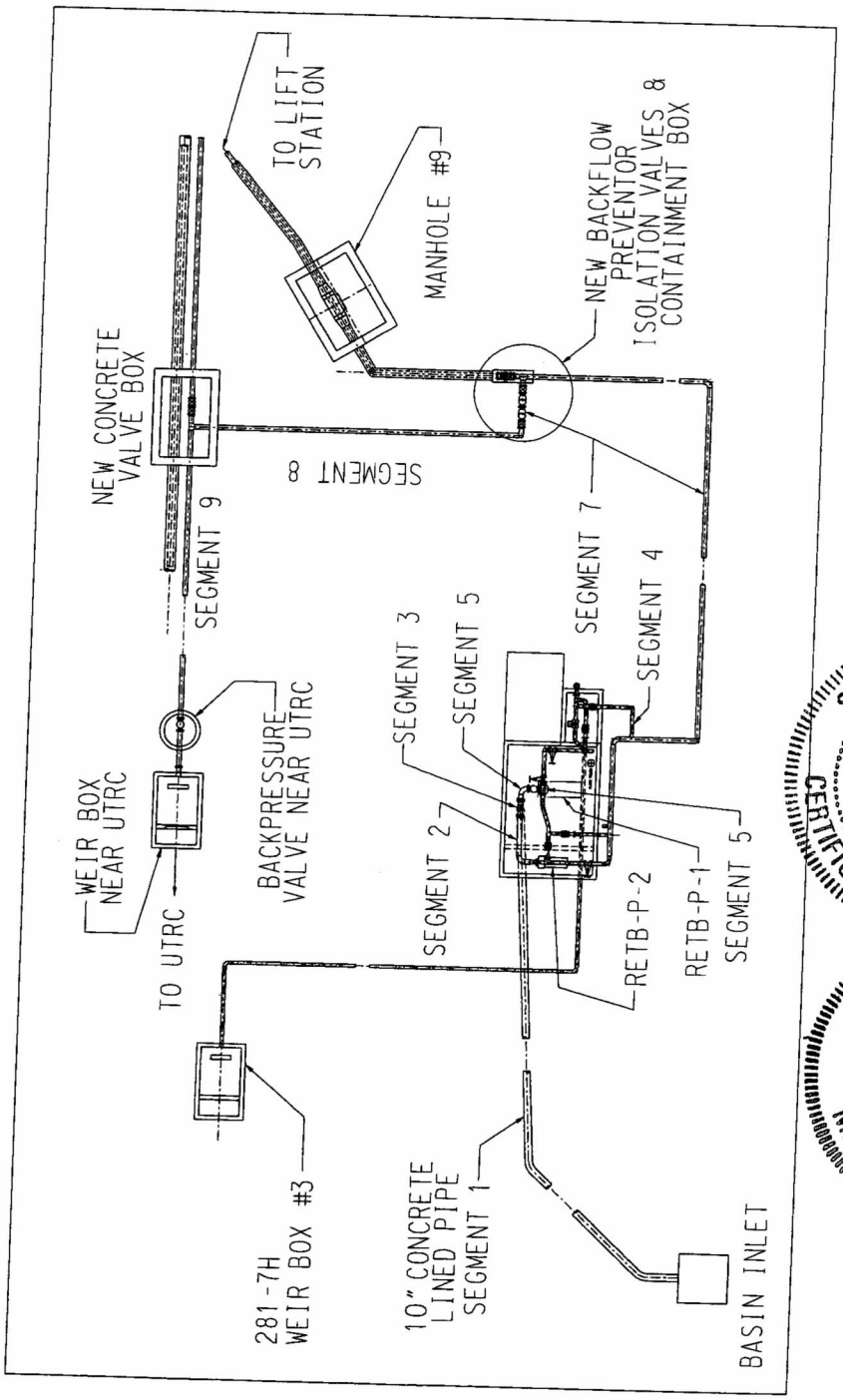
Figure 3
Over View of the Basin Water Flow Path



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Calculation Continuation Sheet

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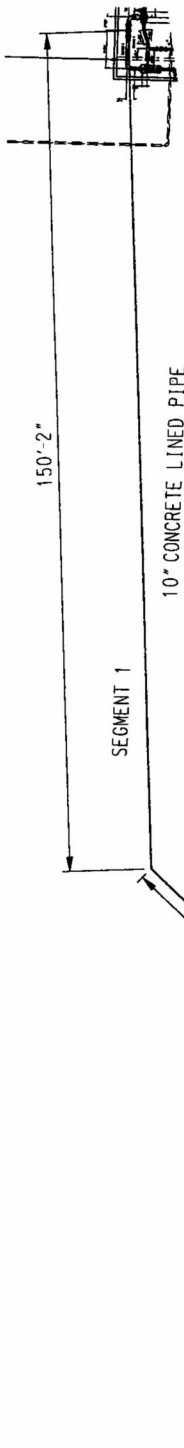
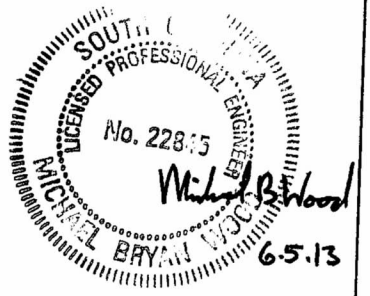
Figure 4
Piping Length from Basin to Pumps





Attachment 9.12

Calculation Continuation Sheet

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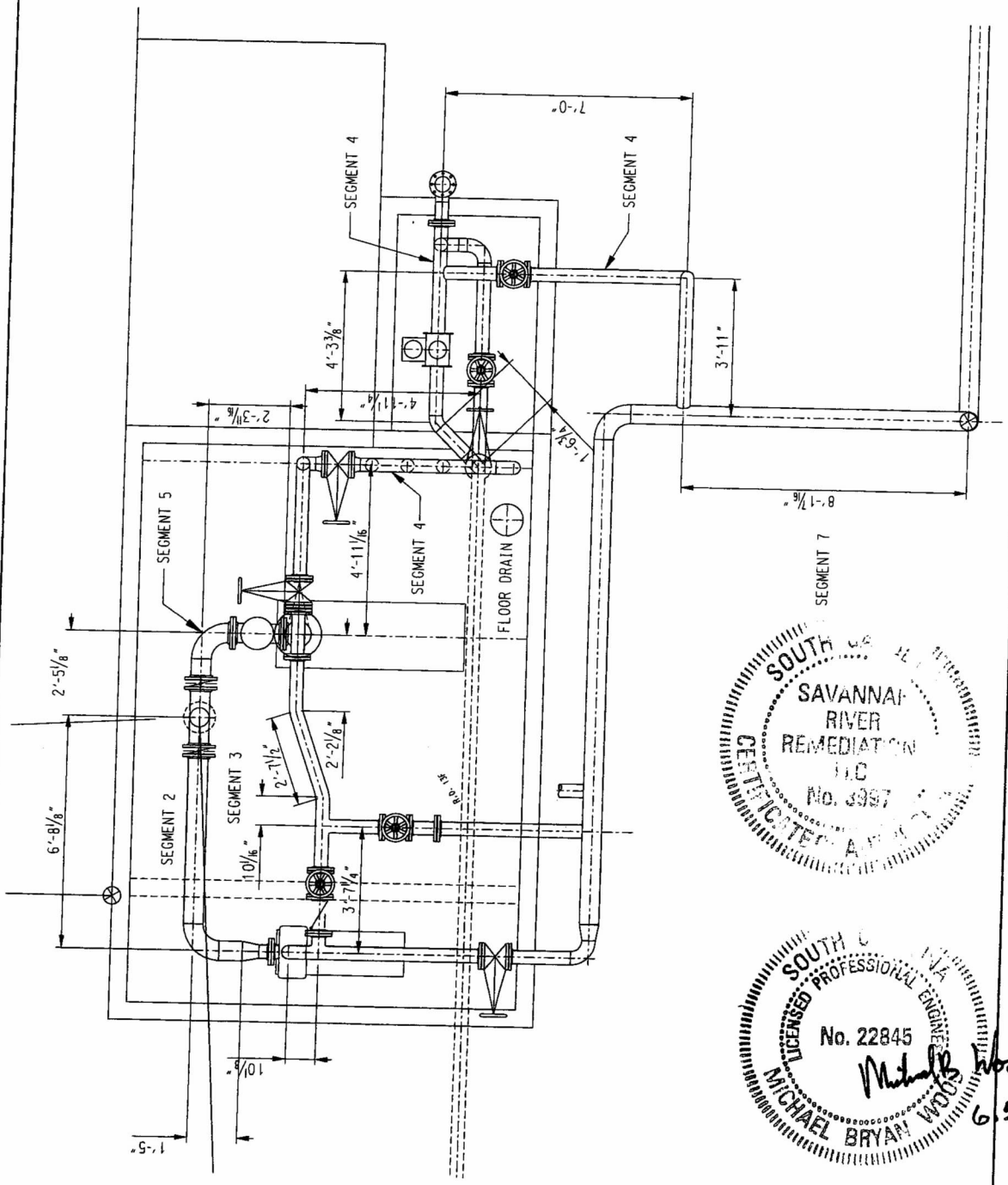
Figure 5
Piping Route at Pumps and to Line 4302



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6.5.13

Attachment 9.12
Calculation Continuation Sheet

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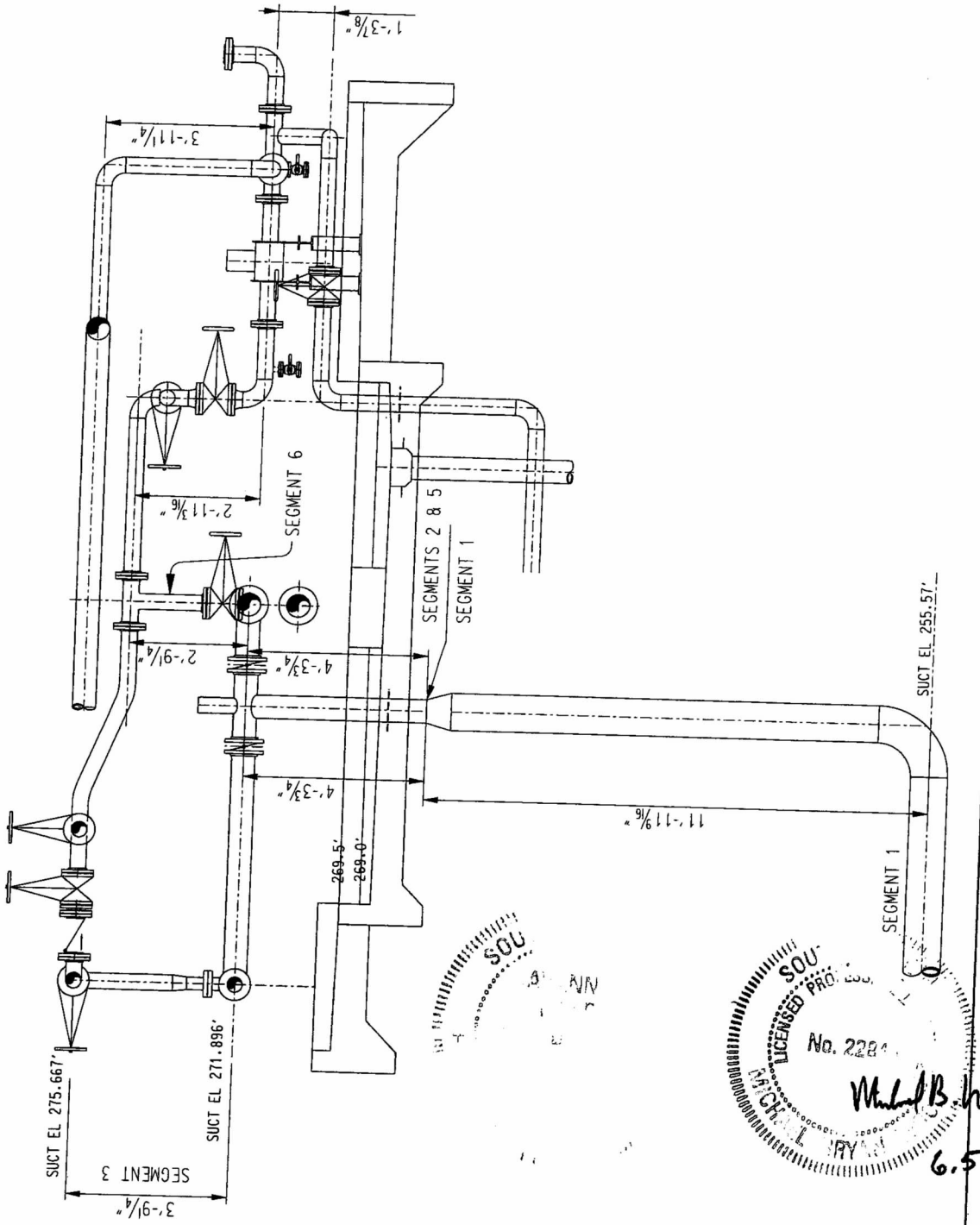
Figure 6
Elevation of Piping from Basin to Pumps



