American Water Works Service Co., Inc.

American Water Engineering

Voorhees, NJ

Process / Out-Source Design Projects / Network – Drawing Standards

Revision Date: June 20, 2007

Table of Contents

Software

1. AutoCad software is the preferred drawing software. The most recent version of AutoCad should be used.

Drafting Procedures

EXTERNALLY REFERENCED DRAWING

1. Begin a new drawing with the Awwborder space template file, **AWWBORDER.DWT.**

AutoCAD Template Files

FILENAME	DESCRIPTION
AWWMODEL. DWT	This template is to be used for all full-scale (real world) Model Space drafting.

2. Draw all items in real world measurements. Ex: a pipe that is 100 feet long shall be drawn at 100 feet.

3. Save Drawing as per AWW file naming procedure (page 2) for externally referenced drawing using the normal save command icon.

Layering Convention

All layer names shall follow the AIA National CAD Standard layering standard. Absolutely **NO** numbers will be used as layer names.

Color Scheme

Colors shall determine the line weight of the object being drawn; the color scheme shall be as follows with the first color being the heaviest and the last being the lightest. CYAN (4), GREEN (3), RED (1), BLUE (5), WHITE (7), YELLOW (2). Color MAGENTA (6) shall be used for all existing objects. The appropriate color will correspond with the discipline of the dwg. Ex: A concrete foundation will be color (4) Cyan on the structural dwgs but will be color (7) white on the mechanical dwgs for new items. All non specific discipline items will be color (7) white. Text and dimensions shall always be color yellow (2). All bold text shall be color cyan (4). All new hatch patterns will be color 253 on all disciplines except if that item is being described or detailed then you would use a heavier color such as blue or red (new items). The color will be changed on the contract dwg (layout) to agree with the

discipline of that dwg. All discipline driven items shall be color (4) cyan or color (3) green or color (1) red or color (5) blue depending on the complexity of the individual detail and its viewport scale. EX: If a detail shows information regarding a complex steel detail and if cyan was used, the detail bleeds into other items after it was plotted, then you would use color green or red to clearly show the information after it has been plotted. This will be at the user's desecration. Typically, cyan is used for the discipline driven item. All none discipline items will always be color (7) white. All existing items on all disciplines will always be color (6) magenta. The Standard .ctb file will be supplied by AW for plotting to follow the above color scheme.

File Naming Procedure

Externally Referenced (XREF) Drawings

Xref drawing files should conform to an eight.three (XXXXXXXX.DWG) naming structure and should identify the objects being drawn as clearly as possible. The following procedure shall be used to name and save Xref drawings:

First Character = X

Second & Third Characters = Location/Building Designation
- AV = Altitude Valve Vault
- BW = Backwash Tank
- CB = Chemical Building
- CW = Clearwell
- ET = Elevated Tank
- FB = Filter Building
- GE = Generator
- GS = General Site
- GST = Ground Storage Tank
- LM=Location Map
- OF = Office
- OF = Outfall Structure
- PS = Pump Station
- RWI=Raw Water Intake
- SB = Sed Basin
- TP=Treatment Plant
- WW = Washwater Tank

Fourth Character = Dash (-)

Fifth Character = Discipline code
- A = Architectural
- C = Civil/Site work
- E = Electrical
- H = HVAC
- I = Instrumentation
- M = Mechanical
- P = Process
- PL = Plumbing
- R = Removals
- S = Structural

Sixth & Seventh Characters = Drawing Type

DT = Detail
EL = Elevation
FP = Floor Plan
PR = Profile
RP=Roof Plan
SC = Section

Externally Referenced (XREF) Drawings (cont'd)

Eighth Character	=	SH = Schematic Floor Level or Revision (if necessary, otherwise don't use) Could also be the Section Number (1,2) or Elevation Direction (N, S, E or W)

For Example:

XCB-MFP1.DWG would be the Chemical Building, Mechanical first floor plan.

XAV-SSCA.DWG would be the Altitude Vault, Structural Section "A".

XFB-AE.DWG would be the Filter Building, Architectural Elevation.

Contract or Sheet Drawings

1. Begin a new drawing with the paper space template file, **AWWBORDER.DWT.** The **AWWBORDER.DWT** shall be used for all disciplines. **The AWWBORDER.dwt shall never be exploded, revised, renamed or scaled. Also, the AWWBORDER.dwt will not be xreferenced into a drawing, a new drawing shall be started each time using the AWWBORDER.dwt.** The limits will remain at **0,0** & **36,24** and be plotted at 1:1. All attributes inside the AWWBORDER.DWT will be filled out according to AWW naming convention for new drawings. AWW uses a document management program and it is **VITAL** that the border template and block remain as is.

AutoCAD Template Files

TEMPLATE NAME	DESCRIPTION
AWWBORDER.DWT	This template is to be used for all layouts and annotation in the Paper Space environment. This template is to be used for all drawings slated to be xrefs once the title block information is deleted.

2. Enter necessary information into the AWW title block with DDATTE icon.

3. Save the drawing as per the AWW File Naming Procedure for Contract Drawings. See attached .pdf file.

4. Toggle to Model Space. Attach the required xref's while on the **G-Anno-Refr** layer.

5. Toggle back to Paper Space and create all necessary viewports with the MVIEW command while on the Defpoints layer.

6. All dimensions shall be on the model space of the xref drawing following the Autocad normal standard procedure for dimensions, all other annotation to the drawing shall be on paper space of the contract drawing utilizing the AWW Text and Dimension Styles as defined on page 5.

7. All contract Dwgs shall be plotted at a scale of 1:1. They will include a graphic scale and north arrow.

8. The title block shall contain all required pertinent information related to the project such as project title, location, engineer of record, date, WBS number, drawing number, sheet numbers and revision dates. In the case of CAD files the file path shall be placed on the drawing along with the plot date using AutoCAD's plot stamp.

9. Generally all drawings shall be aligned with project north to the top of the drawing sheet. A north arrow shall be placed on the drawing in a prominent location.

10. Each drawing shall display project notes in a tabular format when required. Notes shall be project specific as determined by the Project Manager or Designer. Drawing notes shall consist of, but not be limited to, items such as construction/restoration specification, reference map information, utility information etc.

If the drawing contains topographic information the drawing shall include a vertical datum note, which shall indicated the vertical datum utilized on the plan. It will also include surveyor information. Where a specific horizontal datum is utilized, a horizontal datum note shall be shown on the plan.

11. All drawing revisions made after official release of the drawing shall be dated and noted in the revision block.

12. All drawings that are issued outside of E&TS shall be updated in the title block as follows:

(a) "Preliminary" – used for issue of any drawing prior to approval of Final Design. Drawings issued for permitting purposes shall not be stamped.

(b) "Permit Set" – used for the issue of any drawing intended for permits.

(c) "Bid Set" – used for the issue of any drawing intended for bidding.

(d) "Issued for Construction" – used for issue of any drawing intended for construction.

(e) "Record Drawing" – used for as-built drawings.

13. Standard survey note shall be added to the topo graphic sheet and read as follows: "All survey information is taken from a survey information is taken from a survey prepared by (name), (city), (state), registered card surveyor, (number #), prepared (date) for (water company)".

14. All drawing sets shall include cover sheet with drawing index, logo, water co. name, project title, aww engineering name, and month/year.

IF the contractor uses their own title block/border due to their document management sytem, they shall insert the block named Awwblock.dwg and fill out all attributed information according to the AWW Standarads outside of the contractors border. This will allow the AWW document management tracking to take place.

File Naming Procedure

Contract Dwgs

- Design contract drawings are assigned numbers, which are based on a 3 to 4 digit company number, a 3 to 4 digit series number and a 2 to 4 digit discipline sheet number (A = Architectural, G = General, E = Electrical, H = HVAC, I = Instrumentation, M = Mechanical, P = Process, PL = Plumbing, R = Removal, S = Structural).
- For Example:

A drawing prepared for New Jersey American Water Company, Lakewood District, and is an Architectural Dwg would be 350-1234-A1, a Mechanical Dwg would be 350-1234-M1. The following sheets in the discipline would be consecutive, M2, M3, M4 etc.

- Drafting personnel in the System Engineering Corporate Office in Voorhees, NJ, assign drawing numbers. A detailed list is kept for all districts within a Water Company. Since all projects are unique, each drawing set must also have a unique number. To avoid any confusion or duplication of drawing numbers, please contact System Engineering for all drawing numbers. Please provide the following information when calling in: Project Name & Station (location), BP Number, Name of Consultant (if one is used), and approximate number of drawings in the

set. System Engineering drafting personnel will then issue a drawing number for the contract drawings and the sequential number for manufacturer's information drawings.

- The project design engineer prior to the start of drafting should prepare a drawing development schedule. The development schedule will provide the title of the project (line 1) and the discipline, location and type of drawing information (lines 2, 3 and 4) required to complete the title block of each drawing. Drawings should be numbered in accordance with this list.

- The electronic drawing filename should conform to an eight or nine.three (XXXXXXXX.DWG) naming structure and **WILL EQUAL** the AWW drawing number but without the dashes. Call System Engineering Cad Department for numbers (856)-727-6133

- For Example:

  A drawing prepared for New Jersey-American Water Company, Lakewood District whose assigned drawing number is 350-1234-A1, would be electronically filed and saved as 3501234A1.DWG.

IF the contractor uses their own numbering system, all files shall be renamed electronically to follow the AWW standard listed above for final acceptance. The AWW design group will receive a CD containing all electronic drawing files numbered according to the AWW numbering system, including any xrefs, image files and .ctb files.

The table below lists the standard AWW text styles that are to be used when annotating drawings.

AutoCAD Text Styles

TEXT STYLE NAME	FONT	HEIGHT	DESCRIPTION
ROMANS	Roman Simplex	.1	Leaders & Notes & Dimensions
ROMAND	Roman Duplex	.15	Room Names, General Notes Title
ROMANDLG	Roman Duplex	.2	Headings, Titles
STANDARD*	Txt	N/A	Not Used

*AutoCAD Default Style – not used on AWW drawings.

AutoCAD Dimension Styles

Dimensions shall conform to the normal practices as set forth by Autocad for dimensions in model space, xrefs and viewports. All settings within the dimension variables will produce the final size in the viewports, text = .1, text style = Romans, arrow size = .125. Dimension styles shall conform to the following standard: ex: Structural Dimension for a viewport set at 1/4"=1'-0" = S-DIM-48, Architectural Dimension A-DIM-96 for a viewport set at 1/8"=1'-0", this will be repeated for all disciplines and viewports.

HATCH PATTERNS

Standard Hatch Patterns

PATTERN	SCALE	ANGLE	DESCRIPTION
Steel			Sections through Steel Members
ANSI-37			Plans & Sections of Block Walls
AR-B816C			Elevations of Block Walls
ANSI-31			Plans of Brick Walls
AR-BRSTD			Sections of Brick Walls
BRICK			Elevations of Brick Walls
AR-CONC			Sections through Concrete
EARTH		45	Grade - New or Existing
INSUL			Sections through Wall Insulation
INSUL			Sections through Roof Insulation (other than batt)
GRATE			Grating - FRP or Aluminum
HOUND			Select fill (under slabs)
AR-SAND			Sand (i.e. Filter Media, Sub-base Material)
Aggregate			Broken Stone (under footers)
Sqshngle			Roof Shingles (elevation view)
Chainlnk			Chain link Fence (elevation view)
Chkdl			Checkered Plate (double line)

PATTERN	SCALE	ANGLE	DESCRIPTION
Chkds			Checkered Plate (single line)

NOTE: Scale of the hatch pattern shall be left up to the cad operator.

Design Drawing Development Schedule

AMERICAN WATER
SYSTEM ENGINEERING DEPARTMENT
IN-HOUSE DESIGN DRAWING DEVELOPMENT SCHEDULE

1ST LINE: PROJECT TITLE AS INDICATED IN BP MEMORANDUM

	2ND LINE	3RD LINE	4TH LINE
GENERAL	COVER SHEET		
CIVIL	CIVIL	LOCATION & VICINITY	PLANS
	CIVIL	SITE WORK & GRADING	PLANS
	CIVIL	SOIL EROSION & SED. CONTROL	PLANS
	CIVIL	SITE WORK	MISCELLANEOUS DETAILS
	CIVIL	OUTSIDE PIPING	PLANS
	CIVIL	OUTSIDE PIPING	PROFILES
REMOVALS	REMOVALS	LIMITS OF CLEARING	PLAN
	REMOVALS	PARTICULAR STRUCTURE	PLANS (at several elevations)
	REMOVALS	PARTICULAR STRUCTURE	SECTIONS
ARCHITECTURAL	ARCHITECTURAL	PARTICULAR STRUCTURE	PLANS (at several elevations)
	ARCHITECTURAL	PARTICULAR STRUCTURE	ELEVATIONS
	ARCHITECTURAL	PARTICULAR STRUCTURE	WALL SECTIONS
	ARCHITECTURAL	PARTICULAR STRUCTURE	DETAILS & SCHEDULES
STRUCTURAL	STRUCTURAL	PARTICULAR STRUCTURE	PLANS (at several elevations)
	STRUCTURAL	PARTICULAR STRUCTURE	SECTIONS
	STRUCTURAL	PARTICULAR STRUCTURE	DETAILS
MECHANICAL	PROCESS	OVERALL PLANT	SCHEMATIC
	PROCESS	OVERALL PLANT	HYDRAULIC PROFILE
	MECHANICAL	INTAKE/PUMP STATION/	PLANS (at several elevations)
	MECHANICAL	INTAKE/PUMP STATION/	SECTIONS
	MECHANICAL	CLARIFIER/FILTER BLDG./	DETAILS
	CHEMICAL PIPING	CLEARWELL/PUMP STATION	SCHEMATICS
	CHEMICAL PIPING	ETC.	PLANS (at several elevations)
	CHEMICAL PIPING	ETC.	SECTIONS & DETAILS
	PLUMBING	ETC.	PLANS
	PLUMBING	ETC.	SECTIONS
	PLUMBING	ETC.	DETAILS
ELECTRICAL	INSTRUMENTATION	OVERALL PLANT	PROCESS & INST. DIAGRAM
	INSTRUMENTATION	OVERALL PLANT	MOUNTING DETAILS
	ELECTRICAL	OVERALL PLANT	LEGENDS

ELECTRICAL	OVERALL PLANT	MISCELLANEOUS DETAILS
ELECTRICAL	OVERALL PLANT	SITE PLAN
ELECTRICAL	OVERALL PLANT	ONE LINE DIAGRAM
ELECTRICAL	OVERALL PLANT	SCHEMATIC DIAGRAMS
ELECTRICAL	PARTICULAR STRUCTURE	PLANS (at several elevations)
ELECTRICAL	PARTICULAR STRUCTURE	SECTIONS & DETAILS
ELECTRICAL	PARTICULAR STRUCTURE	CONDUIT SCHEMATIC
ELECTRICAL	PARTICULAR STRUCTURE	CABLE & CONDUIT SCHEDULE

NOTES:

Water Company No's.

Contact AWWSC Engineering for Drawing Prefixes
(856)-346-8282

Miscellaneous Procedures

Addendum Sketches

Addendum Sketches are 8 1/2" x 11" (A-size) drawings that are prepared during the bid phase to inform all potential contractors of a change in design. The need for such sketches usually arises during the contractors' review and bid preparation for a project. The Design Engineer for the specific project usually provides input for the Addendum Sketch.

An 8 1/2" x 11" attributed title block has been created and saved as N:\ACADCOM\BORDERS\81-2X11A.DWG and should be inserted **into** a modified or newly prepared plan, section or detail. The size of the sketch has been selected for ease in faxing to the contractors. If a large area of an original drawing is affected by the change/clarification, the entire D-size sheet will be revised and reissued to the all bidding contractors. All clarifying plans, sections or details must also be added to the original bid set of documents for incorporation into the As-built or Record set. Each affected bid set drawing should be updated in a timely manner and the revision should be noted in the Revision block of the title block. Annotation should include: the Addendum number, the drafter's initial, and the current date. Leave space for the approving engineer to initial the revision.

The Addendum Sketch title block contains the following information: Title of Sketch (4 lines), Drafter's Initials, Project Engineer's Initials, Date Sketch was prepared, Project BP Number, Scale of Sketch, Addendum Sketch Number, Sketch Revision Date, and Reference Drawing Number. The Reference Drawing Number is the drawing number of the original design drawing in the bid set where the plan, section or detail was drawn. The Addendum Sketches are assigned drawing numbers in the following format: ADD-001, ADD-002, ADD-003, etc. Senior Drafting Personnel will assign drawing numbers. The original sketch will be filed with the Senior Design Drafter and a copy will be sent to the Approving Engineer for further markup or development.

Working Sketches

Working Sketches are 8 1/2" x 11" (A-size) drawings that are prepared after the project has gone to bid and has been awarded to a contractor. The need for such sketches usually arises during construction and should provide answers to the contractor's questions regarding field changes to the original design. The Design Engineer and/or the Construction Engineer for the specific project usually provide input for the Working Sketch.

An 8 1/2" x 11" attributed titleblock has been created and saved as N:\ACADCOM\BORDERS\81-2X11W.DWG and should be inserted **into** a modified or newly prepared plan, section or detail. The size of the sketch has been selected for ease in faxing to the contractor. If a large area of an original drawing is affected by the change/clarification, the entire D-size sheet will be revised and reissued to the contractor. All clarifying plans, sections or details must also be added to the original bid set of documents for incorporation into the As-built or Record set. Each affected bid set drawing should be updated in a timely manner and the revision should be noted in the Revision block of the title block. Annotation should include: a description of the change, the drafter's initial, and the current date. Leave space for the approving engineer to initial the revision.

The Working Sketch title block contains the following information: Title of Sketch (4 lines), Drafter's Initials, Project Engineer's Initials, Date Sketch was prepared, Project BP Number, Scale of Sketch, Working Sketch Number, Sketch Revision Date, and Reference Drawing Number. The Reference Drawing Number is the drawing number of the original design drawing in the bid set where the plan, section or detail was drawn. The Working Sketches are assigned drawing numbers in the following format: WS-001, WS-002, WS-003, etc. Senior Drafting Personnel will assign drawing numbers. The original sketch will be filed with the Senior Design Drafter and a copy will be sent to the Approving Engineer for further markup or development.

Redlining Procedure For Contract Drawings

Check prints of design contract drawings should be reviewed by the drafting group as well as by the engineering group before they are sent to external agencies for their review,

comments or action. The following should be used as a guideline for redlining these drawings in a concise and consistent manner.

- Red Ink - should be used to indicate all revisions and corrections to a drawing
- Green Ink - should be used to indicate any desired deletions to a drawing
- Yellow Ink - should be used to indicate that any new or revised work has been done correctly
- Blue Ink - should be used by drafting personnel to indicate that a redlined item has been incorporated into the drawing. This will also assist personnel when reviewing the updated check print.
- Pencil - should be used to indicate notes or directions to drafting (things that drafting should do, but not things that should appear on the final drawing - i.e. “Move this electrical cabinet over 3 feet to the right”).

Appendix A
AWW Abbreviations

Abbreviation	Description
A.B.	Anchor Bolt
ADJ	Adjacent
ALUM.	Aluminum
ANSI	American National Standards Institute
APPROX.	Approximate
ARCH.	Architectural
AMP	Ampere
ASME	American Society of Mechanical Engineers
ASSY	Assembly
ASTM	American Society for Testing and Materials
UTO.	Automatic
AUX.	Auxiliary
AVG	Average
BLDG	Building
B.O.M.	Bill of Material
B.O.C.	Bottom of concrete
B.O.S.	Bottom of steel
BR	Bronze
BR	Brass
BTM	Bottom
C	Channel
°C	Centigrade, or Celsius
C to C	Center to Center
CFM	Cubic feet per minute

CHKD	Checked/Checkered (as in plate)
CI	Cast Iron pipe
CL.	Clearance
CM	Centimeter
COL.	Column
C.O.	Cleanout
CONC.	Concrete
CONSTR.	Construction
CONT.	Continued
CPLG	Coupling
CU.	Cubic
DEG(°)	Degrees
DIA.	Diameter
D.I.P.	Ductile Iron Pipe
DIM.	Dimension
DISCH.	Discharge
DN	Down
DPI	Differential Pressure Indicator
DWG	Drawing
E	East
EA.	Each
EA	Exhaust Air
E.F.	Each face
EL.	Elevation
ELL	Elbow
EQUIP.	Equipment
E.S.	Each Side
E.W.	Each way
EXIST.	Existing
EXPAN.	Expansion
F	Fan
°F	Fahrenheit
FD	Floor drain
FIG.	Figure
FL.	Floor
FLG	Flange
FLGD	Flanged
FPS	Feet per second
FS	Far side
FT(‘)	Foot or feet
FTG	Fitting
GAL.	Gallon(s)
GALV.	Galvanized
GPM	Gallons per minute
GND	Ground (as in electrical)
H	Height
HB	Hose Bibb

HEX	Hexagon(al)
HORIZ.	Horizontal
HP	Horsepower
HVAC	Heating, ventilation, and air conditioning
HZ	Hertz (frequency)
I.D.	Inside Diameter
IN.(“)	Inches
INV.	Invert (inside bottom of pipe)
JT.	Joint
KG	Kilogram
KVA	Kilovolt amperes
KW	Kilowatts
L	Length
LBS	Pounds
LR	Long Radius (of elbow)
M	Meter
MATL	Material
MAX.	Maximum
MCC	Motor Control Center
MECH.	Mechanical
MFR.	Manufacturer
MH	Manhole
MJ	Mechanical Joint (Pipe)
MIN.	Minimum
MISC.	Miscellaneous
MM	Millimeter
MVA	Megavolt amperes
N	North
N/A	Not applicable
NC.	Normally Closed
N.O.	Normally Open
NO.	Number
NOM.	Nominal
NPS	National pipe size
NPT	National pipe thread
NS	Near Side
NTS	Not to scale
OA	Outside air
O.D.	Outside Diameter
OH	Overhead
OPN’G.	Opening
ORIG.	Original
O.S.D.	Open Site Drain
P&ID	Process & Instrumentation Diagram
PE	Plain End (Pipe, etc.)
PERP.	Perpendicular
PL	Plate

PRESS.	Pressure
PRV	Pressure reducing/regulating valve
PSI	Pound per square inch
PSIA	Pound per square inch absolute
PSIG	Pound per square inch gauge
PVC	Polyvinyl chloride
QTY	Quantity
QUAD.	Quadrant
RED.	Reducing/Reducer
REINF.	Reinforcing/Reinforcement
REQ'D.	Required
REV.	Revision
RPM	Revolutions per minute
S	South
SCH or SCHED.	Schedule
SHT	Sheet
SLV	Sleeve
SQ.	Square
SR	Short Radius (of elbow)
S.S.	Stainless Steel
STD	Standard
STRUCT.	Structure/Structural
SUCT.	Suction
TEMP.	Temperature
THRU	Through
T.O.C.	Top of concrete
T.O.P.	Top of pipe
T.O.S.	Top of steel
TYP.	Typical
UG	Underground
UH	Unit heater
V	Volts
VERT.	Vertical
W	Watts
W	West
W	Width

MINIMUM STANDARDS FOR DRAWINGS FOR DEVELOPER INSTALLED WATER MAIN PACKET

Three complete sets of design drawings are to be submitted to the Water Company for preliminary review; one set will be returned to the Developer that will include corrections or alterations. One set of final plans signed and sealed by the project engineer and one set of diskettes with the drawings prepared in the Auto CAD version used by the Water Company will then be submitted by the Developer to the Water Company.

1. Design drawings shall be drawn on 24-inch by 36-inch sheets and shall show all water mains and appurtenances (as applicable.) The drawings will have a north arrow and the drawing scale indicated. The acceptable drawing scales are 1" = 20' or 1" = 50'. The name of the subdivision as well as name and address of the Developer and Engineer will be shown on the drawings. Site elevation information will be shown when dictated by site/pipe route topography which will allow adequate assessment of the main being installed. Drawings will show the location, size and type of existing sanitary and storm sewers, storm drains, water mains, culverts, power lines, gas lines and other existing surface structures. Drawings will also illustrate the layout, type and size of proposed utilities and structures such as water mains, sanitary laterals and mains, storm mains, culverts, other drainage structures, street improvements, gas and power lines.

2. Include an overall location and key map for the entire project at a scale not to exceed 1 inch = 200 feet and a vicinity map with a scale not to exceed 1 inch = 2,000 feet.

3. The minimum specific requirements for items shown on water main drawings is as follows:

    i) R-O-W width and centerline of road.

    ii) Back of curb with dimension.

    iii) Dedicated, exclusive or drainage and utility easements.

    iv) Property lines.

    v) Length, type, pressure rating of water main must be shown.

    vi) Location and dimension to main within easement and relative to back of curb and R-O-W.

    vii) Depth of cover over main.

    viii) Show all fittings, blow-offs, fire hydrants, valves and other appurtenances along with method of restraint.

4. The Water Company Standard Details for water main construction shall apply.

5. All water mains shall be shown on the drawings and constructed within a dedicated Water Company easement or public right of way. The minimum width of easements required shall be 20 feet. Due to specific site constraints, the Water Company may require wider easements than stated.

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TECHNICAL RQUIREMETS FOR PROJECT (Rev. 1 7.09.18)

Technical Requirements for Project

(Rev. 1 – 7.9.2018)

Project Overview

The project requires the Design Build firm (D-B) to design and install complete, functional, and operational facilities for two Aquifer Storage and Recovery (ASR) well facilities in Seaside, California; a location map of the project sites is presented in Appendix 1, (Sht. T-1), and Appendix E (Fig. 1). The sites are currently undeveloped easement parcels along the eastern side of General Jim Moore Blvd., immediately west of Ardennes Circle.

Background

The existing Monterey Peninsula ASR system generally consists of four ASR wells located at two separate ASR Facilities. The Santa Margarita (SM) ASR Facility includes the ASR-1 and ASR-2 wells and related facilities (e.g., a common backflush pit, electrical/chemical building, etc.), while the Seaside Middle School (SMS) ASR Facility includes the ASR-3 and ASR-4 wells and related facilities (e.g., an electrical control building). The SMS ASR facility has no backflush pit or chemical injection facilities due to restrictions imposed by the Monterey Peninsula Unified School District (MPUSD) during property negotiations.

The proposed ASR-5 and ASR-6 wells would be part of California American Water Co. (CAWC) larger Monterey Peninsula Water Supply Project, which generally consists of a desalination plant and related facilities, supplemented by expansion of the existing ASR system. The ASR-5 and ASR-6 wells and related facilities are to be located within the Fitch Park base housing area, located on the East side of General Jim Moore (GJM) Blvd. approximately 5,000 feet north of the SM ASR facility.

In addition to the construction of two new ASR wells at the site, various site improvements, utilities, and infrastructure will be needed to effectively utilize the wells; these facilities have been conceptually designed and sized through a separate contract agreement with CAWC.

CAWC has determined that both cost and schedule savings may be achieved by implementing the above-ground facilities development at the

Fitch Park sites as a Design-Build (D-B) type project rather than a conventional Design-Bid-Build (D-B-B) project.

In implementing the project, the D-B will be required to address the following:

- Review and incorporate the basic project features described herein into the project.
- Evaluate and analyze the preliminary design information provided herein and assess the validity and accuracy of the preliminary design with the D-B's proposed project design.
- Incorporate Cal-Am's standard design practices and standard materials/manufacturers into project engineering, final design, and construction.

Specific site background, details, and design requirements for each site are summarized below.

ASR-6 Facility

General. The ASR-6 facility shall consist of a dual-purpose injection/extraction well (ASR well) and associated piping and electrical facilities to allow the recharge and recovery of various water sources conveyed to the site. The ASR well shall be constructed by others; however the D-B shall provide site preparation work to allow the mobilization and construction of the well and shall provide post-construction services to incorporate the new well into the site facility.

The ASR-6 facility shall have the following functionality:

A. Injection of 1,500 gpm of treated, chlorinated potable water from the Cal-Am Distribution system (ie the Carmel River supply system) or from the pending Desal Plant. Recharge water supplies will be conveyed to the site via new transmission pipelines provided by others under separate contract.

B. Recovery/Production of up to 3,000 gpm from the underlying Santa Margarita Sandstone (Tsm) aquifer system, which may include native

ground water, stored Carmel River water, stored Desal water, or stored purified water from the Pure Water Monterey reclaimed water system. Recovered waters shall be conveyed into the above noted new transmission line installed in the GJM Blvd corridor by others; this water will flow southward to ASR-5 and then to Cal-Am consumers in Monterey. Refer to drawing T-1 for additional details.

C. ASR well backflushing (aka pump-to-waste) of up to 3,000 gpm for periodic flushing of the well via connection to a new waste pipeline installed in the GJM Blvd corridor by others, which terminates at the backflush/percolation pit at the existing Santa Margarita ASR facility approximately 5,400 ft. south at 1910 GJM Blvd.

D. Remote monitoring of all facility functions and remote operability of facility via a local PLC at each site and connection to the main Cal-Am SCADA system.

The following sections describe the specific design/engineering constraints associated with the ASR-6 facility.

1. Process (Piping and Instrumentation Diagram).

The general process and instrumentation features required for the facility are shown on sheet I-1 in Appendix 1. This P&ID is similar to the processes at the existing Seaside Middle School (SMS) ASR 3 & 4 facility and the Santa Margarita (SM) ASR 1 & 2 facility. The functionality of the new ASR 6 facility are consistent with the design of the existing ASR sites, Cal-Am desires that the new facilities remain consistent with the piping and operation of all existing Cal-Am ASR facilities. –Therefore, the process piping, valves, and instrumentation should not be changed without consultation and approval from Cal-Am.

2. Pump and Motor

Because the facility wells (ASR-5 & 6) do not yet exist, assumptions were made regarding the performance of the wells to facilitate general equipment sizing and layout. Specific assumptions regarding the well and the Cal-Am system parameters included the following:

- Well specific capacity = 14.6 gpm/ft drawdown**

  (** SC basis at 210 days pumping w/40% fouling loss)

- Static water level = 350' b.g.s.
- Additional interference drawdown from adjacent wells = 34'
- Hydraulic grade line of Cal-Am system at sites = 529' elev.

The above parameters yielded an approximate brake horsepower of 750, which was rounded up to a nominal 800 Hp motor sizing based on discussions with Cal Am staff. A Technical Memorandum documenting the well pump sizing (Dated 6-2-17) is included in Appendix 2.

The well pump and motor parameters developed in preliminary design included the following:

- Flow = 3000 gpm @ 792' TDH @ 82% eff.
- Special fabricated steel discharge head, 12" x 12" with internal wet barrel design to allow placement of three 1" sounding tube ports downhole.
- TEFC motor with Inverter Duty windings (480 volt)
- Zincless bronze Alloy C952 impellers and intermediate shaft bearings
- Enclosed tube, water flush tube and shaft design
- 12", X-42 grade column pipe, 550' long, uncoated
- 12x8 Baski "FCV" Downhole Flow Control Valve, set at 500' bgs

3. Civil/Site Development

Civil / site development will need to be implemented in two phases: an initial site clearing and rough grading task to allow mobilization of the well drilling contractor (not a part of the D-B contract) and the second phase of completing all other work after the well driller has demobilized. The existing site is relatively flat and undeveloped, with no existing utilities or infrastructure except for a deep monitoring well located in the Southeast corner of the site. A topographic map showing the site, site boundaries, proposed well location, and preliminary site

improvement design is provided in Appendix 1 – Sheet C-1. The primary civil improvements required at the site include the following:

- General site clearing and rough grading
- Final grading and drainage, with on-site percolation of storm water runoff
- Driveway aprons at GJM Blvd for ingress/egress
- Paving on site for utility and maintenance vehicle access
- Security fencing
- Site access shall be via manually opened double gates secured via padlocks

The following items should be noted in implementing the project:

- The proposed well site location shall not be changed due to the logistical constraints of initial well construction and ongoing well maintenance.
- A Soils Report has not been completed for the facility, and shall be required to be completed by the D-B contractor prior to final facilities design. Soils reports were performed for the extant SM and SMS facilities by Pacific Crest Geotechnical of Watsonville, CA, and were utilized for purposes of the preliminary design work.
- Pavement design shall be for a presumed H-20 load at the facility.

4. Utility Building/Structures

Preliminary design studies included an Electrical/Controls building to house sensitive equipment. The building conceptual design also incorporated a sound attenuation enclosure for the well to mitigate noise issues associated with well pump operation; the D-B may wish to revisit the benefits of this conjoined concept vs two separate structures. Specific design features of the building included the following:

- The electrical/controls building shall be of Non-combustible CMU construction with concrete plank roof as previously negotiated with Seaside Fire Department to avoid internal building sprinklering.

- The electrical/controls building is envisioned as a UBC Type U building classification

- Mediterranean style architecture similar to existing SMS and SM ASR facilities on GJM Blvd.

- Minimum 380 sq ft interior size, suitable for housing all electrical and control equipment.

- The well pump and motor shall be enclosed within a removable sound attenuation enclosure to mitigate noise from the unit. The enclosure must be fully removable on at least three sides (North, South, and West) to allow maintenance workover rigs to periodically service the well. The enclosure need not be fully enclosing nor must it have a roof, as long as the noise attenuation limits noise to a maximum of 60 dBA at the property (easement) lines at all times. The enclosure must also be designed and/or include features to allow adequate ventilation for the nominal 800 Hp, 480 volt TEFC well pump motor.

Preliminary design work also included the development of an initial Massing Study which conceptualized the well enclosure and electrical building as a single structure; this drawing is included in Appendix 1 as Sheet A-1, but is not a specific design requirement. The D-B may elect to separate the electrical building from the well enclosure or develop a different aesthetic design concept with approval of Cal-Am.

5. Piping and Valves

Piping for the facility has largely been identified in keeping with the P&ID extant for the existing SM and SMS ASR facilities nearby. Preliminary piping plans are provided in Appendix 1 – Sheets G-1 and M-1. Piping specialties are noted on the drawings; the following items are especially noted:

- Remotely controlled valves shall be Cla-Val Co, with Fusion Bonded Epoxy coating in and out, 110 v solenoid operation with manual override on the solenoid, stainless steel trim, indicating limit switches for fully open and closed positions, pilot strainers, opening and closing speed control valves, and isolation cocks.

- Flow meters shall be Sparling 656 Tigermag magnetic flowmeters, with local display plus remote transmission 4-20 mA output, polyurethane liner, and bidirectional rate and bidirectional totalizing functions.

- Aboveground piping spools shall be standard weight carbon steel, Class 125 flanges, fusion-bonded epoxy coated in and out, and 1" thread-o-let ports located 6" from the flange face for each spool.

- Water flush lube system for the well pump shall include both real time flow measurement and lube line filter differential pressure instrumentation; both with Interlock Shutdown of the well pump upon loss of flow or pressure in the lube line.

Additional information is provided on the piping drawings G-1, and M-1, and the P&ID (Sheet I-1), both in Appendix 3.

6. Electrical

Electrical design and installation shall be implemented in accordance with the following American Water design criteria, standards and applicable codes:

- *3.1: "Recommended Electrical Design Criteria and Standards"*
- 3.2: "*Power System Study and Arc Flash Analysis Requirements Version Date: March 2018"*
- 3.3:"*Acceptable Electrical Equipment Manufacturers and Suppliers, March 2018"*
- *3.4: "SEL Devices Monitoring Points (Modbus to SCADA /RTU)"*
    - Note: Cal Am has agreed to the following exceptions to the above standards:

- LED lighting shall be used in all areas of the facilities.

The standards and attachments are in Appendix 3

- California Electrical Code – Latest Edition

The 800 HP Rated Vertical Motor is based on the pump sizing discussed in Item 2 above. The design basis is for the 800 HP motors to have a voltage rating of 460 volts, for use on a 480V system. This voltage rating was chosen primarily due to the need for portable emergency generator backup power at the site. See "Electrical Service Alternatives" Technical Memorandum (TM), 7-27-17 in Appendix 2.

An indoor NEMA 1G Variable Frequency Drive (VFD) will be used to feed the 800 HP Well Pump Motors. The VFD allows speed/flow adjustment of the pump during production and flushing of the well and limits the motor starting voltage drop to meet PG&E requirements. The VFD shall have the following general specifications:

- 18-pulse width modulation (PWM) drive unit
- No VFD bypass
- Heavy-Duty service (50 C vs standard 40 C temperature rating)
- dV/dT output filter
- Allen Bradley is an acceptable VFD supplier for low voltage VFD's.

The one-line (single-line) diagram design is based on using an Allen Bradley Power Flex 755.

Auxiliary electrical loads such as building heating, ventilation and air conditioning (HVAC) and miscellaneous pumps shall be fed from 480-volt motor control centers or switchboards.

Per CAWC electrical design criteria and standards, the air conditioning units shall be provided with an economizer mode which uses outside air as the first stage and be designed to withdraw heat from above the VFD exhaust vents and introduce cooling air near the VFD air intakes.

Lighting and convenience receptacles will be fed from 208V/120V transformers and lighting panels.

System Loading and PG&E Electrical Service:

ASR-5 and ASR-6 well pumps shall have separate electrical services from PG&E. The basis for this decision is detailed in "Electrical Service Alternatives" TM, 7-27-17 in Appendix 2.

Each pump station system NEC calculated full-load amperage (F.L.A.) is 1282 amperes, which includes well pump, and the miscellaneous auxiliary loads, as shown in the Table "MSB & Feeder Load Schedule" on Drawing E-1. The panel has been sized as a 1600-ampere meter/main service panel. This size panel is larger than required but allows for consistency in equipment size with ASR-5. Final size to be determined in detailed design.

PG&E has indicated the PG&E transformers will probably each be a 1500 kVA unit. The pad-mounted transformer will be located near each of the electrical buildings and be fed from service drops from the 12 kV overhead line passing by the site on General Jim Moore Boulevard. See Drawings G-1, and G-2 in Appendix 1. Final location of the transformer depends on configuration of the electrical room and final discussions with PG&E.

The PG&E contact information, Application Number and system short circuit data for the facility is in Appendix 4. The short circuit data shall be used to perform the power system studies required by the "Power System Study and Arc Flash Analysis Requirements: Reviewed March 2018" in Appendix 3.

The preliminary electrical One Line Diagram (O.L.D) and Load Schedule for the ASR-6 facility is presented on Drawing E-1 in Appendix 1.

Layout for the major electrical equipment are shown on Drawing E-2 in Appendix 1

7. Controls

The facility controls shall be similar in scope and configuration to the existing SM and SMS facilities. The primary functions of the control system shall:

- Allow start/stop of the well pump
- Allow speed adjustment of the well pump in various operational modes, based of flow or pressure setpoint, or manual adjustment
- Allow actuation of the process Clavalves
- Provide alarm, warning, and shutdown interlock functions
- Record and store process operational data
- Communicate with main Cal-Am SCADA system

The control system shall also include a Local Control Panel (LCP) proximate to the well pump to allow operators to start, stop, and control the various Cla-Val valves during transitional operations of well backflushing and injection. A TM (Dated 6-2-17) discussing the various controls and the P&ID (I-1) is provided in Appendix 2.

The PLC shall have enough input and output capacity for the existing instrumentation and controls plus approximately ten percent spare analog and digital inputs and outputs.

A local Operator Interface Panel (OIP) shall be provided on the front of the control panel. The PLC program and OIP screens will be programmed to control the pumps and show the new booster and well pump operation, status and alarms, indicated above and on the P&ID.

The PLC shall communicate to Cal Am's central office by cellular modem. All signals shown on the P&ID shall be transmitted.

New SCADA screens shall be developed and loaded into the system to display the pump/facilities operation at Cal Am's office.

PLC and SCADA programming and equipment shall be consistent with the existing SM and SMS facilities.

Differential pressure and pressure transmitters shall be heat traced and mounted inside O'Brien instrument enclosures. All transmitter tubing shall be heat traced.

ASR-5 Facility

General. The ASR-5 facility shall consist of a dual-purpose injection/extraction well (ASR well) and associated piping and electrical facilities to allow the recharge and recovery of various water sources conveyed to the site. The ASR well shall be constructed by others; however the D-B shall provide site preparation work to allow the mobilization and construction of the well and shall provide post-construction services to incorporate the new well into the site facility.

The ASR-5 facility shall have the following functionality:

A. Injection of 1,500 gpm of treated, chlorinated potable water from the Cal-Am Distribution system (ie the Carmel River supply system) or from the pending Desal Plant. Recharge water supplies will be conveyed to the site via new transmission pipelines provided by others under separate contract.

B. Recovery/Production of up to 3,000 gpm from the underlying Santa Margarita Sandstone (Tsm) aquifer system, which may include native ground water, stored Carmel River water, stored Desal water, or stored purified water from the Pure Water Monterey reclaimed water system. Recovered waters shall be conveyed into the above noted new transmission line installed in the GJM Blvd corridor by others, proceeding southwards to Cal-Am consumers in Monterey.

C. ASR well backflushing (aka pump-to-waste) of up to 3,000 gpm for periodic flushing of the well via connection to a new waste pipeline installed in the GJM Blvd corridor by others, which terminates at the backflush/percolation pit at the existing Santa Margarita ASR facility approximately 4,800 ft. south at 1910 GJM Blvd.

D. Remote monitoring of all facility functions and remote operability of facility via a local PLC at each site and connection to the main Cal-Am SCADA system.

E. Chlorination facility to allow 12.5% sodium hypochlorite solution for disinfection of produced waters from both the ASR-5 and ASR-6 facilities prior to their conveyance south to Cal-Am consumers.

The following sections describe the specific design/engineering constraints associated with the ASR-5 facility.

1. Process (Piping and Instrumentation Diagram).

The general process and instrumentation features required for the facility are shown on sheet I-1 in Appendix 1. This P&ID is similar to the processes at the existing Seaside Middle School (SMS) ASR 3 & 4 facility and the Santa Margarita (SM) ASR 1 & 2 facility. Because these facilities and process piping have been found to be satisfactory for the existing sites – and because it is desired to keep the piping and operation of all Cal-Am ASR facilities consistent - the process piping and instrumentation should not be changed without consultation and approval from Cal-Am. *Note that the P&ID does not show the Chlorination system required at the ASR-5 facility; the D-B shall develop a P&ID for these facilities as part of the design work for the project. Further discussion of the Chlorination facilities requirements is provided in section 8 below.*

2. Pump and Motor

Because the facility wells (ASR-5 & 6) do not yet exist, assumptions were made regarding the performance of the wells to facilitate general equipment sizing and layout. Specific assumptions regarding the well and the Cal-Am system parameters included the following:

Because the facility wells (ASR-5 & 6) do not yet exist, assumptions were made regarding the performance of the wells to facilitate general equipment sizing and layout. Specific assumptions regarding the well and the Cal-Am system parameters included the following:

- Well specific capacity = 14.6 gpm/ft drawdown**

  (** SC basis at 210 days pumping w/40% fouling loss)

- Static water level = 350' b.g.s.

- Additional interference drawdown from adjacent wells = 34'

- Hydraulic grade line of Cal-Am system at sites = 529' elev.

The above parameters yielded an approximate brake horsepower of 750, which was rounded up to a nominal 800 Hp motor sizing based on discussions with Cal Am staff. A Technical Memorandum documenting the well pump sizing (Dated 6-2-17) is included in Appendix 2.

The well pump and motor parameters developed in preliminary design included the following:

- Flow = 3000 gpm @ 792' TDH @ 82% eff.
- Special fabricated steel discharge head, 12" x 12" with internal wet barrel design to allow placement of three 1" sounding tube ports downhole.
- TEFC motor with Inverter Duty windings (480 volt)
- Zincless bronze Alloy C952 impellers and intermediate shaft bearings
- Enclosed tube, water flush tube and shaft design
- 12", X-42 grade column pipe, 550' long, uncoated
- 12x8 Baski "FCV" Downhole Flow Control Valve, set at 500' bgs

3. Civil/Site Development

Civil / site development will need to be implemented in two phases: an initial site clearing and rough grading task to allow mobilization of the well drilling contractor (not a part of the D-B contract) and the second phase of completing all other work after the well driller has demobilized. The existing site is relatively flat and undeveloped, with no existing utilities or infrastructure except for a deep monitoring well located in the Southeast corner of the site. A topographic map showing the site, site boundaries, proposed well location, and preliminary site improvement design is provided in Appendix 1 – Sheet C-2. The primary civil improvements required at the site include the following:

- General site clearing and rough grading

- Final grading and drainage, with on-site percolation of storm water runoff
- Driveway aprons at GJM Blvd for ingress/egress
- Paving on site for utility and maintenance vehicle access
- Security fencing
- Site access shall be via manually opened double gates secured via padlocks
- Abandonment of existing Storm Drain drop inlet on western edge of easement

The following items should be noted in implementing the project:

- The proposed well site location shall not be changed due to the logistical constraints of initial well construction and ongoing well maintenance.
- A Soils report has not been completed for the facility, and shall be required to be completed by the D-B prior to final facilities design. Soils reports were performed for the extant SM and SMS facilities by Pacific Crest Geotechnical of Watsonville, CA, and were utilized for purposes of the preliminary design work.
- Pavement design shall be for a presumed H-20 load at the facility.

4. Utility Building/Structures

Preliminary design studies included an Electrical/Controls building to house sensitive equipment, and a Chlorination room to house chemical storage and dispensing equipment. The building conceptual design also incorporated a sound attenuation enclosure for the well to mitigate noise issues associated with well pump operation; the D-B may wish to revisit the benefits of this conjoined concept vs two separate structures. Specific design features of the building included the following:

- The electrical/controls building shall be of Non-combustible CMU construction with concrete plank roof as negotiated with Seaside Fire Department to avoid internal building sprinklering.

- The electrical/controls building is envisioned as a UBC Type U building classification

- Mediterranean style architecture similar to existing SMS and SM ASR facilities on GJM Blvd.

- Minimum 380 sq ft interior size, suitable for housing all electrical and control equipment. The preliminary estimation of the Chlorination room is approximately 900 sq ft.

- The well pump and motor shall be enclosed within a removable sound attenuation enclosure to mitigate noise from the unit. The enclosure must be fully removable on at least three sides (North, South, and West) to allow maintenance workover rigs to periodically service the well. The enclosure need not be fully enclosing nor must it have a roof, as long as the noise attenuation limits noise to a maximum of 60 dBA at the property (easement) lines at all times. The enclosure must be designed and/or include features to allow adequate ventilation for the nominal 800 Hp, 480 volt TEFC well pump motor.

Preliminary design work also included the development of an initial Massing Study which conceptualized the well enclosure, electrical building, and Chlorination room as a single structure; this drawing is included in Appendix 1 as Sheet A-2, but is not a specific design requirement. The D-B may elect to separate the electrical building and/or Chlorination room from the well enclosure or develop a different design concept with approval of Cal-Am.

Note that this Massing Study considered the inclusion of a chlorination room as part of the facility layout. This conceptual layout is provided for informational purposes and may be modified with the approval of Cal-Am. Further discussion of the Chlorination facilities is provided in Section 8 below.

5. Piping and Valves

Piping for the facility has largely been identified in keeping with the P&ID extant for the existing SM and SMS ASR facilities nearby. Preliminary piping plans are provided in Appendix 1 – Sheets G-2 and M-2. Piping specialties are noted on the drawings; the following items are especially noted:

- Remotely controlled valves shall be Cla-Val Co, with Fusion Bonded Epoxy coating in and out, 110 v solenoid operation with manual override on the solenoid, stainless steel trim, indicating limit switches for fully open and closed positions, pilot strainers, opening and closing speed control valves, and isolation cocks.

- Flow meters shall be Sparling 656 Tigermag magnetic flowmeters, with local display plus remote transmission 4-20 mA output, polyurethane liner, and bidirectional rate and bidirectional totalizing functions.

- Aboveground piping spools shall be standard weight carbon steel, Class 125 flanges, fusion-bonded epoxy coated in and out, and 1" thread-o-let ports located 6" from the flange face for each spool.

- The piping drawing does not show or detail the Chlorination injection piping, which is required to disinfect production from both ASR-5 and ASR-6. The D-B shall address this feature in their updated design drawings.

6. Electrical

Electrical design and installation shall be implemented in accordance with the following American Water design standards and applicable codes:

- *3.1:"Recommended Electrical Design Criteria and Standards"* with
- 3.2: *"Power System Study and Arc Flash Analysis Requirements Version Date: July 2017"*
- 3.3: *"Acceptable Electrical Equipment Manufacturers and Suppliers"*
- *3.4: "SEL Device Monitoring Points (Modbus to SCADA RTU)*

- Note: Cal Am has agreed to the following exceptions to the above standards:
  - LED lighting shall be used in all areas of the facilities.

The American Water criteria and standards are in Appendix 3

- California Electrical Code – Latest Edition

The 800 HP Rated Vertical Motor is based on the pump sizing discussed in Item 2 above. The design basis is for the 800 HP motors to have a voltage rating of 460 volts, for use on a 480V system. This voltage rating was chosen primarily due to the need for portable emergency generator backup power at the site. See "Electrical Service Alternatives" Technical Memorandum (TM), 7-27-17 in Appendix 2.

An indoor NEMA 1G Variable Frequency Drive (VFD) will be used to feed the 800 HP Well Pump Motors. The VFD allows speed/flow adjustment of the pump during production and flushing of the well and also limits the motor starting voltage drop to meet PG&E requirements. The VFD shall have the following general specifications:

- 18-pulse unit
- No VFD bypass
- Heavy-Duty service (50 C vs standard 40 C temperature rating)
- dV/dT output filter
- Allen Bradley is an acceptable VFD supplier for low voltage VFD's.

The One Line design is based on using an Allen Bradley Power Flex 755.

Auxiliary electrical loads such as building heating, ventilation and air conditioning (HVAC) and miscellaneous pumps shall be fed from 480-volt motor control centers or switchboards.

Per Cal Am's Electrical Design Criteria, the air conditioning units shall be provided with an economizer mode which uses outside air as the first

stage and be designed to withdraw heat from above the VFD exhaust vents and introduce cooling air near the VFD air intakes.

Lighting and convenience receptacles will be fed from 208V/120V transformers and lighting panels.

System Loading and PG&E Electrical Service:

ASR-5 shall have separate electrical services from PG&E. The basis for this decision is detailed in "Electrical Service Alternatives" TM, 7-27-17 in Appendix 2.

The well pump will operate continuously for a total system NEC calculated load of 1282 amperes, including the preliminary miscellaneous auxiliary loads, as shown in the Table below. The panel has been sized as a 1600-ampere meter/main service panel. This size panel is large enough to supply the anticipated loads shown, as well as the chemical storage and dispensing building loads, to be determined in detailed design.

PG&E has indicated the PG&E transformer will probably be a 1500 kVA unit. The pad-mounted transformer will be located near the electrical building and be fed from a service drop from the 12 kV overhead line passing by the site on General Jim Moore Boulevard. See Drawing G-2 in Appendix 1.

The layout plan shows the preliminary location of the transformer. Final location will depend on configuration of the electrical room and final discussions with PG&E.

The PG&E contact information, Application Number and system short circuit data for the facility is in Appendix 4. The short circuit data shall be used to perform the power system studies required by the "Power System Study and Arc Flash Analysis Requirements, Reviewed March 2018" in Appendix 3.

The preliminary electrical One Line Diagram and Load Schedule for the ASR-6 facility is presented on Drawing E-3 in Appendix 1.

Layouts for the major electrical equipment are shown on Drawing E-4 in Appendix 1.

7. Controls

The facility controls shall be similar in scope and configuration to the existing SM and SMS facilities, with the exception of the addition of disinfection of the ASR-5 and ASR-6 well production. The primary functions of the control system shall:

- Allow start/stop of the well pump
- Allow speed adjustment of the well pump in various operational modes, based of flow or pressure setpoint, or manual adjustment
- Allow actuation of the process Clavalves
- Provide alarm, warning, and shutdown interlock functions
- Record and store process operational data
- Communicate with main Cal-Am SCADA system

The control system shall also include a Local Control Panel (LCP) proximate to the well pump to allow operators to start, stop, and control the various Clavalves during transitional operations of well backflushing and injection. A TM (Dated 6-2-17) discussing the various controls and the P&ID (I-1) is provided in Appendix 2.

The PLC shall have enough input and output capacity for the existing instrumentation and controls plus approximately ten percent spare analog and digital inputs and outputs.

A local Operator Interface Panel (OIP) shall be provided on the front of the control panel. The PLC program and OIP screens will be programmed to control the pumps and show the new booster and well pump operation, status and alarms, indicated above and on the P&ID.

The PLC shall communicate to Cal Am's central office by radio modem. All signals shown on the P&ID shall be transmitted.

New SCADA screens shall be developed and loaded into the SCADA system to display the new pump/facility operation at Cal Am's office.

PLC and SCADA programming and equipment shall be consistent with the existing SM and SMS facilities.

Differential pressure and pressure transmitters shall be heat traced and mounted inside O'Brien instrument enclosures. All transmitter tubing shall be heat traced. *Note that the P&ID does not show the Chlorination system required at the ASR-5 facility; the D-B shall develop a P&ID for these facilities as part of the design work for the project. Further discussion of the Chlorination facilities requirements is provided in section 8 below.*

8. Chlorination Facilities

In addition to the features and equipment of the ASR-6 facility, the ASR-5 site shall also include a Chlorination facility to disinfect produced waters from both ASR-5 and ASR-6 as they are conveyed southward to Cal-Am consumers.

