City of Morro Bay
Recycled Water Facilities Design Project

Conceptual Design Report – Final Draft

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Common Acronyms and Abbreviations

AACE	Association for Advancement of Cost Estimating International
AAD	Annual Average Demand (Recycled Water Annual Flow Volume in Acre-Feet per Year)
AADF	Average Annual Daily Flow
ADMM	Average Day Maximum Month Flow
AQMD	Air Quality Management District
ASR	Aquifer Storage and Recovery
CCI	Construction Cost Index
CCR	California Code of Regulations (see also Title 22)
CDPH	California Department of Public Health
CFM	Cubic Feet per Minute
cfs	Cubic Feet per Second
CIP	Capital Improvement Program
City	City of Morro Bay
CF	cubic feet
CWA	Clean Water Act
DIP	Ductile Iron Pipe
DWR	(California) Department of Water Resources
EEM	Energy Efficient Measures
EIR	Environmental Impact Report
ENR	Engineering News Record
EPA	United States Environmental Protection Agency
ETo	Evapotranspiration
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMP	Facilities Master Plan
fps	Feet per Second
GMF	Granular Media Filtration
gpcd	Gallons per Capita per Day
gpd	Gallons per Day
gpm	Gallons per Minute
HDPE	High-Density Polyethylene
HGL	Hydraulic Grade Line
HP or hp	Horsepower
hr	Hour
I&I	Inflow and Infiltration
In	Inches
IPR	Indirect Potable Reuse
KW or kw	Kilowatt
LF	Linear Feet
MCL	Maximum Contaminant Level
MG	Million Gallons
MGD or mgd	Million Gallons per Day
mg/L	Milligrams per Liter (aka “Parts Per Million”) (i.e., Concentration of a Constituent in Water)
ml/L	Milliliters per Liter (i.e., Volume of Constituent in Water)
MSL	Mean Sea Level
NFPA	National Fire Protection Association
NIC	Not Included or Not In Contract
NPDES	National Pollution Discharge Elimination System (Regulatory Framework for Permitting Discharges to Surface Water)
NPSHA	Net Positive Suction Head Available

NPSHR	Net Positive Suction Head Required
NTU	Nephelometric Turbidity Unit (i.e., Measure of Light-Transmitting Property of Waters to Indicate the Quality with Respect to Colloidal and Residual Suspended Matter)
OPC	Opinion of Probable Cost
PDWF	Peak Dry Weather Flow
PHF	Peak Hour Flow (Recycled Water Delivery Rate in gpm)
ppm	Parts per Million (aka Milligrams per Liter)
PS	Pump station
PVC	Polyvinyl Chloride
RW	Recycled (or Reclaimed) Water
RWF	Recycled Water Facilities
RWQCB	Regional Water Quality Control Board
Sch	Schedule (Pipe Dimensions)
SRF	State Revolving Fund (loan program)
SF or sqft	Square Feet
SWP	State Water Project
SWRCB	(California) State Water Resources Control Board
T-Comp	Trailer Mounted Rotary-Screw Type Air Compressor
TDS	Total Dissolved Solids (aka Salinity)
Title 22	Title 22 of California Code of Regulations (Especially, Division 4. Environmental Health, Chapter 3. Water Recycling Criteria)
USBR	United States Bureau of Reclamation
USGS	United States Geologic Survey
UWMP	Urban Water Management Plan
WDR	Waste Discharge Requirements (RWQCB Permits for Discharges to Land or Groundwater)
WRC	Water Resources Center
WRF	Water Reclamation Facility
WWTP	Wastewater Treatment Plant

1. INTRODUCTION

1.1 Background

The City of Morro Bay (City) completed the first two components of its Water Reclamation Facility (WRF) Program in 2022. The first component replaced the 70-year-old Morro Bay-Cayucos Wastewater Treatment Plant (WWTP) (originally constructed in 1953) with the new Water Resources Center (WRC) that is an advanced wastewater reclamation facility capable of treating nearly one million gallons of “potable-quality” recycled water per day. The second component included constructing pump stations and pipelines necessary to transport raw wastewater to the WRC, as well as to convey treated effluent, and advanced purified recycled water from the WRC to the City’s Ocean Outfall and recharge facilities. The advanced purified recycled water produced at the WRC is also referred to as the Indirect Potable Reuse (IPR) product water. The City is now embarking on the design and permitting for the third Program component – the Recycled Water Facilities Project (RWF Project).

1.2 Project Description and Location

The RWF Project-limits cover a large area extending north of Morro Creek and south of the former Pacific Gas & Electric (PG&E) power plant. The Project is located entirely within the Morro Bay City Limits and is bounded by Morro Bay High School to the north, Surf Street to the south, Highway 1 to the east, and Embarcadero Road to the west. The majority of the Project will be constructed in previously disturbed areas (see Figure 1-1 below).

The RWF Project, which is the focus of this Conceptual Design Report, includes the following major components:

- Construction (drilling and casing) of up to three (3) new Injection Wells;
- Equipping of the existing injection well and up to three (3) additional Injection Wells;
- Approximately two miles of pipeline connecting the existing IPR Conveyance Pipeline to the new Injection Wells;
- Recycled water connections for Lila Kieser Park, and Morro Bay High School; and
- A recycled water filling station.

See also Figure 1-1 below that depicts the Project vicinity, existing IPR Conveyance Pipeline Segments A through D, proposed Injection Wells, and possible proposed additional Segments 1 through 7.

Figure 1-1 Recycled Water Facilities Project Vicinity

Once complete, the RWF will improve the reliability of the City's water supply portfolio by enhancing recharge to the Lower Morro Groundwater Basin, protecting against sea water intrusion in the Basin, and providing a new, reliable, and drought resistant water supply source for the City. The RWF will safely enable increased groundwater extraction from the Lower Morro Groundwater Basin and provide a much-needed backup during periods of drought, and reduced State Water availability.

1.3 Purpose and Scope

1.3.1 Purpose

The purpose of this report is to identify options for the major elements and components of the RWF Project, evaluate alternative approaches, make technical recommendations, and document and adopt decisions made by the City Project Team in order to embark on detailed design and construction documents.

1.3.2 Scope of Work

Cannon has prepared a conceptual design report (CDR) that identifies each relevant design item described in the following subtasks.

- Pipeline Alignments and Sizing
- Seawater Desalination Feedwater Pipeline Rehabilitation and Reuse
- Injection Well Equipping Configurations
- Backflush Alternatives Analysis
- Non-potable Water Reuse Alternatives
- Equipment Procurement Analysis

The CDR will outline the preferred design, identify potential environmental impacts and requirements, and right-of-way issues, provide a constructability analysis, consider operation and maintenance requirements, and estimate construction costs. Construction (drilling and casing) and testing of up to three (3) new Injection Wells is expected to be completed by late Fall 2026. The CDR, and any new data obtained from the injection well testing, will be used as the basis for the detailed design of the Project. After incorporating input from the City and Project team, Cannon will finalize the CDR.

1.4 Existing Governing Facilities

As noted, several major components of infrastructure were constructed in the prior phases of the WRF Program. A few of these existing components govern the design and operation of the RWF. For example, the proposed Injection Wells are dependent on the advanced treatment components of the WRC in order to operate and achieve the RWF Project goals. Additionally, the proposed Injection Wells are dependent on the local hydrogeology, and characteristics of the aquifers underlying the City's service area within the RWF Project limits.

1.4.1 Water Reclamation Facilities

The key WRF components governing the design and operation of the RWF are identified below.

- Reverse Osmosis (RO) Feedwater Tanks
- RO Treatment Trains
- Ultraviolet/Advanced Oxidation Process Disinfection System
- Calcite Remineralization System
- Product Water Storage Tank

- IPR Product Water Pump Station
- IPR Conveyance Pipeline
- Injection Well No. 1 (IW-1)

1.4.2 Morro Bay Desal Feedwater Line

The City owns an existing 12-inch diameter pipeline along a portion of the proposed Project corridor that was previously used as a brackish-water feedwater pipeline for the City's former Seawater Desalination Facility. This brackish-water feedwater pipeline (Desal Feedwater Line) was constructed in the late 1990s. The City desires to re-purpose as much of the Desal Feedwater Line as needed for a portion of the IPR distribution pipeline system. There are approximately 4,300 linear feet of Desal Feedwater Line that could potentially be used, including a segment underneath Morro Creek, which would significantly reduce permitting, construction costs, and construction duration.

2. DESIGN CRITERIA

2.1 Hydraulic Context

Hydraulic design of the WRC and IPR Conveyance Pipeline affect the design and operation of the proposed Injection Wells. The major components treating and delivering recycled water for groundwater injection are listed below. The components included in this RWF Project are shown in **bold**.

1. RO Feedwater/Equalization Tanks (2 each, 15,000 gallons/each)
2. RO Treatment Trains (3 each, around 215 gpm/train)
3. Ultraviolet/Advanced Oxidation Process (UV/AOP) Disinfection System
4. Calcite Remineralization System
5. Product Water Storage Tank (approximately 170,000 gallons)
6. IPR Product Water Pump Station (3 pumps, around 323 gpm/each)
7. IPR Conveyance Pipeline, 12” diameter, Sta 115+00 to 174+90, (5,990 linear feet)
8. IPR Conveyance Pipeline, 10” diameter, Sta 35+00 to 115+00, (8,000 linear feet)
9. **IPR Branch Pipelines**
10. **IW-1 (90 gpm injection capacity)**
11. **Initial Phase Injection Wells (IW-3, IW-4 or IW-6, and possibly IW-7)**
12. Final Phase Injection Wells (future Injection Wells for a total of 8 or more Injection Well)

As a first step in developing the design criteria for the Injection Wells, parameters of the WRC and IPR Conveyance Pipeline that affect design of the Injection Wells have been reviewed and evaluated and are briefly discussed in the following subsections.

2.1.1 <u>Water Resources Center – Advanced Wastewater Treatment</u>

The advanced wastewater treatment system (components 1 through 5) produces “potable quality water” for use in Indirect Potable Reuse. There are two RO Feed Tanks, each with a volume of 15,000 gallons, which accept membrane bioreactor (MBR) treated water at the diurnal influent flow rate entering the WRC. The RO Treatment System consists of three treatment trains, each with a capacity of 215 gpm (645 gpm total) with the ability to ramp down each train approximately 10% (to 194 gpm) if necessary. RO treated water is then routed through the UV/AOP Disinfection System, and Calcite Remineralization System before being discharged to the IPR Product Water Storage Tank where it can be used for IPR purposes. See **Appendix A** for the WRC General Process Schematic.

Under optimal conditions, the RO Treatment System will be fed as close to equalized flow as possible from the MBR System and ramp up and down to deliver water to the IPR Product Water Storage Tank while keeping the tank as close to full as possible. It is noted that the ability of the Injection Wells to meet the operational goal of the Initial and Final Phases is dependent upon the ability of the RO Treatment System to supply a relatively steady flow rate to the IPR Pump Station. Capacity of the RO Feedwater Tanks, equalization of the RO feedwater, and capacity of the IPR Product Water Storage Tank will affect the uniformity of the flow to the Injection Wells.

2.1.2 *IPR Product Water Pump Station*

The IPR Product Water Pump Station consists of three pumps each equipped with a variable frequency drive (VFD) as shown in Figure 2-2. The VFDs and pump station control system enable adjustment of discharge pressure and flow rate. In addition to delivering IPR Product Water to the Injection Wells, the goal of the IPR Pump Station operation will be to keep the IPR Conveyance Pipeline pressurized under normal operating conditions to mitigate air entrainment. This will be accomplished by programming the IPR Pump Station to maintain constant pressure (within a narrow range) at the pump discharge and allowing the flow rate to modulate depending on the RO treatment effluent flow rate (IPR Product Water Storage Tank level), and real time ability of the Injection Wells/aquifer to accept flow.

Figure 2-2 IPR Product Water Pump Station

The design point for each pump is 323 gpm at 37 feet of total dynamic head (TDH) at full speed of 1,775 rpm (or **300 gpm @ 39' TDH**). As explained in subsection 2.2.1 below, for the initial phase of the RWF, an average operating injection rate of 300 gpm is required. Under desired conditions for the Initial Phase, the IPR Pump Station will deliver 300 gpm through the IPR Pipeline to the Initial Phase Injection Wells while maintaining positive pressure in the IPR Conveyance Pipeline at the pipeline high point at Bella Vista Street.

2.1.3 *IPR Conveyance Pipeline*

The existing IPR Conveyance Pipeline consists of approximately 13,500 feet of 10” and 12” diameter HDPE pipe. The IPR Conveyance Pipeline and Branch Lines, when fully constructed, will consist of over 20,000 feet of pipe ranging in size from 4” to 12” diameter. The locations of the existing IPR Pipeline Segments A through D, and possible proposed additional Branch Segments 1 through 7, are shown in Figure 2-3 on following page.

One of the key operational goals is to minimize air entrainment within the IPR Pipeline network by keeping the pipeline under pressure, and providing abundant air purging through air release and combination air valves strategically located along the IPR Pipeline network. Accomplishing this goal is discussed in detail in subsection 2.2.2 below.

2.2 Injection Well Operational Goals and Strategies

2.2.1 *Maximize Annual Injection Quantity*

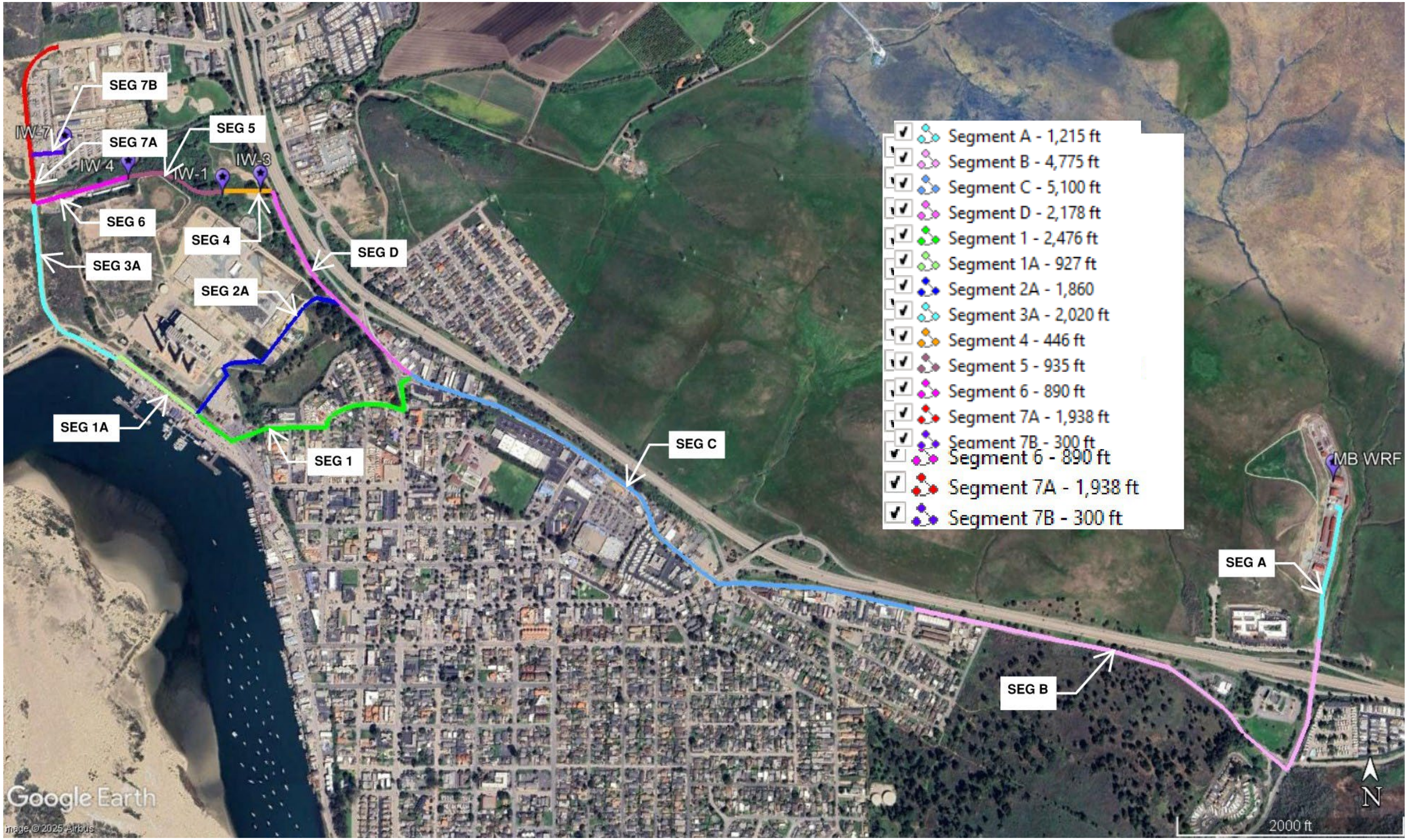
The primary operational goal of the Project is to construct the Initial Phase RWF capable of delivering and injecting 412.5 acre-feet per year (AFY) of IPR water within 5 years of completion of Initial Phase construction (estimated to be by June 2031). The ultimate goal of the Final Phase is to increase the injection rate to a cumulative total of 825 AFY. Assuming 100% operational efficiency (i.e., the injection system is in operation 100% of the time with 0% downtime), 412.5 AFY and 825 AFY are equivalent to an average annual injection rate of 255 gpm, and average annual cumulative injection rate of 510 gpm, respectively. However, as identified in the 2023 Basis of Design Report by GSI Water Solutions, assuming 95% operational efficiency (i.e. the injection system is in operation 95% of the time with 5% downtime for maintenance), the required injection rates equate to an average annual operating injection rate of 270 gpm for the Initial Phase, and an average annual cumulative operating injection rate of 540 gpm for the Final Phase.

Cannon believes that for the purposes of Injection Well design, a more conservative approach is warranted due to a wide variety of reasons that could cause the Injection Wells to be out of service or operating at a reduced injection rate for a few hours, a few days, or a few weeks. Some of the more common reasons are listed below. With exception of high groundwater levels, these items are considered breakdowns, lower cost routine and annual maintenance, and higher cost periodic maintenance and replacements.

IPR Pipeline
- IPR Pipeline main break or leak, and
- IPR Pipeline valve failure.

Injection Wells
- **high groundwater levels**,
- wellhead main break or leak,
- wellhead valve or actuator failure,
- backflush sequence,
- backflush pump failure,
- backflush motor failure,
- component failure in electrical panel,

Figure 2-3 IPR Conveyance Pipeline Overview Map



- component failure in control panel, and
- loss of SCADA communication.

<u>Water Resources Center</u>

- RO system valve or actuator failure,
- RO feed pump failure, or maintenance,
- RO feed motor failure,
- RO cartridge filter failure, maintenance, or replacement,
- RO membrane failure, maintenance, or replacement,
- RO booster pump failure, or maintenance,
- RO booster motor failure,
- UV/AOP Disinfection System component failure, maintenance, or replacement,
- Calcite Remineralization System component failure, maintenance, or replacement,
- IPR Pump Station valve or actuator failure,
- IPR pump failure, or maintenance,
- IPR motor failure,
- component failure in RO, UV, Calcite, and IPR electrical panels,
- component failure in RO, UV, Calcite, and IPR control panels, and
- loss of SCADA communication.

<u>PG&E</u>

- Distribution system problem power failure, and
- Public Safety Power Shutoff.

During "above average" rainfall years, and "wet" years, groundwater levels will be high in late winter and early spring requiring injection flow rates to be curtailed and/or temporarily ceased. In addition, due to the multiple processes, systems, and components required to be able to treat and deliver IPR water to the Injection Wells, a more conservative assumption of operational efficiency is recommended.

It is estimated that "above average" rainfall years will occur once every 5 years, and during these years injection will have to cease for 4 weeks and be curtailed for an additional 4 weeks. It is also estimated that "wet" rainfall years will occur once every 5 years, and during these years injection will have to cease for 8 weeks and be curtailed for an additional 4 weeks. Downtime for lower cost routine and annual maintenance, and higher cost periodic maintenance and replacements is estimated to average 4 weeks per year (together referred to as "maintenance"). This equates to an average annual injection efficiency of 86% (as calculated below based on a 5-year period), an **average annual operating injection rate of 300 gpm for the Initial Phase**, and **average annual cumulative operating injection rate of 600 gpm for the Final Phase**. The new IPR Branch Lines, extending from the IPR Pipeline to the Injection Wells, will be designed to accommodate the cumulative Final Phase flow rates.

Average Annual Downtime =

Maintenance: (5 yrs x 4 wks maintenance downtime/yr +
Above Average Rainfall Year: 4 wks hi-hi level downtime + 4 wks hi level (0.5 downtime) +
Wet Rainfall Year: 8 wks hi-hi level downtime + 4 wks hi level (0.5 downtime) / 5 years

= 36 weeks downtime/5 years

= 7.2 weeks downtime/year

Injection Efficiency = (52 wks/yr – 7.2 wks downtime/yr) / 52 wks/yr = 0.86 = 86%

The strategy to accomplish the total combined injection rate includes designing the injection facilities based on the unique aquifer characteristics at each well location to optimize individual injection rates. The expected range of long-term, continuous injection rates per well is anticipated to range from 45 gpm to 90 gpm with an average capacity of approximately 75 gpm per well. The ability to inject water will likely vary depending on several factors, including aquifer characteristics, ground saturation levels (due to rainy season verses dry season), and nearby groundwater extraction well withdrawals. Each injection well will be equipped with an automatic control valve and piping to maintain a desired water level/pressure within the well casing such that injection water does not reach the surface. The automatic control valve will balance the upstream pressure from the IPR Pump Station and the desired level/pressure within the well casing. The corresponding flow rate will be a result of what the groundwater basin will accept at each Injection Well given real time groundwater conditions.

2.2.2 Minimize Air Entrainment

Another key operational goal is to minimize air-entrainment in the pipeline, injection tubes, well screens, gravel pack, and aquifer formation. In the pipeline, entrained air can create hydraulic restrictions and reduce capacity. Air entrainment down the wells can promote conditions that favor bacterial growth and subsequent fouling of the well screens. Additionally, entrained air bubbles can lodge in the gaps of the well screen, pore spaces of the gravel pack, and aquifer formation reducing the wells' ability to receive and draw in recharge water. This in turn can significantly lower injection rates.

The strategy to minimize air entrainment in the water to be injected involves three components:

- Purging entrained air at key locations along the IPR Conveyance Pipeline,
- Purging entrained air at the wellhead piping, and
- Operation of wellhead or downhole flow control valves to minimize the introduction of air to the injection tube or downcomer.

IPR Conveyance Pipeline. There are four key high points along the IPR Conveyance Pipeline where entrained air will tend to accumulate, and combination air valves are recommended. These include two intermediate high points as well as the beginning of the IPR Pipeline (at the WRC-IPR Pump Station), and the end of the Pipeline along the bike path near Morro Creek. However, for long reaches of ascending or descending pipeline, additional air/vacuum valves or combination air valves are recommended.

Cannon has reviewed the IPR Conveyance Pipeline Record Drawings to evaluate the adequacy of air purging along the Pipeline. The two intermediate high points include combination air valves. However, there is no air release valve at Station 35+00 which is the downstream end of the IPR Conveyance Pipeline and a high point. Therefore, adding a 2” combination air valve at this point near Morro Creek (or future high point if the IPR Branch Pipeline is extended north) is recommended. There is a low point along the IPR Pipeline around Station 49+00 and the IPR Pipeline continues to rise from there back to the Pipeline beginning at Station 35+00. Adding a 2” combination air valve around Station 44+15 (about 8 feet beyond the end of the casing pipe) is also recommended.

In addition, the Vent-Tech SDG valve installed at the WRC-IPR Pump Station (other high point) is specifically designed for wastewater applications, not for clean water such as the IPR water. See photo of the Vent-Tech SDG valve installed at the IPR Pump Station in Figure 2-4 below.

Figure 2-3 Vent-Tech SDG Valve on IPR Pump Station Discharge Header

The Vent Tech SDG air/vacuum valve has a screened inlet which restricts air flow, and it does not have an air release function to continuously purge small amounts of entrained air. Also, it is not NSF approved. Cannon does not believe it is an appropriate valve for this application. We recommend replacing the Vent-Tech SDG valve with a standard combination air valve (for potable water service) of the same size. Also, to adequately address air purging (and vacuum relief) along the long reaches of the IPR Pipeline, 2” combination air valves are recommended to be added around Stations 72+25, and 140+00. Finally, we recommend replacing the 2” air release valve at Station 94+67 with a 2” combination air valve. Review of the IPR Pipeline air release valves is summarized in Table 2-2 below.

Table 2-2 Summary of IPR Pipeline Air Release Valve Review

No.	Pipeline Station	Existing Valve	Recommendation
1	IPR Pump Station	2” SDG Valve (sewer)	Replace with 2” CAV
2	140+00	-	Add 2” CAV
3	126+83	2” CAV *	Good as is. *
4	114+48	3” CAV *	Good as is. *
5	94+67	2” ARV	Replace with 2” CAV
6	72+25	-	Add 2” CAV
7	44+15	-	Add 2” CAV
8	35+00	-	Add 2” CAV

*Note: * It is reported by City operations staff that these valves may also be Vent Tech SDG valves. If so, Cannon recommends replacing these as well with 2” CAVs.*

Additionally, to facilitate draining the IPR Pipeline when repairs and maintenance are required, the City may wish to consider adding 4” Blowoffs (or Fire Hydrants) near Stations: 50+25, 96+10, and 150+25. Blowoffs can be installed in vaults or above ground.

Wellhead Piping. The second component of the strategy to minimize air entrainment in the injection water includes intentionally designing a raised section of piping, just prior to the well injection tube or downcomer, to allow any entrained air to accumulate and be purged prior to injection. Along the raised section of wellhead piping, a pair of 1” air release valves (ARVs) will be strategically located to purge entrained air. The first ARV will be located at a high point shortly after the pipeline transitions from below ground to above ground. The second ARV will be located near the end of the raised section of wellhead piping just before it turns down to feed the injection tube or downcomer. These ARVs will purge remaining entrained air in the pipeline and will not include a vacuum relief feature.

Wellhead or Downhole Flow Control Valve. The third component of the strategy includes the use of wellhead or downhole flow control valves (FCVs) to minimize the introduction of air to the injection tube at the beginning or end of an injection period. The concept is to keep the wellhead or injection tube piping under pressure at all times (prior to, during, and after an injection period) such that the piping does not become depressurized and allow air to enter the piping. For flow control at the wellhead, butterfly valves are recommended. The butterfly valves can be either manually or electrically actuated. If downhole flow control is desired, Baski Flow Control Valves are the preferred valve as evaluated and described later in Section 5.2. Operation of the FCV will keep the piping upstream of the valve under pressure and prevent air being introduced into the piping upstream of the valve.

2.2.3 Maintain High Injection Rates

The last key operational goals are to maintain high injection rates over the life of the facilities and achieve the annual injection volumes as required under the grant. To accomplish this requires favorable hydrogeologic conditions, an effective cleaning program, and good routine maintenance.

The Injection Wells need to be sited in locations with favorable hydrogeologic conditions, including sufficient aquifer characteristics that are conducive to injection at the desired capacities to meet the Project goals. In 2022, GSI implemented an Injection Well Pilot Feasibility Study with construction and testing of IW-1, located on the Vistra Corp (Vistra) Property, west of Highway 1. Testing of IW-1 indicated that an injection rate of approximately 90 gpm was feasible at that location, and additional Injection Wells were recommended to meet the Project cumulative injection capacity objective. Subsequently, sonic drilling was implemented in fall of 2024 to determine suitable sites for three (3) additional new Injection Wells. Seven sonic borings (SB-2 through SB-8) were drilled within the Project limits, with total drilled depths to bedrock between 55' and 100'. Three sonic boring locations (SB-3, SB-4 and SB-7) appeared favorable and are the recommended locations for the new Injection Wells.

Once the Injection Wells have been installed, equipped, and placed into operation, an effective well screen cleaning program (by airlifting or backflush pumping) must be implemented, coupled with appropriate regularly scheduled routine maintenance. Routine well cleaning will help reduce the potential for clogging and fouling of the well screen and help maintain injection rates.

Well screen cleaning is planned to be accomplished by either airlifting or backflush pumping. If airlifting is selected, airlifting is anticipated to occur initially at a frequency of approximately once per month for a duration of 60 minutes. An initial procedure of six (6) 10-minute cycles is recommended. Each 10-minute cycle would consist of 4 minutes of airlifting/flushing followed by 6 minutes of rest. If backflush pumping is selected, backflush pumping is anticipated to occur at a frequency of approximately once per month for a duration of 50 minutes. An initial procedure of five (5) 10-minute cycles is recommended with 5 minutes of pumping followed by 5 minutes of rest. As the effectiveness of the cleaning process is observed over time, the airlifting or backflush pumping duration and frequency can be adjusted to optimize the process for the unique conditions at each injection well.

At the planned maximum injection rate of 100 gpm, the recommended design backflush pumping rate is approximately 1.4 times the average injection rate, or upwards of 140 gpm maximum. The list below provides values associated with these design flow rates, Schedule 40 piping dimensions, and the velocity in the annular space between the 12" diameter casing pipe and 4" diameter column/drop pipe.

- Q1 = 100 gpm = 13.37 CFM = 0.2228 cfs
- Q2 = 140 gpm = 18.72 CFM = 0.3119 cfs

- 12" diameter Schedule 40 steel casing pipe: OD = 12.75" = 1.0625'
- 12" diameter Schedule 40 steel casing pipe: ID = 11.94" = 0.9950'
- 4" diameter Schedule 40 steel column/drop pipe: OD = 4.50" = 0.3750'
- 4" diameter Schedule 40 steel column/drop pipe: ID = 4.03" = 0.3358'
- A12 (area inside 12" steel casing pipe) = 0.7772 SF
- A4 (area of 4" steel column/drop pipe) = 0.1104 SF
- AA (area of annular space) = A12 – A4 = 0.6668 SF

- V1 (velocity in annular space at 100 gpm) = Q1/AA = 0.2228/0.6668 = 0.33 fps
- V2 (velocity in annular space at 140 gpm) = Q2/AA = 0.3119/0.6668 = 0.47 fps

At 140 gpm, the estimated total backflush pumping volume is approximately 3,500 gallons (140 gpm x 5 minutes x 5 cycles) per backflush event.

The maximum volume of backflush water generated by the airlifting process is estimated to be approximately 2,160 gallons. The maximum volume of water within the casing, above the tip of the airline (based on the airline tip at an elevation of -70', and groundwater at an elevation of 7') is approximately 60 CF (450 gallons). The estimated volume of water purged from the well per air lift cycle is 80% of the water volume above the airline tip, or 360 gallons. Six airlifting cycles at 360 gallons/cycle equals the total of 2,160 gallons per event. Management of backflush discharge water is discussed in detail in Chapter 6 below.

2.3 Injection Well System Hydraulics

The elevations of hydraulically relevant IPR System features are listed in Table 2-3 below. These elevations are used in the hydraulic modeling and other analysis described in this Section.

Table 2-3 Elevations of Relevant IPR System Features

IPR System Feature	Elevation (feet)
IPR Storage Tank High Water Level/Overflow (HWL)	121.65
IPR Storage Tank **Normal Operation Low Water Level**	**110.00**
IPR Storage Tank Low Water Level/Inlet (LWL)	107.81
IPR Storage Tank Floor Elevation	104.00
IPR Pump Station Suction Header (Spring Line)	106.38
IPR Pump Station Finished Floor	104.00
IPR Pipeline **Bella Vista** Street High Point (Spring Line)	**148.66**
Highest Injection Well Wellhead Piping (Spring Line)	24.0
Highest Injection Well Ground Elevation	21.0
Highest Injection Well Groundwater Elevation	7.6
Lowest Injection Well Wellhead Piping (Spring Line)	16.0
Lowest Injection Well Ground Elevation	13.0
Lowest Injection Well Groundwater Elevation	5.4

Approximate velocities within the wellhead piping, and IPR Branch Lines are presented in Table 2-4 below.

Table 2-4 Wellhead Piping and IPR Branch Line Velocities

Nominal Pipe Diameter	Minimum Flow Rate (gpm)	Minimum Velocity (fps)	Maximum Flow Rate (gpm)	Maximum Velocity (fps)
4" (at Wellhead)	40	1.0	200	5.0
6"	40	0.44	200	2.4
10"	80	0.32	600	2.4

2.3.1 IPR Conveyance Pipeline Hydraulic Modeling

An Excel hydraulic model was prepared (by Cannon) to simulate flow rates, friction losses, and pressures throughout the proposed pipeline network for the Initial and Final Phases of the Project. The existing HDPE pipe (IPR Conveyance Pipeline) segments are modeled including pipe inside diameter, and length, and are designated as Segments A, B, C, and D. See Figure 2-4 below. To analyze varied conditions, two modeled pipeline networks (scenarios) were developed and analyzed. Each Network was analyzed under the Initial Phase (four Injection Wells), and Final Phase (eight Injection Wells) conditions. The pipeline networks are defined as follows:

- **Network 1** includes Segments A, B, C, and D, plus Segment 4 to supply IW 1 and IW 3, and Segments 5A and 6 to supply IW 4 and IW 7A, and Segment 7A to supply all additional wells of the Final Phase.

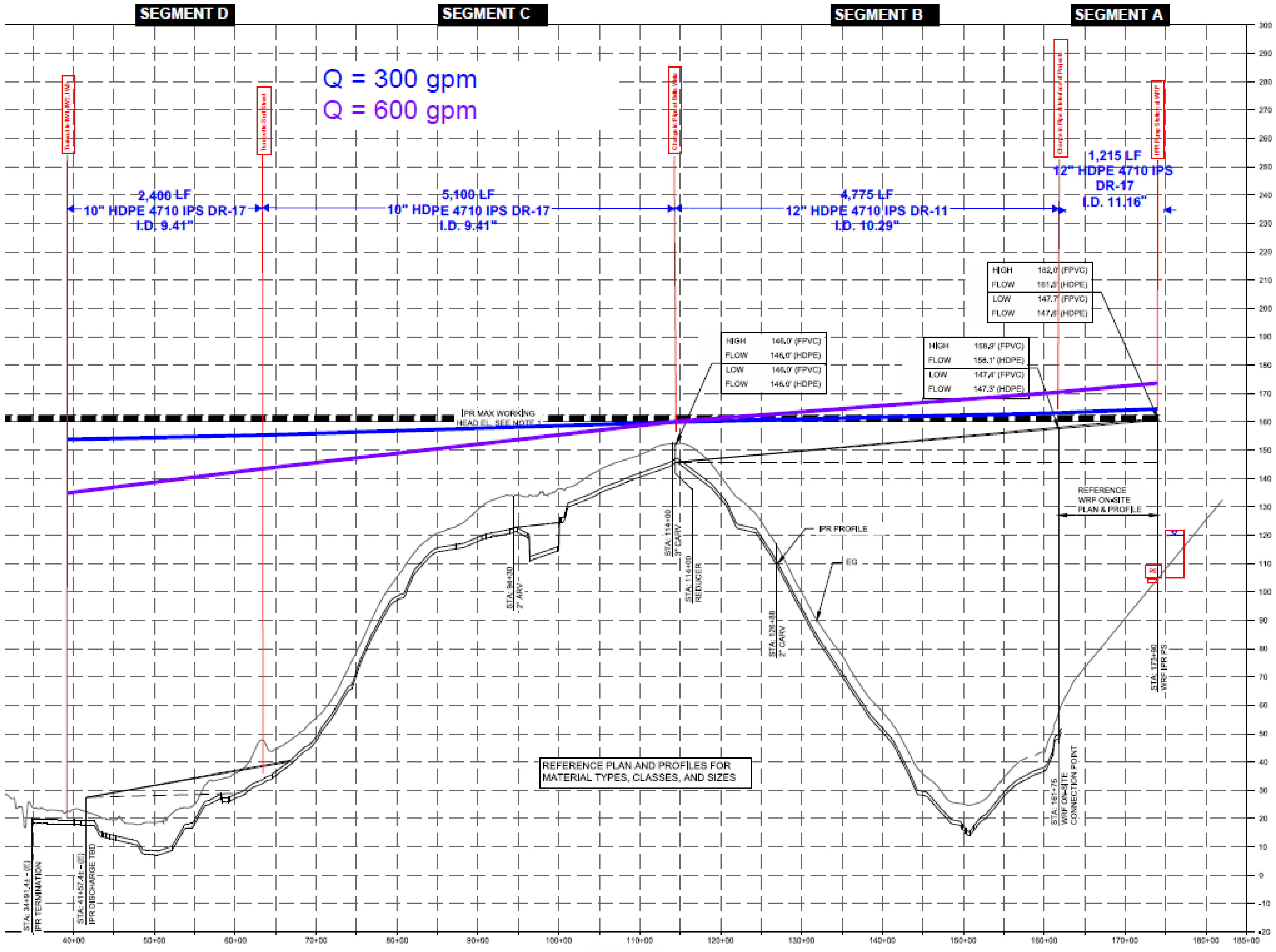
- **Network 2** includes Segments A, B, and C, and Segments 1, 3A, and 6 to supply IW 4, and Segment 7A to supply IW 7A and all additional wells of the Final Phase.

Because Segment 1 is significantly longer than Segment 2A, Segment 1 represents the controlling condition for modeling purposes, and a third pipeline network including Segment 2A is not required. Also, in Network 2, because Segments 1 and 3A will provide the majority of flow and represent the controlling condition for modeling purposes, modeling Segments D and 4 is not necessary.

Segments 1, 4, and 6 are new sections of pipe, whereas Segments 3A and 7A consist of the existing re-purposed Desal Feedwater Line (12” diameter PVC Yelomine pipe). Under Alignment Alternative 3, Segment 1 was modeled as 10” diameter HDPE pipe, and dead-end Segments 4 and 6 were modeled as 6” diameter HDPE pipe. Under Alignment Alternative 1, Segments 4, 5A and 6 were modeled as 10” diameter HDPE pipe.

Results of the hydraulic modeling have determined that the pumps at the IPR Pump Station may not be sufficient to deliver 300 gpm to the Initial Phase Injection Wells while maintaining positive pressure of at least 5 psi in the IPR Conveyance Pipeline at the pipeline high point at Bella Vista Street. The required resultant hydraulic grade lines for the Initial and Final Phases are estimated and plotted in Figure 2-4 below. Full results of the Excel hydraulic model are presented in **Appendix B**. A detailed Technical Memorandum to evaluate the ability of the pumping system to meet both the initial phase (300 gpm) and final phase (600gpm) requirements is being prepared as a supplement to this report.

Figure 2-4 IPR Conveyance Pipeline Segments & Hydraulic Profile



2.4 Injection Well Equipping Design Parameters

2.4.1 Wellhead Piping

While instantaneous injection well flow rates are expected to range from 45 gpm to 90 gpm, for piping design purposes, a broader range (40 gpm to 120 gpm) that includes a small factor of safety is utilized. Wellhead piping will be 4” diameter, with velocities ranging from 1.0 fps to 3.0 fps for injection flow rates of 40 gpm to 120 gpm, respectively.

Wellhead piping material will be steel pipe in accordance with AWWA Standards C200 and C220. Steel pipe will be epoxy coated, and either epoxy or cement-mortar lined, in accordance with AWWA Standards C205, C210, and C213 (or stainless-steel in accordance with C220).

Steel fittings will be included in accordance with applicable AWWA standards. Pipe assembly and dismantling will be accommodated by judicious use of sleeve-type couplings, flanged coupling adapters, and unions in accordance with applicable AWWA standards.

Ball valves, gate valves, and butterfly valves will be provided for isolation in accordance with AWWA Standards C507, C509, and C519, respectively. Silent check valves will be included in accordance with applicable AWWA standards.

2.4.2 Injection Tube & Flow Control Valves

The injection tube is the column pipe that conveys the IPR water from the wellhead down into the well casing to below the groundwater surface. The injection tube will be 4” diameter stainless-steel, in accordance with AWWA Standard C220. The bottom end of the injection tube will be set approximately 5 feet below the historic low groundwater level, and a minimum of 3 feet above the well screen. See Chapter 6 for additional details. The flanged well discharge head will be fabricated stainless steel in accordance with AWWA Standards C226 and C228.

Injection flow control will be managed by either a downhole 4” Flow Control Valve (Baski Valve), or an electrically actuated 4” butterfly valve as part of the surface wellhead piping. Both options provide for modulation and accurate flow rate control.

2.4.3 Submersible Pump

One alternative for backflushing an injection well and cleaning the well screen is the use of a permanently installed submersible pump. For this backflushing alternative, the following information, and design criteria apply. As previously mentioned, at the maximum injection rate of 100 gpm, the recommended maximum backflush pumping rate is 1.4 times the injection rate, or 140 gpm. With a 4” diameter column pipe, the velocity will be approximately 3.5 fps.

The maximum static lift for a submersible pump in an injection well will be approximately 95 feet, based on maintaining a minimum suction head of 10 feet (i.e., water level 10 feet above the pump inlet). The desired discharge pressure is approximately 25 psi (58 feet). The friction and minor losses are estimated to be 7 feet and 3 feet, respectively. Operating at an efficiency of 60%, the required submersible motor size is 10 HP. A multi-stage 4” diameter vertical turbine pump is recommended, with all stainless-steel components. A 6” diameter submersible motor is recommended. Submersible pump and motor parameters are summarized in Table 2-6 below.

Table 2-6 Summary of Submersible Pump and Motor Parameters

Parameter	Value	Units
Wellhead Pipe Diameter	4	inches
Column Pipe Diameter	4	inches
Design Backflush Flow Rate	**140**	**gpm**
Maximum Design Velocity	3.5	fps
Minimum Suction Head	10	feet
Maximum Static Lift	95	feet
Discharge Pressure	58	feet
Estimated Frictional Losses	7	feet
Estimated Minor Losses	3	feet
Total Dynamic Head	**163**	**feet**
Submersible Pump Diameter	4	inches
Pump Speed	3,500	rpm
Estimated Number of Stages	3	stages
Estimated Pump Efficiency	60	percent
Submersible Motor Diameter	6	inches
Submersible Motor Size	**10**	**HP**

2.4.4 Air Lift Line & Air Compressor

A second alternative for backflushing an injection well and cleaning the well screen is airlifting, accomplished with the use of a large air compressor and permanently installed air lift line. The Project Design Team reviewed the Orange County Water District's (OCWD) Alamitos Barrier Project, which utilizes airlifting and permanently installed 1" diameter air lift lines as the backflushing method for each of their 60 injection wells. Their injection wells are 8" diameter with an average depth of approximately 270 feet and maximum depth of 484 feet. OCWD operators backflush each of their injection wells once every 2 years which successfully restores full injection capacity to each well.

