COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY
PIEDMONT REGIONAL OFFICE
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L. Preston Bryant, Jr.
Secretary of Natural Resources

David K. Paylor
Director

Gerard Seeley, Jr.
Regional Director

April 4, 2007

King William County
Central Crossing Subdivision
Section 2 Pump Station
22506

Jim Duke
Rodgers – Chenault, Inc.
7240 Lee Davis Road
Mechanicsville, Virginia 23111

Dear Mr. Duke:

This Office has received plans and specifications, as prepared by Timmons Group, for the referenced facility. The plans entitled "Central Crossing, Section 2, Acquinton District, King William County, Virginia" contain nine sheets and are engineer stamp dated March 30, 2007. The specifications entitled "Central Crossing, Section 2, Project Manual, Technical Specifications, King William County, Virginia" are engineer stamp dated February 6, 2007.

The project consists of .construction of 900 linear feet of 4-inch, PVC force main and a pump station to serve a 124 unit residential subdivision. The pump station will be equipped with duplex submersible pumps, each rated at 76 gallons per minute at 117 feet TDH. The system will be owned by King William County.

The evaluation of these plans and specifications has been confined to technical requirements and design criteria, as stipulated in the Commonwealth of Virginia *Sewage Collection and Treatment Regulations*.

In accordance with Virginia Water Control Law, *Code of Virginia*, 1950 as amended in Title 62.1, Section 62.1-44.19, this letter report is to advise that the previously mentioned plans and specifications are technically adequate and are approved by this office with the condition that an Operations and Maintenance Manual is submitted for approval by the Department Of Environmental Quality before issuance of a Certificate to Operate.

King William County
Central Crossing Subdivision
Section 2 Pump Station
22506

One copy of the previously described report with Virginia Department of Environmental Quality approval stickers is enclosed.

This letter provides your authorization to construct the previously described project. This approval is valid for 5 years from the date of this approval letter. This letter also provides your authorization by DEQ to operate the previously described project for 30 days after construction and prior to issuance of a Certificate to Operate.

Once the project is completed, this Office will need a statement of completion from the licensed engineer who oversaw construction of the project. At that time, this Office will initiate the certificate to operate process.

Sincerely,

Raymond R. Barrows, Jr., P.E.
Area Engineer
Office of Wastewater Engineering

J. R. Bell Jr., DEQ-PRO
Thomas Irungu, M.D., M.P.H., Director, Three Rivers Health District
James C Pyne, Ph.D., P.E., HRSD
Frank A. Pleva, Administrator, King William County
James H. Christian, P.E., Timmons Group

5/06

Project: Central Crossings 2

PUMP STATION
REVIEW FORM

Page 1 of 6
Date 2/20/07
Reviewed By: RRB

REQUIREMENT	REFERENCE	COMMENTS
Location of Pump Station: King William, Central Garage		
Buffer zone: 100' +	sh 3	100' recommended
Station Protected from 100-year flood: above		
Fully operational during 25-year flood: OK		
All-weather access road provided: OK		

RECEIVING FACILITIES accepted by King William and HRSD

Capacity of receiving sewer line _____ MGD		Adequate?
Capacity of receiving pump stations _____ MGD		Adequate?
Capacity of receiving STW = _____ MGD _____ STP average flow (1 yr.) _____ MGD		Adequate?

PRETREATMENT

Discharge piping designed to prevent grit from settling in lines of pumps not in operation: (Y/N)	
Briefly describe any pretreatment provided: (restaurants must have a grease trap)	None

PUMPING UNITS

Type of Pumps Provided: submersible, grinder		
Number of pumping units provided: 2		minimum of 2

Pump No.	Friction Head (ft)	Static Head (ft)	Rated Capacity (gpm)	Rated TDH (ft)	Operating Capacity (gpm)	Computed TDH (ft)	Variable Constant Speed
1-2	68	48	76	116	82	116	C

5/06

Project: Central Crossings 2

PUMP STATION
REVIEW FORM

Page 2 of 6
Date 2/28/07
Reviewed By: RRB

STATIC HEAD: -

High point elev:
Pump Off elevation:

RESIDUAL HEAD: -

FRICTION HEAD; -

APPERTENANCE:

C =

EQ LENGTH OF PIPE, ft

Friction losses:

FLOW (gpm)	RES + STATIC HD (ft)	FRICTION LOSSES (ft)	TDH (ft)	velocity (fps)	loss/100' (ft)

Plot FLOW against TDH on the next page (pump curve).

The pumps will operate at 95 gpm vs. 114 feet TDH,
to 213 gpm vs. 71 feet TDH.
powered by a 7.5 HP electric motor.

5/06

Project: Central Crossings 2

PUMP STATION
REVIEW FORM

Page 3 of 6
Date 2/20/07
Reviewed By: RRB

REQUIREMENT	REFERENCE	COMMENTS
Is capacity of pumping equipment adequate? (Y/N)		
Can peak flow be pumped with largest unit out of service? (Y/N)		
Alternating control: yes	spec 13709	
Type of control mechanism: float switch	"	Adequate?
Controls adequately protected from the weather: (inside or NEMA rated: yes)		
Junction Box out of Wet Well? yes	sh 5	
Individual suction and intake lines:	N/A	
Suction line size ____ inches	N/A	4-inch minimum
Velocity (range) in suction line ____ fps	N/A	2 to 6 fps
Discharge line size 4 inches		$\frac{80}{2.5 \times 16}$
Velocity (range) in discharge line 2 fps		2 to 8 fps
Are line sizes and velocities adequate? (Y/N)		
Is there a limit switch? (Y/N) Velocity range ok? (Y/N) (If the velocity is low, they can use a proximity switch)		
Is gate valve provided on each suction line? (Y/N)	N/A	
Gate valve and check valve on each discharge line? (Y/N)	sh 4	both on each line
Size of spheres that pass through pump ____ inches	N/A	minimum 3" diameter Can pass 2" if a ≤ 2" bar screen is provided
If less than 3 inches, explain: grinder		
Adequate lighting provided? (Y/N)	portable	to work at night

SUBMERSIBLE PUMP STATIONS

Provisions for pump quick disconnect & reconnect:	spec 11132	for small stations
Hoist and accessories: yes	sh 5	
Shut-off & check valves located in a separate vault? (Y/N)	sh 4	

SUCTION LIFT STATIONS

Net positive suction head requirements met? (Y/N)		
Air relief piping on pump discharge line? (Y/N)		min. 1.25" diameter
Pumps, shutoff, & check valves located outside wet well?		
Separate access to wet well provided? (Y/N)		

5/06

Project: Cantwell Crossing 2

PUMP STATION REVIEW FORM

Date 2/20/07

Reviewed By: RKB

REQUIREMENT	REFERENCE	COMMENTS
WET WELL		
Is there mechanical equipment/screens which requires personnel to enter the wet well? (Y/N)	_____	If yes, there must be mechanical ventilation
If "No", is a 4-inch downward-facing, screened vent provided? (Y/N)	_____	
Volume from floor to rim = _____ cu. ft. (next page)	_____	
Ventilation fan capacity _____ cfm	_____	
Air changes per hour (30 air changes/hr minimum for intermittent operation) (12 air changes/hr minimum for continuous operation)		
air changes/hr = fan capacity x 60 / volume = (cfm) x 60 / (cu. ft.) =		air changes/hr
Is ventilation adequate? (Y/N)		
Fan of non-sparking variety? (Y/N)	_____	
Adequate access provided? (Y/N)	_____	to pull equipment
Wet well fillets provided? (Y/N) Slope 1:1	_____	minimum of 1:1
Wet well divided? (Y/N) If "yes", properly interconnected? (Y/N)	_____	
Volume between pump off and pump 1 on = 380 gallons		
Is design adequate to prevent both pump from overheating due to excessive starts and septic conditions due to excessive detention time? (Y/N)		
DRY WELL		
Adequate access provided? (Y/N)	_____	
Provisions for removing equipment? (Y/N) Describe	_____	
Sump pump provided? (Y/N) Discharge point _____	_____	Back to wet well and down towards the water level
Gate valve provided on suction line? (Y/N)	_____	
Volume of dry well = _____ cu. ft.	_____	
Ventilation fan capacity _____ cfm	_____	
Air changes per hour (30 air changes/hr minimum for intermittent operation) (12 air changes/hr minimum for continuous operation)		
air changes/hr = fan capacity x 60 / volume = (cfm) x 60 / (cu. ft.) =		air changes/hr
Is ventilation adequate? (Y/N)		

5/06

Project: Central Crossings 2

PUMP STATION REVIEW FORM

Date 2/20/07

Reviewed By: RRB

Wetwell:

Elevations

--Top = 130

--Ground =

--Inlet = 113

--Alarm = 112.5

--Lag Pump On = 112

--Lead Pump On = 111.5

--Pump Off = 109.5

--Intake = 108

--Floor = 117.5

WETWELL

A. TOTAL VOLUME:

B. OPERATING VOLUME:

C. ABOVE ALARM VOLUME:

VFD open

CYCLE TIME

1. PUMP TIME = $\frac{\text{OPERATING VOLUME}}{\text{PUMP RATE - MIN. INFLOW}}$ $\frac{2 \times 380}{76 - 15} = 11$

2. FILL TIME = $\frac{\text{OPERATING VOLUME}}{\text{MINIMUM INFLOW}}$ $\frac{2 \times 380}{15} = 30$

3. CYCLE TIME = 41

4. OVERFLOW TIME = $\frac{\text{ABOVE ALARM VOLUME}}{\text{PEAK FLOW IN}}$ $\frac{380 \times 12}{95} = 48$

NET POSITITVE SUCTION HEAD:

Atmospheric Head	(+)	33.9
Vapor Head	(-)	-1.0
Friction Head	(-)	
Suction or Head (+) Lift(-)		
Safety Factor		-2.0
NPSH Available		
NPSH Required		

($NPSH_A$ must be > $NPSH_R$)

SUBMERGENCE:

5/06

Project: Centralia Crossings 2

PUMP STATION REVIEW FORM

Page 6 of 6
Date 8/20/07
Reviewed By: RRD

REQUIREMENT	REFERENCE	COMMENTS
FLOW MEASUREMENT (IF PROVIDED)		
Type of measuring device _____	none	
Capacity/Rating _____ Properly Sized? (Y/N)	_____	
CROSS-CONNECTION CONTROL		
RPZ device on potable water line to pump station?	_____	
If "No", explain	internal to hydrant	
Seal water system provided? (Y/N) Adequately protected? (Y/N)	_____	
RELIABILITY		
Reliability Class	II	
Provision for continuous operability provided?	no	
Describe provision _____ Adequate? (Y/N)		
Is adequate power distribution provided? (Y/N)	_____	capable of starting the specified pumps
Breaker settings or fuse ratings adequate? (Y/N)	_____	
Electrical control center locations adequate? (Y/N)	_____	inside and be able to see the pump station
Are 3-phase motors adequately protected from short circuits and overloads? (Y/N)	_____	check the phase that is available to the station
Low voltage protection for motors? (Y/N)	_____	all pump motors
Emergency power equipment adequately located? (Y/N)	_____	
Adequate emergency power generator starting system?	N/A	battery with a trickle charge or can start three consecutive times
Is the alarm system adequate for the designated reliability class? (Y/N)	local + relay	

(Class I must monitor main power supply, auxiliary power supply, failure of each pump to discharge, and high liquid level in wet/dry wells; and be equipped with a test function and a back-up power supply. On-site audio-visual alarm required with telemetry to site manned 24 hours per day.) Decibel rating for the audio alarm = _____ decibels at _____ feet.

(Class II/III must monitor high liquid level in wet well with on-site audio/visual alarm.)

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.

