Water Production Department, Injection Recharge Group

MID BASIN

INJECTION WELLS

Operations & Maintenance Manual

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TABLE OF CONTENTS

APPENDICES

LIST OF ABBREVIATIONS

INTRODUCTION

The primary objective of the Mid Basin Injection (MBI) Project is to replenish groundwater upgradient of a heavily pumped portion of the Principal Aquifer with Groundwater Replenishment System (GWRS) product water. The MBI Project also increases the recharge capacity of the Basin, by freeing up capacity in the OCWD Forebay spreading grounds for recharging available SAR and imported water flows. Together, the DMBI Project (injection well MBI-1) and MBI Centennial Park Project (injection wells MBI-2, MBI-3, MBI-4, and MBI-5) comprise the MBI Project. Figure 1 below shows the location of the MBI Project.

The objective of this manual is to present a comprehensive overview of the MBI system supported by detailed operational procedures to be used by Injection Recharge System Operators (IRSOs). This operations manual is a living document that will be updated with changes in District policy, operational procedure or the injection recharge facilities. The responsibility of updating this manual lies with the Distribution and Injection Well Supervisor.

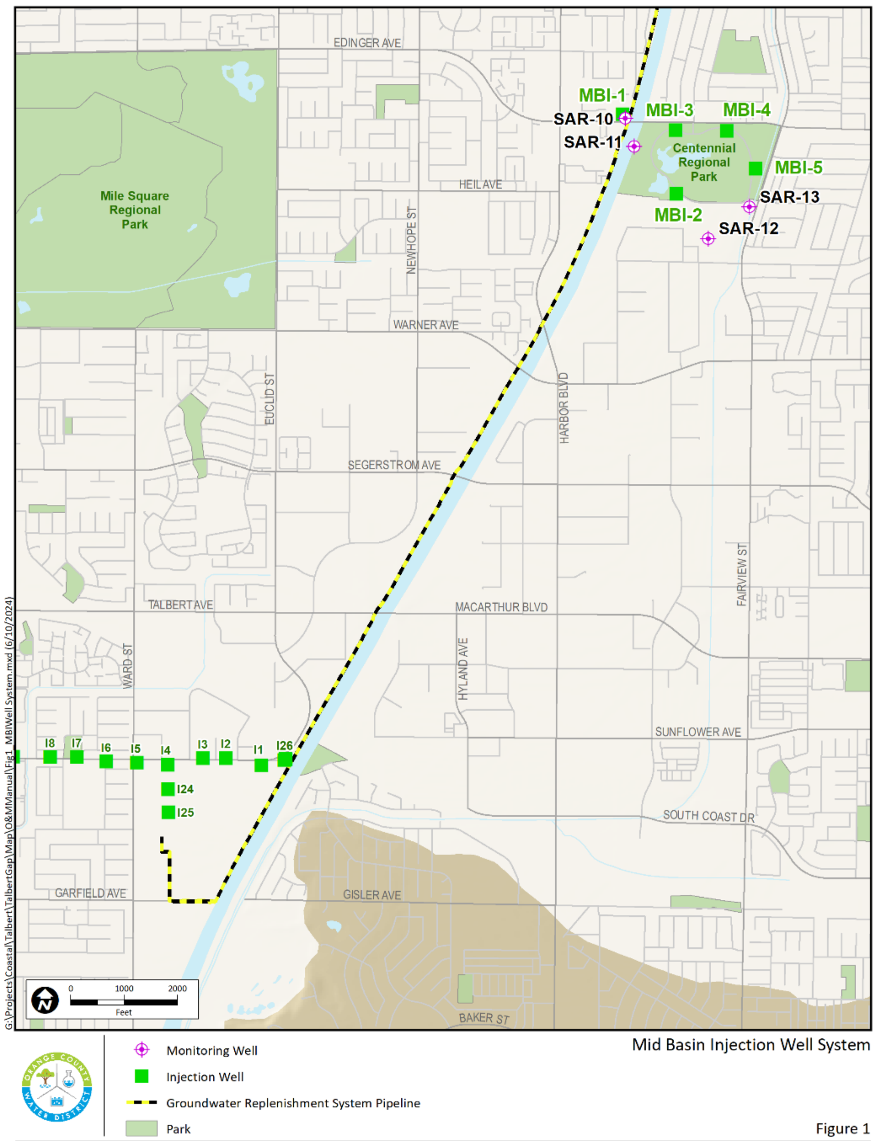


Figure 1

MBI project location map.

BACKGROUND

The MBI Project was implemented in two parts: an initial Demonstration MBI (DMBI) Project that became operational in April 2015, and the subsequent MBI Centennial Park Project that began operation in March 2020.