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Attachment 9.12

Calculation Continuation Sheet

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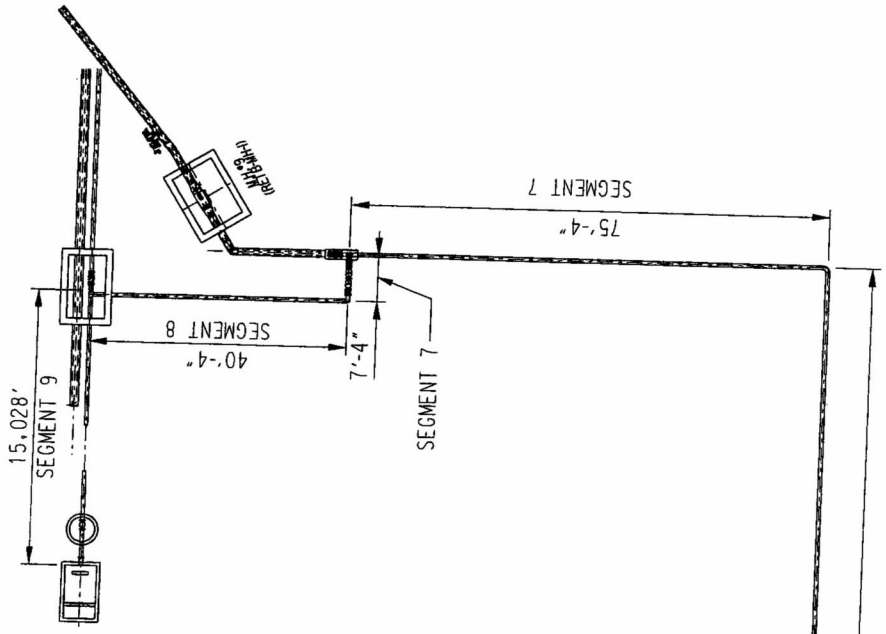
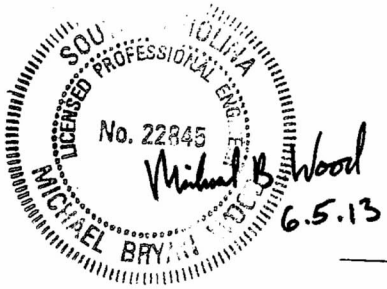
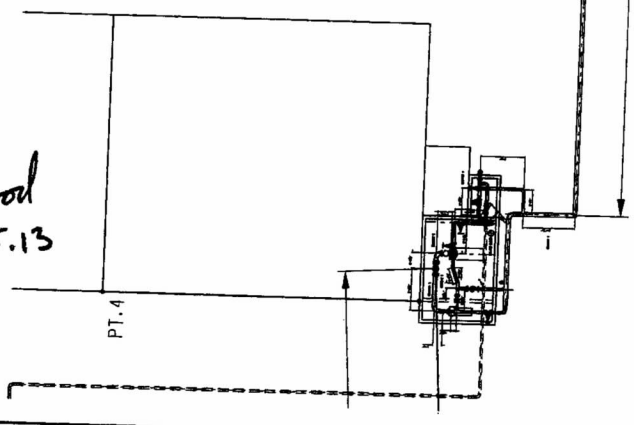
Figure 7
Line 4302 to Treated Water Line Tie-in Point







Attachment 9.12
Calculation Continuation Sheet

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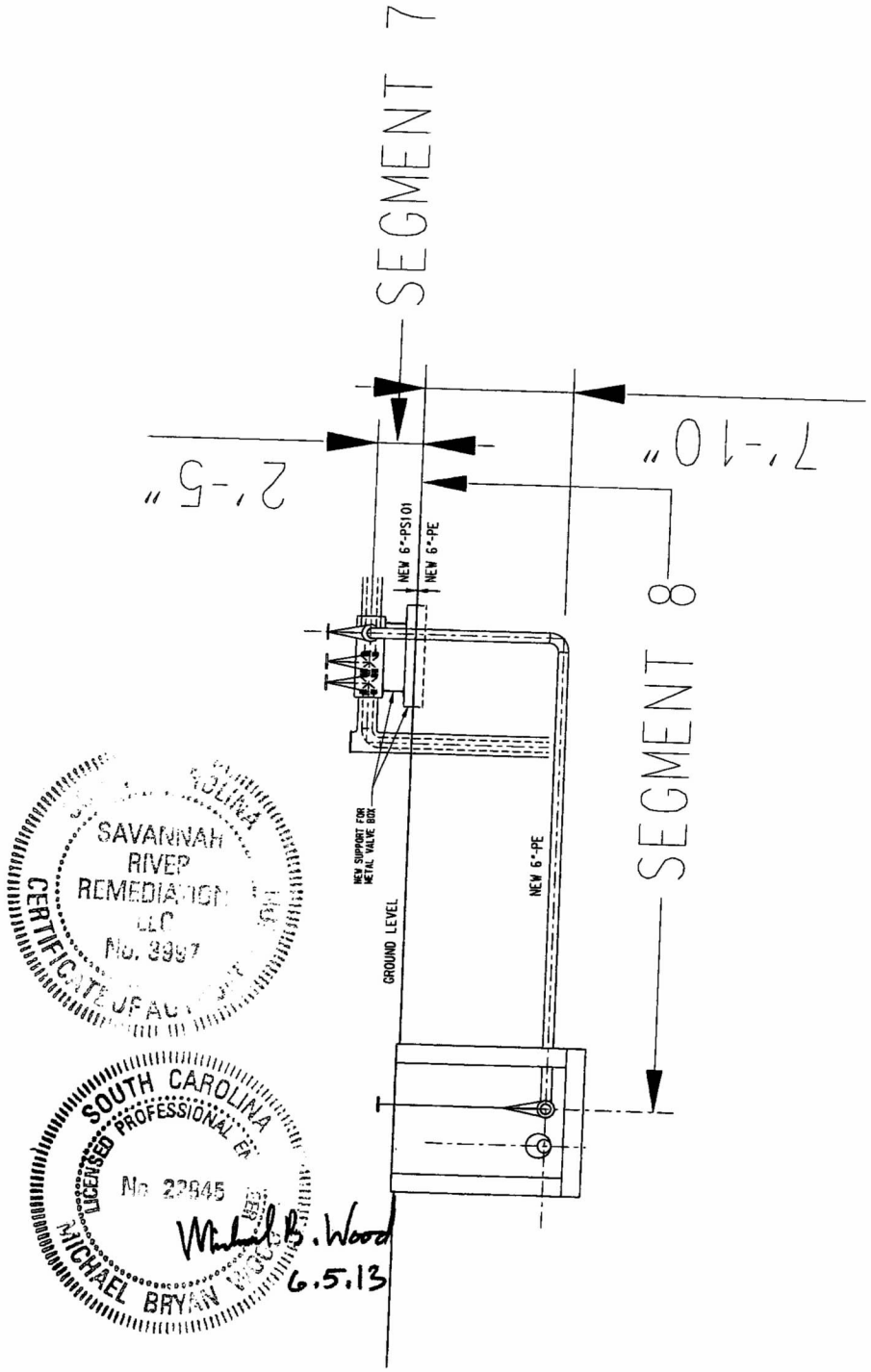
Figure 8
Elevation of Pipe Tie-in at Treated Water Line



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Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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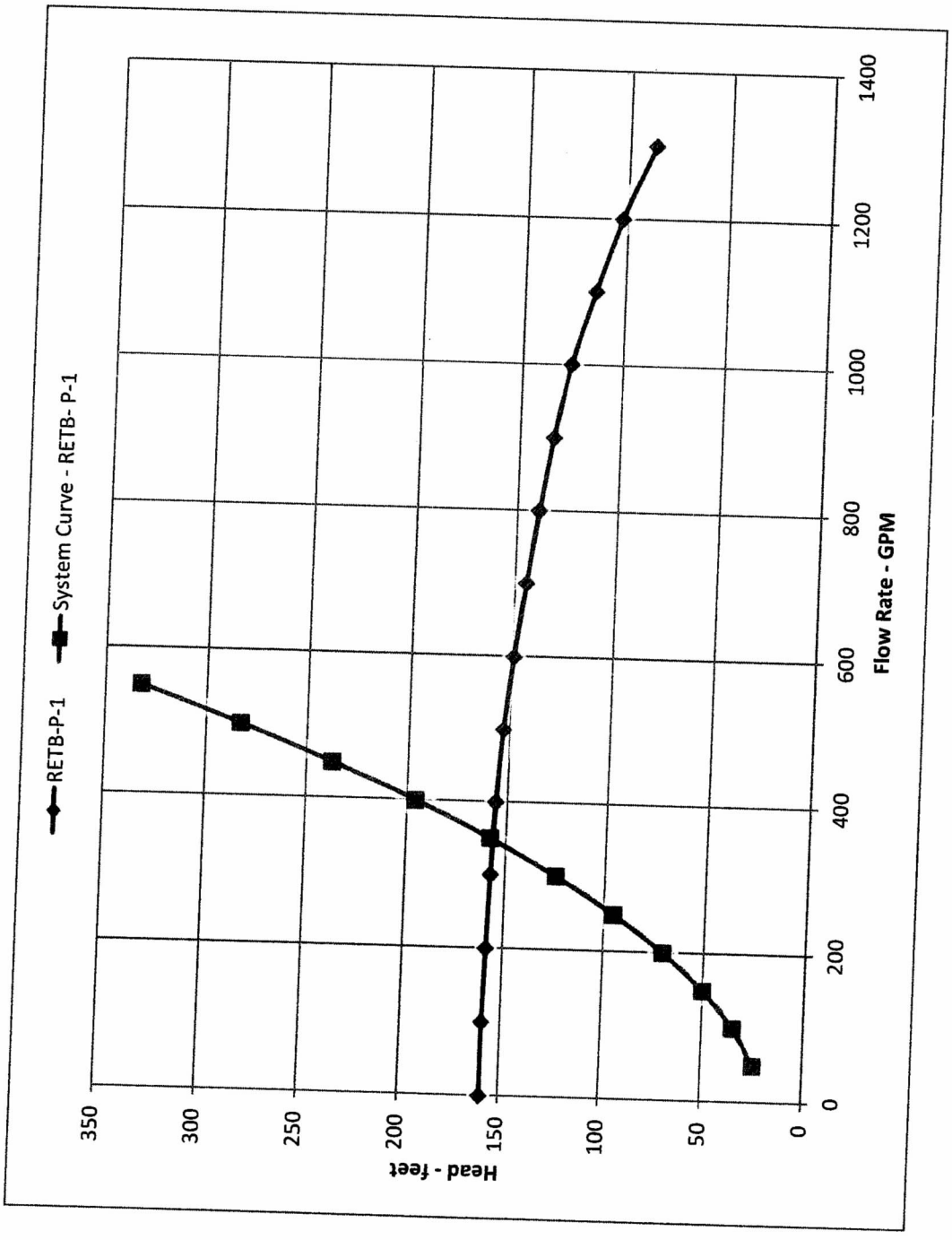
Figure 9
System-Pump Curve for the Transfer Route Using RETB-P-1



Attachment 9.12
Calculation Continuation Sheet

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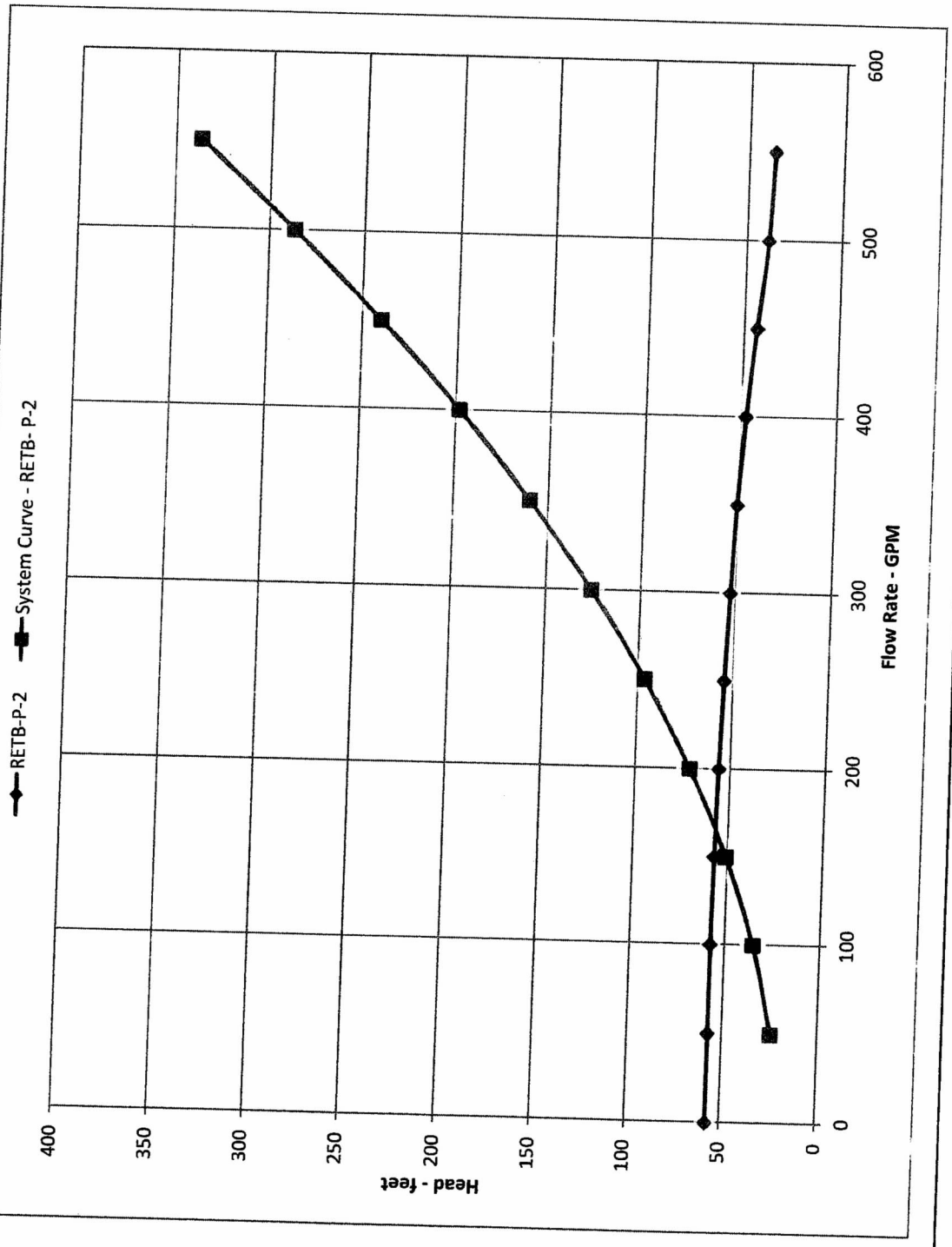
Figure 10
System-Pump Curve for the Transfer Route Using RETB-P-2