TRANSMITTAL

TO: Reed Barrows
DEQ
4949-A Cox Road
Glen Allen, VA 23060

Date: 2/6/2007 Job #: 22917
Project: Central Crossing - Sec. 2
Reference:
Copies Sent To:

RECEIVED
FEB 07 2007
PRO

☒ ENCLOSED PLEASE FIND:
☐ WE ARE SENDING UNDER SEPARATE COVER:

COPIES	DATE	NUMBER	DESCRIPTION
1			Plans and Specifications for Central Crossing - Sec. 2
2			Calculations

THESE ITEMS ARE TRANSMITTED:
If enclosures are not as noted, please notify us at once.

COMMENTS: Please review the enclosed for DEQ a

Reed - Please note that only one set of plans is enclosed. Additional copies will be submitted upon approval or at your request.

cc: Terry Cave
Charles Riedlinger
King William County Planning Dept.

SIGNED: Judy Ding
Judy Ding, PE, Project Manger

2/6/07

1001 Boulders Parkway, Suite 300 | Richmond, VA 23225
TEL 804.200.6500 FAX 804.560.1016
www.timmons.com
Site Development | Residential | Infrastructure | Technology

RECEIVED
DEC 07 2007
PRO

DEQ SUBMITTAL FORM

SEWERAGE PLANS AND/OR SPECIFICATIONS

County/City: King William Co.

Project: Central Crossing - Section 2

I. The following items must be submitted with the plans and/or specifications.

- ✓ project cost = $ 310,000
- ✓ one set of design calculations
- ✓ pump curve
- ✓ buoyancy calculations
- ____ flow certificate (requested or enclosed) Previously Submitted
- ____ flow acceptance letter
- N/A portable equipment form
- ✓ correct number of plans and/or specifications*

* four sets of plans and/or specifications are required for approval, but one set can be submitted initially

II. The following items must be on the plans or in the specifications.

- ✓ original P.E. seal, signature, and date on each cover sheet (plans and specifications)
- ✓ facsimile P.E. seal and signature on each subsequent plan sheet
- ✓ date on plans and specifications
- ✓ adequate title
- ✓ legible plans
- ✓ owner of the sewerage project with an address and phone number
- ✓ engineer with an address and phone number
- ✓ project location (1:2000 map)
- ✓ site plan with topography
- ✓ plan and profile views
- ✓ City/County specifications identified (if used)
- N/A manhole stationing and sewer slopes
- ✓ method of continuous operation = Emergency Pump Connection
- ✓ alarm system
- ✓ electrical specifications
- ✓ available power to the site = 208Y/120 volts and 3 phase

All gravity sewer and force main projects must be submitted to the Department of Environmental Quality (DEQ) for review. All pump stations with $\geq$ 25 gpm pump rate (at 100 feet TDH) must be submitted to DEQ for review. DEQ reviews all VPDES discharge sewage treatment facilities projects and vacuum sewerage systems.

TABLE OF CONTENTS

Design Summary 1
WATERCAD® Model Summary 2
Sewage Flow Projections 3
Design Considerations 4
Central Crossing Section 2 Pump Station Design 5
Central Crossing 2 Wetwell Design 5
Wet Well Buoyancy 6
All Pumps Stations Running 7
System Head Curve: All Pump Stations Running 7
Only Central Crossing Section 2 Pump Station Running 8
System Head Curve: Only Central Crossing Section 2 Running 8
Manufacturer's Pump Curve 10
Forcemain Design 11
Pipe Selection 11
Pipe Schematic 12
Hydraulic Analysis 13
WaterCAD® Output – ALL Pumps Running 14
WaterCAD® Output –Only Central Crossing Section 2 Pump Station Running 17
Water Hammer Analysis 22
Central Crossing 2 Pump Station: Hydraulic profile, All Pumps Running 23
Hydraulic profile: Only Central Crossing 2 Pump Station Running 24
APPENDIX 25
WaterCAD® Hydraulic Analysis Outputs 25
Appendix A: Hydraulic Analysis – Only Kennington Pump Station Running 26
Appendix B: Hydraulic Analysis – Only McCauley Pump Station Running 29
Appendix C: Hydraulic Analysis – Only Central Crossing Section 1 Pump Station Running 33
Appendix D: Hydraulic Analysis – Dead Head Condition 37

LIST OF TABLES

Table 1 Central Garage Projects Flow Projections 3
Table 2 Water Hammer Analysis 22

LIST OF FIGURES

Figure 1 Central Crossing 2 Pump and System Head Curves 9

Figure 2 Manufacturer's Pump Head and System Head Curves 10

Design Summary

Central Crossing 2 Pump Station: Design Peak Flow 76 gpm

Pump Operating Range

95 gpm	vs.	**116.7 ft** TDH
213 gpm	vs.	**77.5ft** TDH

Powered by a **7.5 HP** electric motor.

Additional information

Kennington Pump Station: Design Peak Flow 386 gpm

Pump Operating Range

393 gpm	vs.	214.93 ft TDH
501 gpm	vs.	196.81 ft TDH

Powered by a 60 HP electric motor.

McCauley Pump Station: Design Peak Flow 248 gpm

Pump Operating Range

248 gpm	vs.	233.80 ft TDH
353 gpm	vs.	209.64 ft TDH

Powered by a 50 HP electric motor.

Central Crossing 1 Pump Station: Design Peak Flow 45 gpm

Pump Operating Range

24 gpm	vs.	176 ft TDH
115.4 gpm	vs.	66.26ft TDH

Powered by a 10 HP electric motor.

WATERCAD® Model Summary

Pump Station	LWL Elevation (ft)	Discharge (gpm)	Pump Name & Model	Discharge Pump Pressure (psi)	Pump Head (ft)	Discharge Pump Grade (ft)
Central Crossing 2	**109.5**	**95**	**Flygt M3127-266**	**38.03**	**87.9**	**197.4**
Central Crossing 2 Alone	**109.5**	**213.14**		**15.12**	**34.94**	**144.44**
Kennington	71	393	Flygt C-3201-325SH	76.04	175.76	246.76
Kennington Alone	71	501		73.45	169.77	240.77
McCauley	56.5	248	Myers 4RC-7.25	84.01	194.18	250.68
McCauley Alone	56.5	352.9		78.77	182.05	238.55
Central Crossing 1	115	24	Flygt M3102-262	48.16	111.31	226.31
Central Crossing 1 Alone	115	115.4		11.74	27.13	142.13

Sewage Flow Projections

Table 1 Central Garage Projects Flow Projections

TIMMONS GROUP
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Central Garage Projects, King William County, Virginia						
Discharge Facility	**Qty**	**Flow Rate GPD-1**	**Average Daily Flow GPD**	**Peaking Factor**	**Average Peak Flow GPD**	**Average Peak Flow GPM**
Central Crossing 2						
Single Family	**124**	**350**	**43,400**	**2.5**	**108,500**	**75**
		Total	**43,400**	**2.5**	**108,500**	**75**
Kennington						
Single Family	229	350	80,150	2.5	200,375	139
Town home	172	350	60,200	2.5	150,500	105
Retail	26	2,000	51,980	2.5	129,950	90
Office	20	1,500	30,255	2.5	75,638	53
		Total	222,585	2.5	556,463	386
Discharge Facility	Qty	Flow Rate GPD-1	Average Daily Flow GPD	Peaking Factor	Average Peak Flow GPD	Average Peak Flow GPM
Central Crossing I						
Discharge Facility	Qty	Flow Rate GPD-1	Average Daily Flow GPD	Peaking Factor	Average Peak Flow GPD	Average Peak Flow GPM
Single Family	66	350	23,100	2.5	57,750	40
		Total	23,100	2.5	57,750	40

McCauley Park						
Discharge Facility	Qty	Flow Rate GPD-1	Average Daily Flow GPD	Peaking Factor	Average Peak Flow GPD	Average Peak Flow GPM
Single Family-Sec 2	75	350	26,250	2.5	65,625	46
Single Family-Sec 3	74	350	25,900	2.5	64,750	45
Multifamily	93	350	32,550	2.5	81,375	57
Retail	18	2,000	35,960	2.5	89,900	62
Office	10	1,500	15,000	2.5	37,500	26
		Total	135,660	2.5	339,150	236
					Use	248

Design Considerations

1. Sewage Flow Projections are based on the King William County Design Standards for Gravity Sewer, Section 2.2.02 and for Water Distribution Facilities, Section 4.2.04.

2. The Forcemain from Central Crossing Section 2 manifolds at J-17 into the forcemain carrying flow from Central Crossing Section 1, McCauley and Kennington Pump Stations. J-17 is the point of transition from 8" diameter HDPE pipe to 10" diameter HDPE pipe.

3. Calculations are provided for Central Crossing Section 2 with:
   a. Central Crossing Section 2, Central Crossing Section 1, McCauley and Kennington Pump Station Running at the same time and
   b. Only Central Crossing Section Pump Station Running by itself.

   c. Additional design calculations are provided for Central Crossing Section 1, McCauley and Kennington Pump Station in the appendix for reference only.

4. From the pumping system schematic, sewage flow by gravity would occur from J-25 to the wastewater treatment plant (WWTP) creating a vacuum/introducing air in the forcemain. Per HRSD comments, this is not acceptable.

5. A Pressure Sustaining Valve/Control Valve is provided at the Wastewater Treatment Plant, to maintain a full pipe and prevent introducing air into the forcemain.

6. C-Factor normally used for plastic pipe is 130. A lower C-Factor of 125 was used in the calculation of friction losses, to account for fitting losses along the forcemain.

7. Forcemain hydraulic analysis with the Pressure Control Valve was performed using WaterCAD® software. Data below shows hydraulic conditions when:
   a. All Pumps are running (CONTROL STATUS: ON)
   b. Only one of each pump is running

8. Water hammer/surge analysis was performed for the pumping system.
   a. The highest pressure is experienced at McCauley Pumping Station. A pressure relief valve (PRV) was recommended at this location.
   b. An additional PRV is to be installed at Kennington Pumping Station.

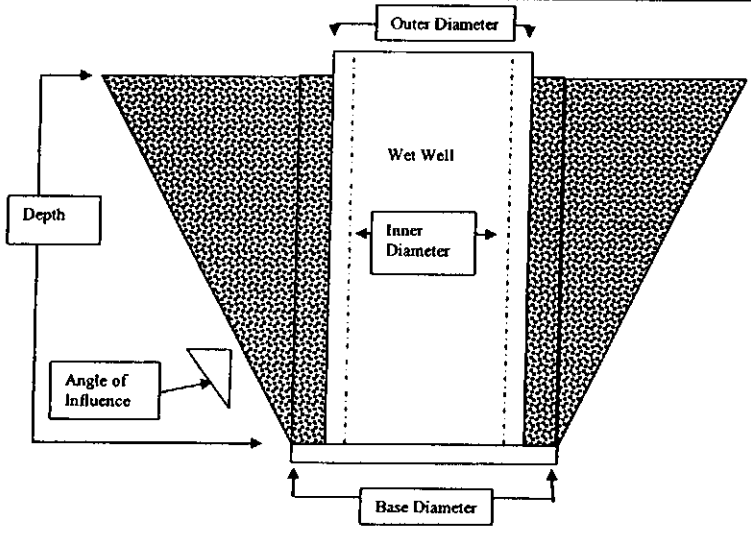
Central Crossing Section 2 Pump Station Design

