



Notice of Public Hearing for Clifton Water District

Date: November 12, 2026

Time: 5:00pm

Location: Clifton Water District Office

Address: 510 34 Road
Clifton, CO 81520

Topic: Clifton Water District WTP Controls, Electrical, and Pumping Improvements Project

Meeting information and agenda materials will be posted on the Clifton Water District website at <https://www.cliftonwaterdistrict.org/board-meetings>.

A public hearing will be conducted for the purpose of informing citizens and soliciting public input, written or oral, regarding the Clifton Water District (CWD) Project Needs Assessment (PNA) for the Charles A. Strain Water Treatment Plant Controls, Electrical, and Pumping Improvements Project. The PNA is a report describing the proposed project, including project need, alternatives evaluated, selected alternative, project costs, and anticipated environmental impacts. The PNA is being submitted to the Colorado Department of Public Health and Environment (CDPHE) in support of an application for Drinking Water Revolving Fund (DWRF) financing.

The proposed project is intended to address aging infrastructure, operational inefficiencies, and limited system control at the Clifton Water District water treatment plant. Existing pumping, electrical, and control equipment is approaching or has exceeded its useful life, resulting in increased maintenance demands and reduced operational flexibility. In addition, the existing effluent pump configuration limits firm pumping capacity to approximately 10 million gallons per day (MGD), below the treatment plant's design capacity of 12 MGD.

Several alternatives were evaluated to address these deficiencies. The preferred alternative includes replacement and reconfiguration of the effluent pump station, installation of new pumps, upgrades to electrical systems, implementation of centralized programmable logic controller (PLC) and supervisory control and data acquisition (SCADA) systems, and related improvements to enhance reliability, operational efficiency, and system control. The selected alternative is anticipated to restore firm pumping capacity to 12 MGD and improve operational resilience and strengthen cybersecurity through modernization of the plant control systems.

During earlier design phases, the total project cost was estimated to be approximately \$14.5 million and is currently estimated at approximately \$17-\$18.5 million. Funding is anticipated to be provided through a combination of DWRF financing and other District funding sources. Clifton Water District maintains a user charge system based on metered water use with tiered rate structures to support operations, maintenance, debt service, and capital improvements. Rates are periodically evaluated and adjusted to meet operational and long-term infrastructure funding needs. Additional information regarding project financing and any potential rate impacts will be presented during the public hearing.

Construction activities are anticipated to occur within the existing water treatment plant site. Environmental impacts are expected to be limited because work will occur within an existing developed facility. Potential environmental reviews and permits may include floodplain/floodway development approvals, construction-related stormwater controls, and cultural resource review requirements.

Copies of the PNA will be available for public review prior to the hearing at the following location:
Clifton Water District Office
510 34 Road
Clifton, CO 81520

The point of contact for Clifton Water District is:
Jacob Lenihan
Assistant Manager
jacobl@cliftonwaterdistrict.org
(970) 434-7328

September 10, 2026

Ty Jones
Clifton Water District
510 34 Street
Clifton, CO 81520

Re: Clifton Water District Drinking Water Revolving Fund (DWRf)
Project Needs Assessment (PNA) Approval Letter
DWRf Project No.140451D-Q, Mesa County
PWSID CO0139180

Dear Ty Jones:

The Water Quality Control Division (Division) has reviewed the Drinking Water Revolving Fund (DWRf) PNA prepared by the District dated July 2, 2026. The PNA is approved, and the project may proceed through the SRF process subject to the conditions outlined in the following sections.

Engineering Section Review Comments:

- The Engineering Section review comments in the PNA review letter have been adequately addressed. Please review the attached ES PNA Acceptance memo.

Final Environmental Determination:

CATEGORICAL EXCLUSION

The project meets the criteria for a Categorical Exclusion (CatEx) as the State Environmental Review Process states a CatEx may be granted for projects where no federal crosscutters are impacted, there are no known or expected extraordinary circumstances, and the facilities planning is solely directed toward:

DWRf

- Minor rehabilitation of existing facilities.
- Functional replacement of equipment.
- Construction of additional facilities adjacent to existing facilities that do not affect the degree or capacity of treatment by more than 30 percent of the existing population.

At a minimum, the following coordination appears to be required to confirm there is no significant impact to state and/or federal crosscutters:

- Local floodplain permitting

- Other local, state, and federal crosscutter coordination as applicable. **It is the responsibility of the applicant to ensure that all required crosscutter coordination is completed to meet NEPA requirements.**

SRF Equivalency projects are required to complete the following additional crosscutter coordination:

- SHPO Section 106 Consultation
- Executive Order 11988 regulates the actions of agencies to ensure floodplain mitigation. Facilities may be required to be located above the 500-yr floodplain or up to 3 feet above the 100-year floodplain. Compliance with the Floodplain Certification must be evaluated in the Environmental Assessment. To meet this requirement, the borrower must provide the [Floodplain Regulation Certification of Compliance](#).
- Section 7 Consultation USFWS

Review of submissions regarding SRF environmental review requirements, including agency coordination and Environmental Assessment review, etc., is conducted under a separate cover. Please contact your GLU Project Manager regarding the status of reviews.

Financial Analysis Comments:

- An updated financial analysis has been completed by DOLA and is attached to this memo. Please review the memo for important notes and recommendations.

Infrastructure Investment and Jobs Act (IIJA) Principal Forgiveness Eligibility Review:

- The Clifton Water District confirmed that IIJA funding is requested for the project. If available at the time of Loan application, IIJA funding will be used to evaluate the loan package, including the amount of IIJA principal forgiveness the applicant may be eligible for at the time of the loan application. This is not a guarantee of funds and may be subject to prioritization, potential caps, and availability of funds.

Project Priority Points:

If your project's priority score is at or above the threshold, you may apply at any loan application cycle throughout the year. If your project's priority score is below the threshold, you may only apply at the "Open" cycles.

- January 5th (leveraged) - Open
- February 5th - Open
- April 5th - Open
- June 5th (leveraged) - Open
- August 5th - Limited
- October 5th - Limited
- November 5th - Limited

If you are applying only for the Infrastructure Investment and Jobs Act Emerging Contaminants funding, or only Green Project Reserve (GPR) Funding, you may apply at any loan application cycle, OR if your community is determined to be a DAC as indicated in the table below, you may apply at any loan application cycle.

The 2026 DWRF priority point threshold is 110 points.

The following table indicates your project's priority point score, whether the score is preliminary or final, and your disadvantaged community (DAC) status.

Final Scoring:	Final
Your project's DWRF priority score:	125

Disadvantaged Community Status:	No
Eligible loan application cycles based on priority score and/or DAC status.	All loan application cycles

Important Notes and Requirements:

- The following are outstanding items the Clifton Water District must still complete before submittal of a loan application to the SRF program:
 - Public Meeting
 - CatEx required agency coordination submission
- A public meeting is required to inform the citizens in the affected area of the proposed project. The meeting must be publicly noticed in a local newspaper a minimum of one time, at least 30 days before the meeting. The meeting must include a discussion of project alternatives, the preferred alternative, projected rate increases, and the project's construction and environmental impacts. Projects requiring an EA must provide a draft EA for review at the meeting. An affidavit of publication, agenda, meeting minutes, and a list of attendees must be submitted to the Division. [SRF Public Meeting guidance](#) is available on the Grants and Loans Unit website.
- The project is required to comply with federal requirements as described and detailed in the **Colorado SRF Required Specifications**. The requirements are listed below. Please note this list may be subject to change, and the final list of requirements will be verified at bid package approval.
 - Davis-Bacon Prevailing Wages
 - Suspension and Debarment, Equal Opportunity & Civil Rights, OSHA, and the Archaeological & Historic Preservation Act, Administration of the Clean Air Act, Federal Water Pollution Control Act, and the Uniform Relocation Assistance and Real Property Acquisition Policies Act.
- This project is deemed a CO SRF Equivalency and is required to meet certain additional federal requirements. The equivalency requirements are specified below in the list of specifications that apply to the project.
 - **SRF Equivalency** projects are required to comply with the following specifications in addition to the list above:
 - Build America, Buy America (BABA) **IMPORTANT: EPA released the BABA implementation guidance that will apply. The guidance can be viewed here: [OW-BABA Implementation Procedures 11-3-2022](#).**
 - Disadvantaged Business Enterprise Procurement
 - Signage
 - Prohibition of Certain Telecom & Video Surveillance Services or Equipment
- This project is required to comply with the following SRF Certifications as applicable:
 - Technical, Managerial, and Financial compliance resolution
- All State Revolving Fund recipients are required to include the **Colorado SRF Required Specifications** in the bid package and construction documents. The 100% Guaranteed Maximum Price (100% GMP) Contract Documents must be submitted to the Grants and Loans Unit project manager for approval before execution. Submit the 100% GMP a minimum of 14 days before intended execution. This requirement also includes all materials and equipment procurement, and any other construction-related contracts.
- Environmental clearance must be obtained before construction begins. This means that the Categorical Exclusion (CatEx) has been published, and the 30-day comment period has lapsed with no comments or all comments, if any, have been resolved.

- Before construction, the project must obtain Final Plans and Specifications for Construction Approval from the Water Quality Control Division Engineering Section, or obtain acceptance of self-certification for eligible projects. If you have questions regarding the status, please contact the WQCD Engineering Section review engineer Steven Daniels at steven.daniels@state.co.us or by telephone at (720) 257-9319. Or contact CDPHE.WQEngReview@state.co.us
- If the project scope changes, the Clifton Water District must submit an amended PNA for approval. Project amendments may require changes to environmental and/or design approvals.
- This letter does not guarantee the award of funds. Award of funds is subject to meeting all technical and SRF requirements and approval by the Colorado Water Resources & Power Development Authority Board of Directors. Availability and terms of funding for both IIJA and base program SRF funds are subject to change at any time.

Resources:

- Information on the Infrastructure Investment and Jobs Act (IIJA) and key funding updates are available at <https://cdphe.colorado.gov/wqibill>.
- Coaching assistance is available to assist the borrower in addressing drinking water system issues and/or meeting TMF capacity requirements. The Local Assistance Unit offers free training and support to applicants who request it. The training is presented on-site at the system and provides an understanding of the TMF requirements and tools. In addition, the unit can provide additional training for training units (TUs) to certified operators. To request assistance, visit: <http://cdphe.colorado.gov/dwtrain> and click "Online training request" under "Customized coaching and assistance" or contact the Local Assistance Unit at cdphe.wqdwtraining@state.co.us.

Please contact me at (720) 260-4584 or via email at erin.reilley@state.co.us with any questions.

Regards,



Erin Reilley
Project Manager
Grants and Loans Unit
Water Quality Control Division

ec: Jacob Lenihan, Assistant District Manager
Steven Daniels, WQCD Engineering Section
Monica Munoz-Revelo, Department of Local Affairs
Giorgio Gazashvili, Colorado Water Resources Power Development Authority
Ana Ruiz, Compliance Specialist, WQCD SRF
Aly Ulibarri, Work Group Lead, WQCD SRF Team
Alex Hawley, Unit Manager, WQCD SRF Team

Attachments:

DOLA Financial Analysis
Engineering Section PNA Acceptance Memo



COLORADO

Department of Local Affairs

Division of Local Government

MEMORANDUM

To: Erin Reilley, WQCD Grants and Loans Unit
Cc: Wesley Williams, CWRPDA
From: Monica Munoz-Revelo, Division of Local Government
Date: July 24, 2026
Re: DWRF PNA Review, and Technical, Managerial and Financial (TMF) Review Findings for the Clifton Water District

We have reviewed the materials associated with the District's DWRF project needs assessment.

TMF

Based on the TMF capacity criteria of the DWRF program, we found no mandatory financial requirement needing follow up by the District.

Financial Analysis Update

As a part of this review, we have reviewed the most up-to-date financial statements and have updated our financial analysis based on the selected alternative.

- Based on 2025 financials, an assumed loan request of \$14,600,000, a 20-year loan term, and estimated 3.25% interest rate, the projected coverage ratio is 200% with tap fee revenue, and 131% without tap fee revenue.
- The District's operating and maintenance reserve is currently at 29%. It is important to note that one of the covenants set for loans under this program is that the borrower has enough reserves to cover 3-months of operating and maintenance expenses.

DOLA Priority Point Score: 80

Eligibility Determination for Infrastructure Investment and Jobs Act (IIJA)/Bipartisan Infrastructure Law (BIL) Principal Forgiveness:

In order to qualify for IIJA/BIL principal forgiveness, a community must score three points using the IIJA/BIL Principal Forgiveness Eligibility Criteria outlined in the Intended Use Plans. The District scores 4 points using the following criteria:





IIJA/BIL PF DETERMINATION				
	Benchmark		Borrower	Points
1. Five Year % Change in Population	0.73%	>	N/A	0
2a: County Job Change	0.00%	>	14.23%	0
2b: County Unemployment	5.35%	<	4.01%	
3: Median Household Income, or MHI exceeds 125% of state MHI (-1 point)	\$95,470	>	\$52,100	1
	\$119,338	<		
4: Rates to MHI	0.76%	<	1.25%	1
5: Project addresses removal of lead or emerging contaminants	Yes		No	0
6: % Minority	40.00%	<	32.52%	0
7: % Households Housing Burdened	50.00%	<	38.50%	0
8: % Population under 200% Poverty Level	40.00%	<	44.35%	1
9: % Population under 200% Poverty Level + % Population over 65 years old	55.00%	<	59.58%	1
10: Meets DAC criteria	Yes		No	0
Total Points Scored:				4

The District is eligible for IIJA/BIL principal forgiveness and may receive a portion of their loan as principal forgiveness, subject to funding availability and principal forgiveness caps. This determination is effective for a loan application received within 12-months from the date of the PNA approval letter. If the loan application is received after 12-months, the District's eligibility will be re-evaluated at that time using current criteria.

Please contact us if we can provide additional information.





MEMORANDUM

Date: August 18, 2026

To: Erin Reilley, GLU Project Manager

From: Steven Daniels, ES Review Engineer

cc: Alex Hawley, GLU Unit Manager
Aly Ulibarri, GLU Workgroup Lead
Emily Wong, ES Engineering Review Unit Manager
Ian Sutton, ES Work Group Lead

Re: DW SRF Project Needs Assessment Review - Acceptance
Clifton Water District, WTP Controls, Electrical, and Pumping Improvements Project
Public Water System Identification Number: C00139180, Mesa County
GLU Project No. 140451D-Q, ES Project No. 260489

The Colorado Department of Public Health & Environment (Department), Water Quality Control Division, Engineering Section reviewed the engineering related portions of the Project Needs Assessment (PNA). Based on the submitted information, the PNA engineering related portions appear to address the Department's PNA requirements and is in conformance with the Drinking Water Revolving Fund Intended Use Plan.

Project Components from the PNA and Pre-Qualification Form:

1. Water treatment plant improvements
 - a. Motor Control Center (MCC) replacement
 - b. Plant control and electrical system upgrades
 - c. New effluent pumps
 - d. New reverse osmosis forwarding pumps

General Comments:

- Under Section 8.11.1 - Proposed Schedule, the schedule appears to include an adequate amount of time between design plan submittal and construction start date for Engineering Section review and approval. However, the schedule appears to include an advertisement for bids and contract award date prior to the submittal of the PNA. The implementation schedule of these components may need to be revised to ensure they meet GLU requirements for SRF funding opportunities.
- Under Section 8.9 - Costs, the 20-year cash flow projection included as Attachment 7 must reflect the capital and operation and maintenance costs associated with the selected alternative. The selected alternative appears to have an estimated O&M cost of roughly \$251,000 compared to the existing O&M cost of roughly \$360,000. The 20-year cash flow projection does not appear to include this difference in expected O&M cost. The difference equates to roughly 1% of the expected total O&M cost for system operation and thus is within the margin of error of cash flow projections and does not pose a significant issue at this time.

Documents Reviewed:

- Drinking Water Project Needs Assessment dated July 2026. Prepared by CDM Smith on behalf of Clifton Water District.

Self-Certification:

The system does not intend to self-certify all or a portion of the project.

Design Review Process:

For all public water systems, the supplier must not begin construction of any new waterworks, make improvements to or modify existing waterworks, or begin use of a new source until the supplier submits and receives Department approval of plans and specifications for such construction, improvements, modifications, or use.

Decisions regarding the review and approval of plans and specifications for new waterworks or improvements or modifications to existing waterworks shall be based on conformance to the design criteria developed by the Department specified in Policy DW-005, State of Colorado Design Criteria for Potable Water Systems.

DWRF Priority Points Worksheet:

Based on a review of the PNA documents, the priority points assigned by the Engineering Section have been completed.

Engineering Section Support:

- ☒ The Engineering Section supports the PNA selected alternative.
- ☐ Other alternatives may be more affordable and/or better aligned with long-range planning.

Conclusion:

The engineering related portions of the PNA requirements appear to be adequately addressed. If you have any questions, please contact me via email at steven.daniels@state.co.us or by telephone at 720-2579319.



Clifton Water District Drinking Water Revolving Fund (DWRF) Project Needs Assessment (PNA) Engineer's Seal

As condition for receiving assistance through the Colorado Drinking Water Revolving Fund (DWRF), I certify that the information provided within this Project Needs Assessment (PNA) for the Clifton Water District's proposed Water Treatment Plan Controls, Electrical, and Pumping Improvements Project is accurate as of the date of PNA completion.

Padraic W Gray PE

Name of Licensed Professional Engineer (Printed)

7/2/2026

Date

Associate – CDM Smith
Project Technical Leader

Title of Licensed Professional Engineer (Printed)

Signature and Stamp of Licensed Professional Engineer





Project Needs Assessment (PNA)



Drinking Water Project Needs Assessment (PNA) Form

Water Quality Control Division

General Information

Facility Name:	CLIFTON WATER DISTRICT		Original ID:	
Mailing Address 1:	510 34 Road	Mailing Address 2:	County:	
City:	Clifton	State:	CO	Zip Code: 81520
Property Address 1:	510 34 Rd	Property Address 2:	County:	
City:	Clifton	State:	CO	Zip Code: 81520
Latitude :	39.7517291	Longitude :	-104.992107	
Name of Project:	WTP Controls, Electrical, and Pumping Improvements Project			
Type of Project (Check all that apply)				
☒ Treatment	☐ Distribution / Transmission	☐ Water Supply	☐ Water Storage	

Please enter the following information for your organization if you have it.

1. Applicant Information:

First Name:	Ty	Middle Name:		Last Name:	Jones
Phone Number:	970-434-7328				
Mailing Address1:	510 34 Road	Mailing Address2:			
City:	Clifton	State:	CO	Zip Code:	81520
E-mail:	tjones@cliftonwaterdistrict.org				

Consulting Engineer Information:

First Name:		Middle Name:		Last Name:	
Phone Number:					
Mailing Address1:		Mailing Address2:			
City:		State:	CO	Zip Code:	
E-mail:					

Self-Certification:

☐ Yes ☒ No Does the system intend to self-certify all or a portion of the project?

2. Executive Summary

The Clifton Water District (CWD) Charles A. Strain Water Treatment Plant (WTP) Controls, Electrical, and Pumping Improvements Project is intended to address aging infrastructure that has created operational challenges, increased maintenance demands, and constrained system performance. While the treatment facility was substantially modernized through the 2015 microfiltration (MF) and ultrafiltration (UF) upgrade, portions of the pumping, electrical, and control infrastructure are now approaching or have exceeded their useful service life. Current operations rely heavily on manual controls, including pump operation, valve adjustments, and chemical dosing changes, which increase operator burden and limit operational flexibility. In addition, the existing effluent pump configuration creates hydraulic inefficiencies that reduce effective firm pumping capacity to approximately 10 MGD, below the treatment plant's 12 MGD design capacity.

The selected project will replace aging motor control centers, install new effluent and reverse osmosis (RO) forwarding pumps, upgrade electrical systems, and implement centralized PLC and SCADA controls. These improvements will restore firm pumping capacity to 12 MGD, improve reliability and operational efficiency, reduce maintenance demands, enhance process control, and strengthen operational resilience and cybersecurity.

The project provides public health benefits by supporting reliable treatment and delivery of safe drinking water, reducing the risk of service interruptions, and supporting continued compliance with drinking water regulations. The project addresses existing system deficiencies and maintains reliable service rather than accommodating growth.

3. System Structure and Operation

3.1 Legal Ownership of System (TMF: Managerial-1)

First Name: Clifton Water District

Mailing Address1: 510 34 Road Mailing Address2: _____

City: Clifton State: CO Zip Code: 81520

Phone Number: 970-434-7328 Fax: _____

3.2 Organizational Chart

Include an Organizational Chart as Attachment 2.

3.3 Plans (TMF: Managerial-2)

Monitoring Plan - Include a copy of the Monitoring Plan as Attachment 3.

Cross Connection Control Plan - Include a copy of the Cross Connection Control Plan as Attachment 4.

Water Conservation Plan (if system sells over 2,000 acre feet of water annually) - Include a copy of the Water Conservation Plan as Attachment 5.

☐ Not Applicable

3.4 Current Operator in Responsible (ORC) Charge (TMF: Technical-14)

First Name: Isaac Middle Name: _____ Last Name: Brown

Certification Number: CWP-WA-00625-0818 Certification Expiration Date: 08/23/2027

Operator Certification Level (check one) ☒ Staff Operator ☐ Contract Operator

Treatment ☐ Class D ☐ Class C ☐ Class B ☒ Class A

Distribution ☐ Class 4 ☐ Class 3 ☐ Class 2 ☐ Class 1

Combined Treatment/Distribution ☐ Class S ☐ Class T

3.5 Operator Certification (TMF: Technical-15)

☒ Yes ☐ No Do the system operators have adequate operator certification levels for the proposed project as defined by Regulation 100 Water and Wastewater Facility Operators Certification Requirements?

Explain the impact of the proposed project on the required operator in responsible charge (ORC) certification level and other predicted staffing changes.

There are no anticipated impacts to the Operator in Responsible Charge (ORC) certification level. Under Regulation 100.4.2, water treatment facility classification is based on treatment type and plant design flow rate, with advanced processes such as membrane filtration (MF/UF), reverse osmosis (RO) and disinfection corresponding to higher classification levels. The Clifton Water District treatment plant utilizes membrane filtration and RO processes and is classified as a Class A water treatment facility under these criteria. The proposed project does not modify treatment processes or plant capacity and instead focuses on pumping, electrical, and SCADA upgrades. Because classification is based on the most complex treatment process and no changes to the treatment train are proposed, the facility classification and ORC certification level will remain unchanged. No additional staffing or certification changes are anticipated.

3.6 Record Keeping (TMF: Managerial-3)

Describe the system's record retention policy that meets the requirements of the Colorado Primary Drinking Water Regulations (Regulation 11) including: record type, retention period, and record location.

CWD follows the requirements set forth by Regulation 11. All records are kept electronically on an internal server. Written sample logs or other data are scanned in and kept electronically.

3.7 Annual Budget (TMF: Financial-1)

- ☒ Yes ☐ No Does the system prepare an annual budget?
- ☒ Yes ☐ No Does the system prepare and maintain a Capital Improvement Plan?

Please provide a narrative of the process for annual budgeting and financial planning.

CWD conducts annual budgeting and financial planning through its established budget development process, which includes review of anticipated operating, maintenance, administrative, debt service, and capital improvement needs. The District's annual budget is organized into general/administrative, distribution, water treatment plant, and non-operating categories to support ongoing operations and infrastructure investment. Financial planning includes evaluation of projected revenues, user charge structures, capital improvement priorities, and reserve/contingency considerations to maintain long-term financial sustainability and support planned system improvements.

3.8 Financial Status (TMF: Financial-2)

Describe the current financial status and multi-year financial planning for the system including O&M costs, existing debt, required reserve accounts, rate structure, other capital improvement programs, and the system's reserve policies.

The Clifton Water District's 2026 budget reflects a structured multi-year financial planning approach across general/board/administrative functions, distribution system operations, water treatment plant operations, and non-operating expenditures. Total 2026 budgeted cash expenditures are approximately \$12.6 million, including approximately 60% (\$7.6 million) in operating expenses, 31% (\$4.0 million) in non-operating/capital-related expenditures, and 9% (\$1.1 million) in debt service, reflecting the District's ongoing investment in utility operations, infrastructure maintenance, and long-term capital improvements. CWD maintains a user charge system based on metered water use with tiered rate structures to support revenue generation for operations, maintenance, debt service, and capital improvements. Rates are periodically evaluated and adjusted to meet operational and long-term infrastructure funding needs. Capital improvements are funded through a combination of operating revenues, tap fees/system development fees, non-operating revenues, and planned expenditures identified through the annual budgeting process. The District currently carries approximately \$10.1 million in outstanding debt and continues to make scheduled debt service payments, with no new debt issued in 2024 and compliance with existing loan covenants. Financial indicators from the 2024 audit demonstrate a stable financial position, including approximately \$13.3 million in unrestricted net position and a 14.76 working capital ratio. CWD maintains financial reserves and contingency funding through its budgeting process to support operations and capital needs.

20-year cash flow projection

Include a copy of the 20-year cash flow projection as Attachment 8.

3.9 Audits (TMF: Financial-5)

Has the system submitted audits to the Department of Local Affairs or has the received State exemption of the statutory audit requirement?

- ☒ Yes - Provide a copy of the most recent audited financial statement or exemption from State as Attachment 9. ☐ No

3.10 Insurance (TMF: Financial-6)

Does the system maintain general liability insurance?

☒ Yes - Provide a copy of the most recent audited financial statement or exemption from State as Attachment 9.

☐ No

4. Project Purpose and Need

Discuss the issue or concern that the proposed project will address. Specific issues are outlined below. All issues must be discussed in each sub section below even if they are not the project driver.

4.1 Health and Compliance

Summarize the system's compliance status that necessitates the proposed project.

CWD has not had any violations within the previous 12 months. The proposed improvements to the water treatment plant supports CWD's continued compliance with all state and federal water quality standards under variable water quality and operating conditions.

4.2 Existing facility limitations

Summarize existing water system facility(ies) limitations that necessitate the proposed project.

Existing water system facility limitations at the Clifton Water District (CWD) treatment plant include aging infrastructure, operational inefficiencies, and limited system control. The effluent pump station consists of multiple vertical turbine pumps, many of which are approaching or have exceeded their useful service life, resulting in reduced efficiency and increased maintenance burden. The current system relies heavily on manual operation, including valve adjustments and chemical dosing controls, which limit operational flexibility and increase the potential for inconsistent performance. Additionally, the existing pump configuration and discharge manifold create hydraulic inefficiencies and operational complexity, particularly under varying demand conditions. The treatment process includes ultrafiltration (UF) and RO blending, with disinfection occurring through a chlorine contact chamber and downstream rechlorination. Multiple chemical dosing points and manual adjustments based on pump operation indicate a lack of centralized process control. These limitations contribute to increased operational costs, reduced reliability, and challenges in maintaining consistent system performance. As a result, upgrades to pumping systems, electrical infrastructure, and SCADA systems are necessary to improve efficiency, system control, reliability, and operational resilience.

The existing controls environment is decentralized and relies on aging hardware, limited system integration, and manual operation. Proposed SCADA and control system upgrades will implement modern PLCs, centralized monitoring and control, improved network architecture, and enhanced user access management. These improvements will improve system visibility, support timely response to abnormal operating conditions, reduce reliance on outdated technologies, and strengthen overall operational resilience and cybersecurity.

4.3 Operations and Maintenance Issues

Summarize operational and maintenance (O&M) issues with the existing water facilities.

Operational and maintenance (O&M) issues at the CWD treatment facilities are primarily driven by aging equipment, manual system operation, and inefficient process control. The effluent pump station includes multiple vertical turbine pumps, many of which are nearing or have exceeded their useful life, resulting in increased maintenance requirements, reduced efficiency, and higher operational costs. The current configuration also relies on a combination of constant speed pumps with limited variable frequency drive (VFD) capability, restricting operational flexibility under varying demand conditions. System operation is largely manual, including pump control, valve operation, and chemical dosing adjustments. Operators must manually select and adjust chemical feed rates at multiple dosing points based on which pumps are in operation, increasing labor demands and the potential for inconsistent dosing and process variability. Additionally, the lack of centralized and automated control systems creates inefficiencies during treatment upset conditions, delays operator response times due to manual requirements, and limits the ability to optimize system performance and respond efficiently to changing conditions or emergencies. Hydraulic inefficiencies within the existing pump station and discharge configuration further contribute to operational challenges, while aging mechanical and electrical components increase the risk of equipment failure and unplanned downtime. Collectively, these issues result in higher O&M costs, increased operator burden, and reduced overall system reliability, supporting the need for system upgrades and modernization. The existing systems require a high level of operator intervention, which increases the potential for inconsistent system performance and limits the ability to respond efficiently to changing operating conditions due to the lack of automation.

5. Existing Facilities Analysis

5.1 Existing Source Water– Section required for treatment and supply projects

☐ Not applicable (for distribution and storage projects, only)

5.1.1 Raw Water Supply (TMF: Technical-2)

Explain the system's existing raw water source(s), seasonal variability, and availability. Explain the system's raw water quality including primary water quality parameters of concern, variability and potential sources of contamination in the watershed or source aquifer. Identify whether sources are classified as surface water, groundwater, or groundwater under direct influence of surface water (GWUDI). Explain water usage including multiple sources of differing qualities.

Source Name	Source Classification	Source Description
Colorado River Pipeline	SurfaceWater	Shared Colorado River diversion infrastructure. Ownership is shared between the City of Grand Junction (80%) and Clifton Water District (20%). CWD's current allocation includes approximately 16.42 cfs absolute and 3.58 cfs conditional for municipal supply. As a Colorado River surface water source, water quality is subject to seasonal variability, including lower TDS during spring snowmelt runoff and elevated turbidity/suspended solids during storm runoff or high-flow events.
L.H. Hurt Pump	SurfaceWater	Colorado River diversion structure owned/controlled by CWD. Water court documentation identifies the L.H. Hurt Pump as a Colorado River source with approximately 4.0 cfs allocated for domestic municipal use. This source accesses the same Colorado River watershed supply and is subject to similar seasonal variability and source water quality considerations, including fluctuations in TDS, turbidity, and watershed-related contamination risks.

Grand Valley Canal	SurfaceWater	Conveyance system carrying Colorado River water; not a separate watershed source. CWD owns approximately 1,953 shares (1,301 domestic; 652 irrigation) in the Grand Valley Canal system, which is owned and operated by Grand Valley Irrigation Company. Water quality reflects Colorado River source conditions and may be affected by seasonal runoff, turbidity, and upstream watershed contamination events such as permitted wastewater discharges and agricultural activities.
--------------------	--------------	--

5.1.2 Water Rights (TMF: Technical-3)

CWD relies on surface water supplies from the Colorado River system supported by a portfolio of decreed water rights and regional conveyance infrastructure. This includes participation in the Grand Junction Colorado River Pipeline, which provides diversion and delivery capacity for municipal use under decreed rights, as well as ownership interests in the Grand Valley Irrigation Company (GVIC) canal system through stock certificates that convey water through the Grand Valley Canal network. The District also holds additional direct flow water rights, including the L.H. Hurt water rights, which provide diversion from the Colorado River for municipal supply. These combined water rights and conveyance systems form the basis of the District's existing water supply portfolio. Current water rights and associated supply infrastructure are sufficient to meet existing average and peak water demands. Planning analyses indicate that firm yield exceeds current demand, and the combination of direct diversion rights, canal shares, and regional pipeline infrastructure provides operational flexibility and supply reliability under existing conditions.

5.2 Existing treatment– Required for treatment and supply projects only

☐ Not applicable (for distribution and finished water storage projects, only)

5.2.1 Overall treatment description (TMF: Technical-5)

Provide a current treatment description including: treatment processes used, major design parameters (e.g., process capacities, detention times, unit loading rates, disinfection log inactivation).

The CWD treatment process consists of conventional pretreatment, membrane filtration, reverse osmosis (RO), and disinfection. Raw surface water from the Colorado River is conveyed through a raw water pumping station and settling pond, followed by rapid mix, flocculation, and sedimentation using high-rate inclined plate settlers to remove suspended solids prior to membrane treatment.

Water is then treated using microfiltration and ultrafiltration (MF/UF) membrane systems consisting of polymeric hollow fiber membranes operating in a dead-end flow configuration. The system includes eight membrane racks (six duty and two standby) and is designed with a maximum flux of approximately 100 gallons per square foot per day (gfd) at 20°C (57 gfd at 1°C), a maximum transmembrane pressure of 29 psid, and a minimum recovery of 96 percent. Pretreatment includes automatic backwashing pressure strainers and a feed wet well with a volume of approximately 125,664 gallons.

Additional treatment is provided through RO, including dual media filtration, 5-micron cartridge filtration, and four membrane racks configured in a 2:1 array. The RO system has a flow rate of approximately 0.6 MGD per rack and a minimum recovery of 85 percent.

The treatment plant has a maximum design capacity of 12 MGD. Disinfection is achieved through chlorination in a concrete contact chamber with an active volume of approximately 68,200 gallons and a baffling factor of 0.6. The system is designed to achieve 4-log virus inactivation, 3-log Giardia removal/inactivation, and 2–3 log Cryptosporidium removal/inactivation in accordance with Regulation 11 requirements.

Additional process components include membrane backwash systems, air scour, chemical cleaning systems, blend tank storage, and clearwell storage. The proposed project does not modify the treatment process; it upgrades pumping systems, electrical infrastructure, and SCADA controls to improve operational reliability, process control, and efficiency.

5.2.2 Existing Process Flow Diagram (TMF: Technical-8)

Include an existing treatment facility process flow diagram as Attachment 13.

5.2.3 Current Compliance Status (TMF: Technical-1)

Discuss the system's current compliance status with Regulation 11, as well as violations and significant deficiencies documented during sanitary surveys.

CWD is currently in compliance with Regulation 11 requirements based on available regulatory and compliance data. Review of EPA Enforcement and Compliance History Online (ECHO) records indicates that the system has had no reported violations and no quarters of noncompliance over the past three years (2022–2025), and no formal enforcement actions have been identified. Sanitary survey records conducted by the State in 2020 and 2024 indicate that the system is generally well maintained, with most evaluated categories receiving "No deficiencies" ratings. Minor deficiencies have been noted in certain areas, and the 2024 survey identified a significant deficiency related to finished water storage; however, no widespread or systemic compliance issues were identified. The treatment system was originally designed and approved by CDPHE to meet Regulation 11 requirements, including required pathogen removal and disinfection criteria, and current compliance history indicates that these requirements continue to be met under existing operations.

5.2.4 Appropriateness of Treatment Technologies (TMF: Technical-6)

Discuss if the existing treatment process(es) are appropriate to meet Regulation 11 considering existing source water quality and potential sources of contamination.

The existing treatment processes at CWD are appropriate for meeting Regulation 11 requirements given the characteristics of the source water and potential sources of contamination. The system treats surface water from the Colorado River, which is subject to variability and potential impacts from upstream agricultural activities, permitted wastewater discharges, mining-related influences, and natural watershed processes .

As a surface water source, Colorado River water quality is subject to seasonal variability, including changes in turbidity and dissolved solids, necessitating a robust multi-barrier treatment approach. The treatment process incorporates conventional pretreatment (coagulation, flocculation, and sedimentation) to remove suspended solids and reduce turbidity, followed by MF/UF membranes that provide effective removal of particulate matter and pathogens, including Giardia and Cryptosporidium. Additional treatment through NF/RO addresses dissolved constituents such as total dissolved solids and other inorganic contaminants. Final disinfection is achieved through chlorination in a contact chamber designed to meet required pathogen inactivation. The treatment system was designed and approved by CDPHE to meet Regulation 11 requirements and is required to achieve 4-log virus inactivation, 3-log Giardia removal/inactivation, and 2–3 log Cryptosporidium removal/inactivation under defined operating conditions. The combination of conventional treatment, membrane filtration, and disinfection provides a multi-barrier approach that is well suited to address both particulate and dissolved contaminants present in the source water.

5.2.5 Capacity of Treatment Technologies (TMF: Technical-7)

Is the capacity of the existing water treatment system appropriate to meet water demands through the next 20 years?

☒ Yes ☐ No

Please explain:

The treatment plant has a design capacity of 12 MGD; however, current pumping limitations reduce effective capacity to approximately 10 MGD. The proposed WTP Controls, Electrical, and Pumping Improvements Project will restore firm capacity to 12 MGD. Current and near-term demands are within existing system capacity, with a potential supply gap emerging in the longer term (beyond the 20-year planning horizon) if no additional improvements are made. Based on this, projected average day and peak day demands over the 20-year planning period are expected to remain at or below the improved treatment capacity of 12 MGD, although demand may approach system limits under future growth conditions. Therefore, the restored treatment capacity of 12 MGD is expected to be sufficient to meet projected 20-year demands while improving system reliability and operational flexibility.

5.2.6 Operational Controls (TMF: Technical-10)

Describe if the existing treatment process(es) has appropriate operational controls.

