

Design Guidelines

Sacramento Area Sewer District

Version 5.0



June 2025

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1.0 Introduction

This document presents a summary of discipline-specific general design requirements for Sacramento Area Sewer District (District) projects located throughout the District and including the EchoWater Resource Recovery Facility (EchoWater Facility), formerly known as the Sacramento Regional Wastewater Treatment Plant (SRWTP).

1.1 Purpose

The purpose of the District Design Guidelines is to present discipline-specific guidelines that shall be followed during the course of design development. In general, the guidelines discuss criteria, parameters, preferences, and philosophies related to certain design aspects as desired by the District.

In addition to the District Design Guidelines, the Designer is encouraged to review applicable District Guide Specification sections in order to obtain further information on product, material, and construction details. The concepts are that all elements of the design (plans, specifications, etc.) need to work together, and that there are appropriate “homes” to present the necessary information. Stating information in a single location avoids duplication and potential conflicts.

1.2 Relationship with other District Design Standards

This document is one component in a suite of District Design Standards. The standards are created and maintained in order to provide consistency and efficiency among design projects at the District. The standards clearly document requirements, issues, decisions, products, and procedures preferred by District staff.

Each component of the standards is targeted for a specific purpose. The purpose of this document is as stated above. The additional components of the District Design Standards include:

- **Design Contract Requirements** – Presents the content requirements for contract documents prepared for design projects.
- **Guide Specifications** – A library of contract requirements and technical specifications available for project use. A list of available guide specifications is provided in Appendix A.
- **CAD/BIM Standards** – Standards to be used on computer aided drafting (CAD) drawings and Building Information Model (BIM) requirements for data and file management.
- **Standard Drawings and Typical Details** – A library of CAD drawings common across all projects and typically used details available for use by the Designer. A list of common drawings and typical details is provided in Appendix A.
- **Commissioning Plan Preparation Guide** – Describes the level of effort the District requires of the Design Engineer to develop plans for subsequent use and implementation by the Contractor during facility commissioning and startup.

- **Operations Manual Development Guide** – Presents the level of effort required, from the Design Consultant, to develop an Operations Manual for each project. In addition to providing details of the respective project, the Operations Manual also must include details of the interconnections to the existing EchoWater Facility or other District projects. The Operations Manual will serve as a teaching and reference tool for SacSewer.

The District has developed a Program Management Manual for internal use by District staff. This two-volume manual addresses design project management procedures (Volume 1) and construction management procedures (Volume 2). This manual may also be used as a resource during the course of the project upon request.

1.3 Organization

This District Design Guidelines document is organized as follows:

- Chapter 1 provides an introduction to this document.
- Chapter 2 presents general guidelines for design.
- Chapters 3 through 10 present discipline-specific design guidelines for civil; architectural; structural; mechanical; heating, ventilation and air conditioning (HVAC); plumbing; electrical; and instrumentation and control (I&C) disciplines, respectively.
- Chapter 11 presents general guidelines for corrosion control.
- Chapter 12 presents information regarding regulatory requirements.

1.4 Designer Proposed Changes

It is recognized that not all guidelines may be applicable or appropriate for each design project. When the Designer believes project-specific changes are warranted, the Designer shall annotate the specific District Design Guidelines and propose changes to the Project Team. If accepted by the Project Team (and any other affected District staff and management, as applicable), the Designer shall incorporate the changes, together with the annotated District Design Guidelines, into the Project Design Manual.

2.0 General Design Requirements

The purpose of this chapter is to provide Designers with general design requirements to ensure continuity with previous projects and current District standards.

2.1 Codes and Standards

There are several codes referenced in subsequent chapters specific to each discipline. The project shall be designed to comply with applicable portions of the latest codes and standards in effect at time of design.

The local governmental jurisdictions of projects associated with District may include the State of California and one or more of the following:

- County of Sacramento
- County of Yolo
- City of Elk Grove
- City of Folsom
- City of Rancho Cordova
- City of Citrus Heights
- City of Sacramento
- City of Carmichael
- City of West Sacramento

2.2 Calculations

In addition to the following requirements for calculations, refer to the District Design Contract Requirements for specific design calculations submittal information and the respective discipline chapter in this document for the types of calculation required.

Calculations shall be presented on 8-1/2 inch by 11-inch sheets for computations and/or 11-inch by 17-inch foldout sheets for plan layout or details.

Where special equations or source materials are used in calculations, the designer shall show the equation and reference so that others can easily follow the computations. Charts or tables used as design aids shall be copied and included with the calculations.

Simulated models used for computer analysis shall be included in the calculations.

The computer input/output printout shall be presented in the calculations.

Derivation of model geometry, member properties, boundary conditions, and applied loads shall be provided.

Sample calculations depicting how computer results are used in the final design shall be shown.

For proprietary models, design shall provide the electronic models and software for District review of models. If necessary, non-disclosure agreements can be used to protect the proprietary nature of the models.

All electronic files such as Excel spreadsheets and MathCAD printouts shall be provided for review. Spreadsheets shall be scrubbed such that all non-essential information is removed from the files. All spreadsheets shall be print ready for 8-1/2 inch by 11-inch pages (portrait or landscape) or 11-inch by 17-inch landscape pages. Spreadsheets shall be annotated with narratives to show the objective, assumptions, references, inputs, and outputs. All formula calculations provided in the cell shall be displayed.

2.3 Drawings

All drawings shall be prepared using Revit or AutoCAD Version 2025 (supplied by AutoDesk, Inc.) or latest version used by the District. Refer to the District CAD/BIM Standards for the specific listing of software requirements. Other types of computer aided drafting software shall not be used unless specifically approved by the District.

District requires the use of standardized arrangements, formats, symbols, and techniques for all contract drawings. Refer to the District CAD/BIM Standards document for specific information related to CAD standards.

Contract drawings prepared to describe modifications to existing treatment areas or systems shall include the necessary details as on existing record drawings. All modifications and new work shown on existing record drawings shall be drawn with bold lines and the area clouded. Optionally, the existing facility can be shown screened back, and the new work shown with solid lines. On notes and drawing callouts, avoid using the term “New” since the line weights will differentiate new and existing work.

A Key Map shall be located in the lower right hand corner of all plan drawings to show what part of the facility is being depicted on the particular drawing.

When incorporating topographical drawing files for site drawings (or any background files for other drawings), no lettering or other line work shall write over any of the background file. Do not write or draw on any background file. If foreground lettering, leaders, and/or line work cannot be located in a clear area of the background drawing file, the background file shall be bound to the drawing file and the background erased. Electronic copies of both the bound and unbound drawings shall be provided to the District via upload to PMWeb, or on a CD/DVD or thumb drive if the file size is too large to upload.

Projects that have demolition work shall include separate demolition drawings including plans, sections and details. Separate drawings for demolition and construction work shall be provided. Include demolition drawings for all affected disciplines.

Avoid using the term “Contractor...” or “The Contractor shall...” on any drawing.

2.3.1 Index Drawings

These drawings shall show an index of all drawings in numerical order. Index shall include sheet number, drawing number, and drawing title. Detailed information on preparing Index drawings is provided in the District CAD/BIM Standards. For projects with multiple work areas, the index shall be divided into separated areas.

2.3.2 Symbols and Abbreviations

These drawings shall depict all symbols and abbreviations used on the drawings. Symbols shall conform to National CAD Standards (NCS) as described in the District CAD/BIM Standards.

2.3.3 Construction Details

Construction details shall depict construction requirements specific to this project. They shall not include any detail not used on this project. Details not used shall be removed from the drawings, line-outs and blank spaces are not acceptable. Typical details shall be drawn to a selected scale, but labeled “Not to Scale”.

The District maintains a Standard Detail Library for structural, mechanical, electrical details; a complete list is included in Appendix A. For civil details, the City of Elk Grove (https://www.elkgrovecity.org/city_hall/departments_divisions/public_works/standards_plans_and_specs/archive/standard_details_and_drawings) or the Sacramento County Civil Standard Details should be used (www.saccountyspecs.net/drawings.htm). Please note that if there is a conflict between the City of Elk Grove or Sacramento County details versus the District’s Guide Specifications, the guide specifications shall prevail. When a detail is provided from within the City or County library, simply refer to it by its “Title” and “Drawing Number” (i.e.: COMMERCIAL DRIVEWAY TYPE A-6, PER SACRAMENTO COUNTY STANDARD DWG NO 4-14) at a minimum. The City or County Standard Details are not required to be in the plan set unless a detail is modified, but you may choose to also incorporate the unmodified details to produce a complete set without external reference for the Contractor.

2.3.4 Drawing numbering

As discussed in the District’s CAD/BIM Standards, the numbering of project drawings shall follow the United States National CAD Standards with some District modifications. The sheet number uses a discipline designator (Civil, Mechanical, etc.) followed by a one digit sheet type designator following by a three digit sheet sequence number. The District also uses a two digit area number that is added at the end of the sheet sequence number. Specific zone numbers for projects are assigned by the District. The sheets should be grouped first by discipline and then by process area.

2.4 Word Processing Requirements

All reports, manuals, memos, meeting agendas and minutes, etc. shall be prepared on the computer word processing software, Microsoft Word 2016, or latest version used by the District.

All printed or typed data shall be a minimum of 10 point font, with 12 point font preferred. All printing shall be done on recycled paper and double-sided.

2.5 Specifications

The District has a guide specification library that should be used for all projects that use the CSI Masterformat 50 Division Specification numbering system; a list of available guide specifications has been provided in Appendix A. All new specifications shall match the numbering system and formatting of the District Guide Specifications.

2.6 Testability of Systems

Process systems shall be designed with features that allow for “Preoperational Testing” (PREOP) during construction and “Operational Testing” (OP TEST) after construction to verify process operation status and project commissioning. Examples of features include tees and tapped bosses in pipelines for pressure testing and flow diversions.

Designer shall refer to the District Project Test Plans Preparation Guide and prepare the installation, operational and reliability test plans concurrently with the final design which will identify any special requirements for testing and start up.

2.7 Equipment Numbering and Coding System

A unique tag number should be assigned to any item at this facility that requires any type of maintenance; has one or more moving parts; or is monitored for leakage (i.e.: tanks or pipelines). Tag numbers should be assigned for all equipment covered under a construction contract. This helps assure that Maintenance Staff receives the appropriate maintenance information for the equipment installed.

Blocks of numbers have been pre-assigned to various structures and or processes and will be provided by the District to be incorporated in the Design Submittals. The common feature of all numbering systems is the first two digits, which in all cases refers to a specific group of structures or Equipment Zones as follows:

Table 2-1. Equipment Zone Numbering System

First Two Digits	Zone
10-19	Security Gate, Administrative and Maintenance Buildings, Main Substation
20-29	Influent/Effluent Pumping Building
30-39	Primary Treatment
40-48	CO Tanks and Secondary Sedimentation Tanks
50	Primary Effluent Pumping Station and Odor Control Facility
51	Biological Nutrient Removal Facility
52	Biological Nutrient Removal Blower Building
59	Nitrifying Sidestream Treatment Facility
61	Disinfection Contact Basin and Chemical Storage
70	Water Recycling Facility
73	Filter Influent Pumping Station
74	Granular Media Filtration Facility
79	Granular Media Filtration Miscellaneous Support Facilities
80-89	Solids Processing
90-99	Chemical, Outfall, ESB's, SSB's, Bufferlands Building and Storage Building, Heavy Equipment and Maintenance Building, Harvest Crew Trailer, Materials Test Lab/Paint Building, and other miscellaneous structures

Figure 2-1 also shows the locations of the Equipment Zones for all facilities within the treatment plant boundary. For the existing zones above, contact the District Documentation staff to obtain specific two digit area numbers. For locations outside the treatment plant boundary, a Facility Code will be used in lieu of an Equipment Zone. Contact District Documentation Staff during the pre-design phase of the project to obtain the Facility Code numbering for facilities outside the treatment plant boundary.

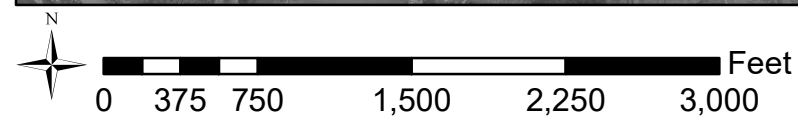
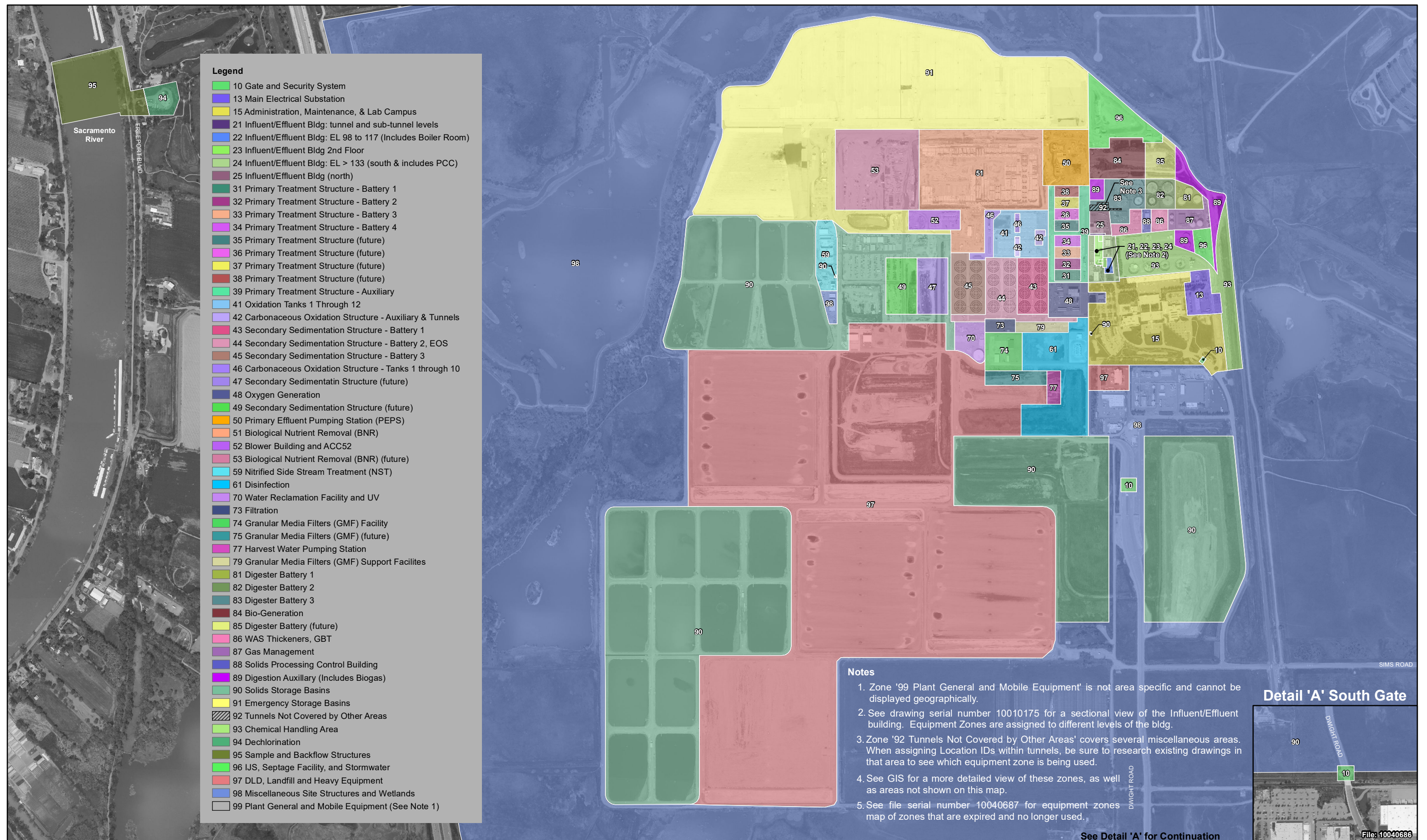
The District currently uses an auto numbering system that defines the syntax used for equipment and valve and manhole numbers. Common Contract Drawing number GI006 also shows the syntax used for numbering equipment. A guide to the District's Equipment Numbering System and workflow are included Appendix B of this document for reference.

2.7.1 Mechanical Equipment

Mechanical equipment is that equipment which is part of the process flow and is considered a discrete piece of equipment, including all the auxiliaries associated with the particular piece of equipment. Mechanical equipment numbers include a 4-character (maximum) prefix followed by a 2-digit area number followed by a 4-digit sequential number. Auxiliary equipment associated with the mechanical equipment will contain a suffix character.

2.7.2 Electrical Equipment

Electrical Equipment is that equipment which is not considered "discrete equipment" as defined, but is related to the switchgear. This would include but is not limited to motor control centers (MCCs), transformers, and electric breakers.



EchoWater Resources Recovery Facility (EchoWater Facility)
Equipment Zones Map
November 2021

Figure 2-1

2.7.3 Instrument Equipment

Instrument Equipment is that equipment which is part of the process flow and is considered a discrete piece of equipment. Separate from the instrument equipment numbering are the PLC/PCCS numbers which are specified by the Designer.

2.7.4 Manual Valves

Manual Valves are those valves which are manually operated (lever or chain), with no electric, pneumatic or hydraulic control connected. Manual valve numbers shall be issued to all valves in a process system and shown on process and piping system schematic diagrams.

2.7.5 Manholes

Manholes are considered as Process manholes and Electrical manholes.

Process manholes are those units that a fluid can flow through. Details and schedules for these units are found in the “General” drawings of the contract documents.

Electrical manholes and handholes are those units that power, control and signal cables run through.

2.7.6 Slide Gates, Control Units, and Utility Stations

Slide Gates (SLG) are those gates which are manually installed and removed; they are used for isolation of channels. Details and schedules for these gates are found in the “Structural” drawings of the contract documents. “Control Units” (CU) are assemblies that supply regulated water flow to process equipment. “Utility Stations” (US) are assemblies used for accessing EchoWater Facility utility systems (i.e.: WRH, WP, Steam, SA). Details and schedules for these assemblies are found in the “Mechanical” drawings of the contract documents.

2.7.7 Doors and Rooms

Each room in each structure of this facility must be identified with a four digit unique number for construction and maintenance purposes. Each room will be given a unique sequential number as defined in the Auto-numbering Guide. These numbers will always be shown on the “Architectural” drawings of the contract documents.

Each door shall be given a number similar in format to the room numbers. These numbers will always be shown on the “Architectural” drawings of the contract documents.

Schedules for both rooms and doors shall be located in the “Architectural” drawings of the contract documents. **(Note: Temporary facilities, such as trailers, shall also receive room and door numbers for maintenance purposes. They shall receive a three digit number. The numbers shall be identified by complex.)**

2.7.8 Pipelines outside of the Plant Property

Pipelines outside the plant property will be identified by pipe segments. Pipe segment lengths will be determined by the nearest appurtenance (diameter change, valve, blowoff, ARV, etc.).

2.8 Special Area Classifications

Certain areas of the existing EchoWater Facility or new process areas may fall under special classifications which require special requirements. During pre-design, potential areas shall be identified. Appropriate design details shall be considered and provided in the plans and specifications. Special classifications include, but are not limited to:

- Hazardous (Classified) Areas – As defined in National Fire Protection Association (NFPA) 820
- Corrosive Areas – Areas over open tanks, chemical rooms,
- Wet Areas – All outdoor areas and indoor process areas. Wet areas shall be considered to be subjected to high-pressure water.

3.0 Civil Design

The following are the civil design guidelines to be considered for District projects.

3.1 Codes and Standards

The project shall be designed to comply with applicable portions of the codes and standards listed in Table 3-1 below and as described in this chapter. Designer is to use the most current County-adopted code edition as posted to www.building.saccounty.net/pages/buildingcodes.aspx up to submission of the Final Preliminary Design Report (PDR); the Designer is not responsible for any newer editions beyond Final PDR.

Table 3-1. Applicable Codes and Standards for Civil Design

ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
Highway Design Manual	California Department of Transportation
State Standard Specifications	California Department of Transportation
Standard Specifications	County of Sacramento Standard Construction Specifications
Improvement Standards	City of Elk Grove
Improvement Standards	Sacramento County; Section 9 Storm Drainage Design
CBC	California Building Code
CFC	California Fire Code
AASHTO	American Association of State Highway Transportation Officials
ACI	American Concrete Institute
Cal OSHA	California Occupational Safety & Health Administration
Cal DHS	California Department of Health Services Water & Sewer Separation Guidelines

3.2 Surveying

The Designer shall show the location and character of all survey monuments within the construction area and place a note on the General Civil Notes plan sheet stating that the Contractor is responsible for the protection and restoration of all existing monuments and other survey markers in accordance with Section 8771 of the Land Surveyor's Act. The District shall supply the Designer with a map of the current benchmarks on EchoWater Facility property.

3.3 Existing Utility Coordination

The Designer shall prepare a project Utility Investigation Plan as outlined in the *District Design Contract Requirements* to assess potential conflicts between any existing utilities and new construction.

3.4 Roadways within District Property

The following sections describe roadway geometry for various types of facility roads.

3.4.1 Process Area Roadways

Table 3-2 lists how the road geometry within the process areas shall be designed:

Table 3-2. Process Area Roadway Geometry

Width	24 feet measured from edge of pavement
Vehicle Turning Radius	40 feet minimum (inside); 60 feet minimum outside
Design Speed	25 miles per hour
Cross Slopes	1 percent minimum for concrete paved areas, 2 percent maximum 2 percent for asphalt paved areas
Longitudinal Slopes	Less than 5 percent

Pavement design shall be based on the size and frequency of the traffic (Traffic Index) and the soil site conditions per the geotechnical engineer's recommendations. At a minimum, the pavement section shall be 3-inch asphalt concrete over 12-inch aggregate base.

3.4.2 Main Ingress/Egress Roadways

Table 3-3 lists how the main ingress/egress roadway geometry shall be designed:

Table 3-3. Ingress/Egress Roadway Geometry

Width	24 feet measured from edge of pavement
Vehicle Turning Radius	40 feet minimum (inside); 60 feet minimum outside
Design Speed	25-45 miles per hour, request clarification from District during design
Cross Slopes	Centerline crown with standard cross-slope of 2 percent
Longitudinal Slopes	Less than 5 percent
Vertical Curve Length	50 feet minimum
Gradient Change for Vertical Curve	2 percent

Pavement design shall be based on the size and frequency of the traffic (Traffic Index) and the soil site conditions per the geotechnical engineer recommendations. At a minimum, the pavement section shall be 3-inch asphalt concrete over 12-inch aggregate base.

3.5 The main access roadway connection to existing Dwight Road shall be designed per the City of Elk Grove Improvement Standards, except that median design, landscaping, and lighting may be modified for the sections on District property. **Roadways Beyond District Property**

The following sections are intended to provide guidance beyond the facility boundary and includes Traffic Control.

3.5.1 Civil Requirements

Refer to Section 3.1 above for codes and standards that apply in City and County roads beyond District property.

3.5.2 Traffic Control

The following is to be considered for District projects outside of the plant boundary.

3.5.2.1 Codes and Standards

All traffic control plans shall be prepared in accordance with the following documents. In case of conflicts, the order of precedence shall be in accordance with the numeric designation, with lower numbers taking precedence over higher numbers and the Contract Documents taking precedence over all reference documents.

Table 3-4. Applicable Codes and Standards for Traffic Control

1A. County of Sacramento, Public Works Agency	Standard Construction Specifications and Traffic Control Plan Templates, latest edition and supplements (for work within unincorporated Sacramento County)
1B. City of Elk Grove, Public Works Department	Standard Construction Specifications, latest edition and supplements (for work within City of Elk Grove)
2. State of California, Department of Transportation	Standard Plans and Specifications, latest edition and supplements
3. State of California, Department of Transportation	California Manual on Uniform Traffic Control Devices for Streets and Highways (CA MUTCD), Part 6, Temporary Traffic Control, latest edition and supplements.
4. U. S. Department of Transportation, Federal Highway Administration	Uniform Traffic Control Devices for Streets and Highways (MUTCD) Part 6, Temporary Traffic Controls, latest edition and supplements

3.5.2.2 Traffic Control Plans

Traffic control plans shall include a traffic control layout for each construction stage of the project.

Traffic Control plans shall include traffic control measures for all road users, including but not limited to motorists, cyclists, pedestrians, equestrians, transit providers, and emergency responders.

Traffic control plans shall be prepared by a licensed Civil or Traffic Engineer in California with expertise in construction stage traffic control.

If a traffic control plan is to be prepared by the Contractor, the Contractor shall have a California C-31 Contractor license. The design engineer shall include a conceptual traffic control plan in the design plan set so that bidders can bid on the traffic control work based on the design engineer's concept.

All traffic control plans shall be submitted to the governing agencies for review and approval.

3.6 Curbing

3.6.1 Type 1 Curb and Gutter

Type 1 Curb and Gutter (rolled curb and gutter) shall be used along all streets in the process areas of the EchoWater Facility.

3.6.2 Type 2 Curb and Gutter

Type 2 Curb and Gutter (vertical curb and gutter) shall be used along streets adjacent to landscaped areas and pedestrian walkways, and shall be placed in front of buildings to help protect buildings from damage caused by vehicles.

Vertical curb and gutter also shall be used for drainage control in parking areas.

3.6.3 Type 3, 4, or 5 Curb

Type 3, 4, or 5 Curb (barrier curb) shall be provided at all edges of parking lots that do not have vertical curb and gutter.

A barrier curb shall be provided at the back of sidewalks where landscape planters containing soil and/or mulch are adjacent to the sidewalk. A barrier curb is not required at the back of sidewalks adjacent to lawn.

A barrier curb shall be provided at the back of sidewalks where the ground slopes away from the sidewalk at greater than 6:1 (H:V). Where a retaining wall is allowed, creating a drop-off adjacent to the sidewalk, a minimum 36-inch-high barrier fence shall be provided in lieu of the barrier curb.

3.7 Cross Gutter

Cross gutter shall not be used. Exceptions will be made for intersections that cannot reasonably be drained to an underground system.

3.8 Sidewalks and Walkways

Sidewalks and walkways shall have a minimum width of 4 feet, a longitudinal slope less than 5 percent, and a transverse slope less than 2 percent. Sidewalks and walkways to be used by maintenance personnel shall be 6-feet wide. Concrete walkways shall be provided around the exterior of all structures and shall slope away from buildings at a minimum slope of 0.01:1 (H:V). Landscaping adjacent to structures should be avoided.

3.9 Parking

Visitor and employee parking areas shall be provided with tree shading as required by Sacramento County Zoning Code. Visitor and employee parking areas shall have accessible parking spaces for disabled people as required by the California Building Code.

Parking areas within the process areas of the EchoWater Facility which are not generally used by the public need not comply with the above requirements for shading and accessible parking spaces.

Utility cart and bicycle parking shall be provided at all EchoWater Facility process buildings.

3.10 Slope Protection

Embankments with erosion potential shall have a minimum slope of 3:1 (H:V) and an aggregate topping (such as AB) should be considered as a minimum finish. If additional protection is required, an erosion protection system such as rip-rap may be used. Seeding shall not be used.

3.11 Landscaping

No landscaping shall be required within the process areas of the EchoWater Facility.

3.12 Storm Drainage

Incorporate Low Impact Development (LID) techniques where possible to address storm water runoff (e.g., permeable pavement).

The design of a new storm drain system shall include consideration of the downstream storm drain. The Designer shall show that the existing storm water system can convey the proposed drainage without adverse flooding, erosion or other water quality impacts to upstream, downstream or adjacent facilities or areas; or that such facilities or areas are being improved or protected to the point where the drainage can be conveyed without adverse impacts.

The entire EchoWater Facility is protected by a 400-year flood levee. New structures are not required to have the building pad elevations certified to be set at least 1.2 feet above all sources of 100-year flooding elevation, but shall be coordinated with the final civil site improvements to avoid water intrusion into the buildings.

All open channel drainage systems shall be designed to carry the 100-year frequency design storm, using the worst-case duration, with freeboard greater than 1 foot. The maximum velocity shall be 6 feet per second for earth channels, 10 feet per second for fully lined channels, and 8 feet per second for bottom-lined channels.

The design of closed conduit drainage systems shall use the Sacramento City/County Drainage Manual Volume 2: Hydrology Standards and Section 9 Storm Drainage Design of the Sacramento County Improvement Standards, as appropriate. The minimum inside diameter for pipes shall be no less than 12 inches. Use of plastic, polyvinyl chloride (PVC) or high density polyethylene pipes (HDPE) at channel or detention basin outfall shall not be allowed. The minimum full flow velocity shall be no less than 2 feet per second.

A manhole, junction box, or inlet shall be located at pipe junctions, angle points greater than 15 degrees, and changes in pipe size or materials. Spacing of access points shall not exceed

400 feet for drains 15 inches and smaller in diameter, 500 feet for drains between 18 inches and 36 inches in diameter, and 600 feet for drains greater than 42 inches in diameter.

3.13 Potable and Non-Potable Water Supply Systems

In general, water supply systems shall be looped, with two points of connection to water sources, separated by a minimum of one isolation valve.

The Hazen-Williams formula shall be used in the hydraulic study of the system, using a “C” value of 125 for cement-lined pipe, polyvinyl chloride pipe, and ductile iron pipe. Velocity in distribution mains shall not exceed 7 feet per second at peak hour. Head loss shall not exceed 5 pounds per square inch (psi) per 1,000 feet.

Water supply pressures shall be designed as follows:

- Potable water systems shall be designed so that normal operating pressures at service connections to the distribution system are no less than 35 psi and no more than 100 psi. During periods of maximum day domestic demand, the pressure shall not be less than 20 psi at the location of the fire flow and no less than 10 psi elsewhere in the distribution system.
- Non-potable water systems shall be designed to maintain a minimum pressure of 40 pounds per square inch (psi) at the service connection.

Required fire flows shall be determined by the California Uniform Fire Code.

Ten (10) feet shall be the minimum horizontal distance between parallel water supply and sanitary sewer mains or non-potable water mains. The invert of the water supply main shall be at a higher elevation than the sewer main or non-potable water main. Separation may be less if it is in accordance with California State Department of Health Services requirements and approved by the District.

At all utility crossings, the water supply main shall maintain a minimum separation of at least 12 inches from the utility. Sanitary sewer and water main crossings shall comply with the latest California Department of Health Services criteria.

3.14 General Site Piping Design Criteria

To preserve access for future pipeline extensions and to minimize conflicts, separate utility corridors will be provided for buried utilities.

Where feasible, consider adding pipe chases for utilities crossing under heavily traveled roadways.

Where feasible, process yard piping will be located outside of roadways and electrical ductbank corridors.

Chapter 3. Civil Design Guidelines

Water, plant water, plant drainage, and natural gas piping will be located in roadways, where feasible.

Electrical ductbanks will be located in 20-foot-wide corridors away from process yard piping and outside of plant roadways.

All pipelines located beneath structures will be concrete encased.

Minimum cover for pressurized process pipes (not for irrigation) shall be 3-feet.

Pipe profiles shall be prepared for process pipe larger than 18-inches in diameter and for all gravity pipe systems.

Buried valves 30-inches in diameter and larger shall be installed in vaults.

4.0 Architectural Design

This guideline has been developed for architects to use in the course of designing buildings and providing content for related construction documents. It does not replace the required professional judgment exercised by a competent architect licensed to practice in the State of California.

Per California Government Code Section 53091, local building and zoning ordinances are not applicable to the location or construction of wastewater facilities by a public agency. Therefore, the powers vested in a “Building Official” as defined by the 2013 edition (or most recent County-adopted code as posted to www.building.saccounty.net/pages/buildingcodes.aspx) of the California Building Code Section 104 shall be discharged by an authorized person within the District. As needed, the District may defer these duties to the local governmental jurisdiction.

Architects in charge of designing facilities for the District shall prepare designs according to an industrial architectural vocabulary consistent with existing contexts where applicable. Industrial buildings and new office buildings shall be consistent with an industrial style even if existing office buildings have been designed with more expressive features.

Note that the most cost-effective design that meets code and program requirements shall be the default in design direction.

4.1 Codes and Standards

The project shall be designed to comply with applicable portions of the codes and standards listed in Table 4-1 below and as described in this chapter. Designer is to use the most current County-adopted code edition as posted to www.building.saccounty.net/pages/buildingcodes.aspx up to submission of the Final Preliminary Design Report (PDR); the Designer is not responsible for any newer editions beyond Final PDR.

Table 4-1. Applicable Codes and Standards for Architectural Design

CBC	California Building Code
CEC	California Electrical Code
CMC	California Mechanical Code
CEnC	California Energy Code
CFC	California Fire Code
CGBS	California Green Building Standards
Cal OSHA	California Division of Occupational Safety and Health
ADA	American’s with Disabilities Act
ASTM	American Society for Testing and Materials
ANSI	American National Standards Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
	SMACNA’s 2003 Architectural Sheet Metal Manual
NAAMM	National Association of Architectural Metal Manufacturers

UL	Underwriter's Laboratory
FMRC	Factory Mutual Research Corporation
SSPC	Steel Structures Painting Council
NFPA 10	National Fire Prevention Association Standard for Portable Fire Extinguishers
NFPA 13	National Fire Prevention Association Standard for Automatic Fire Sprinklers
NFPA 430	National Fire Prevention Association Standard for Storage of Liquid and Solid Oxidizers
NFPA 820	National Fire Prevention Association Standard for Wastewater Treatment and Collection Facilities

Model codes such as the “International Building Code,” “National Electrical Code,” “NFPA 101,” “NFPA 5000” or similar codes do not have force within this jurisdiction and shall not be referenced since they have not been adopted by the State of California.

In the case of conflicting codes or standards, the most restrictive shall apply.

The 2022 Edition of the California Code of Regulations, Title 24, as now adopted, includes Part 11, California Green Building Standards. The design should, as a minimum, address applicable "Mandatory Measures" identified therein. Refer to Appendix C for a summary of how the mandatory measures shall be incorporated into District projects.

4.2 Architectural Code Analysis

The following method of code review shall be used in assuring compliance to non-structural code provisions.

- Step 1: The architect shall look up *Effective Use of the IBC/CBC* located on page v in the 2022 *CBC*.
- Step 2: The architect shall follow the instructions and compose a list of code sections identified in *Nonstructural Provisions*, then provide written justification pertaining to each section.
- Step 3: The architect shall include this annotated list in the construction documents as part of the code review sheet(s) in the construction drawings. Each listing shall briefly describe compliance in context to the design. Overall, the architect should avoid copying the text in the code word-for-word unless accuracy is important.
- Step 4: The architect shall create an annotated architectural site code review plan that includes egress routes and accessibility features. This shall only show enough detail to show compliance to code. Site features may reference civil sheets. Include this in the construction drawings.
- Step 5: The architect shall create an annotated floor code review plan that includes occupancy loads, egress routes, fire ratings, egress travel distances, occupancy types, exit sign locations (reference electrical drawings) and fire extinguisher locations. Include this in the construction drawings.

4.3 Accessibility Requirements

The District Board has approved exemption of the EchoWater Facility process areas from compliance with ADA requirements; reference the November 23, 1993 County of Sacramento Board of Directors letter with subject line “*Approval of Sacramento Regional Wastewater Treatment Plant (SRWTP) New Construction Guidelines for Americans with Disabilities Act (ADA) Compliance*”. Accessibility requirements for all other areas on a project shall be designed per Chapter 11B of the California Building Code.

4.4 General Materials Guide

Materials shall be selected on the merits of durability, safety, economy, maintenance, sustainability, and aesthetic context. For economy, materials and designs with the lowest life cycle costs are preferred over materials or designs that have lower initial costs that will be offset by higher maintenance costs, replacements costs, or shorter life.

4.4.1 Concrete

- Durability
 - ❖ Concrete shall be selected where reinforced concrete structure is acceptable as the finished element. Selection on this basis is inherently durable.
 - ❖ In industrial areas especially, appropriately designed reinforced concrete can withstand a hit from vehicular traffic.
 - ❖ Ballistic resistant.
- Safety
 - ❖ Provide a non-slip surface where required.
 - ❖ Coordinate recessed thresholds with structural engineer.
- Economy
 - ❖ Concrete finishes tend to be economical when compared to other applied finishes. Concrete may be stained, sealed, hardened or painted with epoxy. See Section 4.7.
 - ❖ Stairwells shall not be cast-in-place concrete.
 - ❖ Utilities shall not be embedded into cast-in-place structures.
- Maintenance
 - ❖ Inherently easy to maintain.
 - ❖ Over time, efflorescence may become an issue. To reduce this risk, consider the following during design.

- Review water table levels in the soil and follow the recommendation of a soils report issued by a geotechnical engineer. Use under slab vapor barriers where recommended.
- Use below grade waterproofing on the exterior of foundation walls. Make sure that the perimeter foundation is well drained.
- Use a weather proof sealer on vertical exterior surfaces.
- Sustainability
 - ❖ Consider using a fly ash additive.
- Aesthetic
 - ❖ Much of the EchoWater Facility is composed of cast-in-place concrete. Matching this aesthetic is an important consideration.
 - ❖ Use of pigments is not advisable unless specifically requested.
 - ❖ Exterior concrete surfaces shall be standard concrete grey.
 - ❖ Where appropriate, form liners may provide texture or relief in a concrete surface.

4.4.2 Masonry

- Durability
 - ❖ Concrete masonry shall be selected where reinforced concrete masonry structure is acceptable as the finished element. Selection on this basis is inherently durable.
 - ❖ In industrial areas especially, appropriately designed reinforced fully grouted concrete masonry can withstand a hit from vehicular traffic.
 - ❖ Ballistic resistant.
 - ❖ Glass masonry or glass block should be considered only where there is a low risk of impact.
- Economy
 - ❖ In general, concrete masonry is one of the most economical options to provide durable, structural, and aesthetically pleasing walls.
- Maintenance
 - ❖ Inherently easy to maintain.

- ❖ Over time, efflorescence may become an issue. To reduce this risk, consider using a weather proof sealer on vertical exterior surfaces.
- Aesthetic
 - ❖ Concrete masonry is available in a wide range of colors, textures and surfaces. Ensure that the use of concrete masonry is compatible with the overall context of the facility.

4.4.3 Metal

- Durability
 - ❖ Steel
 - Corrosion is a primary concern. Most steels will require a coating designed to withstand the expected risk of corrosion.
 - Use lead-free coatings and coating tints.
 - When selecting coatings for corrosion resistance consult the District, appropriately certified members of NACE, and SSPC standards.
 - Consider stainless steel in corrosive locations that are difficult to access, have intricate shapes, or slender sections such as trusses. The ongoing maintenance and replacement cost of coatings in these locations often makes stainless steel competitive when considering life cycle costs.
 - Hot-dipped galvanized steel shall be used on external fabricated steel structures when size allows.
 - Consider aluminum where corrosion is a concern.
 - ❖ Aluminum
 - If aluminum products are incorporated, provide di-electric separation between metal and substrate in accordance with manufacturer instructions.
 - A protective coating or barrier shall be used between aluminum and cement and similar construction material.
 - Use metal stud for framing, avoid wood studs.
- Economy
 - ❖ Substantiate metal choices based on economy by checking current pricing.
 - ❖ Strength and corrosion resistance shall be considered along with economy.
- Maintenance

- ❖ If alternatives are being weighed, consider that metal may need regular inspection for corrosion of weather exposed elements.
- ❖ COR-TEN steel is an alternative steel that, if exposed to weather, will create a protective oxidized surface.
- ❖ Use stainless steel or aluminum for gutters, downspouts, drain pans, flashing or for similar sheet metal installations that are routinely exposed to moisture maximize service life.

4.4.4 Wood

- Durability
 - ❖ Wood as a construction material should be avoided and in no case should be used as an alternative to corrosion resistant materials.
 - ❖ Fire retardant treated wood may have limited use for sheathing in roofing. Fire retardant treated wood may be used as shims only in locations totally sealed from moisture and sunlight exposure.
 - ❖ Wood may have limited use as an interior finish in an office context.
- Safety
 - ❖ Oxidizers such as sodium hypochlorite may be prone to ignition or increased flammability in the presence of wood or other carbon based materials.
- Economy
 - ❖ Wood is inherently an inexpensive material compared to other building materials, but generally not appropriate for industrial construction.
- Maintenance
 - ❖ Wood is subject to checking or cracking if not properly painted or finished.
 - ❖ Keep wood construction well ventilated and as dictated in the CBC.
 - ❖ Wood is not appropriate in wet areas unless provided with adequate coatings or pressure treatment.
- Sustainability
 - ❖ Consider using wood and wood products from sustainable sources.

4.4.5 Plastic

- Use fiber-reinforced plastic (FRP) panel wainscot for toilet rooms, shower rooms, locker rooms or restrooms if ceramic tile is not preferred.
- Use UV resistant ultra-high-molecular-weight (UHMW) polyethylene or similar plastic for shims in locations with potential exposure to moisture or sunlight and for pipe support piers or blocks that rest on roof.
- Use UHMW or similar plastic material for pipe support piers or blocks that are rest on a roof.
- Durability
 - ❖ FRP has excellent strength and corrosion resistant properties and is commonly used for grates, guardrails and doors.
 - ❖ FRP is used where corrosion is likely on ferric based metal.
 - ❖ FRP panels may be used as sheathing over metal stud framing. Provide thickness as manufacturer recommends.
 - ❖ 8-mm FRP may be used over water-resistant gypsum board as a finish primarily in locker rooms and restrooms. It can also be used in laboratories.
- Maintenance
 - ❖ FRP panels may be used in non-emersion wet areas, places with corrosion risk, or where there is a need for abuse resistant surface. Provide thickness as manufacturer recommends.
 - ❖ Edge beads are typically used, but tend to break off or become bent. Consider more substantial transition especially in janitor closets and restrooms located in industrial areas.
- Aesthetic
 - ❖ FRP 8-mm panels come in a variety of textures and colors. However, the most common color is white.
 - ❖ FRP 8-mm panels can be used as an economical alternative to ceramic tile for wall applications.

4.5 Thermal and Moisture Protection (Roofs, Siding, etc.)

4.5.1 Vapor Barrier

- Vapor barriers are required to control moisture laden warm air from reaching the location of the dew point within a wall or roof assembly. Vapor barriers shall always be placed on the warm side of the assembly.

- Architect shall determine the warm side of the wall. This may be difficult since during the summer, the exterior is clearly the warm side, and in the winter, the inside is clearly the warm side. DO NOT put a vapor barrier on both sides. Entrapment of moisture is a leading cause of mold within the wall structure.
- Use silicon sheet or ethylene propylene diene monomer (EPDM) membranes to bridge construction gaps (window-wall, wall-wall assemblies, curtain walls) for air/vapor seals. Do not specify rubberized asphalt (sheet air/vapor barriers [AVBs]).

4.5.2 Sealants and Waterproofing

- Apply waterproofing to exterior below grade walls during construction. Avoid post-construction methods for waterproofing such walls.
- Design building and flashings so as not to rely on sealants in the shedding of water and moisture. Make sure to use capillary breaks.
- Sealant and waterproofing materials shall be warranted for at least 30 years.
- Sealant
 - ❖ Use sealant containing asbestos-free formula.
 - ❖ Check the width of the gap to be sealed with the manufacturer's recommended span.
 - ❖ Check substrate and compare with manufacturer's recommendation.
 - ❖ Check that elasticity is appropriate for joint movement.
 - ❖ Check performance of UV exposure if in direct sunlight.
- In building joints, use EPDM sheet as a moisture barrier within the joint (behind the cover).
- Sealant or caulking materials shall be compatible with the construction materials and location.

4.5.3 General Roof and Parapet Requirements

- The roof deck, insulation, and membrane shall be a Factory Mutual (FM) tested and approved assembly rated for the expected wind loading (See Section 5.4).
- Assume all roofs will be accessed for ongoing maintenance and inspection activities and provide an appropriate fall protection design. See Sections 4.15 and 4.16 for fall protection and access requirements, respectively.
- On flat roofs provide reinforced walkways 360 degrees around process equipment, HVAC equipment, and photovoltaic panels. Provide reinforced walkway from equipment to roof hatches, and ladder. On steep roofs provide working platform 360 degree around process and HVAC equipment.

- All roofs to be Title 24 SRI (Solar Reflective Index) compliant. Roofs on unoccupied and unconditioned structures shall have a minimum SRI of 64 for flat roofs and 16 for steep roofs.
- Do not pierce roof curb caps and parapet copings to mount equipment. Weld fasteners to the cap or coping or use other supporting structure attached to the curb or parapet for anchoring equipment.
- Skylights and tubular daylights must be mounted on roof curbs.
- For any given type roofing material and assembly, those with longer warranties are preferred. Warrantee shall cover parts and labor for the life of the warrantee.
- Additions to existing roofs.
 - ❖ Roofing that has evidence of leakage after inspection in conjunction with a new addition shall be removed. Install new roofing over both new and existing parts of roof structure.
 - ❖ Existing roofing installation aged 12 years or more in conjunction with a new addition shall be removed. Install new roofing over both the new and existing parts of the roof structure.

4.5.4 Roof-Mounted Equipment and Solar Panels

- All roof equipment located on roofs must be mounted on roof curbs.
- Design roofing assembly such that roof-mounted HVAC or process equipment need not be removed during replacement of the roofing system.
 - ❖ Provide 110V electrical ground fault interrupter (GFI) outlet and potable water hose bib adjacent to any roof-mounted process or HVAC equipment. See Electrical and Plumbing Design Standards.
 - ❖ New roofs shall be built with infrastructure engineered to accommodate the future installation of solar panels. This includes method of attachment, penetrations for power, cables, proper drainage and cleaning water source.
 - ❖ Design solar panel attachment points so that repairs or alterations to the roof membrane are not required when mounting brackets are installed. It is preferred that solar panel brackets attach to a roof curb or similar permanently installed structure.
 - ❖ Ensure that the structure supporting solar panels does not interfere with roof drainage.
 - ❖ Design the solar panel attachment to withstand expected wind loads. See Section 5.4

4.5.5 Flat Roofs

- Flat roofs must have a minimum 1/2-inch per foot slope.

- ❖ Roof slope shall be achieved through the structural roofing members, not with tapered insulation board. Tapered insulation board shall be used exclusively for cricket installation.
- ❖ Slope to scuppers and conductor heads leading to rainwater leaders. Avoid drains that route rainwater through interior of the building.
- ❖ Provide crickets to sufficiently divert water around curbs and toward drains/scuppers.
- ❖ Standard compression strength of polyisocyanurate insulation is 20 pounds per square foot. Provide additional reinforcing by use of counter battens, additional cover board layers, or use of polyisocyanurate with increased compression strength when roof is near photovoltaic panels or solar water heating panels.

4.5.6 Built-Up Roof (Not Used)

4.5.7 Single-Ply Roof Membrane.

- Single-ply roof membranes should be thermoplastic polyolefin (TPO), mechanically applied or fully-adhered.
- Mechanically applied or fully-adhered single ply EPDM membrane may be specified, but only if specifically requested by the District project manager.
 - ❖ Install using fasteners or adhesives, do not use installation tapes or self-adhering products
 - ❖ Provide a suitable cover board between polyisocyanurate insulation and roofing. Cover board shall be mechanically attached to the structural roof deck.

4.5.8 Shingles

- Asphalt shingles are the District preference for sloped roofs over occupied (office/ industrial/ laboratory/ storage) floor space.
 - ❖ Do not specify residential grade.
 - ❖ Nail according to high wind or hurricane standards.
 - ❖ Asphalt shingles are easily damaged and should be handled, installed and maintained with utmost care.
 - ❖ Specify 40 year warranty.
 - ❖ Use on roofs greater than or equal to 3:12 or what is recommended by manufacturer, whichever is steepest.
 - ❖ Avoid designs that place equipment on sloped roofs. If done, provide maintenance platforms with harness latch points or guardrails at locations requiring routine

maintenance or inspections. This shall be provided so that the worker doing the maintenance or inspection can do so without special safety preparation.

- ❖ Caution: Routine foot traffic will cause damage. Design roofs and access requirements to avoid routine foot traffic.

- Do not specify wood shingles or shakes.

4.5.9 Clay Tile Roof (Limited Application)

- Not for use at the EchoWater Facility.
- This roofing shall not be allowed unless providing repair or renovation work directly associated with existing clay tile roof.
 - ❖ This roofing is featured on existing buildings at the Lower Northwest Interceptor facility locations in the City of Sacramento and in Yolo County.
 - ❖ See Section 4.5.10 Concrete Tile Roof if matching the clay tile is in the scope for new buildings.
- Caution: Foot traffic will cause damage. Design roofs and access requirements accordingly.
- Use high wind resistant (hurricane) type installation regardless of roof size or elevation.

4.5.10 Concrete Tile Roof (Limited Application)

- Not for use at the EchoWater Facility.
- This is the preferred material to match the existing clay tile roof at Lower Northwest Interceptor facility locations.
- Specify tiles with a 50 year warranty.
- The roof structure must be specifically designed to carry significant additional loads compared to other options.
- Avoid designs that place equipment on sloped roofs. If done, provide maintenance platforms with harness latch points or guardrails at locations requiring routine maintenance or inspections. This shall be provided so that the worker doing the maintenance or inspection can do so without special safety preparation.
- Caution: Routine foot traffic will cause damage. Design roofs and access requirements to avoid routine foot traffic.
- On high elevation or large roofs, specify high wind resistant installation.

4.5.11 Standing Seam Metal Roof

- Standing seam metal roofs shall not be used except as canopies or awnings over doorways or windows or as weather protection over equipment.

4.5.12 Metal Siding

- Metal siding has many of the same benefits as standing seam metal roof including corrosion resistant coatings.
- Concealed fasteners are preferred over exposed fasteners because the fastener is concealed behind a sealing flange in the siding section. The fastener is not exposed to the weathering elements as would an exposed fastener.

4.5.13 Canopies

- Where canopies are used to protect equipment, install bird netting from canopy to ground to prevent birds from accessing or nesting on the equipment. Netting to be designed to provide ingress/egress points and to be secured to prevent wind damage.

4.6 Windows, Louvers, and Doors

- Daylighting of building interiors shall be provided wherever feasible. Daylighting may be provided by windows, skylights, clerestories or tubular daylighting devices.
- Where doors and windows are needed, locate to minimize impacts of prevailing winds.

4.6.1 Windows and Louvers

- First floor windows shall be fixed to insure access security. Use operable windows on upper levels. Exceptions to this include;
 - ❖ All floors that require fixed windows to maintain fire rated continuity.
 - ❖ All floors that require fixed windows to maintain proper air flow balance.
 - Evaluate cost benefit of operable window ventilation vs. mechanical ventilation. Consider that operable windows must be globally closed (by automatic or manual means) when temperatures reach above mid-70s (F) for comfort.
 - ❖ Compliance with CBC.
 - ❖ Compliance with specific program requirement.
 - ❖ Interior windows.
- Louvers and Windows
 - ❖ Skylights and clerestory windows should be darkly tinted low-e, frosted, or similarly opaque type of glass. Translucent fiberglass material may be used where glass would create a safety hazard.
 - See Section 4.15 for additional fall protection requirements at skylights.
- Glazing
 - ❖ Shall be insulated and tinted for doors and windows.

- ❖ See CBC for locations requiring safety glass.