Central Crossing 2 Wetwell Design

Pump Station Capacity			
Description	***Value***	***Units***	***Notes***
Average Daily Flowrate	0.044	MGD	$Q_p = 3.5(Q_a^{0.807})$
Calculated Sewer Peak Factor	6.40		Based on $\frac{18 + \sqrt{P}}{4 + \sqrt{P}}$ (p=pop. in 1000s)
Calculated Peak Hour Factor	4.00		
Calculated Peak Capacity	1.500	MGD	
Peak Factor Used	2.50		
Design Flowrate	76	gpm	
Wet Well Sizing			
Description	***Value***	***Units***	***Notes***
Wetwell Diameter	8.00	feet	Provides for 100% additional Storage Vol.
Minimum Pump Cycle	20	min	
Unit Volume	376	gal/ft	$V = \frac{TP}{4}$
Wet Well Drawdown Volume	380	gal	Based on
Minimum Flowrate (VFD Operation)	76	gpm	
Minimum Operating Depth	1.01	ft	
Control Settings			
100-year Flood Plain Elevation	n/a	ft	From FEMA Maps
Top of Wet Well	130.00	ft	From Site Survey
Lowest Invert In	113.00	ft	1 feet of safety included
High Level Alarm	112.50	ft	0.50' Below Influent Line
Lag Pump On	112.00	ft	0.50' Below High Level Alarm
Lead Pump On	111.50	ft	0.50' Below Lag Pump On
Both Pumps Off	109.50	ft	2.00' Below Both Pump Off
Pump entrance diameter	3.00	inches	
Minimum Submergence	0.95	ft	H.I. Stds: S=(1+2.3*F*)D where F=v(gD)$^{-0.5}$
Suction Entrance Elevation	108.00	ft	1.50' Below Both Pump Off
Wetwell Floor	107.50	ft	6" Below Suction Entrance
Depth of Wet Well	22.50	ft	
Pump Station Head Loss - Discharge Side			
Description	***Value***	***Units***	***Notes***
Pump Station Pipe Diameter	4	inch	
Pump Station Pipe "c" value	120		(Hazen-Williams)
Equivalent Length of Fittings	76.19	ft	From Fitting Friction Loss Table at Right
Straight Pipe Quantity	21	ft	
Total Equivalent Length	97.19	ft	Use 150 ft
Pump Station Head Loss	0.52	ft	

Wet Well Buoyancy

Wet Well Buoyancy			
Description	***Value***	***Units***	***Notes***
Outer Diameter	14.0	ft	
Inner Diameter	8.0	ft	
Depth	22.5	ft	
Concrete Volume	2,333	ft^3	
Wetwell Weight	338,232	lb	Based on 145 lb/ft^3
Displaced Volume	3,464	ft^3	
Buoyancy Force	216,129	lb	
Buoyant Weight of Wetwell	122,103	lbs	Wetwell is not buoyant
Base Buoyancy Credit			
Description	***Value***	***Units***	***Notes***
Base Diameter	14.0	ft	6" Minimum Base Recommended
Base Thickness	1.0	ft	
Concrete / Displaced Volume	154	ft^3	
Base Weight	22,321	lb	Based on 145 lb/ft^3
Buoyancy Force	9,606	lb	
Buoyant Weight of Base	12,715	lb	
Buoyant Weight of Structure	*134,818*	lb	Structure is not buoyant without soil
Soil Impact			
Description	***Value***	***Units***	***Notes***
Angle of Influence	30.0	degrees	
Angle of Influence	0.524	radians	
Top of Triangle	98	ft	
Top Diameter	210	ft	
Bottom Diameter	14	ft	
Saturated Soil Density	110.0	lb/ft^3	From Geotechnical Report / Estimate
Depth of Soil above Base	169.5	ft	
Volume of Soil	2,064,649	ft^3	Volume of Soil (frustrum of cone, less wetwell)
Buoyant Weight of Soil	98,277,309	lb	
Buoyancy Float Check			
Description	***Value***	***Units***	***Notes***
Total Difference	122,103	lb	Structure is not buoyant



All Pumps Stations Running

Data source: WaterCAD® model

Pump Station Name	Central Crossing 2	
Location	King William County	
Grade Elevation	130	ft
Hundred-Year Flood Elev.:		
Average Flow	30.4	gpm
Peak Factor	2.5	
Peak Flow	76	gpm
WaterCAD Uses	95	gpm
Pump Station Size	0.044	MGD
Pump Station Capacity	0.109	MGD
Static Head:	**48.50**	ft
High Point Elevation:	158	ft
Pump Off Elevation:	109.5	ft
Friction Head:	**68.22**	ft
Total Dynamic Head	**116.7**	ft

Junction	**Diameter**	**Flow**	**Forcemain Length**	**Headloss**	**Total Friction Headloss**
	(in)	**gpm**	**ft**	**ft/ft**	**ft**
Pump Station Losses	4	95	150	0.02887	4.33
J-41 to J-17	6.1	95	700	0.00095	0.66
J-17 to WWTP	9.7	760	13,587	0.00465	63.23
			14,437	0.004725	**68.22**

Equivalent Forcemain Diameter	9.7	Inches
C- Factor	125	Typical 130, Lower C used to account for fitting loses
Head Loss at 95 gpm	0.0000998	ft/ft
Equivalent Velocity in Forcemain	0.33	ft/s
Forcemain Equivalent Length	683,776	ft (Includes pump Station/Appurtenances Headlosses)

System Head Curve: All Pump Stations Running

Flow (gpm)	Static Head (ft)	Friction Losses (ft)	TDH (ft)	Velocity (fps)	Pump Curve (Ft)
0	48.5	0.0	48.5	0.00	154
10	48.5	1.1	49.6	0.04	150
30	48.5	8.1	56.6	0.13	145
40	48.5	13.7	62.2	0.17	137
60	48.5	29.0	77.5	0.26	128
76	48.5	44.9	93.4	0.33	120
95	**48.5**	**67.9**	**116.4**	0.41	98
102	48.5	77.5	126.0	0.44	16

Only Central Crossing Section 2 Pump Station Running

Data source: WaterCAD® model

Pump Station Name	Central Crossing 2	
Location	King William County	
Grade Elevation	130	ft
Hundred-Year Flood Elev.:		ft
Average Flow	30.4	gpm
Peak Factor	2.5	
Peak Flow	76	gpm
WaterCAD use	213	gpm
Pump Station Size	0.044	MGD
Pump Station Capacity	0.109	MGD
Static Head:	**48.50**	ft
High Point Elevation:	158	ft
Pump Off Elevation:	109.5	ft
Friction Head:	**28.96**	ft

Total Dynamic Head 77.5 ft

Junction	**Diameter**	**Flow**	**Forcemain Length**	**Headloss**	**Total Friction Headloss**
	(in)	**gpm**	**ft**	**ft/ft**	**ft**
Pump Station Losses	4	213	150	0.13327	19.99
J-41 to J-17	6.1	213	700	0.00423	2.96
J-17 to WWTP	9.7	213	13,587	0.00044	6.01
			14,437	0.002006	**28.96**
Equivalent Forcemain Diameter	9.7	inches			
C- Factor	125	Typical 130, Lower C used to account for fitting loses			
Head Loss at 76 gpm	0.0000657	ft/ft			
Equivalent Velocity in Forcemain	0.33	ft/s			
Forcemain Equivalent Length	440,553	ft (Includes pump Station/Appurtenances Headlosses)			

System Head Curve: Only Central Crossing Section 2 Running

Flow (gpm)	**Static Head (ft)**	**Friction Losses (ft)**	**TDH (ft)**	**Velocity (fps)**	**Pump Curve (ft)**
0	48.5	0.0	48.5	0.00	154
10	48.5	0.1	48.6	0.04	150
30	48.5	0.8	49.3	0.13	145
40	48.5	1.3	49.8	0.17	137
60	48.5	2.8	51.3	0.26	128
76	**48.5**	**4.3**	**52.8**	**0.33**	**120**
90	48.5	5.9	54.4	0.39	98
102	48.5	7.4	55.9	0.44	16
213	**48.5**	**29.0**	**77.5**	0.92	--

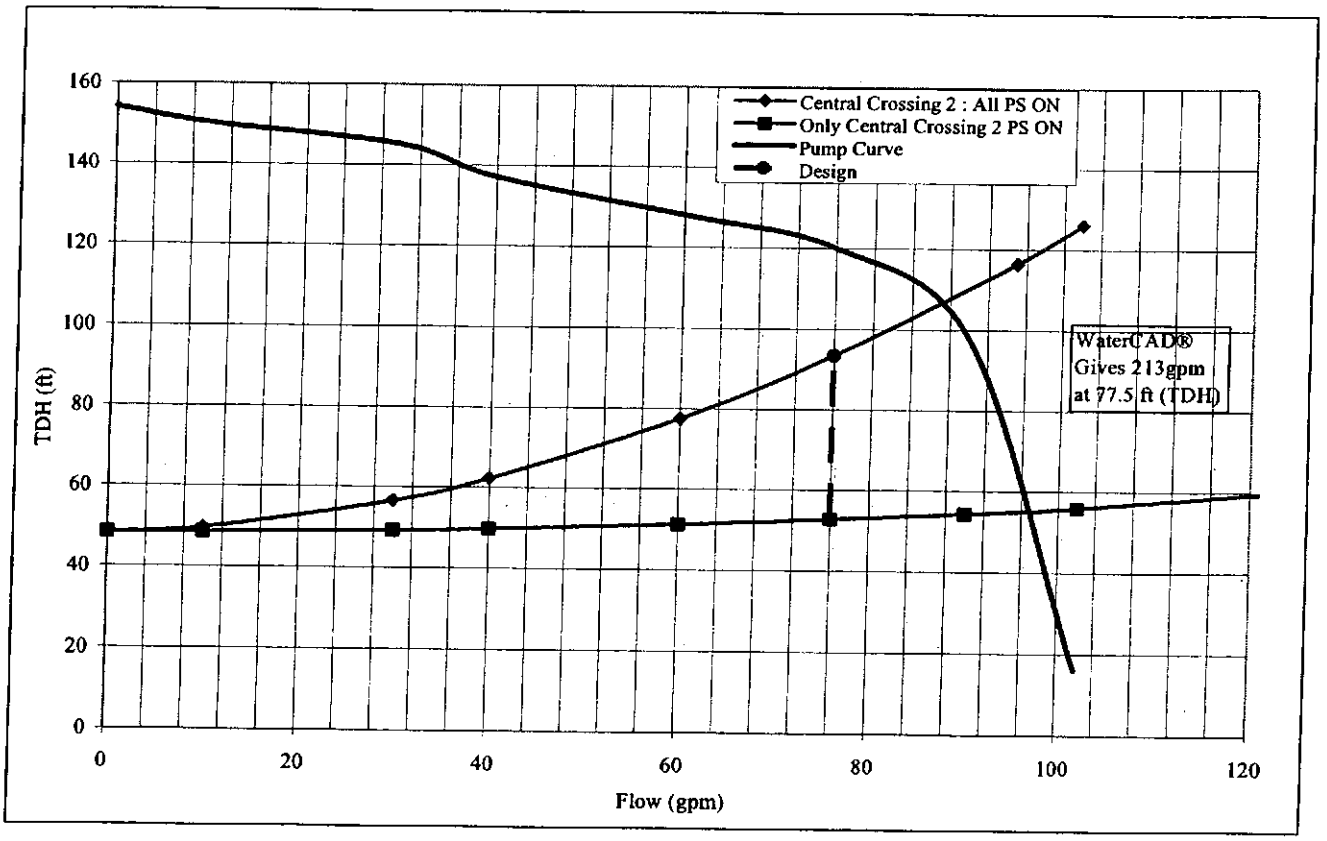


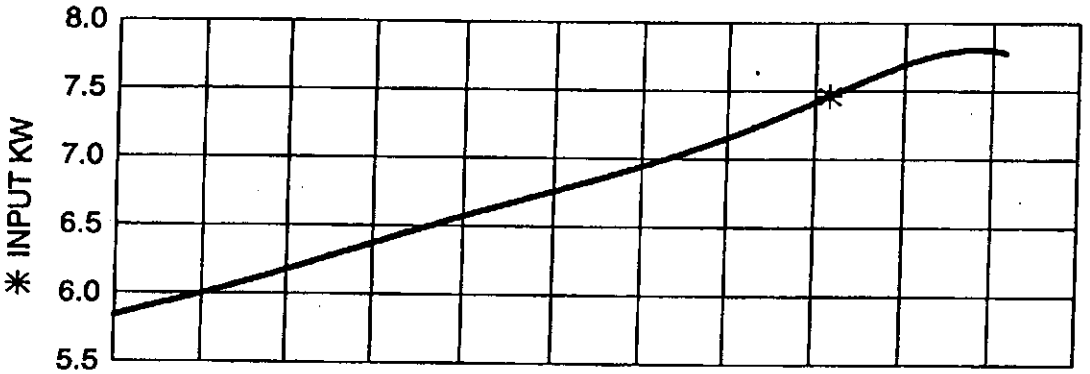
Figure 1 Central Crossing Section 2 Pump and System Head Curves