The existing treatment system includes multiple process components (conventional pretreatment, membrane filtration, and chlorination) that provide operational flexibility to address routine and variable source water conditions such as changes in flow, turbidity, and dissolved solids. Operators are able to adjust process conditions including chemical dosing and treatment configuration; however, under the current system, these adjustments are largely performed manually. Operation of pumps, valves, and chemical feed systems require operator intervention, with dosing rates and application points adjusted based on system conditions and pump configurations. This manual and decentralized control approach allows operators to respond to routine changes in flow and water quality but limits the ability to consistently and efficiently respond to unanticipated treatment challenges, such as rapid changes in source water quality or system demand. Planned improvements include implementation of a centralized SCADA system, programmable logic controllers (PLCs), and automated controls, which will significantly enhance real-time monitoring, automated chemical dosing, and system-wide responsiveness. These upgrades will improve real-time monitoring, system responsiveness, and process control reliability to improve the system's ability to respond to both routine operational adjustments and unanticipated events, while increasing reliability and consistency of treatment performance.

5.2.7 Residuals Management (TMF: Technical-9)

If the treatment process produces waste residuals, please discuss the water system's residuals management strategy.

The treatment process generates residuals associated with sedimentation and membrane treatment processes. Residuals are managed through sludge collection systems, washwater recovery facilities, and on-site backwash ponds.

List documentation for all existing discharge permits and/or residuals for the water treatment plant including residuals for disposal or beneficial use (e.g., NPDES discharge permits, EPA UIC Permit, HMWMD radioactive materials license, HMWMD Solid Waste licenses).

There are no permits associated with residuals management, disposal, or discharge.

Include a copy of discharge permits and/or residual documentation as Attachment 14 ☒ Not Applicable

5.3 Distribution - Required for distribution and storage projects only

☒ Not applicable (for supply and treatment projects, only)

6. Facility Planning Analysis

6.1 Planning Area Description

6.1.1 Project Area Map

Provide a map showing a minimum of a 3-mile radius around the project area that includes environmental features (lakes, streams, wetlands, floodplains). Map must include current and proposed service area, existing drinking water facilities (plants, major distribution lines, water sources, storage facilities), existing wastewater outfalls/permitted discharge points, and any new or affected sources with regard to the pertinent watershed. Include the map as Attachment 16.

6.1.2 Urban Growth Boundary

☒ Yes ☐ No Is the project within or near an urban growth boundary?

The project is located within the City of Grand Junction's Urban Development Boundary. The proposed project consists of improvements to existing water treatment and pumping infrastructure within an already developed and serviced area. As such, the project supports planned growth within the UDB by maintaining and improving critical public water infrastructure necessary for reliable service. The project does not extend infrastructure into undeveloped or rural areas outside the boundary and is consistent with regional planning objectives for efficient, managed growth. No conflicts with other identified planning limitations were identified, as the project is limited to upgrades within the existing system footprint and does not involve land use changes or expansion beyond the current service area.

6.1.3 Local and Regional Issues

☒ Yes ☐ No Were local and regional planning efforts considered?

Please describe.

CWD works closely with its regional partners on water resource management, demand planning, and water conservation. CWD has participated in several regional water planning efforts including the 2011 Grand Valley Regional Water Conservation Plan and the 2023 Grand Junction Regional Water Efficiency Plan. The original 2011 plan and the 2023 update were developed collaboratively among Clifton, Grand Junction, and Ute Water and include coordinated demand forecasting, supply planning, and conservation strategies. CWD also participated in the development of the Drought Response Plan with the Drought Response Information Project (DRIP) committee. The DRIP committee includes two other domestic water providers, City of Grand Junction and Ute Water Conservancy District, and other partners including Orchard Mesa Irrigation District, Tri River Area Colorado State University Extension Horticulture Program, and the National Oceanic and Atmospheric Administration/National Weather Service. Regional water quantity efforts are also addressed through shared supply planning, demand projections, and conservation measures.

☒ Yes ☐ No Were local and regional water quality and/or quantity efforts considered?

Please describe.

Regional water quality and quantity efforts were considered through CWD's participation in collaborative planning with the City of Grand Junction and Ute Water Conservancy District. These efforts include the 2011 Grand Valley Regional Water Conservation Plan and the 2023 Grand Junction Regional Water Efficiency Plan, which incorporate coordinated demand forecasting, supply planning, and conservation strategies to address long-term water quantity needs. In addition, CWD participates in the Drought Response Information Project (DRIP) committee, which includes regional partners and agencies and supports coordinated drought response, public outreach, and resource management. These efforts collectively address regional water quantity and, to a lesser extent, water quality considerations through watershed awareness, conservation, and supply reliability planning.

☐ Yes ☒ No Was consolidation with another water system / treatment facility considered?

If yes, describe the consolidation considerations. If no, please indicate why consolidation was not considered.

6.2 Population and Water Demand Projections (TMF: Technical-2)

For a 20 year planning period, forecast the population growth, projected increase in Equivalent Residential Taps (ERT), and projected drinking water demands.

Current ERT - As Calculated in the Prequalification Form: 13582.9551059944

Population and Demand Projections - The department generally accepts two methodologies for projecting water flows over the 20 year planning period. Other methodologies are acceptable with a clear explanation and all assumptions and parameters listed:

☒ Method 1: Population based projections. Recommended for primarily residential systems and/or for systems without water meter data

☐ Method 2: Equivalent Residential Taps (ERT) Analysis. Recommended for systems with a high multifamily, commercial, industrial, irrigation demands.

Method 1 and 2 templates can be found at the end of this form.
Attach the population projection as Attachment 17.

Discuss supporting data and reasons for projected future growth during the 20 year planning period.

Note: Projects designed solely to serve future development or population growth are not eligible for State Revolving Fund financing.

Clifton Water District's projected future growth is based on regional planning efforts, including the 2023 Grand Junction Regional Water Efficiency Plan, which incorporates population projections, historical demand trends, and coordinated regional demand forecasting. These projections consider continued residential development, commercial activity, and seasonal irrigation demands typical of the service area. Historical trends indicate increasing demand driven primarily by population growth and outdoor water use, while conservation measures have helped moderate per capita demand.

Future growth projections also reflect coordination with regional partners, including the City of Grand Junction and Ute Water Conservancy District, and are supported by shared planning assumptions regarding land use, service area development, and long-term supply reliability. In addition, participation in regional drought planning efforts (e.g., DRIP) supports consideration of climate variability and supply constraints in future demand projections.

The proposed project is not intended to serve new growth alone but is necessary to address aging infrastructure, improve system reliability, and maintain consistent compliance with drinking water standards for existing customers. While future growth is considered in planning analyses, the project primarily supports existing demand and system performance, consistent with State Revolving Fund eligibility requirements.

6.3 Source Water Planning

6.3.1 Overall Water Resource Management Description (TMF: Technical-2)

For a 20 year planning period, describe the system's water resource management plan.

CWD's water resource management approach is coordinated regionally with the City of Grand Junction and Ute Water Conservancy District and incorporates demand forecasting, conservation strategies, and shared supply planning. This regional framework supports system resilience and long-term water supply reliability, including ongoing efforts to protect and enhance Colorado River supplies such as participation in basin-level water rights initiatives.

6.3.2 Water Rights (TMF: Technical-3)

For the 20 year planning period, discuss how the system will be able to meet the projected population and increased industrial/commercial water demands.

Long-term planning identifies that while current supplies are adequate, future demand growth may require additional supply development, infrastructure improvements, or expanded regional partnerships to fully meet buildout conditions. Existing supply infrastructure and water rights are currently sufficient to meet average and peak demands; however, long-term projections indicate a potential supply gap under future growth scenarios if additional supply or demand management measures are not implemented.

Provide documentation supporting the system's water rights, if not provided in section 5.1.2 above, as Attachment 18.

6.3.3 Source Water Supply Capacity (TMF: Technical-4)

For the 20 year planning period, discuss if the source water supply infrastructure is capable of delivering adequate source water to meet projected needs.

Source water supply infrastructure is currently capable of delivering adequate source water to meet existing demand, with existing source water rights and regional supply infrastructure are currently adequate to meet existing demand. The system benefits from regional supply infrastructure and coordination with the City of Grand Junction and Ute Water Conservancy District, which supports operational flexibility and supply delivery. For the 20-year planning period, projections indicate that while the existing infrastructure is generally adequate to meet near-term demands, future demand growth may approach system capacity limits. Long-term planning documented in the 2023 Grand Junction Regional Water Efficiency Plan indicates that future demand growth under projected buildout conditions may approach available source water supply capacity, suggesting that additional supply development, infrastructure improvements, or continued regional coordination may be needed to fully meet long-term projected demands. Please see Attachment 17: Grand Junction Regional Water Efficiency Plan.

7.Assessment of Alternatives

7.1 Alternatives

For each alternative, please provide:

1. A description of the alternative addressing the issues identified in Section 4: Project Purpose and Need. (TMF: Technical-7)
2. Capital cost estimates and annual operation and maintenance costs.
3. Advantages and Disadvantages of each alternative.

Alternative 1 Title : Effluent Pump Station
(EPS) Configuration (3-
Pump Configuration)

Alternative 1 Description (2000 character limit):

Reconfiguration of the existing effluent pump station to improve hydraulic efficiency and operational reliability. Includes installation of new vertical turbine pumps (3 pumps), replacement of aging infrastructure, and modifications to piping and discharge manifold. Incorporates electrical, controls, and SCADA upgrades to improve control, monitoring, and system resilience. Designed to increase firm pumping capacity from approximately 10 MGD to match the treatment plant capacity of 12 MGD.

Alternative 1 Capital and Operation and Maintenance Costs (2000 character limit):

The total cost for this alternative including direct costs, indirect costs, contingencies, and escalation, is \$14.6 million, based on the January 2025 30% BODR opinion of probable construction cost (OPCC), escalated to current dollars using a 4.83% U.S. Bureau of Labor Statistics Consumer Price Index (CPI-U) adjustment. Original planning-level direct construction costs for Alternative 1 were estimated at approximately \$8.39 million. Major components include effluent pump station upgrades (\$4.44 million), SCADA/control upgrades (\$2.29 million), a new VFD building (\$1.0 million), RO forwarding pump station (~\$600,000), and chemical feed improvements (~\$27,000). Annual operations and maintenance costs for Alternative 1 are estimated at approximately \$243 thousand per year.

Alternative 1 Advantages and Disadvantages (2000 character limit):

Advantages: Improves hydraulic efficiency and simplifies system configuration, reduces operational complexity compared to existing system, enhances reliability and consistency of flow delivery, supports full utilization of treatment plant capacity (12 MGD), and integrates with planned SCADA and control system upgrades.

Disadvantages: Provides less operational redundancy compared to the four-pump configuration evaluated under Alternative 2. Fewer, larger pumps limit turndown capabilities for the total station.

Alternative 2 Title : Effluent Pump Station
(EPS) Configuration (4-
Pump Configuration)

Alternative 2 Description (2000 character limit):

Alternative reconfiguration of the effluent pump station with installation of 4 pumps instead of 3. Includes similar infrastructure improvements (pump replacement, piping reconfiguration, electrical and SCADA upgrades). Intended to provide increased operational flexibility and redundancy compared to Alternative 1.

Alternative 2 Capital and Operation and Maintenance Costs (2000 character limit):

The total cost for this alternative including direct costs, indirect costs, contingencies, and escalation is \$14.5 million, based on the January 2025 30% OPCC total of approximately \$13.8 million, escalated to current dollars using a 4.83% adjustment. Original planning-level direct costs for Alternative 2 were estimated at approximately \$8.36 million. Major cost components include effluent pump station and electrical building upgrades (\$4.44 million), SCADA/control room upgrades (\$2.29 million), a new VFD building (\$1.0 million), RO forwarding pump station improvements (\$990,000), and chemical feed additions (\$27,000). Annual operations and maintenance costs for Alternative 2 are estimated at approximately \$251 thousand per year. While more pumps potentially result in the opportunity for more maintenance, the smaller pumps are anticipated to operate at improved efficiency.

Alternative 2 Advantages and Disadvantages (2000 character limit):

Advantages: Increased redundancy and operational flexibility due to additional pumps and potential for improved reliability under varying demand conditions. Variability in pump size allows for maximum and efficient turndown.

Disadvantages: Slightly higher estimated O&M cost compared to Alternative 1.

Alternative 3 Title : No Action Alternative

Alternative 3 Description (2000 character limit):

Under the no action alternative, no measures would be taken to address facility limitations at the WTP, including aging infrastructure, operational inefficiencies, and limited system control.

Alternative 3 Capital and Operation and Maintenance Costs (2000 character limit):

Annual operations and maintenance costs for Alternative 3 are estimated at approximately \$360 thousand per year. This is due to inefficient pumps operating at the end of their useful life and regular maintenance required for pumps and/or discharge piping components. .

Alternative 3 Advantages and Disadvantages (2000 character limit):

Advantages: Avoids immediate capital expenditures and short-term construction disruption to plant operations.

Disadvantages: Does not address aging infrastructure or limited system control at the WTP. Continued reliance on manual operations would maintain higher operator burden, while aging pumps, electrical equipment, and controls would likely result in increasing maintenance demands and elevated risk of equipment failure. Aging infrastructure operates less efficiently and breaks more often resulting in higher annual O&M costs. This alternative would also leave effective firm pumping capacity below the treatment plant's 12 MGD design capacity.

Provide discussions of additional alternatives as Attachment 19.

8. Selected Alternative

8.1 Justification of Selected Alternative (TMF: Technical-6)

Please demonstrate why the selected alternative best meets system needs based on both monetary and non-monetary considerations. For treatment facility projects, if the EPA-BAT technology is not selected then the report must include a treatment rational.

The selected alternative (Alternative 2) best meets system needs by improving reliability, operational efficiency, and firm pumping capacity while maintaining compatibility with the existing treatment process. Alternative 2 simplifies the effluent pump configuration, reduces operational complexity, and supports full utilization of the treatment plant's 12 MGD design capacity. Proposed project upgrades, including new pumps, electrical improvements, and SCADA integration, improve system control and reduce reliance on manual operation, addressing key deficiencies identified in the existing system. From a monetary perspective, the selected alternative represents a targeted investment in critical system components, with total capital costs estimated at approximately \$14.5 million based on the January 2025 30% BODR OPCC, escalated to current dollars using CPI-U. These improvements focus on rehabilitating aging infrastructure and optimizing system performance rather than expanding treatment capacity, which supports cost-effective use of funds. Compared to Alternative 1, which utilizes a three-pump configuration, Alternative 2 provides additional operational redundancy and flexibility through a four-pump configuration while achieving the targeted firm pumping capacity and reliability improvements. While the overall capital costs of the two alternatives are comparable, Alternative 2 is expected to result in lower capital costs, reduced equipment servicing requirements, and a less complex control arrangement. The proposed project does not involve changes to treatment technology; therefore, EPA Best Available Technology (BAT) considerations are not applicable. The existing treatment process remains appropriate for source water conditions and supports continued compliance with Regulation 11 requirements.

8.2 Technical Description and Design Parameters (TMF: Technical-5)

For the selected alternative, please describe all proposed project components and assumed design parameters.

The proposed improvements focus on restoring capacity, improving reliability, and modernizing system controls rather than expanding treatment processes. The selected alternative consists of improvements to the effluent pump station (EPS) to increase system reliability, efficiency, and capacity. Project components include replacement and reconfiguration of existing pumps with new vertical turbine pumps, modifications to piping and the discharge manifold to improve hydraulic performance, and upgrades to electrical systems, controls, and SCADA to provide centralized and automated operation. The improved EPS is designed to increase firm pumping capacity from approximately 10 MGD to match the treatment plant's design capacity of 12 MGD. The system will include multiple pumps (anticipated three duty units) with VFDs to allow operational flexibility and efficient response to varying demand conditions. Associated improvements include valve replacements, instrumentation upgrades, and integration of automated chemical feed control with plant operations. The proposed project does not modify the treatment process itself; however, it supports full utilization of the existing 12 MGD treatment plant capacity and improves system-wide operational control. Design parameters are based on the 30% BODR, including reliable pumping at peak flow conditions, improved hydraulic efficiency, compatibility with existing treatment and storage infrastructure, and integration with upgraded electrical and control systems. The BODR is included as Attachment 24 for supplemental detail.

8.3 Proposed Process Flow Diagram

Include a proposed treatment facility process flow diagram or map of the distribution system, as applicable as Attachment 20.

8.4 Appropriateness of Treatment Technologies (TME: Technical-6)

Discuss appropriateness of the proposed treatment process(es) to meet Regulation 11 considering anticipated source water quality and potential sources of contamination.

The proposed improvements to the treatment process will allow CWD to maintain compliance with all state and federal drinking water standards through improved process control, automated chemical dosing, and consistent operational responses while maximizing operational and electrical efficiencies. The existing and proposed treatment processes are appropriate to meet Regulation 11 based on current source water conditions and historical system performance. Clifton's source water is surface water from the Colorado River, which is known to be subject to typical upstream influences such as agricultural runoff, wastewater discharges, and other watershed activities as identified in the Consumer Confidence Report. The treatment plant utilizes ultrafiltration (UF), reverse osmosis (RO), and chlorination, which are robust treatment processes capable of addressing a wide range of contaminants and are consistent with Safe Drinking Water Act (SDWA) requirements. The proposed project does not modify the existing treatment process itself but focuses on improvements to pumping systems, process controls, and chemical feed systems. These upgrades, including implementation of centralized SCADA, improved automation, and optimized chemical dosing, are expected to enhance operational reliability, consistency, and process control rather than degrade treatment performance. As such, the improvements support continued compliance with Regulation 11. EPA ECHO records for CWD (PWS ID CO0139180) indicate no violations or significant noncompliance from October 2022 through September 2025, supporting that the system has met SDWA/Regulation 11 requirements in recent years.

8.5 Environmental Impacts

Describe direct and indirect impacts on floodplains, wetlands, wildlife habitat, historical and archaeological properties, etc., including any projected permits and certifications.

The proposed project consists of upgrades within the existing water treatment plant (WTP) site and is not expected to result in significant direct or indirect environmental impacts. The facility is located within a FEMA-designated floodway; however, because work will occur within an existing developed facility, impacts are expected to be limited. Project implementation may require local floodplain/floodway development review to demonstrate that proposed improvements do not adversely affect flood conveyance or increase flood risk. No direct impacts to wetlands are anticipated. Although wetlands exist in the surrounding area, all construction will occur on previously disturbed ground within the existing WTP site, and no wetland disturbance is proposed. Impacts to wildlife habitat are expected to be minimal. Several federally listed species have the potential to occur in the broader region; however, the project will not affect river channels, remove vegetation, or impact identified critical habitat. No impacts to cultural or archaeological resources are anticipated because construction will occur within previously disturbed areas. Two historic properties are located within three miles of the project site. Potential impacts to nearby waterbodies, recreation areas, and agricultural lands are expected to be temporary and limited to construction activities and will be minimized through stormwater and erosion control best management practices. Required permits and certifications may include applicable floodplain/floodway development approvals, construction-related stormwater controls, and other environmental compliance measures identified during final design. CWD is also conducting a cultural resources review in accordance with National Historic Preservation Act Section 106 requirements, with completion anticipated by fall 2026.

8.6 Land Requirements

Identify all necessary sites and easements, permits and certifications, and specify if the properties are currently owned, to be acquired, or leased by the applicant.

Construction activities will occur within the established boundaries of the existing water treatment plant. CWD anticipates submitting design plans for the proposed project to CDPHE for review to demonstrate compliance with CDPHE's Drinking Water Design Criteria. CWD will also submit any necessary permit applications to CDPHE, such as a Construction Permit for demolition, installation of the prefabricated electrical building, construction of a small VFD enclosure, skylight installation at the RO pumps, and other internal construction activities. Because the existing WTP site is located within a FEMA-designated floodway, the project may also require local floodplain/floodway development review, including demonstration that proposed improvements do not adversely affect flood conveyance or increase flood risk, as determined during final design and permitting. Final design will confirm compliance with local floodplain/floodway requirements and demonstrate no adverse impacts to flood conveyance.

8.7 Construction Requirements

Discuss construction concerns such as subsurface rock, high water table, limited access, or other conditions that may affect cost of construction or operation of a facility.

Rock excavation will not be required for the proposed project and only nominal dewatering may be needed. Although no concerns are anticipated due to the pre-disturbed project area, the design and engineering team is currently conducting a geohazard assessment of the site to confirm. No other construction concerns are anticipated for this project or operation of the facility after project implementation.

8.8 Operational Aspects

Discuss the operator staffing requirements, operator certification level requirements (including distribution), the expected basic operating configuration and process control complexities, and the operational controls and equipment that allows operational personnel to respond to routine and unanticipated treatment challenges, such as flow rate, chemical feed dosing, and process monitoring.

CWD WTP is currently classified as a Class A treatment facility and a Class 3 distribution system. CWD will continue to rely on its existing water utility staff, led by the ORC Isaac Brown, who holds a Class A Water Treatment certification. These credentials meet Regulation 100 requirements for the facility's classification, and the proposed improvements to the WTP including the installation of the new effluent and RO forwarding pumps will not result in any changes to the minimum certification level needed for the ORC or distribution operators. The proposed project will help address the current operational challenges with the existing effluent discharge pumps including manual control of finished water chemicals dosing, manual control of chemical feed application points, and lack of automation to control the effluent pump station, reducing manual operator intervention and improving consistency of process control.

8.9 Costs (TMF: Financial-2 and -3)

Summarize the capital costs associated with the selected alternative. The 20 year cash flow projection included in Attachment 7 must reflect the capital and operation and maintenance costs associated with the selected alternative. (No more than 2,000 Characters)

Per the 30% BODR escalated to current dollars using the CPI-U, project costs total approximately \$14.5 million, including direct costs, indirect costs, contractor markups, contingency, and escalation. The project includes effluent pump station upgrades, electrical improvements, a new VFD building, RO forwarding pump station upgrades, chemical feed improvements, and SCADA/control system modernization. Automating the effluent and RO forwarding pump controls and implementing a centralized SCADA system may reduce long-term operation and maintenance demands through improved efficiency, reduced manual intervention, and more consistent system performance. These costs are associated with replacement and modernization of aging infrastructure necessary to maintain reliable operations.

Cost Category Selection (Assign a percent to each applicable category)

Planning and Design Only (non-construction)	10
Construction - Treatment	60
Construction - Transmission and distribution	0
Construction - Source	0
Construction - Storage	0
Purchase of Systems	0
Restructuring	0
Land Acquisition	0
Water Rights	0
Other	30
Total: (must equal 100%)	100

Please include an estimate of the projected increase in and total average monthly user charges. Does the user charge system allow for billing, collection, and enforcement?

The system utilizes a volumetric user charge system that supports billing based on metered water usage, including tiered rates for residential and commercial customers. Current rate assumptions, fee structures, and billing/enforcement mechanisms are documented in the Clifton Water District 2026 Adopted Budget (Attachment 7), which includes water sales revenue projections, base and consumption tier rate increases, delinquency fees, disconnect/shutoff fees, and lien procedures for delinquent accounts. Based on the 20-year financial projections, the average monthly user charge is estimated to be approximately \$69.75 per connection in 2026, with gradual increases over time to support operation, maintenance, debt service, and capital improvement needs. The projected increase in user charges reflects the costs associated with maintaining and upgrading aging infrastructure, including the proposed project improvements, while supporting continued compliance with drinking water standards. Rate adjustments are incorporated into the long-term financial planning model to maintain financial sustainability and meet debt service obligations. The user charge system allows for billing, collection, and enforcement through established District procedures, including payment monitoring, delinquency fees, service shutoff, and lien mechanisms for unresolved nonpayment.

8.10 Environmental Checklist

Include the Environmental Checklist for the Selected Alternative as Attachment 22.

8.11 Project Implementation

8.11.1 Proposed Schedule

Loan application	<u>01/05/2027</u>	Design Plans (60 day review period)	<u>01/05/2027</u>
Advertisement for bids	<u>09/07/2025</u>	Award Contracts	<u>02/09/2026</u>
Start Construction	<u>06/01/2027</u>	Complete Construction	<u>12/01/2028</u>

8.11.2 Public Meeting

Provide documentation of a public meeting held or describe when and where the meeting will be held. The meeting must be noticed for 30 days. Provide the public notice, proof of publication, sign in sheet, and agenda as Attachment 23 or provide to your project manager in the Grants and Loans Unit after the meeting has taken place.

☐ Include the public meeting documentation as Attachment 23.

Or, will be provided to the Grants and Loans Unit project manager after the meeting takes place.

9. Projecting Water Flows Method 1: Population based projections

Assumptions/Data

Information Source

Current System Population	<u>40700</u>	People	<u>CWD</u>
Current Service Area Population (If providing water to neighboring community)	<u></u>	People	<u>CWD</u>
Population Growth Rates	<u>1.5</u>	% increase/year	<u>2023 Grand Junction Regional Water Efficiency Plan</u>
Average Daily per Capita Flow Rate	<u>72.49</u>	Gallons per capita day	<u>CWD</u>
Maximum Daily per Capita Flow Rate	<u>175</u>	Gallons per capita day	<u>CWD</u>
Peak Hour Factor	<u>2.4</u>	Gallons per capita day	<u>CWD</u>

Year	System Population	Service Area Population (if different)	Average Daily Flow	Maximum Daily Flow	Peak Hour Flow
+0	0	0	2.95	7.12	7.08
+5	44900		3.18	7.67	7.62
+10	49600		3.42	8.26	8.21

+15	54900		3.69	8.91	8.86
+20	60500		3.97	9.59	9.53

10. Projecting Water Flow Method 2: Equivalent Residential Taps (ERT)

Current Equivalent Residential Taps (ERT)		
A	Number of active residential taps:	0
B	Total annual consumption (gallons per year) - Residential	0
C	Estimated equivalent residential tap water usage Annual flow per ERT = B / A	0
D	Total annual consumption (gallons per year) - Commercial / Industrial / Irrigation	0
E	Estimated Commercial / Industrial / Irrigation flow in ERT # of commercial / industrial / irrigation ERT = D / C	0
F	Total ERTs = A + E	0

Population and Flow Assumptions / Data

Current System Population	_____ People	_____
Current Service Area Population (If providing water to neighboring community)	_____ People	_____
Population Growth Rates	_____ % increase/year	_____
Average daily flow per ERT	_____ Gallons per capita day	_____
Maximum daily flow per ERT	_____ Gallons per capita day	_____
Peak Hour Factor	_____ Gallons per capita day	_____

Information Source

Year	System Population	Service Area Population (if different)	Residential Taps (ERTs)	Multifamily Residential Taps (ERTs)	Commercial/ Industrial Taps (ERTs)	Irrigation Taps (ERTs)	Total Taps (ERTs)	Average Daily Flow	Maximum Daily Flow	Peak Hour Flow
+0										
+5										
+10										
+15										
+20										



PLANT CONTROL SYSTEM AND EFFLUENT PUMP STATION
PROGRESSIVE DESIGN-BUILD
FEBRUARY 2025

Basis of Design Report 30%

Prepared for:

Clifton Water District



**CDM
Smith**



Contents

Acronyms and Abbreviations	i
Executive Summary	ES-1
1.0 Introduction	1-1
1.1 Pumping and Chemical Feed Systems	1-1
1.2 Instrumentation and Control Systems	1-1
1.3 Electrical Systems	1-1
2.0 Project Overview	2-1
2.1 Existing Systems	2-1
2.1.1 Effluent Pumps.....	2-1
2.1.2 RO Forwarding Pumps	2-5
2.1.3 Existing Effluent Chemical Feed Systems.....	2-6
3.0 Pumping and Chemical Feed Systems	3-1
3.1 Effluent Pump Systems.....	3-1
3.1.1 Hydraulic Design Criteria	3-1
3.1.2 Preliminary Equipment Sizing and Selection	3-4
3.1.3 Facility Layout	3-9
3.2 RO Forwarding Pumps.....	3-10
3.2.1 Hydraulic Design Criteria	3-10
3.2.2 Preliminary Equipment Sizing and Selection	3-13
3.2.3 Facility Layout	3-18
3.3 Effluent Chemical Feed Systems Modifications	3-19
4.0 Instrumentation and Control.....	4-1
4.1 Introduction.....	4-1
4.1.1 Background	4-1
4.1.2 Purpose	4-1
4.2 Applicable Codes and Standards	4-2
4.3 Design Approach Overview	4-2
4.4 HMI and SCADA System.....	4-3
4.4.1 Introduction	4-3
4.4.2 SCADA System Architecture.....	4-3
4.4.3 SCADA System Hardware and HMI Software.....	4-3
4.4.4 HMI Design Basis.....	4-4
4.4.5 HMI Workstations	4-5
4.4.6 SCADA Communications Network	4-5
4.4.7 Programmable Logic Controllers	4-10

4.4.8 Industrial Control System Cybersecurity	4-18
4.4.9 Equipment Tagging Convention.....	4-18
4.4.10 Process Control Philosophy	4-22
5.0 Electrical.....	5-1
5.1 Introduction.....	5-1
5.2 Existing Electrical Distribution	5-1
5.2.1 Existing Effluent Pumping Electrical Distribution System Description	5-1
5.2.2 Existing RO Process Electrical Distribution System Description	5-1
5.3 Proposed Electrical System Improvements.....	5-1
5.3.1 Effluent Pumping Electrical Distribution System Improvements.....	5-1
5.3.2 RO Process Electrical Distribution System Improvements.....	5-2
5.4 Codes and Standards	5-2
5.5 Design Requirements	5-3
5.5.1 Electrical Systems.....	5-3
5.5.2 Selection of Major Electrical Equipment	5-3
5.5.3 Electrical Materials.....	5-4
5.5.4 Electrical Systems.....	5-5
6.0 Architecture.....	6-1
6.1 Applicable Codes and Standards	6-1
6.1.1 Control Room	6-1
6.1.2 Electrical Building and VFD Building	6-1
6.1.3 Roof Hatches	6-1
7.0 Structural	7-1
7.1 Applicable Codes and Standards	7-1
7.2 Structural Design Criteria	7-1
7.2.1 Structural Materials	7-1
7.2.2 Structural Modifications at Effluent Pumps.....	7-2
7.3 Structural Modifications at RO Forwarding Pumps.....	7-2
7.4 Prefabricated Electrical Buildings	7-2
8.0 Pre-Construction Services (Future Tasks).....	8-1
8.1 Permitting Requirements	8-1
8.1.1 CDPHE	8-1
8.1.2 Construction Permitting.....	8-1
8.2 30% Design Opinion of Probable Construction Costs.....	8-2

Figures

Figure 2.1 Effluent Clearwell (ECW) and Effluent Pump Well (EPW) Process Flow Diagram	2-2
Figure 2.2 Operating Floor with Wet Well Delineation	2-2
Figure 2.3 Existing Effluent Pump Manifold.....	2-3
Figure 2.4 RO Forwarding Pump – Isometric View	2-5
Figure 3.1 Historical Combined Effluent Flow Trends.....	3-1
Figure 3.2 System Curve Generation	3-2
Figure 3.3 CWD-Effluent Pump Station System Curve.....	3-3
Figure 3.4 Extended System Curve	3-3
Figure 3.5 Comparison of CWD’s Distribution System Model and System Curve Extrapolation.....	3-4
Figure 3.6 Best-Fit Curve – Fairbanks Pentair	3-7
Figure 3.7 Best-Fit Curve – National Pump Company.....	3-8
Figure 3.8 Conceptual Design for Effluent Pump Station	3-9
Figure 3.9 Historical RO Feed Flow Trends	3-10
Figure 3.10 RO Skid Inlet Pressure Gauge Location	3-12
Figure 3.11 Evaluated RO Forward Pump System Curve	3-12
Figure 3.12 Best-Fit Curve – Flowserve.....	3-15
Figure 3.13 Best-Fit Curve – Fairbanks – Pentair	3-16
Figure 3.14 Best-Fit Curve – National Pump Co.....	3-17
Figure 3.15 Proposed RO Forwarding Pump Arrangement	3-18
Figure 3.16 Modified Effluent Flow and Chemical Dose Regime.....	3-19
Figure 3.17 Five Scenarios of Effluent Chemical Feed Systems	3-21
Figure 4.1 Current Plant SCADA and Control Systems Topology	4-1
Figure 4.2 Micro820 PLC Panel	4-6
Figure 4.3 Aprisa 4RF Radio Panel	4-6
Figure 4.4 I-3 SCADA Network Block Diagram	4-7
Figure 4.5 I-4 PLC Control System Block Diagram.....	4-8
Figure 4.6 I-5 SCADA Communication Block Diagram.....	4-9
Figure 4.7 Nano/RO Main PLC Panel.....	4-13

Tables

Table 2.1: Existing Effluent Pump Summary	2-4
Table 2.2: Existing RO Forwarding Pump Summary.....	2-6
Table 3.1 Statistical Summary of Effluent Pump Station Flow and Discharge Pressure	3-1
Table 3.2 Proposed Effluent Pumps – Pump Criteria.....	3-6
Table 3.3 Statistical Summary of RO Forward Flows and Discharge Pressure.....	3-11

Table 3.4 Pump System Criteria for Flowserve, Fairbanks, and National Pump Company	3-14
Table 4.1 Equipment and Instrument Tagging Sample.....	4-18
Table 4.2 Equipment and Instrument Abbreviations.....	4-18
Table 4.3 Equipment and Instrument ID.....	4-22

Appendices

Appendix A CWD-Effluent Pump Study Technical Memorandum

Appendix B Facility Drawings



Acronyms and Abbreviations

A	ampere
ACI	American Concrete Institute
AFD	adjustable frequency drive
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
BLDG	Building; Constructed, Modular and Prefabricated
BODR	Basis of Design Report
CCC	chlorine contacts chamber
CPU	central processing unit
CWD	Clifton Water District
ECW	effluent clearwell
EPS	effluent pump station
EPW	effluent pump well
HMI	Human Machine Interface
I&C	Instrumentation and Control
IBC	International Building Code
ICEA	Instrument Cable Engineers Association
ID	identification
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society of North America
ISA	International Society of Automation
kcmil	kilo circular mils
kVA	kilovolt-ampere
LCS	Local Control Station
LOR	Local/Off/Remote
MCC	Motor Control Center
MGD	million gallons per day
NEC	National Electrical Code

NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PLC	programmable logic controller
RO	reverse osmosis
SCADA	Supervisory Control and Data Acquisition
UF	ultrafiltration
UPS	Uninterruptible Power Supply
VFD	variable frequency drive
WTP	Water Treatment Plant



Executive Summary

This Progressive Design-Build project aims to address the needs of the Clifton Water District for the upgrade to the plant Supervisory Control and Data Acquisition (SCADA) control system, pumping systems for the reverse osmosis (RO) forwarding and effluent systems, and the electrical distribution systems associated with these areas at the Charles A. Strain Water Treatment Plant (WTP). This Basis of Design Report (BODR) describes the design approach and the engineering decision rationale for this project.

The design goals for the plant SCADA control system upgrade are to (1) improve operational efficiencies by automating the effluent and RO forwarding pump controls, (2) improve plant-wide communications, and (3) standardize programmable logic controllers (PLCs) throughout the existing treatment facility.

The design for the plant SCADA control system upgrades will be in accordance with the partial hardware upgrade work that has been completed by the plant staff outside of this project. The completed hardware upgrades have been a solid investment in materials and labor to address immediate concerns. This project's scope of work will be conducted in a standardized manner to complement the plant-wide upgrades.

New PLC Control Panels will be provided for the Main Panel, River Pump Station Panel, and Blend Vault Control Panel. Existing PLC Control Panels that have been recently upgraded or that meet the hardware standard for the Chemicals, Pre-Treatment, Main Nano/RO and Membrane Filtration system will remain as is. A new fiber-optic network will be installed in a ring topology to improve reliability of plant-wide communications to the PLC Control Panels. A new top-end SCADA system will be provided to consolidate and replace the individual systems that are currently used for the plant—the RO and ultrafiltration (UF) control systems. The new SCADA system will provide for efficient operator access to the entire plant from one centralized interface system location.

The design goals for the pumping system upgrades are to improve operations of the pumping systems, improve energy efficiency, and facilitate maintenance of the new equipment. Improvements to the chemical feed systems will be made to allow for improved automation of the pump start-up and shutdown cycles.

Effluent pumps will be upgraded into a new 5-pump configuration, thus replacing the current 10-pump configuration. The pump configuration will include three 4-million-gallons-per-day (MGD) variable frequency drive (VFD) pumps and two 2 MGD VFD pumps. This configuration will provide a pumping capacity of 12 MGD for the plant as well as allow for an effective turndown capacity for minimum flow conditions by operating one of the 2 MGD pumps at reduced speed. Pumps will be arranged to split the north and south pump wet wells to allow for isolation of these wells during maintenance without requiring a total plant outage.