4.6.2 Doors

- At exterior out swinging doors on east and west exposures, consider locating hinges on the south jamb. On exterior double doors, locate the active leaf with hinges on the south jamb.
- On all except storefront and restroom windows, provide a 100 square inch view light.
- Standard personnel door size is 3 feet wide by 7 feet tall.
- Where borrowed light or side light is provided, and extraction/installation of equipment larger than personnel door is required, provide removable transom or jamb.
- Storefront
 - ❖ May be used for office or laboratory building entrances.
 - ❖ May be used for interior office partitions.
 - ❖ Not advisable for process areas.
 - ❖ If center mullion is part of a double door assembly, provide removable mullion for forklift access.
- Hollow Metal Doors and Frames
 - ❖ Use insulated hollow metal doors at exterior locations and non-insulated hollow metal doors at interior locations.
 - ❖ May be used at non-corrosive locations of a facility interior and exterior.
 - ❖ Use galvanized steel in moderately corrosive environments; stainless steel may be used in harsh environments.
 - ❖ Grout frames solid at concrete and concrete masonry walls.
 - ❖ Use anchors appropriate for the adjacent wall type.
 - ❖ Fire rated doors and frames shall be listed and labeled.
 - ❖ Exterior single doors shall have concrete landings providing at least 60 inches clear in front of the door, 24 inches clear from the strike side of the jamb, and 12 inches clear from the hinge side of door.
 - ❖ Exterior double doors shall have concrete landings providing at least 60 inches clear in front of the door and 12 inches clear from the jambs.
 - ❖ See CBC for other landing requirements.

- ❖ Unless there is a compelling reason otherwise, exterior doors shall open out.
- FRP Doors and Frames
 - ❖ Shall be used in high corrosive and/or humid environments. Use stainless steel doors as an alternative.
 - Areas of flowing water.
 - Area of gravity belt thickener.
 - Area of bar screen.
 - ❖ See metal doors and frames for other requirements.
- Access Doors
 - ❖ Size doors and locate to provide access to valves or controls within walls or ceilings.
 - ❖ Not needed for access above suspended ceilings.
- Overhead doors
 - ❖ Prefer motorized operation over manual.
 - ❖ Preference for elastomeric sheet type curtain for most non-security type high speed rolling doors.
 - ❖ Care should be taken in selecting a finish as many types are available. Avoid the use of powder coating on stainless steel.
 - ❖ Use coiling door as a default. Sectional doors may be considered for use but consider overhead spatial requirements.
 - ❖ Provide 12-inch clearance on each side and 24 inches above the door head.
- Roof Hatches
 - ❖ Avoid where possible.
 - ❖ Determine hatch size by evaluating the size of what needs access and how it is being extracted or placed.
 - ❖ Check CBC for guard rail placement. Roof hatches within 10 feet of the roof edge require the installation of guard rails or 42-inch high parapets.
 - ❖ Consider placing a parapet upwind of hatch to block wind. Opening hatch into the wind may present a safety issue.

4.6.3 Hardware

- Doors must have the ability to open a minimum of 90 degrees.
- Coordinate with structural on recessed thresholds or recessed entrance mats.
- All doors shall be provided with a means of stopping before hardware or door leaf contacts the adjacent wall or similar feature.
 - ❖ Door stop control shall preferably be accomplished with floor or landing-mounted stops. Other means of door stop control shall be installed where this presents a tripping hazard.
 - ❖ Provide a wall-mounted door stop as an alternative where floor/landing-mounted door stop presents a tripping hazard.
 - ❖ Where door frame is not flush with the swing side wall surface, and floor-mounted door stop would otherwise present a tripping hazard, provide door stop control through closer or other means to prevent contact with corner of rough opening.
 - ❖ Door stops shall be installed at 90-degree open position or 180-degree open position depending on location of adjacent wall or other feature.
 - ❖ Wall-mounted door stops shall have backing in metal stud constructed walls.
 - ❖ Door stops shall not interfere with entry lockset function.
- See CBC for panic hardware requirements.
- Use flush bolts top and bottom on inactive leaf of double door.
- Use cylinder locksets over mortise locksets. Do not specify mortise locksets.
- Use knurling on hardware in areas subjected to wet processes.
- Use brushed stainless steel as default hardware finish.
- Provide removable keyed mullion where forklift traffic is expected through double door needing such hardware.
- C-card reader featured doors shall be equipped with electric strikes. Do not specify electric locks. Coordinate with electronic security system.
- Provide rim devices in lieu of vertical rod type exit devices.
- Locksets on interior doors (ACC/MCC, telephone, electrical, AHU, mechanical rooms, etc.) shall be equipped with passage locksets unless security issues take precedence.
- Exit doors shall be equipped with rim type panic hardware.
- Preferred hardware brands include:
 - ❖ Best Series 90 locksets

- ❖ Von Duprin exit devices
- ❖ LCN closers.

4.7 Finishes

- Non-bearing metal studs.
 - ❖ Provide for deflection at top of wall.
 - ❖ Adequately detail backing. Backing in framed walls shall be engineered by the Architect to adequately support the wall hung loads. Use a minimum 16-gauge steel unless engineering or CBC requires thicker gauge.
 - Restrooms
 - Kitchens
 - Test Stations
 - Laboratories
 - Cabinets
 - Shelves
 - Monitors
 - Mirrors
 - Test equipment
 - Hand rails
 - Towel bars
 - Grab bars
 - Fire extinguisher cabinets
 - Bulletin Boards
 - Marker Boards
 - Benches

- ❖ Provide adequate space in wall cavity for plumbing, supports and carriers, especially for wall-hung toilets. If wall-hung toilets or lavatories are specified, ensure that the appropriate wall backing support is provided.
- ❖ Use metal studs (20-gauge steel / 0.0329 inch thickness) at minimum 16-inch on centers as a default. Provide thicker gauges and/or spaced more closely apart as required by CBC or engineering [the ASTM certified third party testing statement for equivalent thicknesses shall not apply].
- Gypsum Board
 - ❖ Use the latest edition of Gypsum Association GA-600 when detailing fire rated or sound control wall assemblies.
 - ❖ See CBC for fire rated wall labeling on gypsum board.
 - ❖ Use mold resistant gypsum products where moisture or humidity is known to be an issue.
 - ❖ Use cement backer board for ceramic tile.
 - ❖ See special framing requirements in the CBC for hard ceilings over showers.
 - ❖ “Gypsum sheathing” as opposed to “gypsum wallboard” shall be used on exterior gypsum board applications.
 - ❖ Spaces above hard ceiling where there is a temperature difference (such as attics) need ventilation as prescribed in the CBC.
- Suspended Ceiling
 - ❖ Ventilation is not needed.
 - ❖ Provide seismic restraints.
- Carpet
 - ❖ For office use only.
 - ❖ Carpet tiles are preferred.
- Ceramic Tile
 - ❖ Detail from the North American Tile Council standards.
 - ❖ Use cement backer board.
 - ❖ Coordinate with structural for recessed drainage.

- Sheet Flooring
 - ❖ Always specify and install under-slab vapor barrier below concrete slab and have concrete slab tested for moisture prior to installing sheet flooring over concrete.
 - ❖ Before specifying flooring product, determine chemical resistance needed.
- Epoxy Flooring
 - ❖ Always specify and install under-slab vapor barrier below concrete slab and have concrete slab tested for moisture prior to installing epoxy flooring over concrete.
 - ❖ Before specifying flooring product, determine chemical resistance needed.
 - ❖ In laboratories and test facilities, cove up walls 4 inches to 6 inches.
 - ❖ Where interior concrete stemwalls are used, install coving to cover up exposed concrete.
- Paint
 - ❖ See the District Guide Specifications for appropriate industrial coatings.

4.8 Specialties

- Fire Extinguishers
 - ❖ Provide according to CFC and NFPA 10.
 - ❖ Consult fire department to confirm number and location.
 - ❖ Confirm type and volume of each fire extinguisher with the fire department. If the fire department is not available, provide a reasonable allowance for fire extinguisher selection after bid is awarded.
 - ❖ Bracket-mounted fire extinguishers are preferred. Fire extinguisher cabinets are preferred in laboratories and administrative office spaces.
- Signage
 - ❖ Install exterior building signs for new building displaying the name and building number according to the context of other existing buildings.
 - ❖ Provide CBC Chapter 11b compliant signage labeling for each room and egress in locations not designated as a process area. See CBC and Board of Directors letter dated November 23, 1993.
 - ❖ Provide illuminated exit signage per CBC. Coordinate with electrical engineer.

4.9 Special Construction

4.9.1 Pre-Engineered Metal Buildings (PMB)

- Detail where the limits of the PMB transitions to the foundation or adjacent permanent or existing building.
- Consider 4'-0" high cast-in-place concrete or concrete masonry wainscot as an impact resistant surface.
- Take care to establish dimension points and maintain them. Metal framing tends to not have a uniform dimension.
- Select manufacturer recommended coatings consistent with specific corrosion risk factors.

4.9.2 Elevators

- Coordinate elevator design and installation with electrical, mechanical and structural engineers.
- See CBC for ventilation and shaft fire resistance requirements.
- See the latest adopted version of ASME 17.1 and Chapter 30 CBC for fire pit requirements, emergency requirements, and other design requirements.
- Check CBC for gurney requirements.

4.9.3 Monorails and Cranes

- Coordinate design and installation with mechanical, structural and electrical engineers.
- Select according to weight lift, lifting height, rig height and travel distance needed. Rig height should be assumed to be one-half the width of the lifted load.

4.10 Personal Protection Gear

- In areas deemed by the District safety officer exceeding acceptable risk levels, a personal protection gear station shall be provided.
 - ❖ Contents may include:
 - Safety glasses
 - Ear plugs or headsets
 - First aid kit
 - Spill kit
 - Gloves
 - Face shield

- At locations next to a sink with potable water, include also a blood-borne pathogen clean up kit.
- Emergency Eyewash and Showers
 - ❖ In exterior locations, eyewash stations and showers shall include insulated piping, freeze and scald valves, with an upstream strainer and a line to a drain.
 - ❖ Place in a location free of barriers en-route from hazard. Such barriers to a distressed individual may include a door, stairway, or rounding corners. Access routing to emergency eye wash and shower must be along a straight path.
 - ❖ Place emergency eye wash and shower not more than a 10-second walk from hazard.
 - ❖ Where substances that are a known risk to human health are stored or distributed, provide an emergency eye wash and shower with drainage featuring primed traps. Refer to Section 6.17 in the mechanical design guidelines for additional information regarding chemical handling, delivery, and storage.
 - ❖ Consider placing interior and exterior emergency showers and eye washes at a single risk location when fumes or hazardous vapors are an issue.

4.11 Maintenance Access

Rooms and enclosures for equipment shall be designed to provide clearance equal to the largest maintenance part plus 12 inches or 30 inches minimum, whichever is larger, where servicing of equipment is required. This shall not be construed as an adequate egress width which is dictated in the CBC. See Cal OSHA for additional servicing clearances.

- Access widths
 - ❖ Maintenance walkways shall be a minimum of 6 feet wide.
 - ❖ Forklift access ways shall be a minimum of 8 feet wide.
 - ❖ Mobile crane access shall be a minimum of 12 feet wide.
- Forklift Access
 - ❖ Where lifting of objects greater than 50 pounds is required, provide forklift access unless other lifting methods such as a crane or monorail are provided.
- Elevated Locations
 - ❖ Where maintenance may be required on elevated process, HVAC, or plumbing provide tie off points. See Section 4.15 for fall protection requirements.

4.12 Sound Control

- Meet Cal OSHA standards for designing based on maximum exposure limitations. Sounds may not be more than 80 dBA 3 feet from operating equipment.
- Equipment producing 85 dBA or higher noise shall be placed in enclosures that will reduce noise to 70 dBA outside of enclosure.
- Acoustical insulation shall be provided in noise-sensitive locations such as offices and control rooms.
- Engineered sound control shall employ the expertise of a competent acoustic engineer licensed in the State of California.
 - ❖ Acoustic engineer shall provide recommendations for mitigating sound problems in a design.
 - ❖ Acoustic engineer shall provide commissioning testing to verify effectiveness of design.
- Architect shall design wall, floor and ceiling assemblies in accordance with tested assemblies having certified sound transmission ratings (STCs) such as identified in the Gypsum Association GA-600 manual.

4.13 Multiple Conduits

- Buildings with a high concentration of conduit must be designed to minimize attachment issues and accommodate future conduit additions.
- Coordinate with electrical engineer.

4.14 Floors

- Provide non-slip floor surfaces in areas prone to wet conditions.
- Finish elevation of ground level concrete floor slabs shall be above grade to minimize hazard of flooding and ensure drainage away from building.

4.15 Fall Protection

Designs are to provide permanently installed features for various applications that comply with the requirements of the CBC and Cal/OSHA for safe access. Assume all roofs and elevated maintenance platforms will have ongoing access requirements.

- Designs requiring a person to provide more than a harness and lanyard or a portable ladder tie off for safe access are not acceptable. Provide 42-inch minimum parapets or permanently installed guardrails, harness latch points, tie-offs, or similar safety features
- Flat roofs without parapets or handrails at openings or edges shall have a 4-inch-wide safety yellow line applied 6 feet from the edge or opening in addition to lanyards and harness anchors or similar permanently installed safety systems.

- Maintenance platforms on steep roofs shall be accessible by permanently installed ladders and walkways.
- All hatches and skylights are considered roof openings and shall be protected with a 42-inch railing or parapet. The opening side of the hatch shall have a chain or other OSHA compliant barrier to prevent falls through an open hatch.
- Fall protection devices shall be directly attached to the building structural elements. 316 stainless steel is the preferred material for harness latches, tie-offs, and similar devices.
- Fall protection harness anchors and or ladder tie-offs shall be installed on both sides of roll-up doors. Position for safe working access to the shaft and operating mechanism.
- Ladder tie-offs shall be installed at locations intended to be accessed using portable ladders and on roofs that require access by portable ladder.
- Install tie off and harness anchors in the ceiling or pipe support structure along any run of piping with an elevation greater than of more than 6' above floor level. Fall protection harness anchors and/or ladder tie-offs shall be installed on both sides of roll-up doors. Position for safe working access to the shaft and operating mechanism.
- Install harness attachment points for fall protection equipment in areas having elevated equipment.

4.16 Roof Access

- All flat roofs shall be accessible via ladders or stairs.
- Metal canopies over equipment do not require roof access.
- Hatches are the least acceptable method of roof access for equipment maintenance. Stairs or exterior ladders are preferred.
- Provide manual hoists adjacent to ladders or hatches where filters or maintenance parts will need to be transported to and from the roof.
- If there is roof mounted equipment, provide a location where a forklift can be positioned to lift supplies to roof level.

4.17 Railing

- Consult CBC and Cal/OSHA for guardrail and handrail design.
- Guardrails and toe guards shall be configured and installed in accordance with the CBC.
- Preferred metal guardrails shall be painted galvanized steel. Match existing rail material where renovations or additions demand continuity with existing conditions.
- Industrial guardrails may have horizontal intermediate rails.
- Guardrails in public or employee areas shall have vertical balustrades.

- Handrails shall never double as guardrails on a stairway except on equipment platforms where Cal/OSHA regulations can exclusively be justified.
- Handrails shall be mounted alongside the guardrail and not integrated as part of a guardrail.
- Design backing for wall mounted handrails at metal stud framed construction.

4.18 Plumbing Fixtures

- Number and scope of plumbing fixtures shall be determined by California Plumbing Code Table 4 as a minimum except for drinking fountains.
- Do not install drinking fountains. In lieu of drinking fountains, provide floor space and power for regularly serviced and supplied drinking water dispensers with the same distribution as drinking fountains in Table 4 of the CPC.

4.19 Emergency Lighting

- Refer to Section 9.13 of the electrical design guidelines in Chapter 9.

4.20 Vehicle/Bicycle Parking

- Refer to Section 3.9 of the civil design guidelines in Chapter 3.

5.0 Structural Design

This chapter describes the structural design guidelines that will be used for design of structures, both building and non-building structures, within the District, including applicable codes and standards, design load criteria, and materials of construction.

5.1 Codes and Standards

The project shall be designed to comply with applicable portions of the codes and standards listed in Table 5-1 below and as described in this chapter. Designer is to use the most current County-adopted code edition as posted to www.building.saccounty.net/pages/buildingcodes.aspx up to submission of the Final Preliminary Design Report (PDR); the Designer is not responsible for any newer editions beyond Final PDR.

Table 5-1. Codes and Standards for Structural Design

Reference	Title
ACI 318	Building Code Requirements for Structural Concrete and Commentary
ACI 350	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI 350.1	Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary
ACI 350.3	Seismic Design of Liquid-Containing Concrete Structures and Commentary
ACI 350.4	Design Considerations for Environmental Engineering Concrete Structures
ACI 530	Building Code Requirements for Masonry Structures
AISC 341	Seismic Provisions for Structural Steel Buildings
AISC 360	Specification for Structural Steel Buildings
AISC Manual of Steel Construction	
ASCE 7	Minimum Design Loads for Buildings and Other Structures
Aluminum Association - Aluminum Design Manual	
AASHTO	American Association of State Highway and Transportation Officials - Standard Specifications for Highway Bridges
CMAA	Crane Manufacturers Association of America - Specifications No. 70 and 74 for Cranes
AWS D1.1	American Welding Society - Structural Welding Code
AWS D1.2	American Welding Society - Structural Welding Code - Aluminum
AWS D1.4	American Welding Society - Structural Welding Code – Reinforcing Steel
AWS D1.6	American Welding Society – Structural Welding Code – Stainless Steel
CBC	California Building Code, with local amendments
OSHA	Code of Federal Regulations, 24 CFR Part 1910, Occupational Safety and Health Administration Standards, with local amendments
All applicable state and local codes	

5.2 General Service Loads

5.2.1 Dead Loads

Dead loads will consist of the weight of the structure and all equipment of a permanent or semi-permanent nature including but not limited to pumps, cranes, and HVAC equipment. A superimposed dead load of 20 pounds per square foot (psf) shall be included in the design of floors and roof structures to account for HVAC ductwork, piping, electrical wiring and lighting, and interior partitions; this superimposed dead load may not be used to resist uplift forces due to wind or seismic loads.

Minimum live loads shall be as stated in the CBC, except as stated in Table 5-2 below:

Table 5-2. Minimum Live Loads by Location

Location	Live Load
Process Areas	Equipment + 50 psf or 200 psf minimum or maximum fork lift wheel loads, whichever governs
Mechanical Rooms	150 psf and 2,000 pounds concentrated load
Electrical/Control Rooms	300 psf
Storage Areas	250 psf
Corridors, lobbies, stairways	100 psf
Catwalks, platforms for access only	100 psf
Slab-on-grade (vehicle area)	250 psf
Deck-at-grade (vehicle area)	HS-20 loading or applicable crane/vehicle loading
Building Roof	20 psf + Equipment Load or 40 psf, whichever governs
Tank roof or walkway (for maintenance)	40 psf
Grating, checkered plate, and hatches	Same as adjacent area

5.2.2 Crane and Monorail Loads:

Design of crane girders or runway beams, monorail beam and supports will be in accordance with CMAA Specifications No. 70 & 74, and AISC Manual of Steel Construction.

5.2.2.1 Lift operation:

- Impact for crane: 25 percent of lift load and trolley/bridge weight
- Impact for monorail: 50 percent of lift load and trolley/bridge weight.
- Lateral force: 20 percent of lift load and trolley/bridge weight.
- Longitudinal force: 10 percent of lift load and trolley/bridge weight.

5.2.2.2 Limitation on deflection:

- Maximum crane girder (not including impact load): $L/1000$
- Maximum monorail beam (not including impact): $L/1000$
- Maximum crane girder or monorail beam horizontal deflection (not including impact): $L/400$

- Where L = span length
- Centrifugal force and torsion shall be considered on curve track.

5.2.3 Heavy Equipment Loads

In areas subject to heavy equipment traffic, the structures shall be capable of supporting existing and planned vehicle loads such as forklifts, maintenance vehicles, mobile cranes, etc. Consideration shall be given for moving, stationary, and operational loads (such as crane setup to lift equipment loads), including expected Contractor's equipment to be used during construction.

All equipment gallery floors, ground level floors with large access doors shall be designed for forklift loads or any anticipated maintenance vehicle loads.

The design engineer shall coordinate with the EchoWater Facility Mechanical Maintenance group to obtain information regarding typical vehicle and crane uses at the EchoWater Facility.

5.2.4 Differential Settlement Loads

For backfilled foundations, the structure shall be checked for a minimum $\frac{1}{4}$ -inch differential settlement over 20 feet, or as recommended by the geotechnical engineer.

5.2.5 Mechanical Vibration Control

The structural framing for supporting machine vibrations shall be designed at least having 50 percent offset of critical dynamic response of the disturbing force.

5.3 Seismic Loads

Seismic loads and design requirements shall conform to the latest editions of the CBC and the ASCE 7 adopted by the Co

- The EchoWater Facility's Seismic Design Category = D, per CBC Section 1613.5.6.
- The EchoWater Facility is in Occupancy Category III.
- Seismic Importance Factor (I_e) = 1.25
- Seismic loads due to earth pressure shall be specified in the project specific geotechnical report.
- Hydrodynamic forces consisting of an impulsive force and a convective force, each acting at their respective heights, shall be included in the design of liquid-containing structure walls. Seismic design of liquid-containing concrete structures shall be in accordance with ACI 350.3.

5.4 Wind Loads

Wind loads and design requirements shall conform to the CBC.

- The EchoWater Facility is considered an Occupancy Category III.
- The EchoWater Facility is located in basic wind speed zone of 100 mph per ASCE7-16.
- The EchoWater Facility is located in exposure C category.
- The EchoWater Facility Topographic Factor (K_{zt}) = 1.0.

5.5 Soil Information

A Geotechnical Interpretation Report (GIR) shall be prepared for the project. The GIR shall address all of the information needed for compliance with codes, structural design, buried piping, roads, walkways, and other design elements. The GIR shall emphasize specific construction concerns and concerns regarding the integrity of sewers, pavement and structures. The Consultant shall be responsible for establishing the actual scope of work for the GIR. Recommendations for use in design shall include:

- Allowable soil bearing pressures – Dead Loads, Dead Loads + Live Loads, Dead Loads + Live Loads + short duration loads such as Wind and Earthquakes.
- Settlement potential, including total and differential settlement estimates. Differential settlement shall be given for a specific distance.
- Allowable lateral earth pressures – Active, at-rest, passive. Include lateral pressures for saturated conditions.
- Surcharge loading – Construction, traffic.
- Friction factors – Soil to concrete base, soil to concrete wall.
- Seismic earth pressures and parameters.
- Potential geologic and seismic hazards such as ground shaking, liquefaction potential, and differential settlement due to seismic shaking.
- Groundwater table elevation. If groundwater table is expected to be high, a pumping test shall be required to determine dewatering parameters for inclusion in the specifications.
- Buried structures shall be checked for adequacy for buoyant forces. Minimum safety factor against buoyancy shall be 1.5 for normal ground water elevation, and 1.1 for flooding water elevation.
- Describe and categorize soil types and soil excavation, identify location of hard and stiff soils, evaluate on-site soil backfill suitability, provide backfill compaction criteria and pipe bedding requirements, provide trench shoring requirements.
- Address in detail the excavation impact of the proposed work on all existing utility trenches in the vicinity of the proposed project. Evaluate the potential collapse of the earth prism located between existing parallel utilities and the trench excavated for any proposed utility installation.

- Evaluate soil contamination and identify potential for off-site disposal requirements and locations.

5.6 Liquid Loads

A unit weight of 65 pounds per cubic foot (pcf) will be used for the design of structural elements in contact with liquid. The maximum operating fluid level will be used for the static load case.

Environmental durability factors in accordance with ACI 350 for the appropriate environmental exposure will be applied to fluid loads for the static load case. In addition to the static load case, maximum fluid level to the top of an open containment or to the maximum level possible due to overflow will be used for the overflow case. Environmental durability factors will not be applied to the overflow loading condition.

5.7 Load Combinations

The above loads will be combined in accordance with Section 1605 of the CBC for non-liquid containing structures. For liquid containing structures, the above loads will be combined in accordance with ACI 350, Section 9.2.1. An environmental durability factor will be applied to load combinations for liquid containing structures as required by Section 9.2.6 of ACI 350.

The design should account for at least two basic soil loading conditions. The first condition to account for is when the tank is empty and the hydrostatic load is not available to counteract the soil pressures. The second condition to account for is when the tank is full to the normal operating level and there is no soil backfill to counteract the hydrostatic pressures.

Vehicular access will be provided to the top of any basin that exceeds 100 feet in any principal direction for removal and maintenance of equipment.

5.8 Structural Systems

Structures should be designed with appropriate and adequate vertical and lateral load resisting systems. A description of the structural lateral load resisting systems shall be provided in the structural calculations and on the drawings.

5.9 Materials - General

General specifications for construction materials shall be as specified in the applicable project technical specifications.

The following is a list of guidelines to be used with the specific materials.

5.9.1 Concrete

For large projects utilizing large quantities of concrete the source of material and potential for material shortages shall be investigated during the design phase for implementing an uninterrupted material procurement plan.

All construction and expansion joints shall be shown on the contract drawings. Construction joints shall be placed at points of least shear in suspended slabs and beams. The distance between construction joints shall not exceed 30 feet in walls and 40 feet in slabs.

All construction and expansion joints in liquid-containing structures shall be provided with waterstops.

Minimum shrinkage reinforcing will be based on ACI 350 and the grade of reinforcing steel used. Contraction joints will not be considered as a “movement joint”. Only full expansion joints will be considered as a “movement joint” to reduce the minimum shrinkage and temperature reinforcement.

Appropriate environmental exposures in accordance with ACI 350 will be used to determine the maximum allowable stresses of the flexural reinforcement.

On liquid containing concrete structures rounded fillets shall be provided at wall to floor joints to prevent debris accumulation.

Reinforcing steel shall conform to ASTM A615 or ASTM A706, Grade 60.

Liquid-containing concrete structures shall be designed to conform to ACI 350. Special attention shall be taken with the performance specifications for concrete for obtaining durable, low shrinkage, concrete mix designs. Water curing should be specified for minimum shrinkage.

For concrete at containment tanks and basins, furnish concrete suitable for the following exposure categories based on ACI 318:

- Permeability: P1 (Low Permeability Required)
- Corrosion Protection: C2 (Severe) at slabs rated for vehicular traffic and tanks containing chlorides. C1 (Moderate) at all other areas.

Concrete structures that are protected with a lining system shall have seams located at least 12 inches away from 90-degree corners.

5.9.2 Masonry

Reinforced masonry shall be designed in accordance with Chapter 21 of the CBC and ACI 530.

Masonry structures shall be designed using a specified compressive strength (f'_m) of 1,500 psi. Higher compressive strengths require more expensive prism testing and more comprehensive special inspection program.

All reinforced masonry construction requires special inspection.

5.9.3 Structural Steel

All structural steel members and connections shall be designed and detailed in accordance with AISC Specification for Building Structures. The design of structural connections shall not be left to the detailed shop drawings.

All structural steel connections shall be made with high strength bolts conforming to ASTM A325 Type N, bearing type connections with threads excluded from the shear plane, unless otherwise required by the design. The use of machine bolts shall be limited to non-structural applications.

All steel welding qualification and workmanship shall be in accordance with AWS.

Wide Flange shapes shall conform to ASTM A992, Grade 50.

Hollow Structural Sections (HSS) shall conform to ASTM A500, Grade B.

Structural Steel Pipe shall conform to ASTM A53, Grade B.

5.9.4 Stainless Steel

Type 304 or 316 stainless steel bars, shapes, plates, fasteners, and anchor bolts shall be considered for use in corrosive or submerged areas for long life and low maintenance. Type 316 stainless steel is a Molybdenum containing grade which is more resistant to localized corrosion and is preferred for more aggressive conditions, or for greater assurance against unusual conditions. For MCCs the use of Type 304 stainless steel anchor bolts could be appropriate. In all cases, a business case evaluation (BCE) should determine material type.

Type 304L or 316L stainless steel shall be used for welded construction; these low carbon grades are resistant to intergranular corrosion after welding without further heat treatment.

5.9.5 Aluminum

Aluminum shall not be used without specific approval by the District.

Aluminum shall be selectively used for miscellaneous structural support systems, walkway grating and diamond plate, handrailing and guardrailing, and cover plates to reduce odors. Severe corrosion conditions shall be considered before specifying aluminum.

Aluminum alloy for structural shapes, bars, plates, and sheets shall be 6061-T6.

Bolts and fasteners for aluminum fabrication shall be Type 316 or Type 304 stainless steel.

5.9.6 Fiberglass Reinforced Plastic

FRP or reinforced thermoset polyester (RTP) shall not be used without specific approval by the District.

FRP or RTP shall be selectively used for grating, guardrail, and cover plates in corrosive areas, explosive environments, or electrical areas.

A responsible party specializing in fiberglass design shall design FRP or RTP structural elements.

FRP and RTP products shall be manufactured using pultruded process utilizing either flame retardant isotropic polyester or a flame-retardant vinyl ester resin containing an ultra-violet (UV) inhibitor.

5.9.7 Wood

Unless otherwise approved due to nature of the project, the use of wood construction in permanent structures shall be limited to nonstructural applications such as nailers, cabinetry, etc.

5.9.8 Metal Framing (Strut Type) Inserts

Metal framing (strut type) inserts used for support of equipment and appurtenances shall be embedded at 5 feet on center vertically in all concrete walls and horizontally in concrete ceilings.

Metal framing (strut type) inserts shall be embedded at the stem bottom of precast “T” beams.

Reinforcing steel in concrete structures shall be placed at least 1.5 inches from the embedded face of the metal framing strut.

5.9.9 Seismic Bracing

Seismic bracing shall be included in the Contract Documents for pipes larger than 18 inches, HVAC, electrical conduits, and light fixtures. The design of pipe supports and racks shall be in accordance with the latest edition of ASCE 7.

Seismic bracing for pipes larger than 18 inches, non-standard bracing systems for critical equipment, or where the location of the seismic bracing is critical, the contract documents shall identify the location.

5.10 Design Loads on Drawings

In order to furnish information for future use, all live loads used in the design of a structure shall be listed under the general notes on the standard structural drawings.

For loadings that do not comply with the general notes, loading information shall be shown and noted on the plan of the area being designed for the special loads.

5.11 Serviceability

Structural systems and members shall be designed to have adequate stiffness to limit deflection and lateral drift. The deflection of structural members over span L, shall not exceed that permitted by the following table.

Element	Deflection
Steel Floor Plates and Gratings	L/240 Live Load
Beams, Lintels, or Slabs Supporting Masonry	L/720 (3/8 inch maximum for lintels above windows) total load
Roof without Ceilings	L/240 Live Load, L/180 Total Load
Roof with Ceilings	L/360 Live Load, L/240 Total Load
For metal roof decks without buildup roofing or ceilings	L/180LiveLoad
Floors	L/360LiveLoad,L/240TotalLoad
Steel	Refer to AISC360.
Concrete	Refer to ACI318 and ACI350.

5.12 Special Inspection

Designers shall specify on the structural drawings where special inspections per the CBC are required.

At the EchoWater Facility, special inspection will typically be required for foundation subgrade preparation, deep foundation systems, reinforcing steel placement for concrete structures, concrete placement, structural steel welding, structural steel connections, reinforced masonry, and post-installed anchor bolts.

Where special inspections are required, the Designer shall develop a procedure for the special inspector to follow. The procedure shall include a narrative description of duties, forms, checklists, and any other measures to verify compliance with special inspection requirements. These procedures shall be discussed with the Construction Manager prior to construction.

5.13 Electrical Transformer Structure Design

A standard electrical detail showing the general configuration of a typical oil filled transformer floor mounting has been developed by the EchoWater Facility. Below are some specific items to address in the structural drawings.

- Transformers shall be surrounded by a containment area sized, as a minimum, for the volume of oil from a single transformer plus the precipitation from a 25 year storm event. This required volume is in addition to the volume displaced by river rock placed in the containment area. For the EchoWater Facility, the precipitation from a 25 year storm event shall be taken as 3.5-inches of rain.
- A concrete blast wall between the dual transformers shall be at least 10-inch thick with two curtains of reinforcing steel. Height of wall shall be at least as high as transformers.

6.0 Mechanical Process Design

The following are the design guidelines to be utilized in conjunction with the mechanical process design.

6.1 Codes and Standards

The project shall be designed to comply with applicable portions of the following codes and standards in Table 6-1 below and as described in this chapter. Designer is to use the most current County-adopted code edition as posted to www.building.saccounty.net/pages/buildingcodes.aspx up to submission of the Final Preliminary Design Report (PDR); the Designer is not responsible for any newer editions beyond Final PDR.

Table 6-1. Codes and Standards for Mechanical Process Design

ABMA	American Bearing Manufacturer's Association Standards
AGMA	American Gear Manufacturer's Association Standards
ASHRAE 90A	American Society of Heating, Refrigeration and Air Conditioning Engineers, Energy Conservation in New Building Design
ASME B&PV	American Society of Mechanical Engineers Boiler and Pressure Vessel Code
ASTM	American Society for Testing and Materials Standards
HI	Hydraulic Institute Standards
OSHPD	California Office of Statewide Health Planning and Development
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code

6.2 Mechanical Design Intent

Provide a description of each mechanical system in the Preliminary Design Report, including major components, criticality value from the District's Availability of Critical Equipment (ACE) Table (see Section 6.15), sequence of operation, remote and local control modes of operation for use by the control system design. Motors shall be supplied by the equipment manufacturer. 480V, 3Ø Electrical starters shall be located in electrical equipment rooms. Single-phase motor starters and controllers shall be located near the driven equipment, Coordinate mechanical drive requirements with the electrical design.

6.3 Mechanical Design Calculations

Provide mechanical calculations, pump and fan performance curves, and a range of operating points for all equipment and systems. The system curves should provide operations zones for various operation modes, such as winter and summer modes; cycle modes, and slow/fast modes if applicable.

For units that have fast and slow speed operations, units should be properly sized such that slow speed is utilized a majority of runtime hours at highest efficiency.

For units that have temperature requirements, temperature assumptions and respective operational mode described (i.e. heat exchanger pumping)

For systems that cycle between multiple units the cycle times should be optimized for various modes (i.e. wet and dry modes, flushing modes)

For units controlled by variable frequency drives (VFDs) and larger than 100hp or system with multiple units greater than 25 hp provide system performance curves that plot the variable frequency curves against the system curves; various parameters; and operating modes. A typically graph layout should have head on the y-axis, flow on the x-axis with selected parameter (hydraulic efficiency, BHP, system head) plotted along various frequency curves (i.e. 20hz, 30hz, 40hz, 50hz, 60hz). Various operational ranges (i.e., dry, wet, low and high temperature) appropriate to system type should be superimposed onto the graphs along with the system curve.

Specific design deliverable requirements are described in the District Design Contract Requirements.

6.4 Mechanical Equipment

Where required, equipment shall be reviewed for reliability, performance, and maintainability.

Equipment selection shall be made using the latest version of the District's template for the preparation of an Equipment Business Case Evaluation (BCE) and the requirements for Reliability Centered Design (RCD).

6.4.1 Equipment Clearance and Removal

Provide more than adequate clearance for service or removal of equipment while adjacent equipment is in operation. Coordinate with structural design the location of hatches, removable partitions, landing areas, roll up doors, and bridge cranes to facilitate major equipment removal and loading for transportation. The District places a high emphasis on the maintainability of its mechanical systems.

6.4.2 Steam Equipment

For equipment utilizing steam, such as steam-to-hot water heat exchangers, the design working pressure shall be at least 175 pounds per square inch (psi) saturated steam pressure.

6.4.3 Gauges

Gauges are required for the operator to monitor equipment performance during rounds. Provide gauges on equipment for local readout at a minimum in the following locations:

- Pump suction (as appropriate) and discharge lines shall be provided with local pressure gauges for maintenance.
- Pump flush water systems shall be provided with local gauges: pressure gauges and rotameters. Provide PVC or poly tubing after the wye strainer for flushing of water lines

(Galvanized pipe grows tubercles, causing clogs and/or break away that damages the mechanical seals).

- Lines with increased risk of plugging (thickened sludge, grit, etc.) shall be provided with local pressure gauges where plugs are likely to occur (near valves, elbows and horizontal legs).
- Consider locating piping taps (w/ plugs) at intervals along problematic lines so gauges can be easily installed later to assist in locating plugs.
- Gauges on lines containing wastewater, sludge, or chemicals shall be isolated with diaphragm or annular seals.
- During design, District operations staff shall be engaged to verify what local gauges are required for the specific system being designed.

6.4.4 Recommended Equipment Types:

The District recommends specific types of equipment as a starting point for design based on previous equipment experiences. Table 6-2 lists the type of equipment recommended by the District for various services:

Table 6-2. Types of Process Mechanical Equipment

Service	Type of Equipment
Circulating Sludge	Chopper Pump, Vaughan or Wemco
Condensate (Steam)	Pumping Traps.
CWS Primary Pumps (large)	Double Suction Centrifugal Pumps.
CWS Secondary Pumps (large)	End Suction Centrifugal Pumps.
CWS Secondary Pumps (small)	In-line Centrifugal Pumps
Digested Sludge at Processing Digesters	Progressive Cavity Pumps
Digested Sludge at Blending Digesters	Progressive Cavity Pumps
Effluent	Non-clog Centrifugal Pumps.
Grinders	Spherical Rotor Grinder.
Grit	Recessed Impeller Pump. Wemco Model C or Twin Pump.
HRS Primary Pumps (large)	Double Suction Centrifugal Pumps.
HRS Secondary Pumps (large)	End Suction Centrifugal Pumps. (Motor max Speed 1800 RPM)
HRS Secondary Pumps (small)	In-line Centrifugal Pumps
Influent	Non-clog Centrifugal Pumps.
Mixed Sludge	Chopper Pump, Vaughan or Wemco
Pumped Drainage	Submersible Pump (1 st choice) Self-priming Centrifugal Pump (2 nd choice)
Primary Scum	Progressive Cavity Pumps
Primary Sludge	Progressive Cavity Pumps
Thickened Waste Activated Sludge	Progressive Cavity Pumps
Thickened Waste Activated Sludge Float	Rotary Lobe Pump

6.5 Hydraulics

Specific hydraulic design criteria, standards, and guidelines are summarized in this section.

6.5.1 Design Flow

Pressure pipe and pumping systems should be designed for the following flow conditions:

1. Peak flow at the design year;
2. Most common flow for the particular system. A variety of flow analysis and system control may be required to ensure proper selection that optimizes energy usage. Examples include:
 - Average annual flow and mid-point between initial operating year and design year
 - Diurnal flow patterns based on time of day.
 - Winter flow patterns vs. summer flow patterns;
 - For systems that cycle between multiple units the cycle times should be optimized for various modes (i.e. wet and dry modes, flushing modes)
3. Minimum flow at initial operating year.

6.5.2 Design of Pressure Piping

Because pump system curves are largely dependent on the piping system layout, design guidelines for piping systems are presented. Criteria for the design of piping systems include various velocity considerations, major losses, minor losses, surge issues, and piping characteristics. Each is discussed below.

6.5.2.1 Velocity

At the design peak flow, with all pumps except the standby pump(s), the maximum velocity in pressure lines should not exceed 8 ft/sec. Some exceptions are possible for discharge lines shorter than 10 feet or pipes with diameters greater than 36 inches. Minimum velocity in the solids bearing fluid at minimum flow shall not be less than 2 ft/sec or 3.5 ft/sec depending on continuous versus intermittent pumping operations. Where grit is present, adjust velocity sufficient to maintain solids in suspension. Additional velocity design criteria can be found in the ASCE Journal of Hydraulic Engineering (April 2003) for the velocity required to keep sand moving up slopes in inverted siphons.

For solids bearing fluid, vertical discharge piping on pumps with VFDs should be sized to maintain minimum design velocities during a programmed initial flushing period. VFDs should be designed and programmed to provide a flushing velocity in the pressure line of at least 3.5 ft/sec at the beginning of each pumping cycle. After an initial flushing of the maximum practical duration, depending on the wet well volume, the pumping velocity may be reduced. Velocities should not be allowed to fall below 2 ft/sec.

Average pipe velocities in wastewater and water piping should generally be limited to less than 5 feet per second (fps), except in piping over 16 inches in diameter, where average velocity can be increased up to 6 fps.

Maximum velocities in aeration air and gas piping should be appropriate for the diameter of the pipe. Generally, maximum velocities should be in the ranges listed in Table 6-3 below:

Table 6-3. Range of Air Velocity by Pipe Diameter

Air Pipe Diameter	Velocity, fpm
4 inches to 10 inches	1,800 to 3,000
12 inches to 24 inches	2,700 to 4,000
30 inches to 60 inches	3,800 to 6,500

6.5.2.2 Hydraulic Major Losses

For sizing pipe and determining the head loss, the Darcy–Weisbach equation should be used in lieu of the Hazen-Williams equation because of the greater accuracy associated with Darcy–Weisbach when applied to the size ranges of pipes used by the District. Table 6-4 contains value of specific roughness that should be used. In developing a system curve for pump selection, both the high roughness and low roughness values should be evaluated to verify that the system can operate at all intermediate conditions between two scenarios.

Table 6-4. Value of Specific Roughness for Common Pipe Materials

Pipe Material	Pipe Class	High Roughness, ft	Low Roughness, ft	Typical Roughness, ft
DIP	Mortar-lined Class 53	0.001083	0.000417	0.000917
HDPE	DR 32.5-7.3	0.000667	0	0.0005
Concrete	AWWA 303 Cylinder Pipe	0.001083	0.000417	0.000917
PVC	Sched. 40 and 80	0.000667	0	0.000208
Commercial Steel	Sched. 10-160	0.0003	0.0001	0.00015
Cement Mortar	Centrifugally Spun	0.00108	0.000417	0.000917
Cement Mortar	Troweled in Place	0.00167	0.00067	0.00117

Note: Adapted from Pumping Station Design Manual; Garr Jones et al, 2008

6.5.2.3 Hydraulic Minor Losses

Table 6-5 contains values for minor loss coefficients that should be used. Particularly for short piping systems, both the high minor loss and low minor loss values should be carefully evaluated to verify that the system can operate at all intermediate conditions between two scenarios.

Table 6-5. Value of Minor Loss Coefficients for Common Fittings and Valves

Type of Minor Loss	High Loss	Low Loss	Typical Loss
90 Elbow, standard	0.4	0.1	0.25
90 Elbow, long radius	0.4	0.1	0.18
45 Elbow	0.3	0.1	0.18
22 Elbow	0.15	0.08	0.1
Branch Tee	3	0.4	0.75
Passing Tee	1.4	0.08	0.3
Gate	0.3	0.1	0.2
Globe	6	4	5
Swing Check	2.2	0.6	2
Butterfly	0.35	0.16	0.3
Plug	1	0.5	0.6

Note: Adapted from Pumping Station Design Manual; Garr Jones et al, 2008

6.5.2.4 Surge Issues

Surge analysis, or hydraulic transient analysis, for the pump system, pressure lines, and appurtenances (air release valves) should be performed if one of the following conditions exists:

1. Pumping total dynamic head (TDH) is greater than 40 feet and flow exceeds 500 gpm.
2. Pipelines have high points or “knees”. Power failures can cause a partial vacuum at the knee and can result in column separation (with only water vapor in the pipe at the knee).

Surge mitigation can be accomplished by the following control strategies:

- a. Reroute force mains to avoid knees by removing or relocating obstructions.
- b. Use pump control valves that open and close gradually.
- c. Increase rotating moment of inertia by adding a flywheel (with oversized bearings).
- d. Use engine drives on some pumps so the entire system cannot fail at once.
- e. VFDs guard against continual pounding at startup and shut down but do not protect from power failure.
- f. Add sewage rated air-vacuum relief valves at critical points.
- g. Hydropneumatic tanks. If specified, hydropneumatic tanks should be designed, fabricated, and tested in accordance with the ASME Code for Unfired Pressure Vessels, and should be equipped with compressed air system controls to maintain air-to-water ratio.

6.5.2.5 Piping Characteristics

Suction piping diameter to the pump should be at least one size larger than the pump inlet diameter.

6.5.3 Pipeline Features and Appurtenances

Pumping systems should be designed so that the pipeline is always full and the vertical alignment should never go above the energy grade line. The number of low and high points should be kept to a minimum because high points can lead to air traps and sulfide corrosion. If high and low points are unavoidable, air relief/vacuum (rated for type of service) and sewage-rated blowoff valves should be installed respectively at high and low points. If possible, blowoff valves should discharge to a sanitary sewer manhole. Sewage-rated valves should be used for any service where solids may be present. Cleanout or flushing attachments to facilitate maintenance should be provided. Valve location versus the pipe cross section should consider the potential for scum and grease accumulation.

A 2-inch ball valve with a vent line should be provided on the top of the pump volute discharge to allow removal of air after servicing and prior to placing dry well pumps back in service. The vent line should be plumbed to discharge to the wet well or to the plant drain.

To avoid shearing force mains due to differential settlement, a minimum of two flex couplings should be used on pipelines when exiting structures and vaults. Thrust forces in pressure lines should be mitigated through joints that are restrained or anchored to prevent excessive movement and joint separation.

6.6 Pump Selection Criteria

Hydraulic design and pump selection is an iterative process that is dependent on pump operating levels, dimensions and characteristics. The process starts by developing the high and low system curves assuming static and dynamic loss conditions and then selecting a pump that matches those conditions. The pump's dimensions are then used to verify that the pump meets the standards set by the American National Standards Institute/Hydraulic Institute Standards (HI Standards).

Pumps should be selected to operate under the full range of projected system hydraulic conditions. Evaluation of both new and aged pipe conditions should be used to determine the limits of pumping conditions while minimizing opportunities for pump runout. There are a number of critical constraints and criteria for selecting pumps. Selection criteria constituting good practice should include the following:

1. Suction specific speed preferred value should be 8,500 and the acceptable value should be no greater than 10,000 where:

$$N_{ss} = n \frac{\sqrt{Q_{bep}}}{(NPSH_{3bep})^{0.75}}$$

N_{ss}	=	Suction Specific Speed, (U.S. Units)
n	=	Speed at rated condition, rpm
Q_{bep}	=	Flow, gpm at best efficiency point (BEP)

NPSH_{3bep} = Net Positive Suction Head at 3 percent loss of head at BEP, feet H₂O

2. At no point should the pump operate outside of the allowable operating region (AOR) for the flow rate and TDH range. Per the HI, the extent of the AOR is established by the pump manufacturer.
3. During the most common flow conditions, the pump should operate well within the preferred operating region (POR) for the flow rate and TDH range. For large pump stations the most common flow should be determined using a flow frequency histogram where existing flow information is available. Per HI, for pumps with specific speeds greater than 4,500 the POR extends from 80 percent of QBEP to 115 percent of QBEP. As pump approaches peak flow conditions, the pump can operate outside of the POR, but must remain within the allowable operating region (AOR).
4. To prevent cavitation damage of the pump impeller and other low suction head related problems, ensure that adequate NPSH is available by providing sufficient NPSH margin. NPSH margin for low energy pumps should be at a minimum 1.3 when flow is within +/- 15% of the BEP. NPSH margins for flows outside of this range, for high energy pumps, or for column pumps, may be significantly higher. Care should be taken to not select too high of a NPSH margin which could result in the following:
 - a. Additional costs for pumping equipment (larger/slower pumps),
 - b. Reduced pump efficiency
 - c. Reduced operating range due to selection of a higher suction specific speed pump

NPSH_{margin} is defined as follows

$$\text{NPSH}_{\text{margin}} = \frac{\text{NPSHA}}{\text{NPSH}_3}$$

NPSH_{margin} = Net Positive Suction Head Margin Ratio, unit less

NPSHA = Net Positive Suction Head Available, feet H₂O

NPSH₃ = Net Positive Suction Head at 3 percent loss of head, feet H₂O

5. Pump Efficiency: Both pump and wire-to-water efficiencies should be evaluated in selecting a manufacturer's pump offering. Pump efficiency is the criteria used to assess pump performance both hydraulically and mechanically. Wherever possible, specify premium efficiency motors. When it is necessary to consider standard versus high efficiency motors, the total wire to water efficiency must be evaluated.
6. For pumping systems greater than 50 mgd, lateral and torsional critical speed analyses should be performed to determine critical speeds for either constant speed

or variable speed pumps; especially when floor-mounted pumps are used with extension shafts. In general, no operating speed should be considered within 10% of any critical speed.

7. The pump should have a head–capacity curve that rises continuously from its BEP to shutoff.

6.7 Wet Well Sizing Criteria for Start/Stop Pumping

To prevent excessive pump starts, the wet well volume required must be checked and compared against the available volume (including upstream channel volume). The minimum wet well volume required is calculated by the following formula:

$$V = \frac{TQ}{4}$$

V	= Minimum active wet well volume, gal
Q	= Pumping capacity, gpm
T	= Allowable minimum cycle time

The above equation is derived based on the relationship that pumps will cycle the most when the influent flow is half the capacity of the pump. Wet wells with constant speed (C/S) pumps should be sized based on the equation above. For variable speed pumps, operational volume should be evaluated considering minimum pump speed and cycle time. Starts per hour for non-submersible pump motors in a dry pit arrangement should be limited to 6 starts per hour for 200 horsepower or less. Larger dry pit motors would be limited to 3-4 starts per hour or less. Submersible motors in a submerged application would have more allowable starts per hour due to improved heat transfer. Submersible motors that are 100 horsepower or smaller can have up to 8 starts per hour. Larger submersible motors should be maintained at a maximum of 6 starts per hour.

6.8 Process Piping

Process piping systems shall have the following features:

1. Process piping materials shall conform to District Guide Specifications, where available. Materials can be modified for specific conditions based on process area locations.
2. Piping shall be located with consideration for maintenance and known future improvements. Avoid locating piping where it cannot be replaced in the future.
3. Provide isolation valves throughout piping systems including mains and branches. Additional valves provide operations and maintenance flexibility.
4. Provide PCCS monitored flow and pressure transmitters throughout the distribution system at key mains and branches for the purpose of detecting leaks and broken valves.

5. To reduce unnecessary shutdowns of process systems, loop utility piping systems where practical.
6. All exterior equipment/piping that is fiberglass/PVC etc. shall have a screen, cover, or coating that prevents direct exposure to sunlight.
7. All exposed piping shall be labeled with the name of the content as well as direction of flow. Labels shall be placed as necessary to allow the pipe to be traced from end to end.
8. Provide bypass to allow startup and testing for all equipment.

6.8.1 Air Piping

Air piping systems shall have the following features:

1. Provide flow and pressure meters throughout the distribution system limited to key mains and branches for the purpose of detecting air leaks and broken valves/actuators. The pressure and flow meter information should reside in the PCCS.
2. If piping is required to be covered with insulation then it is preferred that materials provided reduce the ability of air leaks to travel in insulation material undetected. Otherwise provide other methods (i.e. reduce insulation spans) that improve the ability to detect leaks in long pipe spans.
3. Where possible low pressure or high pressure compressed air sources should be located as close to use point as possible to reduce the leak potential.

6.8.2 Flow Measuring

Application of flow measurement requires evaluation of the total cost, flow profile, flowing condition, Reynolds number, density, turndown, mechanical installation constraints and accuracy requirements. Turndown shall be selected so that the flowmeter has the ability to cover the range of flow rates within specified accuracy limits. Calculate the Reynolds number for the minimum and maximum flow rates. Minimum Reynolds number is calculated by using the minimum expected fluid flow and density and the maximum expected viscosity. A maximum Reynolds number is calculated using the maximum expected fluid flow and density and the minimum expected viscosity. Use Moody's charts to compensate for pipe or channel roughness and select piping or channel size to accommodate the required flow profile over the entire operating range. Locate flowmeters to suit the specific technology requirements. Magnetic flowmeters are the preferred type for pipelines and typically require a full pipe and straight pipe lengths of 5x upstream and 3x diameter downstream of their location. Multiple path transit-time acoustic flowmeters are the preferred type for channels or large pipes and typically require straight pipe or channel lengths of 10x upstream and 2x diameter downstream of their location. For difficult conditions consider flow conditioners as necessary to isolate the liquid flow disturbances from the flowmeter while minimizing the pressure drop across the

conditioner. The flow conditioner should remove swirls from the fluid stream and allow the profile velocity to come up to fully developed turbulent flow, or at least a stable acceptable geometry. Coordinate meter installation requirements with Structural design for channels and I&C design for location.