The two critical factors in sizing an air compressor for well screen cleaning by airlifting are capacity in CFM, and operating pressure. The compressor capacity must be high enough such that the casing can be filled with air quickly such that the water column is forced up and purged at the surface rather than the air escaping through the water column. The minimum operating pressure must be about10 psi higher than the water pressure at the tip of the airline.

OCWD utilizes a trailer mounted rotary-screw type air compressor with a capacity of 750 cubic feet per minute (CFM) and rated operating pressure of 150 psi. This compressor appears to be significantly oversized for most of their injection wells. It is important to note that OCWD's injection wells are much deeper and have more screened intervals than the proposed Project Injection Wells. Additionally, their hydrogeologic conditions are different than the Lower Morro Groundwater Basin. The backflushing method selected for the RWF Project will take into consideration site-specific hydrogeologic conditions.

The United State Geologic Survey (USGS) utilizes airlifting to clean the well screens on their numerous monitoring wells. Many of their monitoring wells have 6” diameter casings and are less than 300 feet deep. For these wells, the USGS utilizes a trailer mounted rotary-screw type air compressors with a capacity of 185 CFM and rated operating pressure of 125 psi. Based on Cannon’s conversations with Alexander Pump Service, a local well service contractor, for well screen cleaning they utilize a trailer mounted rotary-screw type air compressors with a capacity of 185 CFM and rated operating pressure of 150 psi.

If airlifting is utilized for the RWF Project, an injection well would be equipped with a 1.5“ diameter stainless-steel air lift line that extends down the well through the center of the injection tube. After passing through the injection tube, the air lift line would extend down the casing pipe to a few feet below the bottom of the well screen (into the well sump) and terminate with a “J” hook to redirect air upward along the inside surface of the well screen. The tip of the “J” hook will be set 4’ below the bottom of the lowest section of well screen. Airlifting will provide for periodic air scouring and cleaning of the well screen. Forced air will be provided to the air lift line by either a trailer-mounted or permanently installed air compressor at each Injection Well site. Air compressors will be rotary-screw type with corrosion resistant components and housed within a weather resistant enclosure. See subsection 6.4 for additional details.

As previously described, the maximum static lift for a submersible pump in an injection well will be approximately 95 feet (41 psi). This is also the maximum static lift the air compressor must overcome (41 psi). The minimum desired air lift discharge pressure is about 25 psi. Based on a total length of 150 feet of 1.5” air lift line, the friction and minor losses are estimated to be around 15 psi and 10 psi, respectively. Therefore, the minimum required compressor operating pressure is approximately 91 psi (41 + 25 + 10 + 15). Applying a 1.25 factor of safety results in a minimum required operating pressure of 114 psi. Therefore, the recommended compressor size is 185 CFM with a minimum rated operating pressure of 125 psi. The power requirement for a 185 CFM air compressor is 50 horsepower (HP). Air Compressor requirements are summarized in Table 2-7 below.

Table 2-7 Air Compressor Requirements

Injection Well Diameter	CFM	Rated Operating Pressure (psi)	Horse Power (HP)
12”	185	125	50

2.4.5 Submersible Pump versus Air Lift Line & Air Compressor for Well Cleaning

Submersible pumps, and air lift lines with compressors for well screen cleaning each offer their own advantages and disadvantages. The cost of a 185 CFM compressor is about the same as the cost of a 140-gpm submersible pump with 10 HP motor. Therefore, the overall Project cost is the same with a submersible pump or compressor located at each well site. However, the air compressor for an air lift system requires a much larger motor than the equivalent submersible pump system and will have much higher ongoing power consumption.

As previously mentioned, air lift cleaning provides more agitation along the face of the well screen and will clean that surface better than a submersible pump. However, due to the shallow depth of the planned injection wells of only 100 feet or less, it was uncertain whether or not air lift cleaning would be effective with such a small volume of water within the casing pipe below the well screen. A system that includes a submersible pump will allow for effective cleaning of the well screen, and partial cleaning into the gravel pack even with shallow injection wells.

Due to the uncertainty of the effectiveness of air lift cleaning, field testing of both cleaning methods was performed at IW-1 by GSI Water Solutions from February through April of 2025. The results of the field testing are documented in their technical memorandum titled, *Morro Bay Injection Well IW-1 Backflush Operations Summary*, May 2025. It was confirmed that the submersible pump backflush pumping exercised the gravel pack and removed clogging material from the near-bore gravel pack. IW-1 has an approximate injection capacity of 90 pgm, and backflush pumping maintained a discharge flow rate of 120 gpm or higher with a maximum flow rate of 130 gpm. Air lift cleaning only achieved a maximum flow rate of 108 gpm, and was observed to clen the well less effectively.

At sites where a small footprint is desired, a submersible pump system requires no additional space. In contrast, an air lift system requires additional space because the air compressor is large. The footprint of a 185 CFM unit is approximately 4' x 6'. In addition, the air compressors are noisy and may not be appropriate for all injection well locations such as the Morro Dunes RV Park. The primary advantages and disadvantages of the two well screen cleaning options are noted below.

<u>Submersible Pump</u>

Advantages:	Lower initial cost Much lower power consumption Small footprint (no additional space required) Minimal operating noise Able to clean gravel pack
Disadvantages:	Not as effective at cleaning surface of well screen Pump/motor replacement is more complicated and disruptive

<u>Air Lift Line & Air Compressor</u>

Advantages:	More effectively cleaning surface of well screen Maintenance/replacement is less complicated and disruptive
Disadvantages:	Higher initial cost Much higher power consumption Very large footprint (requires much more space) Relatively noisy Not able to clean gravel pack Requires APCD permit and subject to permit requirements

For these reasons, well screen cleaning by submersible pump backflush pumping is the superior and recommended method. Table 2-8 below provides a summary of the advantages/disadvantages of the two well screen cleaning options. See Section 7.3 for additional discussion regarding injection piping configuration alternatives.

Table 2-8 Summary of Well Cleaning Options

Well Cleaning Option	Initial Cost	Power Consumption	Footprint	Noise	Cleaning Capability
Submersible Pump Systems	Moderate	Moderate	Small	Low	Good
Air Lift Systems	Moderate	High	Large	High	Very Good

2.4.6 Control Strategy

A preliminary outline of the control strategy for the Injection Wells is provided as follows.

1. General. The Injection Wells will operate in a Remote Automatic mode through a PLC and control panel. Controls will allow for AUTO-OFF-HAND operation. Controls will provide for automated normal operation, and operation under abnormal conditions such as routine maintenance. The system will be monitored and controlled through SCADA. SCADA screens will be provided to display an overview of the Injection Well System (all wells), display each individual well, and display operation of the IPR Pump Station for reference. Local operation will be provided through an HMI screen at the control panel.

   The Injection Wells will be operated to maximize the injection rate, and total volume of IPR water injected annually. A flow control valve at each well will allow the injection rate to modulate based on the aquifer's ability to receive IPR water. A magnetic flow meter will measure instantaneous flow rate and totalized injection volume. Upon startup, controls will activate a brief automated flushing period to flush the IPR Pipeline Branch Line (through a bypass-to-waste line) prior to injection. Following this, injection will begin and continue for an extended period of time. After a period of injection, at a pre-programmed interval, controls will activate an automated backflush cycle to clean the well screen, and discharge through a designated backflush line. Following this, injection will resume.

2. Normal Operation. Under Normal Operation the following operational modes will occur:
   A. Flush mode with flow meter and adjustable duration.
   B. Injection mode with water level, casing pressure, or flow rate control options, and flow control modulation. The wellhead piping pressure transducer, groundwater level sensor, and well casing pressure transducer will include set points and alarm conditions.
   C. Communication with other Injection Wells, and modulation of their flow control valves. The highest capacity injection well will be the first to modulate flow rate when necessary.
   D. Backflush mode with multiple cycles, and adjustable duration and frequency.
   E. Off during periods of no injection, fault, or maintenance.

3. Abnormal Operation. When automatic controls are not available, or when maintenance is to be performed, the Injection Well facilities can be operated manually for all Normal Operation modes. In addition, upon power failure or specified alarms, controls will allow for steady state operation, or automatic shut-down of Injection Wells on a case-by-case basis.

4. Alarm Conditions. A preliminary list of alarms for the Injection Well operation include the following:
    A. Wellhead Piping Low Pressure
    B. Well Casing High Pressure
    C. High Groundwater Level
    D. Low Groundwater Level
    E. Wellhead Low Flow Rate
    F. Valve fail to open
    G. Valve fail to close

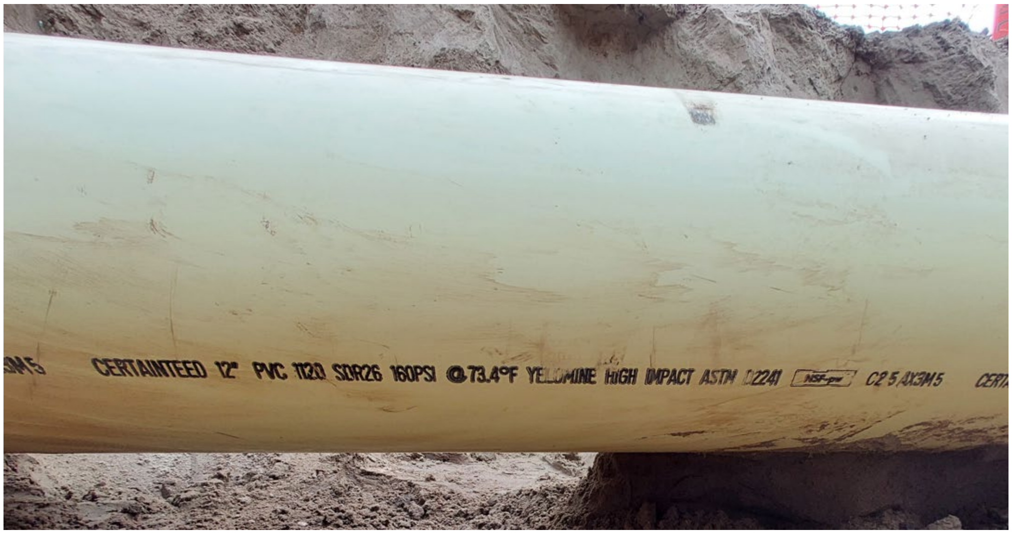
3. SEAWATER DESALINATION PIPELINE REUSE AND REHABILITATION

The City of Morro Bay owns an existing 12" PVC pipeline located along the Embarcadero which formerly conveyed brackish groundwater from a series of shallow extraction wells to a seawater desalination plant along Atascadero Road. See Figure 2-3 above (Segments 3A and 7A). This pipeline has been out of service since the early 2000's and has remained inactive. The City would like to re-purpose a portion of the pipeline and convert it to an IPR Branch Pipeline to supply Injection Wells and possible recycled water service connections. The purpose of this chapter is to evaluate the viability of re-purposing the pipeline, or a portion thereof, for this Project.

3.1 Pipeline Condition Assessment

The City has completed several initial steps to evaluate the pipeline's integrity and determine if there are any obvious "fatal flaws" with re-purposing this pipeline. Listed below are the steps taken thus far, and initial findings.

- Pipe Material. The pipe material was confirmed to be 12" diameter PVC pipe. The majority of the pipeline was installed in the mid 1990's using a fully restrained water pipe system developed by CertainTeed Corporation called Certa-Lok Yelomine PVC Pipe. Yelomine pipe is NSF 61 certified and can be used for drinking water purposes. Despite being 30 years old, the pipe has seen relatively minimal use and should have over 50 years of remaining useful life.
- Pressure Class. The pipe dimension ratio and pressure class were confirmed to be SDR 26 and 160 psi, respectively. See photo below.
- Thrust Restraint. The 12" Yelomine PVC pipe includes the Certa-Lok joint restraint system. The Certa-Lok joint restraint system consists of precision-machined grooves on the pipe and within the coupling or integral bell, which when aligned allow a nylon spline to be inserted, creating a bi-directionally restrained joint.
- Pipe Condition. The exterior of the pipe in areas where it was exposed for inspection showed no signs of wear and tear and was generally in good condition. See photo below.



- Pipe Material at Morro Creek Crossing. A portion of the 12" Yelomine PVC pipe was removed and replaced/relocated in 2014 to accommodate a new bridge across Morro Creek and maintain the seawater feedline integrity. The material used in the relocation was 12" C900 PVC. Pipe bends were accomplished with ductile iron fittings. See photos below.

- Pressure Class. The C900 PVC pipe dimension ratio and pressure class were confirmed to be DR 18 and 235 psi, respectively.
- Thrust Restraint. The C900 PVC pipe was restrained with thrust blocks installed at the horizontal bends. The photos below show soil removed at the bends in preparation of pouring the concrete thrust blocks.
- Pipe Condition. The C900 PVC pipe is relatively new and considered to be in very good condition. See photos below.

- <u>Tracer Wire</u>. The C900 PVC pipeline was installed with a tracer wire along its entire length. As a result, City staff recently located and marked the horizontal location of the pipeline for Cannon's survey crew. If this pipeline becomes an IPR Branch Pipeline, the tracer wire will allow the City to more accurately locate and mark the pipeline in the future.
- <u>Hydrostatic Pressure Test</u>. City staff conducted a 24-hour hydrostatic integrity test on March 7, 2024, and the segment of pipe tested held pressure at approximately 100 psi for 2 hours. During the subsequent 22 hours the pressure slowly dropped to approximately 75 psi. Those conducting and witnessing the test commented that it took several hours to get the pipe up to pressure and that there was likely air trapped in the line that wasn't initially purged. The entrapped air could be one reason why the pipe lost pressure over the 22 hours as air was slowly released through joints and end caps installed for testing. A subsequent test was conducted on April 16, 2025, and after installation of two air release assemblies and slowly filling the pipeline, the pipe held a pressure of 150 psi (at low point) for two hours and met the "passing test" requirements as outlined in AWWA Manual M23, Chapter 8.
- <u>Pipe Interior</u>. The interior of the Yelomine PVC pipe has a thin residual stain which is likely from previously conveying water from the brackish wells known to contain iron and manganese. Upon inspection of the section removed for the hydrostatic test, the film can be removed with warm water and using a cloth towel with firm hand pressure. See photo below.

- Pipeline Separation. Based on Cannon's recent field survey, there are no apparent separation issues between either potable waterlines or sewer mains in the vicinity of the Desal Feedwater Line.
- Pipeline Identification. The 12" Yelomine pipeline was not originally installed with "CAUTION: NONPOTABLE WATER" or "CAUTION: RECLAIMED WATER—DO NOT DRINK" markings, labeling, or vinyl marking tape; however, all but 100-ft (near the morro creek bridge abutments) is white in color and should not be construed as potable water pipe.

In summary, the existing segments of 12" Yelomine PVC pipeline and short section of 12" C900 PVC pipeline, which are being considered for re-purposing, are in good condition, and of sufficient pressure class to function as IPR Branch Lines. We recommend reusing these pipelines as IPR Branch Lines and further developing the Project design accordingly.

3.2 Pipeline Rehabilitation

Based on the initial findings discussed above, we do not believe pipeline repair or rehabilitation such as relining is necessary. As described below, we recommend a thorough pipe cleaning, and installation of air/vacuum release valves at key locations to restore the pipeline to its full capacity and prepare it for service as an IPR Branch Line.

3.2.1 Pipe Cleaning

There are several methods of cleaning existing large diameter buried pipelines. The following methods of pipe cleaning (as identified by Peterson Pipeline Products) are used in industrial applications. Key considerations are also noted.

- Flushing. Flushing calls for using water (in some cases high temperature water) at scouring velocities (3 fps or more) to remove debris inside the pipe.

- Pigging. Pigging involves using a cylindrical device called a "pig" to push or scrape debris from inside a pipeline. Standard options include foam and rubber pigs, while smart pigs come equipped with sensors for inspection. Pipeline cleaning balls can also be used alongside pigs for enhanced cleaning. This method is cost-effective and suitable for moderate to heavy deposits. However, this method can potentially damage pipelines if not managed properly.
- Hydro-Jetting. Hydro-jetting uses high-pressure water jetting nozzles, which may be adapted to different pipe sizes, to remove debris and buildup from pipes. Drain jetters are useful in smaller pipelines. This approach is quick and effective for large deposits, but is costly, and can potentially damage pipelines if not managed properly.
- Chemical Cleaning. Chemical cleaning calls for specialized solutions, such as acids and alkalis, to dissolve and remove deposits from pipelines. For effective results, chemical solutions like phosphoric acid for rust removal or caustic soda for organic deposits are employed. Chemical injection systems, including dosing pumps and mixers, are utilized to precisely move these agents through the pipeline. This method is effective for tackling corrosion and stubborn deposits. However, it can be costly and time consuming and may pose environmental risk.
- Ice-Pigging. Ice Pigging cleans pipelines using an ice slurry which targets biofilm and other lighter debris. The procedure uses ice slurry generators, and specialized pigging equipment. It is faster than traditional pigging and more successful for lighter debris, but it is not ideal for major blockages.
- Steam Blowing. Steam blowing pipe cleaning uses very high-pressure steam. This method utilizes sophisticated high-pressure steam generators, and precise nozzles to effectively deliver and control the flow of steaming. Although this technique offers good results, it requires expert knowledge, and high energy consumption.

Key considerations when choosing a pipeline cleaning method include pipe material, pipe diameter, types of debris to be removed, and environmental conditions at the pipeline location. The primary steps in proceeding with a pipeline cleaning project include the following:

1. Determine the pipeline interior conditions such as type and amount of debris. This may involve an initial CCTV inspection.
2. Choose a cleaning method. This may involve performing a preliminary trial on a sample section of the pipeline.
3. Prepare for and implement the cleaning process.
4. Verify effectiveness of cleaning. This may involve a second CCTV inspection.

The recommended pipe cleaning approach for the existing 12” Yelomine PVC pipeline is a two-step approach including chemical treatment, followed by high velocity flushing. Chemicals used for treatment should be designed for use in potable water systems, and be NSF approved, such as Johnson Screens, Descale Safe Nu-Well 120 Liquid Acid. This product consist primarily of food grade phosphoric mineral acid and sulfuric acid and is designed to remove common mineral deposits found in water systems such as carbonate, iron, manganese, and sulfates. PVC is chemically compatible with diluted phosphoric acid and sulfuric acid.

3.2.2 Air Release Valves

There are two key high points along the existing Desal Feedwater Line where entrained air will tend to accumulate, and combination air valves are recommended. These high points are as follows:

1. Along Embarcadero Road, approximately 700 feet south of the southerly bridge abutment of the bridge over Morro Creek.
2. Along Embarcadero Road, approximately 700 feet north of the northerly bridge abutment of the bridge over Morro Creek.

Addition of a 1" combination air valve at each of these locations is recommended. Also, addition of 4" Blowoffs (or Fire Hydrants) near the north and south ends of the segment to be re-purposed as an IPR Branch Line is recommended to facilitate draining the line when repairs and maintenance are required. Blowoffs can be installed in vaults or above ground.

3.3 Recommended Reuse Approach

As mentioned, rehabilitation/lining of the Desal Feedwater Line are not required for reuse. To reuse the existing Desal Feedwater Line as a new IPR Branch Line, the following steps are recommended during the design and construction phases.

Design Phase

- Discuss approach with DDW/DHS/RWQCB and get by-off and/or additional requirements.

Construction Phase

- Remove 3' sections of discharge pipe from the old seawater wells, and cap "tees" to isolate the wells from the rehabbed pipeline.
- Install CARV's as described above.
- Install gate valves at key locations along the Desal Feedwater Line where new pipe will be joined.
- Thoroughly clean the interior of the pipeline.
- Flush the pipeline after cleaning.
- Install "Purple Pipe" markers along the route and add to the City's USA marking protocols.

3.4 Cleaning Verses Replacement Cost

The cost to thoroughly clean and flush 5,000 linear feet of the existing Desal Feedwater Line is around $75K. The total cost to retrofit the Desal Feedwater Line including isolating the old seawater wells, adding gate valves, adding combination air valves, cleaning, pressure testing, repairing leaks, and contingency is estimated at around $486,000. However, the cost to replace 5,000 linear feet of the Desal Feedwater Line is over $2 million. The cost to clean and retrofit the Desal Feedwater Line is about 25 percent of the cost to replace the Line. Therefore, cleaning and retrofitting the existing Desal Feedwater Line for reuse is the recommended approach. Reuse of the Desal Feedwater Line as an IPR Branch Line is expected to save the City close to $1.5 million. In addition, the savings are likely more due to only needing to re-purpose approximately 1,600 linear feet of the existing feedwater pipeline rather than 5,000 linear feet.

4. NON-POTABLE WATER REUSE

4.1 Background and Purpose

In addition to recycled water pipelines, and Injection Wells, the City's Request for Proposals for the Recycled Water Facilities Design Project identified non-potable recycled water connections, and a recycled water fill station as the final components of the Project. The City desires to investigate non-potable recycled water connections to Lila Keiser Park and Morro Bay High School, and replacement of an existing recycled water fill station. The recycled water fill station is to provide recycled water for non-potable use by industrial and agricultural users, and residents. The City desires to locate the recycled water fill station near Lila Keiser Park.

The source of the non-potable recycled water supply is IPR water treated at the WRC and delivered via the IPR Conveyance Pipeline and IPR Branch Lines. The non-potable recycled water connections and recycled water fill station are intended to offset demand for potable water and contribute towards the City's Initial Phase goal of utilizing 412.5 AFY of IPR water.

The purpose of this chapter is to report on Cannon's preliminary investigation of regulatory requirements, and recycled water customer uses, demands, implementation requirements, and operational requirements.

4.2 Regulatory Summary

Recycled water from sources that contain domestic waste may be used for a variety of non-potable applications in California including irrigation, and approved agricultural, industrial and commercial uses. The allowable applications, required treatment, and use area requirements are defined within Water Recycling Criteria - Title 22, Division 4, Chapter 3, California Code of Regulations.

Disinfected tertiary recycled water (including IPR water produced from the City's WRC) can generally be used for the widest variety of applications, including landscape irrigation of publicly accessible areas, irrigation of food crops, non-restricted recreational impoundments, dual plumbed facilities, and various industrial and commercial processes where the water may come in contact with workers. The recycled water uses anticipated with the City's RWF Project are all State approved uses.

Requirements for landscape and agricultural irrigation uses are described in Title 22 Section 60304. Requirements for use areas are described in Title 22 Section 60310. Some use area requirements are designed to limit public exposure to the recycled water, and may include signage, setback requirements from domestic water supply wells, and limits on runoff and overspray. A dual plumbed system, such as a public restroom with toilets supplied with recycled water, is defined in Section 60301.250. When a system is determined to be dual plumbed, the project must comply with Sections 60313 through 60316.

The Water Recycling Criteria (Title 22, Section 60323) requires an engineering report, approved by the State Water Resources Control Board – Division of Drinking Water (DDW), for all recycled water projects. The purpose of an engineering report is to describe how a project will comply with the Water Recycling Criteria. The Criteria prescribe:

- Recycled water quality and wastewater treatment requirements for the various types of allowed uses (Sections 60303 through 60307);

- Use area requirements pertaining to the actual location of use of the recycled water, including dual plumbed facilities (Sections 60310 through 60316); and
- Reliability features required in the treatment facilities to ensure safe performance (Sections 60333 through 60355).

For each use area, the engineering report must describe a variety of characteristics such as specific type of reuse proposed, the parties responsible for the distribution and use of the recycled water, and other governmental entities which may have regulatory jurisdiction over the use area such as the US Department of Agriculture, and California Department of Public Health. The report must include a map showing specific areas of use, areas of public access, surrounding land uses, and location and construction details of wells within 1,000 feet. The report must also describe use area containment measures, location and type of signage, the degree of potential access by employees and/or the public, and description of the cross-connection control procedures which will be used.

The engineering report must describe the training which use area employees will receive to ensure compliance with the Water Recycling Criteria and identify the entity that will provide the training and its frequency. The report must also identify written manuals of practice to be made available to employees. The report must describe what will be irrigated, method of irrigation (e.g., spray, flood, or drip), measures to be taken to minimize ponding and runoff from leaving the use area, protection measures of drinking water fountains and designated outdoor eating areas, location and wording of public warning signs, proposed irrigation schedule, and measures to be taken to minimize public contact. The engineering report must also include construction plans.

In summary, the implementation of non-potable recycled water user connections will create additional ongoing regulatory and maintenance requirements for City staff.

4.3 Customer Requirements

4.3.1 Lila Keiser Park

Lila Keiser Park is located at the south end of Park Street off Atascadero Road on a 10-acre parcel owned by Vistra but under long-term lease to the City of Morro Bay. The Park is situated just north of Morro Creek and just west of the City's coastal bike/ped path and Hwy 1 south bound on ramp. Lila Keiser Park includes two large lighted baseball/softball fields, spectator/bleacher areas, small playground, large group covered picnic area with barbecue pit, several picnic tables throughout, horseshoe pits, restrooms, and large parking lot with 70 plus parking spaces. Potential non-potable recycled water uses include approximately 3.5 acres of turf irrigation throughout the park, and flush water for restroom toilets. The restroom is approximately 1,000 square feet and includes approximately 6 toilets and 2 urinals.

City water meter records indicate that for the 12-month (1-year) period from October 2023 through September 2024, the irrigation water usage was 3,783 Hundred Cubic Feet (HCF), or 8.7 acre-feet. Based on California Irrigation Management Information System (CIMIS) data, Lila Keiser Park lies within Evapotranspiration (ETo) Zone 1 with an annual ETo rate of 32.9 inches, and highest monthly ETo rate of 4.65 inches/month in July. This yields an estimated average irrigation demand of **9.6** acre-feet per year (AFY) which correlates closely with actual metered usage. Preliminary recycled water demands and design parameters for the Park turf irrigation and toilet flush water are estimated and presented in Table 4-1 below.

Table 4-1 Lila Keiser Park – Preliminary Recycled Water Parameters

Irrigation Meter Size (in)	Irrigation Area (acres)	Design Flow Rate (gpm)	Yearly Demand (AFY)	Required Pressure (psi)	Available Pressure (psi)
1.5	3.5	55	9.6	85	60
Restroom Meter Size (in)	**Fixture Units**	**Design Flow Rate (gpm)**	**Yearly Demand (AFY)**	**Required Pressure (psi)**	**Available Pressure (psi)**
1	70	40	0.08	55	60

Based on the limitations of the existing IPR Pump Station, there is not adequate system pressure for a recycled water irrigation meter at Lila Keiser Park. Addition of a small booster pumping station or retrofit of the IPR Pump Straton is required to provide adequate system pressure.

Based on the low estimated annual water usage for toilet flushing, annual revenue would be around $200/year. Restroom/toilet retrofit cost would be around $15,000 or more. Therefore, it does not appear to be economically feasible to retrofit the public restroom at the Lila Keiser Park for recycled water.

4.3.2 Morro Bay High School

Although Morro Bay High School has an Atascadero Road address, the School itself is located about 500 feet north of Atascadero Road at the end of the long entrance driveway. The High School is situated between Hwy 1 on the east, and sand dunes and the Pacific Ocean on the west. Potential non-potable recycled water uses at Morro Bay High School include landscape/turf irrigation, and flush water for restroom toilets.

The High School includes three large multi-use athletic fields running along its entire north boundary for baseball, softball, football, soccer, track & field events, and physical education. These multi-use athletic fields include approximately 10.8 acres of natural turf. In addition, there are several small landscaped and grass sitting areas and restrooms scattered throughout the campus. However, due to existing hard-scape improvements and utility lines, the cost to retrofit restrooms for recycled water would be very high. Therefore, use of recycled water for toilet flushing is considered cost prohibitive.

City records indicate that for the 12-month (1-year) period from October 2023 through September 2024, the High School irrigation water usage was 12,936 HCF, or **29.7** acre-feet. This is equivalent to approximately 7% of the 412.5 AFY IPR water usage goal. Morro Bay High School also lies within Evapotranspiration (ETo) Zone 1 with an annual ETo rate of 32.9 inches, and highest monthly ETo rate of 4.65 inches/month in July. This yields an estimated average irrigation demand of 29.6 AFY which correlates closely with actual metered usage. Preliminary recycled water demands and design parameters for the High School turf irrigation are estimated and presented in Table 4-2 below.

Table 4-2 Morro Bay High School – Preliminary Recycled Water Parameters

Meter Sizes (in)	Irrigation Area (acres)	Design Flow Rate (gpm)	Yearly Demand (AFY)	Required Pressure (psi)	Available Pressure (psi)
2	10.8	100	29.7	85	60

Again, based on the limitations of the existing IPR Pump Station, there is not adequate system pressure for a recycled water irrigation meter at Morro Bay High School. Addition of a small booster pumping station or retrofit of the IPR Pump Station is required to provide adequate system pressure.

4.3.3 Recycled Water Fill Station

The City's existing Non-Potable Water Fill Station is located at the Flippos Well site along the east side of Park Street, approximately 350 feet south of Atascadero Road. The Flippos Well is an active municipal well that is used when needed to supplement the City's water supply during State Water shutdowns and other outages. When utilized, water produced from the Flippos Well is treated through RO membranes at the City's nearby Brackish Water Reverse Osmosis (BWRO) Treatment Facility before entering the distribution system.

Water supplied by the Flippos Well to the Fill Station is not treated (non-potable). Water trucks and larger vehicles can access the Fill Station by driving to the end of Park Street, making a U-turn in the Lila Keiser parking lot, and then pulling up to the curb adjacent to the Fill Station. However, the existing Fill Station is not in service at this time and was only in service for a few years during the past major drought when drought restrictions prohibited potable water from being used for construction dust control.

If the new Recycled Water Fill Station is to be supplied by IPR water, it should be located away from the Flippos Well. It is recommended that the new Fill Station be located adjacent to the Desal Feedwater Line. More specifically, the recommended new Fill Station location is along the south side of Atascadero Road a few hundred feet east of the Embarcadero Road curve, and away from possible Final Phase injection well locations. This location will allow for low construction cost, and easy access. The new Recycled Water Fill Station can easily be incorporated into the Final Phase of Injection Wells. If the City chooses to implement a new recycled water irrigation service to Lila Keiser Park, then the recommended new Fill Station location would be at the west end of the Lila Keiser parking lot. This would allow for a single Branch Line from Atascadero Road to serve the Lila Keiser Park irrigation and Fill Station.

Past non-potable water usage at the Fill Station was limited, and annual usage figures were not tabulated. Therefore, an estimate of future recycled water usage at the new Fill Station has been made. Assuming an average of five grading permits are issued annually, an average of 15 days of grading work are required per permit, and a 5,000-gallon water truck is filled three times each day for compaction and dust control, this results in an annual water usage for grading purposes of 112,500 gallons or 0.35 AFY. Agricultural and residential use is estimated to average 750 gallons per week, or 0.12 AFY. Therefore, for planning purposes, annual Fill Station water usage may be estimated to be around 0.5 AFY.

Preliminary recommended design parameters for the new Recycled Water Fill Station are presented in Table 4-3 below. The design would include separate low flow and high flow outlets (1" and 2.5" connection points respectively), 4" backflow prevention device, isolation valves, protective bollards, and appropriate signage.

Table 4-3 Recycled Water Fill Station – Preliminary Operating Parameters

Outlet Size (in)	Meter Size (in)	Maximum Flow Rate (gpm)	Yearly Demand (AFY)	Required Pressure (psi)	Available Pressure (psi)
1	1	25	0.1	50	60
2.5	2	100	0.4	55	60

4.4 WRC and Non-Potable System Limitations

The primary design considerations with the use of IPR water for recycled water purposes in Morro Bay include:

- Water quality,
- Available supply,
- Available flow rate,
- Available pressure,
- Separation requirements,
- Health and safety requirements, and
- Construction cost.

The water quality of the IPR water produced by the WRC exceeds the minimum Title 22 recycled water standards. The annual demand from the recycled water uses under consideration is far less than the annual supply capacity of the WRC. It is anticipated that separation requirements for the recycled water lines and services from existing water and sewer lines can be met through design. In addition, it is expected that health and safety requirements, such as overspray prevention, can be met through design, and by trained operators.

Based on an offset irrigation schedule, the maximum required flow rate for the recycled water uses under consideration is approximately 100 gpm, and the planned capacity of the Initial Phase Injection Wells is 300 gpm. With two pumps in operation, the design capacity of the IPR Pump Station is approximately 594 gpm at 37 feet TDH. Therefore, the available flow rate for recycled water purposes during the Initial Phase is sufficient. During the Final Phase, the IPR Pump Station would have to operate at maximum conditions with both pumps running to provide the required flow rate. However, as discussed further below, the Pump Station is unable to deliver the required system pressure. The existing 10" and 12" IPR Conveyance Pipelines are adequately sized for the Injection Wells plus the recycled water uses under consideration.

The design requirement that presents the greatest challenge for the non-potable (recycled water) uses under consideration is the available pressure from the IPR Pump Station. As previously noted, the IPR Pump Station is not adequately sized to provide the required system pressure for recycled water purposes <u>at any flow rate</u>. This is due to undersized pumps, and pumps with relatively flat pump curves over the operating range. Retrofit of the IPR Pump Station is required in order for the Pump Station to deliver the desired flow rate and system pressure. The pumps would need to be replaced with pumps capable of delivering **700 gpm at approximately 120 feet TDH**. This would provide the required pressure of 85 psi in the IPR Conveyance Pipeline near the irrigation connections. This system pressure is within the DR-17 (125 psi) pressure rating of the 10" HDPE IPR Conveyance Pipeline.

Construction costs to provide recycled water for the uses under consideration with adequate flow rate and system pressure would involve the following:

1. 800 feet of 4" PVC recycled waterline (to Lila Keiser Park),
2. 2" water service and 1.5" meter for Lila Keiser Park,
3. 1,200 feet of 6" and 800 feet of 4" PVC recycled waterline (to Morro Bay High School),
4. Two 2" water services with 2" meters for Morro Bay High School,
5. Irrigation system retrofits,
6. Signage, and
7. Retrofit of IPR Pump Station

4.5 Best and Highest Use Considerations

With multiple possible uses of the IPR water, it is appropriate to consider the best and highest use of the water. As water supplies throughout California have become more limited, and drought periods common, advanced treatment of wastewater for direct and indirect potable use is now considered the best and highest use of wastewater. Producing recycled water for irrigation use is no longer considered the best and highest use of wastewater.

The IPR water produced by the City's WRC is nearly to potable drinking standards. So, reuse for potable purposes via injection wells, aquifer purification, and extraction wells is considered the best and highest use of the IPR water. It is presumed that with the Initial and Final Phases of the RWF Project a total of 8 or more Injection Wells will be constructed. Construction of additional facilities for recycled water irrigation service connections would be over and above the Injection Well cost. Therefore, considering this relatively high capital cost, use of IPR water for irrigation purposes at Lila Keiser Park and Morro Bay High School is not recommended.

5. PIPELINE ALIGNMENT AND SIZING

5.1 Pipeline Alignment Background

Two previously completed studies evaluated pipeline alignments for the IPR Conveyance Pipeline, and the IPR Branch Pipelines within the proposed injection well area. Both studies were completed by Water Works Engineers (WWE). The first study, completed in May 2019, evaluated multiple alignment alternatives for the IPR Conveyance Pipeline from the Water Resources Center IPR Pump Station, and the Injection Well area surrounding Morro Creek west of Hwy 1. The selected IPR Conveyance Pipeline alignment extends from the WRC, down South Bay Boulevard, Quintana Road, Main Street, and the Bike/Ped Path west of Hwy 1. Construction of the IPR Conveyance Pipeline was completed in April 2023.

The IPR Pump Station, which delivers treated water to the IPR Conveyance Pipeline, is designed for a maximum output of 0.93 MGD (645 gpm). The draft "Bais of Design Report for Groundwater Injection," completed by GSI Water Solutions in August 2023, identified and recommended eight Injection Wells (IW-1 through IW-8) to achieve the injection goal of 887 AFY.

The second WWE study, completed in March 2024, is titled the "IPR Alignment Alternatives Feasibility Assessment." This study developed conceptual design criteria, identified constraints, and evaluated multiple alignment alternatives for the IPR Branch Pipelines. Fourteen preliminary alignment segments were identified for the IPR Branch Pipelines to connect the IPR Conveyance Pipeline to the proposed Injection Wells. See **Appendix C** for the complete WWE study including figures that identify the Injection Well locations and illustrate the alignment segments.

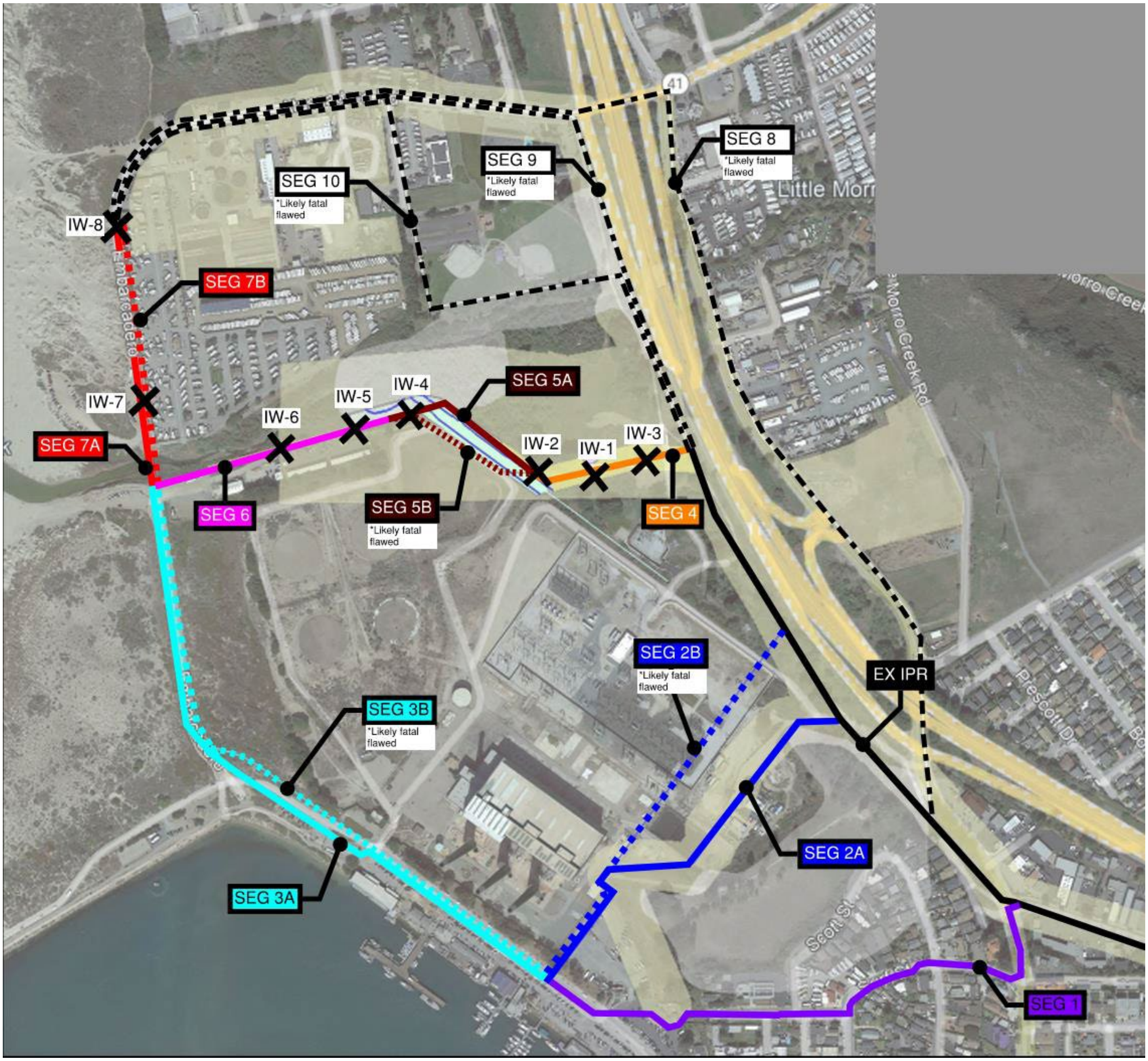
Six alignment segments were deemed fatally flawed (2B, 3B, 5B, 8, 9, and 10). Ultimately, three alignment alternatives were identified being made up of multiple segments as described below. Figure 5-1 below presents a cropped version of a figure from the WWE IPR Alignment Alternatives Feasibility Assessment that illustrates the segments that comprise the three alignment alternatives.

1. Vistra *North* (Willow Camp Creek): Segments 4, 5A, 6, and 7A or 7B

2. LS-2 Vistra *South*: Segments 2A, 3A, 6, 7A or 7B, and 4

3. Surf Street Right-of-Way: Segments 1, 3A, 6, 7A or 7B, and 4

Figure 5-1 Three Initial Alignment Alternatives



In the WWE study, alignment Segments 3A and 7A are assumed to reuse the 12" Yelomine Desal Feedwater Line (as discussed previously in Chapter 3 of this Report). WWE considered Segment 5A to have significant constraints and determined open cut trenching to be the most cost effective and least environmentally impactful construction method rather than horizontal directional drilling (HDD). WWE determined construction of Segment 5A by HDD to be infeasible (presumably due to construction challenges associated with the narrow width and location of the existing easement). Alternatively, Cannon believes construction of Segment 5A by HDD methods is feasible if the alignment of the existing easement can be adjusted to accommodate the sweeping alignment of HDD construction. In addition, construction of Segment 5A by HDD methods would have minimal, if any, impacts to riparian habitat and existing cultural sites in contrast to open cup trenching construction methods.