Because the ASR wells have not been constructed, precise water quality information (including Chlorine Demand) is not available. For purposes of planning and preliminary design, water quality was assumed to include a Chlorine Demand of 0.75 mg/L, and a desired free Chlorine residual into the Cal-Am conveyance system of 1.5 mg/L, for a total dose of 2.25 mg/L. The D-B will need to address the current uncertainty in water quality and well performance in the design process. An estimate of the Chlorine dosing needs for the facility (dated 9-26-17) and a TM addressing the preliminary design issues for chlorination (dated 10-4-17) are included in Appendix 2.

The Chlorination facility shall have the following features:

- Dosing of up to 3 mg/L max (2.25 mg/L design) sodium hypochlorite 12.5% solution.
- Storage for 30 days supply of bulk delivered hypochlorite on site.
- Double containment for all chemical storage and dispensing equipment.

- Chemical offloading facilities to accommodate bulk hypochlorite delivery, including an offloading/washdown pad sized for a WB-50 / 5,000 gallon tanker truck vehicle.
- Compressed air supply to pressurize truck and offload chemical.
- Redundant day tanks and transfer pumps.
- Bulk storage tank level indication and vent scrubber.
- Redundant chemical injection quills and injection ports with static mixers for hypochlorite injection.
- Chemical room temperature control to prevent solution freezing and heat degradation.
- Safety showers, Eyewash stations, Chemical spill containment equipment, and related chemical safety features and equipment.

Appendix 1

Preliminary Design Drawings

T-1: Title Sheet & Facility Map

I-1: Piping & instrumentation Diagram: ASR-5 & 6

G-1: ASR-6 Site

C-1: ASR-6 General Site Layout

M-1: ASR-6 Site Mechanical Plan

A-1: ASR-6 Architectural Mass Study

E-1: ASR-6 Electrical One Line Diagram

E-2: ASR-6 Building Electrical Layout

G-2: ASR-5 Site

C-2: ASR-5 General Site Layout

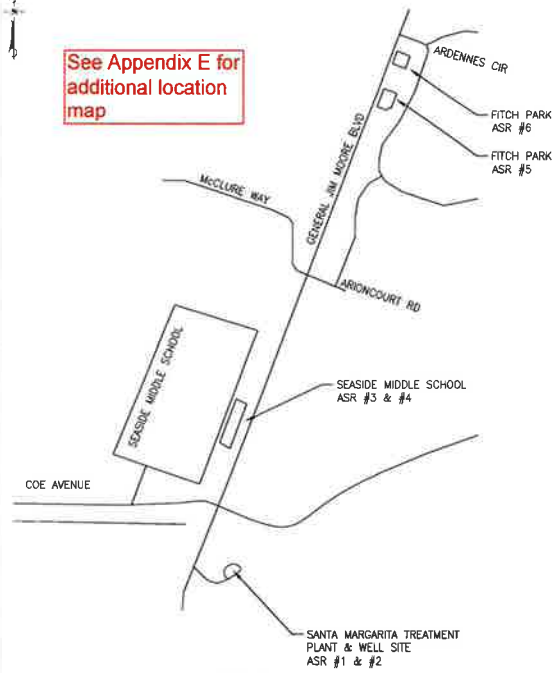
M-2: ASR-5 Site Mechanical Plan

A-2: ASR-5 Architectural Mass Study

E-3: ASR-5 Electrical One Line Diagram

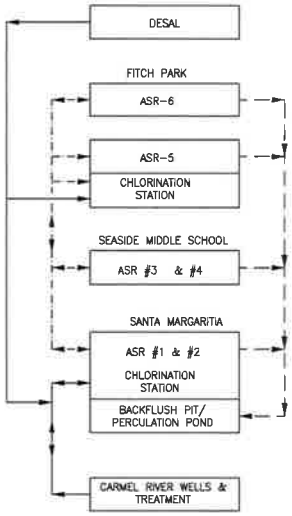
E-4: ASR-5 Building Electrical Layout

See Appendix E for additional location map



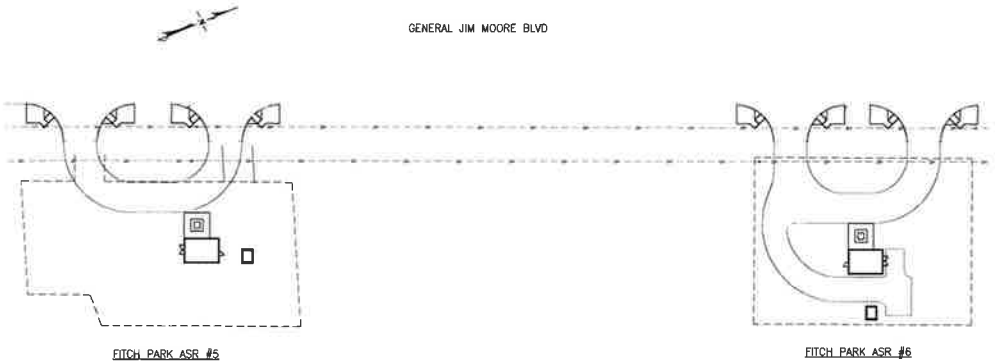
VICINITY MAP

NTS



BLOCK DIAGRAM - MONTEREY PENINSULA WATER PROJECTS

DRAWING LIST



FACILITY MAP

SCALE: 1"=40'-0"

SCALE: 1"=40'-0"

0 40 80 120 160

REV	DATE	BY	DESCRIPTION

WARNING

0 1"

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED 1/2___1

DRAWN ____

CHECKED ____

California American Water

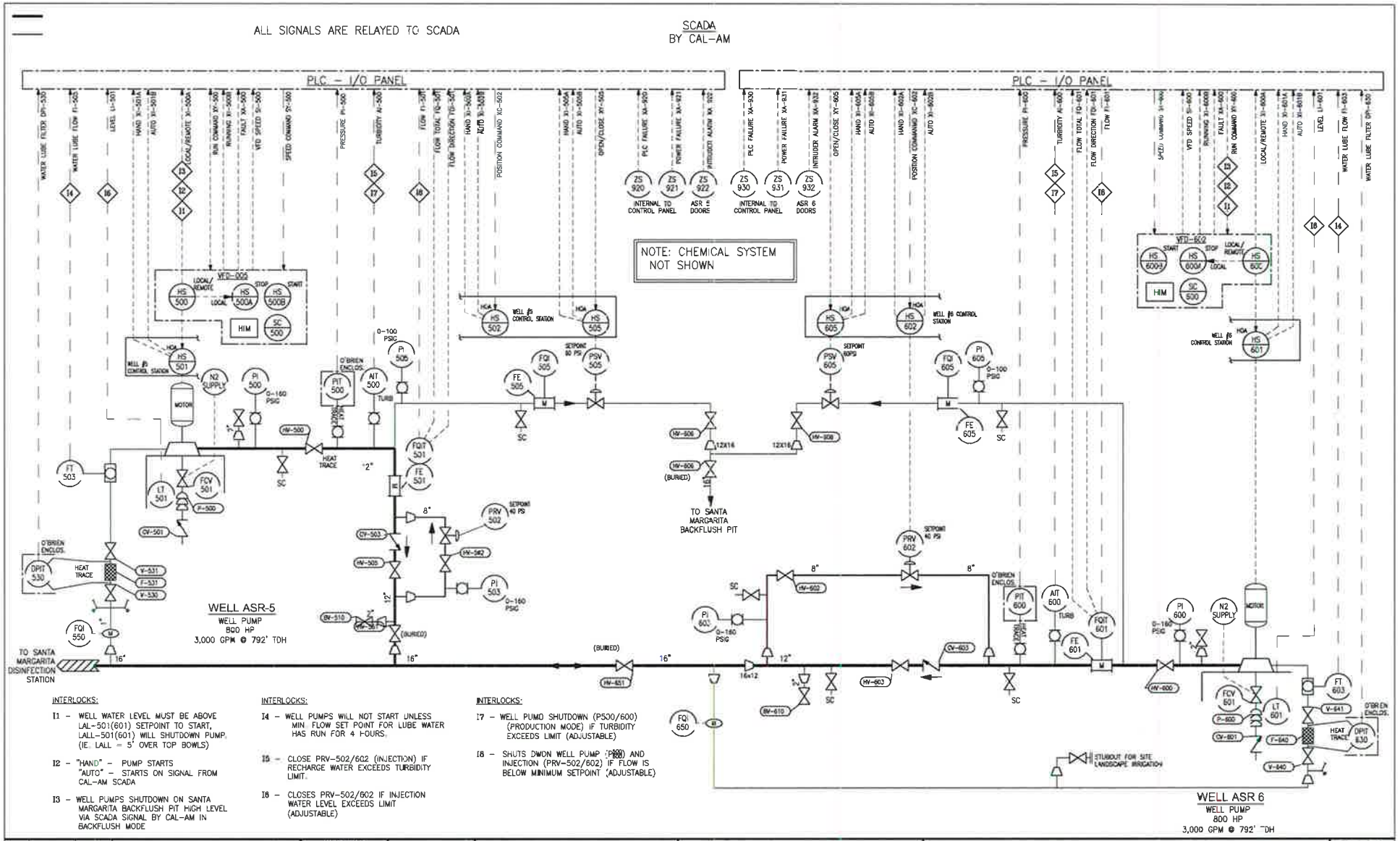
511 Forest Lodge Rd, Suite 100
Pacific Grove, Ca 9350

CALIFORNIA AMERICAN WATER

TITLE SHEET & FACILITY MAP
FITCH PARK ASR #5 & #6
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO. —

T-1



REV	DATE	BY	DESCRIPTION

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED 1/2__1
DRAWN
CHECKED

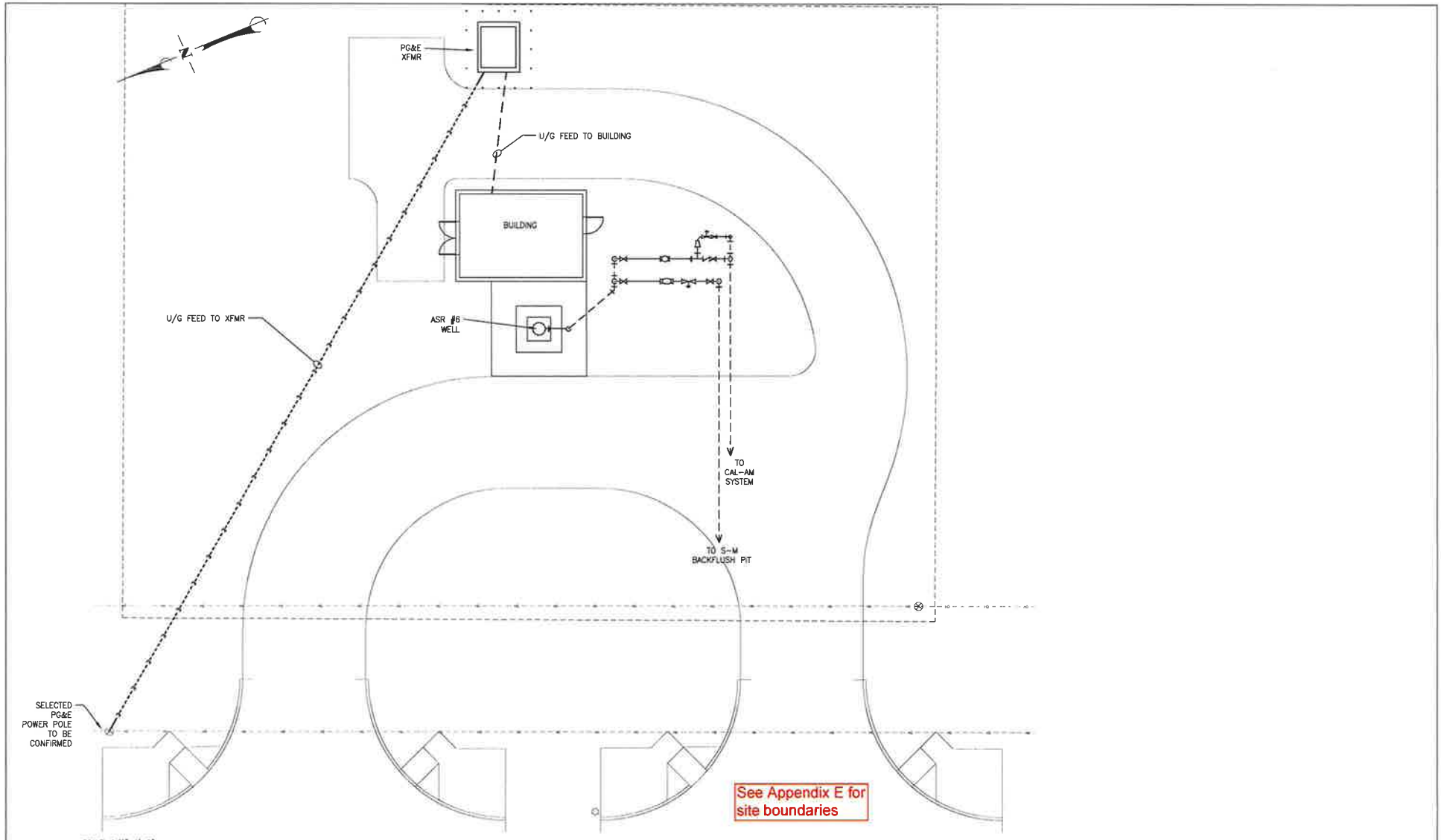
UNAUTHORIZED CHANGES & USES CAUTION: The engineer preparing these plans will not be responsible for, or liable for, unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by the preparer of these plans.

California American Water
511 Forest Lodge Rd, Suite 100
Pacific Grove, Ca 9350
CALIFORNIA AMERICAN WATER

PIPING & INSTRUMENT DIAGRAM
FITCH PARK SITE ASR #5 & #6
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO. -

I-1



REV	DATE	BY	DESCRIPTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED
DRAWN
CHECKED

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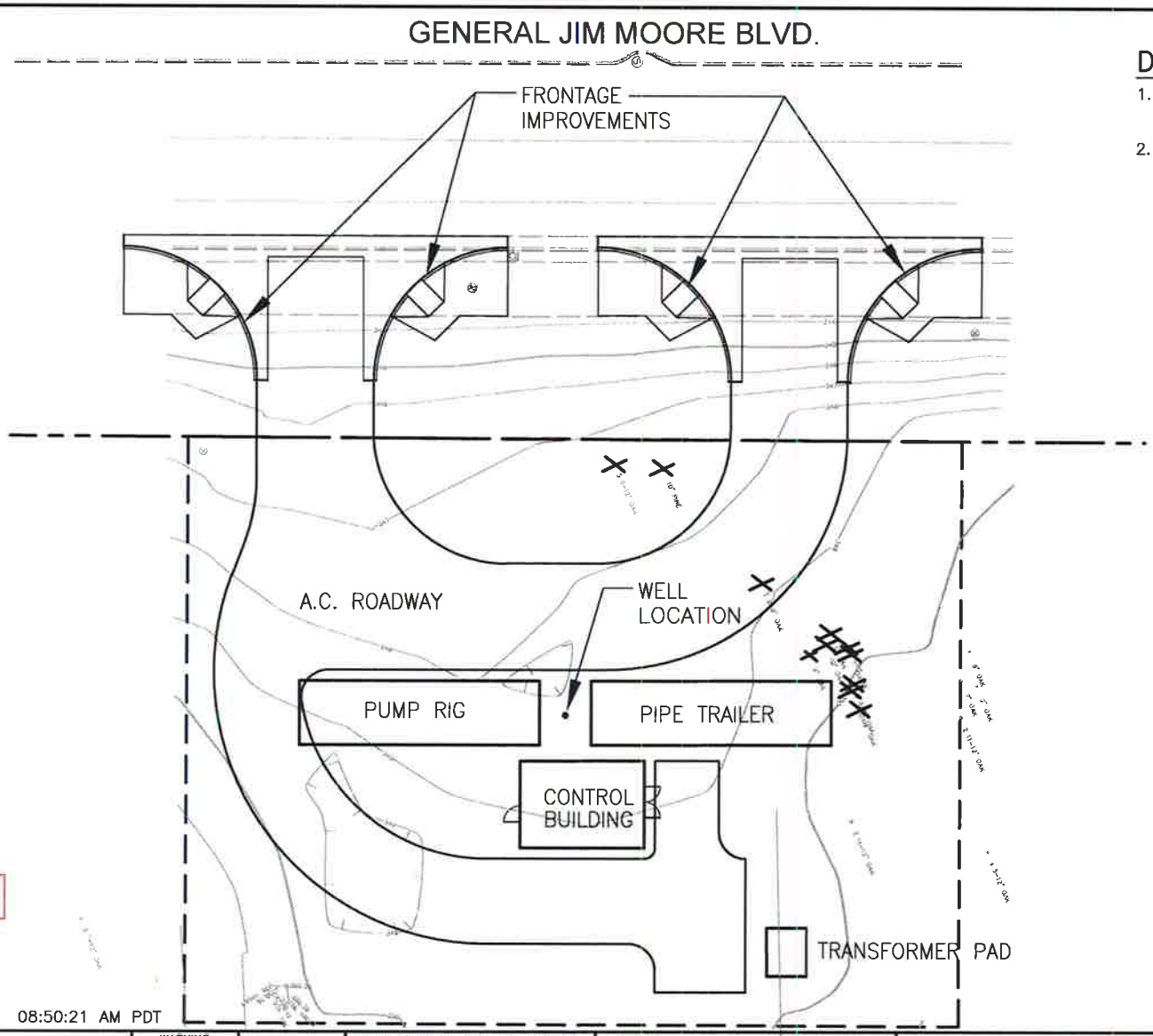
Suite 100
Pacific Grove, Ca 9350

CALIFORNIA AMERICAN WATER

GENERAL LAYOUT
FITCH PARK SITE ASR #6
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO.
-

G-1



DESIGN PARAMETERS

1. ROADWAY SHALL BE DESIGNED TO ACCOMMODATE A WB50 TRUCK.
2. "X" MARKS ON OAK TREES ARE IDENTIFIED FOR REMOVAL/DEMOLITION.

see Appendix E for site boundaries

SCALE: 1"=20'

0478PGDP.DWG 04/09/18 08:50:21 AM PDT

REV	DATE	BY	DESCRIPTION

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED ____
DRAWN ____
CHECKED ____

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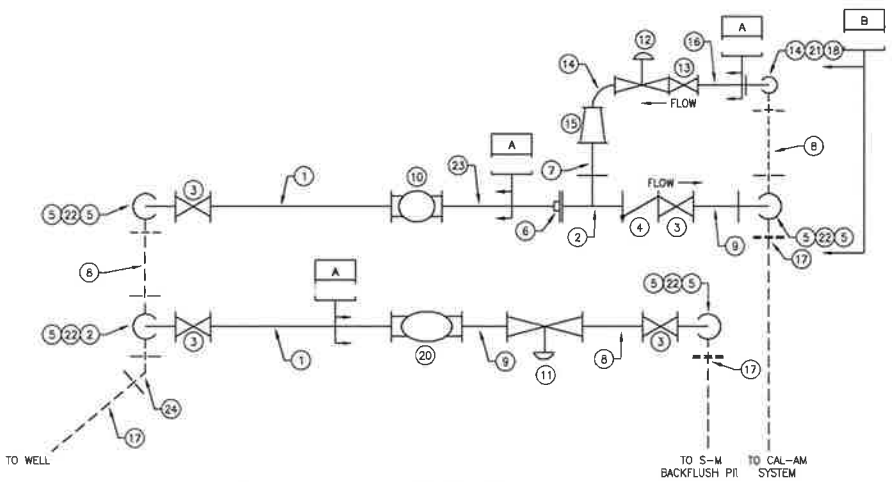
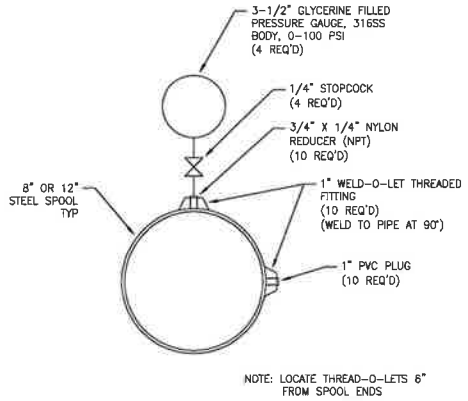
CALIFORNIA AMERICAN WATER

EXHIBIT
GENERAL SITE LAYOUT - ASR-6
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO. PROJECT
C-1



1 — PIPING PLAN
SCALE: 1/2" = 1'-0"



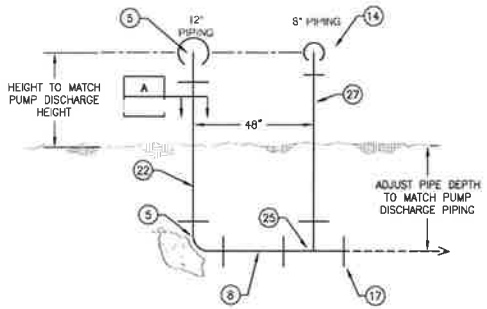
A — TYPICAL PRESSURE GAUGE & SAMPLE PORTS ON ALL 8" & 12" PIPE SPOOLS

MATERIAL LIST

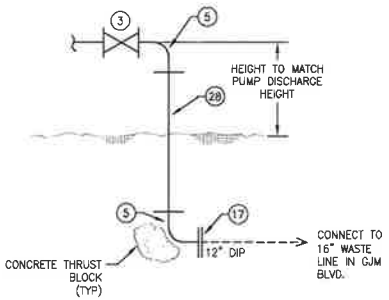
ITEM	PIPE SIZE	DESCRIPTION	QTY
1	12"	72" LONG SPOOL, FLG.	2
2	12"	FLG. TEE	3
3	12"	FLG. GATE VALVE WITH HANDWHEEL	4
4	12"	APCO MOD. 612 CHECK VALVE	1
5	12"	90° ELBOW, FLG.	6
6	12"	DRESSER STYLE 128 FLANGE ADAPTOR	2
7	12"	13" LONG SPOOL, FLG.	1
8	12"	24" LONG SPOOL, FLG.	3
9	12"	18" LONG SPOOL, FLG.	2
10	12"	SPARLING TIGERMAG 657 METER	1
11	12"	CLAVALVE 650 (SEE NOTE 1)	1
12	8"	CLAVALVE 90 (SEE NOTE 2)	1
13	8"	GATE VALVE, FLG.	1
14	8"	90° ELBOW, FLG.	2
15	8"	8 X 12" REDUCER, FLG.	1
16	8"	15-3/8" LONG SPOOL, FLG.	1
17	12"	MEGAFLANGE ADAPTOR	2
18	12"	8 X 12" REDUCING ELBOW, FLG.	1
19	12"	SPOOL, 28" LONG, FLG. X P.E. WITH TIE BACK LUGS & 2" THREAD-O-LET	1
20	12"	WATER SPECIALTIES ML-04 METER SEE NOTE 4	1
21	8"	SPOOL, 75" LONG	1
22	12"	SPOOL, 72" LONG	4
23	12"	SPOOL, 45" LONG, FLG. X P.E. WITH TIE BACK LUGS	1
24	12"	45° ELBOW, FLG.	
25	12"	12 X 8 X 12" (R-B-R) TEE, FLG.	1

NOTES:

1. 12" CLAVALVE MODEL 650E-G-03BSKC-DS W/120V SOLENOID W/ MANUAL OPERATOR, GLOBE STYLE, EPOXY LINED, STAINLESS STEEL TRIM, CHECK FEATURES, PILOT BALL VALVES, OPENING SPEED CONTROL
2. 8" CLAVALVE MODEL 93E-G-01BCSYKC-DS W/120V SOLENOID W/ MANUAL OPERATOR, GLOBE STYLE, EPOXY LINED, STAINLESS STEEL TRIM, CHECK FEATURES, SOLENOID SHUTOFF, PILOT BALL VALVES, OPENING AND CLOSING SPEED CONTROL
3. ALL SPOOLS SHALL BE SCH. 40 STEEL FUSION BONDED EPOXY COATED PER AWWA D213.
4. WATER SPECIALTIES ML-04 METER, 12" SIZE, INDICATOR & TOTALIZER IN GALLONS, STANDARD VELOCITY CONSTRUCTION.



B — UNDERGROUND INTERTIE DETAIL
SCALE: 1/2" = 1'-0"



C — FLUSH PIPING ELEVATION
SCALE: 1/2" = 1'-0"

REV	DATE	BY	DESCRIPTION

WARNING
0
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED 1/2
DRAWN
CHECKED

UNAUTHORIZED CHANGES & USES CAUTION: The engineer preparing these plans will not be responsible for, or liable for, unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by the preparer of these plans.

California American Water
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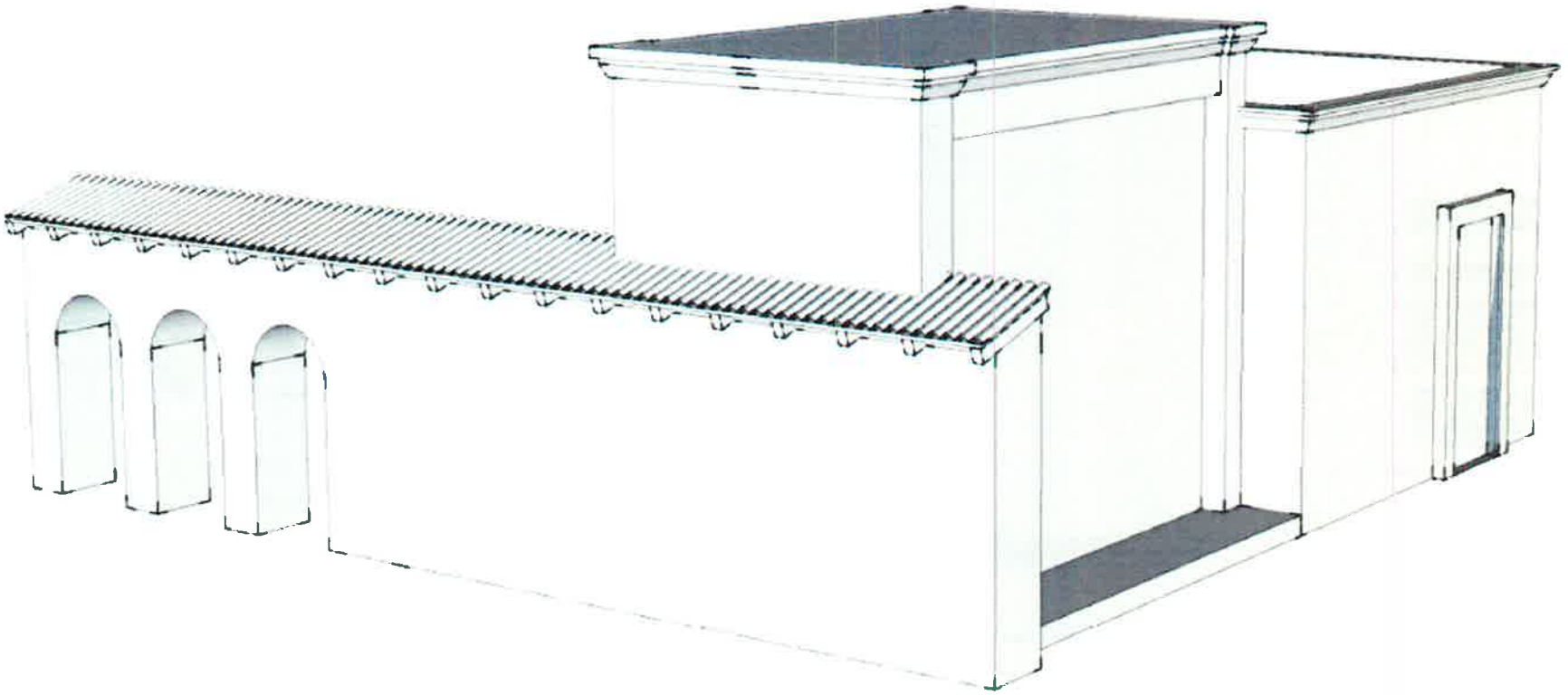
Pacific Grove, Ca 9350

CALIFORNIA AMERICAN WATER

MECHANICAL PLAN
FITCH PARK SITE ASR #6
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO.
-

M-1



ASR-6 CONCEPTUAL DESIGN

SCALE: NTS

REV	DATE	BY	DESCRIPTION

WARNING

0 1"

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED 1/2___1

DRAWN ____

CHECKED ____

UNAUTHORIZED CHANGES & USES CAUTION: The engineer preparing these plans will not be responsible for, or liable for, unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by the preparer of these plans.

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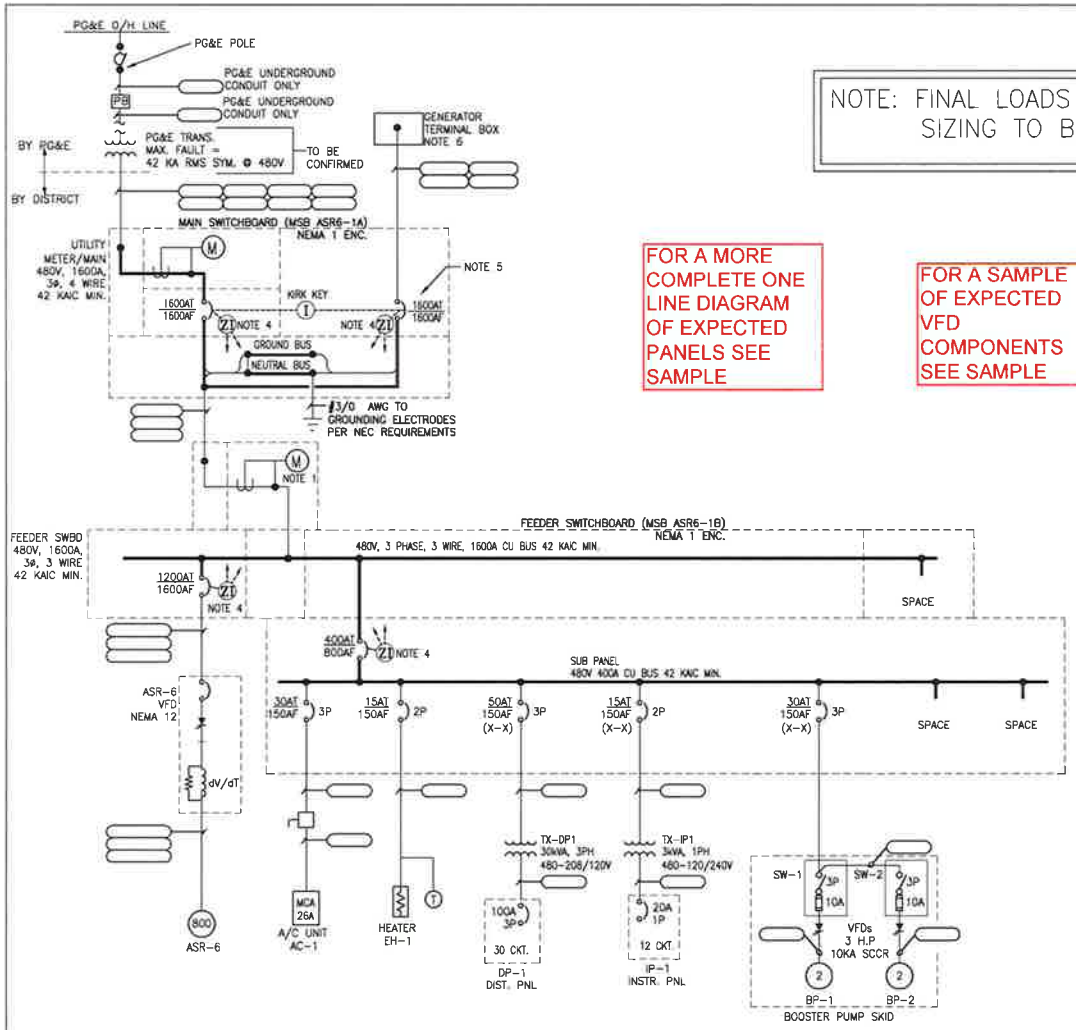
CALIFORNIA AMERICAN WATER

ARCHITECTURAL MASS STUDY
FITCH PARK SITE ASR #6
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO.
-

A-1



ONE-LINE DIAGRAM

NOTE: FINAL LOADS & EQUIPMENT SIZING TO BE DETERMINED

FOR A MORE COMPLETE ONE LINE DIAGRAM OF EXPECTED PANELS SEE SAMPLE

FOR A SAMPLE OF EXPECTED VFD COMPONENTS SEE SAMPLE

NOTES

1. CUSTOMER METERING WITH MODBUS TCP ETHERNET CAPABILITY. UNIT IS CAPABLE OF MONITORING DEMAND, KW, KVAR, KVA, KWH, KVARH, VOLTS, AMPS AND HARMONICS.
2. MAIN BREAKER AND GENERATOR BREAKER ARE INSULATED CASE BREAKER, SOLID STATE TRIP WITH LONG TIME, SHORT TIME AND GROUND FAULT TRIP FUNCTIONS.
3. VFD BREAKER IS AN INSULATED CASE BREAKER, SOLID STATE TRIP WITH LONG TIME, SHORT TIME, GROUND FAULT AND SHUNT TRIP FUNCTIONS.
4. VFD FEEDER BREAKER & SUBPANEL MAIN BREAKER ARE ZONE INTERLOCKED (ZI) WITH MSB ASR6-1A MAIN AND GENERATOR BREAKER.
5. STANDBY GENERATOR BREAKER SHALL BE INTERLOCKED WITH THE MAIN BREAKER. BOTH BREAKERS CANNOT BE CLOSED SIMULTANEOUSLY.
6. STANDBY GENERATOR CONNECTION IS SIZED TO FEED THE ENTIRE FACILITY LOAD.

MSB & FEEDER LOAD SCHEDULE

MOTOR TAG NO.	M OR F	PHASE	MOTOR(M) H.P. OR FEEDER(F) kW	F.L.A.	DESCRIPTION
ASR-6 WELL	M	3	800	893	WELL MOTOR/VFD
MCC LOADS	F	3	139	168	FROM MCC SCHEDULE BELOW - INCLUDES LCL
TOTAL CURRENT				1061	
LARGEST MOTOR X .25				223	
FEEDER LCL X .25					
TOTAL CURRENT				1284	
TOTAL kVA				1067	

SUBPANEL OR MCC LOAD SCHEDULE

MOTOR TAG NO.	M OR F	PHASE	MOTOR (M) H.P. OR FEEDER(F) kW	F.L.A.	DESCRIPTION
AC-1	F	3	40.0	48.1	AC UNIT
EH-1	F	3	2.0	2.4	ELECTRIC HEATER
BP-1	M	3	2.0	3.4	COMBINED POTABLE WATER BOOSTER PUMPS FEEDER
BP-2	M	3	2.0	3.4	
FEEDER LOADS					
TX-ASR6-DP1	F	3	20.0	26.1	LTG. TRANSFORMER (208/120V)
TX-ASR6-IP1	F	1	3.0	6.3	INSTRUMENT TRANSFORMER
TOTAL CURRENT				123.5	LARGEST LEG CURRENT
LARGEST MOTOR X .25				0.9	
FEEDER LCL X .25				43.2	
TOTAL CURRENT				167.6	
TOTAL kVA				139.1	

REV	DATE	BY	DESCRIPTION

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED 1/2___1
DRAWN ____
CHECKED ____

California American Water
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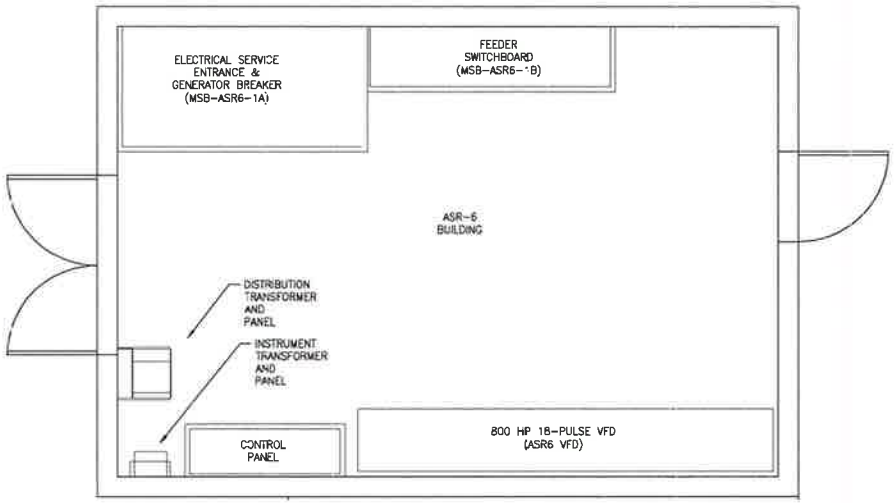
Pacific Grove, Ca 9350

CALIFORNIA AMERICAN WATER

ONE LINE DIAGRAM
FITCH PARK SITE ASR #6
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO. -

E-1



ASR #6 BULDING LAYOUT

SCALE: 1/2"=1'-0"

REV.	DATE	BY	DESCRIPTION

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED
DRAWN
CHECKED

UNAUTHORIZED CHANGES & USES CAUTION: The engineer preparing these plans will not be responsible for, or liable for, unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by the preparer of these plans.

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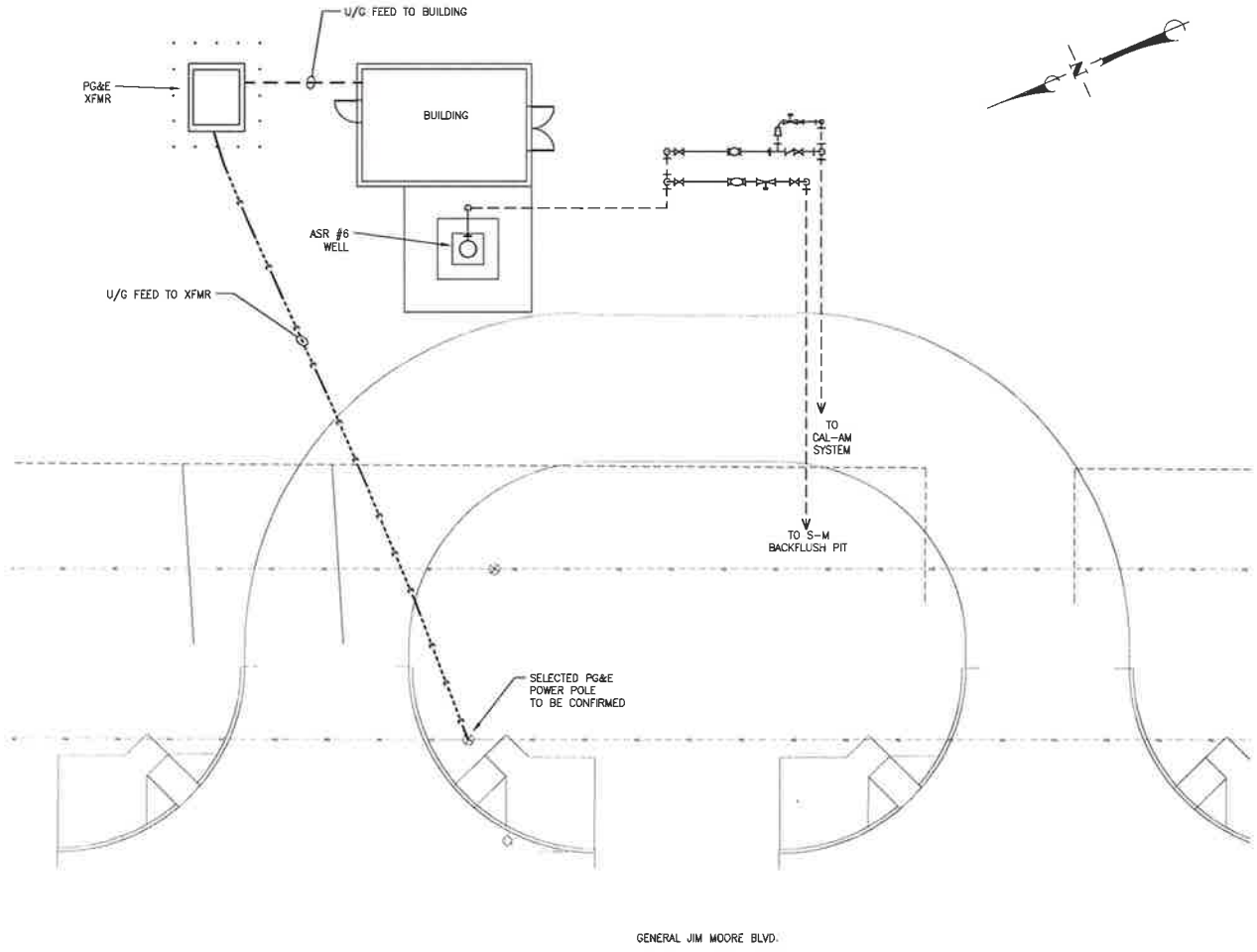
CALIFORNIA AMERICAN WATER

BUILDING ELECTRICAL LAYOUT
FITCH PARK SITE ASR #6
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO.
-

E-2

NOTE: CHEMICAL STORAGE & DISPENSING BUILDING AND PIPING NOT SHOWN



SCALE: 1/8"=1'-0"

0 8 16 24 32

REV	DATE	BY	DESCRIPTION

WARNING
0 1"
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED 1/2 1
DRAWN
CHECKED

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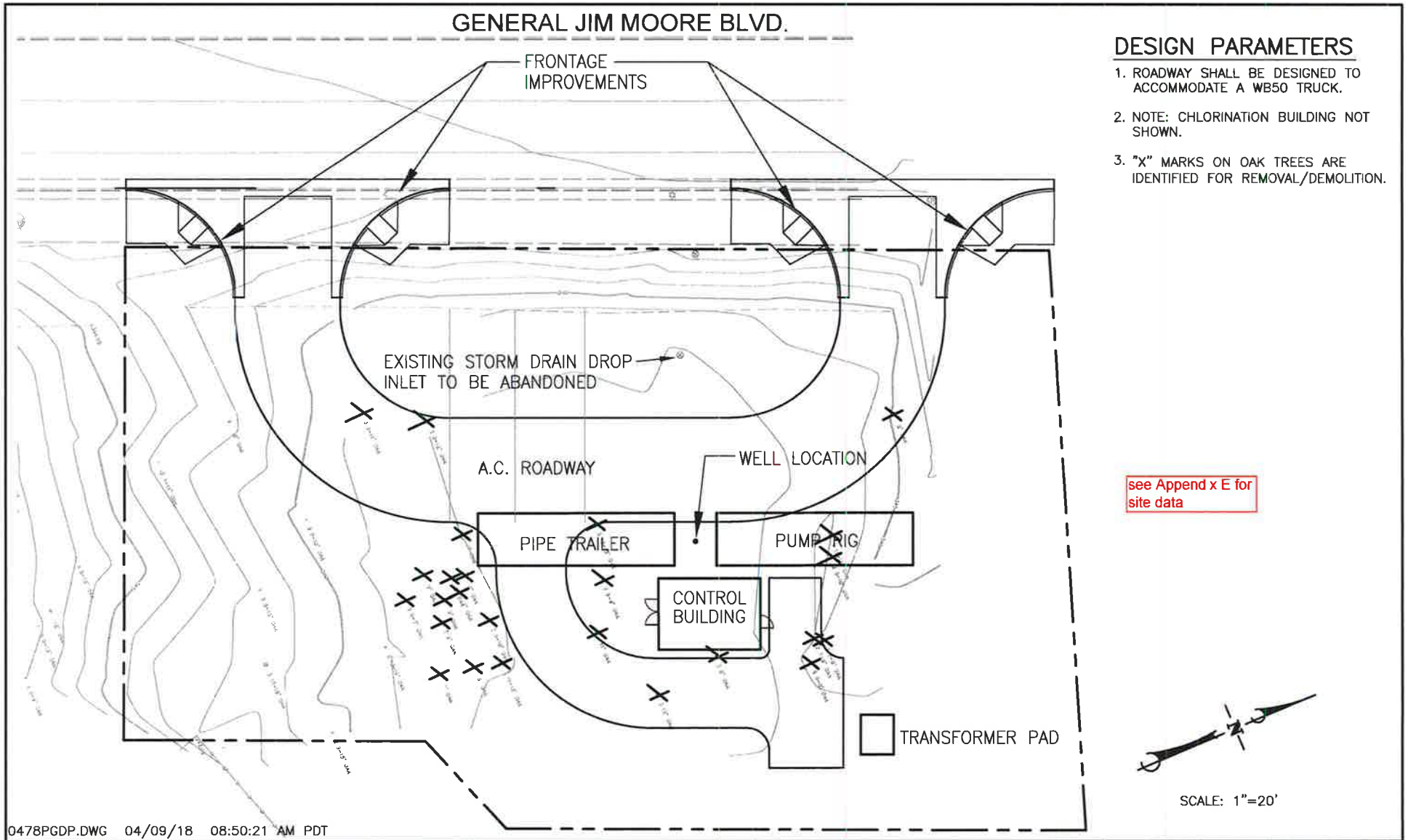
Pacific Grove, Ca 9350

CALIFORNIA AMERICAN WATER

GENERAL LAYOUT
FITCH PARK SITE ASR #5
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO. –

G-2



DESIGN PARAMETERS

1. ROADWAY SHALL BE DESIGNED TO ACCOMMODATE A WB50 TRUCK.
2. NOTE: CHLORINATION BUILDING NOT SHOWN.
3. "X" MARKS ON OAK TREES ARE IDENTIFIED FOR REMOVAL/DEMOLITION.

see Append x E for site data

SCALE: 1"=20'

0478PGDP.DWG 04/09/18 08:50:21 AM PDT

REV	DATE	BY	DESCRIPTION

WARNING
0 1/2 1
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DESIGNED
DRAWN
CHECKED

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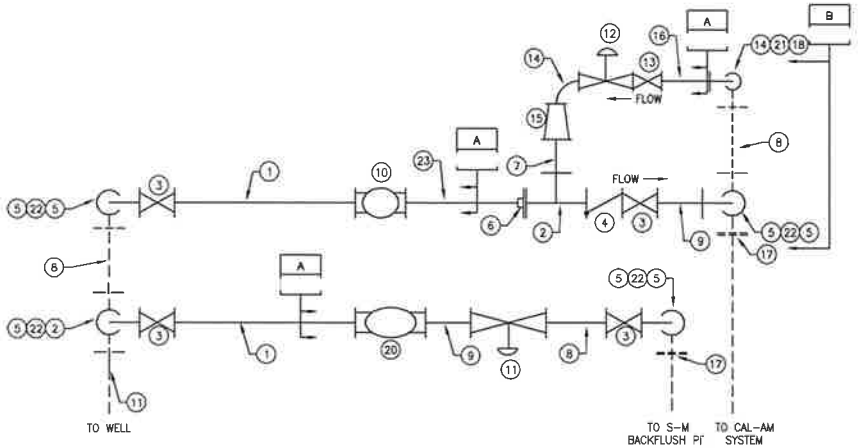
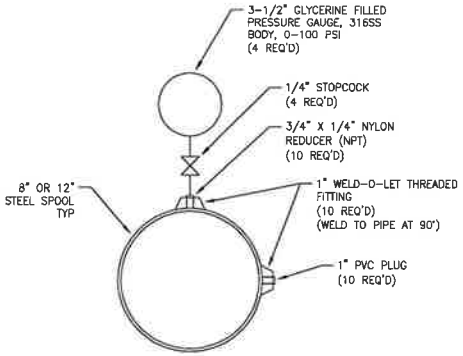
CALIFORNIA AMERICAN WATER

EXHIBIT
GENERAL SITE LAYOUT - ASR-5
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO. PROJECT
C-2



1 PIPING PLAN
SCALE: 1/2" = 1'-0"

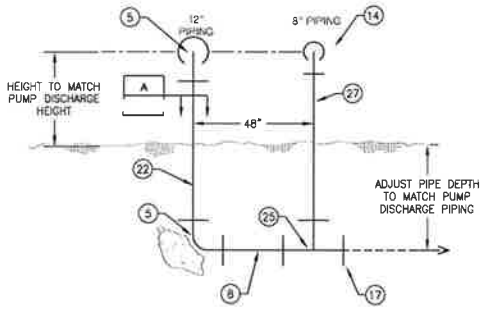


NOTE: LOCATE THREAD-O-LETS 6" FROM SPOOL ENDS

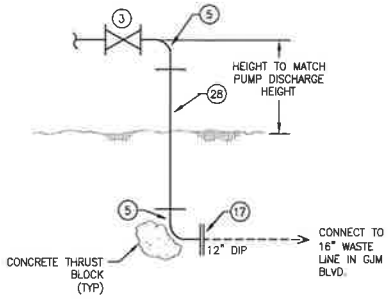
A TYPICAL PRESSURE GAUGE & SAMPLE PORTS ON ALL 8" & 12" PIPE SPOOLS

MATERIAL LIST

ITEM	PIPE SIZE	DESCRIPTION	QTY
1	12"	72" LONG SPOOL, FLG.	2
2	12"	FLG. TEE	3
3	12"	FLG. GATE VALVE WITH HANDWHEEL	4
4	12"	APCO MOD. 612 CHECK VALVE	1
5	12"	90° ELBOW, FLG.	6
6	12"	DRESSER STYLE 128 FLANGE ADAPTOR	2
7	12"	13" LONG SPOOL, FLG.	1
8	12"	24" LONG SPOOL, FLG.	3
9	12"	18" LONG SPOOL, FLG.	2
10	12"	SPARLING TIGERMAG 657 METER	1
11	12"	CLAVALVE 650 (SEE NOTE 1)	1
12	8"	CLAVALVE 90 (SEE NOTE 2)	1
13	8"	GATE VALVE, FLG.	1
14	8"	90° ELBOW, FLG.	2
15	8"	8 X 12" REDUCER, FLG.	1
16	8"	15-3/8" LONG SPOOL, FLG.	1
17	12"	MEGAFLANGE ADAPTOR	2
18	12"	8 X 12" REDUCING ELBOW, FLG.	1
19	12"	SPOOL, 28" LONG, FLG. X P.E. WITH TIE BACK LUGS & 2" THREAD-O-LET	1
20	12"	WATER SPECIALTIES ML-04 METER SEE NOTE 4	1
21	8"	SPOOL, 75" LONG	1
22	12"	SPOOL, 72" LONG	4
23	12"	SPOOL, 45" LONG, FLG. X P.E. WITH TIE BACK LUGS	1
24	12"	45° ELBOW, FLG.	
25	12"	12 X 8 X 12" (R-B-R) TEE, FLG.	1



B UNDERGROUND INTERTIE DETAIL
SCALE: 1/2" = 1'-0"



C FLUSH PIPING ELEVATION
SCALE: 1/2" = 1'-0"

NOTES:

1. 12" CLAVALVE MODEL 650E-G-03BSKC-DS W/120V SOLENOID W/ MANUAL OPERATOR, GLOBE STYLE, EPOXY LINED, STAINLESS STEEL TRIM, CHECK FEATURES, PILOT BALL VALVES, OPENING SPEED CONTROL
2. 8" CLAVALVE MODEL 93E-G-01BCSYKC-DS W/120V SOLENOID W/ MANUAL OPERATOR, GLOBE STYLE, EPOXY LINED, STAINLESS STEEL TRIM, CHECK FEATURES, SOLENOID SHUTOFF, PILOT BALL VALVES, OPENING AND CLOSING SPEED CONTROL
3. ALL SPOOLS SHALL BE SCH. 40 STEEL FUSION BONDED EPOXY COATED PER AWWA D213.
4. WATER SPECIALTIES ML-04 METER, 12" SIZE, INDICATOR & TOTALIZER IN GALLONS, STANDARD VELOCITY CONSTRUCTION.