For large pumps powered at 4kV or greater, flowmeters should be provided for maintenance bench marking of efficiency and to confirm performance during startup.

6.8.3 Flow Measuring Elements

Flow measuring elements will vary widely depending on specific process conditions. All flow meters shall be designed and installed in accordance with the manufacturer's recommendations for application and installation configuration. Table 6-6 contains guidelines for flowmeter type and corresponding application.

Table 6-6. Flowmeter Type and Application

Flowmeter Type	Application
Magnetic	Magnetic flowmeters are the preferred instrument for most liquid flows.
Differential Pressure (Pitot)	Pitot tubes are to be used on smaller oxygen lines for flow balancing. Pitot tubes should not be used on liquid flows.
Orifice Plate	Orifice plates shall be used to measure flows when fluid characteristics are compatible with this design and pressure loss is not an important factor. Used on large oxygen lines.
Rotometer	Variable area meters (rotometers) shall be used on small flows of suitable liquids and gases where remote indication is not required
Vortex Shedding	Vortex shedding flowmeters with straightening vanes shall be used on oxygen and steam flows when high accuracy and high turndown (range ability) are required.
Ultra Sonic Clamp-On	Nonconductive liquids, abrasive flows (including grit) and existing piping where installation of other meters is impractical
Thermal Dispersion	Thermal dispersion gas flow meters are used on air headers, steam, digester gas and Cl ₂ & SO ₂ gas.
Propeller	Ground Water Well
Multipath Ultra Sonic	Open Channel or a large diameter closed pipe
Flume	Open Channel

6.8.4 Piping for Magnetic Flowmeters

Pipe layout for magnetic flowmeters shall provide for the following details:

- Straight pipe length upstream of flowmeter shall be a minimum of 5 times (5X) pipe diameter. Straight pipe length downstream of flowmeter shall be a minimum of 3 times (3X) pipe diameter.
- Include isolation valves and bypass piping where piping system cannot be removed from service for flowmeter maintenance.

- Magnetic flowmeters are subject to fouling by grease and sludge and are recommended to have an in-place method of cleaning the electrodes. Refer to the flowmeter piping elevation Method B in Appendix D for flow elements that are likely to be fouled by grease and sludge.
- Regardless of the location and position, the electrodes axis must be approximately horizontal.
- To reduce vibration, support the pipeline on both sides of the flowmeter.
- Large meter sizes (>8-inch), require additional spool pieces to permit axial shifting of counter-flanges to facilitate installation.
- Avoid strong electromagnetic fields in vicinity of flowmeter.
- Do not insulate flowmeter where installed on thermally insulated pipes.
- To avoid measuring errors due to debris or air inclusion, observe the following:
 - ❖ Arrange piping so the flowmeter is full of liquid. Install flowmeters in horizontal lines with 2° upward slope or preceding and upward elbow. Where practical locate flowmeters in vertical lines with upwards flow.
 - ❖ The pipe configuration shall avoid a buildup or accumulation of any secondary phase (solids or air). Entrained air shall be carried out of the meter by flow, or by buoyancy (at zero flow). Solids shall fall from the meter by gravity under zero flow.
 - ❖ For unlined conducting pipe grounding straps shall be required to be bonded between the pipe flanges and flowmeter flanges with one side connected to ground. Non-conducting pipe or insulated lined pipes shall be required to have grounding rings bonded between the pipe flanges and flowmeter flanges with one side connected to ground.
 - ❖ Avoid installing in the highest point of the line. For an open feed or discharge, install flowmeter in the low section of pipe.
 - ❖ Where flow tubes are installed in locations with restricted access, locate the transmitter remotely at 48 inches above floor and within the maximum recommended cable length between flow tube and transmitter.
 - ❖ Meter size shall be selected to provide nominal velocity requirements of 6 to 9 feet per second (ft/sec), minimum full scale range is 1.5 ft/sec; maximum is 30 ft/sec, depending on flowmeter type.
 - ❖ For solids bearing fluids, the velocity should be between 9 and 15 ft/sec to prevent deposits.

- ❖ Reducing and expanding from the carrier pipe to a smaller meter size may prove to be more economical for pipe runs with a low flow velocity. The pressure loss resulting from pipe reduction/expansion and from the greater velocity in the flowmeter spool head shall be calculated.
- ❖ Specific process requirements may warrant consideration of Venturi tubes, flow nozzles, propeller meters, weirs, and flumes.

6.8.5 Piping for Non-Magnetic Flowmeters

When compared to magnetic flowmeters, non-magnetic flowmeters are more sensitive to piping configurations. Refer to the flowmeter piping requirements table in Appendix E (per www.preferred-mfr.com) for guidelines on diameters of straight pipe for various types of flowmeters and piping configurations.

6.9 Equipment Anchorages

The construction contractor shall design the equipment anchorages as part of the equipment submittal.

6.10 Pipe Supports and Racks

The design of pipe supports and racks shall be in accordance with the latest edition of ASCE 7.

For standard process pipes 12 inches or less that do not have significant thermal expansion issues, the design engineer shall provide anchoring tables and standard details and the contractor shall show the actual location of the pipe supports in the Contractor's pipe layout shop drawing submittal. For standard process pipes, the design engineer should verify appropriateness of any typical pipe support detail used on the project for worst-case loading and configuration.

Any process pipe with special mounting requirements, any process piping with thermal expansion requirements, and any process piping greater than 12 inches in diameter shall be designed by the design engineer. For these non-standard process pipes, the design engineer shall provide adequate calculations, specific pipe support details, and identify all pipe support locations. The Contractor's pipe layout shop drawing submittal shall show and confirm the final location of the pipe supports for non-standard process pipes.

Consider using cantilever-style piping racks where racks are required. Allow sufficient vertical space above outer piping to remove and replace inner piping on the same arm. Piping racks shall be sized for known future piping, plus spare capacity.

Provide section drawings where necessary to show pipe racks and coordination with electrical conduit racks and HVAC ductwork. Areas for conduit racks and ductwork shall be identified with an "X" and labeled "electrical" or "HVAC", respectively.

6.11 Process and Instrumentation Diagrams

Process and instrumentation diagrams (P&IDs) graphically depict the design information and the method of process control and monitoring. They also schematically represent plant piping, indicating size, service, and thus piping materials. Valves are shown on all lines. Pipe material is defined by service (such as primary sludge (PS), mixed sludge (MS), etc.) in the PIPESPEC sheets presented in the District Guide Specifications. Only those valves which are modulated are given control valve numbers.

6.11.1 Drawing Preparation

A P&ID is developed in two distinct phases. In the first phase, the process/mechanical group inputs the basic process information and in a preliminary manner, describes the process control using process control narratives. The resultant drawing contains most of the process information and should be prepared in final draft form as defined in the project scope.

In the second phase of P&ID development, the instrumentation and control (I&C) discipline graphically describes the control system, including inputs and outputs to the main control system, interlock description, and a more detailed illustration of the required control devices. The I&C group also uses the P&IDs to extract information for each device included in the project. Refer to Chapter 10 for I&C design guidelines.

6.11.2 Revision Documentation

Because P&ID drawings form the major process design summary, documentation of their preparation provides a useful chronology of design development. Changes to a P&ID should always be accompanied by a written description of the change and the reasoning.

6.11.3 Existing Components

Where existing components (process, mechanical or instrumentation) interact with new or modified equipment, they will be annotated sufficiently to define the interface from a control point of view.

6.12 Process and Piping Schematics

Process and Piping Schematics (P&PS) are prepared to clarify the desired piping layout. Piping schematics illustrate the piping in a manner similar to the P&ID, with the same tags and designations. I&C information is not shown except for in-line elements such as meters and control valves. Illustration of these items gives the piping designer a full description of the piping to be installed. Additionally, Piping Schematics generally show process equipment in plan rather than in elevation. Representing the equipment in this manner allows the piping to be better illustrated. P&PS drawings are only required to the extent needed for the Designer to provide the necessary details and clearances needed for a fully functional and constructable set of contract documents.

6.13 Vibration Design Requirements

All machinery foundations, auxiliary structural supports, and interface piping shall be designed so as not to significantly increase or otherwise amplify acceptable machinery vibration levels as a machine is operated throughout its normal operating range.

The Hydraulic Institute (HI) Standards shall be used to define responsibility for proper design and for correcting installed machinery vibration problems. Specific vibration requirements shall be included in the individual equipment specifications and these requirements shall supersede HI requirement.

Contractor shall provide vibration acceptance testing for all equipment with specified vibration limits. Equipment provided with machine health monitoring systems do not require additional vibration acceptance testing independent of the machine health monitoring system. Vibration requirements include the following:

- Individual technical specifications shall state allowable vibration limits and testing for construction quality control.
- At a minimum vibration measurements shall be per manufacturer's recommendations. Typical pump vibration measurements of amplitude and frequency taken at the pumps operating point are outboard and inboard bearing housings on the motor and pump in the vertical and horizontal directions and axial vibration measurement on the pump.
- Machinery health monitoring systems applications shall be based on criticality, cost of repairs verses cost of monitoring system and rate of failure. District vibration monitoring consists of route based and machinery health monitoring systems.
- The District has standardized machinery health monitoring systems on Bentley-Nevada equipment.
- Typical applications include critical pumps, engines, turbines, cooling tower fans, compressors, high speed blowers and gear boxes.

During design, District staff should be engaged to determine which equipment will have health monitoring systems on a case-by-case basis. To provide examples, the following are applications where health monitoring systems are currently installed at the EchoWater Facility:

- X01 Influent pumps-1,250hp, 4kV
- X01 Effluent pumps- 1,500hp, 4kV
- X01 Channel Air single-stage centrifugal blowers – 1,750hp, 4kV
- X04 Recirculation compressors- 250-350Hp, 480V
- X07 Multi-stage centrifugal compressors for the oxygen plant – 2,000-3,000hp, 4kV
- X08 MSG compressors- 125hp, 480V

6.14 Sound Control

All outdoor and indoor equipment areas shall be designed to control noise level. Design considerations shall include the following:

- Guidelines shall address control of sound pressure per the requirements of Cal-OSHA T8CCR5097, Hearing Conservation Program. Whenever possible, the employees 8-hour Time Weighted Average (TWA) should be below the 85dBa “action level”.
- Areas where sound pressure exceeds Cal-OSHA limits, shall be identified on the plans and specifications with noise rating warning placards.
- Sound controls shall consist of machinery enclosures, location of equipment to minimize exposure, sound absorption materials on walls/ceiling, sound curtains and equipment vibration isolators per ASHRAE recommendations.
- Equipment producing 85 dBA or higher noise shall be placed in enclosures that will reduce noise to 70 dBA (max) outside of enclosure.

6.15 Equipment Criticality

During design, District staff will assign criticality to specific equipment. Equipment selected shall be rated and included in the ACE Table based on the criteria in the District’s Standard Maintenance Practices (SMP) Manual (Available upon request), Section 4.1- Equipment Criticality Policy. The SMP Manual can be obtained from the District upon request. Criticality assignments will be made in consultation with the Designer.

6.16 Conveyance Channels

The following sections provide guidelines for conveyance channels.

6.16.1 Channel Slide Gates Storage Pits and Access

Slide gate storage pits shall be below grade and covered with H-20 rated open grating. Ensure that a crane can access both the storage pits and all gate insertion locations. The designer shall design for the appropriate loading rates for cranes that are required to access equipment in and around channels. The current plant crane used for work in the channels weighs approximately 22 tons. Install lighting for night time crane operation at all storage rack locations.

6.16.2 Steel Materials within the Channel

All structural steel and hardware, including slide gate channels, slide gates, and pipe hangers, within the channel should be stainless. Hatches shall be constructed of aluminum plate, but the rails, springs and all hardware, shall be stainless steel. Hatches shall have an H-20 traffic rating.

6.16.3 Channel Mixing with Shear Diffusers

Where air diffusers are required for mixing it is preferred that imbedded shear diffusers not be used in the channel floor. If imbedded shear diffusers are a necessity, all material should be stainless steel.

6.16.4 Channel WRL Washdown Utility Station

At each channel isolation section access hatch, locate a WRL utility station. The WRL utility station will assist the crew in cleaning out the channels for entry and maintenance and would also assist them in filling a channel prior to putting it back in service. The intent of the WRL utility station locations is to minimize labor requirements during channel entry and maintenance.

6.16.5 Channel Safety for Employee Entry

Where possible provide double isolation gates as a means of protection for channels that have potential for rapid pressure or head fluctuations. If double gates are not possible then design single gates with appropriate structural integrity for employee entry and work.

For safe access to channels provide no more than fifty feet between hatches. Hatches shall be flush mounted with a minimum size of 3-ft x 4-ft double leaf and spring assisted. In addition to access hatches, provide penetrations at each end of each isolated section of channel for ventilation air inlet and outlet.

6.17 Chemical Delivery, Handling, and Storage

Chemical delivery, handling, and storage areas shall be designed with the following features:

1. Liquid chemical truck delivery sites shall be provided with a compressed air service capable of providing a flow of 30 scfm at a pressure of 110 psi.
2. Spill kits shall be provided along with containment, PPE, eye wash at hazardous chemical storage areas, petroleum storage areas, and satellite collection locations.
3. Fire suppression equipment shall be provided if required by the chemical or regulations.
4. Chemical facilities shall have correct and prominent labeling displaying content, NFPA 701 Fire Diamond, capacity, and other appropriate information.
5. Cold sensitive chemicals such as sodium bisulfate tanks and piping shall be heat traced.
6. For only chemicals used in the process, secondary containment shall have drainage to plant head works that is isolated via manually operated normally closed valves.
7. Chemicals not used in the process shall not have drainage back to the plant headworks.
8. Secondary containment shall be approachable by a vehicle. It shall be above grade to eliminate underground storage tank issues.
9. Concrete in secondary containment areas for strong corrosives shall be coated with a chemical resistant coating.

10. The chemical delivery connection, from truck to plant via hose shall have the following features:
 - a. Located within a spill containment area
 - b. Initial camlock fitting followed by
 - c. Butterfly valve followed by
 - d. Check valve followed by
 - e. Strainer and piped to the storage tank
 - f. Located 24-inches to 36 inches above grade
 - g. Have a minimum of two connections.

6.18 Blow-Offs for Utility and Process Piping

For both utility and process piping (WRL, WRH WN) greater than 18-inches that cross under roads, provide blow-offs on buried piping at low spots. Blow-offs are needed so the pipeline can be isolated and drained.

6.19 Motor Sizing

- Constant load: Motors shall be selected based on the bHP and torque requirements of the driven unit. Select a motor for which the load is 75 to 95% of the motor's rated capacity. For steady loads with a long duty cycle, select motors close to its full-load capacity, in the area of 95%. The motor's service factor shall not be considered in the calculation.
- Variable load: Motors shall be selected based on the bHP and torque requirements of the driven unit over the entire load range over which it will operate. Calculate the peak load RMS horsepower requirement and size the motor so the load falls within 75 to 100% of the motor capacity. The motor's service factor shall not be considered in the calculation.
- Motors for VFD systems shall be required to deliver the motor's nameplate horsepower rating by any load imposed by the driven machine at any specified operating condition or any load condition indicated by the driven machine's performance curve at all operating speeds. VFD systems shall have horsepower selected for necessary cooling at the lowest operating speed based upon motor manufacturer's heating curves. The motor's service factor shall not be considered in the calculation. Select TEBC (auxiliary blower) cooled motors as necessary for constant torque loads at low speeds.

7.0 Heating, Ventilation, and Air Conditioning Design

Design guidelines utilized in conjunction with heating, ventilating, and air conditioning (HVAC) systems shall be as follows.

7.1 Codes and Standards

The project shall be designed to comply with applicable portions of the codes and standards listed in Table 7-1 below and as described in this chapter. Designer is to use the most current County-adopted code edition as posted to www.building.saccounty.net/pages/buildingcodes.aspx up to submission of the Final Preliminary Design Report (PDR); the Designer is not responsible for any newer editions beyond Final PDR.

Table 7-1. Codes and Standards for HVAC Design

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CALGreen	California Green Building Standards Code
CAL OSHA	California Department of Industrial Relations, Division of Occupational Safety and Health
CBC	California Building Code
CEC	California Energy Code
CFC	California Fire Code
CMC	California Mechanical Code
CPC	California Plumbing Code
EGFDO	Elk Grove Fire District Ordinance
OSHA	U.S. Department of Labor Occupational Safety and Health Administration
OSHPD	California Office of Statewide Health Planning and Development
NEC	National Electric Code
NFPA	National Fire Protection Association
SMACNA	Sheet metal and Air Conditioning Contractors Association
Title 24	California Administrative Code
UL	Underwriters Laboratory
	Sacramento County Ordinances

7.2 Definitions

CIRCULATION RATE: the rate of air movement through the space in question, expressed as air changes per hour.

VENTILATION RATE: the rate that air within the space is replaced with fresh air, also called PURGE RATE, expressed as air changes per hour.

7.3 General

The District prefers HVAC systems to be designed to industrial standards; smaller systems where industrial grade equipment is unavailable may be designed to commercial or residential standards. Exceptions to this standard shall be approved by the District.

The District requires HVAC system design be based on ventilation for personnel safety and comfort, and for protection of process equipment, to remove heat generated by equipment, and to purge the atmosphere within a space. The Cosumnes Fire District Ordinance discusses additional requirements for smoke purging.

The District prefers that any hazardous areas be ventilated sufficiently to achieve the lowest possible electrical classification per NFPA 820.

This HVAC design guideline does not cover odor control and treatment systems.

7.4 Outside Design Conditions

HVAC systems shall be designed for the outdoor design conditions as given below in Table 7-2:

Table 7-2. Outdoor Design Conditions

Outside Design Conditions		Notes
Winter Design Temperature	31°F dry bulb	99.6% ASHRAE Design Temperature
Summer Design Temperature	100°F dry bulb, 70° wet bulb	0.4% ASHRAE Design Temperature
Prevailing Wind Direction:	from the southwest	
Average Wind Speed	15 to 20 mph	

7.5 Inside Design Conditions

The summer and winter inside design temperatures for each of the process areas are as follows in Table 7-3:

Table 7-3. Indoor Design Conditions

	Winter	Summer	Notes
ACC	72°F	75°F	--
Administrative	72°F	75°F	--
Computer rooms (MIS)	78°F	78°F	Positive pressure, alarm at 85°F
Electrical rooms (MCC or switchgear)	-	86°F	Positive pressure
Laboratory	68°F	75°F	Negative pressure
Mechanical rooms	vent only	vent only	--
Process areas (in general)	vent only	vent only	--
Restrooms	vent only	vent only	Negative pressure, no recirculation
Shops	68°F	75°F	--
Storage	vent only	vent only	--
Tunnels	vent only	Evap Cool	--

7.6 Ventilation Rates

The ventilation rate guidelines for each of the process areas are as follows in Table 7-4; ventilation rates for specific areas of the project shall be established:

Table 7-4. Ventilation Rates

	Ventilation Rate	Notes
Equipment galleries and tunnels	6 to 10 air changes per hour	--
Toilet and locker rooms	200 cfm minimum, 10 cfm per locker	--
Pump rooms	6 to 10 air changes per hour	--
Headworks, screen rooms, wet wells, dewatering rooms, and grit handling rooms	20 to 30 air changes per hour	Apply NFPA 820 ventilation rates as a minimum. Direct exhaust, negative pressure; consider hazardous gas monitors with alarms at entrance doors. Provide fan failure alarms.
Chlorine and sulfur dioxide areas	10 to 20 air changes per hour, normal ventilation 60 air changes per hour purge ventilation	Apply NFPA 820 ventilation rates as a minimum. Purge ventilation-perform evaluation considering scrubber size along with a credible chemical leak rate.
Gas compressor rooms	20 air changes per hour	--
Maintenance areas and workshops	2 to 6 air changes per hour	Consider evaporative cooling and unit heaters
Other Areas	To California Mechanical Code and California Energy Code Standards	--

7.7 HVAC Design Intent

HVAC Design Intent should be included in the Preliminary Design Report, and shall include design criteria, applicable codes and standards, design assumptions, and performance standards. Items requiring special attention in design should be identified.

Provide a description of each HVAC system, including major components, intended operation, sequence of operation, etc.

Contract drawings shall include a full design of all control and logic associated with HVAC equipment.

7.8 HVAC Design Submittals

Specific design deliverable requirements are described in the District's Design Contract Requirements and CAD/BIM Standards.

Provide HVAC calculations, pump and fan curves, and a range of operating points for all equipment and systems. Calculations shall support capacity selections and code compliance.

Provide full control and logic diagrams for all HVAC controller equipment.

Provide drawings detailing the fire alarm control panels, HVAC control panels and all inputs/outputs to them (i.e. smoke detectors, pull stations, strobes, fire riser components, etc.).

Provide schematics on the drawings for each ventilated area showing equipment, circulation and ventilation flow rates, temperature zoning, and pressure relationships between spaces.

Provide a simplified control narrative on the drawings describing the operating scenarios for all powered equipment.

Provide a simplified equipment list on the drawings, not a complete equipment schedule.

7.9 HVAC Equipment

Equipment shall be selected for reliability, performance, and maintainability. District preference is for robust equipment. Equipment to be located in corrosive environments shall be specified with appropriate materials of construction and protective coatings.

Where possible, select matching equipment from a single manufacturer for equipment such as split system air conditioners.

Equipment utilizing Waste Heat Water Supply (WHWS) requires special materials of construction. Examples include cuprous nickel heat exchanger tubing, tube sheets, water boxes, and head covers.

Follow manufacturer clearance recommendations at a minimum and provide adequate clearance to remove and replace equipment as a whole; provide more than adequate clearance for service or removal of equipment. Provide removable panels or walls if needed. Assume that the replacement equipment will be slightly larger. Size concrete pads accordingly.

Provide gauges on equipment for local readout:

- For airside differential pressure gauges, use Dwyer Photohelic gauges with built in switches. These gauges provide visual indication of the differential pressure for non-corrosive gases, plus adjustable pressure switches that do not need periodic recalibration.
- For small airside equipment without gauge ports, use flush- or surface-mounted Dwyer Magnehelic gauges without switches.
- For waterside differential pressure gauges, use Dwyer Capsu-Photohelic gauges with built in switches.

The first-choice location for HVAC air handlers, pumps, etc. is inside mechanical equipment rooms. The second-choice location is outside at grade level. The last-choice location is on the roof of structures. However, roof exhaust fans may be roof mounted; exceptions will be evaluated on a case-by-case basis.

For roof mounted equipment, the design shall be in accordance with NRCA and SMACNA recommendations on location, clearances, and maintenance walkways. All roofing details shall be in accordance with the NRCA Handbook for low slope roofs and District standards. All roof mounted equipment requiring maintenance shall be provided with a 110v convenience outlet and a water supply and hose-bib within 50 feet. All roof-mounted equipment shall be provided with material handling equipment or access such as hand powered hoist or forklift access at the closest wall.

Roof curbs shall have a minimum height of 14 inches above the finished roof for roof maintenance.

Closely spaced roof curb rails are discouraged as it creates roof maintenance issues.

Table 7-5 lists the type of equipment preferred for various services.

Table 7-5. Type of Equipment for Various Services

Service	Type of Equipment
Condensate (Steam)	Pumping Traps or electric-driven pump as appropriate.
CWS Primary Pumps (large)	Double Suction Centrifugal Pumps.
CWS Secondary Pumps (large)	End Suction Centrifugal Pumps.
CWS Secondary Pumps (small)	In-line Centrifugal Pumps
HRS Primary Pumps (large)	Double Suction Centrifugal Pumps.
HRS Secondary Pumps (large)	End Suction Centrifugal Pumps.
HRS Secondary Pumps (small)	In-line Centrifugal Pumps
Pumped Drainage	Submersible Pump (1 st choice) Self-priming Centrifugal Pump (2 nd choice)

Hydronic pumps shall be specified with the manufacturer's standard mechanical seals.

All pump motors 5 HP and above shall have a maximum motor speed of 1,800 rpm.

7.10 Heating Systems

There are three alternative heating methods:

- Hot water heating shall be considered for all applications. A District utility map shows locations of the heating water system which is currently near capacity; any proposed new connections to the heating water system will require calculations to verify available capacity and shall be included in the Preliminary Design Report, and must be approved by the District.
- Natural gas furnaces are used where gas is available and hot water is not available.
- Heat pumps and electric heat strips are used where neither natural gas nor hot water are available.

Electric or gas unit heaters may be considered for freeze protection in remote locations and similar applications.

Supply air temperature shall be no more than 40°F warmer than the room temperature design setpoint.

7.11 Cooling Systems

There are three methods of cooling used at the EchoWater Facility:

- Direct evaporative cooling is used for process areas and tunnels; never for MCC rooms, electrical rooms, or computer rooms.
- Chilled water cooling is used for ACC's, administrative areas, computer rooms, shop/maintenance areas, and laboratories. Chilled water cooling coils should not exceed a face velocity of 500 feet/minute. Verify with the District that sufficient chilled water capacity is available at the project location before designing new hydronic systems.
- Direct expansion cooling is used where chilled water cooling is not available, and also as a backup to the chilled water system for computer rooms and other applications requiring backups. Refrigerant R-22 should not be considered.

No below grade refrigerant piping shall be allowed where the interior coil is at the same grade or higher. For refrigerant oil trapping; follow industry standards to provide trapping prevention and oil return.

The District favors 100 percent redundant cooling systems for server rooms. No condensate drain piping, pressurized water piping, or ductwork shall pass over or be located within three feet of any electrical panel, panel board, or load center. Space clearance zones required by the NEC above and aside electrical panels, panel boards, and load centers shall be maintained.

Supply air temperature shall be no more than 25°F cooler than the room temperature design setpoint.

The District owns and uses portable units for backup and emergency cooling. Provide electrical and drainage connections for the portable cooling units for all conditioned spaces.

The District prefers not to have systems requiring cooling towers.

7.12 Equipment Locations

Ventilation equipment including fans, ductwork, registers, diffusers, and exhaust grilles, should be selected and designed to maximize the effectiveness of the system's ability to purge the ventilated spaces. This is especially important in process-related areas.

When locating equipment, air intakes and exhausts should take into account the prevailing wind direction and potential sources of odorous, toxic, or corrosive gases. The HVAC room itself should be conveniently located to minimize long duct runs and should be sized to allow sufficient access to equipment. Avoid locating fans directly above noise sensitive areas such as conference rooms.

Elevated air handlers and fans that require routine maintenance shall be provided with a 360° maintenance platform and access ladder.

The District prefers not elevating air handlers.

7.13 Configuration

Do not transfer air from one space to another space, such as cleaner areas with sensitive equipment to less sensitive areas.

Air from hazardous areas, rest rooms, locker rooms, kitchens, and odor-generating rooms shall be exhausted, and not recirculated.

Provide ventilated spaces with powered supply and powered exhaust.

Conditioned spaces shall be designed with recirculating air to minimize heating and cooling costs. Consider economizers for spaces that need cooling in winter.

Terminal units may serve up to three offices with similar exposures, occupancies, and heat loads. Balancing dampers must be provided in the branch ducts for each office.

Areas with chlorine or hydrogen sulfide shall be designed with exhaust grilles at low elevations for effective scavenging.

7.14 Special HVAC and Fire Extinguishing Requirements for Switchgear and Motor Control Center Rooms

Special HVAC requirements:

- Switchgear and MCC Rooms shall have dedicated HVAC or ventilation units capable of exhausting 100% of the return air upon sensing smoke. Make up air shall be 100% outside air.
- Any ductwork penetrating the walls or ceiling of switchgear and MCC rooms shall be protected with fire/smoke dampers at the penetration.
- Ductwork within the room shall be a minimum of 26-gauge metal.
- Switchgear rooms shall have an HVAC shutdown and purge mode monitoring and control panel located on an exterior wall adjacent to the entrance door. A remote shutdown switch shall be provided outside an electrical room exterior exit door for electrical room purge activation after leaving the building (a breakglass switch is acceptable).
- The air supply to MCC rooms shall be chemically filtered per the requirements of Section 7.17 (Air Filtration Equipment).

Special Fire Extinguishing Requirements:

- Portable carbon dioxide fire extinguishers shall be placed at the entrances and at locations such that the travel distance between extinguishers is no greater than 50 feet.
- Prepare test procedure requirements for verifying the proper operation of all fire alarm system elements and all HVAC elements controlled by the fire alarm system.

7.15 Fans

7.15.1 Centrifugal Utility Fans

Centrifugal utility fans requiring a static pressure of 2 inches or more, or fans with motors larger than 3 horsepower shall have backward inclined airfoil, or backward inclined blades for high efficiency. Forward curved blades should only be used on small fans or when low first cost is of primary concern.

All fans shall be provided with guards and vibration isolators. All fans not operated continuously shall be provided with backdraft dampers.

7.15.2 Propeller Wall Fans

Propeller wall fans shall be V-belt driven when possible. Small propeller wall fans (smaller than 18 to 24 inches) are only available in a direct drive configuration. Propeller fans shall be provided with drive-side guards and wall mounting sleeves.

7.15.3 Roof Exhaust Fans

Roof exhaust fans shall be specified with manufacturer-supplied roof curbs. Options should include a hinged base and disconnect switch. Provide direct drive fans where available. Large fans requiring guaranteed closure shall be provided with motorized dampers.

7.15.4 In-Line Fans

In-line axial, mixed flow, and centrifugal fans will be used where limited space is available for installation. In-line fans shall be provided with vibration isolators and flexible-duct connections at each end.

7.15.5 Cabinet Fans and Ceiling Fans

Small cabinet fans and ceiling fans provided with ducting through the roof or wall shall be used for very small air flow. Ceiling fans shall be considered where air flows are too small for roof exhaust fans. Differential pressure switches and motorized dampers shall not be used with small cabinet fans and ceiling fans.

Specify non-sparking fans and explosion-proof motors for service in hazardous areas.

Specify fan failure alarms for service in hazardous areas.

7.16 Air Handling Units

Air handling units (AHU) shall be packaged units which can supply heating, cooling ventilation, and air filtration. The air handling unit shall be of the single-zone type.

The District prefers outdoor air handling units to be located on grade as opposed to roof-mounted. Air handling unit cabinets located outdoors shall be weatherproof.

Indoor mechanical rooms may be considered for larger buildings subject to architectural decisions. Indoor HVAC rooms shall be provided with floor drains and equipment drains for the condensate.

Air handlers shall be provided with access to water and a hose bib with vacuum breaker within 50 feet of the unit.

Air handlers shall be provided with a 110v convenience outlet within 10 inches of the control panel.

7.17 Air Filtration Equipment

Filtered air ventilation systems shall be provided only when required by code, or noted as necessary by the District for specific areas. Pleated panel 30% filters shall be used with a face velocity below 500 feet per minute. Use 4 inch thick filters where possible. Clean pressure drop shall be about 0.2 inch, and dirty pressure drop of about 1.0 inch.

- Provide potassium permanganate chemical filters for motor control center ventilation systems. Chemical filter systems shall include a 30% 2 inch pre-filter, a chemical filter, and a 30% post-filter. Chemical filters shall be cartridge type and non-refillable design. The entire filter system shall be provided with differential pressure gages and alarms. District preference is for custom filter modules and standardized packaged units over custom air handlers. A minimum amount of outside air shall be supplied to these rooms and they shall be maintained at a slight positive pressure to prevent infiltration of untreated outside air.

7.18 Ductwork

7.18.1 General

ASHRAE and SMACNA standards and recommendations shall be used for all duct designs. Aluminum ductwork shall be used for all applications except as stated below. Aluminum ductwork will be fabricated according to Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) standards for low-pressure or medium pressure applications. Fasteners for aluminum ductwork shall be aluminum or stainless steel.

Fiberglass (reinforced thermoset plastic, RTP) ducting shall be used in applications requiring a high degree of corrosion resistance. RTP ducting shall be treated to be fire resistant.

Galvanized steel ductwork shall not be used.

Flexible duct shall be used only to connect ceiling diffusers to rigid ductwork. Flexible duct shall not exceed 5 feet in length, and shall not be used on exposed ductwork.

7.18.2 Duct Sizing and Velocity Ranges

The computation of total system pressure (static pressure plus velocity pressure) shall be based on the equal friction method as defined by SMACNA.

Pressure drop shall be approximately 0.07 to 0.1 inch per 100 feet.

All ducts (except foul air ducts), supply, exhaust, transfer, or return air ducts shall be sized for the following air velocities, with preference toward the lower end of the range in each case, especially for noise sensitive areas:

Rectangular	Main ducts	1,500 to 2,000 fpm
	Branch ducts	800 to 1,600 fpm
Round	Main ducts	1,800 to 2,500 fpm
	Branch ducts	1,000 to 1,800 fpm

Foul air ducts (RTP type) shall be sized for the following air velocities:

Round	Main ducts	2,500 to 3,000 fpm
	Branch ducts	2,000 to 2,500 fpm

7.18.3 Insulation

Thermal insulation shall be provided in accordance with the California Mechanical Code or the California Energy Code (whichever is more stringent) on all supply, transfer, or return ducting which carries heated or cooled air. Thermal insulation shall also be provided where required to prevent condensation. This insulation may be external insulation where damage from traffic is unlikely, or internal insulation. Internal insulation also acts as acoustical insulation.

7.18.4 Duct Dimension and Design

Rectangular and round ductwork shall have whole number dimensions expressed in inches. Manufacturer's standard duct sizes and fittings shall be used whenever possible.

Where space permits, round ductwork is preferred over rectangular ductwork.

Rectangular ducts shall be designed with the smallest possible aspect ratio; aspect ratios of greater than 4:1 shall be avoided.

7.18.5 Duct Accessories

Turning vanes shall be of the same material as the duct and shall be the single-walled type with trailing edges.

Access doors shall be provided adjacent to all pieces of duct-mounted equipment or instrumentation.

Fire dampers will be UL classified with UL-listed fusible links, rated at 160 to 165 degrees Fahrenheit. Fire dampers shall also be in accordance with NFPA 90A requirements and all applicable local codes.

Flexible duct connectors shall be used for vibration isolation of moving equipment. Flexible duct connectors shall allow a minimum of 2 inches of free space between two metal collars to ensure that no vibration is transmitted from the equipment to the ductwork.

Splitter dampers shall be used to divert and control airflow from a main duct to two branch ducts of opposite directions. Splitter dampers will be of the same material as the duct.

7.18.6 Grills, Registers, and Diffusers

Grilles, registers, and diffusers shall be sized in accordance with the manufacturer's recommendations for air velocity and throw. Noise rating shall not exceed NC-25 for administrative areas and NC-30 for process areas (including electrical rooms). Grills, registers, and diffusers shall be of the same material as the duct.

7.18.7 Drum Louvers and Ball Turret Louvers

Drum louvers and ball turret louvers shall be considered for air distribution systems when concise directional air throws or air throws in excess of approximately 20 feet are used.

7.19 Louvers

Intake and exhaust louvers shall be provided with and insect screens. Together with the louver blades, these screens shall produce a 0.05 to 0.10-inch pressure drop when clean. Intake louvers shall be sized for a face velocity of about 500 fpm, exhaust louvers shall be sized for a face velocity of no more than 800 fpm.

Location, finish, and color of louvers shall be coordinated with the project architect.

7.20 Control Dampers

Mixing dampers shall be the opposed-blade right-angle type.

Backdraft dampers shall be the parallel-blade type.

Dampers for open-close service shall be parallel-blade type.

Balancing dampers shall be butterfly type in ducts 12 inches and smaller and opposed-blade type in ducts larger than 12 inches. Balancing dampers shall be provided at all supply, return, and exhaust duct branch takeoffs.

Variable air volume mixing boxes and terminal units in office areas shall be located such that ladder access to the ceiling will not be blocked by office furniture.

7.21 HVAC Controls

Controls for HVAC systems shall be compatible with the existing Johnson Controls HVAC DDC System with network connection back to the master station located in HCC-2 next to the Boiler Room. Specifications shall require that DDC software and testing and calibration equipment be turned over to District upon completion of project.

The following controls shall be provided:

- Differential pressure sensor across major or critical fans to indicate fan flow.
- Duct smoke detector with alarm at discharge of each unit, per NFPA 90A.
- Differential pressure gage and/or switch with alarm across air filters.
- Economizer cycles shall not be generally used for MCC Rooms, due to possible odors and corrosive or hazardous gases.
- Thermostats and controllers to operate the HVAC units.
- Alarms shall be local and remote, audible and/or visual, and can start or stop equipment depending upon the particular application.
- Alarm and SCADA monitoring (including zone temperatures and humidity) shall be routed through the DDC system network back to the HCC master workstation.

All new HVAC control systems shall consist of Johnson Controls (JC) equipment (no “or equal”) for connection into the existing plant BACnet system. The network controller shall be JC DDC controller MS-NAE3510-2. This first tier Controller shall be a fully user-programmable, supervisory controller. The Network Controller shall monitor the network of distributed VMA and FEC controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers. The Network Controller shall reside on the existing campus wide Ethernet Network. Each NAE shall support a sub-network of controllers on the second tier network.

The second tier network of field controllers shall be Metasys MS-FEC2621 BACnet series and shall be used for all AHU’s, split systems, condensing units, and purge systems. Room thermostats shall be model NS-BTB7003-0.

All other sensors required to meet the needs listed above shall be compatible with the specified master Network Controller.

The HVAC and Purge systems shall each have dedicated control panels. The designer shall provide panel layout drawings, control and logic diagrams, and interconnection diagrams for each system.

All equipment shall be NAE 35/45 compatible and should be designed to interface completely with the plant Metasys network. The room temperature and humidity shall be pulled off the Metasys network for independent relay to the EchoWater Facility PCC. The controls contractor will be responsible to provide a full, compatible, turnkey product.

7.21.1 Standardized Equipment

Refer to Appendix A of the District’s Design Contract Requirements for a table of standardized equipment.

7.22 Motor Sizing

Variable load: Motors shall be selected based on the bHP and torque requirements of the driven unit over the entire load range over which it will operate. Calculate the peak load RMS horsepower requirement and size the motor so the load falls within 75 to 100% of the motor capacity. The motor’s service factor shall not be considered in the calculation.

Motors for VFD systems shall be required to deliver the motor’s nameplate horsepower rating by any load imposed by the driven machine at any specified operating condition or any load condition indicated by the driven machine’s performance curve at all operating speeds. VFD systems shall have horsepower selected for necessary cooling at the lowest operating speed based upon motor manufacturer’s heating curves. The motor’s service factor shall not be considered in the calculation.

8.0 Plumbing Design

Design guidelines utilized in conjunction with the plumbing design shall be as follows.

8.1 Codes and Standards

The project shall be designed to comply with applicable portions of the codes and standards listed in Table 8-1 below and as described in this chapter. Designer is to use the most current County-adopted code edition as posted to www.building.saccounty.net/pages/buildingcodes.aspx up to submission of the Final Preliminary Design Report (PDR); the Designer is not responsible for any newer editions beyond Final PDR.

Table 8-1. Codes and Standards for Plumbing

CBC	California Building Code integrated with the Americans with Disabilities Act Accessible Guidelines
CFC	California Fire Code
CMC	California Mechanical Code
CPC	California Plumbing Code
UL	Underwriters Laboratory
OSHA	U.S. Department of Labor Occupational Safety and Health Administration
CAL OSHA	California Department of Industrial Relations, Division of Occupational Safety and Health
NFPA	National Fire Protection Association
NEC	National Electric Code
ASTM	American Society for Testing and Materials
ANSI	American National Standards Institute
PDI	Plumbing and Drainage Institute
AWWA	American Water Works Association
	Cosumnes Community Services District Fire Department Ordinances
	Sacramento County Ordinances

8.2 Floor Drains

In process areas and tunnels, traps will not normally be provided in floor drains. The drain piping will be trapped and vented at the location it enters the drain sump normally by submerging the drain entrance below the low water level of the sump.

Drain traps shall be provided on building drains outside of process area.

Floor drains in remote areas shall be specified to include trap primers that operate on other than line pressure fluctuations; electronic trap primers or flow metering devices are acceptable; mechanical trap seals are not acceptable.

8.3 Plumbing Design Intent

Plumbing Design Intent should be included in the Preliminary Design Report, and shall include design criteria, applicable codes and standards. Systems requiring special attention in design should be identified.

8.4 Plumbing Design Submittals

Ensure adequate sizing of the drain, waste and vent system; because this is an industrial facility, CPC code minimum sizes may not be sufficient.

Specific design deliverable requirements are described in the **District Design Contract Requirements**.

Provide plumbing calculations to support sizing and code compliance.

8.5 Plumbing Piping

Provide water hammer arresters throughout the domestic hot and cold water systems.

Di-electric unions shall be eliminated by use of compatible piping if possible. When di-electric unions are necessary, they shall be rated for 180 degrees F and 250 psig.

8.6 Plumbing Equipment

The District prefers use of domestic water heaters when appropriate. Power by natural gas when available.

8.7 Plumbing Fixtures

8.7.1 Lavatories

Stainless steel and enameled cast iron are preferred for durability. Vitreous china shall not be specified.

Lavatory sinks shall be provided at all new restrooms. In general, all lavatory sinks should be provided with AC-powered, sensor-type faucets and gooseneck spouts. Specify water-conserving flowrate of 0.5 gpm per Calgreen.

8.7.2 Service Sinks

Stainless steel floor sinks with stainless steel backsplashes are preferred for janitor rooms.

8.7.3 Water Closets

Water closets shall be provided at all new restrooms. Wall-hung water closets with AC-powered sensor-type flush valves with manual override are preferred. Specify water-conserving flowrate of 1.28 gallons per flush per Calgreen.

8.7.4 Urinals

Urinals shall be provided at all new men's and unisex restrooms. Provide AC-powered automatic sensor flush valves with manual override for all urinals. Specify water-conserving flowrate of 0.5 gallons per flush. Waterless urinals are not to be specified.

9.0 Electrical Design

Design guidelines utilized in conjunction with the electrical design shall be as follows.

9.1 General

The electrical systems shall be heavy-duty industrial type with design emphasis placed on safety, reliability, maintainability & economics.

9.2 Codes & Standards

The project shall be designed to comply with applicable portions of the following codes and standards listed in Table 9-1 below and as described in this chapter. Designer is to use the most current County-adopted code edition as posted to www.building.sacounty.net/pages/buildingcodes.aspx up to submission of the Final Preliminary Design Report (PDR); the Designer is not responsible for any newer editions beyond Final PDR.

Table 9-1. Codes and Standards for Electrical

IEEE 141, 142, 242, 399, 446, 493 and 739	Institute of Electrical and Electronic Engineers—"color book" series
Lighting Handbook	Illuminating Engineering Society (IES)
NFPA 70	National Electrical Code (NEC)
NFPA 72	Fire Alarm Signaling
NFPA 101	Life Safety Code
NFPA 820	Standard for Fire Protection in Waste Water Treatment Plants
Cal Title 24	Buildings Standards Code
Consumes Fire Department	Ordinance Requirements

9.3 Electrical Design Calculations and Studies

Electrical design calculations shall include a load flow study, short-circuit study, voltage drop (where applicable), arc flash analysis and harmonic distortion/resonance analysis report.

Branch and feeder voltage drop shall be 5% to the farthest outlet. Motor voltage drop allowed shall be 10% starting and 5% running at full load.

Total harmonic distortion (THD) for voltage shall be 5% at the primary switchgear and secondary double-ended switchgear and 3% for individual harmonic distortion per IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems. Electrical system shall be modeled to include short circuit, load flow and coordination studies. The District uses Paladin Design Base, which is the preferred model if the Designer has the option; however, the Designer is not required to use Paladin Design Base.

9.4 Power Distribution System

9.4.1 Type

The power distribution system type shall be a two source primary and secondary selective system. Both the primary and secondary systems shall be double ended with automatic and

dummy tie breakers at both primary switchgear and secondary switchgear. Refer to the District's Master Set Drawings E51, 23E50A through 23E50F for information.

9.4.2 Primary Substation Arrangement (69kV/12.47kV)

Utility service is provided by the Sacramento Municipal Utility District (SMUD) via 69kV overhead lines to the existing main substation which steps down the voltage to 12.47kV for EchoWater Facility distribution. Major changes in loads shall be coordinated with SMUD for incorporation into their power system and protective relay scheme. The 69kV system shall be over-head line connected SF₆ main breaker, load break isolation switches, and main transformer primary. The main transformers shall be liquid-filled primary unit substation style, Δ-primary, wye-secondary with solid neutral ground, with manual no-load primary and automatic full local secondary tap changers. Main transformer secondary shall be underground cabled with voltage rotation shifted to match the SMUD secondary distribution system rotation. Main switchgear shall be 12kV double-ended with automatic and dummy tie breakers.

9.4.3 480V Secondary Substation Arrangement

The substation shall consist of a 12kV load rated fused interrupter switch and outdoor liquid-filled secondary unit substation style transformer to double-ended switchgear with dummy and tie breakers. Transformers shall be a Δ-primary, wye-secondary solid neutral ground. 480V motors shall be fed from grouped MCCs located in the Electrical room.

9.4.4 12kV (4kV) Secondary Substation Arrangement

The substation shall consist of a 12kV load rated fused interrupter switch and outdoor liquid-filled primary (secondary) unit substation style transformer to double-ended switchgear with dummy and tie breakers. Transformers for large motors shall be a Δ-primary, wye-secondary resistor neutral ground. Medium voltage motors shall be fed from grouped MCCs located in the Electrical room. 480V loads 1000kVA and under shall be sub-fed from the medium voltage switchgear to indoor dry-type secondary unit substation style transformers feeding double-ended switchgear with dummy and tie breakers. 480V motors shall be fed from grouped MCCs located in the Electrical room.

9.4.5 Liquid Filled Transformers

Liquid filled transformers shall be surrounded by a liquid containment structure sized per EPA requirements with a concrete wall between transformers. Containment area shall be filled with river rocks to quench temperature and the remaining void volume shall provide for the largest single transformer oil volume plus an additional 3.5 inches of freeboard for precipitation from a 25-year storm event.

Distribution transformers shall be sized to carry the entire switchgear design load at its maximum fan cooled rating. Select standard size transformers by varying the future capacity in the 20-25% range.

9.4.6 12.47kV Distribution System

The main 12kV switchgear shall distribute dual 12kV feeders from opposite sides of the main tie breaker to process area substations to dual outdoor 12kV fused isolation switches. Distribution system shall consist of underground medium voltage cables routed through dual manhole and duct system.

9.4.7 Instrument Power

Instrument power at 120/208V shall be derived through an automatic transfer switch which is fed from both sides of the double-ended switchgear via dry type transformers. Transfer switch shall be PCCS monitored for voltage loss on the output circuit. Distribute to all field instruments via a distribution panelboard.

9.4.8 Uninterruptable Power Supply (UPS)

For loads determined to be on a UPS system 120/208V shall be derived through automatic transfer switch which is fed from both sides of the double-ended switchgear. Transfer switch shall be PCCS monitored for voltage loss on the output circuit. UPS shall be PCCS networked data monitored for status. Distribute to PCCS network and HMI equipment, fire alarm, public address, security system via a dedicated distribution panelboard.

9.4.9 Standardized Equipment

Refer to Appendix A of the District's Design Contract Requirements for a table of standardized equipment.

9.5 Power Quality Monitoring System

The District currently has a Power Quality Monitoring System that connects the power monitoring devices to the end users devices via the PCCS and maintenance network.

Switchgear main and feeders are monitored with power quality meters with dual integrated Ethernet ports and Embedded Web Server. MCC motor loads are monitored with motor management relays, VFDs, and motor starter smart overloads. All monitoring devices shall be capable of Ethernet connections to the PCCS and Maintenance networks as described in Section 10.9.

9.6 Conductor Sizing

Feeder and branch circuits shall be all sized for the loads that they are connected to per the NEC. Voltage drop shall be considered for long runs and the conductors increased in size based on the voltage drop calculations.

9.7 Motor Sizing

Motors for VFD systems shall be required to deliver the motor's nameplate horsepower rating by any load imposed by the driven machine at any specified operating condition or any load condition indicated by the driven machine's performance curve at all operating speeds.

Coordinate with mechanical design guidelines in Chapter 6, including variable frequency curves vs. system curves.

9.8 Electrical Rooms

9.8.1 Arrangement

MCC and switchgear front and back work space distances are shown in Table 9-2 below. All electrical distribution switchgear shall be located inside environmentally controlled buildings at or above grade. Outdoor or below grade switchgear is unacceptable.

Table 9-2. Electrical Equipment Work Space Distances

480V Equipment	(feet)
MCC (Front)	4.5
Switchgear (Front)	5
Switchgear (Rear)	4
UPS (all sides)	4
Access Corridor	5
4KV and 12KV Equipment	(feet)
MCC (Front)	6
Switchgear (Front)	8
Switchgear (Rear)	7
Access Corridor	5

Electrical rooms shall have a load break type disconnect for the service entrance equipment located on the exterior wall of the electrical room.

All conduit penetrations from the electrical room to other adjacent process area rooms shall be fire stopped.

Coordinate with the civil and architectural design guidelines in Chapters 3 and 4, respectively.

9.8.2 Layout

Electrical rooms typically include switchgear, MCCs and distribution panelboards. 12kV and 4kV electrical rooms also include PLC/HMI controls and PCCS workstations. Do not locate PCCS I/O cabinets in the 480V switchgear electrical room. All electrical room roofs shall be sloped and no penetrations or water pipes are allowed above electrical equipment. Provide a dedicated HVAC with chemical filters housed indoors with an access door inside the electrical room. Medium voltage electrical only buildings shall include a separate battery room with an access door inside electrical room. Additionally, provide approximately 64 square feet of clear working space in 480V electrical rooms and approximately 100 square feet of clear working space in medium voltage electrical rooms for electrical maintenance and electrician use. Minimum distance across working space shall be 8 feet clear.

Horizontal workplace clearance requirements per the NEC shall be adhered to when considering the layout of the electrical equipment in the room.

Coordinate with mechanical and HVAC design guidelines in Chapters 6 and 7, respectively.

9.8.3 Fire Protection System

Refer to SacSewer's March 5, 1997 *Memorandum of Understanding between the Sacramento Regional Treatment Plant (SRWTP) and the Elk Grove Fire Department (EGFD) regarding the SRWTP Fire Protection Utility Master Plan* included in Appendix F.

Rooms shall be constructed of noncombustible material and include features such as fully enclosed wiring, fire detection, fire dampers, fire stops, dedicated chemically treated HVAC, smoke purge system, portable halon extinguishers, and an external main disconnect.

9.9 Switchgear

9.9.1 12.47kV Switchgear

12.47kV switchgear shall be metal clad, rack out, sized for design load, rated at 15kV, 3000A minimum, 3W, double-ended configuration with dummy and automatic tie breakers. Switchgear shall be arc-resistant type, if available. AIC rating shall be based upon the maximum available fault current at the transformer connection. Tie breakers shall be sized at 120% of highest single side load. The switchgear shall be configured as a cabled bottom entry with single breaker per section located in the lower compartment only with auxiliaries in the upper compartment. Refer to District Master Set Drawing E51.

9.9.1.1 Standardized Equipment

Refer to Appendix A of the District's Design Contract Requirements for a table of standardized equipment. Locate vacuum breakers in bottom cubicles only and electro-mechanical relays (matching existing) in adjacent top cubicle.

9.9.1.2 Controls and Monitoring

PCCS Workstation and HMI/PLC breaker control panel are to be located 10 feet away from switchgear. Switchgear monitoring and control at the PCCS shall consist of: transfer control logic, mains and tie breakers status, room temperature and main transformer secondary voltage.