The study evaluated the three feasible alignment alternatives based on the following non-cost constraints and potential impacts that were identified: traffic and public impacts, cultural resources impacts, environmental impacts, stakeholder risk, utility conflicts, constructability, and long-term reliability. The study concluded that Alternative 3, the Surf Street Right-of-Way Alternative, is the longest alignment, but likely exposed to the fewest constraints, risks, and potential impacts, and might be constructed sooner due to likely the shortest permitting timeline. The WWE study favors Alternative 3. The study concluded that Alternative 1, the Vistra *North* Alternative (including Segment 5A), is the shortest alignment, but may be exposed to the most constraints, risks, and potential impacts, and is at the highest risk of schedule delays. Again, this is based on the assumption that Segment 5A would be constructed by open cut trenching methods, not HDD methods. Cannon's subsequent pipeline alignment evaluation and conclusions are discussed in the following subsections of Chapter 5.

5.2 Alignment Constraints

When evaluating pipeline alignment alternatives, each alignment will have its unique set of constraints, challenges, and impacts. Cannon essentially agrees with the list of non-cost constraints identified in WWE's March 2024 "IPR Alignment Alternatives Feasibility Assessment." Cannon has updated and refined the definitions of the constraints to focus primarily on the construction phase. The constraints are listed below.

- <u>Traffic Impacts and Public Inconvenience</u>. Extent of traffic congestion, detours, and commuter delays, risk of accidents, noise, poor air quality, and reduced business activity resulting from construction.
- <u>Cultural Resources Impacts</u>: Potential risk of excavating and impacting cultural resources during construction.
- <u>Environmental Impacts</u>: Potential risk of impacting environmentally sensitive areas, and special status species during construction.
- <u>Stakeholder Risk</u>: Potential need for increased coordination, and additional/traded easements from Vistra, and increased site security during construction.
- <u>Utility Conflicts</u>: Potential risk of utility conflicts requiring relocation during construction.
- <u>Constructability</u>: Ease, efficiency, and timeliness with which the pipeline can be constructed.
- <u>Long-term Reliability</u>: Comparison of total length of existing pipeline, with reduced remaining lifespan, used to complete the Project.

5.3 Alignment Alternatives

Cannon has thoroughly reviewed the WWE's March 2024 "IPR Alignment Alternatives Feasibility Assessment" (**Appendix C**). WWE has clearly attempted to identify all feasible alignment alternatives for IPR Branch Pipelines to serve the proposed Injection Wells. Cannon concurs with the three alignment alternatives identified by WWE. As mentioned above, the three identified alignment alternatives are as follows:

1. Vistra *North* - Willow Camp Creek (Segments 4, 5A, 6, and 7A or 7B). This alignment connects to the IPR Conveyance Pipeline near its northerly terminus along the Bike/Ped Path. This

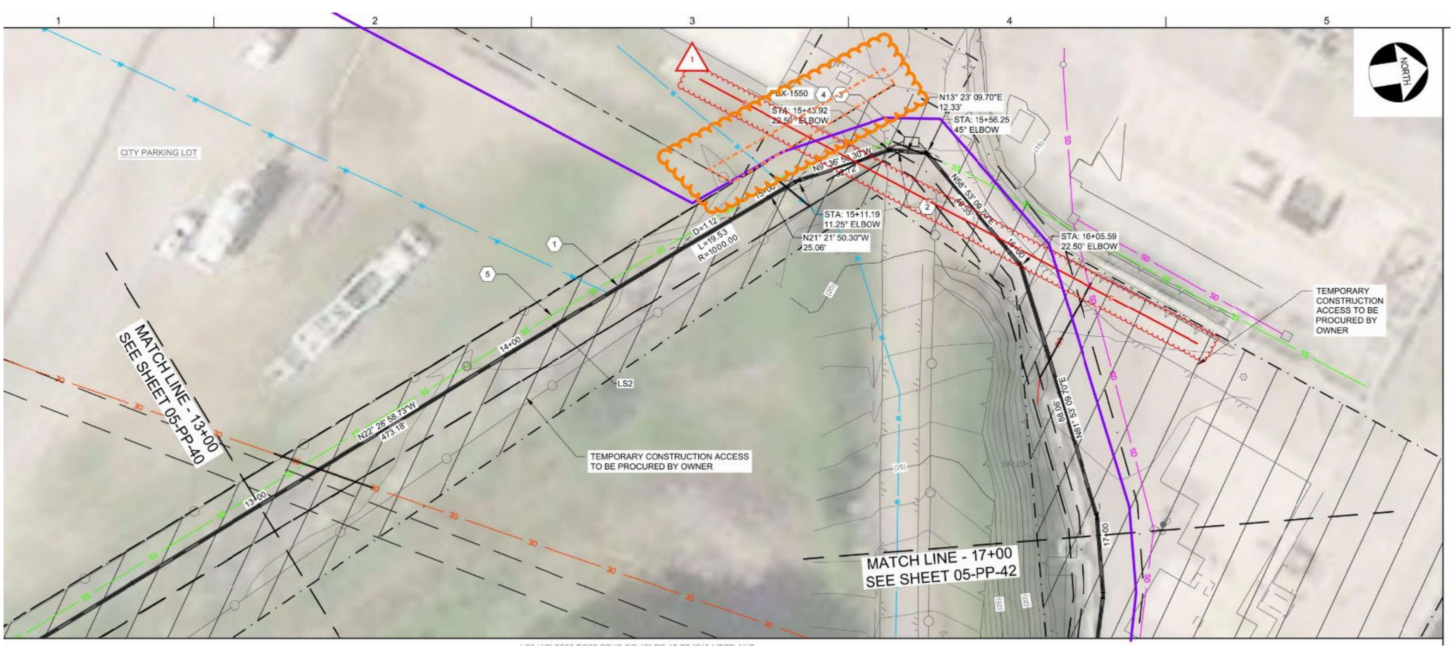
alignment includes the same two Branch Lines that extend to IW-1/IW-3, and IW-4. However, this alignment also includes Segment 5A that connects the ends of these two Branch Lines by crossing through Vistra property and the Willow Camp Creek area. By means of these three Branch Lines in series, the IPR Conveyance Pipeline is connected to the Desal Feedwater Line.

Construction of Segment 5A by HDD methods is feasible but would require adjustment of the existing easement to accommodate the sweeping alignment of HDD construction. The middle and southeasterly portions of the easement would not require adjustment. The northwesterly end of the easement would need to shift to the south and align with the paved area at the east end of the fisherman's storage area (near IW-4).

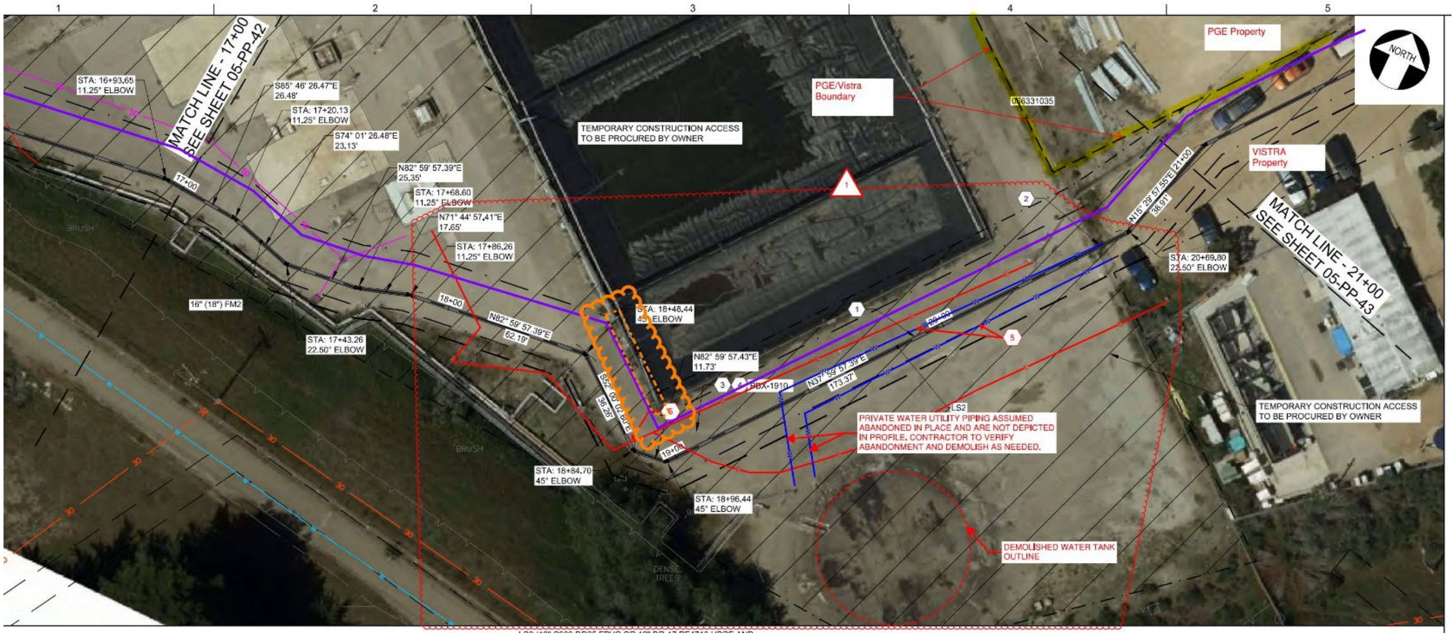
2. LS-2 Vistra *South* (Segments 2A, 3A, 7A or 7B, 6, and 4). This alignment connects to the IPR Conveyance Pipeline near the north end Quintana Road, extends west across Vistra property, then across the northwest edge of the Maritime Museum parking lot to Embarcadero Road, then north on Embarcadero Road to connect to the Desal Feedwater Line. This alignment also includes a Branch Line off the IPR Pipeline to IW-1 and IW-3, and a Branch Line off the Desal Feedwater Line to IW-4.

   After reviewing this alignment in detail, it has been determined that adjustment of the existing easement would be required in two locations to meet DDW water and sewer pipeline separation standards. See orange clouded areas in Figure 5-2 below. In addition, to meet the separation standards, the new IPR Branch Line would need to be located within 4 feet or less of the easement edge along several hundred feet of the alignment and would require a construction easement for installation. (Note that the chain-link fence along the middle portion of this alignment, between the PG&E and Vistra properties, appears to be encroaching a few feet into the Vistra property.)

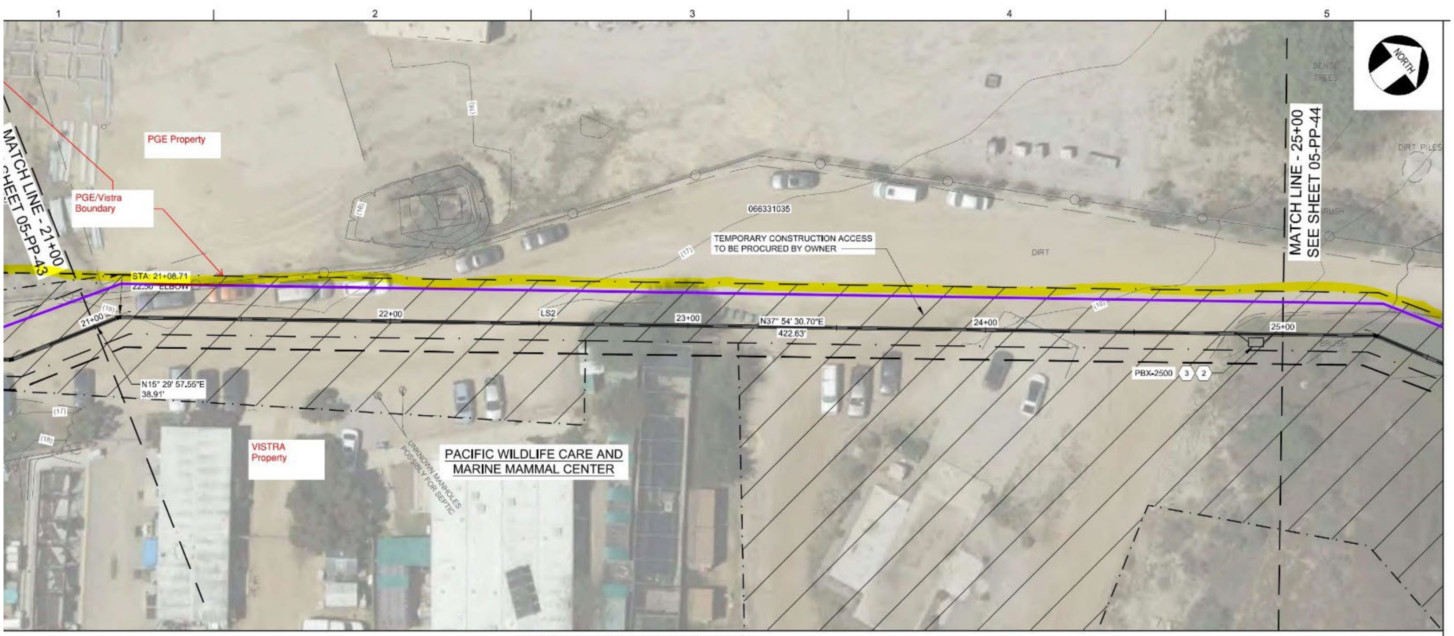
Figure 5-2 Alignment Alternative 2 Details



Sheet 1 of 4



Sheet 2 of 4



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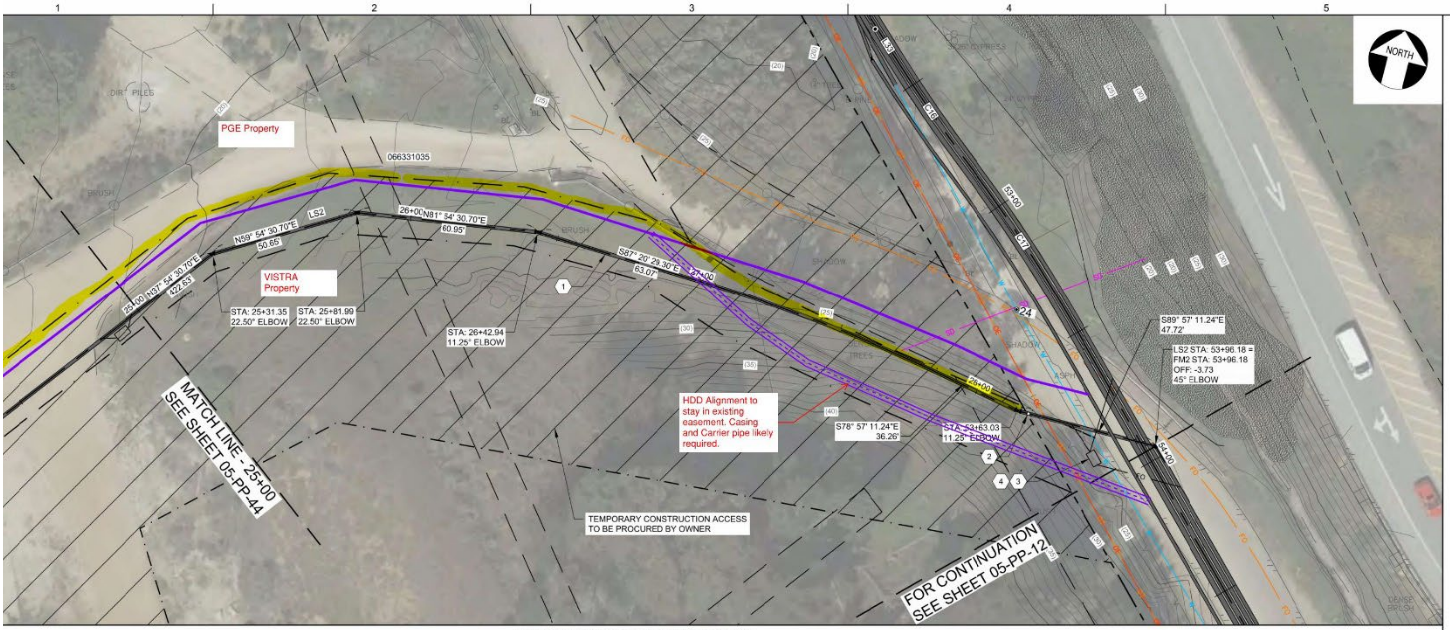


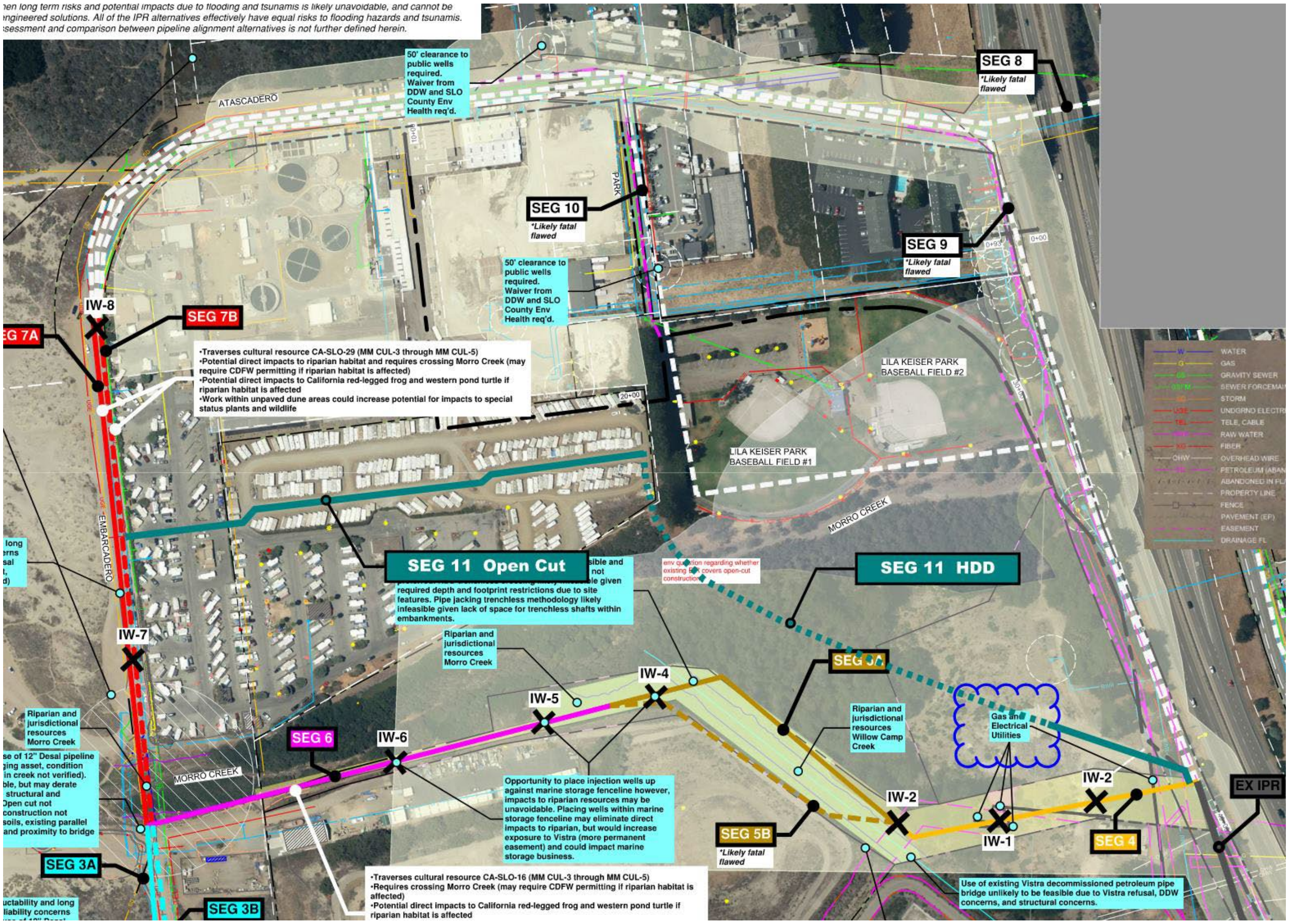
Sheet 4 of 4

3. Surf Street Right-of-Way (Segments 1, 3A, 7A or 7B, 6, and 4). This alignment connects to the IPR Conveyance Pipeline at the intersection of Quintana Road and Main Street, extends down Main Street, then along Surf Street, then across a City parking lot to Embarcadero Road, then north on Embarcadero Road to connect to the Desal Feedwater Line. This alignment also includes a Branch Line off the IPR Pipeline to IW-1 and IW-3, and a Branch Line off the Desal Feedwater Line to IW-4.

Cannon has identified one additional alignment alternative (Alternative 4) that includes a new Segment 11 that is a variation of Segment 10. Segment 11 would require adjustment of the existing easement.

4. Morro Creek-Self Storage (Segments 11, 7A or 7B, 6 and 4). Segment 11 connects to the IPR Conveyance Pipeline near its northerly terminus along the Bike/Ped Path, then extends under Morro Creek (and surrounding riparian area) by HDD methods, then extends west through the self-storage area and RV Park to Embarcadero Road where it connects to the Desal Feedwater Line. This alignment also includes a Branch Line off the IPR Pipeline to IW-1 and IW-3, and a Branch Line off the Desal Feedwater Line to IW-4. Figure 5-2 below presents a cropped version of a figure from the WWE IPR Alignment Alternatives Feasibility Assessment in which Segment 11 has been added to illustrate Alterative 4.

Figure 5-3 Alignment Alternative 4



Segment 11 is made possible by deep HDD under Morro Creek and surrounding culturally/environmentally sensitive areas. WWE consider Segment 10 fatally flawed because they expect difficulty in obtaining permits for work in this area, especially if there are other alternatives. However, permitting for a construction approach that utilizes approximately 1,500 feet of deep HDD, to completely avoid the sensitive areas, may be much easier.

The question then becomes: Does Alignment Alternative 4 have significant enough advantages compared to Alignment Alternative 1 such that it should be considered further? The answer is NO. Alternative 4 clearly involves significantly more new piping than Alternative 1 and is therefore much more expensive. Also, the longer and deeper HDD for Segment 11 poses more construction, cultural and environmental risk than HDD for Segment 5A. Therefore, Alternative 4 will not be considered further.

5.4 Recommended Alignment

As mentioned above, the WWE feasibility study favors Alignment Alternative 3, the Surf Street Right-of-Way Alternative, while acknowledging this alternative is the longest and most expensive alternative. Based on the evaluation criteria, Alternative 3 received the highest score by WWE, and was considered to have the easier pathway forward. The WWE feasibility study identified Alignment Alternative 1, the Vistra *North* Alternative (including Segment 5A), as the shortest and least costly alternative, but scored this alternative the lowest thinking it may be exposed to the most constraints, potential impacts, and risk of schedule delays. Again, this is due to WWE considering the construction of Segment 5A by HDD as infeasible and basing their evaluation on open cut trenching of Segment 5A.

Cannon believes construction of Segment 5A by HDD methods is feasible and has conducted an updated independent evaluation of the alignment alternatives. Our findings are presented below.

5.4.1 Evaluation Criteria

Relevant evaluation criteria are utilized to facilitate an easier comparison of the alternatives. In their study, WWE utilized the list of non-cost constraints as their evaluation criteria by which the alternatives may be compared. Cannon concurs with this approach. Therefore, for simplicity and consistency, Cannon has utilized the same evaluation criteria, with updated and refined definitions focusing primarily on the construction phase, to evaluate the alignment alternatives. The evaluation criteria are listed below. In addition, Cannon considers the construction cost to be a key evaluation criterion and has included that.

- Traffic Impacts and Public Inconvenience. Extent of traffic congestion, detours, and commuter delays, risk of accidents, noise, poor air quality, and reduced business activity resulting from construction.
- Cultural Resources Impacts: Potential risk of excavating and impacting cultural resources during construction.
- Environmental Impacts: Potential risk of impacting environmentally sensitive areas, and special status species during construction.
- Stakeholder Risk: Potential need for increased coordination, and additional/traded easements from Vistra, and increased site security during construction.
- Utility Conflicts: Potential risk of utility conflicts requiring relocation during construction.
- Constructability: Ease, efficiency, and timeliness with which the pipeline can be constructed.
- Long-term Reliability: Comparison of total length of existing pipeline, with reduced remaining lifespan, used to complete the Project.

Construction costs are taken from the March 2024 WWE study and scored based on magnitude of scale.

- The cost of Alternative 1 is $2,022,000
- The cost of Alternative 2 is $2,762,000 (37% higher than Alt 1)
- The cost of Alternative 3 is $3,289,000 (63% higher than Alt 1)

5.4.2 Evaluation Matrix

An evaluation matrix is used to clearly present the comparison of alignment alternatives. A score of 1 through 5 is assigned to each criterion for each alternative (with exception of cost). A score of 5 is most favorable and a score of 1 is least favorable. Because the construction cost is such an important consideration for decision makers, and will impact the rate payers the most, it is assigned twice the weight of any other criteria, and scored 1 through 10. Wherever conditions are considered very similar between alternatives they are scored equally. A summary of the evaluation, including cost, is presented in Table 5-1 below.

Table 5-1 Alignment Alternatives Evaluation Matrix

Criteria	Alignment Alternative 1	Alignment Alternative 2	Alignment Alternative 3
Traffic Impacts and Public Inconvenience	5	4	2
Cultural Resources Impacts	3	5	5
Environmental Impacts	4	5	5
Stakeholder Risk	3	3	5
Utility Conflicts	5	2	2
Constructability	5	3	3
Long-term Reliability	5	2	2
Construction Cost	10	7	5
Total Score:	**40**	**31**	**29**

5.4.3 Conclusion

Based on the identified evaluation criteria, Alternative 1 (including HDD of Segment 5A) is far superior to Alternatives 2 and 3. The cost to construct Segment 5A by HDD verses open cut trenching should be less because tree removals, disposal of trench spoils, sand bedding, and landscape restoration are not required. The City may need to educate permitting agencies on the cultural and environmental benefits of horizontal directional drilling.

5.5 Pipeline Sizing

As noted in subsection 2.3, Cannon prepared an Excel® hydraulic model to simulate flow rates, friction losses, and pressures throughout the existing and proposed pipeline network for the Initial and Final Phases of the Project. This includes existing HDPE pipe (IPR Conveyance Pipeline) Segments A, B, C, and D, as well as proposed Branch Pipeline Segments 1, 3A, 7A, 4, 5A, and 6. Results of the hydraulic model are presented in subsection 2.3, and **Appendix B**.

Based on the hydraulic modeling, and anticipated maximum flow rates, the recommended HDPE pipe sizes for the various alignment alternatives are presented in Table 5-2 below. Even if the injection rates are significantly higher than expected, and a maximum flow rate of 800 gpm is required, the maximum velocity in the 10” diameter HDPE pipe would remain under 4 fps with relatively low headloss per 100 feet of pipeline.

Table 5-2 Recommended Pipe Sizes and Hydraulic Conditions

Alignment Alternative	Pipe Segment	Nominal Diameter (in)	Dimension Ratio (DR)	Inside Diameter (in)	Max. Flow Rate (gpm)	Max. Velocity (fps)	Headloss Per 100 ft (psi)
1	**4-5A-6**	10	13.5	9.06	600	3.0	0.15
2	**2A**	10	13.5	9.06	600	3.0	0.15
3	**1**	10	13.5	9.06	600	3.0	0.15
2 & 3	**4**	6	15.5	5.72	200	2.5	0.18
2 & 3	**6**	6	13.5	5.58	100	1.3	0.06

PVC pipe of the same nominal diameter and pressure class may be substituted for HDPE pipe. Because PVC pipe has a larger inside diameter than the corresponding size HDPE pipe, use of PVC pipe would result in lower velocities and headloss than the HDPE pipe.

6. DOWNHOLE FLOW CONTROL VALVE EVALUATION

Maintaining injection line pressure and preventing freefalling water down the casing (and associated air entrainment) are important considerations when designing injection wells. For a low capacity injection well a small diameter downcomer or injection tube with orifice plates is the most common (and suitable) method to accomplish this (in conjunction with a modulating valve at the wellhead). For a high capacity injection well a more common method of accomplishing this is through the use of a downhole flow control valve. There are three waterworks valves on the market designed for this purpose: the Baski - InFlex Flow Control Valve, the 3R Valve - Flow Control Valve, and the ASR Resources - V-Smart BIC-V Injection Control Valve. Although the Morro Bay Recycled Water Facilities injection wells will be low capacity, the City is considering the possible use of downhole flow control valves. Therefore, in this chapter, the design and operation of these flow control valves (FCVs) are described, compared, and evaluated.

6.1 Baski - InFlex Flow Control Valve

The Baski InFlex Flow Control Valve (InFlex Valve) is a fluid-actuated valve that regulates the flow of water from the surface into an injection well and permits pumping water (or backflushing) to the surface using the same column pipe. The InFlex Valve is designed for use in conjunction with a submersible or vertical turbine pump for injection wells and Aquifer Storage and Recovery (ASR) wells. The Baski InFlex Valve is the most widely used injection well/ASR well flow control valve in the U.S.

InFlex Valve allows for adjustment and holding of desired injection rates and is designed with no sliding seals that may become jammed. Based on the injection pipeline/system pressure, injection water is forced from the column pipe through a series of circular annular orifices, and then through a long annular-gap flow path within the InFlex Valve. The flow rate is controlled by adjusting the gap between the annular orifices and the rubber bladder within the valve, thus reducing or enlarging the flow path. Stainless steel channels frame the adjustable flow path and stabilize the rubber bladder as it is pushed out and stretched by the inflation gas (typically nitrogen). The flow path provides non-cavitating head loss. All components of the InFlex Valve are made from 316 stainless steel with exception of the rubber bladder. The design is wear-resistant and relatively trouble free because there is no place within the valve for sand to collect and no sliding surfaces to become sand locked.

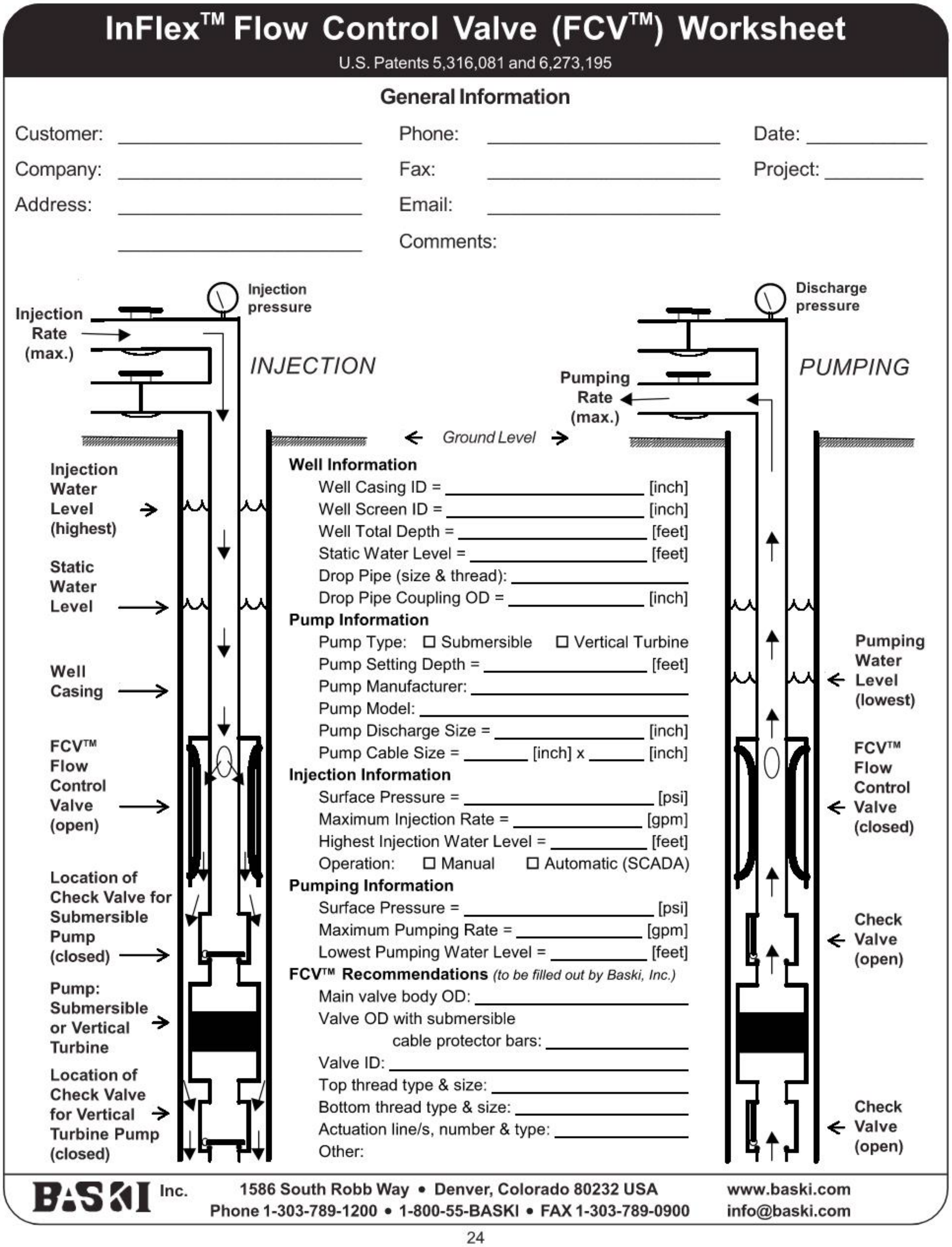
It is undesirable to drain the column pipe when the injection well is off because this can result in a slug of air in the column pipe that gets introduced to the well screen when the well is turned on. Air introduced to the well screen can cause air binding of the well screen and gravel pack, and air fouling of the screen over time. The InFlex Valve maintains a column of water (under pressure) in the column pipe at all times. This minimized the possibility of cascading water, air entrainment, and air being introduced into the column pipe, thereby minimizing air binding and air fouling of the well screen.

The InFlex Valve is sized based on the desired injection flow rate and minimum driving head (pressure) conditions in the injection pipeline. Compressed nitrogen gas is recommended to actuate the valve because it is clean, inert, non-combustible, low cost, and readily available. Compressed air can be used but results in a more complicated system and requires ongoing power. K size nitrogen cylinders (9.25” D x 60”H, 135 lbs.) are commonly used.

The InFlex Valve modulates the injection flow rate when the user inflates or deflates the reinforced rubber bladder inside of the valve. Whenever the bladder is inflated to a higher pressure, nitrogen is added to the system, and when the bladder is deflated (either partially or completely), nitrogen is let out of the system (to atmosphere). If the InFlex Valve is left in any position, open or closed, no additional nitrogen is consumed. Therefore, the amount of nitrogen used is directly related to how often the valve is cycled or modulated. For this Project, nitrogen cylinders may have to be replaced every 4 to 6 months depending on how often the InFlex Valve is cycled or modulated. Redundant control lines of ¼" stainless steel tubing extend from the nitrogen cylinders through the InFlex Valve control panel, and down the column pipe to the valve's liquid inflation chamber (rubber bladder). Baski provides a control panel allowing the valve to be automatically or manually operated and adjusted.

For submersible pump installations, the InFlex Valve is set above a check valve and the pump, and below the lowest pumping water level. The InFlex Valve accommodates a wide range of injection capacities and comes with a limited 5-year warranty. See below for the InFlex Flow Control Valve Worksheet, a cut-away view of the valve that illustrate the operation of the InFlex Flow Control Valve, and a photo of valve installation.

Figure 6-1 Baski InFlex Flow Control Valve Worksheet



InFlex™ Flow Control Valve (FCV™) Worksheet

U.S. Patents 5,316,081 and 6,273,195

General Information

Customer: ____________ Phone: ____________ Date: ____________

Company: ____________ Fax: ____________ Project: ____________

Address: ____________ Email: ____________

____________ Comments:

Well Information

Well Casing ID = ____________ [inch]
Well Screen ID = ____________ [inch]
Well Total Depth = ____________ [feet]
Static Water Level = ____________ [feet]
Drop Pipe (size & thread): ____________
Drop Pipe Coupling OD = ____________ [inch]

Pump Information

Pump Type: ☐ Submersible ☐ Vertical Turbine
Pump Setting Depth = ____________ [feet]
Pump Manufacturer: ____________
Pump Model: ____________
Pump Discharge Size = ____________ [inch]
Pump Cable Size = ________ [inch] x ________ [inch]

Injection Information

Surface Pressure = ____________ [psi]
Maximum Injection Rate = ____________ [gpm]
Highest Injection Water Level = ____________ [feet]
Operation: ☐ Manual ☐ Automatic (SCADA)

Pumping Information

Surface Pressure = ____________ [psi]
Maximum Pumping Rate = ____________ [gpm]
Lowest Pumping Water Level = ____________ [feet]

FCV™ Recommendations *(to be filled out by Baski, Inc.)*

Main valve body OD: ____________
Valve OD with submersible cable protector bars: ____________
Valve ID: ____________
Top thread type & size: ____________
Bottom thread type & size: ____________
Actuation line/s, number & type: ____________
Other:

BASKI Inc. 1586 South Robb Way • Denver, Colorado 80232 USA
Phone 1-303-789-1200 • 1-800-55-BASKI • FAX 1-303-789-0900
www.baski.com
info@baski.com

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Figure 6-2 Baski InFlex FCV – Cut-Away View

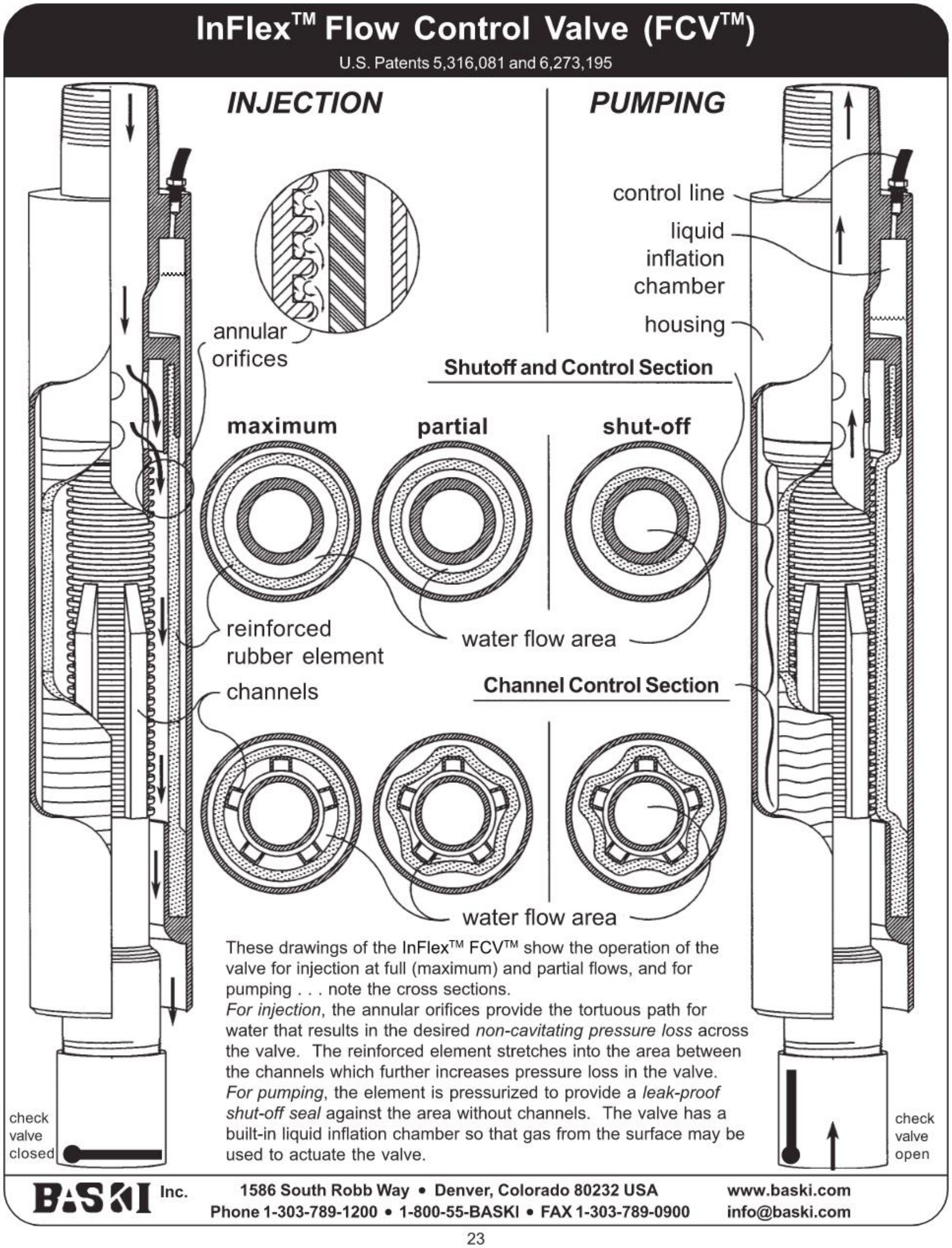


Figure 6-3 Baski InFlex Valve Installation

6.2 3R Valve – Flow Control Valve

The 3R Valve – Flow Control Valve (3R Valve) regulates the flow of water from the surface into an injection well and permits pumping water (or backflushing) to the surface using the same column pipe. The 3R Valve operates to 1) maintain positive wellhead pressure during injection, 2) meet a flow setpoint, and 3) manage the aquifer level. In the open position, the 3R Valve allows water to be injected down the column pipe, out through the valve orifices, and into the aquifer. In the closed position, the valve allows water to be pumped from the aquifer up through the column pipe and valve sleeve to the surface.

The 3R Valve is designed with all hydraulic components, including seal surfaces, located inside the valve, and an arrangement of smaller discharge ports that dissipate the energy of the exiting water to reduce hydraulic mining of the well bore. The 3R Valve major components include the outer valve body containing the orifices, an inner ultra-high molecular weight (UHMW) polyethylene sleeve, an upper and lower pair of hollow pistons and glands, a 1 HP hydraulic pump, and hydraulic control lines. All components of the 3R Valve are made from stainless steel with exception of the UHMW polyethylene sleeve.