REV	DATE	BY	DESCRIPTION

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED 1/2
DRAWN
CHECKED

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California American Water
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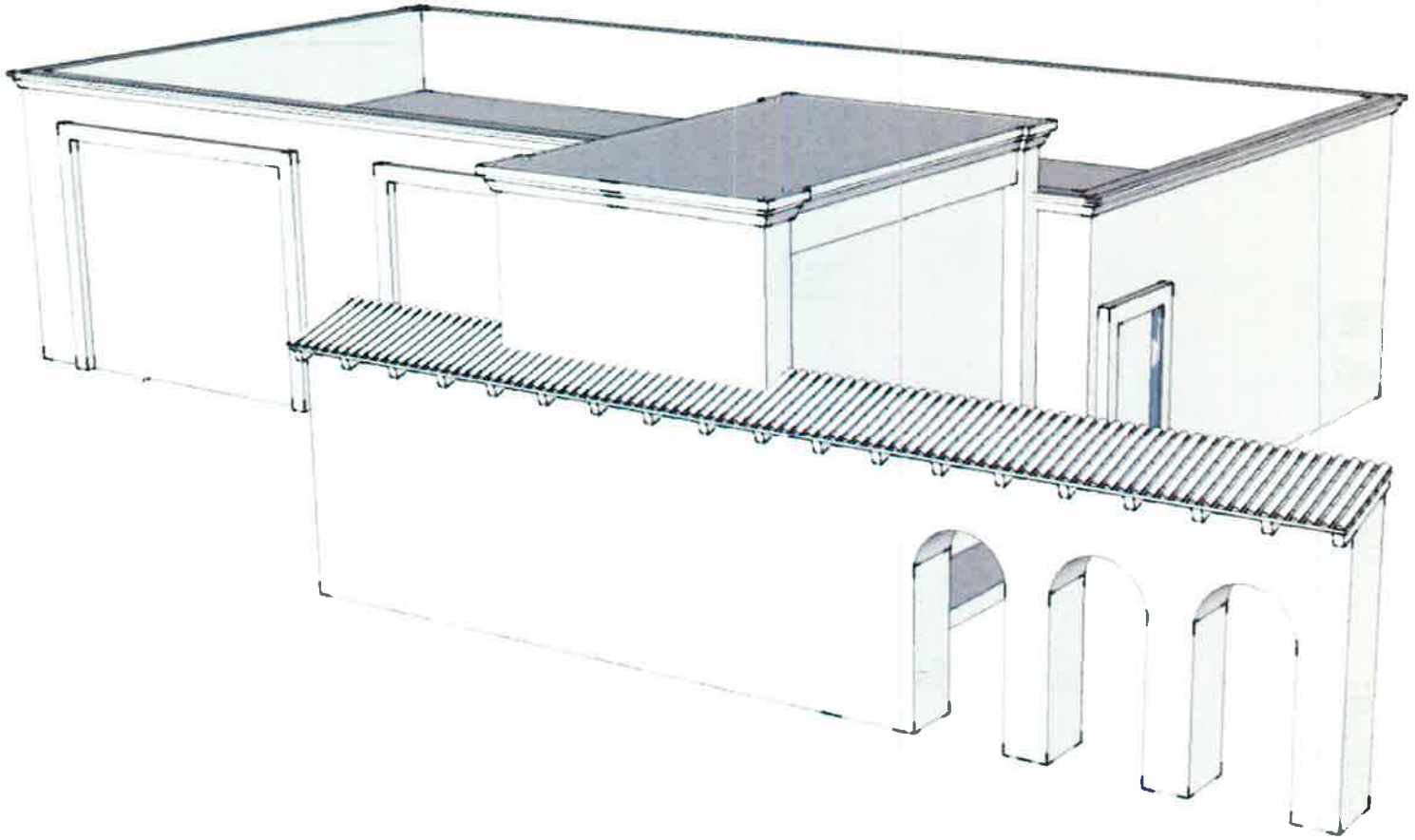
Pacific Grove, Ca 9350

CALIFORNIA AMERICAN WATER

MECHANICAL PLAN
FITCH PARK SITE ASR #5
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO. -

M-2



ASR-5 CONCEPTUAL DESIGN

SCALE: NTS

REV	DATE	BY	DESCRIPTION

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED

DRAWN

CHECKED

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California American Water

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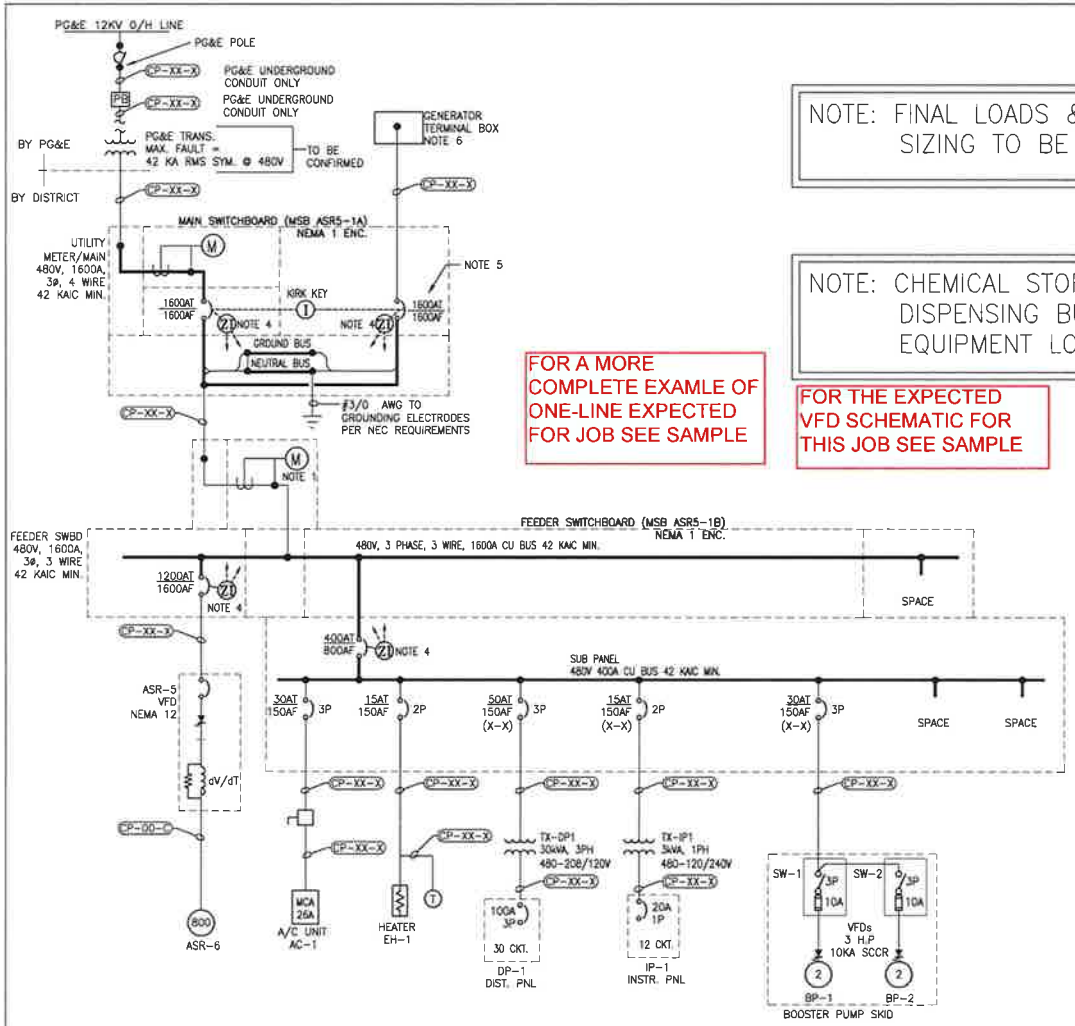
Suite 100
Pacific Grove, Ca 9350

CALIFORNIA AMERICAN WATER

ARCHITECTURAL MASS STUDY
FITCH PARK SITE ASR #5
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO.
-

A-2



ONE-LINE DIAGRAM

NOTE: FINAL LOADS & EQUIPMENT SIZING TO BE DETERMINED

NOTE: CHEMICAL STORAGE & DISPENSING BUILDING AND EQUIPMENT LOADS NOT SHOWN

FOR A MORE COMPLETE EXAMLE OF ONE-LINE EXPECTED FOR JOB SEE SAMPLE

FOR THE EXPECTED VFD SCHEMATIC FOR THIS JOB SEE SAMPLE

NOTES

1. CUSTOMER METERING WITH MODBUS TCP ETHERNET CAPABILITY. UNIT IS CAPABLE OF MONITORING DEMAND, KW, KVAR, KVA, KWH, KVARH, VOLTS, AMPS AND HARMONICS.
2. MAIN BREAKER AND GENERATOR BREAKER ARE INSULATED CASE BREAKER, SOLID STATE TRIP WITH LONG TIME, SHORT TIME AND GROUND FAULT TRIP FUNCTIONS.
3. VFD BREAKER IS AN INSULATED CASE BREAKER, SOLID STATE TRIP WITH LONG TIME, SHORT TIME, GROUND FAULT AND SHUNT TRIP FUNCTIONS.
4. VFD FEEDER BREAKER & SUBPANEL MAIN BREAKER ARE ZONE INTERLOCKED (ZI) WITH MSB ASR5-1A MAIN AND GENERATOR BREAKER.
5. STANDBY GENERATOR BREAKER SHALL BE INTERLOCKED WITH THE MAIN BREAKER. BOTH BREAKERS CANNOT BE CLOSED SIMULTANEOUSLY.
6. STANDBY GENERATOR CONNECTION IS SIZED TO FEED THE ENTIRE FACILITY LOAD.

MSB & FEEDER LOAD SCHEDULE

MOTOR TAG NO.	M OR F	PHASE	MOTOR(M) H.P. OR FEEDER(F) kW	F.L.A.	DESCRIPTION
ASR-5 WELL	M	3	800	893	WELL MOTOR/VFD
MCC LOADS	F	3	139	168	FROM MCC SCHEDULE BELOW - INCLUDES LCL
TOTAL CURRENT				1061	
LARGEST MOTOR X .25				223	
FEEDER LCL X .25					
TOTAL CURRENT				1284	
TOTAL kVA				1067	

SUBPANEL OR MCC LOAD SCHEDULE

MOTOR TAG NO.	M OR F	PHASE	MOTOR (M) H.P. OR FEEDER(F) kW	F.L.A.	DESCRIPTION
AC-1	F	3	40.0	48.1	AC UNIT
EH-1	F	3	2.0	2.4	ELECTRIC HEATER
BP-1	M	3	2.0	3.4	COMBINED POTABLE WATER
BP-2	M	3	2.0	3.4	BOOSTER PUMPS FEEDER
FEEDER LOADS					
TX-ASR5-DP1	F	3	30.0	36.1	LTG. TRANSFORMER (208/120V)
TX-ASR5-IP1	F	1	3.0	6.3	INSTRUMENT TRANSFORMER
TOTAL CURRENT				123.5	LARGEST LEG CURRENT
LARGEST MOTOR X .25				0.9	
FEEDER LCL X .25				43.2	
TOTAL CURRENT				167.6	
TOTAL kVA				139.3	

REV	DATE	BY	DESCRIPTION

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED 1/2___1
DRAWN ____
CHECKED ____

UNAUTHORIZED CHANGES & USES CAUTION: The engineer preparing these plans will not be responsible for, or liable for, unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by the preparer of these plans.

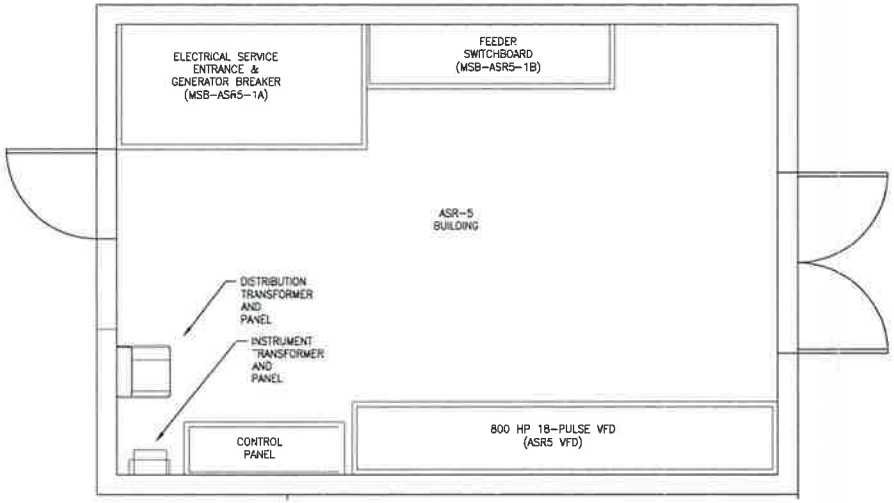
California American Water
511 Forest Lodge Rd, Suite 100
Pacific Grove, Ca 9350
CALIFORNIA AMERICAN WATER

ONE LINE DIAGRAM
FITCH PARK SITE ASR #5
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO. —

E-3

NOTE: CHEMICAL STORAGE & DISPENSING BUILDING AND PIPING NOT SHOWN



ASR #5 BULDING LAYOUT

SCALE: 1/2"=1'-0"

REV	DATE	BY	DESCRIPTION

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED 1/2___1
DRAWN ____
CHECKED ____

UNAUTHORIZED CHANGES & USES CAUTION: The engineer preparing these plans will not be responsible for, or liable for, unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by the preparer of these plans.

California American Water
511 Forest Lodge Rd,
Suite 100
Pacific Grove, Ca 9350

CALIFORNIA AMERICAN WATER

BUILDING ELECTRICAL LAYOUT
FITCH PARK SITE ASR #5
FITCH PARK ASR DESIGN-BUILD PROJECT
CALIFORNIA AMERICAN WATER CO.

PROJECT NO.
-

E-4

Appendix 2

Project Technical Memoranda

Project Facilities Permitting TM: 6-6-17

Process and P&ID TM: 6-8-17

Well Pump Sizing Estimate: 6-2-17

Electrical Service Alternatives TM: 7-27-17

Hypochlorite Dosing Estimate: 9-26-17

Chlorination Design Issues TM: 10-4-17

TECHNICAL MEMORANDUM
Pueblo Water Resources, Inc.
4478 Market St., Suite 705
Ventura, CA 93003

Tel: 805.644.0470
Fax: 805.644.0480

To:	Donald Robert Monette, Project Mgr	Date:	May 12, 2017
Copy to:	Chris Cook, PE, Engineering Mgr.	Project No:	15-0132
From:	Stephen P Tanner, PE		
Subject:	Jurisdiction & Permit Oversight Issues for Fitch Park ASR Facility		

In accordance with our recent discussions, we are providing herein a summary of pertinent permitting and jurisdictional issues we believe will be applicable to the proposed ASR facilities at the Fitch Park site. We acknowledge that this project has numerous overlapping areas of planning, permitting, and implementation, and we want to establish the correct and most efficient plan for moving the project through the various regulatory processes.

The project is envisioned to include the following features:

- Two ASR wells, outfitted with 800 Hp, electric motor driven, lineshaft turbine pumps
- An Electrical / Controls Building of 500-700 square feet (sf) size
- Aboveground and underground piping to convey the produced waters, utility waters and waste discharges off site
- Site grading and drainage improvements
- Paved ingress and egress access from general Jim Moore Blvd

As a potable water production facility, we opine that the facility is exempt from general planning and zoning review processes. The facility design and construction is, however intended to comply with applicable code provisions and design standards for potable water production facilities. The primary project element subject to regulatory oversight is the Electrical/Controls building; the envisioned building features are summarized in Table 1 below.

Table 1 – Fitch Park Electrical Building Features Summary

Building Size (square Feet)	500-700
Construction	Type V-B; Non-combustible CMU and/or reinforced concrete,
Building Occupancy Classification	Utility (Class U)
Interior Plumbing	None
Restroom	None
Building Contents	Electrical Switchgear, motor starter/drives, PLC controls
Windows	None
Interior lighting	Yes
HVAC	Yes, for equipment cooling only
Chemical Storage	None
Equipment/Parts Storage	Yes – (non-hazardous materials / spare parts / maintenance)
Occupancy Status	Unmanned facility, no ongoing personnel duty assignment

The building is proposed to be designed in accordance with the following standards:

- California Building Code (CBC)
- California Electrical Code (CEC)
- California Mechanical Code (CMC)
- CA Title 24 Energy Efficiency Stds.

We opine that the following agencies may be involved in processing permits for the facility:

- Presidio of Monterey: - Fire Department (fire protection and plan review)
  - Building & Safety (building permit)

  - Land Use Permit (building , landscaping, security fencing architectural review)
  - Site Grading / Site Civil Improvements / tree removal

- City of Seaside: General Jim Moore Blvd Encroachment (encroachment permit)
- State Water Resources Control Board: Amendment to Cal-Am Water System Permit

Some of the above-cited permits may involve other agencies, or include multiple agency review; these items should be identified as soon as possible to expedite project implementation.

We hope this summary assists Cal-Am in the advancement of this portion of the project. Please call us if you have questions or desire to meet to discuss these issues.

TECHNICAL MEMORANDUM
Pueblo Water Resources, Inc.
4478 Market St., Suite 705
Ventura, CA 93003
Tel: 805.644.0470
Fax: 805.644.0480

To:	Donald Monette, PE, Project Mgr	Date:	June 6, 2017
Copy to:	Chris Cook, PE, Engineering Mgr.	Project No:	15-0132
From:	Stephen Tanner, PE		
Subject:	Preliminary P&ID for Fitch Park ASR Facility - ***DRAFT***		

In accordance with our recent discussions, we have completed a preliminary Piping and Instrumentation Diagram (P&ID) for the Fitch Park ASR facility. The intent in issuing this drawing early is to allow circulation and review by Cal-Am staff to ensure all have a uniform understanding of the proposed features and functions of the proposed facility and its intended integration into the regional project and the Cal-Am system in general.

As discussed previously, the facility has 4 general operating modes:

1. *Injection/Recharge mode*, which will occur at a design rate of 1,500 gpm for each of the 2 wells (for a facility total of 3,000 gpm, or 4.32 MGD); recharge operation is designed to accommodate single or dual well simultaneous injection. Injection rate is adjustable between 500-1500 gpm via a downhole flow control valve (FCV-501). The anticipated recharge season is 4 months per year on average, which results in an annual/seasonal recharge capacity of 1,590 acre-feet/year (afy).

2. *Production/Recovery* mode, which will be at an instantaneous rate of flow of 3000 gpm for the facility as a whole; this is generally anticipated to occur via the pumping of one of the two wells at a rate of 3,000 gpm (ie 4.32 MGD). If the need arises, the recovery may be accomplished by pumping both wells simultaneously at 1,500 gpm each, although this will result in higher operating costs and other potentially undesirable long term effects if practiced regularly. The head conditions for well pump design have been estimated for a hydraulic grade line (HGL) of approximately 529' at the General Jim Moore (GJM) Blvd transmission line immediately adjacent to the facility based on information obtained from Cal-Am. The resulting pumping condition for each of the pumps has been preliminarily estimated at 3000 gpm @ 792' Total Dynamic Head (TDH) at 81% bowl efficiency, which will require a nominal 800 Hp motor. The design recovery season is 7 months, which results in a seasonal production of approximately 2,780 afy.

3. *Idle or Storage mode*, in which the facility neither injects nor recovers water. This period has a design season of one month, however it could be longer depending upon the availability of recharge water. The only anticipated activity during this period is the possible activation of one or both well pumps for collection of aquifer water quality samples; this would require pumping to waste for 1-4 hours on a designated sample collection day.

4. *Backflushing mode*, which will occur on an approximate weekly basis for each well during active injection periods to flush accumulated particulates and biomass from the well bore area. The preliminary design rate for backflushing is 3,000 gpm; flushing will be implemented in a pump-and-surge mode for 1 to 4 hours as determined by well performance trials after construction. Well backflushing discharges will be conveyed to the percolation pit located at the Santa Margarita ASR facility at 1910 GJM Blvd. Only one well will be backflushed at a time, and typical operations will be to backflush one well while the other is in active injection mode.

The P&ID process and controls presented in Sheet I-1 reflect the above operational modes. The process lines for the production/recovery mode are shown in bold/heavy line, whereas the injection and backflushing (and other non-process lines) are shown in normal line weight. Instrument tags are shown in oval boxes with individual tag numbers for each process element. All items associated with ASR-5 are designated in the 500 series of tags, and ASR-6 elements are designated with 600 series tags; this maintains consistency with the existing ASR facilities, ie ASR-1 elements are designated in the 100 series tags, etc. Standard Instrument Society of America (ISA) nomenclature is used for tag prefixes.

Specific elements shown in the P&ID are identified and discussed briefly below.

P-500 & 600, Well Pump. These are the main well pump assemblies, and will have the following general features: enclosed tube and shaft assemblies with water flush (not oil lubricated) lineshaft, 12" column, 12" suction with check valve (foot valve), Baski downhole flow control valve assembly (FCV-501/601) with manual nitrogen gas control assembly. This will be similar to ASR 1-4 wells.

FT-503/603, Well Pump Lube Line Flow Meter & Alarm. As described above, the well pumps will have enclosed tube & shaft configuration with water flush lubrication. This avoids the numerous problems with oil lubricated well pumps used in ASR operations, while retaining the desirable features of enclosed tube & shaft systems. In order to operate properly, these systems require a minimum of 1.6-2.0 gpm of fresh (potable) water to maintain intermediate shaft bearing lubrication. The flow meters will continually monitor lube water flow, and will alarm and interlock shutdown the well pump if flow drops below setpoint (Interlock I-4). These meters are ½" NPT sized vortex meters with highly sensitive flow capability

and no moving parts that could malfunction. This configuration is identical to the ASR 1-4 wells. Lube water supply originates from the Cal-Am system via a 1" service line connected directly to the main transmission line in GJM Blvd. This water is filtered via a cartridge filter (F-500/600) to prevent any pipe scale or debris from entering the shaft lube assembly, which could impair shaft lube flow.

VFD 501& 601, Variable Frequency Drive units to feed the P-500/600 motors. To maintain consistency, these will be Allen Bradley / Rockwell Automation units with identical features to the ASR-1-4 units. The VFD's will be NEMA 1 type, housed in an environmentally controlled building on the ASR-6 site. The units will have Hand-Off-Auto control features, plus Local/Remote actuation from the VFD unit itself (HS 500A/600A) or from the Local Control Panel (LCP) located at each well (HS501/601); this will allow the operator to start/stop the well from the immediate proximity of the well (for backflushing operations) or via the Electrical/Control Building, or via SCADA. The VFD will allow variability of flow and head conditions to address the various operating modes described above, and to compensate for well performance loss due to well plugging and/or aquifer water level declines.

PRV 502/602, Injection Pressure Reducing Valve. Pressure control will be needed to maintain a constant injection pressure under the variable system pressures (vis a vis variable system demands) encountered in the Cal-Am system. The valves will be Clavalve 131 Series externally modulating valves tied to a Clavalve control module located at each well head; this system will allow local and remote adjustment of injection pressure according to a SCADA or manually input setpoint. This operation will be different than the ASR 1-4 wells, which have Clavalve 90-03 Series self modulating pressure control valves with solenoid override to close and manual setpoint adjustment features. The change is envisioned to allow greater flexibility in setpoint adjustment , particularly via SCADA – which is not possible at the other wells. This feature is only applicable to the Injection/Recharge mode of operation.

PSV-505/605, Well Flush-to-Waste Valve. This valve allows discharges from the well, or from the Cal-Am distribution system to be flushed to the percolation pit at the Santa Margarita site; it will be a Clavalve 50-03 Series valve with pressure relief and solenoid override to open (flush) functions. The pressure relief feature will serve as a safety to pipeline overpressure from surge or loss of control, and is manually adjusted to setpoint. The solenoid override feature will act as an Open/Shut valve for initial pump-to-waste operations during well production, and as the flush valve in well backflushing operations. The valve can be actuated via SCADA, the local PLC panel, or the individual Local Control Panels at each well. This configuration is identical to those at ASR 1-4.

FQIT 501/601, Flow Meter. The main flow meter for injection and recovery operations is a bidirectional rate and bidirectional totalizing meter; to maintain

consistency with the ASR 1-4 sites the meters will be Sparling Tigermag EP meters with local readout and transmitting functions. The output from the meter will be used to monitor and adjust injection flow rate setpoint and as a feedback signal to the well pump VFD's in Recovery and Backflush modes. Flow readout will be visible at the meter/well head, at the facility PLC HMI panel, and via SCADA.

LT-501/601, Downhole Water Level Transducer. This transducer will be located within the well casing at approximately the top of pump bowls. It will transmit water level in the well casing in all operational modes. The display information will be visible at the facility PLC HMI panel, and via SCADA, and will be used in the production mode as a permissible signal to allow the well pump to start, as a shutdown signal if the pumping water level drops to within 5 feet (adjustable) of the pump bowls during production and backflushing (Interlock I-1), and in the injection mode to alarm if excessive well draw-up occurs due to well plugging.

FQI-505/605, Flush to Waste Flow Meter. ASR operations require flushing to waste under various scenarios; when in the injection mode, initial injection water from the distribution system must be flushed from the lines to remove scale, debris, and stagnant water from entering the well. Once injection operations are in progress, the well must be shut down periodically and pumped to waste to remove accumulated particulate matter and biomass resulting from recharge operations. When in the Recovery mode, initial well flushing is necessary to purge the well of stagnant water and debris originating from flow velocity surges in the well casing. In all of these modes, the waste flow is discharged to the Santa Margarita percolation pit, and the flow rate and total discharge is indicated via the FQI-500 flow meter. This meter is a conventional in-line propeller meter with dial readout of rate and totalizer parameters. It is not a transmitting meter, as Cal-Am operators should be present at all time when flushing operations occur; this configuration is identical to the ASR 1-4 wells.

DP-100, Percolation Pit (Located off-site at the Santa Margarita ASR facility). The percolation pit serves as the terminus of all flush waters from all ASR facilities, as neither the Middle School (ASR 3 & 4) nor the Fitch Park (ASR 5 & 6) sites have waste disposal capabilities. The current (2016) capacity of the pit is approximately 245,000 gallons; however it is planned for expansion to 465,000 gallons in 2018. The pit accepts water from the various wells via air gap piping which dumps into an energy dissipater column. Water level is monitored via LT-101, which communicates to the Fitch Park PLC via SCADA; an interlock (I-3) will close the automated flush valves (PSV-500/600) in the event of a high water level.

PLC-600, Fitch Park facility PLC. The facility PLC will closely resemble those at the Santa Margarita and Middle School sites, and will control the local equipment at the facility only (the existing PLC's at other sites are Allen Bradley Micro Logix units, model 1769 Compact Logix 1500). The P&ID shows the layering of local vs PLC vs

SCADA hierarchy for the facility. Because the facility is spatially spread out and on two separate parcels, Local Control Panels (LCP's) will be located near the well head on each parcel. The LCP will have essential control functions to allow the operator to start, stop, or adjust functions for that proximate well; these functions include the following:

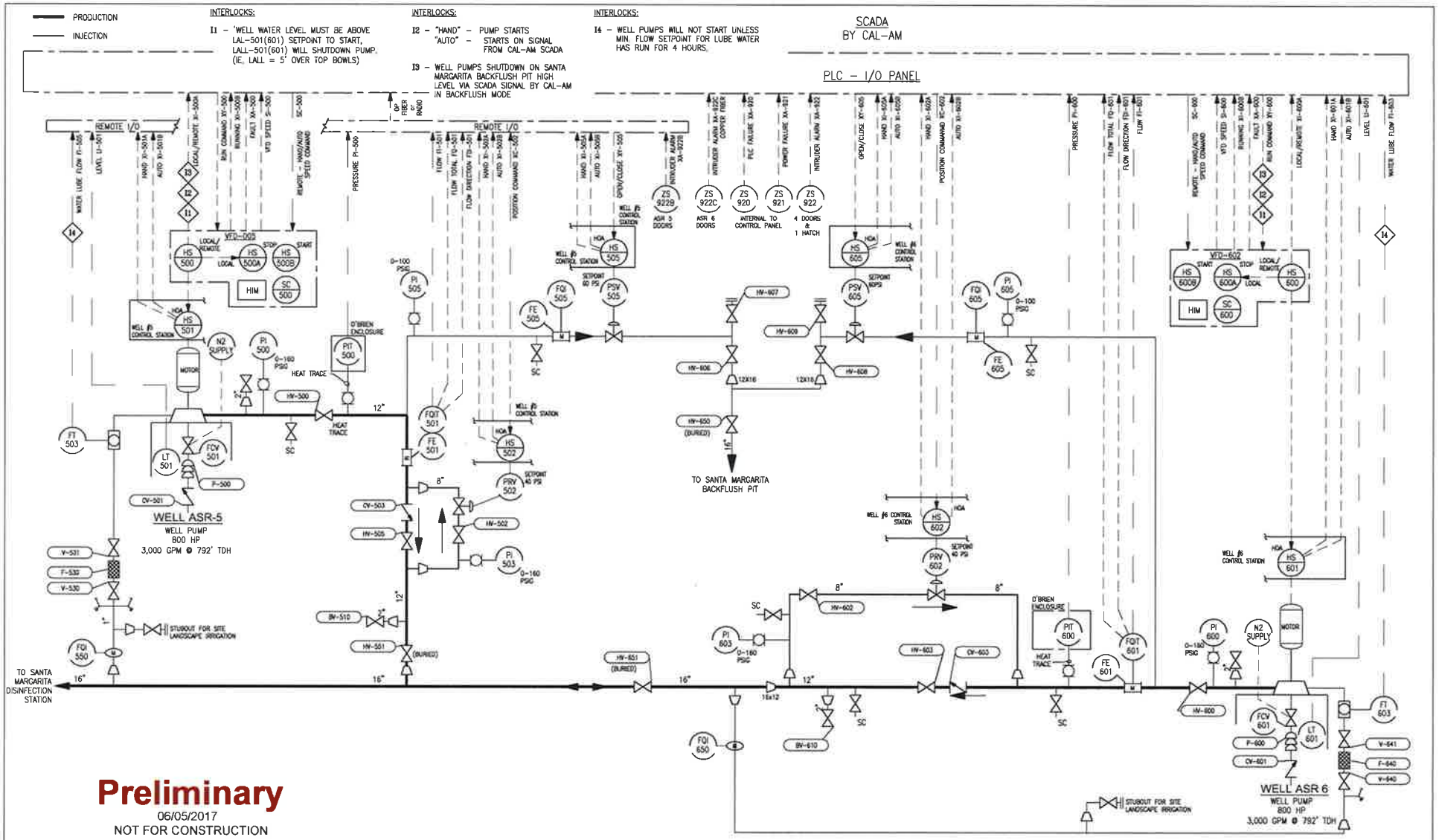
- Start and stop the well pump (P-500/600) (Note that flow rate will only be adjustable at the facility PLC HMI, not at the LCP's)
- Start, stop and adjust injection flow rate (PRV-502/602)
- Open and close the flush to waste valve (PSV-505/605)

Additional notes in review of the P&ID include the following:

There is currently no Turbidity monitoring of the well production, nor the injection flow; if desired, these can be added as a protection against off-spec water entering the well or the distribution system.

The LCP stations could include additional features, such as speed (flow) adjustment of the well pumps, readout of well casing water level, or readout of the Santa Margarita percolation pit water level; input on these issues is welcomed.

The design currently assumes that the GJM main line will always be 'live' and have a pressure commensurate with the proposed 529' HGL; if the use of the Terminal Storage Reservoir is reinstituted and the production/recovery mode returns to a 355' HGL (approximation), then line pressure will be inadequate to supply water to the well lube system, and a Utility Booster Station will need to be added to the facility. This is the existing condition at the Middle School ASR facility.



REV	DATE	BY	DESCRIPTION
B	8/5/17	SPT	PRELIMINARY DESIGN
A	4/17/17	RLK	PRELIMINARY DESIGN

SCALE:
HOR. 1"=XX
VER. 1"=XX

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED RLK
DRAWN WNS
CHECKED RLK

KIYOI ENGINEERING INC.
5366 Hollister Avenue #117
Santa Barbara, CA 93111
Phone: (805) 681-0980

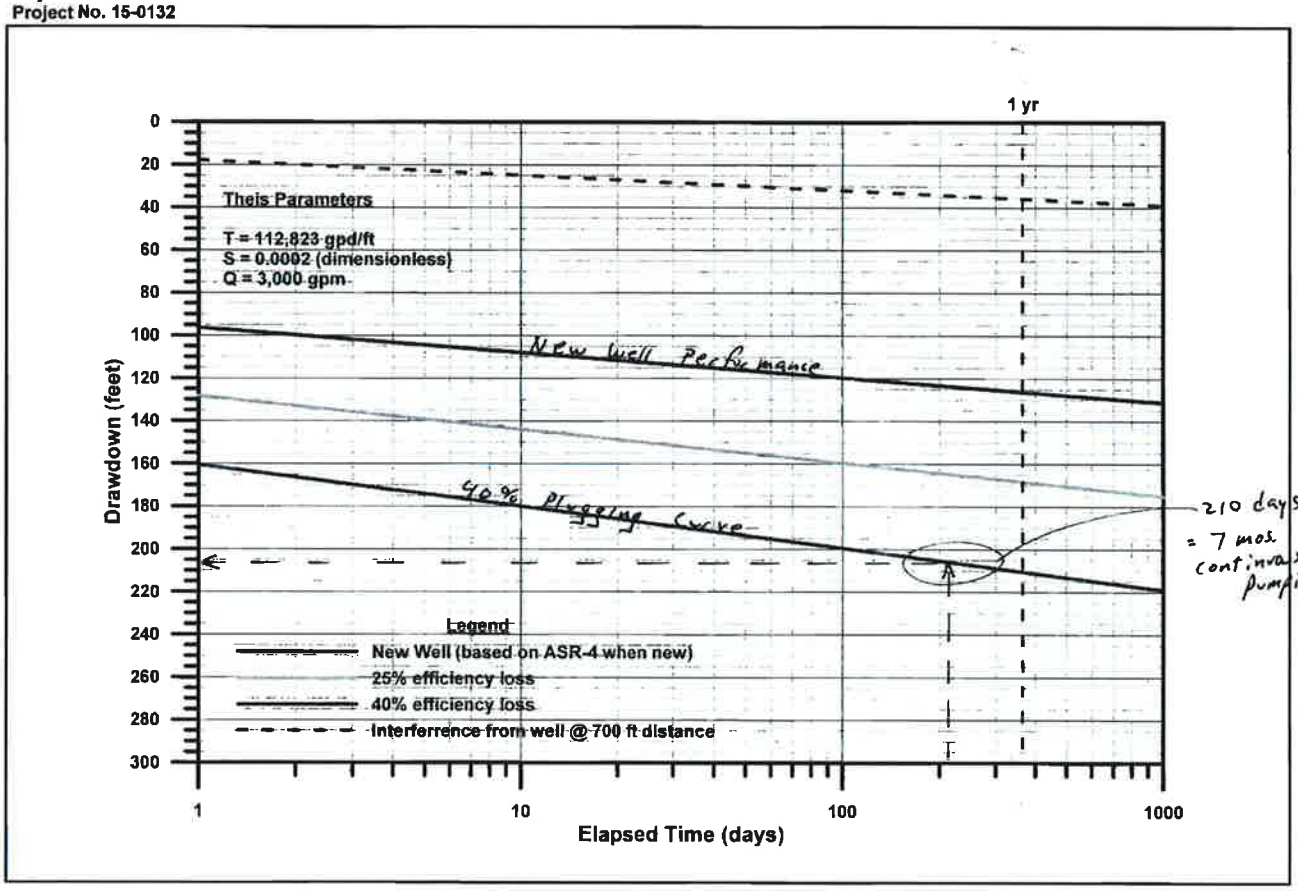
PIPING AND INSTRUMENT DIAGRAM

CALIFORNIA AMERICAN WATER CO.
FITCH PARK SITE ASR 5 & 6 PROJECT

PROJECT NO. 20016

I-1

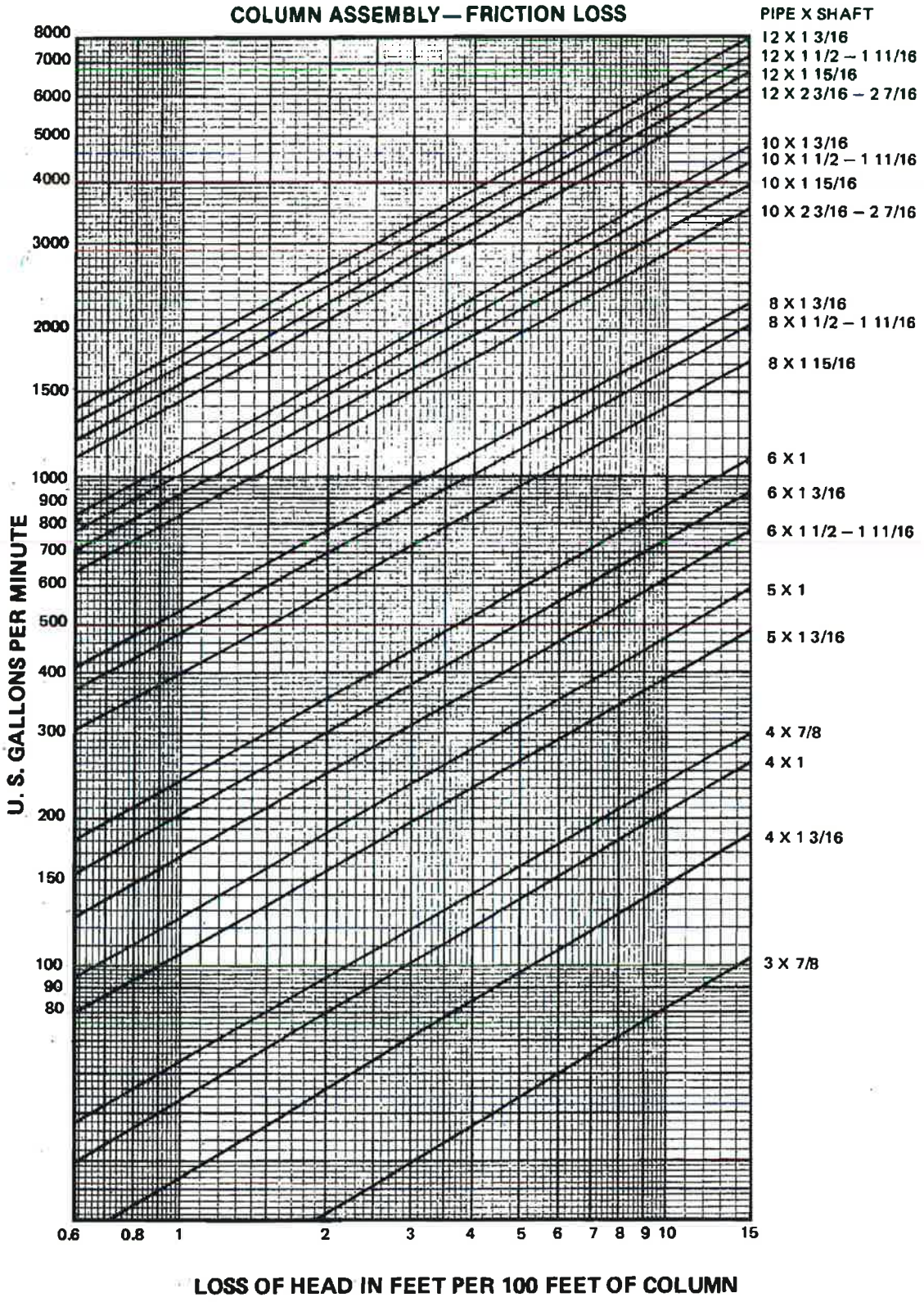
May 2017
Project No. 15-0132



PUEBLO water resources

FIGURE 1. THEIS-PREDICTED DRAWDOWN
Fitch Park ASR Facility Project
California American Water

COLUMN SELECTION CHART



TECHNICAL MEMORANDUM

Pueblo Water Resources, Inc.
4478 Market St., Suite 705
Ventura, CA 93003
Tel: 805.644.0470
Fax: 805.644.0480

To:	Donald Monette, PE, Project Mgr	Date:	July 27, 2017
Copy to:	Chris Cook, PE, Engineering Mgr.	Project No:	15-0132
From:	Stephen Tanner, PE		
Subject:	Fitch Park Facility: Electrical Service and Electrical Building Issues - ***DRAFT***		

As you know, recent discussions have taken place regarding the provision of electrical service to the Fitch Park site from the local electricity provider, Pacific Gas and Electric (PG&E). During the conference call of July 7 with yourself and Messrs. Karl Landis, Bob Kiyoi, Jesus Sanchez , and myself, it was decided that a low voltage service (480 volt, 3 phase) was best suited for the project, mainly due to the need for (portable) standby electrical generator service in the event of emergency (other factors also favored the decision, but this was considered a critical issue). With the low voltage service issue resolved, we performed voltage drop and current capacity calculations to serve the two wells; these calculations addressed two scenarios, (1) a single service drop from PG&E with private (ie Cal-Am) feed of power to both wells sites, and (2) provision of PG&E service at each of the two sites, with separate meter/main and switchgear equipment at each site. Option 2 would necessarily require an electrical building at each site to house this equipment; however, the buildings would be smaller than that which would be required with a single, central electrical building.

As you also recall, we sent a technical memorandum on June 8, 2017 regarding the historical configuration of the Fitch Park ASAR facility, which included a utility and transit corridor between the two well sites. With the current facility configuration having eliminated this direct utility piping corridor, all piping and electrical is now required to traverse the General Jim Moore Blvd right-of-way and then proceed easterly to the well sites; this adds several hundred feet to the electrical power feeds, which was addressed in the voltage drop analysis.

In the assessment of the single vs two electrical service alternatives, we evaluated the electrical, logistical and cost factors associated with each option. The table below summarizes the cost factors for each alternative – and as presented, the costs of each option are nearly the same, with the two-service alternative being approximately $50,000 less. The primary reason for this is that the cost of electrical cable and conduits for the VFD feeds to each well is exceptionally high,

and because of the distances involved and the associated impedance issues there must be adequate separation of the lines for proper operation.

Table 1 – Reconnaissance Level Cost Comparison:

Central vs Separate PG&E Service for Fitch Park ASR Facility

Item	Single Service Cost	Separate Services Cost	Comments
Building, complete in place	$300,000	$396,000	1 @ 500sf vs 2 @ 330sf ea @ $600/sf
Meter/Main & Switchgear	$179,000	$225,000	
VFD Cable – Single Service	$71,000	--	2895 Ft. @ 777 kcmil/phase shielded VFD cable
VFD Cable – Two Services	--	$12,000	500 Ft. @ 777 kcmil/phase shielded VFD cable
4-inch Conduits	$163,000	$29,000	500 Ft vs 2895 Ft + pullboxes, etc.
Total Estimated Cost	**$713,000**	**$662,000**	

The electrical and logistical issues associated with the alternatives include the following:

1. The voltage drop and current capacity of conductors with the associated energy losses are lower with the two service option; in the event of PG&E voltage dips or brown-out conditions, these factors would be exacerbated with a single, central service at one site.

2. With respect to facility reliability and redundancy, the two-service option is clearly superior. If any element of one site failed, whether it be fuses, transformers, air conditioning, or PLC; the other site would not be affected and would remain in service. In addition, the ability to acquire a portable generator will be much more feasible, as the power requirement is more commonly available in generator capacity.

3. Having process lines within GJM Blvd is less desirable from a maintenance standpoint for the obvious reasons of operator safety and logistical complications of traffic control when maintenance activities are required.

Because of the above issues, we recommend that Cal-Am pursue the two-service alternative for the Fitch Park facility. We will proceed with the two-service design with PG&E upon your concurrence with this recommendation.

Subject: Assess Chlorination Station @ Fitch Park

Project: Fitch Park / ASR 5 & 6 Site Development

Client: Cal-Am / Monterey Div.

Project No.: 15-0132 By: S. Tu Date: 9.26-17 Sheet No.: 1 of 1

PUEBLO water resources

Basis: - Chlorination for ASR 5 & 6 only
- Prod. Capacity of 3000 gpm (4.3 MGD) from each well
- Design Case: 1 well @ 4.3 MGD Max. Case: 2 wells @ 4.3 MGD
- Facility Basis: 30 days of chem storage w/ 24/7 operation, plus 3 days.

Dose Basis:

Total Feed = Residual + Demand, = 1.5 mg/L Resid. + 0.75 mg/L Demand

* Both Resid. & Demand are assumed! Actual demand will not be avail. until wells are constructed & tested. Cl demand factors are:

* Fe: 0.67 mg/mg Mn: 1.4 mg/mg H_2S: 9-10 mg/mg oxidation w/ HOCl

Dose Est. (from above) using C = DW (#/day)

Design: (4.3 MGD)(8.34 #/gal)(2.25 mg/L) = 81 #/day Cl_2

Max Case: (2)(4.3 MGD)(8.34 #/gal)(2.25 mg/L) = 161 #/day Cl_2 = Max demand/day

* If 12.5 % HOCl is used, then dosing is

Design: $\frac{81}{.125}$ = 648 #/d HOCl, @ 10#/gal, or $\frac{648}{10} \approx$ 65 gal/day

Max Case: $\frac{161}{.125}$ = 1291 #/d HOCl, @ 10#/gal, or $\frac{1291}{10} \approx$ 129 gal/day max feed

Storage Basis:

30 days storage + 3 days buffer, ∴ 33 days vol in main tank

∴ 33 days @ 65 gpd = 2,145 gal design

and 33 " @ 129 gpd = 4,257 gal max case

* ∴ Tanker Truck delivery needed, assume WB-50 type vehicle

* ∴ Storage Tank for 12.5% HOCl ≈ 4,000 - 4500 gal cap., ≈ 10'ø x 10'H (Polypropylene Const.)

TECHNICAL MEMORANDUM
Pueblo Water Resources, Inc.
4478 Market St., Suite 705
Ventura, CA 93003

Tel: 805.644.0470
Fax: 805.644.0480

To:	Donald Robert Monette, Project Mgr	Date:	October 4, 2017
Copy to:	Chris Cook, PE, Engineering Mgr.	Project No:	15-0132
From:	Stephen P Tanner, PE		
Subject:	Chemical Storage and Dispensing Issues for Fitch Park ASR Facility ****DRAFT****		

In accordance with your recent request, we are providing herein a summary of pertinent design, permitting, and logistical issues we believe will be applicable to the addition of a Chlorination Station at the proposed ASR facilities at the Fitch Park site. We provide this summary as an initial list of pertinent issues to assess the regulatory and logistical applicability of this type of facility; further investigation and confirmation of these areas will be needed as the concept moves forward.

BACKGROUND

The Fitch Park ASR Facility as originally proposed included two ASR wells with associated piping, electrical, and instrumentation to allow injection of up to 3000 gpm (4.3 MGD) of treated potable water from the Carmel River watershed and/or the proposed Desalination facility. The facility design also provided for recovery of these waters (plus stored water from the proposed Pure Water Monterey recycled water facility) of 4.3 MGD with the capability of 8.6 MGD (ie simultaneous recovery from both wells) if needed.

State and Federal regulations require the disinfection of these waters upon recovery and conveyance to the potable water distribution system; this disinfection process was originally envisioned to occur at the Santa Margarita ASR Facility located approximately 1 mile south at 1910 General Jim Moore Blvd. This was to serve as the central disinfection point for all recovered ASR waters as it was the most southerly facility in the conceptualized ASR well field.

Since its original planning, other factors have raised the question regarding the feasibility of having an independent Chlorination Station at the Fitch Park facility.

PRIMARY CONSIDERATIONS

Disinfection at the Fitch Park ASR facility will need to address several basic needs for a facility of this type. These include the following:

1- Cal-Am has standardized on the use of 12.5% Sodium Hypochlorite solution (NaOCl) for its disinfection facilities in Monterey, due to its ease of transport and application, cost, and superior safety considerations (compared to Chlorine gas). It is similarly an appropriate choice of disinfectant for the Fitch Park facility.

2- At the Design and Maximum Case production rates, the facility would need a storage volume of approximately 4,000 gallons of 12.5% Sodium Hypochlorite solution for a recommended 30-day supply of chemical. *(Note that the 4,000 gallon storage volume is based on a max production case of 8.6 MGD, having a Free Chlorine Residual of 1.5 mg/L and an assumed Chlorine Demand of 0.75 mg/L. These base numbers may vary significantly (higher) depending on the actual water quality found at the ASR-5 & 6 wells, which will not be constructed until 2018.)*

3- Because of the close proximity of ASR-5 and ASR-6 at the site, it would be both logistically and economically preferable to have only one disinfection station serving both wells. Because produced waters from the facility will always flow to the South for conveyance to the Cal-Am system, it is more desirable to have the disinfection point at the more southerly site, ASR-5. (Coincidently, this is also the only one of the two sites with adequate space and vehicular access to accommodate these facilities.)

4- The quantity of chemical needed to supply the facility is too large for individual 55 gallon drums or 275 gallon tote bins to be used; delivery via bulk tanker truck shipment will be needed to supply the facility. Because of this, the facility will need to be sized and designed to accommodate tanker truck deliveries and off-loading of chemicals.

5- Although Government Code Section 53091 states that facilities for the storage and treatment of water are exempt from building and zoning ordinances, it is unclear if this applies to properties under the jurisdiction of POM; this should be investigated. Similarly, it should be verified that any CC&R's for the Fitch Park development do not preclude the storage and dispensing of chemicals.

DESIGN CONSIDERATIONS

The following items will need to be addressed in design of the proposed facilities:

- Provision for adequate ingress/egress for 18-wheel semi trailer tanker delivery trucks (WB-50 vehicle configuration or similar). A suitably sized

chemical off-loading pad will be needed as well, with inclusion of chemical spill containment.

- Double containment for bulk chemical storage tanks and piping.
- Dual/redundant chemical injection quills for injection of hypochlorite into produced water lines.
- Chlorine Residual Analyzer instrumentation, including monitoring, recording, and feedback/control loop provisions as needed.
- Separately enclosed chemical storage room/building, of UBC H-7 classification; non-flammable construction, temperature controlled environment (60°-80° F), with no direct accessibility to electrical or pump rooms.
- Storage tank(s), day tank(s), transfer pump(s), and metering pump(s)
- Chemically compatible materials of construction for the building, electrical, and piping components of the facility.
- Ventilation and vent scrubbing to control off-gassing of Chlorine gas from solution.
- Provision of chemical spill control equipment, safety showers and eyewash stations, and appropriate personal protection equipment (PPE) for Sodium Hypochlorite solution.

OTHER CONSIDERATIONS

In addition to the above design and logistical considerations, if the Fitch Park ASR Facility will include chlorination capability, it may be prudent to consider the inclusion of *dechlorination* capability as well. The need for dechlorination of waters occurs periodically in many water systems, and current investigation of water quality issues for ASR operations may result in the recommendation of dechlorination of all waters injected into the Seaside Basin to mitigate undesirable water quality interactions with minerals within the Santa Margarita Sandstone (Tsm) formation. The addition of dechlorination equipment would be relatively straightforward if chlorination capabilities already exist at the site.

Appendix 3

Cal Am Electrical Standards

3.1: Recommended Electrical Design Criteria and Standards

3.2: Power System Study and Arc Flash Analysis Requirements
Version Date: July 2017

3.3: Acceptable Electrical Equipment Manufacturers and Suppliers

3.4 SEL Device Monitoring Points (Modbus to SCADA (RTU)

AMERICAN WATER

RECOMMENDED ELECTRICAL DESIGN CRITERIA AND STANDARDS

AMERICAN WATER BUSINESS SERVICES ENGINEERING

March 27, 2018

AMERICAN WATER ENGINEERING
RECOMMENDED ELECTRICAL DESIGN CRITERIA AND STANDARDS

INTRODUCTION

Design of safe, reliable, and cost effective electrical power distribution systems is an essential aspect of the design of water and wastewater pumping, storage, and treatment facilities. Safety begins with proper sizing, coordination, selection, and installation of appropriate materials and power system components, all of which are critical to minimize the risk of worker injury and equipment damage from electrical hazards. Reliability is also tied to proper design and equipment selection because power system components are subject to unique thermal, magnetic, and vibration forces on an often continuous basis. Cost-effectiveness is impacted by numerous design decisions, including equipment location/layout, operating voltage, equipment specifications, design safety factors, environment, etc.

The purpose of this standard is to provide recommendations for electrical system design criteria and standards that American Water Engineering has found to be effective for maximizing value by assuring safe, reliable, and cost-effective electrical power system installations. None of the recommendations included herein shall be construed as superseding local building code requirements, and all facility designs and installations must fully comply with current electrical and building code requirements applicable to the project. In addition, it is the responsibility of the designer to develop a fully integrated and complete set of design plans and specifications based to the degree possible on these design recommendations.

Included with this guidance document are the following three attachments:

1. Attachment A – Power System Studies & Arc Flash Hazard Analysis Requirements. Provides detailed requirements for performing electrical coordination analysis and arc flash hazard assessments. These requirements are considered essential for a complete, coordinated design and should be included as part of a consultant's design scope of services.

2. Attachment B – Acceptable Electrical Equipment Manufacturers List. Identifies acceptable manufacturers for electrical equipment and systems. This listing is to be reviewed with the Owner prior to implementing the design in order to establish preferred sourcing of equipment and suppliers based on Owner preference, service/support and availability. The list is not intended to establish an order of preference; only manufacturers who have demonstrated capability to provide materials and quality of construction for the intended installations and applications. Other sources may be considered if accepted by the Owner in advance of the Design Memorandum submission. Any revisions are to be documented in writing with this submission.

3. Attachment C - SEL Device Monitoring Points (Modbus to SCADA /RTU): Identifies typical data acquired from the various SEL metering and protective relay devices provided on AW Projects. This list is not intended to capture all data that may be necessary nor is intended to limit the actual devices provided.

POWER DISTRIBUTION AND ARC FLASH HAZARD CONSIDERATIONS

Arc flash hazard evaluations have continually shown that the incoming (line-side) terminations on 277/480 VAC and/or 480 VAC services pose significant risk due to high incident energy levels. Frequently, incident energy at the incoming service exceeds 40 cal/cm2, or PPE-4 level of protective equipment. To address this issue, AW recommends installing the incoming main service disconnect

device in a separate enclosure, and then sub-feeding from this over-current protection device (OCPD) to a main lug panel or distribution assembly. While this may still pose the risks at this service-entrance location, it is intended that the design and selection of the main device will lower the incident energy associated with the downstream equipment to a level below the PPE-4 maximum protective equipment available for any energized work required.

AW recommends only circuit breakers (no fusible switch equipment) be used for this main service over-current protection device. This allows the operator to "reset" the main in the event of a "trip" incident without having to "open" the equipment (to check fuses, etc.). This "main" should also be provided with the metering input components and devices as outlined herein under item #12 – "Power Monitoring/Metering and Protective Relaying" where this metering is desired by the Owner.