Power quality monitors shall be provided at the mains and feeder breakers.

The 125Vdc chargers shall be monitored for trouble by the PCCS.

9.9.1.3 Protection Relay Power

Protection relays shall be powered by a 125Vdc system derived from sealed lead-acid batteries with dual chargers and distributed through a fused distribution panelboard for breaker trip and PLC power. 120Vac system shall be derived from the 12kV bus via a control power transformer with appropriate fuse protections to an external automatic transfer switch feeding a circuit breaker panelboard for breaker closing power, spring charging motors and battery chargers.

9.9.2 4.16kV Switchgear

4.16kV switchgear shall be sized for design load, rated 5kV, 3W, double-ended with dummy and automatic tie breakers. AIC rating shall be based upon the maximum available fault current at the transformer connection. Tie breakers sized at 120% of highest single side load. Switchgear shall be arc-resistant type, if available.

9.9.2.1 Standardized Equipment

Refer to Appendix A of the District's Design Contract Requirements for a table of standardized equipment. Locate vacuum breakers in bottom cubicles only and electro-mechanical relays (matching existing) in adjacent top cubicle.

9.9.2.2 Controls and Monitoring

Locate HMI/PLC breaker control panel 10 feet away from switchgear.

Switchgear monitoring and control at the PCCS shall consist of: transfer control, mains and tie breakers status, room temperature, main transformer secondary voltage, networked switchgear data monitoring at mains and feeder breakers. The 125Vdc chargers shall be monitored for trouble by the PCCS.

Power quality monitors shall be provided at the mains and feeder breakers.

9.9.2.3 Power

125Vdc system derived from sealed lead-acid batteries with dual chargers and distributed through fused distribution panelboard for breaker trip and PLC power. 120Vac system shall be derived from the 4kV bus via a control power transformer with appropriate fuse protections to an external automatic transfer switch feeding a circuit breaker panelboard for breaker closing power, spring charging motors and battery chargers.

9.9.3 480V Switchgear

480V switchgear shall be sized for design load rated 600V, 3W, double-ended with dummy and automatic tie breakers. Switchgear shall be arc-resistant type, if available. Tie breakers sized at 120% of highest single side load. All motors over 200hp shall have individual feeder breakers. Use vacuum draw-out breakers with switchgear for motor loads greater than 200hp.

9.9.3.1 Standardized Equipment

Refer to Appendix A of the District's Design Contract Requirements for a table of standardized equipment.

9.9.3.2 Controls and Monitoring

Switchgear monitoring and control at the PCCS shall consist of: transfer control, mains and tie breakers status, room temperature, main transformer secondary voltage, networked switchgear data monitoring at mains and feeder breakers.

Power quality monitors shall be provided at the mains and feeder breakers.

9.9.3.3 Power

All low voltage panel boards shall be feed from dry type transformers to limit short circuit current. All dry type transformers and panel boards shall be 3Ø, 100A minimum.

9.10 Motor Control Centers (MCCs)

9.10.1 Arrangement

MCCs shall be front access only and installed against the wall and/or back-to-back configurations to minimize floor space. For single story structures, MCC shall have a floor trench system for cable routing to exterior duct bank terminations. In multiple story structures, MCCs shall have full length pull boxes with clear access from the lower story room. Coordinate with Architectural Design Guide.

9.10.2 Interface with Existing

When new process equipment will be fed out of existing MCCs, new starters shall be installed for the equipment under the contract. Existing starters shall not be modified or reused for new process equipment. New starters can be installed in spare spaces, existing unnecessary starters can be removed, or (load and space permitting) new MCC sections can be added where space is available in the MCC or Electrical Room.

9.10.3 480V MCCs

480V MCCs shall be sized for design loads, rated 600V, 3W with main lugs or bus duct connections to switchgear. The MCC shall include spaces for known future loads and 20% equipped space. Arrange similar loads including known futures loads distributed between MCCs that are feed from the opposite sides of the double-ended switchgear. Multilin 469 motor protection relays for large specialty and Variable-speed motors over 200Hp.

9.10.3.1 Standardized Equipment

Refer to Appendix A of the District's Design Contract Requirements for a table of standardized equipment.

9.10.3.2 Controls and Monitoring

MCC monitoring and control at the PCCS shall consist of: start, stop, ready, running, trouble, speed controls, and networked data monitoring of all feeders. For interchangeability, do not locate timers, relays or pilots devices in the MCC cubicles.

Power quality of motor loads shall be monitored with motor starter smart overloads, VFDs, and motor management relays.

9.10.4 4.16kV MCCs

4.16kV MCCs shall be sized for design load, rated 5kV, 3W with main lugs or bus duct connections to switchgear. MCC shall be arc-resistant type, if available. Known future loads shall be equipped spaces. Arrange similar loads including known futures distributed between MCCs that are feed from the opposite sides of the double-ended switchgear.

9.10.4.1 Standardized Equipment

Refer to Appendix A of the District's Design Contract Requirements for a table of standardized equipment.

9.10.4.2 Controls and Monitoring

MCC monitoring and control at the PCCS shall consist of: start, stop, ready, running, trouble, speed controls, and networked data monitoring.

Power quality monitoring via motor starter smart overloads, VFDs, and motor management relays.

9.11 Variable Frequency Drive Systems

In general, VFDs shall be located in the electrical room in an environmentally controlled space. However, field mounted VFDs may be allowed in cases where they are needed near the process for control purposes or to limit motor lead lengths or a building is not practical or desirable due to added cost. Field mounted VFDs shall be in an enclosure that includes a through-the-back heat sink integral to the VFD to dissipate heat outside of the enclosure. Harmonic mitigation shall include a line reactor on the VFD input and if necessary for a group of VFDs active harmonic filtering at the switchgear bus to limit the voltage THD to 5% in accordance with IEEE 519.

Low voltage (480V) VFDs shall be 6 step, pulse width modulation type (PWM). Table 9-3 is provided as a guide for VFD output mitigation against high voltage peaks at the motor. However, if an inverter duty motor with high winding insulation is used to guard against peak motor voltages additional mitigation may not be necessary.

Table 9-3. VFD Output Mitigation

	Output Reactor	dv/dt Filter
Up to 60 HP	>40 ft.	>200ft.
60HP-150HP	>150ft.	>200ft.
Over 150HP	>300ft.	>300ft.

Medium voltage (4.16kV) VFDs shall be 18- or 24-step, PWM type or cascaded H-bridge current source type. Medium Voltage VFDs shall be fan cooled up to 430A and ducted air over heat sink cooled above 430A. All medium voltage VFDs shall be grouped in HVAC controlled building structures. VFDs shall operate at less than 85dB at 6 feet or additional noise reduction methods will be required to meet the limit. Medium voltage drives shall include a full bypass contactor as determined by Reliability Centered Design.

Drive controller data shall be available over protocols outlined in Section 10.7.2.

Required voltage harmonic mitigation shall limit the total harmonic distortion to 5% on the process area switchgear bus For VFD systems, the Consultant shall perform a preliminary harmonic analysis of the EchoWater Facility's electrical system to calculate the THD and check

for harmonic resonant frequencies. Where necessary, consultant shall design harmonic resonant filters to shunt harmonic resonant frequencies to ground.

Motors for variable torque load VFD systems shall not be required to deliver more than 80 percent of the motor's nameplate horsepower rating by any load imposed by the driven machine at any specified operating condition or any load condition indicated by the driven machine's performance curve at all operating speeds. Motors for constant torque VFD systems shall have horsepower selected for necessary cooling at the lowest operating speed based upon motor manufacturer's heating curves. The motor's service factor shall not be considered in the calculation. Power factor correction capacitors on VFD systems are not allowed.

9.11.1 Standardized Equipment

Refer to Appendix A of the District's Design Contract Requirements for a table of standardized equipment.

9.12 Grounding System

9.12.1 Design

Submit calculations showing the grounding system shall be designed will achieve a 2 ohm resistance earth to ground and conform to IEEE Standard 142. It shall consist of a perimeter ground grid with rods in test wells for each new substation, structure, or facility. Building steel, process equipment, electrical equipment and enclosures, and exposed metal which might become a current conductor shall be connected to the ground grid. Exposed ground connections shall be compression lug type. Concealed, buried, or embedded ground connections shall be made by the exothermic method, except for the connection to the ground rod which shall be compression lug type. All conduits shall contain an equipment grounding conductor per the NEC.

9.12.2 Interface with Existing

Interconnections between each ground grid and the existing grounding system shall be provided by ground conductors running within interconnecting duct banks.

9.13 Lighting System

9.13.1 Design

Provide lighting software calculations showing compliance with California Title 24 requirements in all areas. Identify all fixtures with type letters and provide mounting details for all fixtures. Preferred voltage is 277V; utilize 120V if 277V is not economically feasible. Circuits feeding outdoor lighting fixtures shall be protected by ground fault interrupting (GFI) circuit breakers. Conduits for lighting circuits and 120V receptacles are not shown on the plans.

Exterior roadway and area site lighting shall provide adequate lighting levels to move throughout the plant and perform operations and maintenance tasks at various process area locations. Areas where process tasks are performed generally require more lighting than others

areas such as walkways. Table 9-4 outlines lighting intensity based on specific process area locations.

Design shall consider emergency light types and installation to keep the ease of monthly inspections and repairs and not include wet cell type battery back-up, dry cell only.

Table 9-4. Lighting Levels per Target Area

Area	Lighting Level (fc)
Entries, Building Indoor (Vestibules, Lobbies, Mud Rooms)	10 day 5 night
Entries, Building Outdoor (Canopied Entries/Exits)	2
Conference Rooms	40
Dim for Projection	10
Control rooms	30
Electrical rooms	35
General site	1
Walkways in Process area	3
Areas with valves, hydrants, manual operators	6
Areas with electrical operating equipment	12(15 preferred)
Substation	3
Roadway, process area general	0.5
Roadway, process area intersections & driveways	1
Lunchrooms	35
Laboratories	75
Designated Maintenance areas	50
Office	50
Process, inside	30
Gallery, general	3
Walkways in gallery, along piping	3

Area	Lighting Level (fc)
Areas with valves, hydrants, manual operators	6
Areas with electrical operating equipment	12(15 preferred)

9.13.2 Luminaries

Research on Light Emitting Diode (LED) as an illumination source has been conducted due to improvements in technology and affordability. The result is the selection of LED as the approved luminaire for both indoor and outdoor lighting. Outdoor lighting shall be LED with integral photocells. Indoor low and high-bay locations shall be LED and architecturally finished areas shall be standard recessed troffers or wrap-around surface mounted LED. Emergency lighting shall conform to Life Safety Requirements utilizing self-contained battery packs.

9.13.3 Interface with Existing

Only “standardized” fixture is for site lighting to match existing Holophane Somerset HLP square pole mounted on round concrete base per District Typical Detail E2. Select light fixtures similar in appearance to existing fixtures.

9.14 Receptacle System

9.14.1 Convenience Receptacles (120V)

120V receptacles shall be powered from dedicated 120/208V panel boards. Adjacent receptacles shall be fed from alternate panelboard circuits. Locate separately powered receptacles adjacent to HVAC and other specialized equipment. In interior and exterior process areas, locate receptacles every 50 feet and every 12 feet of wall space in occupied areas. Ground fault interrupting (GFI) type receptacles shall be located in lavatories, outdoors, wash-down process areas, below-grade structures, rooftops and tunnels.

9.14.2 Power Receptacles

Locate 3Ø, 60 ampere, 480 volt power outlets near convenience receptacles near major process equipment and structures. For large process areas, maximum spacing shall be 200 feet. Multi-story structures shall have power outlets on each floor. Receptacles shall not be mounted on lighting fixture poles or handrails. Receptacles shall be stanchion-mounted and grouped with other power and 120V receptacles. Provide weatherproof covers where located outdoors.

9.15 Raceway System

9.15.1 Branch circuits:

All low voltage panel boards shall be feed from dry type transformers to limit short circuit current; all dry type transformers shall be 3Ø.

9.15.1.1 Interior Circuits

All interior power and control circuits shall be installed in conduit. Minimum conduit size shall be ¾" and sized based on the NEC using THW insulation with minor variations. Interior circuit conductors shall have THWN/THHN insulation except VFD line side conductors shall be XHHW.

9.15.1.2 Conduit Racks

Conduits shall be routed exposed on conduit racks per District Typical Detail E26. Avoid embedded pull boxes or large numbers of conduits embedded in slabs and walls, where ever possible. Exceptions will be reviewed by the District on a case-by-case basis. Show size of large pull boxes and conduit racks width and bottom elevation on plan views. Instrumentation cables will be installed in either cable tray or conduit. All interior conduit racks, pull boxes, wireways and cable trays shall be designed for 25% spare capacity in addition to the NEC requirements for sizing cable trays and pullboxes.

Show conduit rack area on mechanical and HVAC drawings; coordinate with Mechanical and HVAC Design Guides.

9.15.1.3 Hazardous Areas

Hazardous areas as defined by NFPA 820 shall be identified on the drawings. Similarly, corrosive areas shall be identified on the drawings. The determination of hazardous and corrosive areas shall be made at the pre-design phase.

9.15.2 Equipment and Conduit Identification

All conduit, equipment, control devices, and major boxes shown will be assigned unique identifying numbers. All conduits shall be individually identified on the plans or sections. The use of typical details to show raceway numbering is unacceptable. Identifying numbers shall follow the format of the Standard Schedules provided as part of the District Standard Drawings.

9.15.3 Exterior Circuits

Distribute 12.47kV power to process areas via dual redundant manholes for each feeder pair, Minimum size medium voltage manhole is 8 feet by 8 feet. Typical medium voltage cable shall be 500kcmil or 750kcmil maximum.

Distribute low voltage power/control and signal in process areas in separate duct banks. Minimum size power/control and signal conduit is 2 inches, P, C & PC- power and control (480-120Vac) can be combined in ducts. P, C & PC- are routed via handholes & manholes labeled "HH" and "MH." S- signal (<100V and fiber optic) are combined and routed via hand holes labeled "SB." Low voltage conductor insulation shall be XHHW.

9.15.3.1 Underground Conduits

Underground conduits shall be grouped in duct banks. All exterior circuits shall be installed in conduit and multiple conduit runs shall be grouped into reinforced concrete encased duct banks per District Typical Detail E8. Duct banks under concrete slabs or building floor shall be non-reinforced per District Typical Detail E7. Minimum ductbank conduit size shall be 2-inch

polyvinyl chloride (PVC). Minimum duct bank depth from top of finished grade shall be 2 feet for low voltage and 3 feet for medium voltage. Include 10% spare conduit (with one spare minimum) in all duct banks. Duct banks shall be sloped a minimum of 4 inches per 100 feet and shall be designed to drain away from structures and equipment. Redundant medium voltage duct banks shall be routed through separate adjacent manholes. All duct banks shall be shown in plan view. In addition, full-length profiles of all duct banks shall be provided. Duct bank high and low point elevations shall be shown on the plan and profile views. Conduit cross sections shall be provided for all duct banks.

9.15.3.2 Handholes and Manholes

Hand holes shall be sized at 10 times conduit size and plans shall list the required length, width and depth. Handholes deeper than 3 feet shall be 4 feet square minimum. Handholes deeper than 4 feet shall have one side 5 feet in length minimum for portable ladder access. Medium voltage manholes shall be 8 feet square minimum and shall have a 480V three-phase sump pump. Sump pump shall be designed to surface discharge away from the manholes. Handholes and manholes shall not be located at low points of surface drainage systems. This includes the gutter in street areas. Handhole and manhole lids shall be set 1 inch to 2 inch above grade and be traffic rated where located in traffic and parking areas. Locate handholes and manholes on the site plans.

Coordinate with the civil design guidelines in Chapter 3.

9.15.3.3 Spacing

Pull boxes, handholes, and manholes shall be located as follows:

Straight pulls	400 feet maximum
Bends @ 90°	300 feet maximum
Bends @ 180°	200 feet maximum
Bends @ 270°	100 feet maximum
Bends over 270°	Not acceptable

9.15.3.4 Voltage Separation

In general, low voltage signal systems shall be run separately, in dedicated raceway systems. Underground medium voltage duct banks shall be separated from low voltage duct banks by 3 feet minimum for parallel alignments, and 1 foot minimum for crossing alignments. Underground low voltage duct banks shall be separated from signal duct banks by 2 feet minimum for parallel alignments, and 1 foot minimum for crossing alignments.

9.15.3.5 Local Disconnects

Local disconnects shall not be provided except for HVAC equipment, specialized equipment or special cases, or as required by the NEC. Where provided, they shall be equipped provided with auxiliary contacts that when opened, the control circuit is also opened and loses READY status to the PCCS.

9.16 Surge Protections

The Surge Protection Device (SPD) applications covered under this section include low voltage distribution and branch panel locations, MCCs, switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A.

9.16.1 SPD Type

All SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

9.16.2 Electrical Requirements

9.16.2.1 Maximum Continuous Operating Voltage (MCOV)

The MCOV shall not be less than 115% of the nominal system operating voltage. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

9.16.2.2 Protection Modes

The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following:

Configuration	L-N	L-G	L-L	N-G
Wye	•	•	•	•
Delta	N/A	•	•	N/A
Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

9.16.2.3 Nominal Discharge Current (In)

All SPDs applied to the distribution system shall have a 20kA Inrating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449

9.16.3 Electrical Demolition Work

9.16.3.1 Interface with Existing

Demolition work shall not disable existing electrical circuits to equipment that is to remain in place. Where necessary, design shall include temporary wiring to continue these circuits until final connections are complete. Reusing existing raceway for new or relocated equipment is not allowable unless the specific sequence constraints are listed in the project Request for Proposal (RFP) Section - Work Sequence. Add new raceway in these cases, the existing raceways will become spares.

9.16.3.2 General

Except for undisturbed wiring, all unused conductors shall be removed. All unused raceways in conduit racks shall be left in place and relabeled spare per the raceway schedule. Where exposed raceway conflicts with new work, the raceway shall be removed to the nearest coupling clear of the new installation. Where embedded raceway stub up conflicts with new work, it shall be cut off, ground flush and plugged with non-shrink grout on both ends. For abandoned embedded junction boxes, remove all conductors and install a blank cover inscribed "abandoned."

9.17 Cable and Raceway Schedules

Raceway numbering shall be issued for all systems – control, power, signal, fire alarm, PA, security, telephone, etc. -- with the exception of lighting and 120V receptacles which are unscheduled. Please refer to District Guide Specification Section 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL, Section 26 06 20.21 ELECTRICAL RACEWAY SCHEDULE and Section 26 06 20.25 ELECTRICAL CABLE SCHEDULE for specific numbering format.

Any electrical box with more than two (2) raceways termination on it will require a unique tag number.

All raceway numbering shall run from the power source to the equipment.

New spare raceways or existing raceways abandoned in place shall be numbered with the prefix "X" and shown in the raceway schedule. All existing raceways to be removed shall be listed in a separate demolition schedule.

Equipment numbers shall be included on all nameplates. Electrical equipment numbering shall be coordinated with District staff to ensure numbers are not duplicated. Raceway numbers shall be assigned unique numbers associated with the equipment numbers the raceway is serving.

Control block diagrams shall show the MCC, ACC, Control Panels and all control devices in block format. Diagrams shall list the equipment cable and raceway numbers and shall also show the type, number and gauge of all interconnecting control conductors. Control block diagrams are NOT part of the contract documents. These diagrams shall be submitted by the Designer to the District to aid the review of the cable and raceway schedules.

10.0 Instrumentation and Control Design

The purpose of this chapter is to provide design conformity with previous District projects and standards.

10.1 Codes and Standards

The project shall be designed to comply with applicable portions of the codes and standards listed in Table 10-1 below and as described in this chapter. Designer is to use the most current County-adopted code edition as posted to [Sacramento County Title 16 Buildings and Construction](#) up to submission of the Final Preliminary Design Report (PDR); the Designer is not responsible for any newer editions beyond Final PDR.

Table 10-1. Codes and Standards for Instrumentation and Control Design

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CBC	California Building Code
CFC	California Fire Code
EIA	Electronics Industries Alliance
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
ISA	Instrumentation Systems and Automation
NEC	National Electric Code
NFPA	National Fire Protection Association
NFPA 70	National Electrical Code
NFPA 72	Fire Alarm Signaling
NFPA 820	Standard for Fire Protection in Wastewater Treatment and Collection Facilities
NFPA 101	Life Safety Code
TIA	Telecommunications Industry Association
UL	Underwriters Laboratory

10.2 Drawings

District maintains a library of Common Contract Drawings for use on improvement projects. Review the drawings for project applicability and propose changes for particular project requirements. The District also maintains a Master Set library of drawings that document the existing Plant Computer Control System (PCCS); these drawings are available by request for information only.

10.3 Specifications

District maintains a library of guide specifications and schedules for use on improvement projects. Review the District Guide Specifications and schedules for project applicability and propose changes for particular project requirements.

10.3.1 Plant Computer Control System Control Strategies and Programmable Logic Controller Control Narratives

District Guide Specifications include PCCS Control Strategy and Programmable Logic Controller (PLC) Control Narrative standard format to document I/O points and programmatic monitoring and control in the Emerson Ovation distributed control system (DCS) and “Area” PLCs. The PCCS Control Strategies are descriptions of supervisory and regulatory control logic that is to be programmed in the Emerson Ovation distributed control system. PLC Control Narratives are descriptions of supervisory and regulatory control logic that is to be programmed in one or more Allen-Bradley (Rockwell Automation) “Area” PLCs. An Area PLC provides supervisory and regulatory control, communication with field equipment and instruments, other Area PLCs, subsystem PLCs and communicates with the Ovation DCS through Ovation ELC (Ethernet Link Controller) modules.

For Area Control Centers (ACCs) with one or more Area PLCs, the supervisory and regulatory logic is defined by the PLC Control Narratives and does not require a PCCS Control Strategy definition. For ACCs without an Area PLC, the PCCS Control Strategy definition is required to describe supervisory and regulatory control logic and the PLC Control Narrative is not required. The Emerson Ovation system is the primary HMI (Human Machine Interface) for the entire control system. New projects associated with one or more ACCs containing no Area PLC should add an Area PLC per ACC as part of the new project especially when subsystem PLCs (vendor systems) are included.

Supervisory control is defined as system control of multiple loops, multiple equipment and/or multiple processes working together for a common purpose. Regulatory control is narrower in scope and focuses on individual control loops, equipment, and process trains. is defined as having direct connections with instruments and control of field equipment or as providing system control over individual equipment PLCs such as master blower control PLC control over individual blower PLCs provided as part of the vendor’s control system. Regulatory control continues closed loop control after a communications failure with a remote supervisory control system based on maintaining the last good setpoint or supervisory command.

While division of supervisory and regulatory control may need to be considered on a case-by-case basis by the District and Designer staff, in general the following rules apply when the Area PLC exists or will be added as part of the project:

1. All supervisory control of multiple dissimilar pieces of equipment or processes shall reside in the Area PLC and be documented in PLC Control Narratives.
2. All operator process monitoring and control graphics shall reside in the Ovation DCS. All operator accessible process, calculated, and alarm variables shall available in the Ovation DCS from the Area PLC and be documented in PLC Control Narratives.
3. All supervisory I/O points shall conform to the District standard point naming conventions included in the PLC programming guide and documented in the I/O point schedule and PLC Control Narratives.

4. All master control of identical pieces of equipment or process trains shall be considered regulatory control and documented in PLC Control Narratives.
5. All field device measurement and control shall be monitored and controlled by the regulatory controller and documented in PLC Control Narratives.
6. All field device statuses shall be monitored and controlled by the regulatory controller and documented in PLC Control Narratives.
7. All local control panel, MCC, drive, actuator, and instrument statuses shall be monitored and controlled by the regulatory controller and documented in PLC Control Narratives.
8. All alarm switches and emergency stop statuses shall be monitored and controlled by the regulatory controller and documented in PLC Control Narratives.
9. All control, field device measurement and control, local control panel, MCC, drive, actuator, instrument, and alarm statuses for subsystem controllers shall be documented in the subsystem vendor package specification.
10. All area PLC I/O points shall conform to the District standard point naming conventions included in the PCCS programming guide and documented in the I/O point schedule and PLC Control Narratives.
11. All subsystem supplied PLCs (vendor package systems) shall be considered regulatory control, including all master PLCs provided with large subsystems which encompass multiple process trains.
12. All subsystem PLC I/O points shall be communicated through the Area PLC. The Area PLC's configuration will name subsystem PLC I/O points to conform to the District standard point naming conventions included in the PLC programming guide and documented in the I/O point schedule and PLC Control Narratives.

When an Area PLC does not exist in an ACC and is not being added by the project in question as decided by the District and designer staff, the supervisory and regulatory control logic is defined for the Ovation DCS by the PCCS Control Strategies. Field I/O points are connected to RTP or PLC-based hardware and managed by the associated Ovation DCU (distributed control unit).

10.3.2 Instrument and Input/Output Schedules

The PCCS instrument schedule shall include all instruments connected to the Emerson Ovation controllers, Area PLCs and subsystem PLCs. Subsystem supplied instruments shall be clearly identified as such in the PCCS instrument schedule.

The PCCS input/output (I/O) schedule includes all hardwired and networked inputs and outputs that are to be programmed in the Emerson Ovation control system. The PLC I/O schedule

includes all hardwired and networked inputs and outputs that are to be programmed in the Allen-Bradley ControlLogix PLCs. The I/O schedules shall include all subsystem I/O associated with vendor package systems. Subsystem I/O shall be clearly identified as such in the PLC I/O schedule.

Instrument and I/O schedules are developed by the designer specific for the improvement project. As a minimum, identify the parameters included in the guide specifications for the instrument, PCCS I/O, and PLC I/O schedules.

10.3.3 Cable and Conduit Schedules

Connection wire and location of exact panel terminations shall not be scheduled for wire within an Area Control Center (ACC) Control Room or facility Control System Room. ACC supervisory and regulatory control cabinets shall be considered as a single cabinet, for the raceway and cable schedule preparation. Connecting wiring between these cabinets shall not be in the raceway and cable schedule, it is part of the installer's detailed design. All cable and conduit schedules shall be coordinated with the Cable and Raceway Schedule section in Chapter 9 of these Design Guidelines.

10.3.4 PCCS and PLC Programming Standards

The District has PCCS Programming Standards and PLC Programming Standards that shall be referenced from the specifications and followed by the Emerson Distributed Control System (DCS) and PLC programmers. Typically, the District provides programming services for control logic defined by a PCCS Control Strategy. Typically, the construction contractor provides programming services for control logic defined by a PLC Control Narrative coordinating with the District for any District-provided programming services for the Emerson DCS HMI programming associated with the PLC Control Narrative. Refer to 10.3.1 for details about the PCS Control Strategies and PLC Control Narratives. Deviations from this should be approved by District and Designer staff.

10.4 Plant Computer Control System

The Plant Computer Control System (PCCS) is a combination of an Emerson Process Management Ovation Distributed Control System (DCS) and Allen-Bradley ControlLogix PLCs (Area PLCs).

The DCS provides:

- Supervisory and regulatory control in some ACCs
- HMI – visualization and historical trending
- SCADA (Supervisory Control And Data Acquisition)
- Alarm Management
- Data origination for the read-only HMI platform (Enterprise Data Server (EDS))

- Historical Data Collection
- Reporting functions

The Area PLCs provide:

- Supervisory and regulatory control in some ACCs
- Common interface points for subsystems

The PCCS extends to into all ACCs with each ACC containing all necessary components of the Ovation DCS including PLCs, where applicable, to operate independently from the rest of the control system if disconnected. The general architecture of the PCCS is shown on District Common Contract drawings.

The Plant Control Center (PCC), located in the Influent/Effluent (I&E) pump building, hosts the main HMI for the PCCS and interfaces to other supporting systems like fire and CCTV, and provides operational supervision and process control for the EchoWater Facility and Interceptor Pumps Stations and Facilities (Interceptor PSF). Refer to the District's Site Plan in the Common Contract Drawings, for the location of each process area, and the District's Master Set drawings that document the PCCS.

Primary PCCS components and services such as the database, historian, thin-client, and view client services, supporting servers and data storage, communication network hardware and main HMI are hosted and administered in the influent/effluent building with backup components in the Administration Building. The remainder of the PCCS infrastructure is distributed throughout the plant and extends via the SCADA system to include PLCs at remote locations outside the plant. The distribution is shaped by the ACCs shown in **Error! Reference source not found.** and the remote sites shown in **Error! Reference source not found.**

The PCCS Emerson Ovation control system HMI, database, historian, related servers and services, and workstation equipment runs on a Microsoft Windows operating system.

10.4.1 Area Control Center Configurations

An ACC groups process areas with similar purpose and location and creates a division for local operation support. Refer to Table 10-2 below for locations and a list of the main PCCS components in each ACC.

Each ACC contains one or more Ovation DCS controllers with their PCCS I/O subsystem and supporting control system equipment such as HMI workstations, control panels, backup control panels, instrumentation, communication network hardware, power distribution, motor control centers, and other facilities like an area control room.

Older ACCs have backup control panels for local monitoring and control of equipment. Typical backup control panels have analog controllers and indicators manufactured by Fisher-Porter and Yokogawa, and discrete controllers "Discrete Control Station Assemblies (DCSA)" for

controlling on/off type devices. Field wiring terminations for backup control panels are shown on District Standard Drawings. Newer ACCs with Area PLCs do not have backup control panels but rely on controller redundancy, process redundancy and instrumentation redundancy as required instead.

The PCCS I/O subsystem consists of RTP, Allen-Bradley PLC5, ControlLogix, Modicon PLC I/O and Ethernet Link Controller (ELC) I/O. The Ovation DCS controllers communicate with legacy RTP I/O over an Ethernet connection to one or more RTP Ethernet I/O Board Controllers (EIOBC) resident in the RTP I/O chassis. The EIOBC communicates with the RTP I/O cards over the RTP I/O backplane. The RTP I/O subsystem utilizes a pulse train output to the analog loop controller to raise/lower the analog output generated by the loop controller. The RTP I/O subsystem sends discrete output commands to the DCSA modules, which are wired to field devices.

The DCSA modules provide backup operation interface and can perform interlock functions for discrete devices. Local equipment control selector switches are provided on the DCSA modules and at local control stations adjacent to the field equipment.

Existing ACCs also have Beta-Alarm annunciator panels. All alarms are hardwired from either the RTP or Allen Bradley I/O to the annunciator panel. ACC 9 and ACC 14 utilize Allen-Bradley PanelView HMI interfaces instead of panel-mounted loop controllers.

ELCs are present in ACCs with Area PLCs to provide data exchange for the DCS HMI by managing network communications between Emerson DCS controllers and Area PLCs. The ELCs are part of the PCCS I/O subsystem because they are part of the Emerson DCS controller system exchanging Area PLC I/O data with the controller. The ELCs support multiple Ethernet communication protocols, but only EtherNet/IP is used as part of the PCCS to interface with Area PLCs.

No new ACC shall use the old ACC configuration. The use of backup control panels and RTP I/O are legacies that shall not be included in any future ACC design. Provide Area PLCs instead for future designs.

Table 10-2. Equipment within the EchoWater Facility

PCCS Equipment Type	Building	Location	Treatment Processes
PCCS Redundant Controllers (Primary Drop/Secondary Drop)			
Controllers: Area 1 (ACC 1)	Influent/Effluent Building	X01 Control Room	- Influent Pumping (RTP) - Effluent Pumping (RTP) - Reclaimed Water: WRL-WRH-WHWS (RTP) - ESB-D (A/B) - Boiler Room (A/B) - Barscreens & Grinding (A/B)
Controllers: Area 2 (ACC 2)	Influent/Effluent Building	X02 Control Room	- Influent Pumping (RTP) - Effluent Pumping (RTP) - Scum & Grit Removal - Potable and Non-potable Water: WN, WP (RTP) - Reclaimed Water Filter: WRF(A/B) - Walnut Grove TP (A/B) - Boiler Fdwater: BRF (A/B) - I-6 Alarms (A/B) - Headworks: Barscreens Dewatering and Disposal (A/B) - Utility & Service Air (RTP)
Controllers: Area 3 (ACC 3)	Primary Treatment Building	X03 Control Room	Primary Treatment (RTP)
Controllers: Area 4 (ACC 4 /ACC 11)	Secondary Treatment Building South	X04 Control Room	- Secondary Treatment (RTP) - West Secondary Substation - Recirculation compressor room (RTP) - Waste pumping (RTP) - Classifying selector (RTP) - Return Activated Sludge Pumping (Area)
Controllers: Area 5 (ACC 5 and ACC 6)	Chemical Building	X05 Control Room	- Chemical Handling (RTP) - Railyard Cl₂/SO₂ Leak Detect
Controllers: Area 61	Disinfection Operations Building	X61 Control Systems Room	- O₂ Substation (A/B) - Disinfection Chemical Storage (Area)
Controllers: Area 8 (ACC 8)	Solids Building	X08 Control Room	- Sludge Digestion & Disposal (RTP) - Solids Storage Basin (RTP) and (A/B) - Gravity Belt Thickener - Main Substation (A/B) - FOG - Weather Station (A/B) - L-DLD (A/B)

PCCS Equipment Type	Building	Location	Treatment Processes
Controllers: Area 9 (ACC 9)	Outfall Building	X09 Control Room	• Outfall (RTP) • AVM (RTP) • Caustic/Bisulfite Feed (A/B, Area) • River Flowmeter (A/B)
Controllers: Area 8 (ACC 10, ACC 13 and ACC 14)	Solids Building	X08 Control Room	• Sludge (RTP) • Main Substation (RTP, A/B) • Gas Handling (RTP) • Sludge & Gas (A/B)
Controllers: Area 12 (ACC 12)	Secondary Treatment Building North	X12 Control Room	• North Secondary CO Tanks (RTP & A/B) • Channel Aeration Blowers (Area) • Flow Equalization (Area)
Controllers: Area 52 (ACC 50, ACC 51, ACC 52)	BNR Building	X52 Control Systems Room	• Primary Effluent Pump Station (Area) • Biological Nutrient Removal (Area) • BNR Blowers (Sub-System)
Controllers: Area 59 (ACC 59)	NST Building	X59 Control Systems Room	• Nitrifying Sidestream Treatment (Area) • Lime Slakers (Sub-System) • Storm Drain Pump Station (Area)
Controllers: Area 75 (ACC 73, ACC 74, ACC 75, and ACC 79)	GMF Building	X75 Control Systems Room	• Filter Influent Pump Station (Area) • Granular Media Filters (Area) • Harvest Water Pump Station (Area) • Electrical Substation (Area)

10.4.2 Modifications to Existing ACC Backup Panels

Refer to District Common Contract Drawings.

Demolition work shall not disable existing control circuits that are to remain in place during the modification work. Where necessary, design shall include temporary wiring to continue these circuits until final connections are complete. Reusing existing raceway for new or relocated equipment is not allowable unless the specific sequence constraints are listed in the project Request for Proposal (RFP) Section - Work Sequence. Add new raceway in these cases and the existing raceways will become spares. All demolition work shall be coordinated with other sections of the District Design Guidelines.

The addition of any new I/O to an existing ACC shall use either Emerson Ovation I/O modules or Allen-Bradley PLC I/O cards depending on the type and complexity of monitoring and control functionality being added. For larger projects, add one or more Area PLCs to manage the new I/O.

In the very rare case where the design requires expansion with existing ACC panel mounted backup controllers and/or RTP I/O (and the District approves of expanding with non-Ovation I/O), the District will provide the additional RTP I/O cards, chassis, and any panel mounted

backup analog or discrete controllers. The District standard panel mounted loop control is a Yokogawa YS1700. The District standard RTP I/O to a panel mounted loop controller utilizes pulse train outputs connected to the loop controller to raise/lower the loop controller analog output controlling the valve actuator or other field device. The District standard panel mounted discrete output controller is a DCSA module. A local equipment control selector switch will be provided on the DCSA module and at the local control station adjacent to the field equipment.

10.4.3 Interceptor Pump Station and Facilities Equipment

The Interceptor Pump Station and Facilities (PS&F) SCADA system communicates with the PCCS through redundant Ovation SCADA servers located in the computer room adjacent to the PCC. The preferred system architecture at an offsite facility includes a Modicon Quantum PLC (new installs use Modicon M580 PLC) with a PanelMate HMI (new installs use Schneider Electric's Harmony HMI). All regulatory controls reside locally in the PS&F's PLC. Refer to Interceptor PS&F operational strategies which include a PLC Control Narrative describing the controls at existing facilities. The PCCS monitors and provides supervisory control with Interceptor PS&F PLCs over an Ethernet connection to the Interceptor PS&F station. The communication link to all large interceptor pumping stations, is a contracted service; some of these pump stations (N50, N51, and N19) have either a licensed (N51) or an unlicensed (N50 and N19) radio link. All other interceptor pumping stations and facilities have cellular communication links. The facilities are described below in Table 10-3.

Table 10-3. Interceptor Pump Station & Facilities (Interceptor PS&F)

Facility Name	Facility Description	Facility Location	GPS Coordinates
N15	Northeast Siphon Inlet Structure	Located immediately south of the entrance gate to the Northeast Pump Station, 1000 River Walk Way. (299-B3)	38°34'58.8"N 121°20'26.1"W
N16	Northeast Siphon Outlet Structure	Located on the North side of Mira Del Rio Dr., West of 9535 Mira Del Rio Dr. (299-B4)	38°34'34.3"N 121°20'39.0"W
N18 ¹	Northeast Chlorination Station	Located at 1000 River Walk Way (299-B3)	38°34'58.8"N 121°20'26.1"W
N19	Arden Sewage Pumping Station	Located at 1021 Howe Avenue (298-C3)	38°34'58.1"N 121°25'05.5"W
N20	Arden Force Main Oxygen Structure	Located at 4480 S Watt Ave (318-H3)	38°32'09.5"N 121°22'16.2"W
N40	Iron Point Pumping Station	Located at 1855 Iron Point Road. (281-E2)	38°38'40.7"N 121°08'44.8"W
N50	South River Pump Station	Located 900ft South of 5030 S River Road (316-E7)	38°30'07.0"N 121°33'37.7"W
N51	New Natomas Pump Station	Located at 3350 Airport Road (277-A4)	38°37'43.7"N 121°30'49.9"W
N52	Power Inn Pump Station (Fruitridge Interceptor Facility)	Located at 8150 Fruitridge Road (318-D4)	38°31'29.8"N 121°24'24.8"W
N53	Van Maren Lift Station	Located at 6680 Van Maren Lane (259-F3)	38°41'10.7"N 121°18'29.9"W
N55	West Sac Transition Structure	Located at 2071 Muscovy Road (316-H1)	38°32'43.2"N 121°32'11.9"W

S23 ¹	County Sanitation District 2 Sewage Pumping Station	Located on East side of Elvas Freeway at North Levee of American River. Access at exit from Cal Expo Blvd at freeway underpass. (297-J2)	38°35'36.7"N 121°26'38.4"W
S30	Natomas Sewage Pumping Station	Located North of the intersection of San Juan Rd and Airport Rd, East side of Airport Rd. (277-A4)	38°37'43.7"N 121°30'49.9"W
S33	Cordova Sewage Pumping Station	Located at the former Cordova Treatment Plant, Northwest of Coloma Rd to the West end of Chase Dr. (299-E1)	38°36'08.6"N 121°18'43.5"W
S055	Northeast Sewage Pumping Station	Located at 1000 River Walk Way (299-B3)	38°34'58.8"N 121°20'26.1"W

¹ SCADA is not implemented at these locations.

10.5 Area Control Center Networks and Control Systems Rooms

An Area Control Center (ACC) groups like processes located near one another. Operationally, an ACC is defined by its data and communication network infrastructure and facility rooms. These design elements provide localized monitoring and operational control support for the associated process areas while interconnecting with the other ACCs to participate in overall management of the plant's treatment processes. Should an ACC be operationally isolated from the rest of the plant (e.g., network failure with the root systems), the operational technology (OT) networks and facility design shall allow operations within the ACC to continue while connection to the rest of the plant is restored.

10.5.1 ACC Networks

The ACC networks include the following physically separated local area networks (LANs) grouped by operational technology (OT) and information technology (IT) systems as shown in Figure 10-1.

- OT LANs:
 - PCCS LAN: There will be a redundant PCCS network defined A and B network switches. The PCCS network will be configured as a redundant star topology with rapid spanning tree protocol. The A side will connect to the PCCS root switch and the B side will connect to the PCCS backup root switch. The A side shares the same backbone cable as A side of the PLC network but communicate over dedicated fibers. The B side and B side of the PLC network will share a fiber optic cable and communicate independently over dedicated fibers.
 - PLC LAN: There will be a PLC network divided by A and B network switches and internally managed with virtual local area networks (VLANs). The PLC network will be configured as a redundant star topology with rapid spanning tree protocol. The PLC A network switch will connect to the PLC A network root switch and the PLC B network switch will connect to the PLC B network backup root switch. PLC A network switch will share the same backbone cable as A side of the PCCS LAN but communicate over dedicated fibers. PLC B network switch and the B side of the PCCS LAN share a fiber optic cable as well and communicate independently over dedicated fibers.

- Maintenance Networks: This network includes VLANs for the following applications: Power Management, Vibration Monitoring, HVAC, Fire Alarm, PLC Programming and Profibus device administrative access. The maintenance network is configured using redundant star topology with rapid spanning tree protocol between the root and fanout switches, but the fanout switches are non-redundant. The fanout switches connect to both the A side root switch and the B side backup root switch. The A side of the network shares the same backbone cable as the PCCS A and PLC A sides of their networks but communicates over dedicated fibers. The B side of the network shares the same backbone cable as the PCCS B and PLC B sides of their networks but communicates over dedicated fibers.
- Security Network: This network is configured as a star topology and supports District standard closed-circuit television (CCTV) and access control systems.
- IT LANs:
 - IT Networks (formerly known as MIS): This system of networks is configured as a star topology and supports District IT business applications, printers, voice over IP (VoIP) telephony applications and public address (PA) system and wireless guest internet access. The PA system is managed as part of the IT network and communicates via proprietary protocol over fiber optic and copper cables to distributed public address system equipment. The wireless guest internet access is managed as part of the IT network but has its own equipment to provide wireless connectivity and isolation from business systems. The IT network provides client connections to systems associated with other LANs as required.

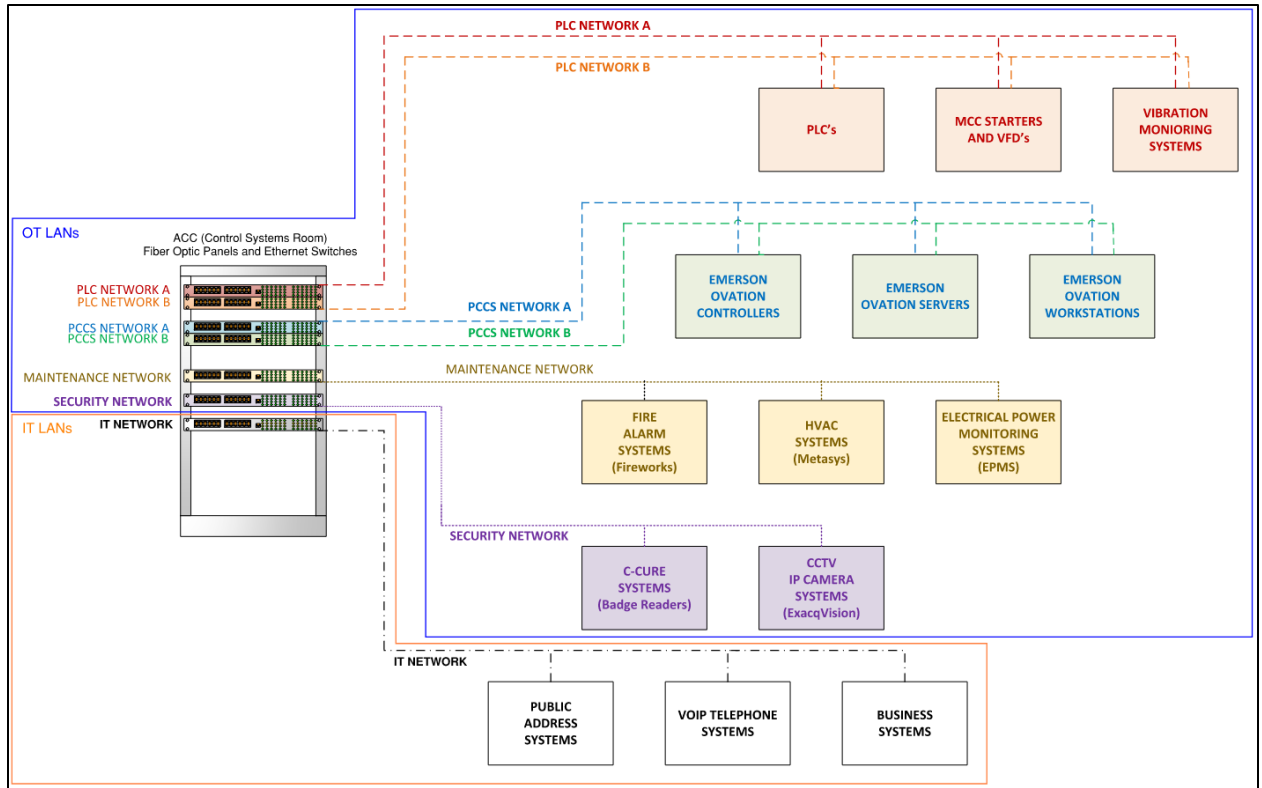


Figure 10-1. ACC Networks

The primary control networks include the PCCS local area network (LAN) connecting all of the Emerson Ovation DCS components together as an integrated system and the PLC network connecting all of the area PLCs and subsystem PLCs together as an integrated system. The PCCS and PLC networks are connected through routers in each Area Control Center (ACC). Both the PCCS network and the PLC network are configured as redundant star networks that utilize root and backup root switches.

In addition to the plant-wide PCCS LAN, the PCCS includes a wide area network (WAN) for communications with the Interceptor PFS. This network is managed by the District Control and Electrical Systems (CES) Department. The LAN connects all the Ovation operator/engineering workstations, Ovation servers, Ovation controllers, and Ovation SCADA system. The WAN connects the Ovation DCS via the Ovation SCADA servers to each of the remote Interceptor Facility LANs.

The PCCS network shall utilize Emerson supplied network equipment installed, connected and programmed by Emerson staff into racks and cabinets installed by the construction contractor (refer to Figure 10-5). The PLC network shall conform to OT network equipment standards and shall utilize OT standard networking equipment. The District shall install, connect and program the PLC network equipment into racks installed by the construction contractor. Networking equipment inside of PLC cabinets is built and installed by the construction contractor. Industrial networking equipment supplied with PLC control panels is specified in the PROGRAMMABLE LOGIC CONTROLLERS Specification Section 40 63 43.

The plant's fiber optic (FO) backbone network infrastructure is comprised of two 96-strand single-mode (SM) cables terminated with LC connectors and connected to FO termination panels distributed throughout the plant.

The preferred FO cables for expanding from the backbone network FO patch panel to another area as a spur off the backbone shall be one FO cable with 48-strands of SM fibers.

Check with the District for availability of existing backbone fibers. FO patch cables on existing FO termination panel are installed by the District. FO cables are to be scheduled on the conduit and cable schedule. FO patch cables should connect between the FO patch panels and FO ports on switches, routers, and other networked equipment. The use of FO media converters should be avoided wherever possible. Extensions to the FO system shall be shown on the project drawings. FO termination panels are documented on the X-401 series project drawings and shall include front view with cabinet size, material list and nameplate engraving schedule. Refer to District Standard Drawings.

10.5.2 New ACC Arrangement

The preferred ACC arrangement consists of separate spaces for an operations Control Room, a Control Systems Room (CS Room), and an Electrical Equipment Room. The Control Room shall include working space for an operations crew with maintenance and operations supervisor offices and common space for operations meetings. The Control Room equipment shall include two PCCS workstations each with one or two large monitors (specific size to be determined at the time of design), one IT workstation, printer, fire alarm panel and other system interfaces and communication tools as determined by the needs of Operations in that area.

The CS Room shall be a secured area and include all PCCS and auxiliary systems. The network equipment shall include all network media (cable and jumpers), routers, switches, termination panels, computers, and equipment racks, with the exception of operator workstation and printers located in the Control Room. In addition, the CS Room will include the PCCS and auxiliary equipment including: an Emerson Ovation DCS control panel, an Area PLC control panel, PCCS or auxiliary system servers, access control panel, HVAC control panel, UPS, and public address amplifier panel.

The electrical equipment room shall include all equipment described in the Electrical Rooms section of Chapter 9 of these District Design Guidelines. ACC design shall be coordinated with the architectural design guidelines presented in Chapter 4 and the electrical design guidelines included in Chapter 9.

Smaller process areas shall be provided with a secure CS Room and Electrical Equipment Room, but not a Control Room. The small process area CS Room will as a minimum include PCCS and PLC networking equipment, an Area PLC control panel (optionally supplied with a desktop PC running Emerson Ovation HMI software), and UPS. The minimal PCCS and PLC networking equipment shall include a fiber optic termination panel for termination of the fiber optic cable connecting the small process area building with its associated ACC, and switches for connecting the redundant PLCs to the PLC-A and PLC-B fanout network switches, and

optionally, switches for connecting the operator workstation HMI(s) to the PCCS-A and PCCS-B fanout network switches.

The Operators will control the large and small area processes from the PCC and operator workstations in the ACC Control Room. Subsystem control panels typical have no HMI or a dedicated non-Emerson local HMI. The data used for monitoring and control for the subsystem HMI shall be replicated to an Area PLC and made available to the Emerson Ovation HMI. No Emerson HMI is required at subsystems control panels.

10.6 PCCS Ovation and Area PLC Controllers

All new process improvement projects will utilize one or more Emerson Ovation controller pairs for interfacing with one or more Allen-Bradley ControlLogix PLC(s) for supervisory and regulatory control. See the Plant Computer Control System Control Strategies and Programmable Logic Controller Control Narratives, paragraph 10.3.1, for clarification on assignment of control to supervisory or regulatory controller.

A simplified diagram of a typical ACC's PCCS and PLC network equipment, network interface, and network connections are shown schematically on Figure 10-1 below. VLANs are not shown for clarity.