The hydraulic pump is located at the wellhead. The hydraulic pump is motor driven, and solenoid operated and includes a 2.5-gallon oil reservoir. The hydraulic pump sends hydraulic oil to the upper piston to open the valve, or the lower piston to close the valve. The hydraulic oil travels from the oil reservoir, through hydraulic lines, down along the column pipe, to the top and bottom of the valve. The hydraulic oil drives either the upper piston or lower piston that in turn slides the inner UHMW polyethylene sleeve down or up to expose more or fewer orifices in the outer valve body, thus allowing or preventing injection water from flowing down the column pipe, and through the valve. The motor only runs when the 3R Valve is directed to change position such as when opening and closing. No power is required to hold the valve in a set position.

In the unlikely event a failure in the control lines causes a hydraulic pressure loss, the 3R Valve can be designed to either remain open and maintain the current discharge rate or automatically close. Depending on the injection/ASR well design, automatic closure can prevent uncontrolled water discharge rates that could lead to well overflow.

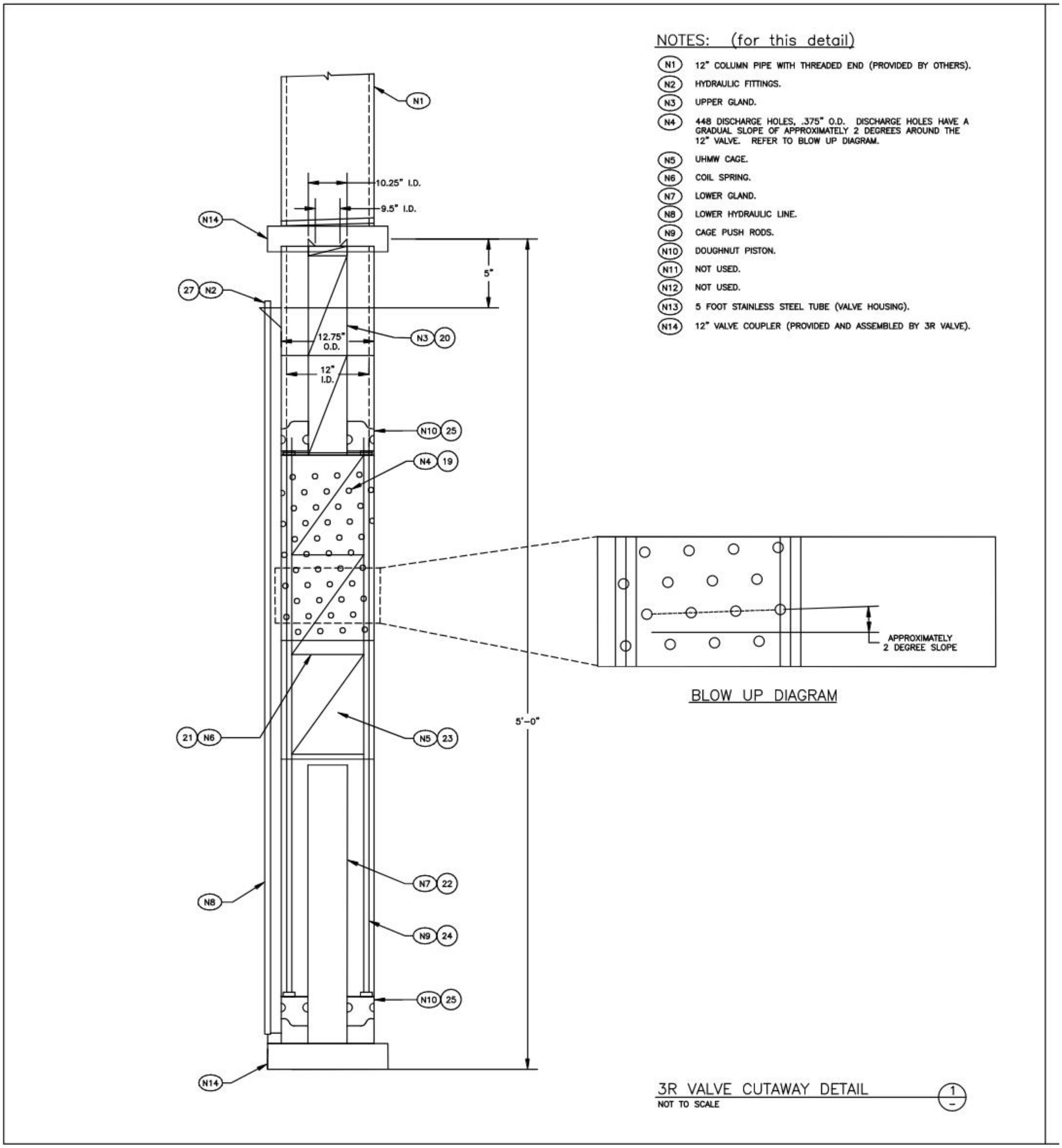
For submersible pump installations, the 3R Valve is set above a check valve and the pump, and below the lowest pumping water level. The 3R Valve accommodates a wide range of injection capacities, and the manufacturer furnished control panel allows the valve to be automatically or manually operated and adjusted. The body of the valve is stainless steel, all components of the valve are NSF 61 approved, and the valve comes with a limited 5-year warranty. See below for photos of a 3R Valve, valve installation, valve features, and a cut-away view of the valve that illustrate the operation of the 3R Flow Control Valve.

Figure 6-4 3R Valve and Installation

Figure 6-5 3R Valve Cage Assembly with UHMW Sleeve

Figure 6-6 3R Valve Orifices and Injection Flow Pattern

Figure 6-7 3R FCV Cut-Away View



6.3 ASR Resources - V-Smart Injection Control Valve

The ASR Resources V-Smart BIC-V Injection Control Valve (V-Smart Valve) regulates the flow of water from the surface into an injection well and permits pumping water (or backflushing) to the surface using the same column pipe. The V-Smart Valve operates to 1) maintain positive wellhead pressure during injection, 2) meet a flow setpoint, and 3) manage the aquifer level. In the open position, the V-Smart Valve allows water to be injected down the column pipe, out through the valve orifices, and into the aquifer. In the closed position, the V-Smart Valve allows water to be pumped from the aquifer up through the column pipe and full port valve body to the surface.

The V-Smart Valve is a relatively simple design intended to increase reliability, limit operating cost, and reduce maintenance. The V-Smart Valve major components include the outer sliding sleeve (with hydraulic chambers and throttle skirt), the inner valve body containing the hydraulic lines and injection orifices, a 0.75 HP hydraulic pump, and hydraulic control lines. The outer sliding sleeve contains upper and lower annular chambers. When the upper chamber is pressurized with hydraulic oil the valve opens, and when the lower chamber is pressurized the valve closes.

The hydraulic pump is located at the wellhead. The hydraulic pump is motor driven and includes a 3-gallon food grade mineral oil reservoir. The hydraulic oil travels from the oil reservoir, through hydraulic lines, down along the column pipe, to the upper and lower annular chambers. The hydraulic oil drives the outer sleeve up or down to gradually open or close the orifices in the inner valve body, thus allowing or preventing injection water from flowing down the column pipe, and through the valve. A throttle skirt is located at the bottom of the outer sleeve to direct all injection water down along the pump column. This avoids potential disturbance of the gravel pack. The motor only runs when the V-Smart Valve is directed to change position such as when opening and closing. No power is required to hold the valve in a set position.

In the unlikely event a failure in the control lines causes a hydraulic pressure loss, the V-Smart Valve can be designed to either remain open and maintain the current discharge rate or automatically close. Depending on the injection well design, automatic closure can prevent uncontrolled water discharge rates that could lead to well overflow.

For submersible pump installations, the V-Smart Valve is set above a check valve and the pump, and below the lowest pumping water level. The V-Smart Valve accommodates a wide range of injection capacities, and the manufacturer furnished control panel allows the valve to be automatically or manually operated and adjusted. All metallic components of the V-Smart Valve are made of stainless steel including the inner valve body and outer sliding sleeve, and all components of the valve are NSF 61 approved. The valve comes with a limited 1-year warranty. See below for photos of a V-Smart Valve installation, and photos that illustrate the operation of the V-Smart BIC-V Injection Control Valve.

Figure 6-8 V-Smart Valve Installation

Figure 6-9 V-Smart Valve Positions

Figure 6-10 V-Smart Streamlined Hydraulic Lines

6.4 Flow Control Valve Comparison

To facilitate an easier evaluation and comparison of the FCV options, a list of the most relevant evaluation criteria was established and scored. The evaluation criteria considered, and brief discussion of how they apply to the options are provided below.

Manufacturer's Engineering Expertise & Support. All three valve manufacturers provide engineering support. However, the level of engineering expertise and support varies between the manufacturers. For example, the type and amount of technical information available from each manufacturer varies. Also, the scope of engineering support for pertinent and related injection well facilities varies considerably. As an example, the V-Smart Valve programming looks at water level rise over time, with trend analysis, to determine backwash frequency. ASR Resources, the manufacturer of the V-Smart Valve, offers significantly more project-related engineering and support than the other two manufacturers.

NSF Approved. All components of the ASR Resources and 3R Valve FCVs in contact with the water are NSF 61 approved. The internal inflatable bladder of the Baski InFlex flow control valve is constructed of reinforced natural rubber material but is not NSF 61 approved.

Injection Flow Pattern. The V-Smart Injection Control Valve provides full annular flow and includes a throttle skirt over the injection orifices that directs flow downward around the annulus of the valve. This prevents any possibility of the injection flow damaging or negatively affecting the well screen and gravel pack. The InFlex Flow Control Valve also provides full annular flow and directs flow downward around the annulus of the valve. The 3R Flow Control Valve has several circular orifices around the perimeter of the valve body that direct jets of water outward toward the well screen or well casing pipe. Unless the 3R-Valve is located adjacent to blank casing pipe, the jets of water through the orifices may negatively impact the well screen and gravel pack. The injection flow pattern of the V-Smart Valve and InFlex Valve are considered superior to the 3R Valve.

Valve Modulation. All three flow control valves are capable of modulation and delivering varying flow rates within a range. The 3R Valve and the V-Smart Valve Utilize an electric driven hydraulic pump and hydraulic oil to open, close and modulate the valve. The hydraulic fluid is non compressible. The Baski InFlex Valve utilizes compressed nitrogen gas provided by nitrogen gas cylinders to inflate/pressurize the rubber bladder and close, open, and modulate the valve. When the bladder is pressurized, the valve is closed. When the bladder is depressurized, the nitrogen gas is vented to the atmosphere and the valve opens. The nitrogen gas is compressible. Therefore, fluctuations in the water level within the injection well can lead to minor changes in the valve set point without operator command. However, because the Morro Bay Injection Wells will all be relatively shallow, this effect will be negligible.

Valve Size. The Baski InFlex Valve is the longest and heaviest of the three flow control valves. The V-Smart Valve is the most compact and lightest of the three with a length less than half of the other two valves. The 3R Valve is of similar weight and length to the InFlex Valve. From a size and weight perspective, the V-Smart Valve is the most desirable.

Power to Operate. The InFlex Valve operates based on pressurized nitrogen gas and requires no power to operate. During a power outage the InFlex Valve continues to operate based on pre-established operating criteria and settings. The 3R Valve and V-Smart Valve both require power to operate their electric motor driven hydraulic pumps. During a power outage these valves hold their fixed position prior to power outage. If desired, these valves can be designed to close upon power outage but do not continue to operate automatically.

Disposable Materials. As mentioned, when the InFlex Valve bladder is pressurized, the valve is closed. When the bladder is depressurized, the nitrogen gas is vented to the atmosphere and the valve opens. As the valve is operated, the repeated closing, opening, and modulation of the valve vents nitrogen gas to the atmosphere, gradually depleting the nitrogen gas cylinders. Based on the preliminary injection well operation concept, it is estimated that the nitrogen gas cylinders will have to be replaced approximately 3 times per year. The 3R Valve and V-Smart Valve require no disposable materials to operate.

Internal Port. Due to the design of the InFlex Valve and 3R Valve, the internal port (through the valve) for pumped backflush water is slightly reduced in diameter. Although the design of the V-Smart Valve locates two ¼" hydraulic lines along the inside wall of the port, the design provides a full port internal diameter. If the final design includes a backflush pump, the V-Smart Valve will result in the least head loss during backflush pumping conditions.

Operations & Maintenance. Based on reported valve operations, the three valves have similar operations and maintenance requirements. The Baski InFlex Valve will require periodic change out of the compressed nitrogen gas cylinders resulting in a certain number of maintenance hours annually. The 3R Valve and V-Smart Valve will require minor periodic maintenance of their electric driven hydraulic system and pump, also resulting in a certain number of maintenance hours annually.

Reliability. The Baski InFlex Valve and 3R Valve both come with a limited 5-Year Warranty. The V-Smart Valve offers a limited 1-Year Warranty. All three manufacturers have been producing downhole flow control valves for around 30- years. The Inflex Valve and V-Smart Valve have a simpler, more rugger design. The InFlex Valve has no moving parts but only an inner bladder that inflates and deflates. The design of the V-Smart Valve incorporates an upper and lower piston wall scraper to continuously clean the operating surfaces to ensure trouble free operation. The 3R Valve design is more complex and therefore considered slightly less reliable. The 3R Valve design also locates hydraulic lines on the exterior of the main valve body, making this valve slightly more prone to damage during installation and removal. Reliability data as reported by each manufacturer and gleaned from their literature, are summarized below in Table 6-1. The Baski InFlex Valve appears to be the most reliable followed by the ASR Resources V-Smart Valve. This conclusion is consistent with reliability data as reported by the Orange County Water District.

Table 6-1 Valve Reliability Data

Production & Reliability Data	InFlex Valve	3R Valve	V-Smart Valve
Warranty (Years)	5	5	1
Simple/Rugged Design	Yes	No	Yes
Number of Valves Installed	**265**	45	49
Number of Problems During First 5 Years (since 2000)	1	4	3
Valves in Service Around 20 Years	Yes	Yes	Yes

Cost. The valve cost comparison considers material costs only. The cost of installation of all three valves is expected to be essentially the same, and therefore not considered further in this evaluation. The cost of the Baski InFlex Valve with compressed nitrogen gas automatic/manual control panel is **$55,000/each**. The cost of the 3R Valve with hydraulic oil PLC control panel is **$170,000/each**. The cost of the V-Smart Valve with hydraulic oil PLC control panel is **$98,500/each**. As noted, the 3R Valve is 3 times more expensive than the Baski InFlex Valve, and the V-Smart Valve is 2 times more expensive than the InFlex Valve.

A score of 1 through 5 was assigned to each criterion for each option (with the exception of cost). A score of 5 is most favorable and a score of 1 is least favorable. Because of the greater importance of cost, it was given a greater weight and assigned a score of 1 through 10. A summary of the evaluation, including cost, is presented in Table 6-2 below. Where conditions are similar between options for a particular criterion, those options are assigned an equal score.

Table 6-2 Summary of Flow Control Valve Comparison

Comparison Criteria	Baski InFlex FCV	3R Valve FCV	ASR Resources V-Smart ICV
Manufacturer's Engineering Expertise & Support	4	3	5
All Components NSF Approved	4	5	5
Optimal Injection Flow Pattern	5	3	5
Ability to Modulate Flow Rate	5	5	5
Valve Size	4	4	5
Power to Operate	5	3	3
Disposable Materials	4	5	5
Full Port Internal Diameter (relevant if backflush pumping)	4	4	5
O&M Requirements	4	4	4
Valve Reliability	5	3	4
Valve & Control Panel Cost	10	3	6
Total Score:	**54**	**42**	**52**

Based on the evaluation criteria, the Baski InFlex Valve is the preferred downhole FCV if the City decides to use downhole FCVs. The primary advantages the Baski InFlex Valve has over the V-Smart Valve are significantly lower cost, no power required, and longer warranty. Both the Baski InFlex Valve and V-Smart Valve are considered superior to the 3R Valve. Additional important factors for the City to consider in selecting its preferred downhole flow control valve include the following:

- The Baski InFlex Valve has significantly lower capital cost.
- The Baski InFlex Valve comes with a 5-year warranty, whereas the ASR Resources V-Smart Valve only offers a 1-Year warranty.
- ASR Resources provides more engineering and operations support.
- Advanced DDW approval may be required for use of the Baski InFlex Valve due to the reinforced natural rubber inner bladder not being NSF 61 approved.
- The annual power cost to operate the V-Smart Valve is estimated to be about half the annual cost of replacement nitrogen cylinders ($900) for the Baski InFlex Valve.

Although the Baski InFlex Valve is the preferred FCV among the three available, due to the low capacity of the proposed Morro Bay injection wells, the more common (and less costly) approach of using downcomers with orifice plates is recommended.

7. INJECTION WELL DOWNHOLE CONFIGURATION & ABOVE-GROUND PIPING (INJECTION WELL EQUIPPING)

Successful implementation of the RWF Project in large part depends on thoughtful design of the above ground and downhole piping, flow control valves, air lift/pumping equipment, and other appurtenances, to result in facilities that meet RWF Project objectives, are cost effective, operate smoothly, and require minimal maintenance. Site conditions and constraints must be understood. Alternative downhole flow control valves must be researched and evaluated. Injection Well equipping including above ground piping and downhole configuration alternatives must be identified and evaluated. And capital costs, and operations and maintenance requirements must be considered.

7.1 Site Considerations

As mentioned, the Initial Phase of the City's RWF Project includes three to four Injection Wells. The first injection well (IW-1) has been drilled and is located west of Highway 1 and south of Morro Creek within a City easement on property owned by Vistra. The City has determined that the Initial Phase of the Project will include two to three additional Injection Wells IW-3, IW-4, and IW-7. IW-3 will also be located within the same City easement east of IW-1 near the bike path and Highway 1. IW-4 will be located at the east end of the driveway to the fisherman's storage area (east of Embarcadero Road), and approximately 140 feet south of Morro Creek. IW-7 will be located near the middle of the Morro Dunes RV Park at 1700 Embarcadero Road, approximately 420 feet north of Morro Creek. The discussion of various site considerations provided below applies to all three proposed injection well sites.

7.1.1 *<u>Land Use</u>*

IW-3 will be located at the north end of the old PG&E power plant site. This area was formerly zoned M-2 (Coastal Dependent Industrial) but was rezoned several years ago to VSC (Visitor Serving Commercial). Adjacent areas are zoned PF (Public Facility) to the south, and PR (Park and Recreation) to the north and west. Highway 1 is located immediately to the east.

The harbor related self-storage facility where IW-4 will be located is zoned M-2/PD (Coastal Dependent Industrial / Planned Development). The Morro Dunes RV Park where IW-7 will be located is zoned M-1/PD (Light Industrial / Planned Development). From an engineering perspective, the areas proposed for IW-3, IW-4, and IW-7 are suitable for the intended use.

7.1.2 *<u>Property Ownership</u>*

As mentioned, existing IW-1 and proposed IW-3 are located on property owned by Vistra. At this location, the City holds two adjoining variable width easements for their Injection Wells covering 5.76 acres as follows:

1. Parcel 1. 70 feet wide easement, approximately 1,200 feet in length; and
2. Parcel 2. Approximately 2,000 feet of 100 feet wide easement that reduces to 30 feet wide for an additional approximately 500 feet. The 100 feet wide easement area is of adequate width and length for locating proposed IW-3.

Proposed IW-4 is located in the fisherman's storage area also on property owned by Vistra. The City has a short-term lease agreement with Vistra to use that area. The City will have to acquire an easement(s) from Vistra to locate I W4 there, similar to the easements for IW-1 and IW-3. Vistra has indicated informally that they are open to discussions with the City for such an easement(s). The Morro Dunes RV Park, where IW-7 is proposed to be located, is owned by the City but under a long-term lease with the RV Park. For proposed IW-1, IW-3 and IW-7, property ownership does not appear to hinder implementation of the Initial Phase Project. However, as noted, for IW-4, the City will have to acquire an easement(s) from Vistra.

7.1.3 Site Access

The easements for IW-1 and IW-3 can be accessed from the City's bicycle/pedestrian path. The path is located west of and parallel to Highway 1, within the Caltrans right-of-way. The entrance to the bicycle/pedestrian path is located on Quintana Road, about 300 feet from the intersection of Quintana Road and Main Street. See Figure 7-1 below. The easement entrance is located approximately 1,300 feet northwest down the paved bicycle/pedestrian path on the west side.

Figure 7-1 Bicycle/Pedestrian Path

Access to the proposed IW-4 site is from Embarcadero Road along a gravel and paved road south of Morro Creek, and across the fisherman's storage area property leased by the City. Access to the proposed IW-7 site is from Embarcadero Road through the entrance to the Morro Dunes RV Park (near Atascadero Road). From an engineering perspective, access to all sites is adequate for construction purposes, and for ongoing operations and maintenance.

7.1.4 Environmental Resources

The comprehensive Water Reclamation Facility Program includes eight or more new Injection Wells. The Morro Bay City Council certified the EIR covering the Water Reclamation Facility Program on August 14, 2018. Subsequently, injection well locations have shifted, the recycled waterline has been realigned, and two additional recycled water users have been added to the RWF Project. Therefore, the City's environmental consultant is preparing an EIR Addendum at this time to address these Project modifications. There do not appear to be any significant environmental hurdles that would hinder Project implementation at this time.

7.1.5 Construction Related Permitting Requirements

Project permitting is being handled by Carollo Engineers and GSI Water Solutions. Permitting requirements of the California Coastal Commission, the Central Coast Regional Water Quality Control Board (RWQCB), and the County of San Luis Obispo Environmental Health Services Division are covered in documents prepared by Carollo and GSI. Therefore, only a cursory discussion of construction related permitting requirements is provided here.

Permitting for the RWF Project is intended to cover all phases of the Project. The RWF Project is expected to have less than 1 acre of disturbance. Therefore, a stormwater Construction General Permit is not expected to be required. However, due to the Project proximity to Morro Creek and the shoreline, it is recommended that a Stormwater Pollution Prevention Plan (SWPPP) be prepared and implemented. There does not appear to be any Injection Well work necessary within the Caltrans right-of-way. Therefore, a Caltrans Encroachment Permit should not be required.

Although not anticipated, if repairs to the Desal Feedwater Line are needed at the Embarcadero Road bridge over Morro Creek, replacement of this section by horizontal directional drilling (HDD) is recommended. Replacement, rather than repairs, will avoid the following regulatory permits: United State Army Corps of Engineers, Section 404 Permit; California Department of Fish & Wildlife, Section 1602 Streambed Alteration Permit; and Regional Water Quality Control Board, Section 401 Water Quality Certification. At this time no other permits are expected to be required.

7.1.6 Utility Connections and Conflicts

As previously discussed, the existing Desal Feedwater Line will be repurposed as an Injection Well feed line. Pipelines branching off the existing IPR Conveyance Pipeline are yet to be constructed and will be referred to as IPR Branch Pipelines. Injection Wells IW-1 and IW-3 will be fed by a common IPR Branch Line connected to the IPR Conveyance Pipeline near the existing Bike-Ped Path south of Morro Creek and west of Hwy 1. Injection Wells IW-4 and IW-7 will be fed by individual IPR Branch Pipelines connected to the repurposed Desal Feedwater Line located in Embarcadero Road. Electrical connections are discussed in the next subsection.

The Injection Wells will be located to avoid conflicts with existing utilities, and, to the degree possible, meet health and safety separation requirements, such as distance from existing sewer lines. Existing sewer lines and laterals will be relocated as needed to meet separation requirements, or a variance sought from DDW where feasible. At this time, relocation of existing sewer lines and laterals is expected to be needed. No other significant existing utility relocations are expected at this time.

7.1.7 Electrical Service

PG&E electrical power is available in the vicinity of all proposed Injection Well sites. Up to three new electrical services are required for the proposed Injection Wells. One electrical service is sufficient to serve both IW-1 and IW-3. Separate electrical services are required for IW-4 and IW-7. Based on site specific evaluations, PG&E will be contacted to discuss the new loads and coordinate the installation of new transformers and meter/mains for the proposed sites. The new transformers will be sized adequately for the new loads and verified with PG&E. Emergency backup power will not be provided. A preliminary summary of the anticipated major loads at each site are listed below.

- Electrically Actuated Valves
- Backflush Pump
- Surge Protection Equipment
- Lighting Panel
- SCADA Panel and Telemetry Equipment

The following considerations will be incorporated into the electrical design of the proposed new Injection Wells:

- The Injection Wells will receive power from new PG&E feeds and transformers from nearby power poles or grid.
- The Injection Well feeders will be 120/240V, single-phase, 3-wire, or 480V, 3-phase, 4-wire based on design loads.
- Free-standing, lockable NEMA 3R meter pedestals will be provided. The pedestals will house the PG&E meter and a main disconnect. Each meter pedestal will be mounted on a reinforced concrete pad.
- Free-standing, lockable NEMA 4X equipment cabinets will be provided. The cabinets will house the backflush pump control panel for the Injection Wells, and auxiliary power for miscellaneous lighting, loads, etc. Each cabinet will be mounted on a reinforced concrete pad.
- The control panels will operate the backflush pump motors that will be controlled by new PLC panels.
- The control panels will also provide branch-circuit connections to a light and a double-duplex receptacle within the Injection Well equipment cabinets.
- Conduit and conductors will be provided for connections of all equipment, instrumentation, and controls.

7.1.8 Constructability

The Construction Industry Institute (CII) defines “constructability” as the optimal use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives. In the context of the Morro Bay RWF Project, constructability (or buildability) is the measure of ease, efficiency, economy, and eco-friendliness with which the Injection Wells (and IPR Branch Pipelines) can be constructed. Factors determining project constructability include available contractors, available equipment, available materials, construction methodology, accessibility, permit conditions, and opportunity for construction innovation.

With regards to the injection piping alternatives, all alternatives are buildable. However, the availability of materials, and permit conditions appear to be the constructability factors that vary the most between the injection piping alternatives (as described further below). Other constructability factors appear to be relatively equal among the injection piping alternatives. In brief, the simpler the design, and fewer pieces of manufactured equipment involved, the higher the constructability.

7.2 Injection Well Downhole Configuration Alternatives & Above Ground Piping (Equipping)

Design of downhole and wellhead piping for injection wells can range from a very simple approach with limited control to a complex approach with several control features, and various hybrid options in between. For example, the injection flow rate can be controlled by a downhole flow control valve, modulating butterfly valve on the wellhead piping, injection tube with orifice plate, or small diameter downcomer pipe. Also, cleaning of the well screen can be accomplished by submersible pump backflush pumping or airlifting (air scour) with a permanently installed air lift pipe. Five different downhole injection piping alternatives have been identified and developed for the Morro Bay RWF Project, each capable of meeting the Project objectives.

1. Downhole Flow Control Valve and Pump System,
2. Downcomer and Pump System,
3. Downhole Flow Control Valve and Air Lift Pipe System,
4. Injection Tube and Air Lift Pipe System, and
5. Simple Downcomer System.

(Note that construction and O&M costs are typically proportional to the complexity of the design.)

7.2.1 Flow Control Valve & Pump System

The primary features of the flow control valve and pump injection piping system include a downhole flow control valve to provide back pressure and control the injection flow rate, and a submersible pump to backflush the well screen and gravel pack. Electrical service is required to power the submersible pump, FCV control panel, and electrically actuated valves. Features of the downhole piping at each Injection Well are listed below.

- 4” Diameter Column Pipe
- Water Level Transducer
- 4” Flow Control Valve
- Check Valve (on column pipe between FCV and pump)
- Submersible Well Pump (for backflushing)
- Submersible Motor (to power well pump)

The above-ground wellhead piping includes a tee (with branch line) and electrically actuated valves to alternate between injection mode and backflush mode. A facility to receive the backflush water is required. Features of the above-ground wellhead piping at each Injection Well are as follows.

- 4” Diameter Wellhead Piping
- 4” Isolation Gate Valves
- Three 4” Modulating Butterfly Valves
- 4” Silent Check Valves
- Two 1” Air Release Valves (to purge injection line of entrained air)
- 4” Pressure Sustaining Valve
- 2” Pressure Relief Valve (to dissipate pressure surges)
- Two 4” Meters (to record flushing, injection, and backflush volumes)
- Pressure Gauges, Pressure Switch, and Pressure Transmitter
- Sample Tap, Hose Bib Connection, and other minor appurtenances
- Sand Separator (if needed)

See **Appendix D** for injection well downhole configuration (profile), and **Appendix E1** for above-ground wellhead piping layout.

7.2.2 Downcomer & Pump System

The primary features of the downcomer and pump injection piping system include a small diameter downcomer injection pipe, and a submersible pump to backflush the well screen and gravel pack.

Injection occurs through the downcomer pipe that extends from the wellhead down the casing pipe to below the low water level. The downcomer pipe is 1.5” to 2” diameter based on the well’s injection capacity and designed to hang from a threaded coupling in the discharge head. Orifice plates are used inside the downcomer pipe to maintain back pressure. Electrical service is required to power the submersible pump, and electrically actuated valves. Features of the downhole piping at each Injection Well are listed below.

- 1.5” to 2” Diameter PVC Downcomer Injection Pipe (depending on maximum injection flow rate)
- 4” Diameter Column Pipe
- Water Level Transducer
- Submersible Well Pump (for backflushing)
- Submersible Motor (to power well pump)

The above-ground wellhead piping includes a tee (with branch line) and electrically actuated valves to alternate between injection mode and backflush mode. A facility to receive the backflush water is required. Features of the above-ground wellhead piping at each Injection Well are as follows.

- 4” Diameter Wellhead Piping
- 1.5” Diameter Wellhead Piping
- 1.5” Isolation Ball Valves
- 4” Isolation Gate Valves
- Three 4” Modulating Butterfly Valves
- 4” Silent Check Valves
- ½” and 1” Air Release Valves (to purge injection line of entrained air)
- 4” Pressure Sustaining Valve
- 2” Pressure Relief Valve (to dissipate pressure surges)
- 4” Meter (to record backflush and flushing volumes)
- 1.5” Turbine Meter (to record injection volumes)
- Pressure Gauges, Pressure Switch, and Pressure Transmitter
- Sample Tap, Hose Bib Connection, and other minor appurtenances
- Sand Separator (if needed)

See **Appendix D** for injection well downhole configuration (profile), and **Appendix E2** for above-ground wellhead piping layout.

7.2.3 Flow Control Valve & Air Lift Pipe System

The primary features of the flow control valve and air lift pipe injection piping system include a downhole flow control valve to provide back pressure and control the injection flow rate, a permanently installed air lift pipe to backflush and clean the well screen, and an air compressor. The air lift pipe is installed through the port of the flow control valve to an elevation a few feet below the bottom of the well screen. The air lift pipe includes a J tool at its tip to direct air flow upwards to maximize agitation and cleaning at the surface of the well screen. (Alternatively, the air lift pipe could be hung from a threaded coupling in the flange of the discharge head.)

Electrical service is required to power the FCV control panel, electrically actuated valves, and air compressor. A facility to receive the backflush water is required. The well casing pipe includes a backflush branch line that is connected to the upper section of the well casing and routed directly to the backflush facility. Features of the downhole piping at each Injection Well are listed below.

- Well Casing Pipe with backflush branch line (near top of casing)
- 4” Diameter Column Pipe
- Water Level Transducer
- 4” Flow Control Valve
- Air lift pipe with J tool tip

Features of the above-ground wellhead piping at each Injection Well are as follows.

- 4” Diameter Wellhead Piping
- 4” Isolation Gate Valves
- Three 4” Modulating Butterfly Valves
- 4” Silent Check Valves
- Two 1” Air Release Valves (to purge injection line of entrained air)
- 4” Pressure Sustaining Valve
- 2” Pressure Relief Valve (to dissipate pressure surges)
- Two 4” Meters (to record flushing, injection, and backflush volumes)
- Pressure Gauges, Pressure Switch, and Pressure Transmitter
- Sample Tap, Hose Bib Connection, and other minor appurtenances
- Sand Separator (if needed)

See **Appendix D** for injection well downhole configuration (profile), and **Appendix E3** for above-ground wellhead piping layout.

7.2.4 Injection Tube & Air Lift Pipe System

The primary features of the injection tube and air lift pipe injection piping system include an injection tube with orifice plate to provide back pressure, a modulating butterfly valve on the wellhead piping to control the injection flow rate, a permanently installed air lift pipe to backflush and clean the well screen, and an air compressor. Flow in the injection tube is restricted with an orifice plate. The air lift pipe is installed through the injection tube to an elevation a few feet below the well screen. The air lift pipe includes a J tool at its tip to direct air flow upwards to maximize agitation and cleaning at the surface of the well screen. (Alternatively, the air lift pipe could be hung from a threaded coupling in the flange of the discharge head.)

Electrical service is required to power the electrically actuated valves, and air compressor. A facility to receive the backflush water is required. The casing pipe includes a backflush branch line that is connected to the upper section of the casing and routed directly to the backflush facility. Features of the downhole piping at each Injection Well are listed below.

- Casing pipe with backflush branch line (near top of casing)
- 4” Diameter Injection Tube/Column Pipe
- Water Level Transducer
- Air lift pipe with J tool tip

Features of the above-ground wellhead piping at each Injection Well are as follows.

- 4” Diameter Wellhead Piping
- 4” Isolation Gate Valves
- Three 4” Modulating Butterfly Valves
- 4” Silent Check Valves
- Two 1” Air Release Valves (to purge injection line of entrained air)
- 4” Pressure Sustaining Valve
- 2” Pressure Relief Valve (to dissipate pressure surges)
- Two 4” Meters (to record flushing, injection, and backflush volume)
- Pressure Gauges, Pressure Switch, and Pressure Transmitter
- Sample Tap, Hose Bib Connection, and other minor appurtenances
- Sand Separator (if needed)

See **Appendix D** for injection well downhole configuration (profile), and **Appendix E4** for above-ground wellhead piping layout.

7.2.5 Simple Downcomer System

The primary features of the simple downcomer injection piping system are a modulating butterfly valve on the wellhead piping to control the injection flow rate, and a small diameter PVC downcomer pipe with orifice plate to provide back pressure. Injection occurs through the downcomer pipe that extends from the wellhead down the casing pipe to below the low water level. The downcomer pipe is 1.5” to 2” diameter based on the wells’ injection capacity and designed to hang from a threaded coupling in the discharge head. Alternatively, a column pipe can be utilized and reduced in size from 4” diameter to an appropriate size to allow injection through the column pipe (injection tube). Orifice plates are used inside the downcomer pipe to maintain back pressure.

This piping configuration will require periodic well screen cleaning (rehabilitation) in which the downcomer is removed, and the well screen and gravel pack are cleaned. Cleaning may include acid treatment, wire brushing, swabbing, and flushing. Because the small diameter downcomer pipe minimizes air entrainment, there is less potential for biological growth and precipitate formation. Well screen cleaning may only be needed about once every two years. Electrical service can be eliminated if desired, but a small electrical panel would be required to connect Injection Well instruments to the City’s SCADA system. Features of the downhole piping at each Injection Well are listed below.

- 1.5” to 2” Diameter PVC Downcomer Injection Pipe (depending on maximum injection flow rate)
- Water Level Transducer

The above-ground wellhead piping is greatly simplified and does not require a branch line for backflushing. Also, no facility is needed to convey backflush water. However, adequate space must be provided around the wellhead to accommodate the well rehabilitation equipment such as drill rig and tanks to contain the water flushed from the well during well screen cleaning. Water in the tanks must be neutralized before discharge to the City’s sewer collection system or Water Resources Center. Features of the above-ground wellhead piping at each Injection Well are as follows.

- 4” and 2” Diameter Wellhead Piping
- 4” Gate Valves

- 4” Modulating Butterfly Valves
- 2” Ball Valves
- (Optional 2” Combination Pressure Reducing/Pressure Sustaining Valve)
- Two 1” Air Release Valves (to purge injection line of entrained air)
- 4” Pressure Sustaining Valve
- 2” Pressure Relief Valve (to dissipate pressure surges)
- 2” Turbine Meter (to record flushing and injection volumes)
- Pressure Gauges, Pressure Switch, and Pressure Transmitter
- Sample Tap, Hose Bib Connection, and other minor appurtenances

See **Appendix D** for injection well downhole configuration (profile), and **Appendix E5** for above-ground wellhead piping layout.

7.3 Downhole Injection Piping Configuration Comparison

The advantages and disadvantages of the various downhole injection piping alternatives can be summarized based on four key evaluation criteria as defined below. As discussed in subsection 2.2.2, the ability of the Injection Well design to mitigate air entrainment is based on the inclusion of downhole or above ground flow control valves, and wellhead piping air release valves. All Injection Well designs will include wellhead piping air release valves, and the injection well designs that do not include a downhole FCV will include an above ground FCV. Therefore, the ability of the various downhole injection piping alternatives to mitigate air entrainment is considered equal, and not a factor in comparing the alternatives.

1. <u>Initial Construction Cost</u>. Initial construction costs are compared and scored based on the relative magnitude of scale of the costs. (The initial costs will also determine future facility replacement costs.)
2. <u>Flow Control Capability</u>. Relative ability of the system to modulate and control the injection flow rate.
3. <u>Long-Term Injection Capacity</u>. Relative ability of the system to clean the well screen and maintain the injection flow rate.
4. <u>Ongoing Operations and Maintenance Cost</u>. Relative ongoing operating costs (including items such as power consumption), and level of routine maintenance required

As noted in Chapter 2, the cost of a 185 CFM compressor is about the same as the cost of a 140-gpm submersible pump with 10 HP motor. Also, IW-1 and IW-3 are relatively close to each other, which would allow for a single compressor to serve both Injection Wells. These factors considered, the overall Project construction cost is about the same with submersible pumps or compressors at each well site. However, the compressor for an air lift system requires a larger motor than the equivalent submersible pump system and will result in higher ongoing power costs.

At sites where a small footprint is desired, a submersible pump system requires no additional space. In contrast, an air lift system at each site requires additional space because the air compressor is large. The footprint of a 185 CFM unit is approximately 4’ x 6’. In addition, compressors are noisy and may not be appropriate for all Injection Well locations. As noted in Section 2.4.5 above, well screen cleaning by submersible pump backflush pumping is the superior and recommended method.

As previously mentioned, the primary operational goal of the Project is to inject 412.5 AFY of IPR water by approximately June 2031. Therefore, added control of injection flow rates is an important consideration due to daily and seasonal fluctuations in IPR Water produced, and groundwater levels. A fabricated steel injection tube allows for smoother reducers/transitions and use of orifice plates and is considered to have slightly better flow control than a downcomer pipe. Although ongoing maintenance will impact the long-term injection capacity of each well, the initial design of the injection piping and ability of the facility to self-clean the well screen will also affect the long-term injection capacity.

The ongoing operations and maintenance costs are impacted by the following:

- Complexity of the system,
- Reliability/durability of the system,
- Power usage,
- Disposable materials needed,
- Equipment, maintenance and replacement,
- Life expectancy of the equipment, and
- Demand on operations staff time.

It is estimated that downhole rehabilitation (acid treatment and brushing) will be required every 10 years for the piping configurations that include a submersible pump or air lift pipe, and every 2 years for the Simple Downcomer System. For these shallow wells, downhole rehabilitation/cleaning is estimated to cost about $15,000/well.

A summary of the alternatives' evaluation is presented in Table 7-1 below. Note that an additional alternative that was not drawn in profile, the Downcomer with Air Lift System, is also listed and scored. A score of 1 through 10 was assigned to each criterion for each injection piping alternative. The higher the score the better the alternative. Where conditions are similar between alternatives for a particular criterion, an equal score is assigned. In Table 7-1 below, the blue shaded alternatives include full power to the site. The pale orange shaded alternative has no power provided to the site.

Table 7-1 Comparison of Downhole Injection Piping Alternatives

Comparison Criteria	FCV & Pump System	Downcomer & Pump System	FCV & Air Lift System	Inj. Tube & Air Lift System	Simple Downcomer System
Initial Construction Cost	5	7	5	6	10
Flow Control Capability	9	8	9	8	5
Long-Term Injection Capacity	9	9	6	6	4
O & M Cost	6	7	6	6	8
Total Score:	**29**	**31**	**26**	**26**	**27**

As indicated, based on the evaluation criteria, the top scoring alternatives is the Downcomer & Pump System, followed by the FCV & Pump System. The advantages of the Downcomer & Pump System versus the FCV & Pump System are:

- lower construction cost,
- less complex system and fewer moving parts resulting in higher reliability and uptime,
- City staff performed O&M vs. Vendor required O&M, and
- Custom piping design to fit the uniqueness of each site vs. using one-size-fits-all solution from FCV Manufacturer (4-inch is smallest valve size available)

Although lowest cost, the Simple Downcomer System has limited flow control capability, and is expected to have significantly lower long-term injection capacity. Achieving the City's Project goals would be most difficult with use of the Simple Downcomer System. Full power to the injection well sites allows for fully remote operation, maximizing annual injection volumes, and no staff operations time required to modulate valves and clean the well screens. The automated capability of well screen cleaning with the Downcomer & Pump System may encourage more frequent rather than less frequent well screen cleaning which may contribute to the long-term success of the Project. Cannon recommends the Downcomer & Pump System for the downhole injection piping configuration.

8. BACKFLUSH WATER DISPOSAL

8.1 Disposal Alternatives

Well backflushing for cleaning purposes is planned to be accomplished by either airlifting or pumping at each injection well. The backflush cleaning process was described in more detail in subsection 2.2.3 above. In either case, a backflush discharge will be generated and require a method of disposal.

At the planned maximum injection rate of 100 gpm, the recommended design backflushing rate is 2 times that of the average injection rate (i.e., upwards of 200 gpm), with a total backflush volume of approximately 3,500 gallons per backflushing event per well. The volume of backflush water generated by the air lift process is estimated to be approximately 2,160 gallons per airlifting event per well.

Four alternative methods of managing backflush discharges from the four new Injection Wells (IW-1, IW-3, IW-4, and IW-7) have been evaluated. The four alternatives are described in the following subsections. Each alternative has advantages and disadvantages as summarized in Table 8-1 below.