For those facilities where it is intended to also provide permanent or portable standby generator power, the following recommendations should be considered.

1. On 120/208-240 VAC power systems, AW recommends considering the use of circuit breaker transfer equipment in lieu of the individually-mounted "main" circuit breaker and contactor-based transfer equipment (e.g., typical Asco transfer switch). Benefits include combined (but shielded) circuit breakers for the utility and generator protection, UL service-entrance listed as well as UL-1008 listed/labeled for automatic transfer switch (ATS) applications and non-automatic operation associated with portable generator installations. AW has developed a configuration including standard and "optional" features associated with this equipment. The potential for high Incident Energy levels above 40 cal/cm2 and resulting PPE in these low voltage installations typically does not exceed the PPE available to workers and contractors; the 277/480 VAC Systems are where the highest concerns regarding Incident Energy and "Danger – No Safe PPE Exists" equipment labeling have thus far been determined.

   Overall, this circuit breaker type ATS equipment typically represents a lower cost and requires less physical space within the facility providing a cost-effective solution where appropriate and where provided. For those facilities and service areas where contactor-based ATS equipment is already in service, the Owner may elect to continue to provide this type of equipment. However, the features and functions outlined as needed for OCP and Arc Flash Hazard isolation and protection shall be met.

2. On our 277/480 VAC Systems it is recommended to use the separately enclosed "Main" Circuit Breaker to isolate the Utility from the rest of the power distribution system. The use of contactor based ATS equipment requires the use of this separate "Main" as well as an additional "generator circuit breaker" for those applications involving portable generator connections. Additionally, and as a minimum, a shunt-trip interface (i.e. E-Stop control station) shall be provided at the Automatic Transfer Switch (ATS) for disconnection of power associated with any permanently installed generator.

3. Portable standby generator installations offer unique challenges. Many of our portable generators are over-sized for the smaller stations they serve. As such, the OCPD on the generator will typically be larger than the service equipment ampacity ratings in the facility. This is the reason for the "generator circuit breaker" recommended above. Without this additional device, the station equipment is not adequately protected against an over-current event. The shunt-trip device mentioned previously is necessary to "trip" the circuit breaker on the permanently installed generator in order to isolate this power from the building system in the event of an emergency (fire or similar event). The use of the circuit breaker type ATS equipment addresses this concern and is part of the reason AW recommends consideration of this type equipment.

Connection of portable generators is another area which is to be carefully considered. The use of portable generators with large cables and connector bodies poses risks during the installation and connection of these devices to the station. To address this, AW recommends using a color coded pin and sleeve type connector assembly similar to Trystar's Generator Docking Station (complete with cam-lock connections and generator cabling color coded for voltage rating) for those installations 200 Amperes and larger in lieu of the three-phase connector plug and receptacle method. This allows easier and safer connectivity of the equipment by operational staff during an event. In locations where portable generators may be connected for extended periods of time, the transfer switch's control conductors are to be wired to a twist-lock style two-pole grounding receptacle locally mounted near the generator's connector assembly. This will allow the portable unit with remote starting capability to auto-start upon loss of power. Also, where environmental conditions warrant, provide a separate receptacle of suitable voltage and rating for connection of the generator's battery charger and water jacket heater.

TECHNICAL CRITERIA AND DESIGN STANDARDS

1. Basic Electrical Materials and Raceways

a. All materials shall be suitable for the location and environment where installed. Specifically, AW Engineering has identified the following areas/environments as not being compatible with Stainless Steel (SS) enclosures and supports.
    1) Chlorine and chlorinous vapors
    2) Fluosilicic acid and vapors
    3) Orthophosphate and vapors (zinc orthophosphate, phosphoric acid)
    4) Other potential areas and compatibility of materials are to be reviewed with the Owner for final selection of installed systems

b. Control panels and related enclosures in corrosive areas shall generally be non-metallic type with non-metallic hardware; NEMA 12 metallic or non-metallic in non-corrosive areas unless otherwise accepted. The use of stainless steel enclosures should be limited to areas not exposed to chlorine fluoride fumes. Provide NEMA 4X non-metallic enclosures in these and other corrosive areas. It is acceptable to install NEMA 3R enclosures outdoors where the area of installation does not include corrosive atmosphere. VFDs are not recommended to be installed in NEMA 4X enclosures due to issues with localized heating within the enclosure. These enclosures do not have the ability to ventilate using outside air, which potentially overheats the enclosure where a VFD would be installed. It is recommended to install VFDs in NEMA 3R enclosures when installed outdoors and only installed in NEMA 1 or NEMA 12 enclosures when installed indoors in non-corrosive areas. For VFDs installed in corrosive areas indoors, a NEMA 4X enclosure would need to be evaluated to determine if a local mounted AC unit to cool the enclosure is required.

c. All feeders (and branch circuits rated 100 amps and larger) shall be provided in rigid hot-dipped galvanized steel (RGS) or aluminum conduit. The use of fiberglass conduit is an acceptable alternative where approved by the Owner. Other building areas to utilize raceway materials as outlined herein (see 2 below) unless otherwise indicated. Exposed exterior locations may utilize hot-dipped RGS or aluminum conduit where determined suitable for the application. Additionally, the use of fiberglass conduit is acceptable where determined to be suitable for the location and application. The use of intermediate metal conduit (IMC) is prohibited anywhere on the project. The use of electro-metallic tubing (EMT) is prohibited on any Industrial Buildings and Related Type Areas as outlined below.

d. All conduit fittings to utilize gasketed screw covers; clip cover fastening type fittings are prohibited. Provide "Myers hub" type connectors associated with exterior and wet location enclosures.

e. Where served from overhead or above, raceway penetrations into buried or below grade equipment / enclosures and exposed exterior equipment enclosures shall not enter the top; they shall enter the bottom side and be provided with a means for draining moisture from the raceway and sealed between the raceway and the enclosure with duct-seal material. These enclosures shall be provided with a vapor corrosion inhibitor (Cortec, or equivalent) sized appropriately for the interior volume of the cabinet.

f. Receptacles and switches to be heavy-duty rated, 20 ampere minimum rated; material type and configuration to be suitable for the application.

g. Control Station devices should be NEMA 12 minimum; NEMA 4X rated in corrosive and damp locations where available; all devices to be 30 mm minimum size for gloved operation. All pilot lights are to be high intensity 120 VAC LED type; red for "run", green for 'off" ", amber for "alarm", and white for general indication. Other colors to be coordinated with the Water Company to match existing conventions or as requested; generally in accordance with NFPA-79, Table 10.3.2.

2. Raceway Material and General Applications

a. GENERAL NOTE:

1) Raceways are not permitted to be installed concealed in water-bearing walls. All equipment, devices and raceways shall be installed on the dry-side wall surface using nominal 7/8" non-metallic channel support stand-offs installed vertically to allow ventilation air to pass behind equipment and raceways. Fastening hardware to be 316 Stainless Steel or other accepted materials where required due to the environmental conditions of the area

2) No raceway is permitted to penetrate the floor or wall into the containment area of a chemical room. Note: final connections and raceway installations serving equipment located within this containment zone shall be supplied from outlets and equipment enclosures mounted above the maximum containment level identified. All penetrations, outlets, and equipment are to be located above the containment zone in the room. This prevents a failure of the raceway system from potentially becoming a "drain".

The following general criteria are to be used for raceway material selection and installations. This listing is not intended to address all applications and/or specific equipment requirements which may be outlined elsewhere on the Engineer's Drawings or indicated in the Specifications.

b. Industrial Buildings and Related Type Facilities or Areas:

1) Chemical Storage and Dispensing (non-hazardous materials)

i. Exposed from Finished Floor to 8"-0" AFF

a. PVC Coated rigid galvanized steel (RGS) Conduit and Liquidtight Flexible Metal Conduit are recommended. PVC Schedule 40 Conduit and Non-Metallic Liquid-tight Flexible raceways may be used in areas where not subject to physical damage from O&M activities such as chemical deliveries or vehicular traffic.

i. Alternate Materials: the selective use of fiberglass conduit provides another means of addressing corrosion resistance and maintaining a non-metallic installation. [Note: AW Engineering does not recommend the use of PVC conduit, even Schedule 80 PVC where subject to physical damage

b. Outlet and Junction Boxes - PVC Coated, Cast Type, FD capacity for use with the PVC Coated RS Conduit. As above, where non-metallic raceways are utilized, the use of non-metallic outlet and junction boxes may be provided.
c. All outlet cover plates to be "in-use", weather-protected type and gasketed.

ii. Exposed 8'-0" AFF and above within the room

a. PVC Schedule 40 Conduit may be used in lieu of PVC Coated RS Raceways. Where provided, the Contractor shall include the use of expansion and axial connectors as recommended by the non-metallic raceway Manufacturer (not just at building expansion points).
b. Junction Boxes - PVC, FD capacity for use with the PVC Conduit System.

iii. *NOTE: No "in-floor" conduit or floor penetrations are permitted within chemical containment areas.*

iv. As above, the use of fiberglass conduit systems is permitted to be used in place of the PVC Coated RGS raceways and PVC Schedule 40 Conduit hybrid systems outlined above as well as other locations throughout the facility. As above, no penetrations within the chemical containment areas are permitted.

Engineers NOTE - Potentially, a listing or some other form for identifying which chemicals / areas require the use of seal-offs will need to be determined and included in the Contract Documents (below)

v. Transitions from Chemical Storage and Dispensing Areas to other building areas shall utilize PVC Coated RS Conduit within the area and transition to RGS material where extending to a non-chemical area. Provide seal-off fittings and appropriate sealing material (as specified) to prevent vapor transmission through the raceway system at this transition point inside the chemical area.

2) "Damp" Areas, including those areas involving enclosed tanks and piping, but do not involve direct wash-down or similar use of water, and where the ambient temperature of the space may drop below 65 degrees F.

i. Rigid Galvanized Steel (RGS) Conduit and fittings.
ii. Liquidtight Flexible Metal Conduit.
iii. Exposed outlets - Cast Type, FD capacity.
iv. Recessed Outlets (where permitted) - one-piece galvanized steel (expandable metal outlets not permitted).
v. Cover plates – stainless steel or cast cover type or as specified and/or indicated on the Drawings.

3) "Wet" Areas, including those areas involving exposed/open tanks and direct wash-down and similar applications, where water is routinely present.

i. Rigid Galvanized Steel (RGS) Conduit and fittings or PVC Coated RGS Conduit and PVC Coated fittings as indicated on the Drawings.

ii. Liquidtight Flexible Metal Conduit.
iii. Exposed outlets - Cast Type, FD capacity (PVC Coated where coated raceway systems are indicated on the Drawings.
iv. Recessed Outlets (where permitted) - one-piece galvanized steel (expandable metal outlets not permitted).
v. All outlet device cover plates to be "in-use", weather-protected and gasketed type.

Engineers Note - "Damp" and "Wet" terms will need to be defined and included in the Contract Documents.

Owner's Note – AWBSE has found metallic raceway systems provide higher reliability and longevity than PVC systems, but Owner may consider the use of non-metallic raceway systems on projects involving limited conduit lengths and where risks for damage to raceway is considered minimal.

4) Electrical, Mechanical (HVAC) and General Equipment Storage Rooms

i. Rigid Galvanized Steel (RGS) Conduit and fittings.
ii. Flexible Metal Conduit - Lighting Fixtures and similar type equipment.
iii. Liquidtight Flexible Metal Conduit - motor (and similar equipment involving close proximity to water and/or oil) connections.
iv. Exposed outlets - Cast Type, FD capacity.
v. Recessed Outlets (where permitted) - one-piece galvanized steel (expandable metal outlets not permitted).
vi. Cover plates - companion type as specified and/or indicated in Specifications or on the Drawings.

5) Hangers, Supports and Fasteners

i. In chemical and corrosive areas, FRP Threaded Rod with non-metallic FRP channel supports and fasteners shall be provided. In areas other than Chlorine and Fluoride environments, the use of 316 Stainless Steel threaded rod and fasteners also is permitted. Where the weight of the installation exceeds that permitted by the FRP materials, the use of 316 SS channel supports and threaded rod will be considered acceptable. PVC Coated steel channel supports is not accepted.

ii. In all other areas channel supports shall be hot-dipped galvanized and threaded rod shall be galvanized steel. All fasteners shall be 316 Stainless Steel.

6) Cable Tray and Trough Systems

i. The use of aluminum or FRP cable tray is an acceptable practice for wiring of equipment; especially in pipe galleries, alongside of walkways and similar tight areas where access to equipment is very restricted.
ii. Solid-bottom (or ventilated bottom) cable trough systems are also considered acceptable for locations where ladder type cable tray is not appropriate due to special considerations of the work.
iii. The use of cable tray and / or trough systems is to be reviewed with and accepted by the Owner prior to the start of design. The Design Memorandum shall include a description of what is being proposed and wiring systems to be included.
iv. Cable types to be UL Listed for the applications and isolation between voltages, including low voltage and instrumentation systems shall be included in the design.

c. Administrative Buildings and Related Type Facilities or Areas

1) All areas within conditioned rooms (those spaces where heating and/or air conditioning/ventilation is provided to maintain a nominal ambient temperature of 68 degrees and higher).

2) General Installations

i. Conduits 1-¼" and smaller may be EMT. This raceway type may be provided for either exposed or concealed raceways. All EMT connectors and fittings shall be compression type only (the use of set-screw fittings is NOT permitted)
ii. Rigid Galvanized Steel (RGS) Conduit and fittings shall be used for all raceways 1-½" and larger.
iii. PVC Conduit is NOT to be used for any application other than for approved in-floor (or other encased in concrete) applications as outlined elsewhere in these Documents.
iv. Flexible Metal Conduit - Recessed Lighting Fixture connections and similar type equipment terminations. Alternatively, the use of MC Cable is permitted for lighting fixture installations where determined acceptable by the Owner.
v. Liquidtight Flexible Metal Conduit is to be used for motor and transformer terminations as well as other equipment where vibration and/or access is required that would otherwise be impeded by a fixed raceway installation. Connections are to utilize stainless steel fittings; PVC Coated where installed in chemical and corrosive atmospheres
vi. Exposed outlets - Cast Type, FD capacity.
vii. Recessed Outlets - one-piece galvanized steel (expandable metal outlets not permitted).
viii. Cover plates - companion type as specified and/or indicated on the Drawings.

3) In-floor (or other encased in concrete) Installations

i. PVC Schedule 40 for 120 volt and greater general power / branch circuits; transition to metallic or fiberglass raceway system for continuation in or on wall as identified above. (Note - refer to VFD cabling installation requirements for special installation considerations).
ii. EMT for Data, Instrumentation and low voltage signal (less than 50 V) circuits; maintain metallic raceway system for continuation in or on wall as identified above.
iii. All conduits embedded in concrete floor to be compliant with ACI-318 criteria for minimum embedment and spacing requirements to assure structural integrity of structure.
iv. All transitions from "in-floor" to above floor in any area or room where water is also supplied in the room shall utilize PVC Coated RS Conduit sweeps to provide corrosion / physical protection; extend PVC Coated raceway minimum 6" AFF. Alternatively, the use of fiberglass raceways may be accepted if approved by the Owner. No transitions to be installed where raceway penetrates floor finish on an angle of the radius.

d. Underground and Similar Raceway Applications

1) Encased in Concrete Raceway Installations - (Ductbanks, Equipment Bases, etc) as identified on the Drawings

i. Minimum size conduits for underground installation to be 1".

ii. Conduits smaller than 2" in diameter - PVC Schedule 40 Conduit with PVC Schedule 40 sweep radius horizontal bends and PVC Coated RS raceway sweep radius bends for vertical transitions to above grade or concrete surface.
iii. Conduits 2" in diameter and greater - PVC Schedule 40 Conduit with RGS or fiberglass sweep radius horizontal bends and PVC Coated RS Conduit sweep radius bends for vertical transitions to above grade or concrete surface.
iv. Alternative use of fiberglass raceways is acceptable where approved by the Owner for those underground horizontal and vertical transitions to above grade or floor / concrete base.
v. Note - Refer to VFD cabling installation requirements for special installation considerations that may alter the criteria outlined above.
vi. Conduit supports, spacing and concrete / reinforcement to be as specified.

2) Direct Burial Raceway Installations - Ductbanks, Branch Circuits and Feeders as Identified on the Drawings

i. Conduits smaller than 2" in diameter - PVC Schedule 40 Conduit with PVC Schedule 80 sweep radius horizontal bends and PVC Coated RS raceway sweep radius bends for vertical transitions to above grade or concrete surface.
ii. Conduits 2" in diameter and greater - PVC Schedule 40 Conduit with RGS sweep radius horizontal bends and PVC Coated RS Conduit sweep radius bends for vertical transitions to above grade or concrete surface. .
iii. Alternative use of fiberglass raceways may be considered acceptable where approved by the Owner for those underground horizontal and vertical transitions to above grade or floor / concrete base.
iv. Note - Refer to VFD cabling installation requirements for special installation considerations that may alter the criteria outlined above
v. Conduit spacing and protective concrete cover to be as specified below or as detailed on the Drawings. Note, Direct Burial installations do not use conduit "chairs" or separators; embedment is provided by screening material only.
vi. Provide 5" thick concrete protective pour with 10 x 10 WWF over top of screening backfill for physical protection and vehicular wheel loading. Where crossing roadways or drives, conduit work to be reinforced, concrete encased as in #d.1 above; extended a minimum 10' on either side of pavement.
vii. Transitions from underground to building or other structure to be provided as detailed on the Drawings

e. Special Applications and Locations:
i. Wastewater installations rating to be established by NFPA 820 and installations in compliance with Article 501 of the NEC
ii. Hazardous locations where determined are to be installed in accordance with the NEC while addressing the use of corrosive-resistant materials as outlined above.
Provide raceway seal-offs and fire seals as required by Code. Additional raceway seal-offs to be provided to prevent the migration of corrosive vapors from a chemical area into an adjoining area and sealed with a non-water soluble compound material

3. Lighting Systems

a. Indoor Locations:
1) Fluorescent lighting systems are typically considered very cost-effective and suitable for all interior applications; fixture types and source control as outlined in Appendix B.

These systems allow for component replacement and enclosure types to address any normal application or location. Based on AWBSE and Manufacturer data, the proper selection of lamp, ballast and control components has shown long term life-cycle and maintainability benefits.

2) The use of LED lighting sources and devices has become more popular in recent time as their costs have become more competitive with other systems. As a result, AW Engineering recommends an initial evaluation be considered to address initial costs as well as maintainability of the systems. These systems are to be considered and used upon approval from the Owner and after review of the life-cycle costs associated with total installations. The Engineer shall identify and provide all information regarding potential rebates, off-setting cost programs, etc. available for the use

3) Night-lighting / means of egress lighting fixtures shall be incorporated in the normal lighting layout / scheme to ensure that all passages and exits remain illuminated in the event of a power failure. These fixtures may be switched in areas where required providing they include the lighting transfer device integral with the fixture. (i.e... training and AV presentation areas, operational control rooms, etc.). This pass-thru/night lighting should be otherwise be un-switched; other lighting in the area or room to be controlled by means of suitable occupancy sensors

4) Separate battery-powered emergency lighting units shall also be provided to augment this night-lighting system and provide Code required means of egress lighting in the event of a power failure of the Utility and/or Stand-By Power System. Provide a remote battery-controlled lamp on the exterior of building exit doors connected to the interior unit to provide illumination away from the building. These units are to be powered from the local area night-lighting circuits and wired ahead of any switching. . All emergency lights, including outdoor remote head, are to be provided with twin lamps so failure of one lamp does not leave area in total darkness

5) Lighting fixtures types are to be suitable for the environments where installed and shall be located (serviceable and accessible) for routine maintenance. Provide calculations and fixture catalog data/specification sheets for review and acceptance by the Water Company.

b. Outdoor Locations:
   1) The use of LED type lighting fixtures shall be used in the design for the exterior of the building; HID lighting (HPS) shall be an acceptable alternative for exterior use where providing similar type to match existing. Illumination levels to be as recommended by IES for the space and tasks being performed.

   2) Wall mounted lighting units to be coordinated with AW Security Group for illumination of areas where specifically required.

   3) Pole mounted fixtures to utilize tapered aluminum poles; height as required to meet lighting illumination levels in area. Pole heights and locations to also address maintainability issues for Owner replacement and repair.

   4) Outdoor lighting design is to comply with local ordinances for trespass lighting, up-lighting, pole height, and additional requirements the AHJ may have for the installation location

c. Where otherwise required by the authority having jurisdiction , provide means of egress and emergency lighting systems in conformance with NFPA 101 (the Life Safety Code)

d. Illuminated Exit Signs: IF REQUIRED by CODE, provide LED type and placed inside the facility per the latest requirements of NFPA 101 (the Life Safety Code) as applicable. Otherwise, provide non-illuminated, non-metallic exit signage for general egress direction and identification as determined by the engineer/architect and/or building official.

4. Cables

a. Low Voltage Wire and Cable:

1) All conductors to be copper

2) Those rated for 480V and below shall be listed as XHHW-2 for general underground, damp and wet locations and other similar areas. In addition, only XHHW-2 insulated conductor material is to be used with any variable frequency drive application.

3) Dual-rated THHN/THWN type is for use ONLY in interior, *(Administrative Buildings and Related Type Facilities or Areas as previously defined)* dry locations. *[NOTE: on projects involving multiple environmental conditions, AW has found that allowing both types of insulation has often resulted in field errors of the wrong type wire being installed. As a result, AW Engineering recommends using the Type XHHW-2 insulated wire throughout the project to eliminate this situation.]*

4) Insulation shall be UL listed for at least 90 degrees centigrade but applied at its 75 degree ampacity rating (maximum). Provide specific information in the Documents outlining where each type of conductor insulation material for review and acceptance by the Water Company

5) Multi-conductor, Tray Rated Cable to be provided for cable tray applications as outlined. All cables to be 600 volt insulated, 90 ^{0}C rated / applied at 75 ^{0}C ampacity rating. In general, provide;
   i. Type A – XHHW-2 (XLP) insulated conductors with ICEA Method E-1 or E-2 color coding; note this info on the Drawings. Cable to have PVC outer jacket. Uses include power and control devices.
   ii. Type B – THHN/THWN-2 with black insulated conductors with white printed numbers, #14 AWG, number of conductors as required; PVC overall jacket. Uses include control / monitoring interface with SCADA/RTU equipment and field devices
   iii. Other types and specific color coding to be provided based on voltage application for power conductors and control wiring for interface with SCADA/RTU equipment in accordance with AW Standards for these applications.

6) VFD Cables
   i. Acceptable Manufacturers (included herein to identify basis of material design for these special cables) Refer to AW Acceptable Manufacturers List for additional/supplemental information:
      a. Belden 29 Series (600VAC Rated Cable); wire gauge as indicated on the Drawings
      b. AmerCable, Inc. – CIR Type (600VAC Rated) VFD Power Cable Gexol Insulated; wire gauge as indicated on the Drawings.

ii. Description: Three-conductor plus ground with cross-linked polyethylene or polyolefin listed insulation with fully-rated and identified equipment grounding conductor(s); 90 degree C listed for Wet or Dry applications with outer PVC jacket.

iii. Conductor: Tinned-Copper, multi-conductor cable, size as indicated on the Drawings.

b. Medium Voltage Cable:
   1) Provide Type MV-105 shielded medium voltage cable for all normal power and feeder installations unless specifically required otherwise by the serving Utility Company for materials associated with a medium voltage service entrance installation.

   2) For medium voltage motor installations, provide shielded conductors (Type MV-105) along with means for terminating the cable shields (and bonding to the equipment grounding conductor) before entering the motor termination box on the motor.

   3) All conductors to be copper.

5. Grounding

a. General - Unless otherwise indicated or required, all facility installations shall utilize grounded power distribution systems. Normally, all will be solidly-grounded; provide resistance-grounded systems only where determined to be required for equipment and/or life-safety protection.

b. The electrical system and equipment grounding is to be in compliance with the National Electrical Code. A buried grounding grid or counterpoise is to be provided for the new switchgear equipment, transformers and standby generators.

c. Conductors shall be No. 2 AWG stranded copper (minimum) for interconnecting ground rods and for connection to transformers and MCC's and other major electrical equipment. All connections to this underground earthing system shall be made using exothermic weld process. Connections to reinforcement steel in foundations shall utilize hydraulic compression fittings. Bolted connections shall only be provided where accessibility and temporary removal for testing is required. All electrical equipment shall be bonded to the grounding system including motors, transformers, panelboards, other equipment, metal stairs / ladders, etc. and metallic raceway systems. All conduits containing power and control wiring shall be provided with a separate "green" grounding conductor; use of the raceway system as a sole means of grounding is not permitted.

d. Provide test well for grounding system testing at main service bonding to ground rod and other locations as determined appropriate by the Owner. Ground test well to be minimum 12' x 12" with tamper-resistant stainless steel bolted cover and "Ground" cast into the cover plate.

e. Increased conductor sizing to be as required by Code and/or grounding calculations where associated with switchgear substations and lightning protection system installations.

f. Instrumentation Grounding – review and provide grounding associated with the special requirements for this system.

6. Medium Voltage Equipment

a. The following criteria apply to 5 KV – 15 KV maximum installations *(higher voltage applications to be coordinated with AWBSE).*

b. Medium Voltage Transformers
   1) AWBSE recommends the use of dry-type transformers over liquid-cooled units to avoid potential environmental concerns and risks as well as reduced maintenance requirements and associated O&M costs. Our preferred equipment uses cast-coil, epoxy encapsulated windings on the primary and secondary windings. Other possible solutions involve the use of VPE insulated assemblies which provide a higher degree of protection over the standard VPI insulated units.
   2) The use of liquid-cooled units is generally only recommended where transformers are needed for 5 MVA and larger service applications; the type and associated ratings, cooling capabilities and auxiliary features and appurtenances to be coordinated with Utility and Owner criteria as outlined in the RFP for the project.
   3) Provide alarm monitoring for reporting to the process control system and include provisions for forced air cooling were appropriate
   4) All transformers are to utilize copper winding material – primary and secondary coils.

c. Medium Voltage Switchgear
   1) Type of Equipment: Plated copper bus as determined suitable for the installation/location and environmental conditions, 3-phase, 3-wire plus ground operating at 60 Hz. Utilize draw-out vacuum circuit breakers and/or fusible type switchgear assemblies where specifically identified in the RFP. All components are U.L. listed. Switchgear equipment shall consist of standardized, freestanding structures bolted together for form a single dead-front panel assembly containing circuit breakers, control devices, protective relay and metering units and all interlocking and miscellaneous control / interface devices.
   2) Fusible sections (where applicable) to be configured from left to right; use of front to back fuse arrangements are not permitted.
   3) Protective relaying and/or metering to be as outlined in #12 below. Relay coordination settings and ratings to be selected by the Engineer based on the Protective Coordination and Arc Flash Hazard analysis outlined in Attachment A
   4) In general, Metal-Enclosed Switchgear is considered acceptable. Provide Metal-Clad Switchgear type design where required or indicated or otherwise due to specific design and/or Utility considerations.

d. Medium Voltage Motor Controllers
   1) Type of Equipment: Tin-plated copper bus (phase and ground), 3-phase, 3-wire plus ground operating at 60Hz. All components are U.L. listed. MCC equipment shall consist of standardized, freestanding structures bolted together for form a single dead-front panel assembly containing combination vacuum contactor motor controller units; feeder units; metering, relaying, and interlocking and miscellaneous control devices. Provide magnetically-held or mechanically latched type of vacuum contactor controllers as required for the application or equipment served.
   2) Fusible sections to be configured from left to right; use of front to back fuse arrangements are not permitted. Fuse types and ratings to be selected by the Engineer based on the Protective Coordination and Arc Flash Hazard analysis outlined in Attachment A
   3) Starters:
      i. Full-Voltage or Reduced Voltage NEMA rated fusible switch / contactor type combination controllers as outlined in the RFP or otherwise determined by the Engineer and Owner. The use of IEC rated controller is prohibited.

ii. Solid-state reduced voltage motor starters shall be utilized where required due to power utility requirements, process control of hydraulic transients, and/or engine-generator sizing considerations.
iii. The Engineer shall coordinate starter types with the Water Company.

4) Control power – provide each starter with individual 120 VAC CPT rated for minimum 100 VA above that required for loads served; min 150 VA. CPT's to be fused on primary and secondary.
5) Control devices – provide minimum 30 mm diameter devices for all control switches, push buttons and pilot lights. Pilot lights to be high intensity, 120 VAC LED type; color as outlined herein or otherwise required by Owner.
6) Protective relaying and/or metering to be as outlined below. Relay coordination settings and ratings to be selected by the Engineer based on the Protective Coordination and Arc Flash Hazard analysis outlined in Attachment A.

7. Low Voltage Motor Control Centers/Motor Controllers

a. Type of Equipment: Tin-plated copper bus (phase and ground), 600V, 3-phase, 3-wire plus ground operating at 60Hz; provide a neutral bus (3-phase, 4-wire plus ground applications) only in those MCC assemblies where required. All components are U.L. listed. MCC equipment shall consist of standardized, freestanding structures bolted together for form a single dead-front panel assembly containing combination motor control units; feeder units; metering, relaying, and interlocking and miscellaneous control devices and will be of the per definitions in the latest edition of NEMA ICS 3 and UL 845.

b. Starters:
1) Full-Voltage NEMA rated (Size 1 minimum) combination magnetic starters shall be utilized as required. The use of IEC rated starters is prohibited.
2) Solid-state reduced voltage motor starters may be utilized where required due to power utility requirements, process control of hydraulic transients, and/or engine-generator sizing considerations.
3) The Engineer shall coordinate starter types with the Water Company.

c. Circuit Breaker Compartments and Circuit Breakers: Control center disconnects shall be three-pole, single-throw, 600-volt, molded-case circuit breakers
1) Feeder and branch circuit breakers to be thermal-magnetic or solid-state trip type as required for the loads served, protective coordination and arc-flash hazard considerations.
2) Circuit breakers associated with combination starters shall be magnetic motor circuit protector (MCP) type where appropriate.
3) All shall be manually operated with quick-make, quick-break, trip-free toggle mechanism.

d. Control power – provide each starter with individual 120 VAC CPT rated for minimum 100 VA above that required for loads served; min 150 VA. CPT's to be fused on primary and secondary

e. Control devices – provide minimum 30 mm diameter devices for all control switches, push buttons and pilot lights. Pilot lights to be high intensity, 120 VAC LED type; color as outlined herein or otherwise required by Owner.

f. Protective relaying and/or metering to be as outlined in #12 below. Relay coordination settings and ratings to be selected by the Engineer based on the Protective Coordination and Arc Flash Hazard analysis outlined in Attachment A.

g. VFD Installations – while not recommended, where VFD's are required to be installed in MCC type construction, locations and general arrangements to address ventilation requirements of equipment. These installations typically will necessitate use of NEMA 1 configurations to avoid undue costs for the overall assembly; special attention to this is required to coordinate the design. Where it is determined NEMA 12 (or NEMA 4X) is necessary, VFD's shall not be included in MCC type construction.

h. Enclosure Type: Typically NEMA 1 is acceptable for conventional MCC construction utilizing only starters and circuit breakers. Match existing NEMA ratings in equivalent areas of the plant. Engineer shall also propose modifications to the NEMA rating if appropriate for intended service.

8. Variable Frequency Drives (VFDs)

a. In general, 6 pulse VFDs with line reactors are to be used for motor loads 50 HP and smaller. On motors greater than 50 HP but less than 100 HP evaluation of drive type to be determined based on base load versus non-linear loading. On all drives where harmonics at the Owner's equipment bus is potentially determined to be greater than 5% TDD. Provide VFD with passive or active harmonics filter / line conditioning unit.

b. In general, 18 pulse VFDs are to be used on motors 100 HP and larger. However, final determination from harmonics analysis and evaluation of linear versus non-linear loading is to be taken into account in making final selection. Harmonics at the Owner's equipment is to be below 5% TDD. Provide harmonics filtering / line conditioning as required to meet these criteria.

c. For motor applications involving long cable feeders between the VFD and the motor (e.g., ~100'+ or as defined by manufacturer), provide dv/dt output filters based on VFD and motor criteria for selected equipment.

d. VFD's installed in damp locations to be provided as NEMA 12 type equipment; those installed in locations such as dedicated electrical equipment rooms may be NEMA 1 type. However, all drives to be provided with door filter units mounted on exterior for access where possible.

e. All VFDs shall be rated as Industrial Duty / Heavy Duty type and be rated for a 50 ^{0}C ambient location. The use of 40 ^{0}C rated equipment and "HVAC" rated VFDs are not permitted.

f. Unless specifically accepted, all VFDs shall be stand-alone enclosed, wall or floor mounted equipment; do not combine in common enclosures or MCC construction.

g. VFDs shall be provided with Bypass starters where outlined in the RFP. Bypass starter type and rating to be as outlined; FVNR or RVSS types are typically required based on starting and hydraulic concerns in the system.

Note: Ventilation / Air Conditioning – AWBSE recommends ventilation air be used as the primary means of cooling for VFD applications and installation locations. The use of Air Conditioning (A/C) is not typically required in most geographic locations. Where A/C is determined to be necessary, the units shall be provided with an economizer mode which uses outside air as the first stage. Additionally, ventilation system should be designed to withdraw heat from above VFD enclosures and introduce cooling air near lower air intake section of VFD.

9. Miscellaneous Power Distribution:

a. Panelboards and Switchboards: Circuit breakers will be of the "Bolt-On" type;"Push-On" / "Plug-On" type circuit breakers are not allowed. Use plated copper bus and ensure U.L. labeling of entire system.
b. Provide a Surge Protective Device (SPD) on the main of each power distribution panel where applicable. In addition, provide an SPD on panels serving sensitive electronic equipment and instrumentation devices. For more specific requirements for the protection of sensitive electronic instrumentation, see Instrumentation section.

c. Lighting and General Power Transformers: Dry type to limit maintenance items. A minimum of (2) taps will be provided above rated voltage (in 2.5% increments) and a minimum of (2) taps will be provided below rated voltage (in 2.5% increments). Open type transformer cases are not allowed. All units located in wet or chemical areas will be of sealed type construction. Provide open ventilated type enclosures for other general dry, environmentally ventilated/conditioned spaces. All transformers to utilize copper windings; 115 degree C rated. The Engineer shall examine the need to install transformers with a higher than average Basic Impulse Level (BIL) that is not normally required in the 480V class.

10. **Power Monitoring/Metering and Protective Relaying**

a. General: AW objective is to provide power monitoring to allow trouble-shooting, harmonics assessment, and data collection for evaluating efficiency, etc.

b. AW has a national contract agreement with SEL and is our preferred manufacturer for new work. Refer to RFP for systems involving modifications / upgrades to existing installations

c. Low Voltage Systems: For small stations involving a limited number of motors / loads, metering as outlined below alone is sufficient. On larger low voltage systems, addition protective relays and monitoring may be appropriate to allow evaluation of sub-distribution equipment and systems and data collection of power characteristics to be captured by the SCADA system for evaluation and reporting. Specific criteria associated with metering and equipment monitoring/protection is to be reviewed with the Owner at the initial design memorandum stage of the project.

d. Make provisions for power monitoring/metering on incoming three-phase electrical services (main) as follows:
   - All 480/277 VAC services are to provide 3-PTs and CTs wired to field terminal blocks for connection to metering equipment.
   - On installations where the metering is provided by Owner, allow physical space next to main incoming OCP device for meter enclosure installation.
   - On installations where metering is to be provided with equipment, refer to the RFP for specific criteria or review with Owner to define requirements.

e. Medium Voltage Systems: Power distribution systems involving medium voltage motors and equipment are to be provided with the protective relaying/monitoring devices for not only equipment protection, but also to allow data collection of power characteristics to be captured by the SCADA system for evaluation and reporting. Provide 3- PT / CT input devices and control voltage for power metering and protective relays as required for system protective schemes required by the design.

f. Data Collection: The use of fiber-optic interface between devices and to SCADA is a preferred method of communicating the data transfer between devices and into the process control system. Applications involving the use of copper are to be specifically approved by the Owner. Where available, dual-port communications capabilities of the protective relays shall be utilized and the devices configures in a loop with IP addressing. The design and configuration of the communications loop and serial connectivity is to be developed as part of the instrumentation design effort.

g. Power Monitoring/Metering;
   1) Provide microprocessor based SEL 735 metering unit on main incoming feeder circuit breaker. Unit shall compute voltage, amperes, power factor, kilowatt-hour, etc. Communications will be via fiber-optic cable back to a port on a plant's process control system.

h. Protective Relaying;
   1) Provide SEL 710 motor protective units on all medium voltage motors wired to plant's process control system for monitoring, trending and archiving.
   2) Provide SEL 849 motor protective units on 480 VAC motor loads typically larger than 50 horsepower *(exact application to be coordinated with Project requirements and Owner)* wired to plant's process control system RTU for monitoring, trending and archiving
   3) Provide SEL 751A Feeder protective units on MV Feeders wired to plant's process control system for monitoring, trending and archiving
   4) Other protective relays as outlined in Attachment C and provided as applicable to the Project

i. Other SEL protective relays to be provided as determined through the design; reviewed and accepted by the Owner.

j. SCADA / RTU communications and data acquisition information to be monitored is outlined in Attachment C - SEL Device Monitoring Points (Modbus to SCADA /RTU. This baseline data is to be evaluated and supplemented as appropriate for the project as well as other potentially beneficial data for trend analysis, wire-to-water calculations, and preventative maintenance.

k. Refer to RFP for additional and/or supplemental information regarding protective relays, applications and coordination of Ethernet communications requirements.

ATTACHMENTS

A. American Water Power System Study Requirements – Short Circuit, Protective Coordination, and Arc Flash Hazard Analysis/Evaluation

B. Acceptable Electrical Equipment Manufacturers and Suppliers

C. SEL Device Monitoring Points (Modbus to SCADA /RTU)

AMERICAN WATER

AMERICAN WATER
POWER SYSTEM STUDY AND
ARC FLASH ANALYSIS REQUIREMENTS

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AMERICAN WATER POWER SYSTEM STUDY AND ARC FLASH ANALYSIS REQUIREMENTS

1. DESCRIPTION OF WORK REQUIRED

A. Provide all items of labor, materials and equipment necessary for data collection, development, evaluation and report generation of the work described in this Section. The entire power distribution system (all equipment), new and existing is to be included in the study being provided for this Project.

B. Visit the site to determine actual conditions, equipment and settings and related elements necessary to prepare a complete oneline diagram of the entire power distribution system. Provide a complete oneline diagram including all equipment (loads/ratings), cable and raceway information and other data associated with the installations to allow evaluation and calculation of the various Studies to be provided in the Report outlined herein. Where required, coordinate field work with the Owner and shall follow all applicable safety standards for the activities required.

1. Those involved with the field data collection work shall review / compare the Owner's operational and safety standards with their own and provide adequate Personal Protective Equipment (PPE) for those individuals involved in any data gathering activities as outlined by applicable Regulatory Agencies. No extra compensation will be allowed by failure to determine existing conditions.

C. Furnish a complete Short-Circuit, Protective Coordination, and Arc Flash Hazard Analysis Study per the requirements set forth in the criteria established for the Project, the criteria outlined herein this document, and as identified in the latest version of NFPA 70E– 2015 Edition; *Standard for Electrical Safety in the Workplace and as outlined herein regarding American Water Site Specific PPE Category Labeling criteria.* The arc flash hazard analysis shall be performed according to the IEEE Standard 1584-1992 including latest revisions and IEEE 1584-2004 and IEEE 1584-2011 addenda; the IEEE *Guide for Performing Arc-Flash Calculations;* modified as hereinafter identified.

D. Arc-Flash Equipment Labeling shall be provided upon acceptance of the Engineer's final report. Labeling shall be provided for all equipment as identified herein this document.

E. In addition, where indicated in the Scope of Work identified by the Owner, provide a Load Flow analysis using the power systems software identified herein to model the operational scenarios required for the project and requested by the Owner. These Load Flow analysis reports are to be provided in accordance with the Owner's criteria for loading and report submission.

F. Any Drawings and Material Data Sheets / Product Information provided by the Owner is considered as generally indicative of Power System but is not to be considered as matching actual site conditions. Modifications/field changes may have occurred which were not recorded; therefore, provide field verification as necessary to validate the Power System as Work under this project in preparation of the Short-Circuit, Protective-Coordination and Arc-Flash Study and Analysis.

G. The general (not limited) approach to the evaluation and analysis work included in this assignment shall include the following effort;

1. Collect system and "as-installed" data associated with all electrical equipment, feeders, and devices associated with this Study/Report. This effort shall also include obtaining the

necessary load-history and available fault current (max and min) and Utility Overcurrent Protective Device (OCP) device(s) from the serving Power Utility Company along with the technical data associated with their system and transformer equipment being provided.

2. Determine system modes of operation by conducting interviews with Owner's Operational / Production Staff
3. Determine bolted short-circuit and arc fault currents
4. Determine protective device characteristics and duration of arcs
5. Document system voltages and classes of equipment
6. Evaluate existing equipment short circuit ratings against computed available fault currents.
7. Arc Flash Hazard Analysis to select working distances as outlined herein, determine incident energy for all equipment and determine flash-protection boundary zones for all affected equipment. Conduct arc flash analysis based on the utility fault current and at a value approximately 50% of this or as otherwise determined from the fault current range as provided by the serving Utility Company.

    a. In addition, where Standby power (generator) is also provided as part of the Project, evaluate the arc flash hazard based on this power source. Summarize each evaluation and develop arc flash labeling based on the worst case scenario or as otherwise accepted by the Owner.
        1) Where the installation includes the use of a portable generator, provide a cautionary label on both the transfer switching equipment and on the outdoor generator termination enclosure as outlined in Attachment D.
    b. Furthermore, provide analysis of any arc flash reduction methods being utilized or included for the equipment. While these devices are not considered in actual labeling, they are to be clearly identified and reported for potential use by maintenance staff when required activities include conducting work on energized and exposed electrical equipment. Provide full analysis of these devices including effects on the downstream equipment being served where applicable.
    c. Finally, where power distribution systems involve the application of "Main – Tie – Main" or similar multi-operational configurations, provide analysis for these schemes in order to determine effects of the operational differences with regard to loading, short-circuit, protective coordination and arc flash hazard. As above, each operational scenario is to be clearly identified in the reports submitted.

2. REFERENCES

A. ANSI – American National Standards Institute, Inc.
1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

B. ASTM – American Society for Testing and Materials

C. IEEE – Institute of Electrical and Electronic Engineers
1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis

4. IEEE 1584, Latest Edition – Guide for Performing Arc-Flash Hazard Calculations; including all Addenda

D. IPCEA – Insulated Power Cable Engineers Association

E. NEMA – National Electrical Manufacturers Association

F. NESC – National Electrical Safety Code

G. NFPA – National Fire Protection Association
   1. NFPA 70 – National Electrical Code, latest edition
   2. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition

3. STUDY REQUIREMENTS

A. The Work associated with this assignment must comply with all Federal and State, municipal or other authority's laws, rules and/or regulations. These services shall be provided by a qualified, licensed Professional Engineer (hereinafter referred to as Engineer and/or Engineer-of-Record) to conduct the actual analysis, evaluation and development of the Report and Arc Flash labeling.

B. The Power System Study / Analysis is to include all electrical equipment; and specifically include / address the following:
   1. In general (not limited to) and starting at the Utility, all electrical equipment including the main service transformer, Utility OCP device and system ratings shall be evaluated and included in this Study.
   2. Where included, all medium voltage equipment, motors, transformers (primary and secondary) shall be included as applicable, as well as all 480 VAC low voltage equipment, motors nominally 25 HP (or as otherwise outlined) and larger, all transfer switch equipment, safety disconnect switches rated 100 amps and above, all automatic and manual transfer switches, panelboards, transformers (primary and secondary locations) and other electrical equipment requiring routine inspection or maintenance while energized (including Infrared (IR) Scans).
      a. 120/208-240 VAC equipment shall be included in the Study in accordance with the latest information and Addenda issued with IEEE / NFPA criteria, and as outlined herein below
      b. 120/240 VAC Single phase equipment need not be included in the actual analyses where the fault current is determined to be less than 10 kAIC, but these panelboards and related transformers, etc. shall be shown on the facility's oneline diagrams for identification and labeling shall be provided as outlined herein below.
   3. Refer to other criteria and reporting requirements are outlined elsewhere in this Document.

C. 120/208-240 VAC, Three Phase Power Systems – American Water Corporate Engineering has developed the following recommendations for Arc Flash Hazard labeling on 120/208 – 240 VAC, three-phase grounded and ungrounded power systems:
   1. Service-Entrance and sub-distribution locations: AW Engineering recommends the application of a "standard" label (see Attachment B herein) at those locations where the Main OCP device is less than 250 amps and the following criteria has been verified. Typically, this equates to a 100, 150 or 200 amp self-contained metered electrical service application as well as those installations served from a transformer 75 KVA and smaller.

a. Based on criteria evaluated, and the with specific reference to the 2015 NFPA-70E Tables ("Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems"), AW recommends that the AW standardized Arc Flash Hazard Warning Labels indicating an Arc Flash PPE Category 2 hazard be used where the following criteria has been determined and/or otherwise verified.
    1) Voltage is
        a. 120/208 VAC, 3-phase, 4-wire (grounded WYE); or
        b. 120/240 VAC, 3 –Phase, 4-wire ("High-leg Delta"); or
        c. 240 VAC, 3-phase, 3-wire (Ungrounded Delta)
    2) AND, Main OCP device is less than 250A (fused switch or circuit breaker)
    3) AND, the Transformer size is 75 KVA or less OR available fault current is less than 22,000 AIC (22 kAIC.)

b. NOTE: Where the ampacity rating for the electrical service is 250 amps or greater or the transformer is larger than 75 KVA (or available fault current is greater than 22 KAIC), engineering analysis of the system is to be provided.

D. 120/240 VAC, Single-Phase Power Systems – American Water Corporate Engineering has developed the following recommendations for Arc Flash Hazard labeling on 120/240 VAC, single-phase grounded power systems:
    1. Service-Entrance and sub-distribution locations: AW Engineering recommends the application of a "standard" label (see Attachment C herein) at those locations where the Main OCP device is 200 amps or less and the following criteria has been verified. Typically, this equates to a 100, 150 or 200 amp self-contained metered electrical service applications as well as those installations served from a transformer 25 KVA and smaller.
        a. Based on criteria evaluated, and the with specific reference to the 2015 NFPA-70E Tables ("Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems"), AW recommends that the AW standardized Arc Flash Hazard Warning Labels indicating an Arc Flash PPE Category 2 hazard be used where the following criteria has been determined and/or otherwise verified.
            1) Voltage is 120/240 VAC, 1-phase,3-wire, grounded
            2) AND, main OCP device is 200A or less (fused switch or circuit breaker)
            3) AND, the Transformer size is 25 KVA or less OR available fault current is less than 10,000 AIC (10 kAIC.)
        b. NOTE: Where the ampacity rating for the electrical service is greater than 200 Amps or the transformer is greater than 25 KVA (available fault current is greater than 10KAIC), engineering analysis of the system is to be provided.

E. The Report(s) with calculations must be supplied to the Owner before final equipment labels are printed and applied before the work is considered accepted or approved. The Engineer shall provide documentation for all presumptions / assumptions related to machine impedances, cable impedances (both resistance and inductance), transformer impedances and other equipment values used to complete the computations where obtaining actual data is not available.

F. The Engineer shall consider fault conditions under minimum, maximum, and average power consumption scenarios based on facility operations as well as in the varying Utility fault conditions outlined previously. The Engineer shall also develop fault scenarios with standby power generators where included and used instead of or in conjunction with the electric utility source along with the other scenarios outlined. Arc Flash Hazard analysis and equipment evaluations to be provided as hereinafter indicated.

G. All oneline diagrams included in the Study / Report shall utilize naming conventions and identifiers matching the Design Documents or actual equipment field labels; generic identifiers are not considered appropriate. Coordinate equipment naming / identifiers with the Owner taking into account any existing terminology used. Individual oneline diagrams are required for each of the following evaluations as well as each scenario associated with the work outlined for various operational modes, arc reduction methods/devices and multiple configuration capabilities within the power distribution system. The following ones identified are listed only to establish the primary categories associated the overall scope of evaluations to be included; include supplemental documentation as necessary to clearly and individually identify the study scenario and/or evaluation being considered.
    1. Provide annotated onelines for the Power Distribution System identifying all equipment and naming conventions as stated above.
    2. Provide annotated onelines identifying the available short-circuit current at each piece of equipment; include this in the Report; tabbed as associated with this topic.
    3. Provide annotated onelines identifying the settings associated with the protective device settings at each piece of equipment; include this in the Report; tabbed as associated with this topic. Additional setting details associated with electronic trip devices, relays, etc. are to be clearly identified and included on the partial oneline clips associated with the protective coordination TCC diagrams.
    4. Provide annotated onelines identifying the Incident Energy and Arc Flash Hazard Level at each piece of equipment; include this in the Report; tabbed as associated with each Topic and Evaluation
    5. All onelines shall be legible and readable with a minimum 10 point (Arial or similar) font size; coordinate drawing size (not to exceed 22" x 34") accordingly. Provide sleeved drawing holders where printed size is larger than 11" x 17".

H. Short Circuit, Protective Coordination and Arc Flash Hazard Analysis Study
    1. A short circuit, protective coordination and arc flash hazard analysis study shall be made for the entire distribution system in accordance with ANSI/IEEE C37.10 & C37.13, IEEE Std. 141, 242 and 399 beginning at Utility connections and ending at the largest feeder from each motor control center or panel as applicable for the system and analysis being conducted in coordination with paragraph "B" above.
    2. Actual Utility data including system and equipment impedances, X/R Ratios, OCP device(s) and other applicable ratings are to be obtained by the Engineer; include this data as provided by the Utility Company in the Report provided.
    3. The protective coordination study shall consist of the following:
        a. All protective devices contained in the scope of work shall be evaluated. The coordination study shall include computer generated log-log plots of phase overcurrent and where applicable, ground overcurrent protection devices on log-log time-current characteristic paper as produced by the engineering software used for these evaluations and analyses. Complete plots of these devices will be accurately plotted through their operating range. Each TCC Plot shall include a oneline sketch showing the device identifications and

ratings. The Engineer shall identify areas of non-coordination where considerations for modification may be determined. Actual modifications are not necessarily considered included in the scope of services under this project. Any suggested modifications affecting equipment and modifications to the system that the Owner may wish to consider will be handled as a change in the Contract. Appropriate maximum fault levels, transformer inrush currents, conductor insulation withstand curves and transformer damage curves / withstand points shall be plotted on each coordination plot sheet to assure adequate component protection and maximum system reliability.

b. Where included in the power distribution system, each current transformer shall be checked for saturation to insure that they accurately translate all fault currents which may be available on the system.
c. All protective relay and solid-state device settings; fuse sizes; and low-voltage circuit breaker settings shall be tabulated and included on the respective TCC.
d. A complete set of coordination curves (complete with device settings indicated on the TCC) are to be prepared starting with the Utility Company's OCP device(s) and the main distribution devices protecting the Owner's service down through and including all on-site services, feeders, sub-feeders, transformers and secondary main and branch circuit devices, shall be included in the Study. These shall be arranged to provide a uniform approach to the review and device coordination for the system and shall include a "snap-shot"/annotated oneline diagram on each TCC sheet outlining the devices included. Provide sufficient overlap on the TCC evaluations included to demonstrate "upstream / downstream" coordination.
e. The Engineer shall also evaluate ground fault protection where provided in conjunction with the project. Provide Time Current Characteristic (TCC) curves for all GFI circuit breaker equipment protection as outlined above.
f. Motor starting current profiles for all large motors (over 25 HP or as otherwise determined and accepted by the Owner) shall be included on the appropriate TCC's to identify coordination and provided based on the starter type being provided; other motors to be configured as combined loads as applicable to the application
g. Tabulations shall include a listing of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings. This tabulation shall also include indication of acceptability or, in the event of a noted deficiency, provide recommended solution for corrective action.
h. As indicated, points of non-coordination shall be brought to the attention of the Owner; provide existing TCC identifying the issue and a separate TCC outlining proposed modifications and/or adjustments recommended for corrective action.
i. The Study shall include all electrical equipment as included in the Scope of Work for this assignment. The use of documentation and record information as may be provided by the Owner shall not be construed as providing all data necessary; the EOR shall be responsible to conduct or obtain field verification necessary to determine / obtain all required data in establishing the power distribution one-line diagram for the system being evaluated.
j. Submissions and approval of these studies are required as outlined herein after in this document.