Attachment 9.12

Calculation Continuation Sheet

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Attachment 1
Nomenclature

A	Cross sectional area of pipe or orifice (ft^2)
a	Cross sectional area of pipe or orifice (in^2)
h_L	Friction head (ft)
h_v	Velocity head (ft)
h_S	Static head (ft)
h_T	Total Dynamic Head (ft)
g	Gravity acceleration constant (32.174 ft/sec^2)
f	Friction factor (Darcy)
h	Total Head (ft)
L	Length (ft)
V	Fluid velocity (ft/sec)
d	Pipe inside diameter (in)
D	Pipe inside diameter (ft)
K	Resistance coefficient
f_T	Friction factor in zone of complete turbulent flow
R_e	Reynolds Number
ρ	Density (lb_m/ft^3)
μ	Dynamic viscosity (cp)
Q	Rate of flow (gallons/min)
q	Rate of flow (ft^3/sec)
β	Ratio of small to large diameter in contractions or enlargements in pipes
ε	Absolute Roughness (ft)
η	Pump Efficiency
S	Specific Gravity
C	Flow coefficient for orifice
BHP	Brake Horse Power

Attachment 9.12
Calculation Continuation Sheet

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Attachment 2
Backflow Preventer Data

ES-709L

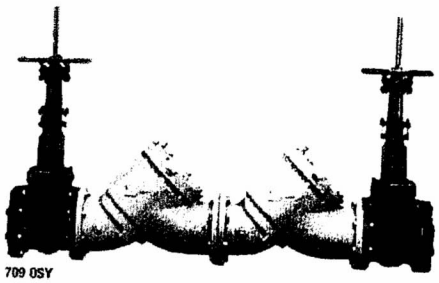
For Non-Health Hazard Applications

Job Name _____ Contractor _____
Job Location _____ Approval _____
Engineer _____ Contractor's P.O. No. _____
Approval _____ Representative _____

Series 709
Double Check Valve Assemblies

Sizes: 2½" – 10" (65 – 250mm)

Series 709 Double Check Valve Assemblies are designed to prevent the reverse flow of polluted water from entering into the potable water system. This series can be applied, where approved by the local authority having jurisdiction, on non-health hazard installations. Series 709 features a modular check design concept to facilitate easy maintenance. Check with local jurisdictional authority as to installation requirements.


709 OSY

Features

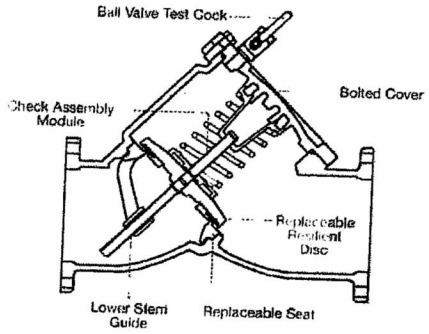
- Replaceable bronze seats
- Maximum flow at low pressure drop
- Design simplicity for easy maintenance
- No special tools required for servicing
- Captured spring assemblies for safety
- Approved for vertical flow up installation

Models

Suffix:
NRS – non-rising stem resilient seated gate valves
OSY – UL/FM outside stem and yoke resilient seated gate valves
S-FDA – FDA epoxy coated strainer
BB – bronze body - 2½" – 3" (64 – 76mm)
QT – quarter-turn ball valves
QT-FDA – FDA epoxy coated ball valve shutoffs
LF – without shutoff valves

Specifications

A Double Check Valve Assembly shall be installed at referenced cross-connections to prevent the backflow of polluted water into the potable water supply. The cross-connections shall be determined by local inspection authority for use where a high hazard situation does not exist. Valve shall feature modular check assemblies with center stem guiding. Each check module shall have a captured spring and be accessible through a bolted cover plate. Seats shall be replaceable without special tools. It shall be a complete assembly including tight-closing resilient seated shutoff valves, test cocks, and a strainer is recommended. The assembly shall meet the requirements of ASSE No. 1015; AWWA C510-92; CSA B64.5 and UL Classified File No. EX3185. Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California. Assembly shall be a Watts Regulator Company Series 709.



Check Assembly Module

Series 709 features a modular design concept which facilitates complete maintenance and assembly by retaining the spring load. Also, the first and second check module are identical and can be interchanged.

***IMPORTANT:** INQUIRE WITH GOVERNING AUTHORITIES FOR LOCAL INSTALLATION REQUIREMENTS*

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Watts product specifications in U.S. customary units are used in the BF series. Metric units are provided for reference only. For precise measurements, please contact Watts Technical Service. Watts reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Watts products previously or subsequently sold.

WATTS®

Attachment 9.12
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Attachment 2
Backflow Preventer Data
(continued)

Materials
Check Valve Bodies: Epoxy coated cast iron
Seats: Bronze

Pressure — Temperature
Temperatures Range: 33°F – 110°F (0.5°C – 43°C) continuous, 140°F (60°C) intermittent
Maximum Working Pressure: 175psi (12.1 bar)

Standards
AWWA C510-92
IAPMO PA 31
USC Manual for Cross-Connection Control, 8th Edition

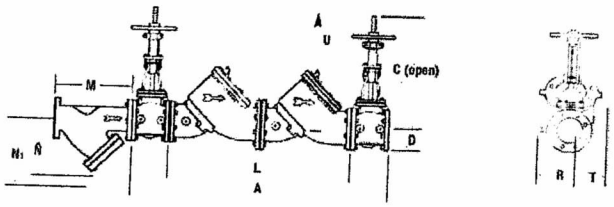
Approvals
1015 B64.5

Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California. Sizes 4" – 10" (100 – 250mm) approved horizontal and vertical "flow up" Size 2½" and 3" (65 – 80mm) approved horizontal only.

Factory Mutual approved 4" – 10" (80 – 250mm) vertical "flow up" with OSY gate valves only.

Note: Model "S" not listed

Dimensions — Weights



SIZE (DN)	DIMENSIONS													
in.	mm	A in.	A mm	C (OSY) in.	C (OSY) mm	C (NRS) in.	C (NRS) mm	D in.	D mm	L in.	L mm	U* in.	U* mm	M in.	M mm	N in.	N mm
2½	65	39	1000	16½	416	9⅜	238	3½	89	24⅛	613	11	279	10	254	6½	165
3	80	40	1025	16½	479	10¼	260	3¾	95	24⅛	613	14	356	10⅛	257	7	178
4	100	52	1330	22¾	578	12⅜	310	4½	114	34⅛	867	14	356	12⅛	308	8½	210
6	150	62½	1597	30⅛	765	16	406	5½	140	41⅛	1057	16	406	18½	470	13½	343
8	200	75	1905	37½	959	19⅞	505	6½	165	52	1321	21	533	21½	549	15½	394
10	250	90	2286	45¾	1162	23¾	605	8	203	64	1626	25	635	26	660	18½	470

SIZE (DN)	DIMENSIONS								WEIGHT						STRAINER	
	R††		R		R◆		T		NRS		OSY		QT		Weight	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kgs.	lbs.	kgs.	lbs.	kgs.	lbs.	kgs.
2½	65	10	254	4	102	16	406	3	76	167	76	170	77	154	70	28	13
3	80	10	254	5	127	16	406	3	76	167	76	170	77	162	73	34	15
4	100	12	305	6	152	19¾	502	6	152	366	167	383	174	275	125	60	27
6	150	20	508	11	279	26	660	7½	191	627	284	707	321	611	277	122	55
8	200	22¾	576	11¼	286	11¼	286	9	229	1201	545	1307	593	1419	644	247	112
10	250	28	711	12½	318	12½	318	10¼	260	2003	909	2073	940	2466	1119	370	168

† - Dimension required for screen removal. ◆Quarter-turn (QT) valve dimensions.
*Service clearance for check assembly from center.

Attachment 9.12
Calculation Continuation Sheet

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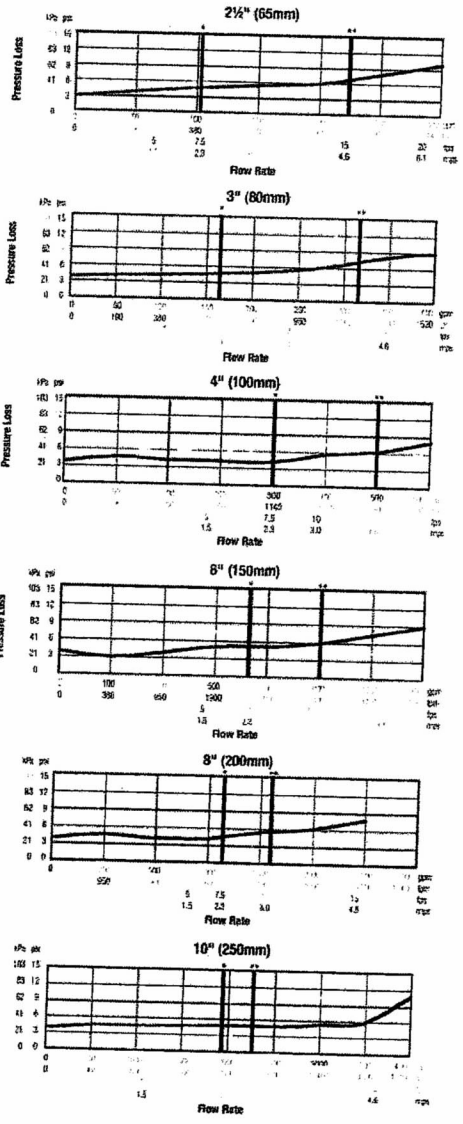
Attachment 2
Backflow Preventer Data
(continued)

Capacity

*Typical maximum system flow rate (7.5 feet/sec.) **UL rated flow



Attachment 9.12

Calculation Continuation Sheet

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Attachment 3
Head Loss Calculation

A	B	C	D	E	F	G	H	I	J	K	L	M
2	Basin Water											
3	ρ =	62.38 lbs$_m$/ft^3										
4	μ =	1.004 cP										
5	Segment 1 - 10" Sch 40S, CLP											
6	ε =	0.01 ft										
7	d =	9.520 inches										
8	D =	0.7933 feet										
9	L =	280.88 feet										
10	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
11	v (fps) =	0.23	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.48
12	R_e =	16,512	33,024	49,535	66,047	82,559	99,071	115,583	132,095	148,606	165,118	181,630
13	f =	0.0293	0.0258	0.0243	0.0235	0.0229	0.0225	0.0222	0.0220	0.0218	0.0216	0.0215
14												
15	h_L Pipe (ft) =	0.01	0.03	0.06	0.10	0.16	0.23	0.30	0.39	0.49	0.60	0.73
16	h_L Fittings (ft) =	0.00	0.01	0.02	0.03	0.04	0.06	0.08	0.11	0.14	0.17	0.21
17	Total h_L (ft) =	0.01	0.04	0.08	0.13	0.20	0.29	0.39	0.50	0.63	0.77	0.93

O	P	Q	R
Segment 1 - 10" Sch 40S, CLP			
Fittings	K-multiple	Number	Sub-total
90° Standard Elbow	30	1	30.0
45° Standard Elbow	16	2	32.0
		Total	62.0

O	P	Q	R
Segment 1 - 10" Sch 40S, CLP			
Fittings	K-factor	Number	Sub-total
Entrance, sharp edged	0.5	1	0.5
Reducer 10x6	0.317	1	0.317
		Total	0.8

A	B	C	D	E	F	G	H	I	J	K	L	M
28	Segment 2 - 6-inch CSP Sch 40S - P-2											
29	ε =	0.00015 ft										
30	d =	6.065 inches										
31	D =	0.5054 feet										
32	L =	12.41 feet										
33	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
34	v (fps) =	0.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.55	6.11
35	R_e =	25,918	51,836	77,754	103,672	129,590	155,508	181,426	207,344	233,262	259,180	285,098
36	f =	0.0242	0.0207	0.0189	0.0179	0.0171	0.0165	0.0160	0.0156	0.0153	0.0150	0.0148
37												
38	h_L Pipe (ft) =	0.00	0.01	0.02	0.03	0.05	0.07	0.09	0.12	0.15	0.18	0.21
39	h_L Fittings (ft) =	0.02	0.06	0.12	0.21	0.31	0.43	0.57	0.73	0.91	1.10	1.32
40	Total h_L (ft) =	0.02	0.07	0.14	0.24	0.36	0.50	0.66	0.85	1.05	1.28	1.53