The Pump will operate at:

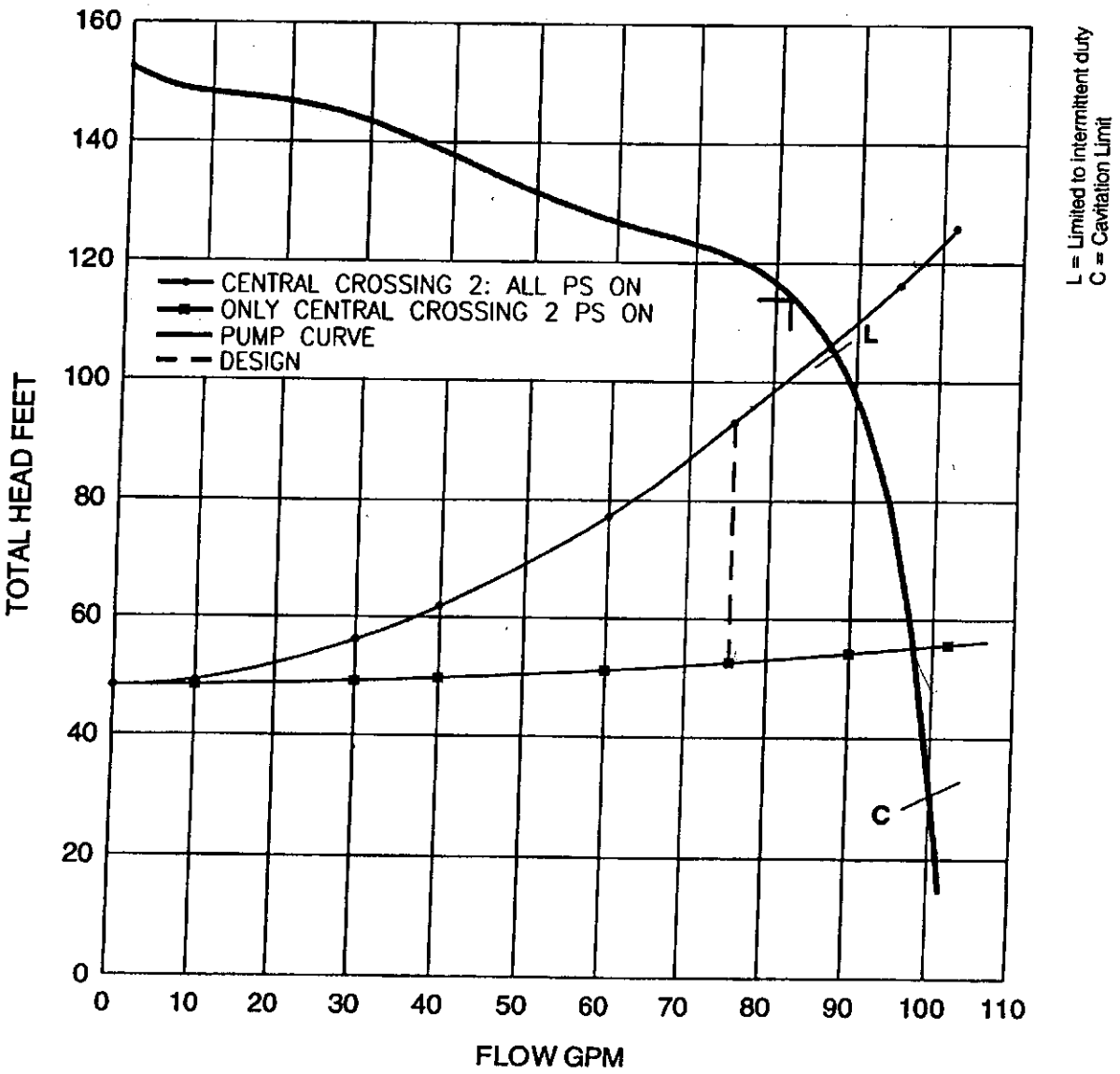
95 gpm vs. **116.7 ft** TDH
to **213 gpm** vs. **77.5 ft** TDH.

Powered by a 7.5 HP electric motor.

See actual manufacturer's pump curve on next page.



FLYGT M-3127 PUMP
W/ 266 IMPELLER



Forcemain Design

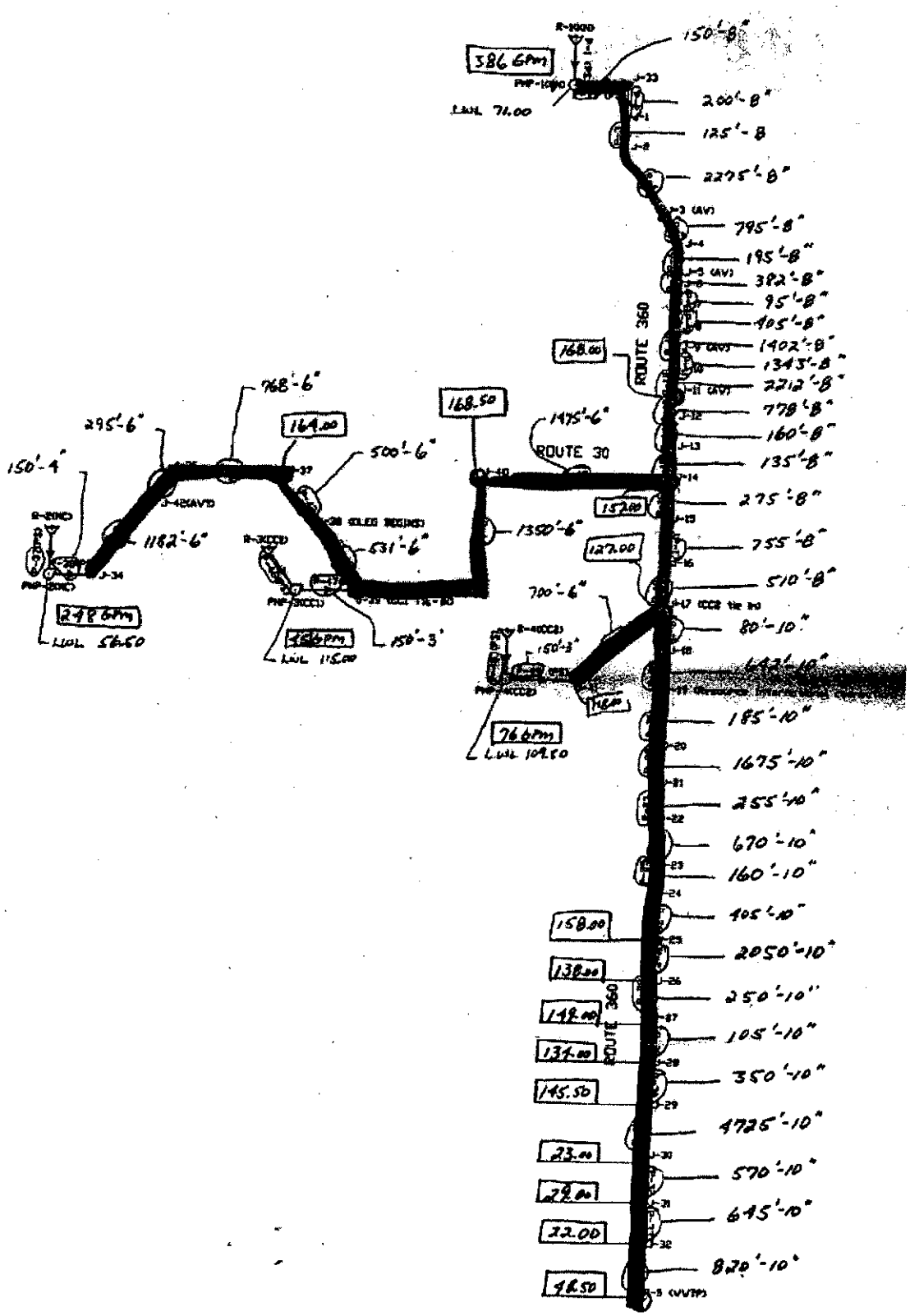
Pipe Selection

HDPE Pipe Class 100DR-17 ..... (Source: ISCO HDPE Product Catalog.)

Pipe Size	ID
6"	6.056"
10"	9.742"

4" Pipe and 3" Pipe at the Pump Stations is Ductile Iron. Nominal Pipe Sizes were used and 150" length was used for equivalent Equipment and Pipe Loss. The Nominal ID was used for calculations.

Pipe Schematic



Hydraulic Analysis

Additional hydraulic analysis data for Central Crossing Section 1, Kennington and McCauley Pumping stations is provided in the Appendix.

Scenario: Base
Steady State Analysis
Pump Report

Label	Elevation (ft)	Control Status	Discharge Pump Grade (ft)	Intake Pump Grade (ft)	Discharge (gpm)	Pump Head (ft)	Calculated Water Power (Hp)
PMP-1(KN)	71.00	On	246.76	71.00	392.91	175.76	17.43
PMP-2(MC)	56.50	On	250.68	56.50	247.91	194.18	12.15
PMP-3(CC1)	115.00	On	226.31	115.00	23.98	111.31	0.67
PMP-4(CC2)	109.50	On	197.40	109.50	95.38	87.90	2.12

Scenario: Base
Steady State Analysis
Pipe Report

Label	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)
P-1 (PS	0.10	30.0	125.0	392.91	0.00	0.00
P-3	125.00	7.9	125.0	392.91	0.46	3.70
P-4	2,275.00	7.9	125.0	392.91	8.42	3.70
P-5	795.00	7.9	125.0	392.91	2.94	3.70
P-6	195.00	7.9	125.0	392.91	0.72	3.70
P-7	382.00	7.9	125.0	392.91	1.41	3.70
P-8	95.00	7.9	125.0	392.91	0.35	3.70
P-9	405.00	7.9	125.0	392.91	1.50	3.70
P-10	1,402.00	7.9	125.0	392.91	5.19	3.70
P-11	1,343.00	7.9	125.0	392.91	4.97	3.70
P-13	778.00	7.9	125.0	392.91	2.88	3.70
P-14	160.00	7.9	125.0	392.91	0.59	3.70
P-15	135.00	7.9	125.0	392.91	0.50	3.70
P-16	275.00	7.9	125.0	664.79	2.70	9.80
P-17	755.00	7.9	125.0	664.79	7.40	9.80
P-18	510.00	7.9	125.0	664.79	5.00	9.80
P-19	80.00	9.7	125.0	760.18	0.37	4.62
P-20	642.00	9.7	125.0	760.18	2.97	4.62
P-21	185.00	9.7	125.0	760.18	0.86	4.62
P-22	1,675.00	9.7	125.0	760.18	7.75	4.62
P-23	255.00	9.7	125.0	760.18	1.18	4.62
P-24	670.00	9.7	125.0	760.18	3.10	4.62
P-25	160.00	9.7	125.0	760.18	0.74	4.62
P-26	405.00	9.7	125.0	760.18	1.87	4.62
P-27	2,050.00	9.7	125.0	760.18	9.48	4.62
P-28	250.00	9.7	125.0	760.18	1.16	4.62
P-29	105.00	9.7	125.0	760.18	0.49	4.62
P-30	350.00	9.7	125.0	760.18	1.62	4.62
P-31	4,725.00	9.7	125.0	760.18	21.85	4.62
P-32	570.00	9.7	125.0	760.18	2.64	4.62
P-33	645.00	9.7	125.0	760.18	2.98	4.62
P-35 (P	150.00	7.9	125.0	392.91	0.56	3.70
P-2	200.00	7.9	125.0	392.91	0.74	3.70
P-37(PS	0.10	30.0	125.0	247.91	0.00	0.00
P-38(PS	150.00	4.0	125.0	247.91	6.51	43.42
P-41	768.00	6.1	125.0	247.91	4.27	5.56
P-42	500.00	6.1	125.0	247.91	2.78	5.56
P-43	531.00	6.1	125.0	247.91	2.95	5.56
P-44	1,350.00	6.1	125.0	271.88	8.90	6.60
P-45	1,475.00	6.1	125.0	271.88	9.73	6.60
P-46(PS	0.10	30.0	125.0	23.98	0.00	0.00
P-47(PS	150.00	3.0	125.0	23.98	0.35	2.33
P-48 (P	0.10	30.0	125.0	95.38	0.00	0.00
P-49 (P	150.00	3.0	125.0	95.38	4.51	30.07
P-50	700.00	6.1	125.0	95.38	0.66	0.95
P-51	1,182.00	6.1	125.0	247.91	6.57	5.56
P-52	295.00	6.1	125.0	247.91	1.64	5.56
P-12	2,212.00	7.9	125.0	392.91	8.19	3.70
P-34	820.00	9.7	125.0	760.18	3.79	4.62
P-54	20.00	12.0	125.0	760.18	0.03	1.64