4. Arc Flash Hazard Analysis
   a. The arc flash hazard analysis shall include the incident energy and flash boundary calculations.
      1) Unless otherwise specified or approved in writing by the Owner, the EOR shall utilize a Working Distance of 18 inches for ALL voltage levels (low & medium voltage values). Typical other typical distances (i.e... 24" or 36") for low voltage systems and/or 36" for medium voltage systems as otherwise permitted under NFPA-70E / IEEE are not permitted.
      2) As indicated, calculated incident energy values shall be provided for both line and load sides of all transformers and the overcurrent protective devices served from these transformers or other separately derived sources and labeling developed to identify both calculated Incident Energy and Site-specific Arc Flash PPE Category values in addition to other equipment and devices as previously outlined herein. Equipment Arc Flash Hazard Analysis labeling to be provided with this and other labeling information as outlined herein to properly identify and notify workers to the hazards present.
   b. The Engineer shall furnish the Arc Flash Hazard Analysis Study per the latest edition of NFPA 70E - *Standard for Electrical Safety in the Workplace*, reference Article 130.3 and as indicated in Annex D to these specifications.
   c. The analysis shall utilize the appropriate short-circuit and clearing times associated with the over-current protective devices. Where this information is not available, alternative methods for similar devices shall be identified and submitted in the study for review and comment by the Owner.
      1) The arc flash study shall be run under a minimum of the following scenarios in order to account for varying source conditions and available Utility deviations. The worst case from these scenarios shall be considered in developing the PPE and Arc Flash Labeling for the equipment unless otherwise discussed and accepted by the Owner. Power Study scenarios to be considered include;
         a) Utility at nominal short circuit contribution,
         b) Utility at 50% of nominal contribution (or as otherwise determined based on available range of Utility data), and
         c) Standby (generator) contribution (where applicable)
         d) Other scenarios as previously indicated.
      2) Incident energy is greatly influenced by protective device clearing time, which is determined by the available short circuit current at that location. The intent for utilizing a 50% source is to provide some measure of assurance that a "low" utility source will not result in incident energy values higher than those indicated on the equipment labels.
      3) The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system as outlined herein.
   d. The Arc-Flash Hazard Analysis shall include all medium voltage and 480/277 volt locations, as well as those three phase locations associated with the 240 volt and 208 volt systems as previously outlined..
   e. All electrical equipment as herein outlined shall be labeled regardless of the arc-flash energy / incident energy level determined.
   f. Safe working distances shall be identified for calculated fault locations based upon a calculated arc flash boundary considering a minimum Incident Energy level of 4 cal/cm^2; site-specific Arc Flash PPE Category as identified in Attachment D. Working distances shall be based on 18" as outlined previously and in accordance with the general criteria as outlined in IEEE

1584. The calculated arc flash protection boundary shall be determined using this working distances.

g. The Arc Flash Hazard analysis shall include calculations for contributions of fault current magnitude (based on the available fault-current values and not the AIC ratings of the equipment) as previously outlined herein. The calculations shall include all motor and other sources that can contribute to the available fault current. Where necessary, the Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

h. As previously noted, Arc flash computations shall include line and load side calculations associated with the "main" (service-entrance) breaker as well as any other transformer OCP devices associated with internal power distribution. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. AW does not consider the use of this IEEE Exception to be appropriate. (Maximum clearing time of 2 seconds *based on IEEE 1584 is not acceptable*)

i. Results of the Analysis shall be submitted in tabular form, include device or bus name, (based on actual naming ID as identified on the Facility Oneline Diagram; not simply an ID assigned by the software), bolted fault and arcing fault current levels at the various scenarios outlined herein, flash protection boundary distances, personal-protective equipment classes and the arc flash incident energy levels determined. These results shall also be included on the oneline diagram associated with the specific study/scenario being evaluated.

j. The Report shall also include identification of the Personnel-Protective Equipment (PPE) Categories and identify minimum PPE required for each location. This information shall be included in the Report but not shown on the equipment labels.

k. Arc Flash Labeling of Electrical Equipment: Provide copies of the Arc Flash Labels (see sample attached below) in the Report for documentation of the information being identified on the equipment in a separately tabbed section of the report. Include in this section definitions of the terms and distances outlined along with information on the various PPE equipment classifications indicated.

4. POWER SYSTEM STUDY AND ARC FLASH ANALYSIS QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled (*minimum of 10 years of demonstrated experience in conducting power systems studies; provide qualifications upon request*) in performing and interpreting the power system studies. The final report, including copies of the Arc Flash Labels, shall be sealed and signed by the EOR.

5. ENGINEERING STUDY / REPORT SUBMISSIONS

A. Submit the following Reports for AW Engineering / Owner Review and Comment. Coordinate these submission with the Design Criteria / Documentation Submissions as outlined for the Project. In general, the "Preliminary" Report should be provided with the 30% Design (or otherwise defined Project) Submission; the "Pre-Final" Report with the 60% submission and the "Final" Report provided with the 100% submission. Final

adjusted report information, including final equipment labels to be provided once all field adjustments and acceptance testing has been completed. This Record Document Report shall be provided as part of the Operation and Maintenance Documents.

1. Preliminary – Submission to contain an annotated One-line Power Riser Distribution Diagram with OCP devices and other basic configurations associated with the power distribution system included; not a completely detailed and documented diagram. This diagram is intended to show the available power sources and devices which comprise the system and it's configuration for operation. Additionally, this initial diagram is to include the major loads and presumptions for miscellaneous general power requirements which may be appropriate in considering Load Flow evaluations where necessary.
   a. As part of this Preliminary effort, consideration related to new equipment selections shall be included. Provide initial discussion and/or indication related to proposed equipment for Owner consideration and comment.
   b. Include the overall oneline diagram utilizing this simplified computer modeling approach. This information and modeling will allow basic configuration, operations and evaluations associated with equipment short-circuit ratings and types of devices to be considered / developed with the Owner.

2. Pre-Final – Report to contain an annotated One-line Power Riser Distribution Diagram with OCP devices, device ratings/settings and cable feeders (conductor size/type and raceway size/type) identified.
   a. As part of this continuing effort, consideration related to equipment selections shall include type of device and over-current protective features needed for protective coordination with other elements of the power distribution system and loads served. (including type of trip unit, potential arc flash reduction methods as applicable, etc.).
   b. Calculations associated with Short-Circuit AIC values and Equipment suitability along with Arc-Flash Hazard Analysis Report and sample of proposed / typical ANSI Z535.* label information (**current edition*) documentation are to be included.
   c. Included in this Report, Oneline Drawings for the overall Power Distribution Power Riser diagram, an annotated oneline outlining the Short-Circuit ampacity values calculated, and an annotated oneline showing the Arc Flash Incident Energy and PPE Levels calculated.
   d. In addition, a copy of the oneline diagram with the OCP devices indicated shall be included with the Protective Coordination TCC's. Each TCC shall include the partial oneline drawing associated with the protective coordination elements being evaluated and included.

3. Final - Provide a written response to Owner comments provided regarding Pre-Final Study Report. Finalize the information; update data, settings and other appropriate information including any accepted recommendations and/or modifications.
   a. Provide three hard-copies of each submission Report as well as editable Word electronic formatted Report document with the Final submission. Power Distribution Riser Diagrams shall be provided for all analysis configurations conducted including, but not limited to, short-circuit models for minimum and maximum operational scenarios and arc flash hazard models. Include hardcopies of equipment reports and calculations performed.
   b. Submit an electronic copy of the final Arc Flash Hazard Analysis and One-line Power Riser Diagram, complete with all associated equipment

databases formatted with the engineering software used and as outlined herein.

c. It is recommended that the final report include the following sections:
   1) Executive Summary including Introduction, Scope of Work and Results/Recommendations
   2) Short-Circuit Methodology Analysis Results and Recommendations
   3) Short-Circuit Device Evaluation Table
   4) Protective Device Coordination Methodology Analysis Results and Recommendations
   5) Annotated and revised oneline diagrams (all) as outlined in "2" above shall be provided with the Final Report.
   6) Protective Device Settings Table associated with the field installed devices.
   7) Time-Current Coordination Graphs and Recommendations
   8) Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
   9) Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as actual copies of the label images.
   10) One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

B. Upon acceptance of the Final Report, provide labeling of the power distribution equipment in accordance with ANSI Z535.4– Product Safety Signs and Labels; label size to be 4" x 6". Labels to be provided as outlined in Articles 1.03, C and 3.03 below. Label materials furnished to be suitable for either the interior or exterior locations where they are to be applied; provide samples for review and approval by the Owner along with data sheets from the Manufacturer outlining these applications.

C. As part of the final documentation associated with the project Record Drawing data, provide a copy of the oneline diagram that includes the essential equipment and devices without ratings to provide a concise representation of the power distribution system. All equipment and devices shall be identified based on the actual nameplates and identifiers developed under the project design; coordinate with final nameplates provided. Drawing size to be based on size of power distribution system but shall be large enough to provide clear reading of the text based on an Arial 10 point font or equivalent of the equipment naming and identifiers; maximum sheet size to be 22" x 34". Provide multiple drawings for systems where information cannot be legibly contained on a single sheet. This diagram is to include all revisions and modifications determined through the course of construction.

6. COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using ETAP power systems software as provided by Operation Technology, Inc. (OTI), or SKM Systems Analysis Power Tools for Windows (PTW) software program.

B. Provide a final electronic file copy of all data, reports and the oneline diagram in electronic engineering database (ETAP or SKM) format to the Owner prior to final acceptance of the Project. This information is to be validated by the EOR as representing "As-Built" conditions including all over-current protective devices and their settings, feeder conductors and raceway information and load data; including inductive, resistive and combination loads.

C. The files shall contain all Reports (in Microsoft Word) conducted including Short-Circuit evaluations, Protective Coordination and Load Flow Studies as well as the Arc Flash analysis values determined as well as copies of the Arc Flash labels. The EOR for the Study shall attest to this validation in writing when submitting the final electronic copy of the project.

7. FIELD INVESTIGATION / DATA COLLECTION AND IMPLEMENTATION ACTIVITIES

A. The Engineer (or authorized designee of the Engineer) conducting the field data collection work shall review and provide compliance with the following:
   1. Continuity of Service:
      a. If any service or system must be interrupted, the Engineer shall request permission in writing stating the date, time, etc. the same will be interrupted and the areas affected. This request shall be made in sufficient time (approximately 1 week minimum in advance) for proper arrangements to be made. Written permission shall be obtained from the Owner before any interruption to electrical power is permitted.
   2. Lock-Out / Tag-Out Procedures
      a. The Engineer shall provide his own lock-out / tag-out equipment in coordination with the Owner's program; coordinate with the Owner's field operational and maintenance staff.
      b. The Engineer shall have in effect a written safety program that includes a lock-out / tag-out safety program in accordance with OHSA under Part 1910, Subpart S.
   3. Electrical Safety Program
      a. The Engineer shall review the Owner's Electrical Safety Program and take the necessary precautions, in conjunction with his own safety program for employee protection.
      b. The Engineer is to have in effect a written electrical safety program that includes all applicable provisions of the NFPA-70E which has been adopted by OHSA under Part 1910, Subpart S.

B. The Engineer shall provide written documentation indicating that his employees, those working on American Water projects, have been trained and certified on all provisions applicable to B and C above upon request from the Water Company.

C. The Engineer's employees shall follow all provisions of "B" and "C" above including, but not limited to, the use of personal protective equipment (PPE), establish protective barriers, approach boundaries and documentation for such activities. Provide a written statement attesting to the above requirements prior to the start of the Field Investigation / Data Collection activities.

D. Field Adjustment
   1. The Engineer shall adjust protective devices settings based on the final accepted Study/Report provided by the Engineer; settings to be listed in a table format and submitted as part of the final O&M Manual for the equipment / system.

E. Arc Flash Warning Labels
   1. Provide an ANSI Z535.4 compliant (size 4 in. x 6 in.) thermal transfer or equivalent type two color die-cut arc flash label as provided by DuraLabel or Brady for each work location analyzed and included in this project. Material type to be suitable for the locations; IE indoor, outdoor, chemical resistively, etc.
   2. The label shall have either an orange header with black lettering and the wording, "**WARNING, ARC FLASH HAZARD**", or a red header with white lettering and the wording, **"DANGER, ARC FLASH HAZARD".** Include the ANSI Safety Symbol in the header as recommended. The Danger signal wording shall be provided for all calculated incident energy values greater than 40 Cal/cm^2; Warning to be used for all calculated incident energy values below 40 Cal/cm^2. These labels shall include the following information:
      a. Location designation
      b. Shock Hazard Information including; Nominal voltage, Limited Approach and Restricted Approach with Covers Removed
      c. Flash protection boundary
      d. Site-specific Arc Flash PPE Category
      e. Available Fault Current – include reference to Power Study as outlined on sample labels included in the Attachments to this criteria
      f. Incident energy (calculated based on Incident Energy Analysis Method)
      g. Working distance (18" typical for all equipment and applications)
      h. Engineer, report number, revision number and issue date
      i. Reference to "Owner's Arc Flash Procedures Manual" in lieu of actual listing of clothing and glove requirements.

      Refer to Attachment at end of this document for Sample Label and Information to be included
   3. Labels shall be machine printed, with no field markings. The size of the lettering is to be in accordance with ANSI-Z535.4 recommendations for a safe viewing distance of 3' minimum based on favorable viewing conditions and information to be included.
   4. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended over-current device settings. Coordinate the data provided with the Arc Flash Study results and the ANSI labeling requirements. Quantities outlined below are considered minimum quantities necessary; provide additional labeling as may be required by Regulatory or Inspection Agencies at no additional cost to the project.
      a. For each transformer, 480 and applicable 240 and/or 208 volt panelboard, individually-mounted circuit breaker and safety disconnect device, one arc flash label shall be provided
      b. For each motor control center, one arc flash label shall be provided at the top of each vertical section *(see footnote below).*
      c. For each low voltage switchboard, one arc flash label shall be provided at the top of each vertical section *(see footnote below).*
      d. For each low voltage switchgear, one arc flash label shall be provided at the top of each vertical section *(see footnote below).*
      e. For each medium voltage switchgear, one arc flash label shall be provided for each cell within each vertical section *(see footnote below).*
      f. For medium voltage switches one arc flash label shall be provided at the top of each vertical section *(see footnote below).*

g. For each motor power terminal box, 25 horsepower and larger, one arc flash label shall be provided.
h. Additional arc flash labels to address installations and specific equipment requirements to be provided based on an individual evaluation basis and coordinated with the Owner.
i. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

(Footnote – where control center, switchboard, or switchgear assemblies are dual-fed, provide an arc flash label at each main entrance device or section as well as at any "Tie" device location. For equipment that is front and rear accessible, provide the same labeling on the rear sections as outlined above.)

5. Labels shall be field installed by the (Contractor or Engineer) at the conclusion of the project after acceptance by the Owner.

8. ATTACHMENTS

A. Sample Labels - Three Phase Systems involving calculated incident energy analysis:
   1. DANGER
   2. WARNING

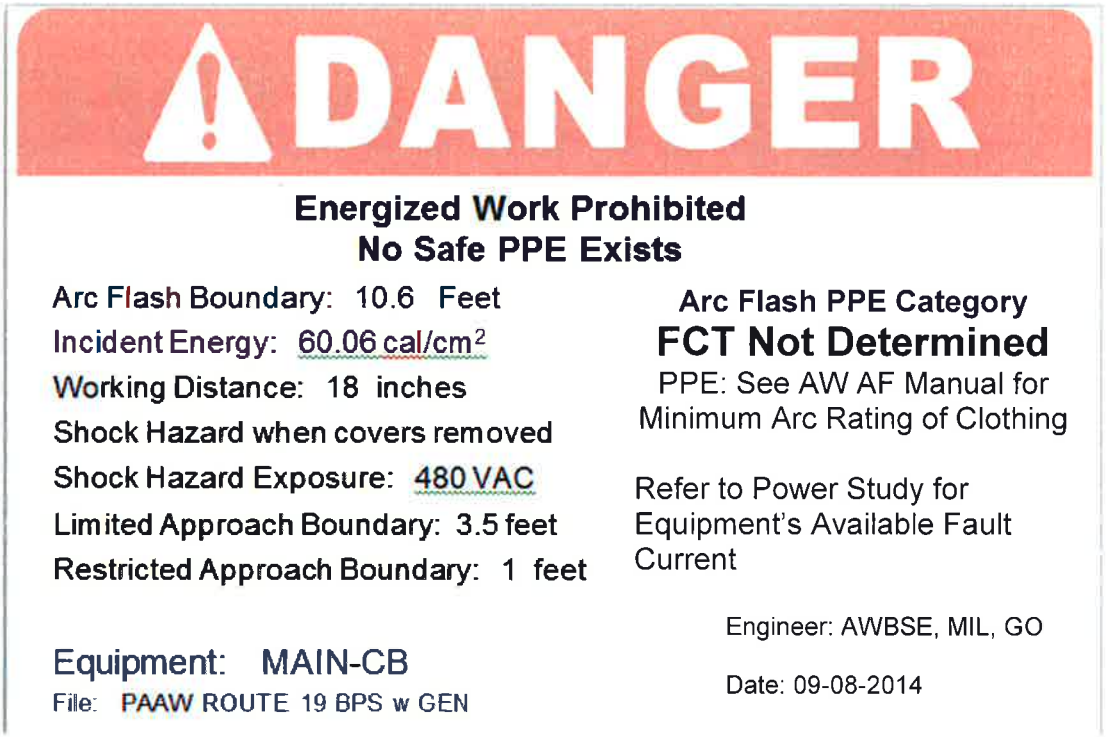
B. Sample Labels – Three Phase 120/208-240 VAC Systems associated with AW Standardized labeling
   1. WARNING

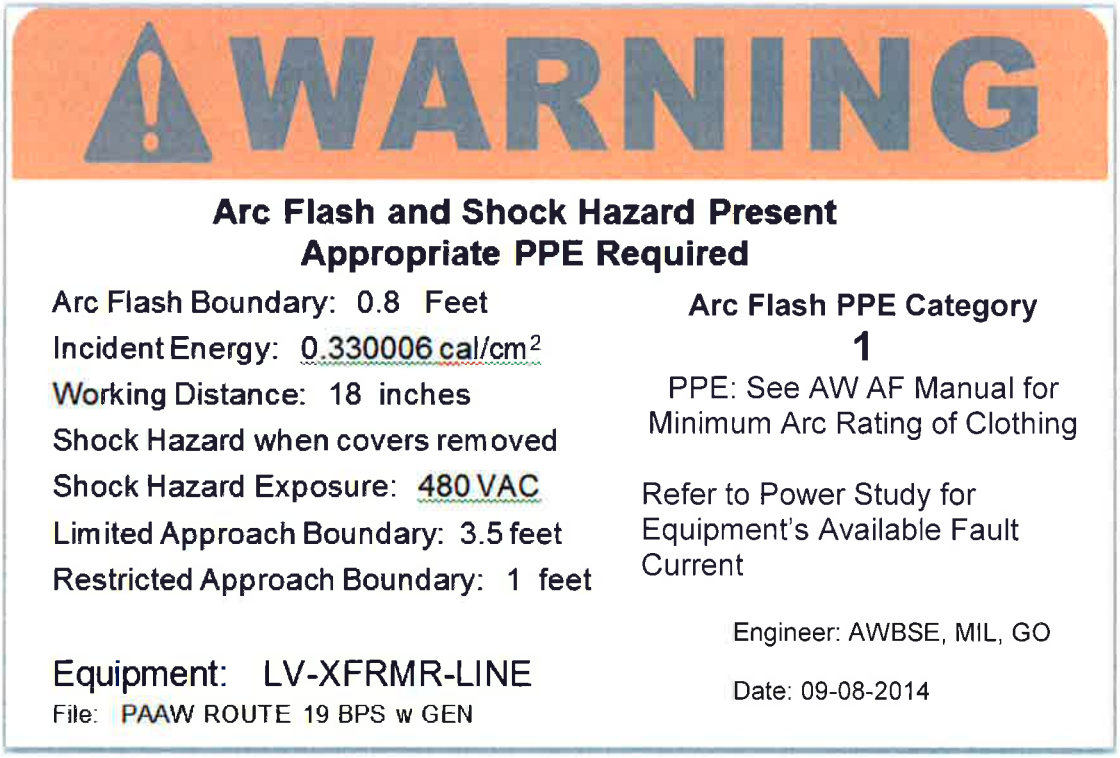
C. Sample Labels – Single Phase 120/240 VAC Systems associated with AW Standardized labeling
   1. WARNING

D. AW Engineering Criteria for Portable Generator Transfer Switch and Termination Enclosure Identification

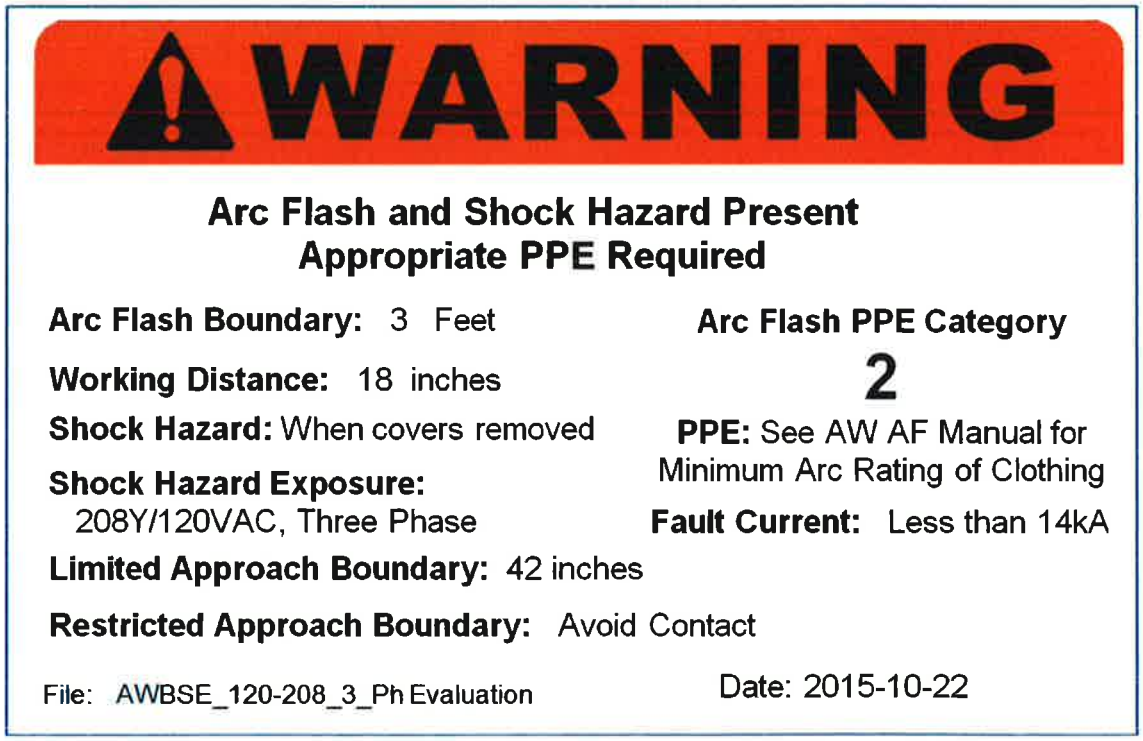
E. AW Engineering Criteria for Site Specific Arc Flash PPE Category Identification

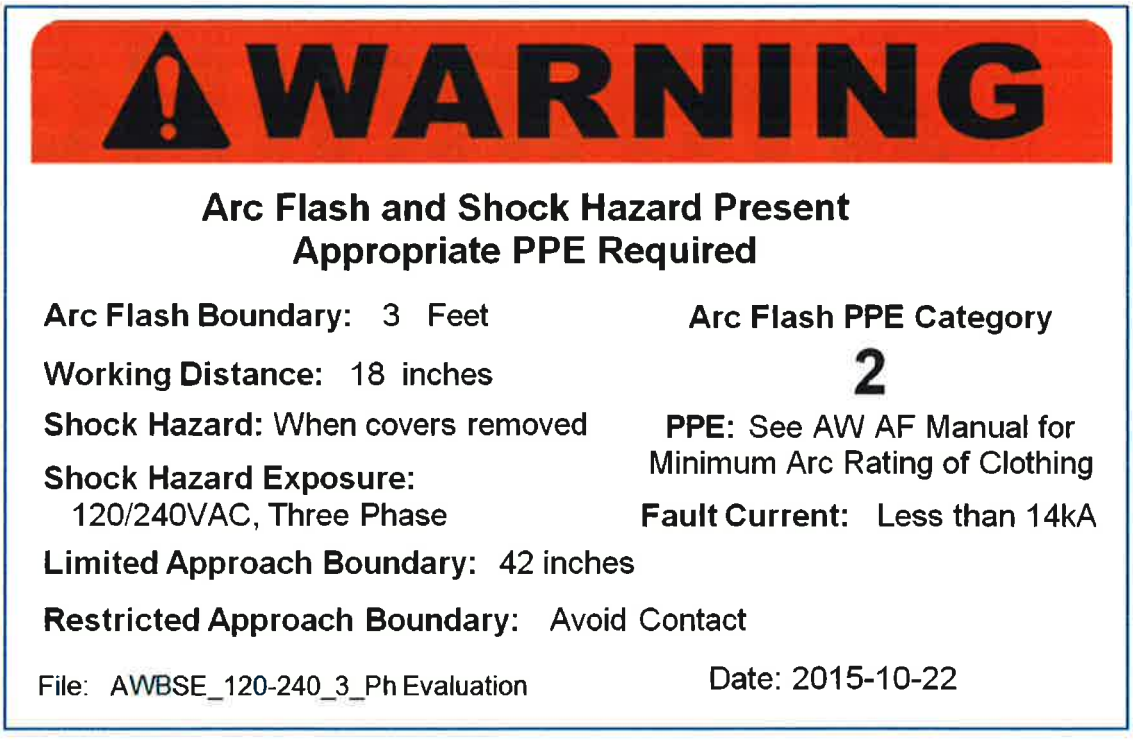
ATTACHMENT A –
Three Phase Systems involving calculated incident energy analysis





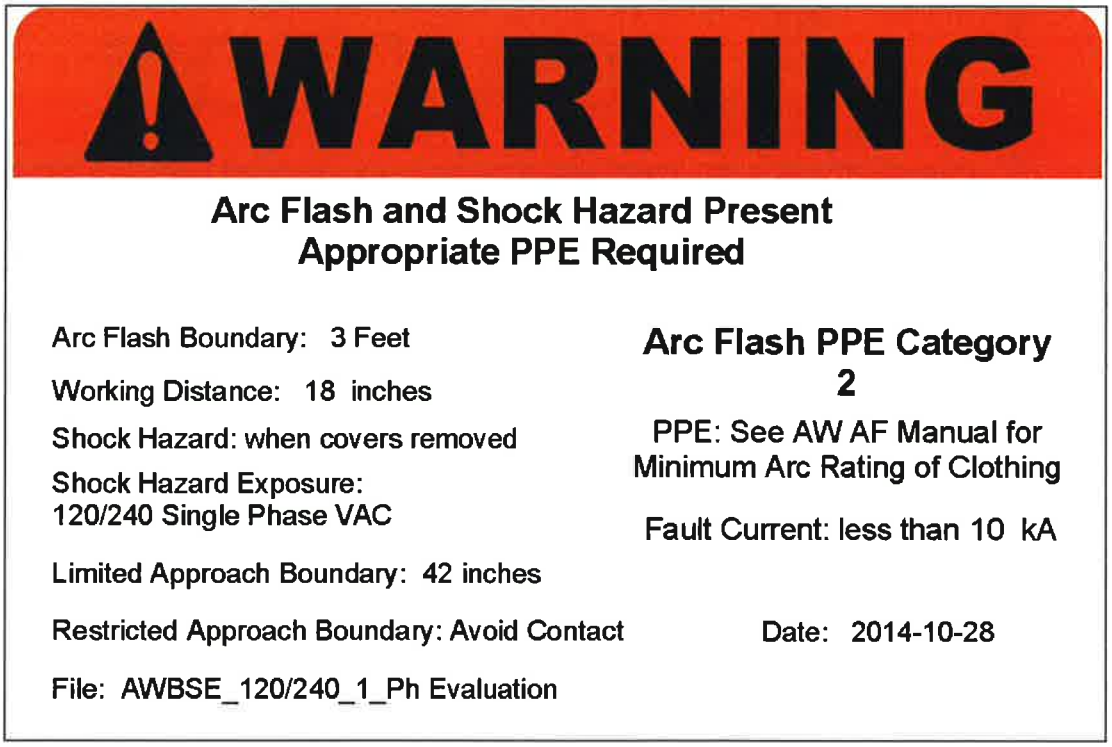
ATTACHMENT B -
Three Phase 120/208-240 VAC Systems associated with AW Standardized labeling





ATTACHMENT C –

Single Phase 120/240 VAC Systems associated with AW Standardized labeling



ATTACHMENT D –

AW Engineering Criteria for Portable Generator Transfer Switch and Termination Enclosure Identification

ATTACHMENT E –

American Water Engineering Criteria for Site Specific Arc Flash PPE Category Identification

Incident Energy Range (cal/cm²)	Arc Flash PPE Category
0 – 4.0	1
4.01 – 8.0	2
8.01 – 25.0	3
25.01 – 40.0	4
40.01 and above	DANGEROUS (No Safe PPE Exists)

Revised 3-23-2018; KEL

AMERICAN WATER
ACCEPTABLE ELECTRICAL EQUIPMENT MANUFACTURERS AND SUPPLIERS

The following listing is intended to identify those manufacturers that are generally acceptable and capable of meeting American Water's Recommended Design Standards, and provides a unified approach in design, maintenance and operation across the entire Company.

Unless specifically indicated, the naming of the manufacturers outlined below is not intended to provide the specified "order" for equipment selections. The list should be reviewed with the Water Company during the initial design phase to add or eliminate any manufacturers that are preferred or rejected by the local Operations team. The Consultant may propose other suppliers/manufacturers for Owner review and acceptance based on the specific nature of the Work and site location and/or conditions. The Consultant shall include a listing of proposed major electrical equipment manufacturers with the Design Memorandum for consideration by the Owner. The Basis of Design shall be established based on the Owner's preferences.

Note: These manufacturers and descriptions below are intended to outline the basis for the equipment design and criteria for development in the project; not exclusive approval.

Equipment Description	Manufacturers
MV Switchgear – Vacuum Breaker, Draw-Out	Cutler-Hammer Square D ABB Siemens General Electric
Medium Voltage Automatic Transfer Switchgear (Circuit Breaker Transfer Equipment – Manual or Automatic)	Cutler-Hammer Square D ABB Siemens General Electric Or Acceptable Manufacturer from above provided by Generator Equipment Manufacturer (subject to Owner approval)
MV Fusible Switchgear	Cutler-Hammer Square D *(Note - HVLcc Type Equip Not Accepted)* ABB Siemens General Electric S&C
MV Switchgear – SF6 Type	*Not Preferred Equipment*
MV Motor Control Equipment, MC Lineups (FVNR, RVSS Equipment)	Cutler-Hammer ABB Siemens General Electric
MV Variable Frequency Drives	Toshiba Allen Bradley – Voltage Source Equipment (not Current Source Drive) Cutler-Hammer Siemens/Robicon

Equipment Description	Manufacturers
LV Power Distribution Equipment – (Swgr, Swbds, Panelboards, Circuit Breakers, etc)	Cutler-Hammer Square D ABB Siemens General Electric
Transformers – Dry Type, VPI, VPE Insulation	Cutler-Hammer Square D/Sorgel Siemens ABB
Transformers – Cast-Coil	Square D/Sorgel ABB
Transformers – Liquid-Filled	*Not Preferred Equipment*
Protection Relays & Monitoring Relays for Voltage, Current, Phase Loss, Etc.	SEL (Schweitzer Engineering Laboratories) *Other acceptable manufacturers may include the following (subject to prior approval by AW Engr / Owner)* All to be provded with Fiber-Optic Communications over Ethernet / Modbus TCP/IP
Power Quality Metering, Motor Monitoring & Feeder Protection Relays	SEL 735, SEL 710, SEL 751A, SEL-489 Other SEL devices as applicable for the design of the power distribution system. *Communications to utlilize fiber-optic interface; dual-port for loop configuration where available. Copper communications to be utilized only where specifically indicated. All to be provded with Fiber-Optic Communications capability Ethernet / Modbus TCP/IP and DNP3*
Low Voltage Motor Control Centers	Cutler-Hammer Square D ABB Siemens General Electric
Full Voltage Motor Starters	Cutler-Hammer Square D ABB Siemens General Electric
Reduced Voltage (Solid-State, Soft Start) Motor Starters	Cutler-Hammer Square D ABB Siemens General Electric Danfoss Benshaw

Equipment Description	Manufacturers
Low Voltage Variable Frequency Drives – Stand Alone Applications (Free-Standing or Wall Mounted Units) *NOTE: Basic Criteria - All VFD equipment to be "Heavy Duty" / "Industrial Duty", rated for 50 C. and suitable for full load rating with 3% voltage unbalance. Cooling fans shall be accessible without requiring total dismantling of the drive assembly; top outlet discharge preferred.* *"HVAC Rated" Drives are Not Permitted* *** NEMA4X Note: Drive assembly to be rated NEMA 4x by manufacturer; use of open chassis or NEMA 1 drives installed in NEMA 4x enclosure is not suitable in meeting this criteria.*	Free-Standing – Wall or Floor Mounted Square D Cutler-Hammer Allen Bradley Toshiba ABB Siemens/Robicon Danfoss Benshaw Yaskawa NEMA 4X Type (where required)** Allen Bradley Yaskawa T B Woods Others as determined suitable for the application Harmonic Filters (where required) TCI Mirrus MTE
Low Voltage Variable Frequency Drives – Part of MCC Lineup/Equipment *(Not an AW preferred method)*	Cutler-Hammer Square D ABB Seimens General Electric
Low Voltage Automatic or Manual Transfer "Switches" – Contactor Type assembly	ASCO 4000 Series (unless otherwise suitable) Other potential Suppliers include: Cutler-Hammer GE/Zenith Russelectric
Low Voltage (*Service Entrance Rated where applicable*) Automatic Transfer Equipment (Circuit Breaker Transfer Equipment – Manual or Automatic) *NOTE: Circuit Breaker – Main and Circuit Breaker – Standby (where identified) REQUIRED unless specifically accepted otherwise*	Cutler-Hammer/Eaton Square D ASCO 4000 Series Russelectic Switchgear General Electric
Uninterrupted Power Supplies	APC Powerware General Electric Mesta Liebert MCG

Equipment Description	Manufacturers
Surge Protective Devices (UL-1449, Rev 4 Compliant and **Listed/Labeled**) *Note: use of integral SPD with panelboards and equipment not permitted; provide stand-alone external devices only unless otherwise specifically approved*	APT – Advanced Protection Technologies "XDS" Series MCG Cutler-Hammer "SPD" Series
NOTE: The following descriptions provide general guidelines for lighting fixtures and applications. As LED technology continues to be available at lower costs, American Water recommends evaluation between LED and Fluorescent lamps/fixtures. Where fluorescent fixtures are used (T-5 and T-8 fluorescent lamps), provide Programmed / Rapid-Start Ballasts. (*note- the use of Instant-Start ballasts is prohibited*) The use of LED technology is recommended for all exterior applications unless special aesthetic and/or other site-specific criteria is established by the Owner or Regulatory Authority	
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor Enclosed and Gasketed Fluorescent for Damp and Wet Locations (Process and Chemical Rooms)	EPCO GFF Series w/SS Latches, Simkar EN 2 or 3 w/SS Latches, Holophane ERS Series, Lithonia FSW or FHE Series, ILS Others as accepted by Owner *(Note – the use of fixtures similar to Lithonia DMR Series, Columbia LUN Series, Simkar OV450, etc are generally prohibited due to on-going physical / performance issues associated with this type of design (limited latches retaining sealed integrity of the assembly)). Fixture selection is to take into consideration lamp output, lumen maintenance, and environmental factors associated maintainability of the overall system.*
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor dry applications	Benjamin, Philips, Keene, Lithonia and Others as accepted by Owner
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor Hazardous Locations	Appleton Crouse-Hinds Killark Others as accepted by Owner
Lighting Fixtures – LED Indoor	Lithonia Philips Cree Others as accepted by Owner
All LED luminaires must be UL Listed (e.g. UL8753 / UL8750) and tested to IESNA LM-79 and LM-80 standards and that the results of those tests must be submitted to the Owner as part of the submittal review process. LED fixtures to be provided with a minimum 5 year warranty covering the driver, the LED components and the luminaire.	
Lighting Fixtures – LED Outdoor	RAB Cree Philips Dialight Lithonia Others as accepted by Owner
Lighting Fixtures – HPS Outdoor	Holophane, Infranor Devine, Philips Others as accepted by Owner

Equipment Description	Manufacturers
Lighting Control - Occupancy Sensors	Sensor Switch (High Humidity / Low Temperature Type) – process & chem. Areas Leviton, Hubbell, P&S along with others mfgrs and products to be provided as determined suitable for the location and environment where installed. *NOTE: Technology (passive IR, ultrasonic, or dual) to be based on location where installed.*
Lighting Control – Daylight Harvesting and/or Special Function and Dimming	Lutron Wattstopper Day Light Controls Others as accepted by Owner
Control and Timing Relays ("Ice-cube" relay style)	Diversified Potter Brumfield Syrelec Allen Bradley Square D Cutler-Hammer Seimens Releco Others as accepted by Owner
Push Buttons, Selector Switches & Pilot Lights (30 mm minimum size devices, NEMA 4X style preferred and high-intensity LED pilot lamps)	Cutler-Hammer Square D Seimens Allen Bradley Kraus & Naimer
Definite Purpose Relays and Contactors	Cutler Hammer Square D Siemens Allen Bradley
PVC Coated Rigid Steel Conduit	Ocal Robroy
Fiberglass Conduit	Champion FRE
Power Generation Equipment – (Diesel engine driven units)	Onan/Cummins Caterpillar Kohler Others only as determined accepted by Owner
Industrial and Corrosion Resistant Wiring Devices	Cooper Industries Legrand Leviton Hubbell Meltric Woodhead, http://www.woodheadsales.com

Attachment 8.3.4

SEL Device Monitoring Points (Modbus to SCADA /RTU)

The following Information represents typical data monitoring from many of the SEL metering and protective relays identified in the AW Recommended Electrical Design Criteria and Standards.

The information provided herein as a starting point for baseline data acquisition; additional information may also be required for specific maintenance assistance, trend analysis, etc. and does not include all of the data points/registers available.

The Engineer is to review with the Owner potential supplemental data and configuration that may be needed or recommended based on the specifics of the project, preventative maintenance, alarm reporting as well as other devices.

SEL-735:

TCP Modbus Register	Signal
912	PFT3_True_Power_Factor_3_Phase
351	IA_Phase_A_RMS_Current
353	IB_Phase_B_RMS_Current
355	IC_Phase_C_RMS_Current
1016	VAB_RMS_Voltage
368	VBC_RMS_Voltage
370	VCA_RMS_Voltage
901	Frequency
1020	W3_3_Phase_kWatts

Attachment C - 3.4

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-710

TCP Modbus Register	Signal
689	ApparentPwr
714	BearingTempMax
651	CurrentA
653	CurrentB
655	CurrentC
664	CurrentImbal
1806	Enabled
1827	Fault
690	Frequency
691	MWhOut_HighWord
692	MWhOut_LowWord
692	MWhOut_Total
689	PowerFactor
687	ReactivePwr
686	RealPwr
1694	TotDemand
1699	TotPeakDemand
1806	TripAlarm
668	VoltageAB
670	VoltageBC
672	VoltageCA
685	VoltageImbal
713	WindingTempMax

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-751A

TCP Modbus Register	Signal
689	ApparentPwr
651	CurrentA
653	CurrentB
655	CurrentC
664	CurrentImbal
1806	Enabled
1827	Fault
690	Frequency
691	MWhOut_HighWord
692	MWhOut_LowWord
689	PowerFactor
687	ReactivePwr
686	RealPwr
1694	TotDemand
1699	TotPeakDemand
1806	TripAlarm
668	VoltageAB
670	VoltageBC
672	VoltageCA
685	VoltageImbal
692	MWhOut_Total
144	BreakerClosed

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-351

TCP Modbus Register	Signal
689	ApparentPwr
193	BreakerClosed
651	CurrentA
653	CurrentB
655	CurrentC
664	CurrentImbal
1806	Enabled
1827	Fault
690	Frequency
691	MWhOut_HighWord
692	MWhOut_LowWord
692	MWhOut_Total
689	PowerFactor
687	ReactivePwr
686	RealPwr
1694	TotDemand
1699	TotPeakDemand
1806	TripAlarm
668	VoltageAB
670	VoltageBC
672	VoltageCA

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-787

TCP Modbus Register	Signal
729	ApparentPwr
176	BreakerClosed
685	CurrentA
687	CurrentB
689	CurrentC
8	Enabled
732	Frequency
733	MWhOut_Total
730	PowerFactor
728	ReactivePwr
727	RealPwr
759	TotDemand
764	TotPeakDemand
169	TripAlarm
710	VoltageAB
712	VoltageBC
714	VoltageCA
152	TemperaureAlarm
207	FaultAlarm
771	THD_IA_Pri
772	THD_IB_Pri
773	THD_IC_Pri
777	THD_VA_Pri
778	THD_VB_Pri
779	THD_VC_Pri
784	WindingTempMax

Attachment Q- 3.1

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-700G

TCP Modbus Register	Signal
689	ApparentPwr
651	CurrentA
653	CurrentB
655	CurrentC
664	CurrentImbal
1806	Enabled
1827	Fault
690	Frequency
691	MWhOut_HighWord
692	MWhOut_LowWord
689	PowerFactor
687	ReactivePwr
686	RealPwr
1694	TotDemand
1699	TotPeakDemand
1806	TripAlarm
668	VoltageAB
670	VoltageBC
672	VoltageCA
685	VoltageImbal
692	MWhOut_Total
144	BreakerClosed

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-849

TCP Modbus Register	Signal
	ApparentPwr
	CurrentA
	CurrentB
	CurrentC
	CurrentImbal
	Enabled
	Fault
	Frequency
	MWhOut_HighWord
	MWhOut_LowWord
	MWhOut_Total
	PowerFactor
	ReactivePwr
	RealPwr
	TotDemand
	TotPeakDemand
	TripAlarm
	VoltageAB
	VoltageBC
	VoltageCA
	VoltageImbal

Other Devices and Monitoring Data evaluated based on Project Requirements and Specific Criteria needed

Appendix 4

PG&E Information

The PG&E Utility Planner:

Mr. Jose Saldana

PG&E Representative

Phone: 831 784-3574

Email: JFSE@PGE.com

PG&E Application Number: 112903042

Secondary Arc Flash Assessment – PG&E Distribution System

Secondary Arc Flash Assessment – PG&E Distribution System

Date: 12/14/17
PG&E Representative:
Telephone #:

Dear Customer,

PG&E recommends that all electrical work on the main breaker to the service panel be done in a de-energized condition to eliminate arc flash hazards.

PG&E's electric system is dynamic, and due to its many variables a range of impedances should be considered in an arc flash assessment. The dynamics of the system include:

- The electric system that is feeding your location is continually being reconfigured due to system needs and general maintenance. These changes can lead to significant changes in the system impedance.
- When a distribution transformer is replaced, the size is reassessed based on the expected loading, and the replacement transformer can have an impedance anywhere in the range specified in Attachment 1.
- The protective devices associated with the distribution transformer are intended to provide protection to the primary system, and should not be relied upon to protect the service panel or customer systems.

The following data should be used for the system impedance:

Maximum: 500 MVA
Minimum: 4.5 MVA
Maximum X/R ratio: 40

It has been determined that at the following location:
Address: Street: General Jim Moore at Ardennes
City: Seaside

The present system characteristics are:

	Circuit Base Voltage:	12 kV: 12470 V
	System Positive Sequence Impedance:	0.8454 ΩR 2.6802 ΩX
	System Zero Sequence Impedance:	1.29794 ΩR 5.0996 ΩX
	3Ø Asymmetric:	2924 A
System Short Circuit Duty	3Ø Symmetric:	2589 A
	Single-Line to Ground:	2006 A

The existing distribution transformer characteristics are:

External Primary Protective Device - Type, Size and Setting (when available from mapped data)[1]:	Recloser, 400A rating; Phase Trip = 200A, Phase Slow Curve = 165; Ground Trip = 70A, Ground Slow Curve = 165
Transformer Type:	3 Phase Pad Mount (Tbl 3)
Transformer Size:	kVA
Transformer Phase-Phase Primary Voltage:	12000 V
Transformer Secondary Voltage:	277/480 3 Phase
Transformer Impedance:	See specified table in Attachment 1

[1] This is often not available from mapped data or not applicable to the transformer type.

PG&E Distribution System and Arc Flash Assessment
Attachment 1 – System Voltages & Transformer Impedance Ranges

The impedance of PG&E's transformers is required to be within the indicated range. Either the design or tested impedance of the transformer is recorded on the transformer nameplate. A field check and an electrical shutdown may be required to read the nameplate.

Each table below lists the full range of transformer sizes for each transformer type. At the time of replacement, any size listed in the table could be installed. For Example: Referring to Table 3a the possible replacement transformer sizes for a 3-phase 300kVA 208Y/120V pad-mount transformer range from 75 kVA to 1000 kVA.

Table 1: Single-Phase Pad-Mount Transformer Impedance Range

Transformer kVA	Secondary Voltage 120/240	
	Minimum	Maximum
25-75	1.4%	2.4%
100	1.8%	3.0%
167-500	2.0%	5.0%

Table 2: Duplex Transformer Impedance Range

Transformer kVA	Secondary Voltage 120/240	
	Minimum	Maximum
25/10 – 75/15	1.4%	2.4%
100/25 – 100/50	1.8%	3.0%

Table 3: Three-Phase Pad-Mount Transformer Impedance Range

a)

Transformer kVA	Secondary Voltage 208Y/120 or 240/120	
	Minimum	Maximum
45-75	1.4%	3.5%
112.5-225	1.9%	4.5%
300	2.8%	4.5%
500-1000	5.3%	6.2%

b)

Transformer kVA	Secondary Voltage 480Y/277	
	Minimum	Maximum
45-75	1.4%	4.5%
112.5-225	1.4%	4.5%
300-500	1.9%	4.5%
750-3325	5.3%	6.2%

c)

Transformer kVA	Secondary Voltage 2400/4160Y/2400	
	Minimum	Maximum
300	1.9%	4.5%
750-3325	5.3%	6.2%

Table 4: Single-Phase Subsurface Transformer Impedance Range

Transformer kVA	Secondary Voltage 120/240 or 240/480	
	Minimum	Maximum
25 and 50	1.4%	2.4%
100	1.8%	3.0%
167 and larger	2.0%	5.0%

Table 5: Three-Phase Subsurface and Vault Transformer Impedance Range

a)

Transformer kVA	Secondary Voltage 208Y/120	
	Minimum	Maximum
112.5-150	1.9%	4.5%
300	2.8%	4.5%
500-1000	5.3%	6.2%

b)

Transformer kVA	Secondary Voltage 480Y/277	
	Minimum	Maximum
112.5-150	1.4%	4.5%
300-500	1.9%	4.5%
750-2500	5.3%	6.2%

Table 6: Single-Phase Overhead Transformer Impedance Range

a)

Transformer kVA	Secondary Voltage 120/240	
	Minimum	Maximum
5-75	1.4%	2.4%
100	1.8%	3.0%
167-500	2.0%	5.0%

b)

Transformer kVA	Secondary Voltage 240/480	
	Minimum	Maximum
5-75	1.4%	2.4%
100	1.8%	3.0%
167-500	2.0%	5.0%

c)

Transformer kVA	Secondary Voltage 4160/2400	
	Minimum	Maximum
50-500	2.0%	5.4%

Table 7: Three-Phase Overhead Transformer Impedance Range

a)

Transformer kVA	Secondary Voltage 208Y/120	
	Minimum	Maximum
45 – 112.5	1.4%	3.5%
150	1.9%	4.5%
225	2.1%	4.5%
300	2.8%	4.5%

b)

Transformer kVA	Secondary Voltage 480Y/277	
	Minimum	Maximum
45 – 112.5	1.4%	4.5%
150	1.4%	4.5%
225	1.4%	4.5%
300	1.9%	4.5%

PG&E Distribution System Base Voltages:
4160, 4800, 12470, 18000, 21600, 34500 V

PG&E Distribution Transformer Primary Base Voltages:
2400, 4160, 4800, 6930, 7200, 12000, 17200, 20780, 34500 V

Appendix 5

Figure 1. Project Location Map

Exhibit 3: Site Plan

Plate 2: Monitoring Wells No. 1 Location Map

Disposal Location Map

EL-4: Sample One-line Diagram Pump Station

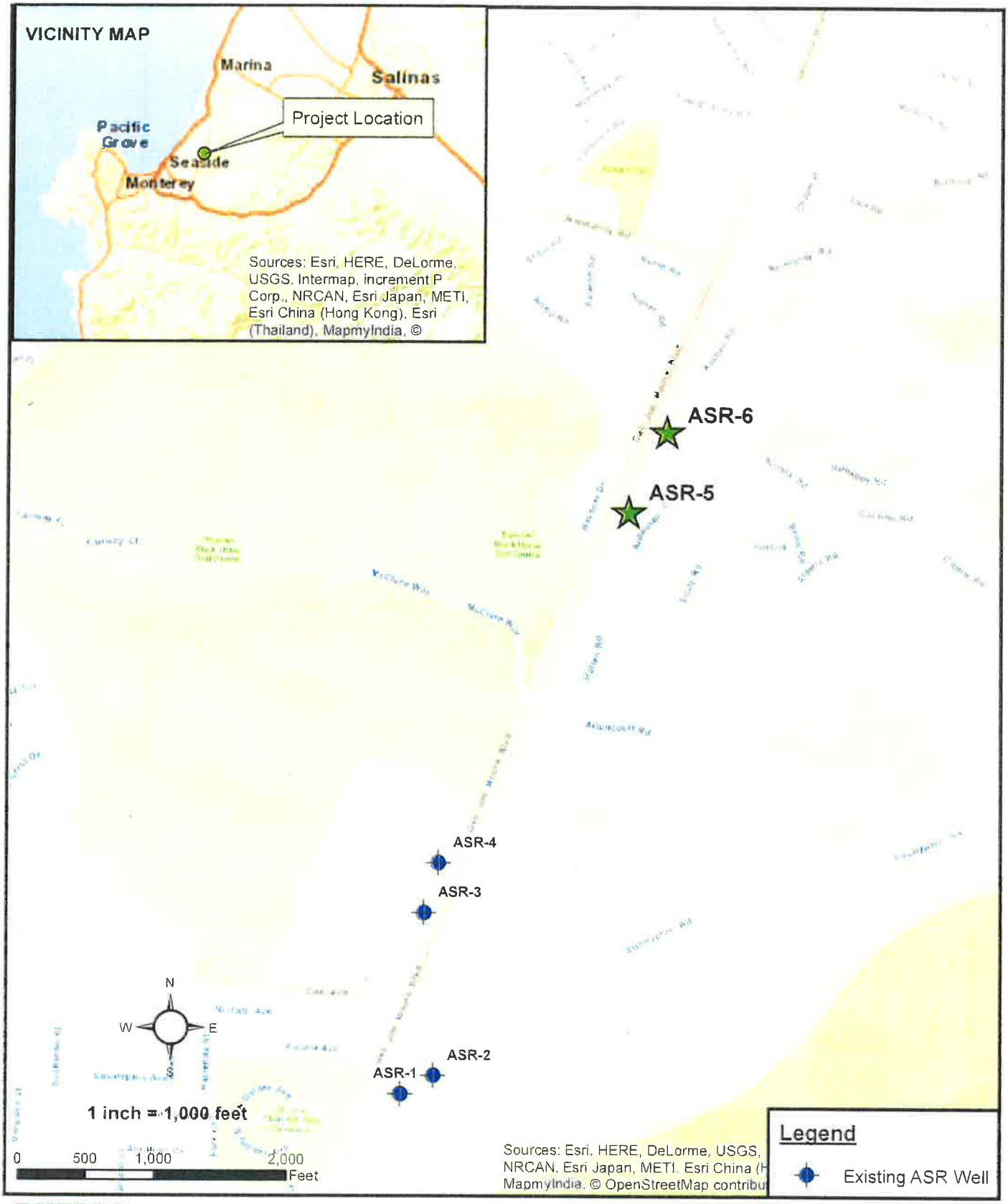
EL-07: Sample VFD Schematic Wiring Diagram