O	P	Q	R
Segment 2 - 6-inch CSP Sch 40S - P-2			
Fittings	K-multiple	Number	Sub-total
Butterfly Valve	45	1	45.0
90° Standard Elbow	30	1	30.0
Standard Tee, FTB	60	1	60.0
		Total	135.0

O	P	Q	R
Segment 2 - 6-inch CSP Sch 40S - P-2			
Fittings	K-factor	Number	Sub-total
Reducer 6x4	0.280	1	0.280
		Total	0.3

A	B	C	D	E	F	G	H	I	J	K	L	M
48	Segment 3 - 4-inch CSP Sch 40S - P-2											
49	ε =	0.00015 ft										
50	d =	4.026 inches										
51	D =	0.3355 feet										
52	L =	13.86 feet										
53	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
54	v (fps) =	1.26	2.52	3.78	5.04	6.30	7.56	8.82	10.08	11.34	12.60	13.86
55	R_e =	39,044	78,089	117,133	156,177	195,222	234,266	273,311	312,355	351,399	390,444	429,488
56	f =	0.0221	0.0190	0.0175	0.0166	0.0159	0.0154	0.0150	0.0147	0.0144	0.0142	0.0140
57												
58	h_L Pipe (ft) =	0.02	0.08	0.16	0.27	0.41	0.57	0.75	0.96	1.19	1.44	1.72
59	h_L Fittings (ft) =	0.07	0.24	0.51	0.85	1.29	1.80	2.39	3.06	3.80	4.62	5.52
60	Total h_L (ft) =	0.09	0.32	0.67	1.12	1.69	2.36	3.14	4.01	4.99	6.07	7.24

O	P	Q	R
Segment 3 - 4-inch CSP Sch 40S - P-2			
Fittings	K-multiple	Number	Sub-total
Gate Valve	8	1	8.0
Swing Check Valve (flanged)	50	1	50.0
90° Standard Elbow	30	1	30.0
45° Standard Elbow	16	2	32.0
Standard Tee, FTR	20	2	40.0
Standard Tee, FTB	60	1	60.0
		Total	120.0

O	P	Q	R
Segment 3 - 4-inch CSP Sch 40S - P-2			
Fittings	K-factor	Number	Sub-total
Enlarger 4x3	0.176	1	0.176
		Total	0.176

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Attachment 3
Head Loss Calculation

A	B	C	D	E	F	G	H	I	J	K	L	M
69	**Segment 4 - 6-inch CSP Sch 40S**											
70	ε =	0.00015 ft										
71	d =	6.065 inches										
72	D =	0.5054 feet										
73	L =	33.49 feet										
74	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
75	v (fps) =	0.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.55	6.11
76	R_e =	25,918	51,836	77,754	103,672	129,590	155,508	181,426	207,344	233,262	259,180	285,098
77	f =	0.0242	0.0207	0.0189	0.0179	0.0171	0.0165	0.0160	0.0156	0.0153	0.0150	0.0148
78												
79	h_L Pipe (ft) =	0.01	0.03	0.05	0.09	0.14	0.19	0.25	0.32	0.39	0.48	0.57
80	h_L Fittings (ft) =	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81	Total h_L (ft) =	0.01	0.03	0.05	0.09	0.14	0.19	0.25	0.32	0.39	0.48	0.57

O	P	Q	R
Segment 4 - 6-inch CSP Sch 40S			
Fittings	K-multiple	Number	Sub-total
Gate Valve	8	4	32.0
90° Standard Elbow	30	5	150.0
45° Standard Elbow	16	1	16.0
Standard Tee, FTB	60	3	180.0
		Total	378.0

A	B	C	D	E	F	G	H	I	J	K	L	M
92	**Segment 5 - 6-inch Sch 40S - P-1**											
93	ε =	0.00015 ft										
94	d =	6.065 inches										
95	D =	0.5054 feet										
96	L =	6.74 feet										
97	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
98	v (fps) =	0.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.55	6.11
99	R_e =	25,918	51,836	77,754	103,672	129,590	155,508	181,426	207,344	233,262	259,180	285,098
100	f =	0.0242	0.0207	0.0189	0.0179	0.0171	0.0165	0.0160	0.0156	0.0153	0.0150	0.0148
101												
102	h_L Pipe (ft) =	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.10	0.11
103	h_L Fittings (ft) =	0.03	0.10	0.21	0.35	0.52	0.72	0.96	1.22	1.51	1.83	2.18
104	Total h_L (ft) =	0.03	0.11	0.22	0.37	0.55	0.76	1.01	1.28	1.59	1.93	2.29

O	P	Q	R
Segment 5 - 6-inch Sch 40S - P-1			
Fittings	K-multiple	Number	Sub-total
Butterfly Valve	45	1	45.0
90° Standard Elbow	30	1	30.0
Tee, FTB	60	3	180.0
		Total	255.0

A	B	C	D	E	F	G	H	I	J	K	L	M
112	**Segment 6 - 4-inch CSP Sch 40S - P-1**											
113	ε =	0.00015 ft										
114	d =	4.026 inches										
115	D =	0.3355 feet										
116	L =	2.77 feet										
117	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
118	v (fps) =	1.26	2.52	3.78	5.04	6.30	7.56	8.82	10.08	11.34	12.60	13.86
119	R_e =	39,044	78,089	117,133	156,177	195,222	234,266	273,311	312,355	351,399	390,444	429,488
120	f =	0.0221	0.0190	0.0175	0.0166	0.0159	0.0154	0.0150	0.0147	0.0144	0.0142	0.0140
121												
122	h_L Pipe (ft) =	0.00	0.02	0.03	0.05	0.08	0.11	0.15	0.19	0.24	0.29	0.34
123	h_L Fittings (ft) =	0.01	0.02	0.05	0.09	0.13	0.18	0.24	0.31	0.38	0.46	0.55
124	Total h_L (ft) =	0.01	0.04	0.08	0.14	0.21	0.29	0.39	0.50	0.62	0.75	0.89

N	O	P	Q	R
112	**Segment 6 - 4-inch CSP Sch 40S - P-1**			
113	Fittings	K-multiple	Number	Sub-total
114	Gate Valve	8	1	8.0
115	Standard Tee, FTB	60	1	60.0
116			Total	68.0

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Attachment 3
Head Loss Calculation

A	B	C	D	E	F	G	H	I	J	K	L	M
125	**Segment 7 - 6-inch CSP Sch 40S**											
126	ε =	0.00015 ft										
127	d =	6.065 inches										
128	D =	0.5054 feet										
129	L =	257.24 feet										
130	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
131	v (fps) =	0.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.55	6.11
132	R_e =	25,918	51,836	77,754	103,672	129,590	155,508	181,426	207,344	233,262	259,180	285,098
133	f =	0.0242	0.0207	0.0189	0.0179	0.0171	0.0165	0.0160	0.0156	0.0153	0.0150	0.0148
134												
135	h_L Pipe (ft) =	0.06	0.20	0.42	0.70	1.04	1.45	1.91	2.44	3.02	3.66	4.35
136	h_L Fittings (ft) =	0.03	0.09	0.20	0.33	0.49	0.68	0.90	1.15	1.42	1.72	2.05
137	h_L BFP (ft) =	12.69	12.69	12.69	12.69	12.69	12.69	12.69	12.69	12.69	12.69	12.69
138	Total h_L (ft) =	12.77	12.98	13.30	13.71	14.22	14.82	15.50	16.27	17.13	18.07	19.09

O	P	Q	R
Segment 7 - 6-inch CSP Sch 40S			
Fittings	K-multiple	Number	Sub-total
90° Standard Elbow	30	2	60.0
Standard Tee, FTB	60	3	180.0
		Total	240.0

A	B	C	D	E	F	G	H	I	J	K	L	M
152	**Segment 8 - 6-inch PE Sch 40S**											
153	ε =	0.000005 ft										
154	d =	5.845 inches										
1555	D =	0.4871 feet										
156	L =	48.17 feet										
157	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
158	v (fps) =	0.60	1.20	1.79	2.39	2.99	3.59	4.19	4.78	5.38	5.98	6.58
159	R_e =	26,894	53,787	80,681	107,574	134,468	161,361	188,255	215,148	242,042	268,935	295,829
160	f =	0.0240	0.0204	0.0187	0.0176	0.0168	0.0162	0.0157	0.0153	0.0150	0.0147	0.0144
161												
162	h_L Pipe (ft) =	0.01	0.04	0.09	0.15	0.23	0.32	0.42	0.54	0.66	0.80	0.96
163	h_L Fittings (ft) =	0.01	0.04	0.07	0.12	0.18	0.25	0.33	0.42	0.52	0.63	0.75
164	Total h_L (ft) =	0.02	0.08	0.16	0.28	0.41	0.57	0.75	0.96	1.19	1.44	1.71

O	P	Q
Segment 8 - 6-inch PE Sch 40S		
Fittings	K-multiple	Number
90° Standard Elbow	30	1
Standard Tee, FTB	60	1
		Total

A	B	C	D	E	F	G	H	I	J	K	L	M
172	**Segment 9 - 6-inch PE Sch 40S**											
173	ε =	0.000005 ft										
174	d =	5.845 inches										
175	D =	0.4871 feet										
176	L =	15,027.69 feet										
177	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
178	v (fps) =	0.60	1.20	1.79	2.39	2.99	3.59	4.19	4.78	5.38	5.98	6.58
179	R_e =	26,894	53,787	80,681	107,574	134,468	161,361	188,255	215,148	242,042	268,935	295,829
180	f =	0.0240	0.0204	0.0187	0.0176	0.0168	0.0162	0.0157	0.0153	0.0150	0.0147	0.0144
181												
182	h_L Pipe (ft) =	4.10	13.97	28.76	48.14	71.86	99.76	131.72	167.64	207.43	251.02	298.35
183	h_L Fittings (ft) =	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00	135.00
184	Total h_L (ft) =	139.10	148.97	163.76	183.14	206.86	234.76	266.72	302.64	342.43	386.02	433.35

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Calculation Continuation Sheet

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Attachment 4
Summary of Head Loss

A	B	C	D	E	F	G	H	I	J	K	L	M
191	**System Curve - RETB- P-1**											
192	Summary of h_L (ft)											
193	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
194	Total hL (ft) Segment 1 =	0.01	0.04	0.08	0.13	0.20	0.29	0.39	0.50	0.63	0.77	0.93
195	Total hL (ft) Segment 5 =	0.03	0.11	0.22	0.37	0.55	0.76	1.01	1.28	1.59	1.93	2.29
196	Total hL (ft) Segment 6 =	0.01	0.04	0.08	0.14	0.21	0.29	0.39	0.50	0.62	0.75	0.89
197	Total hL (ft) Segment 7 =	12.77	12.98	13.30	13.71	14.22	14.82	15.50	16.27	17.13	18.07	19.09
198	Total hL (ft) Segment 8 =	0.02	0.08	0.16	0.28	0.41	0.57	0.75	0.96	1.19	1.44	1.71
199	Total hL (ft) Segment 9 =	139.10	148.97	163.76	183.14	206.86	234.76	266.72	302.64	342.43	386.02	433.35
200	h_L Static (ft) =	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75
201	h_L Pressure (ft) =	0	0	0	0	0	0	0	0	0	0	0
202	h_L Velocity (ft) =	0	0	0	0	0	0	0	0	0	0	0
203	Total h_L (ft)	24.20	34.46	49.86	70.02	94.70	123.74	157.02	194.41	235.84	281.24	330.52

A	B	C	D	E	F	G	H	I	J	K	L	M
209	**System Curve - RETB- P-2**											
210	Summary of h_L (ft)											
211	Q (gpm) =	50	100	150	200	250	300	350	400	450	500	550
212	Total hL (ft) Segment 1 =	0.01	0.04	0.08	0.13	0.20	0.29	0.39	0.50	0.63	0.77	0.93
213	Total hL (ft) Segment 2 =	0.02	0.07	0.14	0.24	0.36	0.50	0.66	0.85	1.05	1.28	1.53
214	Total hL (ft) Segment 3 =	0.09	0.32	0.67	1.12	1.69	2.36	3.14	4.01	4.99	6.07	7.24
215	Total hL (ft) Segment 4 =	0.01	0.03	0.05	0.09	0.14	0.19	0.25	0.32	0.39	0.48	0.57
216	Total hL (ft) Segment 7 =	12.77	12.98	13.30	13.71	14.22	14.82	15.50	16.27	17.13	18.07	19.09
217	Total hL (ft) Segment 8 =	0.02	0.08	0.16	0.28	0.41	0.57	0.75	0.96	1.19	1.44	1.71
218	Total hL (ft) Segment 9 =	139.10	148.97	163.76	183.14	206.86	234.76	266.72	302.64	342.43	386.02	433.35
219	h_L Static (ft) =	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75	-127.75
220	h_L Pressure (ft) =	0	0	0	0	0	0	0	0	0	0	0
221	h_L Velocity (ft) =	0	0	0	0	0	0	0	0	0	0	0
222	Total h_L (ft)	24.28	34.73	50.42	70.96	96.13	125.74	159.67	197.81	240.07	286.38	336.67

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Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