Scenario: Base
Steady State Analysis
Junction Report

Label	Elevation (ft)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-1	87.00	245.46	68.56
J-2	83.50	245.00	69.87
J-3 (AV)	134.00	236.58	44.38
J-4	126.00	233.63	46.57
J-5 (AV)	129.50	232.91	44.74
J-6	113.50	231.50	51.05
J-7	117.50	231.15	49.17
J-8	108.00	229.65	52.63
J-9 (AV)	141.50	224.46	35.89
J-10	136.00	219.48	36.12
J-11 (AV	168.00	211.30	18.73
J-12	141.50	208.42	28.95
J-13	161.00	207.82	20.26
J-14	157.00	207.32	21.77
J-15	153.00	204.63	22.34
J-16	144.00	197.23	23.03
J-17 (CC	127.00	192.22	28.22
J-18	124.50	191.85	29.14
J-19 (Re	126.00	188.89	27.21
J-20	122.00	188.03	28.57
J-21	151.50	180.29	12.45
J-22	142.00	179.11	16.05
J-23	150.00	176.01	11.25
J-24	148.00	175.27	11.80
J-25	158.00	173.40	6.66
J-26	138.00	163.92	11.21
J-27	149.00	162.76	5.95
J-28	134.00	162.27	12.23
J-29	145.50	160.66	6.56
J-30	23.00	138.81	50.10
J-31	29.00	136.17	46.37
J-32	22.00	133.19	48.11
J-33	82.00	246.20	71.04
J-34	78.00	244.17	71.89
J-36	146.00	235.96	38.92
J-37	164.00	231.69	29.29
J-38 (OL	137.00	228.91	39.76
J-39 (CC	129.00	225.96	41.95
J-40	168.50	217.05	21.01
J-41	118.00	192.89	32.40
J-42(AV	158.00	237.60	34.44

Scenario: CC2 Pump Only
Steady State Analysis
Junction Report

Label	Elevation (ft)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-1	87.00	121.51	14.93
J-2	83.50	121.51	16.45
J-3 (AV)	134.00	121.51	-5.40
J-4	126.00	121.51	-1.94
J-5 (AV)	129.50	121.51	-3.46
J-6	113.50	121.51	3.47
J-7	117.50	121.51	1.74
J-8	108.00	121.51	5.85
J-9 (AV)	141.50	121.51	-8.65
J-10	136.00	121.51	-6.27
J-11 (AV)	168.00	121.51	-20.11
J-12	141.50	121.51	-8.65
J-13	161.00	121.51	-17.09
J-14	157.00	121.51	-15.35
J-15	153.00	121.51	-13.62
J-16	144.00	121.51	-9.73
J-17 (CC2 tie in)	127.00	121.51	-2.38
J-18	124.50	121.48	-1.31
J-19 (Resource International connection)	126.00	121.19	-2.08
J-20	122.00	121.11	-0.38
J-21	151.50	120.38	-13.47
J-22	142.00	120.27	-9.40
J-23	150.00	119.97	-12.99
J-24	148.00	119.90	-12.16
J-25	158.00	119.72	-16.56
J-26	138.00	118.82	-8.30
J-27	149.00	118.71	-13.10
J-28	134.00	118.67	-6.63
J-29	145.50	118.51	-11.68
J-30	23.00	116.44	40.43
J-31	29.00	116.19	37.72
J-32	22.00	115.91	40.63
J-33	82.00	121.51	17.09
J-34	78.00	121.51	18.82
J-36	146.00	121.51	-10.60
J-37	164.00	121.51	-18.38
J-38 (OLEG BEGINS)	137.00	121.51	-6.70
J-39 (CC1 TIE-IN)	129.00	121.51	-3.24
J-40	168.50	121.51	-20.33
J-41	118.00	124.45	2.79
J-42(AV?)	158.00	121.51	-15.79

Scenario: CC2 Pump Only
Steady State Analysis
Valve Report

Label	Elevation (ft)	Diameter (in)	Minor Loss Coefficient	Control Status	Discharge (gpm)	From HGL (ft)	To HGL (ft)	Headloss (ft)
PSV-1	48.50	6.0	0.00	Throttling	213.14	115.55	48.50	67.05

Scenario: CC2 Pump Only
Steady State Analysis
Pump Report

Label	Elevation (ft)	Control Status	Discharge Pump Grade (ft)	Intake Pump Grade (ft)	Discharge (gpm)	Pump Head (ft)	Calculated Water Power (Hp)
PMP-1(KN)	71.00	Off	121.51	71.00	0.00	0.00	0.00
PMP-2(MC)	56.50	Off	121.51	56.50	0.00	0.00	0.00
PMP-3(CC1)	115.00	Off	121.51	115.00	0.00	0.00	0.00
PMP-4(CC2)	109.50	On	144.44	109.50	213.14	34.94	1.88

Scenario: CC2 Pump Only
Steady State Analysis
Pipe Report

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Discharge (gpm)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)
P-1 (PS	30.0	0.10	125.0	0.00	0.00	0.00
P-3	7.9	125.00	125.0	0.00	0.00	0.00
P-4	7.9	2,275.00	125.0	0.00	0.00	0.00
P-5	7.9	795.00	125.0	0.00	0.00	0.00
P-6	7.9	195.00	125.0	0.00	0.00	0.00
P-7	7.9	382.00	125.0	0.00	0.00	0.00
P-8	7.9	95.00	125.0	0.00	0.00	0.00
P-9	7.9	405.00	125.0	0.00	0.00	0.00
P-10	7.9	1,402.00	125.0	0.00	0.00	0.00
P-11	7.9	1,343.00	125.0	0.00	0.00	0.00
P-13	7.9	778.00	125.0	0.00	0.00	0.00
P-14	7.9	160.00	125.0	0.00	0.00	0.00
P-15	7.9	135.00	125.0	0.00	0.00	0.00
P-16	7.9	275.00	125.0	0.00	0.00	0.00
P-17	7.9	755.00	125.0	-0.00	0.00	0.00
P-18	7.9	510.00	125.0	-0.00	0.00	0.00
P-19	9.7	80.00	125.0	-0.00	0.00	0.00
P-20	9.7	642.00	125.0	213.14	0.04	0.44
P-21	9.7	185.00	125.0	213.14	0.28	0.44
P-22	9.7	1,675.00	125.0	213.14	0.08	0.44
P-23	9.7	255.00	125.0	213.14	0.73	0.44
P-24	9.7	670.00	125.0	213.14	0.11	0.44
P-25	9.7	160.00	125.0	213.14	0.29	0.44
P-26	9.7	405.00	125.0	213.14	0.07	0.44
P-27	9.7	2,050.00	125.0	213.14	0.18	0.44
P-28	9.7	250.00	125.0	213.14	0.90	0.44
P-29	9.7	105.00	125.0	213.14	0.11	0.44
P-30	9.7	350.00	125.0	213.14	0.05	0.44
P-31	9.7	4,725.00	125.0	213.14	0.15	0.44
P-32	9.7	570.00	125.0	213.14	2.07	0.44
P-33	9.7	645.00	125.0	213.14	0.25	0.44
P-35 (P	7.9	150.00	125.0	213.14	0.28	0.44
P-2	7.9	200.00	125.0	0.00	0.00	0.00
P-37(PS	30.0	0.10	125.0	0.00	0.00	0.00
P-38(PS	4.0	150.00	125.0	0.00	0.00	0.00
P-41	6.1	768.00	125.0	0.00	0.00	0.00
P-42	6.1	500.00	125.0	0.00	0.00	0.00
P-43	6.1	531.00	125.0	0.00	0.00	0.00
P-44	6.1	1,350.00	125.0	0.00	0.00	0.00
P-45	6.1	1,475.00	125.0	0.00	0.00	0.00
P-46(PS	30.0	0.10	125.0	0.00	0.00	0.00
P-47(PS	3.0	150.00	125.0	0.00	0.00	0.00
P-48 (P	30.0	0.10	125.0	0.00	0.00	0.00
P-49 (P	3.0	150.00	125.0	213.14	0.00	0.00
P-50	6.1	700.00	125.0	213.14	19.99	133.28
P-51	6.1	1,182.00	125.0	213.14	2.94	4.20
P-52	6.1	295.00	125.0	0.00	0.00	0.00
P-12	7.9	2,212.00	125.0	0.00	0.00	0.00
P-34	9.7	820.00	125.0	0.00	0.00	0.00
P-54	12.0	20.00	125.0	213.14	0.36	0.44
				213.14	0.00	0.16