8.1.1 Alternative B1 – Sanitary Sewer System

Discharging the backflush water to the City sanitary sewer system has three primary advantages: 1) the discharge is controlled by the City and an additional permit is not required, 2) the backflush water will be treated and recycled, and 3) a gravity sewer connection is a low maintenance option. A gravity sewer connection at each injection well will require construction of a discharge pipe for the backflush water, an inlet structure with air gap, and sewer lateral.

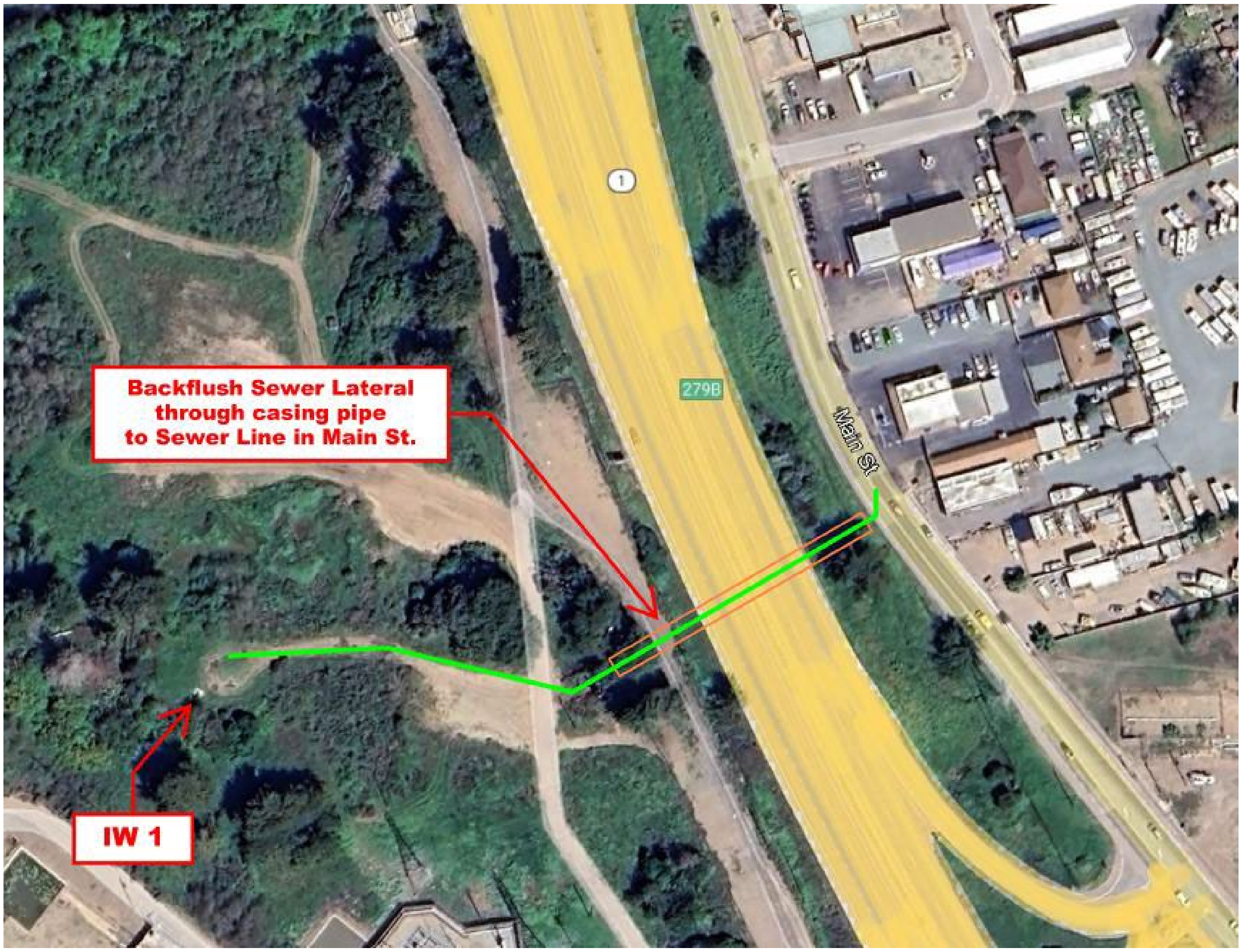
Discharge of backflush water from IW-1, and IW-3 to the City sanitary sewer system by gravity appears to be possible directly to the east, and to the south. The easterly route to connect to the existing sewer system is more feasible and would require approximately 720 feet of 6” diameter sewer lateral, 280 feet of 14” diameter steel casing pipe under the bike/ped path and Highway 1, and connection to the existing 12” VCP gravity sewer at Manhole 13.34 in Main Street approximately 400 feet south of Preston Lane. This route would require an Encroachment Permit from Caltrans. The backflush sewer lateral would need to run at minimum slope to clear underneath the recently constructed IPR Conveyance Pipeline, and Force Mains 1 and 2. Additional potholing of existing utility lines would be required to confirm feasibility. See Figure 8-1 below.

The backflush discharge flow rate is 140 gpm. Although the capacity of the existing sewer line in Main Street would need to be verified, it does not appear that sewer line capacity would be a problem. Based on diurnal fluctuations in sewer flow rate, it appears the timing of the backflush discharge could be adjusted to coincide with low flow periods.

The southerly route to connect IW-1 and IW-3 to the existing sewer system appears to be cost prohibitive and may require an easement. The southerly route would require approximately 1,450 feet of 6” diameter sewer lateral and sleeving the last 325 feet through the old 8” cast iron pipe (CIP) force main that runs from the bike/ped path under Hwy 1.

A third option to connect IW-1 and IW-3 to the existing sewer system would require 400 feet of 4” sewer lateral extending from IW-1 and IW-3 to a small, packaged sewer lift station, approximately 100 feet of 4” force main, and connection to the sewer force main along the bike/ped path to the east. Although feasible, due to the added capital cost, complexity, and maintenance burden, this option is considered impractical.

Figure 8-1 Backflush to the Sanitary Sewer System



The backflush discharge flow rate is 140 gpm. Although the capacity of the existing sewer line in Main Street would need to be verified, it does not appear that sewer line capacity would be a problem. Based on diurnal fluctuations in sewer flow rate, it appears the timing of the backflush discharge could be adjusted to coincide with low flow periods.

For IW-4 and IW-7, connection and discharge of spent backflush water to the existing 18” PVC gravity sewer line in Embarcadero Road is feasible. Connection of IW-4 would require a small package pump station, sewer manhole, and approximately 640 feet of 4” diameter sewer force main. Connection of IW-7 would require approximately 360 feet of 6” diameter sewer lateral at a slope of approximately 1 percent. There are other existing sewer laterals in closer proximity to IW-4 and IW-7. For IW-4, the recommended approach is to install a new manhole on the existing sewer lateral west of the fisherman’s storage area, and terminate the new 4” force main at that point. Direct connection to the existing 18” sewer line in Embarcadero Road is the recommended approach for IW-7. Additional potholing of existing utility lines would be required to confirm feasibility.

8.1.2 *Alternative B2 – Storm Drain System*

Discharge of spent backflush water to the municipal storm drain system is a low maintenance option but would be subject to the City's NPDES Permit conditions. The backflush discharge piping will require an air gap prior to discharge to the storm drain system, and a baffled settling tank may also be needed prior to discharge to remove any silt. The spent backflush water would not be percolated into the groundwater basin and would instead flow to the Pacific Ocean.

There are no municipal storm drain facilities located near Injection Wells IW-1, IW-3, and IW-4. The nearest municipal storm drain pipelines are located on the east side of Highway 1, or the opposite side of Morro Creek. Therefore, due to distance and depth of existing storm drain lines (gravity flow constraints), discharge to the storm drain system for these Injection Wells is not feasible. Surface discharge and drainage to the adjacent creeks is not recommended. Based on Cannon's experience, permitting agencies prefer other methods of discharge whenever other feasible alternatives exist.

The City has a 24" RCP storm drain line that runs through the middle of the Morro Dunes RV Park approximately 80 feet away from the proposed IW-7 site. Discharge of spent backflush water to the existing 24" storm drain line is feasible. Additional potholing of existing utility lines would be required to confirm feasibility.

8.1.3 *Alternative B3 – Infiltration Basins*

Percolation testing conducted by GSI indicates that infiltration rates near the Project site are generally high, and that surface percolation is a feasible alternative for disposal of backflush water. The advantages of shallow infiltration basins are: 1) spent backflush water is returned to the ground, 2) simple, low-maintenance operation, and 3) requires minimal piping and appurtenances.

GSI's field infiltration testing used a maximum submerged depth of two feet. Using a 2 feet depth, and a worst-case backflush volume of 3,500 gallons (468 CF) a basin measuring 12 feet by 26 feet would be required to capture one full backflush with 6" of freeboard. As noted, infiltration basins require a large amount of area. With ample space available at the IW-1 and IW-3 sites, infiltration basins are a feasible backflush disposal alternative.

Because the infiltration basins would be percolating the same treated water as the Injection Wells, it may be possible to have them both approved simultaneously by DDW and RWQCB. However, the infiltration basins are easily accessible to birds and amphibians which could lead to undesirable environmental issues.

Due to significant space constraints at the IW-4 and IW-7 sites, infiltration basins are not a feasible alternative for backflush water disposal.

8.1.4 *Alternative B4 – Drywells with French Drains*

A stormwater drywell is a gravity-fed manhole with perforated walls, and gravel filled bottom, designed to allow for infiltration of the water fed to the drywell. Drywells are usually constructed deep enough to reach permeable soil layers allowing for infiltration. Addition of a perforated pipe (French drain) system to a drywell makes it feasible in a broader range of conditions, expands its functionality, and allows for a shallower drywell.

For the Morro Bay Injection Wells, this backflush disposal alternative consists of constructing 6 feet diameter drywells to a depth of approximately 6 feet with approximately 400 feet of 8" diameter French drain line extending from the drywell. The advantages of the drywell backflush disposal alternative include: 1) simple low maintenance operation, 2) spent backwash is percolated back to the groundwater basin, and 3) feasible where connection to the sanitary sewer system is infeasible or cost prohibitive.

Due to the amount of available space, this backflush disposal alternative is feasible for IW-1 and IW-3. Because these Injection Wells will be located within approximately 360 feet of each other, an 8" diameter French drain system can be connected between them at a depth of approximately 3 feet. The French drain will link the two drywells together such that when one injection well is backflushing it will effectively have the percolation capacity of the French drain system and both drywells. The drywell with French drain backflush disposal alternative is recommended for IW-1 and IW-3.

Although not recommended, the drywell with French drain backflush disposal alternative is also feasible for IW-4 with French drain routed for about 400 feet along the access driveway. Due to space constraints, and the current use of the Morro Dunes RV Park, the drywell with French drain backflush disposal alternative is not suited for the IW-7 site.

Available regulatory information and guidelines for drywell construction and permitting mostly apply to the infiltration of stormwater runoff. Based on their dimensions, stormwater drywells fall under the US EPA Region 9 Underground Injection Control regulations and are considered Class V injection wells. Although there are no statewide permitting requirements for the use of drywells, the City's NPDES permit guidelines associated with infiltration chambers are applicable.

8.2 Recommended Backflush Disposal Alternative

Each injection well site is unique and has specific site constraints that determine what backflush disposal alternatives are feasible, and associated cost. Therefore, the backflush disposal recommendations, summarized in Table 8-1 below, are tailored for each injection well site considering feasibility and cost.

Table 8-1 Backflush Disposal Recommendations

Injection Well Site	Recommendation	Alternate Recommendation	Notes
IW-1	Drywell with French Drain	Connection to Sanitary Sewer	400' French drain shared with IW-3
IW-3	Drywell with French Drain	Connection to Sanitary Sewer	400' French drain shared with IW-1
IW-4	Connection to Sanitary Sewer	Drywell with French Drain	18" PVC sewer in Embarcadero Rd
IW-7	Connection to Sanitary Sewer	Connection to Storm Drain	18" PVC Sewer in Embarcadero Rd

9. EQUIPMENT PROCUREMENT

9.1 Special Funding Requirements

The City of Morro Bay has been awarded three grants, and two low interest loans to assist the City in completing the RWF Project as follows.

- Federal grant under the Title XVI grant program,
- US Bureau of Reclamation (USBR) Federal grant,
- State grant under the California Department of Water Resources, Integrated Regional Water Management (IRWM) grant program,
- Environmental Protection Agency (EPA) Federal loan under the Water Improvements for the Nation Act of 2016 (WIFIA Loan), and
- State Revolving Fund (SRF) loan through the California State Water Resources Control Board.

The Build America, Buy America (BABA) Act which went into effect in May 2022 requires that all iron, steel, manufactured products, and construction materials used in an infrastructure project receiving Federal financial assistance are produced in the United States. However, the City may seek waivers from BABA requirements based on the dates that the project funding agreements were executed, and design planning was initiated. Although BABA requirements may be waived, receipt of Federal financial assistance still makes the project subject to provisions of the American Iron and Steel (AIS) provision of the 2021 Infrastructure Law.

It is anticipated that materials and manufactured products subject to BABA for this project will include well casing and well screen, pipe and appurtenances, pumps, electrical wiring and panels, and control systems. A more comprehensive listing will be prepared at the 60% design phase. Under BABA, the United States Environmental Protection Agency (EPA) requires that the manufacturer of each of these products prepare a document certifying that that they were produced in the United States.

The AIS provision of the 2021 Infrastructure Law requires that all SRF and WIFIA funded projects use iron and steel products that are produced in the United States. Since the RWF Project is being funded in part with Federal funding, the AIS provision will apply to this Project. Similar to BABA, the EPA requires that the manufacturer of each of these products prepare a document certifying that that they were produced in the United States. The EPA published a memorandum dated March 20, 2014, defining iron or steel products that must comply with AIS provision, and stating:

..."*one of the following made primarily of iron or steel that is permanently incorporated into the public water system or treatment works:*

- *Lined or unlined pipes or fittings;*
- *Manhole Covers;*
- *Municipal Castings;*
- *Hydrants;*
- *Tanks;*
- *Flanges;*
- *Pipe clamps and restraints;*
- *Valves;*
- *Structural steel;*
- *Reinforced precast concrete; and*
- *Construction materials* "

9.2 Owner Furnished Materials and Equipment Strategy

The RWF Project will include and require several items from the EPA list such as steel pipe, fittings, manhole covers, valves, pipe supports, and electrical cabinets. Therefore, the BABA provision will impact the Project. However, the impact will vary depending if the items are more common and readily available, or if the items have a long lead time. The impact will be insignificant for common items that are readily available.

Once the design has reached the 60% complete stage, and products have been specified in sufficient detail, the impact (if any) of the BABA provision on the Project schedule associated with securing long lead items will be evaluated. Once the preliminary specifications have been prepared, a survey will be conducted regarding the availability of long lead items from US manufacturers. If there are problems with availability or pricing, potential solutions will be identified such as: 1) specifying alternative materials and products that meet BABA requirements and are more readily available, 2) pre-purchasing items with long lead times, and 3) request formal waiver from Federal requirements. In some circumstances, USBR or EPA may waive BABA requirements through an application process followed by a 15-day public comment period. It is also noted that at this time the City has not indicated any owner's preferences that would be in conflict with the BABA provision.

The primary reasons for owner furnished materials and equipment are to shorten project construction schedules and save money. Cost savings are experienced when an owner pre-purchases major materials and/or equipment and avoids the contractor's markup, which is commonly around 10% to 15%. When projects involve materials and/or equipment with long lead times, project construction schedules can be shortened when an owner pre-purchases such items prior to the design being completed and project being advertised for bids.

The primary disadvantages of owner pre-purchased materials and equipment are increased owner liability and risk. If the materials arrive damaged or defective, the cost of rectifying the problems, and the effect this may have on the project schedule fall on the owner. Owner furnished equipment and materials have a high potential for causing claims. Late deliveries, defects, and non-compliance with the contract requirements can delay and disrupt the project, which in turn will lead to claims for the costs of corrective or additional work, and schedule extensions. It only takes one serious claim to quickly evaporate any owner pre-purchasing savings achieved.

Owners must also be careful of unintended consequences. A contractor's markup is more likely to increase when purchasing requirements are minimal, as this becomes the only avenue for achieving a profit. Contractors are experienced at purchasing construction equipment and materials. They are aware of the necessary delivery schedules, degree of assembly, installation needs, and other physical requirements of a project. In choosing to supply their own materials and equipment, an owner is not benefiting from the contractor's expertise, and instead is taking on additional responsibility, and liability.

9.3 Long Lead Items

Based on the current conceptual level of Project detail, only a few items with long lead items are anticipated to be included in the Project:

- Electrical Panels
- Motor Control Centers/Control Panels

Because items such as the rotary-screw compressors, Baski Flow Control Valves, small submersible pumps, small submersible motors, flow meters, and electric vale operators have lead times less than 6 months, purchase and delivery of these items should not impact the Project schedule.

9.4 Procurement Recommendations

Regarding the design phase schedule, it is not expected that the design will be completed to sufficient degree to allow for confident owner pre-purchasing far enough in advance of the Project bidding and construction start, to achieve more than 3 months maximum time savings. In addition, for the RWF Project, the disadvantages of owner pre-purchasing of materials and equipment appear too far out to weigh the cost savings benefit. Therefore, for these reasons, owner pre-purchase of materials and equipment is not recommended.

10. PRELIMINARY COST OPINION

Chapter 10 provides preliminary construction cost opinions for: 1) the IPR Branch Pipelines (Alignment Alternative 1), and 2) the Downcomer & Pump System Injection Well Construction and Equipping. The construction cost estimates presented are preliminary and based on a conceptual level of design detail. Therefore, as defined by the Association for the Advancement of Cost Engineering (AACE), the construction cost estimates are considered Class 4 estimates with an accuracy range of -20% to +30%. A +25% contingency is applied to the estimates. The construction cost estimates are summarized below, and the detailed cost estimates are included in **Appendix F**.

10.1 IPR Branch Pipelines Construction Cost

- Retrofit of the Desal Feedwater Line $ 486,000
- IPR Branch Pipelines $ 1,864,000
- Total Construction Cost (including contingency) **$ 2,350,000**

Our rough estimate of the construction cost to retrofit of the IPR Pump Station if modifications are determined necessary is around $100,000.

10.2 Downcomer & Pump System Injection Well Construction and Equipping Cost

- Total Construction Cost (including contingency) **$ 6,162,000**
- Approximate Cost per Injection Well (Total $/3.5) $ 1,761,000

In addition to the cost above, up to 8 monitoring wells will be required as part of the Groundwater Replenishment Reuse Project (GRRP) Permit to be issued for the RWF Project by RWQCB and DDW. This would be two monitoring wells per injection well. The estimated construction cost of up to 8 monitoring wells is approximately $200,000.

11. CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

Key Conclusions of the Conceptual Design Phase are summarized as follows:

1. The ability of the Injection Wells to meet the operational goal of the Initial and Final Phases is dependent upon the ability of the RO Treatment System to supply a relatively steady flow rate to the IPR Pump Station.
2. Cannon estimates the average annual injection efficiency will be 86%. Therefore, the required Initial Phase and Final Phase cumulative average operating injection rates are 300 gpm and 600 gpm, respectively.
3. The long-term, continuous injection capacities per well are expected to range from 45 gpm to 90 gpm, with an average capacity of approximately 75 gpm per well.
4. Additional air purging along the existing IPR Conveyance Pipeline is needed. See recommendations in Section 11.2 below.
5. The IPR Product Water Pump Station consists of three pumps, each equipped with a variable frequency drive (VFD). The design point for each pump of the IPR Pump Station is 323 gpm at 37 feet TDH at full speed of 1,775 rpm (or 300 gpm @ 39' TDH).
6. Based on a low water level of 110.00 feet in the IPR Storage Tank, and one pump running at 300 gpm at 39 feet TDH, the IPR Pump Station will have a discharge HGL of 149 feet. The IPR Conveyance Pipeline has a spring line elevation of 148.66 feet at the Bella Vista Street high point. The IPR Pump Station is unable to deliver flows up and over the Bella Vista high point. Only when the IPR Storage Tank operating level is 114 feet and above is the IPR Pump Station able to overcome the Bella Vista high point and deliver flow to the Injection Wells. This means the IPR Storage Tank must remain at least half-full (above 115 feet) at all times for the IPR Pump Station to be able to deliver IPR water.
7. Adequate injection flow rate modulation is accomplished by either downhole flow control valves, or electrically actuated butterfly valves as part of the wellhead piping.
8. Better routine Injection Well backflushing can be accomplished by submersible pump backflush pumping, rather than airlifting.
9. Backflushing with a submersible pump would require a pump design point of approximately 140 gpm at 163' TDH, and a 10 HP submersible motor.
10. For periodic cleaning of the well screen, a submersible pump system offers the following advantages over an air lift system: lower operating cost, no staff time required to backflush the well screen, no Air Quality Management District (AQMD) permit requirements, smaller footprint, and less noise.
11. The Injection Wells will be operated and maintained to maximize the injection rate and the total volume of IPR water injected annually. A modulating valve at each well will allow the injection rate to vary based on the aquifer's ability to receive IPR water at any given time. Injection Well operation may be controlled by water level, casing pressure, and/or desired injection rate.

12. The existing segments of 12" Yelomine PVC pipeline and 12" C900 PVC pipeline that are being considered for re-purposing are in relatively good condition, and of sufficient pressure class to function as IPR Branch Lines.

13. Based on the capabilities of the existing IPR Pump Station, there is not adequate pressure in the IPR Branch Pipelines for recycled water irrigation meters at Lila Keiser Park, and Morro Bay High School. To provide adequate pressure for irrigation purposes, the IPR pumps would need to be replaced with pumps capable of delivering 700 gpm at approximately 120 feet TDH or each end-user connection would need its own booster pumping station.

14. Construction of Segment 5A by HDD methods appears feasible if the alignment of the existing easement can be adjusted to accommodate the sweeping alignment of HDD construction.

15. One additional alignment alternative (Alternative 4) was identified as a new Segment 11, which is a variation of Segment 10. Segment 11 connects to the IPR Conveyance Pipeline near its northerly terminus along the Bike/Ped Path, then extends under Morro Creek (and surrounding riparian area) by HDD methods. Segment 11 would require adjustment of the existing easement. Alternative 4 involves significantly more new piping than Alternative 1. As such it is much more expensive than Alternative 1 and not considered further.

16. Based on the identified evaluation criteria, Alignment Alternative 1 (including HDD of Segment 5A) is far superior to Alignment Alternatives 2 and 3.

17. There are three waterworks valves on the market designed to maintain injection line pressure and prevent freefalling of water down the casing (and associated air entrainment): the Baski - InFlex Flow Control Valve, the 3R Valve - Flow Control Valve, and the ASR Resources - V-Smart BIC-V Injection Control Valve.

18. When comparing the downhole Flow Control Valves based on relevant criteria, the Baski – InFlex Valve is considered the best for this project. The Baski – InFlex Valve and ASR Resources V-Smart valve are considered superior to the 3R Valve. The Baski InFlex Valve has significantly lower capital cost than the ASR Resources V-Smart Valve and 3R Valve and comes with a 5-year warranty. The ASR Resources V-Smart Valve and 3R Valve only offer a 1-Year warranty. However, due to the low capacity of the proposed Morro Bay injection wells, the more common (and less costly) approach of using downcomers with orifice plates is recommended.

19. The experience of OCWD and other agencies has demonstrated that properly sized and designed downcomers and injection tubes, with modulating butterfly valves to control injection rates, perform comparable to expensive downhole flow control valves for injection wells. Therefore, use of expensive downhole flow control valves for the RWF Project is not necessary.

20. Five different injection well piping and equipping alternatives have been identified and developed for the RWF Project, each capable of meeting the City's Project objectives:
    a. Flow Control Valve & Pump System,
    b. Downcomer & Pump System (with and without permanent power),
    c. Flow Control Valve & Air Lift Pipe System,
    d. Injection Tube & Air Lift Pipe System, and
    e. Simple Downcomer System.

21. Based on the evaluation criteria, the Downcomer & Pump System is the top scoring alternative.

22. Well backflushing and cleaning is planned to be accomplished by submersible pump backflush pumping at each injection well.

23. Four alternative methods for disposal of the backflush discharge from the four new Injection Wells have been evaluated including discharge to: Sanitary Sewer System, Strom Drain System, Infiltration Basins, and Drywell with French Drain. Connection to the sewer system, and drywells with French drains are the best disposal methods for the injection wells for the initial phase of this project.

11.2 Project Recommendations

Based on the analysis, and alternatives evaluations of the Conceptual Design Phase, our Project recommendations are as follows:

1. It is recommended that two existing air release valves on the IPR Conveyance Pipeline be replaced with <u>combination</u> air valves, and four new combination air valves be added at the identified locations.

2. To mitigate air entrainment in the IPR Conveyance Pipeline, a minimum pipeline pressure of approximately 5 psi (12 feet of head) is recommended at the Bella Vista Street high point.

3. We recommend re-purposing the existing 12” Yelomine PVC pipeline, and 12” C900 PVC pipeline as IPR Branch Pipelines. We also recommend adding 1” combination air valves and 4” Blowoffs (or Fire Hydrants) at key points along the pipeline.

4. The recommended pipe cleaning approach for the existing 12” Yelomine PVC pipeline is a two-step approach including chemical treatment, followed by high velocity flushing.

5. Use of IPR water for irrigation purposes at Lila Keiser Park and Morro Bay High School is not recommended because there is insufficient IPR Pipeline pressure, and it is not cost effective.

6. Cannon recommends Alignment Alternative 1 for the IPR Branch Lines with 10” HDPE piping through Segments 4, 5A, and 6.

7. The recommended wellhead piping diameter at all Injection Wells is 4 inches.

8. The Downcomer & Pump System is the recommended Injection Well equipping configuration. Full power and SCADA automation to the injection well sites allows for fully remote operation, maximizing annual injection volumes, and no staff operations time required to modulate valves and clean the well screens.

9. Preliminary sizing of the submersible pump for the Downcomer and Pump System is 140 gpm at 163’ TDH, with a 10 HP submersible motor.

10. For managing backflush discharges, the drywell with French drain system is recommended for IW-1 and IW-3, and for IW-4 and IW-7 connection and discharge to the sewer system is recommended.

11. Owner pre-purchase of materials and equipment is not recommended, because it is not expected that the design will be completed to sufficient degree to allow for confident owner pre-purchasing far enough in advance of the Project bidding and construction start, to achieve more than 3 months maximum time savings, and the increased owner liability and risk appear too far out to weigh the minor cost savings benefit.

12. Construction (drilling and casing) and testing of two (2) or three (3) new Injection Wells is expected to be completed by late Fall 2026. This CDR, and any new data obtained from testing of the new Injection Well, will be used as the basis for the detailed design of the Project.

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City of Morro Bay – WRF IPR Alignment Alternatives Feasibility Assessment, Waterworks Engineers, March 2024

City of Morro Bay Sewer Operator Map Book, Public Works Department, May 2024

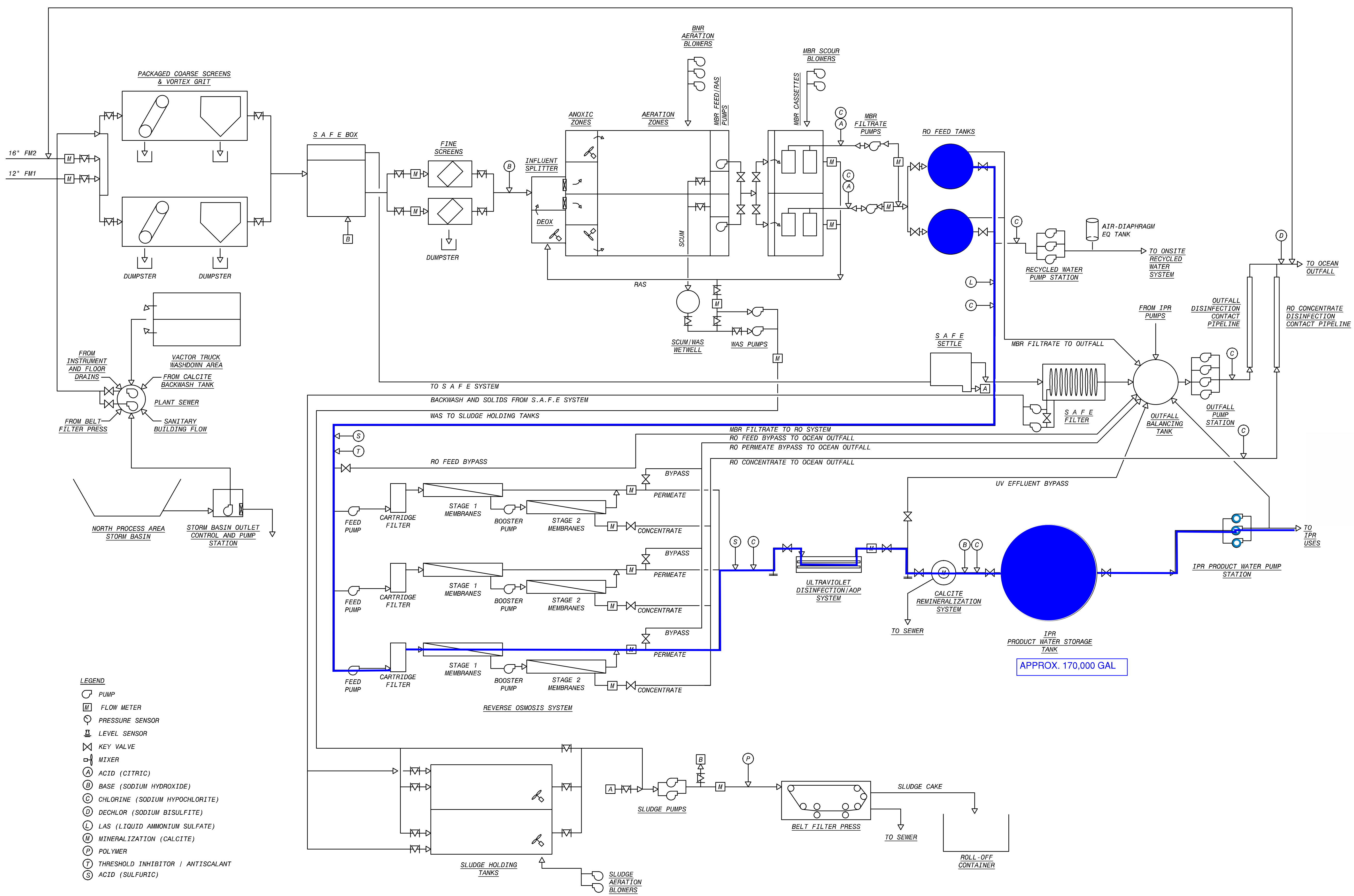
Morro Bay Injection Well IW-1 Backwash Operations Summary, GSI Water Solutions, May 2025

TECHNICAL APPENDICES

The following technical appendices are included:

- Appendix A - Water Resources Center General Process Schematic
- Appendix B - Excel Hydraulic Modeling of the IPR Conveyance Pipeline
- Appendix C - IPR Alignment Alternatives Feasibility Assessment, Water Works Engineers, March 2024
- Appendix D - Injection Well Downhole Configurations (Profiles)
- Appendix E1 - Flow Control Valve & Pump System - Wellhead Piping Layout
- Appendix E2 - Downcomer & Pump System - Wellhead Piping Layout
- Appendix E3 - Flow Control Valve & Air Lift System - Wellhead Piping Layout
- Appendix E4 - Injection Tube & Air Lift System - Wellhead Piping Layout
- Appendix E5 - Simple Downcomer System - Wellhead Piping Layout
- Appendix F - Detailed Construction Cost Estimates

APPENDIX A - Water Resources Center General Process Schematic



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JOINT VENTURE
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FILANC

CITY OF MORRO BAY
MORRO BAY WATER RECLAMATION FACILITY (WRF)

GENERAL PROCESS SCHEMATIC

DESIGNED: EVB, KEZ
DETAILED: MAK
CHECKED: EVB
APPROVED: EVB
DATE: 08/2023

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PROJECT NO. 400530

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CONFORMED TO CONSTRUCTION RECORDS

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APPENDIX B - Hydraulic Modeling of the IPR Conveyance Pipeline

Initial Phase: 300 gpm with 149' HGL

Alignment Alternative 3

Flow Path to IW-1, IW-3

Pipeline Segment	Segment A	Segment B	Segment C	Segment Ds	Segment 4
	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	300	300	300	165	165
Inside Diameter, in	11.16	10.29	9.41	9.41	5.72
Manning's "n"	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	2,200	450
Velocity, ft/s	0.98	1.16	1.38	0.76	2.06
hf, ft	0.45	2.72	4.68	0.61	1.77
HGL, ft (u/s end)	149.00	148.55	145.83	141.16	140.55
HGL, ft (d/s end)	148.55	145.83	141.16	140.55	138.77
Ground Elev. , ft (d/s end)	65	149	45	21	20
Residual Pressure, psi (d/s end)	36.2	(1.4)	41.6	51.8	51.4
Maximum Static Pressure, psi (d/s end)	36.4	-	45.0	55.4	55.8

Flow Path to IW-4 and IW-7 and Future IWs

Pipeline Segment	Segment A	Segment B	Segment C	Segment 1	Segment 3A	Segment 6	Segment 7A
	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	300	300	300	135	135	70	65
Inside Diameter, in	11.16	10.29	9.41	9.41	11.73	5.58	11.73
Manning's "n"	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	3,110	2,300	710	2,130
Velocity, ft/s	0.98	1.16	1.38	0.62	0.40	0.92	0.19
hf, ft	0.45	2.72	4.68	0.58	0.13	0.58	0.03
HGL, ft (u/s end)	149.00	148.55	145.83	141.16	140.58	140.45	140.45
HGL, ft (d/s end)	148.55	145.83	141.16	140.58	140.45	139.87	140.42
Ground Elev. , ft (d/s end)	65	149	45	12	15	15	17
Residual Pressure, psi (d/s end)	36.2	(1.4)	41.6	55.7	54.3	54.1	53.4
Maximum Static Pressure, psi (d/s end)	36.4	-	45.0	59.3	58.0	58.0	57.1

Total Q, gpm	300
HGL, ft (u/s end)	149
Percentage of Seg C going to Seg 1 and 3A	45.0%
Percentage of Seg C going to Seg D and 4	55.0%
Inject Well 1, gpm	90
Inject Well 3, gpm	75
Inject Well 4, gpm	70
Inject Well 7, gpm	65
Future Injection Wells, gpm	300

Alignment Alternative 1

Flow Path to IW-1, IW-3, IW-4, IW-7 and Future Wells

Pipeline Segment	Segment A	Segment B	Segment C	Segment Ds	Segment 4	Segment 5A	Segment 6	Segment 7A
	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	300	300	300	300	225	135	65	65
Inside Diameter, in	11.16	10.29	9.41	9.41	9.06	9.06	9.06	11.73
Manning's "n"	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	2,200	450	950	710	2,130
Velocity, ft/s	0.98	1.16	1.38	1.38	1.12	0.67	0.32	0.19
hf, ft	0.45	2.72	4.68	2.02	0.28	0.22	0.04	0.03
HGL, ft (u/s end)	149.00	148.55	145.83	141.16	139.14	138.86	138.64	138.60
HGL, ft (d/s end)	148.55	145.83	141.16	139.14	138.86	138.64	138.60	138.58
Ground Elev. , ft (d/s end)	65	149	45	21	20	15	15	17
Residual Pressure, psi (d/s end)	36.2	(1.4)	41.6	51.1	51.5	53.5	53.5	52.6
Maximum Static Pressure, psi (d/s end)	36.4	-	45.0	55.4	55.8	58.0	58.0	57.1

Total Q, gpm	300
HGL, ft (u/s end)	149
Percentage of Seg C going to Seg D and 4	100.0%
Inject Well 1, gpm	90
Inject Well 3, gpm	75
Inject Well 4, gpm	70
Inject Well 7, gpm	65
Future Injection Wells, gpm	300

Indicates Bella Vista Street High Point.

Indicates minimum normal operating HGL at IPR Pump Station discharge.

IPR Storage Tank minimum normal operating level of 110.00 plus 300 gpm at 39 feet TDH.

Segment Ds = the portion of Segment D to Segment 4.

Initial Phase: 165 gpm with 149' HGL

Alignment Alternative 3

Flow Path to IW-1, IW-3

Pipeline Segment	Segment A	Segment B	Segment C	Segment Ds	Segment 4
	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	165	165	165	91	91
Inside Diameter, in	11.16	10.29	9.41	9.41	5.72
Manning's "n"	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	2,200	450
Velocity, ft/s	0.54	0.64	0.76	0.42	1.13
hf, ft	0.14	0.82	1.41	0.18	0.54
HGL, ft (u/s end)	149.00	148.86	148.04	146.63	146.44
HGL, ft (d/s end)	148.86	148.04	146.63	146.44	145.91
Ground Elev. , ft (d/s end)	65	149	45	21	20
Residual Pressure, psi (d/s end)	36.3	(0.4)	44.0	54.3	54.5
Maximum Static Pressure, psi (d/s end)	36.4	-	45.0	55.4	55.8

Flow Path to IW-4 and IW-7 and Future IWs

Pipeline Segment	Segment A	Segment B	Segment C	Segment 1	Segment 3A	Segment 6	Segment 7A
	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	165	165	165	74	74	9	4
Inside Diameter, in	11.16	10.29	9.41	9.41	11.73	5.58	11.73
Manning's "n"	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	3,110	2,300	710	2,130
Velocity, ft/s	0.54	0.64	0.76	0.34	0.22	0.12	0.01
hf, ft	0.14	0.82	1.41	0.17	0.04	0.01	0.00
HGL, ft (u/s end)	149.00	148.86	148.04	146.63	146.45	146.41	146.41
HGL, ft (d/s end)	148.86	148.04	146.63	146.45	146.41	146.40	146.41
Ground Elev. , ft (d/s end)	65	149	45	12	15	15	17
Residual Pressure, psi (d/s end)	36.3	(0.4)	44.0	58.2	56.9	56.9	56.0
Maximum Static Pressure, psi (d/s end)	36.4	-	45.0	59.3	58.0	58.0	57.1

Total Q, gpm	165
HGL, ft (u/s end)	149
Percentage of Seg C going to Seg 1 and 3A	45.0%
Percentage of Seg C going to Seg D and 4	55.0%
Inject Well 1, gpm	90
Inject Well 3, gpm	75
Inject Well 4, gpm	70
Inject Well 7, gpm	65
Future Injection Wells, gpm	300

Alignment Alternative 1

Flow Path to IW-1, IW-3, IW-4, IW-7 and Future Wells

Pipeline Segment	Segment A	Segment B	Segment C	Segment Ds	Segment 4	Segment 5A	Segment 6	Segment 7A
	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	165	165	165	165	90	0	-70	-70
Inside Diameter, in	11.16	10.29	9.41	9.41	9.06	9.06	9.06	11.73
Manning's "n"	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	2,200	450	950	710	2,130
Velocity, ft/s	0.54	0.64	0.76	0.76	0.45	-	(0.35)	(0.21)
hf, ft	0.14	0.82	1.41	0.61	0.05	-	0.04	0.03
HGL, ft (u/s end)	149.00	148.86	148.04	146.63	146.02	145.97	145.97	145.93
HGL, ft (d/s end)	148.86	148.04	146.63	146.02	145.97	145.97	145.93	145.90
Ground Elev. , ft (d/s end)	65	149	45	21	20	15	15	17
Residual Pressure, psi (d/s end)	36.3	(0.4)	44.0	54.1	54.5	56.7	56.7	55.8
Maximum Static Pressure, psi (d/s end)	36.4	-	45.0	55.4	55.8	58.0	58.0	57.1

Total Q, gpm	165
HGL, ft (u/s end)	149
Percentage of Seg C going to Seg D and 4	100.0%
Inject Well 1, gpm	90
Inject Well 3, gpm	75
Inject Well 4, gpm	70
Inject Well 7, gpm	65
Future Injection Wells, gpm	300

Indicates Bella Vista Street High Point.
Indicates minimum normal operating HGL at IPR Pump Station discharge.
IPR Storage Tank minimum normal operating level of 110.00 plus 300 gpm at 39 feet TDH.
Segment Ds = the portion of Segment D to Segment 4.