RO forwarding pumps will be replaced and reconfigured to two 3 MGD VFD-driven pumps and one 1 MGD VFD-driven pump. The new configuration will provide a firm pumping capacity of 4 MGD to the RO system, as well as allow for minimum flow capacity of 0.5 MGD through the use of the 1 MGD pump

operated at reduced speed. Changes to the RO forwarding pump structure will be made to allow for easier removal of the pumps for future maintenance.

The chemical feed system will implement changes to automate configuration of the chlorine and fluoride feed systems, thereby allowing for different operational and pump selection between operational scenarios using the north, south, and both wet wells.

- **Electrical improvements for the effluent pumps** include removing Motor Control Center (MCC)-1 from the existing control room location and providing a new distribution switchboard and VFDs for the effluent pumps in a new Electrical Building. The new Electrical Building, which will house the new Main PLC Control Panel, will be located adjacent to the Process Building along the east wall and south of the existing generators. The new Electrical Building is planned to be a stand-alone, prefabricated, insulated, metal building with interior dimensions that measure approximately 37 feet (ft) long by 10 ft wide.
- **Electrical improvements for the RO forwarding pumps** include removing the existing motor starters in MCC-1 and replacing the existing feed breakers. Power to the new RO forwarding pumps will be provided through new VFDs housed in a second new Electrical Building. This Electrical Building will be located on the west wall of the Process Building and adjacent to the existing location of the RO forwarding pump structure.

Additional architectural, civil, and structural design work will be completed in the future design phase of this project, as needed, to support these primary design objectives.



1.0 Introduction

1.1 Pumping and Chemical Feed Systems

Pumping system improvements summarized in this report are designed to provide Clifton Water District (CWD) with 12 MGD firm capacity at the effluent pump station, and 4 MGD firm capacity at the reverse osmosis (RO) forwarding pump station. New variable frequency drive (VFD) vertical turbine effluent and RO forwarding pumps will replace all existing constant-speed pumps nearing the end of their useful life.

Additional process improvements are being designed to consolidate the existing effluent pump station chlorine and fluoride application points into a single dosing location for the north and south wet wells. The RO permeate return pipeline will be extended to the south clearwell to accommodate this change.

1.2 Instrumentation and Control Systems

The instrumentation and control (I&C) improvements for the project will provide for standardized hardware installation throughout the plant. New control panels will be designed and provided where hardware upgrades have not already been completed. A new Supervisory Control And Data Acquisition (SCADA) Human Machine Interface (HMI) system will be provided to consolidate the existing graphical interface systems used for the plant—the RO and ultrafiltration (UF) systems. Improvements will be made to the plant control system network by creating a new fiber-optic network in a ring-type topology. Standardizing control system hardware, establishing a resilient communications network, and providing redundant HMI servers in this upgrade will increase overall system availability and reliability.

The plant SCADA control system improvements include logical PLC programming and graphical HMI interface programming for automating pumping and chemical feed processes that are currently labor dependent. These improvements are meant to allow for efficient remote centralized operation of these systems and to provide automated controls in anticipation of operational configuration changes for electrical demand requirements during peak billing periods.

1.3 Electrical Systems

Upgrades to the electrical systems will be designed to meet the operational power requirements of the new RO forwarding and effluent pumping configurations. The upgrades will improve overall safety—such as reducing arc flash exposure in occupied working areas—by removing MCC-1 from the control room. New VFD motor controls will be used for the RO forwarding pumps and the effluent pumps to expand the overall operational range and efficiencies of these systems.

Two new prefabricated Electrical Buildings will be provided for the effluent pumps and the RO forwarding pumps electrical systems.



2.0 Project Overview

2.1 Existing Systems

The following is a brief description of the existing facilities within the plant.

2.1.1 Effluent Pumps

2.1.1.1 Effluent Pump Station

The existing effluent pump station (EPS) consists of the effluent pump well (EPW) and effluent clearwell (ECW), which are segregated into north and south wells below the operating floor in the facility's Process Building. The ECW is fed by a blend of ultrafiltration (UF) filtrate and reverse osmosis (RO) permeate.

Before entering the clearwell, filtrate from the UF process is disinfected via the water treatment plant (WTP) serpentine chlorine contacts chamber (CCC). Disinfection in the CCC is achieved by adding chlorine (via chlorine gas feed loop) in the 24-inch UF filtrate pipe entering the CCC. Disinfected water is then discharged into the north end of the clearwell (north clearwell) via a 126-inch by 24-inch concrete opening. Chlorine residual is monitored at the discharge end of the CCC for the purposes of disinfection compliance.

Once in the north clearwell, flow can be directed to the southern end of the clearwell (south clearwell) or into the north and/or south EPW (north pump well and south pump well, respectively) by means of manual slide gate valve operation. Gate valve openings are provided at the northern, central, and southern ends of the ECW.

To meet treated water quality goals, CWD redirects a portion of the clearwell storage to their RO process to achieve a seasonal UF/RO finished water blend. The facility's UF-filtrate/RO-permeate blend ratio is approximately 1:20 in the summer and 1:2 in the winter. The portion of flow diverted to the RO process must be dechlorinated before reaching the membranes. RO permeate is then stored and blended back into the EPW, as needed. RO permeate blend can be directed to the north or south pump well.

A process flow diagram depicting this flow regime is provided in **Figure 2.1**.

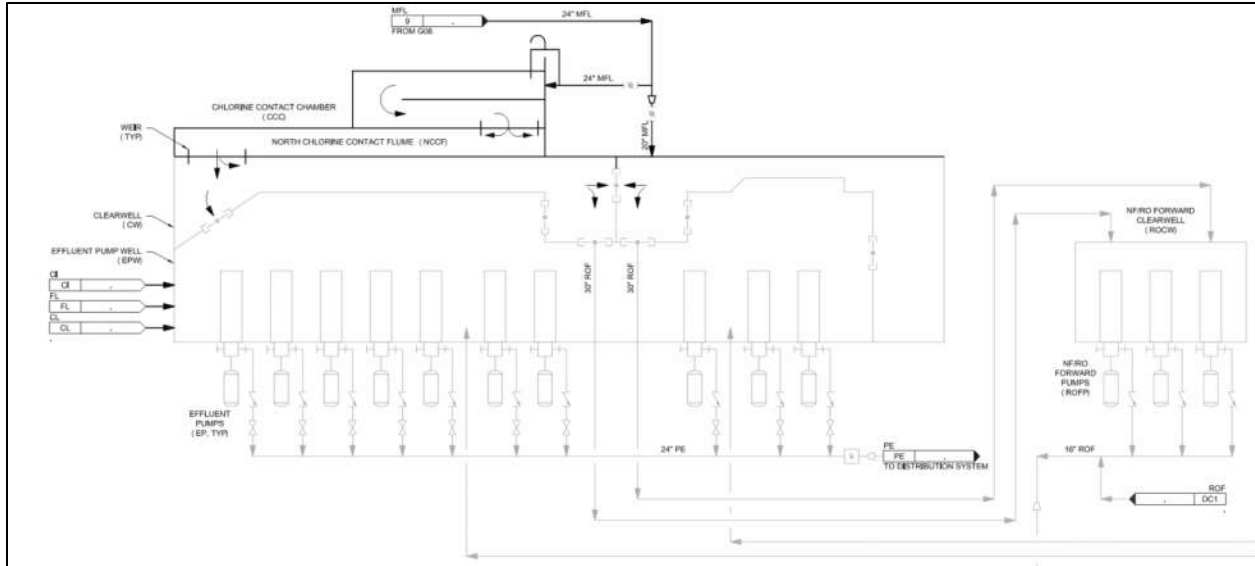


Figure 2.1 Effluent Clearwell (ECW) and Effluent Pump Well (EPW) Process Flow Diagram

The CCC, clearwell, and pump well form part of a common concrete structure in the Process Building with a top slab elevation at 4,649.83 and base slab finished floor at 4,642.67. The clear depth of the clearwell and pump wet well is 6.33 ft, which is relatively shallow. The effluent pumping units, discharge piping, and common discharge piping manifold are set at the operating floor elevation of 4,649.83.

Figure 2.2 shows the operating floor slab of the EPS with the relevant wet wells delineated.



Figure 2.2 Operating Floor with Wet Well Delineation

2.1.1.2 Effluent Pumps

The effluent pumps consist of nine vertical turbine pumps of varying flow ratings connected to a combined discharge manifold. Discharge from these pumps convey blended clearwell water (finished water) to CWD's distribution system storage tanks and various service areas. An isometric view of the existing effluent pump manifold is shown in **Figure 2.3**. Criteria for each existing effluent pump is summarized in **Table 2.1**.

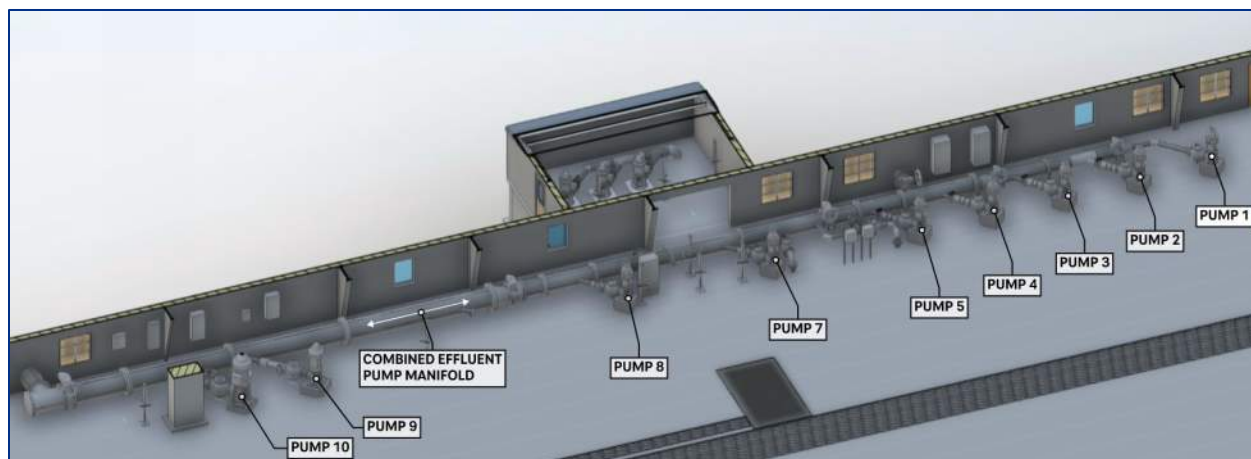


Figure 2.3 Existing Effluent Pump Manifold

Table 2.1: Existing Effluent Pump Summary

Pump Criteria	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6	Pump 7	Pump 8	Pump 9	Pump 10	
Manufacturer	Fairbanks Morse	Fairbanks Morse	Fairbanks Morse	Fairbanks Morse	Fairbanks Morse	DEMOLISHED	Fairbanks Morse	Fairbanks Morse	Fairbanks Morse	Fairbanks Morse	
Type	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine		Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	
Flow Rating (gpm)	800	800	800	800	800		800	800	1,389	2,780	
Flow Rating (MGD)	1.15	1.15	1.15	1.15	1.15		1.15	1.15	2.0	4.0	
Motor Drive	Constant	Constant	Constant	Constant	Constant		Constant	Constant	Constant	VFD	
Max Rated HP	100	100	100	100	100		100	100	150	300	
Total Head (ft)	369	369	369	369	369		369	369	346	346	
Rated Efficiency	82.0%	82.0%	82.0%	82.0%	82.0%		82.0%	82.0%	83.0%	83.0%	
Pump Control Mechanism	ROSS Valve						ROSS Valve				ROSS Valve w/VFD

All existing effluent pumps are constant-speed, except from Pump 10, which is equipped with a variable frequency drive (VFD). All pumps include discharge piping and fittings, including a globe style pump control valve (Ross), butterfly isolation valve, and dresser coupling. Combined pumping service can be discharged from the northern end of the manifold between Pump 4 and Pump 5 or from the southern end, adjacent to Pump 10.

Various sections of the effluent manifold can be isolated using a combination of six manual butterfly valves located along the EPS discharge header. For surge control, the combined effluent manifold includes a surge anticipator valve (Singer) with a relief line piped to the clearwell.

2.1.2 RO Forwarding Pumps

2.1.2.1 RO Pump Station

The RO forwarding pump station consists of a pumphouse and wet well located directly west of the EPS in the facility's Process Building. Pumps are housed in an extended portion of the metal building. An isometric view of the existing RO forwarding pump station and its components is shown in **Figure 2.4**.

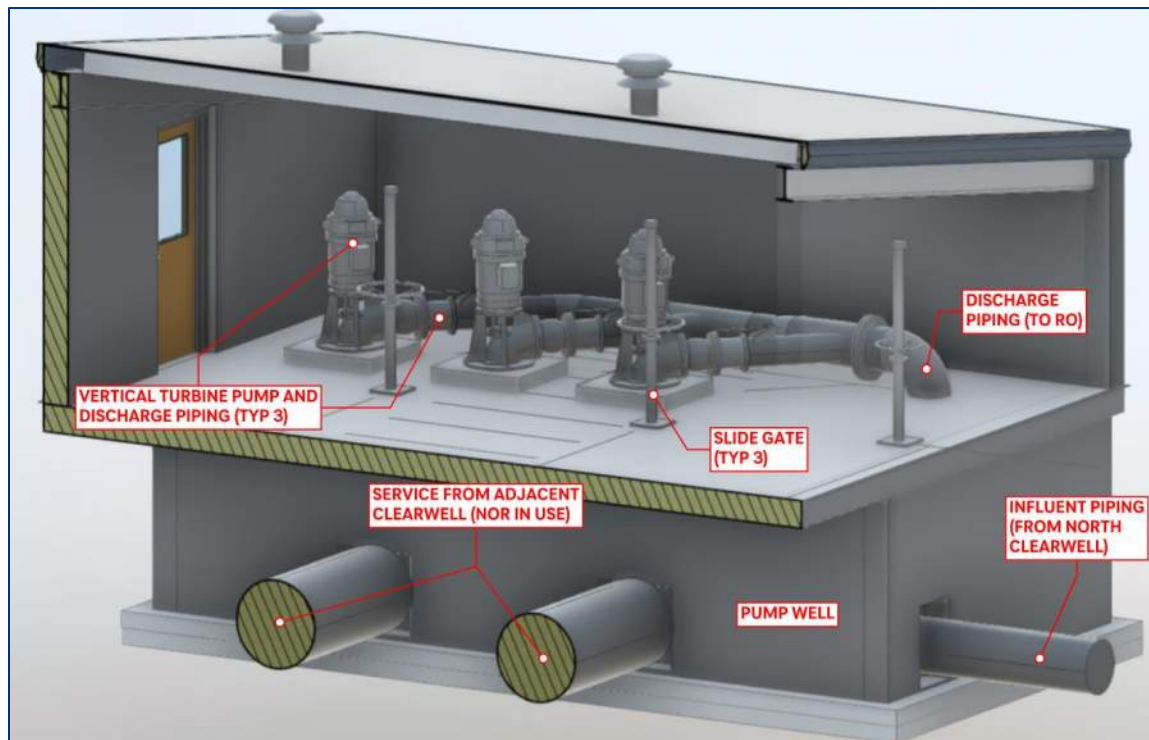


Figure 2.4 RO Forwarding Pump – Isometric View

Source water for the RO forwarding pumps is provided by a buried gravity pipeline conveyed from the north clearwell to the southern end of the pump well. Two 30-inch pipes connect the RO forwarding pump well directly to the EPWs, but they are currently not in use. All three RO forwarding pumps discharge to a common discharge header that conveys flow to the RO process room via a 16-inch pipeline. The pump well is a continuation of the concrete operating floor in the Process Building with a top slab elevation at 4,649.83 and base slab finished floor at 4,642.67. The depth of the pump well is 6.33 ft.

2.1.2.2 RO Forwarding Pumps

The RO forwarding pump station includes three constant-speed vertical turbine pumps originally installed in the 1990s. A summary of the existing pump criteria is shown in **Table 2.2**. Each pump is fitted with 10-inch discharge piping, including a roll seal style check valve and coupling. Discharge piping does not include pressure monitoring instrumentation or mechanical means for isolating pumps. Pump discharge piping combines into a common header progressively increasing in diameter from 10-inch to 16-inch. Combined flows are conveyed to the RO Process Building.

Table 2.2: Existing RO Forwarding Pump Summary

Pump Criteria	Pump 1	Pump 2	Pump 3
Manufacturer	National Pump Company	National Pump Company	National Pump Company
Type	Vertical Turbine	Vertical Turbine	Vertical Turbine
Flow Rating (gpm)	1,390	1,390	1,390
Flow Rating (MGD)	2	2	2
Motor Drive	Constant	Constant	Constant
Max. Rated HP	60	60	60
Total Head (ft)	134	134	134
Rated Efficiency	79.3	79.3	79.3

2.1.3 Existing Effluent Chemical Feed Systems

Because a chlorine residual is not carried across the RO process, CWD rechlorinates their blended effluent to meet minimum finished water chlorine residual requirements. Nine chlorine and fluoride application points are situated along the length of the EPW, corresponding to dosing locations at each individual effluent pump impeller. CWD operators manually select ball valves dedicated to each finished water pump application point (based on which pumps are operating at any given time). Dedicated ball valves are also used to manually actuate feed rates to each pump to target a combined effluent chlorine residual. Because of the arrangement of the current ECWs and UF/RO blending regime, there is no workable approach for consolidating finished water chemical feed to a single dosing location.

Finished water quality parameters are monitored at the combined effluent manifold, including free chlorine, fluoride, temperature, pH, and turbidity. CWD's finished water compliance monitoring location is situated on the southern extend of the combined effluent manifold.

3.0 Pumping and Chemical Feed Systems

3.1 Effluent Pump Systems

3.1.1 Hydraulic Design Criteria

Combined effluent flow data from Years 2019 to 2024 and discharge pressure from Years 2021 to 2024 were provided by CWD to generate pump system curves and ascertain seasonal service demands.

Figure 3.1 shows a 5-year trend of combined effluent flow data. A statistical analysis of this flow data, including discharge pressures, is summarized in **Table 3.1**.

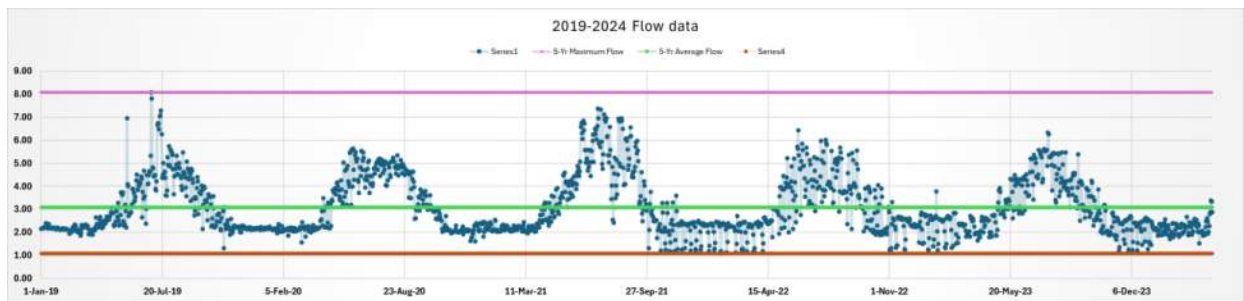


Figure 3.1 Historical Combined Effluent Flow Trends

Table 3.1 Statistical Summary of Effluent Pump Station Flow and Discharge Pressure

Flow Scenario	Effluent Flow (MGD) 2019–2024	Discharge Pressure (psi) 2021–2024	Discharge Head (ft) 2021–2024
Maximum Flow	8.08	273.9	632.7
99th Percentile Flow	6.79	139	321.2
Average Flow	3.08	122.6	283.2
Minimum Flow	1.08	96.8	223.6

An effluent pump system (EPS) requires a reliable system curve for ascertaining current pump system operation and sizing future pump replacements. The system curve evaluation described herein reflect recent pressure and flow measurements as well as static lift and dynamic loss corrections. The following points and assumptions briefly describe the methodology used for generating the EPS system curve.

- Combined effluent flow (MGD) from CWD’s effluent flowmeter provided reliable system flow data.
- Discharge pressure (psi) collected from CWD’s combined effluent manifold pressure gauge provided reliable system operating pressure at the EPS header level.
- Static lift requirements were added from the EPW water surface elevation. The EPW low-water level was assumed at 5.0 ft above finished floor elevation. The effluent high-water level was assumed to be 14 inches below the pump well top of slab elevation.

- Dynamic loss corrections were made for the section of pipe through the effluent discharge header. These losses account for pump lift requirements between the pump well water surface elevation and CWD's pressure gauge transmitter.

Total system operating pressures were generated by adding the historical gauge pressure, plus the static lift requirements, plus the dynamic loss correction from the header (**Figure 3.2**).

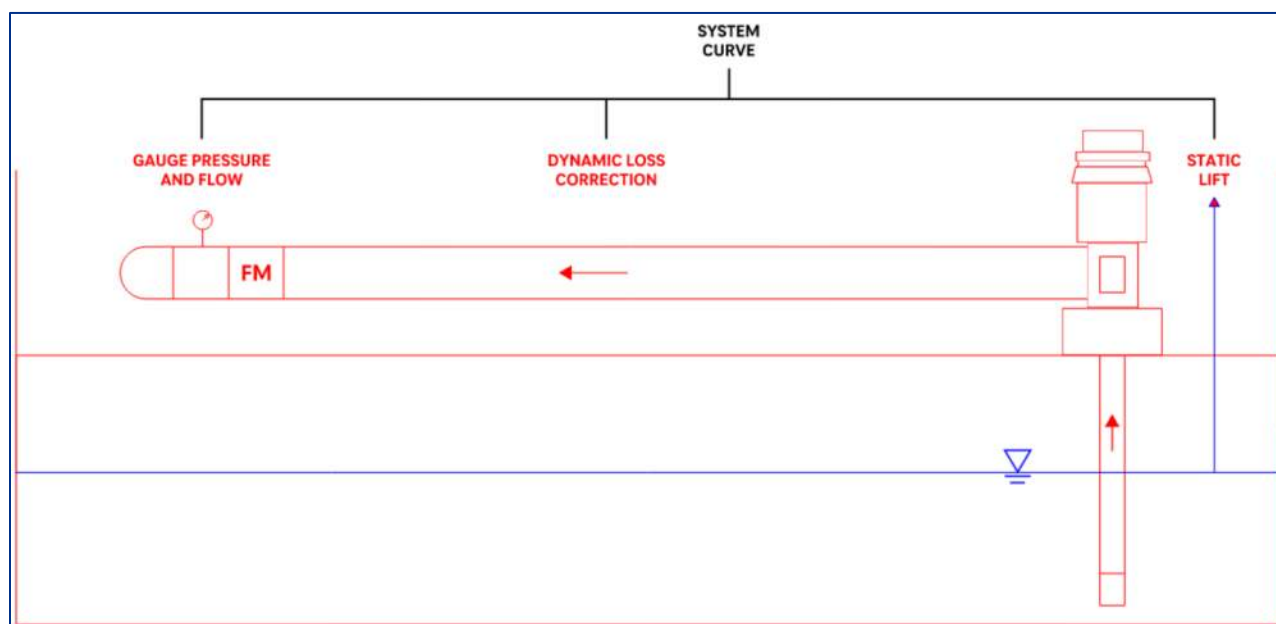


Figure 3.2 System Curve Generation

A system curve is generated by plotting total system pressures against historical flow values. A clear trend in CWD's effluent pump system operating points is plotted in **Figure 3.3**. CWD reported that effluent discharge pressure spikes above the normal trend are likely caused by periods of operation through their 16-inch ACP transmission main.

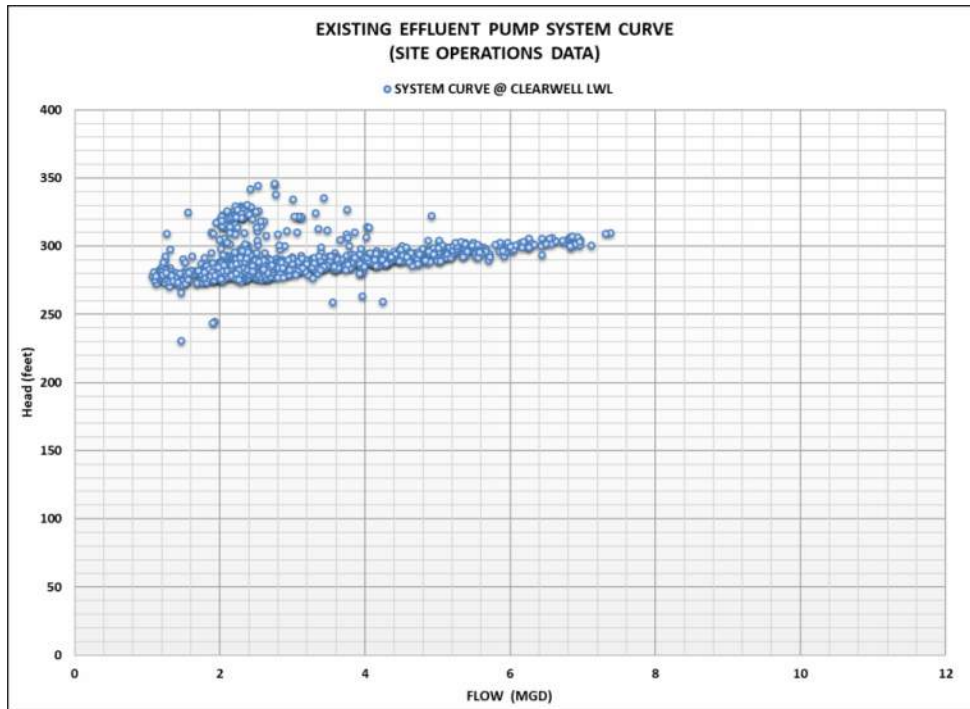


Figure 3.3 CWD-Effluent Pump Station System Curve

Using linear regression, CWD's current operational system curve can be extended by extrapolating system pressures that would be required for future capacity upgrades. **Figure 3.4** shows a projected system curve at flows reaching 12 MGD.

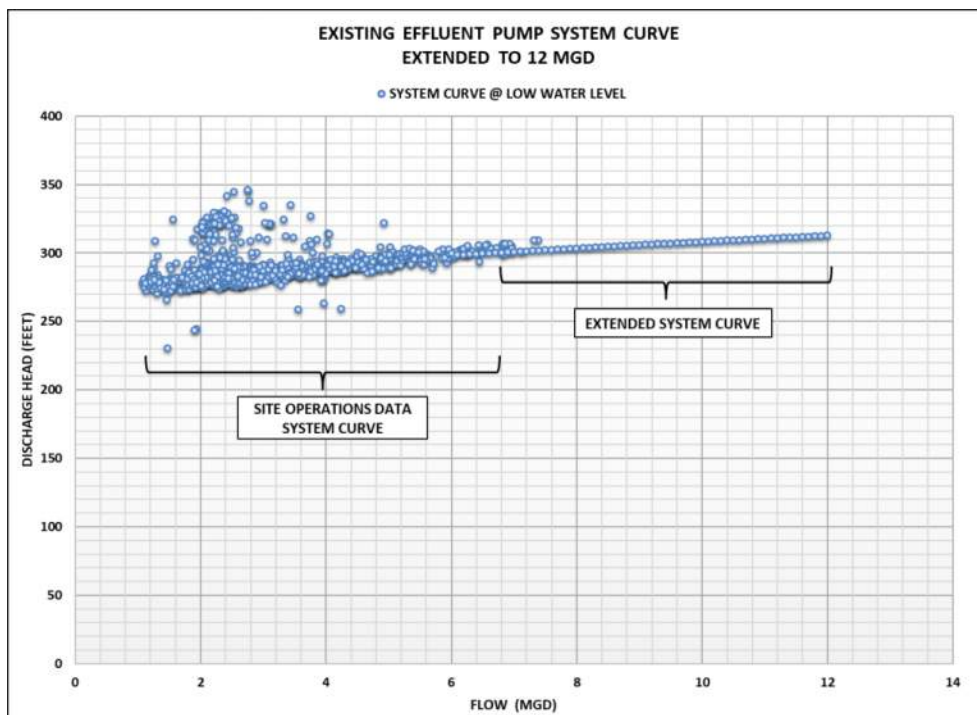


Figure 3.4 Extended System Curve

To further verify future pressure demand requirements, CWD's distribution system model was utilized to generate effluent pump discharge pressure data for flows of 2 MGD to 12 MGD. **Figure 3.5** shows the results of the distribution model, experts plotted against the extrapolated system curve projections shown in **Figure 3.5**.

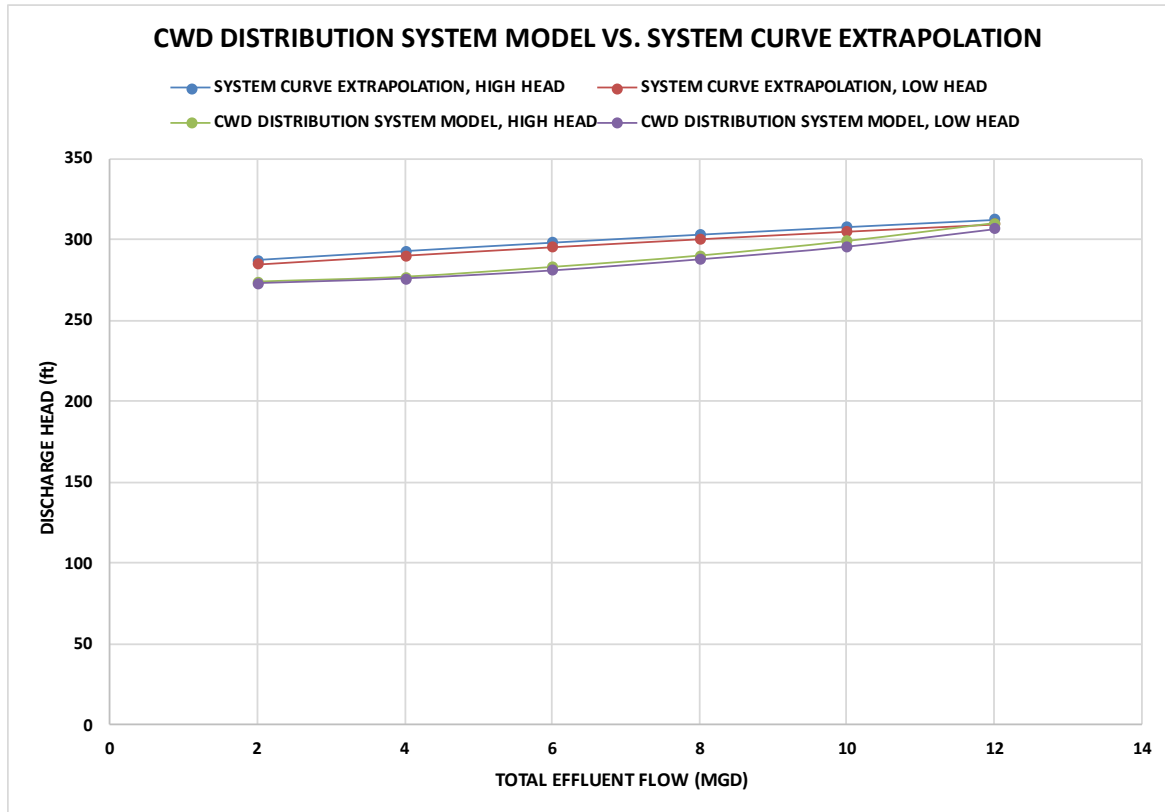


Figure 3.5 Comparison of CWD's Distribution System Model and System Curve Extrapolation

*For both cases, this model assumes both transmission mains to be open and WTP pumps to be at an elevation of 4,650 ft. CWD considers a worst-case scenario to involve the shutdown of the 32 Road pump station and average-day demands, generating the higher head condition, whereas the lower head condition considers a functioning 32 Road pump station and maximum day demands.

As shown, the distribution model projected system demand values within a close margin of the extrapolated system curve utilizing linear regression.

3.1.2 Preliminary Equipment Sizing and Selection

As presented in earlier sections, the existing EPS at Clifton WTP has seven constant-speed pumps rated at 1.15 MGD, one constant-speed pump rated at 2 MGD, and one VFD-driven pump rated at approximately 4 MGD. This equates to a total EPS Firm Capacity of 10 MGD. CWD wants to increase the engineering, procurement, and construction (EPC) firm capacity to match the firm capacity of the UF system at 12 MGD. CWD would also like to maintain the ability to operate at low flows (1.4 MGD) for the purpose of generating turnover in distribution system tanks.

EPS upgrades aim to meet the following goals:

- Meet a firm capacity goal of 12 MGD.
- Consolidate effluent pumping equipment.
- Solve the operational challenges identified at the effluent pump system. These are described within the Effluent Pump Study Technical Memorandum (**Appendix A**).

Improvements selected to achieve these goals include:

- **Keep** Pump 10: 4 MGD VFD-driven pumps.
- **Demolish** Pumps 1, 2, 3, 4, 5, 7, 8, 9.
- **Add** Two new VFD-driven 2 MGD pumps.
- **Add** Two new VFD-driven 4 MGD pump.

To justify these pump sizes for each alternative, multiple pump manufacturers were contacted for preliminary pump selections. The following criteria were considered while making the pump selections:

- Pumps need to operate within their preferred operating region (the majority of the time) within the required system curve operating range.
- Pump efficiencies need to be similar-to or higher-than those of the existing effluent pumps.
- Minimum submergence requirements of the pumps need to be less than the current minimum operating levels in the pumping well.

3.1.2.1 Effluent Pump Selection

Four new VFD-driven vertical turbine pumps—two (2) 4 MGD and two (2) 2 MGD—are proposed. The existing 4 MGD VFD-driven pump (Pump 10) will remain. This 5-pump configuration will be operated in parallel and aimed to provide an EPS Firm Capacity flow of 12 MGD. Minimum flows would be achievable at approximately 1 MGD with one of the 2 MGD pumps operating at half speed.

To determine whether the EPS system curve generated in Section 3.1.1 can be fulfilled, pump manufacturers were engaged to provide vertical turbine pump selections and corresponding pump curve performance data. Pump curve selections received from pump manufacturers were analyzed to evaluate the best-fit option. The best-fit plots for each manufacturer considered is summarized below:

- Fairbanks – Pentair: Pump selections obtained from Fairbanks – Pentair are shown in **Figure 3.6**. These selections also show that plant firm capacity of 12 MGD can be achieved by two 2 MGD and two 4 MGD new vertical turbine pumps operated at maximum speed.
- National Pump Company: **Figure 3.7** shows best-fit plots using pump selections obtained from the National Pump Company. Selections from this manufacturer show that the Alternative 1 configuration achieves 12 MGD plant firm capacity by operating two 2 MGD pumps and two 4 MGD pumps at reduced speed.

Table 3.2 provides the pump system criteria for the new EPS configuration.