Tree Removal Map ASR-6 Site

Tree Removal Map ASR-5 Site

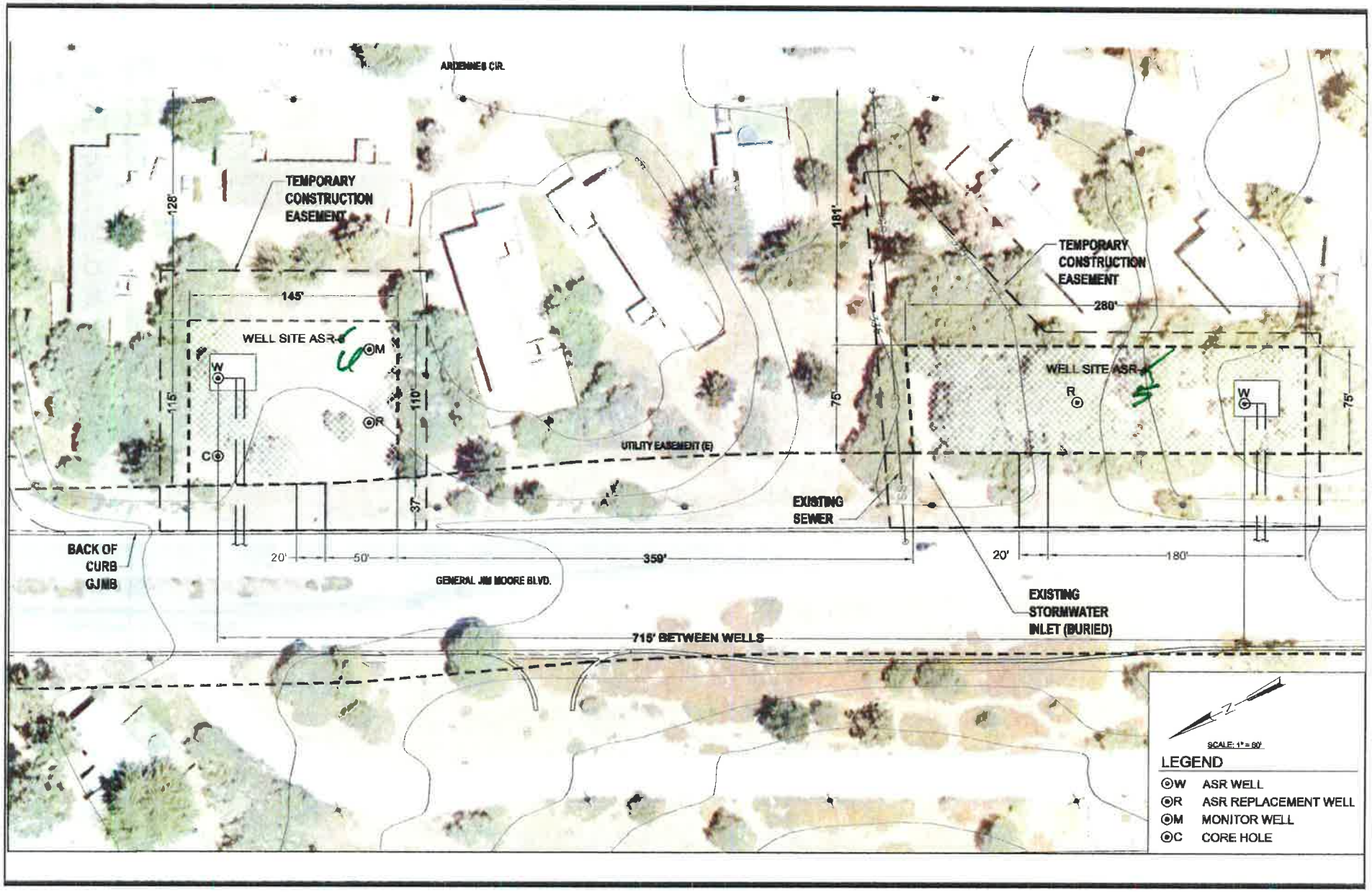
Email: 12/12/2017 PGE Power Grid (Fort Ord Circuit)

PGE Application for Power for ASR 5 and ASR 6, (app. # 112903042)



PUEBLO water resources

FIGURE 1. PROJECT LOCATION MAP
Fitch Park ASR-5 and ASR-6 Project
California American Water

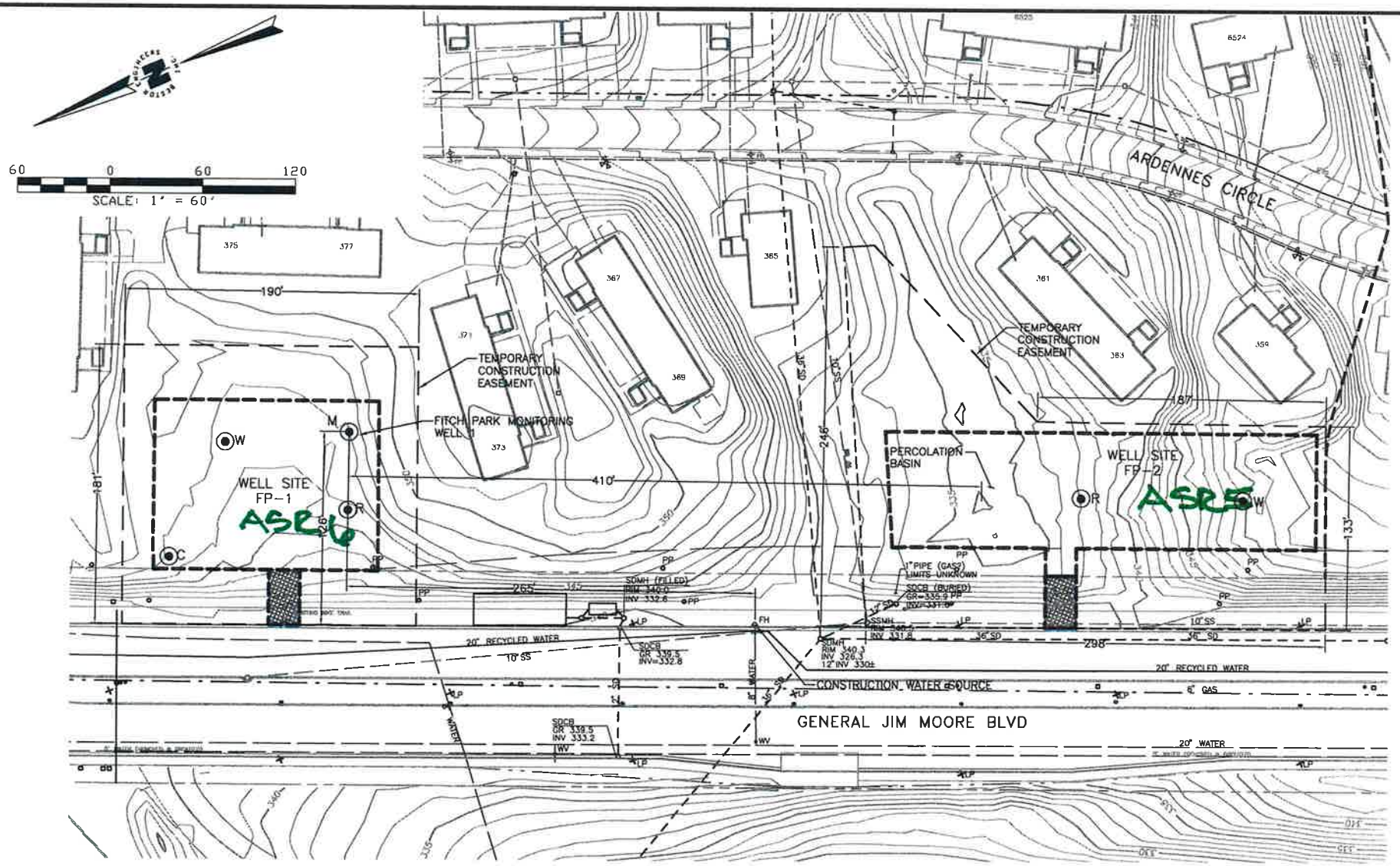


RBF CONSULTING

SITE PLAN

Coastal Water Project - Aquifer Storage and Recovery (ASR)

Exhibit 3



CALIFORNIA AMERICAN WATER

Monterey Division
511 Forest Lodge Road, Ste. 100
Pacific Grove, CA 93950

REVISIONS				
REV	DESCRIPTION	BY	DATE	APP'R

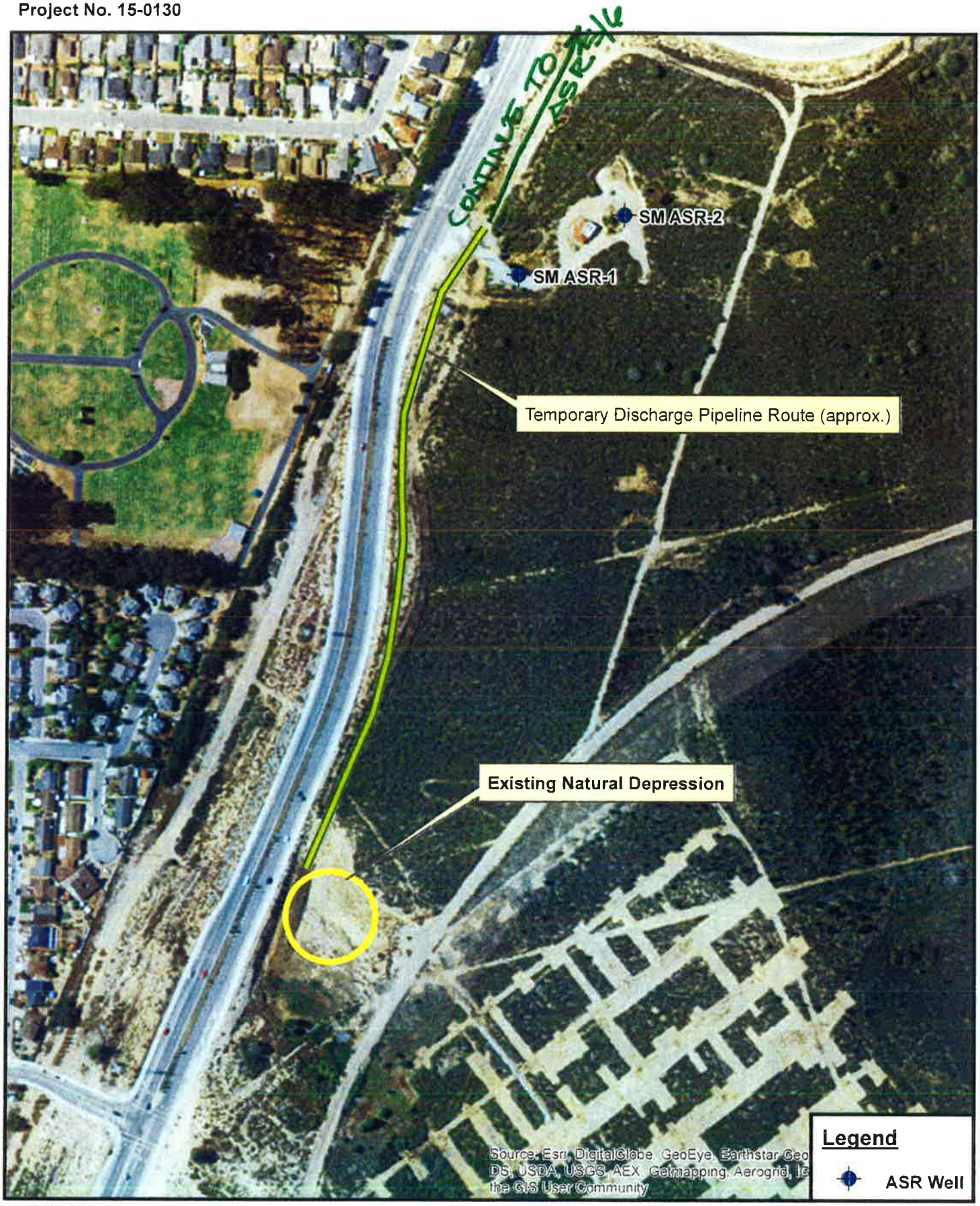
BESTOR ENGINEERS, INC.
9701 BLUE LARKSPUR LN.
MONTEREY, CA. 93940
(831)373-2941

DATE: MAY 9, 2010
DRAWN: STAFF
DESIGN: STAFF
CHECKED: H.P. WARD
PROJECT ENGINEER: JAMIE PLATZ

PROJECT NAME:
MONTEREY BAY REGIONAL WATER SUPPLY PROJECT
ASR TEST WELLS

SHEET TITLE:
PLATE 2 -- MONITORING WELL NO. 1 LOCATION MAP

WORK ORDER NO.: 6684.00
BUDGET PROJECT NO.:
SCALE: AS SHOWN
DIMENSIONS GOVERN OVER SCALE
USE ONLY APPROVED DRAWINGS FOR CONSTRUCTION PURPOSES
SHEET NO.: 1



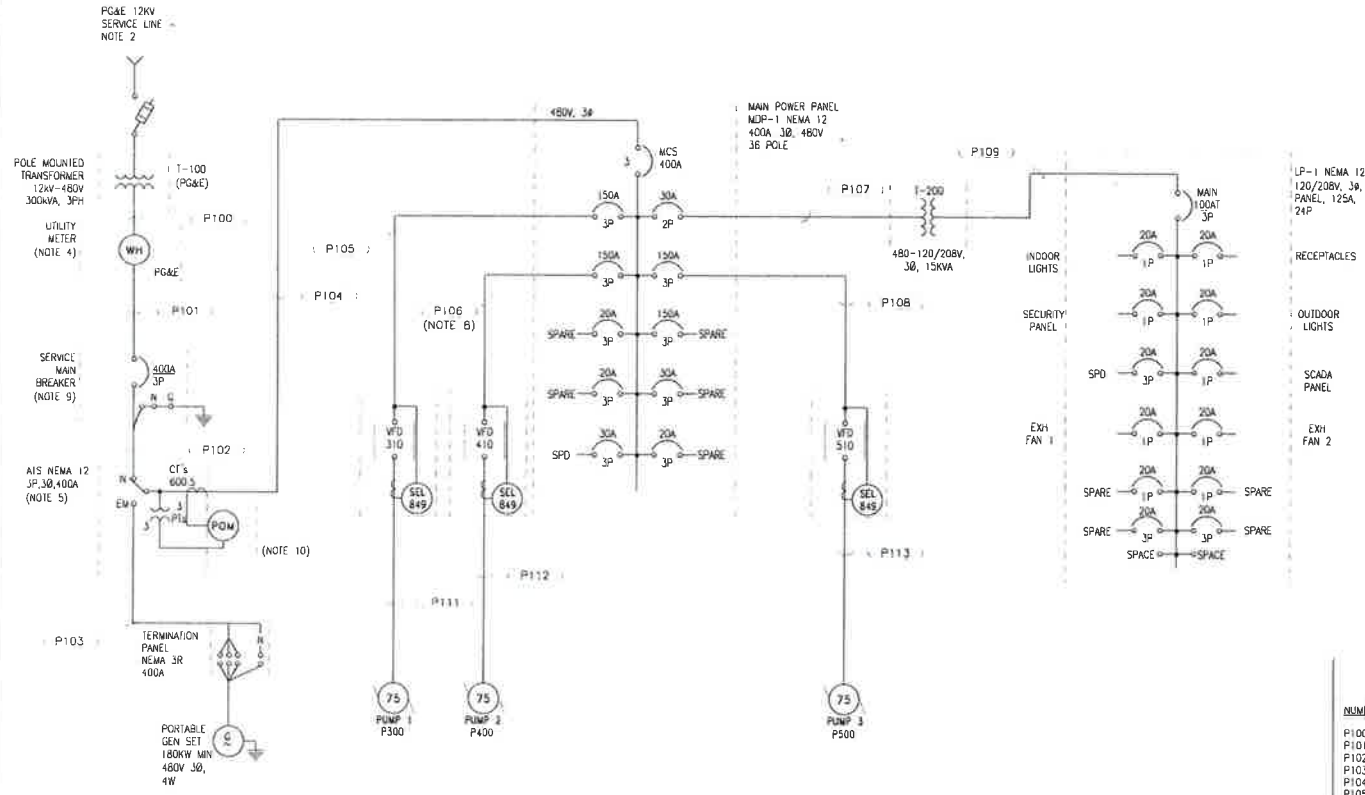
PUEBLO water resources

N
W E
S

1 inch = 300 feet

0 150 300 600
Feet

FIGURE 1. DISCHARGE DISPOSAL LOCATION MAP
Fitch Park ASR-5 and ASR-6 Project
California American Water



SHEET NOTES:

1. SEE SITE PLAN FOR GENERAL ELECTRICAL NOTES.
2. ELECTRICAL SERVICE AND METERING PANEL DRAWINGS SHALL BE SUBMITTED TO OWNER AND PG&E FOR REVIEW AND APPROVAL BEFORE PLACING EQUIPMENT ORDER.
3. CONTRACTOR TO CONFIRM SERVICE CONDUIT SIZE AND ROUTING WITH PG&E. PROVIDE SERVICE CONDUIT AND TRENCH CONSTRUCTION IN ACCORDANCE WITH PG&E REQUIREMENTS.
4. CONTRACTOR SHALL PROVIDE SERVICE METER PANEL IN ACCORDANCE WITH PG&E METER REQUIREMENTS.
5. AUTOMATIC TRANSFER SWITCH, RATED 400A, 480V, 3 POLE, SHALL BE NEMA 12, CONTACTOR TYPE. SEE SPECIFICATIONS.
6. CONTRACTOR SHALL PROVIDE STRUCTURAL DESIGN FOR ALL ELECTRICAL PANELS AND PROPOSED PANEL MOUNTING METHODS, INCLUDING SEISMIC AND OVERTURNING CALCULATIONS.
7. CONDUITS SHALL BE PVC, SCHEDULE 40, BELOW GRADE AND RIGID GALVANIZED STEEL ABOVE GRADE WITH PVC COATED GRS SWEEPS WHERE TRANSITIONING FROM BELOW GRADE OR CONCRETE TO ABOVE GRADE OR FLOOR. PROVIDE LIQUIDTIGHT FLEXIBLE METAL CONDUIT FOR FINAL CONNECTIONS TO FIELD DEVICES (E.G., MOTORS, FLOW METER, TRANSMITTERS). SEE SPECIFICATIONS FOR COMPLETE CONDUIT AND CONDUCTOR REQUIREMENTS.
8. CONTRACTOR SHALL PROVIDE SEPARATE CONDUITS FOR EACH VFD POWER CIRCUIT AND CONTROL DEVICES WITH SHIELDED POWER CONDUCTORS. ONLY TWO PUMPS WILL RUN AT ONE TIME.
9. MAIN BREAKER SHALL BE SOLID STATE ADJUSTABLE TRIP. SEE SPECIFICATIONS.
10. CAW POWER QUALITY METER SHALL BE SEL 735. PROVIDE CAT 6 READOUT TO SCADA PANEL.

POWER CONDUIT SCHEDULE

NUMBER	SIZE	FILL (CU WIRE)	FROM	TO
P100	5"	BY PG&E	T-100	UTILITY METER
P101	4"	3#500KCMIL, #1/0 NEUT, #1/0 GND	UTILITY METER	MAIN BKR
P102	4"	3#500KCMIL, #1/0 NEUT, #1/0 GND	MAIN BKR	ATS
P103	4"	3#500KCMIL, #1/0 NEUT, #1/0 GND	GEN SET	ATS
P104	4"	3#500KCMIL, #1/0 NEUT, #1/0 GND	ATS	MAIN POWER PANEL
P105	2"	3#1/0 #6 GND	MAIN POWER PANEL	VFD-P1
P106	2"	3#1/0 #6 GND	MAIN POWER PANEL	VFD-P2
P107	3/4"	3#10 #12 GND	MAIN POWER PANEL	T-200
P108	2"	3#1/0 #6 GND	MAIN POWER PANEL	VFD-P3
P109	2"	4#1/0 #6 GND	T-200	LP-1
P110	2"	1-3/C#2/0 SHIELDED #6 GND	VFD-310	P300
P112	2"	1-3/C#2/0 SHIELDED #6 GND	VFD-410	P400
P113	2"	1-3/C#2/0 SHIELDED #6 GND	VFD-510	P500

REVISIONS

CARMEL VALLEY PUMP STATION
ELECTRICAL

SINGLE LINE DIAGRAM

CALIFORNIA AMERICAN WATER

AECOM
300 LAKESIDE SUITE 400
OAKLAND CALIFORNIA 94612

AECOM

CALIFORNIA AMERICAN WATER

DRAWN BY C PLANK
PROJECT ENGR S KHALSA
APPROVED C SMITH

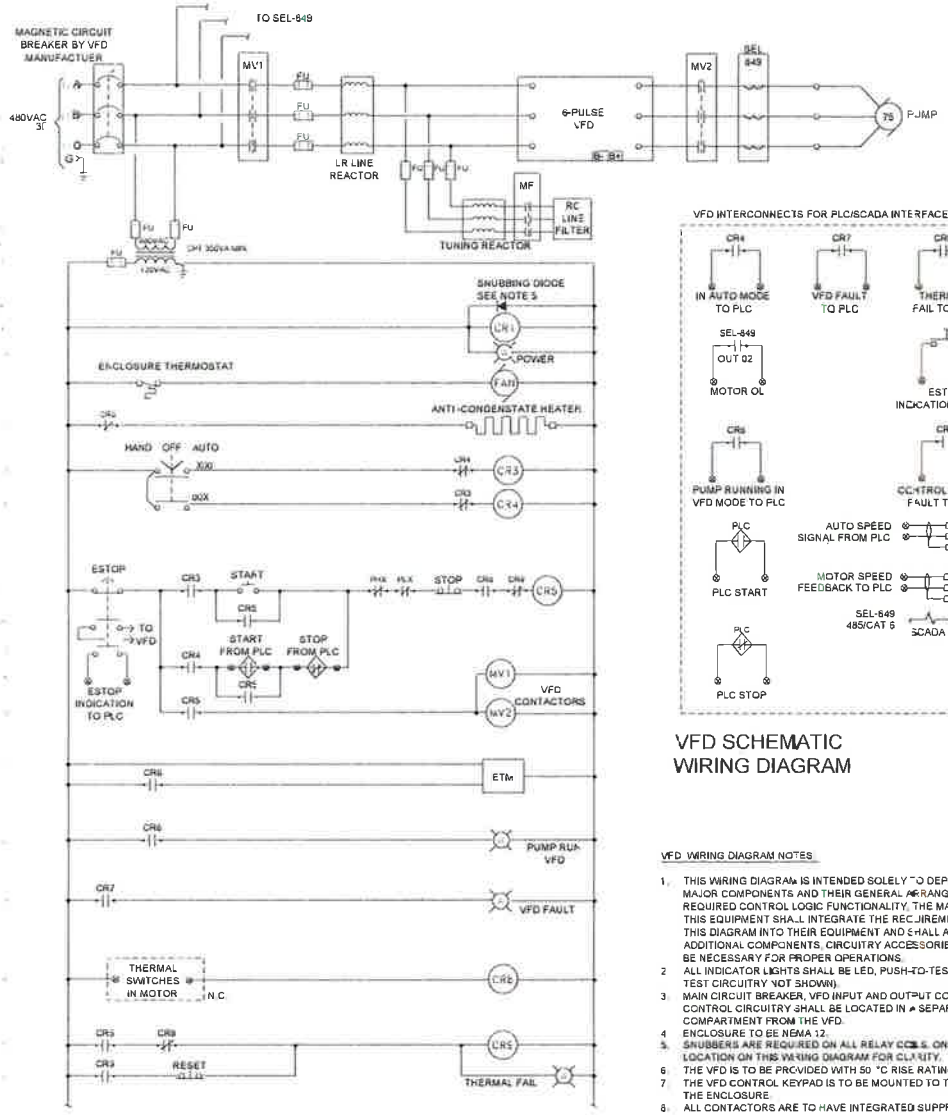
DATE APRIL 2018
PROJECT 60468016

USE DIMENSIONS ONLY
SCALE AS SHOWN

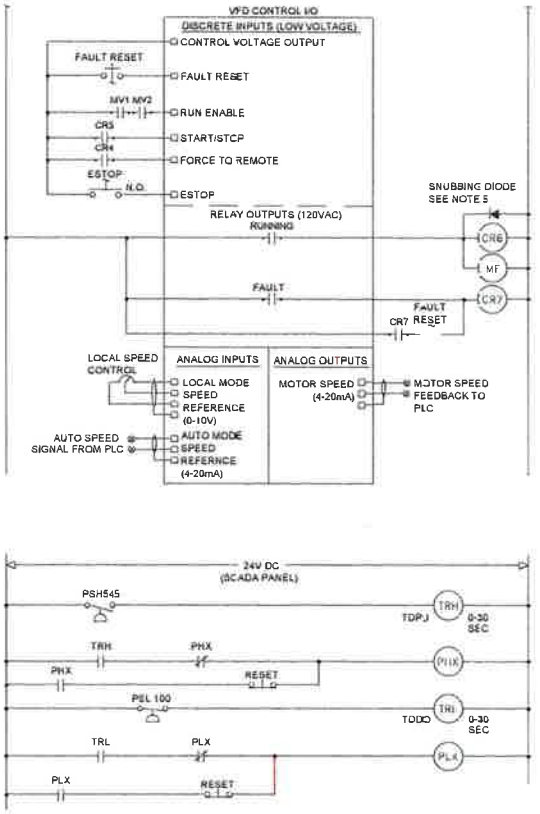
✓USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

EL-04

SAMPLE



VFD SCHEMATIC WIRING DIAGRAM



VFD WIRING DIAGRAM NOTES

1. THIS WIRING DIAGRAM IS INTENDED SOLELY TO DEPICT THE REQUIRED MAJOR COMPONENTS AND THEIR GENERAL ARRANGEMENT, AS WELL AS REQUIRED CONTROL LOGIC FUNCTIONALITY. THE MANUFACTURER OF THIS EQUIPMENT SHALL INTEGRATE THE REQUIREMENTS DEPICTED BY THIS DIAGRAM INTO THEIR EQUIPMENT AND SHALL ALSO PROVIDE ANY ADDITIONAL COMPONENTS, CIRCUITRY ACCESSORIES, ETC. WHICH MAY BE NECESSARY FOR PROPER OPERATIONS.
2. ALL INDICATOR LIGHTS SHALL BE LED, PUSH-TO-TEST TYPE (PUSH TO TEST CIRCUITRY NOT SHOWN).
3. MAIN CIRCUIT BREAKER, VFD INPUT AND OUTPUT CONTACTORS AND ALL CONTROL CIRCUITRY SHALL BE LOCATED IN A SEPARATE (BARRIERED) COMPARTMENT FROM THE VFD.
4. ENCLOSURE TO BE NEMA 12.
5. SNUBBERS ARE REQUIRED ON ALL RELAY COILS. ONLY SHOWN IN ONE LOCATION ON THIS WIRING DIAGRAM FOR CLARITY.
6. THE VFD IS TO BE PROVIDED WITH 50 °C RISE RATING.
7. THE VFD CONTROL KEYPAD IS TO BE MOUNTED TO THE FRONT FACE OF THE ENCLOSURE.
8. ALL CONTACTORS ARE TO HAVE INTEGRATED SUPPRESSORS.

SAMPLE

REVISIONS

CARMEL VALLEY PUMP STATION
ELECTRICAL
VFD SCHEMATIC WIRING DIAGRAM

CALIFORNIA AMERICAN WATER

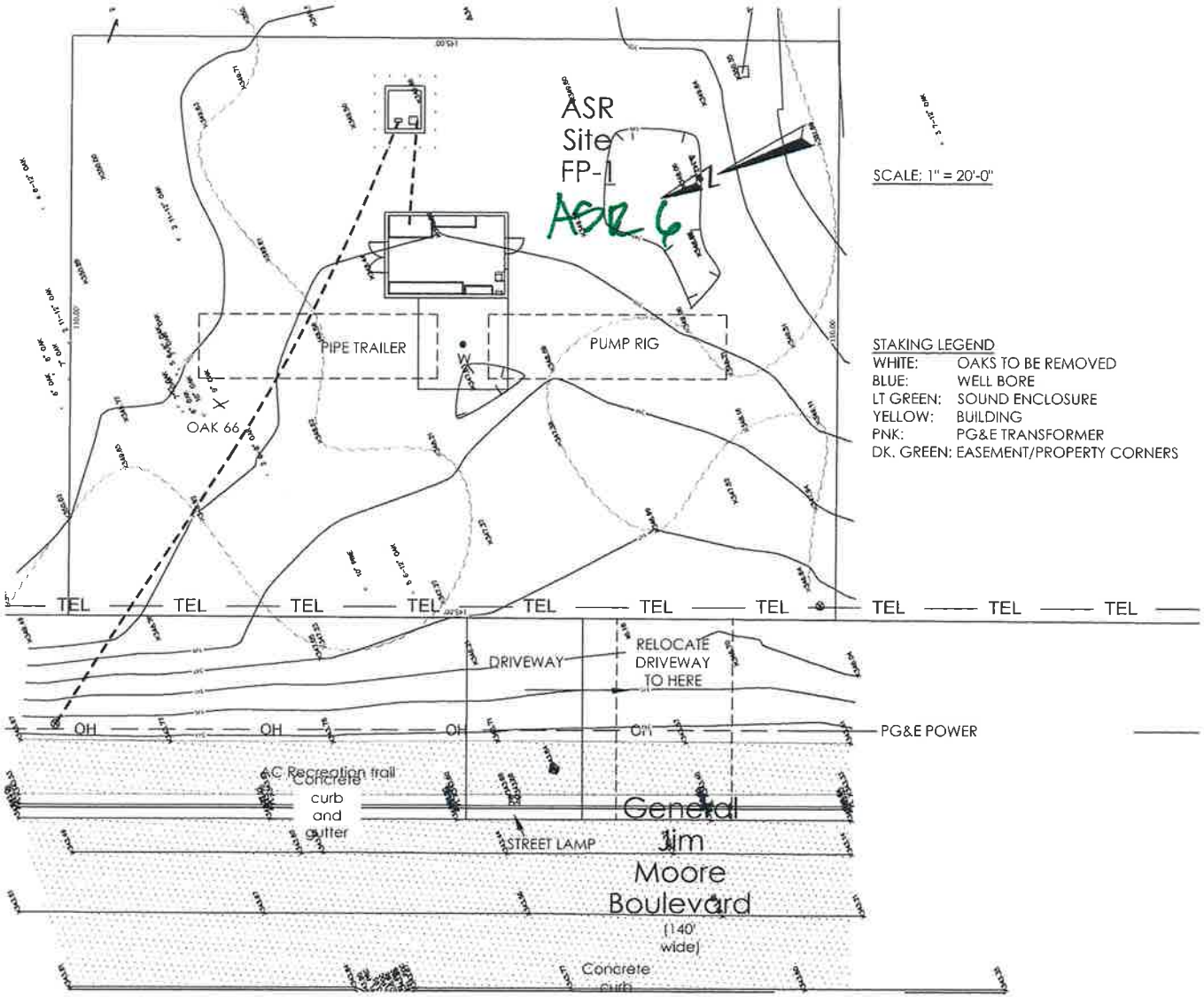
AECOM
300 LAKESIDE DR. SUITE 400
OAKLAND, CA 94612

CALIFORNIA AMERICAN WATER

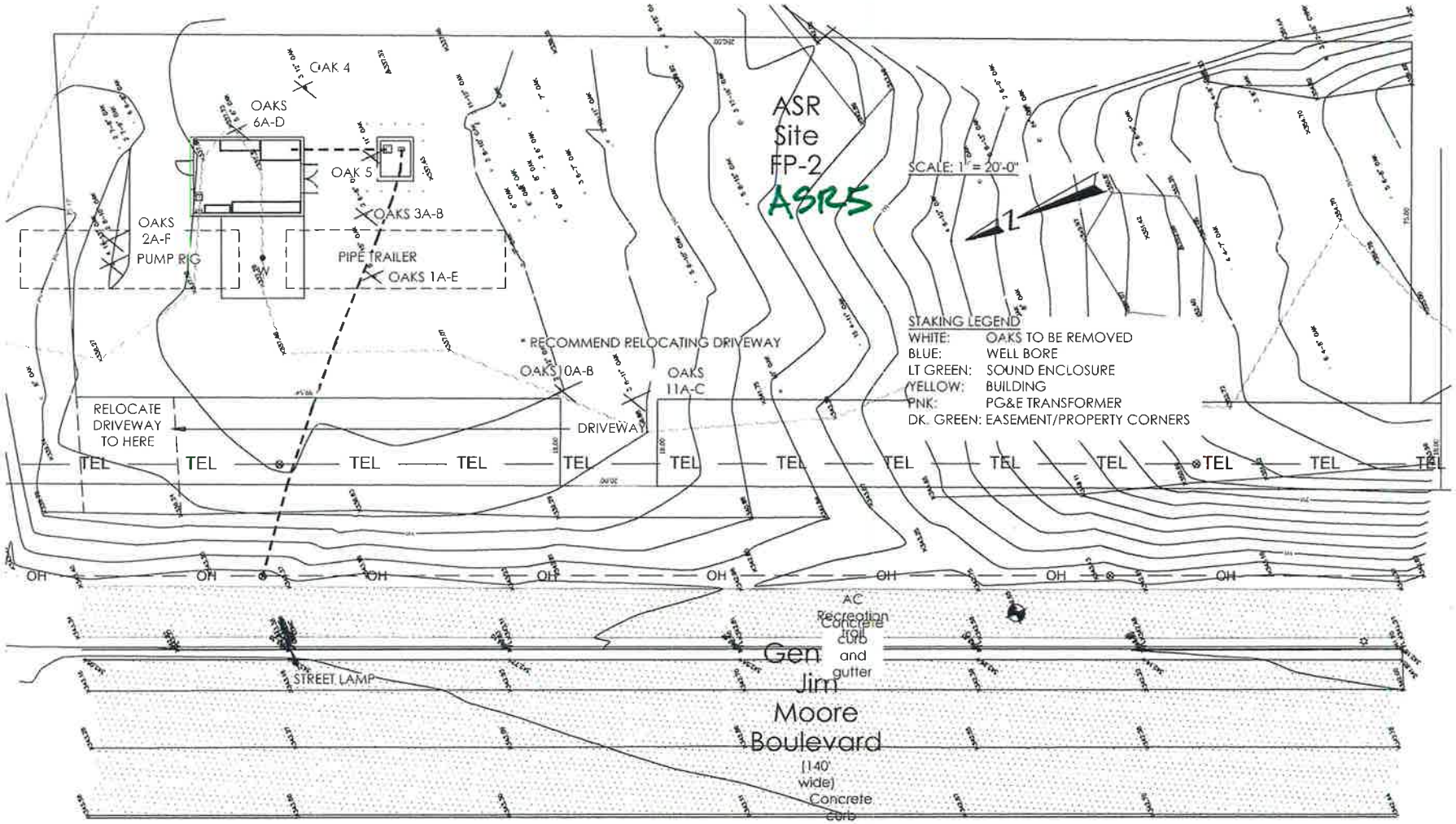
DRAWN BY R. MORRISON
PROJECT ENGR S. KHALSA
APPROVED
DATE
PROJECT
USE DIMENSIONS ONLY
SCALE AS SHOWN

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

EL-07



TREE REMOVAL



TREE REMOVAL

Donald R Monette

From: Saldana, Jose <JFSe@pge.com>
Sent: Tuesday, December 12, 2017 7:28 AM
To: Robert Kiyoi
Subject: Gen Jim

PGE Power Grids

Robert;

This is the best I can do regarding Maps:

The Coe Ave Pumps are being fed from a Monterey Circuit and the Ardennes Pumps will be fed from a Fort Ord Circuit.

Thanks
JoseS

ASR 1/2 ? 1/4 ? !

Pacific Gas and Electric Company

Application for Service **New - Commercial**

Fitch Park Asr

Application: 112903042

Request

Commodity: Electric (Underground)
Other Services: Temporary Power
Submitted on: 06/01/2017

Service Needed By: 07/01/19
PG&E Rep: Jfse
Jose.saldana@pge.com
831-784-3574

Contacts

Applicant:
Chris Cook
California American Water, Central Divis
511 Forest Lodge Road, Suite 100
Pacific Grove, CA 93950
831-646-3241 (day)
8312772405 (cell)
Christopher.cook@amwater.com

Representative:
Robert Kiyoi
4141 State St Suite E10
Goleta, CA 93110
805-681-0980 (day)
8056899253 (cell)
Rlkiyoi@kiyoieng.com

Contractor:

Legal

Signatory:
Chris Cook
511 Forest Lodge Road, Suite 100
Pacific Grove, CA 93950
831-646-3241
Christopher.cook@amwater.com

Name on Contract: California American Water
Legal Status: Corporation
State of Incorp: CA

Billing

Send Bills To: Chris Cook
Existing Account? No

Mailing Address: 511 Forest Lodge Road, Suite 100
Pacific Grove CA 93950
Phone: 831-646-3241
Email: Christopher.cook@amwater.cor

Pacific Gas and Electric Company

Application for Service **New - Commercial**

Fitch Park Asr

Application: 112903042

Project Description

Project Type:	Industrial Service (new)	Project Address:	General Jim Moore Blvd @ Ardennes Circle SAND CITY 93955
Location Latitude:		County:	MONTEREY
Location Longitude:		Cross Street:	Ardennes Circle
NAICS Code:			
Business Activity:	Water Supply		
Assessor Parcel No:	N/a	Number of Buildings:	1
Building Permit No:		Number of Floors:	1
		No. of Svc Locations:	1
		Total Sq Footage:	600

Service Details

No. of Electric Meters:	1
Main Switch Size:	2500
Voltage:	480/277-4wire-3phase
Electric Rate Schedule:	E-25

Temporary Power

Needed for <1 Year? **No**

If temporary power will be used for > a year, additional Federal and State taxes will need to be collected.

Temporary Power Needed By:

Will Applicant or a Contractor install pole? **No**

Main Switch Size:

Design Contractor

Will you be using a Design Contractor? **No**

PG&E must provide project specific information to design contractors. PG&E can provide this information sooner if we know whether or not you are considering using a design contractor to design gas/electric distribution or service facilities.

Providing this information on this Application is voluntary and is not binding. PG&E will provide you with a bid for the design work

Fitch Park Asr

Application: 112903042

regardless of whether or not you answer this question now and will not require a final decision from you until later in the process.

Construction

Existing PG&E facilities require?

Relocation or Removal: No

Undergrounding: No

Service Trench

Who will install conduits/substructure? Applicant

Who will trench and backfill:

Electric Facilities? Applicant

Gas Facilities?

Trench Occupants: Electric Phone

Trench Needed By: 06/01/19

Joint Trench Drawings Prepared by: Applicant

Distribution Trench

Who will install conduits/substructure? Pge

Who will trench and backfill:

Electric Facilities? Pge

Trench Occupants: Electric Phone

Trench Needed By: 06/01/19

Joint Trench Drawings Prepared by: Applicant

Trench Information

Transformer Type: P

Electric Load

Submersible Pump?

Largest 1 Phase Motor: 1.0

Largest 3 Phase Motor: 800.0

Total 1 Phase Motors: 1.0

Total 3 Phase Motors: 1600.0

Largest 1 Phase A/C:

Largest 3 Phase A/C: 8

Appliances & Equipment:

Street Lights

Number of Streetlights:

Bulb Type:

Responsible Party:

Mailing Address:

Pacific Gas and Electric Company

Application for Service **New - Commercial**

Fitch Park Asr

Application: 112903042

Watts Per Lamp:

Rate Schedule:

Self Generation

Are you planning on installing any self-generation equipment? No

Type of Generation:

Total Output of All Generation:

No.of Generation Units:

Operating Hours

Typical Operating Hrs: From: 00:00 To: 00:00

Other Details:

Days open per week: 7

Months open per year: 12

Documents

Customer Comments:

06/01/2017 13:21:29 The 2 Large 800 Hp Motors Will Be On Variable Frequency Drives To Limit Motor Inrush.we Are Submitting Our Application So That Discussions Can Begin Regarding Any Distribution Line Work That May Be Required To Feed The Facility.we Would Like To Meet With A Planner To Do A Preliminary Field Survey Of The Site And To Discuss Options.our Facility Plans Are Pending.

February 6, 2019

California American Water
511 Forest Lodge Rd, Suite 100
Pacific Grove, CA 93950
ATTN: Donald Monette
Jay V. Drewry
Email: donald.monette@amwater.com
Jay.Drewry@amwater.com

Re: **ASR 5 & 6, Above Ground Facility; HHCI Clarification**
Response due: February 6, 2019 at 4:00 PM

Dear Mr. Monette and Mr. Drewry,

Thank you for your consideration of Hal Hays Construction, Inc. (HHCI) for this key project. We consider it an honor to support California American Water.

Per your request, attached are the clarifications for Fitch Park ASR Wells 5 & 6, Above Ground Facility.

Offeror Information

Address	4181 Latham Street, Riverside, CA 92501		**License #**	667560
Tax ID #	54-2084366		**Phone** **Estimating Fax**	(951) 788-0703 (951) 289-7112

Persons Authorized to Negotiate

Names & **Titles**	Kirby Hays, President/CEO Reza Afshar, Civil Estimator		**Emails**	khays@halhays.com rafshar@halhays.com

If you have any questions regarding this proposal, please feel free to contact us.

Best regards,

Kirby S. Hays
CEO
Hal Hays Construction, Inc.
khays@halhays.com

CAW Monterey Peninsula Water supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities
Seaside, CA
Table of Contents

1. BID FORM: Bid Item 2, is to be applied ***only to*** the ***remainder of the design services that are not included in bid items, 1,3-42.*** Provide a cost estimate for bid item 2 as described below in 3.

HHCI confirms that Bid Item 2 applied only the remainder of the design services that are not included in bid items 1, 3-42. Below is a summary of those activities as required by Scope of Design Services (SDS) as follows:

Design costs carried in item #2:

- SDS A.6: Total interaction with all utility companies.
- SDS A.7: Determine all necessary permits and prepare applications – *except Building Code Review is in Bid Item 4*.
- SDS A.8: Preparation of preliminary budget construction cost estimate.
- SDS A.9 and Appendix H: Preparation of Design Memorandum with a 15% Design, provided as Draft and Final, with updates to the Design Memorandum throughout the design.
- SDS A.10: Preparation of a narrative description of operations as an extension to the Design Memorandum (functional descriptions)
- SDS C.2: Shop drawing and approvals including review and approval of resubmittals, and maintenance of shop drop log indicated dates received returned and status. *Assumed 24-electrical and 30-other submittals and resubmittals.*
- SDS C.3: Preparation of supplementary detailed working drawings, specifications, and written instructions throughout construction. *Assumed 12-Electrical RFIs, and 15-civil/ mechanical/ structural/ architectural RFIs.*
- SDS C.5: Provide the services of the Design Project Manager/Engineer during startup, at least five (5) days. Allow ten (10) site visits for Engineers from all other engineering disciplines to resolve start-up issues. *Assumed 5 Days for Civil Engineer, 10 Visits for Electrical Engineer, 3 Visits for Architect, 1 Visit for Structural.*
- SDS C.8: Provide services of Design Project Manager for one (1) days on a twelve months anniversary inspection with written report summarizing warranty repairs and any operational modifications recommended to optimize performance.
- Agreement Section 14.08-B: SRF Funding Reimbursement Technical Assistance. *Assumed 2 hours per month throughout design and construction.*
- Project Management and QA/QC: *Assumed 1 hour per week and 1 hour per each major deliverable.*

2. BID FORM: Bid Item 66, is intended for the contractor to price the two electrical buildings for site ASR 5 and ASR 6. The contractor has changed the quantity from 2 to 1 in your proposal. It should remain as a quantity of 2. Indicate unit price for each electrical building, and for the total of two buildings.

It is confirmed that the price in bid item # 66 covers both buildings. Please see attachment 1 for an updated price sheet.

3. DESIGN PROFESSIONAL SERVICES COST ESTIMATE: Provide a professional services cost estimate of the design services including itemizes Task, Task Description, Hourly Rate, Professional Classification, estimated hours for completion of the tasks, and cost for each line item. The dollar amounts for design services are to match the proposal for PF-3, items "a, b, c, d".

Please see attachments 2a, 2b & 2c for Task Breakdown, Hourly rate, professional classification, estimated hours for completion of the tasks, and costs for each line item. There is a supplemental task description document that elaborates on what is included with each design task.

4. PROPOSAL FORM PF-3 "e": **All items "a, b, c, and d" on this for are for design services/pre-construction services during design, and are compromised of bid items 1-42. Total construction cost "e" is to be entered on form PF-3, as the total of bid items 43-73.**

Please see attachment 3, updated PF-3. The reason that in the original proposal, the difference between items a + b+ c + d and items 1-42 was $346,977 is because the "30% contingency" cost requirement was spread through items a-d, and was added as a line item at that bottom of the overall price sheet. Updated PF-3 now shows the actual design price (which matches 1-42), and adds the 30% contingency on the side.

5. CONTRACTOR'S EQUIPMENT MANUFACTURER'S LIST: Bid addendum 3 required the list of the major equipment that contractor intended in the bid price. This had not been provided. Review the attached list of Cal Am equipment; circle the choice of equipment, and that equipment only on the list. Return the list you have selected.

Please see attachment 4, circled list of major equipment included in the bid price.

6. LIST OF DRAWINGS (DRAWING INDEX): Prepare the required list of drawings anticipated for the project in a drawing index. Approximately 80-90 drawings are required for this project. Justify your index necessary so that the reviewer understands your intent for scope design services.

Please see attachment 5, Drawing Index from HHCI's DOR, LSCE. This list of 80 design drawings encompasses the project scope of work. Additionally, it is anticipated that key subconsultant, Telstar Instruments, will provide 8-10 detailed shop drawings to supplement the design drawings pertaining to their scope of work.

7. LIST OF CSI SPECIFICATIONS: Prepare a list of CSI specifications that are anticipated for this project. See attached CSI list of specifications, review and delete by cross-out, any inappropriate specifications, and if necessary why a specification is not applicable.

Please see attachment 6, Modified/Red-lined List of Project Specifications from HHCI's DOR, LSCE.

8. SDS-10: See attached copy of the scope of work requirements that were included in the RFP. Initial each page at the bottom as confirmation that you are providing the required scope of work. If you have exceptions, provide clear explanations.

Please see attached initialed sheets (Attachment 7).

9. Bid ADDENDUM 3: Provide the list of SCADA/instrumentation equipment you have selected for the project. This list was required as part of the proposal. Circle the equipment for this project from the list, and return the list. Do not remove any pages.

Please see attachment 8, circled list of SCADA/Instrumentation equipment included in the bid price.

10. BID ADDENDUM 3: Select one of the two system integrators: either Telstar or Controls System West. This selection was required as part of the proposal.

HHCI selects Telstar as the System Integrator for this project.

11. BID ADDENDUM 5: Provide confirmation that you bid offer includes the Allen Bradley 18 PWM VFD per addendum 5. Provide the option as described for the active front-end drive as an option items 1-17 are provided in the bid price.

Confirmed. HHCI's price includes the Allen Bradley 18PWM VFD per addendum 5. The option for the active front-end drive needs to be explored further, and will be as part of the design efforts, however, we can confirm that the price for this option will not exceed the price as currently specified.

Please see attachment 9. For a general comparison between the Allen Bradley 18 PWM VFD and Active Front-End (AFE) Drives as well as responses to option items 1-17.

Additionally, it was confirmed during this RFI process that Allen Bradley inadvertently failed to include pricing for the specified enclosure as well as the required spare parts list for the project. Their pricing has been updated to reflect this (Bid Item #69).

12. SCHEDULE: The schedule is not acceptable. However, your schedule will be revised if your proposal is accepted.

Understood.

13. GENERATOR: Provide the required information per Bid Addendum 5.

Generator - We will keep the generator within the following parameters with all loads considered for this project:
Engine HP under 82% utilization
Alternator harmonics below 7%
Voltage dip <10% during ramping
Voltage regulation at <1% during steady state operation.
FYI: This yields a 900kw unit with 1000kw alternator. Not sure what was assumed for the proposal.