Initial Phase with Retrofit IPR Pump Station: 300 gpm with 164' HGL

Alignment Alternative 3

Flow Path to IW-1, IW-3

Pipeline Segment	Segment A	Segment B	Segment C	Segment Ds	Segment 4
	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	300	300	300	165	165
Inside Diameter, in	11.16	10.29	9.41	9.41	5.72
Manning's "n"	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	2,200	450
Velocity, ft/s	0.98	1.16	1.38	0.76	2.06
hf, ft	0.45	2.72	4.68	0.61	1.77
HGL, ft (u/s end)	164.00	163.55	160.83	156.16	155.55
HGL, ft (d/s end)	163.55	160.83	156.16	155.55	153.77
Ground Elev. , ft (d/s end)	65	149	45	21	20
Residual Pressure, psi (d/s end)	42.7	5.1	48.1	58.2	57.9
Maximum Static Pressure, psi (d/s end)	42.9	6.5	51.5	61.9	62.3

Flow Path to IW-4 and IW-7 and Future IWs

Pipeline Segment	Segment A	Segment B	Segment C	Segment 1	Segment 3A	Segment 6	Segment 7A
	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	300	300	300	135	135	70	65
Inside Diameter, in	11.16	10.29	9.41	9.41	11.73	5.58	11.73
Manning's "n"	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	3,110	2,300	710	2,130
Velocity, ft/s	0.98	1.16	1.38	0.62	0.40	0.92	0.19
hf, ft	0.45	2.72	4.68	0.58	0.13	0.58	0.03
HGL, ft (u/s end)	164.00	163.55	160.83	156.16	155.58	155.45	155.45
HGL, ft (d/s end)	163.55	160.83	156.16	155.58	155.45	154.87	155.42
Ground Elev. , ft (d/s end)	65	149	45	12	15	15	17
Residual Pressure, psi (d/s end)	42.7	5.1	48.1	62.2	60.8	60.6	59.9
Maximum Static Pressure, psi (d/s end)	42.9	6.5	51.5	65.8	64.5	64.5	63.6

Total Q, gpm	300
HGL, ft (u/s end)	164
Percentage of Seg C going to Seg 1 and 3A	45.0%
Percentage of Seg C going to Seg D and 4	55.0%
Inject Well 1, gpm	90
Inject Well 3, gpm	75
Inject Well 4, gpm	70
Inject Well 7, gpm	65
Future Injection Wells, gpm	300

Alignment Alternative 1

Flow Path to IW-1, IW-3, IW-4, IW-7 and Future Wells

Pipeline Segment	Segment A	Segment B	Segment C	Segment Ds	Segment 4	Segment 5A	Segment 6	Segment 7A
	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	300	300	300	300	225	135	65	65
Inside Diameter, in	11.16	10.29	9.41	9.41	9.06	9.06	9.06	11.73
Manning's "n"	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	2,200	450	950	710	2,130
Velocity, ft/s	0.98	1.16	1.38	1.38	1.12	0.67	0.32	0.19
hf, ft	0.45	2.72	4.68	2.02	0.28	0.22	0.04	0.03
HGL, ft (u/s end)	164.00	163.55	160.83	156.16	154.14	153.86	153.64	153.60
HGL, ft (d/s end)	163.55	160.83	156.16	154.14	153.86	153.64	153.60	153.58
Ground Elev. , ft (d/s end)	65	149	45	21	20	15	15	17
Residual Pressure, psi (d/s end)	42.7	5.1	48.1	57.6	57.9	60.0	60.0	59.1
Maximum Static Pressure, psi (d/s end)	42.9	6.5	51.5	61.9	62.3	64.5	64.5	63.6

Total Q, gpm	300
HGL, ft (u/s end)	164
Percentage of Seg C going to Seg D and 4	100.0%
Inject Well 1, gpm	90
Inject Well 3, gpm	75
Inject Well 4, gpm	70
Inject Well 7, gpm	65
Future Injection Wells, gpm	300

Indicates Bella Vista Street High Point. (green)

Indicates minimum normal operating HGL at IPR Pump Station discharge. (orange)

IPR Storage Tank minimum normal operating level of 110.00 plus 300 gpm at 39 feet TDH.

Segment Ds = the portion of Segment D to Segment 4.

Initial & Final Phases with Retrofit IPR Pump Station: 600 gpm with 174' HGL

Alignment Alternative 3

Flow Path to IW-1, IW-3

Pipeline Segment	Segment A	Segment B	Segment C	Segment Ds	Segment 4
	Phase 1+2 Flow	Phase 1+2 Flow	Phase 1+2 Flow	Phase 1 Flow	Phase 1 Flow
Q, gpm	600	600	600	165	165
Inside Diameter, in	11.16	10.29	9.41	9.41	5.72
Manning's "n"	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	2,200	450
Velocity, ft/s	1.97	2.31	2.77	0.76	2.06
hf, ft	1.79	10.87	18.70	0.61	1.77
HGL, ft (u/s end)	174.00	172.21	161.34	142.63	142.02
HGL, ft (d/s end)	172.21	161.34	142.63	142.02	140.25
Ground Elev. , ft (d/s end)	65	149	45	21	20
Residual Pressure, psi (d/s end)	46.4	5.3	42.3	52.4	52.1
Maximum Static Pressure, psi (d/s end)	47.2	10.8	55.8	66.2	66.7

Flow Path to IW-4 and IW-7 and Future IWs

Pipeline Segment	Segment A	Segment B	Segment C	Segment 1	Segment 3A	Segment 6	Segment 7A
	Phase 1+2 Flow	Phase 1+2 Flow	Phase 1+2 Flow	Phase 1+2 Flow	Phase 1+2 Flow		Phase 1+2 Flow
Q, gpm	600	600	600	435	435	70	365
Inside Diameter, in	11.16	10.29	9.41	9.41	11.73	5.58	11.73
Manning's "n"	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	2,980	2,300	710	2,130
Velocity, ft/s	1.97	2.31	2.77	2.01	1.29	0.92	1.08
hf, ft	1.79	10.87	18.70	5.74	1.37	0.58	0.89
HGL, ft (u/s end)	174.00	172.21	161.34	142.63	136.89	135.52	135.52
HGL, ft (d/s end)	172.21	161.34	142.63	136.89	135.52	134.94	134.63
Ground Elev. , ft (d/s end)	65	149	45	12	15	15	17
Residual Pressure, psi (d/s end)	46.4	5.3	42.3	54.1	52.2	51.9	50.9
Maximum Static Pressure, psi (d/s end)	47.2	10.8	55.8	70.1	68.8	68.8	68.0

Total Q, gpm	600
HGL, ft (u/s end)	174
Percentage of Seg C going to Seg 1 and 3A	72.5%
Percentage of Seg C going to Seg D and 4	27.5%
Inject Well 1, gpm	90
Inject Well 3, gpm	75
Inject Well 4, gpm	70
Inject Well 7, gpm	65
Future Injection Wells, gpm	300

Alignment Alternative 1

Flow Path to IW-1, IW-3, IW-4, IW-7 and Future Wells

Pipeline Segment	Segment A	Segment B	Segment C	Segment Ds	Segment 4	Segment 5A	Segment 6	Segment 7A
	Phase 1+2 Flow	Phase 1+2 Flow	Phase 1+2 Flow	Phase 1+2 Flow	Phase 1+2 Flow		Phase 1+2 Flow	Phase 1+2 Flow
Q, gpm	600	600	600	600	525	435	365	365
Inside Diameter, in	11.16	10.29	9.41	9.41	9.06	9.06	9.06	11.73
Manning's "n"	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Length, ft	1,215	4,775	5,100	2,200	450	950	710	2,130
Velocity, ft/s	1.97	2.31	2.77	2.77	2.61	2.16	1.82	1.08
hf, ft	1.79	10.87	18.70	8.07	1.55	2.24	1.18	0.89
HGL, ft (u/s end)	174.00	172.21	161.34	142.63	134.56	133.02	130.78	129.60
HGL, ft (d/s end)	172.21	161.34	142.63	134.56	133.02	130.78	129.60	128.70
Ground Elev. , ft (d/s end)	65	149	45	21	20	15	15	17
Residual Pressure, psi (d/s end)	46.4	5.3	42.3	49.2	48.9	50.1	49.6	48.4
Maximum Static Pressure, psi (d/s end)	47.2	10.8	55.8	66.2	66.7	68.8	68.8	68.0

Total Q, gpm	600
HGL, ft (u/s end)	174
Percentage of Seg C going to Seg D	100.0%
Inject Well 1, gpm	90
Inject Well 3, gpm	75
Inject Well 4, gpm	70
Inject Well 7, gpm	65
Future Injection Wells, gpm	300

Indicates Bella Vista Street High Point.

Indicates **required** minimum normal operating HGL at IPR Pump Station discharge.

IPR Storage Tank minimum normal operating level of 110.00 plus 600 gpm at 60 feet TDH.

Segment Ds = the portion of Segment D to Segment 4.

APPENDIX C - IPR Alignment Alternatives Feasibility Assessment, Water Works Engineers, March 2024

MORRO BAY
OUR WATER
RELIABLE. CLEAN. FOR LIFE.

CITY OF MORRO BAY
INCORPORATED JULY 17, 1964

City of Morro Bay Water Reclamation Facility (WRF)
Recycled Water Facilities Program

Indirect Potable Reuse (IPR) Alignment Alternatives Feasibility Assessment

FINAL TECHNICAL MEMORANDUM

Date: March 11, 2024

REGISTERED PROFESSIONAL ENGINEER
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STATE OF CALIFORNIA
03/11/2024

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1 Background

1.1 Purpose

In support of the Recycled Water Facilities component of the City of Morro Bay's (City) Water Reclamation Facilities (WRF) Program, Water Works Engineers (Water Works) has developed this Technical Memorandum to document the design basis of the Indirect Potable Reuse (IPR) pipeline. The IPR alignment alternatives, design criteria, project non-cost constraints, estimated construction costs, and alignment alternatives comparison are presented herein.

1.2 Water Reclamation Facility Program Overview

The overall Water Reclamation Facility Program consists of three projects:

- The Water Reclamation Facility located to the northeast of Teresa Road which is designed to treat up to 8.14 mgd of wastewater conveyed to the site via dual forcemains. This facility was constructed in 2023 and was recently renamed the Water Resources Center (WRC).
- The Conveyance Facilities Project consists of multiple pump stations, pipelines and conduits. Sanitary sewer forcemain pipelines convey pumped wastewater from two new pump stations from the City's lower-elevation sanitary sewer collection system up to the higher-elevation WRF. In return, a pump station at the WRC conveys tertiary treated effluent down to the City's existing ocean outfall in Atascadero. In addition, a pump station at the WRF also conveys purified water (advanced treated recycled water) down a separate pipeline (IPR pipeline) to an intermediate location. The sewer forcemains and the effluent pipeline share the similar line and grade (alignment, slopes, and invert elevations) in a jointly constructed trench and are parallel to each other. The IPR pipeline generally runs in parallel at a shallower elevation in a separate trench. This facility was designed by Water Works Engineers and finished construction in 2023.
- The Recycled Water Facilities (RWF) Project connects to the terminus of the IPR pipeline and will convey advanced treated recycled water and inject it via groundwater injection wells into the local aquifer to supplement City groundwater supplies and to also increase seawater intrusion protections. Secondarily, the pipeline may be utilized to convey advanced treated recycled water for irrigation purposes. The City recently completed the draft Basis of Design Report (GSI, August 2023) that has located injection wells and set design flow rates.

1.3 Conveyance Project Alignment (Route) Selection

Water Works Engineers developed and assessed multiple alignment alternatives for the conveyance pipelines with varying total lengths, pipeline sizes, hydraulic constraints and conditions. The West alignment alternative (WRF to Theresa to South Bay to Quintana to Main to Bike Path to Atascadero) was preferred by City staff and selected for final design. The alignment and points of interest are depicted in Figure 1 and described below.

- WRF IPR pump station at easterly terminus of pipeline
- WRF offsite to onsite connection point at Theresa Rd
- Bella Vista High Point: highest elevation along the alignment

- Roundabout Tunnel: depressed profile elevation due to microtunnel trenchless tunnel construction under Quintana to Morro Bay roundabout
- Terminus of IPR at the "west" injection well study area before Morro Creek and off of the bike path, to be completed as part of the RWF Project.

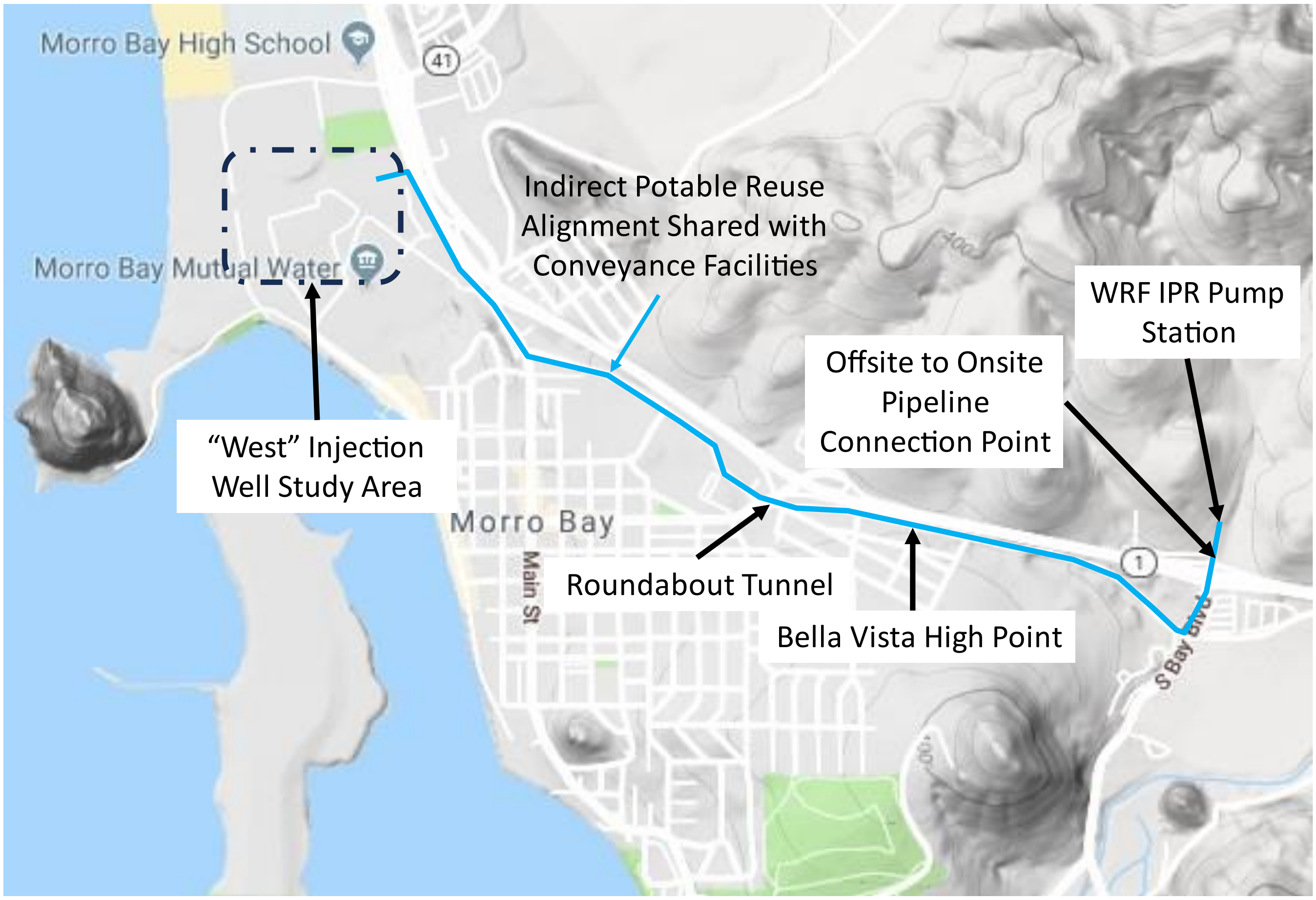


Figure 1: IPR Overview

1.4 Hydraulic Design Responsibility

The hydraulic design responsibility for the IPR pipeline system is shared and is depicted in Figure 2 alongside the pipeline profile. The WRC Project (onsite) design engineer was responsible for the hydraulic design of the WRF IPR pump station and a portion of the IPR pipeline to the Bella Vista High Point. The hydraulic design responsibility of the remainder of the IPR pipeline system from the Bella Vista High Point downstream to the "west" injection well study area was the Conveyance Facilities (offsite pipelines) design engineer. The focus of this technical memorandum is the RWF pipeline component of the IPR system.

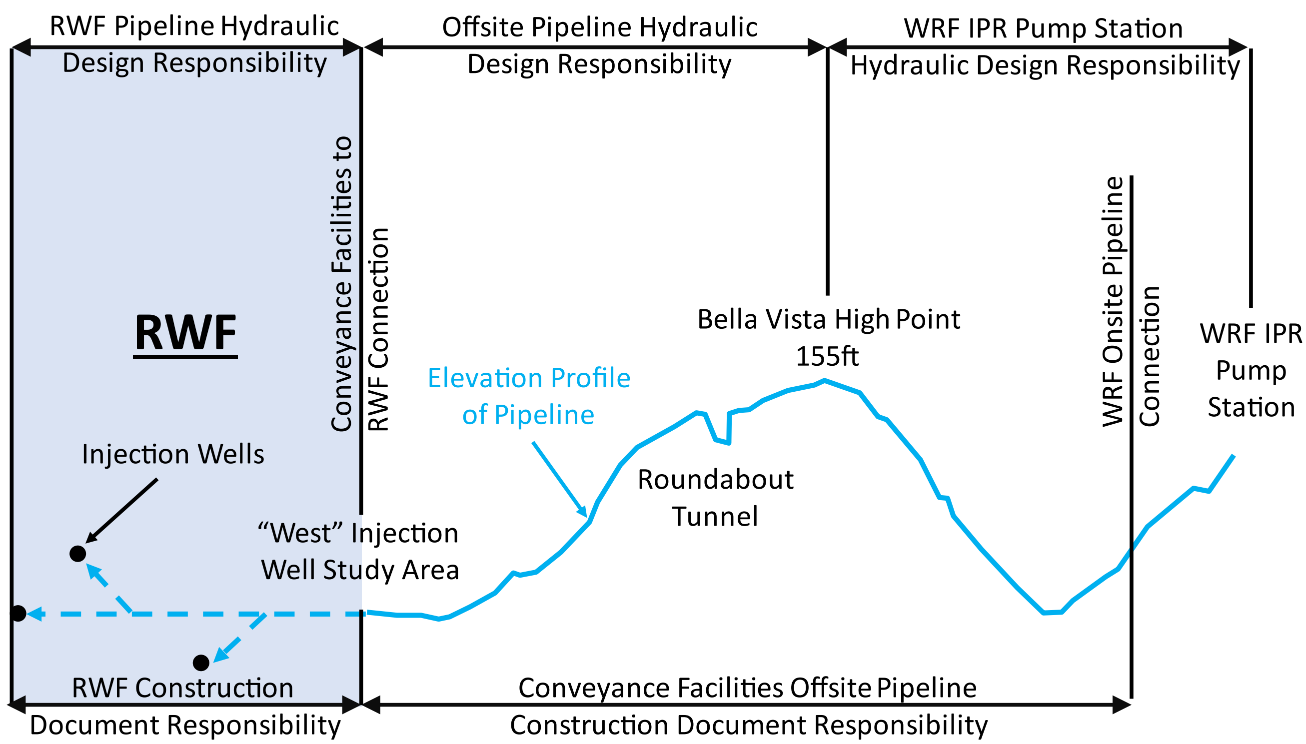


Figure 2: IPR Profile and Hydraulic Design Responsibility

1.5 WRF IPR Pump Station Design Flow

The WRF IPR pump station is designed for a max output of 0.93 mgd (645 gpm) with the stated goal of the RWF Project injecting 887 acre-feet per year (AFY), per the *Basis of Design Report for Groundwater Injection, Monitoring and Extraction (GSI, August 2023)*.

2 Design Criteria and Constraints

2.1 Injection Well Sites

Pursuant to the *Basis of Design Report (GSI, August 2023)*, a total of eight (8) injection wells are proposed as depicted in Figure 3 . The wells can be grouped into three subsets:

- East of Willow Camp Creek (IW-1, IW-2, IW-3)
    - These injection wells (one is already constructed) are located within an easement the City obtained from the Vistra Corporation and are immediately adjacent to the bike path and the existing terminus of the Conveyance Facilities IPR pipeline.
    - Target injection flows = 90 gpm per well
- Parallel to Morro Creek (IW-4, IW-5, IW-6)
    - These injection wells are located in close proximity to Morro Creek and potentially may be located within a narrow strip of easement fronting a marine storage yard.
    - Target injection flows = 70 gpm per well

- Beachfront/Atascadero (IW-7, IW-8)
  - The injection wells are located in Atascadero beachfront and are intended to provide a barrier to seawater intrusion
  - Target injection flows = 35 gpm per well

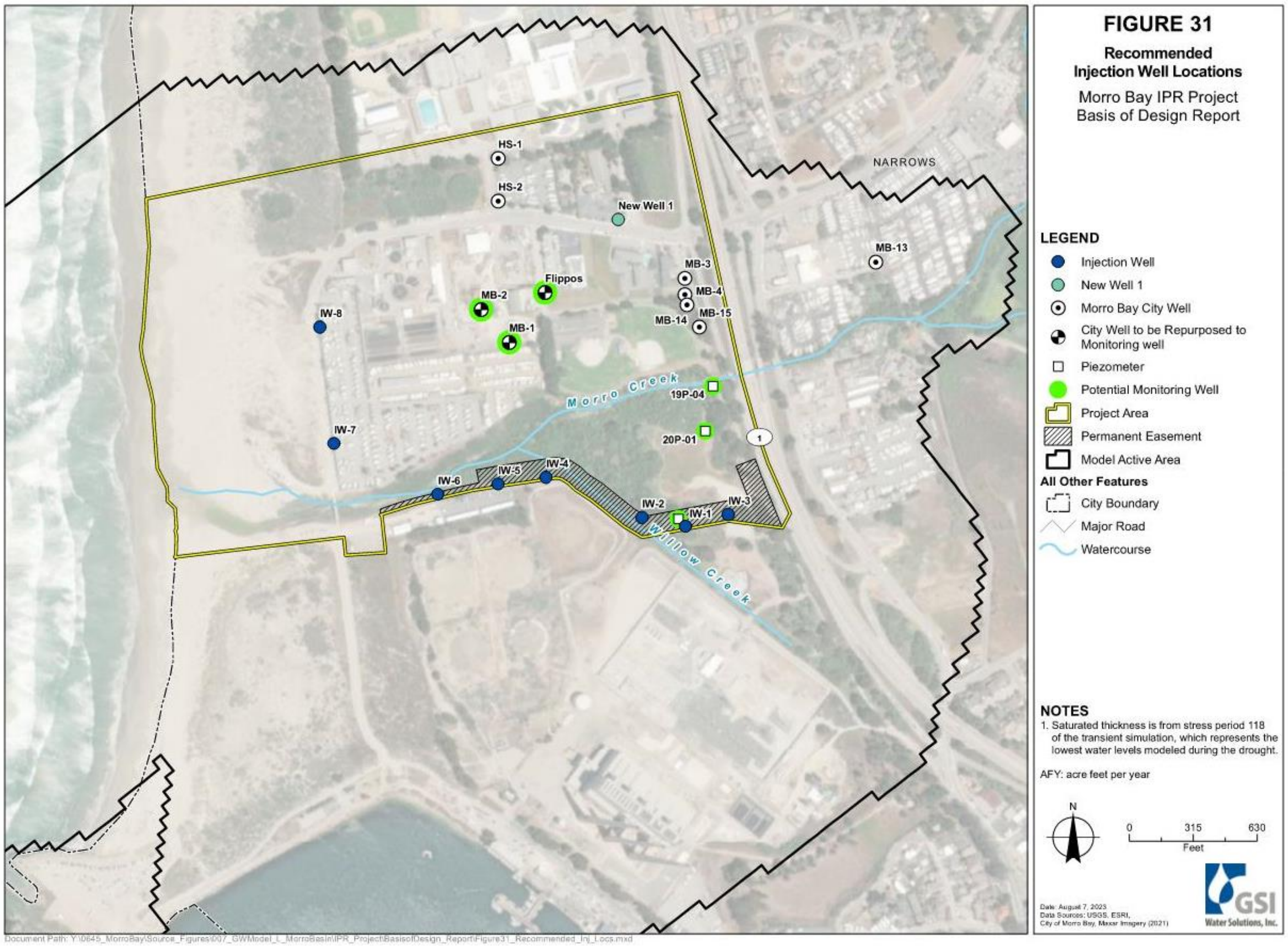


Figure 3: Recommended Injection Well Site Locations

Injection well preliminary design details are to be defined in future design phases and it is assumed that the IPR pipeline will run by the well and tee off to it.

It is understood that the injection wells will need to be backwashed or purged on an intermittent basis and the water would best be discharged into gravity sewer. IW 7 & 8, and IWs 4, 5 & 6 could potentially have access to local sewer pipelines on the Atascadero-Embarcadero beachfront. IW 1, 2 & 3 are “landlocked” and have no easy access to gravity sewer. Consequently, it is assumed that the City may pursue alternative backwash disposal means (land applied spray fields, percolation ponds, or infiltration galleries, etc.) for these wells.

Regardless of the discharge location or methodology, it is assumed that an additional low pressure, and small diameter pipeline may be required for backwash purposes, and it may be installed in a parallel trench to the IPR pipeline. Details for the backwash lines will be defined in future design phases.

2.2 Irrigation End Use

There may be an opportunity to utilize the IPR pipeline to convey recycled water for irrigation purposes at the Morro Bay High School and Lila Kaiser Park to offset the use of potable water for landscape irrigation. Existing irrigation piping, demands, operations, and DDW (Department of Drinking Water) water-sewer-recycled water separation requirements for these facilities are unknown currently. To facilitate these recycled water uses, it is assumed that additional piping would be required to convey 645 gpm of flow from Atascadero Road (near IW-8) to these landscape irrigation users. Additional details regarding use of the IPR pipeline to convey water for landscape irrigation use are to be defined in future design phases.

2.3 Pipeline Material

The existing IPR pipeline for the Conveyance Facilities is 10" DR-17 HDPE PE4170 (9.41"ID). It is strongly recommended that any new pipe be constructed of the same material and class so that there is continuity of material composition and the City will not need separate repair procedures and equipment in an emergency. In addition, use of a fully-restrained and fused pipeline material (jointless) is preferred if separation to existing potable water mains and sanitary sewer facilities is less than 10 feet and may require a variance from DDW.

2.4 Hydraulics

The existing grade of the injection well area and on Atascadero Road is between approximately 10-20 feet. Because the IPR conveyance system is driven by the Bella Vista high point (148-ft invert), the IPR pipeline can deliver an elevated HGL and the system is intended to remain fully pressurized and not be allowed to drain and transition into a partial gravity and partial pressure system.

The worst case, governing hydraulic scenario is where the full 645 gpm available is conveyed along the longest single flow path to IW-8 (Surf Street Alternative). Hydraulic calculations of this scenario result in:

- HW C=140 9.41"ID 10" DR-17 IPS HDPE or all new pipe, and HW C=140 12"ID for any reuse of the 12" Desal Feed Line
  - Assuming maximizing reuse of 12" Desal Feed Line, the HGL at the terminus is 118-ft (approximately 46 psi) near IW-8
  - Assuming reuse of 12" Desal is not feasible and new 10" pipe required = HGL at the terminus is 110-ft (approximately 42-psi) near IW-8

This analysis shows that there is at least 42-psi at 645-gpm is available for the injection wells and the pipeline terminus if 10" DR-17 IPS HDPE PE4170 is utilized (peak velocity of 3 ft/s).

2.5 Air Valves, Isolation Valves, and Pipeline Appurtenances

Air valves will be required at localized high points and long ascending or descending runs of pipe. DDW will require that the valves be safe from inundation and cross contamination, and valves will likely be above ground and protected in enclosures and with bollards as needed. Intermediate mainline isolation valves are generally discouraged on specialized conveyance system applications like this as the City would be able to shut down the system to make repairs relatively easily without them. If added, intermediate main line valves could be added to branching locations or paired with air valves at local high points, and would likely be buried. Lastly, all new open-constructed pipe will be paired with in-trench tracer wire, intermediate tracing stations, and ground rods at dead ends.

2.6 Open Cut Construction

For open cut constructed applications, the pipeline is recommended to be installed at a minimum 36-in depth of cover to existing grade and would likely need to maintain minimum vertical separation (1-ft where feasible) to crossing water mains, storm drains, and sewer mains. To be consistent with the Conveyance Project, it is recommended that controlled low strength material (CLSM) cement slurry be utilized for pipe zone backfill, which will serve to better protect the pipe, mitigate seismic liquefaction concerns, and acts as a continuous trench dam to eliminate trench groundwater migration.

2.7 IPR Operation

A detailed discussion of the WRF IPR Pump Station (upstream boundary conditions) operation and control strategy in coordination with the injection wells or other irrigation uses (downstream boundary conditions) is beyond the scope of this tech memo. It is recommended that the pipeline not be allowed to routinely drain, meaning that pipeline flow rates (demands) should be controlled and not allowed to outstrip pump station flows and/or minimum pressures sustained.

2.8 Communication Conduits

It is understood that new fiber networks installed in parallel and along the entire IPR pipeline is likely infeasible. It is the City's expectation that injection wells might be connected to existing radio communications for control purposes to take advantage of good line of sight to existing radio towers. Consequently, it may be advantageous to link injection wells near each other to reduce the number of antennas and radio infrastructure via communication conduits. Additional details are to be defined in future design phases.

2.9 Water and Sewer Separation Requirements

DDW requires 10-ft clear separation between potable water and non-potable sources. The IPR is not considered potable nor sanitary sewer, and so for separation purposes, is treated by DDW as needing to maintain clearance to both sewer and water mains. Due to high utility densities, it is unlikely that 10-ft clearances can be maintained in some locations. The City would likely need to procure a new alternative water standard (waiver) for the pipeline, as it did during the Conveyance Project, where it successfully permitted the IPR pipeline being within 3-ft clear horizontal, and 1-ft vertical clear of parallel sewer facilities, and 3-ft clear horizontal from water mains. Note that this was specific to the Conveyance Project and DDW will not consider it precedent. If minimum clearances are still not feasible, then there is always the opportunity to install the IPR pipeline in a casing (sleeve) where required to meet DDW standards. In addition, 50-ft clearance is required from non-potable sources to public water wells such as Flippos in Park Rd, which would require variances from DDW and SLO County Environmental Health.

2.10 Traffic and Public Impacts

Traffic conditions vary across the project area. Embarcadero Road is a very high-volume corridor where open cut construction is highly impactful and will likely be very constrained to short constructed runs and advanced traffic control (active flaggers and passive barriers, signs and flags). Atascadero Road is a medium volume corridor with wider space than Embarcadero Road and would likely require intermediate traffic control measures (passive barriers, signs and flags). Surf Street is a medium volume corridor through heavy residential areas and will likely require intermediate traffic control measures (passive barriers, signs and flag). The Lila Keiser Park to Main Street bike path is a low-volume pedestrian and biking corridor and would need to be temporarily shut down and users bypassed and routed to alternative routes along Embarcadero to Atascadero bike path. The Embarcadero to Atascadero bike path is a medium-volume pedestrian and biking corridor that would also need to be temporarily shut down and users bypassed and routed to the Lila Keiser Park to Main Street bike path.

2.11 Flooding and Tsunami Risk Mitigation

Siting pipeline corridors and injection wells in close proximity to the beach, Morro Creek, and Willow Camp Creek potentially exposes these assets to flooding hazards (inundation and scouring) and all these facilities are within the tsunami zone. Given the recycled water facilities are not considered critical facilities, and placement of these assets is governed by geological and groundwater constraints that cannot be modified, long term risks and potential impacts due to flooding and tsunamis is likely unavoidable and cannot be effectively mitigated with industry-standard engineered solutions. All of the IPR alternatives effectively have equal risks to flooding hazards and tsunamis. Therefore, a flooding and tsunami inundation risk-based assessment and comparison between pipeline alignment alternatives is not further discussed herein and is beyond the scope of this tech memo.

3 Preliminary Alignment Development

3.1 Preliminary Alignments

Water Works identified fourteen (14) preliminary alignment segments to connect the already constructed IPR pipeline (shared with Conveyance Facilities) to the injection well locations. The alignments are defined in Table 1 below and are depicted in Appendix A.

Table 1: Preliminary Alignments

Seg. #	Description	Length (ft)
1	Surf Street R/W / Trenched New Pipe	2591
2A	Parallel LS-2 FM / Vistra Easement / Trenched New Pipe	1761
2B	Reuse Ex Aband. 8” LS-2 SSFM / Under PGE Substation & Vistra Easement / + Trenched New Pipe	1733
3A	Reuse Ex Aband. 12” Desal Feed / Embarcadero R/W / + Trenched New Pipe	2744
3B	Reuse Ex 12" sewer FM from LS 2 to LFA	2719
4	Connect to Bike Path IPR Termination / Vistra Easement / Trenched New Pipe	641
5A	Cross Willow Camp Creek East Bank / Vistra Easement / Trenched New Pipe	695
5B	Cross Willow Camp Creek West Bank / Vistra Easement / Decom. Fuel Bridge / Trenched New Pipe	651
6	Parallel Morro Creek and Marine Storage / Ex & New Easement Vistra / Trenched New Pipe	973
7A	Cross Morro Creek & Reuse Ex Aband. 12” Desal Feed / Embarcadero R/W / + Trenched New Pipe	1038
7B	Cross Morro Creek Ex Pedestrian Bridge / Embarcadero R/W / Trenched New Pipe	1038
8	Main Street / 2x Caltrans HWY-1 Undercrossings / Morro Creek Bridge Crossing / Trenched New Pipe	5665
9	Bike Path Caltrans HWY-1 & Atascadero / Morro Creek Crossing Ex Pipe Bridge / Trenched New Pipe	3472
10	Bike Path and Lila Keiser Park and Atascadero / Morro Creek Crossing Ex Pipe Bridge / Trenched New Pipe	3656

3.2 Fatal Flawed Alignments

Out of the preliminary alignment segments, six (6) are likely fatal flawed and were removed from additional assessment. Justification is discussed and listed in Table 2.

Table 2: Fatal Flawed Alignments

Seg. #	Description	Fatal Flaws
2B	Reuse Ex Aband. 8" LS-2 SSFM / Under PGE Substation & Vistra Easement / + Trenched New Pipe	Old 8" sewer forcemain pipeline is undersized, aging, and is in unknown condition and is considered to have a very high risk of failure. PGE will not permit adapted use of the pipeline under a substation. DDW will not permit use of a pipeline for purified water if it was used for sewer in the past.
3B	Reuse Ex 12" sewer FM from LS-2	Old 12" sewer forcemain pressure class is unconfirmed. City does not consider the pipeline abandoned and intends to continue to use it as a backup. DDW will not permit use of a pipeline for purified water if it was used for sewer in the past.
5B	Cross Willow Camp Creek West Bank / Vistra Easement / Decom. Fuel Bridge / Trenched New Pipe	Sliplining the existing large diameter decommissioned steel fuel pipeline crossing of Willow Camp Creek for the IPR pipeline is likely not permissible under DDW due to cross contamination concerns. It is also unlikely that Vistra will permit this, or open cut construction and placement of the pipeline in the fuel farm berm.
8	Main Street / 2x Caltrans HWY-1 Undercrossings / Morro Creek Bridge Crossing / Trenched New Pipe	Per the Conveyance Project Conceptual Design Report, the Main Street corridor is likely fatal flawed for IPR pipeline use due to no available crossing options of Morro Creek (no trenchless options in City R/W, aging bridge likely infeasible due to high flooding risk). Trenchless crossing within Caltrans R/W will trigger several tree removals, which Caltrans will not permit due to potential for scenic tree classification. There is a high potential for cultural resource impacts during open cut construction in HWY-41 (Atascadero) Undercrossing in Caltrans R/W that make it very unlikely that this alignment will be successfully permitted.
9	Bike Path Caltrans HWY-1 & Atascadero / Morro Creek Crossing Ex Pipe Bridge / Trenched New Pipe	Extension from the bike path into Lila Keiser Park and into the HWY-1 SB On-Ramp Shoulder beyond the 50-ft buffer of the bike path public water wells will not be permitted by Caltrans as the entire shoulder has been utilized and there is no more available space. In addition, there is a high potential for cultural resource impacts that make it very unlikely that this alignment will be successfully permitted.
10	Bike Path and Lila Keiser Park and Atascadero / Morro Creek Crossing Ex Pipe Bridge / Trenched New Pipe	There is high potential for cultural resource impacts within Lila Keiser Park that make it unlikely that this alignment will be successfully permitted if there are alternatives.

4 Final Alignment Alternatives

The remaining alignments (not fatal flawed) were further defined, assessed, and compared. Three fully functioning alternatives to reach every injection well were developed from available alignment segments:

- Surf Street (7987 ft)

- Segment 1
- Segment 3A
- Segment 6
- Segment 7A or 7B
- Segment 4

- LS-2 Vistra (7157 ft)
  - Segment 2A
  - Segment 3A
  - Segment 6
  - Segment 7A or 7B
  - Segment 4
- Vistra (3347 ft)
  - Segment 4
  - Segment 5A
  - Segment 6
  - Segment 7A or 7B

Detailed figures for each alternative can be found in Appendix B.

4.1 Segment 3A and 7A Desalination Feed Pipeline Reuse

Alignment segments 3A and 7A assume reuse of the existing ~30 year old 12" Desal Feed Line which was installed during an emergency condition along with installation of brackish water extraction wells on Embarcadero Road near the power plant in the 1990s. The pipeline is known to be 12" Certa-Lok Yelomine (PVC) with fully restrained proprietary joints. Available asbuilts and construction documentation are limited and the pressure class of the pipe is unknown. Existing conditions are unverified, but the City believes the pipeline is in good condition and is abandoned in place with raw water in it that has likely fouled. The condition and status of existing connections to decommissioned wells and other potential cross connections are unknown. The Conveyance Project did cut into a portion of the pipe to be adapted for other uses for a small section in Atascadero Road from the old WWTP to the BWRO Facility and the pipeline was pressure tested to 60 psi and it appeared to pass inspection. The following steps should be taken to re-use the pipeline:

- Conduct an additional search for all available records and identify any product specifications/cut sheets/purchase orders from manufacturer to verify pipe class.
- Expose a portion of the pipeline and look for pipe markings to verify pipe class.
- Expose all existing connections to brackish wells and confirm all connections are capped and there are no cross connections.
- Expose current capped line in front of Power Plant that was cut to facilitate construction of the Coast Guard facility.
- Trace and identify any trapped air and install new air valves as necessary.
- Develop a disinfection plan for DDW approval.
- Conduct a hydrostatic pressure test.
- Flush repeatedly and conduct a flow test verifying there are no obstructions or trapped air.

As with any application when reusing an aged pipeline asset, there may be surprises and more constraints identified during future design efforts when the pipeline condition is verified. Overall, however, the City believes that the pipeline is operable and that although it is approximately 30 years old, it was only operated under relatively low pressures for a short duration and has not seen the typical pattern of "wear and tear" that a water distribution main might experience.

4.2 Segment 7B Morro Creek Crossing

If the existing desal feed line crossing of Morro Creek is not feasible, then a new crossing of Morro Creek at Embarcadero Road could be a cost effective alternative if the pipeline is supported on the side of the existing vehicular and pedestrian bridge constructed in 2014. This is a very common modification made to bridges and is not difficult to accommodate. The pipeline would likely be sleeved in a casing and either end would be landed in flexible, seismic relief joints.

4.3 Segment 5A Willow Camp Creek Crossing

A detailed trenchless or raised (aerial) construction feasibility assessment exceeds the scope of this tech memo and an open cut construction methodology is assumed at this time to be the most cost effective and potentially least environmentally impactful construction methodology across Willow Camp Creek. Justification for this approach is summarized below:

- Willow Camp Creek is a well-defined trapezoidal earthen channel with a raised embankment on the west side that also serves as a berm for the demolished fuel farm. Consequently, the western embankment is highly sensitive, and open-cut construction would need to be minimized as much as possible when near it.
- Easement limits to the east of the creek are narrow and near the embankment edge and there is very limited space.
- Extensive riparian habitats surround the Willow Camp Creek and Morro Creek and any construction along the corridor would likely trigger a 1602 CDFW permit.
- Area has high groundwater conditions.
- No perpendicular crossing with broad entrance and exit conditions is possible and the crossing would be highly constrained on either side, and the alignment would have to "jog" to navigate the corner of the fuel farm berm.

These constraints and conditions likely rule out trenchless construction methodologies:

- Pipe jacking or pipe ramming technologies likely infeasible as there little to no space to construct 40'x40' and 30'+ deep receiving and jacking shafts in in opposing embankments. Likely infeasible to bring a crane out to the receiving shaft on the western side. Large excavation at toe of fuel farm berm is not ideal.
- Horizontal directional drilling (HDD) likely infeasible due to site topography and alignment constraints and the orientation of the fuel farm berm at the confluence of Morro Creek and Willow Camp Creek. HDD allows for limited curvilinear path that cannot negotiate the geometry of both the embankments, property lines, and easements all the while maintaining sufficient vertical clearance to the bottom of the creek to avoid hydraulic frac-out risks into the creek.

These constraints and existing conditions also likely rule out a raised/aerial crossing construction methodology:

- Similar to trenchless methodologies, a 90-ft+/- long premanufactured steel or aluminum utility bridge to span the creek would require large shaft excavations for concrete abutments. It is likely infeasible to bring a crane out to the shaft on the western side. A deep and large excavation at the toe of the fuel farm berm is not ideal.

Open cut constructed pipelines are often perceived to be more environmentally impactful for creek crossings, but in this application, open cut may be less impactful to riparian limits surrounding the jurisdictional creek features. The primary constraint with an open-cut creek crossing is that it will likely trigger 404 USACE and 401 RWQCB permits due to the presence of jurisdictional resources, in addition to the 1602 CDFW permit. There may be longer procurement lead times associated with those permits that could impact the start of construction. All options would likely trigger extensive cultural resource monitoring and biological resources monitoring, but an open-cut constructed option may reduce the overall excavated and site disturbance footprint, which is preferable.

Open cut trenched pipelines can be installed in much narrower corridors (as small as 20-ft wide) with smaller, typical construction equipment. Fewer tree removals, and substantially decreased clearing and grubbing footprints are required. The construction is also significantly faster (2-3 weeks versus 4-6 months for trenchless or aerial alternatives) and can be completely constructed during conditions when Willow Camp Creek is dried out and there is no flow. Limited to no dewatering is anticipated during summer months, while extensive dewatering operations would be required for a trenchless or aerial crossing. The open cut pipeline would be installed a minimum 4-feet below the flowline of the creek and would likely be encased in concrete pipe zone backfill. The trench would be restored with native material within the creek limits.

4.4 Recommended Pathway for Environmental Compliance

The likely California Environmental Quality Act (CEQA) permitting pathway for the various final alignment segments is listed below in Table 3 per a preliminary, and high-level assessment produced by Rincon Consultants (July 2023). Note that a supplemental EIR requires a lengthier and more robust development effort than an addendum to the existing EIR and is not preferable. Additional studies are required to confirm these preliminary assumptions, but it appears that maximizing use of the existing 12” Desal Feed line and potentially relocation of Injection Wells 4, 5 and 6 and Segment 5A to more inland (i.e., into the City’s marine storage yard easement area and reducing encroachment into riparian limits, if possible) is advantageous. Completion of these studies will better inform the City on the potential to construction the injection wells and pipelines under an addendum to the existing EIR or if a supplemental EIR is required.