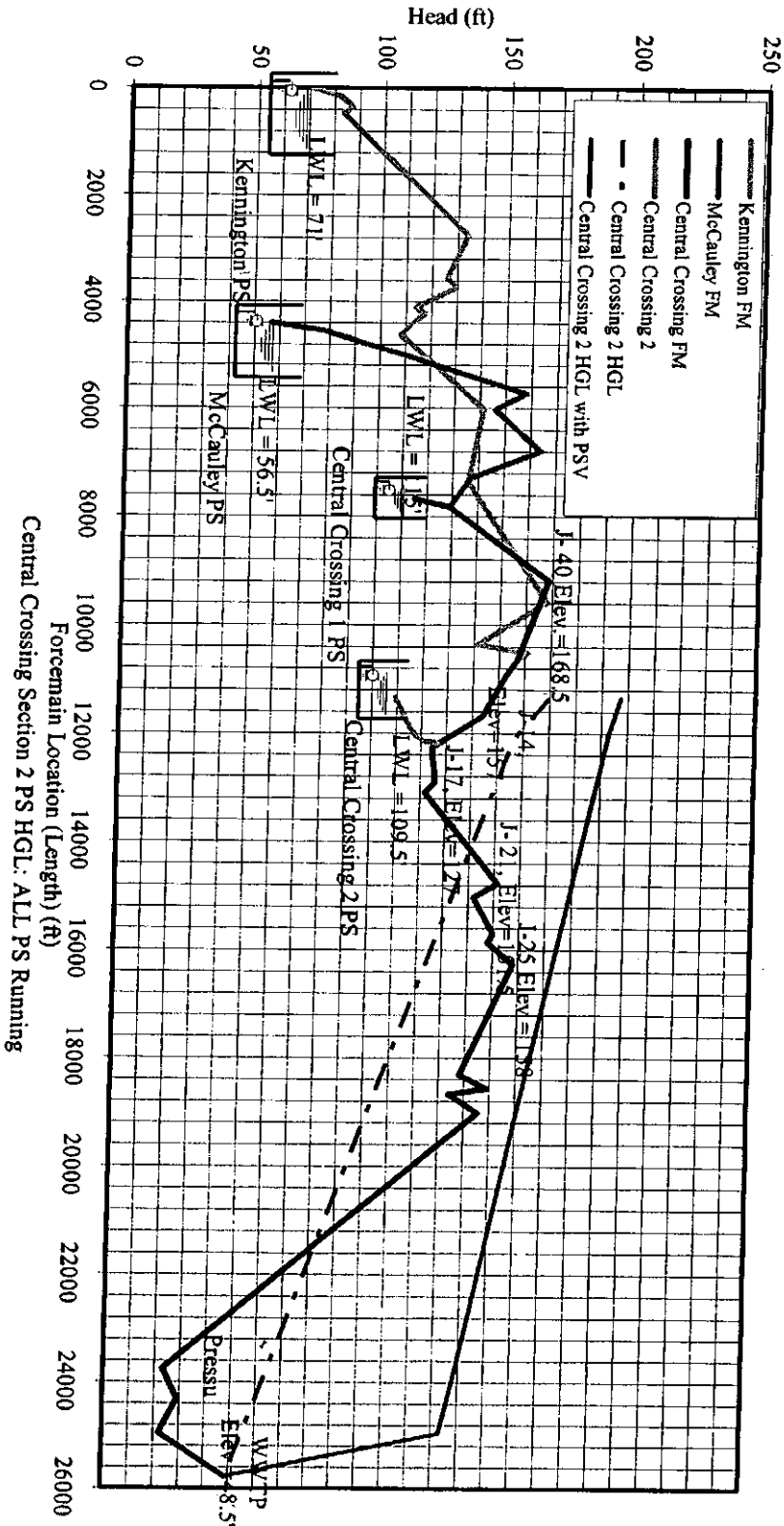
Water Hammer Analysis

1. Central Crossing Section 2 Pumping station is the least affected under the worst case surge conditions.
2. Maximum pressure will be experienced at McCauley Pumping Station
3. A Pressure Relief Valve will be installed at Kennington Pumping Station
4. A Pressure Relief Valve (PRV) was recommended for McCauley Pumping station
5. The PRVs at McCauley and Kennington Pumping stations will be sufficient to handle any surges in the forcemain system.
6. ALL WATER HAMMER CONDITIONS HAVE BEEN MET (See Table 2 – Water Hammer Analysis). HDPE, DR17 Pressure Class 100 Pipe is acceptable

Table 2 Water Hammer Analysis

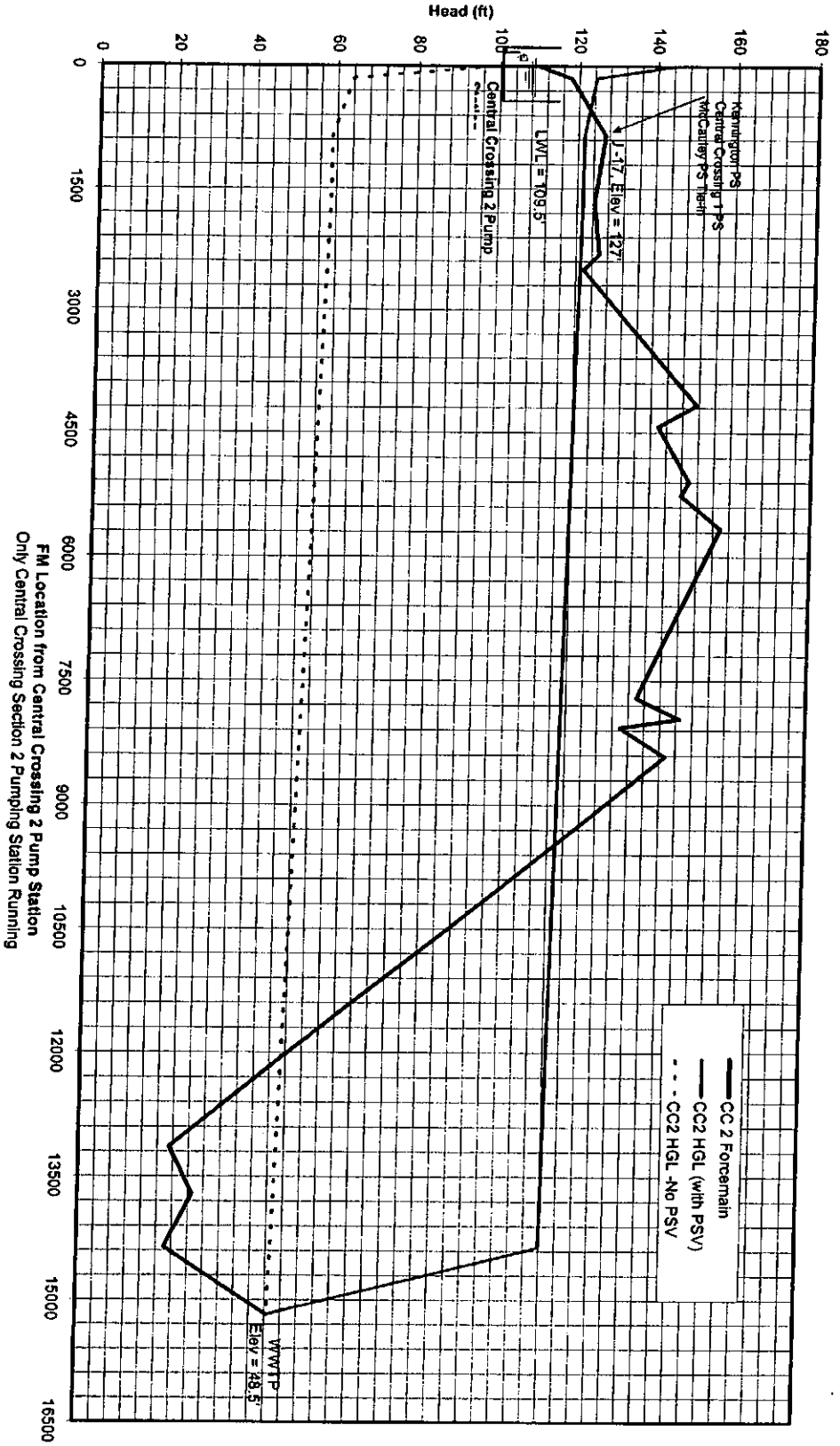
Reference AWWA C906		
Data source: WaterCAD® model	Design Flow (gpm)	WaterCAD® Flow (gpm)
Design Conditions		
Central Crossing 2	**76**	**95**
Kennington	386	393
McCauley	248	248
Central Crossing 1	45	24
Maximum Pump Discharge Pressures with Pressure Control Valve Active		
Pumping Station	Pump Head (ft)	Discharge Pump Pressure (psi)
Central Crossing Section 2 Pump Station	**87.9**	**38.03**
Kennington Pump Station	175.76	76.04
McCauley Pump Station	194.18	**84.01**
Central Crossing Section 1 Pump Station	111.31	48.16
Working Pressure, WP	84.01	Max. Discharge Psi at McCauley Pump Station
Material: HDPE	PE 3408	
Pipe Class (PC)	100.0	DR 17
WPR	100.0	Psig
Temperature Compensation Multiplier, F_T	1.0	up to 80°C
Recurring Surge Capacity P_{RS}	50.0	(Psi) Max. Anticipated Recurring Pressure
Corresponding Sudden Velocity Change	4.4	Fps
Occasional Pressure Surge, P_{OS}	100.0	(Psi) Max. Anticipated Occasional Pressure surge
Corresponding Sudden Velocity Change	8.9	
CONDITION 1	**OK!**	**$WP + P_{RS} \leq 1.5\ PC \times F_T$, Then OK**
Working Pressure + Anticipated Recurring Pressure	**134.01**	$WP + P_{RS}$
1.5 x Pressure Class x F_T	**150**	Psi 1.5 PC x F_T
CONDITION 2	**OK!**	**$WP + P_{RS} \leq 2.0\ PC \times F_T$, Then OK**
Working Pressure + Occasional Pressure Surge, P_{OS}	184.01	
2.0 x Pressure Class x F_T	200	
CONDITION 3	**OK!**	**In All Cases $WP \leq PC \times F_T$**

Central Crossing 2 Pump Station: Hydraulic profile, All Pumps Running



Central Crossing Section 2 PS HGL: ALL PS Running

Hydraulic profile: Only Central Crossing 2 Pump Station Running



APPENDIX

WaterCAD® Hydraulic Analysis Outputs

Forcemain hydraulic analysis with the Pressure Control Valve was performed using WaterCAD® software. Data below shows hydraulic conditions when:

1. All Pumps are running (CONTROL STATUS: ON)
2. Only one of each pump is running

Scenario: KN Pump Only
Steady State Analysis
Pump Report

Label	Elevation (ft)	Control Status	Discharge Pump Grade (ft)	Intake Pump Grade (ft)	Discharge (gpm)	Pump Head (ft)	Calculated Water Power (Hp)
PMP-1(KN)	71.00	On	240.77	71.00	500.99	169.77	21.47
PMP-2(MC)	56.50	Off	178.92	56.50	0.00	0.00	0.00
PMP-3(CC1)	115.00	Off	178.92	115.00	0.00	0.00	0.00
PMP-4(CC2)	109.50	Off	169.98	109.50	0.00	0.00	0.00

Scenario: KN Pump Only
Steady State Analysis
Pipe Report

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Discharge (gpm)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)
P-1 (PS	30.0	0.10	125.0	500.99	0.00	0.00
P-3	7.9	125.00	125.0	500.99	0.73	5.81
P-4	7.9	2,275.00	125.0	500.99	13.21	5.81
P-5	7.9	795.00	125.0	500.99	4.62	5.81
P-6	7.9	195.00	125.0	500.99	1.13	5.81
P-7	7.9	382.00	125.0	500.99	2.22	5.81
P-8	7.9	95.00	125.0	500.99	0.55	5.81
P-9	7.9	405.00	125.0	500.99	2.35	5.81
P-10	7.9	1,402.00	125.0	500.99	8.14	5.81
P-11	7.9	1,343.00	125.0	500.99	7.80	5.81
P-13	7.9	778.00	125.0	500.99	4.52	5.81
P-14	7.9	160.00	125.0	500.99	0.93	5.81
P-15	7.9	135.00	125.0	500.99	0.78	5.81
P-16	7.9	275.00	125.0	500.99	1.60	5.81
P-17	7.9	755.00	125.0	500.99	4.38	5.81
P-18	7.9	510.00	125.0	500.99	2.96	5.81
P-19	9.7	80.00	125.0	500.99	0.17	2.14
P-20	9.7	642.00	125.0	500.99	1.37	2.14
P-21	9.7	185.00	125.0	500.99	0.40	2.14
P-22	9.7	1,675.00	125.0	500.99	3.58	2.14
P-23	9.7	255.00	125.0	500.99	0.54	2.14
P-24	9.7	670.00	125.0	500.99	1.43	2.14
P-25	9.7	160.00	125.0	500.99	0.34	2.14
P-26	9.7	405.00	125.0	500.99	0.87	2.14
P-27	9.7	2,050.00	125.0	500.99	4.38	2.14
P-28	9.7	250.00	125.0	500.99	0.53	2.14
P-29	9.7	105.00	125.0	500.99	0.22	2.14
P-30	9.7	350.00	125.0	500.99	0.75	2.14
P-31	9.7	4,725.00	125.0	500.99	10.09	2.14
P-32	9.7	570.00	125.0	500.99	1.22	2.14
P-33	9.7	645.00	125.0	500.99	1.38	2.14
P-35 (P	7.9	150.00	125.0	500.99	0.87	5.81
P-2	7.9	200.00	125.0	500.99	1.16	5.81
P-37(PS	30.0	0.10	125.0	-0.00	0.00	0.00
P-38(PS	4.0	150.00	125.0	-0.00	0.00	0.00
P-41	6.1	768.00	125.0	-0.00	0.00	0.00
P-42	6.1	500.00	125.0	-0.00	0.00	0.00
P-43	6.1	531.00	125.0	-0.00	0.00	0.00
P-44	6.1	1,350.00	125.0	-0.00	0.00	0.00
P-45	6.1	1,475.00	125.0	-0.00	0.00	0.00
P-46(PS	30.0	0.10	125.0	0.00	0.00	0.00
P-47(PS	3.0	150.00	125.0	0.00	0.00	0.00
P-48 (P	30.0	0.10	125.0	0.00	0.00	0.00
P-49 (P	3.0	150.00	125.0	0.00	0.00	0.00
P-50	6.1	700.00	125.0	0.00	0.00	0.00
P-51	6.1	1,182.00	125.0	0.00	0.00	0.00
P-52	6.1	295.00	125.0	-0.00	0.00	0.00
P-12	7.9	2,212.00	125.0	-0.00	0.00	0.00
P-34	9.7	820.00	125.0	500.99	12.84	5.81
P-54	12.0	20.00	125.0	500.99	1.75	2.14
				500.99	0.02	0.76