California American Water
Monterey Peninsula Water Supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities

Attachment 1: **Bid Form**

MONTEREY PENINSULA WATER SUPPLY PROJECT
ASR 5 AND 6 - DESIGN BUILD
ABOVE GROUND FACILITIES PROJECT

10/20/2018
Rev. 0

BID ITEM	APPROX. QTY.	UNIT	DESCRIPTION WITH UNIT PRICE (PRICE IS INCLUSIVE OF ALL APPLICABLE TAXES, PROFIT, INSURANCE, BONDS AND OTHER OVERHEAD)	UNIT PRICE	TOTAL ITEM PRICE	HAYS	
						UNIT PRICE	TOTAL PRICE
PREDESIGN/DESIGN SERVICES							
1	1	ALLOW	Community Outreach	$7,000.00	$7,000.00	$7,000.00	$7,000.00
2	1	LS	**REMAINDER OF Design Services (Part III. Scope of Design Services, SDS 1-10) , PER RFI SLL DESIGN SERVICES OTHER THAN 1, 3-42**		$0.00	**$202,325.00**	**$202,325.00**
3	1	LS	Dust and Noise Control Plan & Implementation		$0.00	$14,120.00	$14,120.00
4	1	LS	Building Code Review, Procedures & Plan		$0.00	$5,325.00	$5,325.00
5	1	LS	Mobilization, Security Fencing, Access Plan		$0.00	$65,060.00	$65,060.00
6	1	LS	Temporary Power Plan		$0.00	$3,200.00	$3,200.00
7	1	LS	Mobilization, Security Fencing, Access Plan, etc.		$0.00		$0.00
8	1	LS	SWPPP/Erosion & Sediment Control Plan		$0.00	$22,215.00	$22,215.00
9	1	LS	Environmental Requirements {Permits 2.7.3)		$0.00	$3,100.00	$3,100.00
10	1	LS	AVETTA Certification (2.7.3)		$0.00		$0.00
11	1	LS	Utility Potholing & AutoCAD Mapping		$0.00	$5,000.00	$5,000.00
12	1	LS	Staking/Surveying Plan, Mapping, & Implementation		$0.00	$35,000.00	$35,000.00
13	1	LS	Geotechnical Investigations & Borings, Soils Report (2 Sites)		$0.00	$22,300.00	$22,300.00
14	1	LS	Demolition of Existing Structure Plan		$0.00	$1,500.00	$1,500.00
15	1	LS	Traffic Control Plans & Implementation		$0.00	$6,700.00	$6,700.00
16	1	LS	Acceptance Testing Plan & Implementation(2.7.4)		$0.00	$2,000.00	$2,000.00
17	1	LS	Quality Management Plan (Design & Construction, (2.7.5)		$0.00	$3,500.00	$3,500.00
18	1	LS	Materials Testing Plan (e.g. Concrete & Soils)		$0.00	$67,110.00	$67,110.00
19	1	LS	**(Bid Addendum 4)** ~~DELETE: "Pump Test Plan & Performance Testing. ".~~ **REPLACE WITH: Emergency Spill Response Plan**		$0.00	$1,025.00	$1,025.00
20	0	LS	**(Bid Addendum 4)** DELETE: ~~Well Pump/Line shaft Vibration Test Plan, & Critical Speed Calculations~~		$0.00		$0.00
21	1	LS	Inspection & Test Procedures & Plan		$0.00	$16,125.00	$16,125.00

22	1	LS	Factory Acceptance Testing/Designer Inspections, (SDS-9)		$0.00	$12,805.00	$12,805.00
23	1	LS	Operations & Maintenance Training (2.7.6)		$0.00	$4,000.00	$4,000.00
24	1	LS	Installation Operation, & Maintenance Manual (IOM), Scanned pdf & CD,		$0.00	$1,100.00	$1,100.00
25	1	LS	Start-Up & Commissioning Procedures Plan		$0.00	$11,625.00	$11,625.00
26	1	LS	Facility/Utility Shut-Down Plan		$0.00	$2,010.00	$2,010.00
27	1	LS	Warranty & Acceptance Test Plan		$0.00	$9,860.00	$9,860.00
28	1	LS	CSI format Technical Specifications (16 Divisions)		$0.00	$58,650.00	$58,650.00
29	1	LS	Assess Validity, Evaluate, Analyze Accuracy of Preliminary Design		$0.00	$16,320.00	$16,320.00
30	1	LS	Architectural Drawings/Renderings for Agency Approvals		$0.00	$63,890.00	$63,890.00
31	1	LS	Civil Drawings, Auto Cad, Full and Half-Sizes		$0.00	$52,100.00	$52,100.00
32	1	LS	Mechanical Drawings, Auto Cad, Full and Half-Sizes		$0.00	$56,385.00	$56,385.00
33	1	LS	Electrical & Drawings, Auto Cad, Full and Half-Sizes		$0.00	$99,280.00	$99,280.00
34	1	LS	Plumbing Drawings, Auto Cad Full and Half-Sizes		$0.00	$9,450.00	$9,450.00
35	1	LS	Instrument Drawings, Auto Cad Full and Half Sizes		$0.00	$39,350.00	$39,350.00
36	1	LS	HVAC Drawings, Auto Cad, Full and Half Sizes		$0.00	$12,315.00	$12,315.00
37	1	LS	Process (P& ID) Drawing Updates, Add Disinfection, Auto Cad, Full/Half Sizes		$0.00	$60,300.00	$60,300.00
38	1	LS	As-Built Drawing & Conformed Drawings in Auto-CAD		$0.00	$42,950.00	$42,950.00
				Item 2			**$202,325.00**
				ITEMS 1, 3-45			**$832,670.00**
			SUBTOTAL DESIGN SERVICEDS				**$1,034,995.00**
PROJECT MANAGEMENT/CONSTRUCTION MEETINGS/REVIEWS							
39	1	LS	Design Meetings (10)		$0.00	$32,700.00	$32,700.00
40	1	LS	Construction Meetings (24)		$0.00	$65,300.00	$65,300.00
41	1	LS	Constructability Review (3)		$0.00	$9,415.00	$9,415.00
42	1	LS	Value Engineering (3)		$0.00	$14,180.00	$14,180.00
			SUBTOTAL REVIEWS/Pm/ MTGS				**$121,595.00**
PROCUREMENT/CONSTRUCTION							
43	1	LS	Mobilization/demobilization, Phase 1		$0.00	$131,000.00	$131,000.00
44	1	LS	Mobilization/demobilization, Phase 2		$0.00	$255,000.00	$255,000.00
			SUBTOTAL CONSTRUCTION MOB/DEMOB				**$386,000.00**
CIVIL/MECHANICAL/PROCESS							
45	1	LS	Site Preparation for Phase 1 Well Drilling (2 Sites)		$0.00	$79,100.00	$79,100.00

46	1	LS	Site Preparation, All other work, Phase 2		$0.00	$125,340.00	$125,340.00
47	1	LS	On-Site Drainage Percolation System, Infiltration Tests		$0.00	$62,825.00	$62,825.00
48	1	LS	AC Pavement and Subgrade (Tech, Req, Appendix 1)		$0.00	$193,740.00	$193,740.00
49	1	LS	Site Access & Perimeter Chain Link Fencing, & 7 ft. height, Double Gates (both sites)		$0.00	$76,505.00	$76,505.00
50	1	LS	ASR Underground Pipeline connections to General Jim Moore Blvd at ASR 5 and 6 (Sheet I-1, Appendix 1)		$0.00	$319,190.00	$319,190.00
51	1	LS	ASR Above Ground Piping/Valves (Sheet I1 G1, M1 Appendix 1)		$0.00	$235,650.00	$235,650.00
52	1	LS	Cla-Val Valves, remote controlled, fusion bonded epoxy coating in/out, 110V solenoid manual override, stainless steel trim, indicating limit switches, pilot strainer, open/close speeds, isolation cocks (Tech Req, G1, M1 Appendix 1)		$0.00	$119,830.00	$119,830.00
53	1	LS	Flow meters, Sparling 656 Tigermag magnetic, local display plus remote transmission 4-20 mA output, polyurethane liner, bidirectional rate and bidirectional totalizing functions (Tech Req, Appendix 1)		$0.00	$61,080.00	$61,080.00
54	2	EA	Pump water flush lube system, real time flow measurement and lube line differential pressure instrumentation, with interlock shutdown of well pump upon loos of low or pressure in lube line (Tech Req, Appendix 1)		$0.00	$20,680.00	$41,360.00
55	1	LS	ASR Underground Pipeline connections to General Jim Moore Blvd at ASR 5 and 6 (Sheet I-1, Appendix 1)		$0.00		**$0.00**
56	1	LS	ASR Above Ground Piping/Valves (Sheet I1 G1, M1 Appendix 1)		$0.00		**$0.00**
57	1	LS	Isolation Valves, (with manual operators larger than 8" diameter)		$0.00	$11,215.00	$11,215.00
58	2	EA	**(Bid Addendum 4) DELETE: ~~Vertical Turbine Pumps, 800 HP, 480V, 3 ph, 3000 gpm, 792' TDH 82% Efficiency, TEFC motor, zinc less bronze allow C952 impeller, intermediate shaft bearings~~**		$0.00		$0.00
59	2	EA	**(Bid Addendum 4) DELETE:~~12" x X-42 Grade Column Pipe, 550 ft. long, enclosed tube water flush tube and shaft design~~**		$0.00		$0.00
60	2	EA	**(Bid Addendum 4) DELETE:~~12 x 8 Baki "FCV" Downhole Flow Control Valve, set at 500' bgs~~**		$0.00		$0.00
61	1	LS	Complete Chemical Offloading Facility for bulk sodium hypochlorite deliver off-loading, with wash-down pad sized for WB-50/5,000 gallon storage tanker truck, local control panel, audible alarm, and warning lights, sump, and sump pump and underground chemical resistant storage tank 1000 gal., Compressed air supply to pressurize truck and offload chemical, Operator Interface Panel with level indicator for chemical level in bulk tank, safety showers (2), eyewash stations (2), chemical injecting quills, and injecting ports with static mixers for hypochlorite injection (at ASR 5 SITE ONLY.)		$0.00	$29,560.00	$29,560.00
62	1	LS	Complete Disinfection Process Faculty for Sodium Hypochlorite system (12.5% solution strength), assume dosing up to 3 mg/l, storage of 30 days supply of bulk storage, FRP bulk storage tank, (2) day tank, (2) bulk transfer pumps, (2) chemical metering pumps, piping and valves, and ancillary equipment. Note a P & ID has not been completed. Contractor shall attach proposed P & ID with the bid for approval. Assume double containment for all chemical storage and dispensing equipment (at ASR 5 SITE ONLY).		$0.00	$134,525.00	$134,525.00

			SUBTOTAL CONSTRUCTION CIVII/MECH/PROCESS				**$1,489,920.00**
Structural/HVAC							
63	1	LS	Complete ASR 6 Electric/Controls Bldg. 380 sq. ft. interior minimum, Removable Sound Attenuation Enclosure around pump, non-combustible CMU with Concrete Plank Roof, UBC Type U Building Classification, Mediterranean style, similar to ASR 3 & 4 (Appendix 1)		$0.00	$370,000.00	$370,000.00
64	1	LS	Complete ASR 5 Electric/Controls Bldg. (min interior 350 sq. ft.) and Disinfection Bldg. (**min. interior 900 (bid addendum 4)** ~~**650**~~ sq. ft.). interior minimum, Sound Attenuation Enclosure around pump, non-combustible CMU with Concrete Plank Roof, UBC Type U Building Classification, Mediterranean style, similar to ASR 3 & 4 (Appendix 1)		$0.00	$676,980.00	$676,980.00
65	2	EA	Complete HVAC, Air Conditioning with Economizer mode systems each for Electrical/control Building (Tech Req, Appendix 1)		$0.00	$46,160.00	$92,320.00
			SUBTOTAL CONSTRUCTION STRUCTURAL/HVAC				**$1,139,300.00**
Electrical							
66	READ	LS	Complete Electrical Systems, for NEC calculated full-load amperage (FLA) of 1282 amperes, which includes pump, & misc. auxiliary loads, as shown in "Table MSB & Feeder Load Schedule" on Drawing E-1. Panels sizes for 1600-ampere meter/main		#VALUE!	**$856,125.00**	**$856,125.00**
67	2	EA	Short Circuit and Arch Flash Studies, developed per Cal Am standards, and PGE system data (Appendix 1, 3, 4).Layout per Dwg E-2, Appendix 1.		$0.00	$10,200.00	$20,400.00
			SUBTOTAL CONSTRUCTION ELECTRICAL				**$876,525.00**
Instrumentation/Controls							
68	2	EA	Complete control system, functionality including start, stop, speed control of the pumps, based on either flow or pressure set point, or manual adjustment. actuation of the Cla Val process valves, Alarm, warning and shutdown interlock functions, record and store process operational data, communicate with main Cal-Am SCADA system, PLC with 10% spare digital I/O, local control panel (LCP), (Tech Req, Drawing I-1, Appendix 1)		$0.00	$28,130.00	$56,260.00

69	2	EA	Variable Frequency Drive (VFD), indoor NEMA 1G, 18 pulse PWM, No bypass, Heavy Duty Service (50 C rated), dv/dt output filter, Allen Bradley Power Flex 755		$0.00	$329,695.00	$659,390.00
70	2	EA	Programmable Logic Controllers, Allen Bradley only. PLC program and OIP screens programmed to control the pumps and show booster and well pump operation, status, and alarms, indicated in Tech requirements and on P & ID, Appendix 1		$0.00	$31,085.00	$62,170.00
71	2	EA	Data System to Transmit Data via SCADA to Cal Am's central Office in Pacific Grove via cellular modem.		$0.00	$18,880.00	$37,760.00
72	2	EA	Local Operator Interface Panel (OIP), on front of each control panel. PLC program and OIP screens programmed to control the pumps and show booster and well pump operation, status, and alarms, indicated in Tech requirements and on P & ID, Appendix 1		$0.00	$14,270.00	$28,540.00
73	1	LS	Differential Pressure Transmitters, and pressure transmitters, heat traced and mounted in O'Brien instrument enclosures All transmitter tubing shall be heat traced		$0.00	$32,340.00	$32,340.00
			SUBTOTAL CONSTRUCTION INSTRUMENTATION/CONTROLS				**$876,460.00**
				SUBTOTAL			**$ 5,924,795**
					$ -		
					$ -		

BOND	**$44,052.00**
TOTAL	**$ 5,968,847**

California American Water
Monterey Peninsula Water Supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities

Attachment 2a: **DOR's Breakdown Summary**

Hal Hays Construction, Inc
Owner: California American Water
Project: Design-Build FP ASR Wells 5

Date: December 7, 2018

Cost of Service Proposal

HHCI's OH+P

Task	Billing Level	LSCE					SUB CONSULTANTS					DIRECT EXPENSES		TOTALS (Engineers)	TOTALS (HHCI's PH+P)	TOTALS
		Principal Professional	Supervising Engineer	Project Engineer	Staff Engineer	AutoCAD Drafter	Electrical Engineer	Instrumentaion Engineer	Structural Engineer	Building Architect	Acoustical Engineer	Travel	Copies / Reproduction			
	Billing Rate ($/Hr)	$225	$210	$170	$145	$140	Lump*		Lump*	Lump*	Lump*	Incurred	Incurred			
A. Preliminary Design up to and Including Issuing of the Design Memorandum	**LSCE (hours) LSCE (cost) Subconsultant Direct Expenses**	30 $6,750	140 $29,400	90 $15,300	110 $15,950	210 $29,400	$50,084	$20,500	$9,289	$20,973		$1,500	$2,000	**580** **$96,800** **$100,846** **$3,500**		
	Subtotals													**$201,146**	**$30,172**	**$231,318**
B. Preliminary Design Completion through Final Design Phases	**LSCE (hours) LSCE (cost) Subconsultant Direct Expenses**	40 $9,000	280 $58,800	113 $19,210	230 $33,350	300 $42,000	$84,351	$28,939	$13,498	$46,800		$1,000	$5,000	**963** **$162,360** **$173,588** **$6,000**		
	Subtotals													**$341,948**	**$51,292**	**$393,240**
C. Construction/Operation Phase	**LSCE (hours) LSCE (cost) Subconsultant Direct Expenses**	8 $1,800	390 $81,900	60 $10,200	160 $23,200	100 $14,000	$94,051	$39,434	$3,450	$18,078		$4,150	$1,500	**718** **$131,100** **$155,013** **$5,650**		
	Subtotals													**$291,763**	**$43,649**	**$335,412**
Total LSCE Hours		**78**	**810**	**263**	**500**	**610**								**2261**		
Total LSCE Cost		**$17,550**	**$170,100**	**$44,710**	**$72,500**	**$85,400**								**$390,260**		
Total Sub-Consultant Cost							**$228,486**	**$88,873**	**$26,237**	**$85,851**	**$0**			**$429,447**		
Total Direct Expenses Cost												**$6,650**	**$8,500**	**$15,150**		
													COST OF SERVICE PROPOSAL - TOTAL	**$834,857**	**$125,113**	**$959,970**

California American Water
Monterey Peninsula Water Supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities

Attachment 2b: **DOR's Breakdown by Tasks**

Hal Hays Construction, Inc
Owner: California American Water
Project: Design-Build FP ASR Wells 5

Cost of Service Proposal

A. Preliminary Design up to and including issuing of Design Memorandum

Task Items	LSCE					Sub-Consultants					Direct Expenses		
Billing Level	Principal Professional	Supervising Engineer	Project Engineer	Staff Engineer	AutoCAD Drafter	Electrical Engineer	Instrumentaion Engineer	Structural Engineer	Building Architect	Acoustical Engineer	Travel	Reproduction	
Rate	$225	$210	$170	$145	$140	Lump*	Lump	Lump*	Lump*	Lump*	Incurred	Incurred	
Team Members	B. Gustavson T. Elson	J. Shobe J. Coleman	P. L'Amoreaux	K. Miller	A. Cronk G. Garrison	Frisch Engineering	Telstar	William Merkel Associates					Cost Total
Brief critique of design	5	8	8	8		$3,100			$1,277				$4,377
Initial Conference (mtg #1)	5	8				$2,250					$250		$2,500
Initial Utility Interactions		4		8									
Permit Requirements Review		4		8									
Design Basis Memorandum - Draft	2	10	12	10					$1,429				$1,429
15% Plans	2	8		10	60	$8,500		$1,380	$2,600			$500	$12,980
15% Review (mtg #2)	2	8							$2,410		$250		$2,660
Design Basis Memorandum - Final	2	8	6	8		$2,754			$483				$3,237
30% Plans and Specs	2	12	32	8	70	$5,180		$4,025	$3,530			$750	$13,485
30% Review (mtg #3)		8		10		$3,250			$1,932		$250		$5,432
60% Plans, Specs & Estimate	2	10	32	16	80	$21,800		$3,884	$5,380			$750	$31,814
60% Review (mtg #4)		8		8		$3,250			$1,932		$250		$5,432
Value Engineering Review (mtg #5&6)	5	10		8							$500		$500
SRF Funding Techncial Assistance		16		8									
Project Management and QA/QC	3	18											
Total LSCE Hours	30	140	90	110	210								
Total LSCE Cost	$6,750	$29,400	$15,300	$15,950	$29,400								$96,800
Total Sub-consultant Cost						$50,084	$20,500	$9,289	$20,973				$100,846
Total Direct Costs											$1,500	$2,000	$3,500
TOTAL													**$201,146**

B. Preliminary Design Completion Through Final Design Phases

Task Items	LSCE					Sub-Consultants					Direct Expenses		
Billing Level	Principal Professional	Supervising Engineer	Project Engineer	Staff Engineer	AutoCAD Drafter	Electrical Engineer	Instrumentaion Engineer	Structural Engineer	Building Architect	Acoustical Engineer	Travel	Reproduction	
Rate	$225	$210	$170	$145	$140	Lump*	Lump	Lump*	Lump*	Lump*	Incurred	Incurred	
Team Members	B. Gustavson T. Elson	J. Shobe J. Coleman	P. L'Amoreaux	K. Miller	A. Cronk G. Garrison	Frisch Engineering	Telstar	William Merkel Associates					Cost Total
90% Plans, Specs	8	48	48	48	176	$36,541		$6,670	$23,400			$2,500	$69,111
90% Review (mtg #7)		16		16							$250		$250
Utility Service Apps (w, ss, st, e)		12		30		$1,600		$1,380					$2,980
Building Permit Review		12		20									
DDW Drinking Water Review		16		26									
Environmental Review		2		12									
Fire Permit Review		2		12									
Meeting to Review Permits (mtg #8)		16		14							$250		$250
Value Engineering (mtg #9)		16		9							$250		$250
Functional Description	20	48		12									
Testing and Warranty Plans			17	5		$23,180							$23,180
100% Plans, Specs & Estimate	8	48	48	10	124	$23,030		$5,448	$23,400			$2,500	$54,378
100% Review (mtg #10)		28		12							$250		$250
SRF Funding Techncial Assistance				4									
Project Management and QA/QC	4	16											
Total LSCE Hours	40	280	113	230	300								
Total LSCE Cost	$9,000	$58,800	$19,210	$33,350	$42,000								$162,360
Total Sub-consultant Cost						$84,351	$28,939	$13,498	$46,800				$173,588
Total Direct Costs											$1,000	$5,000	$6,000
TOTAL													**$341,948**

C. Construction/Operation Phase

Task Items	LSCE					Sub-Consultants					Direct Expenses		
Billing Level	Principal Professional	Supervising Engineer	Project Engineer	Staff Engineer	AutoCAD Drafter	Electrical Engineer	Instrumentaion Engineer	Structural Engineer	Building Architect	Acoustical Engineer	Travel	Reproduction	
Rate	$225	$210	$170	$145	$140	Lump*	Lump	Lump*	Lump*	Lump*	Incurred	Incurred	
Team Members	B. Gustavson	J. Shobe	P. L'Amoreaux	K. Miller	A. Cronk G. Garrison	Frisch Engineering	Telstar	William Merkel Associates					Cost Total
Construction Meetings (x24 mtgs)		200				$16,870					$3,040		$19,910
Review of Shop Dwg (x50 submittals)		16	40	80		$24,687		$2,012					$26,699
Supplementary Design Information		16	12	32	30	$11,247							$11,247
FAT Inspection Services		16		4		$6,377							$6,377
Startup - Design Engineer (5 Days)		40									$860		$860
Speciality Sub Startup (10 Days)						$29,488		$1,438					$30,926
Record Drawings		20		16	70	$5,382						$1,500	$6,882
O&M Manuals		20	8	16									
1-year Anniversary Inspection		10									$250		$250
SRF Funding Techncial Assistance				12									
Project Management and QA/QC	8	52											
Total LSCE Hours	8	390	60	160	100								
Total LSCE Cost	$1,800	$81,900	$10,200	$23,200	$14,000								$131,100
Total Sub-consultant Cost						$94,051	$39,434	$3,450	$18,078				$155,013
Total Direct Costs											$4,150	$1,500	$5,650
TOTAL													**$291,763**

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Attachment 2c: **Item D Breakdown**

Hal Hays Construction, Inc
Owner: California American Water
Project: Design-Build FP ASR Wells 5 & 6

Cost of Service Proposal

HHCI's OH+P

Task	Billing Level	HHCI						SUBCONTRACTOR		DIRECT		TOTALS (HHCI, Direct Cost)	TOTALS (HHCI's PH+P)	TOTALS
		Project Executive	Project Manager	Project Superi	Project Engineer	Estimator	Scheduler	Electrical		Travel	Copies / Reproduction			
	Billing Rate ($/Hr)	$148	$128	$120	$85	$128	$120	Lump*	Lump*	Incurred	Incurred			
d. Pre-construction Services during Design Phase	**HHCI's Hours**	140	560	140	340	96	80					**1356**		
	Direct Expenses	$20,720	$71,680	$16,800	$28,900	$12,288	$9,600	$4,500		$4,200	$2,012	**$159,988** **$4,500** **$6,212**		
	Subtotals											**$170,700**	**$25,920**	**$196,620**

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Attachment 3: **Updated PF-3 (For Item 4)**

Proposal; and Proposer has not sought by collusion to obtain for itself any advantage over any other Proposer or over Owner.

P-4 CONTRACT PRICE

4.01 Proposer will complete the Work in accordance with the Contract Documents for the following price(s):

A. COST OF THE WORK

1. The Cost of all Work other than Unit Price Work shall be determined as provided in Paragraph 10.01 of the General Conditions, as revised or amended by the Supplementary Conditions and shall include the following amounts subject to increases or decreases for changes in Work as provided for in Article 8 of the Agreement

2. Lump Sum Fees

a. Design Professional Services - Preliminary Design up to and Including Issuing of the Design Memorandum.

$ **231,318.00**

b. Design Professional Services – Preliminary Design Completion through Final Design Phases.

$ **393,240.00**

c. Design Professional Services – Construction/Operational Phase

$ **335,412.00**

d. Pre-Construction Services during Design Phase

$ **196,621.00**

e. **Total construction costs: includes Bid Form,** Construction Supervision and Superintendence.

$ **4,768,205.00**

f. Cost of Bond Premiums (Based on construction estimate):

$ **44,051.00**

Premium unit Price $ **8.00** /$ **1,000.00**

Range: $**4,000,000** to $ **8,000,000**

TOTAL LUMP SUM (a. + b. + c. + d. + e. + f.):

$ **5,968,847.50**

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Attachment 4: **Elect Equip List**

Revised 3-23-2018; KEL

Equipment Description	Manufacturers
LV Power Distribution Equipment – (Swgr, Swbds, Panelboards, Circuit Breakers, etc)	Cutler-Hammer Square D ABB Siemens General Electric
Transformers – Dry Type, VPI, VPE Insulation	Cutler-Hammer Square D/Sorgel Siemens ABB
Transformers – Cast-Coil	Square D/Sorgel ABB
Transformers – Liquid-Filled	*Not Preferred Equipment*
Protection Relays & Monitoring Relays for Voltage, Current, Phase Loss, Etc.	SEL (Schweitzer Engineering Laboratories) *Other acceptable manufacturers may include the following (subject to prior approval by AW Engr / Owner)* All to be provded with Fiber-Optic Communications over Ethernet / Modbus TCP/IP
Power Quality Metering, Motor Monitoring & Feeder Protection Relays	SEL 735, SEL 710, SEL 751A, SEL-489 Other SEL devices as applicable for the design of the power distribution system. *Communications to utilize fiber-optic interface; dual-port for loop configuration where available. Copper communications to be utilized only where specifically indicated. All to be provded with Fiber-Optic Communications capability Ethernet / Modbus TCP/IP and DNP3*
Low Voltage Motor Control Centers	Cutler-Hammer Square D ABB Siemens General Electric
Full Voltage Motor Starters	Cutler-Hammer Square D ABB Siemens General Electric
Reduced Voltage (Solid-State, Soft Start) Motor Starters	Cutler-Hammer Square D ABB Siemens General Electric Danfoss Benshaw

Equipment Description	Manufacturers
Low Voltage Variable Frequency Drives – Stand Alone Applications (Free-Standing or Wall Mounted Units) *NOTE: Basic Criteria - All VFD equipment to be "Heavy Duty" / "Industrial Duty", rated for 50 C. and suitable for full load rating with 3% voltage unbalance. Cooling fans shall be accessible without requiring total dismantling of the drive assembly; top outlet discharge preferred.* *"HVAC Rated" Drives are Not Permitted* *** NEMA4X Note: Drive assembly to be rated NEMA 4x by manufacturer; use of open chassis or NEMA 1 drives installed in NEMA 4x enclosure is not suitable in meeting this criteria.*	Free-Standing – Wall or Floor Mounted Square D Cutler-Hammer Allen Bradley Toshiba ABB Siemens/Robicon Danfoss Benshaw Yaskawa NEMA 4X Type (where required)** Allen Bradley Yaskawa T B Woods Others as determined suitable for the application Harmonic Filters (where required) TCI Mirrus MTE NO IN THIS PROJECT
Low Voltage Variable Frequency Drives – Part of MCC Lineup/Equipment *(Not an AW preferred method)*	Cutler-Hammer Square D ABB Seimens General Electric
Low Voltage Automatic or Manual Transfer "Switches" – Contactor Type assembly NO IN THIS PROJECT	ASCO 4000 Series (unless otherwise suitable) Other potential Suppliers include: Cutler-Hammer GE/Zenith Russelectric
Low Voltage (*Service Entrance Rated where applicable*) Automatic Transfer Equipment (Circuit Breaker Transfer Equipment – Manual or Automatic) *NOTE: Circuit Breaker – Main and Circuit Breaker – Standby (where identified) REQUIRED unless specifically accepted otherwise*	Cutler-Hammer/Eaton Square D ASCO 4000 Series Russelectic Switchgear General Electric NOT IN THIS PROJECT
Uninterrupted Power Supplies	APC Powerware General Electric Mesta Liebert MCG

Equipment Description	Manufacturers
Surge Protective Devices (UL-1449, Rev 4 Compliant and **Listed/Labeled**) *Note: use of integral SPD with panelboards and equipment not permitted; provide stand-alone external devices only unless otherwise specifically approved*	APT – Advanced Protection Technologies "XDS" Series MCG Cutler-Hammer "SPD" Series
NOTE: The following descriptions provide general guidelines for lighting fixtures and applications. As LED technology continues to be available at lower costs, American Water recommends evaluation between LED and Fluorescent lamps/fixtures. Where fluorescent fixtures are used (T-5 and T-8 fluorescent lamps), provide Programmed / Rapid-Start Ballasts. (*note- the use of Instant-Start ballasts is prohibited*) The use of LED technology is recommended for all exterior applications unless special aesthetic and/or other site-specific criteria is established by the Owner or Regulatory Authority	
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor Enclosed and Gasketed Fluorescent for Damp and Wet Locations (Process and Chemical Rooms)	EPCO GFF Series w/SS Latches, Simkar EN 2 or 3 w/SS Latches, Holophane ERS Series, Lithonia FSW or FHE Series, ILS Others as accepted by Owner *(Note – the use of fixtures similar to Lithonia DMR Series, Columbia LUN Series, Simkar OV450, etc are generally prohibited due to on-going physical / performance issues associated with this type of design (limited latches retaining sealed integrity of the assembly)). Fixture selection is to take into consideration lamp output, lumen maintenance, and environmental factors associated maintainability of the overall system.*
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor dry applications	Benjamin, Philips, Keene, Lithonia and Others as accepted by Owner
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor Hazardous Locations	Appleton Crouse-Hinds Killark Others as accepted by Owner
Lighting Fixtures – LED Indoor	Lithonia Philips Cree Others as accepted by Owner
All LED luminaires must be UL Listed (e.g. UL8753 / UL8750) and tested to IESNA LM-79 and LM-80 standards and that the results of those tests must be submitted to the Owner as part of the submittal review process. LED fixtures to be provided with a minimum 5 year warranty covering the driver, the LED components and the luminaire.	
Lighting Fixtures – LED Outdoor	RAB Cree Philips Dialight Lithonia Others as accepted by Owner
Lighting Fixtures – HPS Outdoor	Holophane, Infranor Devine, Philips Others as accepted by Owner

Equipment Description	Manufacturers
Lighting Control - Occupancy Sensors	Sensor Switch (High Humidity / Low Temperature Type) – process & chem. Areas Leviton, Hubbell, P&S along with others mfgrs and products to be provided as determined suitable for the location and environment where installed. *NOTE: Technology (passive IR, ultrasonic, or dual) to be based on location where installed.*
Lighting Control – Daylight Harvesting and/or Special Function and Dimming	Lutron Wattstopper Day Light Controls Others as accepted by Owner
Control and Timing Relays ("Ice-cube" relay style)	Diversified Potter Brumfield Syrelec Allen Bradley Square D Cutler-Hammer Seimens Releco Others as accepted by Owner
Push Buttons, Selector Switches & Pilot Lights (30 mm minimum size devices, NEMA 4X style preferred and high-intensity LED pilot lamps)	Cutler-Hammer Square D Seimens Allen Bradley Kraus & Naimer
Definite Purpose Relays and Contactors	Cutler Hammer Square D Siemens Allen Bradley
PVC Coated Rigid Steel Conduit	Ocal Robroy
Fiberglass Conduit	Champion FRE
Power Generation Equipment – (Diesel engine driven units)	Onan/Cummins Caterpillar Kohler Others only as determined accepted by Owner
Industrial and Corrosion Resistant Wiring Devices	Cooper Industries Legrand Leviton Hubbell Meltric Woodhead, http://www.woodheadsales.com

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Attachment 5: **CAW Item 6 Drawings**

LIST OF DRAWINGS

Sheet	Drawing	Title
GENERAL		
1	G01	TITLE SHEET AND LOCATION MAP
2	G02	INDEX OF DRAWINGS
3	G03	ABBREVIATIONS, NOTES AND SYMBOLS
CIVIL		
4	C01	OVERALL SITE PLAN HORIZONTAL CONTROL – ASR 5
5	C02	OVERALL SITE PLAN HORIZONTAL CONTROL – ASR 6
6	C03	PHASE 1 SITE PREPARATION PLAN – ASR 5
7	C04	PHASE 1 SITE PREPARATION PLAN – ASR 6
8	C05	PIPING PLAN – ASR 5
9	C06	PIPING PLAN – ASR 6
10	C07	GRADING AND DRAINAGE PLAN – ASR 5
11	C08	GRADING AND DRAINAGE PLAN – ASR 6
12	C09	CUT/FILL SECTIONS – ASR 5
13	C10	CUT/FILL SECTIONS – ASR 6
14	C11	SOIL EROSION & SEDIMENT CONTROL PLAN – ASR 5
15	C12	SOIL EROSION & SEDIMENT CONTROL PLAN – ASR 6
16	C13	EROSION CONTROL DETAILS
17	C14	FENCE DETAILS
18	C15	CAWC STANDARD DETAILS I
19	C16	CAWC STANDARD DETAILS II
20	C17	CAWC STANDARD DETAILS III
21	C18	CIVIL DETAILS III
22	C19	CIVIL DETAILS IV
23	C20	CIVIL DETAILS V
MECHANICAL		
24	M01	WELL HEAD AND STATION PIPE PLAN – ASR 5
25	M02	WELL HEAD AND STATION PIPE PLAN – ASR 6
26	M03	CHEMICAL/CONTROL BUILDING ARRANGEMENT - ASR 5
27	M04	CONTROL BUILDING ARRANGEMENT - ASR 6
28	M05	BUILDING PLUMBING PLAN - ASR 5
29	M06	BUILDING PLUMBING PLAN - ASR 6
30	M07	BUILDING HVAC PLAN - ASR 5
31	M08	BUILDING HVAC PLAN - ASR 6
32	M09	CHEMICAL DETAILS – ASR 5
33	M10	ANALYZER STATION DETAILS – ASR 5 & 6
34	M11	WELL COMPLETION DETAILS - ASR 5 & 6
35	M12	SOUND ENCLOSURE DETAILS - ASR 5 & 6
36	M13	MECHANICAL DETAILS I
37	M14	MECHANICAL DETAILS II
38	M15	MECHANICAL DETAILS III
STRUCTURAL		
39	S01	STRUCTURAL GENERAL NOTES & DETAILS
40	S02	FOUNDATION PLAN - ASR 5
41	S03	FOUNDATION PLAN - ASR 6
42	S04	PARAPET ROOF PLAN & DETAILS - ASR 5
43	S05	PARAPET ROOF PLAN & DETAILS - ASR 6
44	S06	STRUCTURAL DETAILS I
45	S07	STRUCTURAL DETAILS II
ARCHITECTURAL		
46	A01	ARCHITECTURAL NOTES & DETAILS
47	A02	FLOOR PLAN - ASR 5
48	A03	FLOOR PLAN - ASR 6
49	A04	EXTERIOR ELEVATIONS - ASR 5
50	A05	EXTERIOR ELEVATIONS - ASR 6
51	A06	FINISH SCHEDULE AND DOOR SCHEDULE - ASR 5 & 6
52	A07	DOOR AND WINDOW DETAILS I
53	A08	ARCHITECTURAL DETAILS I
54	A09	ARCHITECTURAL DETAILS II

Sheet	Drawing	Title
ELECTRICAL		
55	E01	ELECTRICAL SYMBOLS AND ABBREVIATIONS
56	E02	ONE-LINE DIAGRAM AND ELEVATION – ASR 5
57	E03	ONE-LINE DIAGRAM AND ELEVATION – ASR 6
58	E04	PANEL SCHEDULES
59	E05	ELEMENTARY DIAGRAM – ASR 5
60	E06	ELEMENTARY DIAGRAM – ASR 6
61	E07	PLC CONTROL PANEL LAYOUT
62	E08	PLC CONTROL PANEL WIRING DIAGRAM I
63	E09	PLC CONTROL PANEL WIRING DIAGRAM II
64	E10	PLC CONTROL PANEL WIRING DIAGRAM III
65	E11	VIDEO MONITORING SYSTEM CONTROL DIAGRAM
66	E12	PUMP ENCLOSURE POWER PLAN
67	E13	PUMP ENCLOSURE LIGHTING AND RECEPTACLE PLAN
68	E14	CHEMICAL BUILDING POWER PLAN
69	E15	CHEMICAL BUILDING LIGHTING AND RECEPTACLE PLAN
70	E16	SITE ELECTRICAL PLAN - ASR 5
71	E17	SITE ELECTRICAL PLAN - ASR 6
72	E18	ELECTRICAL DETAILS I
73	E19	ELECTRICAL DETAILS II
INSTRUMENTATION		
74	I01	INSTRUMENTATION SYMBOLS AND ABBREVIATIONS
75	I02	WELL SYSTEM P&ID - ASR 5 & 6
76	I03	CHEMICAL FEED SYSTEMS P&ID - ASR 5
77	I04	MISCELLANEOUS SYSTEMS P&ID
78	I05	COMMUNICATIONS BLOCK DIAGRAM
79	I06	INSTRUMENTATION DETAILS I
80	I07	INSTRUMENTATION DETAILS II

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Attachment 6: **CAW Item 7 Specs**

* = optional Section, info can be included in other sections

Add Sections:
02825 Site Security Fencing

Redundant, covered under Division 3 and plan details

Modify for "Vertical Turbine Pumps - DB Components"

Add Sections:
13224 Sodium Hypochlorite Tank
13230 Chemical Feed Equipment

Typically combine into two sections
15025 Pipe (Station, Distribution, and Drainage)
15110 Valves and Related Appurtenances

Where is pressuer sustaining valve ?

DIVISION 16 - ELECTRICAL

Replaced with Sections:

California American Water
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Attachment 7: **Scope of Design Services – Initialed**

III. SCOPE OF DESIGN SERVICES

A. Design Professional Services- Preliminary and Final Design

Design Professional Services shall include the work described in General Conditions 6.01 as amended by the Supplementary Conditions and work described in this Scope of Design Services including all listed Attachments.

Review of the design will be performed by American Water engineering personnel. Any changes in the scope of services during the design phase must be addressed by the Design/Builder before the work is performed. Changes will be made in accordance with Articles 3 and 11 of the General Conditions.

1. Preparation of a brief critique of the design concepts to determine what modifications to the concepts may result in a more cost effective project, simplified construction, and/or improved operating procedures. This document shall be submitted prior to the initial design meeting.

2. Attendance at periodic meetings with the Owner at their site located in **Pacific Grove, CA**. At least ten (10) working days shall be allotted in the schedule for review of information by Owner prior to any meeting. It is expected several one-day meetings (unless otherwise noted) will be required during the design phase including:

    1. An initial conference (this will include review of the design critique and alternative concepts and be coupled with a one day partnering meeting mentioned below and in Supplementary Conditions SC-2.05 Initial Conference),
    2. Two meetings to review the instrumentation requirements (these will be coupled with the 30% and 60% design review meetings),
    3. Meetings to review the progressive completion at (15%, 30%, 60%, 90%, and 100%) of design drawings and specifications and to prepare for permit submittals. The draft Design Memorandum will be submitted for review prior to the 15% meeting. The final Design Memorandum and preliminary drawings will be reviewed at the 30% meeting.

    The Design Builder is responsible for preparing notes summarizing the discussions and the conclusions from the meetings and distributing the notes within 7 days following the meeting.

    The preliminary design phase will be considered complete at the 60% completion of design and upon Owner's approval of the construction cost estimate.

3. All land survey work as necessary to adequately complete the design and file permit applications and provide reference points for construction layouts. As a minimum, property lines, topographic information and location of existing structures are to be included.

4. All geotechnical investigations including soil borings, rock cores, and auger probing as necessary to adequately complete the design and estimate and plan construction earthwork.

5. All environmental activities as necessary to adequately complete the design and file permit applications.

6. Total interaction with all utility companies to design and specify proper service for the proposed improvements and to coordinate the relocation of existing utilities as required. The Design/Builder shall also determine if any additional capital or usage fees will be imposed by any specific utility.

7. Determine which Local, State, and Federal permits are required for the facility, prepare the necessary applications, and provide technical input as required in securing these permits. The Design/Builder shall also provide Owner with information regarding the approximate length of review time for each permit, and any special requirements that could delay this process (e.g., public hearings). When required by the permitting agency, the permit applications will be formally submitted by Owner.

8. Preparation of a preliminary budget construction cost estimate broken down by major work item, and a detailed construction cost estimate breakdown: (labor, materials, equipment, subcontract, temporary construction etc.) organized by Construction Specifications Institute (CSI) division and major process components. The preliminary estimate is to be submitted with the Design Memorandum. The detailed construction estimate is to be submitted in accordance with the Supplementary Conditions SC-6.01 Design Professional Services.

9. Preparation and maintenance of a Design Memorandum. The Design Memorandum is a summary of design data presented in outline format along with other pertinent project information. The primary intent of the memorandum is to allow Owner to review and comment on the design before the Design/Builder proceeds with detailed design and drafting. The memorandum shall be updated throughout the design and submitted to the Owner with each set of updated drawings. A summary of the information to be included in the memorandum is outlined in the Attachments. After completion of the draft Design Memorandum a meeting (15% completion) will be held with all parties. The purpose of the meeting will be to review the Design/Builder's Design Memorandum to determine and evaluate alternative concepts to reduce capital and operating costs and/or to improve operations. The Design Memorandum will be modified with the results of this evaluation by the Design/Builder.

10. Preparation of a narrative description of the operation of the proposed facilities to be used by plant operations personnel to familiarize themselves with the operation, capabilities, and limitations of the proposed improvements. The narrative shall be an extension of the process sections from the Design Memorandum, but in text format. It shall explain the intent and function of each unit process in addition to the system as a whole, and it shall include the detailed written control strategies (functional descriptions), which were prepared for the Design Memorandum submission. Preparation of the narrative shall not begin until the Design Memorandum is finalized and accepted. The narrative shall be submitted as a separate document for review at the final design review meeting. It shall serve as the foundation of the Operations and Maintenance Manual discussed in the Construction/Operation Phase section of this document.

11. Preparation of a complete and coordinated set of design drawings for all engineering disciplines with an adequate level of detail to allow for review/approval by permitting agencies and construction by the Design/Builder. Drawings used for permit applications and bidding require the signature and seal of a licensed professional engineer in the State of California. The drawing sets require segregation by major discipline: site, architectural, structural, mechanical, electrical, instrumentation, etc. Drawings shall not contain extensive notes and written instructions that are more appropriate for the specifications. Standard detail drawings shall exclude items that are not applicable to the current project.

    The Design/Builder shall prepare all drawings using the most current version of AutoCAD for Windows. The Owner will not accept drawings created in an alternative CAD program, such as MicroStation, and "converted" to AutoCAD format. The Design/Builder shall use only AutoCAD and AutoLISP routines and no vendor-furnished or third party programs.

    PLEASE REFER TO AMERICAN WATER DRAWING STANDARDS AND SAMPLES.

    It is recommended that the Design/Builder submit an early review (e.g., 15 percent complete) set of .dwg files for this project. The Owner shall review the .dwg files for conformity with the Owner's AutoCAD standards and advise the Design/Builder of any necessary changes. The Owner then shall assume that the Design/Builder completes the remainder of the design in conformity with the Owner's AutoCAD standards. If it is later found that final documents do not conform, the Design/Builder shall revise the final .dwg files at the Design/Builder's cost. The Design/Builder shall have the opportunity to discuss the Owner's AutoCAD standards with Company staff.

    Standards developed by the Owner, and applicable to this project, and selected drawings of the existing facilities are provided in the Attachments. The information provided in the record drawings may not represent actual field conditions. The Design/Builder has the responsibility to field verify and record the existing conditions as necessary to complete the design phase.

    Electrical drafting symbols shall conform to IEEE Standard 315 and 315A. Specific requirements for the design of instrumentation and controls for water treatment processes or water distribution, where applicable, are:

    a. Conduct on-site investigations, interface with process engineers/designers, and review design materials and drawings to determine the type and location of primary sensors, control devices, panels and related instruments, and control equipment. The locations, elevations, and mounting details for these devices shall be included on the drawings.

    b. Prepare P&ID drawings in accordance with ISA Standard S5.1 and Remote Terminal Unit (RTU) Interconnection drawings (input/output point lists) from the P&IDs. Example RTU Interconnection drawing and an electronic template will be provided to the selected Design/Builder upon request. The RTU interconnection drawings must be sufficiently detailed and accurate such that they can be utilized by the System Integrators and provided back to the Owner as record drawings. The Design/Builder is responsible for allowing each of the pre qualified System

Integrators identified by the Owner to review the RTU Interconnection drawings prior to the final design review meeting. The minimum information to be included on the RTU Interconnection drawings is as follows:

- Wiring from field instruments to the appropriate I/O point on the RTU.
- All signal isolation and signal conditioning equipment as required (e.g., a current to current isolator).
- Connections associated with the communications between RTUs (radios, fiber optic modems, etc.).
- Contacts and coils on digital outputs.
- Wiring tags showing the RTU number, I/O type (AI, AO, DI, DO), RTU card number, and I/O point number.
- Connections for DC power supplies.

c. Prepare ladder logic diagrams to show the hard wired logic in panels and motor control logic in PLCs. Drawings shall be prepared to show the general configuration of all new panels, consoles, and the wiring between interconnected hardware components.

d. Prepare conduit and wiring drawings showing conduit and signal wire routing using scaled base drawings of all facilities. Where appropriate, the conduit and wiring drawings shall be integrated into the electrical drawings.

12. Preparation of technical specifications, Divisions 2 through 16 in the CSI Spec-Text format, and the list of required shop drawings, in final electronic form for printing, copying, and binding by the Design/Builder. Specifications shall reflect only the scope of work for the current project. Standard specifications shall be modified to exclude items not applicable to the current project.

    Specifications shall be prepared using the most current version of the Microsoft Word for Windows word processor. If your standard specifications are in a format other than Microsoft Word, they must first be converted to Microsoft Word format, thoroughly checked to ensure that a complete conversion was accomplished (including all tables, charts, headers, footers, etc.), then edited for this project as appropriate within Microsoft Word. The text shall be 11 point Arial font. An electronic file name for each specification section shall include a descriptive name preceding a 5-digit specification section number followed by the Microsoft Word file extension (e.g., PROJECT 11500.doc).

    The American Water System Construction Contract Documents prohibit a Design/Builder from submitting substitute or "or equal" materials or equipment when a proprietary product, named manufacturer, or supplier has been specified. Provisions exist for bidders to submit alternatives to these items at bid time only. To ensure competitive pricing is being obtained for material and equipment that is not necessary to be a sole source item, it is recommended that at least three (3) acceptable manufacturers or products be listed in the specifications for each of these items. Specifying less than three (3) manufacturers is acceptable only when approved by the Owner in cases where the products of additional manufacturers are not deemed to be comparable or do not meet the project requirements. If design details have been used on the drawings that are based on one of the listed products,

this should be noted in the specifications. If design revisions are necessary to accommodate the other acceptable products, additional details shall be provided for the other products to facilitate complete and accurate bidding. Where an item is to be furnished on a sole source basis, only one (1) acceptable manufacturer or product will be listed in the specifications. If common items are included in multiple specification sections, language is to be included in the specifications that the same manufacturer is to be used for these common products.

In general one of the two specification methods above shall be used for all process, mechanical, and electrical equipment and other materials that are unique to the design (e.g., certain piping, valve, structural, mechanical, electrical and architectural products). Specifications for other materials or products that can be written prescriptively, by performance, or by reference to applicable standards, do not need to include specific manufacturers or products unless desired by the Design/Builder or the Owner.

The specific items and requirements of the specifications for the electrical control circuits and the instrumentation and controls for water processes or water distribution, where applicable, are listed below. The Design/Builder shall interface closely with the Owner in the development of these items.

a. Specifications for the digital equipment, and field and panel mounted instruments. Communication protocol between control system equipment and other digital equipment shall be specified by the Design/Builder and verified that it is compatible with the DCS. Data to be transferred by serial communications with other digital equipment shall also be identified.

b. An input/output point list.

c. Instrument specification sheets that are in accordance with ISA Standard S20.

d. Detailed written control logic and strategies (functional descriptions). Identification of the initial set points to be used at startup when variable set points are required in the control strategy shall also be identified.

e. Graphic display descriptions. Each specific display shall be identified and a brief description provided. Each I/O point (or calculated value) that should appear on each display must also be identified (preferably by indicating the name or number of the display directly on the I/O list). Sample displays, which will be provided by the Owner, shall be included in the contract documents.

f. Report definitions. All typical reports that the Owner will generate shall be integrated with the control system and be accessible via an electronic spreadsheet (Microsoft Excel) or electronic database (Microsoft Access). The Owner will provide examples of each specific report that shall be provided in the specifications. The I/O point or tag number that corresponds to each entry space in each report shall be identified directly on the example reports with appropriate instructions such as whether the data is an average, taken at a specific time of the day, etc. Entry spaces that the system cannot accommodate and need to be filled in manually shall be identified as such.

g. Alarming strategies for all alarms conditions including both warning alarms and critical alarms. Warning alarms are defined as analog (or calculated) alarms that provide notification that a critical condition is being approached (e.g. high turbidity, low chlorine residual, etc.). Critical alarms initiate automatic action by the system to address a critical condition (e.g. shut down the facility, start a backup piece of equipment, etc.). The specific action associated with each critical alarm shall also be identified. The Design/Builder shall identify all initial alarm set points to be used at startup.

h. Structured Query Language (SQL) database definition. All analog values, integrated values, and other relevant historical data shall be identified by the Design/Builder for inclusion in the SQL database and trending by the Systems Integrator. The Integrator shall store all historical data in a Microsoft SQL Server format.

i. Narrative descriptions of all pump control circuits (pump starters for example). These descriptions shall describe in detail the operation of these circuits in the various operating modes (manual, auto, remote, etc.) and shall provide information relating to the purpose of each device (relays, timers, lights, etc.) included in the circuit.

13. Provide a total of ten (10) sets of design memoranda, drawings, and specifications to be used during the design period for review purposes prior to each meeting. This same distribution of final drawings and specifications along with all final design information shall be made at the completion of design. Where possible, this information shall be submitted in electronic format. The information shall include all design notes and calculations, the design memorandum, drawings, and specifications. Electronic information, submitted at the end of (or during) the project, shall be on electronic media acceptable to Owner. Provide one set of full-size plans at the completion of final design phase, along with an electronic PDF format set.

14. Performance of a constructability and Value Engineering review by the Design/Builder with participation of Owner. Review each element of construction work with consideration given to feasible methods of construction, constraints to construction (materials, labor, specialty construction, weather, plant operations, other, etc.), design details, time required to complete each element of work, and possible alternatives which would reduce costs.

B. Pre-Construction Services

Pre-Construction Services shall include but not be limited to the following:

1. Make arrangements, schedule, chair and take minutes for all meetings during the design phase portion of the project.

2. Preparation and maintenance of a progress schedule throughout the duration of the design and construction phases is required. The schedule requirements are described in the General Conditions and Section 1300 of the Specifications. The initial schedule for this project must focus on completing work necessary to file the

necessary permit applications and procurement of necessary equipment and materials to meet the Contract Times.

3. Preparation and agreement of the Target Cost of Construction. The Target Cost is to be mutually agreed between the Owner and Design/Builder on an open book basis (with costs established upon the principles of Cost of Work under paragraphs 10.01 to 10.03 of the General Conditions) during the course of the design development. Upon reaching stated percentage completion of the design, including reconciliation of Owner's comments, the Design/Builder shall prepare and present the Target Cost for Owner's agreement.

   Target Cost Development:

   General: As a minimum, the Target Cost shall be prepared and presented in general conformance with the Sixteen (16) Division Format of the Construction Specifications Institute (CSI) and/or by Area of Work as defined in the Estimated Cost of Construction template form; the final content and format is to be agreed with the Owner. Full description of the Target Cost arrangement is provided in the Supplementary Conditions and the Agreement.

   A minimum of three (3) quotations or proposal from Owner-approved suppliers, vendors, manufacturers, subcontractors, etc. shall be obtained to set the target cost for all equipment, materials, products, and subcontracted labor and services. Receiving less than three (3) quotations or proposals is acceptable when approved by the Owner or in cases where the products or services of additional or other suppliers, vendors, manufacturers, subcontractors, etc. are not deemed to be comparable or do not meet the project requirements. The lowest responsive quotation or proposal shall be used to set the cost unless approved by the Owner. The cost for self performed work shall be agreed upon pursuant to SC 10.01. An amount for the Design/Builder's risk/contingency may be included as set forth in the Agreement.

   The Design/Builder shall submit the Target Cost to Owner and include a cover letter detailing the basis of the Target Cost, CSI and/or Work Area estimates and all supporting documentation that shall be clearly listed, labeled and itemized.

   Target Cost shall be developed as follows:

   A. Preliminary Target Cost shall be developed at the 30% design completion stage. Quotations and proposals shall be based on and reference the 30% design documents and shall be specific to model, size, material, etc. as applicable. "Budgetary" quotations or proposals may be used to develop costs if the design of that item or discipline has not progressed to the point where more specific quotations or proposal can be furnished.

   B. The Target Cost shall be developed upon completion of the 60% design, including incorporation of Owner's comments. Quotations and proposals shall be based on and reference the 60% design documents and shall be specific to model, size, material, etc. as applicable. The quotations and proposals shall be accurate, complete and remain valid for a minimum of 60 days and be ready for execution by the Design/Builder. "Budgetary" quotations or

proposals may not be used to develop the Target Cost unless approved by the Owner. In such instances, the budgetary quotation may be used as a "place-holder" to assist in setting the Target Cost at the discretion of the Owner and will be subject to revision once appropriate quotations or proposal can be obtained.

4. Preparation of a detailed construction sequence and logistics plan describing how the proposed facilities will be constructed and placed in-service while keeping existing facilities in-service as necessary. The plan shall consider seasonal limitations and shall specifically define all partial or full outages (including electrical) with estimated time for each outage as well as details on proposed time of day (i.e. regular working hours or evening/weekend hours), proposed time of year (i.e. during peak or off-peak demand seasons) and any special precautions, actions, temporary facilities, etc, that shall be required to safely complete each outage. The plan must be reviewed and approved by Owner to ensure that operations of any existing facilities will be properly maintained during construction. The plans are to show, at a minimum, the scheduled completion of construction on a calendar quarterly basis. Cost associated with keeping the plant on-line as a result of this plan shall be included in the Cost of Construction. As a consequence, the detailed construction sequence and logistics plan must be completed as part of the 60% design.

5. Provide constructability reviews at the 15%, 30%, 60%, and 90% of the design development phase. Review each element of construction work with consideration given to feasible methods of construction, constraints to construction (materials, labor, specialty construction, weather, plant operations, etc.) design details, time required to complete each element of work, and possible alternatives which would reduce costs, and maintain the level of quality expected by the Owner.

   The reviews shall include the appropriate designers, the Owner, and subcontractors if required as participants.

   Include providing the net cost and or time savings associated with each suggested change or modification to the design. Maintain a log tracking each suggestion with the results pertaining to cost and or time savings and acceptance/partial acceptance/rejection.

6. Performance of a bidability review with participation of Owner. Review the breakdown of the work into bid packages that will yield the most cost effective construction program with consideration given to the availability of qualified subcontractors and vendors. Develop interest in the project from prequalified subcontractors and vendors.

7. Maintain electronic communication capabilities throughout the design and construction phases of the project.

   The Web browser that you utilize must be capable of handling file attachments, and your e-mail must be MIME (Multipurpose Internet Mail Extensions) compatible in order to send file attachments without the need to encode/decode. Additionally, all electronic data files (word processing documents, spreadsheets, etc.) created by American Water will be prepared using the **2010 version of Microsoft Office**, and the Consultant must have the ability to read these file formats. It is preferred, but not

mandatory, that the consultant also create all data files that may need to be shared via the Web or e-mail in Microsoft Office format.

8. Identify the permits that are required for construction phase of the project, and prepare the necessary applications, and secure these permits. Provide the Owner with information regarding the approximate length of review time for each permit, and any special requirements that could delay this process. Provide all information required for the permit application and submit the fees required. The Owner will reimburse the Design/Builder for all permit application and permit fees at their direct cost. Include but not limited to the Building Permit, electrical, etc. including wastewater discharge if required.

C. Design Professional Services – Construction/Operation Phase

Design Professional Services-Construction/Operation Phase must include the following services:

1. Attendance at construction progress meetings, resolution of construction problems related to the design, and review and interpretation of the design.

2. Shop drawing review and approvals including review and approval of resubmittals, and maintenance of a shop drawing log indicating dates received, returned, and status.

3. Preparation of supplementary detailed working drawings, specifications, and written instructions or meetings as necessary throughout the construction period to interpret the contract plans and documents and to resolve changes brought about by actual field conditions encountered.

4. Provide the services of the I&C Staff Engineer or Subconsultant to witness the factory acceptance test (FAT) of the assembled I&C system prior to the system's shipment from the factory to the job site. The first goal is to ensure that the system has been assembled properly and is in proper working order. This will include testing of each individual I/O point and should be witnessed by the I&C Staff Engineer. The second goal is to simulate and test the control logic, and this portion of the FAT should be attended by the Design Project Manager/Engineer or someone familiar with the details of the process design and operation of the facility. Additionally, provide the services of the I&C Staff Engineer for site visits to review and inspect the instrumentation and wiring of field mounted instruments, resolution of problems, initial calibration and testing, and system start-up.

5. Provide the services of the Design Project Manager/Engineer who will participate in and observe each process and/or phase of initial operation of the project (start-up) and review operation and performance tests required by the contract specifications. At least five (5) days should be allotted for on-site start-up services and resolution of initial operating problems. Engineers from all of the engineering disciplines shall be made available to resolve start-up issues as required, and also to resolve problems which may arise during the construction period allow ten (10) site visits for these services.

6. Preparation and submittal of electronic record drawings within two (2) months after start-up. The record .dwg files shall conform to the Company's AutoCAD standards. If it is found that final documents do not conform to the Company's AutoCAD standards, the Consultant shall revise the final .dwg files at the Consultant's cost. Data, information, sketches and working drawings, to be incorporated with the record drawings, shall be provided by the Design/Builder. The record drawings shall include all above and below grade changes from the original design drawings for all engineering disciplines. Changes made to reflect the as-installed conditions shall be made in the same level of detail and to the same degree of drafting quality as the original design drawings. The I&C engineer must review record drawings prepared by the wiring contractors to verify their accuracy prior to substantial completion. Reference Division 1 of the specifications for additional information.

7. Provide four (4) copies of an operation and maintenance manual containing operating, maintenance, and repair information from manufacturer's submittals. The O&M manual shall also contain the final narrative description of the operation of the proposed facility, and a complete description of start-up and shut-down procedures. The O&M manual shall be bound in 3-ring binders and indexed with tabs according to major process designations in the order of the treatment process. Four (4) complete electronic copies of the final O&M manual shall also be provided on CD. An initial draft of the O&M manual, without manufacturer's data, shall be submitted for review at approximately the 50% point of construction completion. The complete O&M manual containing all manufacturer's data shall be submitted at the 95% point of construction completion but no later than one (1) month before scheduled start-up.