Table 3: Recommended Path For Environmental Compliance (Rincon Consultants, December 2023)

Constraints	Segment											
	1	2A	2B	3A/3B	4	5A	5B	6	7A/7B	8	9	10
Impact Area Covered by Existing EIR	No	Partially[1]	No	No	Yes	Yes	Yes	Partially[2]	No	Partially[3]	Partially[4]	Partially[4]
Proximity to Morro Shoulderband Snail Habitat/Survey Area (MM BIO-3)	X	X		X		X	X	X		X	X	X
Proximity to Unpaved Dune Areas (Potential Impacts to Special Status Plants and Wildfire)				X					X	X	X	X
Proximity to Cultural Resources (MM CUL-3 to CUL-5)		X	X	X		X	X	X	X		X	X
Air Quality, Noise, Traffic in Residential Area (MM AQ-1b, MM AQ-1c, TRAF-1)	X											
Potential Direct Impacts to Jurisdictional Waters/ Wetlands (May Require USACE/CDFW/RWQCB Permitting)						X						
Potential Direct Impacts to Riparian Habitat (May Require CDFW Permitting), California Red-Legged Frog, and Western Pond Turtle						X	X	X	X	X	X	X
Recommended Pathway for CEQA Compliance[5]	Addendum to EIR			Addendum to EIR if work occurs outside unpaved dune areas – otherwise, potentially Supplemental EIR	Addendum to EIR	Addendum to EIR if direct impacts to riparian habitat and existing cultural sites are avoided - otherwise, potentially Supplemental EIR		Addendum to EIR if direct impacts to riparian habitat, impacts to special status plants and wildlife in dune areas, and impacts to existing cultural sites are avoided – otherwise, potentially Supplemental EIR		Addendum to EIR if impacts to special status plants and wildlife in dune areas are avoided – otherwise, potentially Supplemental EIR		

[1] Southernmost portion of Alternative 2 outside of "Design APE" not covered.
[2] Western half of Alternative 6 is not covered.
[3] Alternative 8 is covered except for portion from Quintana Road to Radcliff Avenue, portion from Errol Road to Highway 41, and portion extending west past Atascadero Road into dune area.
[4] Covered except for portion extending west past Atascadero Road into dune area.
[5] Supplemental biological and cultural reports are recommended to support the CEQA process for all alternatives except Alternative 4.

5 Alternatives Assessment

The following non-cost constraints and potential impacts were identified to assess and compare each IPR alternative:

- Traffic and Public Impacts
- Cultural Resources Impacts
  - Potential risk of excavation of cultural resources.
- Environmental Impacts
  - Exposure to environmentally sensitive areas such as jurisdictional resources and riparian limits, and potential risk of impacts to special status species.
- Stakeholder Risk
  - Greater exposure to key outside stakeholders such as Vistra with any alternative that may impact site security, or require additional easements, or require increased coordination.
- Utility Conflicts
  - Potential risks of utility conflicts requiring relocations, tighter construction conditions, and use of sleeves/casings.
- Constructability
  - Physical constraints (existing structures, narrow corridors) etc. that may impact the ease of construction of the pipeline.
- Long Term Reliability
  - Use of new pipeline assets will maximize long term reliability versus using older assets with a reduced remaining lifespan.

Water Works scored the final alignment segments based on these non-cost constraints (higher score is better) in Table 4 using an equal weighting system. The totals for each alternative are listed in Table 5.

Table 4: Non-Cost Constraint Scoring For IPR Alignment Segments

SEGMENT	Constraints							Tot.
	Traffic	Cultural	Environmental	Stakeholder Risk	Utilities	Constructability	Long Term Reliability	
1	-1	0	1	1	-1	1	1	2
2A	1	-1	1	-1	-1	-1	1	-1
3A	0	1	1	1	1	0	-1	3
4	1	-1	-1	0	1	1	1	2
5A	1	-1	-1	0	1	0	1	1
6	1	-1	0	-1	1	0	1	1
7A	1	0	1	1	1	0	-1	3
7B	-1	-1	0	1	0	0	1	0

Table 5: Total Non-Cost Constraint Scores for IPR Alignment Alternatives

Alternatives Total Scores (Higher Score Is Better)	
1. Vistra **4+5A+6+7A**	7
2. LS-2 Vistra **2A+3A+4+6+7A**	8
3. Surf Street R/W **1+3A+4+6+7A**	11

The net result is that the Surf Street R/W Alternative may be the longest alignment, but is likely exposed to the least constraints, risks, and potential impacts, and may have the shortest permit procurement timeline and could be constructed sooner. The Vistra alignment conversely is the shortest alignment, but may be exposed to the most constraints, risks, and potential impacts and is at the highest risk of schedule delays.

6 Estimated Construction Costs and Conclusions

Water Works developed "hard" construction cost estimates for the IPR alternatives as defined herein which incorporate 40% design and 10% construction contingencies, in 2023 dollars, which are built on the following assumptions and is listed in Table 6.

- Does not cover "onsite" injection well improvements, or "offsite" communication conduits, or "offsite" backwash systems
- Only uses preliminary design information for the IPR pipeline, and conceptual design information for other connected systems
- Only covers direct pipeline hard construction costs, and does not incorporate mid-point project cost escalation nor soft costs (design, construction management, program management, administration, cultural monitoring, archaeological monitoring, biological monitoring, specialized inspections, environmental studies and reports, fees, mitigation fees, and permit procurement)
- Unit costs and breakdown by each segment can be found in Appendix C.

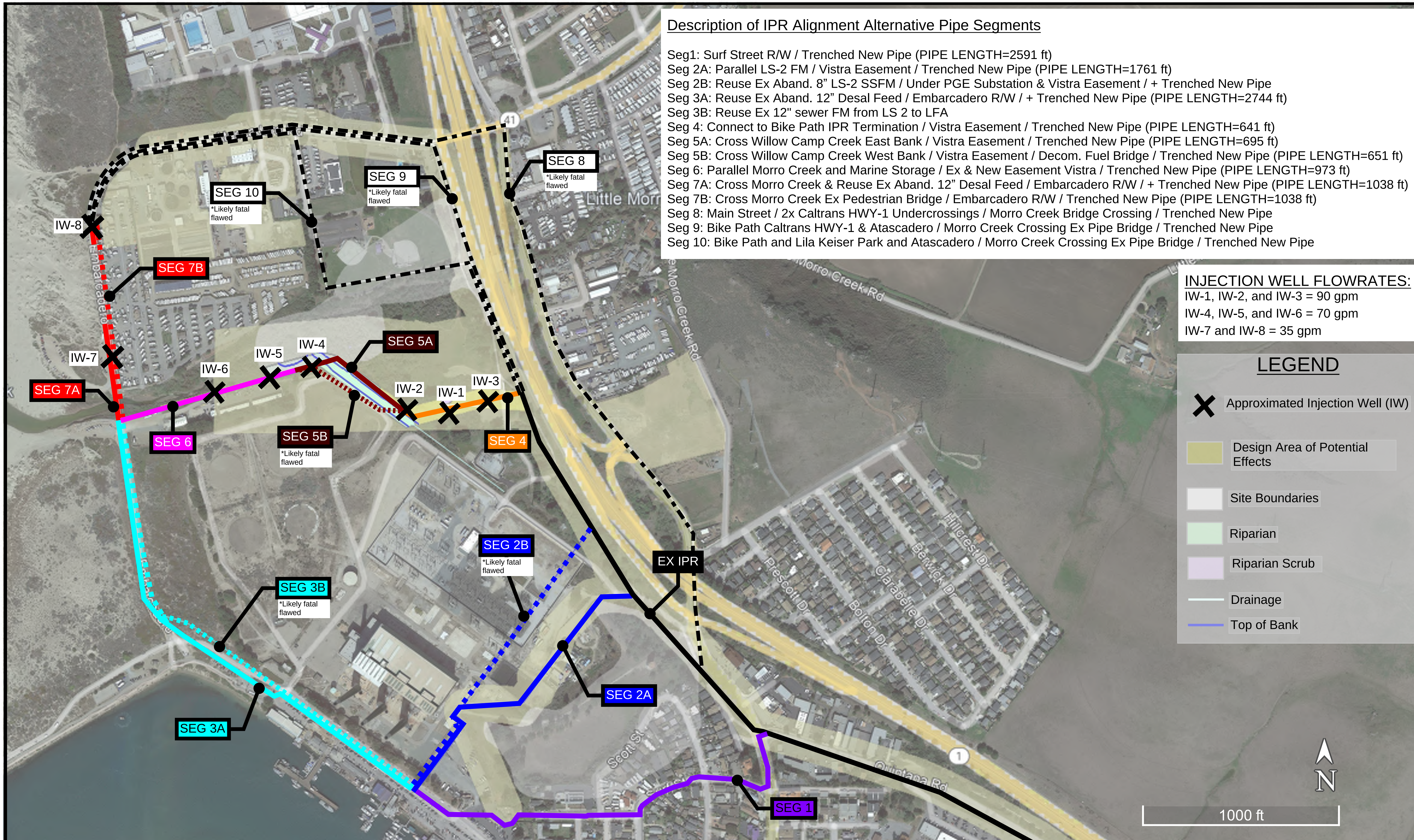
Table 6: IPR Pipelines Hard Construction Cost Estimate

Feasible Alternatives	Injection Wells Reached	Pipeline Alignments	Construction Hard Cost Estimate*
n/a	1,2,3	4 (Vistra)	$ 363,000
n/a	1-6	4+5A+6 (Vistra & Willow Camp Creek)	$ 1,799,000
n/a	1-6	2A+3A+4+6 (Vistra LS2 FM to Embarcadero)	$ 2,539,000
n/a	1-6	1+3A+4+6+6 (Surf Street to Embarcadero)	$ 3,066,000
1	1-8	4+5A+6+7A (Vistra & Willow Camp Creek to Atascadero)	$ 2,022,000
2	1-8	2A+3A+4+6+7A (Vistra LS2 FM to Embarcadero to Atascadero)	$ 2,762,000
3	1-8	1+3A+4+6+7A (Surf Street to Embarcadero to Atascadero)	$ 3,289,000

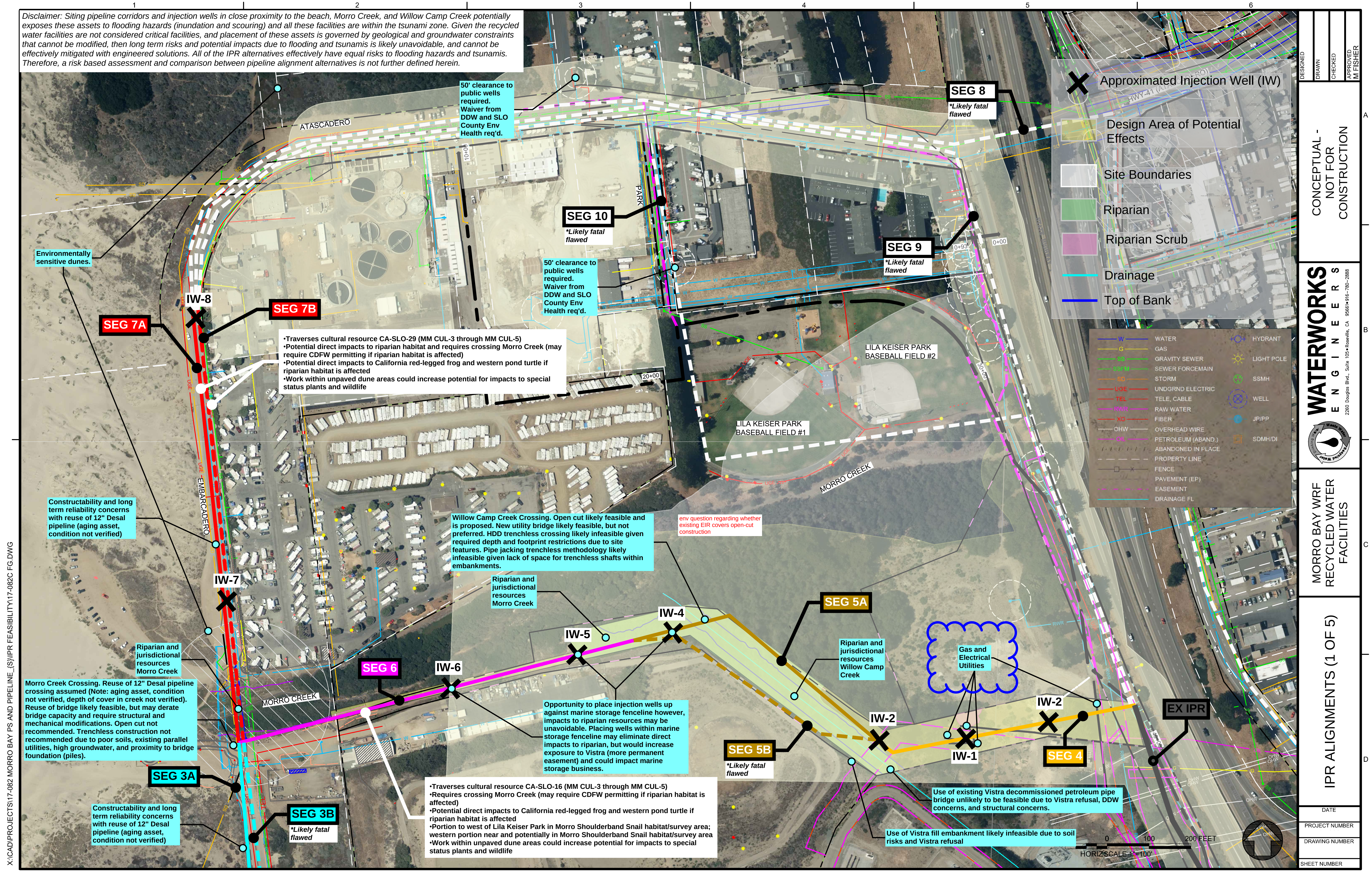
*See assumptions above

The results indicate that because the Surf Street R/W alternative is the longest alignment, it predictably has the highest hard construction costs when compared to the shortened Vistra or LS-2 Vistra alternatives. However, the non-cost constraints and added soft costs and schedule constraints associated with the Vistra-based alternatives that are not quantified herein at this preliminary design stage are potentially significant and may narrow the range of the overall construction cost gap between the alternatives.

Further refinement of the cost estimate to incorporate soft costs and eliminate assumptions will require final design studies (biological, cultural, geotechnical as needed, etc.), final acceptance of injection well siting, major development of the supplemental EIR or addendum to EIR, confirmation of program implementation/construction schedule, receipt of topographical surveys, 60% design of the IPR alternatives, 60% injection well final design, 60% irrigation facilities final design, and 60% level of WRF IPR pump station communications and controls coordination and confirmation of inspection and monitoring costs and strategy.



MORRO BAY OUR WATER RELIABLE. CLEAN. FOR LIFE.	City of Morro Bay Project	**IPR Alternative Alignments**	WATERWORKS ENGINEERS	FIGURE 1



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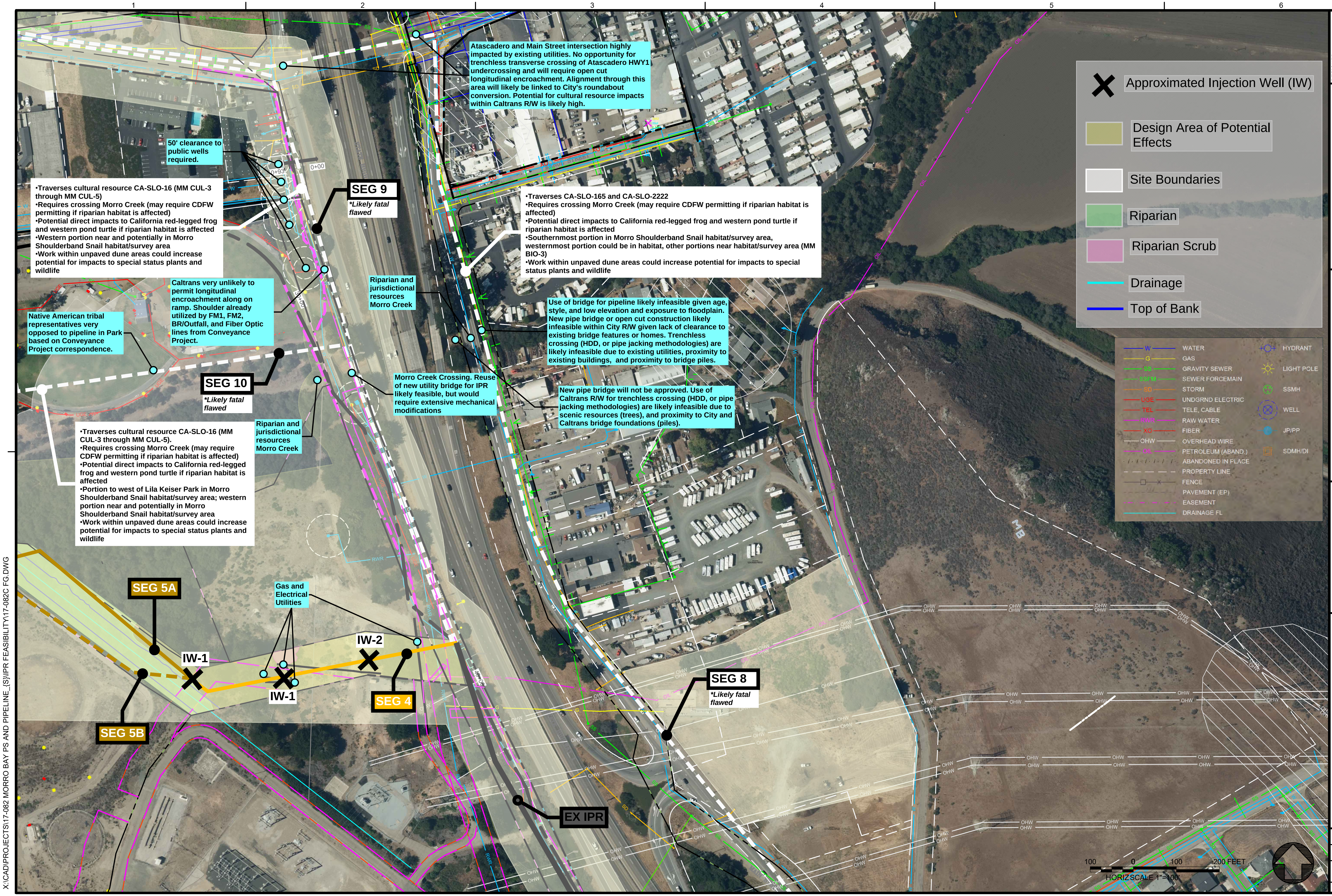

DESIGNED | DRAWN | CHECKED | APPROVED M FISHER

CONCEPTUAL - NOT FOR CONSTRUCTION

WATERWORKS ENGINEERS
2260 Douglas Blvd., Suite 105 • Roseville, CA 95661 • 916-780-2888

MORRO BAY WRF RECYCLED WATER FACILITIES

IPR ALIGNMENTS (2 OF 5)

DATE

PROJECT NUMBER

DRAWING NUMBER

SHEET NUMBER

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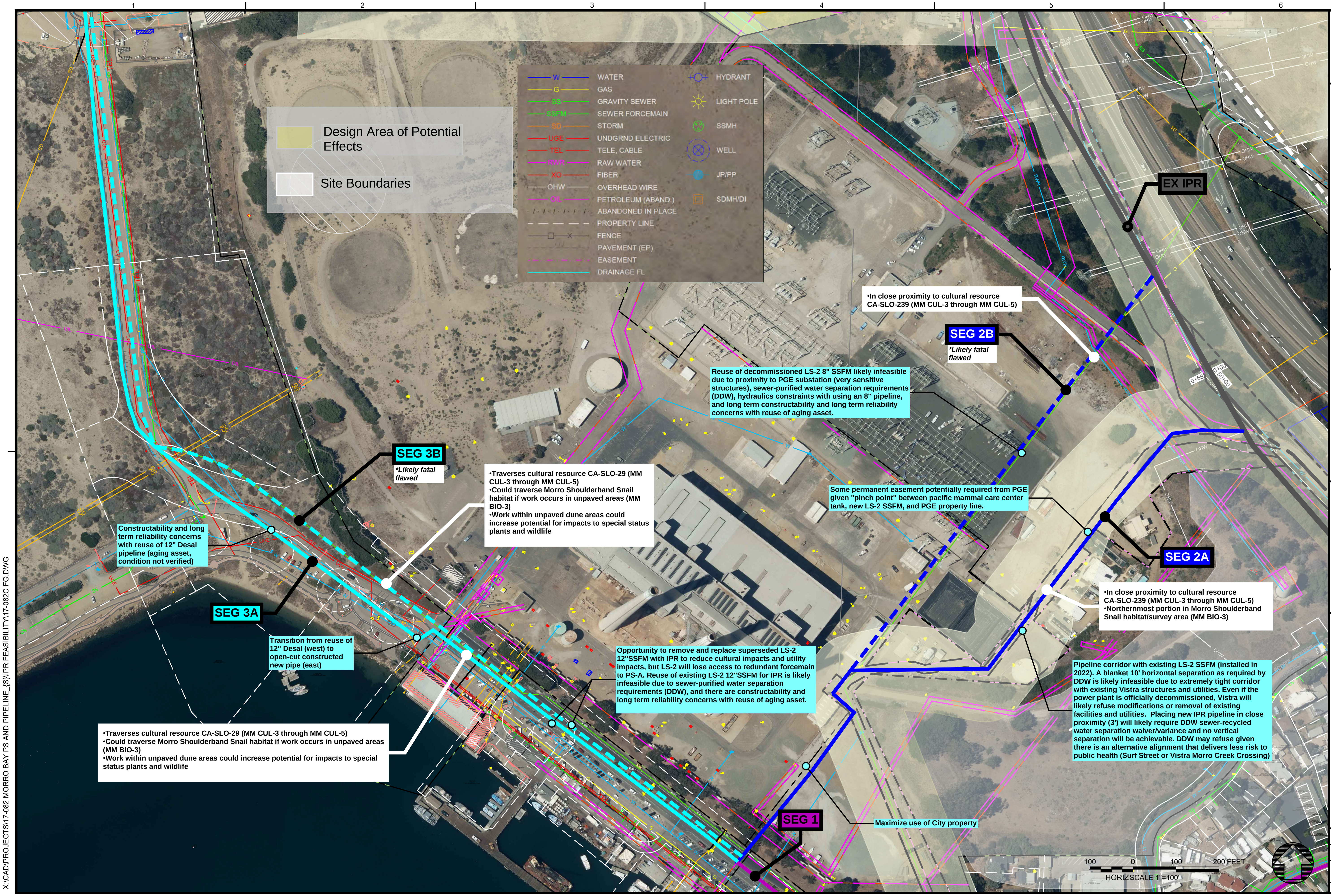

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MORRO BAY WRF RECYCLED WATER FACILITIES

IPR ALIGNMENTS (3 OF 5)

DATE
PROJECT NUMBER
DRAWING NUMBER
SHEET NUMBER

X:\CAD\PROJECTS\17-082 MORRO BAY PS AND PIPELINE_(S)\IPR FEASIBILITY\17-082C FG.DWG

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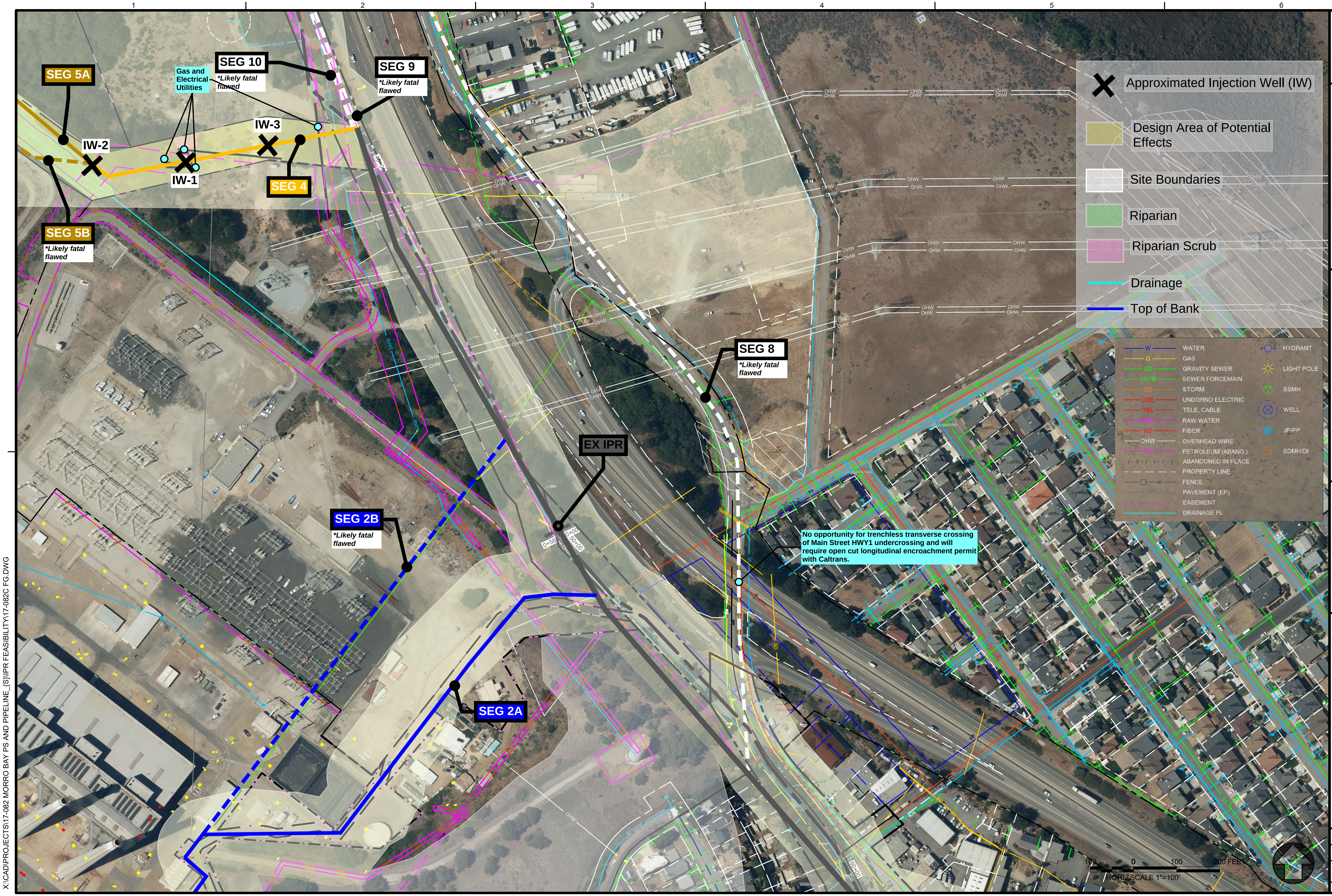

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DESIGNED | DRAWN | CHECKED | APPROVED M FISHER

CONCEPTUAL - NOT FOR CONSTRUCTION

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MORRO BAY WRF RECYCLED WATER FACILITIES

IPR ALIGNMENTS (4 OF 5)

DATE

PROJECT NUMBER

DRAWING NUMBER

SHEET NUMBER

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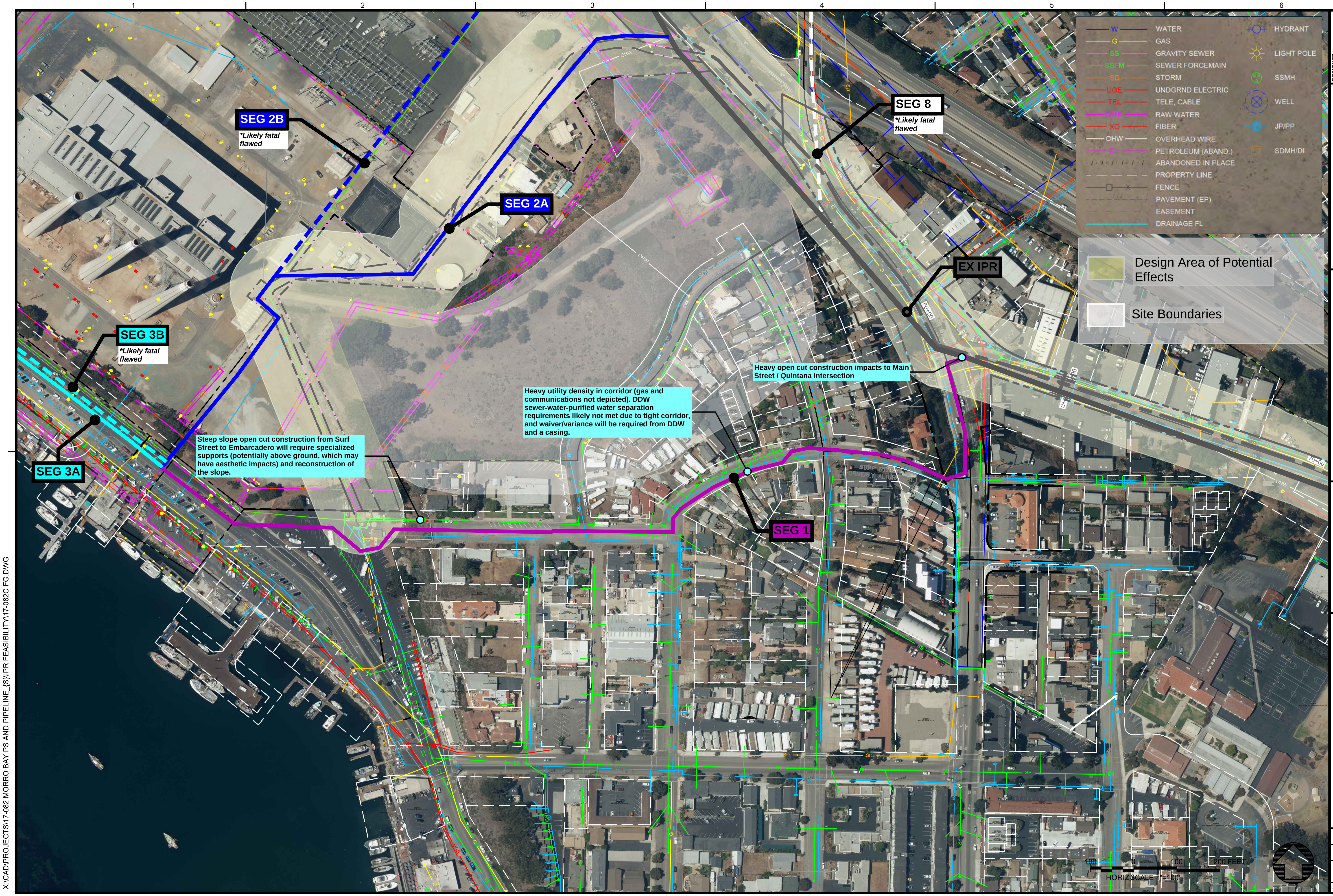

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DESIGNED
DRAWN
CHECKED
APPROVED M FISHER

CONCEPTUAL - NOT FOR CONSTRUCTION

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MORRO BAY WRF RECYCLED WATER FACILITIES

IPR ALIGNMENTS (5 OF 5)

DATE
PROJECT NUMBER
DRAWING NUMBER
SHEET NUMBER

JOB NUMBER: 17-082 FILENAME: 17-082C FG.DWG PLOT DATE: 10/6/23 PLOT TIME: 15:50:13

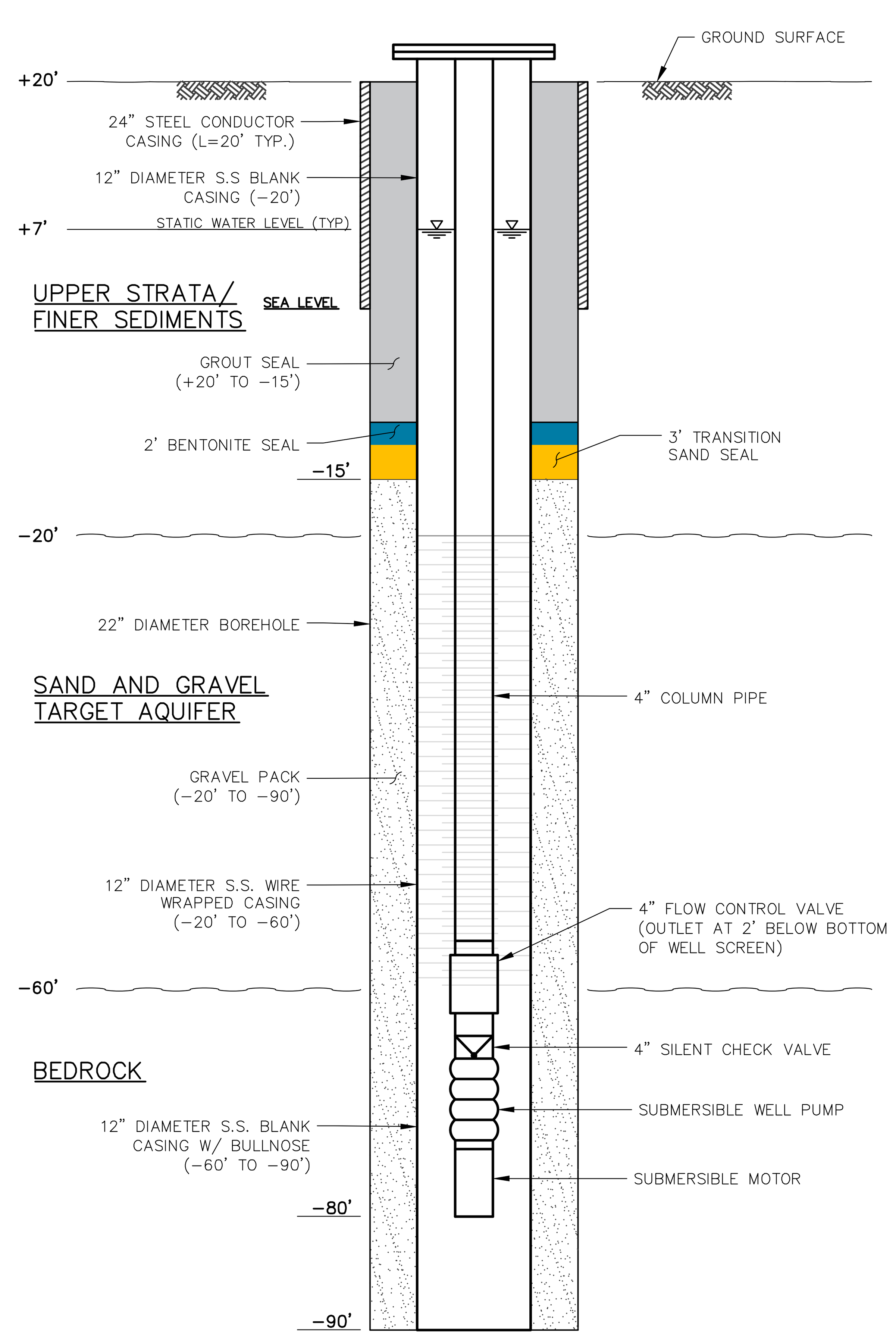
City of Morro Bay: Recycled Water Facilities IPR Pipeline Co
Calcs By: TL
Checked By: MJF

Cost by Alignment

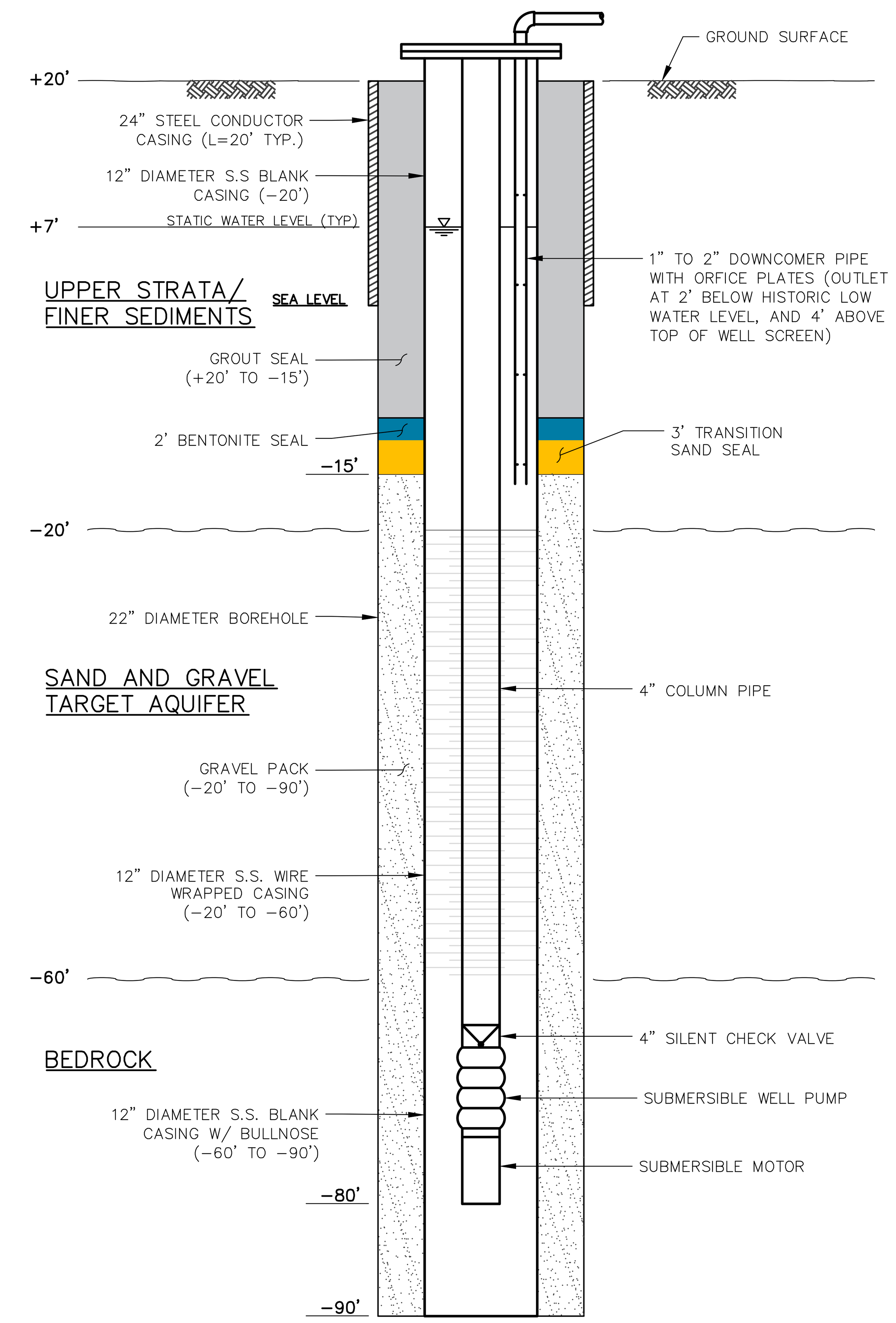
Alignment	IPR Alignment Alternatives to Connect to Injection Wells 1-8							
Segment Name	1	2A	3A	4	5A	6	7A	7B
Segment Length	2591	1761	2744	641	695	973	1038	1038
Description	Surf Street R/W / Trenched New Pipe	Parallel LS-2 FM / Vistra Easement / Trenched New Pipe	Reuse Ex Aband. 12" Desal Feed / Embarcadero R/W / + Trenched New Pipe	Connect to Bike Path IPR Termination / Vistra Easement / Trenched New Pipe	Cross Willow Camp Creek East Bank / Vistra Easement / Trenched New Pipe	Parallel Morro Creek and Marine Storage / Ex & New Easement Vistra / Trenched New Pipe	Cross Morro Creek & Reuse Ex Aband. 12" Desal Feed/Embarcadero RW/+ Trenched New Pipe	Cross Morro Creek Ex Pedestrian Bridge / Embarcadero R/W / Trenched New Pipe