Table 3.2 Proposed Effluent Pumps – Pump Criteria

Pump Parameters	Fairbanks – Pentair-		National Pump Company	
Pump Rated Flow (MGD)	4	2	4	2
Number of Pumps	2	2	2	2
Lift Rating (ft)	326	367	350	355
Rated Impeller Diameter (inches)	12.65	10.23	11.69	10.68
Pump Efficiency (percentage [%])	78.7	78.7	80	85
Motor Drive	VFD	VFD	VFD	VFD
Max Rated Motor (hp)	350	200	350	200

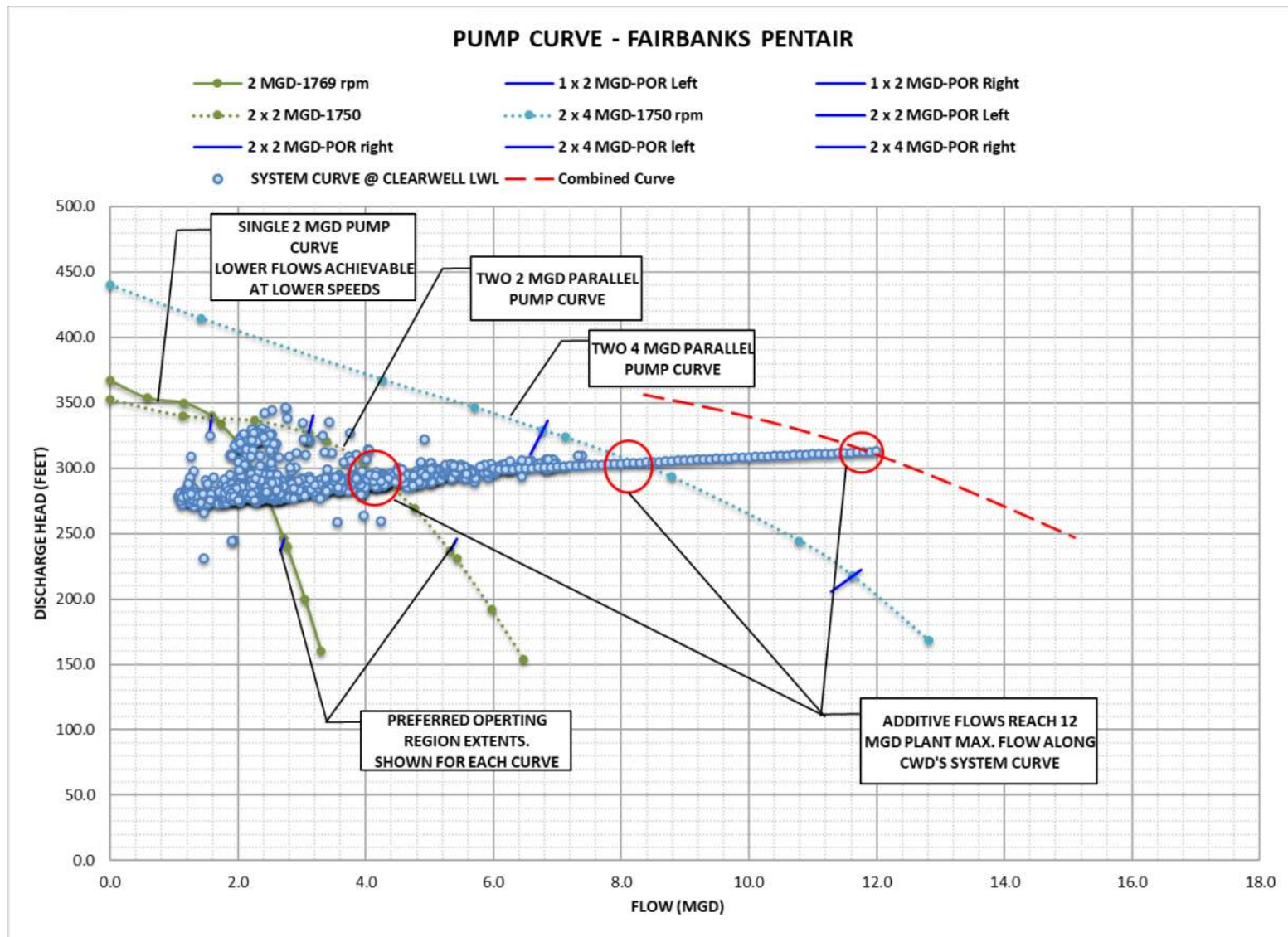


Figure 3.6 Best-Fit Curve – Fairbanks Pentair

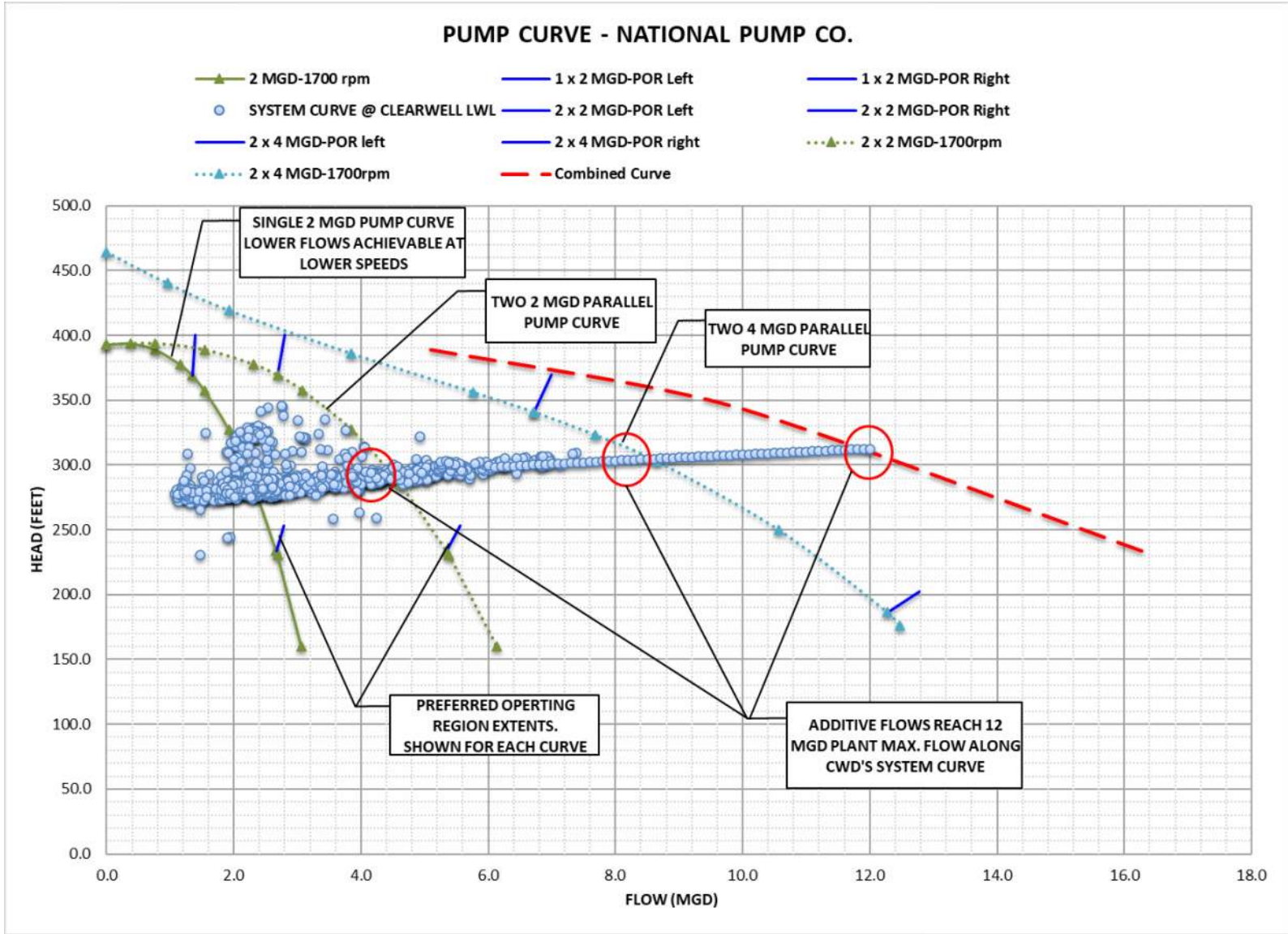


Figure 3.7 Best-Fit Curve – National Pump Company

3.1.3 Facility Layout

Effluent pump improvements proposed, as per Section 3.1.2.1, require the adding two new 4 MGD pumps and two new 2 MGD VFD-driven vertical turbine pumps to the EPS. The existing 4 MGD VFD-driven pump (Pump 10) will remain, to serve as standby.

It is proposed to install one 4 MGD and one 2 MGD at the north pump wet well where the north RO-permeate flow feed can be blended with the forward plant flows received at the north pump wet well. The respective pump discharge headers are connected to an existing 24-inch carbon steel effluent pump header. The existing 18-inch carbon steel effluent pump header connected to the 24-inch header is to be demolished. (Demolition plans for existing piping is contained in **Appendix B**). This arrangement allows for operation of the 18-inch plant effluent north of the EPS.

Similarly, it is proposed to install one 4 MGD pump and one 2 MGD pump on the south pump wet well in-line with the existing 4 MGD pump. Their respective discharge headers are connected to an existing 30-inch carbon steel pump header. RO-permeate flows, if added using the extended south RO-permeate feed line, can be blended with the clearwell flows received at the south pump wet well facilitating flow transmission using a 30-inch plant effluent main. The existing 24-inch effluent header in the north is connected to the existing 30-inch effluent header in the south, thus allowing operation of either north or south or both effluent mains. Isolation and flow control through the north and south mains is provided by means of existing 24-inch butterfly valve. **Appendix B** contains the proposed EPS improvements.

The abovementioned pump configuration is to be operated in parallel and is aimed to provide an effluent firm capacity flow of 12 MGD. Minimum flows can be reached by operating the proposed 2 MGD VFD-driven pump at reduced speeds. A conceptual plan of this facility is shown in **Figure 3.8**.

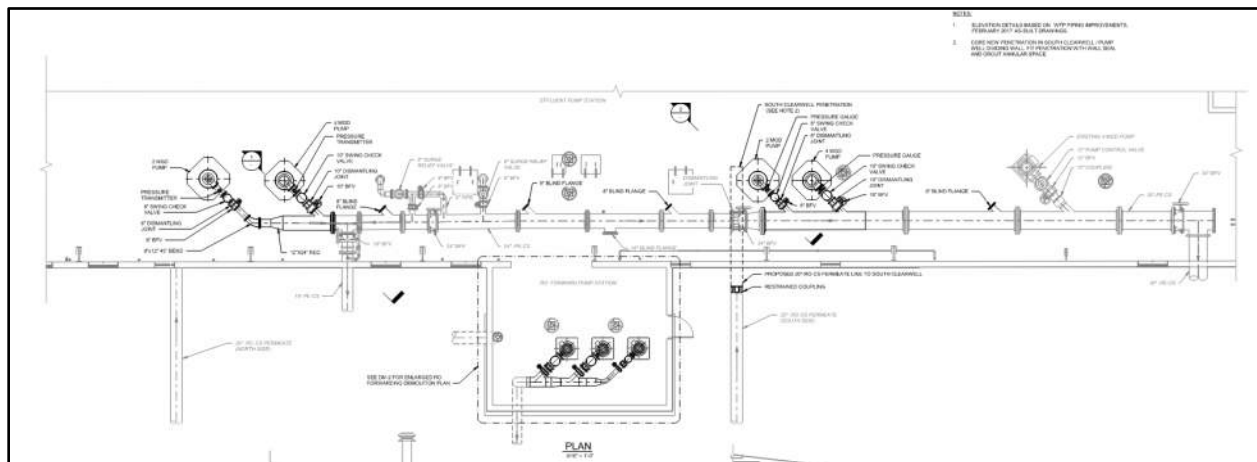


Figure 3.8 Conceptual Design for Effluent Pump Station

3.2 RO Forwarding Pumps

3.2.1 Hydraulic Design Criteria

Historical RO feed flow for each RO skid, and discharge head data from the Years 2019 to 2023 were provided by CWD operations to generate RO forwarding pump system curves and to ascertain the seasonal variation in demand. **Figure 3.9** shows the 5-year trend of feed flows to each RO skid.

A statistical analysis of this flow data, including the discharge pressure, is summarized in **Table 3.3**.

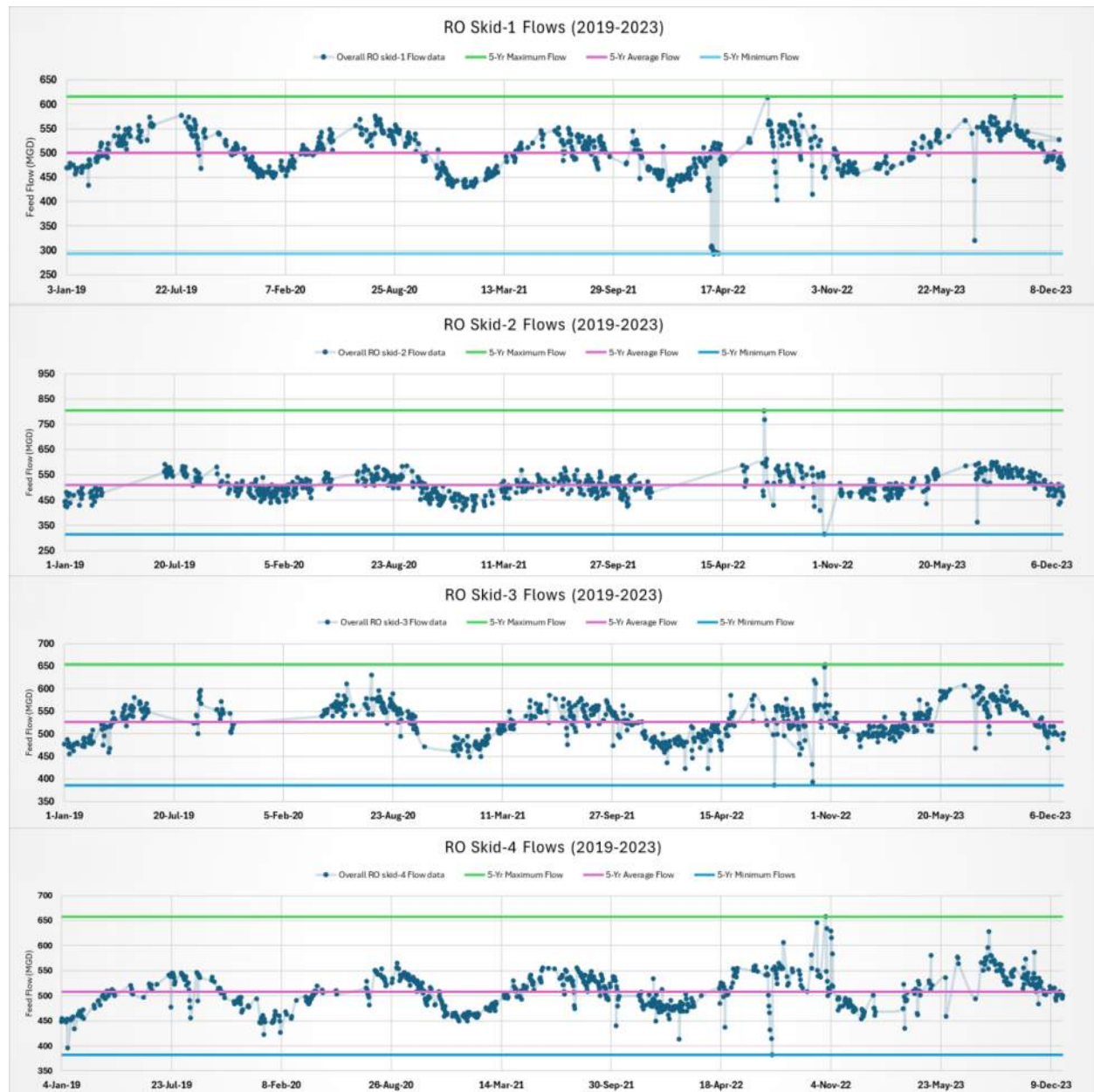


Figure 3.9 Historical RO Feed Flow Trends

Table 3.3 Statistical Summary of RO Forward Flows and Discharge Pressure

Flow Scenario	RO Feed Flow (MGD) 2019–2024	RO Feed Flow (gpm) 2019–2024	RO Inlet Pressure (psi) 2021–2024	RO Inlet Head (ft) 2021–2024
Maximum Flow	3.11	2,160	69	159.4
99 th Percentile Flow	2.99	2,044	68	157.1
Average Flow	1.45	1,007	53.6	124
Minimum Flow	0.6	424	22	50.8

Flow from RO forwarding pumps feeds RO skids. Therefore, RO feed flow and inlet pressure data obtained at the RO skids were used as a basis for evaluation of RO forwarding pump system curve. This correlation was evaluated by calculating the static and dynamic loss corrections along the pumped pipeline discharging to RO skids. The following points and assumptions briefly describe the methodology used for generating an RO forwarding pump system curve.

- Historical RO feed flows (gpm) from CWD’s RO feed measurements showed reliable system flow data.
- Historical RO skid inlet pressure (psi) from CWD’s RO feed measurements showed reliable system operating pressure at the RO skids.
- Static lift requirements were added from the RO forward pump well water surface elevation. The RO forward pump well low-water level was assumed at 3.0 ft above finished floor elevation. The high-water level was assumed to be 28 inches below the pump well top of slab elevation.
- Dynamic loss corrections were made for the section of pipe through the RO discharge header. These losses account for pump lift requirements between the pump well water surface elevation and CWD’s RO inlet pressure gauge transmitter.

Total system operating pressures were generated by adding the historical gauge pressure, plus the static lift requirements, plus the dynamic loss correction from the RO forward supply header (**Figure 3.10**).

To evaluate at a reliable system curve, it was observed that RO skids are operated at an average inlet pressure of 53 psi and a minimum pressure of 22 psi (**Table 3.4**). This pressure range serves as the inlet pressure for RO booster pumps installed at each of the four RO skids. A discharge pressure value between these points, of 50 psi, is chosen for designing the RO forward pump system. Based on the historical maximum flow supplied to RO skids (**Table 3.4**), CWD wants to increase the RO treatment firm capacity to 4 MGD. Using the static lift and dynamic loss corrections, a system curve for RO forward pumps was produced. **Figure 3.10** shows the RO skid inlet pressure gauge location. **Figure 3.11** shows the RO forward pump system curve.



Figure 3.10 RO Skid Inlet Pressure Gauge Location

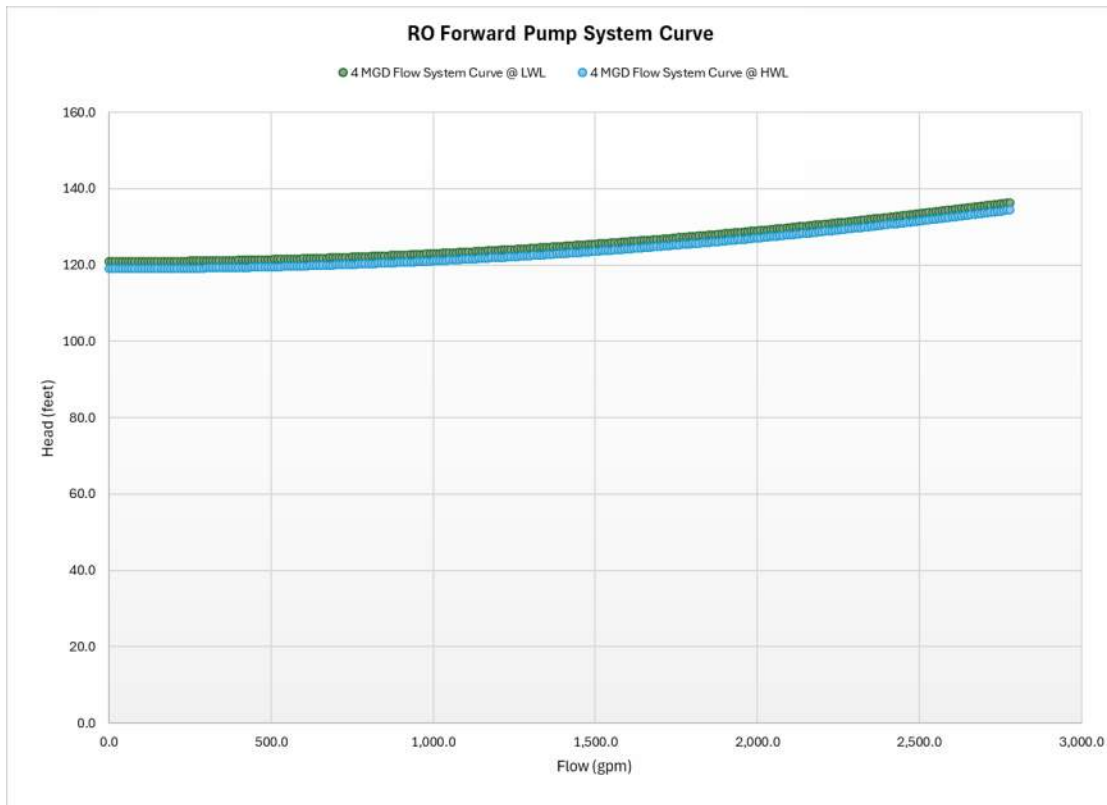


Figure 3.11 Evaluated RO Forward Pump System Curve

3.2.2 Preliminary Equipment Sizing and Selection

This section describes the existing pump configuration at Clifton WTP RO forwarding pump station, which has three constant-speed pumps rated at 2 MGD. When two RO skids are in operation, only one forward pump is operated. This means that two 2 MGD pumps must be operated to run the four RO skids, with the third pump used in standby capacity. CWD stated RO Firm Capacity requirements of 4 MGD with individual RO skids requiring an approximate 500-gallon-per-minute flow. The alternative reconfiguration of RO forwarding pumps intends to meet the following objectives:

- Meet a firm capacity of 4 MGD.
- Automate RO forward flows based on plant effluent requirements.

The RO forward pump reconfiguration alternative includes the following:

- **Demolish** existing constant-speed 2 MGD pumps.
- **Add** one VFD-driven 1 MGD pump.
- **Add** two VFD-driven 3 MGD pumps.

To derive a sizing for these pumps, multiple pump manufacturers were contacted for their preliminary pump selections. Following criteria were considered in making the pump selections:

- Pumps need to operate within their preferred operating region (the majority of the time) within the required system curve operating range.
- Pump efficiencies need to be similar-to or higher-than those of the existing effluent pumps.
- Minimum submergence requirements of the pumps need to be less than the current minimum operating levels in the pumping well.

Details of the abovementioned discussed alternative pump reconfiguration are discussed in the subsequent sections.

3.2.2.1 RO Forwarding Pump Selection

Three VFD-driven vertical turbine pumps—two 3 MGD and one 1 MGD pumps—are proposed. The existing three constant-speed pumps of 2 MGD capacity will each be removed. The proposed three-pump configuration will be operated in parallel to provide RO firm capacity of 4 MGD. The 1 MGD pump will be capable of achieving the minimum flow requirements of approximately 500 gpm at RO skids by operating at half speed. A conceptual plan and layout of the alternative is discussed in Section 3.2.3.

To ensure the system curve (**Figure 3.12**) generated, as per Section 3.2.1, fulfills the 4 MGD capacity, pump manufacturers were engaged to provide vertical turbine pump selections and corresponding pump curve performance data. Pump curve selections received from pump manufacturers were analyzed to evaluate the best-fit option. The best-fit plots for each manufacturer considered is summarized as follows:

- **Flowserve:** **Figure 3.13** shows the best-fit plot for pump selections received from Flowserve. Using selections provided by the manufacturer, the maximum flow capacity of 4 MGD can be achieved by operating one 3 MGD and one 1 MGD pump at reduced speed.
- **Fairbanks – Pentair:** Pump selection provided from Fairbanks – Pentair is shown in **Figure 3.14**. The selection shows that, by using one 3 MGD at rated speed and one 1 MGD pump at reduced speed, the required 4 MGD flow capacity at RO skids can be achieved. It also shows that operation of 1 MGD pump at reduced speed can be used to achieve minimum flows.
- **National Pump Company:** **Figure 3.14** shows the pump best-fit plot for pump selections received from Flowserve. Using selections given by the manufacturer, the maximum flow capacity of 4 MGD can be achieved by operating one 3 MGD and one 1 MGD pump at maximum speeds.

Table 3.4 provides the pump system criteria for above proposed pump reconfiguration.

Table 3.4 Pump System Criteria for Flowserve, Fairbanks, and National Pump Company

Pump Parameters	Flowserve		Fairbanks – Pentair		National Pump Company	
Pump Rated Flow (MGD)	3	1	3	1	3	1
Number of Pumps	2	1	2	1	2	1
Lift Rating (ft)	137	137	137	137	137	137
Rated Impeller Diameter (inches)	10.63	7.31	10.86	6.99	8.58	7.98
Pump Efficiency (%)	77.8	76.9	77.2	79.51	79.1	84
Motor Drive	VFD	VFD	VFD	VFD	VFD	VFD
Max Rated Motor (hp)	100	40	100	40	100	30

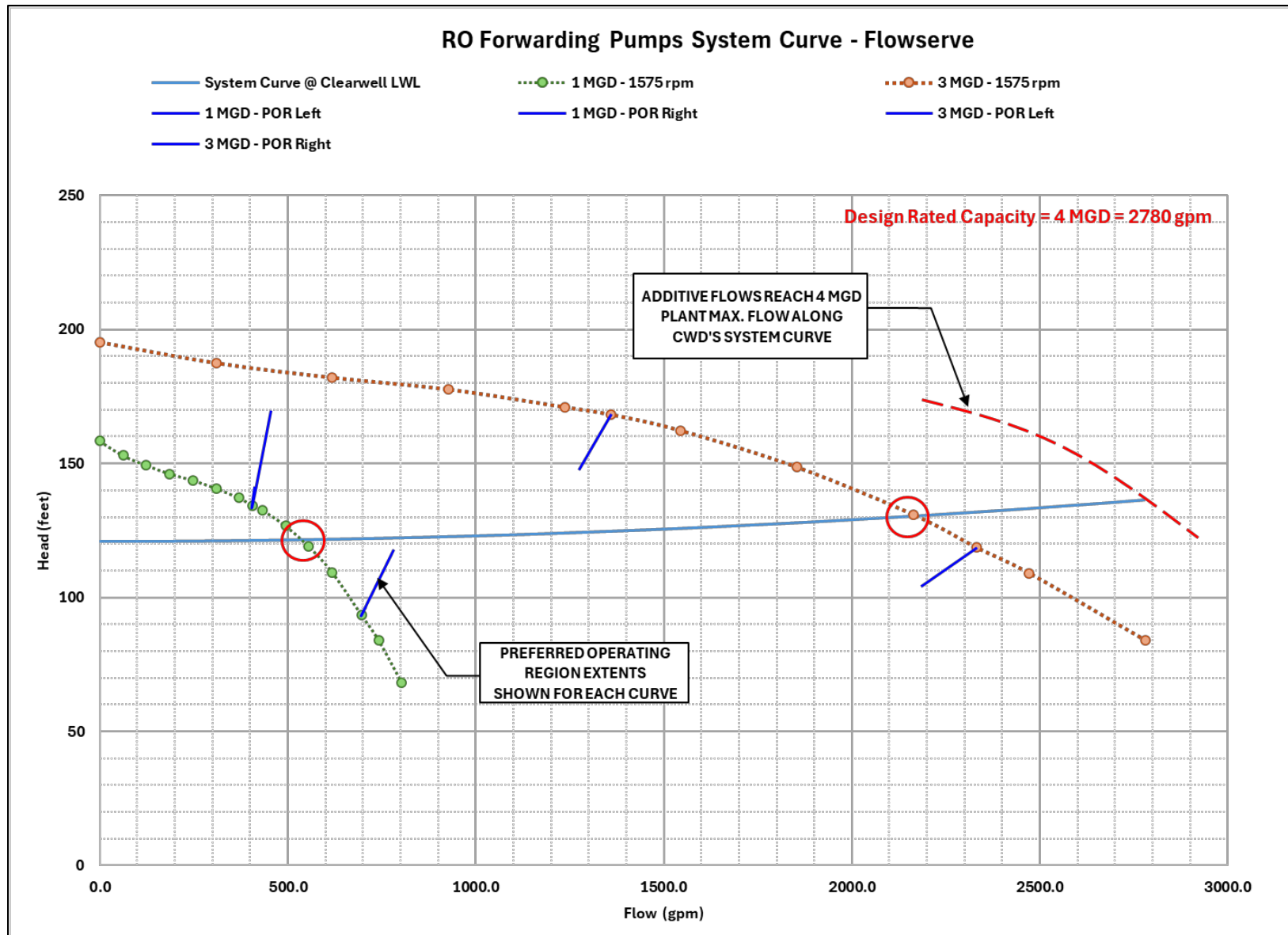


Figure 3.12 Best-Fit Curve – Flowserve

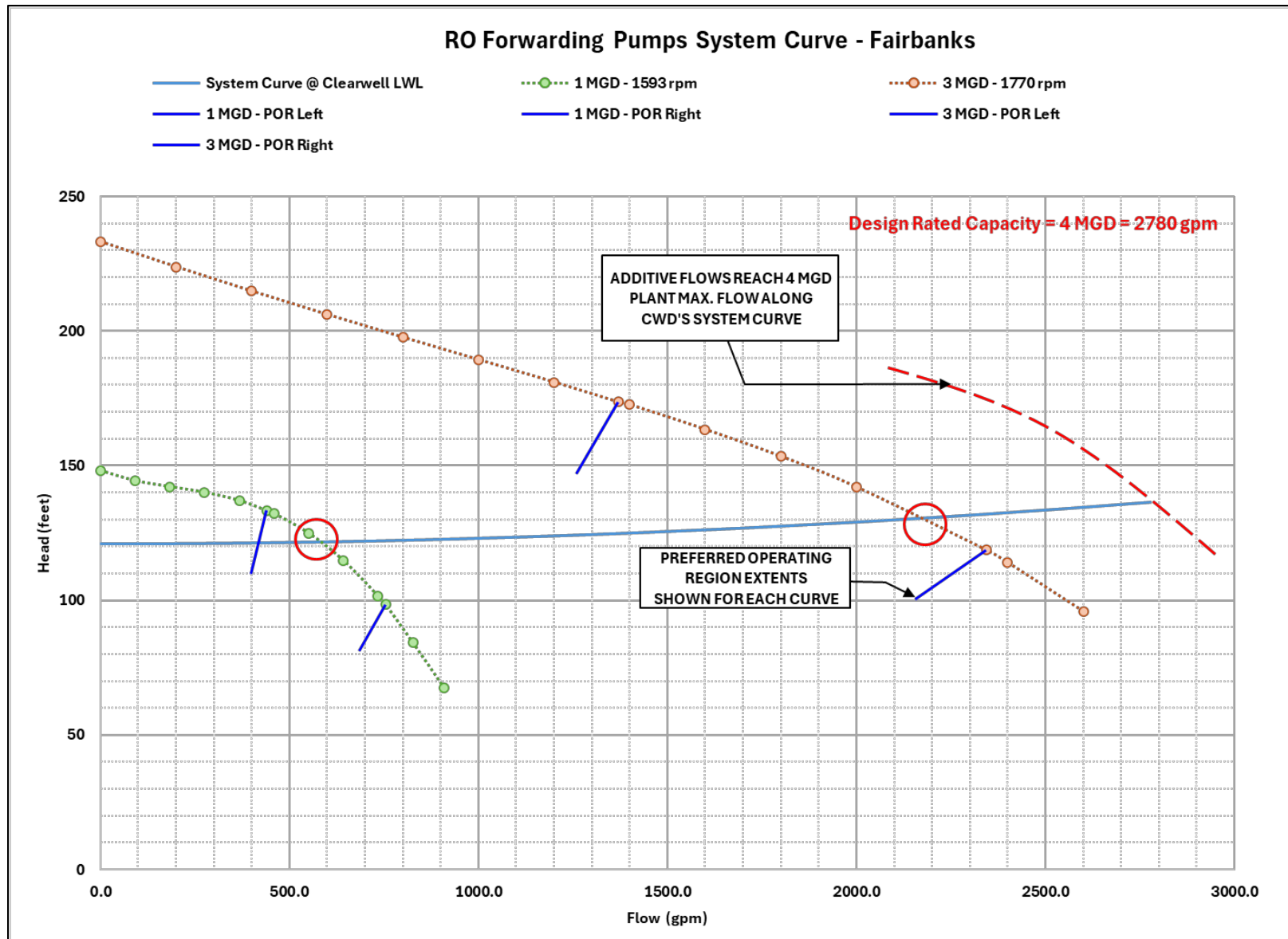


Figure 3.13 Best-Fit Curve – Fairbanks – Pentair

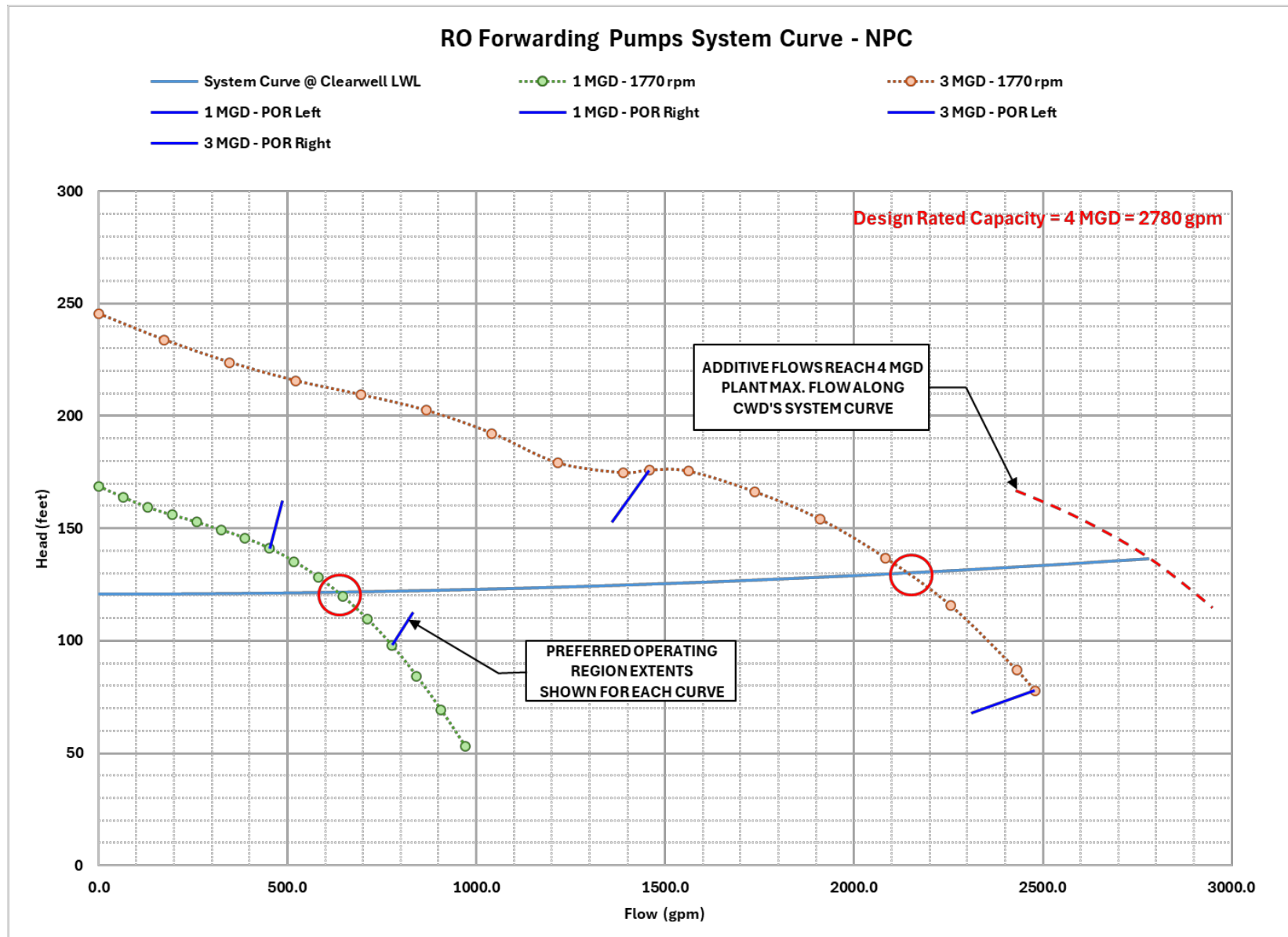


Figure 3.14 Best-Fit Curve – National Pump Company

3.2.3 Facility Layout

Regarding the RO forwarding pump improvements, the existing three 2 MGD constant-speed pumps are to be demolished. **Appendix B** contains the RO forwarding pump station demolition plans. Two new 3 MGD and one new 1 MGD VFD-driven vertical turbine pumps are proposed. This configuration provides one 3 MGD pump on standby with the other 3 MGD and 1 MGD pumps operated to achieve 4 MGD RO forward flows. Each pump discharge header is proposed with a swing check valve for pump isolation along with a dismantling coupling and a butterfly valve for flow control. The individual pump discharge headers are connected to a 16-inch pump manifold that is provided with a 16-inch butterfly valve for manifold flow control.

The proposed pump configuration is to be operated in parallel and is aimed to provide an RO forwarding firm capacity flow of 4 MGD. Minimum flows can be reached by running the 1 MGD pump at reduced speeds. A conceptual plan of this facility is shown in **Figure 3.15**. The proposed RO forward pumps well will stay part of a concrete structure in the Process Building with a top slab elevation at 4,649.83 feet and base slab finished floor at 4,642.67 feet. **Appendix B** refers to improvements proposed for RO forwarding pumps with conceptual plans and sectional details.