Scenario: KN Pump Only
Steady State Analysis
Junction Report

Label	Elevation (ft)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-1	87.00	238.74	65.65
J-2	83.50	238.01	66.85
J-3 (AV)	134.00	224.80	39.29
J-4	126.00	220.18	40.75
J-5 (AV)	129.50	219.05	38.75
J-6	113.50	216.83	44.71
J-7	117.50	216.28	42.74
J-8	108.00	213.93	45.83
J-9 (AV)	141.50	205.79	27.82
J-10	136.00	197.99	26.82
J-11 (AV	168.00	185.15	7.42
J-12	141.50	180.63	16.93
J-13	161.00	179.70	8.09
J-14	157.00	178.92	9.48
J-15	153.00	177.32	10.52
J-16	144.00	172.94	12.52
J-17 (CC	127.00	169.98	18.59
J-18	124.50	169.81	19.60
J-19 (Re	126.00	168.44	18.36
J-20	122.00	168.04	19.92
J-21	151.50	164.46	5.61
J-22	142.00	163.92	9.48
J-23	150.00	162.49	5.40
J-24	148.00	162.15	6.12
J-25	158.00	161.28	1.42
J-26	138.00	156.90	8.18
J-27	149.00	156.37	3.19
J-28	134.00	156.14	9.58
J-29	145.50	155.39	4.28
J-30	23.00	145.30	52.91
J-31	29.00	144.08	49.79
J-32	22.00	142.70	52.22
J-33	82.00	239.90	68.31
J-34	78.00	178.92	43.66
J-36	146.00	178.92	14.24
J-37	164.00	178.92	6.46
J-38 (OL	137.00	178.92	18.14
J-39 (CC	129.00	178.92	21.60
J-40	168.50	178.92	4.51
J-41	118.00	169.98	22.49
J-42(AV	158.00	178.92	9.05

Scenario: KN Pump Only
Steady State Analysis
Valve Report

Label	Elevation (ft)	Diameter (in)	Minor Loss Coefficient	Control Status	Discharge (gpm)	From HGL (ft)	To HGL (ft)	Headloss (ft)
PSV-1	48.50	6.0	0.00	Throttling	500.99	140.95	48.52	92.44

Scenario: McCauley Pump Only
Steady State Analysis
Pump Report

Label	Elevation (ft)	Control Status	Discharge Pump Grade (ft)	Intake Pump Grade (ft)	Discharge (gpm)	Pump Head (ft)	Calculated Water Power (Hp)
PMP-1(KN)	71.00	Off	160.79	71.00	0.00	0.00	0.00
PMP-2(MC)	56.50	On	238.55	56.50	352.90	182.05	16.22
PMP-3(CC1)	115.00	Off	191.00	115.00	0.00	0.00	0.00
PMP-4(CC2)	109.50	Off	156.12	109.50	0.00	0.00	0.00

Scenario: McCauley Pump Only
Steady State Analysis
Pipe Report

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Discharge (gpm)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)
P-1 (PS	30.0	0.10	125.0	-0.00	0.00	0.00
P-3	7.9	125.00	125.0	0.00	0.00	0.00
P-4	7.9	2,275.00	125.0	0.00	0.00	0.00
P-5	7.9	795.00	125.0	0.00	0.00	0.00
P-6	7.9	195.00	125.0	0.00	0.00	0.00
P-7	7.9	382.00	125.0	0.00	0.00	0.00
P-8	7.9	95.00	125.0	0.00	0.00	0.00
P-9	7.9	405.00	125.0	0.00	0.00	0.00
P-10	7.9	1,402.00	125.0	0.00	0.00	0.00
P-11	7.9	1,343.00	125.0	0.00	0.00	0.00
P-13	7.9	778.00	125.0	0.00	0.00	0.00
P-14	7.9	160.00	125.0	0.00	0.00	0.00
P-15	7.9	135.00	125.0	0.00	0.00	0.00
P-16	7.9	275.00	125.0	352.90	0.83	3.03
P-17	7.9	755.00	125.0	352.90	2.29	3.03
P-18	7.9	510.00	125.0	352.90	1.55	3.03
P-19	9.7	80.00	125.0	352.90	0.09	1.12
P-20	9.7	642.00	125.0	352.90	0.72	1.12
P-21	9.7	185.00	125.0	352.90	0.21	1.12
P-22	9.7	1,675.00	125.0	352.90	1.87	1.12
P-23	9.7	255.00	125.0	352.90	0.28	1.12
P-24	9.7	670.00	125.0	352.90	0.75	1.12
P-25	9.7	160.00	125.0	352.90	0.18	1.12
P-26	9.7	405.00	125.0	352.90	0.45	1.12
P-27	9.7	2,050.00	125.0	352.90	2.29	1.12
P-28	9.7	250.00	125.0	352.90	0.28	1.12
P-29	9.7	105.00	125.0	352.90	0.12	1.12
P-30	9.7	350.00	125.0	352.90	0.39	1.12
P-31	9.7	4,725.00	125.0	352.90	5.28	1.12
P-32	9.7	570.00	125.0	352.90	0.64	1.12
P-33	9.7	645.00	125.0	352.90	0.72	1.12
P-35 (P	7.9	150.00	125.0	0.00	0.00	0.00
P-2	7.9	200.00	125.0	0.00	0.00	0.00
P-37(PS	30.0	0.10	125.0	352.90	0.00	0.00
P-38(PS	4.0	150.00	125.0	352.90	12.53	83.51
P-41	6.1	768.00	125.0	352.90	8.21	10.69
P-42	6.1	500.00	125.0	352.90	5.35	10.69
P-43	6.1	531.00	125.0	352.90	5.68	10.69
P-44	6.1	1,350.00	125.0	352.90	14.43	10.69
P-45	6.1	1,475.00	125.0	352.90	15.77	10.69
P-46(PS	30.0	0.10	125.0	0.00	0.00	0.00
P-47(PS	3.0	150.00	125.0	0.00	0.00	0.00
P-48 (P	30.0	0.10	125.0	0.00	0.00	0.00
P-49 (P	3.0	150.00	125.0	0.00	0.00	0.00
P-50	6.1	700.00	125.0	0.00	0.00	0.00
P-51	6.1	1,182.00	125.0	352.90	12.64	10.69
P-52	6.1	295.00	125.0	352.90	3.15	10.69
P-12	7.9	2,212.00	125.0	0.00	0.00	0.00
P-34	9.7	820.00	125.0	352.90	0.92	1.12
P-54	12.0	20.00	125.0	352.90	0.01	0.40

Scenario: McCauley Pump Only
Steady State Analysis
Junction Report

Label	Elevation (ft)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-1	87.00	160.79	31.93
J-2	83.50	160.79	33.44
J-3 (AV)	134.00	160.79	11.59
J-4	126.00	160.79	15.05
J-5 (AV)	129.50	160.79	13.54
J-6	113.50	160.79	20.46
J-7	117.50	160.79	18.73
J-8	108.00	160.79	22.84
J-9 (AV)	141.50	160.79	8.35
J-10	136.00	160.79	10.73
J-11 (AV)	168.00	160.79	-3.12
J-12	141.50	160.79	8.35
J-13	161.00	160.79	-0.09
J-14	157.00	160.79	1.64
J-15	153.00	159.96	3.01
J-16	144.00	157.67	5.91
J-17 (CC2 tie in)	127.00	156.12	12.60
J-18	124.50	156.03	13.64
J-19 (Resource International connection)	126.00	155.32	12.68
J-20	122.00	155.11	14.32
J-21	151.50	153.24	0.75
J-22	142.00	152.95	4.74
J-23	150.00	152.21	0.95
J-24	148.00	152.03	1.74
J-25	158.00	151.58	-2.78
J-26	138.00	149.29	4.88
J-27	149.00	149.01	0.00
J-28	134.00	148.89	6.44
J-29	145.50	148.50	1.30
J-30	23.00	143.22	52.02
J-31	29.00	142.59	49.14
J-32	22.00	141.87	51.86
J-33	82.00	160.79	34.09
J-34	78.00	226.03	64.04
J-36	146.00	210.23	27.79
J-37	164.00	202.02	16.45
J-38 (OLEG BEGINS)	137.00	196.68	25.82
J-39 (CC1 TIE-IN)	129.00	191.00	26.82
J-40	168.50	176.56	3.49
J-41	118.00	156.12	16.49
J-42(AV?)	158.00	213.39	23.96

Scenario: McCauley Pump Only
Steady State Analysis
Valve Report

Label	Elevation (ft)	Diameter (in)	Minor Loss Coefficient	Control Status	Discharge (gpm)	From HGL (ft)	To HGL (ft)	Headloss (ft)
PSV-1	48.50	6.0	0.00	Throttling	352.90	140.95	48.51	92.45

Scenario: CC1 Pump only
Steady State Analysis
Pump Report

Label	Elevation (ft)	Control Status	Discharge Pump Grade (ft)	Intake Pump Grade (ft)	Discharge (gpm)	Pump Head (ft)	Calculated Water Power (Hp)
PMP-1(KN)	71.00	Off	131.90	71.00	0.00	0.00	0.00
PMP-2(MC)	56.50	Off	135.71	56.50	0.00	0.00	0.00
PMP-3(CC1)	115.00	On	142.13	115.00	115.41	27.13	0.79
PMP-4(CC2)	109.50	Off	131.31	109.50	0.00	0.00	0.00