	B	C	D	E
2	**Fluid Properties**	μ (cP)	SG	ρ (lbm/ft³)
3	Water @ 68°F / 20°C	1.004	1.0	62.38
4	Water @ 104°F / 40°C	0.6529	0.9922	61.95
5				
6	**Friction Factors (f_T)**			
7	8 to 10-inch NPS Pipe	0.014		
8	6-inch NPS Pipe	0.015		
9	4-inch NPS Pipe	0.017		
10				
11	Aboslute roughness (ε) pipe - CSP	0.00015	ft	
12	Aboslute roughness (ε) pipe - CLP	0.01	ft	
13	Aboslute roughness (ε) pipe - PE	0.000005	ft	
14				
15	Pipe Data	OD	ID	
16	10-inch 40S Cement Lined Pipe - in.	10.75	9.520	
17	10-inch 40S Pipe - in.	10.75	10.020	
18	8-inch 40S Pipe - in.	8.625	7.981	
19	6-inch 40S Pipe - in.	6.625	6.065	
20	6-inch PE Pipe - in.	6.625	5.845	
21	4-inch 40S Pipe - in.	4.500	4.026	
22	3-inch 40S Pipe - in.	3.500	3.068	
23				
24	**Flow Rate Range - gpm**	50	100	150
25				
26	10" Sump suction elevation	254.05 ft		
27	Min basin level elevation	259.50 ft		
28	Max basin level elevation	270.00 ft		
29	Max basin operating elevation	266.00 ft		
30	Pump P-2 suction elevation (170-10)	271.90 ft		
31	Pump P-1 suction elevation (EP-100H)	271.90 ft		
32	4" Pipe Elevation Line - 4302 (max)	275.33 ft		
33	6" Pipe Elevation Line - 4302 (max)	275.53 ft		
34	High Point elevation	284.75 ft		
35	Max elevation (estimated)	297.00 ft		
36	Discharge elevation	131.75 ft		

F	G	H	I	J	K	L	M
200	250	300	350	400	450	500	550

Attachment 9.12
Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

A41	B	C	D	E	F
42	**Pipe Segment**	**Total**			
43	**Segment 1 - 10" Sch 40S, CLP**	**Total**	**W238897**	**W238978**	**W239022**
44	Pipe (ft)	280.88	268.92		11.96
45	90° Standard Elbow	1			1
46	45° Standard Elbow	2	2		
47	Entrance, sharp edged	1	1		
48	Reducer 10x6	1			1
49	**Segment 2 - 6-inch CSP Sch 40S - P-2**	**Total**	**W239022**	**W814332**	**& Figures 5 & 6**
50	Pipe (ft)	12.41	4.31	8.09	
51	Butterfly Valve	1		1	
52	90° Standard Elbow	1		1	
53	Standard Tee, FTB	1		1	
54	Reducer 6x4	1		1	
55	**Segment 3 - 4-inch CSP Sch 40S - P-2**	**Total**	**W814332**	**& Figures 5 & 6**	
56	Pipe (ft)	13.86	13.86		
57	Enlarger 4x3	1	1		
58	Gate Valve	1	1		
59	Swing Check Valve (flanged)	1	1		
60	90° Standard Elbow	1	1		
61	45° Standard Elbow	2	2		
62	Standard Tee, FTR	2	2		
63	Standard Tee, FTB	1	1		
64	**Segment 4 - 6-inch CSP Sch 40S**	**Total**	**W814332**	**& Figures 5 & 6**	
65	Pipe (ft)	33.49	33.49		
66	Gate Valve	4	4		
67	90° Standard Elbow	5	5		
68	45° Standard Elbow	1	1		
69	Standard Tee, FTB	3	3		
70	**Segment 5 - 6-inch Sch 40S - P-1**	**Total**	**W239022**	**W814332**	**& Figures 5 & 6**
71	Pipe (ft)	6.74	4.31	2.43	
72	Butterfly Valve	1		1	
73	90° Standard Elbow	1		1	
74	Tee, FTB	3		3	
75	**Segment 6 - 4-inch CSP Sch 40S - P-1**	**Total**	**W814332**	**& Figures 5 & 6**	
76	Pipe (ft)	2.77	2.77		
77	Gate Valve	1	1		
78	Standard Tee, FTB	1	1		
79	**Segment 7 - 6-inch CSP Sch 40S**	**Total**	**W814332**	**& Figures 7 & 8**	
80	Pipe (ft)	257.24	257.24		
81	90° Standard Elbow	2	2		
82	Standard Tee, FTB	3	3		
83	Backflow Preventer	1	1		
84	**Segment 8 - 6-inch PE Sch 40S**	**Total**	**W814332**	**& Figures 7 & 8**	
85	Pipe (ft)	48.17	48.17		
86	90° Standard Elbow	1	1		
87	Standard Tee, FTB	1	1		
88	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816274**		
89	Pipe (ft)	762.69	762.69		
90	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816273**		
91	Pipe (ft)	1500.00	1500.00		
92	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816272**		
93	Pipe (ft)	1500.00	1500.00		
94	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816271**		
95	Pipe (ft)	1500.00	1500.00		
96	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816270**		
97	Pipe (ft)	1500.00	1500.00		
98	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816269**		
99	Pipe (ft)	1500.00	1500.00		
100	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816268**		
101	Pipe (ft)	1400.00	1400.00		
102	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816267**		
103	Pipe (ft)	1500.00	1500.00		
104	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816266**		
105	Pipe (ft)	1500.00	1500.00		
106	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816265**		
107	Pipe (ft)	1400.00	1400.00		
108	**Segment 9 - 6-inch PE Sch 40S**	**Total**	**W816264**	**D186328**	
109	Pipe (ft)	965.00	965.00		
110	Back Pressure Valve	1	1		

Attachment 9.12

Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G
2	Basin Water					
3	ρ =	=DATA!E3	lbs_m/ft^3			
4	μ =	=DATA!C3	cP			
5	=DATA!B43					
6	ε =	=DATA!$C$12	ft			
7	d =	=DATA!D16	inches			
8	D =	=C7/12	feet			
9	L =	=DATA!$C$44	feet			
10	Q (gpm) =	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24
11	v (fps) =	=(C10*4*144)/ (7.48*60*($C$7^ 2)*PI())	=(D10*4*144)/ (7.48*60*($C$7^ 2)*PI())	=(E10*4*144)/ (7.48*60*($C$7^ 2)*PI())	=(F10*4*144)/ (7.48*60*($C$7^ 2)*PI())	=(G10*4*144)/ (7.48*60*($C$7^ 2)*PI())
12	R_e =	= (50.6 * C10 * $C$3) / ($C$7 * $C$4)	= (50.6 * D10 * $C$3) / ($C$7 * $C$4)	= (50.6 * E10 * $C$3) / ($C$7 * $C$4)	= (50.6 * F10 * $C$3) / ($C$7 * $C$4)	= (50.6 * G10 * $C$3) / ($C$7 * $C$4)
13	f =	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / C12^0.9))^2	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / D12^0.9))^2	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / E12^0.9))^2	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / F12^0.9))^2	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / G12^0.9))^2
14						
15	h_L Pipe (ft) =	=0.1863 *C13 * $C$9 * C11^2 / $C$7	=0.1863 * D13 * $C$9 * D11^2 / $C$7	=0.1863 * E13 * $C$9 * E11^2 / $C$7	=0.1863 * F13 * $C$9 * F11^2 / $C$7	=0.1863 * G13 * $C$9 * G11^2 / $C$7
16	h_L Fittings (ft) =	=0.00259 * (C10^2 / $C$7^4) * ($R$6 * C13 + $R$11)	=0.00259 * (D10^2 / $C$7^4) * ($R$6 * D13 + $R$11)	=0.00259 * (E10^2 / $C$7^4) * ($R$6 * E13 + $R$11)	=0.00259 * (F10^2 / $C$7^4) * ($R$6 * F13 + $R$11)	=0.00259 * (G10^2 / $C$7^4) * ($R$6 * G13 + $R$11)
17	Total h_L (ft) =	=SUM(C15:C16)	=SUM(D15:D16)	=SUM(E15:E16)	=SUM(F15:F16)	=SUM(G15:G16)

A	B	H	I	J	K	L	M
2	Basin Water						
3	ρ =						
4	μ =						
5	=DATA!B43						
6	ε =						
7	d =						
8	D =						
9	L =						
10	Q (gpm) =	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
11	v (fps) =	=(H10*4*144)/(7. 48*60*($C$7^2)* PI())	=(I10*4*144)/ (7.48*60*($C$7^ 2)*PI())	=(J10*4*144)/(7. 48*60*($C$7^2)* PI())	=(K10*4*144)/ (7.48*60*($C$7^ 2)*PI())	=(L10*4*144)/ (7.48*60*($C$7^ 2)*PI())	=(M10*4*144)/ (7.48*60*($C$7^ 2)*PI())
12	R_e =	= (50.6 * H10 * $C$3) / ($C$7 * $C$4)	= (50.6 * I10 * $C$3) / ($C$7 * $C$4)	= (50.6 * J10 * $C$3) / ($C$7 * $C$4)	= (50.6 * K10 * $C$3) / ($C$7 * $C$4)	= (50.6 * L10 * $C$3) / ($C$7 * $C$4)	= (50.6 * M10 * $C$3) / ($C$7 * $C$4)
13	f =	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / H12^0.9))^2	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / I12^0.9))^2	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / J12^0.9))^2	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / K12^0.9))^2	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / L12^0.9))^2	= 0.25 / (LOG10($C$6 / 3.7 / $C$7 + 5.7 / M12^0.9))^2
14							
15	h_L Pipe (ft) =	=0.1863 * H13 * $C$9 * H11^2 / $C$7	=0.1863 * I13 * $C$9 * I11^2 / $C$7	=0.1863 * J13 * $C$9 * J11^2 / $C$7	=0.1863 * K13 * $C$9 * K11^2 / $C$7	=0.1863 * L13 * $C$9 * L11^2 / $C$7	=0.1863 * M13 * $C$9 * M11^2 / $C$7
16	h_L Fittings (ft) =	=0.00259 * (H10^2 / $C$7^4) * ($R$6 * H13 + $R$11)	=0.00259 * (I10^2 / $C$7^4) * ($R$6 * I13 + $R$11)	=0.00259 * (J10^2 / $C$7^4) * ($R$6 * J13 + $R$11)	=0.00259 * (K10^2 / $C$7^4) * ($R$6 * K13 + $R$11)	=0.00259 * (L10^2 / $C$7^4) * ($R$6 * L13 + $R$11)	=0.00259 * (M10^2 / $C$7^4) * ($R$6 * M13 + $R$11)
17	Total h_L (ft) =	=SUM(H15:H16)	=SUM(I15:I16)	=SUM(J15:J16)	=SUM(K15:K16)	=SUM(L15:L16)	=SUM(M15:M16)

N	O	P	Q	R
2	=DATA!$B$43			
3	Fittings	K-multiple	Number	Sub-total
4	=DATA!$B$45	30	=DATA!$C$45	=P4*Q4
5	=DATA!$B$46	16	=DATA!$C$46	=P5*Q5
6			Total	=SUM(R4:R5)
7	=DATA!$B$43			
8	Fittings	K-factor	Number	Sub-total
9	=DATA!$B$47	0.5	=DATA!$C$47	=P9 * Q9
10	=DATA!$B$48	= 0.5 * (1-DATA!$D$19^2/DATA!$D$17^2)	=DATA!C48	=P10*Q10
11			Total	=SUM(R9:R10)