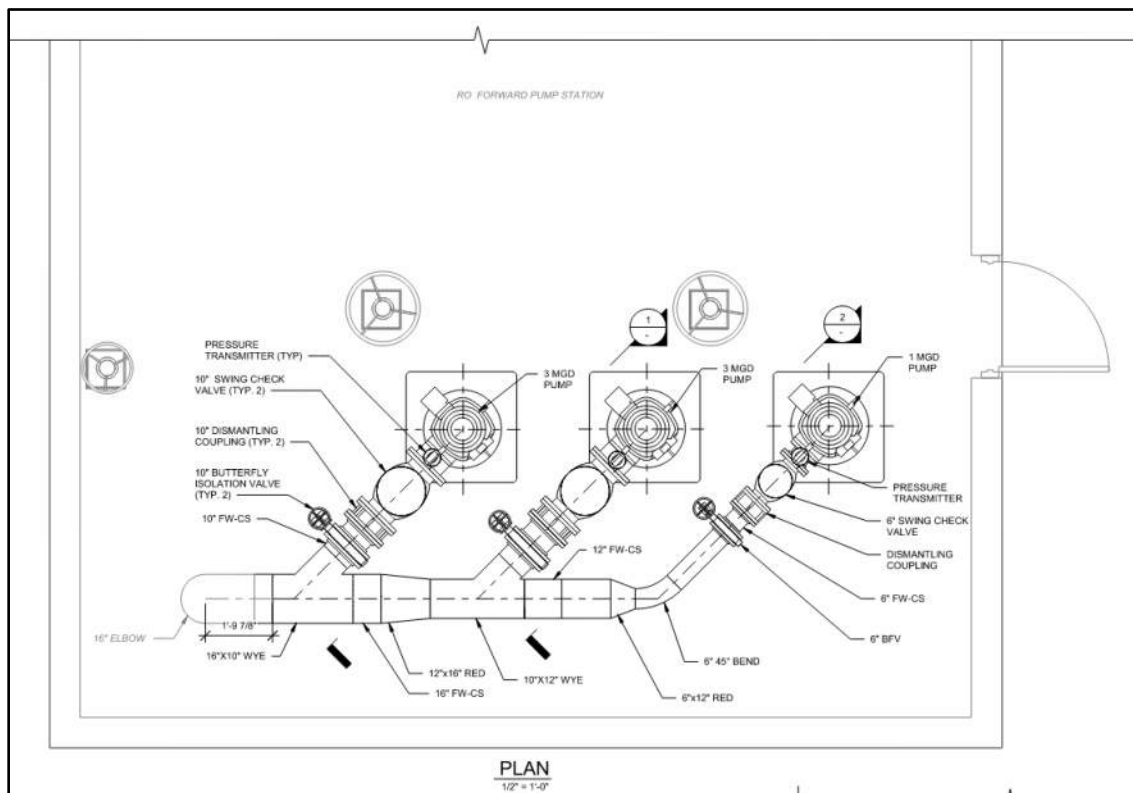


Figure 3.15 Proposed RO Forwarding Pump Arrangement

3.3 Effluent Chemical Feed Systems Modifications

The WTP's current UF/RO blending approach does not allow CWD to dose finished water chemicals (fluoride and chlorine) at a single application point. This results in a complex chemical feed procedure where operators manually control feed rates to each pump impeller. If pump selections or individual pump rates change, operators need to manually change the chemical feed valve selection and/or position to maintain combined effluent chemical concentrations.

Figure 3.16 shows a modified flow and chemical dosing regimen that would consolidate all effluent chemical application points to a single location. This is accomplished by concentrating all blended effluent flow—regardless of the UF/RO blend ratio—to the south clearwell and then to a single-entry point at the south pump well. RO permeate would need to be discharged into the clearwell, not the pump well to accommodate this.

With all blended effluent flow concentrated into one channel, chemical feed rates can be flow-paced with the existing combined effluent flow transmitter via the SCADA system. It is anticipated that adequate mixing can occur in the south clearwell prior to the pump well entry to avoid short-circuiting of chemicals to the southernmost effluent pumps.

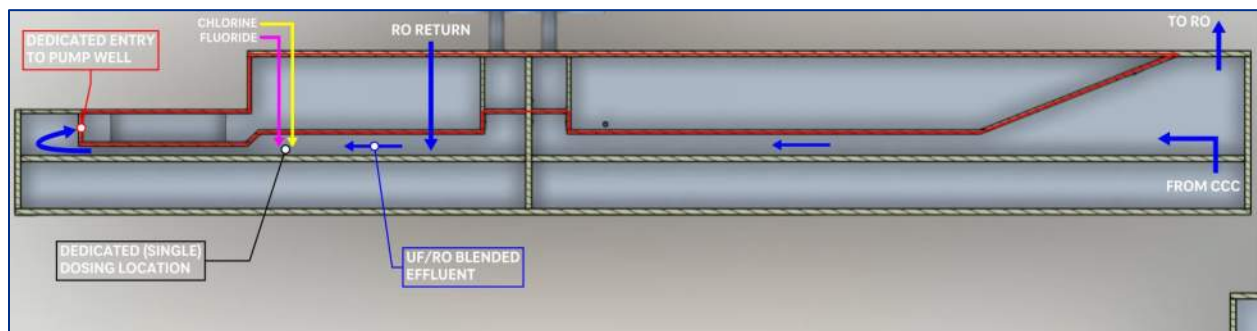


Figure 3.16 Modified Effluent Flow and Chemical Dose Regime

This dosing regimen allows for a functional chemical feed system regardless of which pump well/clearwell is offline. Five potential chemical feed scenarios are outlined below, and depicted in **Figure 3.17**.

- **Scenario 1: All Pump Wells and Clearwells Online**
 - RO permeate will be conveyed to the south clearwell, and chlorine and fluoride will be dosed to the south clearwell. Chlorinated and fluorinated UF-/RO-blended effluent will be conveyed to the south pump well entry point. The chlorine contact chamber effluent will be conveyed from the north clearwell to the south clearwell.
- **Scenario 2: North Clearwell Offline**
 - RO permeate will be conveyed to the south clearwell, and chlorine and fluoride will be dosed to the south clearwell. Chlorinated and fluorinated UF-/RO-blended effluent will be conveyed to the south pump well entry point and continue to the north pump well. The chlorine contact chamber effluent will bypass the north clearwell and enter directly into the south clearwell.

■ Scenario 3: South Clearwell Offline

- RO permeate will be conveyed to the north clearwell, and chlorine and fluoride will be dosed to the north clearwell. Chlorinated and fluorinated UF-/RO-blended effluent will enter the north pump well and continue to the south pump well. The chlorine contact chamber effluent will enter the north clearwell through the north pump well entry point.

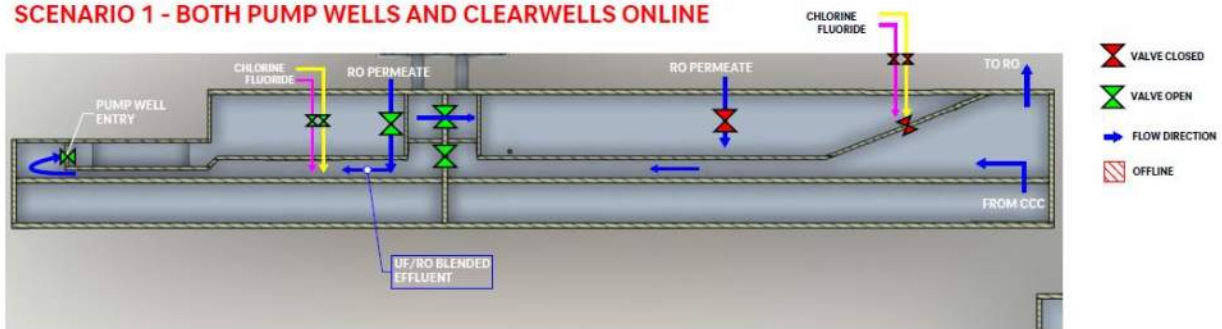
■ Scenario 4: North Pump Well Offline

- RO permeate will be conveyed to the south clearwell, and chlorine and fluoride will be dosed to the south clearwell. Chlorinated and fluorinated UF-/RO-blended effluent will be conveyed to the south pump well entry point. The chlorine contact chamber effluent will be conveyed from the north clearwell to the south clearwell.

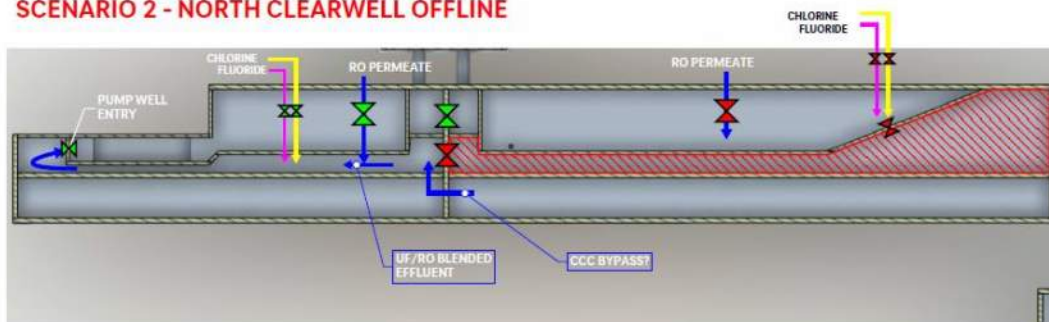
■ Scenario 5: South Pump Well Offline

- RO permeate will be conveyed to the north clearwell, and chlorine and fluoride will be dosed to the north clearwell. Chlorinated and fluorinated UF-/RO-blended effluent will enter the north pump well. The chlorine contact chamber effluent will enter the north clearwell through the north pump well entry point.

SCENARIO 1 - BOTH PUMP WELLS AND CLEARWELLS ONLINE



SCENARIO 2 - NORTH CLEARWELL OFFLINE



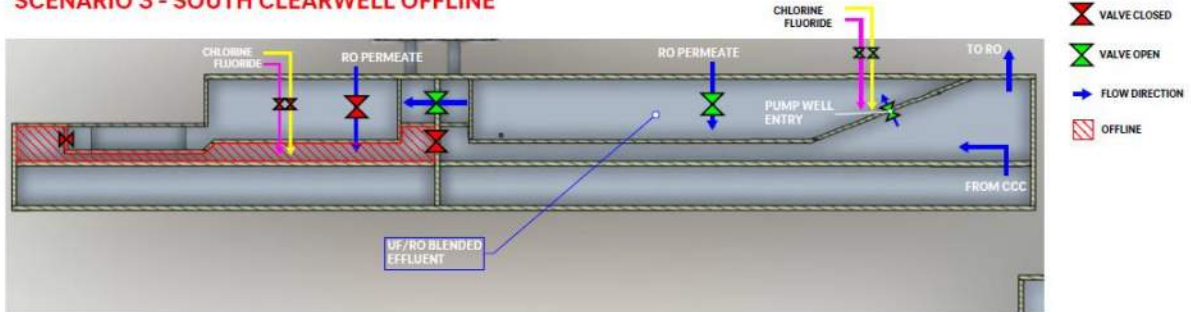
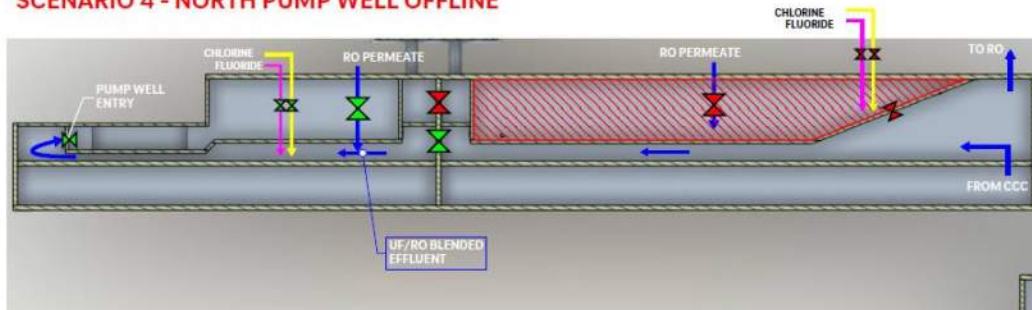
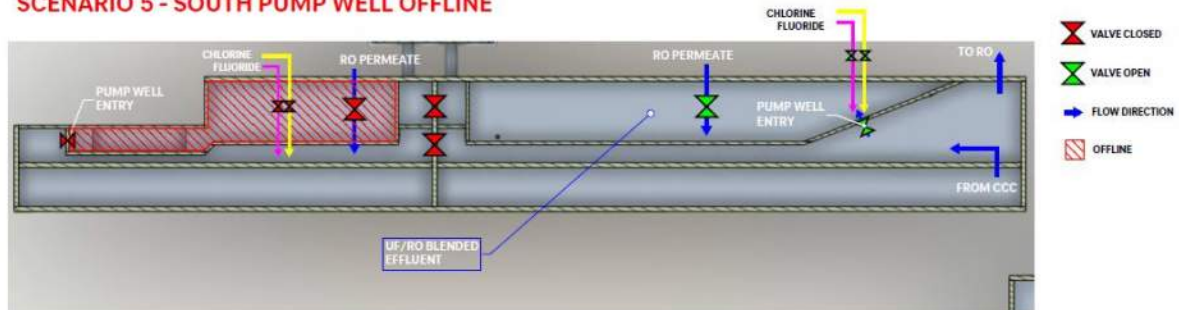
SCENARIO 3 - SOUTH CLEARWELL OFFLINE**SCENARIO 4 - NORTH PUMP WELL OFFLINE****SCENARIO 5 - SOUTH PUMP WELL OFFLINE**

Figure 3.17 Five Scenarios of Effluent Chemical Feed Systems

4.0 Instrumentation and Control

4.1 Introduction

4.1.1 Background

The current plant SCADA system is based on Allen-Bradley PLC for controllers and FactoryTalk View SE for Supervisory Control and Data Acquisition (SCADA). The control system has been gradually undergoing controller upgrades and consolidation onto a single SCADA platform—FactoryTalk View SE. The SCADA and PLC physical topology is depicted in **Figure 4.1**.

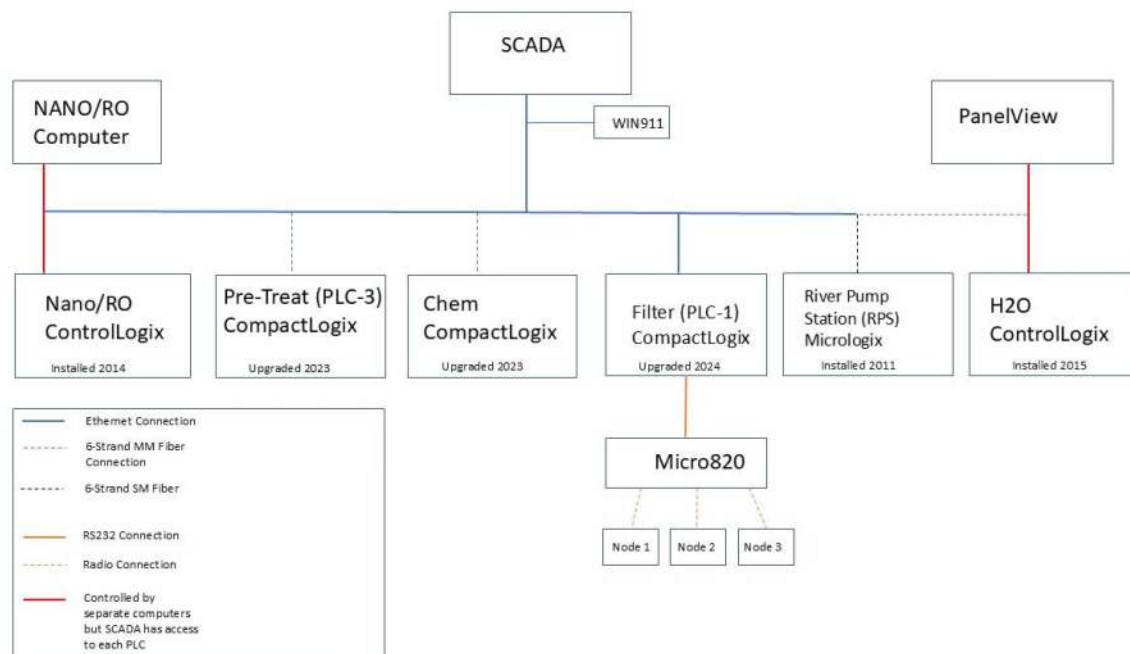


Figure 4.1 Current Plant SCADA and Control Systems Topology

Even though the plant SCADA system is gradually undergoing controller upgrades and consolidation onto a single SCADA platform, it could benefit from a complete modernization and reliable control system that includes improved network communications.

4.1.2 Purpose

The purpose of the instrumentation and control section is to present the basis of design for the new HMI/SCADA system, PLC, and SCADA communication network. In addition, it also presents a recommendation for how to relocate existing radio communication—that currently communicate with remote Nodes 1, 2 and 3—to be front-end.

The Basis of Design Report (BODR) for process I&C includes the following:

- Applicable codes and standards
- Design approach overview
- HMI and SCADA system
- Programmable Logic Controllers (PLCs)
- Industrial control system cybersecurity
- Equipment tag naming convention
- Process control philosophy

4.2 Applicable Codes and Standards

The I&C design will conform to the codes and standards listed below. In case of conflicting requirements, the requirements most applicable to the work will be used.

- National Fire Protection Association (NFPA) – National Electrical Code® (NEC) – NFPA 70
- Underwriters Laboratories, Inc. – UL508A
- The International Society of Automation – ISA S5.1-2009, S20, RP60
- Institute of Electrical and Electronics Engineers – IEEE C2, 472, 802.X
- National Electrical Manufacturers Association – NEMA ICS6
- ASTM International – ASTM A269
- American National Standards Institute – ANSI X3.5
- International Electrotechnical Commission – IEC 61131-3

4.3 Design Approach Overview

This section discusses the basis of design for the SCADA and control system for the water treatment plant (WTP).

- Applicable codes and standards
- SCADA hardware: Multiple SCADA Servers configured for distributed redundancy and automatic failover
- HMI Software: VTScada platform by Trihedral
- PLC Hardware: Allen-Bradley ControlLogix for major process and CompactLogix PLC for minor
- PLC Software: Rockwell Software Studio 5000 Logix Designer
- Multi-mode fiber-optic cable, 12-strand for local area network

4.4 HMI and SCADA System

4.4.1 Introduction

The EPS and SCADA System Improvements Project includes the design of a new SCADA system. The SCADA system provides HMI for monitoring and control of the WTP and pump stations from the control room. The SCADA system will provide local alarm notification and send-out capability (email, text messaging, and voice) to alert off-site operators when the alarm is active. The SCADA system will also include a fully integrated historian, real-time and historical trending, and report generation.

4.4.2 SCADA System Architecture

The WTP SCADA and Control systems will be configured in a ring topology with PLC layout, as shown in **Figure 4.5**.

The existing computer for SCADA FactoryTalk View SE, WIN911 and Historian will be replaced with redundant SCADA servers, as shown in **Figure 4.4**. Three server-rated computers are recommended for the Clifton Water WTP SCADA System. Within this software configuration, the SCADA servers will be set up as redundant servers with automatic backup failover. The following lists are the proposed configurations for each server that would allow sharing central processing unit (CPU) load for services across the computers. If the primary server fails or loses communication, the next backup designated will take over. The order of automatic failover is determined by the default server lists in the SCADA software setup.

Server 1, SVR-001:

- Primary I/O Server
- Backup Historian
- Backup Thin Client Server

Server 2, SVR-002:

- Primary Thin Client Server
- Backup I/O Server
- Backup Historian

Server 3, SVR-003:

- Primary Historian
- Backup Thin Client Server
- Backup I/O Server

4.4.3 SCADA System Hardware and HMI Software

As stated in Section 4.3, three SCADA servers will be provided and configured for distributed redundancy and automatic failover. VTScada platform by Trihedral is recommended for HMI software.

The SCADA hardware—complete with fiber-optic patch panel, network switches, router, and accessories—will be installed in a 19-inch rack frame enclosure. Preferred manufacturers for main components are listed below for selection.

4.4.3.1 19-inch Rack, Frame, and Enclosure

Manufacturers:

- APC NetShelter SV 42U
- Dell PowerEdge 4220

4.4.3.2 19-inch Rack-Mountable Managed Ethernet Switch and Router

Manufacturers:

- Allen-Bradley Stratix 5410 series
- Cisco Catalyst 9300 series
- Moxa IKS-G6824A series
- Red Lion NT328G series

4.4.3.3 19-inch Rack-Mounted Server Computers

Manufacturers:

- Dell PowerEdge R7xx Series
- HP ProLiant DL3xx Gen 11 Series
- Super Micro H13 Series

4.4.3.4 HMI Software

Based on the number of PLCs in the control system, it is recommended to purchase a 25K tag VTScada software for the system. As the system grows, this tag limit can be easily increased by updating the license key. Integrated features, such as Thin Clients and Remote Alarm Notifications, can be unlocked in a similar fashion.

4.4.4 HMI Design Basis

The HMI will be standardized on high-performance graphics, which allows operators to more effectively monitor the processes in the WTP. All current graphic screens will be converted to high-performance graphic screens, including real-time and historical data trending and tabular views. Sample screens will be provided to establish the minimum acceptable level of graphical detail.

Report generation will be added to the system, enabling operators to print reports quickly and accurately, instead of manually compiling them from collected data and handwritten notes. The specific number and content of these automated reports will be determined in later project phases.

Alarm management and alarms/events history will be developed and reviewed with CWD during the design. With the new alarm notification setup, alarm conditions can be sent as an email, text message, and voice to off-site operators.

4.4.5 HMI Workstations

The existing HMI workstation will be replaced with two new HMI Thin Client Workstations in the renovated Control Room. The new HMI Thin Client Workstations will include new high-performance graphics for existing processes, new RO forwarding pumps, and effluent pumps. The HMI Thin Client Workstations will allow both monitoring and control of the water treatment systems and remote stations.

4.4.6 SCADA Communications Network

4.4.6.1 Plant Control System Network

As shown in **Figure 4.1**, the SCADA computer and PLC communication network is a mix of 6-strand multi-mode fibers, 6-strand single-mode, CAT-6 cable, and RS232.

To improve system reliability, resiliency, and availability, a Media Redundancy Protocol is proposed as a primary ring topology standard in the plant and is supported by Industrial Managed Ethernet switches. This creates a ring throughout the facility that allows traffic to automatically reroute to a different path if there are issues encountered when the primary route is interrupted. This provides self-healing capabilities and adds a level of redundancy to the infrastructure.

Figure 4.4 and **Figure 4.5** show the self-healing Ethernet fiber ring topology for the SCADA system. New 12-strand multi-mode fiber-optic cable will be installed between buildings and a dual-fiber port-managed Ethernet switch will be installed in the PLC Control Panel at each building to support the ring. Ethernet/IP protocol will be used for PLC communication.

The River Pump Station is not connected to the WTP's self-healing fiber ring network. To optimize costs, the existing 6-strand, single-mode, fiber-optic cable between the Process Building and River Pump Station will be reused. The River Pump Station PLC will connect to both SCADA network switches NSW-001 and NSW-002 using two pairs of existing fibers for redundancy. Media converters will be installed at each end of the single-mode fiber-optic cable to convert media from single-mode to multi-mode for consistency in network communication.

4.4.6.2 Radio Communication Front-End Relocation

The existing radio communication front end in the plant consists of an antenna and two panels—Allen-Bradley Micro820 PLC Panel and Aprisa 4RF Radio Panel (**Figure 4.2** and **Figure 4.3**). Micro820 PLC receiving/transmitting signals from/to Nodes 1, 2, and 3, and then monitored by PLC-1/SCADA.



Figure 4.2 Micro820 PLC Panel



Figure 4.3 Aprisa 4RF Radio Panel

These two panels, Micro820 PLC and Aprisa 4RF Radio Panel, are currently wall-mounted at the back of the washroom; CWD wants to relocate them to a different location for better access and maintenance.

With the design of the new Main PLC Control Panel, CDM Smith proposes to include a new Aprisa 4RF Radio and transfer all programs in the existing Micro820 PLC to the new Main PLC for radio communication with Nodes 1, 2, and 3. The existing antenna will remain in the current location. A new coax cable will be installed between the antenna and new radio in the Main PLC Control Panel. With this approach, the existing radio communication will remain online until the new panel and the SCADA system installations are completed, tested, and made ready for switching. Radio communication interruptions to Nodes 1, 2, and 3 will be minimal, requiring only the time to disconnect the existing coax cable and reconnect the antenna with the new one.

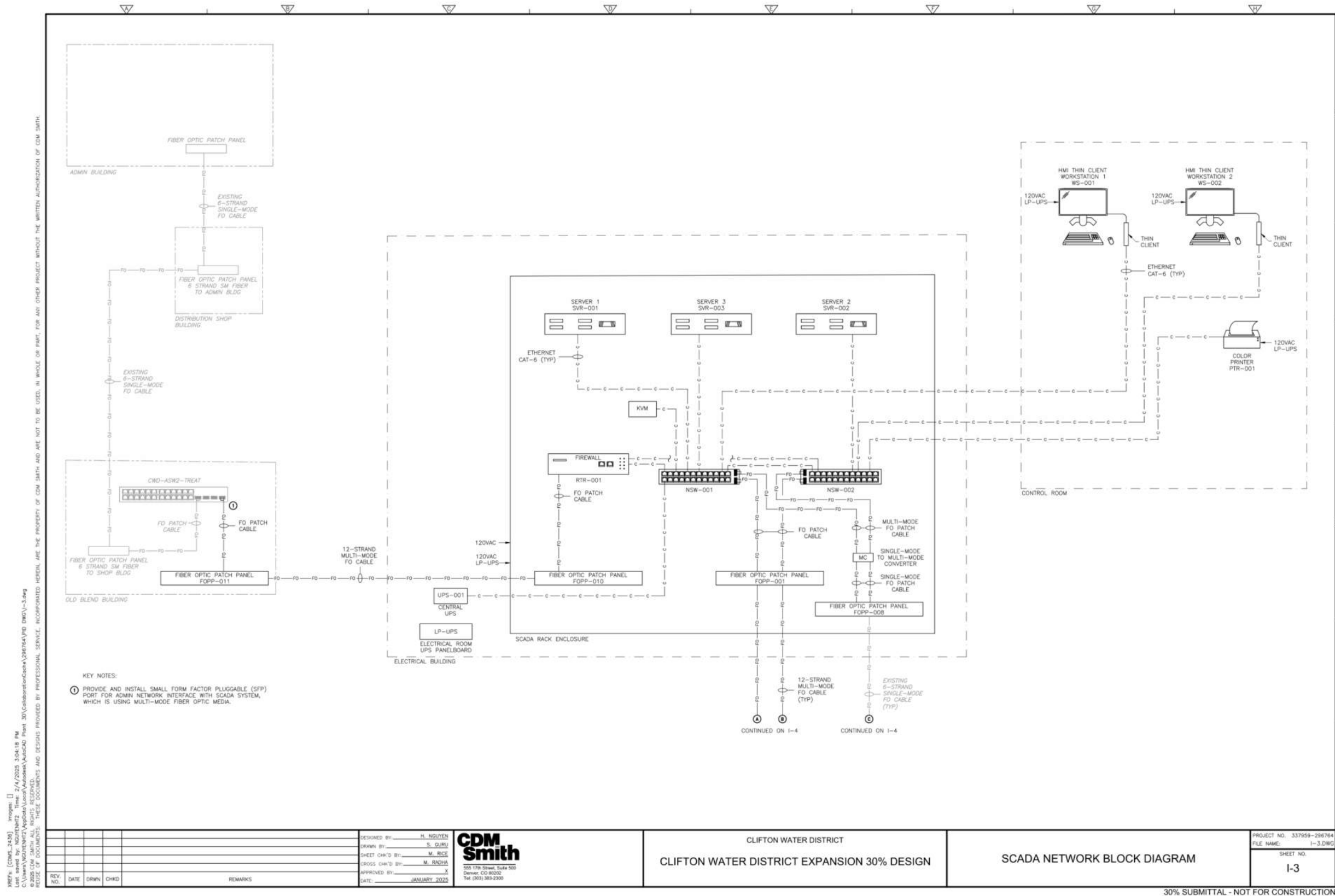


Figure 4.4 I-3 SCADA Network Block Diagram

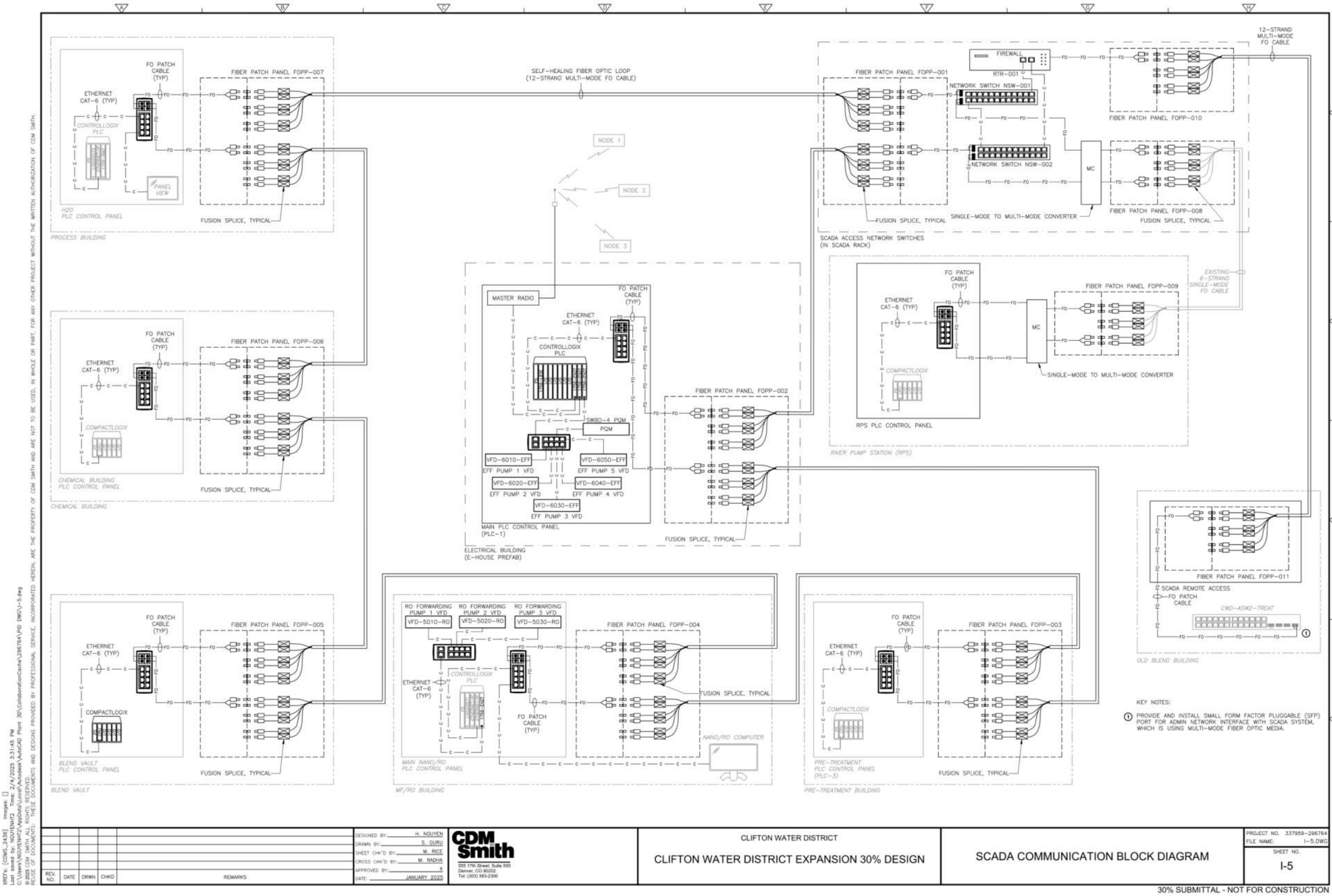


Figure 4.6 I-5 SCADA Communication Block Diagram

4.4.7 Programmable Logic Controllers

4.4.7.1 PLC Design Basis

Programmable Logic Controllers

The PLC SCADA-based system will include, at minimum, a CPU, power supplies, communication modules, input/output (I/O) modules, I/O bases (chassis/rack), and factory-assembled interconnecting cables.

The CPU will contain the required memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points. Discrete Input (DI) and Discrete Output (DO) modules will be 24 VDC. Analog Input (AI) and Analog Output (AO) modules will be 4mA to 20mA, isolated. Provide approximately 20% spare I/O of each type wired to terminal blocks.

PLC will be Allen-Bradley ControlLogix for major process and CompactLogix/MicroLogix for minor. PLC software will be Rockwell Studio 5000 Logix Designer PLC programming.

Programmable Logic Controller Enclosures

Enclosure type must comply with Underwriters Laboratories, Inc. UL508A requirements, suitable for its environment and constructed per specifications. Enclosures will include compact LED lighting fixture activated by a door switch, ground fault interrupter type duplex receptacle, and 30-minute uninterruptible power supply (UPS) either from UPS panelboard or local UPS in the enclosure. Enclosures in non-climate-controlled areas will be provided with an internal panel heater with thermostat to prevent condensation.

Power cable and signal wires must be separated. A 120 VAC control cable must be separated from 4mA to 20mA signals and 24 VDC cabling, as much as practical, inside the enclosures.

PLC Upgrades

Based on our workshops, PLC upgrades will focus on EPS PLC-1, Blend Vault PLC, and River Pump Station PLC.

In addition to the abovementioned PLC upgrades, to support the self-healing Ethernet Ring Topology (as shown in **Figure 4.5** and **Figure 4.6**), new fiber-optic patch panel and dual-fiber ports Ethernet switch will be installed in the following PLC panels: Main PLC (PLC-1) Control Panel, Pre-Treatment PLC (PLC-3) Control Panel, Nano/RO Main PLC Control Panel, Blend Vault PLC Control Panel, Chemical Building PLC Control Panel, and H₂O PLC Control Panel.

Effluent Pump Station Main PLC (PLC-1) Upgrades

The existing PLC-1 (Allen-Bradley CompactLogix) is used for monitoring and control EPS and interfaces with the remote sites via communication front-end Micro820 PLC and radio communications to Nodes 1, 2, and 3, as shown in **Figure 4.1**; PLC-1 enclosure is currently in the control room across MCC-1. PLC-1 will be replaced with a new ControlLogix PLC, and new panel will be in a new Electrical Building. The existing PLC-1 will be maintained throughout construction, PLC-1 will stay online until a new panel and SCADA system installations are completed, tested, and made ready for switching.

EPS improvements will be a major part of the project. The existing constant-speed pumps (seven 1.15 MGD and one 2 MGD) will be replaced with VFD-driven pumps (two 4 MGD and two 2 MGD). The existing 4 MGD VFD-driven pump will remain. This new 5-pump configuration will be operated in parallel to provide a firm capacity flow of 12 MGD. VFD-driven pumps can use a 2 MGD pump in low-flow conditions; for low-flow conditions, one of the 2 MGD could operate at half speed for minimum flows at approximately 1 MGD.

Pump Controls – By replacing pumps and using variable speed control, managing the EPS will become more streamlined and efficient. The effluent pumps will be controlled by VFDs to provide the necessary range of flow. Controlling the pump speeds and starting additional pumps will ensure the required effluent flow meets the set point established by the operator. In addition to automatic control, the operator can manually start/stop pumps and adjust speeds, as necessary, through the SCADA system or locally at the local control station (LCS) by the pump.

Along with effluent pump control improvements, the panel will include devices for the plant's self-healing fiber ring network and a new radio for communication with Nodes 1, 2, and 3, as detailed in Section 4.1.2.

Effluent Pump Station Main PLC System

- Manufacturer: Rockwell Automation Allen-Bradley 1756-L8X ControlLogix
- Discrete Input and Output Modules: 1756 Digital DC Isolated, 16 Channel, 24 VDC
- Analog Input and Output Modules: 1756 HART Analog Isolated I/O Modules, 8 Channel, 4mA to 20mA.
- Communication Interfaces: Support Ethernet/IP and Modbus TCP/IP protocols. Two 100 MB/1G Ethernet and a USB port
- In-Chassis Communication Modules: 1756-EN2T, Ethernet communication module, 10/100M twisted pair connections.

Fiber-Optic Patch Panel

A fiber-optic patch panel will be provided in the PLC panel.

- Manufacturers: Corning, or CommScope
- General: Patch panel must be suitable for multi-mode system operation, 24-port, all fibers must be terminated in the patch panel. Patch panel will be housed in enclosure.

The fiber-optic patch panel is for terminating two 12-strand, multi-mode, fiber-optic cables that form the self-healing fiber ring network around the plant.

Industrial Managed Ethernet Switch with Dual-Fiber Ports

- Manufacturers: Allen-Bradley Stratix 5800 Series, Cisco Catalyst IE3100 Series, Moxa EDS 5XX Series, N-Tron NT5000 Series, or Red Lion NT24k Series

Dual-fiber port-managed Ethernet switch will be installed in the PLC panel for self-healing network communication.

Industrial Managed Ethernet Switch

- Manufacturers: Allen-Bradley Stratix 5800 Series, Cisco Catalyst IE3100 Series, Moxa EDS 5XX Series, N-Tron NT5000 Series, or Red Lion NT24k Series

Managed Ethernet switch will be installed in the PLC panel for VFD Ethernet connections and electrical switchgear Power Quality Monitor connections.

All VFDs will have control signals (Remote Status, Running Status, VFD Fault, Speed, Speed Setpoint, Start, Stop) hardwired to I/O of the PLC. Additional data (voltage, current, kilowatt, kilowatt-hour, volt-ampere reactive) will be transmitted over Ethernet.