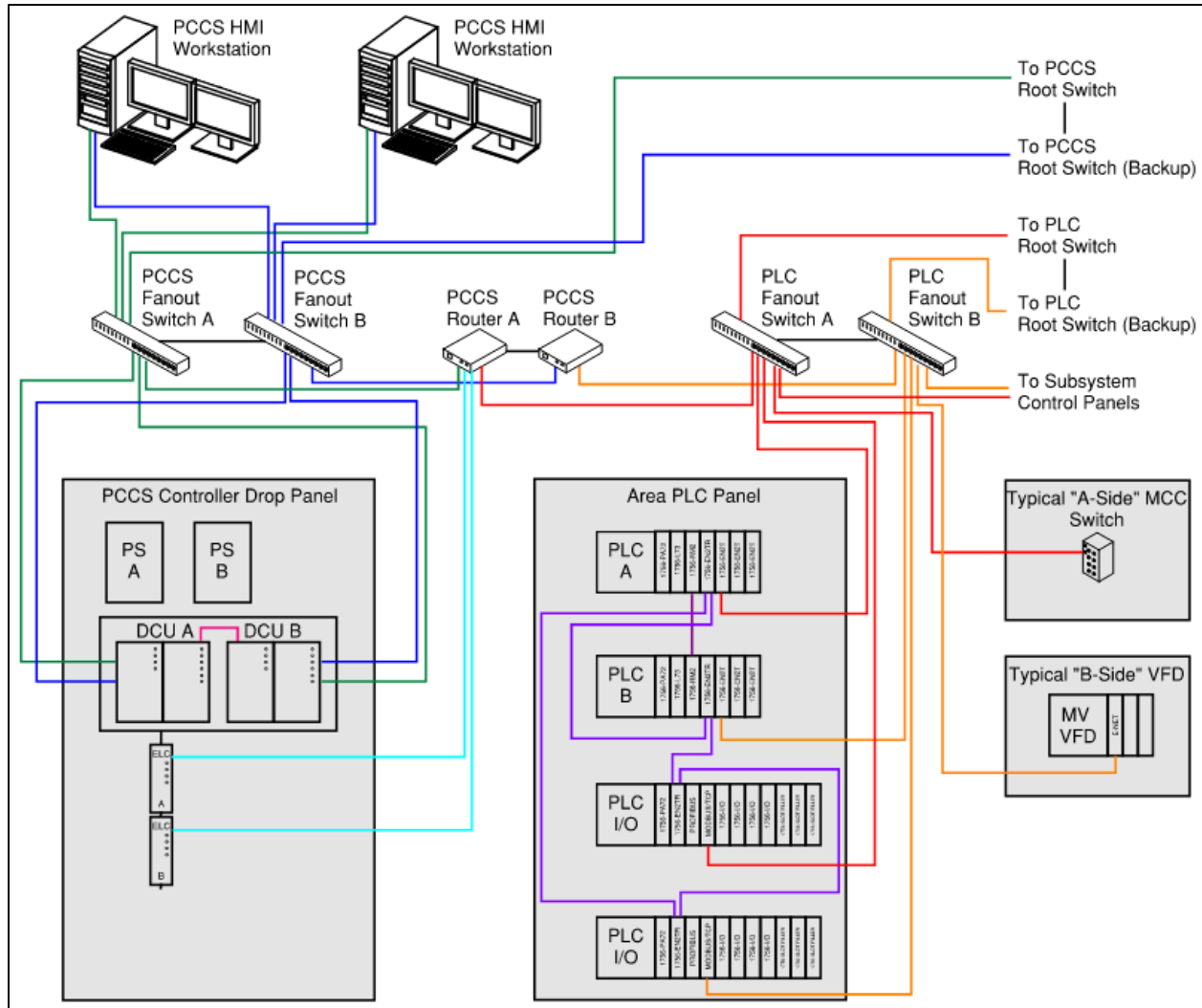


Figure 10-2. PCCS and PLC Network Connections

10.6.1 Supervisory Controllers

Supervisory control panels shall be supplied by Emerson Process Management (refer to Figure 10-5) and shall conform to standard control panel specifications. Redundant Emerson Ovation controllers shall provide supervisory control for each new ACC. The most current version of Ovation controller that is compatible with the currently operating software running on the PCCS shall be selected.

10.6.1.1 Ovation Ethernet Link Controllers

Ovation Ethernet Link Controller (ELC) module is the primary communications interface between the Emerson Ovation control system and the Allen-Bradley Area PLC. To maximize data throughput for this interface, field data flows from the PLC to the PLC network as EtherNet/IP protocol and from the PLC network to the ELC module where it is converted from EtherNet/IP to Ovation protocol. The Ovation protocol data then is routed from the ELC module through the PCCS network and to the Ovation controller. The performance of Ovation/Allen-Bradley communications and the limitations of an ELC will dictate the number of ELC modules required for this interface up to six per Ovation controller pair and no more than 20,000 data points per Ovation controller and 4,000 per ELC. Ovation database I/O will be incorporated into operator graphics, alarms, trends, and supervisory reports. A generalized connection and data flow diagram for a PCCS Ovation Controller and an Area PLC is shown on Figure 10-3 below. The Area PLC manages communications with field devices.

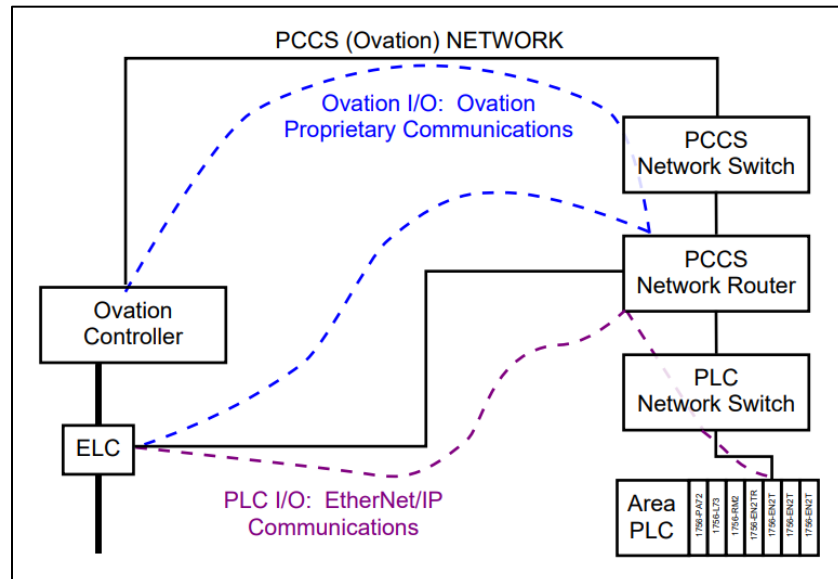


Figure 10-3. Ethernet Link Controller Cabling and Data Flows

10.6.2 Area Programmable Logic Controllers

The Area PLCs will be the Allen-Bradley ControlLogix platform implemented with a redundant controller and EtherNet/IP communication architecture (refer to Attachment A - Standardized Equipment List). As a minimum, each redundant PLC pair will communicate with

the PLC network and be capable of bumpless fail over from the primary PLC to the secondary PLC when there is a primary PLC failure.

EtherNet/IP will be the standard protocol used for the Ovation to Allen-Bradley interface. The PCCS Emerson Ovation controllers will communicate with the ControlLogix PLCs via Ethernet connections to the redundant PLC network using EtherNet/IP protocol. The PLC will be programmed in ladder logic wherever possible with options for structured text if it provides better logic visualization and functionality as approved by the District. All PLC programming and will follow best practices for structured programming and District PLC programming standards.

Ethernet networks will be used to communicate between the redundant PLC network and MCC motor starters, VFDs, and power quality monitors. The fieldbus network connections to the PLC networks are shown schematically in Figure 10-4. MCCs connect to the redundant PLC network and may include redundant industrial network switches but are most commonly provided in a non-redundant configuration with equipment split between MCCs as a way to manage single-points of failure (District's preference is Allen-Bradley Stratix Ethernet switches). Power quality information is routed from the PLC network to the Maintenance network at the PCC-Annex and the Administration Building to communicate power quality data from power quality meters, VFDs, motor starter smart overloads, and motor management relays to the District's power monitoring software. The Ethernet networks support Area PLC communications with field devices using native EtherNet/IP and non-native Open Modbus TCP/IP protocols.

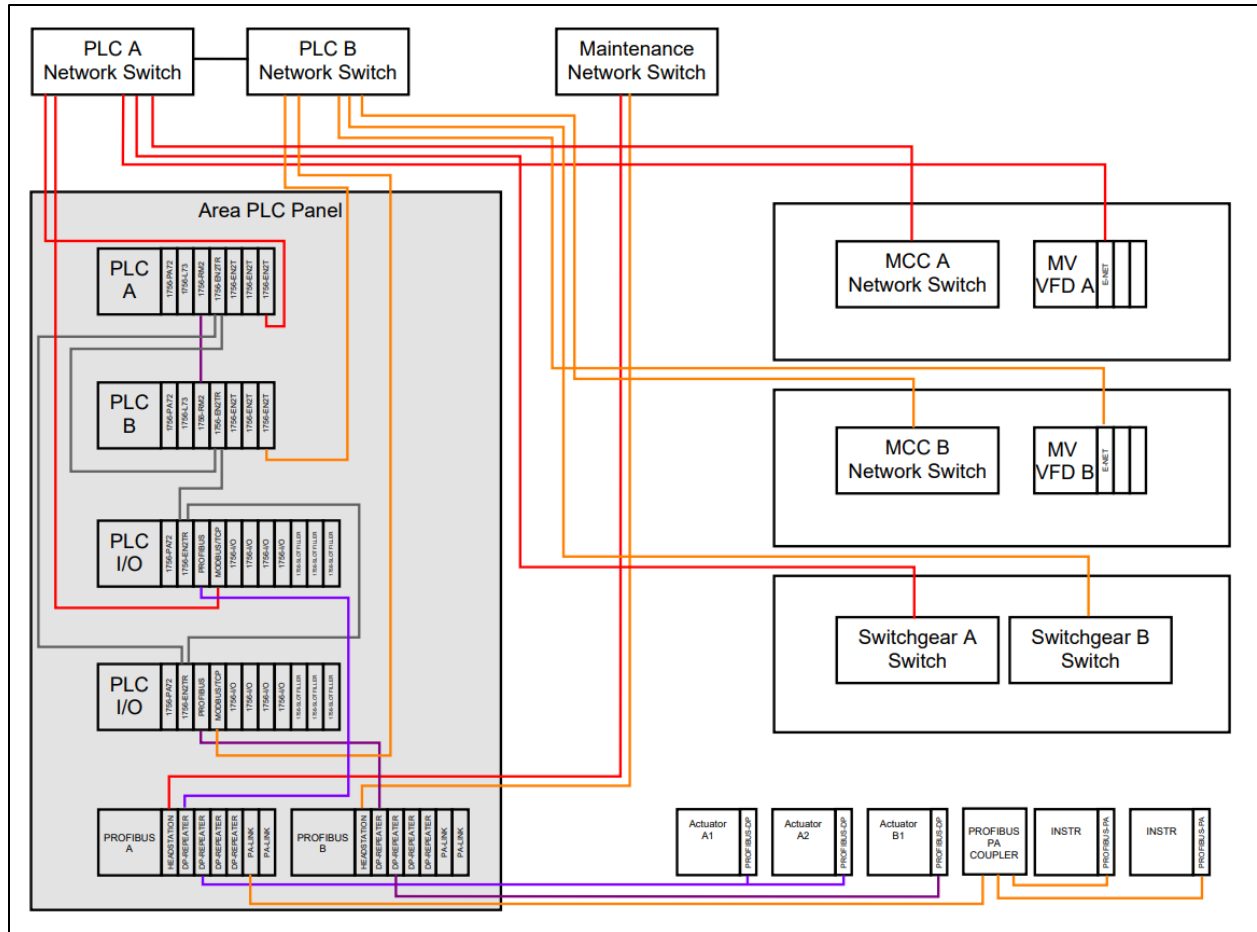


Figure 10-4. Area PLC Fieldbus and Network Connections

10.6.3 Subsystem Programmable Logic Controllers

Subsystem PLCs are standardized equipment and are required to be either Allen-Bradley ControlLogix or CompactLogix PLCs based on the number of I/O and the complexity of the control logic; CompactLogix PLCs are for smaller, less complex systems. Refer to Attachment A - Standardized Equipment List. The subsystem PLCs will communicate with an Area PLC using the PLC network. Subsystems that are supplied with a master PLC shall have the master PLC be a ControlLogix PLC and it shall communicate with the Area PLC using the PLC network. Slave ControlLogix or CompactLogix PLCs associated with the subsystem shall communicate with each other and the master PLC over the PLC Network or on a closed network managed by the subsystem provider. EtherNet/IP will be the standard protocol used for subsystem PLCs communicating with an Area PLC. The subsystem PLC will be programmed following industry best practices for structured PLC programming.

10.6.4 Equipment Providers

A Control Systems Room (CS Room, refer to paragraph **Error! Reference source not found.**) contains network and controller equipment, racks and panels provided and installed by the contractor and also contains equipment provided and installed directly by the District or indirectly by District prov**Error! Reference source not found.** for typical equipment providers. New project plans and specifications

should follow this plan for CS Room equipment construction. Equipment and panels not shown in Figure 10-5 shall be provided by the contractor except for other Emerson Ovation specific hardware such as workstations and thin clients. The contractor installs equipment they provide.

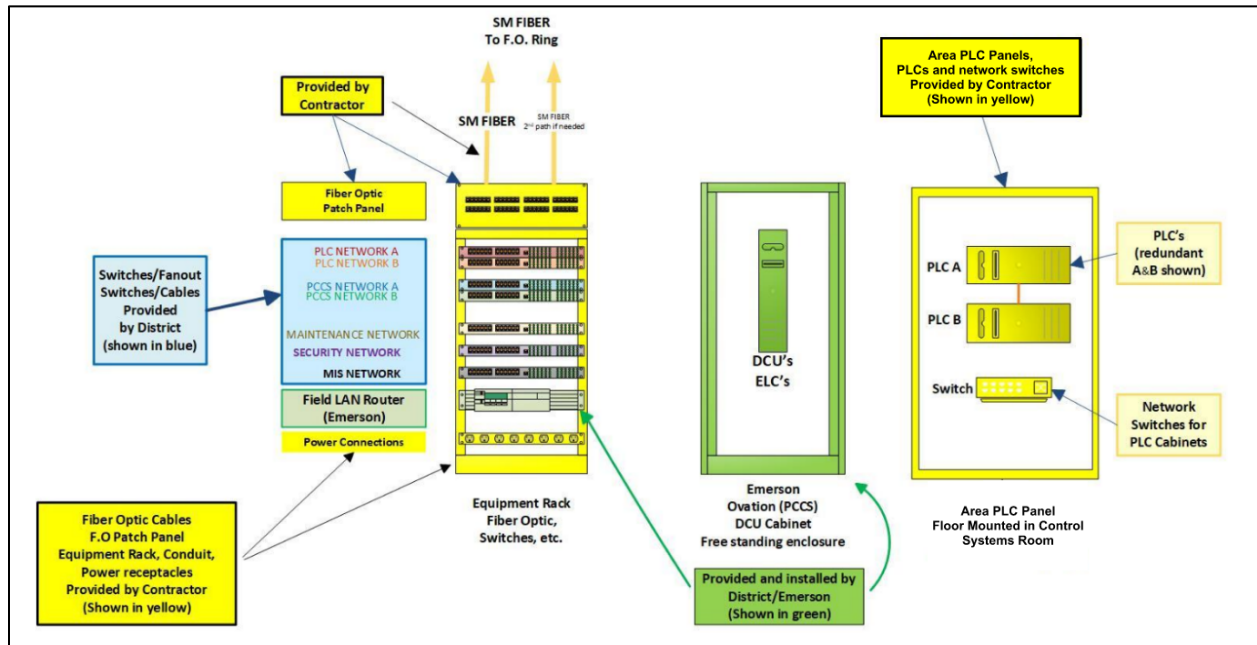


Figure 10-5. New Project Control Systems Room Equipment Provider Example

10.7 I/O Subsystems

Input/Output (I/O) data subsystems are described for PLCs and electrical equipment.

10.7.1 PLC I/O

PLCs monitor I/O from devices like field instruments, analyzers, switches, actuators, power monitors, other PLCs and motor control devices such as VFDs, RVSSs and overloads for the purpose of sharing information providing process monitoring and control. The PLC I/O subsystem defines the technology used to connect I/O signals with PLCs for both Area and Subsystem PLC systems.

Methods for PLC I/O connections to other devices are categorized into three types:

- Hardwired
- Fieldbus
- Networked.

Each type contains cabling, hardware and software components. Hardwired connections provide wired connections of individual signals to purpose-built PLC I/O modules that convert each monitored signal into a PLC memory value (input) or convert a PLC memory value into a control signal (output) (e.g. discrete input, discrete output, analog input, analog output, RTD,

thermocouple). Fieldbus technology defines physical serial communication cabling and signal protocols to exchange I/O data with the PLC (e.g., Profibus). Network technology defines physical network cabling and signal protocols to exchange I/O data with PLC and is commonly defined by industrial standards operating on an Ethernet network (e.g., EtherNet/IP and Modbus TCP/IP). Sometimes more than one connection type is used for a set of signals (e.g., a Remote I/O (RIO) panel can use hardwired connections to the field devices and network connection to the PLC). Wireless communications can be used with all three methods but should only be considered when a non-wireless solution is not economically feasible.

New projects shall emphasize networked and hardwired connection types. The networked connection type should be used for devices with high concentrations of data like a multi-variable device that supports Ethernet connectivity, another PLC or a RIO panel. A multi-variable device contains more than one monitored or controlled value or state. Hardwired connections should be used for lower concentrations of data either from a single-variable device or as part of a RIO panel located near a concentration of field devices. The use of fieldbus technology is discouraged for new projects. If it is justified during preliminary project design, fieldbus designs shall use Profibus and conform to existing Plant standards.

Projects implemented from 2010 - 2023 standardized on Profibus fieldbus technology connecting a majority of the instruments and motorized valve actuators to Area PLCs. Most subsystem providers were not required use and did not use Profibus for devices connections. Profibus DP (RS485) connected most valve actuators and some instruments to PLCs and Profibus PA (Manchester Bus Powered (MBP)) connected most instruments to PLCs. Profibus DP segments were designed with no more than ten devices per segment. Profibus PA segments were configured in a star configuration. When daisy chain configuration was used, all instruments were connected using a “T” connection near the end device allowing communication to all other devices on a segment to continue should a spur line from a “T” connection to a single device be disconnected. In addition, the Profibus network design included redundant power for all Profibus connected communications and support for redundant ControlLogix PLC masters that ensures there is no loss of Profibus data should the primary PLC fails and the secondary PLC take control.

Hardwired signaling with field equipment and instrumentation shall be terminated to PLC(s) as follows: discrete I/O shall utilize 120Vac I/O modules with the exception of 4kV and 12kV switchgear which shall utilize 125Vdc I/O modules. Non-fieldbus networked analog I/O shall utilize 4-20 mA, thermocouple, or RTD I/O modules that support the HART protocol. All of the I/O associated with a single piece of equipment shall be terminated on a single I/O card wherever possible, and I/O associated with redundant equipment shall never be terminated on the same I/O card. Redundant equipment shall have two independent communication paths to the PLC. RIO panels with hardwired I/O modules shall be considered to provide a localized concentration of I/O points with networked connectivity back to the associated PLC. I/O modules shall be from the same manufacturer as the PLC hardware.

Profibus and networked field equipment and instrumentation connections shall be segregated to follow the split power buses, e.g. pumps 1 and 3 powered by the A-Bus may connect using a

common segment/network and pumps 2 and 4 powered by the B-Bus may connect using a different segment/network. In this way, failure in a particular segment or network will mimic equipment failure due to a bus power failure. Refer to paragraph 10.9.1 for more information.

ACC preliminary design shall include an estimate of the total I/O point count (master equipment list (MEL), process control narrative point estimate) expected to be programmed in the PLC to enable the District to determine the required PLC and Emerson Ovation resources.

Field located local control stations are to be provided with all new equipment for backup operations.

10.7.2 Electrical Equipment I/O

Data monitoring and control I/O points for electrical equipment shall be as specified in Chapter 9 of these Design Guidelines. Connectivity of electrical equipment to an Area PLC for control and monitoring shall be by an Ethernet connection using EtherNet/IP. When EtherNet/IP is not available, Modbus TCP/IP can be used. A hardwired starter/drive enable signal sourced from the associated Area PLC to each starter/drive connection shall be provided when it is feasible to provide the hardwired connection. An example where this is may not be feasible is when the network connection to the starter/drive requires a fiber optic cable link. Starters and drives shall typically be configured to stop operating on a communication failure with the associated Area PLC when a network connection is used for both control and monitoring. Scenarios where the starter/drive should continue to operate on a loss of communication are when the connection is for monitoring only or considered on a case-by-case basis for critical motors when the connection is for both control and monitoring.

10.8 Auxiliary Networks

Currently, there are three main Auxiliary Networks in use within the EchoWater Resource Recovery Facility: Information Technology (IT) network, Maintenance network, and Security network. A block diagram of the various ACC network logical connections is shown in Figure 10-6.

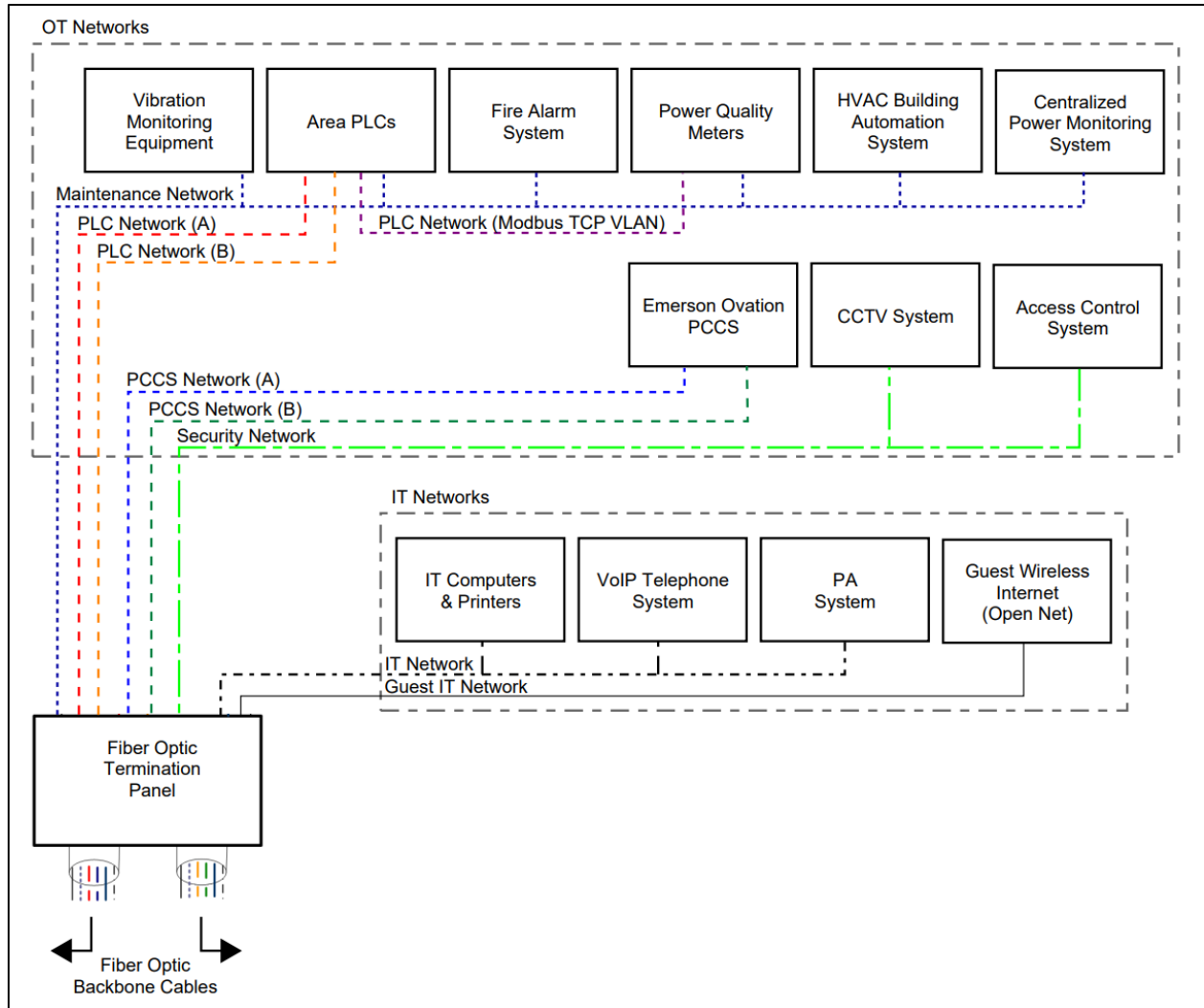


Figure 10-6. ACC Networks Block Diagram

The IT network is the general purpose network managed by the District's IT Department. This system of networks provides all EchoWater Facility personnel with email services, storage services, printer services, Voice over Internet Protocol (VoIP phone services) and the Public Address (PA) system and access to the internet. The IT Guest Network (Open Net) includes all wireless internet access points (Wi-Fi).

The OT Maintenance network includes separate VLANs for the fire alarm system, Heating Ventilation and Air Conditioning (HVAC) system, Programmable Logic Controllers (PLCs), and CCTV devices. This network is managed by the District Control Systems Department.

The OT Security network includes access control and CCTV systems. The CCTV networking includes all IP-based security cameras and the Network Digital Video Recording (NDVR) system.

All IT networks shall conform to IT network equipment standards and shall utilize IT standard networking equipment. District IT staff install, connect and program auxiliary network equipment. Building wiring is provided and installed by the contractor.

All OT networks shall conform to OT network equipment standards. District OT staff install, connect and program auxiliary network equipment. Building wiring is provided and installed by the contractor. Refer to paragraph 10.6.4.

10.9 Power Monitoring System

The District monitors power usage throughout the plant and is viewed in the PCCS.

Power monitoring devices shall provide Ethernet connectivity and support Modbus TCP communications. As shown on Figure 10-6, the power quality monitoring devices are logically connected to both the PLC and the Maintenance networks. All monitoring devices shall be physically connected to a PLC network switch, monitored by an Area PLC and displayed in the PCCS HMI, segregated from other network traffic via VLAN.

10.9.1 Power Monitoring Devices and Network

Power monitor devices include power meters (switchgear data monitors (SDM)) shall communicate over the PLC network. These devices shall be segregated to follow the split power buses; for example, VFDs for pumps 1 and 3 powered by the A-Bus connect to the A-side of the PLC network and VFDs for pumps 2 and 4 powered by the B-Bus connect to the B-side of the PLC network.

Power quality meters are on all switchgear mains and some feeder breakers and connect to the PLC network with split connections to the A-side and B-side similar to the method used for the VFDs mentioned above. Reference Section 9.5.

Low voltage MCCs and medium voltage MCC motor management relays, VFDs, and motor starter smart overloads are connected to PLC Networks for power quality monitoring with split connections to the A-side and B-side similar to the method used for the VFDs mentioned above.

10.9.2 Power Monitoring, Field Devices and User Devices

10.9.2.1 PCCS Power Monitoring

Area PLCs monitor a standardized set of data from field power monitoring equipment. The existing PCCS Ovation HMI/Historian and Enterprise Data Server (EDS) collect historical data and monitors real-time points via the PCCS network. Power monitoring field data is routed to the PCCS network starting from the PLC network, through the PCCS router, through the PCCS Ethernet Link Controller (ELC) module, through the PCCS Ovation Controller and then made available to the PCCS HMI/Historian and EDS.

10.9.2.2 Power Quality Monitoring User Devices

End-user devices include laptops and remote desktops.

Local laptops loaded with power management host software shall plug into the front of the meters to access data and diagnostics information.

Remote desktops loaded with power quality monitoring host software shall access the power quality meters via the Maintenance networks.

10.9.2.3 Power Monitoring Points

Power quality monitoring points communicated to the PCCS network through an Area PLC (as shown in Figure 10-6) is limited and shall consist of Amps, kV, kW and THD (where applicable).

10.10 Local Controls

Local control is required for all equipment with minor exceptions. Local controls vary in size and complexity depending on specific equipment requirements and include: control stations furnished under the electrical system, typically Hand-Off-Auto (HOA) switches, critical interlock status lights, reset buttons, and ready lights near the controlled equipment. Run lights shall be included at control station for submersible or remotely located motors, but otherwise not included. Where a local emergency stop function is required, it shall be accomplished with an E-stop button.

10.10.1 Local Controls Furnished under Electrical System

Local controls are documented on the plan drawings, control and logic diagrams, and P&IDs. Where 120Vac power is required for a single device motor drive, the local control panel power shall be derived from the MCC control circuit.

10.10.2 Local Subsystem Controls Furnished with Mechanical or Process Equipment

Subsystem vendor packaged system controls are documented on the plan drawings, control and logic diagrams, and P&IDs. Some equipment furnished with manufacturer's standard control panels requires certain modifications that are not manufacturer's standard options to integrate into the Area PLCs. Show all interface points on the P&IDs (typically Start, Stop, Ready, Running and Trouble) and specify those interface requirements be networked or hardwired to terminal blocks in the equipment technical specification.

Custom control panels shall reference the CONTROL SYSTEM EQUIPMENT PANELS AND RACKS Specification Section 40 67 00 for the detailed control panel requirements. Equipment technical specification submittal requirements shall include PLC Control Narratives for the subsystem equipment and typical control panel requirements. Where 120Vac power is required for a single device motor drive, the local control panel power shall be derived from the MCC control circuit. If two or more devices are controlled, a separate circuit from an instrument power panel shall be utilized for power.

Subsystem I/O shall be specified in the PROGRAMMABLE LOGIC CONTROLLER INPUT/OUTPUT Specification Section 40 61 93.20, and the subsystem instrumentation shall

be specified in the SCHEDULES OF INSTRUMENTATION FOR PROCESS SYSTEMS Specification Section 40 06 70.

10.10.3 Safety Interlocks

Safety interlocks shall conform to all applicable codes and standards. For covered process areas like the chemical storage and digester gas areas, the safety interlocks will be reviewed for conformance to NFPA 79 and will be configured in a manner that avoids adverse consequences to personnel safety, health, and the environment.

10.10.4 Noncritical Alarms and Interlocks

Noncritical alarms may be generated by discrete outputs from a field device, PLC or processing of an analog value for a trip point. The "READY" status shall be satisfied when all switches and interlocks are in the normal status. The "RUNNING" status shall be obtained through auxiliary contact closure from the motor contactor or pilot relay.

Process interlocks or equipment protection interlocks are not considered safety interlocks and can be either hard wired or for a group of interlocks programmed in a standard programmable logic controller. Refer to Attachment A - Standardized Equipment List.

Refer to Section 10.7.2 for a description of the PLC-controlled enable signal for software interlock implementation.

10.11 Instrumentation

Edit District Guide Specifications for appropriate operating ranges and compatibility of materials. List all instruments in the SCHEDULES OF INSTRUMENTATION FOR PROCESS SYSTEMS Specification Section 40 06 70. In preliminary design, consider the necessity for instrument redundancy for efficient operation, to meet regulatory requirements, and operator safety.

10.11.1 Standardized Equipment and Instruments

The District maintains a table of standardized equipment and instruments (refer to Attachment A - Standardized Equipment List). Designers to propose updates to the Standardized Equipment List with appropriate equipment and instrumentation model numbers as required.

10.11.2 Temperature Measurement

Temperature measuring elements shall be filled system, bimetallic, thermocouple or three-wire platinum RTD bulb elements as the application shall warrant per Table 10-4. In general, type 316 stainless steel protective wells shall be a minimum requirement. High temperature environments shall require Inconel thermal wells. The thermal bulb dimensions, measurement span, speed of response and accuracy will influence the final selection for temperature element.

Table 10-4. Temperature Element Application Guidelines

Element	Service Range	Typical Application
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RTD	Below 500°F	Wastewater process temperature transmitter
Bimetallic	600°F maximum	Local temperature gauge
Filled System	500°F maximum	Remote-mounted local temperature gauge
Thermocouple – K Type	>500°F	Flare temperature monitor
Vapor Pressure Thermal Element	Contact the District I&C Engineer for applicable service range	Temperature switch

10.11.3 Pressure Measurement

Pressure switches shall generally be diaphragm piston type. Pressure transmitters (including differential pressure) shall be capacitance type. Pressure gauges shall be diaphragm type (<10 psi) and bourdon type (>10 psi). Ranges shall be selected such that the normal operating pressures will be within 25 to 75 percent of the calibrated range. Protective diaphragm seals shall be provided only on applications involving slurries, solids bearing, viscous, and corrosive fluids. For solids bearing, slurries, or viscous fluids, provide tri-clover clamps and flushing/calibration ports per District Typical Details.

10.11.4 Level Measurement

Preferred level measurement for process fluids shall be non-contact type whenever possible and includes ultrasonic and microwave types applied within their operational capabilities per Table 10-5.

Table 10-5. Types of Level Elements for Typical Process Applications

Process Application	Element
Sumps (measurement and control)	Bubbler, ultrasonic
Sumps (high alarm level)	Float or Bubbler pressure switch
Sumps (low level cut-out)	Float
Pressurized vessels	Differential pressure cell
Chemical tanks	Ultrasonic
Digesters	Microwave, RF capacitance
Channel levels	Bubbler, ultrasonic, microwave
LSG Holder	Gage head unit
Primary Scum Hoppers	Microwave energy level switch

10.11.5 Flow Measurement

Application of flow measurement requires evaluation of the total cost, flow velocity, flow profile, process, Reynolds number, density, turndown, mechanical installation constraints and accuracy requirements. Turndown shall be selected so that the flowmeter has the ability to cover the range of flow rates within specified accuracy limits. Calculate the Reynolds number for the minimum and maximum flow rates. Minimum Reynolds number is calculated by using

the minimum expected fluid flow and density and the maximum expected viscosity. A maximum Reynolds number is calculated using the maximum expected fluid flow and density and the minimum expected viscosity. Use Moody's charts to compensate for pipe or channel roughness and select piping or channel size to accommodate the required flow profile over the entire operating range. Locate flowmeters to suit specific technology requirements. Magnetic flowmeters are the preferred type for pipelines and typically require a full pipe and straight pipe lengths of 5x upstream and 3x diameter downstream of their location. Multiple path transit-time acoustic flowmeters are the preferred type for channels or large pipes and typically require straight pipe or channel lengths of 10x upstream and 2x diameter downstream of their location. Refer to **Error! Reference source not found.** for flow element information.

For difficult conditions consider flow conditioners as necessary to isolate the liquid flow disturbances from the flowmeter while minimizing the pressure drop across the conditioner. The flow conditioner should remove swirls from the fluid stream and allow the profile velocity to come up to fully developed turbulent flow, or at least a stable acceptable geometry. Coordinate meter installation requirements with mechanical design for pipelines and structural design for channels.

10.12 Electronic Valve Actuators

Profibus DP fieldbus technology is used for many motor-operated valve actuators throughout the EchoWater Facility. Designer shall present alternatives to Profibus DP aligning with paragraph 10.7.1 for controlling electronic valve actuators to District electrical and I&C staff.

10.13 Pneumatic Valve Actuators

Valves for gas management systems typically use pneumatic valve actuators. Actuator should fail to a safe operating state on loss of control air or solenoid power.

10.14 Instrument Installation

Non-Fieldbus analog instruments will utilize 4 to 20 mA transmitters that generally are isolated two-wire type with power and signal being carried by the same shielded pair of wires. Field powered analog sensors (4 wire transmitters, etc.) shall be powered from the nearest 120Vac instrument power panel, see paragraph **Error! Reference source not found.** of these Design Guidelines for further detail on instrument power. The requirement for 120Vac power shall be shown on the P&ID. Provide a local disconnect on all 120Vac powered instruments shown on the electrical drawings ("E" Series).

Profibus network design and installation, if approved for use, shall follow the Profibus International (PI) design guidelines. Profibus network design shall ensure that a failure of one instrument or valve actuator does not cause communications failures to other instruments or valve actuators on the same Profibus segment.

For Ethernet instrument network design refer to 10.15.3 for Ethernet cabling standards.

Identify the explosion proof areas on the electrical plan drawings and verify the instruments in those areas are compatible with the area's environment. Intrinsically safe barriers shall be used whenever possible in preference to explosion proof enclosures.

Instruments with digital (LCD/LED) displays shall not be exposed to direct sunlight. Whenever feasible, outdoor instruments with digital displays shall be oriented to face north. Where it is not feasible to orient north, design a sunshield by adding appropriate notes and details on the applicable drawings and schedules.

Materials of construction shall be compatible with process fluids and suitable for anticipated hostile environmental conditions. Type 316 stainless steel tubing shall be used for all new instrument process connections, except where process conditions require other material. Verify the material compatibility with the process and note any deviations on the drawings and specifications.

10.15 Instrument Cable System

Schedule all instrument field-wiring on the raceway and cable schedules, see paragraph **Error!**

Reference source not found. of these Design Guidelines for cable and raceway schedule requirements. Make maximum use of cable trays in process areas. Run individual conduits from the cable trays to the instrument. Multi-pair cables shall originate and terminate in terminal cabinets. Multi-pair cables shall be utilized when routing signals between areas or buildings and shall include a minimum of 25 percent spare capacity.

10.15.1 Fieldbus

Schedule all fieldbus cable on the raceway and cable schedules. Make maximum use of cable trays in process areas. Run individual conduits from the cable trays to fieldbus network termination panels. Fieldbus termination panels shall be used to route the fieldbus network to individual field devices. Any multi-drop fieldbus cable installation must be designed to ensure communications are not disrupted by failure of a single instrument. The preferred fieldbus design shall employ spur blocks, couplers, or other fieldbus termination devices mounted in a termination panel close to the process equipment to distribute the fieldbus trunk to individual instruments in a star configuration. The fieldbus network and termination panel shall include a minimum of 50 percent spare capacity based on the lesser of software or hardware maximum point or device limitations. The maximum number of instruments connected to one fieldbus trunk shall not exceed ten instruments. The fieldbus network shall parallel the Bus A/ Bus B split bus power distribution and shall be designed so that the failure of one fieldbus network trunk doesn't impact multiple parallel process lines or duty and standby equipment.

10.15.2 Analog Field Sensors

Devices that interface to the Area PLC shall be wired directly to the PLC field wiring terminal blocks within the Area PLC cabinet or a Remote I/O (RIO) cabinet. Non-Fieldbus analog instruments will be 4-20 mA transmitters connected by a shielded two wire type cable with power and signal being carried by the same pair of wires. Field-powered analog sensors (4 wire transmitters, etc.) shall be powered from the nearest 120Vac Instrument Power Panel. The

requirement for 120Vac power shall be shown on the P&ID. Provide a local disconnect on all 120Vac powered instruments shown on the electrical drawings (“E” Series).

10.15.3 Ethernet

Schedule all Ethernet cable on the raceway and cable schedules. Make maximum use of cable trays in process areas. The preferred Ethernet design shall employ home run cable links between the field device or network switch and the CS Room patch panel. The network and termination panel shall include a minimum of 50 percent spare capacity based on the lesser of software or hardware maximum point or port limitations. The network shall parallel the Bus A/ Bus B split bus power distribution and shall be designed so that the failure of one network segment doesn’t impact multiple parallel process lines or duty and standby equipment. Reference IEEE 802.3, ANSI/TIA-1005-A, IEC 61158, IEC 61918, IEC 61784.

Requirements for power over Ethernet (PoE) shall be specified on the drawings.

10.16 Instrumentation Grounding

See the Grounding System section in Chapter 9 for additional grounding requirements.

10.16.1 Cables

The shield drain wire of any cable shall be connected to ground at one end of its length. In general, signal cable shield drain wires shall be grounded by connecting them to the ground bus in a control panel. The major exception to this guideline is that the shield drain wires circuits originating at 4-wire field transmitters shall be grounded at the field transmitter. Whenever shielded cable is terminated, a separate termination screw shall be provided for the signal drain wire.

10.16.2 Control Panels

All control panels shall conform to the requirements of the CONTROL SYSTEM EQUIPMENT PANELS AND RACKS Specification Section 40 67 00. In addition, the PCCS control panels shall conform to the requirements of Emerson Ovation manufacturer recommended grounding practices and the PLC control panels shall conform to the Allen-Bradley ControlLogix manufacturer recommended grounding practices. Bently Nevada control panels shall conform to their standards.

10.16.3 Analog Instruments

In general, all non-fieldbus analog instrument and signal wiring shall be powered from the 24Vdc power supplies mounted in the associated control panel. Each signal circuit must be designed so that only the intended current or voltage will be transmitted throughout the circuit. Analog circuits powered by the 24Vdc power are connected to the negative terminal on the 24Vdc power supply, ground loops can occur if this return wiring is done through more than one path. To prevent ground loops, the following signal wiring and signal isolation standards shall be followed:

- Each analog signal circuit shall be grounded by connection to the 24Vdc signal common at one location in each circuit.
- All field transmitters (2-wire or 4-wire) shall have isolated outputs.
- All signal conversion devices shall have isolated inputs and outputs.
- All panel instruments shall have isolated inputs, or have signal current/current isolator.

10.16.4 Fieldbus Instruments

All fieldbus instruments shall be grounded per the selected fieldbus specifications.

10.17 IT Systems

The information technology (IT) system is defined by the IT network (formerly known as the MIS network) and contains IT workstations, printers, storage devices, telephones and related hardware connect to the IT network for access to business systems and the internet. Parts of the public address (PA) system also use the IT network infrastructure. Facilities related to the IT systems shall be designed and installed in accordance with SacSewer IT Department standards. Applicable elements from Design Submittals shall be provided to the IT Department for review before finalizing.

The design shall include an IT riser diagram on the “X” series project drawings. Voice over internet protocol (VoIP) networking equipment shall be compatible with the District’s existing VoIP telephone system and shown on communication plan “E” series project drawings.

The design shall include conduit and conductors and wall-mounted data receptacles with a minimum of 2 RJ-45 ports in each wall/floor plate, available to patch to the appropriate network. The District’s IT Department will supply the IT hardware such as workstations, printers and VoIP phones for each location.

10.17.1 Public Address System

The Public Address (PA) system as part of the IT network shall be extended to provide clear audible sound in all areas of the project. The existing PA has both normal and emergency zones. Normal zones are all areas except for conference rooms. The emergency zones are conference rooms only.

The design engineer should request the most recent manuals and drawings relative to the PA system from District Control Systems Department. The existing PA system is hosted on the fourth floor of the I/E building and connects to areas of the Plant using the IT network separated from other IT traffic by its own VLAN. The IT network connects to an Ethernet to line-level audio conversion device. The line-level audio connects to a local audio amplifier for audio distribution to the PA speakers using a 70V audio distribution architecture.

The PA system requires at least one distribution amplifier per building for normal paging requirements. A separate PA distribution amplifier is required in buildings with conference

rooms for emergency paging. The preferred location for a PA amplifier is in the CS Room. The PA amplifier(s) shall be mounted in a swing-out panel, unless directed by the District to mount the amplifier(s) in a 19-inch rack. The Ethernet to line-level audio device in each building separates the normal and emergency paging audio for connection to the corresponding distribution amplifier.

PA speakers shall be installed and wired per the manufacturer's recommendations. Emergency zone PA speaker connections to conference rooms shall be separate from other speakers. PA wiring shall be routed through signal conduits or cable trays. PA equipment and wiring shall be shown on the communication plan "E" series drawings. PA riser diagram shall be included in the "X" series project drawings.

10.18 Access Control System

Security System improvements in new process areas are governed by the District's Security Committee policies. During the pre-design period, verify with the District that there have been no changes to the following policies:

- Extend the C-CURE access control system into proposed new and modified areas.
- System architecture extends the Security network backbone into new process areas and communicate over Ethernet to the centralized servers.
- In new areas, mount the access control system panel in the control system room. Control system (PLC or IT) rooms will have a dual access system, meaning C-Cure as well as keyed. C-Cure doors to be door strike type; keyed locks to be the type which cannot be left manually unlocked.
- Mechanical rooms are keyed only.
- Main entry doors (closest to the Ops parking area) for building entrances would have a dual system (as described above for control system rooms) with other access doors keyed only.
- Storage rooms to be keyed only.
- Main access doors to electrical rooms will be a dual type (similar to control system rooms) and all other doors will be egress-only. (This 'limited access' approach reflects safety concerns about high-voltage equipment.)

10.19 Closed-Circuit Television and Digital Video Recording System

The closed-circuit television (CCTV) and digital video recording (DVR) system is based on analog and IP cameras. The cameras installed in all new process areas will be IP-based network cameras powered from the Ethernet connection (PoE). Cameras with heaters may require a separate, non-PoE, power connection due to higher power requirements. Cameras connected via fiber optic cabling will require a power feed. Type of camera(s) to be confirmed with the District.

The area CCTV communicates with the centralized CCTV servers via the Security network. Use single-mode fiber optic and media converters for camera connections when exceeding 300 feet between the camera and the Security network. Centralized NDVR services are managed by the CCTV servers.

10.20 Fire Detection

Each ACC has an Edward's EST-3 or EST-4 Fire Alarm Control Panel (FACP). Each fire alarm panel connects to an EST Fireworks monitoring system located on the 4th floor of the I&E Building using the maintenance network. Fire alarm signaling system for proposed process areas shall be in conformance with NFPA 72 series. The fire alarm system shall have Class B wiring. No wiring other than that directly associated with fire alarm detection or alarm functions shall be permitted in fire alarm conduits. Provide voltage drop calculations in the contractor submittals for notification and initiation circuits. Initiating wiring shall be type FA1 and FA2 for indoor and outdoor uses respectively per the ELECTRICAL POWER CONDUCTORS AND CABLES Specification Section 26 05 21. Notification appliance circuits shall utilize type P&C SC.

Fire detection shall include coverage in ACC's, switchgear rooms, HVAC rooms, and combustible gas handling areas. The fire alarm system shall provide coverage in accordance with NFPA 72 and the AHJ (Cosumnes Fire Department). The fire detection design shall be coordinated with the HVAC design for appropriate duct detection and shutdown circuits. The fire detection design shall also be coordinated with the fire suppression system for appropriate interfacing and monitoring. Examples include pre-action activation and status, sprinkler flow switch, and shut off valve monitoring. The fire detection system shall be shown on the communication plan "E" series drawings. Fire detection riser diagrams shall be included in the "X" series project drawings. Riser diagrams shall also include the point interface with the HVAC purge system.

10.21 Instrument and Control Design Documentation

10.21.1 Control and Logic Diagrams

Control and Logic Diagrams (C&LDs) shall show the logical interconnection between the electrical and control system equipment. Identical equipment numbers shall be shown on an Equipment Number Table. C&LDs with motors powered from a MCC show the power circuit with the motor located at the top left side of the drawing. Fuses, 480/120Vac control power transformer, and MCC terminal block numbers match the MCC standard wiring schematic.

C&LDs are ladder-rung style with sequential rung number on the left rail. Rungs with relay coils have rung numbers where the relay's contact(s) are located listed on the right rail. Differentiating between open and closed contacts by underlining the appropriate contract number is optional. 120Vac relay coil and rung numbers begin with the number 1 (one) on each diagram. C&LD shall show all equipment and devices physically wired together with their appropriate terminal blocks shown. Equipment terminals have unique symbols defined in a symbol list table included on each diagram.

Control panel devices and terminals are confined inside a box on the rungs. Associated cabinet and panel drawing numbers are identified under Notes. Optionally, for small control panels or control stations the front view can be shown on the C&LD with appropriate notes. Example C&LDs are available from the District.

As part of the development of C&LDs, the Designer shall prepare control block diagrams that show the MCC, ACC, Control Panels, and all control devices in block format. Diagrams shall list the equipment, cable and raceway numbers and shall also show the type, number and gauge of all interconnecting control conductors. These diagrams shall be submitted as part of the electrical calculations in Design Submittal 3 (DS3) to aid the review of the cable and raceway schedules. Control block diagrams are not part of the contract documents.

10.21.2 Process and Instrumentation Diagrams

Process and instrumentation diagrams (P&IDs) provide a schematic representation of process piping, equipment, instrumentation and connections to the area and subsystem PLCs. The associated PCCS Control Strategy and PLC Control Narrative numbers are shown in the top right portion of the P&ID diagram. Lines and symbols used on the P&IDs are shown on the Instrumentation Symbol Sheet. An example P&ID and instrumentation symbol sheet is available from the District.

11.0 Corrosion Control Design

The intent of this guide is to allow the Designer to use the appropriate corrosion control methodologies to provide minimal maintenance requirements to achieve desired design life for systems, subsystems, components, subcomponents, and structures within the District. If an introduction to the chemistry and control of corrosion is desired, the Designer should consult AWWA M27.

In general, the best corrosion control strategy is to make use of appropriate materials selection and coatings/linings at the design stage. Cathodic protection is beneficial in protecting metals especially for buried or submerged surfaces in corrosive conditions. A combination of cathodic protection, coatings, and appropriate material selection will achieve the longest service life for assets.

The District Guide Specifications are intended to provide acceptable corrosion protection in common situations. However, it is necessary for the designer to verify that adequate corrosion protection parameters are specified.

11.1 Material Selection

Due to the volume of materials required for most wastewater industry facilities, complete use of high alloy or specialty materials is not economically feasible. The key is to choose the appropriate materials for the anticipated service environment.

The following are general design considerations:

- All metal in the airspace under the cover shall be Type 316 stainless steel.
- Metal submitted to regular wetting such as that above open tanks or that regularly washed down shall be Type 316 stainless steel.
- Pipe connections shall have full gaskets or sleeves to cover any non-corrosion resistant metal faces, edges, and surfaces.
- In many cases the District's COMMON WORK RESULTS FOR PIPING SYSTEMS Guide Specification (40 05 03) designates the materials to be used on various systems at the EchoWater Facility. However, the Designer shall always ensure proper materials are selected for a specific service. If a discrepancy in material selection exists between Guide Specification 40 05 03) and the Designer's recommendation, it shall be brought to the District's attention for resolution.

11.1.1 Corrosion Resistance of Pipeline Materials

The descriptions in the sections below provide guidance for the selection of material characteristics for wastewater materials from a corrosion standpoint. The Designer shall follow the guidance under the Pipe and Structures in Contact with Soil Section in this chapter for general external protection requirements.

11.1.1.1 Ductile-Iron Pipe (AWWA C151)

If soil-environment conditions meet the following, then a bonded coating and cathodic protection system shall be specified:

- Saturated soil resistivity <500 ohm-cm.
- Anaerobic conditions with sulfate-reducing bacteria ($6.5 < \text{pH} < 7.5$) with low redox (negative to +100 millivolts [mV]) and sulfides present.
- Fluctuating water table above the invert of the pipe.

Specify that the ductile iron pipe be manufactured bare (asphaltic coating-free). Specify National Association of Pipe Fabricators (NAPF) 500-03R06 in lieu of Society for Protective Coatings (SSPC) standards for surface preparation.

11.1.1.2 Steel Pipe (AWWA C200, ASTM A53)

Cement-mortar coatings (AWWA C205) on steel pipe shall not be used in soils with a pH of 5 or less, when chloride concentrations exceed 350 ppm (150 ppm in fluctuating groundwater) or when sulfate concentrations are in excess of 2,000 ppm. In this environment, specify a dielectric coating and cathodic protection. Acceptable dielectric coatings include 40 mils of a 100% solids epoxy or polyurethane with fast set and abrasion resistance capabilities. Other dielectric coatings include fusion bonded epoxy and tape wraps.

Specify all joints in cement-mortar-coated steel pipe to be filled with cement-mortar paste that has chemical and structural characteristics as close as possible to the adjacent factory mortar lining and factory mortar coating.

11.1.1.3 Stainless Steel Pipe (AWWA C220, ASTM A312)

Stainless steel piping shall not be buried. If burial is unavoidable, the stainless steel shall be encased with PVC pipe with solvent-welded joints, wax taped in its entirety, or cathodically protected.

11.1.1.4 Reinforced Concrete Pipe (Non pressure)

Reinforced concrete pipe shall not be used in soils with a pH of 5.0 or less. Where the soil environment (including the anticipated backfill material) has a soluble sulfate content greater than 2,000 ppm, Type V cement, 0.45 maximum water/cement ratio and 4,500 pounds per square inch (psi) minimum strength of concrete shall be specified. When the soil chloride concentration is in excess of 350 ppm (150 ppm in fluctuating groundwater), an external dielectric coating shall be specified over the concrete or an alternative pipeline material shall be specified.

11.1.1.5 Reinforced Concrete Pressure Pipe (AWWA C300, C302)

Reinforced concrete pressure pipe (RCPP) shall not be used in soils with a pH of 5.0 or less. If the soil sulfate concentration is in excess of 2,000 ppm, specify Type V cement, 0.45 maximum water/cement ratio and 4,500 pounds per square inch (psi) minimum strength of concrete shall be specified. When the soil chloride concentration is in excess of 350 ppm (150 ppm in

fluctuating groundwater), an external dielectric coating shall be specified over the concrete or an alternative pipeline material shall be specified.