Attachment 9.12

Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G	H	I	J	K	L	M
28	=DATA!B49											
29	ε =	=DATA!$C$11	ft									
30	d =	=DATA!D19	inches									
31	D =	=C30/12	feet									
32	L =	=DATA!C50	feet									
33	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
34	=$B$11	=(C33*4*144)/(7.48*60*($C$30^2)*PI())	=(D33*4*144)/(7.48*60*($C$30^2)*PI())	=(E33*4*144)/(7.48*60*($C$30^2)*PI())	=(F33*4*144)/(7.48*60*($C$30^2)*PI())	=(G33*4*144)/(7.48*60*($C$30^2)*PI())	=(H33*4*144)/(7.48*60*($C$30^2)*PI())	=(I33*4*144)/(7.48*60*($C$30^2)*PI())	=(J33*4*144)/(7.48*60*($C$30^2)*PI())	=(K33*4*144)/(7.48*60*($C$30^2)*PI())	=(L33*4*144)/(7.48*60*($C$30^2)*PI())	=(M33*4*144)/(7.48*60*($C$30^2)*PI())
35	R_e =	= (50.6 * C33 * $C$3) / ($C$30 * $C$4)	= (50.6 * D33 * $C$3) / ($C$30 * $C$4)	= (50.6 * E33 * $C$3) / ($C$30 * $C$4)	= (50.6 * F33 * $C$3) / ($C$30 * $C$4)	= (50.6 * G33 * $C$3) / ($C$30 * $C$4)	= (50.6 * H33 * $C$3) / ($C$30 * $C$4)	= (50.6 * I33 * $C$3) / ($C$30 * $C$4)	= (50.6 * J33 * $C$3) / ($C$30 * $C$4)	= (50.6 * K33 * $C$3) / ($C$30 * $C$4)	= (50.6 * L33 * $C$3) / ($C$30 * $C$4)	= (50.6 * M33 * $C$3) / ($C$30 * $C$4)
36	f =	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / C35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / D35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / E35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / F35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / G35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / H35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / I35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / J35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / K35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / L35^0.9))^2	= 0.25 / (LOG10($C$29 / 3.7 / $C$30 + 5.7 / M35^0.9))^2
37												
38	h_L Pipe (ft) =	=0.1863 * C36 * $C$32 * C34^2 / $C$30	=0.1863 * D36 * $C$32 * D34^2 / $C$30	=0.1863 * E36 * $C$32 * E34^2 / $C$30	=0.1863 * F36 * $C$32 * F34^2 / $C$30	=0.1863 * G36 * $C$32 * G34^2 / $C$30	=0.1863 * H36 * $C$32 * H34^2 / $C$30	=0.1863 * I36 * $C$32 * I34^2 / $C$30	=0.1863 * J36 * $C$32 * J34^2 / $C$30	=0.1863 * K36 * $C$32 * K34^2 / $C$30	=0.1863 * L36 * $C$32 * L34^2 / $C$30	=0.1863 * M36 * $C$32 * M34^2 / $C$30
39	h_L Fittings (ft) =	=0.00259 * (C33^2 / $C$30^4) * ($R$33 * C36 + $R$37)	=0.00259 * (D33^2 / $C$30^4) * ($R$33 * D36 + $R$37)	=0.00259 * (E33^2 / $C$30^4) * ($R$33 * E36 + $R$37)	=0.00259 * (F33^2 / $C$30^4) * ($R$33 * F36 + $R$37)	=0.00259 * (G33^2 / $C$30^4) * ($R$33 * G36 + $R$37)	=0.00259 * (H33^2 / $C$30^4) * ($R$33 * H36 + $R$37)	=0.00259 * (I33^2 / $C$30^4) * ($R$33 * I36 + $R$37)	=0.00259 * (J33^2 / $C$30^4) * ($R$33 * J36 + $R$37)	=0.00259 * (K33^2 / $C$30^4) * ($R$33 * K36 + $R$37)	=0.00259 * (L33^2 / $C$30^4) * ($R$33 * L36 + $R$37)	=0.00259 * (M33^2 / $C$30^4) * ($R$33 * M36 + $R$37)
40	Total h_L (ft) =	=SUM(C38:C39)	=SUM(D38:D39)	=SUM(E38:E39)	=SUM(F38:F39)	=SUM(G38:G39)	=SUM(H38:H39)	=SUM(I38:I39)	=SUM(J38:J39)	=SUM(K38:K39)	=SUM(L38:L39)	=SUM(M38:M39)

N	O	P	Q	R
28	=DATA!$B$49			
29	Fittings	K-multiple	Number	Sub-total
30	=DATA!$B$51	45	=DATA!$C$51	=P30*Q30
31	=DATA!$B$52	30	=DATA!$C$52	=P31*Q31
32	=DATA!$B$53	60	=DATA!$C$53	=P32 * Q32
33			Total	=SUM(R30:R32)
34	=DATA!$B$49			
35	Fittings	K-factor	Number	Sub-total
36	=DATA!$B$54	= 0.5 * (1-DATA!$D$21^2/DATA!$D$19^2)	=DATA!C54	=P36*Q36
37			Total	=SUM(R36:R36)

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Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G
48	=DATA!B55					
49	ε =	=DATA!$C$11	ft			
50	d =	=DATA!D21	inches			
51	D =	=C50/12	feet			
52	L =	=DATA!C56	feet			
53	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24
54	=$B$11	=(C53*4*144)/(7.48*60*($C$50^2)*PI())	=(D53*4*144)/(7.48*60*($C$50^2)*PI())	=(E53*4*144)/(7.48*60*($C$50^2)*PI())	=(F53*4*144)/(7.48*60*($C$50^2)*PI())	=(G53*4*144)/(7.48*60*($C$50^2)*PI())
55	R_e =	= (50.6 * C53 * $C$3) / ($C$50 * $C$4)	= (50.6 * D53 * $C$3) / ($C$50 * $C$4)	= (50.6 * E53 * $C$3) / ($C$50 * $C$4)	= (50.6 * F53 * $C$3) / ($C$50 * $C$4)	= (50.6 * G53 * $C$3) / ($C$50 * $C$4)
56	f =	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / C55^0.9))^2	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / D55^0.9))^2	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / E55^0.9))^2	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / F55^0.9))^2	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / G55^0.9))^2
57						
58	h_L Pipe (ft) =	=0.1863 * C56 * $C$52 * C54^2 / $C$50	=0.1863 * D56 * $C$52 * D54^2 / $C$50	=0.1863 * E56 * $C$52 * E54^2 / $C$50	=0.1863 * F56 * $C$52 * F54^2 / $C$50	=0.1863 * G56 * $C$52 * G54^2 / $C$50
59	h_L Fittings (ft) =	=0.00259 * (C53^2 / $C$50^4) * ($R$56 * C56 + $R$60)	=0.00259 * (D53^2 / $C$50^4) * ($R$56 * D56 + $R$60)	=0.00259 * (E53^2 / $C$50^4) * ($R$56 * E56 + $R$60)	=0.00259 * (F53^2 / $C$50^4) * ($R$56 * F56 + $R$60)	=0.00259 * (G53^2 / $C$50^4) * ($R$56 * G56 + $R$60)
60	Total h_L (ft) =	=SUM(C58:C59)	=SUM(D58:D59)	=SUM(E58:E59)	=SUM(F58:F59)	=SUM(G58:G59)

A	H	I	J	K	L	M
48						
49						
50						
51						
52						
53	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
54	=(H53*4*144)/(7.48*60*($C$50^2)*PI())	=(I53*4*144)/(7.48*60*($C$50^2)*PI())	=(J53*4*144)/(7.48*60*($C$50^2)*PI())	=(K53*4*144)/(7.48*60*($C$50^2)*PI())	=(L53*4*144)/(7.48*60*($C$50^2)*PI())	=(M53*4*144)/(7.48*60*($C$50^2)*PI())
55	= (50.6 * H53 * $C$3) / ($C$50 * $C$4)	= (50.6 * I53 * $C$3) / ($C$50 * $C$4)	= (50.6 * J53 * $C$3) / ($C$50 * $C$4)	= (50.6 * K53 * $C$3) / ($C$50 * $C$4)	= (50.6 * L53 * $C$3) / ($C$50 * $C$4)	= (50.6 * M53 * $C$3) / ($C$50 * $C$4)
56	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / H55^0.9))^2	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / I55^0.9))^2	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / J55^0.9))^2	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / K55^0.9))^2	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / L55^0.9))^2	= 0.25 / (LOG10($C$49 / 3.7 / $C$50 + 5.7 / M55^0.9))^2
57						
58	=0.1863 * H56 * $C$52 * H54^2 / $C$50	=0.1863 * I56 * $C$52 * I54^2 / $C$50	=0.1863 * J56 * $C$52 * J54^2 / $C$50	=0.1863 * K56 * $C$52 * K54^2 / $C$50	=0.1863 * L56 * $C$52 * L54^2 / $C$50	=0.1863 * M56 * $C$52 * M54^2 / $C$50
59	=0.00259 * (H53^2 / $C$50^4) * ($R$56 * H56 + $R$60)	=0.00259 * (I53^2 / $C$50^4) * ($R$56 * I56 + $R$60)	=0.00259 * (J53^2 / $C$50^4) * ($R$56 * J56 + $R$60)	=0.00259 * (K53^2 / $C$50^4) * ($R$56 * K56 + $R$60)	=0.00259 * (L53^2 / $C$50^4) * ($R$56 * L56 + $R$60)	=0.00259 * (M53^2 / $C$50^4) * ($R$56 * M56 + $R$60)
60	=SUM(H58:H59)	=SUM(I58:I59)	=SUM(J58:J59)	=SUM(K58:K59)	=SUM(L58:L59)	=SUM(M58:M59)

N	O	P	Q	R
48	=DATA!$B$55			
49	Fittings	K-multiple	Number	Sub-total
50	=DATA!$B$58	8	=DATA!$C$58	=P50*Q50
51	=DATA!$B$59	50	=DATA!$C$59	=P51*Q51
52	=DATA!$B$60	30	=DATA!$C$60	=P52*Q52
53	=DATA!$B$61	16	=DATA!$C$61	=P53 * Q53
54	=DATA!$B$62	20	=DATA!$C$62	=P54 * Q54
55	=DATA!$B$63	60	=DATA!$C$63	=P55 * Q55
56			Total	=SUM(R50:R53)
57	=DATA!$B$55			
58	Fittings	K-factor	Number	Sub-total
59	=DATA!$B$57	= (1-DATA!$D$22^2/DATA!$D$21^2)^2	=DATA!C57	=P59*Q59
60			Total	=SUM(R59:R59)

Attachment 9.12

Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G	H	I	J	K	L	M
69	=DATA!B64											
70	ε =	=DATA!$C$11	ft									
71	d =	=DATA!D19	inches									
72	D =	=C71/12	feet									
73	L =	=DATA!C65	feet									
74	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
75	=$B$11	=(C74*4*144)/(7.48*60*($C$71^2) *PI())	=(D74*4*144)/(7.48*60*($C$71^2) *PI())	=(E74*4*144)/(7.48*60*($C$71^2) *PI())	=(F74*4*144)/(7.48*60*($C$71^2) *PI())	=(G74*4*144)/(7.48*60*($C$71^2) *PI())	=(H74*4*144)/(7.48*60*($C$71^2) *PI())	=(I74*4*144)/(7.48*60*($C$71^2)* PI())	=(J74*4*144)/(7.48*60*($C$71^2) *PI())	=(K74*4*144)/(7.48*60*($C$71^2) *PI())	=(L74*4*144)/(7.48*60*($C$71^2) *PI())	=(M74*4*144)/(7.48*60*($C$71^2) *PI())
76	R_e =	= (50.6 *C74 * $C$3) / ($C$71 * $C$4)	= (50.6 *D74 * $C$3) / ($C$71 * $C$4)	= (50.6 *E74 * $C$3) / ($C$71 * $C$4)	= (50.6 *F74 * $C$3) / ($C$71 * $C$4)	= (50.6 *G74 * $C$3) / ($C$71 * $C$4)	= (50.6 *H74 * $C$3) / ($C$71 * $C$4)	= (50.6 *I74 * $C$3) / ($C$71 * $C$4)	= (50.6 *J74 * $C$3) / ($C$71 * $C$4)	= (50.6 *K74 * $C$3) / ($C$71 * $C$4)	= (50.6 *L74 * $C$3) / ($C$71 * $C$4)	= (50.6 *M74 * $C$3) / ($C$71 * $C$4)
77	f =	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / C76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / D76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / E76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / F76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / G76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / H76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / I76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / J76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / K76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / L76^0.9))^2	= 0.25 / (LOG10($C$70 / 3.7 / $C$71 + 5.7 / M76^0.9))^2
78												
79	h_L Pipe (ft) =	=0.1863 * C77 * $C$73 * C75^2 / $C$71	=0.1863 * D77 * $C$73 * D75^2 / $C$71	=0.1863 * E77 * $C$73 * E75^2 / $C$71	=0.1863 * F77 * $C$73 * F75^2 / $C$71	=0.1863 * G77 * $C$73 * G75^2 / $C$71	=0.1863 * H77 * $C$73 * H75^2 / $C$71	=0.1863 * I77 * $C$73 * I75^2 / $C$71	=0.1863 * J77 * $C$73 * J75^2 / $C$71	=0.1863 * K77 * $C$73 * K75^2 / $C$71	=0.1863 * L77 * $C$73 * L75^2 / $C$71	=0.1863 * M77 * $C$73 * M75^2 / $C$71
80	h_L Fittings (ft) =	=0.00259 * (C74^2 / $C$50^4) * (0)	=0.00259 * (D74^2 / $C$50^4) * (0)	=0.00259 * (E74^2 / $C$50^4) * (0)	=0.00259 * (F74^2 / $C$50^4) * (0)	=0.00259 * (G74^2 / $C$50^4) * (0)	=0.00259 * (H74^2 / $C$50^4) * (0)	=0.00259 * (I74^2 / $C$50^4) * (0)	=0.00259 * (J74^2 / $C$50^4) * (0)	=0.00259 * (K74^2 / $C$50^4) * (0)	=0.00259 * (L74^2 / $C$50^4) * (0)	=0.00259 * (M74^2 / $C$50^4) * (0)
81	Total h_L (ft) =	=SUM(C79:C80)	=SUM(D79:D80)	=SUM(E79:E80)	=SUM(F79:F80)	=SUM(G79:G80)	=SUM(H79:H80)	=SUM(I79:I80)	=SUM(J79:J80)	=SUM(K79:K80)	=SUM(L79:L80)	=SUM(M79:M80)

N	O	P	Q	R
69	=DATA!$B$64			
70	Fittings	K-multiple	Number	Sub-total
71	=DATA!$B$66	8	=DATA!$C$66	=P71*Q71
72	=DATA!$B$67	30	=DATA!$C$67	=P72*Q72
73	=DATA!$B$68	16	=DATA!$C$68	=P73*Q73
74	=DATA!$B$69	60	=DATA!$C$69	=P74 * Q74
75			Total	=SUM(R71:R74)