Radio Communication

As detailed in Section 4.1.2, the new plant Main PLC Control Panel will include a new Aprisa 4RF Radio. All programs from the existing Micro820 PLC will be transferred to this new Main PLC. The antenna will stay in its current location, with a new coax cable installed between the antenna and the new radio—this ensures that the existing radio communication remains online until the new panel and SCADA system installations are completed, tested, and made ready for switching.

Pre-Treatment PLC (PLC-3) Upgrades

Regarding the existing Pre-Treatment PLC, only a new fiber-optic patch panel and dual-fiber port-managed Ethernet switch will be provided in the existing panel to support the self-healing fiber ring network.

Fiber-Optic Patch Panel

A fiber-optic patch panel will be provided in the PLC panel.

- Manufacturers: Corning, or CommScope
- General: Patch panel must be suitable for multi-mode system operation, 24-port, all fibers must be terminated in the patch panel. Patch panel will be housed in an enclosure.

The fiber-optic patch panel is for terminating two 12-strand, multi-mode, fiber-optic cables that form the self-healing fiber ring network around the plant.

Industrial Managed Ethernet Switch With Dual-Fiber Ports

- Manufacturers: Allen-Bradley Stratix 5800 Series, Cisco Catalyst IE3100 Series, Moxa EDS 5XX Series, N-Tron NT5000 Series, or Red Lion NT24k Series

Dual-fiber port-managed Ethernet switch will be installed in the PLC panel for self-healing network communication.

Nano/RO Main PLC

Per Control System Notes from Mountain Peak Controls, the original Nano (Osmonics) control system had Wonderware HMI with Allen-Bradley PLC5 as a Master PLC. In 2012, after major upgrades, the following were completed by Mountain Peak Controls:

- PLC5 was replaced with a ControlLogix L71 CPU. The PLC programming for the L71 is essentially just a conversion of the old PLC5 program. Only areas that required changes were modified (i.e., timers, counters).
- All the remote I/O racks had the communications processors upgraded to Ethernet (1794-AENTR). None of the I/O modules themselves were replaced.
- Wonderware HMI was replaced with Rockwell FactoryTalk View SE (screens stayed essentially the same).

In 2015, an Ethernet link was added from the Nano PLC to the main operator HMI station when that computer was upgraded. All Nano screens are on the main HMI as well.

Figure 4.7 is a photo of the existing Nano/RO Main PLC panel; this Main PLC will remain “as is” because the controller was upgraded to ControlLogix.



Figure 4.7 Nano/RO Main PLC Panel

The WTP improvements will replace the existing Nano/RO forwarding pumps, motors, and drives. This includes automated control of the forwarding pump and daily pauses on the NF/RO system to optimize energy usage and reduce electrical surge costs during shutdowns and start-ups.

All existing hard I/O points for Nano/RO forwarding pumps are assumed to be in good condition and could be reused for hardwired VFDs control signals (Remote Status, Running Status, VFD Fault, Speed, Speed Setpoint, Start, Stop).

In addition to Nano/RO Forwarding pump replacements and control improvements, a new fiber-optic patch panel and Ethernet switches will be included in the panel to support the self-healing fiber ring network around the plant and communication with VFDs, as described herein.

Fiber-Optic Patch Panel

A fiber-optic patch panel will be provided next to the existing Nano/RO Main PLC Panel.

- Manufacturers: Corning, or CommScope
- General: Patch panel must be suitable for multi-mode system operation, 24-port, all fibers must be terminated in the patch panel. Patch panel will be housed in an enclosure.

The fiber-optic patch panel is for terminating two 12-strand, multi-mode, fiber-optic cables that form the self-healing fiber ring network around the plant.

Industrial Managed Ethernet Switch With Dual-Fiber Ports

- Manufacturers: Allen-Bradley Stratix 5800 Series, Cisco Catalyst IE3100 Series, Moxa EDS 5XX Series, N-Tron NT5000 Series, or Red Lion NT24k Series

Dual-fiber port-managed Ethernet switch will be installed in the existing Nano/RO Main PLC panel for self-healing network communication.

Communication Module 1756-EN2T

A Communication Module 1756-EN2T Ethernet communication module will be provided and installed in the spare slot of the existing Nano/RO Main PLC Rack for connecting the Ethernet switch below.

Industrial Managed Ethernet Switch

- Manufacturers: Allen-Bradley Stratix 5800 Series, Cisco Catalyst IE3100 Series, Moxa EDS 5XX Series, N-Tron NT5000 Series, or Red Lion NT24k Series

A managed Ethernet switch will be installed in the existing Nano/RO Main PLC panel for VFD Ethernet connections.

All VFDs will have control signals (Remote Status, Running Status, VFD Fault, Speed, Speed Setpoint, Start, Stop) hardwired to I/O of the PLC. Additional data (voltage, current, kilowatt, kilowatt-hour, volt-ampere reactive) will be transmitted via Ethernet.

Blend Valve Vault PLC

The Flex I/O in the permeate valve vault currently uses CAT-6 for motorized valve control signals. To enhance reliability, the CAT-6 cable will be replaced with fiber-optic cables and will be connected to the self-healing fiber ring network. A CompactLogix PLC with dual-fiber ports will be installed with a managed Ethernet switch for connections. The Flex I/O with CompactLogix Local I/O will be replaced with valve status and control signals. The blending program will be transferred from the main PLC to the new CompactLogix PLC.

Blend Valve Vault PLC System

- Manufacturer: Rockwell Automation Allen-Bradley 5069 CompactLogix, 5380 Controller
- Discrete Input Modules: 5069 DC Digital Input Modules, 16 Channel, 24VDC
- Discrete Output Modules: 5069 DC Digital Output Modules, 8 Channel, 24VDC

- Analog Input and Output Modules: 5069 HART Analog Isolated Current I/O Modules, 4 Channel, 4mA to 20mA
- Communication Interfaces: Support Ethernet/IP and Modbus TCP/IP protocols; two 10MB/100MB/1G Ethernet and a USB ports

Fiber-Optic Patch Panel

A fiber-optic patch panel will be provided in the PLC panel.

- Manufacturers: Corning, or CommScope
- General: Patch panel must be suitable for multi-mode system operation, be 24-port, and all fibers must be terminated in the patch panel. Patch panel will be housed in an enclosure.

The fiber-optic patch panel is for terminating two 12-strand, multi-mode, fiber-optic cables that form the self-healing fiber ring network around the plant.

Industrial Managed Ethernet Switch with Dual-Fiber Ports

- Manufacturers: Allen-Bradley Stratix 5800 Series, Cisco Catalyst IE3100 Series, Moxa EDS 5XX Series, N-Tron NT5000 Series, or Red Lion NT24k Series.

A dual-fiber port-managed Ethernet switch will be installed in the PLC panel for self-healing network communication.

Chemical Building PLC

Chemical Building PLC will remain “as is” because the controller was upgraded to CompactLogix. Only a new fiber-optic patch panel and dual-fiber port-managed Ethernet switch will be provided in the existing panel to support the self-healing fiber ring network.

Fiber-Optic Patch Panel

A fiber-optic patch panel will be provided next to the existing Nano/RO Main PLC Panel.

- Manufacturers: Corning, or CommScope
- General: Patch panel must be suitable for multi-mode system operation, be 24-port, and all fibers must be terminated in the patch panel. Patch panel will be housed in an enclosure.

The fiber-optic patch panel is for terminating two 12-strand, multi-mode, fiber-optic cables that form the self-healing fiber ring network around the plant.

Industrial Managed Ethernet Switch With Dual-Fiber Ports

- Manufacturers: Allen-Bradley Stratix 5800 Series, Cisco Catalyst IE3100 Series, Moxa EDS 5XX Series, N-Tron NT5000 Series, or Red Lion NT24k Series

A dual-fiber port-managed Ethernet switch will be installed in the existing Nano/RO Main PLC panel for self-healing network communication.

H₂O PLC

Regarding the existing H₂O PLC, only a new fiber-optic patch panel and dual-fiber port-managed Ethernet switch will be provided in the existing panel to support the self-healing fiber ring network.

Fiber-Optic Patch Panel

A fiber-optic patch panel will be provided next to the existing Nano/RO Main PLC Panel.

- Manufacturers: Corning, or CommScope
- General: Patch panel must be suitable for multi-mode system operation, be 24-port, and all fibers must be terminated in the patch panel. Patch panel will be housed in an enclosure.

The fiber-optic patch panel is for terminating two 12-strand, multi-mode, fiber-optic cables that form the self-healing fiber ring network around the plant.

Industrial Managed Ethernet Switch With Dual-Fiber Ports

- Manufacturers: Allen-Bradley Stratix 5800 Series, Cisco Catalyst IE3100 Series, Moxa EDS 5XX Series, N-Tron NT5000 Series, or Red Lion NT24k Series

A dual-fiber port-managed Ethernet switch will be installed in the existing Nano/RO Main PLC panel for self-healing network communication.

River Pump Station PLC

Per CWD, the existing CompactLogix PLC in the PLC-1 control panel will be reused for the River Pump Station PLC upgrades.

Fiber-Optic Patch Panel

A fiber-optic patch panel will be provided in the PLC panel.

- Manufacturers: Corning, or CommScope
- General: Patch panel must be suitable for single-mode, be 12-port, and all fibers must be terminated in the patch panel. Patch panel will be housed in an enclosure.

The fiber-optic patch panel is for terminating an existing 6-strand, single-mode, fiber-optic cable.

Media Converter

New media converters will be installed at each end of the existing single-mode fiber-optic cable to convert media from single-mode to multi-mode to be compatible with the plant communication network. One media converter will be provided in the SCADA rack enclosure and one in the River Pump Station PLC panel.

4.4.7.2 Instrumentation

Instruments play a crucial role in the process of monitoring and controlling process equipment. These instruments are integrated into the system to facilitate automated control or to monitor the functions of the equipment and processes.

Effluent Pump Station Existing Instrumentation

Currently, the following instruments are monitored from EPS PLC-1: Finished Water Tank Level, Effluent Flow, Clearwell Level and Influent Flow. Per CWD, the instruments are in good condition and no upgrades are required.

Currently, existing instruments are powered by the lighting panel and lack backup power in case of an outage, which affects equipment control. It is recommended to rewire the Finished Water Tank Level, Effluent Flow, Clearwell Level, and Influent Flow signals to the new EPS Main PLC (PLC-1) panel, which has UPS backup power.

Effluent Pump Station New Instrumentation

New pressure gauge and pressure-indicating transmitter will be installed on the discharge side of each pump. The pressure will be monitored by the main PLC and SCADA/HMI.

Pressure-Indicating Transmitter Manufacturers:

- ABB 266HRH
- Rosemount 3051CG
- Siemens Sitrans P DS III

Pressure Gauge Manufacturers:

- Ametek US Gauge
- Ashcroft
- Omega Engineering, Inc.

RO Forwarding Pump New Instrumentation

New pressure gauge and pressure-indicating transmitter will be installed on the discharge side of each pump. The pressure will be monitored by the Nano/RO PLC and SCADA/HMI.

Pressure-Indicating Transmitter Manufacturers:

- ABB 266HRH
- Rosemount 3051CG
- Siemens Sitrans P DS III

Pressure Gauge Manufacturers:

- Ametek US Gauge
- Ashcroft
- Omega Engineering, Inc.

4.4.7.3 Uninterruptible Power Supply

Central UPS with distribution panelboards will provide 120Vac UPS to SCADA/HMI devices and new PLC panels such that they will remain active during a complete or partial interruption of incoming line power. The central UPS will be sized for a minimum 30-minute energy-source-rated full-load UPS current at 80 percent power factor.

For this project, the UPS for SCADA/HMI electronic devices, the new plant Main PLC panel, and the new Pre-Treatment PLC panel will be sourced from the central UPS panelboard. Regarding the River Pump Station, the UPS for the River Pump Station PLC panel will be derived from the local UPS within the River Pump Station PLC panel.

SCADA racks and PLC panels will receive power from both 120 Vac normal power and 120 Vac UPS power. Under normal conditions, all devices in the rack or PLC panel will use the 120 Vac normal power source. In the event of a power outage, the power supply will automatically switch to the 120 Vac UPS power supply.

4.4.8 Industrial Control System Cybersecurity

For network system security, firewalls and communication ports will be configured to restrict unauthorized network traffic. Unused communication ports will be closed, and only those that are necessary will be opened. With the proposed SCADA software, firewalls could be set up on the redundant servers to protect the redundancy system from external attacks. The firewall on the main server is only accepting incoming connections on the communication port from the backup server IP address. A detailed cybersecurity plan will be developed with CWD during the next phase of the project's design.

4.4.9 Equipment Tagging Convention

Currently, there is no standard naming convention for equipment and instruments in the CWD WTP. This section proposes a tagging convention, as presented in **Table 4.1**.

Table 4.1 Equipment and Instrument Tagging Sample

Equipment and Instrument Designator	-	Equipment and Instrument Identification (ID)	-	Sequential Number and Optional Letter
PMP	-	1000	-	01A

4.4.9.1 Equipment and Instrument Designator

Abbreviations of equipment and instrument, up to four characters, are listed in **Table 4.2**.

Table 4.2 Equipment and Instrument Abbreviations

Equipment	Abbreviation
Actuator	ACT
Air Handling Unit	AHU
Air Receiver	ARC
Air Release Valve	ARV
Air Release/Vacuum Relief Valve	AVRV
Air Separator	ASPR
Analyzing Indicating Transmitter	AIT
Automatic Transfer Switch	ATS
Back Flow Preventer	BFP
Back Pressure Valve	BPV
Ball Valve	BV

Equipment	Abbreviation
Ball Check Valve	BCV
Basin; Flocculation and Sedimentation	BSN
Battery Pack, Chargers, and Modules	BAT
Blow Off	BOV
Blower	BLWR
Boiler	BLR
Building; Constructed, Modular and Prefabricated	BLDG
Butterfly Gate	BFG
Butterfly Valve	BFV
Catch Basin	CB
Cathodic Protection Station	CPS
Check Valve	CV
Circuit Breaker	CBK
Clearwell	CLW
Cleanout	CO
Closed-Circuit Television System	CCTV
Collectors	COL
Combination Air/Vacuum Valve	AVV
Compressor	COMP
Control Panel; Main and Local	CP
Crane	CRAN
Damper	DMP
Diaphragm Valve	DV
Disconnect Switch – Electrical	DS
Distributed Panelboard	DP
Double Check Valve	DCV
Domestic Water Heater	DWH
Dryer; Air, Desiccants and Refrigerant	DRYR
Electrical Panelboard	PNL
Eyewash and Safety Shower Station	EWS
Filter	FLTR
Filter; Basins and Beds	FIL
Flow Rate Indicating Transmitter	FIT
Gate	GATE
Gate Valve	GV
Generator	GEN
Globe Valve	GLV
Heat Exchanger	HEX
Heater	HTR
Hose Bib	HB

Equipment	Abbreviation
Hose Valve	HV
Injector	INJ
Knife Gate Valve	KGV
Level Indicating Transmitter	LIT
Local Control Station	LCS
Local Operator Interface	LOI
Mini-Power Center	MPC
Mixer	MXR
Motor	MTR
Motor Control Center	MCC
Motor Starter	MS
Needle Valve	NV
Pinch Valve	PNV
Plug Valve	PV
Position-Indicating Transmitter	ZIT
Pressure Relief Valve	PRV
Pressure-Indicating Transmitter	PIT
Pressure Regulating Valve	PRE
Pressure Relief Valve	PRV
Programmable Logic Controller	PLC
Pumps	PMP
Radio	RAD
Remote Input / Output	RIO
Remote Terminal Unit	RTU
Reservoir	RES
Silencer	SIL
Solenoid	SV
Speed Indicating Transmitter	SIT
Strainer	STR
Streaming Current Monitor	SCM
Substation	SUB
Swing Check Valve	SCV
Switchboard	SWBD
Switchgear	SWGR
Tank	TNK
Telephone	TEL
Temperature Indicating Transmitter	TIT
Transformer	XFMR
Transient Voltage Surge Suppressor	TVSS
Uninterruptable Power Supply	UPS

Equipment	Abbreviation
Valve	VLV
Vaporizer	VAP
Variable Frequency Drive Unit	VFD
Vault	VLT
Vibration Indicating Transmitter	VIT
Vibration Monitoring System	VMS
Voltage Indicating Transmitter	EIT

4.4.9.2 Equipment and Instrument Identification

This is four-digit equipment and instrument identification (ID); the first two digits are associated with the process area number and the last two digits are 01–99 (**Table 4.3**).

Table 4.3 Equipment and Instrument ID

Process Area	Area #	ID Range
Raw Water Pump System	00	0001-0099
Pre-Treatment	10	1001-1099
Coagulation	20	2001-2099
Membrane Feed	30	3001-3099
Micro-Screen	32	3201-3299
Filtration, Ultrafiltration	34	3401-3499
Flocculation	36	3601-3699
Fluoridation	38	3801-3899
Chlorination, Gaseous	40	4001-4099
Clearwell	45	4501-4599
Reverse Osmosis	50	5001-5099
Distribution Pump Well/Final Effluent Pumps	60	6001-6099
Reducing Agent, Dechlorination	62	6201-6299
Sedimentation	66	6601-6699
Inhibitor/Sequestering Agent, Phosphate Based	81	8101-8199
Disinfection Contact Time	82	8201-8299
Pre-Sedimentation Raw Water Setting Pond	84	8401-8499
Miscellaneous	90	9001-9099

4.4.9.3 Sequential Number

The sequential number comprises two digits and varies when used in different scenarios, as described below:

- If there is only one type in a same equipment ID number, 00 will be assigned.
- Sequential number (01, 02, 03, etc.) is used for multiple same type equipment (valve, etc.) for a single loop (ID #). When used in this scenario, sequential number does not represent train number.
- Sequential number (01, 02, 03, etc.) is used when multiple trains are used and represents the train number. Optional letter is used after sequential number.

4.4.9.4 Optional Letter

Optional letter (A, B, C, etc.), when used, will distinguish between multiple similar devices.

4.4.10 Process Control Philosophy

General control philosophy is that equipment could be controlled locally by LCS at the equipment, or remotely from the operator workstation in the control room.

LCS consists of a Local/Off/Remote (LOR) selector switch and Start and Stop pushbuttons. The LCS for equipment, which utilizes VFD, will include a speed control potentiometer and meter display for local speed indication. The PLC will have no control over the equipment when LOR is in the “Local” position.

When the LOR is placed in the “Off” position, the equipment will be off and neither the VFD nor the PLC will have control over the equipment.

When the LOR is placed in the “Remote” position and the VFD Human Interface Module is in “Manual,” the equipment can be controlled from the VFD.

When LOR is placed in Remote position, and VFD Human Interface Module in Auto, the equipment is controlled either manually or automatically, depending on a software switch labeled “Remote Auto/Remote Manual” that is provided on the SCADA HMI graphic screen. If the “Remote Auto/Remote Manual” switch is placed in Remote Manual, the equipment can be manually controlled from the operator workstation in the control room. If the “Remote Auto/Remote Manual” switch is placed in Remote Auto, the equipment will be automatically controlled by the logic that is executed in the PLC.



5.0 Electrical

5.1 Introduction

This section provides an overview of the existing electrical power distribution for the effluent pumping and the RO processes, as well as a high-level description of the proposed electrical system modifications. A discussion about applicable codes and standards that govern the electrical system design will be discussed and a basis of design for common electrical systems, such as power distribution and grounding, will be presented. This section also outlines selection criteria for major electrical equipment, such as switchboards, motor control centers (MCCs), adjustable frequency drives, and low-voltage distribution panelboards.

5.2 Existing Electrical Distribution

5.2.1 Existing Effluent Pumping Electrical Distribution System Description

The plant receives a 13.2 kilovolt (kV) utility service via overhead transmission lines. A 1,500 kilovolt-ampere (kVA) pad-mounted transformer steps the service voltage to 480 volts for the effluent pumping electrical power distribution system. Backup power for this system is provided by two on-site 750 kilowatt generators. The main distribution center for this system is a 2,000-ampere (A) switchboard (SWBD-1). An upstream automatic transfer switch provides the means for switching between utility and generator power. A 1,200A switch provides service for motor control center MCC-1, which distributes power to the effluent pumps as well as some other building and miscellaneous loads.

Refer to the one-line diagram for additional details related to the effluent system power distribution.

5.2.2 Existing RO Process Electrical Distribution System Description

A 1,500 kVA pad-mounted transformer steps the service voltage to 480 volts for the RO facility electrical power distribution system. There is no backup power for this system. The main distribution center for this system is a 2,000A motor control center MCC-A. A stand-alone 2,000A circuit breaker with an arc flash energy reduction maintenance switch was retrofitted into the original installation to provide a means of arc flash hazard mitigation. MCC-A distributes power to the RO forwarding pumps as well as other RO process electrical loads and miscellaneous RO building and miscellaneous loads.

Refer to the one-line diagram for additional details related to the RO system power distribution.

5.3 Proposed Electrical System Improvements

5.3.1 Effluent Pumping Electrical Distribution System Improvements

The existing MCC-1, currently located in the main effluent pump building's SCADA room and nearing the end of its useful life, will be replaced with a new distribution switchboard because the effluent pumps will be replaced with VFD pumps. A new stand-alone prefabricated Electrical Building will be provided on-site to house the new switchboard, the new VFD for the effluent pumps, a new PLC, and low-voltage transformer and panels for building power and miscellaneous loads. This stand-alone prefabricated Electrical Building will also support the maintenance of plant operations during the construction period.

5.3.2 RO Process Electrical Distribution System Improvements

Three existing constant-speed RO forwarding pumps will be replaced with three new VFD-driven pumps of slightly larger horsepower. The existing constant-speed starters will be demolished from MCC-A, and the new VFDs for the pumps will be housed in a new prefabricated Electrical Building. This building will also house any SCADA-related panels associated with this system. The existing MCC-A has spare and unused sections that will facilitate the maintenance of plant operations during the construction period.

5.4 Codes and Standards

In addition to the codes and standards listed in the Architectural Section, the following additional codes and standards apply to the project:

- NEC standards
- IEEE standards
- American National Standards Institute (ANSI) standards
- Illuminating Engineering Society of North America (IES), *The Lighting Handbook*
- NEMA standards
- NFPA 72 – National Fire Alarm Code
- NFPA 780 – Standard for the Installation of Lightning Protection Systems
- NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- Instrument Society of America (ISA)
- Insulated Cable Engineers Association (ICEA)
- Occupational Safety and Health Administration (OSHA)
- ASTM International (ASTM)
- InterNational Electrical Testing Association (NETA)
- Factory Mutual (FM)
- Underwriters Laboratory, Inc.
- EPA's Design Criteria for Mechanical, Electric, and Fluid System, and Component Reliability.

Where the requirements of more than one code or standard are applicable, the more restrictive will govern. CDM Smith will use the codes that will be in effect at the completion of the design phase of the project.

5.5 Design Requirements

5.5.1 Electrical Systems

5.5.1.1 Power System Analysis

A power systems analysis comprises various engineering studies. Typical studies are short-circuited, protective device coordination, arc flash hazard, and harmonic analyses. The goal of each study is to verify that the power system for a facility is safe, efficient, and reliable under normal and abnormal conditions. A limited electrical system study will be performed during design to verify that the new electrical system is correctly specified to perform as intended, withstand expected stresses, and be protected against failures.

During detailed design, a preliminary electrical system analysis will be performed for the plant power distribution system and will include a short-circuit study, a selective coordination study, and an arc flash study.

During construction, the construction contractor will be obligated to produce preliminary and final electrical system studies, as outlined in the detailed technical specifications.

A third-party power system analysis specialist will perform this comprehensive study. The preliminary study provides an independent verification that the equipment is being applied within design ratings and can be released by the manufacturer for production. The final study will be an extension of the preliminary study and will provide the construction contractor with the required settings for the actual equipment supplied, before energizing the equipment. The contractor will provide the arc flash labels based on the approved arc flash hazard study for all electrical equipment. The final study will contain “as left” field ratings and settings of the electrical equipment and devices.

5.5.2 Selection of Major Electrical Equipment

5.5.2.1 Motor Controllers and Control Centers

Where six or more combination motor controllers are required, MCCs may be used to provide grouped motor control. Solid-state motor overloads will be used and standard MCC communication and control, rather than “intelligent” MCC, will be specified.

Adjustable frequency drives will be used to provide energy-efficient operation and speed control of various equipment. All VFDs will utilize pulse width modulated technology using Insulated-Gate Bipolar Transistor semiconductor devices for power conversion. Motors less than 100 horsepower will use standard 6-pulse technology. Motors 100 horsepower and greater may use either 18-pulse type with phase shift transformers or active front end technology to mitigate harmonics imposed on the power distribution system. SCADA control of adjustable frequency drives (AFDs) will be via hardwire (discrete and analog wiring) versus control over Ethernet.

A harmonics system study will be required to ensure IEEE 519 standards will be met when the AFD load on distribution equipment exceeds 50% of the connected loads at that distribution equipment.

All medium-voltage VFD designs will be based on Toshiba, as per the owner’s preference.

5.5.2.2 Motors

All motors will be high-efficiency squirrel cage induction type. Motors used in conjunction with AFDs will be rated for inverter duty and be in strict accordance with the latest NEMA MG-1, Part 31 standard. AFD control by its nature can be considered soft start.

Unless otherwise noted, all motors ½ horsepower through 100 horsepower will be rated 230/460 volt, three-phase, 60 Hertz A.C.; motors 125 horsepower and greater will be rated 460V, 3-phase, 60 Hertz A.C., and motors less than ½ horsepower will be rated 115V/230V, 1-phase, 60 Hertz A.C.

Motors 50 horsepower and greater will have a 120V space heater for moisture control when recommended by the design engineers.

5.5.3 Electrical Materials

5.5.3.1 Enclosures and Hardware

NEMA enclosure, area, and equipment classifications will be as follows:

- NEMA 1, 1A, and 12 for dry areas, such as electrical or non-process rooms above grade
- NEMA 4 (and 3R minimum rating) for wet, hose down, watertight (and weatherproof or raintight), which will be for interior and/or exterior areas
- NEMA 4X for wet, hose down, watertight areas, which are corrosive and will be interior and/or exterior areas. Enclosures will be aluminum or type 316 stainless-steel in non-chemical areas and fiber-reinforced plastic in chemical areas
- NEMA 7 for classified hazardous areas, as per National Electrical Code; class, division, and group will be determined during detailed design

Electrical mounting stands, conduit mounting channel, and metal channel, raceway, or box hardware mounted in process or exterior locations will be aluminum or stainless-steel.

5.5.3.2 Raceways

Rigid aluminum conduit will be used in interior dry and wet locations. Where flexible conduit is required, the liquid-tight flexible metal conduit will use an aluminum core rather than a steel core to avoid corrosion issues. All metallic fittings will be aluminum.

Areas designated as “CORROSIVE” on the drawings will use PVC Schedule 80; direct buried underground conduits will be PVC Schedule 80.

PVC Schedule 40 conduit will be used for concrete encased duct banks. Concrete encasement will be provided for selected major underground conduit installations, generally for medium-voltage conduits, large feeders, and/or multi-conductor cables between structures.

The minimum size of conduit allowed will be ¾ inch.

Conduits will be concealed in the slab, in walls, or in the ceiling, to the greatest extent possible.

All underground conduits will be provided with a warning tape above the conduits. Underground electrical conduits will be placed at least 24 inches below grade. Working clearances between underground electrical utilities and other nonelectric underground utilities should be 12 inches (minimum), in addition to other specific equipment requirements.

5.5.3.3 Conductors

Wires and cables will be of annealed, 98% conductivity, soft drawn copper. All conductors will be stranded, except that lighting and receptacle wiring may be solid.

Medium-voltage cable will be copper, single conductor, 15 kV, 133% EPR insulation, copper tape shield.

Power wiring, rated 600V and less, will be NEC type XHHW-2 for sizes up to #4/0 AWG. Sizes 250 kilo circular mils (kcmil) and larger will be NEC type RHW-2. Minimum power wire size: No. 12 AWG. Special AFD power cables will not be provided unless specifically requested. Control wiring will be No. 14 AWG Type XHHW-2, stranded.

All wire and cables will be run in conduits.

5.5.4 Electrical Systems

5.5.4.1 Grounding

The ground source for new Electrical Buildings will have a maximum resistance to ground of 5 ohms and will consist of a combination of underground main water service piping, incoming service ground conductor, exterior-driven ¾-inch by 10-foot copper clad ground rods interconnected in a ring around building perimeters and connected to the building steel.

All inaccessible connections will be exothermically welded.

Neutrals of 480–208Y/120V transformers will be connected to an approved grounding electrode as required by the NEC for separately derived systems. In addition, the neutral must be bonded to the transformer enclosure. A grounding conductor must be run with the supply conductors from the distribution ground bus to the transformer enclosure.

All conductive non-current-carrying components of the electrical system, such as raceways and enclosures, will be grounded.

A separate ground conductor will be installed with the phase conductors in all feeder and branch circuits. A separate ground conductor must be installed with 120V control circuit conductors. Because shielded instrument cables have an internal shield that is grounded, no additional ground wire with these cables will be provided.

Fiber-optic cable conduits will not include an individual ground wire because the fiber system is non-conductive. Because all underground conduits will include detectable warning tape above the conduit, the fiber conduit may be located and traced using this tape.

5.5.4.2 Lighting

Exterior and interior light will be LED type, 120V. Interior lighting will be controlled via individual switches. Outdoor site lighting will be controlled by a photocell control circuit. Illumination levels will be in accordance with IES design guidelines.

Emergency egress lights will be provided with internal 90-minute battery packs/units.



6.0 Architecture

6.1 Applicable Codes and Standards

The following additional codes and standards apply to the project:

- 2018 International Building Code
- 2018 Existing Building Code
- 2023 NEC, NFPA 70
- 2018 International Energy Conservation Code
- 2017 Colorado Accessibility Code

6.1.1 Control Room

Control Room is scoped for renovation of finishes and furniture, as well as removal of legacy equipment and workstations, followed by patch and repair of any damage in preparation for new finishes. Finishes include replacement of ceiling and floor materials. Walls are to be repainted and new wall base is to be installed. Two workstations are included in the scope. Damaged floor and ceiling to be repaired as required. No changes to egress, occupancy, or fire alarm/suppression.

6.1.2 Electrical Building and VFD Building

Proposed Electrical Building and VFD Building are planned to be stand-alone, prefabricated, insulated, metal buildings. The Electrical Building's interior dimensions will be approximately 37 ft long by 10 ft wide. The VFD Building's interior dimensions will be approximately 20 ft long by 10 ft wide. The prefabricated metal buildings are anticipated to be delegated design through performance specifications. The Electrical Building will be located between two existing buildings with less than 10 ft of separation and will require a 2-hour fire-rated wall. A single door and double door will be required for egress.

6.1.3 Roof Hatches

In anticipation of scope at the forwarding pumps, roof hatches will be required for the installation of new equipment. Roof repair and new flashing will be required in the surrounding area of new openings, following installation.



7.0 Structural

7.1 Applicable Codes and Standards

The strength, serviceability, and quality for materials and design procedures will conform to the codes, standards, and references listed below. In case of conflicting requirements, the requirements most applicable to the work will be used. Additional references and standards will also be used, if needed, for specific design components:

- 2018 IBC – International Building Code (IBC)
- 2016 ASCE-7 – Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers (ASCE)
- 2014 ACI 318 – Building Code Requirements for Structural Concrete, American Concrete Institute (ACI)
- 2006 ACI 350 – Code Requirements for Environmental Engineering Concrete Structures, ACI
- American Institute of Steel Construction 15th Edition Steel Construction Manual
- American Institute of Steel Construction 360-16 Specification for Structural Steel Buildings
- 2015 Aluminum Design Manual
- 2018 AWS D1.1 – Structural Welding Code – Steel, American Welding Society (AWS)

7.2 Structural Design Criteria

- Deflection Criteria:
 - Floor Beam and Roof Deck:
 - Live Load: $L/360$
 - Dead and Live Load: $L/240$

7.2.1 Structural Materials

- Concrete:
 - Class E1: $f'_c = 4,500$ psi structural concrete
 - Reinforcing steel: ASTM A615, Grade 60
- Steel:
 - Structural W shapes: ASTM A992
 - Structural steel plates: ASTM A36 or ASTM A572, where required
 - High strength bolts: ASTM F3125 Grade A325, minimum 5/8-inch diameter
 - Cast-in anchor bolts: ASTM F1554, minimum 3/4-inch Diameter

- Aluminum:
 - Structural shapes and plates: Alloy 6061-T6
 - Fasteners: Type 304 stainless-steel with dielectric sleeves and washers
- Anchors:
 - Zinc-Coated: Indoor
 - Stainless-Steel 304: Areas subject to washdown or corrosive environments
 - Stainless-Steel 316: Submerged

7.2.2 Structural Modifications at Effluent Pumps

Based on proposed upgrades, two new 2 MGD and two new 4 MGD pumps will be located at existing pump locations within the north pump well and in new pump locations within the south pump well. Preliminary analysis indicates that locations of the new 2 MGD pumps are sufficiently stiff that vibration is not a concern. It has also been noted by CWD that the current 2 MGD pumps do not exhibit vibratory issues. However, analysis indicates that the 4 MGD pumps, regardless of location, will likely exhibit vibratory issues with the structural slab. To mitigate this concern and stiffen the elevated slab, it is recommended to install concrete beams below the existing slab, on both sides of the pumps. The approximate size of beams is 16 inches wide by 16 inches deep, measured from the bottom of the existing slab.

7.3 Structural Modifications at RO Forwarding Pumps

To facilitate removal of RO forwarding pumps, 4-foot square skylight roof hatches are proposed at the existing roof of the metal building system. It is anticipated that the original designer/manufacturer will be engaged to evaluate the required additional framing for the proposed skylight openings, which would involve relocating existing roof purlins and adding perpendicular framing.

To mitigate concerns regarding vibratory issues at the elevated slab, it is recommended to install concrete beams below the existing slab, near each pump, thus utilizing a “common” beam between the two 3 MGD pumps. The “common” beam will be approximately 24 inches wide by 16 inches deep, and the outboard beams will be approximately 16 inches wide by 16 inches deep, measured from the bottom of the existing slab. The existing hatch will provide access to the wet-well area to construct the beams.

It is also anticipated that an OSHA-compliant life-safety system will be required adjacent to the proposed openings. The metal building system designer/manufacturer will also be engaged to evaluate the required modifications.

7.4 Prefabricated Electrical Buildings

The manufactured structure for the electrical equipment enclosures (the Electrical Buildings) is anticipated to be designed according to performance specification requirements. Based on existing site construction, the steel-framed Electrical Buildings are anticipated to utilize a shallow concrete foundation system. Geotechnical borings and evaluation will be required to provide recommendations based on site-specific soils.

8.0 Pre-Construction Services

8.1 Permitting Requirements

8.1.1 CDPHE

The Colorado Department of Public Health and Environment (CDPHE) provided the below general outline of key events for a construction project involving drinking water systems in Colorado. Project specific requirements will be determined as the design advances:

- 1) **Design Review:** Once the project plans are developed, they need to be submitted to CDPHE for review. This ensures that the design complies with the Drinking Water Design Criteria set by CDPHE to ensure that water systems are designed to meet regulatory standards for safety and quality.
- 2) **Permit Application:** After the design review, the next step is to submit the necessary permit applications to CDPHE, which may include a Construction Permit, depending on the scope of the project. This step may also involve public engagement if required by the specifics of the project.
- 3) **Construction:** With the appropriate permits in place, construction can begin, following the approved design.
- 4) **Testing and Inspection:** During and after construction, the new infrastructure is typically subject to inspections and water quality testing to confirm that it meets state and federal requirements.
- 5) **Final Approval and Operation:** Once the system passes inspections and testing, CDPHE provides final approval for operation. The water system may also be subject to ongoing monitoring and reporting.

8.1.2 Construction Permitting

Permit Action	Action Owner	Cost	Submittal Requirements	Timeline	Stipulations	Agency	Notes
Pre-Fab Electrical Building	CDM Smith	Cost Schedule provided by County	100% IFC Drawings			Mesa County	
Small VFD Enclosure	CDM Smith	Cost Schedule provided by County	100% IFC Drawings			Mesa County	
Sky Light installation (RO Pumps)	CDM Smith	Modification to Building	100% IFC Drawings			Mesa County	
Demolition	CDM Smith	IFC Drawings	100% IFC Drawings			Mesa County	
Any other Internal construction	CDM Smith	IFC Drawings	100% IFC Drawings			Mesa County	



Appendix A CWD-Effluent Pump Study Technical Memorandum

Memorandum

To: Eric Schoeny, P.E., District Engineer, Clifton Water District

From: Jonathan Reed, P.E., CDM Smith

Date: September 27, 2024

*Subject: Clifton Water District
Effluent Pump Station Improvements Technical Memorandum (DRAFT)*

Clifton Water District (CWD, District) has identified the need to implement various improvements to the Supervisory Control and Data Acquisition (SCADA) systems, electrical systems and pumping systems at the Charles A Strain UF Retrofit Plant (WTP, Facility, Plant). This memorandum outlines options for improvements to the Facility's Effluent Pump Station (EPS, pump station, high service pump station).