Where the pipe has a steel cylinder, specify all steel components to be electrically continuous.

All joints that incorporate steel components shall be filled with cement-mortar paste that has chemical and structural characteristics as close as possible to the adjacent concrete.

11.1.1.6 Concrete Bar-wrapped Cylinder Pipe (AWWA C303)

Concrete bar-wrapped cylinder pipe (CCP) shall not be used in soils with a pH of 5.0 or less. If the soil sulfate concentration is in excess of 2,000 ppm, specify Type V cement with a water-to-cement ratio of less than 0.45. When the chloride concentration is in excess of 350 ppm (150 ppm), fluctuating groundwater), an external dielectric coating shall be specified over the concrete or an alternative pipeline material shall be specified.

All joints that incorporate steel components shall be filled with cement-mortar paste that has chemical and structural characteristics as close as possible to the adjacent concrete.

11.1.1.7 Prestressed Concrete Cylinder Pipe (AWWA C301)

Prestressed concrete cylinder pipe (PCCP) shall not be used in soils with a pH of 5 or less. If the pipeline falls within the limits of fluctuating groundwater, specify a dielectric coating over the exterior. If the soil sulfate concentration is in excess of 2,000 ppm, specify Type V cement. When the chloride concentration is in excess of 350 ppm, specify an external dielectric coating applied over the outer cement-mortar coating. Mortar coating shall be 1-inch minimum, with thickness increased as determined necessary for strain-compatibility to avoid cracking during handling.

Incorporate into the pipe design shorting straps or straps placed under the prestressing wires to make all steel components electrically continuous. Specify shorting straps between the wire anchors and steel cylinder. Incorporate electrical bonding of joints and corrosion monitoring test stations.

All joints shall be filled with cement-mortar paste that has chemical and structural characteristics as close as possible to the adjacent concrete core and coating.

11.1.1.8 Plastic Pipe (AWWA C900, C905, C906; ASTM D1785, D3034, D2665, D2661, D2513)

Do not use plastic piping such as polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), acrylonitrile butadiene styrene (ABS), high density polyethylene (HDPE), medium density polyethylene (MDPE), and plastic drain-waste-vent piping in soil containing hydrocarbon contaminants (petroleum and petroleum products).

Provide an adequate UV resistant coating plastic pipe where the piping is exposed to ultraviolet light, such as sunlight. Refer to the District's PAINTING AND COATING Specification (09 90 00) for District's preferences on coating systems for various materials and exposures.

Coat metallic valves and pipe fittings such as flange rings, bolts, joint harnesses, and flexible couplings with wax tape per AWWA C217.

11.1.2 Corrosion Resistance of Other Materials for the Wastewater Industry

Selection of non-pipe materials in the wastewater industry follows much the same methodology as that for pipe material selection. Structural/loading performance of the material in a given service is usually the primary determinate for the selection of that material. Corrosion resistance in that environment is a secondary concern, typically weighed against additional costs that corrosion resistance material can occur. For alloyed material, increases in structural strength typically reduces corrosion resistance and vice versa.

11.1.2.1 Stainless Steel

Minimize design features that would lead to de-aerated conditions with stainless steel. This would include minimizing crevices to the extent possible, reducing sharp corners and protruding outlet/inlet piping, and ensuring process flow velocities are high enough to eliminate stagnant conditions.

11.1.2.2 Copper and Copper Alloys

The Designer shall follow the guidance under the Pipe and Structures in Contact with Soil Section below for external protection requirements.

Copper shall not be used in environments that contain H₂S. If exposure is unavoidable, copper shall have a bonded dielectric coating.

11.1.2.3 Aluminum and Aluminum Alloys

Surfaces of aluminum alloys shall be well drained to prevent accumulation of water. Aluminum shall not be placed in direct contact with concrete, mortar, or cementitious grout.

Ensure aluminum members are electrically isolated from other metals.

Aluminum shall not be buried. If burial is unavoidable, coatings and cathodic protection shall be specified.

11.2 Protective Coatings and Linings

When specifying any type of coating or sheet goods, emphasize surface preparation prior to installation. Follow the manufacturer's recommendations given the coating product and substrate to be coated.

Specified field-applied coatings must adhere to Sacramento Metropolitan Air Quality Management District (SMAQMD) Rule 442 Architectural Coatings. For Industrial Maintenance Coating, this is 250 g/L for volatile organic compounds (VOCs).

In addition, the District's Guide Specification 09 90 00 for Painting and Coating shall be reviewed since in many cases specific coating products have already been designated for particular applications. However, the Designer shall always ensure proper coating materials are selected for a specific service, field touchup or shop application, and for the time

available in fast back-into-service structures. If a discrepancy in coating material selection exists between the District's PAINTING AND COATING Guide Specification (09 90 00) and the Designer's recommendation, it shall be brought to the District's attention for resolution.

11.2.1 Coatings for Metallic Surfaces

11.2.1.1 Inorganic Ceramic (Glass) Linings

Glass linings shall be used for sludge and scum pipelines when solids exceed 4 percent.

11.2.1.2 Liquid Epoxies (AWWA C210)

In wastewater service, epoxies can be specified for use in submerged service on both steel and concrete.

11.2.1.3 Fusion Bonded Epoxy (AWWA C213, AWWA C116)

Fusion-bonded epoxies can be specified for steel pipe, ductile iron pipe, and for ductile-iron and gray-iron fittings.

11.2.1.4 Ceramic Epoxy

Ceramic epoxies are one of the only classes of coatings that can be specified as a lining for ductile-iron pipe for both potable water and wastewater applications. Specify that the Contractor does not use restraining gaskets in order to avoid damaging the pipe coating.

11.2.1.5 Polyethylene Encasement (AWWA C105)

Polyethylene encasement shall be specified to protect ductile iron in moderately and mildly corrosive soil, but it will need accompanying cathodic protection in more aggressive soil. Consideration for a bonded dielectric coating shall also be given in aggressive soil.

11.2.1.6 Polyolefin Tapes (AWWA C209 and C214)

Prefabricated multi-layer cold-applied polyethylene tape coatings shall be applied in accordance with ANSI/AWWA C214. Total thickness of the coating shall be 80 mils. Specials and field joints shall be coated in accordance with ANSI/AWWA C209 with a total coating thickness of 70 mils minimum.

11.2.1.7 Extruded Polyolefin (AWWA C215)

Extruded polyolefin coatings shall be applied in accordance with ANSI/AWWA C215. Total thickness of the coating shall be 60 mils. Specials and field joints shall be coated in accordance with ANSI/AWWA C216 with a total coating thickness of 60 mils minimum.

11.2.1.8 Polyurethane (AWWA C222)

Aromatic polyurethane coating can be specified for immersion service on metallic components.

11.2.1.9 Portland Cement-Based Coatings (AWWA C205)

Portland cement concrete is discussed in depth in the Concrete and Inhibitors section below.

11.2.1.10 Sacrificial Metals

Do not specify galvanizing for underground service. Galvanizing can be specified in aboveground applications such as for fencing, poles, and handrails.

11.2.1.11 Wax Tapes (AWWA C217)

Wax tape shall be specified to protect metallic components of a pipeline which are not easily shop coated with a dielectric coating such as flanges, mechanical and restrained joint bolts, nuts and glands, and grooved-end couplings.

11.2.2 Coatings for Concrete

Any concrete coating shall be specified to be applied during the cooling period of the concrete structure to lessen the tendency for the concrete pores to off-gas.

11.2.2.1 Vinyl and Polypropylene (Sheet Goods)

Plastic liners shall be specified for internal linings of all unit process between the influent sanitary sewers and the primary sedimentation tanks. Specify Armorlok PVC or HDPE liners on flat walls and ceilings whenever possible for large wet wells or basins that are enclosed. Specify to avoid cleaning the joints with anything other than what is specified. Inspection shall be specified to be performed by a qualified inspector.

11.2.2.2 Polyurethane

Aromatic polyurethane coating shall be specified for immersion service in areas where PVC liners are insufficient and where there is no chemical dosing or high H₂S atmospheres.

11.2.2.3 Epoxy Novolac

Epoxy Novolac coating shall be specified for chemical dosing areas, high H₂S atmospheres, secondary containment, acid storage areas, and severe immersion service.

11.2.3 Coating Environments

Each coating system shall be designed for the intended service environment. These are broadly defined below.

- *Mild Environment:* Indoor and outdoor above grade facility conditions that are not subject to wash downs or wet-dry cycles.
- *Moderate Environment:* Industrial facility conditions where surfaces may be occasionally exposed to light-moderately aggressive liquids or gases.
- *Harsh Environment:* Industrial facility conditions where surfaces may be subject to aggressive sewer or chemical liquids or gases, or normally exposed to light-moderately aggressive liquids or gases. This also includes all headspaces where gases would accumulate.

The coating manufacturer shall be contacted for the suitability of the specified product to the intended service environment.

11.2.4 Re-Coating of Existing Structures

Prior to recoating of any existing structure a comprehensive condition assessment shall be performed for the collection of data. The purpose of the condition assessment is to gain background information and understanding of the structure prior to generating specifications. The assessment shall consist of:

- Reviewing existing drawings and reports.
- Scheduling a site visit to perform visual observations and data collections.
- Sampling of existing coatings which shall be tested in a laboratory. Samples shall be tested for heavy metals such as lead, zinc and chromium. Analysis of samples shall be tested in accordance with EPA 7420 Toxicity Characteristic Leaching Procedure (TCLP).
- If samples have been found to contain levels of lead or chromium that exceed the TCLP limit of 5 mg/L, any removal of the lead or chromium material shall be conducted employing the safety precautions and measures in accordance to Title 29, Code of Federal Regulations (29-CFR 1910.1025) normally applied for (declared) hazardous waste sites. In this case, the District's LEAD-CONTAINING PAINT ABATEMENT Guide Specification (02 83 19.13) shall be revised for site-specific conditions and implemented in the design documents.
- Health and safety precautions and procedures should be established based on TCLP results for workers, Owners' personnel and Owners' representative. Key factors involved in the selection of the appropriate PPE is material-hazard specific. The selection of the appropriate PPE should be in accordance with Title 29-CFR 1910.120 Appendix B.
- Determination shall be made by a NACE-certified coating specialist (CIP Level 3) whether the structure can be over coated (encapsulation if heavy metals are present) or full removal and replacement of coating is required. This determination shall be based on visual observations, data collection and laboratory analysis. The determination shall be made in writing and approved by the Engineer.

11.2.4.1 Overcoat and Encapsulation, Heavy Metal Positive

If overcoating an existing coating containing heavy metals (encapsulating), initial surface preparation requirements are as follows:

- Power wash the structure per SSPC SP WJ-4/NACE WJ-4 at a minimum of 4,000 psi, Waterjet Cleaning of Metals—Light Cleaning (WJ-4) or if circumstances hinder WJ-4, hand wash per SSPC SP1 to remove dirt, chalkiness, and other deleterious materials. The surfaces shall be lightly sanded and washed down prior to the application of the overcoat.
- Containment system shall conform to SSPC Guide 6.

- Containment and disposal of lead based debris shall conform to 40 CFR 262, 40 CFR 265, and SSPC Guide 7.
- Should spot repair of rusted steel or damaged coating be required, any removal of the lead or chromium material shall be conducted employing the safety precautions and measures in accordance to Title 29, Code of Federal Regulations (29-CFR 1910.1025) and California Code of Regulations Title 8 Section 1532.1 normally applied for (declared) lead-based paint removal sites. Means and methods of the surface preparation shall be the responsibility of the Contractor and the procedure approved by the Engineer during the submittal process.

Coating application shall be specified to be in accordance with the project specifications and SSPC Painting Manual Volume 1, Good Painting Practice.

11.2.4.2 Overcoat, Heavy Metal Negative

If overcoating an existing coating that does not contain heavy metals, initial surface preparation requirements are as follows:

- Power wash the structure per SSPC SP WJ-4/NACE WJ-4 at a minimum of 4,000 psi, Waterjet Cleaning of Metals—Light Cleaning (WJ-4) or if circumstances hinder WJ-4, hand wash per SSPC SP1 to remove dirt, chalkiness, and other deleterious materials.
- Should spot repair of rusted steel or damaged coating be required, means and methods of the surface preparation shall be the responsibility of the Contractor and the procedure approved by the Engineer during the submittal process. At a minimum, the surfaces shall be lightly sanded and blown down.
- Surface preparations for each type of surface shall be in accordance with the specific manufacturer's requirements of each coating and its intended service, and the Coating System Specification sheets.

Coating application shall be specified to be in accordance with the project specification and SSPC Painting Manual Volume 1, Good Painting Practice.

11.2.4.3 Coating Removal and Replacement, Heavy Metal Positive

For surface preparation and coating removal, full containment shall be required.

- All materials, equipment, services, employee training and testing, insurance, permits and agreements, waste characterization, collection, storage, and decontamination facilities, transport and disposal shall be in accordance with EPA, OSHA, NIOSH, and State of California Code of Regulations Title 8 Section 1532.1, and Title 29 Code of Federal Regulations Section 1910.1025 government regulations.
- Full containment for conventional abrasive blasting or an approved vacuum blast method per SSPC Guide 6.
- Abated coatings and debris shall be stored in approved DOT type containers. Storage of abated coatings on project site shall not exceed 90 days.

- Disposal of lead based debris shall conform to SSPC Guide 7 and local, state, and federal regulations.
- Surface preparations for each type of surface shall be in accordance with the specific manufacturer's requirements of each coating and its intended service, and the Coating System Specification sheets.

Coating application shall be specified to be in accordance with the project specifications and SSPC Painting Manual Volume 1, Good Painting Practice.

11.2.4.4 Coating Removal and Replacement, Heavy Metal Negative

For surface preparation and coating removal, the following shall apply.

- Surface preparations for each type of surface shall be in accordance with the specific manufacturer's requirements of each coating and its intended service, and the Coating System Specification sheets.

Coating application shall be specified to be in accordance with SSPC Painting Manual Volume 1, Good Painting Practice.

11.2.5 Coating Inspection

For all bonded coatings in moderate and harsh environments, full-time inspection shall be coordinated between the District and the Contractor using a NACE CIP Level 3 third party inspector during surface preparation, application, post-application testing, and final acceptance.

11.2.6 Concrete and Inhibitors

Any concrete-embedded metal shall have the same minimum clear cover as specified for reinforcing steel for the anticipated environment in accordance with ACI 318.

Attack on embedded steel that is immersed or buried can be delayed or, in some cases, prevented by the following methods:

- Maintain a minimum concrete clear cover over embedded metal as appropriately determined for the environment and per ACI 318 and ACI 350.
- Use concrete or cement-mortar with a water/cement ratio less than 0.45, but not so low as to adversely affect its workability or hydration.
- Use corrosion inhibitors in the concrete mix for high chloride environments. Corrosion inhibitors in concrete include consumable inorganic inhibitors such as calcium nitrite and organic anodic inhibitors.
- Prevent chloride ions from contacting embedded steel by waterproofing the concrete or requiring cement-mortar surface on pipes, using a plastic moisture barrier, with a gravel capillary break with proper drainage away from the structure; a composite sheet comprising a thick HDPE film, an aggressive pressure sensitive adhesive and a weather-resistant protective coating; or by applying a fusion-bonded epoxy coating to the rebar.

- Cathodic protection can be used to control corrosion of embedded steel. It may be applied either before or after corrosion begins.

11.2.7 Concrete Susceptibility

When the soil pH is less than 5.5, protect concrete structures from external acid attack by preventing contact with its environment. Contact can be prevented with a dielectric coating or waterproofing, a gravel capillary break with proper drainage away from the structure, or a composite sheet comprising a thick HDPE film, an aggressive pressure sensitive adhesive and a weather resistant protective coating.

Use material selection or coatings for protection of both the collection and treatment of wastewater facilities from internal acid attack. Polyethylene, fiberglass-reinforced polyesters, and especially PVC sheeting shall be specified.

To prevent sulfate attack, follow Table 11-1 below:

Table 11-1. Cement Type versus Sulfate in Soil - Wastewater Piping

Sulfates (ppm)	Cement Type
0 to 1,000	Type I or II if chlorides are below 350 ppm, otherwise Type I is preferred, but Type II is acceptable
1,000 to 2,000	Type II with water/cement ratio of 0.50 or lower
2,000 to 10,000	Type V, Type II plus pozzolan with R value of 1.0, or 7-sack Type II with water/cement ratio of 0.45 or lower
10,000 +	Type V plus pozzolan with R value of 1.0 or Type II plus pozzolan with R value of 0.75

When the environment contains 350 ppm chloride concentration (150 ppm with groundwater fluctuation), specify a barrier coating, a protective mix design that includes pozzolan or corrosion admixture, or cathodic protection.

11.2.8 Nonportland Cement Inhibitors

Inhibitors shall not be relied on to provide corrosion control since even a small amount of hydrogen sulfide produced can induce corrosion. The Designer shall focus on material selection and coatings/linings to provide appropriate corrosion control.

11.3 Cathodic Protection

Due to operations and maintenance requirements, cathodic protection shall only be used as a protection method of last resort. The use of plastic pipe is strongly encouraged for buried applications if appropriate for the system being designed.

11.3.1 Preparation for Cathodic Protection Systems

Bond all underground non-circumferentially welded pipe joints for electrical continuity. Electrical continuity is necessary for corrosion monitoring and cathodic protection. Methods

for electrical continuity with push-on joints may include bonding bars or rod-cable-rod bonding for steel pipe and bonding wires or jumpers for ductile-iron pipe.

Electrically insulate underground metallic pipe from dissimilar metals and from above ground metallic pipe with insulating joints per NACE Standard SP0286. The most common problem that prevents the effective application of cathodic protection is lack of electrical isolation from other structures not intended to receive protection or needing protection.

Where metallic pipelines penetrate concrete structures such as building floors, vault walls, and thrust blocks use plastic sleeves, rubber seals, or other dielectric material to prevent pipe contact with the concrete and reinforcing steel.

Incorporate test stations for corrosion monitoring. Install test stations at each end of the pipeline, at each end of all casings, at foreign pipeline crossings, at insulating joints, and other locations as necessary so the interval between test stations does not exceed 1,000 feet. Locate test stations in accessible locations not subject to vehicular traffic. Do not locate test stations in traffic lanes or parking lot stalls. The use of above ground test stations is preferable to maintain boards and hardware corrosion free. However, where it is necessary to have in ground test stations, provide 2 feet by 2 feet by 6 inch thick reinforced concrete pads around test boxes at unpaved sites. Provide sufficient sloping in the concrete pad or surrounding pavement to provide drainage away from the concrete test box.

11.3.2 General Guidelines

The following shall be considered when designing a cathodic protection system. Cathodic protection is most practical for pipelines and must be designed for each application.

- Cathodic protection shall be designed and evaluated in accordance with relevant standards such as NACE International SP0169 or SP0100 and SP0286.
- Galvanic anode cathodic protection shall be utilized to the extent possible. Impressed current cathodic protection shall only be used when the current demand is high enough such that galvanic anode cathodic protection is not economically feasible.
- Ensure the metal structure desired for cathodic protection is electrically continuous throughout the structure.
- Use an appropriate current requirement for the metal given the environment and coating type. Avoid overprotection, especially for mortar-coated pipe.
- Design the cathodic protection system for a service life of at least 20 years.
- Ensure the cathodic protection system will not cause stray current corrosion on nearby foreign structures.

11.3.3 Construction Checkout Testing

The following testing procedures shall be incorporated into the design specifications as applicable.

- Testing of all insulated pipe flanges.
- Electrical isolation testing between the project structure and foreign metallic structures.
- Casing isolation testing.
- Testing of exothermic welds.
- Electrical continuity testing.
- Test station testing.
- Wax tape coating inspection.
- Native potentials before activation of the cathodic protection system.
- Cathodic protection system activation.
- Polarized potentials after activation of the cathodic protection system.
- For galvanic anode cathodic protection systems, anode current output and open circuit potential.
- For impressed current cathodic protection systems, anode current outputs, rectifier output, and rectifier tap settings.

A final report shall be submitted containing all approved submittals and test results during the course of the project. All items testing during the project shall be retested during the final system checkout. Upon completion of the checkout testing, the cathodic protection systems shall be tested annually. Additionally, the rectifiers for impressed current cathodic protection systems shall be checked bi-monthly.

11.4 Location-Specific Guidelines

11.4.1 Pipe and Structures in Contact with Soil

Conduct an analysis of the soil and groundwater for corrosivity towards buried materials and structures. The soil analysis shall include as-received and saturated resistivity, pH, sulfate, chloride, and bicarbonate. For buried copper, ammonium and nitrate shall also be analyzed. If microbiologically induced corrosion is suspected, qualitative sulfide and reduction-oxidation (redox) potential shall be performed. Testing shall follow the standards presented in Table 11-2 below.

The testing shall include sufficient sample points and depths to evaluate site conditions. A report shall be provided that includes the results of the testing and corrosion control design recommendations for the project. The corrosion protection design shall include all buried structures and materials included in the project.

Table 11-2. Soil Corrosivity Testing Standards

Standard Methods Used for Soil Corrosive Testing					
Analysis	Hach #	USEPA	AWWA Standard Methods	ASTM	CTM
Soil Electrical Resistivity	N/A	N/A	N/A	G187 D6639	643
pH	N/A	N/A	N/A	G51	643
Hardness (Ca or Mg)	N/A	N/A	N/A	D6919	N/A
Sodium	N/A	N/A	N/A	D6919	N/A
Conductivity	8160	N/A	2510B	D1125	N/A
Carbonate and Bicarbonate Alkalinity	8221	310.1	2320-B	D513	N/A
Sulfide (Quantitative and Redox potential)	N/A	N/A	AWWA C105 Appendix A	N/A	N/A
Chloride	N/A	300.0	4500-Cr C	D4327	422
Sulfate	N/A	300.0	4500-SO ₄ ²⁻ E	D4327	417
Ammonium	N/A	N/A	N/A	D6919	N/A
Nitrate	N/A	300.0	N/A	D4327	N/A

Upon receipt of the soil corrosivity test results, use Table 11-3 and Table 11-4 to determine the protection requirements.

Table 11-3. Soil Corrosion Rating

Corrosion Rating and Anticipated Corrosion Activity		
Resistivity Range (Ohm-cm)	Corrosion Rating	Anticipated Corrosion Activity
0-1,000	1	Severely Corrosive
1,001-2,000	2	Corrosive
2,001-10,000	3	Moderately Corrosive
OVER 10,000	4	Mildly Corrosive

Table 11-4. General Corrosion Control Requirements

Material Type	Corrosion Rating 1	Corrosion Rating 2	Corrosion Rating 3	Corrosion Rating 4
Steel Pipe <i>See notes 1-4</i>	JB	JB	JB	JB
	TS	TS	TS	TS
	CTG	CTG	CTG	CTG
	CPEI	EI	EI	EI
	CP	CP		
Ductile Iron Pipe <i>See notes 1-4</i>	PE	PE	PE	PE
	JB	JB	JB	JB
	TS	TS	TS	TS
	EI	EI	EI	EI
	CP	CP		
Concrete Cylinder or Mortar Coated Steel <i>See notes 1-4</i>	JB	JB	JB	JB
	TS	TS	TS	TS
	EI	EI	EI	EI
	CP	CP		
Copper Pipe <i>See notes 1, 2, 8, 9, 10</i>	EI	EI	EI	EI
Stainless Steel <i>See note 5</i>	NR	NR	NR	NR

Material Type	Corrosion Rating 1	Corrosion Rating 2	Corrosion Rating 3	Corrosion Rating 4
Galvanized Iron <i>See note 6</i>	NR	NR	NR	NR
Aluminum <i>See note 7</i>	NR	NR	NR	NR
Metallic Fittings <i>See note 1-4</i>	WT CP	WT CP	WT	WT

JB = Joint Bonds

TS = Test Stations at 2001,200-foot Intervals

CTG = Protective Coating System

PE = Polyethylene Encasement

CP= Cathodic Protection

EI=Electrical Isolation

WT = Wax Tape

NR=Not Recommended

Notes:

1. Stray Current Areas

- To be treated as Corrosion Rating 1 (All Pipe). For Copper, Follow Note 9

2. pH

- <5.0 to be treated as Corrosion Rating 1 (All Pipe). For Copper, Follow Note 9
- >5.0 and <6.5 to be treated as Corrosion Rating 2 (All Pipe)
- <5.5 Aggressive to Transite Pipe
- >7.0 Corrosive to Aluminum or Lead

3. Chlorides

- >350 ppm to be treated as Corrosion Rating 1 (Mortar-coated Steel Pipe). Cement-mortar/concrete:0.45 water-cement ratio maximum, 4,500 psi, (Concrete Pipe, or Cement Mortar Coating with Embedded Steel or Rebar)
- >500 ppm and ≤1,500 ppm to be treated as Corrosion Rating 2 (Steel Pipe, Ductile Iron Pipe, and Metallic Fittings)
- >1,500 ppm to be treated as Corrosion Rating 1 (Steel Pipe, Ductile Iron Pipe, and Metallic Fittings)

4. Sulfates

- >1,500 ppm and ≤2,000 ppm to be treated as Corrosion Rating 2 (Steel Pipe, Ductile Iron Pipe, and Metallic Fittings)
- >2,000 ppm Cement-mortar/concrete: maximum 0.45 water-cement ratio, 4,500 psi, Type V cement (Concrete Pipe, or Cement Mortar Coating with Embedded Steel or Rebar). To be treated as Corrosion Rating 1 (Steel Pipe, Ductile Iron Pipe, and Metallic Fittings).
- >20,000 ppm Cement-mortar/concrete Cement-mortar/concrete: maximum 0.45 water cement ratio, 4,500 psi, Type V cement and addition of additives such as Pozzolan

5. Stainless Steel

- Not recommended to be buried

6. Galvanized Iron Pipe

- Not recommended to be buried

7. Aluminum

- Not recommended to be buried

8. Ammonium

- >10 ppm may be aggressive to copper. Follow Note 9

9. Nitrate

- >50 ppm may be aggressive to copper. Follow Note 9

10. Copper

- Environment is aggressive to copper if directed to follow from Note 1, 2, 7 or 8. Install tape coating and cathodic protection or use factory-coated copper pipe (Polyethylene, Minimum 25 mils)

11.4.2 Primary Sedimentation Tanks

Ferrous metals exposed to wastewater such as structural steel, rake arms, skimmers, scum box, baffles, etc. shall be specified as nonmetallic or stainless steel. Steel coated with a durable protective coating is not preferred but may be necessary for some circumstances in conjunction with cathodic protection. Acceptable coatings include high-build polyurethane and high solids epoxy systems.

Exposed ferrous metals such as piping, conduits, and supports shall be specified as nonmetallic where possible, stainless steel, or coated non-stainless steel. An adequate coating would be polyurethane.

If the primary sedimentation tanks are to be covered, aluminum dome covers are sufficient. Ensure electrical isolation between the aluminum components and all other metals and concrete by using dielectric components.

Hardware, such as anchor bolts and fasteners, shall be specified as Type 316 stainless steel.

All concrete above the operational low water level shall have a PVC liner extending two feet below the lowest operating liquid level.

At effluent outlets or other areas where turbulent flow is anticipated, concrete shall be coated with a 100 percent solids aromatic polyurethane.

11.4.3 Secondary Sedimentation Tanks

Nonmetallic components exposed to wastewater such as flights, wear shoes, and wear strips shall be specified to the extent possible.

Where metallic components such as hardware, flight guides, anchor bolts, bolts, nuts, washers, setscrews, and other fasteners are used, they shall be specified as stainless steel in areas where they will be exposed to wastewater.

11.4.4 Aeration Basins

Basins or chambers containing wastewater or liquid and covered shall have a PVC liner extending two feet below the lowest operating liquid level. The basins, chambers, and channels containing return activated sludge (RAS), mixed liquor suspended solids (MLSS), secondary effluent (SE), or finished effluent (FE) do not require PVC lining unless covered. Where not feasible, a protective coating such as 100% solids aromatic polyurethane shall be specified.

PVC line or coat as above all concrete subjected to turbulent or low pH (< 5.5) wastewater.

All ferrous metals shall be coated for harsh environments or specified as stainless steel.

11.4.5 Lift Gates

For sluice gates, the use of either a coated ASTM A436 Ni-Resist cast iron or ASTM A240 Type 316 or 316L stainless steel shall be used.

Slide gates and weir gates shall be fabricated from ASTM A240 Type 316L stainless steel.

Threaded portions of sluice gate stems, machine surfaces of frames and guides shall be grease-coated to protect the wearing surfaces.

11.4.6 Electrical Enclosures

Electrical distribution and control panel equipment in corrosive areas shall be suitable for the environment in which they are located. Use PVC-coated electrical conduit and supports with NEMA 4X stainless steel electrical boxes in corrosive areas.

12.0 Regulatory Requirements

The following regulatory requirements should be considered at a minimum for all District design projects. Unless stated otherwise below, Designers shall initiate contact with District staff as described below during the Preliminary Design Phase.

12.1 Environmental Impact Review

The California Environmental Quality Act of 1970 (CEQA) requires documentation of environmental impacts and proposed mitigation measures associated with a project.

The Project Manager is responsible for initiating request for environmental review by the Sacramento County Department of Environmental Review and Assessment (DERA), which is the lead agency responsible for preparing the documentation required by CEQA. The project manager will initiate the request for environmental review by submitting a “Request for Environmental Document Application Form” to DERA. Prior to submittal, the project description required within the application form shall be reviewed by the District Bufferlands Team to screen for readily avoidable impacts to sensitive biological resources.

The Designers shall provide project information as requested by the Project Manager and incorporate all necessary environmental impact mitigation measures into the project plans and specifications. Mitigation monitoring and reporting plans shall be included in the appendix of the project specifications. As appropriate, the District shall utilize the Bufferlands Team to mitigate impacts to sensitive biological resources.

The District and its contractors will avoid and minimize permanent and temporary impacts to habitats and land cover types used by sensitive species potentially occurring in the project area. Avoidance and minimization of habitat areas will be accomplished during project design work, and/or during construction by implementing best management practices, including establishment of buffer zones, installation of fencing around sensitive habitats, and implementation of a water pollution control plan (WPCP) or storm water pollution prevention plan (SWPPP), as appropriate, to reduce the potential for sediments or contaminants to enter sensitive habitats. For work contained within the perimeter levee of the EchoWater Facility, only a WPCP is required.

The District shall obtain all necessary permits and approvals required to impact riparian habitat and sensitive natural communities, to the extent that these impacts may occur with development of any of the action alternatives. Necessary permits and approvals will include Clean Water Act permits (Section 404 and 401), FESA and CESA permits, and CDFW Lake and Streambed Alteration Agreement, and would include measures to avoid, minimize and compensate for any impacts so as to avoid any net loss in habitat value. Mitigation would include restoration of any habitats that were affected temporarily during construction, and could include purchase of credits from a mitigation bank if there are any permanent impacts to sensitive natural communities. Designer is responsible for identifying when permits are required for a project and notifying the District.

For District projects that are off-EchoWater Facility property and prior to the start of construction, a Phase I hazardous waste/hazardous materials study for soil and groundwater contamination shall be completed for the transmission pipeline by the designer. The recommendations set forth in the Phase I assessment shall be implemented to the satisfaction of applicable agencies before construction begins. If Phase I assessments indicate the potential for contamination within the construction zone of the pipelines, Phase II studies shall be completed before construction begins. Phase II studies will include soil and groundwater sampling and analysis for anticipated contaminants. The Phase II sampling is intended to identify how to dispose of any potentially harmful material from excavations, and to determine if construction workers need specialized personal protective equipment while constructing the pipeline through that area. If soil or groundwater contaminated by potentially hazardous materials is exposed or encountered during construction that was not identified in the Phase I assessment, the appropriate hazardous materials agencies shall be notified. Any contaminated soil that is encountered during construction shall be disposed of in accordance with applicable regulations, at an approved landfill.

The District will prepare a wetland delineation report to identify and characterize aquatic resources within the vicinity of the project area and will use this information to avoid wetlands and waters of the U.S. to the extent feasible. Once verified by the U.S. Army Corps of Engineers (USACE), the delineation will be used to secure permits/approvals under Sections 404 and 401 of the Clean Water Act (CWA). The wetland delineation report will also be used to demonstrate consistency with the South Sacramento Habitat Conservation Plan (SSHCP) and its terms and conditions for CWA and Endangered Species Act compliance. Compliance with SSHCP habitat-level conservation measures is assumed to satisfy mitigation requirements under Section 404 permitting, and conservation measures would be implemented by Regional San even if the SSHCP is not adopted. The District may be required to work directly with the USACE to satisfy Section 404 permitting needs for project impacts to wetlands and other waters of the U.S. if permitting associated with the SSHCP is not finalized at the time of the project permitting phase. Designer is responsible for identifying when a wetland delineation report is required for a project and notifying the District.

The District shall participate in and comply with the terms and conditions of the Sacramento County Tree Preservation Ordinance. Native oak trees with a diameter at breast height (DBH) of six inches or greater, street or public trees, and landmark trees shall not be destroyed, killed, or removed without a permit. The ordinance protects all oak trees unless they are specifically designated for removal as part of an approved project. When oaks are removed they must be replaced with the same tree species equaling in sum the diameter of the tree lost. Designer is responsible for identifying when permits are required for a project and notifying the District.

12.2 National Pollutant Discharge Elimination System (NPDES) Permit

The District operates under Waste Discharge Requirements (WDRs) issued by the California Regional Water Quality Control Board, Central Valley Region (Water Board). The District is currently operating and discharging disinfected tertiary treated wastewater effluent under WDR Order No. R5-2021-0019-02 (NPDES Permit No. CA0077682). The WDRs contain the

limitations and discharge requirements for the discharge of disinfected secondary treated wastewater effluent to the Sacramento River.

All project parameters that may impact the NPDES permit shall be coordinated with District Operations Support.

The District shall implement measures contained in the General Order for Dewatering or other appropriate NPDES permit or Waste Discharge Requirement. If a project is located within the EchoWater Facility, no permit is needed as dewatering water may be discharged into an adjacent manhole that is piped to the EchoWater Facility headworks. Designer to notify District if a dewatering permit might be needed.

12.3 Biosolids and Solids Storage and Disposal Permit

The District operates under a Biosolids and Solids Storage and Disposal Permit WDR Order No. R5-2015-0133 issued by the Water Board and adopted on December 11, 2015 for the operation of treatment, storage, and disposal facilities for digested sludge (biosolids) and other solids (grit and screenings) from the EchoWater Facility. The WDRs contain the limitations and discharge requirements for twenty unclassified Solids Storage Basins (SSBs), five Class II Dedicated Land Disposal (DLD) land treatment units (LTUs), and a closed Class III grit and screenings landfill located at the EchoWater Facility.

All project parameters that may impact the biosolids and solids permit shall be coordinated with District Operations Support.

12.4 Water Reclamation Permit

The District operates under Master Water Reclamation Permit WDR Order No. 2016-0068-DDW for reclamation of treated wastewater from the EchoWater Facility. The WDRs contain the limitations and discharge requirements for the use of reclaimed water as irrigation in publicly owned areas of residential neighborhoods, parks, streetscapes, schools, commercial areas, and at the EchoWater Facility.

All project parameters that may impact the water reclamation permit shall be coordinated with District Operations Support.

12.5 Fire and Life Safety

The Cosumnes Fire Department (CFD) has jurisdiction on fire and life safety matters at the EchoWater Facility. All new construction must meet the applicable fire and life safety requirements contained in the California Fire Code (CFC), California Building Code (CBC), National Electric Code (NEC), National Fire Protection Act (NFPA), and Occupational Safety and Health Act (OSHA). Additionally, the NFPA contains standards specific to wastewater treatment plants (NFPA 820, Recommended Practice for Fire Protection in Wastewater Treatment Plants).

The Project Manager shall initiate a meeting with the CFD and the District Safety Liaison after Design Submittal #1 to introduce the project and to identify potential areas of concern. All areas of concern shall be addressed in Design Submittal #2, which will formally be submitted to CFD for review. The Project Manager shall be responsible for coordinating contact with, and payment of fees to, CFD.

12.6 Hazardous Materials Program

Regulations require that the EchoWater Facility maintain a Hazardous Material Plan (HMP). The HMP covers solids, liquids, and gases.

The District Safety Office shall be consulted to determine if any material or process associated with the project may trigger specific design considerations or necessitate revisions to the existing HMP. The Project Manager shall initiate a meeting between the District Safety Office Senior Safety Specialist and the project designers to determine if the project will affect the HMP.

12.7 Spill Prevention, Control, and Countermeasure Plan

The United States Environmental Protection Agency (USEPA) requires that the EchoWater Facility maintain a Spill Prevention, Control, and Countermeasure (SPCC) Plan. The objective of the SPCC Plan is to document, define, and describe the practices, procedures, structures, and equipment used to prevent, control, and/or mitigate releases of petroleum, oil, and lubricants (POL) products to the environment.

The Designer shall identify all POL products required for the project and provide documentation to District Operations Support during preparation of Design Submittal #1. Such documentation may include a site plan, estimated quantities required, and proposed storage or containment. All project parameters that may impact the SPCC Plan shall be coordinated with District Operations Support.

12.8 Air Quality Permit

Air permitting for the District falls under the jurisdiction of the Sacramento Metropolitan Air Quality Management District (SMAQMD). Air quality permitting is a two-step process. First, a permit application, including appropriate fees, is filed with SMAQMD. Upon review of application, an Authority to Construct is issued by SMAQMD. After the project is built, a representative from SMAQMD conducts an inspection and issues a Permit to Operate. The SMAQMD Authority to Construct must be obtained before construction can proceed, and the Permit to Operate must be secured prior to process start-up.

The Designer shall identify all new pollutant emitting sources and provide documentation to District Operations Support during the permitting process. Such documentation may include a site plan, and schematics of process systems and air pollution abatement systems. Communication with SMAQMD shall involve the District's Air Quality Liaison in Operations Support.

12.9 Asbestos and Lead-Containing Materials

Prior to recoating of any existing structure or connecting to an existing system, a comprehensive condition assessment shall be performed for the collection of data. The purpose of the condition assessment is to gain background information and understanding of the structure or point of connection prior to generating specifications.

12.9.1 Asbestos-Containing Materials

For suspected asbestos-containing materials, the assessment shall consist of:

- Reviewing existing drawings and reports.
- Scheduling a site visit to perform visual observations and data collections.
- Bulk sampling of existing materials shall be tested in a laboratory. Samples shall be analyzed using a Polarized Light Microscopy (PLM) method in accordance with EPA 600/R-93/116.
- If samples have been found to contain levels equal to or greater than 1% asbestos material or Presumed Asbestos Containing Materials (PACM) are encountered, any removal of the material shall be specified to be conducted employing the safety precautions and measures in accordance to Title 29 of the Code of Federal Regulations (29-CFR 1926, subparts C and D), Title 8 of the California Code of Regulations (8CCR 1529 Asbestos) and Sacramento County Air Quality Management District Rule 902 and 304. In this case, the District's ASBESTOS ABATEMENT Guide Specification (02 83 13) shall be revised for site-specific conditions and implemented in the design documents.

The Designer shall identify all potential asbestos-containing materials that may be encountered in the project and notify the District during design. District Safety consults with a specialist at Sacramento County Environmental Services to determine appropriate project-specific abatement controls.

12.9.2 Lead-Containing Materials

For suspected lead-containing materials, the assessment shall consist of:

- Reviewing existing drawings and reports.
- Scheduling a site visit to perform visual observations and data collections.
- Sampling of existing coatings which shall be tested in a laboratory. Samples shall be analyzed for lead, and if warranted heavy metals such as zinc and chromium. Analysis of samples shall be tested in accordance with EPA Flame Atomic Absorption Spectrometry Lead (Pb) in Paint/Coatings Samples Method SW846-3050B-7420.
- If samples have been found to contain detachable levels of lead, any removal of the lead-containing material shall be specified to be conducted employing the safety

precautions and measures in accordance to Title 29, Code of Federal Regulations (29-CFR 1926.62). In this case, the District's LEAD-CONTAINING PAINT ABATEMENT Guide Specification (02 83 19.13) shall be revised for site-specific conditions and implemented in the design documents.

The Designer shall identify all potential lead-containing materials that may be encountered in the project and notify the District during design. District Safety consults with a specialist at Sacramento County Environmental Services to determine appropriate project-specific abatement controls.

APPENDIX A
STANDARD DOCUMENTS

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00 43 25	SUBSTITUTION REQUEST FORM (DURING PROCUREMENT)
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40 67 00	CONTROL SYSTEM EQUIPMENT PANELS AND RACKS
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G-001	SIGNATURE SHEET
G-002	INDEX OF DRAWINGS
GI001	LOCATION AND AREA MAPS
GI002	EXISTING SRWTP SITE PLAN AND PROJECT AREA
GI003	STANDARD ABBREVIATIONS 1
GI004	STANDARD ABBREVIATIONS 2
GI005	STANDARD ABBREVIATIONS 3
GI006	STANDARD ABBREVIATIONS 4
GI007	GENERAL SYMBOLS, MATERIALS, CROSS REFERENCING SYSTEM, DRAWING NUMBER SYSTEM, AND MISCELLANEOUS SYMBOLS
GI008	PIPING AND EQUIPMENT PREFIXES
GI009	EQUIPMENT PREFIXES AND PIPING DESIGNATIONS
GC001	CONSTRUCTION ACCESS
GC002	SURVEY MONUMENT DATA NAD83/NAVD88
GC003	BIOLOGICAL RESOURCES TO BE PROTECTED, REMOVED AND/OR MITIGATED
MECHANICAL	
M-001	HVAC SYMBOLS, SCHEDULE, AND STANDARD DESIGNATIONS
ELECTRICAL	
E-001	ELECTRICAL SYMBOLS
E-002	SYMBOLS FOR ELECTRICAL SCHEMATIC DIAGRAMS
E-003	ELECTRICAL SYNTAX AND RACEWAY AND CABLE NUMBERING CONVENTION
PROCESS AND INSTRUMENTATION	
X-001	PROCESS EQUIPMENT PREFIXES AND PIPING DESIGNATIONS
X-002	PROCESS AND PIPELINE SYMBOLS 1
X-003	PROCESS AND PIPELINE SYMBOLS 2
X-004	PROCESS AND PIPELINE SYMBOLS 3

Detail ID	Typical Detail Title
FOR SEWER, WATER, AND STORM DRAIN DETAILS, REFER TO http://www.saccountyspecs.saccounty.net/Pages/default.aspx	
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E1	TYPICAL DEVICE STANCHION STANDARD DETAIL
E2	LIGHT STANDARD BASE STANDARD DETAIL
E4	FLUORESCENT LUMINAIRE MOUNTING DETAIL STANDARD DETAIL
E5	GROUND WELL AND ROD STANDARD DETAIL
E6	CONDUIT PENETRATION AT EXISTING WALL OR FLOOR STANDARD DETAIL
E7	NON-REINFORCED DUCTBANK STANDARD DETAIL
E8	REINFORCED DUCTBANK STANDARD DETAIL
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E13	TYPICAL PRECAST MANHOLE STANDARD DETAIL
E14	DUAL MANHOLE SUMP PUMPING ARRANGEMENT STANDARD DETAIL
E15	TYPICAL HANDHOLE STANDARD DETAIL
E16	TYPICAL MANHOLE SUMP PUMP STARTER PANEL STANDARD DETAIL
E17	LIGHTING FIXTURE MOUNTING DETAIL STANDARD DETAIL
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E20	480V 3" DIAMETER RECEPTACLE STANCHION STANDARD DETAIL
E21	REINFORCED CONCRETE BASE STANDARD DETAIL
E22	480V 3" DIAMETER RECEPTACLE STANCHION WITH JUNCTION BOX STANDARD DETAIL
E23	REINFORCED CONCRETE BASE STANDARD DETAIL
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E100	600A 3-WAY L-KIT SEPARABLE CONNECTORS STANDARD DETAIL
E101	600A 3-WAY L-KIT SEPARABLE CONNECTORS SECTIONS STANDARD DETAIL
E102	600A 2-WAY L-KIT SEPARABLE CONNECTORS STANDARD DETAIL
E103	600A 2-WAY L-KIT SEPARABLE CONNECTORS SECTIONS STANDARD DETAIL
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M2	PIPE HANGER GENERAL NOTES STANDARD DETAIL
M3	TYPE 1 PIPE HANGER STANDARD DETAIL
M4	TYPE 4 PIPE HANGER (2" THRU 12") STANDARD DETAIL
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Detail ID	Typical Detail Title
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M17	TYPE L STRUCTURAL ATTACHMENT STANDARD DETAIL
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M19	TYPE B PIPE PENETRATION STANDARD DETAIL
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M25	TYPE E PIPE PENETRATION STANDARD DETAIL
M27	PIPE PENETRATION TYPES STANDARD DETAIL
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M31	TYPE 4 PIPE HANGER SEISMIC SUPPORT STANDARD DETAIL
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M34	TYPICAL PIPE SUPPORT RACK STANDARD DETAIL
M35	TYPE A STRUCTURAL ATTACHMENT STANDARD DETAIL
M36	TYPE B STRUCTURAL ATTACHMENT STANDARD DETAIL
M37	TYPE C STRUCTURAL ATTACHMENT STANDARD DETAIL
M38	TYPE D STRUCTURAL ATTACHMENT STANDARD DETAIL
M39	TYPE E STRUCTURAL ATTACHMENT STANDARD DETAIL
M40	TYPE G STRUCTURAL ATTACHMENT STANDARD DETAIL
M41	TYPE H STRUCTURAL ATTACHMENT STANDARD DETAIL
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M43	TYPE K STRUCTURAL ATTACHMENT STANDARD DETAIL
M44	TYPE M STRUCTURAL ATTACHMENT STANDARD DETAIL
M45	TYPE A UTILITY STATION POST-MOUNT STANDARD DETAIL
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M49	FIRE EXTINGUISHER MOUNTINGS STANDARD DETAIL
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M51	TYPE II FLOOR DRAIN STANDARD DETAIL
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M53	TYPE I EQUIPMENT DRAIN STANDARD DETAIL
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Detail ID	Typical Detail Title
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M57	YARD CLEANOUT STANDARD DETAIL
M58	FLOOR AND WALKWAY CLEANOUT STANDARD DETAIL
M59	PRESSURE CLEANOUT STANDARD DETAIL
M60	CLEANOUT (IN-LINE) STANDARD DETAIL
M61	CLEANOUT LINE-END STANDARD DETAIL
M62	TYPICAL BURIED VALVES STANDARD DETAIL
M63	TYPE V CLEANOUT STANDARD DETAIL
M64	PIPE PENETRATION NOTES STANDARD DETAIL
M65	TABLE B (PIPE HANGER TYPES) STANDARD DETAIL
M66	SANITARY PRESSURE GAUGE PIPING CONNECTION STANDARD DETAIL
M68	FLUSHING COCK (FOR AIR RELEASE OR DRAIN AS REQUIRED) STANDARD DETAIL
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M70	SEAL WATER CONTROL UNIT STANDARD DETAIL
M71	CONTROL UNIT TYPE C STANDARD DETAIL
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M73	LOCATING WIRES FOR UNDERGROUND PIPELINES STANDARD DETAIL
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S8	REINFORCING STEEL AT WALL INTERSECTIONS STANDARD DETAIL
S9	REINFORCEMENT AT SLAB AND WALL OPENINGS STANDARD DETAIL
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S12	EQUIPMENT BASE STANDARD DETAIL
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S14	SUSPENDED SLAB WATERPROOFING STANDARD DETAIL
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S17	MODIFICATION OF EXISTING CONCRETE STANDARD DETAIL
S18	CONCRETE STAIRS STANDARD DETAIL
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S21	LIFTING DEVICE STANDARD DETAIL
S22	REINFORCEMENT AT DOOR OPENINGS STANDARD DETAIL
S23	PRESSURE RELIEF VALVE IN CONCRETE SLAB STANDARD DETAIL
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Detail ID	Typical Detail Title
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S29	REINFORCING AT CMU PARTITION WALL INTERSECTIONS STANDARD DETAIL
S30	CMU WALL CONTROL JOINT REINFORCEMENT STANDARD DETAIL
S31	GRATING PLAN (ALUMINUM GRATING) STANDARD DETAIL
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APPENDIX B

AUTONUMBERING GUIDENCE DOCUMENT

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Introduction

This document was created to guide users through the process of assigning unique numbers to SacSewer equipment. The District's numbering system is referred to as 'Auto-Numbering'. Auto-Numbering was developed by the District in 2006 to apply a consistent numbering format to new equipment added to the District.

A unique identifying tag number is assigned to each piece of equipment within the District. Within District applications, the identifying tag number is officially referred to as the '**Location ID**'. It may also be commonly referred to as the 'Equipment Number' or 'Tag Number'.

The following guidelines are to be used only by the Documentation Staff assigned Auto-Numbering duties.

Which Items Need Location IDs?

Items that get a Location ID

Assign numbers to each asset within the District which:

- Requires any type of maintenance.
- Is part of a procedure.
- Needs to be discretely identified on drawings or documentation.
- Needs to be tracked as part of the **Covered Process**.

We have highly regulated substances such as Methane Gas at SacSewer. These systems are referred to as the '**Covered Process**' and are held to strict regulations. Equipment in direct contact with a regulated substance is part of the covered process **and also equipment that does not come in contact with a regulated substance, but its failure may result in a release.**

If an equipment failure could cause a regulated substance release or interfere with mitigating the consequences of an accidental release, it must be included in the covered process as well.

Items that DO NOT get a Location ID

Generally speaking, we only assign Location IDs to **physical assets that exist in the real world**. Here are some examples of items which we **DO NOT** assign numbers to:

- PCCS points shown at the tops of P&IDs.
- Virtual alarms and switches.
- Items inside of panels such as lights, alarms, etc. These are considered to be part of the panel.

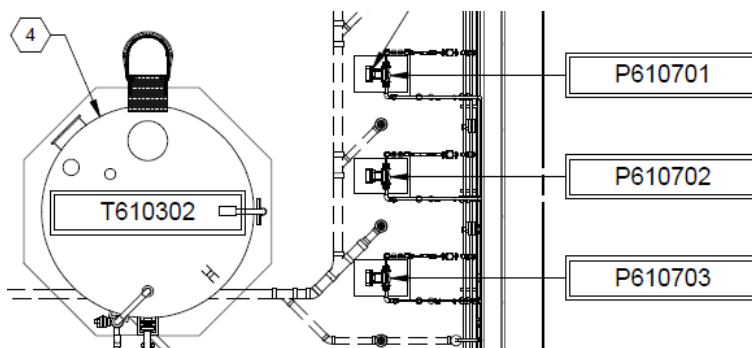
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- Parts inside of packaged equipment supplied by manufacturers (see [SMP - Section 206.10.1](#) for more clarification). Do not assign Location IDs to parts that are built into equipment by the manufacturer as components and are included in the O&M Manual of a package unit.
- Virtual equipment like PLC program components.
- Conduit, Raceway, and Cable numbers shown in schedules.
- Do not assign Location IDs to small valves which are part of a large systems and are service connections such as hose bibs, service connections to utility stations, etc.
- Do not assign Location IDs to any valves ½ inch in size or smaller, or any valve that will not be part of a procedure such as drainage, flushing, isolation, maintenance, etc.

A good way to check if something needs a Location ID is to search the District's list of equipment prefixes. If an item is on the list, then it most likely needs to have a number assigned. If an item is not on the list, then it most likely does not need to be numbered. In some cases, new prefixes need to be created, so when in doubt contact District Staff.



This site plan drawing shows tank T610302 on the left and pumps P610701, P610702 and P610703 on the right. Their Location IDs are labeled in rectangular boxes.

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Why are Location IDs Important?