Attachment 9.12

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G	H	I	J	K	L	M
92	=DATA!B70											
93	ε =	=DATA!$C$11	ft									
94	d =	=DATA!$D$19	inches									
95	D =	=C94/12	feet									
96	L =	=DATA!C71	feet									
97	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
98	=$B$11	=(C97*4*144)/(7.48*60*($C$94^2)*PI())	=(D97*4*144)/(7.48*60*($C$94^2)*PI())	=(E97*4*144)/(7.48*60*($C$94^2)*PI())	=(F97*4*144)/(7.48*60*($C$94^2)*PI())	=(G97*4*144)/(7.48*60*($C$94^2)*PI())	=(H97*4*144)/(7.48*60*($C$94^2)*PI())	=(I97*4*144)/(7.48*60*($C$94^2)*PI())	=(J97*4*144)/(7.48*60*($C$94^2)*PI())	=(K97*4*144)/(7.48*60*($C$94^2)*PI())	=(L97*4*144)/(7.48*60*($C$94^2)*PI())	=(M97*4*144)/(7.48*60*($C$94^2)*PI())
99	R_e =	= (50.6 *C97 * $C$3) / ($C$94 * $C$4)	= (50.6 *D97 * $C$3) / ($C$94 * $C$4)	= (50.6 *E97 * $C$3) / ($C$94 * $C$4)	= (50.6 *F97 * $C$3) / ($C$94 * $C$4)	= (50.6 *G97 * $C$3) / ($C$94 * $C$4)	= (50.6 *H97 * $C$3) / ($C$94 * $C$4)	= (50.6 *I97 * $C$3) / ($C$94 * $C$4)	= (50.6 *J97 * $C$3) / ($C$94 * $C$4)	= (50.6 *K97 * $C$3) / ($C$94 * $C$4)	= (50.6 *L97 * $C$3) / ($C$94 * $C$4)	= (50.6 *M97 * $C$3) / ($C$94 * $C$4)
100	f =	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / C99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / D99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / E99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / F99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / G99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / H99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / I99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / J99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / K99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / L99^0.9))^2	= 0.25 / (LOG10($C$93 / 3.7 / $C$94 + 5.7 / M99^0.9))^2
101												
102	h_L Pipe (ft) =	=0.1863 * C100 * $C$96 * C98^2 / $C$94	=0.1863 * D100 * $C$96 * D98^2 / $C$94	=0.1863 * E100 * $C$96 * E98^2 / $C$94	=0.1863 * F100 * $C$96 * F98^2 / $C$94	=0.1863 * G100 * $C$96 * G98^2 / $C$94	=0.1863 * H100 * $C$96 * H98^2 / $C$94	=0.1863 * I100 * $C$96 * I98^2 / $C$94	=0.1863 * J100 * $C$96 * J98^2 / $C$94	=0.1863 * K100 * $C$96 * K98^2 / $C$94	=0.1863 * L100 * $C$96 * L98^2 / $C$94	=0.1863 * M100 * $C$96 * M98^2 / $C$94
103	h_L Fittings (ft) =	=0.00259 * (C97^2 / $C$94^4) * ($R$97 * C100)	=0.00259 * (D97^2 / $C$94^4) * ($R$97 * D100)	=0.00259 * (E97^2 / $C$94^4) * ($R$97 * E100)	=0.00259 * (F97^2 / $C$94^4) * ($R$97 * F100)	=0.00259 * (G97^2 / $C$94^4) * ($R$97 * G100)	=0.00259 * (H97^2 / $C$94^4) * ($R$97 * H100)	=0.00259 * (I97^2 / $C$94^4) * ($R$97 * I100)	=0.00259 * (J97^2 / $C$94^4) * ($R$97 * J100)	=0.00259 * (K97^2 / $C$94^4) * ($R$97 * K100)	=0.00259 * (L97^2 / $C$94^4) * ($R$97 * L100)	=0.00259 * (M97^2 / $C$94^4) * ($R$97 * M100)
104	Total h_L (ft) =	=SUM(C102:C103)	=SUM(D102:D103)	=SUM(E102:E103)	=SUM(F102:F103)	=SUM(G102:G103)	=SUM(H102:H103)	=SUM(I102:I103)	=SUM(J102:J103)	=SUM(K102:K103)	=SUM(L102:L103)	=SUM(M102:M103)

N	O	P	Q	R
92	=DATA!$B$70			
93	Fittings	K-multiple	Number	Sub-total
94	=DATA!$B$72	45	=DATA!$C$72	=P94*Q94
95	=DATA!$B$73	30	=DATA!$C$73	=P95*Q95
93	=DATA!$B$74	60	=DATA!$C$74	=P96 * Q96
97			Total	=SUM(R94:R96)

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G	H	I	J	K	L	M
112	=DATA!B75											
113	ε =	=DATA!$C$11	ft									
114	d =	=DATA!$D$21	inches									
115	D =	=C114/12	feet									
116	L =	=DATA!C76	feet									
117	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
118	=$B$11	=(C117*4*144)/(7.48*60*($C$114^2)*PI())	=(D117*4*144)/(7.48*60*($C$114^2)*PI())	=(E117*4*144)/(7.48*60*($C$114^2)*PI())	=(F117*4*144)/(7.48*60*($C$114^2)*PI())	=(G117*4*144)/(7.48*60*($C$114^2)*PI())	=(H117*4*144)/(7.48*60*($C$114^2)*PI())	=(I117*4*144)/(7.48*60*($C$114^2)*PI())	=(J117*4*144)/(7.48*60*($C$114^2)*PI())	=(K117*4*144)/(7.48*60*($C$114^2)*PI())	=(L117*4*144)/(7.48*60*($C$114^2)*PI())	=(M117*4*144)/(7.48*60*($C$114^2)*PI())
119	R_e =	= (50.6 *C117 * $C$3) / ($C$114 * $C$4)	= (50.6 *D117 * $C$3) / ($C$114 * $C$4)	= (50.6 *E117 * $C$3) / ($C$114 * $C$4)	= (50.6 *F117 * $C$3) / ($C$114 * $C$4)	= (50.6 *G117 * $C$3) / ($C$114 * $C$4)	= (50.6 *H117 * $C$3) / ($C$114 * $C$4)	= (50.6 *I117 * $C$3) / ($C$114 * $C$4)	= (50.6 *J117 * $C$3) / ($C$114 * $C$4)	= (50.6 *K117 * $C$3) / ($C$114 * $C$4)	= (50.6 *L117 * $C$3) / ($C$114 * $C$4)	= (50.6 *M117 * $C$3) / ($C$114 * $C$4)
120	f =	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / C119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / D119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / E119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / F119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / G119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / H119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / I119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / J119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / K119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / L119^0.9))^2	= 0.25 / (LOG10($C$113 / 3.7 / $C$114 + 5.7 / M119^0.9))^2
121												
122	h_L Pipe (ft) =	=0.1863 * C120 * $C$116 * C118^2 / $C$114	=0.1863 * D120 * $C$116 * D118^2 / $C$114	=0.1863 * E120 * $C$116 * E118^2 / $C$114	=0.1863 * F120 * $C$116 * F118^2 / $C$114	=0.1863 * G120 * $C$116 * G118^2 / $C$114	=0.1863 * H120 * $C$116 * H118^2 / $C$114	=0.1863 * I120 * $C$116 * I118^2 / $C$114	=0.1863 * J120 * $C$116 * J118^2 / $C$114	=0.1863 * K120 * $C$116 * K118^2 / $C$114	=0.1863 * L120 * $C$116 * L118^2 / $C$114	=0.1863 * M120 * $C$116 * M118^2 / $C$114
123	h_L Fittings (ft) =	=0.00259 * (C117^2 / $C$94^4) * ($R$116 * C120)	=0.00259 * (D117^2 / $C$94^4) * ($R$116 * D120)	=0.00259 * (E117^2 / $C$94^4) * ($R$116 * E120)	=0.00259 * (F117^2 / $C$94^4) * ($R$116 * F120)	=0.00259 * (G117^2 / $C$94^4) * ($R$116 * G120)	=0.00259 * (H117^2 / $C$94^4) * ($R$116 * H120)	=0.00259 * (I117^2 / $C$94^4) * ($R$116 * I120)	=0.00259 * (J117^2 / $C$94^4) * ($R$116 * J120)	=0.00259 * (K117^2 / $C$94^4) * ($R$116 * K120)	=0.00259 * (L117^2 / $C$94^4) * ($R$116 * L120)	=0.00259 * (M117^2 / $C$94^4) * ($R$116 * M120)
124	Total h_L (ft) =	=SUM(C122:C123)	=SUM(D122:D123)	=SUM(E122:E123)	=SUM(F122:F123)	=SUM(G122:G123)	=SUM(H122:H123)	=SUM(I122:I123)	=SUM(J122:J123)	=SUM(K122:K123)	=SUM(L122:L123)	=SUM(M122:M123)

N	O	P	Q	R
112	=DATA!$B$75			
113	Fittings	K-multiple	Number	Sub-total
114	=DATA!$B$77	8	=DATA!$C$77	=P114*Q114
115	=DATA!$B$78	60	=DATA!$C$78	=P115*Q115
116			Total	=SUM(R113:R115)

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G
132	=DATA!B79					
133	ε =	=DATA!$C$11	ft			
134	d =	=DATA!$D$19	inches			
135	D =	=C134/12	feet			
136	L =	=DATA!C80	feet			
137	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24
138	=$B$11	=(C137*4*144)/(7.48*60*($C$134^2)*PI())	=(D137*4*144)/(7.48*60*($C$134^2)*PI())	=(E137*4*144)/(7.48*60*($C$134^2)*PI())	=(F137*4*144)/(7.48*60*($C$134^2)*PI())	=(G137*4*144)/(7.48*60*($C$134^2)*PI())
139	R_e =	= (50.6 *C137 * $C$3) / ($C$134 * $C$4)	= (50.6 *D137 * $C$3) / ($C$134 * $C$4)	= (50.6 *E137 * $C$3) / ($C$134 * $C$4)	= (50.6 *F137 * $C$3) / ($C$134 * $C$4)	= (50.6 *G137 * $C$3) / ($C$134 * $C$4)
140	f =	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / C139^0.9))^2	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / D139^0.9))^2	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / E139^0.9))^2	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / F139^0.9))^2	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / G139^0.9))^2
141						
142	h_L Pipe (ft) =	=0.1863 * C140 * $C$136 * C138^2 / $C$134	=0.1863 * D140 * $C$136 * D138^2 / $C$134	=0.1863 * E140 * $C$136 * E138^2 / $C$134	=0.1863 * F140 * $C$136 * F138^2 / $C$134	=0.1863 * G140 * $C$136 * G138^2 / $C$134
143	h_L Fittings (ft) =	=0.00259 * (C137^2 / $C$94^4) * ($R$136 * C140)	=0.00259 * (D137^2 / $C$94^4) * ($R$136 * D140)	=0.00259 * (E137^2 / $C$94^4) * ($R$136 * E140)	=0.00259 * (F137^2 / $C$94^4) * ($R$136 * F140)	=0.00259 * (G137^2 / $C$94^4) * ($R$136 * G140)
144	h_L BFP (ft) =	= 5.5 * 2.3067	= 5.5 * 2.3067	= 5.5 * 2.3067	= 5.5 * 2.3067	= 5.5 * 2.3067
145	Total h_L (ft) =	=SUM(C142:C144)	=SUM(D142:D144)	=SUM(E142:E144)	=SUM(F142:F144)	=SUM(G142:G144)

A	H	I	J	K	L	M
132						
133						
134						
135						
136						
137	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
138	=(H137*4*144)/(7.48*60*($C$134^2)*PI())	=(I137*4*144)/(7.48*60*($C$134^2)*PI())	=(J137*4*144)/(7.48*60*($C$134^2)*PI())	=(K137*4*144)/(7.48*60*($C$134^2)*PI())	=(L137*4*144)/(7.48*60*($C$134^2)*PI())	=(M137*4*144)/(7.48*60*($C$134^2)*PI())
139	= (50.6 *H137 * $C$3) / ($C$134 * $C$4)	= (50.6 *I137 * $C$3) / ($C$134 * $C$4)	= (50.6 *J137 * $C$3) / ($C$134 * $C$4)	= (50.6 *K137 * $C$3) / ($C$134 * $C$4)	= (50.6 *L137 * $C$3) / ($C$134 * $C$4)	= (50.6 *M137 * $C$3) / ($C$134 * $C$4)
140	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / H139^0.9))^2	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / I139^0.9))^2	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / J139^0.9))^2	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / K139^0.9))^2	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / L139^0.9))^2	= 0.25 / (LOG10($C$133 / 3.7 / $C$134 + 5.7 / M139^0.9))^2
141						
142	=0.1863 * H140 * $C$136 * H138^2 / $C$134	=0.1863 * I140 * $C$136 * I138^2 / $C$134	=0.1863 * J140 * $C$136 * J138^2 / $C$134	=0.1863 * K140 * $C$136 * K138^2 / $C$134	=0.1863 * L140 * $C$136 * L138^2 / $C$134	=0.1863 * M140 * $C$136 * M138^2 / $C$134
143	=0.00259 * (H137^2 / $C$94^4) * ($R$136 * H140)	=0.00259 * (I137^2 / $C$94^4) * ($R$136 * I140)	=0.00259 * (J137^2 / $C$94^4) * ($R$136 * J140)	=0.00259 * (K137^2 / $C$94^4) * ($R$136 * K140)	=0.00259 * (L137^2 / $C$94^4) * ($R$136 * L140)	=0.00259 * (M137^2 / $C$94^4) * ($R$136 * M140)
144	= 5.5 * 2.3067	= 5.5 * 2.3067	= 5.5 * 2.3067	= 5.5 * 2.3067	= 5.5 * 2.3067	= 5.5 * 2.3067
145	=SUM(H142:H144)	=SUM(I142:I144)	=SUM(J142:J144)	=SUM(K142:K144)	=SUM(L142:L144)	=SUM(M142:M144)