1.0 Introduction

High service pumping to CWD's distribution system is supplied by a combination of one (1) variable speed and eight (8) constant speed vertical turbine pumps located within the WTP's process building. Many of these pumps are approaching the end of their service life and manual operation of the pump station has resulted in a maintenance burden.

CWD is seeking to upgrade the effluent pump station (EPS) – in conjunction with plant-wide electrical and SCADA improvements – by evaluating alternatives for reconfiguring the EPS's mechanical systems. Upgrades are aimed at replacing aging infrastructure, improving pump station efficiencies and simplifying controls. The following Sections provide an overview of existing EPS facilities and a presentation of two (2) alternatives for retrofitting the pump systems.

2.0 Existing Effluent Pump Station Facilities

The following is a brief description of the existing facilities within the plant.

2.1 Effluent Pump Station

The existing EPS consists of the effluent pump well and effluent clearwell, which are segregated into north and south wells below the operating floor in the facility's process building. The effluent clearwell is fed by a blend of ultrafiltration (UF) filtrate and reverse osmosis (RO) permeate.

Before entering the clearwell, filtrate from the UF process is disinfected via the WTP's serpentine chlorine contact chamber (CCC). Disinfection in the CCC is achieved by means of chlorine (sodium

hypochlorite) addition in the 24" UF filtrate pipe entering the CCC. Disinfected water is then discharged into the north end of the clearwell (north clearwell) via a 126"x24" concrete opening. Chlorine residual is monitored at the discharge end of the CCC for the purposes of disinfection compliance.

Once in the north clearwell, flow can be directed to the southern end of the clearwell (south clearwell) or into the north and/or south effluent pump well (north pump well and south pump well, respectively) by means of manual slide gate valve operation. Gate valve openings are provided at the north, central and south ends of the effluent clearwell.

To meet treated water quality goals, CWD redirects a portion of the clearwell storage to their RO process to achieve a seasonal UF / RO finished water blend. The facility's UF filtrate / RO permeate blend ratio is approximately 1:20 in the summer and 1:2 in the winter. The portion of flow diverted to the RO process must be de-chlorinated before reaching the membranes. RO permeate is then stored and blended back into the effluent pump well as needed. RO permeate blend can be directed to the north or south pump well.

A process flow diagram (PFD) depicting this flow regime is provided in **Figure-1**.

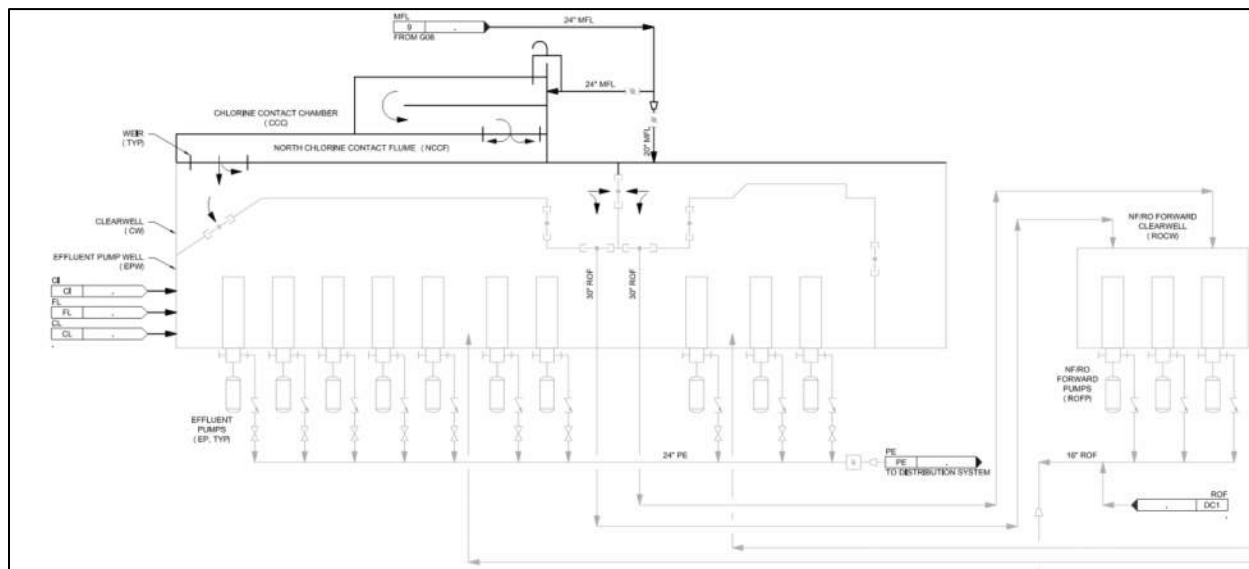


Figure 1: Effluent Clearwell (ECW) and Effluent Pump Well (EPW) Process Flow Diagram

The CCC, clearwell and pump well form part of a common concrete structure in the process building with a top slab elevation at 4649.83 and base slab finished floor at 4642.67. A clear depth of the clearwell and pump wet well is 6.33 ft which is relatively shallow. The effluent pumping units, discharge piping and common discharge piping manifold are set at the operating floor elevation of 4649.83. **Figure 2** shows the operating floor slab of the EPS with the relevant wet wells delineated.

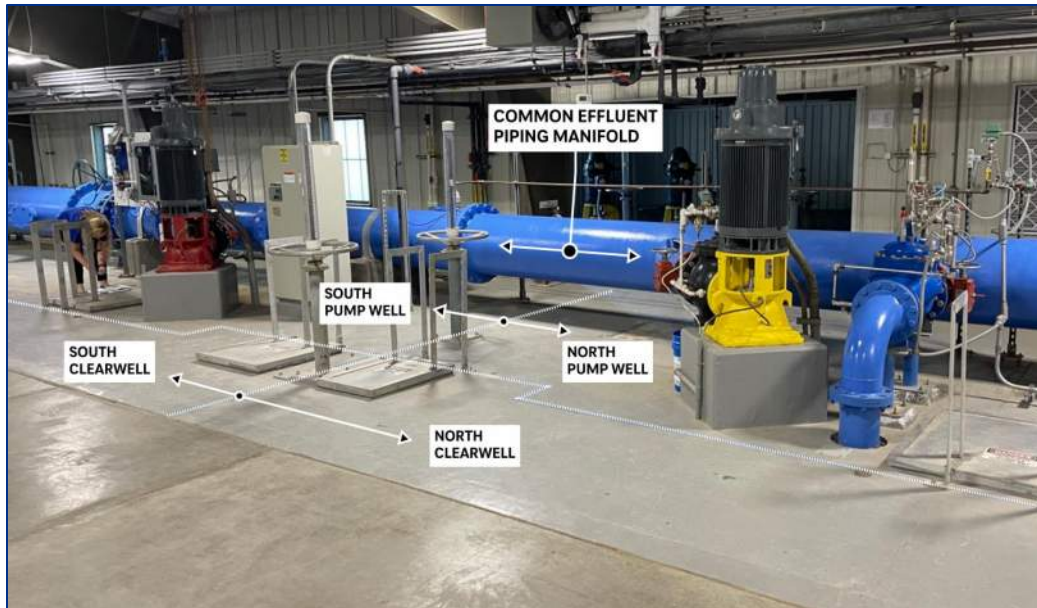


Figure 2: Operating Floor with Wet Well Delineation

2.1.1 Effluent Pumps

The effluent pump station consists of nine (9) vertical turbine pumps of varying flow ratings connected to a combined discharge manifold. Discharge from these pumps convey blended clearwell water (finished water) to CWD's distribution system storage tanks and various service areas. An isometric view of the effluent pump manifold is shown in **Figure 3**. Criteria for each existing effluent pump is summarized in **Table-1**.

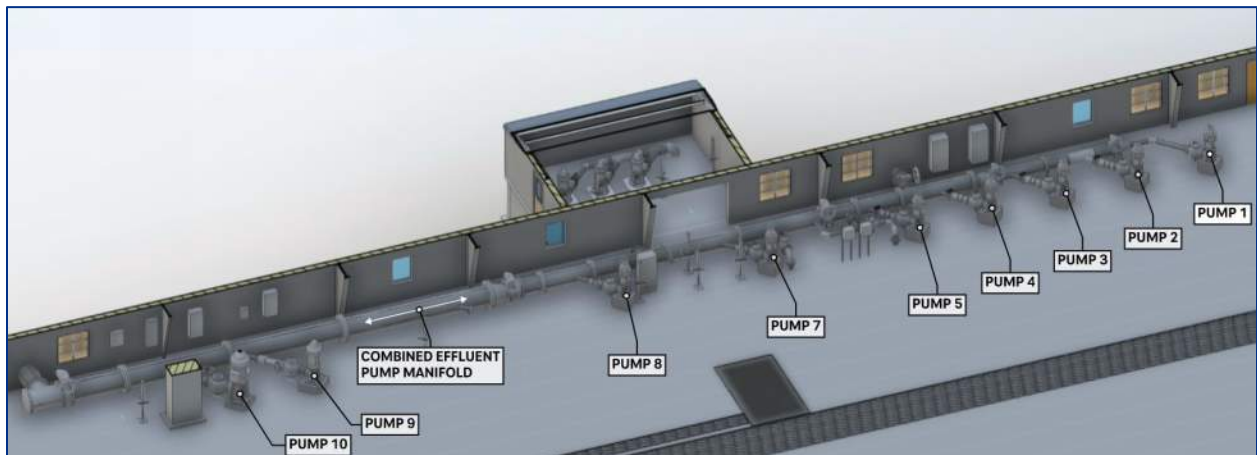


Figure 3: Effluent Pump Manifold

Pump Criteria	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6	Pump 7	Pump 8	Pump 9	Pump 10
Manufacturer	Fairbanks Morse	Fairbanks Morse	Fairbanks Morse	Fairbanks Morse	Fairbanks More	DEMOLISHED	Fairbanks Morse	Fairbanks Morse	Fairbanks Morse	Fairbanks Morse
Type	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine		Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine
Flow Rating (gpm)	800	800	800	800	800		800	800	1,389	2780
Flow Rating (MGD)	1.15	1.15	1.15	1.15	1.15		1.15	1.15	2.0	4.0
Motor Drive	Constant	Constant	Constant	Constant	Constant		Constant	Constant	Constant	VFD
Max. Rated HP	100	100	100	100	100		100	100	150	300
Total Head (ft)	369	369	369	369	369		369	369	346	346
Efficiency	82.0%	82.0%	82.0%	82.0%	82.0%		82.0%	82.0%	83.0%	83.0%
Pump Control Mechanism	ROSS Valve						ROSS Valve			ROSS Valve W/VFD

Table 1: Existing Effluent Pump Summary

All existing effluent pumps are constant speed with the exception of Pump 10, which is equipped with a variable frequency drive (VFD). All pumps include discharge piping and fittings including a globe style pump control valve (Ross), butterfly isolation valve and dresser coupling. Combined pumping service can be discharged from the north end of the manifold between Pump 4 and 5 or from the southern end, adjacent to Pump 10.

Various sections of the effluent manifold can be isolated using a combination of six (6) manual butterfly valves located along the EPS discharge header. For surge control, the combined effluent manifold includes a surge anticipator valve (Singer) with a relief line piped to the clearwell.

2.1.2 Finished Water Chemical Systems

Because a chlorine residual is not carried across the RO process, CWD re-chlorinates their blended effluent to meet minimum finished water chlorine residual requirements. Nine (9) sodium hypochlorite and fluoride application points are situated along the length of the EPW corresponding to dosing locations at each individual effluent pump impeller. CWD operators manually select ball valves dedicated to each finished water pump application point based on what pumps are operating at any given time. Dedicated ball valves are also used to manually actuate feed rates to each pump in order to target a combined effluent chlorine residual. Due to the arrangement of the current effluent clearwells and UF/RO blending regime, there is no workable approach for consolidating finished water chemical feed to a single dosing location.

Finished water quality parameters are monitored at the combined effluent manifold, including free chlorine, fluoride, temperature, pH and turbidity. CWD's finished water compliance monitoring location is located on the southern extend of the combined effluent manifold.

2.2 Operational Challenges of Existing Effluent Discharge Pumps

During conversations and workshops with CWD, several unique operational challenges related to the effluent pump system have been identified. These include:

- Most effluent pumps and their related equipment have reached the end of their useful life. This has contributed to hydraulic inefficiencies driving up operational costs and adding a maintenance burden to the pump system.
- Existing Ross valves require regular manual intervention for pump control.
- Control of the effluent pump station is challenging with a lack of automation and variable speed control.
- Dosing of fluoride and chlorine as finished water chemicals is manually controlled. Multiple application points are fed from a single chemical feed pump and header.
- Selection of chemical feed application points and the rate of application is manually controlled with ball valve isolation and modulation.
- Standard operating procedures for removal of the effluent pump motors and pumps are cumbersome and dangerous.

2.3 Effluent Discharge Pump Operations Data Analysis

2.3.1 Effluent Pump Station (EPS) Operations Data

Historical combined effluent discharge flow data from years 2019-2024 and discharge pressure from years 2021 to 2024 was provided by CWD operations in order to generate pump system curves and understand seasonal service demands. **Figure 4** shows a five year trend of combined effluent flow data. A statistical analysis of this flow data, including historical discharge pressures is summarized in **Table 2**.

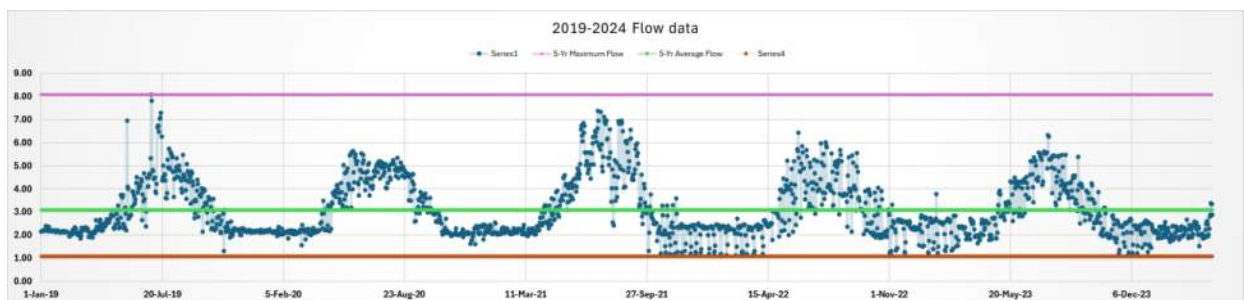


Figure 4: Historical Combined Effluent Flow Trends

Flow Scenario	Effluent Flow (MGD)	Discharge Pressure (psi)	Discharge Head (feet)
	Yr. 2019-2024	Yr. 2021-2024	Yr. 2021-2024
Maximum Flow *	8.08	273.9	632.7
99 th Percentile Flow *	6.79	139	321.2
Average Flow	3.08	122.6	283.2
Minimum Flow	1.08	96.8	223.6

Table 2: Statistical Summary of Historical Effluent Pump Station Flow and Discharge Pressure

2.3.2 Production of EPS System Curve

Generation of a reliable system curve for the effluent pump system is a key criterion for understanding current pump system operation and sizing future pump replacements. The system curve evaluation described here accounted for historical pressure and flow measurements as well as static lift and dynamic loss corrections. The following points and assumptions briefly describe the methodology used for generation of the EPS system curve.

1. Historical combined effluent flow (MGD) from CWD's effluent flow meter provided reliable system flow data.
2. Historical discharge pressure (psi) collected from CWD's combined effluent manifold pressure gauge provided reliable system operating pressure at the EPS header level.
3. Static lift requirements were added from the effluent pump well water surface elevation. The effluent pump well low water level (LWL) was assumed at 5.0 ft above finished floor elevation. The effluent high water Level (HWL) was assumed to be 14 inches below the pump well top of slab elevation.
4. Dynamic loss corrections were made for the section of pipe through the effluent discharge header. These losses account for pump lift requirements between the pump well WSE and CWD's pressure gauge transmitter.

Total system operating pressures were generated by adding the historical gauge pressure, plus the static lift requirements plus the dynamic loss correction from the header (See **Figure 5**).

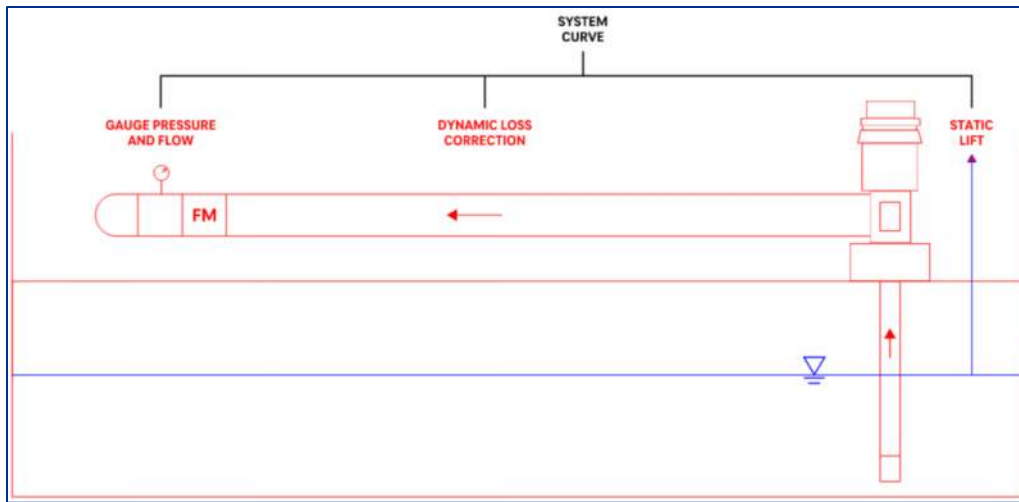


Figure 5: System Curve Generation

A system curve could then be generated by plotting total system pressures against historical flow values. A clear trend in CWD's effluent pump system operating points is plotted in **Figure-6**. CWD reported that effluent discharge pressure spikes above the normal trend are likely caused by periods of operation through their 16" ACP transmission main.

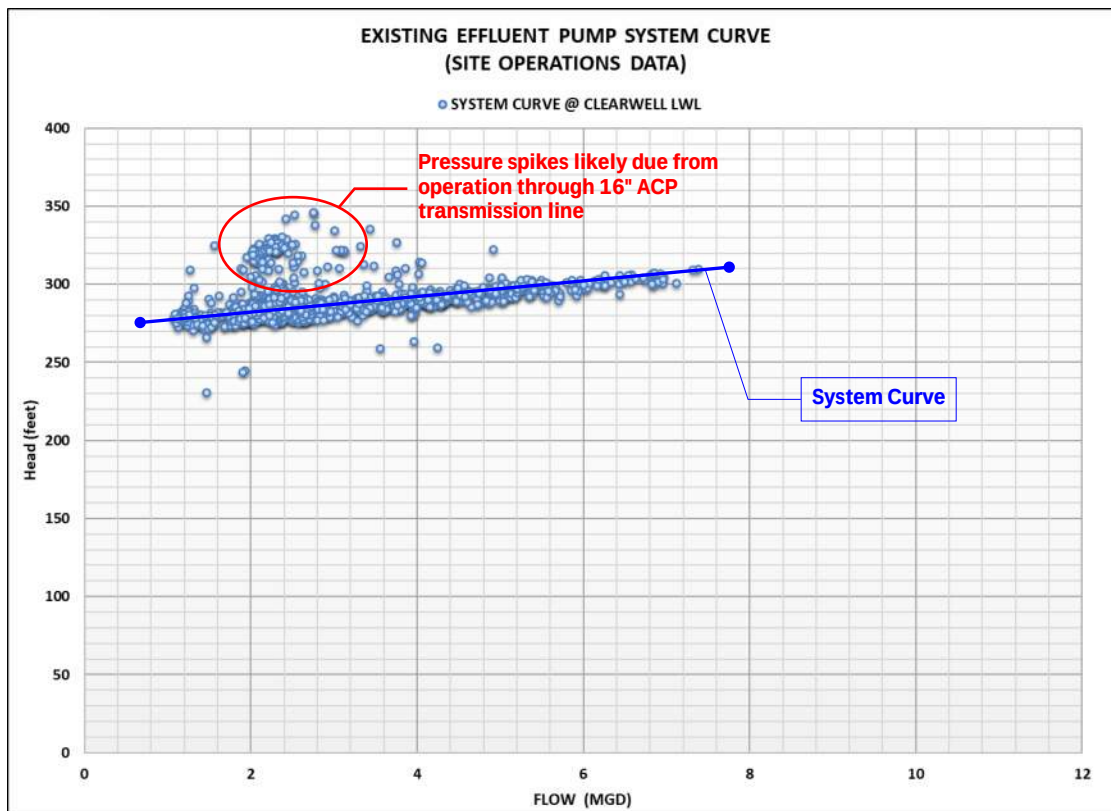


Figure 6: CWD Effluent Pump Station System Curve

Using linear regression, CWD's current operational system curve can be extended by extrapolating system pressures that would be required for future capacity upgrades. **Figure 7** shows a projected system curve at flows reaching 12mgd.

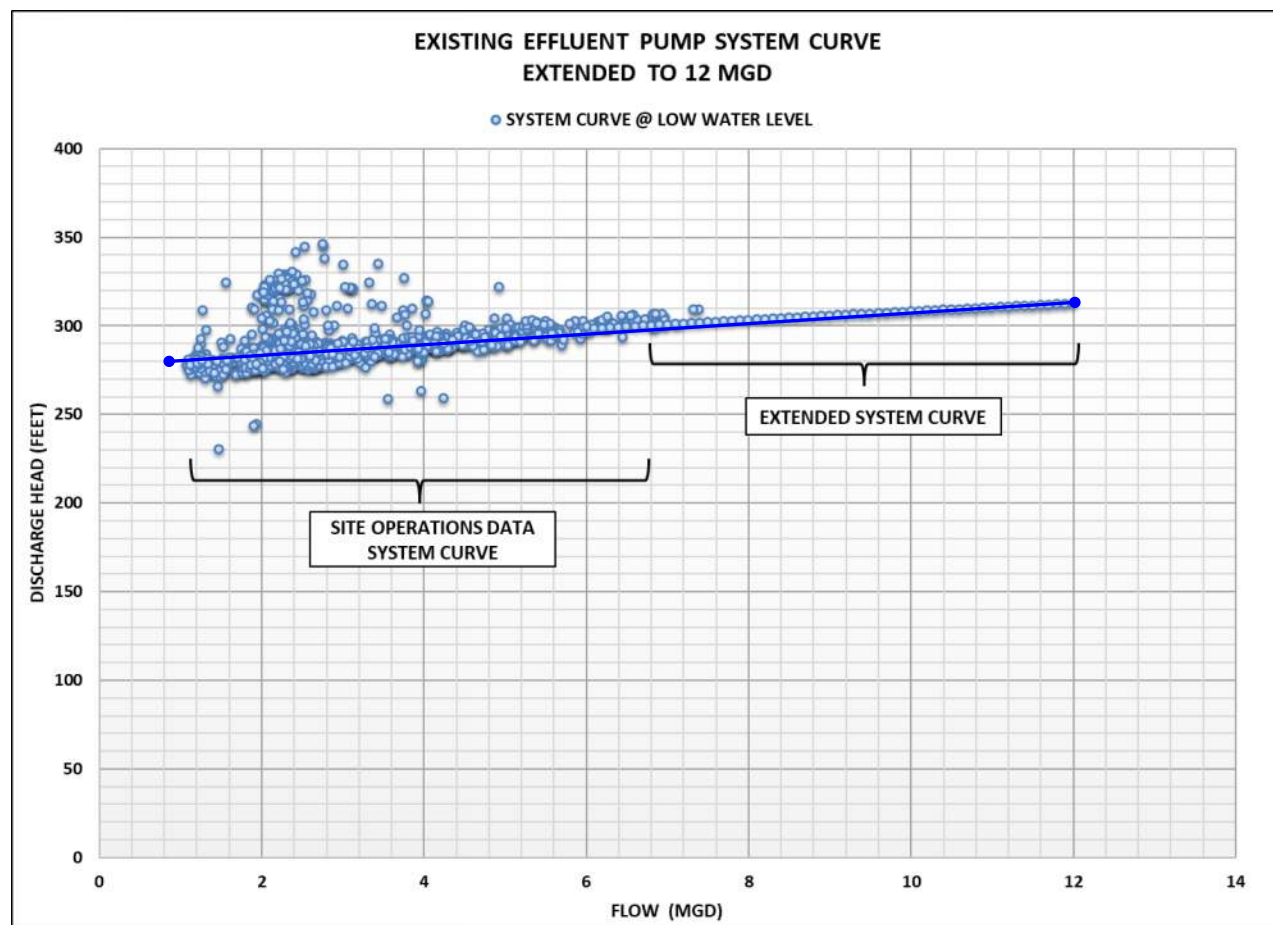


Figure 7: Extended System Curve

3.0 Effluent Pump Station Upgrade Alternatives

As described in earlier sections, the existing effluent pump station at Clifton WTP has seven (7) constant speed pumps rated at 1.15 mgd, one (1) constant speed pump rated at 2 mgd and one (1) VFD-driven pump rated at approximately 4 mgd. This equates to a total EPS firm capacity of 10 mgd. CWD has expressed the desire to increase the EPC firm capacity to match the firm capacity of the UF system at 12mgd. The District would also like to maintain the ability to operate at low flows (1.4mgd) for the purpose of generating turnover in distribution system tanks.

This Section will present two (2) effluent pump system reconfiguration alternatives which aim to:

- Meet a firm capacity goal of 12 mgd

- consolidate effluent pumping equipment
- solve the operational challenges described in Section 2.2.

Effluent pump system reconfiguration alternatives include:

- Alternative 1:
 - **Keep** Pump 10: 4 mgd VFD-driven pump
 - **Keep** Pump 1: 1.15 mgd constant speed pump
 - **Demolish** Pump 2, 3, 4, 5, 7, 8, 9
 - **Add New** two (2) VFD driven 2-mgd pumps
 - **Add New** two (2) VFD driven 4 MGD pump
- Alternative 2:
 - **Keep** Pump 10: 4 mgd VFD-driven pump
 - **Keep** Pump 1: 1.15 mgd constant speed pump (for drain periods)
 - **Demolish** Pump 2, 3, 4, 5, 7, 8, 9
 - **Add New** three (3) VFD driven 4 MGD pump

In order to justify these pump sizes for each alternative, three (3) separate pump manufacturers were contacted for preliminary pump selections. The following criteria were considered while making the pump selections:

- Pumps need to operate within their preferred operating region (POR) most of the time within the required system curve operating range.
- Pump efficiencies need to be similar-to or higher than those of the existing effluent pumps.
- Minimum submergence requirements of the pumps need to be less than the current minimum operating levels in the pumping well.

Details of these alternatives are discussed in the following sections.

3.1 Alternative 1: Two New 2 MGD pump, Two New 4 MGD pump and Existing 4MGD pump in parallel.

In this alternative, four (4) new VFD-driven vertical turbine pumps – two (2) 4 mgd and two (2) 2 mgd – are proposed. The existing 4 mgd VFD-driven pump (Pump No. 10) and 1.15 mgd constant

speed pump (Pump No. 1) would remain. This 6-pump configuration is operated in parallel and aimed to provide an EPS Firm Capacity flow of 13.15 mgd. Minimum flows would be achievable at approximately 1.15 mgd with the remaining constant speed pump running. Minimum flows could also be reached by running the 2mgd pump at reduced speed in the case that the constant speed pump is out of service. A conceptual plan of this alternative is shown in **Figure 8**.

To ensure the EPS system curve generated in Section 2.3.2 could be fulfilled at a 12 mgd firm capacity for this Alternative, pump manufactures we engaged to provide vertical turbine pump selections and corresponding pump curve performance data. Pump curve selections received from pump manufacturers are analyzed to evaluate the best fit option. The best-fit plots for Alternative 1 for all three manufacturers are summarized below

- SIMFLO: **Figure 9** shows the pump best-fit plot for pump selections received from SIMFLO. Using selections given by manufacturer, the maximum flow of 12 MGD can be achieved using two new 2 MGD pumps and 2 new 4 MGD pumps operated at reduced speed.
- Fairbanks - Pentair: Pump selections obtained from Fairbanks – Pentair are as shown in **Figure 10**. These selections also show that plant firm capacity of 12 MGD can be achieved by two 2 MGD and two 4 MGD new VT pumps operated at maximum speed.
- National Pump Company: **Figure 11** shows best fit plots using pump selections obtained from National Pump Company. Selections from this manufacturer show that the Alternative 1 configuration achieves 12 MGD plant firm capacity by operating two 2 MGD pumps and two 4 MGD pumps at reduced speed.

Advantages of Alternative 1 include:

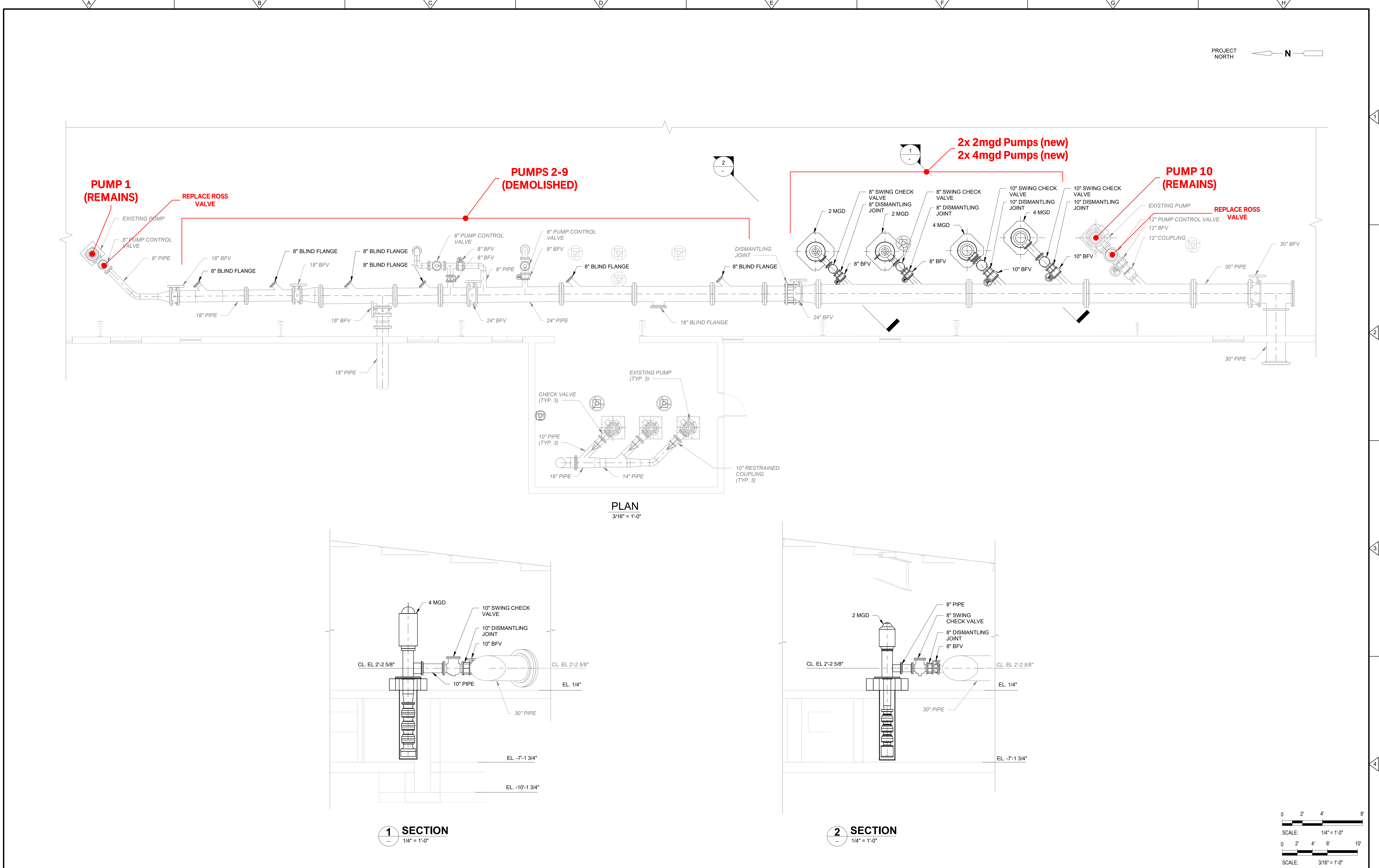
- The inclusion of 2 mgd pumps allow for efficient coverage of a lower flow range including CWD distribution system drain periods.

Table 3 provides the pump system criteria for Alternative 2 pump configuration.

Pump Parameters	SIMFLO- A		Fairbanks - Pentair- B		National Pump Company- C	
Pump rated flow (MGD)	4	2	4	2	4	2
No. of pumps	2	2	2	2	2	2
Lift Rating (feet)	350	369	326	367	350	355
Rated Impeller dia. (inches)	11.4	9.44	12.65	10.23	11.69	10.68
Pump Efficiency (%)	82.6	80.6	78.7	78.7	80	85
Motor Drive	VFD	VFD	VFD	VFD	VFD	VFD
Max Rated motor (hp)	350	200	350	200	350	200

Table 3: Proposed Effluent Pumps (Alternative 1) – Pump Criteria

Last Saved by: JEEVAN B Time: 9/25/2024 6:49:35 PM
Autodesk Docs: /clifton/MW2000PB.rvt
© 2019 CDM SMITH ALL RIGHTS RESERVED
REUSE OF DOCUMENTS: THESE DOCUMENTS AND DESIGNS PROVIDED BY PROFESSIONAL SERVICE, INCORPORATED HEREIN, ARE THE PROPERTY OF CDM SMITH AND ARE NOT TO BE USER, IN WHOLE OR PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CDM SMITH.