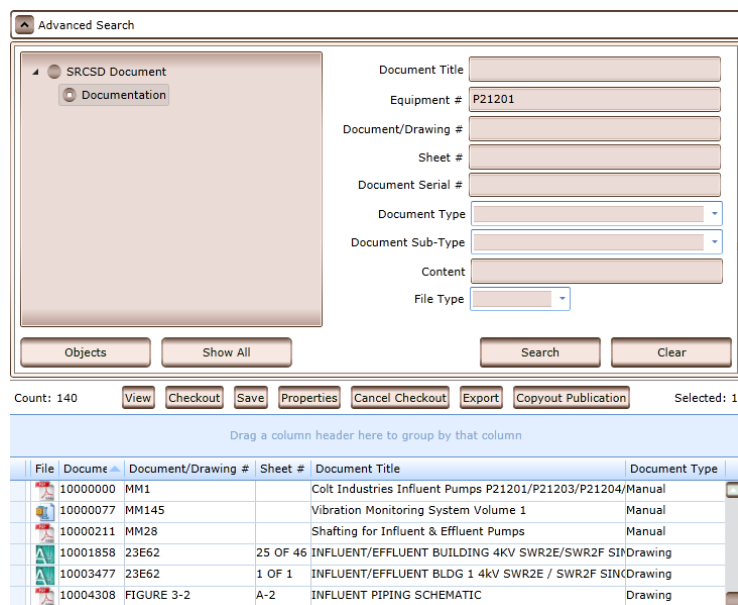
Location IDs are used for tagging equipment in the field, as well as being the unique identifiers on PCCS screens, drawings, diagrams, GIS, manuals, documents, and procedures. The numbers are also the unique identifiers in the District's CMMS Maximo database used for work tracking and asset management.

O&M Procedures

Any asset which is maintained or is part of an Operations and Maintenance (O&M) procedure needs to be included in the **Master Equipment List** (MEL). While some assets appear to be insignificant within the design/build spectrum, the assets play a role in O&M procedures such as Business Practices (BPs), Standard Operating Procedures (SOPs), Operator Training Guides (OTGs), lockout/tag out procedures (LOTO), pipeline isolation procedures, etc. Because of this, it is necessary for O&M to have unique identifiers for assets which may appear to be marginal to Designers or Contractors.

EDM/FileNET for File Retrieval

We are heavily reliant on an electronic file library called EDM/FileNET for the retrieval of documents. Searching using the Location ID is the main way that District staff locate documents after a project is built. They are quickly able to search the electronic file library for documents using the Location ID. Easy retrieval of documents is a critical function within the operation and maintenance of District facilities. This is one of the reasons why so much emphasis is being put on numbering equipment and properly labeling drawings and other documents.



Advanced Search

SRCS Document
Documentation

Document Title:

Equipment #:

Document/Drawing #:

Sheet #:

Document Serial #:

Document Type:

Document Sub-Type:

Content:

File Type:

Objects Show All Search Clear

Count: 140 View Checkout Save Properties Cancel Checkout Export Copyout Publication Selected: 1

Drag a column header here to group by that column

File	Document #	Document/Drawing #	Sheet #	Document Title	Document Type
10000000	MM1			Colt Industries Influent Pumps P21201/P21203/P21204/Manual	Manual
10000077	MM145			Vibration Monitoring System Volume 1	Manual
10000211	MM28			Shafting for Influent & Effluent Pumps	Manual
10001858	23E62	25 OF 46		INFLUENT/EFFLUENT BUILDING 4KV SWR2E/SWR2F SIN	Drawing
10003477	23E62	1 OF 1		INFLUENT/EFFLUENT BLDG 1 4kv SWR2E / SWR2F SIN	Drawing
10004308	FIGURE 3-2	A-2		INFLUENT PIPING SCHEMATIC	Drawing

Entering a Location ID in the EDM search form returns all related documents within seconds.

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Who is Responsible for Assigning Location IDs?

Auto-Numbering uses a complex set of guidelines which are not easy to learn in a short period of time. District Documentation Staff work with Designers or Project Leads to make sure that Auto-Numbering is properly adhered to.

Design/Construction

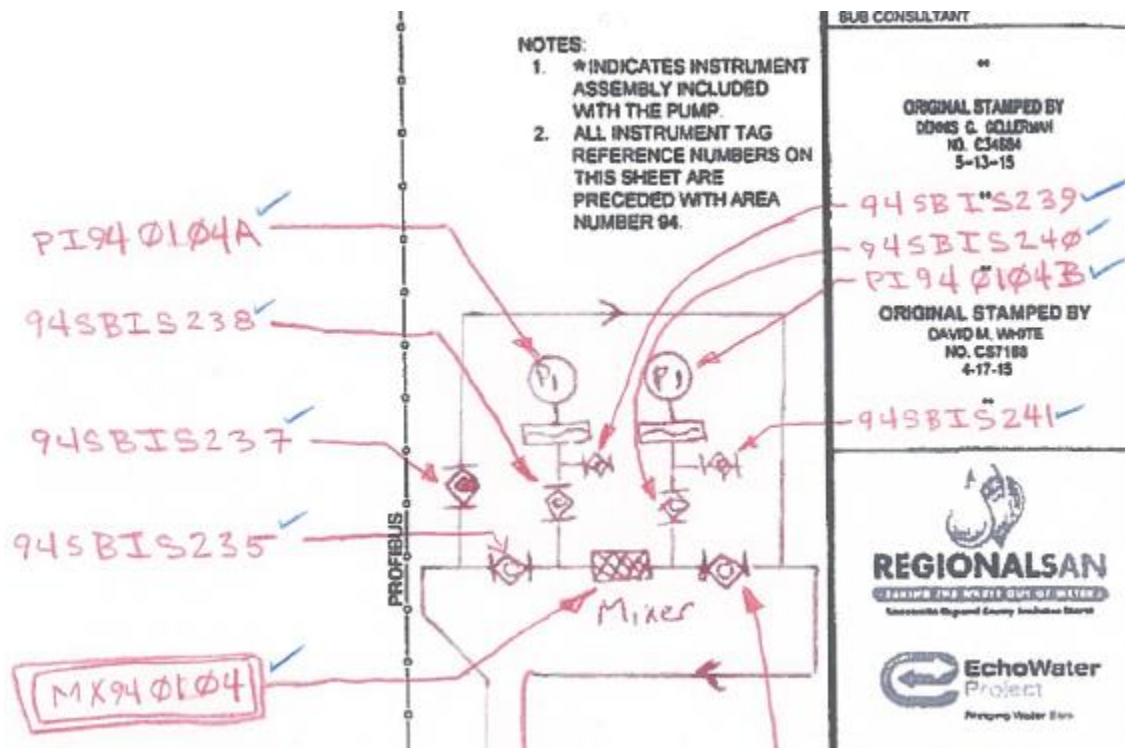
During Design or Construction, the **Designer or Project Manager** is responsible for assigning numbers. Designers are encouraged to be in close contact with District staff so that questions can be resolved early in the design process to avoid costly number changes later down the line.

Equipment Added by District O&M Staff

Equipment is sometimes installed by District O&M staff due to work orders or small projects. In these cases, the **lead person on the job** is responsible for assigning the Location IDs.

Approval

The **Documentation Team** is responsible for vetting and approving Location IDs before they are added to Maximo. See [SMP – Section 206.2](#) for responsibilities.



Hand markups in red show the assignment of new Location IDs

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Location ID Databases

Location IDs and equipment information are supplied to the District's The Documentation Team using Excel spreadsheets. The goal is to have the Designer or Project Lead assign Location IDs using the Auto-Numbering guidelines. Once submitted, the Documentation Team reviews and validates the numbers and provides feedback for any needed changes.

Because some numbers use a sequential format, newly generated numbers within a project may duplicate numbers which have already been used in the past or by other concurrent projects. In these cases, District Staff will provide corrections back to the Designer or Project Lead.

The goal is to have the Designer or Project Lead do their best with Auto-Numbering, and have the District make corrections as needed. As long as the Designer or Project Lead uses a unique number within their own project, the District can easily make corrections.

Refer to the latest workflow procedures to see when to submit equipment spreadsheets to the District during a project.

Master Equipment List (MEL) Excel Template

	A	B	C	D	E	F
1	AssetClassification	Include	AssetCategory	InitialHierarchyLocation	HierarchyLocation	Asset Size and Subtype
	VALVE	Enter "N", "C", "D" or leave blank". See "Intro" tab for further instructions	Asset Category (Design Phase)	Initial Hierarchy Location / Location ID / Eq Tag ID (Design Phase)	Hierarchy Location / Location ID / Eq Tag ID (District Review Phase - Approved)	Asset Size and Type (Design Phase for MEL)
2						
3	VALVE	N			98SSE10	10 INCH, GATE
4	VALVE	N			CAV980084	10 INCH, CAV
5	VALVE	N			N48-98WRF126	18 INCH, BUTTERFLY

The 'Reference Documents' table at the end of this documents has links to the latest templates if you have access. Otherwise, contact SacSewer Documentation or CMMS staff for the latest template. This initial database is to capture equipment being installed, modified, or removed. Asset Location IDs and related information is to be entered into this database by the Designer or Project Lead. District staff will review this spreadsheet and provide feedback for any needed corrections.

IDEA

Unique numbers are verified by District Staff using an application called 'IDEA'. IDEA generates a unique number for each equipment location using Auto-Numbering business rules. After a Master Equipment List (MEL) is submitted to the District, Documentation Staff use IDEA as a final check to make sure that no existing numbers were duplicated and that syntax rules were properly followed.



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Maximo

Maximo is the District's maintenance management database application. MEL Location IDs and data are loaded into Maximo by CMMS Staff for work orders, GIS, asset management, and other business needs.

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Asset ID vs. Location ID

When first learning the system, there is usually some confusion between ‘Asset ID’ and ‘Location ID’.

Location ID

The Designer or Project Lead is responsible for assigning the Location ID. Each piece of SacSewer equipment has a unique identifying number for the location where it physically sits. This is the Location ID.

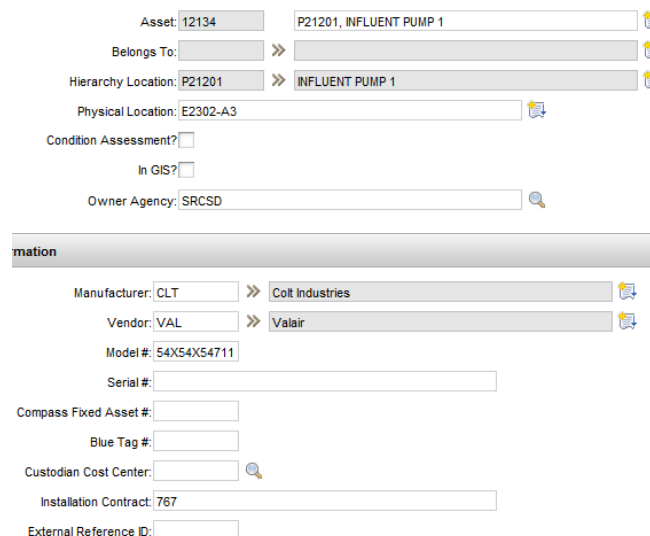
The Location ID is the smart number which is assigned using Auto-Numbering. It is the number used to tag the equipment in the field, and it is identified on the MEL, drawings, procedures, etc.

Asset ID

The Designer or Project Lead is **not** responsible for the Asset ID. The Asset ID is automatically generated by the Maximo database when CMMS staff adds it to Maximo.

The Asset ID is used to track a specific piece of equipment installed at a location. For example, we have a pump with a Location ID of **P21201**. That particular pump has an installation date, remaining useful life, serial number, etc. It is a Colt Industries pump, model number 54X54X54711, etc. The Asset ID for this pump is 12134.

If the pump goes bad and gets switched out with a new Flygt pump, the Location ID will remain **P21201** because the physical location did not change, and the pump is still serving the same purpose within the treatment process. However, the pump will get a new Asset ID, installation date, manufacturer, model, etc.



Asset: 12134 P21201, INFLUENT PUMP 1

Belongs To: »

Hierarchy Location: P21201 » INFLUENT PUMP 1

Physical Location: E2302-A3

Condition Assessment? ☐

In GIS? ☐

Owner Agency: SRCSD

Information

Manufacturer: CLT » Colt Industries

Vendor: VAL » Valair

Model #: 54X54X54711

Serial #:

Compass Fixed Asset #:

Blue Tag #:

Custodian Cost Center:

Installation Contract: 767

External Reference ID:

Maximo screen shot showing production asset data

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Labeling Location IDs on Drawings

Label Location IDs on drawings according to the project's drafting standards. **All equipment numbers captured in the MEL need to be shown on at least one drawing.** If the Designer is not going to show all of the equipment on the P&IDs or plans, then standard assembly details need to include tables relating the individual equipment numbers to the assembly's components.

Changing Numbers

Corrections can be made during the design process to correct or change numbers before they are approved. Once the Location ID has been added to Maximo and the equipment is in production, we generally do not change the number unless there is a significant reason (i.e. duplicate number detected, significant safety concern, etc.). **The existing number serves the purpose of acting as a unique identifier, and will not be changed for aesthetic reasons.**

Changing numbers requires a great amount of effort including:

- We have to change the drawings, manuals, schedules, SOPs, and other documents.
- The Location ID references to EDM/FileNet have to be updated.
- The Location ID may have to be updated in GIS.
- We have to engrave a new tag and change out the tag in the field.
- The old Location ID has to be deleted from databases such as IDEA and Maximo.
- The new Location ID has to be added to databases such as IDEA and Maximo.
- In Maximo, the Asset has to be re-mapped to the new Location ID.
- If work orders or PM's existed in Maximo, those have to be re-mapped to the new Location ID.

The Location ID may be referenced in documentation which is not indexed in EDM/FileNet, such as design drawings, procedure manuals, or construction submittals. In these cases, the change will most likely be missed and become out of sync with the new number. Therefore, **the general policy is that once a Location ID has been assigned and put into production, it will never be changed.**

Changing Existing Duplicate Numbers

Overview

There are cases where equipment in different areas of the District were accidentally assigned the same Location IDs. In these cases, we have to change one of the duplicate Location IDs so each will be unique. This section outlines those guidelines.

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The goal is to make it so that the same Location ID is not shown at different areas of the District for different equipment. This applies to field tags, documentation, Maximo, GIS, and any other applicable uses.

This will **ONLY** be used to resolve existing duplicates that have been installed in the field. It will **NOT** be used to subvert Auto-Numbering rules during design or other processes.

Choosing Which Location ID to Renumber

All factors should be taken into account when renumbering duplicate Location IDs. **Choosing the path that has the least negative impact on the District should be the favored option.** Here are some factors to consider:

- Maximo impact. Will changing one of the locations have more impact on moving assets, work order history, etc.?
- Retagging effort and feasibility. Will one of the locations be difficult or costly to retag, and who will do the work? Will other crafts outside of Documentation need to be involved, work orders set up, etc.?
- Documentation update effort. Will one of the locations require more work to update drawings, manuals, and other documents?
- Probability of documentation or labels that will be missed during the renumbering. Will one of the locations have schedules or other documents that are not likely to be indexed to the Location ID being changed in EDM? Will there be labels inside of panels, on wires, in ACCs, or other locations that will be missed and not updated?
- Location ID prevalence. Is one of the locations used more, or more important than the other? Is one of the locations abandoned, removed, etc.?

Renumbering Methods

Suffixing

When renumbering an existing duplicate Location ID, one option is to add an alphabetic suffix to the existing number. For example, add the suffix 'A' to one of the existing Location ID duplicates to make it unique.

For example, with a large metal manhole cover, renumber one of the duplicates from MH1 to MH1A.

Advantages of Suffixing

- Maintains a level of history. There will be instances where notes on drawings or documents that are not indexed in EDM will still

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reference the original Location ID. Suffixing the original Location ID maintains a connection to the original number.

- May be easier to retag, especially for metal or welded-on tags.
- Makes updating documentation easier in some cases.

Auto-Numbering

In some cases, Auto-Numbering or another method that fits the particular situation best should be used. Again, the path that has the least negative impact on the District should be the favored option.

Duplicate Renumbering Procedure

1. Determine which of the duplicates will be renumbered. Submit an RFI to Documentation to request to have the new number generated in IDEA.
2. Submit an MEL to CMMS to update all Location and Asset data in Maximo. Be sure to add a note to the item being changed that briefly explains the reason for renumbering. For example, 'This manhole was renumbered from MH1 to MH1A because it used the same Location ID as a separate manhole located south of ACC4. The original documents referred to this manhole as MH1, but have been updated to read MH1A.'
3. Submit a DCN to have the documentation and tagging updated as needed. GIS will be updated during the monthly DCN review process.

Piping System Changes

What happens if a WN pipeline is reused for WRH? If a pipeline is repurposed for another use, manual valve Location IDs will become out of sync with the piping system. For example, a WN pipeline will have manual valve numbers using syntax 6 which contain the piping system as part of the Location ID. An example of a manual valve part of a WN pipeline would be 61**WN**22.

For the reasons stated above under 'Changing Numbers', the manual valve Location IDs will **not** be changed if the pipeline is repurposed. For example, you might have a manual valve such as 61WN22 which is on a WRH pipeline. The following changes will be made to make the correct piping system apparent:

1. Update all drawings referencing the piping system.
2. Update all markings or vinyl stickers in the field which denote the piping system.
3. Update the piping system in GIS.

Change in Function

If an asset is modified in way that completely changes its function, then it may be assigned a new number in some instances.



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For example, if a manual valve is converted to a motor operated valve, then you are effectively changing the type of equipment. In this case, you may assign a new number to the motor operated valve (syntax 2), and remove the number of the manual valve (syntax 6). It would go from something like **61WRH22** to **V610045**.

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Grouping and Sequencing Numbers on Plans

While Auto-Numbering can generate unique numbers for assets, it cannot group these assets into any logical order. Assignment of equipment numbers requires conscientious users who understand the processes they are numbering. Equipment numbers should be laid out in some kind of logical fashion that will make sense to operators, maintenance staff, or any other users accessing the facilities. The goal of grouping assets is to make the following tasks easier:

- Assigning numbers during designs
- Sorting lists
- Building schedules or tables
- Identifying assets in the field
- Identifying assets on PCCS screens
- Viewing assets in GIS

Where to Start

Start by familiarizing yourself with the design. Look at all of the drawings to understand how the process works. Once you have a basic understanding of the process and project area, identify the syntax 2 numbers that serve a central or 'parent' asset and group them into zones or sub-zones if needed. Next, you can assign syntax 4 and 5 numbers since they work independently of the other numbers. Finally, you can review the P&IDs to assign syntax 6 numbers and any syntax 2 numbers that stand alone and do not serve a parent asset.

When in doubt, look at existing facilities to see how equipment numbers are grouped. You can look at existing tanks, pumps, and processes to get an idea of how numbers have been applied in the past. Designers should consult with District staff when questions arise.

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Syntax Business Rules

For a detailed look at the District's Auto-Numbering syntax rules, please refer to the detailed [SRCSD Auto-Numbering](#) document. The table below is just a summary of mechanical equipment.

Syntax	Length	Code	Example
Syntax 1 Core/Loop	6	[AA][9999] [max 2-digit plant area number] [max 4-digit sequential core number]	450001 Area 45, Core/Loop# 0001
Syntax 2 Equipment and Instruments	11	[PPPP][AA][9999][S] [max 4-char prefix] [2-digit plant area number] [4-digit sequential core number] [1-char sequential suffix (Null OK)]	P450001A Area 45, Auxiliary Pump 1A
Syntax 4 Process	8	[PPPP][AA][SS] [max 4-char prefix] [2-digit plant area number] [2-char sequential suffix]	SLG45E Slide Gate, Area 45, 5 th gate (E)
Syntax 5 Simple Sequential	8	[PPPP][9999] [max 4-char prefix] [max 4-digit sequential number]	MH17 Electrical Manhole number 17
Syntax 6 Pipe Service	11	[AA][DDDDD][9999] [2-digit plant area number] [max 5-char pipe service code] [max 4-digit sequential core number]	45WRH37 Area 45, WHR system, manual valve number 37

To determine the plant area number, refer to the District's latest '[Equipment Zones Map](#)' or [GIS](#).

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Syntax 2 (Parent/Child with Core Numbers)

Syntax 2 equipment use an area/core number which is used to group related parent/child assets. All of the assets which serve a central, or 'parent' asset, are numbered using the same six digit area/core number.

Syntax 2 Code

[PPPP][AA][9999][S]

PPPP = max 4-char prefix

AA = 2-digit area number

9999 = 4-digit core number

S = 1-char suffix (null OK)

(Example: P614101A)

Start by Grouping Core Numbers on the Plan Drawings

At the beginning of a design, we normally start with the site plan drawings that show the related regions of the project.

Look at the plan view drawings, process schematics, and the P&IDs. Make a judgment as to how the core numbers for the parent assets will be laid out on the plans. Label the parent equipment numbers on the plans so you have a reference for issuing the child numbers later on the P&IDs. Everything will build off of the parent numbers that you establish early on. It may be useful to group the equipment into zones or sub-zones.

We typically start with the flow path of the main process, and then assign core numbers to any secondary or utility systems. We typically use core numbers 0001-0009 for PLCs, so start with core number 0010 or a higher number if there are more PLCs. We don't typically start with 0000.

It may be preferred to number the tanks, then the pumps, then any downstream elements. In some projects, it may make the most sense to number the equipment in sequence along the direction of flow from upstream to downstream.

In another project, it may make more sense to number in groupings based on the physical layout of equipment. Assets that flow through treatment processes lend themselves to numbering in the direction of flow. Chemical feed processes have tanks that are shared by a number of pumps, so it may make more sense to number them in sequence as they are shown on the plans.

Important!: Once a core number has been used, it may not be used again for another group or piece of equipment outside of the assembly. Core numbers will be assigned to

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only one group of parent/child equipment at one physical location. For example, core number 21201 is used for influent pump P21201 located in the I/E Building. You would not assign B21201 to a blower in the same area, even though the number would be technically unique. You would use another core number for the blower and its child assets.

During a design, it may be useful to have one person be in charge of the MEL. In previous projects, isolated design groups such as electrical and HVAC inadvertently used the same core numbers, resulting in changes late in the design process.

Zones and Sub-Zones

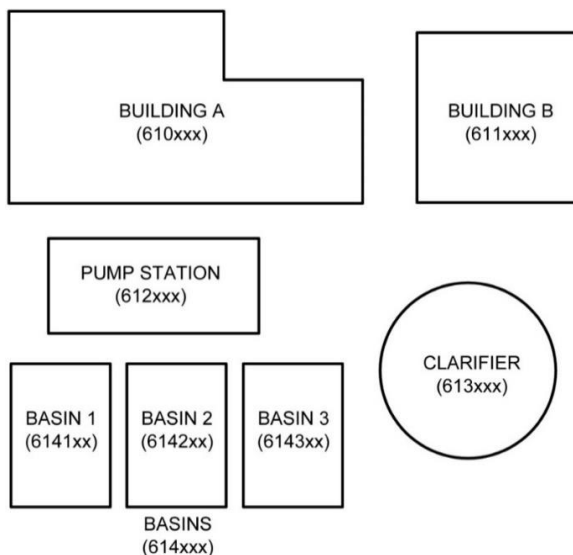
Grouping by physical zones can be done by using the first two digits of the 4-digit core number. As a general procedure, start with the site plan drawings or process schematics. Map out the zone and sub-zone groupings that will be represented by the first two digits in the core number. It may be useful to create a working map of the area numbers and zones to keep them straight during the project (see example on next page).

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The first digit of the 4-digit core number is best used for large zones such as whole buildings or batteries of processes. Let's say we have two buildings, a pump station, a clarifier, and a group of three basins. We want the equipment numbers in each region to have a common thread. To achieve this, we start each of the core numbers with an identifying digit. For example:



Zone	Core Number Series	Samples of Pumps in Each Zone
Building A	0xxx	P610001, P610002, P610003, etc.
Building B	1xxx	P611001, P611002, P611003, etc.
Pump Station	2xxx	P612001, P612002, P612003, etc.
Clarifier	3xxx	P613001, P613002, P613003, etc.
Basins	4xxx	P614001, P614002, P614003, etc.

Rooms within a building do not constitute sub-zones, they just get 'ROOMxxxxxx' numbers. Multiple treatment units within a common zone such as individual SSTs, basins, thickeners, and digesters are good examples of sub-zones. In our example, let's say our process has a group of three basins. You could move to the second-digit in the core number and assign an identifier to each basin within the 'Basins' zone. For basins you could use sub-zone core numbers like this:

Zone	Sub-Zone	Core Number Series	Samples of Pumps in Each Basin
Basins (4xxx)	Basin 1	41xx	P614101, P614102, P614103, etc.
Basins (4xxx)	Basin 2	42xx	P614201, P614202, P614203, etc.
Basins (4xxx)	Basin 3	43xx	P614301, P614302, P614303, etc.

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Applying Core Number Groupings on P&IDs

Once a set of core numbers have been established at the parent level on the plans, the next task is to assign numbers to child assets that serve the parents. The Process and Instrumentation Diagrams (P&IDs) are usually the best tools for figuring which assets should be grouped together using the same core number.

Start by labelling the parent assets on the P&IDs. Once this is finished, circle each grouping of child assets which serve their parent on the P&ID. Any assets that serve the parent will get the same core number. Examples of children would include instrumentation or actuated valves associated with isolation and control of the parent.

Sometimes there are assets which don't tie directly to a parent asset in a 1:1 relationship. For example, we have a flow meter downstream from three pumps which all discharge to a common pipe. Since we can't tie the flow meter to any of the three pumps individually, we give the flow meter its own unique core number.

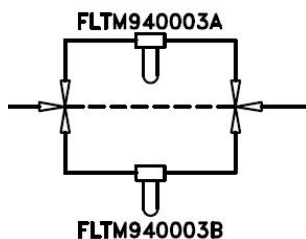
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Examples of Identifying Core Number Groupings

- For pumps, everything from the suction point to a common discharge point takes on the same area/core number. This is true of blowers and other equipment associated with process flows.
- Individual pieces of equipment such as mixers, motor operated valves, gates, etc. may be treated as individual pieces of equipment with distinct core numbers.
- Package compressors are one core equipment group with the compressor being a core number and, if there are two compressors, each are A and B suffixes.
- If a process stream is split into parallel redundant streams that mirror each other, the parent numbers should follow an A and B suffix stream like this:



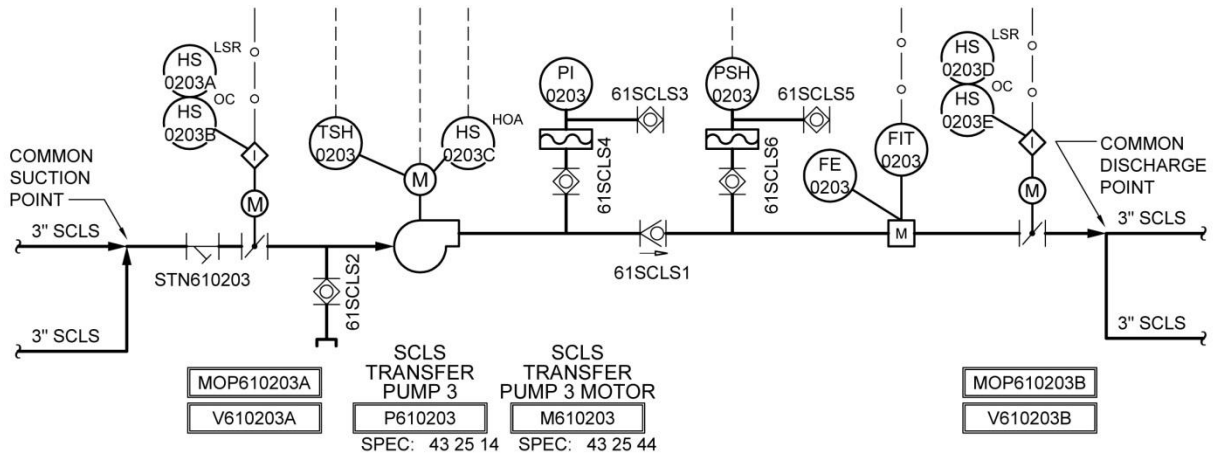
Once the parent/child groupings have been circled on the P&IDs, all you have to do is populate the final equipment numbers. Apply the area/core number of the parent to each of the children using prefixes and suffixes within syntax 2. Within a group of assets that use the same core number, the prefixes will set the numbers apart from each other. Use suffixes when there are several assets in a grouping that all use the same prefix and core number. Try to sequence the child numbers from left to right and from top to bottom as shown on the P&ID.

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Here is a typical grouping of parent and child assets that all use the same core number in area '61'. In this example, we have the pump as the parent asset. The motor, valves, operators, and instruments which serve the pump all get the same core number '610203'. The hand switches are numbered with suffixes A-E because there are five of them with the same prefix and core number. Since there are two valves in this flow sequence, we split them up using suffix 'A' for the suction side and 'B' for the discharge side of the pump.



Children of Pump 'P610203'					
Equipment	Number	Operator	HOA	LSR	OC
Pump	P610203	M610203	HS610203C		
Suction Valve	V610203A	MOP610203A		HS610203A	HS610203B
Discharge Valve	V610203B	MOP610203B		HS610203D	HS610203E
Flow Meter	FE610203	FIT610203			
Pressure	PI610203	PSH610203			
Temperature	TSH610203				
Strainer	STN610203				

Suffixes are added to multiple assets with the same area/core number and prefix. For example, here is a different pump with suction, discharge, and control valves in the main process area, first zone:

Equipment	Number	Operator	HOA	Start/Stop
Pump	P611101	M611101	HS611101A	HS611101B
Suction Valve	V611101A	MOP611101A	HS611101C	HS611101D
Discharge Valve	V611101B	MOP611101B	HS611101E	HS611101F
Control Valve 1	CV611101C	MOP611101C	HS611101G	HS611101H
Control Valve 2	CV611101D	MOP611101D	HS611101J	HS611101K



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Here is a treatment process sequence consisting of a motor operated gate followed by a series of motor operated valves, control valves, mixers, and a pump. Each asset family in this sequence gets its own unique core number.

Parent Asset	Parent Location ID	Operator (Child)	HOA (Child)	Start/Stop (Child)
Gate	G711101	MOP711101	HS711101A	HS711101B
Valve	V711102	MOP711102	HS711102A	HS711102B
Control Valve	CV711103	MOP711103	HS711103A	HS711103B
Valve	V711104	MOP711104	HS711104A	HS711104B
Mixer	MX711105	M711105	HS711105A	HS711105B
Mixer	MX711106	M711106	HS711106A	HS711106B
Pump	P711107	M711107	HS711107A	HS711107B

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Which PLC Should be Listed at the Top of the P&ID?

District Control Systems staff has asked that we show the primary physical PLC processor that instruments report to at the tops of the P&ID sheets. In a typical control panel, there will be three PLCs:

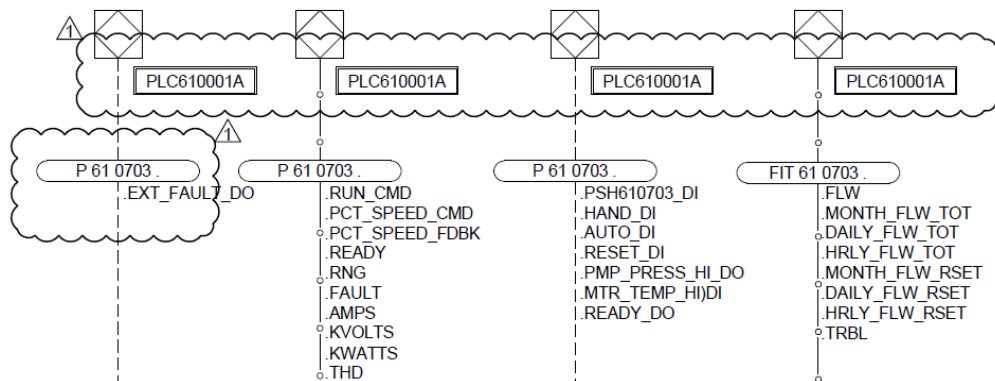
PLC-A (main processor)

PLC-B (for redundancy)

I/O (PLC-C)

Since PLC-A is the main processor, it should be the PLC number shown on the P&ID sheets. All of the PLCs should be shown somewhere on a block diagram or panel drawing.

For example, for the DCS project, the main PLC processor for area 61 is location ID PLC610001A. This is the number that should be shown in the double-box at the top of the P&ID sheets. The benefit to District staff is that they will be able to quickly search in their file library for P&IDs related to the PLC by searching for the PLC location ID and choosing 'Process and Instrumentation Diagram' as the document sub-type.



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Syntax 4 (Process Equipment - [PPPP][AA][SS])

If there are process schematics, use those drawings to assign numbers for syntax 4. Some process flows will not have any process schematics. In these cases, use the plan-view drawings. We typically number process equipment in sequence along the flow path. From the starting point of the flow, each asset will get the next sequential number available.

On the P&IDs we typically start with the flow path of the main process, and then assign numbers to any auxiliary or servicing systems. Assign numbers moving from left to right, then from the top to the bottom.

Do not use the letters 'I' or 'O' for suffixes. The letters can too easily be misinterpreted as the numbers 1 and 0. Skip from H to J and N to P when issuing suffixes.

Syntax 5 (Simple Sequential - [PPPP][9999])

Since these use a sequential syntax, the District has to assign these. Designers will have to use temporary placeholder numbers, and request these from the District. There is no way for the Designer to know which syntax 5 numbers already exist within the District, or have been used by other parallel projects.

Start with the plan-view drawings and number the syntax 5 equipment. Because Syntax 5 numbers do not use an Area Number prefix to set them apart, conflicts are more likely to be encountered with existing numbers.

Most of the assets covered under syntax 5 will be shown on the plan-view drawings. Try to arrange the syntax 5 assets into some kind of logical sequence based on their physical location or proximity to other assets. We typically start numbering at number 10 instead of 1 so the assets group together on lists when sorting alphanumerically.

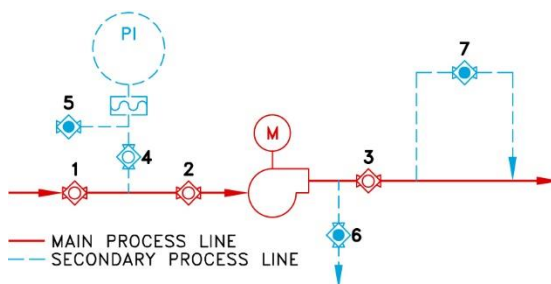
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Syntax 6 (Manual Valves- [AA][DDDDD][9999])

Assign Location IDs to any valves greater than ½ inch in size, or any valve that will be part of a procedure such as drainage, flushing, isolation, maintenance, etc. All assets within a covered process need to have Location IDs assigned. Do not assign Location IDs to small valves which are part of a large systems and are service connections such as hose bibs, service connections to utility stations, etc. Do not assign Location IDs to valves that are built into equipment by the manufacturer as a component and are included in the O&M Manual.

We typically number manual valves in sequence along the flow path. From the starting point of the flow, each manual valve will get the next sequential number available. The Process and Instrumentation Diagrams (P&IDs) are usually the best tools for figuring out how the process flows, and in which order to number the valves.

On the P&IDs, we typically assign numbers to the main process pipeline first, starting upstream and travelling downstream. Next, we assign valve numbers to any secondary or utility pipelines.



Some process flows will not have any process schematics. In these cases, use the plan-view drawings to assign the manual valve numbers in order by flow direction. We typically start numbering at number 10 instead of 1 so the assets group together on lists when sorting alphanumerically.

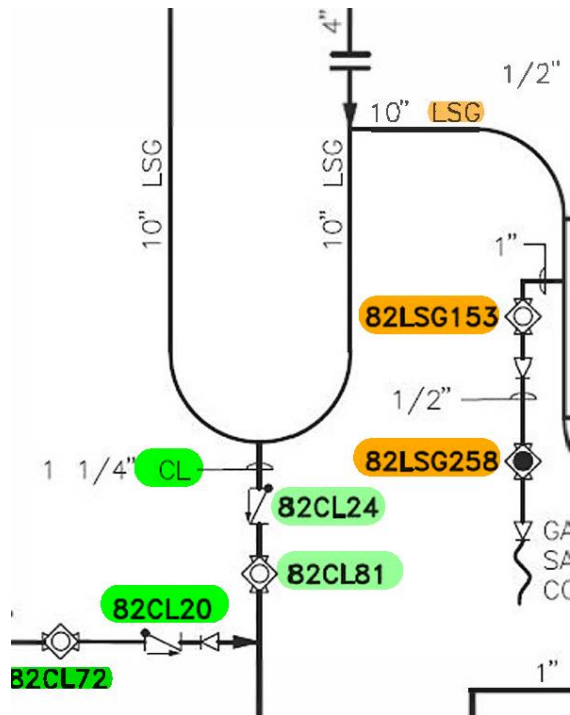
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Identifying Process Flow Pipe System

The Process Fluid/Product that flows through the pipe and process equipment will determine the Pipe System to use. The Pipe Systems will identified in SMP 207C.



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Syntax 7/8 Electrical

This document only gives some brief examples of electrical numbering. For a detailed look at the District's Auto-Numbering electrical syntax rules, please refer to the [SRCSD Auto-Numbering](#) guide.

MCC Buckets

MCC Buckets or 'MCC Cubicles' are entered into the **MCC_BUCKET** tab in the MEL spreadsheet. Enter buckets using the MCC number plus the bucket with a dash in between (syntax 10).

Syntax 10 MCC Buckets

[MCC Number]-[Bucket]

[MCC Number] (Exclude the "MCC" prefix. For example, for MCC52B1A1 use the **52B1A1** portion of the number).

[Bucket] (2J, 7B, etc. – it will depend upon the row or column)

Location ID Example: **52B1A1-2J**

You should be able to get the data for the MCC buckets from the MCC schedules in the 'E' series of drawings. If not, the MCC elevation drawings will also show the information.

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MCC Bucket Description for the MEL

For the description, use the equipment number that the bucket serves.

MCC Bucket; [Location ID of Equipment Fed by Bucket]; [Description of the Equipment Fed by Bucket]

Description Example: **MCC Bucket; P510001; Effluent Pump 1**

MCC Bucket Examples for the MEL

Bucket Location ID	Bucket Description in MEL
52B1A1-2J	MCC Bucket; AHU520002; Air Handling Unit 3
52B1A1-4H	MCC Bucket; P510201, BNR East Drain Pump 1 <i>*(don't use the motor here – use the pump)</i>
52B1A1-3B	MCC Bucket; Spare Breaker
52B1A1-3C	MCC Bucket; Space

**When a bucket serves a pump, please list the pump number and name in the description. Do not use the motor number and name. This is how all of the existing MCCs at the plant are labelled.*

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MCC Bucket Contents

Assets within electrical buckets get their own Location IDs if they meet Auto-Numbering criteria. For items within MCC Buckets, the number after the prefix is basically the same syntax 8 numbers as the breaker number. See examples in the table below:

Table of possible assets which can be contained within a MCC Bucket

Prefix	Description	Sample Number if it is in a MCC Bucket	Yellow Tab in MEL (Classification)
AHF	Active Harmonic Filter	AHF61A1	AHF
BKR	Breaker	BKR61A1	BREAKER
EDM	Electrical Data Monitor	EDM61AB	MISC
MPR	Motor Protection Relay	MPR52A3	MISC
NGR	Neutral Ground Relay	NGR52A	MISC
PDM	Power Data Monitor	PDM61A1	MISC
PNL	Electrical Panel	PNL52A3	PANEL
RVSS	Reduced Voltage Solid State (Soft Start)	RVSS52A3	DRIVE
SOL	Smart Overload	SOL61A1C	OVERLOAD
SPD	Surge Protection Device	SPD61A1C	MISC
STA	Starter	STA61A1D	STARTER
TFR	Transformer	TFR51A1K	TRANSFORMER
VFC	Variable Frequency Controller	VFC52A3	DRIVE
VFD	Variable Frequency Drive	VFD51A1L	DRIVE

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Feeders (FDR)

Overview

Feeders represent the wiring of a circuit between a breaker and the downstream switch. The asset is the wire or wires. Location IDs are assigned so the electrical shop can set up preventative maintenance work orders (PMs) to do work such as hipot (high potential) testing, megger testing, cleaning, and other tasks.

When to Assign a Feeder Location ID

FDR prefixed Location IDs are typically assigned to circuits which are 4160 volts or higher. The electrical shop will identify which feeders need Location IDs assigned.

Syntax

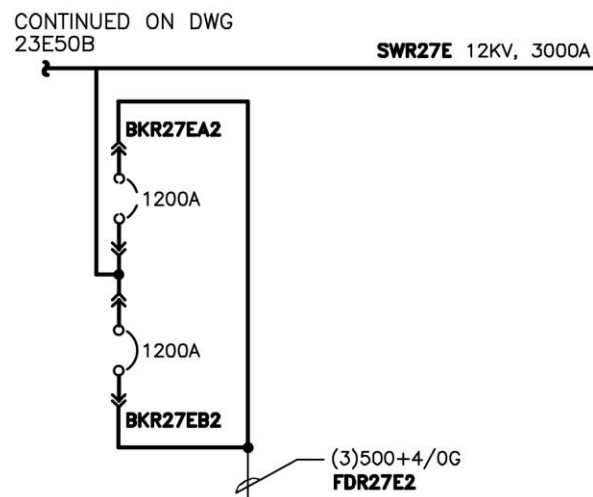
Feeders use syntax 8 and are prefixed with 'FDR' like this: **FDR27E2**

[FDR][Upstream breaker number without A/B side included]

The upstream breaker will determine the number used for the feeder. However, we omit the redundant A/B side designation from the number. For example if a feeder is being fed by the circuit from breakers BKR27EA2 and BKR27EB2, the feeder number will be **FDR27E2**. Note how we dropped the **A** and **B** from the breaker numbers.

Drawings

Show Location IDs for feeder numbers on the Electrical Single Line Diagrams. You typically would show the Location ID with the label for the wiring as shown at the bottom of the image below:



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Junction Boxes, Conduits, and Raceways

Do not add junction boxes, conduits, or raceways to the MEL. The junction boxes shown in our designs are condulets or small boxes that are used for conduit connections and cable routing. They require a designer provided tag (used in raceway and cable schedules) but don't need to be included in the MEL; it is not a maintenance item.

For larger electrical boxes which are above ground, use 'PB' Pullbox syntax 4. Electrical boxes in the ground should use 'HH' Handhole syntax 5. Larger electrical vaults which allow human entry would be considered 'MH' Manhole syntax 5. Don't forget to assign Location IDs for sump pumps or ladders inside of manholes.

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Outlying Facilities (Interceptors)

Outlying facilities include the components of pump stations, the collections system, recycled water systems, and any other assets physically located off the EchoWater Facility site.

This document only gives some examples of outlying facility numbering practices. For a detailed look at the District's Auto-Numbering syntax rules, please refer to the [SRCSD Auto-Numbering](#) document.

Syntax 2F Outlying Facility Pipeline Equipment

[FFF][-][PPPP][9999][S]

Syntax 2F includes most pipeline equipment except for manual valves.

Syntax 2F Code

FFF = 4-char facility code

[-] = dash

PPPP = max 4-char prefix

9999 = 4-digit sequential core number

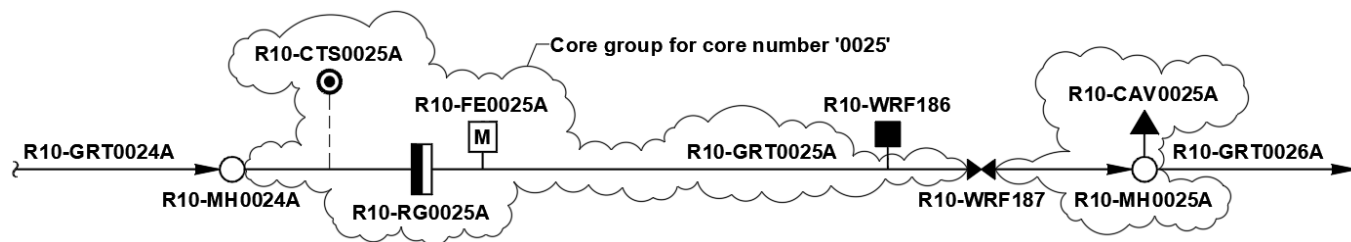
S = 1-char sequential suffix (*Null OK for non-transmission equipment.*

Transmission equipment will always use an alpha suffix (not including I and O).

The null suffix is not allowed.)

(Example: R10-FMT0001A)

A core group (i.e. a section of transmission/collection equipment) shall include everything between two features that change flow properties. It also includes the downstream node. See figure below:



Features that change flow properties and break core numbers:

- Manholes
- Fittings (tee, wye, cross, joint, reducer, blind flange, plug, cap)
- Wet Wells

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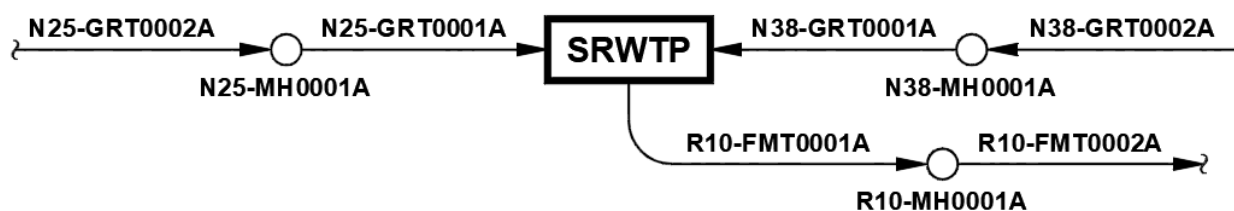
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Features that **do not** change flow properties and **do not** break core numbers:

- Air Valves
- Gates
- Backflow Preventers
- Pumps
- Blowoff Valve Assemblies
- Valves
- Cathodic Protection
- Weirs
- Flow Meters

It is important to note that alphabetic suffixing in the transmission facilities has no inherent meaning. The suffixes indicate nothing more than one item of up to 24 identical items (i.e. things with the same prefix) in a core group. Therefore, many of the numbering suggestions in this document are for aesthetic quality, and will not have a business impact as long as all assets get unique Location IDs.

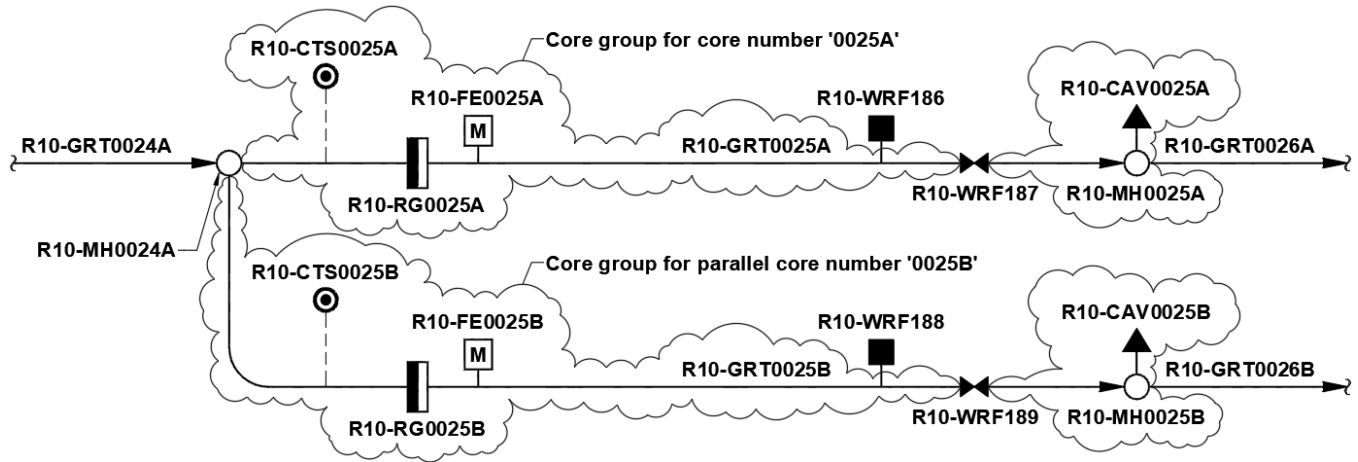
Core numbers on transmission lines are assigned sequentially starting from their downstream termination. Use a 'plant outward' sequence instead of 'downstream to upstream' for force main pipelines leaving the plant. See the 'R10' pipeline in the figure below:



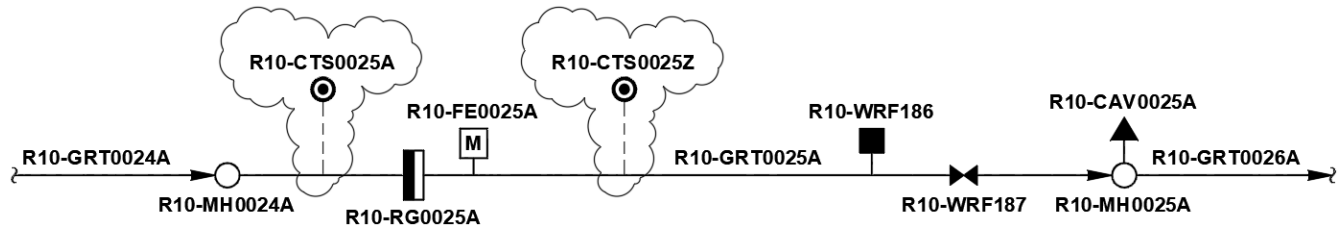
Generally speaking, core numbers will start with the number '0001' at the plant and work sequentially outwards away from the plant. This will allow room for future expansion.

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Sections of parallel transmission equipment will use the same core number. The required alphabetic suffixes will be typically, but not necessarily, be assigned as a sequential pair (i.e. A/B, C/D, etc.) See figure below:



Try to assign the same core number and suffix to any equipment along a pipeline as the pipe itself. When this is not possible, use the same core number and an available suffix that is not already used. See figure below, where a second cathodic test station was added along the same '0025A' core number pipeline. In this case, we used a suffix towards the end of the alphabet ('Z') that won't likely be used by a new leg of pipeline.