N	O	P	Q	R
132	=DATA!$B$79			
133	Fittings	K-multiple	Number	Sub-total
134	=DATA!$B$81	30	=DATA!$C$81	=P134*Q134
135	=DATA!$B$82	60	=DATA!$C$82	=P135*Q135
136			Total	=SUM(R134:R135)

Attachment 9.12

Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G
152	=DATA!B84					
153	ε =	=DATA!$C$13	ft			
154	d =	=DATA!$D$20	inches			
155	D =	=C154/12	feet			
156	L =	=DATA!C85	feet			
157	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24
158	=$B$11	=(C157*4*144)/(7.48*60*($C$154^2)*PI())	=(D157*4*144)/(7.48*60*($C$154^2)*PI())	=(E157*4*144)/(7.48*60*($C$154^2)*PI())	=(F157*4*144)/(7.48*60*($C$154^2)*PI())	=(G157*4*144)/(7.48*60*($C$154^2)*PI())
159	Re =	= (50.6 *C157 * $C$3) / ($C$154 * $C$4)	= (50.6 *D157 * $C$3) / ($C$154 * $C$4)	= (50.6 *E157 * $C$3) / ($C$154 * $C$4)	= (50.6 *F157 * $C$3) / ($C$154 * $C$4)	= (50.6 *G157 * $C$3) / ($C$154 * $C$4)
160	f =	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / C159^0.9))^2	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / D159^0.9))^2	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / E159^0.9))^2	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / F159^0.9))^2	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / G159^0.9))^2
161						
162	hL Pipe (ft) =	=0.1863 * C160 * $C$156 * C158^2 / $C$154	=0.1863 * D160 * $C$156 * D158^2 / $C$154	=0.1863 * E160 * $C$156 * E158^2 / $C$154	=0.1863 * F160 * $C$156 * F158^2 / $C$154	=0.1863 * G160 * $C$156 * G158^2 / $C$154
163	hL Fittings (ft) =	=0.00259 * (C157^2 / $C$94^4) * ($R$156 * C160)	=0.00259 * (D157^2 / $C$94^4) * ($R$156 * D160)	=0.00259 * (E157^2 / $C$94^4) * ($R$156 * E160)	=0.00259 * (F157^2 / $C$94^4) * ($R$156 * F160)	=0.00259 * (G157^2 / $C$94^4) * ($R$156 * G160)
164	Total hL (ft) =	=SUM(C162:C163)	=SUM(D162:D163)	=SUM(E162:E163)	=SUM(F162:F163)	=SUM(G162:G163)

A	B	H	I	J	K	L	M
152	=DATA!B84						
153	ε =						
154	d =						
155	D =						
156	L =						
157	=$B$10	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
158	=$B$11	=(H157*4*144)/(7.48*60*($C$154^2)*PI())	=(I157*4*144)/(7.48*60*($C$154^2)*PI())	=(J157*4*144)/(7.48*60*($C$154^2)*PI())	=(K157*4*144)/(7.48*60*($C$154^2)*PI())	=(L157*4*144)/(7.48*60*($C$154^2)*PI())	=(M157*4*144)/(7.48*60*($C$154^2)*PI())
159	Re =	= (50.6 *H157 * $C$3) / ($C$154 * $C$4)	= (50.6 *I157 * $C$3) / ($C$154 * $C$4)	= (50.6 *J157 * $C$3) / ($C$154 * $C$4)	= (50.6 *K157 * $C$3) / ($C$154 * $C$4)	= (50.6 *L157 * $C$3) / ($C$154 * $C$4)	= (50.6 *M157 * $C$3) / ($C$154 * $C$4)
160	f =	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / H159^0.9))^2	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / I159^0.9))^2	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / J159^0.9))^2	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / K159^0.9))^2	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / L159^0.9))^2	= 0.25 / (LOG10($C$153 / 3.7 / $C$154 + 5.7 / M159^0.9))^2
161							
162	hL Pipe (ft) =	=0.1863 * H160 * $C$156 * H158^2 / $C$154	=0.1863 * I160 * $C$156 * I158^2 / $C$154	=0.1863 * J160 * $C$156 * J158^2 / $C$154	=0.1863 * K160 * $C$156 * K158^2 / $C$154	=0.1863 * L160 * $C$156 * L158^2 / $C$154	=0.1863 * M160 * $C$156 * M158^2 / $C$154
163	hL Fittings (ft) =	=0.00259 * (H157^2 / $C$94^4) * ($R$156 * H160)	=0.00259 * (I157^2 / $C$94^4) * ($R$156 * I160)	=0.00259 * (J157^2 / $C$94^4) * ($R$156 * J160)	=0.00259 * (K157^2 / $C$94^4) * ($R$156 * K160)	=0.00259 * (L157^2 / $C$94^4) * ($R$156 * L160)	=0.00259 * (M157^2 / $C$94^4) * ($R$156 * M160)
164	Total hL (ft) =	=SUM(H162:H163)	=SUM(I162:I163)	=SUM(J162:J163)	=SUM(K162:K163)	=SUM(L162:L163)	=SUM(M162:M163)

N	O	P	Q	R
152	=DATA!$B$84			
153	Fittings	K-multiple	Number	Sub-total
154	=DATA!$B$86	30	=DATA!$C$86	=P154*Q154
155	=DATA!$B$87	60	=DATA!$C$87	=P155*Q155
156			Total	=SUM(R154:R155)

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Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G
172	=DATA!B88					
173	ε =	=DATA!$C$13	ft			
174	d =	=DATA!$D$20	inches			
175	D =	=C174/12	feet			
176	L =	= DATA!C89 + DATA!C91 + DATA!C93 + DATA!C95 + DATA!C97 +DATA!C99 + DATA!C101 + DATA!C103 + DATA!C105 + DATA!C107 + DATA!C109	feet			
177	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24
178	=$B$11	=(C177*4*144)/(7.48*60*($C$154^2)*PI())	=(D177*4*144)/(7.48*60*($C$154^2)*PI())	=(E177*4*144)/(7.48*60*($C$154^2)*PI())	=(F177*4*144)/(7.48*60*($C$154^2)*PI())	=(G177*4*144)/(7.48*60*($C$154^2)*PI())
179	R_e =	= (50.6 *C177 * $C$3) / ($C$174 * $C$4)	= (50.6 *D177 * $C$3) / ($C$174 * $C$4)	= (50.6 *E177 * $C$3) / ($C$174 * $C$4)	= (50.6 *F177 * $C$3) / ($C$174 * $C$4)	= (50.6 *G177 * $C$3) / ($C$174 * $C$4)
180	f =	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / C179^0.9))^2	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / D179^0.9))^2	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / E179^0.9))^2	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / F179^0.9))^2	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / G179^0.9))^2
181						
182	h_L Pipe (ft) =	=0.1863 * C180 * $C$176 * C178^2 / $C$174	=0.1863 * D180 * $C$176 * D178^2 / $C$174	=0.1863 * E180 * $C$176 * E178^2 / $C$174	=0.1863 * F180 * $C$176 * F178^2 / $C$174	=0.1863 * G180 * $C$176 * G178^2 / $C$174
183	h_L Fittings (ft) =	135	135	135	135	135
184	Total h_L (ft) =	=SUM(C182:C183)	=SUM(D182:D183)	=SUM(E182:E183)	=SUM(F182:F183)	=SUM(G182:G183)

A	H	I	J	K	L	M
172						
173						
174						
175						
176						
177	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
178	=(H177*4*144)/(7.48*60*($C$154^2)*PI())	=(I177*4*144)/(7.48*60*($C$154^2)*PI())	=(J177*4*144)/(7.48*60*($C$154^2)*PI())	=(K177*4*144)/(7.48*60*($C$154^2)*PI())	=(L177*4*144)/(7.48*60*($C$154^2)*PI())	=(M177*4*144)/(7.48*60*($C$154^2)*PI())
179	= (50.6 *H177 * $C$3) / ($C$174 * $C$4)	= (50.6 *I177 * $C$3) / ($C$174 * $C$4)	= (50.6 *J177 * $C$3) / ($C$174 * $C$4)	= (50.6 *K177 * $C$3) / ($C$174 * $C$4)	= (50.6 *L177 * $C$3) / ($C$174 * $C$4)	= (50.6 *M177 * $C$3) / ($C$174 * $C$4)
180	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / H179^0.9))^2	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / I179^0.9))^2	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / J179^0.9))^2	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / K179^0.9))^2	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / L179^0.9))^2	= 0.25 / (LOG10($C$173 / 3.7 / $C$174 + 5.7 / M179^0.9))^2
181						
182	=0.1863 * H180 * $C$176 * H178^2 / $C$174	=0.1863 * I180 * $C$176 * I178^2 / $C$174	=0.1863 * J180 * $C$176 * J178^2 / $C$174	=0.1863 * K180 * $C$176 * K178^2 / $C$174	=0.1863 * L180 * $C$176 * L178^2 / $C$174	=0.1863 * M180 * $C$176 * M178^2 / $C$174
183	135	135	135	135	135	135
184	=SUM(H182:H183)	=SUM(I182:I183)	=SUM(J182:J183)	=SUM(K182:K183)	=SUM(L182:L183)	=SUM(M182:M183)

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Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G	H	I	J	K	L	M
191	System Curve - RETB- P-1											
192	Summary of h_L (ft)											
193	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
194	Total hL (ft) Segment 1 =	=C17	=D17	=E17	=F17	=G17	=H17	=I17	=J17	=K17	=L17	=M17
195	Total hL (ft) Segment 5 =	=C104	=D104	=E104	=F104	=G104	=H104	=I104	=J104	=K104	=L104	=M104
196	Total hL (ft) Segment 6 =	=C124	=D124	=E124	=F124	=G124	=H124	=I124	=J124	=K124	=L124	=M124
197	Total hL (ft) Segment 7 =	=C145	=D145	=E145	=F145	=G145	=H145	=I145	=J145	=K145	=L145	=M145
198	Total hL (ft) Segment 8 =	=C164	=D164	=E164	=F164	=G164	=H164	=I164	=J164	=K164	=L164	=M164
199	Total hL (ft) Segment 9 =	=C184	=D184	=E184	=F184	=G184	=H184	=I184	=J184	=K184	=L184	=M184
200	h_L Static (ft) =	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27
201	h_L Pressure (ft) =	0	0	0	0	0	0	0	0	0	0	0
202	h_L Velocity (ft) =	0	0	0	0	0	0	0	0	0	0	0
203	Total h_L (ft)	=SUM(C194:C202)	=SUM(D194:D202)	=SUM(E194:E202)	=SUM(F194:F202)	=SUM(G194:G202)	=SUM(H194:H202)	=SUM(I194:I202)	=SUM(J194:J202)	=SUM(K194:K202)	=SUM(L194:L202)	=SUM(M194:M202)

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Calculation Continuation Sheet

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Attachment 5
Excel Spreadsheet Formulae

A	B	C	D	E	F	G	H	I	J	K	L	M
209	System Curve - RETB- P-2											
210	Summary of h_L (ft)											
211	=$B$10	=DATA!$C$24	=DATA!$D$24	=DATA!$E$24	=DATA!$F$24	=DATA!$G$24	=DATA!$H$24	=DATA!$I$24	=DATA!$J$24	=DATA!$K$24	=DATA!$L$24	=DATA!$M$24
212	Total hL (ft) Segment 1 =	=C17	=D17	=E17	=F17	=G17	=H17	=I17	=J17	=K17	=L17	=M17
213	Total hL (ft) Segment 2 =	=C40	=D40	=E40	=F40	=G40	=H40	=I40	=J40	=K40	=L40	=M40
214	Total hL (ft) Segment 3 =	=C60	=D60	=E60	=F60	=G60	=H60	=I60	=J60	=K60	=L60	=M60
215	Total hL (ft) Segment 4 =	=C81	=D81	=E81	=F81	=G81	=H81	=I81	=J81	=K81	=L81	=M81
216	Total hL (ft) Segment 7 =	=C145	=D145	=E145	=F145	=G145	=H145	=I145	=J145	=K145	=L145	=M145
217	Total hL (ft) Segment 8 =	=C164	=D164	=E164	=F164	=G164	=H164	=I164	=J164	=K164	=L164	=M164
218	Total hL (ft) Segment 9 =	=C184	=D184	=E184	=F184	=G184	=H184	=I184	=J184	=K184	=L184	=M184
219	h_L Static (ft) =	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27	= DATA!$C$36 - DATA!$C$27
220	h_L Pressure (ft) =	0	0	0	0	0	0	0	0	0	0	0
221	h_L Velocity (ft) =	0	0	0	0	0	0	0	0	0	0	0
222	Total h_L (ft)	=SUM(C210:C219)	=SUM(D210:D219)	=SUM(E210:E219)	=SUM(F210:F219)	=SUM(G210:G219)	=SUM(H210:H219)	=SUM(I210:I219)	=SUM(J210:J219)	=SUM(K210:K219)	=SUM(L210:L219)	=SUM(M210:M219)