8. Provide the services of the Design Project Manager/Engineer for a one (1) day inspection of the facilities approximately twelve (12) months after they are placed into operation. The Design Project Manager/Engineer shall provide a written report summarizing warranty repairs that are necessary, as well as any operational modifications that are recommended to optimize performance.

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Attachment 8: **Instrumentation List**

3.4 *Power Supplies*: Separate power supplies shall be provided for analog inputs and PLC's, and digital outputs.

3.5 *Conduit Spacing*: Required between power and signal / control cables as listed in the I.E.E.E Standard 518-1982, current edition.

3.6 Signal/Control Wiring for Corrosive Areas

A. *Ammonia*: Use Schedule 80 PVC conduit material for any new wiring required in these areas. Existing conduit and conductors should be reused wherever possible. Where possible, enclosures for control and electrical components should be located outside of the feed rooms. Where this is not possible, the enclosures shall be fiberglass NEMA 4X type enclosures.

3.7 3 - Wire Control: Required for all pieces of equipment (one normally open contact for start and one normally closed contact for stop). Chemical Metering pumps (require one contact for start and stop).

3.8 Modulating Valves: Analog control with full opened / full closed feedback or open / closed control with position feedback and full opened / full closed feedback.

3.9 Analog inputs and outputs shall be 4-20 mA. Discrete Inputs shall be 24 VDC. Isolated dry relay contacts shall be furnished for all Discrete Outputs – relays may be integral to the I/O module. Interposing relays may be furnished in cases where the I/O module relay contacts do not have adequate electrical ratings.

3.10 Input / Output Modules: Provide high density I/O modules.

PART 4 ACCEPTABLE MANUFACTURER'S LIST

SCADA / INSTRUMENTATION

Equipment Description	Manufacturers
Pressure Transmitter	Rosemount (Monterey) Endress Hauser
Turbidimeter	Hach
pH Analyzer NOT USED	Hach Wallace & Tiernan ProMinent
Chlorine Residual Analyzer NOT USED	Hach Wallace & Tiernan

	Prominent
Industrial Ethernet Switch	Hirschmann Stratix
Radio (Licensed and Un-Licensed) **(Not for New Install) NOT USE	Microwave Data Systems (GE MDS)
Antenna (Radio) **(Not for New Install)	Clearwave Samco Andrew Decibel Pctel
Cellular Modem	Sierra Wireless (GX450)
Programmable Logic Controller	Allen Bradley (ControLogix, CompactLogix L3 or Higher)
Fluoride Ion Monitor NO T USE	ABB, ATI Orion ProMinent
Particle Counters/Monitor NOT USE	Chemtrac Systems, Inc. Hach
Streaming Current Detector NOT USE	Chemtrac Systems Inc.
Temperature / ORP Analyzer NOT USE	Emerson ABB ProMinent
Flow Switch	Dwyer Instruments Inc. Flotect Kobold
Venturi Flowmeter NOT USE	BIF Henry Pratt Primary Flow Signal Badger
Magnetic Flowmeter	ABB Rosemount Endress Hauser Sparling TigerMag (Monterey Preferred)
Displacement & Turbine Flowmeter	Sensus Technologies Neptune McCrometer
Ultrasonic Meter NOT USE	Nusonics Division – Mesa Laboratories Polysonics Panametrics
Ultrasonic Level Probe NOT USE	Endress Hauser Inventron Siemens Flowline Ametek – Drexelbrook
Radar Level Probe NOT USE	Endress Hauser Ohmart-Vega

	Siemens Magnetrol
Capacitance Probe NOT USE	Ametek - Drexebrook Siemens
Float Level Switch NOT USE	Siemens Anchor Scientific
Level Instruments – RF Admittance Probe NOT USE	Ametek - Drexelbrook
Auto Dialer *Note: Not for New Installations NOT USE	Raco Verbatim Antx
Ammonia Analyzer NOT USE	Hach ChemScan
PLC Enclosure	Saginaw Control Engineering (SCE) Hoffman Engineering
Human Machine Interface (HMI) Software	ICONICS Gen32 GE Proficy iFix (Sacramento only)

PART 5 SCADA HMI SCREEN AND SYSTEM REQUIREMENTS

5.1 SCADA HMI screen display must include but not limited to the following. *(Set points include; alarm set points, level control set points, process parameters, and various control points.)*

A. Well Sites

a. Well level with alarm set points
b. Well pump motor control and status
c. Chemical analyzer and chemical feed system controls
d. Discharge pressure and flow display with alarm set points
e. Hydro pneumatic tank level and controls (if applicable)
f. Blow valve status and control
g. Totalizer values for flow, runtime and pump starts
h. Well tuning set points
i. Power monitor
j. Trending graph of critical points

B. Booster Pump Stations

a. Pump motor controls and set point
b. Source and discharge tank level display and set points (if applicable)
c. Inlet and discharge pressure with set points
d. Discharge flow and set points (if applicable)
e. Discharge valve control and status
f. Totalizer values for pump runtime and starts

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Attachment 9a: **Addendum 5, Items 1-17**

Cal Am Water
Design Build of Fitch Park ASR Well 5 and 6

Reply to the RFI 11.

1	Our bid includes Allen Bradley 18 Pulse and AFE, Eaton AFE and Schneider AFE VFD.
2	Our bid includes Allen Bradley 18 Pulse and AFE.
3	See attached information from Allen Bradley where they describe drive features specifically designed for operation on Generator.
4	The Generator size is based on the following minimum guidelines: These are specific for this project. Engine HP under 82% utilization Alternator harmonics below 7% with pump running Voltage dip <10% during ramping Voltage regulation at <1% during steady state operation
5	The Drive Cabinet will be designed by the Manufacturer. We do not have much option to relocate components but will work with them to address concerns of CAW. Typically, the drive transformer will be in its own compartment for a drive this large.
6	The VFD can be operated in 40-60 Hz.
7	The power factor (pf) of 18 Pulse VFD is specfied 0.95 or better.
8	Both 18 pulse and AFE VFD comply with IEEE-519-1992
9	Drive is quoted in NEMA 12 as specified.
10	Both VFD are continuous duty 24 hours, 7 days a week.
11	If the cable length is 100 ft or less the dV/dt filter is not needed. The actual cable length in this application, according to Engineer, is about 50 ft.
12	Rockwell Automation/Allen Bradley 18 pulse PWM Powerflex 755 is provided in the bid.
13	Harmonic mitigration: Rockwell/AB will perform harmonic study to sensure it meet IEEE-519 requirement.
14	Power system Analysis: Rockwell/AB will perform power system analysis during preliminary design.
15	2 years waranty parts and labor are included as sepecified.
16	Rockwell Automation/AB includes spare parts as specified.
17	The Rockwell/AB service center is in East Bay which is within 4 hours drive or 200 miles range. The response time is estimated to be 72 hours or less. The per diem charges for an authorized technician is $2,870/8-hour day plus expense. Price list will be proivded upon selection of manufacturer and drive. Drive Manufacturer will provide confirmation of acceptance upon selection of the Drive.
18	The Drive manufacturer will compile to co-ordinate with motor manufacturers to ensure the motor is compatible with the Drive.

Additional information
Comparion of 18 pulse and AFE VFD

	18 pulse VFD	**AFE VFD**
Footprint	101"(H)X25"(D)X220"(W)	79"(H)X27"(D)X80"(W)
Fitting to Bldg	need to enlarge building	Fit to proposed building
Cost	about $5000 more	slightly cheaper
Saving on building	cost of redesign build and construction	Save ten of thousand dollars on engineering and construction.
Thermal energy	more thermal energy (bigger A/C)	less thermal energy (smaller A/C)
Reiability	reliable. In the market for decades	Rockwell states: more reliable than 18 pulse VFD
Maintenance	difficult to work on and replace components	interchangeable parts in cart and can be easily replaced.

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Attachment 9b: **VFD Information**

Selecting the Best Option for Low Harmonic AC Drives

Jeff Raefield, Power Technical Consultant, Rockwell Automation

For decades, the standard solution for mitigating harmonics created by large AC inverter based Variable Frequency Drives (VFDs) to meet the requirements of IEEE-519, has been to utilize a phase shifting transformer based solution that allows the rectifier portion of the VFD to draw power from the line with less harmonic current distortion. This option, referred to as "Multi-Pulse", "18 pulse" or "12 pulse" drive technology, has always presented challenges that until now, had to be lived with. This paper will explore those challenges and present a more modern approach to solving the issue of harmonics in large VFDs, the Active Front End (AFE) drive. Harmonics is a complicated subject deserving of more detailed explanations, but that is not the purpose of this paper. The focus here is on one aspect, how end users, when taking advantage of the other benefits of using VFDs, deal with harmonic distortion they may cause. So we will only address the salient points to help illustrate the issues discussed about the technologies.

Background

Harmonic distortion to the power system created by the advent of "non-linear" loads has been a problem since the invention of the bridge rectifier, but was initially limited to smaller devices such as computer power supplies, DC drives, electronic ballasts and such. The explosion of AC VFDs into the industrial and commercial marketplace beginning in the late 1980s however exacerbated that once minor issue into one of significant importance because it led, in the early years, to problems such as transformer fires, overloaded conductors, equipment damage and significant economic losses. So to help users address this issue more thoroughly, in 1992 the Institute of Electrical and Electronic Engineers (IEEE) issued a revised statement of standards, number 519, for end users and utilities to follow regarding how they can help avoid this problem, not only for themselves, but for their neighbors. This document, ***IEEE-519-1992***, has been the industry standard for addressing this and although updated in 2014, is still considered the best practice in mitigating the issues.

IEEE-519 outlines separate responsibilities for end users and the power utilities that serve them and since this paper is targeted toward the end users, we will focus on that aspect, beginning with a brief overview of what "harmonic distortion" is and why it is important to deal with it.

Harmonics are frequencies superimposed upon the fundamental frequency (60 Hz in North America, 50 Hz in most other countries) that are multiples, called "orders" of that fundamental. So here in NA the "second order" harmonic is 120 Hz (2 x 60), the third is 180 Hz (3 x 60) etc. When their amplitude is the same, harmonics in any two conductors that are *even* orders, meaning an order number divisible by 2, will cancel each other out. Likewise in a 3 phase system, any "triplen" harmonic, meaning divisible by 3 (i.e. 9th, 15th, 21st etc.) are self cancelling. The problematic harmonics are mostly odd orders that are *not* divisible by 3, called the "***non-triplen***" harmonics, so the 5th, 7th, 11th, 17th, etc. It is these non-triplen harmonics that accumulate in the power system, circulate in transformers causing excessive heating, overload conductors and waste energy, as well as risking failure of the power distribution system as a whole. Harmonics can refer to distortion of the Voltage waveform, or the Current waveform, each of which affects the other.

"Thou Shalt Not Mess Up Thy Neighbor's Voltage!"

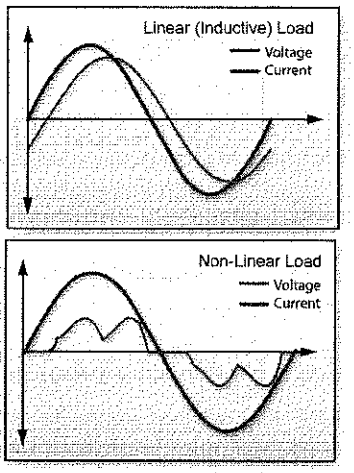
Distortion of the Current waveform is what causes distortion of the Voltage waveform, then having a distorted Voltage waveform can exacerbate Current distortion. But it has to begin with that distortion of the Current waveform, because that is what is related to the WORK being performed at any facility. A simplified way to look at the issue is this:

- Non-linear loads in YOUR facility create harmonic CURRENT distortion.
- Harmonic current distortion in your facility is what causes VOLTAGE distortion
- Voltage distortion can travel, via the utility connections, to your NEIGHBOR's facility.
- Voltage distortion coming INTO any facility can then make CURRENT distortion in that facility worse and the problem can spiral out of control.

So the basic underlying premise for ***users*** in IEEE-519 is that you must do whatever you can to limit the Total Harmonic Distortion of CURRENT (THD-I) that your equipment creates, in order to avoid creating excessive Total Harmonic Distortion of VOLTAGE (THD-V) that might "escape" your facility, travel on the utility lines and affect someone else.

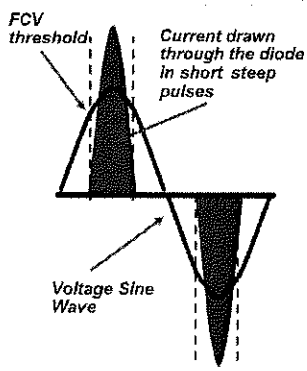
The chief power utility aspect of IEEE-519 is that, because THD-V coming *INTO* a user's facility will exacerbate their THD-I, the utility must ensure that there is a limit to the THD-V in the power they deliver. But remember, the THD-V is not *CREATED* by the utility (for the most part), so the only way they can control this is to impose and enforce rules onto their customers, the users. It then falls upon the utilities to be the ones to monitor their connected customers and insist upon mitigation. That point of measurement is referred to as the "**Point of Common Coupling" or PCC**. They do not, however, dictate HOW mitigation is implemented as they are only interested in the result; the lowest possible THD-V that is passed on to other connected users via their lines.

When to Mitigate



An AC load connected to and drawing current from a source can be considered as having a "linear" or "non-linear" current draw from the source. Linear loads draw current into the device from the source in the same smooth sine wave form as the AC voltage change was taking place. "Linear" loads then are things like resistance heating devices, incandescent lighting, magnetic ballasts, and AC motors that are running Across-the-Line (DOL for those outside of North America). Years ago, most AC loads were linear, hence "harmonics" was virtually unheard of.

Nonlinear loads, as mentioned earlier, are those with rectifiers that create harmonics. Non-linear refers to the way in which the devices draw (pull) current from the source into their rectifier for whatever purpose they are going to use it. As time goes on, more and more of the loads we connect are now considered nonlinear, because ANYTHING with a power supply is a nonlinear load and a lot of our devices are now using power supplies in one form or or another.



When something needs DC power and is fed from an AC source, a **Diode Bridge Rectifier** is often used to convert AC to DC. Diodes conduct in only one direction, hence their use in rectifying. But they do not conduct continuously in that one direction, they have what is called a "Forward Conduction Voltage" (FCV) threshold, below which the diode *doesn't* conduct, above which it *does*. So ***a diode pulls current from the incoming line only at the PEAKS of each sine wave***. This results in a "pulsing" effect on current, which then distorts the voltage sine wave as it happens.

How much distortion takes place has a lot to do with the "stiffness" of the supply source or how much total available current is in the system, meaning what the transformer or generator is capable of delivering with the given impedance on the supply, usually referred to more succinctly as the "Available Short Circuit Current". If you have a very large supply and a very small non-linear load, the effect that one load has on distorting the voltage can be miniscule, whereas a large load can have a more meaningful effect. But the effects are also cumulative, so a large number of small loads can have the same effect as a small number of large loads, and a combination, which is usually the case, can quickly become very problematic.

Determining when mitigation is necessary can be simple if you can just measure the THD at the PCC, but determining in ADVANCE of purchasing new equipment can be difficult. A detailed "Harmonic Study" of all of the relevant factors should be done to be sure and is typically performed by someone with specific knowledge and training in this complex subject. There are also several software based estimators available, in fact Rockwell has some that can be run from Web Based Tools (see appendix for link). But for quick estimating, a simplified "rule of thumb" is as follows:

If the nonlinear load is 20% or higher of the total load in your facility, then you are a good candidate for harmonic analysis and mitigation.

This rule is basically just to determine IF a further study is warranted. But remember, the ONLY loads that are linear now are resistance heating and AC motors running A-T-L. and that ***anything with a power supply is a nonlinear load***. So that includes not only VFDs, but also DC drives, "ECMs" (Electronically Commutated Motors), Servos, PC and PLC power supplies, all forms of monitors and TVs, audio equipment, copiers, printers, UPS systems, battery charges and more recently because of the move away from incandescent lighting, all energy efficient lighting, including HID, Fluorescent, Compact Fluorescent, even LEDs. All these things have what are called "Switch Mode Power Supplies" (SMPS) or something like it and all SMPS create harmonic distortion.

Mitigation Strategies

Once you have determined IF you need to mitigate harmonics, then you must decide on HOW to do that. There are multiple strategies, all valid so long as the end result is achieved; reducing the THD-V at the PCC. But these strategies can be categorized in two main ways;

Mitigate Cumulatively;

If you want to, you can simply look at the total problem, THD-V, at the place it matters, the PCC, and implement a solution there that neutralizes the THD-I to as to control the THD-V. That solution is called an "Active Harmonic Filter" and if the THD-I is relatively low in a facility, this can be a very cost effective approach. But this is not the subject of this paper, except that IF you chose to take that approach, mitigating your larges loads separately can greatly increase the cost effectiveness of this solution.

Mitigate Collectively;

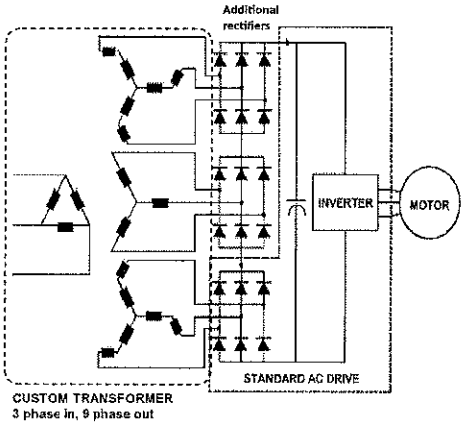
This strategy is based on the precept that if you mitigate each contributor to the problem, you mitigate the total problem because the nature of the problem is ultimately cumulative, so if the contributors are all mitigated, the accumulation is mitigated as well. This of course can become very expensive very quickly as you add harmonic filtering or mitigation systems to each and every nonlinear device in your facility. But the most important aspect of this approach is to mitigate the ***worst offenders*** on that list first, because large VFDs will by definition be a large portion of the nonlinear load profile, making it an important strategy even if you implement an Active Harmonic Filter at the PCC as well.

Large Motor Drive Strategies:

In the collective mitigation approach then, there are two main design strategies for larger drives and are the two that are the subject of this paper; Multi-Pulse Front End drives, which has been the go-to choice for decades, and the newer more modern option, Active Front End (AFE) drives. We will explore these two options in more detail in the following paragraphs.

Multi-Pulse Front End VFDs (18 Pulse)

The strategy behind a multi-pulse front end VFD is to have a custom transformer system that takes 3 phases in on the primary, and has multiple secondaries on the same core, each wound to cause a phase shift relative to the others. For simplicity we will discuss only an 18 pulse design because it is the most prevalent in NA*. So in an 18 pulse drive, that transformer has 3 separate 3 phase secondaries or 9 phases, each shifted from one another by 20 degrees. Each of these 9 phases is connected to two diodes, one for positive, one for negative, hence the 18 "pulses" in how the current is drawn from the line. The phase shifting between these 18 pulses then causes some of the non-triplen harmonics to themselves shift, so some of the 5^{th} becomes 6^{th}, some of the 7^{th} becomes 9^{th} or 10^{th}, some of the 11^{th} becomes 15^{th} or 16^{th}, etc. etc. and because those are now divisible by 2 or 3, they now cancel each other out. Each of the sets of rectifiers then just feeds a common DC bus that goes to the inverter portion and is recreated back to 3 phase to the motor, and the harmonics from creating that DC bus have been mitigated.

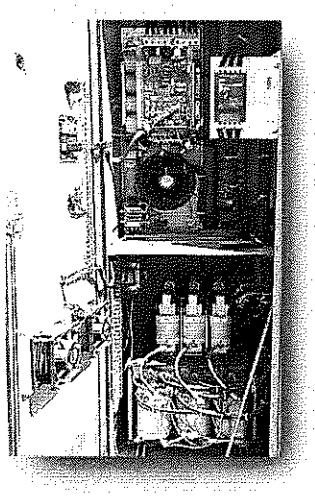


18 Pulse Drive Advantages:

- Familiarity. An 18 pulse VFD is a "tried and true" solution that has been implemented for decades now and is well understood by technicians and support staff.
- The mitigation technology is "passive" in that it is the magnetics of the custom transformer that does the bulk of the work, so there is little impact on the functionality of the VFD itself.
- THD-I created by the VFD system is held to 5% or less**, the most desirable level when considering the effect it might have on the THD-V at the PCC.
- Power factor through the drive is not affected, so it remains at .90 or better.

18 Pulse Drive Challenges;

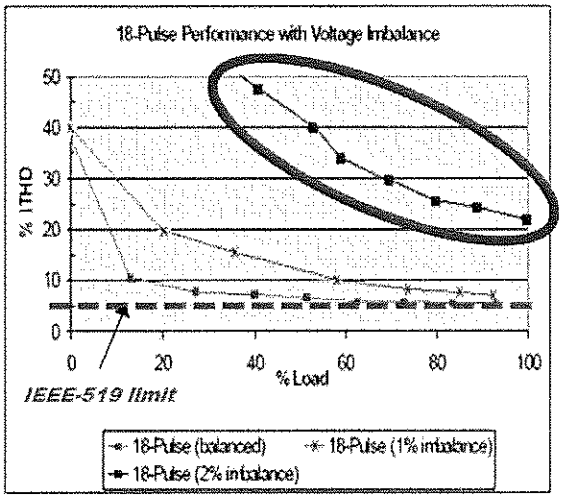
- The transformer is **expensive, large and heavy**, creating challenges at the installation stage if space and maneuverability of a crane is limited. The transformer also presents limitations in conduits can enter and exit.
- The transformer produces **heat** and VFD electronics are sensitive to heat, so keeping an 18 pulse VFD cool can be a challenge, requiring the transformer to be in an adjacent enclosure, increasing the footprint. If space is limited, some manufacturers have chosen to design their drives to minimize floor space by "stacking" the VFD portion on top of the transformer portion. But that then puts the most heat sensitive parts right above the heat generating parts, and since heat rises, it becomes a long term reliability issue.
- The transformers are custom made, so replacements can cause major delays and significant down time.



** 12 pulse designs are more prevalent in countries outside of North America where large loads are few and far between.*

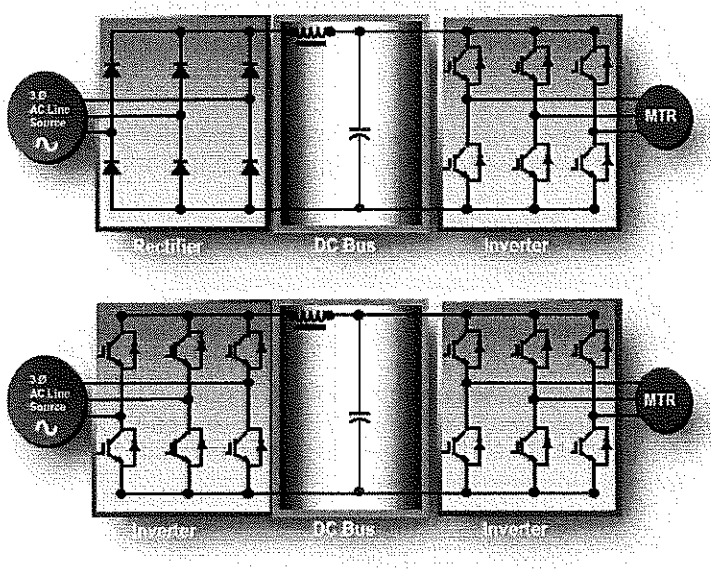
*** 12 pulse typically can only mitigate THD-I to 10-12%*

- Perhaps the biggest challenge, and the "dirty little secret", with 18 pulse drives is the fact that the ***harmonic mitigation suffers if the line voltage is not near perfectly balanced***. This then may result in the fact that you've implemented it and paid for it, but it may not be working as intended! When 18 pulse was the best thing available, this issue was often overlooked (if known about at all) because options were not available *that didn't come with more significant problems*. But studies have shown that at just 1% voltage imbalance between phases, the THD-I mitigation can exceed IEEE-519 recommendations, jumping to as much as 15% THD-I at low load. Worse yet, at 2% imbalance, which is still considered "acceptable" to most utilities, the THD-I can jump to as much as 20% at full load, and 40% THD-I at half load on the drive! This then can cause overheating of the transformer and can also become problems for the diode bridge components. If that transformer fails, you are then faced with that down-time issue in getting a replacement. Yet line voltage balance is usually beyond the control of the end user, it is the result of the utility having to serve multiple customer single phase loads that they have little control over. So what often happens is that an 18 pulse drive is tested and accepted on a good day, then shortly thereafter, the harmonic mitigation is no longer performing, forcing ***the user to FURTHER mitigate, often with ANOTHER strategy such as an Active Filter***, on TOP of the cost of buying the 18 pulse drive.



Low Harmonic Active Front End (AFE) Drives

The AFE drive is not a new concept, they have been used for decades as well, but primarily for line regenerative braking, not for harmonic mitigation. So the only thing that is "new" in the PowerFlex 755TL **Low Harmonic** AFE drive is that they are now being offered for this purpose alone (or combined with line regenerative braking in the PowerFlex 755T**R**). In an AFE drive, the "rectifier" is actually another inverter connected to the LINE side of the drive. This inverter then is an "active" device and the process of rectification is done by the transistors in that front-end inverter. The firing of those transistors is controlled using a special algorithm called "Selective Harmonic Elimination" (S.H.E.) to ***avoid creating*** the 5th, 7th and 11th current harmonic, the ones with the highest amplitude, so that the issues that cause voltage harmonic distortion are avoided in the first place. So an AFE drive is not thought of in terms of a number of "pulses", because in fact it AVOIDS pulses; it is a "pulseless" technology and rather than alter the harmonics as an 18 pulse does, it just never creates very much in the first place.



- As you can see in the diagrams, the Active Front End drive model is almost as if you have two back-to-back VFDs; an inverter that runs the motor, another inverter that interacts with the line as it rectifies the AC to DC.

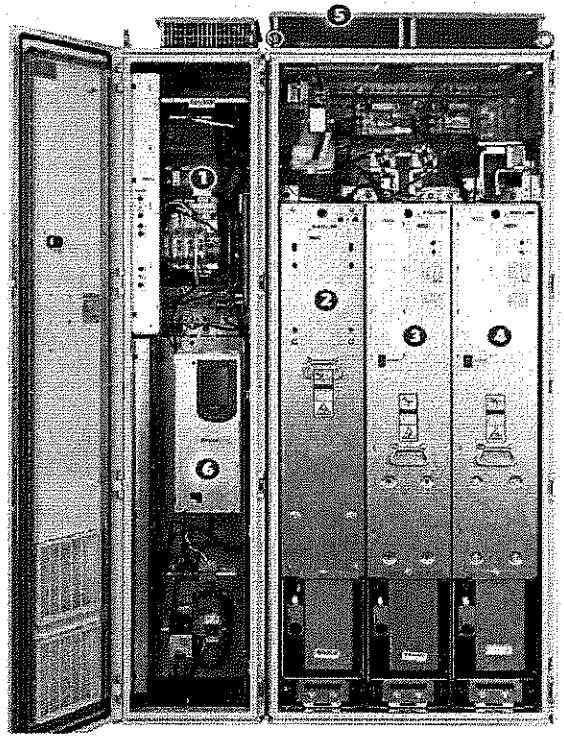
- Not shown in that diagram but very important is that in order to interact with the line source, the drive has to be capable of accurately measuring it first, so there is a lot more sensing of the line taking place than in a standard VFD.

- Also not shown here but equally important is the need for additional line side filtering. As mentioned above, S.H.E. takes care of the bulk of the problem, the 5^{th}, 7^{th} and 11^{th} harmonics. But higher order harmonics, although lower in amplitude, can start to create more EMI and RFI issue. So better designs also add additional line side filtering to capture and mitigate these higher order harmonics.

PowerFlex 755TL AFE drive design

The PowerFlex 755TL Low Harmonic AFE drives 250HP and larger are designed around a "modular" concept where the control and power components are each in their own module within the drive. The modules are;

1. *The Line Disconnect, Circuit Breaker and Pre-charge system that prevents damage to the DC bus capacitors when first energized*
2. *The L-C-L filter module, used to filter out high order harmonics and sense the line side power issues.*
3. *The Line Side Inverter Module that rectifies the AC into DC, eliminating the 5^{th}, 7^{th} and 11^{th} harmonics and conditions the DC bus.*
4. *The Load Side Inverter module that provides the variable frequency / variable voltage AC power out to the motor.*
5. *The ventilation system within each module that takes cooling air into the bottom and channels it through and across the module heat sinks in a dedicated air channel to exit from the top , without mixing that high volume of air with the more sensitive control electronics.*
6. *The "Control Pod" in a separate cabinet (with its own cooling system) that is the brains of the drive and contains the interface for the door mounted HIM, I/O, option and communications boards*



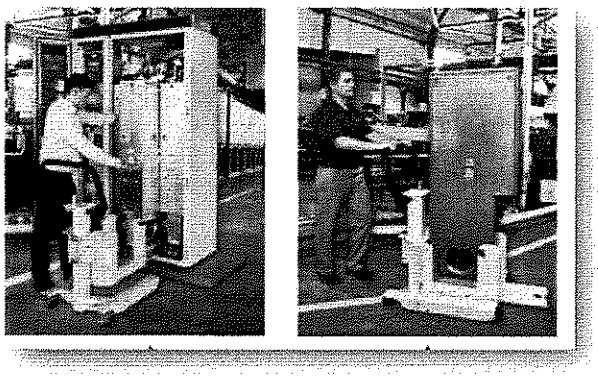
Typical PowerFlex 755TL Frame 8 drive arrangement

As motor power sizes increase, multiple modules of the inverters and/or filters are added in parallel, communicating with each other and the control pod via high speed fiber optics to act as a single unit.

The L-C-L filter and inverter modules are on roll-out chassis for easy servicing and inspection. In addition, the inverter modules are interchangeable, meaning fewer spare parts are required for low down time in the event of an issue.

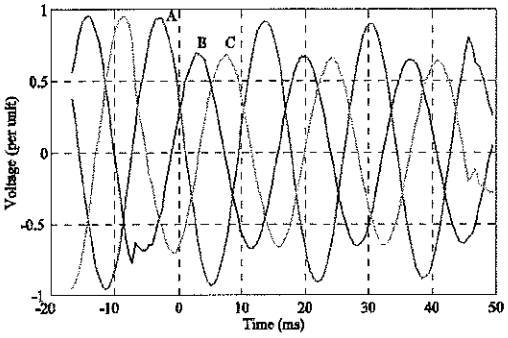
Cooling fans for the power modules are independently located in each power module and can be removed for servicing or replacement from the front with a simple thumb screw.

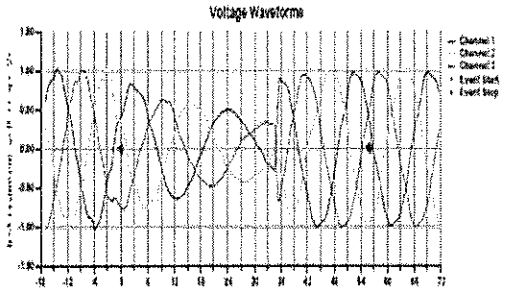
In smaller size drives these same components exist but are not separate modules.



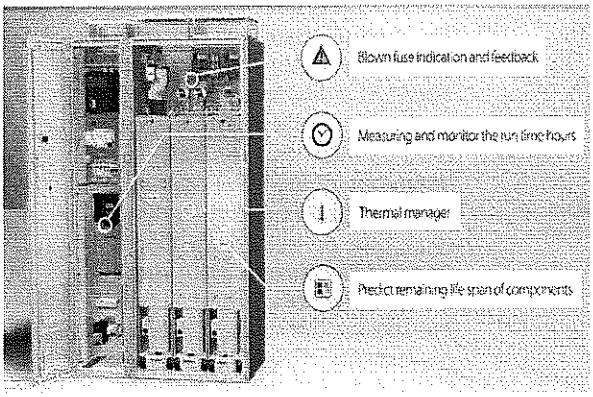
AFE Low Harmonic Drive Advantages:

Because the front end rectifier is "active" it can also provide some new features not available or even possible in VFDs before (note, some of these features are exclusive to Rockwell **PowerFlex 755TL** drives).





- *A **PowerFlex 755TL** AFE drive can monitor and adapt to any changes in the incoming line source. So if there is a voltage imbalance, the drive adapts to it without causing any other problems and maintains the harmonic mitigation.*
- *A **PowerFlex 755TL** AFE drive can create a "boost" to the DC bus when the line voltage sags. So rather than force the output to a lower level because of a utility or generator line sag event as other advanced VFDs can, the AFE drive can actually ride through a line sag of about 10% while still running the motor at full speed and torque!*
- *A **PowerFlex 755TL** AFE drive can continue operation in a sustained "brown out" of up to 70% line voltage by "folding back" the output but not tripping off-line.*
- *A **PowerFlex 755TL** AFE drive can correct Power Factor , both displacement and distortion, to 99.99% as seen by the line. But when the VFD is not being commanded to Run, a "sleep mode" function will open the pre-charge circuit and disconnect the L-C-L filter so that it doesn't leave the capacitors on-line all the time, potentially causing a leading power factor.*
- *The **PowerFlex 755TL** AFE drive offers a smaller footprint than side-by-side 18 pulse drives, but better thermal management than "stacked" designs. The main roll-out power modules of the larger (250HP and up) drives have their own individual thermal management systems, so each part cools only itself and no one single failure of a fan will cause issues with the entire drive. In addition, the PowerFlex 755TL series AFE drive has **prognostic capabilities** that will predict any impending failure of the cooling fans based on monitored operating values, allowing the user to replace them BEFORE they wear out.*
- *Prognostic capabilities in the **PowerFlex 755TL** AFE drive also extend to power systems, such as capacitors and transistors as well. Active modeling and performance monitoring are used to help predict potential impending issues before they become unscheduled shutdowns.*
- *On board diagnostics also alert operators of blown fuses, run time, thermal sues, motor maintenance scheduling and component lifespan issues.*

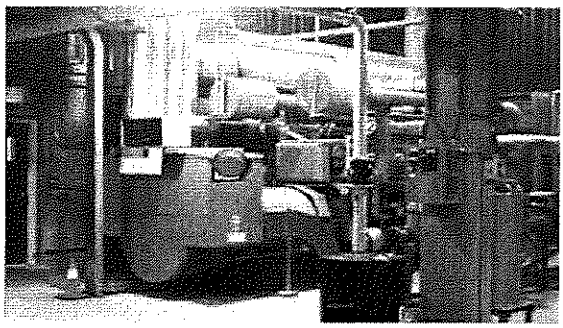


is-

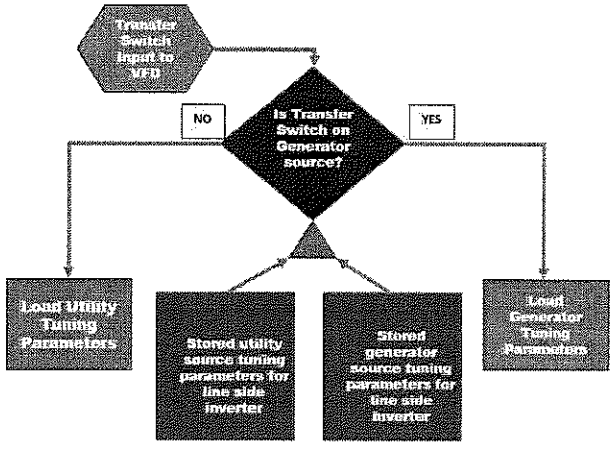
AFE Drive Challenges:

As with all technologies, there are challenges that must be considered and, if possible, overcome. Some of those challenges for AFE drives are:

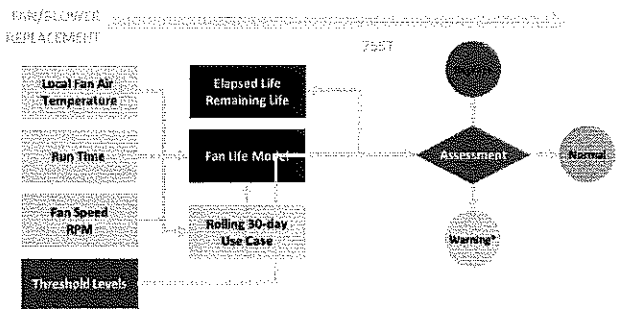
- ***High Order Harmonics:***
  Without proper filtering, high order harmonics can cause line disturbances, negative interactions and EMI/RFI problems. Not all AFE drive designs take that into account and may require special transformers.
  - *The **PowerFlex 755TL** drive however includes an L-C-L Filter assembly to handle harmonics up to the 50th order (3kHz). It works with any power distribution system.*
- ***Generator Operation:***
  Some AFE drives fed by high impedance sources ***such as back-up generators*** present a shutdown risk. A resonance created by the interaction of the high impedance source and the VFD leakage reactance can result in damage to the VFD. This phenomenon has been known for years but was not an issue until AFE drives were used for harmonics only (because when used for braking, you can't use generators anyway). One simplistic way to avoid the damage to the VFD is to disconnect it from the line when that resonance is detected. But for applications where a back-up generator is mandatory such as in the Water / Wastewater industry, this presents a problem because just when you need them the most, if the power goes out and the backup generator comes on, the VFDs are not available. So to address this, Rockwell has taken the following steps:



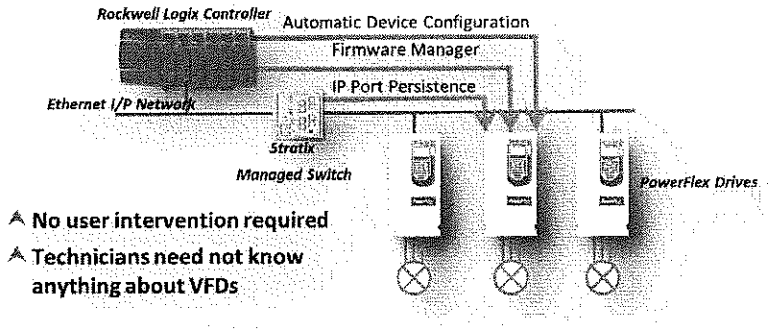
  - *The **PowerFlex 755TL** drive includes a patented system of additional passive dampening to address this problem. It has been specifically designed to avoid this potential resonance issue if at all possible; it will only open the line side input contactor as a last resort.*
  - *In all AFE drives, the line side inverter must be tuned to the incoming system impedance. Because this potential resonance issue is tied to the change in system impedance, the **PowerFlex 755T** can allow for storage of a second set of tuning values that can be loaded into the line side inverter programming when the line source changes. The **PowerFlex 755T** drives have an on-board PLC-like system, called **DeviceLogix**, that can execute programmed routines independently of the VFD operation. So by programming the drive to recognize an input from the transfer switch or a PLC, the drive can **automatically** switch to the second set of source tuning parameters. This allows for the drive to be specifically tuned to the backup generator impedance values to avoid having the resonance become a problem. To accommodate making this changeover after the utility source fails, a small control power UPS is used to keep the VFD control boards alive during the transfer so that by the time the generator starts and the ATS transfers, the VFD is ready for it.*



- ***Reliability concerns:***
  There is a perception that having two inverters increases the number of components in the system (compared to 18 pulse) and therefor has more things that can go wrong.
  - *The prognostic capabilities built-into the **PowerFlex 755TL** drive have been designed to INCREASE reliability and reduce down time by predicting and proactively alerting users to the most common impending issues such as component stress, thermal management issues and lifespan management of critical systems such as cooling fans, transistors and bus capacitors. In addition, the Inverter Modules have been designed to be identical, whether used for Line Side of Load Side, so they are completely interchangeable, reducing the required spare parts. These major systems are also designed to be easily replaceable by one person (using the Service Cart) in minutes.*



  - *Combined with the Rockwell exclusive "Automatic Device Configuration" feature with our controllers, technicians can get a drive up and running with a minimum of down time. ADC allows a Rockwell Controller (ControlLogix or CompactLogix) to store the programming of a Rockwell VFD so that if a VFD (or main control board) must be replaced, the technician need take no action in having to reprogram it, all they need to is connect line and load power and cycle power to it. The PLC, Managed Switch, Ethernet I/P network and VFD coordinate to automatically reconfigure the new component with no special knowledge of the VFD necessary from the technician. **This means that in emergency situations, any qualified electrician can replace a VFD whether they have training on them or not.***



*When compared to 18 pulse, the **PowerFlex 755TL** drive being capable of predicting and alerting users before something fails, having better thermal management aspects, their ability to survive and preform in a more varied electrical environment and the ease of servicing, replacing and returning them to service actually serves to make them **MORE reliable that 18 pulse drives**.*

Summary

When choosing a strategy for addressing harmonics in a facility, mitigating the contributions of large AC motor drives is an effective aspect of any approach. While the old standard for decades has been the "18 pulse drive" option, it was popular mainly because there was no effective alternative. More recently, new methods of applying Active Front End (AFE) drive technology solely for the purpose of mitigating harmonics, the so-called "Low Harmonic AFE drive", has gained momentum and not just because it is a less costly option. AFE drives also present a more reliable solution to harmonic mitigation while at the same time delivering new benefits not previously available in the older technologies. In particular, Rockwell PowerFlex 755TL AFE drives provide all of these benefits, plus solutions to the other challenges facing AFE Low Harmonic Drives that have been recently released, making the PowerFlex 755TL the right choice for your Low Harmonic Drive applications.

18 Pulse	PowerFlex 755-TL AFE
Magnetic solution	Electronic solution
Familiar	Newer concept
Comparable cost	Comparable cost
[illegible]	Voltage imbalance is irrelevant
[illegible]	Mitigation remains consistent with load
[illegible]	Same or smaller footprint
Long term heat issues (if smaller footprint is used)	No added heat issues, better thermal management
No added benefits	Several added benefits
Works with generators	Works with generators (Rockwell 755TL)

www.rockwellautomation.com

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Publication XXX-XXX-XX-X – June 2018

LISTEN. THINK. SOLVE.

California American Water
Monterey Peninsula Water Supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities

Attachment 10: **Allen Bradley's Comments**

Allen Bradley's Comments on VFD & Generator

VFD:

For the PowerFlex 755TL Low Harmonic Active Front End versions OR for the 18 pulse, we recommend that the *available* generator kVA capacity is no less than 150% of the VFD input kVA rating. By available we mean that if there are other loads services by the generator, they are factored in AFTER the 150% sizing requirement.

What Rockwell does to avoid problems with using a backup generator on the Active Front End versions is that our drive can be tuned to accept two different line source profiles, i.e. a Utility Source and a Backup Source. Internally within the drive, we allow selection of which source profile to use via a digital input or communication command. These profiles are programmed and done in the initial commissioning process. It does however require knowledge of the circuit impedance values. So, another requirement of the "portable" generator is that the same generator is used consistently so that the drive is connected to a known source profile, because the VFD itself can only store and select between two. If that is not possible, then the alternative is for the VFD to be connected to a PLC or other higher level control system with added memory and communications, in which ALL known source profiles are stored, then loaded by the PLC or control system into the VFD via comms when a specific generator is connected. If an Automatic Transfer Switch (ATS) is used for open transition of power from one source to the other, we recommend that the VFD have a DC UPS and an auxiliary control power input option card added to avoid a long re-boot sequence with the new source profile. If the backup source is only connected and transfer done manually, this is not necessary. One-line diagrams provided for this project do not indicate that an ATS is being used, so we are not including this option.

Generator:

Other than the above requirements, we do not require any special generator requirements for operating our drives. We recommend that generator suppliers be told of the minimum sizing mentioned above, and that 75% of the load will be non-linear (as mentioned in Item #13) so that they can select the proper offering in their product line.

8. The anticipated number and depth of all soil borings, if any, required after award of contract.

For the geotechnical, our subconsultant Pacific Crest Engineering Inc. will explore, sample and classify surface and subsurface soils by drilling **4-6 exploratory borings** across the project area. Using Cone Penetrometer Test (CPT) soundings and in conjunction with subsurface borings, they will be able to evaluate the density and strength characteristics of the soil profile to the depths explored and obtain samples at selected depths within planned foundation areas.

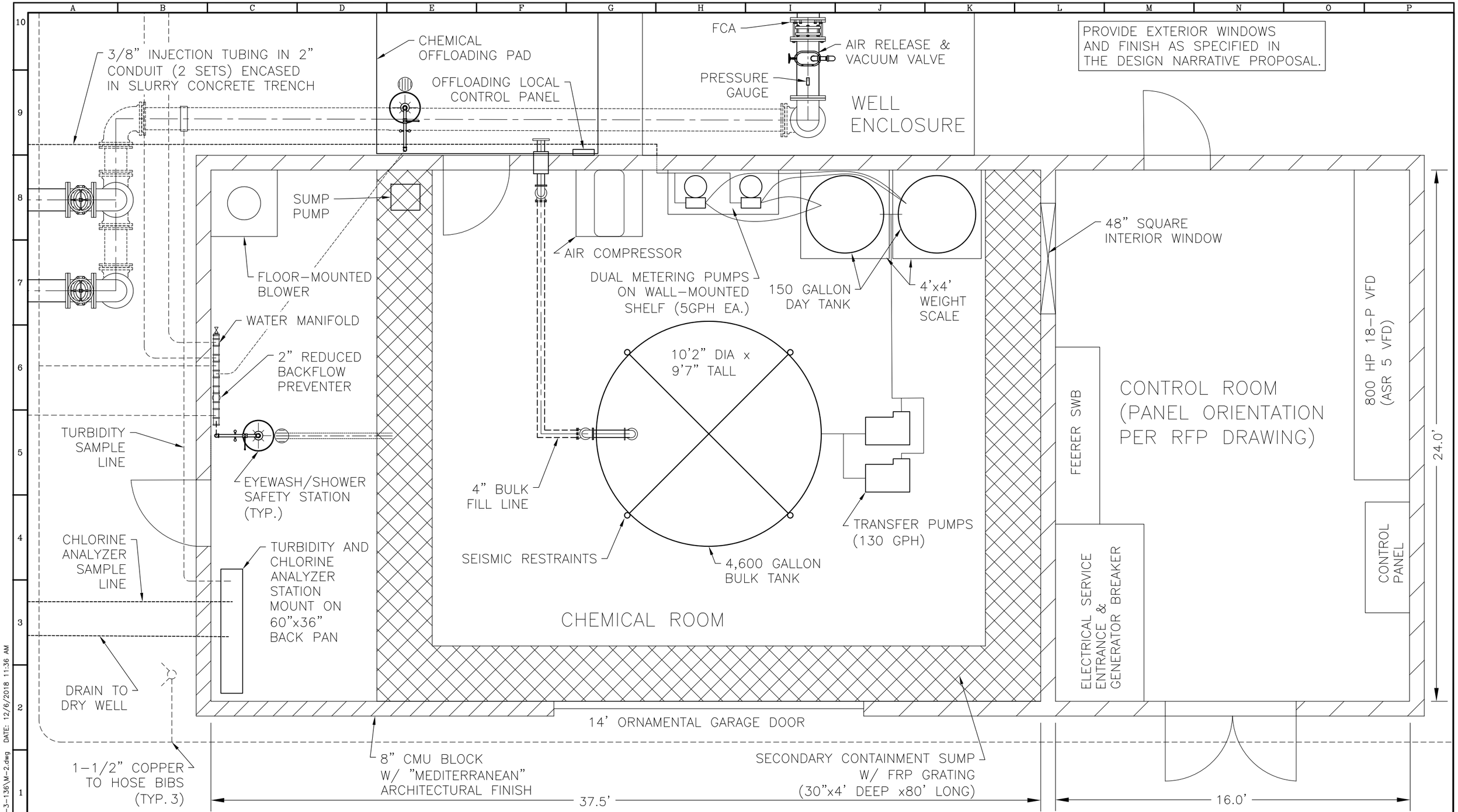
At least one boring in the proximity of the proposed Percolation Basin shall be drilled and converted to an infiltration test hole and tested for infiltration characteristics. We have assumed one day of testing to be performed in accordance with the "Native Soil Assessment for Small Infiltration Based Stormwater Control Measures" guidelines prepared by Earth Systems Pacific for the Central Coast Low Impact Development Initiative. **The anticipated test depth is expected to range from approximately 3 to 5 feet below bottom of design pond elevation.**

The exploratory borings/soundings will range in **depth from 10 to 20 feet**, however, at least one CPT sounding will be extended to a depth of 50 feet to quantitatively address liquefaction and/or dynamic compaction potential beneath the project site. Soil samples will be obtained at selected depths within selected test borings. The test borings will be backfilled with soil cuttings upon completion of drilling.

9. Specifics of any exceptions, which are taken to items requested in this document. If no exceptions are taken, it is not necessary to reiterate the information in the Scope of Services Required.

The following items represent **HHCI's exceptions and clarifications:**

- Permit Fees will be reimbursed by the owner
- Handling and disposal of any Hazardous materials is not included
- Contractor furnish and installs: transformer pad, primary and secondary conduits, meter main switchboard.
- PG&E furnish and installs: transformer, primary/secondary wires, utility meter
- Per addendum 5 Section 4, the generator can be max 80 horsepower / 480 KVa
- Landscaping shall consist of hydroseed of the areas outside of pavement and building areas to restore all disturbed earth to healthy, native, drought tolerant vegetation. The hydroseed mix and supplier shall be approved by the Owner. The hydroseed mix will be a native, drought-tolerant variety that does not require permanent irrigation nor mowing after the fescue is properly established. The hydroseed shall be either Heritage Mix, Native Ornamental Fine Fescue Mix, or California Bay Area Wildflower Mix, or others if directed by the Owner. Installation of hydroseed shall be completed by a Licensed Landscape Contractor. Installation shall include: weed eradication of native soil six weeks and three weeks prior hydroseed planting – required watering and chemicals to kills weeds; soil preparation and amendment using fertilizers; application of hydroseed mix; temporary watering and weed removal for at least three months, or longer, to establish the seed mix.



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DATE: DECEMBER 2018

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"-SCALE ACCORDINGLY)

FILE M-2.DWG
DRAWN ABC/GRG
DESIGNED JMS
CHECKED WAG
CHECKED

NOT FOR CONSTRUCTION FOR PROPOSAL ONLY

Luhdorff & Scalmanini
Consulting Engineers
500 First Street
Woodland, California

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.

CALIFORNIA AMERICAN WATER

FITCH PARK ASR WELLS 5 AND 6 ABOVE GROUND FACILITIES

SUBMITTED: _____ DATE: _____

SUBMITTAL APPROVED: _____ DATE: _____

CHEMICAL & ELECTRICAL BUILDING LAYOUT (ASR 5)

SCALE 1":4'

DRAWING NUMBER **M-2**

SHEET NUMBER 6 OF 7

SCADA & OPERATOR INTERFACE

PLC

CONTROL PANEL

FIELD

LAH 155 — CONTAINMENT HIGH — LA155H

LAH 151 / LAL 151 / LI 151 FT — LEVEL — L151

LAL 152 — HIGH ALARM — LA152L

LAH 152 — HIGH ALARM — LA152H

UAF 111 — FAULT — UA111F

STT/STP — XC111S

SPEED COMMAND — SC111

UAF 112 — FAULT — UA112F

STT/STP — XC112S

SPEED COMMAND — SC112

LAL 252 — LOW ALARM — LA252L

LAH 252 — HIGH ALARM — LA252H

LAH 251 / LAL 251 / LI 251 FT — LEVEL — L251

LAL 254 — LOW ALARM — LA254L

LAH 254 — HIGH ALARM — LA254H

LAH 253 / LAL 253 / LI 253 FT — LEVEL — L253

UAF 211 — FAULT — UA211F

STT/STP — XC211S

SPEED COMMAND — SC211

UAF 212 — FAULT — UA212F

STT/STP — XC212S

SPEED COMMAND — SC212

AAH 181 / AAA 181 / AI 181 MG/L — RESIDUAL — A181

LSH 252

LSL 252

LT 251

HYPOCHLORITE DAY TANK 1 TNK201

CL2 AIT 181 / AE 181

FROM WELL

TRUCK FILL PORT

4" CPVC

LSH 152

LIT 151

LSL 152

HYPOCHLORITE BULK STORAGE TNK101

2" CPVC

TRANSFER PUMP 1 P111

TRANSFER PUMP 2 P112

1-1/2" CPVC

1-1/2" CPVC

LSH 254

LSL 254

LT 253

HYPOCHLORITE DAY TANK 2 TNK202

1/2" CPVC

METERING PUMP 1 P211

TO WELL INJECTOR 1

3/8" PE TUBING IN 2" CONDUIT

TO WELL INJECTOR 2

1/2" CPVC

METERING PUMP 2 P212

LSH 155

5000 GALLON CONTAINMENT SUMP

SODIUM HYPOCHLORITE P&ID

DATE: NOVEMBER 2018

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"-SCALE ACCORDINGLY)

FILE G-1.DWG
DRAWN NIK
DESIGNED TPF
CHECKED TPF
CHECKED

NOT FOR CONSTRUCTION FOR PROPOSAL ONLY

Luhdorff & Scalmanini
Consulting Engineers
500 First Street
Woodland, California

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.

CALIFORNIA AMERICAN WATER

FITCH PARK ASR WELLS 5 AND 6 ABOVE GROUND FACILITIES

SUBMITTED: _____ DATE: _____

SUBMITTAL APPROVED: _____ DATE: _____

INSTRUMENTATION HYPOCHLORITE SYSTEM P&ID

SCALE: NO SCALE

DRAWING NUMBER: I-1

SHEET NUMBER: 7 OF 7