Item	Unit	Unit Cost	1 Quantity	1 Total	2A Quantity	2A Total	3A Quantity	3A Total	4 Quantity	4 Total	5A Quantity	5A Total	6 Quantity	6 Total	7A Quantity	7A Total	7B Quantity	7B Total
Mob / Demob	LS	$ -		$ -		$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
SWPPP	LF	$ 25	100	$ 3,000	1,400	$ 35,000	500	$ 13,000	641	$ 16,000	695	$ 17,000	973	$ 24,000	200	$ 5,000	300	$ 8,000
Tree removal	EA	$ 2,000	-	$ -	6	$ 12,000	-	$ -	8	$ 16,000	35	$ 70,000	10	$ 20,000	-	$ -	-	$ -
Modify Existing Bridge for Utility Crossing	LS	$ 107,700	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -		$ -	1	$ 108,000
Reuse of Existing Pipeline	LF	$ 50	-	$ -	-	$ -	1,944	$ 97,000	-	$ -	-	$ -	-	$ -	1,038	$ 52,000	-	$ -
10" HDPE IPR Shallow Open Cut	LF	$ 182	2,591	$ 472,000	1,761	$ 321,000	800	$ 146,000	641	$ 117,000	695	$ 126,000	973	$ 177,000		$ -	1,038	$ 189,000
10" HDPE IPR Shallow Open Cut Creek Crossing	LF	$ 364	-	$ -	-	$ -	-	$ -	-	$ -	776	$ 282,000		$ -		$ -		$ -
Tracer Wire, Tracing Stations and Ground Rods	LF	$ 7	2,591	$ 17,000	1,761	$ 11,000	800	$ 5,000	641	$ 4,000	695	$ 5,000	973	$ 6,000	-	$ -	1,038	$ 7,000
Surf Street Slope Restoration	LS	$ 75,000	1	$ 75,000	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Hydroseeding/Landscape	LF	$ 13	-	$ -	1,390	$ 17,000	800	$ 10,000.0	641	$ 8,000	695	$ 9,000	973	$ 12,000	100	$ 1,000	200	$ 3,000
CARV or ARV	EA	$ 30,000	2	$ 60,000	2	$ 60,000	3	$ 90,000	2	$ 60,000	2	$ 60,000	2	$ 60,000	2	$ 60,000	2	$ 60,000
New Pipeline Cleaning, Inspection and Testing	LF	$ 5	2,591	$ 13,000	1,761	$ 9,000	2,744	$ 14,000	641	$ 3,000	695	$ 3,000	973	$ 5,000	1,038	$ 5,000	1,038	$ 5,000
Pavement Restoration 1	LF	$ 72	2,491	$ 179,000	457	$ 33,000	800	$ 58,000	-	$ -	-	$ -	200	$ 14,000		$ -	838	$ 60,000
Surface Restoration 1	LF	$ 12	100	$ 1,000	1,304	$ 16,000	1,944	$ 23,000	641	$ 8,000	695	$ 8,000	773	$ 9,000	500	$ 6,000	200	$ 2,000
TCP 1 (advanced)	LF	$ 50	300	$ 15,000	-	$ -	800	$ 40,000		$ -	-	$ -	-	$ -		$ -		$ -
TCP 2 (intermediate)	LF	$ 30	-	$ -	1,150	$ 35,000	-	$ -		$ -		$ -	700	$ 21,000	300	$ 9,000	838	$ 25,000
TCP 3 (reduced)	LF	$ 20	2,191	$ 44,000		$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
TCP 4 (none)	LF	$ 5	100	$ 1,000	611	$ 3,000	1,944	$ 10,000	641	$ 3,000	695	$ 3,000	-	$ -	738	$ 4,000	200	$ 1,000
Utility Transverse Crossing	EA	$ 500	30	$ 15,000	2	$ 1,000	10	$ 5,000	2	$ 1,000.00	-	$ -	2	$ 1,000	5	$ 3,000	5	$ 3,000
Materials, Labor, & Equipment Subtotal				**$ 895,000**		**$ 553,000**		**$ 511,000**		**$ 236,000**		**$ 583,000**		**$ 349,000**		**$ 145,000**		**$ 471,000**
Contractor Overhead & Profit (incl'd w/ unit cost)		0%		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Contractor Bonds & Insurance (incl'd w/ unit cost)		0%		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Construction Subtotal				**$ 895,000**		**$ 553,000**		**$ 511,000**		**$ 236,000**		**$ 583,000**		**$ 349,000**		**$ 145,000**		**$ 471,000**
Design Contingency		40%		$ 358,000		$ 221,200		$ 204,400		$ 94,400		$ 233,200		$ 139,600		$ 58,000		$ 188,400
Construction Bid				**$ 1,253,000**		**$ 774,000**		**$ 715,000**		**$ 330,000**		**$ 816,000**		**$ 489,000**		**$ 203,000**		**$ 659,000**
Construction Contingency		10%		$ 125,300		$ 77,400		$ 71,500		$ 33,000		$ 81,600		$ 48,900		$ 20,300		$ 65,900
Total Construction Cost				**$ 1,378,000**		**$ 851,000**		**$ 787,000**		**$ 363,000**		**$ 898,000**		**$ 538,000**		**$ 223,000**		**$ 725,000**

APPENDIX D - Injection Well Downhole Configurations (Profiles)



FLOW CONTROL VALVE & PUMP SYSTEM
NTS



DOWNCOMER & PUMP SYSTEM
NTS

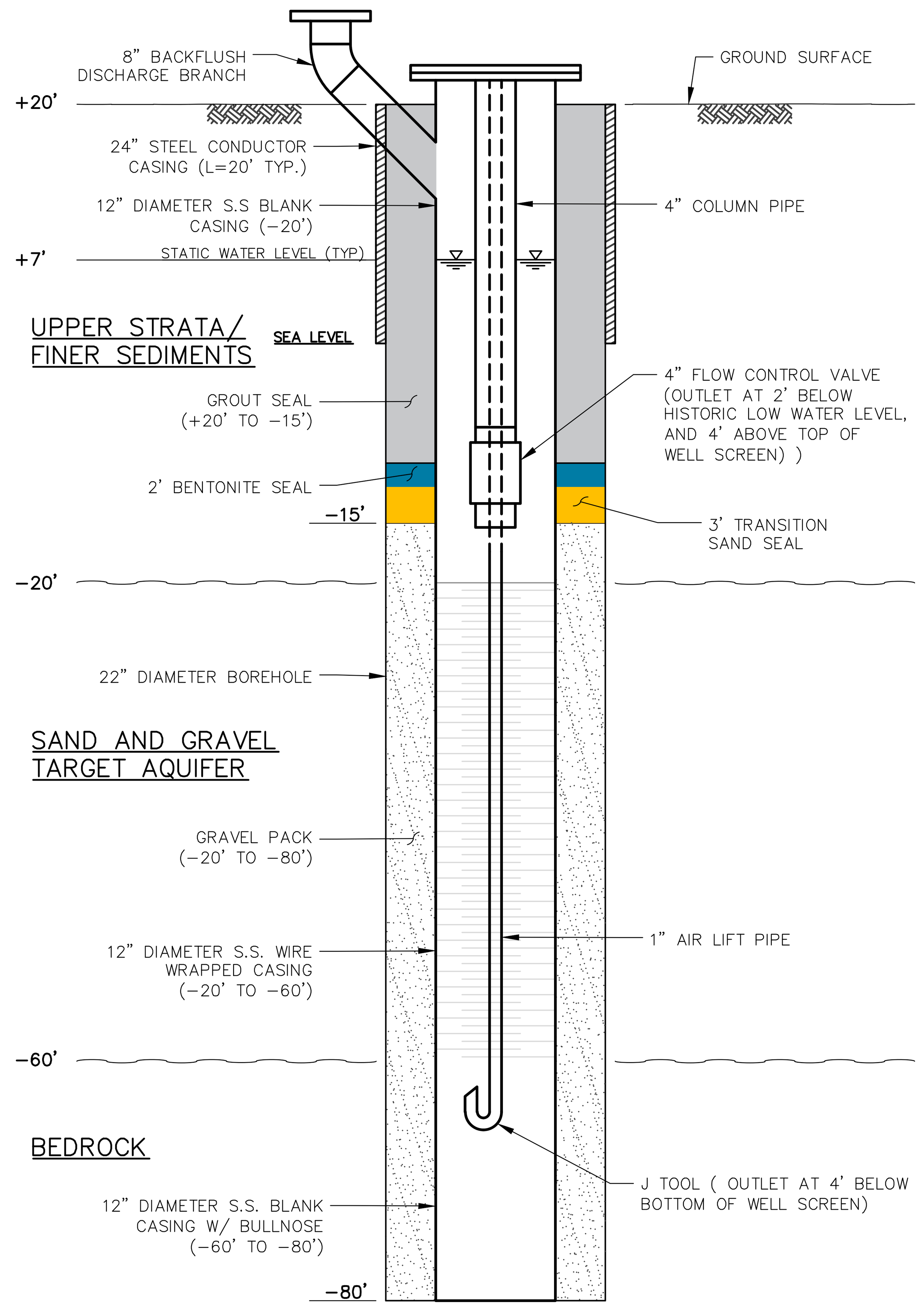
NOTES:

1. FOR EACH INJECTION WELL, SITE SPECIFIC HISTORIC LOW WATER LEVEL AND TOP OF WELL SCREEN WILL BE VERIFIED BEFORE ESTABLISHING BOTTOM ELEVATION OF DOWNCOMER OR INJECTION TUBE.

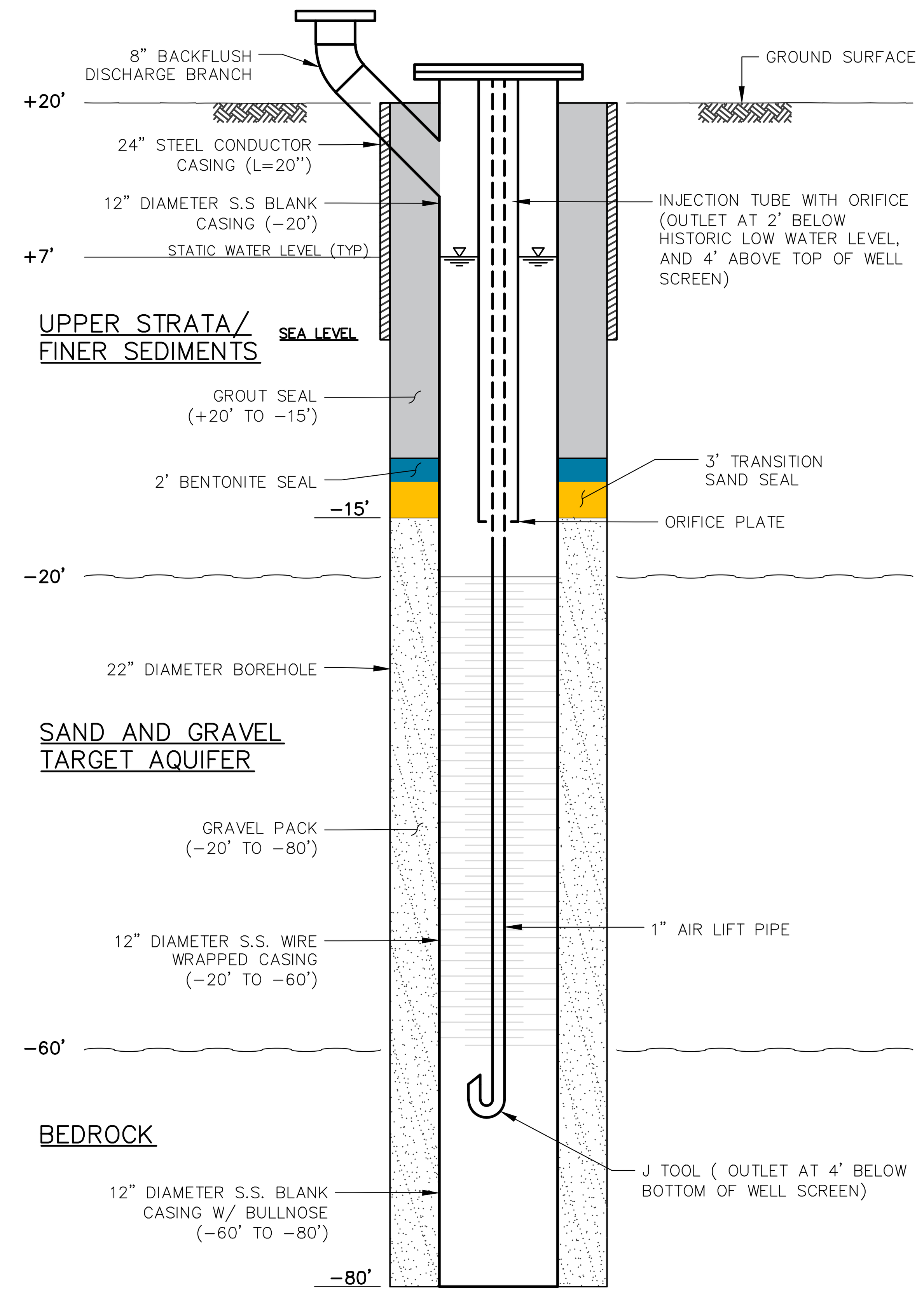
2. ALL INJECTION WELL PROFILES WILL INCLUDE AN INTERNAL SOUNDING TUBE FOR MEASURING WATER LEVELS.

INJECTION WELL DOWNHOLE PROFILES

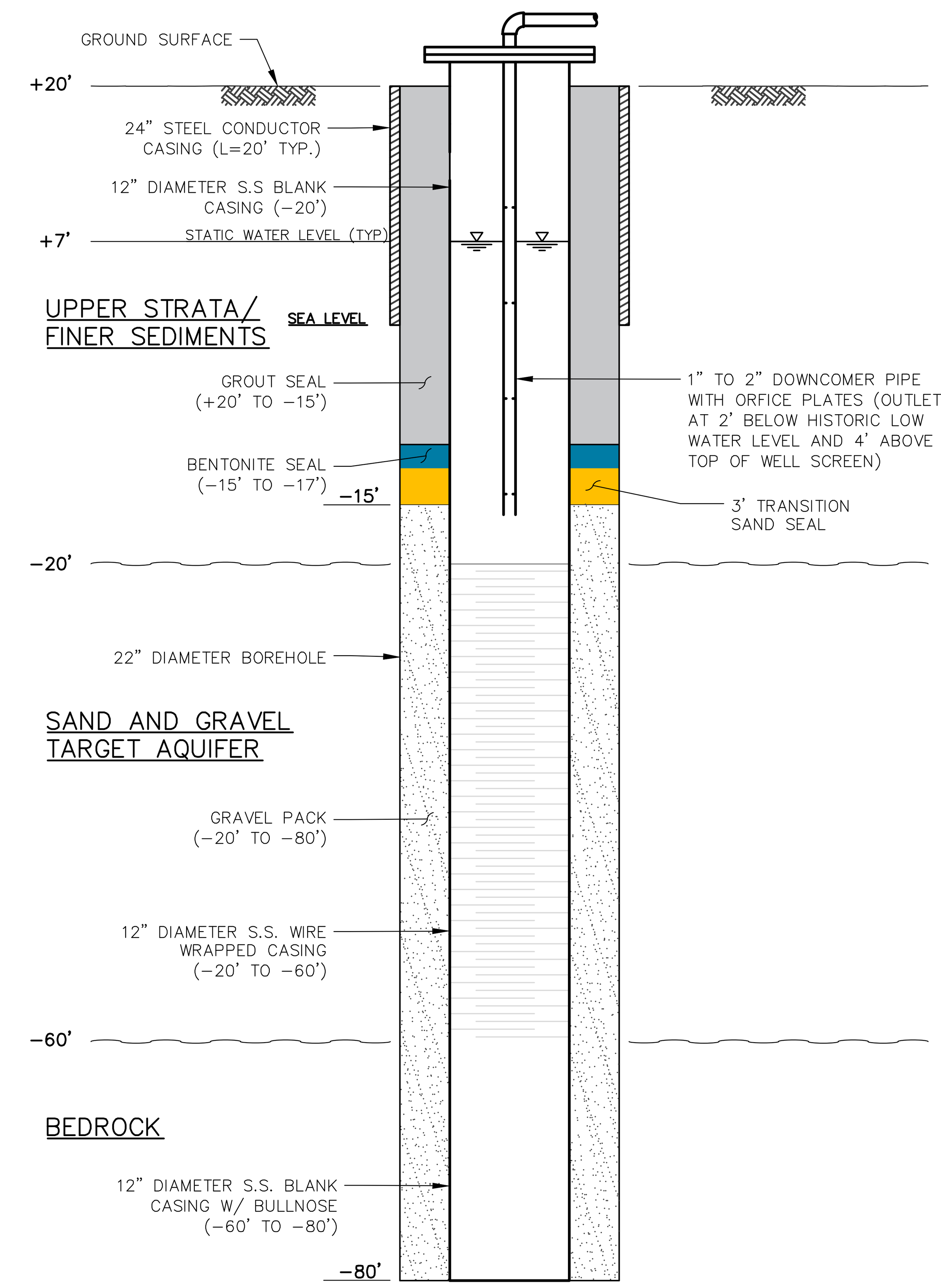
Cannon
1050 SOUTHWOOD DRIVE
SAN LUIS OBISPO, CA 93401
P 805.544.7407 F 805.544.3863



FLOW CONTROL VALVE
& AIR LIFT PIPE SYSTEM
NTS



INJECTION TUBE
& AIR LIFT PIPE SYSTEM
NTS



SIMPLE DOWNCOMER SYSTEM
NTS

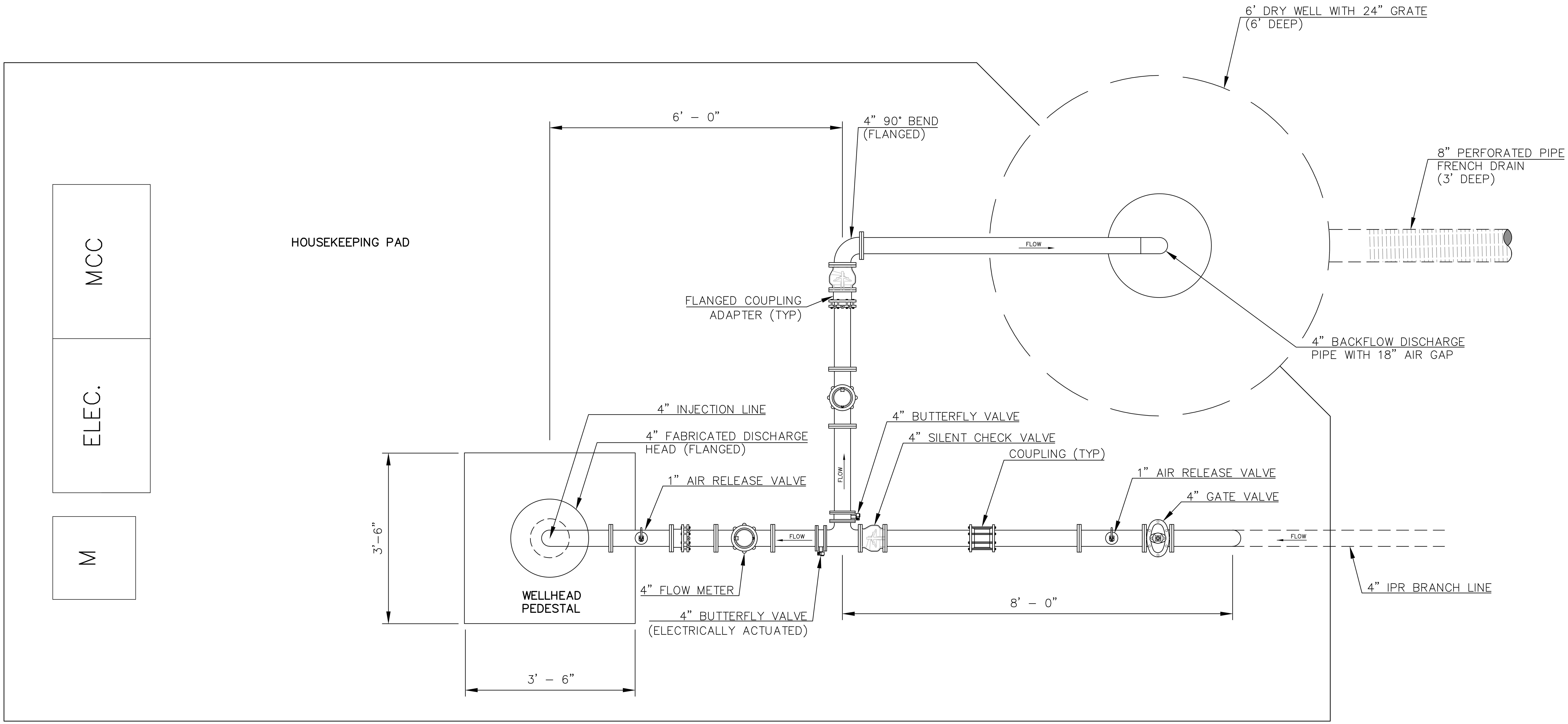
NOTES:

1. FOR EACH INJECTION WELL, SITE SPECIFIC HISTORIC LOW WATER LEVEL AND TOP OF WELL SCREEN WILL BE VERIFIED BEFORE ESTABLISHING BOTTOM ELEVATION OF DOWNCOMER OR INJECTION TUBE.
2. ALL INJECTION WELL PROFILES WILL INCLUDE AN INTERNAL SOUNDING TUBE FOR MEASURING WATER LEVELS.

INJECTION WELL DOWNHOLE PROFILES

Cannon
1050 SOUTHWOOD DRIVE
SAN LUIS OBISPO, CA 93401
P 805.544.7407 F 805.544.3863

APPENDIX E1 - Flow Control Valve & Pump System - Wellhead Piping Layout



NOTE:

1. THE FOLLOWING ITEMS NOT SHOWN AT THIS CONCEPT LEVEL WILL BE INCLUDED IN THE PIPING FINAL DESIGN: SOUNDING TUBE, AIR LINE PORT, PRESSURE GAUGES, PIPE SUPPORTS, VALVE ACTUATORS, SAMPLE TAPS, HOSE BIBS, SAND SEPARATOR, ETC.

FLOW CONTROL VALVE & PUMP SYSTEM – PIPING LAYOUT (1 OF 5)

SCALE HORIZ 1"=2'

APPENDIX E2 - Downcomer & Pump System - Wellhead Piping Layout

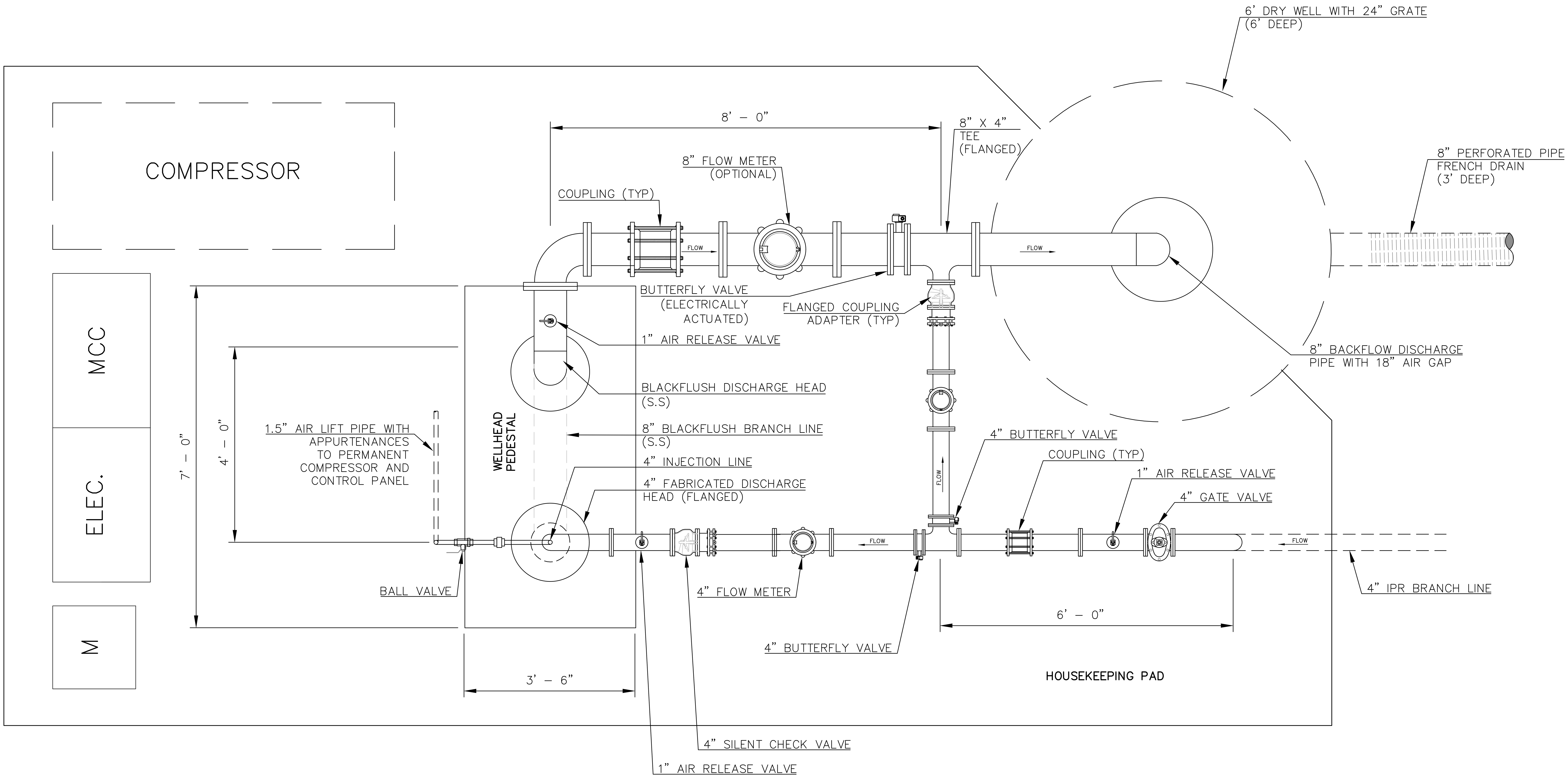
NOTE:

1. THE FOLLOWING ITEMS NOT SHOWN AT THIS CONCEPT LEVEL WILL BE INCLUDED IN THE PIPING FINAL DESIGN: SOUNDING TUBE, AIR LINE PORT, PRESSURE GAUGES, PIPE SUPPORTS, VALVE ACTUATORS, SAMPLE TAPS, HOSE BIBS, SAND SEPARATOR, ETC.

DOWNCOMER & PUMP SYSTEM – PIPING LAYOUT (2 OF 5)

SCALE HORIZ 1"=2'

APPENDIX E3 - Flow Control Valve & Air Lift System - Wellhead Piping Layout



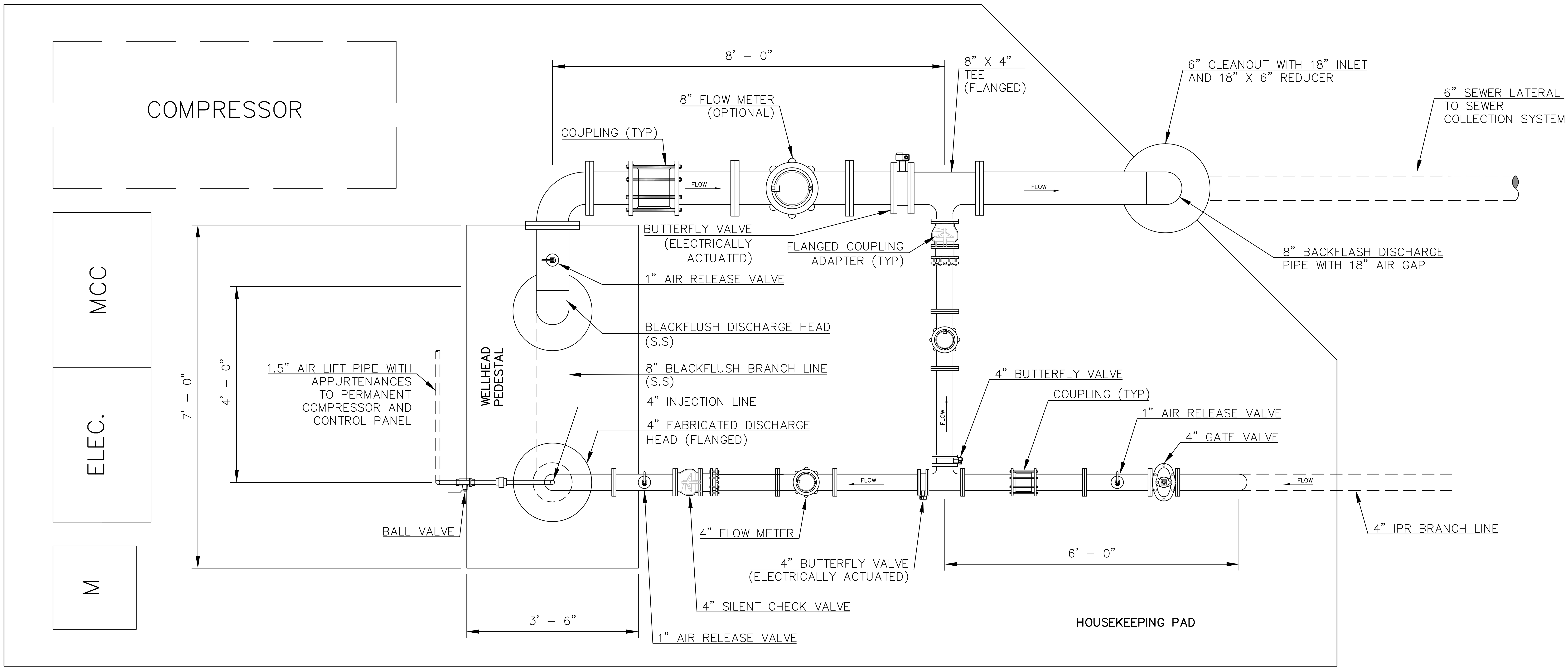
NOTE:

1. THE FOLLOWING ITEMS NOT SHOWN AT THIS CONCEPT LEVEL WILL BE INCLUDED IN THE PIPING FINAL DESIGN: SOUNDING TUBE, AIR LINE PORT, PRESSURE GAUGES, PIPE SUPPORTS, VALVE ACTUATORS, SAMPLE TAPS, HOSE BIBS, SAND SEPARATOR, ETC.

FLOW CONTROL VALVE & AIR LIFT SYSTEM – PIPING LAYOUT (3 OF 5)

SCALE HORIZ 1"=2'

APPENDIX E4 - Injection Tube & Air Lift System - Wellhead Piping Layout



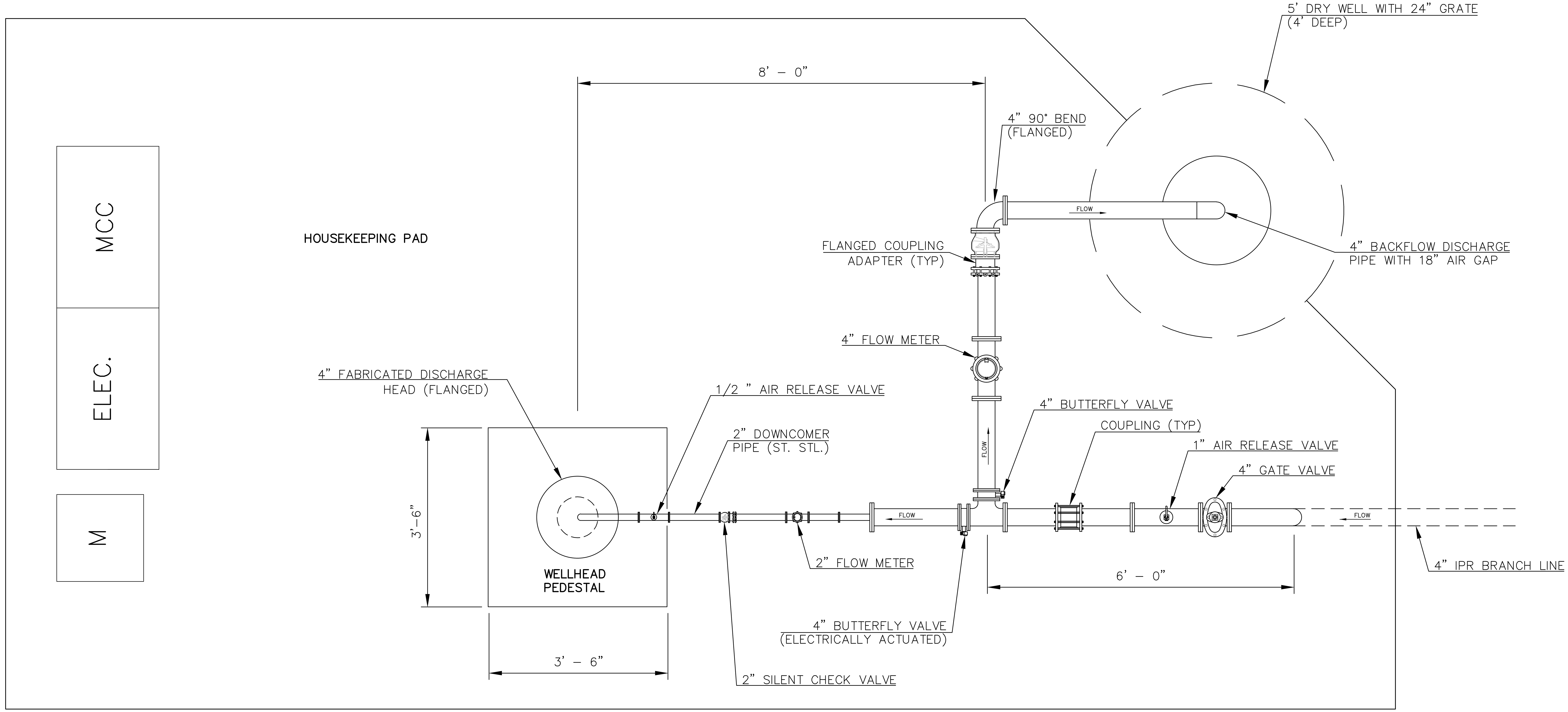
NOTE:

1. THE FOLLOWING ITEMS NOT SHOWN AT THIS CONCEPT LEVEL WILL BE INCLUDED IN THE PIPING FINAL DESIGN: SOUNDING TUBE, AIR LINE PORT, PRESSURE GAUGES, PIPE SUPPORTS, VALVE ACTUATORS, SAMPLE TAPS, HOSE BIBS, SAND SEPARATOR, ETC.

INJECTION TUBE & AIR LIFT SYSTEM – PIPING LAYOUT (4 OF 5)

SCALE HORIZ 1"=2'

APPENDIX E5 - Simple Downcomer System - Wellhead Piping Layout



NOTE:

1. THE FOLLOWING ITEMS NOT SHOWN AT THIS CONCEPT LEVEL WILL BE INCLUDED IN THE PIPING FINAL DESIGN: SOUNDING TUBE, AIR LINE PORT, PRESSURE GAUGES, PIPE SUPPORTS, VALVE ACTUATORS, SAMPLE TAPS, HOSE BIBS, SAND SEPARATOR, ETC.

SIMPLE DOWNCOMER SYSTEM – PIPING LAYOUT (5 OF 5)

SCALE HORIZ 1"=2'

APPENDIX F - Detailed Construction Cost Estimates

City of Morro Bay - Utilities Division

IPR BRANCH LINES OF RECYCLED WATER FACILITIES PROJECT

Alignment Alternative 1 - Segments A, B, C, Ds, 4, 5A, 6, and Desal Feedwater Line

Engineer's Preliminary Construction Cost Estimate

Date Prepared: February 7, 2025

BID ITEM NO.	DESCRIPTION	Bid Quantity	Unit of Measure	Engineer's Estimate	
				Unit Price	Total
1	Mobilization	1	LS	$ 65,000	$ 65,000
2	Stormwater Management (SWPPP)	1	LS	$ 80,000	$ 80,000
3	Project Safety & Traffic Control	1	LS	$ 50,000	$ 50,000
4	Surveying & Construction Staking	1	LS	$ 25,000	$ 25,000
5	Public Notification	1	LS	$ 5,000	$ 5,000
6	Pothole Utilities	5	EA	$ 1,100	$ 5,500
7	Construct Cut-in Connection to Exist. 10" HDPE	1	LS	$ 22,000	$ 22,000
8	Construct Cut-in Connection to Exist. 12" Yelomine PVC	1	LS	$ 20,000	$ 20,000
9	Install 10" C900 PVC Waterline - DR 18 Class 235, Segment 4	450	LF	$ 330	$ 148,500
10	Install 10" HDPE Waterline - DR 18 Class 165, Segment 5A Horizontal Direction Drilling	950	LF	$ 400	$ 380,000
11	Install 10" C900 PVC Waterline - DR 18 Class 235, Segment 6	710	LF	$ 330	$ 234,300
12	Install 10"x6" Tee for Injection Well Connection	3	EA	$ 8,000	$ 24,000
13	Install 12"x6" Tee for Injection Well Connection	1	EA	$ 9,000	$ 9,000
14	Install 4" C900 PVC Waterline - DR 18 Class 235	480	LF	$ 250	$ 120,000
15	Install 10" Gate Valve	4	EA	$ 10,000	$ 40,000
16	Install 6" Gate Valve	4	EA	$ 6,000	$ 24,000
17	Install 2" Combination Air Valve Assembly	2	EA	$ 18,000	$ 36,000
18	Install 4" Blowoff Assembly in Vault	1	EA	$ 32,000	$ 32,000
19	Construct 1.5-Sack Cement Slurry Trench Backfill	295	CY	$ 180	$ 53,100
20	Construct 5” Thick AC Paving	44	Tons	$ 500	$ 22,000
21	Construct 5" Thick Aggregate Base Paving	22	CY	$ 150	$ 3,300
22	Install Traffic Striping & Pavement Legends	1	LS	$ 12,000	$ 12,000
23	Restore Private Improvements to Equal or Better	1	LS	$ 50,000	$ 50,000
31	Perform Miscellaneous Work (T&M not to exceed)	-	T&M	$ 30,000	$ 30,000
	Sub-Total:				**$ 1,490,700**
	DESAL FEEDWATER LINE RETROFIT				
24	Chemical Cleaning & Flushing	1	LS	$ 75,000	$ 75,000
25	Isolate Seawater Wells from Desal Line	7	EA	$ 10,000	$ 70,000

26	Install (Cut-In) 12" Gate Valve	3	EA	$ 22,000	$ 66,000
27	Install 1" Combination Air Valve Assembly	4	EA	$ 12,000	$ 48,000
28	Install (Cut-In) 4" Blowoff Assembly in Vault	2	EA	$ 35,000	$ 70,000
29	Flush, Disinfect, and Pressure Test	1	LS	$ 15,000	$ 15,000
30	Repair Leak	3	EA	$ 15,000	$ 45,000
	Sub-Total:				**$ 389,000**
TOTAL					**$ 1,879,700**
	Contingency:			25%	$ 469,925
	Grand Total Construction Cost (rounded):				**$ 2,350,000**

<u>Notes:</u>

1. In providing opinions of probable construction costs, the District must understand that Cannon has no control over the costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinions of probable costs provided herein are made on the basis of Cannon's qualifications and experience. Cannon makes no warranty, expressed or implied, as to the accuracy of such opinions as compared to bid or actual costs.
2. Based on the current level of "project" definition, this cost estimate is considered a Class 4 estimate with an accuracy range of -20% to +30%. See table below.

3. It is assumed all trenches will be backfilled with 1.5-sack cement slurry.

	Primary Characteristic	***Secondary Characteristic***		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges at an 80% confidence interval
Class 5	0% to 2%	Functional area, or concept screening	SF or m^2 factoring, parametric models, judgment, or analogy	L: -20% to -30% H: +30% to +50%
Class 4	1% to 15%	or Schematic design or concept study	Parametric models, assembly driven models	L: -10% to -20% H: +20% to +30%
Class 3	10% to 40%	Design development, budget authorization, feasibility	Semi-detailed unit costs with assembly level line items	L: -5% to -15% H: +10% to +20%
Class 2	30% to 75%	Control or bid/tender, semi-detailed	Detailed unit cost with forced detailed take-off	L: -5% to -10% H: +5% to +15%
Class 1	65% to 100%	Check estimate or pre bid/tender, change order	Detailed unit cost with detailed take-off	L: -3% to -5% H: +3% to +10%

Table 1 – Cost Estimate Classification Matrix for Building and General Construction Industries

Association for the Advancement of Cost Engineering (AACE)

City of Morro Bay - Utilities Division

INJECTION WELL COMPONENT OF RECYCLED WATER FACILITIES PROJECT

Injection Well Construction & Equipping

Downcomer & Pump System

Engineer's Preliminary Construction Cost Estimate

Date Prepared: May 15, 2025

Bid Item No.	DESCRIPTION	Bid Quantity	Unit of Measure	Engineer's Estimate	
				Unit Price	Total
1	Mobilization	1	LS	$ 250,000	$ 250,000
2	Stormwater Management (SWPPP)	1	LS	$ 80,000	$ 80,000
3	Project Safety & Traffic Control	1	LS	$ 25,000	$ 25,000
4	Surveying & Construction Staking	1	LS	$ 30,000	$ 30,000
5	Public Notification	1	LS	$ 5,000	$ 5,000
6	Pothole Utilities	7	EA	$ 1,100	$ 7,700
7	Drill Well (100' deep with 12" casing)	255	LF	$ 3,112	$ 793,560
8	Construct Wellhead Site Improvements (finish grading, concrete pad, and shade structure)	4	EA	$ 100,000	$ 400,000
9	Install 4" Wellhead Piping & Valves	4	EA	$ 140,000	$ 560,000
10	Install 2" Wellhead Piping & Valves	4	EA	$ 30,000	$ 120,000
11	Install Well Pump (140 gpm @ 163' TDH) & 10 HP Submersible Motor	4	EA	$ 75,000	$ 300,000
12	Install 2" Downcomer Piping	140	LF	$ 80	$ 11,200
13	Install PG&E Service, Meter and Conduits	4	EA	$ 120,000	$ 480,000
14	Install Injection Well Electrical & Control System	4	EA	$ 140,000	$ 560,000
15	Install Injection Well Instrumentation & Telemetry System	4	EA	$ 75,000	$ 300,000
16	Construct Drywell (6' diameter x 6' deep)	2	EA	$ 45,000	$ 90,000
17	Install 8" diameter PVC French Drain System	400	LF	$ 400	$ 160,000
18	Install Package Pump Station (140 gpm @ 12' TDH) (Backflush Disposal)	1	LS	$ 80,000	$ 80,000
19	Construct Sewer Manhole (4' Diameter)	1	EA	$ 15,000	$ 15,000
20	Construct 4" Force Main (Backflush Disposal)	640	LF	$ 350	$ 224,000
21	Construct 6" Sewer Lateral	360	LF	$ 400	$ 144,000
22	Construct 6" Sewer Cleanout	2	EA	$ 12,000	$ 24,000
23	Construct 7' High Chain-Link Fencing and Gates	400	LF	$ 150	$ 60,000
24	Construct 5" Thick Aggregate Base Paving	140	CY	$ 140	$ 19,600
25	Construct 5" Thick AC Paving	280	Tons	$ 500	$ 140,000

City of Morro Bay - Utilities Division

INJECTION WELL COMPONENT OF RECYCLED WATER FACILITIES PROJECT

Injection Well Construction & Equipping

Downcomer & Pump System

Engineer's Preliminary Construction Cost Estimate

26	Perform Miscellaneous Work (T&M not to exceed)	-	T&M	$ 50,000	$ 50,000
TOTAL					**$ 4,929,060**
	Contingency:			25%	$ 1,232,265
	Grand Total (rounded):				**$ 6,162,000**

Notes:

1. In providing opinions of probable construction costs, the District must understand that Cannon has no control over the costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinions of probable costs provided herein are made on the basis of Cannon's qualifications and experience. Cannon makes no warranty, expressed or implied, as to the accuracy of such opinions as compared to bid or actual costs.
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