Scenario: CC1 Pump only
Steady State Analysis
Pipe Report

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Discharge (gpm)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)
P-1 (PS	30.0	0.10	125.0	0.00	0.00	0.00
P-3	7.9	125.00	125.0	0.00	0.00	0.00
P-4	7.9	2,275.00	125.0	0.00	0.00	0.00
P-5	7.9	795.00	125.0	0.00	0.00	0.00
P-6	7.9	195.00	125.0	0.00	0.00	0.00
P-7	7.9	382.00	125.0	0.00	0.00	0.00
P-8	7.9	95.00	125.0	0.00	0.00	0.00
P-9	7.9	405.00	125.0	0.00	0.00	0.00
P-10	7.9	1,402.00	125.0	0.00	0.00	0.00
P-11	7.9	1,343.00	125.0	0.00	0.00	0.00
P-13	7.9	778.00	125.0	0.00	0.00	0.00
P-14	7.9	160.00	125.0	0.00	0.00	0.00
P-15	7.9	135.00	125.0	0.00	0.00	0.00
P-16	7.9	275.00	125.0	0.00	0.00	0.00
P-17	7.9	755.00	125.0	115.41	0.11	0.38
P-18	7.9	510.00	125.0	115.41	0.29	0.38
P-19	9.7	80.00	125.0	115.41	0.20	0.38
P-20	9.7	642.00	125.0	115.41	0.01	0.14
P-21	9.7	185.00	125.0	115.41	0.09	0.14
P-22	9.7	1,675.00	125.0	115.41	0.03	0.14
P-23	9.7	255.00	125.0	115.41	0.24	0.14
P-24	9.7	670.00	125.0	115.41	0.04	0.14
P-25	9.7	160.00	125.0	115.41	0.09	0.14
P-26	9.7	405.00	125.0	115.41	0.02	0.14
P-27	9.7	2,050.00	125.0	115.41	0.06	0.14
P-28	9.7	250.00	125.0	115.41	0.29	0.14
P-29	9.7	105.00	125.0	115.41	0.04	0.14
P-30	9.7	350.00	125.0	115.41	0.01	0.14
P-31	9.7	4,725.00	125.0	115.41	0.05	0.14
P-32	9.7	570.00	125.0	115.41	0.67	0.14
P-33	9.7	645.00	125.0	115.41	0.08	0.14
P-35 (P	7.9	150.00	125.0	115.41	0.09	0.14
P-2	7.9	200.00	125.0	0.00	0.00	0.00
P-37(PS	30.0	0.10	125.0	0.00	0.00	0.00
P-38(PS	4.0	150.00	125.0	0.00	0.00	0.00
P-41	6.1	768.00	125.0	0.00	0.00	0.00
P-42	6.1	500.00	125.0	0.00	0.00	0.00
P-43	6.1	531.00	125.0	0.00	0.00	0.00
P-44	6.1	1,350.00	125.0	0.00	0.00	0.00
P-45	6.1	1,475.00	125.0	115.41	1.82	1.35
P-46(PS	30.0	0.10	125.0	115.41	1.99	1.35
P-47(PS	3.0	150.00	125.0	115.41	0.00	0.00
P-48 (P	30.0	0.10	125.0	115.41	6.42	42.79
P-49 (P	3.0	150.00	125.0	0.00	0.00	0.00
P-50	6.1	700.00	125.0	0.00	0.00	0.00
P-51	6.1	1,182.00	125.0	0.00	0.00	0.00
P-52	6.1	295.00	125.0	0.00	0.00	0.00
P-12	7.9	2,212.00	125.0	0.00	0.00	0.00
P-34	9.7	820.00	125.0	0.00	0.00	0.00
P-54	12.0	20.00	125.0	115.41	0.12	0.14
				115.41	0.00	0.05

Scenario: CC1 Pump only
Steady State Analysis
Junction Report

Label	Elevation (ft)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-1	87.00	131.90	19.43
J-2	83.50	131.90	20.94
J-3 (AV)	134.00	131.90	-0.91
J-4	126.00	131.90	2.55
J-5 (AV)	129.50	131.90	1.04
J-6	113.50	131.90	7.96
J-7	117.50	131.90	6.23
J-8	108.00	131.90	10.34
J-9 (AV)	141.50	131.90	-4.15
J-10	136.00	131.90	-1.77
J-11 (AV)	168.00	131.90	-15.62
J-12	141.50	131.90	-4.15
J-13	161.00	131.90	-12.59
J-14	157.00	131.90	-10.86
J-15	153.00	131.79	-9.17
J-16	144.00	131.51	-5.41
J-17 (CC2 tie in)	127.00	131.31	1.86
J-18	124.50	131.30	2.94
J-19 (Resource International connection)	126.00	131.21	2.25
J-20	122.00	131.18	3.97
J-21	151.50	130.95	-8.89
J-22	142.00	130.91	-4.80
J-23	150.00	130.82	-8.30
J-24	148.00	130.79	-7.44
J-25	158.00	130.74	-11.80
J-26	138.00	130.45	-3.27
J-27	149.00	130.41	-8.04
J-28	134.00	130.40	-1.56
J-29	145.50	130.35	-6.56
J-30	23.00	129.68	46.16
J-31	29.00	129.60	43.53
J-32	22.00	129.51	46.52
J-33	82.00	131.90	21.59
J-34	78.00	135.71	24.97
J-36	146.00	135.71	-4.45
J-37	164.00	135.71	-12.24
J-38 (OLEG BEGINS)	137.00	135.71	-0.56
J-39 (CC1 TIE-IN)	129.00	135.71	2.90
J-40	168.50	133.89	-14.97
J-41	118.00	131.31	5.76
J-42(AV?)	158.00	135.71	-9.64

Scenario: CC1 Pump only
Steady State Analysis
Valve Report

Label	Elevation (ft)	Diameter (in)	Minor Loss Coefficient	Control Status	Discharge (gpm)	From HGL (ft)	To HGL (ft)	Headloss (ft)
PSV-1	48.50	6.0	0.00	Throttling	115.41	129.40	48.50	80.90

Scenario: Deadhead Condition
Steady State Analysis
Valve Report

Label	Elevation (ft)	Diameter (in)	Minor Loss Coefficient	Control Status	Discharge (gpm)	From HGL (ft)	To HGL (ft)	Headloss (ft)
PSV-1	48.50	6.0	0.00	Closed	0.00	268.38	48.50	0.00

Scenario: Deadhead Condition
Steady State Analysis
Pump Report

Label	Elevation (ft)	Control Status	Discharge Pump Grade (ft)	Intake Pump Grade (ft)	Discharge (gpm)	Pump Head (ft)	Calculated Water Power (Hp)
PMP-1(KN)	71.00	Pump cannot deliver head (Closed	268.38	71.00	0.00	0.00	0.00
PMP-2(MC)	56.50	On	268.38	56.50	0.00	211.88	0.00
PMP-3(CC1)	115.00	Pump cannot deliver head (Closed	268.38	115.00	0.00	0.00	0.00
PMP-4(CC2)	109.50	Pump cannot deliver head (Closed	268.38	109.50	0.00	0.00	0.00

Scenario: Deadhead Condition
Steady State Analysis
Pipe Report

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Discharge (gpm)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)
P-1 (PS	30.0	0.10	125.0	-0.00	0.00	0.00
P-3	7.9	125.00	125.0	-0.00	0.00	0.00
P-4	7.9	2,275.00	125.0	-0.00	0.00	0.00
P-5	7.9	795.00	125.0	-0.00	0.00	0.00
P-6	7.9	195.00	125.0	-0.00	0.00	0.00
P-7	7.9	382.00	125.0	-0.00	0.00	0.00
P-8	7.9	95.00	125.0	-0.00	0.00	0.00
P-9	7.9	405.00	125.0	-0.00	0.00	0.00
P-10	7.9	1,402.00	125.0	-0.00	0.00	0.00
P-11	7.9	1,343.00	125.0	-0.00	0.00	0.00
P-13	7.9	778.00	125.0	-0.00	0.00	0.00
P-14	7.9	160.00	125.0	-0.00	0.00	0.00
P-15	7.9	135.00	125.0	-0.00	0.00	0.00
P-16	7.9	275.00	125.0	0.00	0.00	0.00
P-17	7.9	755.00	125.0	0.00	0.00	0.00
P-18	7.9	510.00	125.0	0.00	0.00	0.00
P-19	9.7	80.00	125.0	0.00	0.00	0.00
P-20	9.7	642.00	125.0	0.00	0.00	0.00
P-21	9.7	185.00	125.0	0.00	0.00	0.00
P-22	9.7	1,675.00	125.0	0.00	0.00	0.00
P-23	9.7	255.00	125.0	0.00	0.00	0.00
P-24	9.7	670.00	125.0	0.00	0.00	0.00
P-25	9.7	160.00	125.0	0.00	0.00	0.00
P-26	9.7	405.00	125.0	0.00	0.00	0.00
P-27	9.7	2,050.00	125.0	0.00	0.00	0.00
P-28	9.7	250.00	125.0	0.00	0.00	0.00
P-29	9.7	105.00	125.0	0.00	0.00	0.00
P-30	9.7	350.00	125.0	0.00	0.00	0.00
P-31	9.7	4,725.00	125.0	0.00	0.00	0.00
P-32	9.7	570.00	125.0	0.00	0.00	0.00
P-33	9.7	645.00	125.0	0.00	0.00	0.00
P-35 (P	7.9	150.00	125.0	-0.00	0.00	0.00
P-2	7.9	200.00	125.0	-0.00	0.00	0.00
P-37(PS	30.0	0.10	125.0	0.00	0.00	0.00
P-38(PS	4.0	150.00	125.0	0.00	0.00	0.00
P-41	6.1	768.00	125.0	0.00	0.00	0.00
P-42	6.1	500.00	125.0	0.00	0.00	0.00
P-43	6.1	531.00	125.0	0.00	0.00	0.00
P-44	6.1	1,350.00	125.0	0.00	0.00	0.00
P-45	6.1	1,475.00	125.0	0.00	0.00	0.00
P-46(PS	30.0	0.10	125.0	-0.00	0.00	0.00
P-47(PS	3.0	150.00	125.0	-0.00	0.00	0.00
P-48 (P	30.0	0.10	125.0	-0.00	0.00	0.00
P-49 (P	3.0	150.00	125.0	-0.00	0.00	0.00
P-50	6.1	700.00	125.0	-0.00	0.00	0.00
P-51	6.1	1,182.00	125.0	0.00	0.00	0.00
P-52	6.1	295.00	125.0	0.00	0.00	0.00
P-12	7.9	2,212.00	125.0	-0.00	0.00	0.00
P-34	9.7	820.00	125.0	0.00	0.00	0.00
P-54	12.0	20.00	125.0	0.00	0.00	0.00

Scenario: Deadhead Condition
Steady State Analysis
Junction Report

Label	Elevation (ft)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-1	87.00	268.38	78.47
J-2	83.50	268.38	79.99
J-3 (AV)	134.00	268.38	58.14
J-4	126.00	268.38	61.60
J-5 (AV)	129.50	268.38	60.09
J-6	113.50	268.38	67.01
J-7	117.50	268.38	65.28
J-8	108.00	268.38	69.39
J-9 (AV)	141.50	268.38	54.89
J-10	136.00	268.38	57.27
J-11 (AV)	168.00	268.38	43.43
J-12	141.50	268.38	54.89
J-13	161.00	268.38	46.46
J-14	157.00	268.38	48.19
J-15	153.00	268.38	49.92
J-16	144.00	268.38	53.81
J-17 (CC2 tie in)	127.00	268.38	61.17
J-18	124.50	268.38	62.25
J-19 (Resource International connection)	126.00	268.38	61.60
J-20	122.00	268.38	63.33
J-21	151.50	268.38	50.57
J-22	142.00	268.38	54.68
J-23	150.00	268.38	51.22
J-24	148.00	268.38	52.08
J-25	158.00	268.38	47.76
J-26	138.00	268.38	56.41
J-27	149.00	268.38	51.65
J-28	134.00	268.38	58.14
J-29	145.50	268.38	53.16
J-30	23.00	268.38	106.16
J-31	29.00	268.38	103.57
J-32	22.00	268.38	106.60
J-33	82.00	268.38	80.64
J-34	78.00	268.38	82.37
J-36	146.00	268.38	52.95
J-37	164.00	268.38	45.16
J-38 (OLEG BEGINS)	137.00	268.38	56.84
J-39 (CC1 TIE-IN)	129.00	268.38	60.30
J-40	168.50	268.38	43.21
J-41	118.00	268.38	65.06
J-42(AV?)	158.00	268.38	47.76