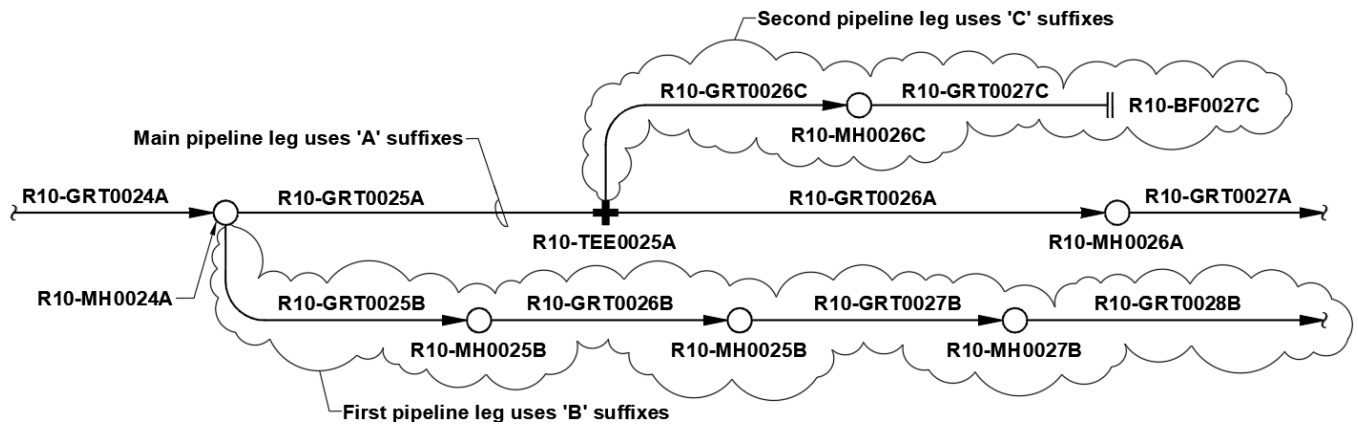
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Forks and Legs Coming off Main Lines

Sections of parallel transmission equipment will start with the same core number. Therefore, any fork or leg coming off a main pipeline will start with the same core number as its parallel pipe, except it will get a new suffix. See figure below:



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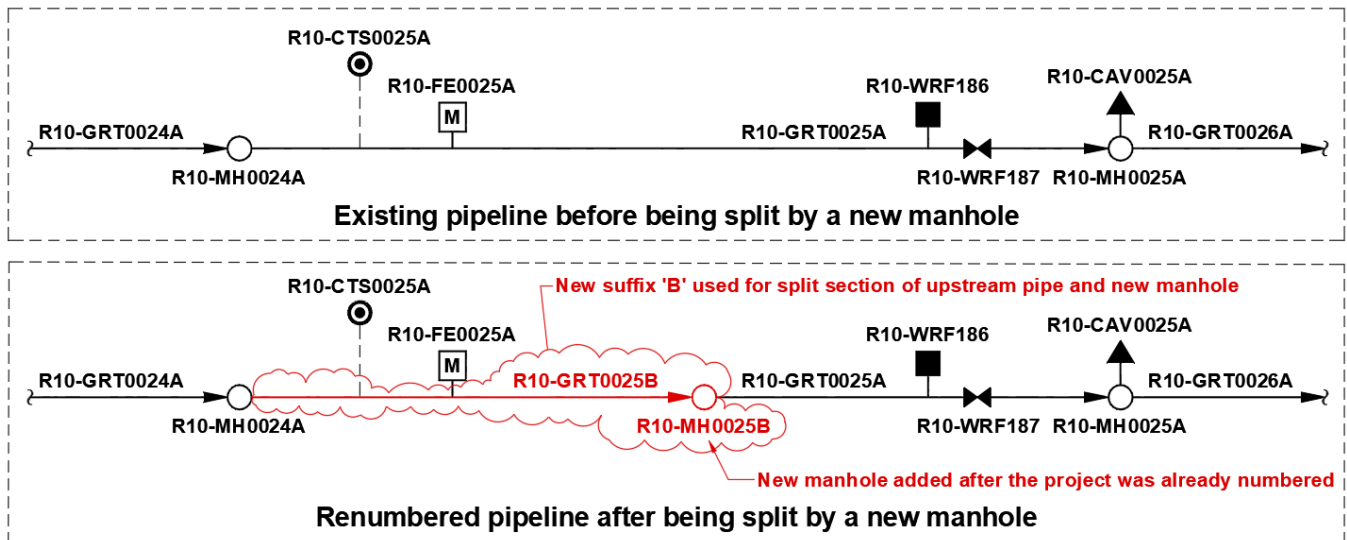
Handling Pipe Splits

Sometimes a new feature is inserted on an existing pipe that has already been numbered. This causes the pipe to be split into two separate Location IDs.

When this happens:

1. The core number will remain the same for both sections. For example, if the original core number was '0025A', then each portion of the pipe on either side of the split will still use '0025' with different suffixes.
2. A new suffix will be used on the split section that is closest to the EchoWater Facility site.
3. Any existing numbers for equipment other than the split section of renumbered pipe will remain unchanged (see R10-CTS0025A and R10-FE0025A in figure below).

See figure below for an example:



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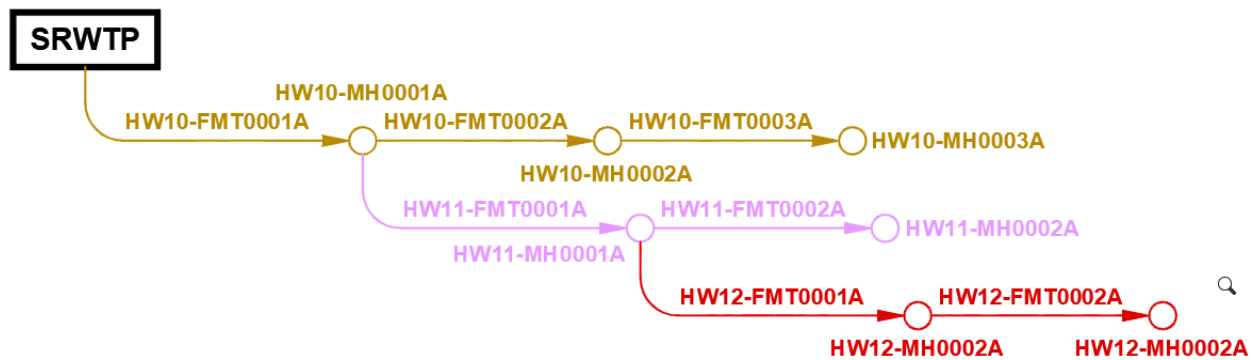
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Harvest Water

Harvest Water uses 'transmission lines' Syntax 2F for the majority of the Auto-Numbering the project. Unlike other pipelines that flow in a linear manner, Harvest Water is a vast network of cross-connected pressure pipelines. Therefore, Harvest Water uses separate facility codes for each construction project. The advantages of this approach are:

1. Designers are able to independently number within each project without duplicating numbers being used by parallel projects.
2. It reduces the likelihood of running out of alpha suffixes for pipeline legs veering off from the main pipeline.
3. It adds a level of grouping to regions.

Each Harvest water project will start with number FMT0001A at the upstream point nearest to the plant and number sequentially outwards away from the plant.



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Syntax 6F Outlying Facility Manual Valves [FFF][-][DDDDD][9999]

This schema is exactly the same as Syntax 6, except the user will also have to select the facility code before the system will generate the next number(s). The IDEA system automatically assigns the next sequential core number, which has no bearing on the valve's location along the pipeline.

Syntax 6F Code

FFF = 4-char facility code]

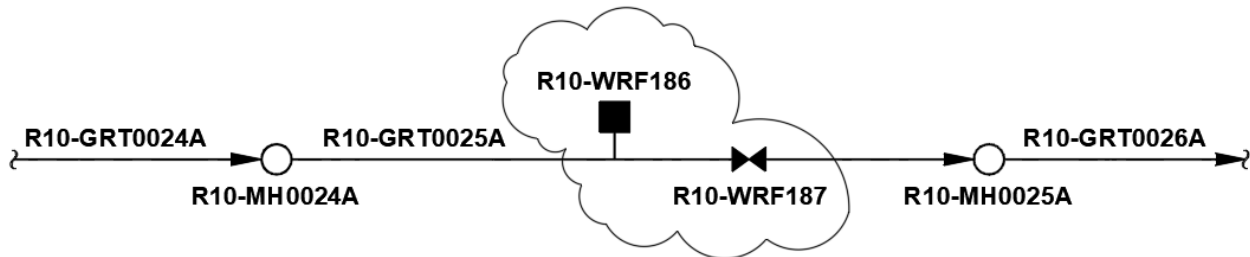
[-] = dash

DDDDD = 5-char pipe service code

9999 = max 4-digit sequential core number (*automatically assigned by IDEA system*)

(Example: R10-WRF186)

We generally assign numbers in order from upstream to downstream, but this is not required.



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Additional Business Rules

Suffixes I and O

Do not use the letters 'I' or 'O' for suffixes in any syntax. The letters can too easily be misinterpreted as the numbers 1 and 0. Skip from H to J and N to P when issuing suffixes.

Tying Into Existing Areas of the Plant

When tying into existing areas of the plant, any new piece of parent-level equipment will use new day-forward numbering. New process streams will get new day-forward core numbers. Only child-level equipment will use existing core numbers when tying into existing parent-level assets.

Planned Future Facilities

When showing future assets for eventual build out, show the parent-level equipment numbers on the plans as 'future'. These numbers can be used if and when the facilities are built.

- In the MEL spreadsheet, add the word "(FUTURE)" to the end of the description.
- Add the word "FUTURE" in the Notes column.

This will alert CMMS to place this location outside of the MAIN hierarchy in Maximo (in the MEL hierarchy) until it is actually installed, and then they move it over.

Drawing Disciplines

Here are some things to look for in each of the drawing disciplines which are commonly overlooked by many Designers.

Civil

Item	Syntax	Prefix	Example
Road	5	ROAD	ROAD1001

Roads

Since these use a sequential syntax, the District has to assign these. Designers will have to use temporary placeholder numbers, and request these from the District.

Roads have their own unique numbering system. We assign Location IDs based on Inspection Units (IUs). Each inspection unit gets its own Location ID in Maximo.

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Number of Inspection Units =
(square footage of the pavement section)/(1000 x width of pavement section)

Calculate the number of inspection units for a given roadway, then divide the road up into that many sections. Each section will get a Location ID. Use the next available 'ROADxxxx' number in IDEA.

Run any proposed road assignments by Ami Patrick, who oversees the asset management program.

Structural

Item	Syntax	Prefix	Example
Ladders	5	LDR	LDR1001

Ladders

Since these use a sequential syntax, the District has to assign these. Designers will have to use temporary placeholder numbers, and request these from the District.

Architectural

Item	Syntax	Prefix	Example
Buildings	5	BLDG	BLDG100210
Roofs	5	ROOF	ROOF100210
Rooms	5	ROOM	ROOM1001

Buildings and Roofs

Since these use a sequential syntax, the District has to assign these. Designers will have to use temporary placeholder numbers, and request these from the District.

When assigning building numbers, use the next available 'BLDGxxxx' number. After generating the building number, generate a corresponding 'ROOFxxxx' number. Building and roof core numbers need to match each other. If IDEA doesn't give you the number that you need, add some dummy numbers in IDEA to get to the numbers you need.

Fire Risers

For Fire Sprinkler Riser details, we don't need to number the individual valves or components. Issue a **FSS – Fire Sprinkler System** syntax 2 number to account for the assembly. Facilities Maintenance does not maintain the fire risers. These assemblies are tested and regulated by external contractors. The FSS number will establish the parent core number which any panels, bells, alarms etc. will follow as child numbers.

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Auto-Numbering Guidelines

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HVAC

For Heating Ventilation and Air Conditioning (HVAC), try to start with an airflow schematic. If the designer did not provide one, ask for one. At the very least, you need to be able to tell how the air flows, and which pieces of equipment are tied to the parent-level asset. In most cases, you will have a parent like an air handling unit (AHU) or heat pump (HP) pushing air through a subset of child assets.

Tips

- Use **ACUxxxxxx** for air conditioners which only supply cold air.
- Use **HPxxxxxx** for heat pumps which are combination heating and cooling units.

Reference Documents

Title	Document Serial# in EDM	Link
Detailed Auto-Numbering Business Rules (SRCSD Auto-Numbering 2007)	CMMS SharePoint	Link
Prefix List (SMP 207 Appendix A)	10086677	Link
Pipe Systems (SMP 207 Appendix C)	10086678	Link
Equipment Zones Map	10040686	Link
MEL Flow Chart	10086679	Link
SMP - Section 2 (See section 2.8.2 to see how to fill out the Location ID (Equipment #) Description column.)	10091700	Link
SMP – Section 206 – Location ID Assignment	10091885	Link
MEL Excel Template	CMMS SharePoint	Link

End of Section

Date	Rev	Appr	Description
03/14/19	0	DJW	Original document converted to SMP format.
03/22/19	1	DJW	Removed package equipment reference, cleaned up obsolete information.
8/13/2019	2	DJW	Added 'Appendix A' SacSewer Equipment Prefix List.
8/13/2020	3	DJW	Added "Identifying Process Flow Pipe Systems".
11/5/2021	4	DJW	Added 'Outlying Facilities' sections.
6/27/22	5	DJW	Added "Duplicate Numbers" sections.



Section 207

Auto-Numbering Guidelines

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[End of document]

APPENDIX C

CALIFORNIA GREEN BUILDING STANDARDS

District Selection of Implementation Measures to:						
Title 24, Part 11 "CALGreen" NONRESIDENTIAL MANDATORY MEASURE COMPLIANCE FOR FACILITY TYPE						
DIVISION	MEASURE (SECTION)	BUILDING TYPE		DIRECTION TO DESIGNERS	CAL Green Measure (Description)	CAL Green Exceptions
		Mechanical/ Electrical/ Process	Occupant			
		Incorporate into Design?				
5.1 - PLANNING AND DESIGN						
	5.106 - SITE DEVELOPMENT					
	5.106.1 - Storm water pollution prevention				Newly constructed projects and additions which disturb less than one acre of land shall prevent the pollution of stormwater runoff from the construction activities through one or more of the following measures:	
	5.106.1.1 - Local Ordinance	YES	YES	Two versions of the 01 57 23 TEMPORARY STORM WATER POLLUTION CONTROL Guide Specification have been developed – one for a Water Pollution Control Plan (WPCP) and one for a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP stormwater pollution control specification has been developed to address stormwater requirements for construction projects that exist outside of the EchoWater Facility Ring Levee and have an area of soil disturbance greater than 1 acre. Projects with less than an acre of soil disturbance that exist outside of the EchoWater Facility Ring Levee will be required to comply with a Water Pollution Control Plan (WPCP). Projects inside the EchoWater Ring Levee, regardless of size, will only require a WPCP as stormwater is treated via routing to headworks.	Comply with the lawfully enacted stormwater management and/or erosion control ordinance.	
	5.106.1.2 - Best management practices	YES	YES		Prevent the loss of soil erosion by implementing BMP(s).	
	5.106.4 - Bicycle parking					
	5.106.4.1 - Short-term bicycle parking	YES*	YES	* While non-occupant buildings could be interpreted as exempt from CAL Green measures, District Guidelines require bicycle parking at these buildings. Per Design Guideline 3.8 "Parking", "Utility cart and bicycle parking shall be provided at all EchoWater Facility process buildings". Provide permanently anchored bicycle racks within 200 feet of the employee entrance door for 5 percent of new vehicle parking spaces, with a minimum of one two-bike capacity rack.	Provide permanently anchored bicycle racks within 200 feet of the visitors' entrance (employee entrance door) for 5 percent of new vehicle parking spaces, with a minimum of one two-bike capacity rack.	
	5.106.4.2 - Long-term bicycle parking	N/A	NO		Provide secure bicycle parking for 5 percent of the tenant vehicular parking spaces being added, with a minimum of one space. Acceptable parking facilities: covered, lockable enclosures, bike rooms, bike lockers.	Less than 10 occupants and 10 parking spaces at building
	5.106.5.2 - Designated parking	NO*	NO*	* If directed by District to provide electrical outlets for plug-in vehicles or utility carts, designate parking spaces with markings at these locations.	Provide designated parking for any combination of low-emitting, fuel-efficient and carpool/van pool vehicles per table 5.106.5.2 (8% +/-)	
	5.106.8 - (Outdoor) Light pollution reduction				Outdoor lighting systems shall be designed and installed to comply with the following:	
	5.106.8 (1) - Light pollution reduction	NO	NO	Treatment Plant lighting well separated from property lines and higher lighting provides more safety	Meet min requirements of the California Energy Code (CEC) for Lighting Zones 1-4	Emergency Lighting and Luminaires that qualify in Section 140.7 of CEC
	5.106.8 (2) - Light pollution reduction	NO	NO	Treatment Plant lighting well separated from property lines and higher lighting provides more safety	Comply with backlight, uplight and glare (BUG) ratings as defined in IES TM-15-11	Emergency Lighting and Luminaires that qualify in Section 140.7 of CEC
	5.106.8 (3) - Light pollution reduction	NO	NO	Treatment Plant lighting well separated from property lines and higher lighting provides more safety	Comply with allowable BUG ratings in Table 5.106.8	Emergency Lighting and Luminaires that qualify in Section 140.7 of CEC
	5.106.10 - Grading and paving	YES	YES	Site grading and drainage will be designed to keep water from entering the building	Site grading and drainage will be designed to keep water from entering the building	
5.2 - ENERGY EFFICIENCY						
	5.201.1 - California Energy Code	NO	YES	This measure refers to Title 24, Part 6- Building Energy Efficiency Standards, authored by the CA Energy Commission.	For the purposes of mandatory energy efficiency standards in this code, the California Energy Commission will continue to adopt mandatory building standards.	
	Topics of interest in Building Energy Efficiency Standards					
	Envelope Insulation	NO*	YES	* Not when providing concrete exterior walls. If other materials besides concrete are used, receive clarification from the District. Occupant buildings to meet envelope insulation requirements of Building Energy Efficiency Standards.		

District Selection of Implementation Measures to:						
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		Mechanical/ Electrical/ Process	Occupant			
		Incorporate into Design?				
	Indoor Lighting- motion sensors	NO	YES	Non-occupant buildings do not require motion sensors. Designer discretion and District Guide Specifications when selecting luminaires. Galleries , considered a non-occupant space, are expected to always have the lights on for safety purposes, and should be lit with LED or other energy efficient luminaires. Occupant buildings to meet Indoor lighting requirements of Building Energy Efficiency Standards.		
5.3 - WATER EFFICIENCY AND CONSERVATION						
	5.303 - INDOOR WATER USE					
	5.303.1 - Meters	N/A	N/A			Building is less than 50,000 sf
	5.303.2 - Water reduction	YES, where equipment or process isn't compromised	YES	Restroom and breakroom plumbing fixtures shall meet the 20% reduction low flow standards. This does not apply to plumbing fixtures for equipment. In case of discrepancy between District Design Guidelines and Cal Green Code, follow Cal Green Code.	Plumbing fixtures shall meet the max flow rate values from table 5.303.23: 1.8 gpm (kitchen faucets) or 20% reduction from "Water Use Baseline" established w/ Table 5.303.2.2	No tenants or separate buildings
	5.303.3 - Water conserving plumbing fixtures and fittings	YES, where equipment or process isn't compromised	YES	Restroom and breakroom plumbing fixtures shall meet the 20% reduction low flow standards. This does not apply to plumbing fixtures for equipment. In case of discrepancy between District Design Guidelines and Cal Green Code, follow Cal Green Code.	Water closets: 1.28 gal/flush; urinals: 0.5 gal/flush and fittings (faucets and showerheads: 2.0 gpm @80psi)	Facility does not have plumbing fixtures for occupant use; plumbing fixtures are for equipment only.
	5.303.4 - Wastewater reduction	YES	YES	Criteria in Section 5.303.2 and 5.303.3 implements this requirement for domestic sewage.	Each building shall reduce by 20 percent wastewater by one of the following methods: 1) Installation of water-conserving fixtures described in Section 5.303.2/3. 2) Utilizing nonpotable water systems.	Facility does not have plumbing fixtures for occupant use; plumbing fixtures are for equipment only.
	5.303.6 - Standards for plumbing fixtures and fittings	YES, where equipment or process isn't compromised	YES	Include the standards listed in Table 5.303.6 in domestic plumbing fixture specifications. This does not apply to plumbing fixtures for equipment.	Plumbing fixtures and fittings shall be installed in accordance with the CA Plumbing Code, and standards referenced in Table 1401.1 and Chapter 6 of CA Plumbing Code.	Facility does not have plumbing fixtures for occupant use; plumbing fixtures are for equipment only.
	5.304 - OUTDOOR WATER USE					
	5.304.1 - Water budget	N/A	N/A	For any outside landscaping, irrigation shall be reclaimed water.	A water budget shall be developed for landscape irrigation....to the local water efficient landscape ordinance or CA DWR	
	5.304.2 - Outdoor potable water use	N/A	N/A	No metering require for potable outdoor water use.	For new water service or for landscaped areas between 1,000 and 5,000 sf (the level at which Water Code 535 applies), separate submeters or metering devices shall be installed for outdoor potable water use.	Landscaped areas outside the limits of 1,000 and 5,000 sf (the level at which Water Code 535 applies)
	5.304.3 - Irrigation design	N/A	NO	Refer to guide spec 32 80 00 IRRIGATION for Automatic Controller requirements for communication with the Remote Irrigation Control System currently in use. For any outside landscaping, irrigation shall be reclaimed water. All irrigation piping shall be purple in color and marked 'Do Not Drink.'	Install automatic irrigation system controllers and sensors which include the following criteria: 1) weather or soil moisture based controllers that automatically adjust irrigation in response to changes in plants' needs as weather conditions change. 2) Weather-based controllers without rain sensors or communication systems shall have a separate wired or wireless rain sensor which connects or communicates with the controller(s).	
5.4 - MATERIAL CONSERVATION AND RESOURCE EFFICIENCY						
	5.407 - WATER RESISTANCE AND MOISTURE MANAGEMENT					
	5.407.1 - Weather Protection	YES	YES	For Concrete and Masonry buildings , refer to District Guideline 4.4.1 "Concrete", "Use a weather proof sealer on vertical exterior surfaces." Also refer to CBC Section 1403.2: "A weather-resistant exterior wall envelope shall not be required over concrete or masonry exterior walls designed in accordance with Chapters 19 and 21, respectively, from CBC and ACI 318." Refer to Coating System Specifications Guidespec, Coating Type CS for sealing concrete. We do not currently have a spec for sealing masonry, but one could be easily developed if necessary.	Provide a weather-resistant exterior wall and foundation envelope as required by CBC Section 1403.2 (Weather Protection) and CA Energy Code Section 150 (Mandatory Features and Devices)	CBC Section 1403.2: A weather-resistant exterior wall envelope shall not be required over concrete or masonry exterior walls designed in accordance with Chapters 19 and 21, respectively, from CBC and ACI 318.
	5.407.2 - Moisture Control				Employ moisture control measures by the following methods:	

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		Mechanical/ Electrical/ Process	Occupant			
		Incorporate into Design?				
	5.407.2.1 - Sprinklers	YES	YES	If landscaping/sprinklers installed, design and maintain landscape irrigation systems to prevent spray on structures.	Design and maintain landscape irrigation systems to prevent spray on structures.	
	5.407.2.2 - Entries and openings	YES	YES	For occupant buildings, provide awning, roof overhand, recessed door, or equivalent protection at primary exterior entries PLUS a nonabsorbent floor and wall finishes within at least 2 feet around and perpendicular to primary exterior entries. For all building types, the finished floor elevation should be several inches above the Lowest Adjacent Grade, with the exception of entryway and roll up door landings.	Design exterior entries and/or openings subject to foot traffic or wind-driven rain to prevent water intrusion into buildings.	
	5.408.1- Construction Waste Management				Recycle and/or salvage for reuse a minimum of 50 percent of the nonhazardous construction and demolition waste.	
	5.408.1.1 - Construction Waste Management Plan	NO	NO	Contractor not required to develop a CWM Plan as part of the specification requirements. Refer to environmental documents (i.e. CEQA) for any special CWM mitigation measures. Contractor will have a financial incentive from third parties to recycle certain materials (aggregate plants, metal recyclers, etc.)		
	5.408.1.2 - Waste management company	NO	NO			
	5.408.1.3 - Waste stream reduction	NO	NO			
	5.408.1.4 - Documentation	NO	NO			
	5.408.3 Excavated soil and land clearing debris	NO	NO	Reuse of excavated soil or stockpiled soil encouraged but due to poor soil quality, not required.	100 percent of trees, stumps, rocks and associated vegetation and soils resulting primarily from land clearing shall be reused or recycled. For a phased project, such material may be stockpiled on site until the storage site is developed.	
	5.410 - BUILDING MAINTENANCE AND OPERATION					
	5.410.1 - Recycling by Occupants	NO	NO	Internal recycling practices and allocated spaces to be implemented by District, not designer	Provide readily accessible areas that serve the entire building and are identified for the depositing, storage, and collection of non-hazardous materials for recycling, including (at a minimum) paper, corrugated cardboard, glass, plastics and metals or meet a lawfully enacted local recycling ordinance, if more restrictive.	
	5.410.2 - Commissioning	YES	YES	Commissioning and a Commissioning Plan to be included in the design and construction processes of the building project to verify that the building systems and components meet the District's project requirements.		
	5.410.4 - Testing and Adjusting	YES	YES	Refer to specification 23 05 93 Testing, Adjusting and Balancing for HVAC	Testing and adjusting of systems shall be required for new buildings under 10,000 square feet	
	5.410.4.5 - O&M Manual	YES	YES	Refer to specification 23 05 93 Testing, Adjusting and Balancing for HVAC	Provide the building owner or representative with detailed operating and maintenance instructions and copies of guaranties/warranties for each system. O&M instructions shall be consistent with OSHA requirements in CCR, Title 8, Section 5142, and other related regulations.	
5.5 - ENVIRONMENTAL QUALITY						
	5.503 - FIREPLACES					
	5.03.1	N/A	N/A	No wood burning fireplaces or stoves		
	5.504 - POLLUTANT CONTROL					
	5.504.1.3 - Temp Ventilation	YES	YES	HVAC systems shall not operate during construction except as allowed in section 5.504.1.3 Temporary Ventilation.		
	5.504.3 - Covering ducts and protecting mech equipment	YES	YES	Contractor methods and means to protect new equipment and air ducts during construction		
	5.504.4 - Finish material pollutant control				Finishing material shall meet the VOC limits established in sections 5.504.4	
	5.504.4.1 - Adhesives, sealants, and caulks	YES	YES	Refer to Guide Spec, Section 07 92 00, Joint Sealants.		
	5.504.4.3 - Paints and coatings	YES	YES	Refer to Guide Spec, Section 09 90 00, Painting and Coating		
	5.504.4.4 - Carpet Systems	N/A	YES	Refer to Guide Spec, Section 09 68 13 Tile Carpeting. Typically N/A for non-occupant buildings		

District Selection of Implementation Measures to:						
Title 24, Part 11 "CALGreen" NONRESIDENTIAL MANDATORY MEASURE COMPLIANCE FOR FACILITY TYPE						
DIVISION	MEASURE (SECTION)	BUILDING TYPE		DIRECTION TO DESIGNERS	CAL Green Measure (Description)	CAL Green Exceptions
		Mechanical/ Electrical/ Process	Occupant			
		Incorporate into Design?				
	5.504.4.5 - Composite wood products	N/A	YES	Refer to Guide Spec, Section 06 40 23 Interior Architectural Wood Work. Typically N/A for non-occupant buildings		
	5.504.4.6 - Resilient flooring systems	N/A	YES	Refer to Guide Spec, Section 09 65 19 Resilient Tile Flooring. Typically N/A for non-occupant buildings		
	5.504.5.3 - Filters	YES	YES	Refer to Guide Spec, Section 23 41 13 Panel Air Filters		
	5.504.7 - Environmental tobacco smoke (ETS) control	N/A	N/A	Not providing smoking areas	Where outdoor areas are provided for smoking, prohibit smoking within 25 feet of building entries, outdoor air intakes and operable windows	
	5.505 - INDOOR MOISTURE CONTROL					
	5.505.1 - Indoor moisture control	YES	YES	Refer to Guide Spec, Section 23 34 19.16, Propeller Wall Fans and 23 81 26, Split System Air Conditioners.	Buildings shall meet or exceed the provisions of CBC, CCR, Title 24, Part 2, Sections 1203 (Ventilation) and Chapter 14 (Exterior Walls.)	A weather-resistant exterior wall envelope shall not be required over concrete or masonry exterior walls designed in accordance with Chapters 19 and 21, respectively, from CBC and ACI 318.
	5.506 - INDOOR AIR QUALITY					
	5.506.1 - Outdoor air delivery	YES	YES	Mechanical rooms are normally mechanically ventilated using wall intake louvers and wall exhaust fans. Motor control centers are normally constant volume conditioned systems, with a fixed outdoor air flow set for the design occupancy of the room. When ductless mini-split systems are used where sufficient outside air is not provided by another system, a dedicated outdoor air system may be necessary in order to comply with the 2013 California Building Energy Efficiency Standards, Section 120.1.	For mechanically or naturally ventilated spaces in buildings, meet the minimum requirements of Section 120.1 (Reqs for Ventilation) of 2013 CEC, or the applicable local code, and Division 1, Chpt 4 of CCR, Title 8	
	5.506.2 - CO2 Monitoring	NO	NO	Demand Controlled Ventilation would normally apply only to large office buildings, not for area control centers, area breakrooms, motor control centers, etc.	For buildings or additions equipped with demand control ventilation, CO2 sensors and ventilation controls shall be specified and installed ... requirements of 2013 CA energy code, Section 120(c)(4)	
	5.507 - ENVIRONMENTAL COMFORT					
	5.507.4 - Acoustical Control	YES	YES	Acoustical insulation shall be provided in noise-sensitive locations such as offices and control rooms. Sound absorbing panels and/or equipment enclosures may be required in process areas.	Employ building assemblies and components with Sound Transmission Calls (STC) values determined in accordance with ASTM E 90 & 413 or Outdoor-Indoor Sound Transmission (OITC) using either prescriptive or performance methods in Section 5.507.4.1 or 2.	Buildings with few or no occupants or where occupants are not likely to be affected by exterior noise,.... such as utility buildings.
	5.508 - OUTDOOR AIR QUALITY					
	5.508.1 - Ozone depletion and greenhouse gas reduction	YES	YES	Refer to Guide Spec, Section 23 81 26 Split System Air Conditioners. Refrigerant shall be R-410-A, which does not contain CFC's.	Installations of HVAC, refrigeration and fire suppression equipment that do not contain chlorofluorocarbons (CFC's) and halons.	
	5.508.2 - Supermarket refrigerant leak reduction	N/A	N/A	N/A- code applies to new commercial refrigeration systems in retail food stores	New commercial refrigeration systems shall comply with the provisions of this section when installed in retail food stores 8,000 square feet or more conditioned area in retail food stores, and that utilize either refrigerated display cases, or walk-in coolers or freezers connected to remote compressor units or condensing units.	
Abbreviations: CWM - Construction Waste Management, N/A - Not Applicable						

APPENDIX D

FLOWMETER PIPING ELEVATION METHODS

In a free flow outlet (drop line) the flowmeter primary should be not be installed at the highest point or in the discharge of the pipeline (meter tube could drain, air bubbles, Fig. 6).

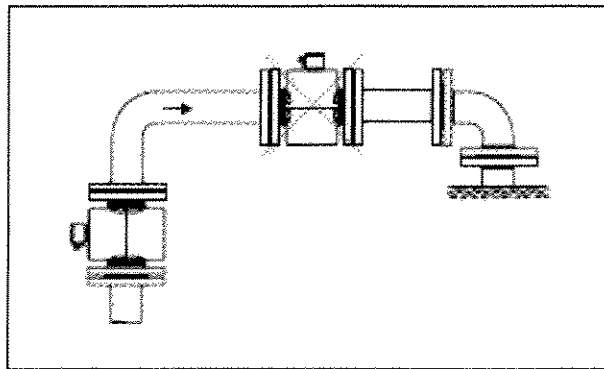


Fig. 6

The measurement principle is independent of flow profile as long as standing eddies do not extend into the measurement section (e.g. after double elbows, tangential inflows or half open valves upstream of the flowmeter primary). In such situations, measures to condition the flow are required. Experience indicates that in most cases a straight upstream section with a length of $3 \times D$ and a downstream section of $2 \times D$ is sufficient (D = flowmeter primary size Fig. 7). The reference conditions for test stands, per DIN 19200, require a straight upstream length of $10 \times D$ and a $5 \times D$ straight length downstream. For Volume Flow Integrators additional installation requirements are mandatory. See Installation of the Certified Designs Section 4.2.5 on Page 9.

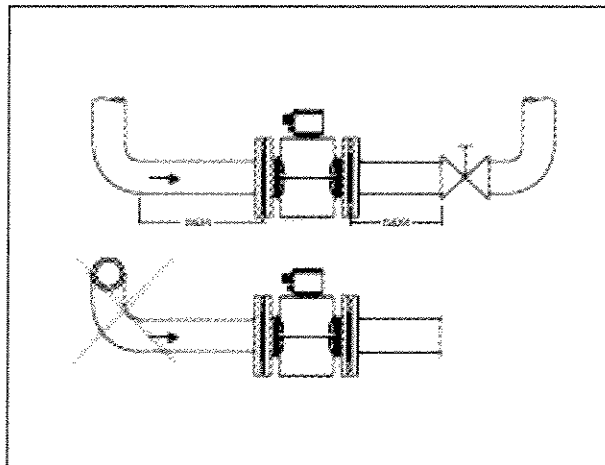


Fig. 7

Wafer valves are to be installed in such a manner that the wafer, when open, does not extend into the flowmeter. Valves or other shut off devices should be installed downstream so that the flowmeter primary cannot drain.

An automatic empty pipe detector option is available in the converter which uses the existing electrodes for its input.

For heavily contaminated fluids a bypass line as shown in Fig. 8 , Design A is recommended, so that the flowmeter may be mechanically cleaned without shutting down the process.

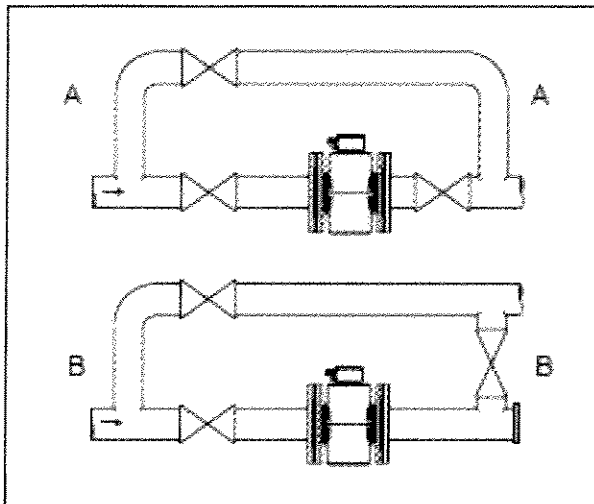


Fig. 8

When it is anticipated that the electrodes may become coated with an insulating layer, a bypass line as shown in Fig. 8 , Design B, should be installed. For flowmeter primaries installed in the vicinity of pumps or other vibrating equipment the utilization of mechanical dampers is advantageous (Fig. 9).

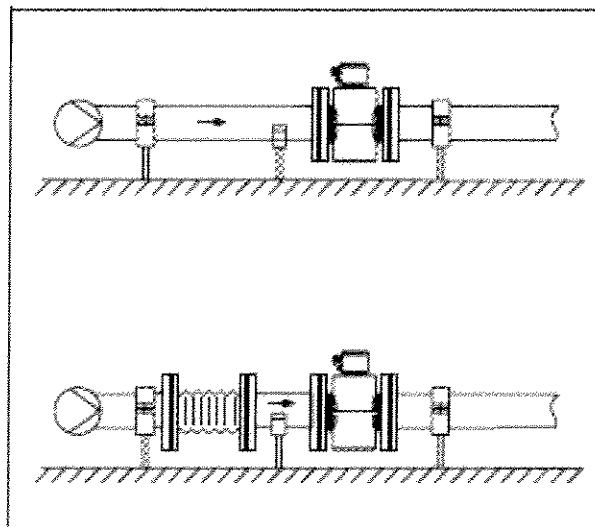


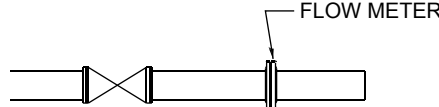
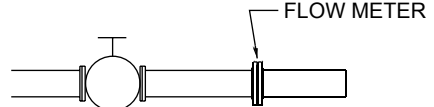
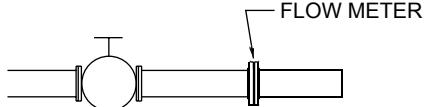
Fig. 9

APPENDIX E

FLOWMETER PIPING REQUIREMENTS TABLE

FLOW METER PIPING REQUIREMENTS

"Diameters" of straight pipe required for various types of flow meters

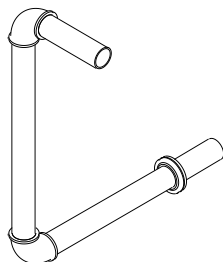
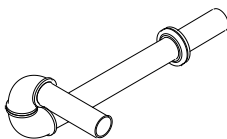
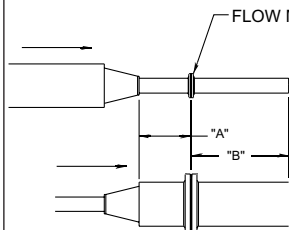
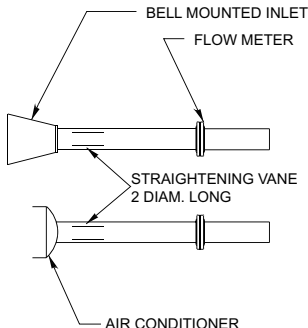
Diameter (D) = nominal Pipe Size Example: 13 Diameters of 6" pipe = 78" 13 Diameters of 10" pipe = 130" Beta = (Bore I.D./Pipe I.D.) Bore is the smallest diameter of an orifice or nozzle Up = Upstream Diameters Down = Downstream Diameters			Fully Open Gate Valve (Unless Another Upstream Fitting Needs More)	Fully Open Globe or Non-Return Valve (Unless Another Upstream Fitting Needs More)	Partially Open Valve or Regulator
					
Orifice/Nozzle	Beta = 0.5	Up	6	11	26
		Down	3	3	3
	Beta = 0.7	Up	10	15	38
		Down	4	4	4
Venturi	Beta = 0.5	Up	5	7	7
		Down	2	2	2
	Beta = 0.7	Up	9	26	26
		Down	4	4	4
Vortex		Up	25	25	30
		Down	5	5	5
Thermal		Up	15	15	40
		Down	5	5	5
Turbine		Up	10	10	10
		Down	5	5	5
Annubar		Up	8	9	24
		Down	3	3	4

Note:

1. The straight runs shown above are conservative minimums. Longer upstream straight pipe lengths provide better accuracy.
2. If the indicated straight run is not available, Consult Factory. Detailed Factory analysis will require accurate fluid data, flow data, and a sketch detailing the piping system 50 diameters upstream and 10 diameters downstream from the proposed meter location.
3. Internal straightening vanes can be used to reduce straight pipe length requirements, Consult Factory.
4. **Positive Displacement and Coriolis Effect Meters** are not influenced by upstream and downstream fittings.

FLOW METER PIPING REQUIREMENTS

"Diameters" of straight pipe required for various types of flow meters

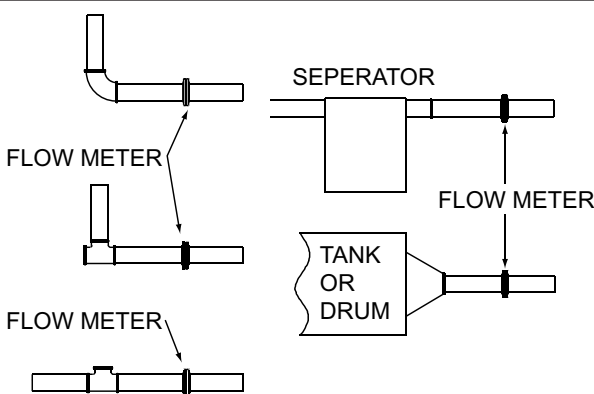
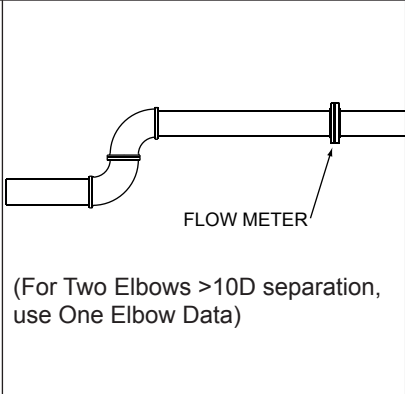
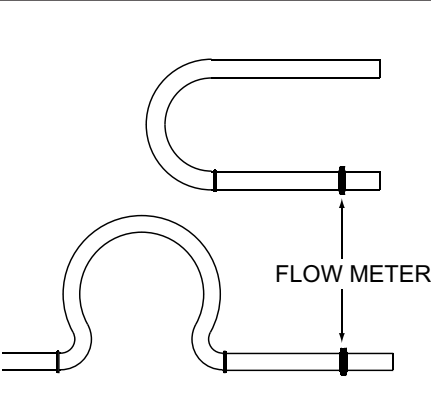
Diameter (D) = nominal Pipe Size Example: 13 Diameters of 6" pipe = 78" 13 Diameters of 10" pipe = 130" Beta = (Bore I.D./Pipe I.D.) Bore is the smallest diameter of an orifice or nozzle Up = Upstream Diameters Down = Downstream Diameters			Two Elbows, > 10 Diameters, Fittings in Different Planes	Two Elbows, < 10 Diameters, Fittings in Different Planes	Reducer or Expander (Unless Another Upstream fitting Needs More)	Atmospheric Intake
						
Orifice/Nozzle	Beta = 0.5	Up	16	20	9	8
		Down	3	3	3	3
	Beta = 0.7	Up	23	30	12	9
		Down	4	4	4	4
Venturi	Beta = 0.5	Up	21	21	5 (reducer), 2 (expander)	—
		Down	2	2	2	—
	Beta = 0.7	Up	21	21	8 (reducer), 4 (expander)	—
		Down	2	2	4	—
Vortex		Up	30	45	25	—
		Down	5	5	5	—
Thermal		Up	15	40	15 (reducer), 30 (expander)	—
		Down	5	10	5 (reducer), 10 (expander)	—
Turbine		Up	10	10	10	—
		Down	5	5	5	—
Annubar		Up	9	19	8	—
		Down	3	4	3	—

Note:

1. The straight runs shown above are conservative minimums. Longer upstream straight pipe lengths provide better accuracy.
2. If the indicated straight run is not available, Consult Factory. Detailed Factory analysis will require accurate fluid data, flow data, and a sketch detailing the piping system 50 diameters upstream and 10 diameters downstream from the proposed meter location.
3. Internal straightening vanes can be used to reduce straight pipe length requirements, Consult Factory.
4. **Positive Displacement and Coriolis Effect Meters** are not influenced by upstream and downstream fittings.

FLOW METER PIPING REQUIREMENTS

"Diameters" of straight pipe required for various types of flow meters

Diameter (D) = nominal Pipe Size Example: 13 Diameters of 6" pipe = 78" 13 Diameters of 10" pipe = 130" Beta = (Bore I.D./Pipe I.D.) Bore is the smallest diameter of an orifice or nozzle Up = Upstream Diameters Down = Downstream Diameters			One Elbow, T, Y, or Tank Exit (Fittings in the Same Plane)	Two Elbows (Fittings in the Same Plane)	Long Radius Bends (Fittings in the Same Plane)
				 (For Two Elbows >10D separation, use One Elbow Data)	
Orifice/Nozzle	Beta = 0.5	Up	7	10	8
		Down	3	3	3
	Beta = 0.7	Up	13	18	16
		Down	4	4	4
Venturi	Beta = 0.5	Up	4	4	4
		Down	2	2	2
	Beta = 0.7	Up	4	4	8
		Down	2	2	4
Vortex		Up	30	30	30
		Down	5	5	5
Thermal		Up	15	20	20
		Down	5	5	5
Turbine		Up	10	10	10
		Down	5	5	5
Annubar		Up	7	9	—
		Down	3	3	—

Note:

1. The straight runs shown above are conservative minimums. Longer upstream straight pipe lengths provide better accuracy.
2. If the indicated straight run is not available, Consult Factory. Detailed Factory analysis will require accurate fluid data, flow data, and a sketch detailing the piping system 50 diameters upstream and 10 diameters downstream from the proposed meter location.
3. Internal straightening vanes can be used to reduce straight pipe length requirements, Consult Factory.
4. **Positive Displacement and Coriolis Effect Meters** are not influenced by upstream and downstream fittings.

APPENDIX F
FIRE MARSHALL MOU



March 5, 1997

Sacramento Regional Wastewater

Treatment Plant

3521 Laguna Station Road

Elk Grove

California

95758-9550

Tele: [916] 375-9000

Fax: [916] 375-9068

Chief Steven Foster
Fire Marshall
Elk Grove Fire Department
8820 Elk Grove Boulevard, Suite 2
Elk Grove, CA 95624

Subject: **Memorandum of Understanding between the
Sacramento Regional Treatment Plant (SRWTP) and
the Elk Grove Fire Department (EGFD) regarding the
SRWTP Fire Protection Utility Master Plan**

Board of Directors

County of Sacramento

Roger Dickinson

Illa Collin

Muriel P. Johnson

Dave Cox

Don Nottoli

City of Sacramento

Samuel C. Pannell

City of Folsom

Tom Accituno

Dear Chief Foster:

SRWTP staff met with you recently regarding the planning of fire protection utilities for current and future facilities. The attached Memorandum of Understanding between the SRWTP and the EGFD details the proposed SRWTP Fire Protection Utility Master Plan. If you approve of the proposed SRWTP Fire Protection Utility Master Plan, please sign both copies of this document and return one copy to SRWTP.

Thank you for your assistance in the preparation of this Fire Protection Utility Master Plan.

Sincerely,

Wendell Kido
Plant Superintendent

Douglas M. Fraleigh
Agency Administrator

Robert F. Shanks
District Engineer

Cheryl F. Creson
District Manager

Wendell Kido
Plant Manager

WHK:dmf

Attachment

cc: Stan Dean, Mike Mulkerin, Vick Kyotani, Greg Lee,
Bill Hendrix, Tony Palmer, Dave Lavezzoli, Mary Snyder,
Tim Weis, Ron Gilman, Russ Armstrong, Doug Frederick

DMF2-D4.mgd

File: FIR 105 5.1.5

**SACRAMENTO REGIONAL TREATMENT PLANT
FIRE PROTECTION UTILITY MASTER PLAN
MARCH 1997**

INTRODUCTION

The Sacramento Regional Treatment Plant is divided into two fire protection zones (see Figure 1), served by separate systems. The zones can be loosely described as follows:

Zone 1--Immediate Plant Process Area and Support Buildings

Zone 2--Outlying Facilities

ZONE 1

The required fire flow and flow duration for Zone 1 is based on Type I fire resistive construction for the Influent-Effluent building and Type II-N/Type III-N construction for the rest of the buildings. The Influent-Effluent building occupancy area is approximately 148,500 sq. ft. All other buildings are less than 70,000 sq. ft. Per Table A-III-A-1 of the 1994 Uniform Fire Code, the required fire flow is 5,500 GPM for 4 hours. The following table summarizes the utilities used to meet this requirement.

Utility	Fire Systems Served	Capacity in GPM	Source
Reclaimed High Pressure Water (WRH)	Fire Hydrants	4,500	Chlorinated secondary effluent System takes suction from secondary effluent channel
Non-Potable Water (WN)	Fire Sprinklers	1,000	Potable Sacramento City water System takes suction from a 41,496 gallon capacity tank, located in the Influent/Effluent Building. Tank is proposed to be increased in size to approximately 100,000 to 150,000 gallon capacity.

ZONE 2

The required fire flow and flow duration for Zone 2 is based on Type II-N and Type III-N construction. The largest building is less than 42,700 sq. ft. Per Table A-III-A-1 of the 1994 Uniform Fire Code, the required fire flow is 4,250 GPM for 4 hours. This required flow is reduced, based on the exception in A-III 5.2 for fire sprinklered buildings. (All buildings in Zone 2 over 5,000 sq. ft. are sprinklered). The reduced flow is 3,000 GPM for 4 hours, with a 750 GPM allowance for sprinklers. The following table summarizes the utilities used to meet this requirement.

Utility	Fire Systems Served	Capacity in GPM	Source
Fire Protection Water (WFP)	Fire Hydrants	3,000	Filtered Reclaimed Water (WRF) and Sacramento County Potable Water (Zone 40)
	Fire Sprinklers	750	
	Total	3,750	System takes suction from a 2,000,000 gallon capacity tank, located at the proposed Water Reclamation Plant. Zone 40 maintains a 3,000 GPM standby for fire protection. In addition, 180,000 gallons of water are reserved in the Water Reclamation tank, for a total fire flow of 3,750 GPM for a minimum duration of 4 hours.

Submitted by:

Wendell Kido

Date: 3/6/97

Wendell Kido, Plant Superintendent

Approved by:

Date: _____

Elk Grove Fire Department

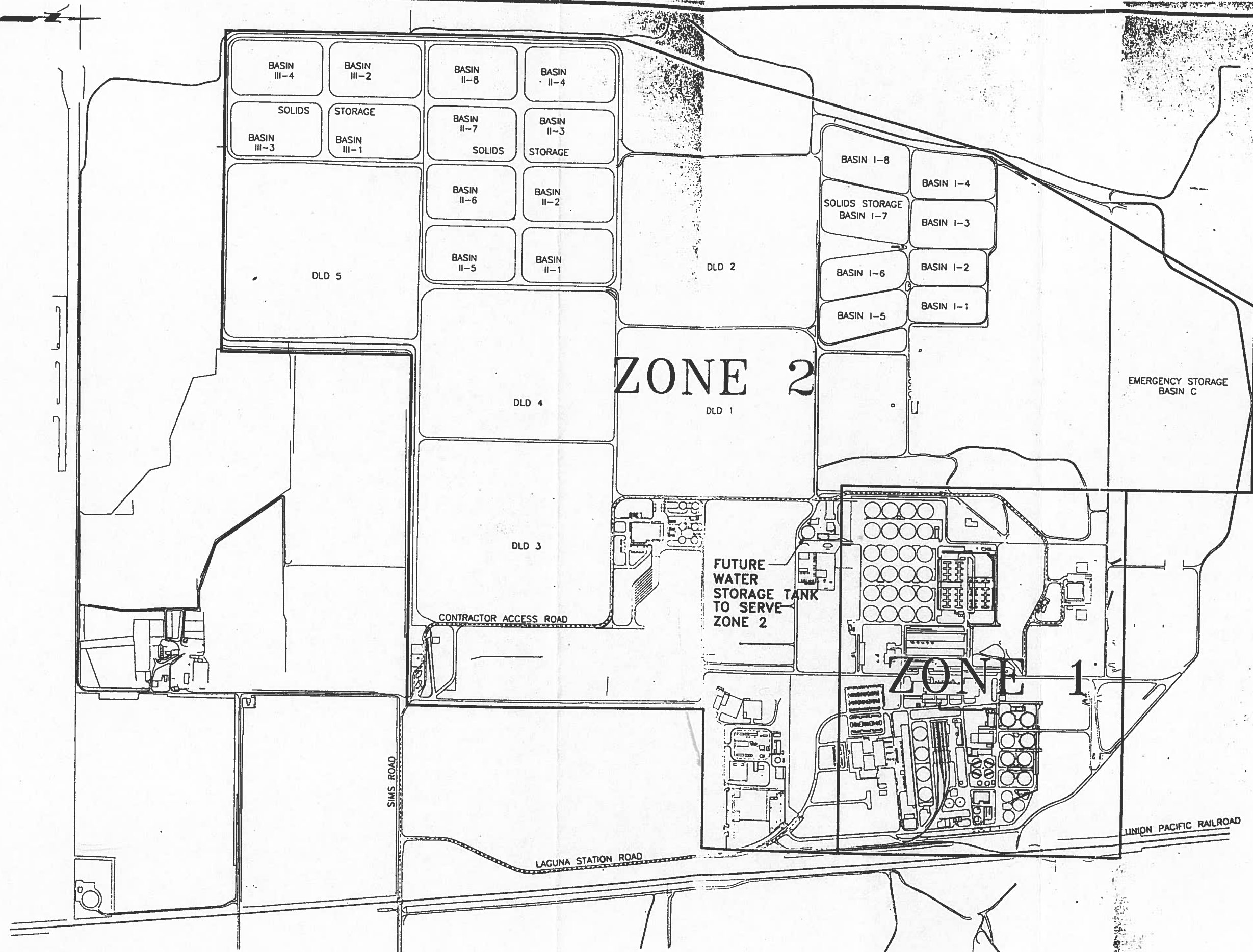


FIGURE 1