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: _____	_____
DRAWN BY: _____	JEEVAN B
SHEET CHK'D BY: _____	
CROSS CHK'D BY: _____	
APPROVED BY: _____	
DATE: _____	SEPTEMBER 2024

CDM
Smith

75 State Street, Suite 701
Boston, MA 02109
tel: (617) 452-6000

CLIFTON WATER DISTRICT
EFFLUENT PUMP STUDY

PROPOSED EFFLUENT PUMP CONFIGURATION
ALTERNATIVE 1

PROJECT NO. 337959-296764
FILE NAME: MW2000PB.rvt

FIGURE
8

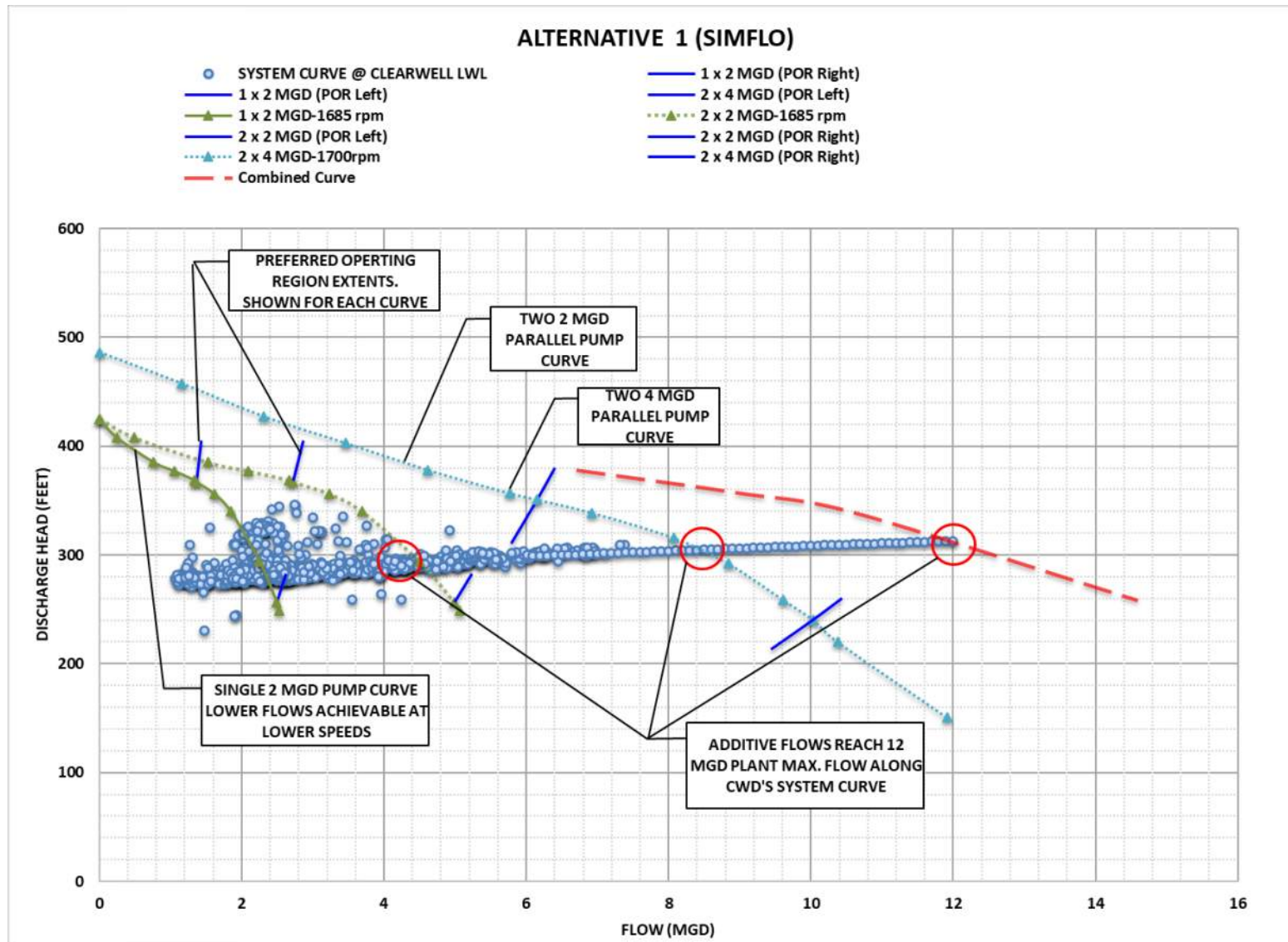


Figure 9 Best-fit Curve – Alternative 1 (SIMFLO)

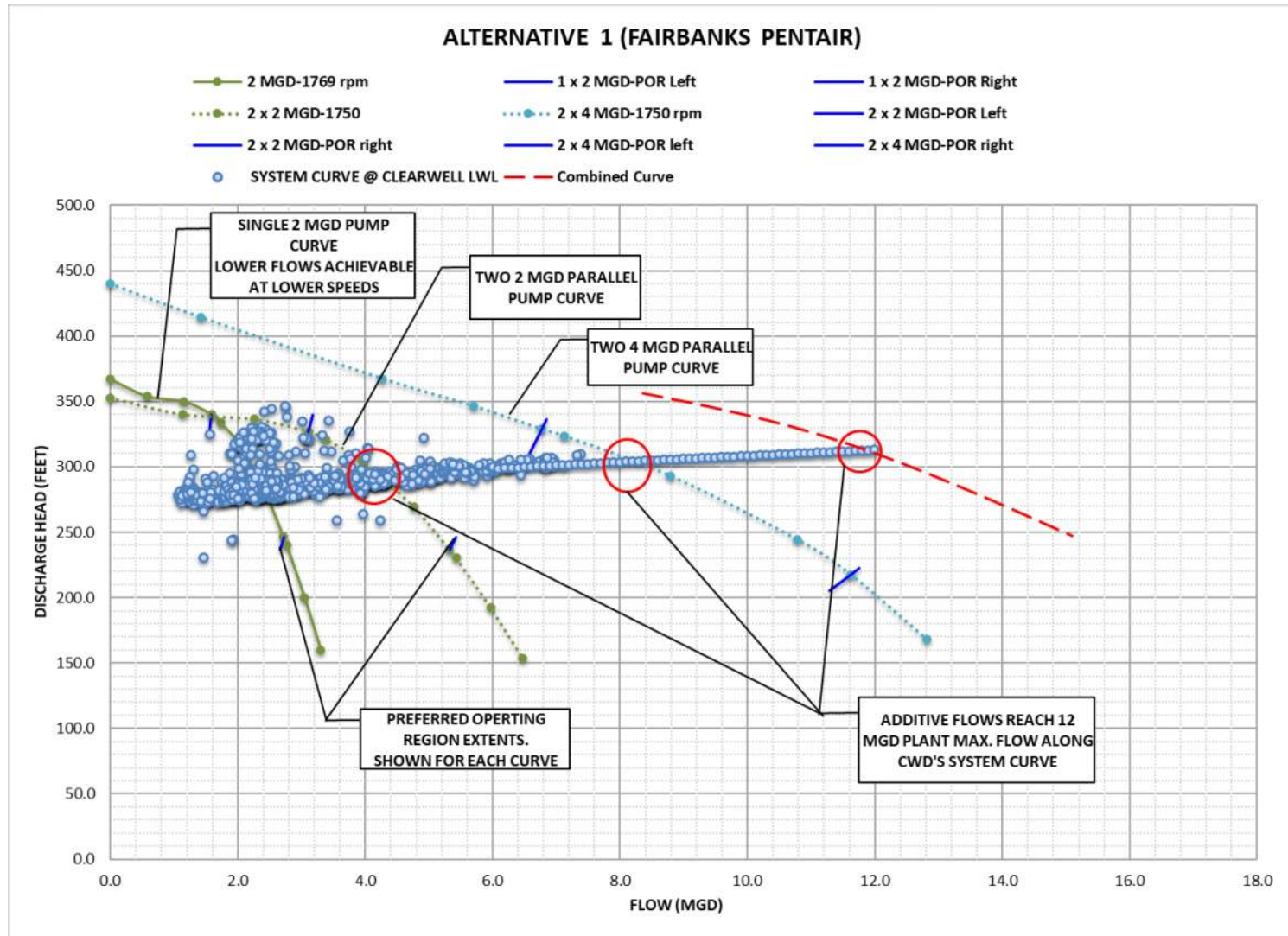


Figure 10 Best-fit Curve – Alternative 1 (Fairbanks Pentair)

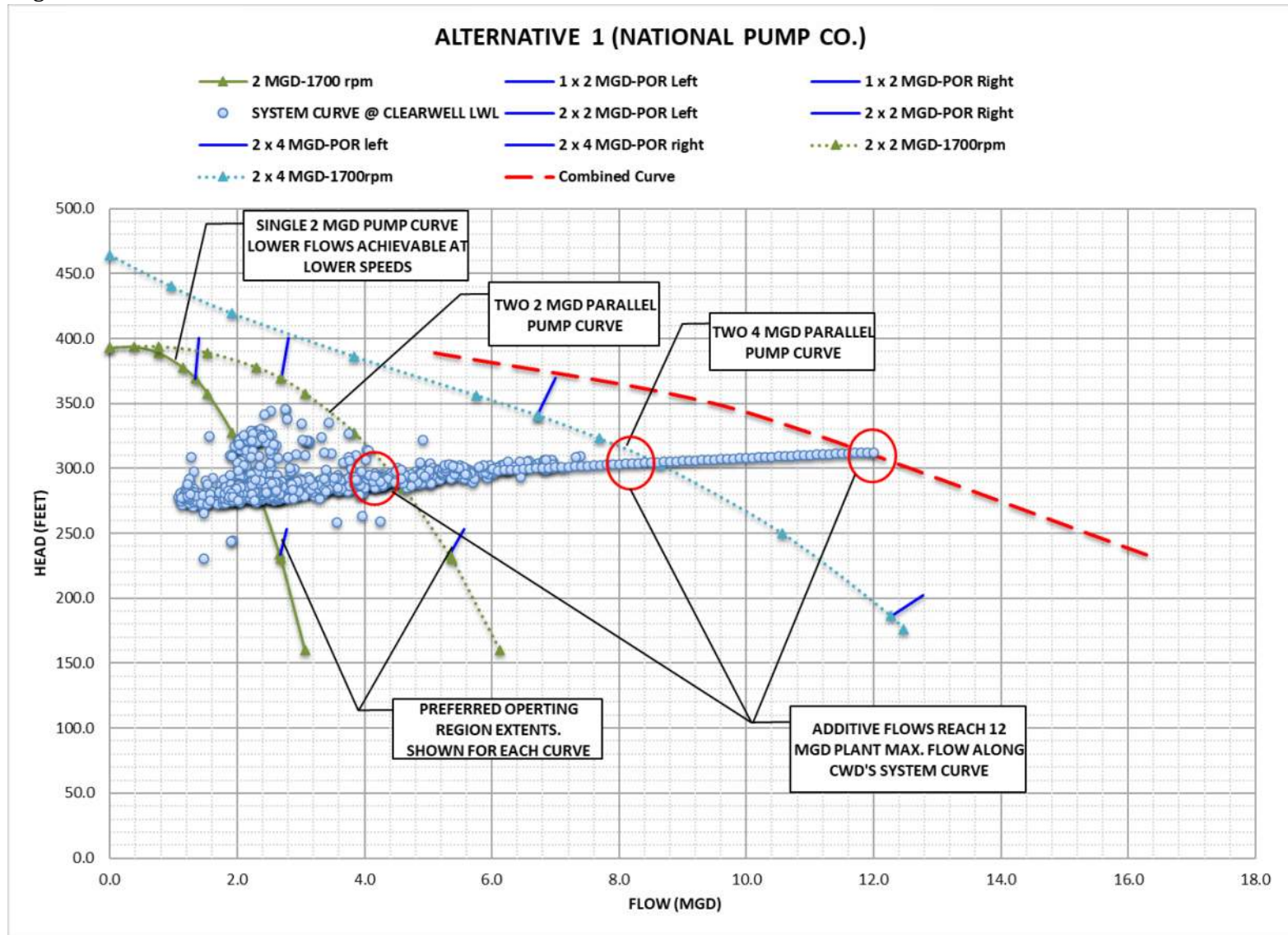


Figure 11 Best-fit Curve – Alternative 1 (National Pump Co.)

3.2 Alternative 2: Three New 4 MGD Pumps and Existing 4 MGD pump in parallel

In this alternative, three (3) new 4 mgd VFD-driven vertical turbine pumps are proposed. The existing 4 mgd VFD-driven pump (Pump No. 10) and 1.15 mgd constant speed pump (Pump No. 1) would remain. This 5-pump configuration is operated in parallel and aimed to provide an EPS Firm Capacity flow of 13.15 mgd. Minimum flows would be achievable at approximately 1.15 mgd with the remaining constant speed pump running. A conceptual plan of this alternative is shown in **Figure 12**.

To ensure the EPS system curve generated in Section 2.3.2 could be fulfilled at a 12 mgd firm capacity for this Alternative, pump manufacturers we engaged to provide vertical turbine pump selections and corresponding pump curve performance data. Pump curve selections received from pump manufacturers are analyzed to evaluate the best fit option. The best-fit plots for Alternative 2 for all three manufacturers are summarized below.

- **SIMFLO:** **Figure-13** shows the best-fit plot for pump selections received from SIMFLO. Using selections given by SIMFLO, 12 MGD can be achieved using three (3) new 4 MGD pumps operated at reduced speed. .
- **Fairbanks - Pentair:** Pump selections obtained from Fairbanks – Pentair are as shown in **Figure 14**. These selections also show that plant firm capacity of 12 MGD can be achieved by operating new three 4 MGD pumps in parallel at max speed.
- **National Pump Company:** Best fit plot using pump selections obtained from National Pump Company in **Figure 15** shows the configuration to achieve 12 MGD plant firm capacity by operating three 4 MGD pumps at reduced speed.

The advantage of providing this pump configuration is:

- Identical pumps allow even split of load while running thus operating within best efficiency regions.
- Ease in automation of pump start and stop.
- Pumps of the same size will provide ease in replacement and maintenance with interchangeable parts.

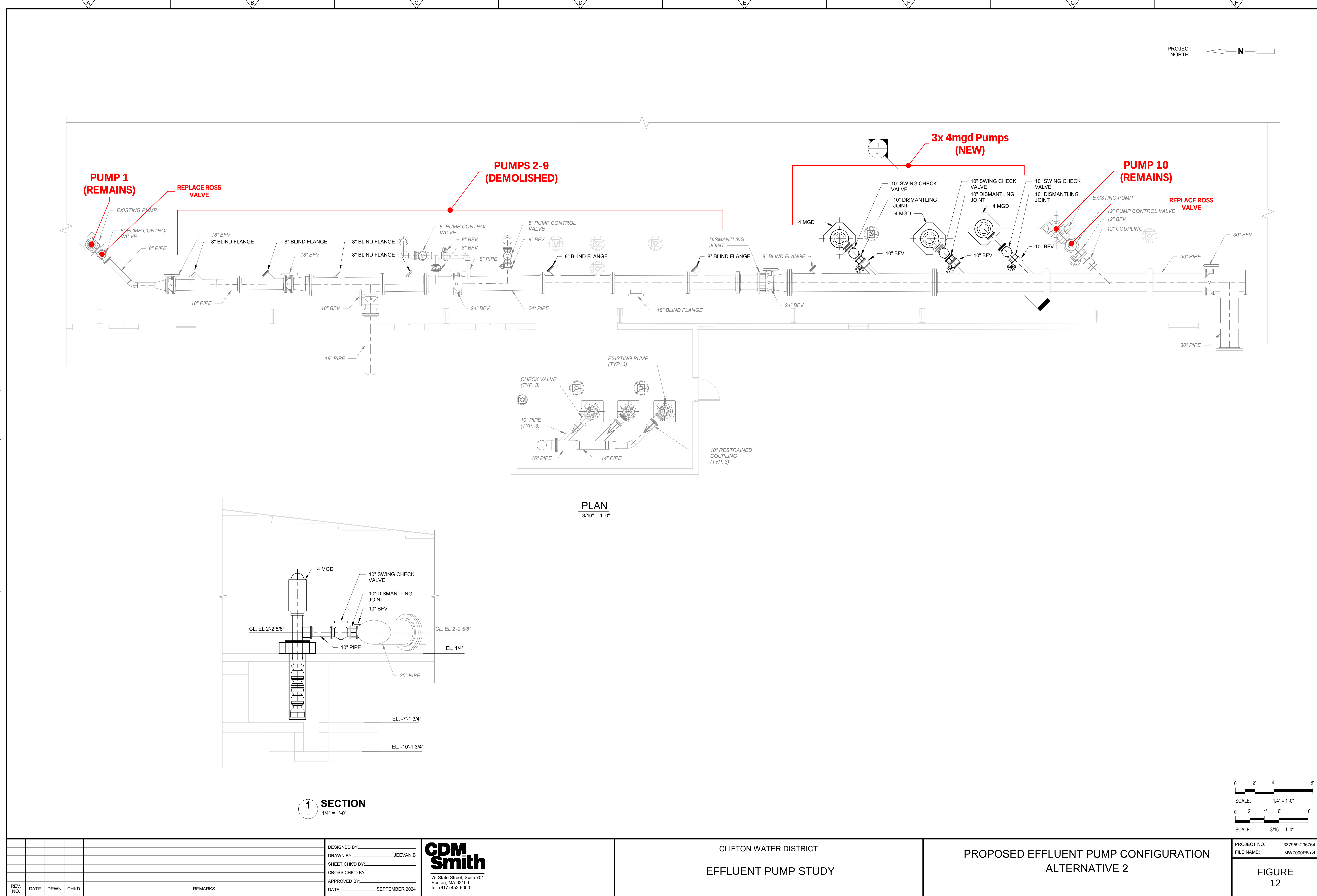
Table 4 provides the pump system criteria for Alternative 2 pump configuration.

Pump Parameters	SIMFLO- A	Fairbanks - Pentair- B	National Pump Company- C
Pump rated flow (MGD)	4	4	4
No. of pumps	2	2	2
Lift Rating (feet)	350	326	350
Rated Impeller dia. (inches)	11.4	12.65	11.69
Pump Efficiency (%)	82.6	78.7	80
Motor Drive	VFD	VFD	VFD
Max Rated motor (hp)	350	350	350

Table 4: Proposed Effluent Pumps (Alternative 2) – Pump Criteria

Last Saved by: JEEVAN B Time: 9/25/2024 6:49:36 PM
Autodesk Docs: \\clifton\mww2000PB.rvt

© 2019 CDM SMITH ALL RIGHTS RESERVED.
REUSE OF DOCUMENTS, THESE DOCUMENTS AND DESIGNS PROVIDED BY PROFESSIONAL SERVICE, INCORPORATED HEREIN, ARE THE PROPERTY OF CDM SMITH AND ARE NOT TO BE USER, IN WHOLE OR PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CDM SMITH.



NOT FOR CONSTRUCTION

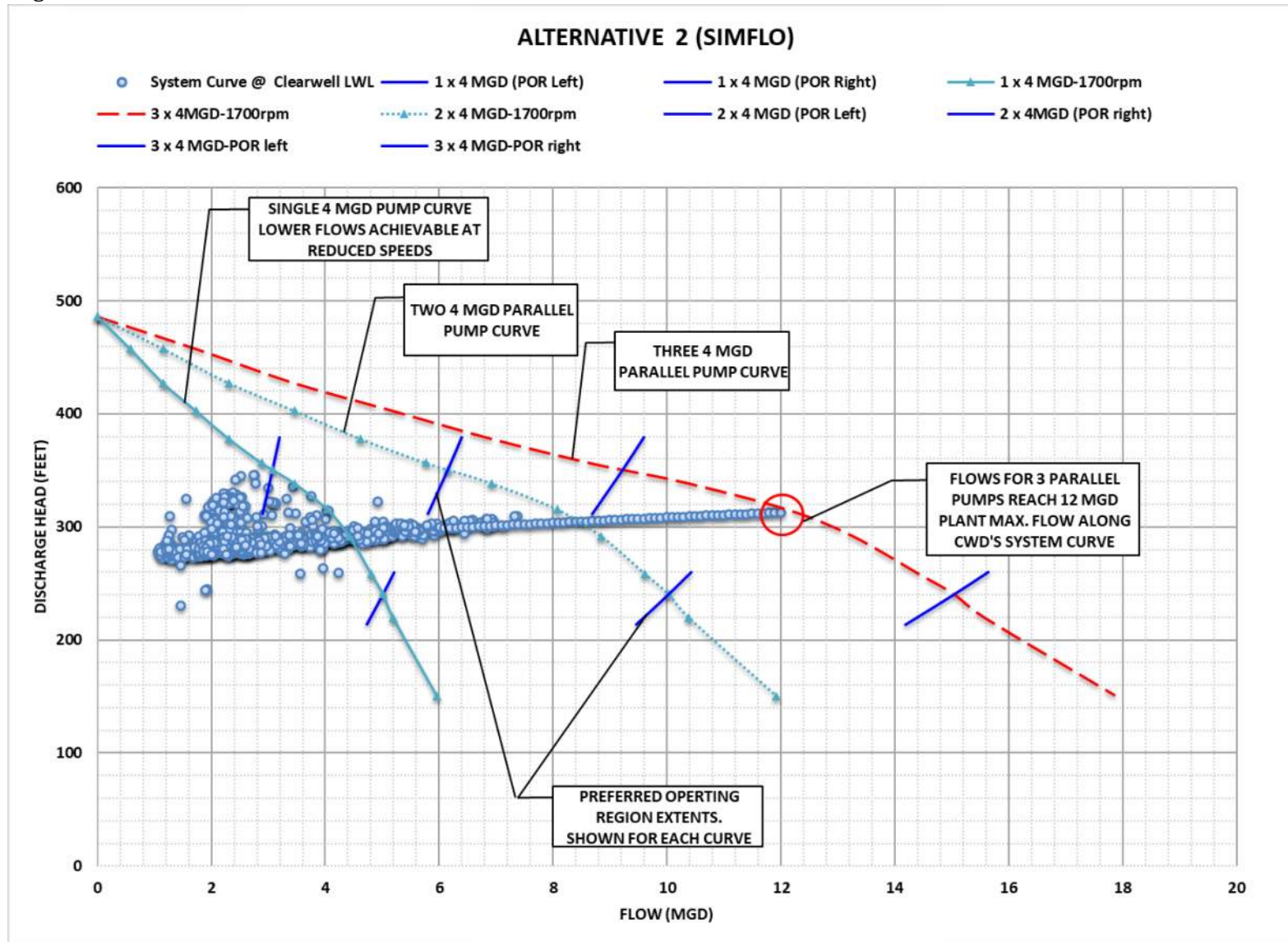


Figure 13 Best-fit Curve – Alternative 2 (SIMFLO)

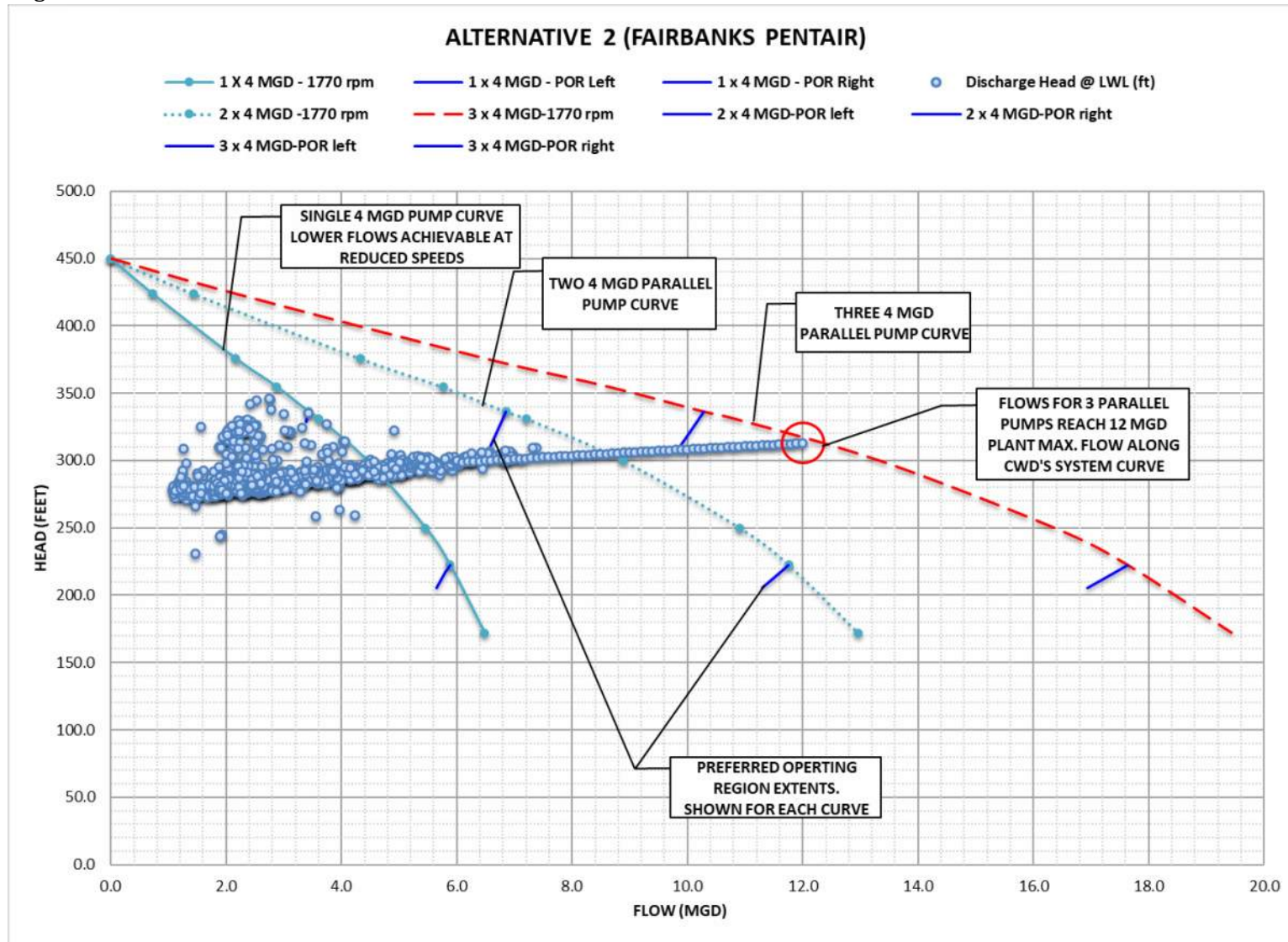


Figure 14 Best-fit Curve – Alternative 2 (Fairbanks Pentair)

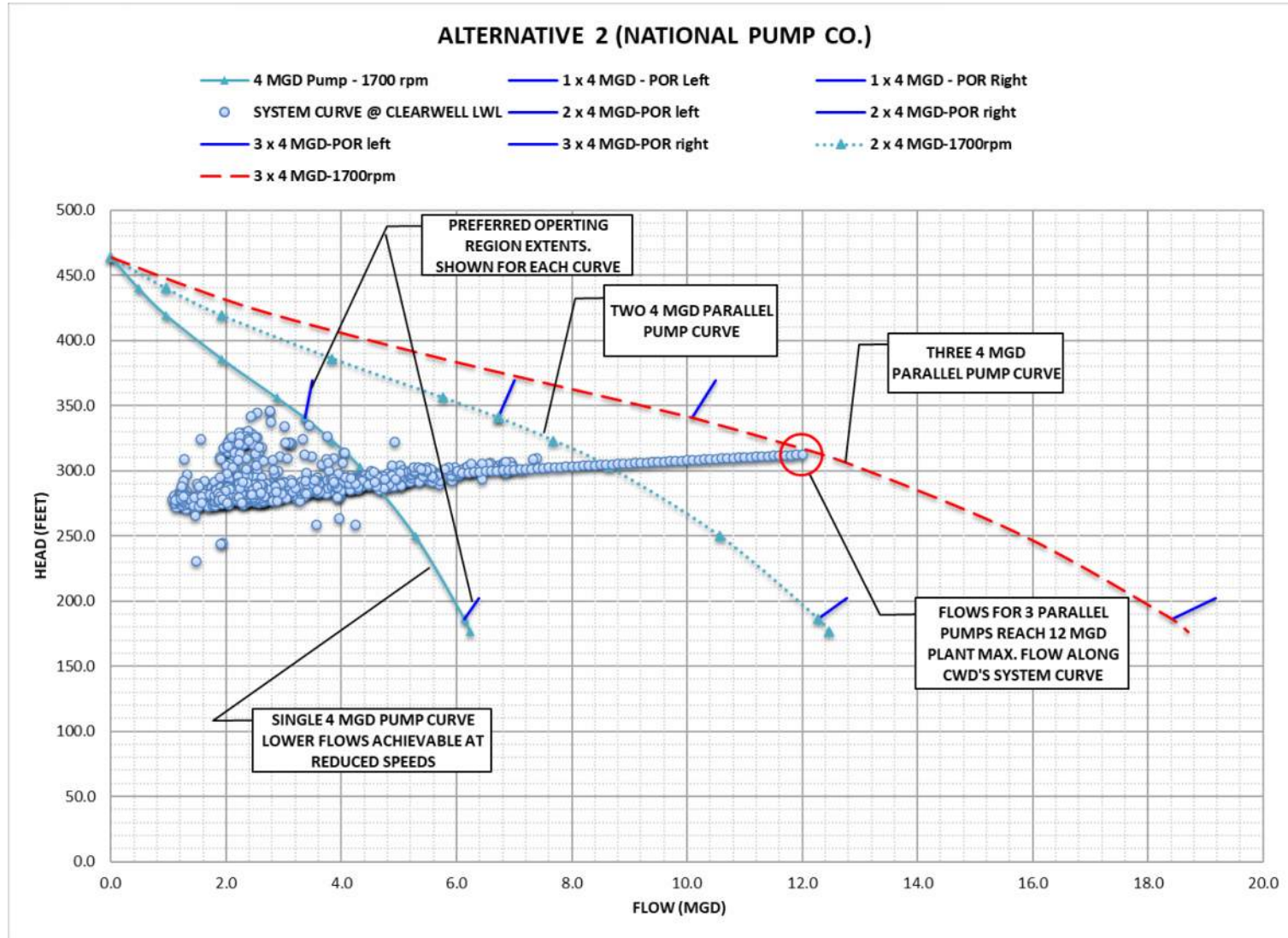


Figure 15 Best-fit Curve – Alternative 2 (National Pump Co.)

3.3 Effluent Pump Discharge Piping

All new pumps will be fitted with new discharge pump appurtenances to accommodate the VFD-driven vertical turbine pump arrangement. Discharge piping (shown in **Figure 16**) will include the following:

- Flanged carbon steel pipe: discharge piping will be rated for CWDs maximum demand pressures.
- Manual pressure gauge: current effluent pumps are not fitted with pressure gauges. Pressure gauges on the new pumps will allow CWD operators to monitor pump lift performance for each individual pump.
- AWWA C508 swing check valve: With the addition of pump VFDs, Ross valves will be replaced with swing check valves to reduce discharge headloss and simplify operation of the pump delivery system.
- Dismantling coupling: dismantling couplings will allow for simplified removal of discharge piping components in a maintenance scenario.
- AWWA C504 butterfly valve: isolation of any pump will be provided by a butterfly valve.

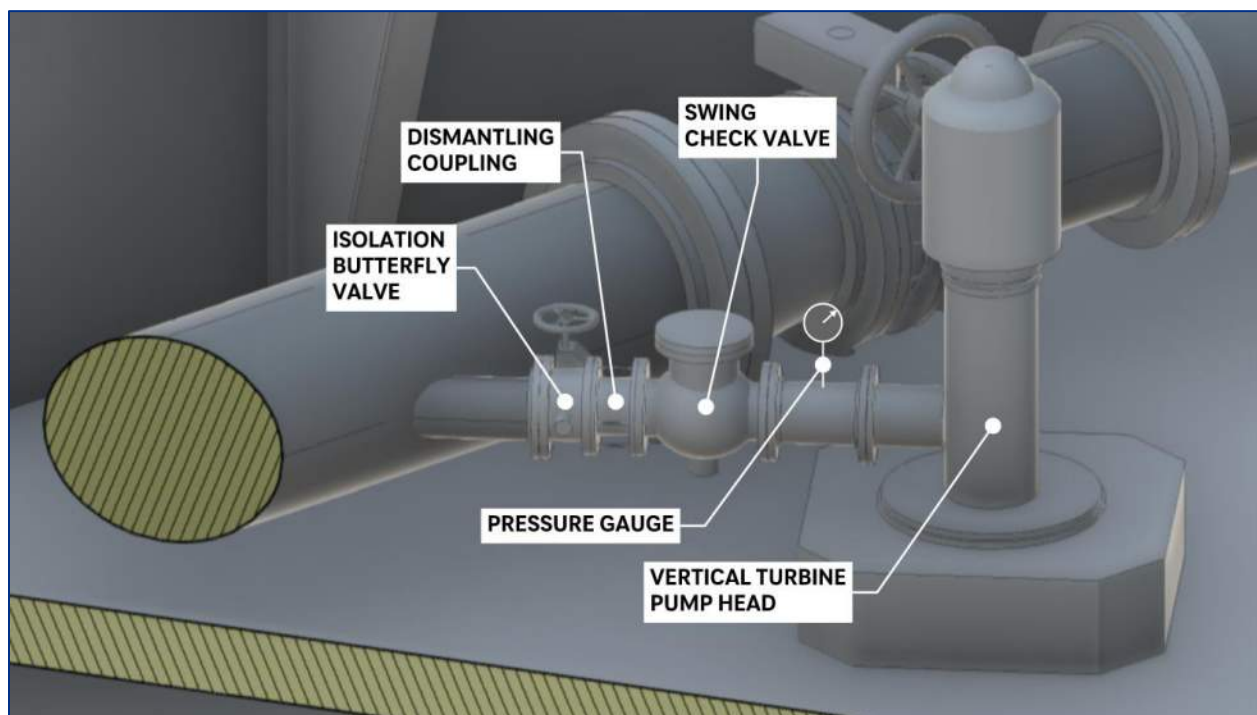


Figure 16: Effluent Pump Discharge Piping

3.4 Effluent Pump Station Chemical Feed Improvements

As discussed in Section 2.1.2, the WTP's current UF/RO blending approach does not allow CWD to dose finished water chemicals (fluoride and chlorine) at a single application point. This results in a complex chemical feed procedure where operators manually control feed rates to each pump impeller. If pump selections or individual pump rates change, operators need to manually change the chemical feed valve selection and/or position to maintain combined effluent chemical concentrations.

Figure 17 shows a modified flow and chemical dosing regime that would consolidate all effluent chemical application points to a single location. This is accomplished by concentrating all blended effluent flow – regardless of the UF/RO blend ratio – to the south clearwell and then to a single entry point at the south pump well. RO permeate would need to be discharged into the clearwell, not the pump well to accommodate this.

With all blended effluent flow concentrated into one channel, chemical feed rates can be flow paced with the existing combined effluent flow transmitter via the SCADA system. It is anticipated that adequate mixing can occur in the south clearwell prior to the pump well entry to avoid short circuiting of chemicals to the southernmost effluent pumps.

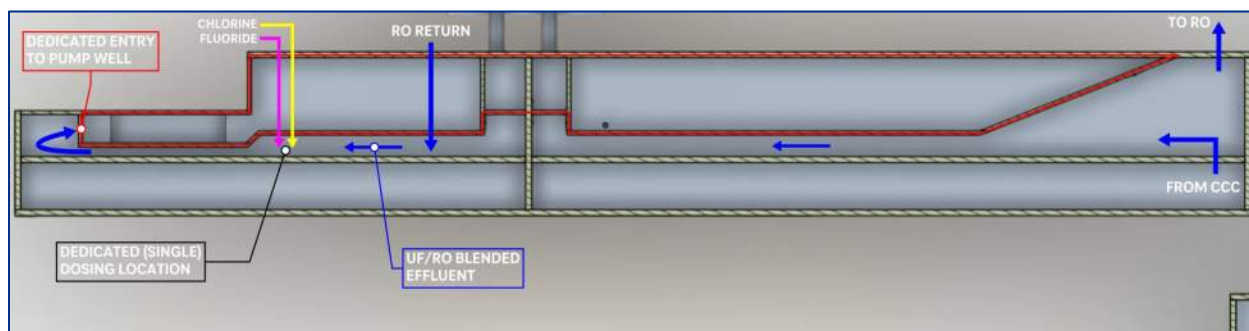


Figure 17: Modified Effluent Flow and Chemical Dose Regime

4.0 Effluent Pump Efficiency and Control

Rated efficiencies for existing effluent pumps are summarized in **Table 1** for each pump's rated operating pressures – 369-ft lift for 1.15mgd/100hp pumps and 346-ft lift for the 4.0mgd/300hp pump. Historical effluent pump system data shows that actual operating pressures range from 260-300-ft lift for the majority of the time. At this lower operating head, actual efficiencies for the existing pumps would be as follows:

- 1.15mgd pumps: 77-80%
- 2mgd pumps: 82-84%
- 4mgd pumps: 78-80%

Without dedicated flow measurement or electrical current monitoring instrumentation for each pump, it is not feasible to exactly determine what efficiency they are operating. However, it is likely that equipment aging and other factors have eroded efficiencies across all the existing effluent pumps further than those noted above.

New pumps and motors would be designed to accommodate CWD's maximum effluent pump flow and system pressure demands. VFDs would then allow lesser duty points to be met while staying in an efficient operating range at lower pump speeds. Preliminary pump manufacturer selections for the proposed 4mgd and 2mgd vertical turbine pumps are targeted to provide the following hydraulic efficiencies at CWDs effluent operating pressures.

- 2mgd pumps: 85%
- 4mgd pumps: 82%

4.1 Pump Controls

The new effluent pumps will be controlled by VFDs to provide the required range of flow. The VFD control will replace the current Ross Valves in providing a controlled ramp up and ramp down of the flow when bringing on and shutting down additional pumps. Speed control of the pumps and starting additional pumps will provide the required effluent flow in order to meet a flow set point determined by the operators.

Automatic control of the pumps will be provided by a new Programmable Logic Controller (PLC) control panel that interfaces directly to the new VFDs. In addition to the automatic control, operators will have the ability to manually start/stop pumps and control speeds as desired through the control system. Additional design development of the PLC control system will be provided as the pump configuration and electrical system are further developed.

5.0 Conclusions

The descriptions and figures provided in the above sections provide CWD with a preliminary summary of proposed upgrades for their effluent pump station systems. These proposed modifications are aimed at improving the efficiency, safety, operability and capacity of the existing pump system. With the adoption of these improvements, CWD can expect the following:

- Improved operator control and automation across a broader range of target effluent pump flows.
- Improved efficiencies with the adoption of new pumps and variable speed control keeping pumps within their preferred operating range at variable speeds.
- Simplified pump ramp-up and shutdown with the removal of Ross valves and addition of VFDs.

- Improved discharge piping headloss with replacement of Ross valves with swing check valves.
- Increased pump station capacity to max UF firm capacity of 12 mgd.
- Simplified finished water chemical feed regime with the adoption of a single dosing location.

Of the pump alternatives presented, both Alternative 1 and Alternative 2 are feasible for this project. Alternative 1 provides the added benefit of smaller pump sizes for full speed control across a wider range of flows. Alternative 2 provides redundancy across all pump sized, which improves consistency in maintenance and interchangeability of parts. Additional detailed design efforts, cost estimating and future workshops with CWD will be required to select the preferred approach.

cc: Ty Jones, District Manager, Clifton Water District
Jacob Lenihan, CWP, Assistant Manager, Clifton Water District
Isaac Brown, CWP, Plant Superintendent, Clifton Water District



Appendix B Facility Drawings