The MBI Project consists of five injection wells (MBI-1 through MBI-5) along with four nearby downgradient multi-depth nested compliance monitoring wells (SAR-10, SAR-11, SAR-12 and SAR-13), located approximately three miles north of the Talbert Barrier, along the GWRS Pipeline at the Santa Ana River and Edinger Avenue (**Figure 1**). **Figure 2** shows a generalized well construction diagram representing the five MBI wells.

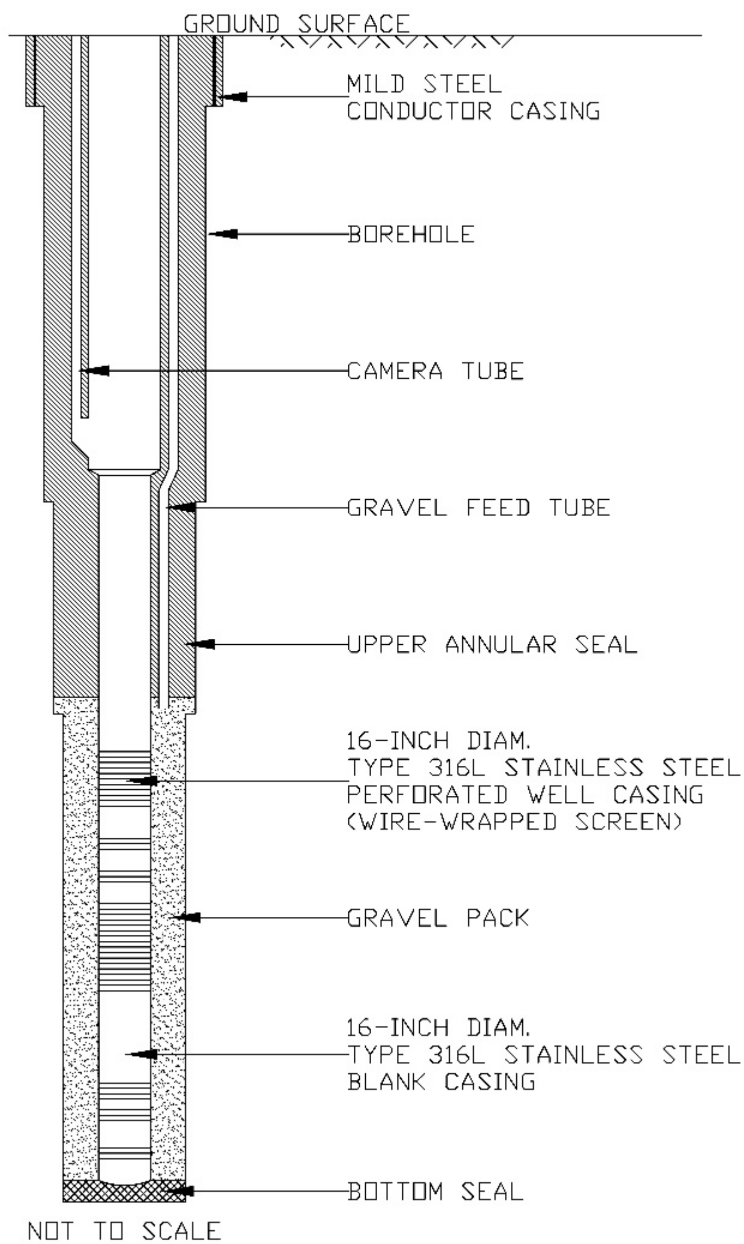


Figure 2
Generalized MBI well construction diagram.

MID BASIN INJECTION DISTRIBUTION SYSTEM

The Mid Basin Injection distribution system is constructed of epoxy lined (cml) and cement mortar coated steel pipe ranging in diameter from 36 to 12-inch. The IRSO follows a maintenance program for the Mid Basin Injection distribution system that includes:

- valve exercising
- blowing off the main pipeline
- monitoring air vacuum and release (air-vac) valves for leakage

To avoid water hammer, main system valves are ideally exercised when there is no or little pressure on the main. The IRSO should always actuate valves slowly. For details on exercising main line and lateral valves see Appendix A-1.

Debris accumulates in the low spots of the main pipeline and needs to be removed periodically to maintain pipeline efficiency. Located at the deep spots along the main pipeline will be a tee with an 8-inch diameter pipe and an 8-inch diameter butterfly valve. The 8-inch pipe terminates in a shallow vault at ground surface near the curb and gutter. Inside the shallow vault the 8-inch pipe is blind flanged and tapped with a threaded fire hose fitting. When the 8-inch valve is opened and the firehouse fitting cap is removed, water and debris flow from the main and discharge to the curb and gutter. This assembly is called a blow-off (b/o) valve. The IRSO can successfully remove accumulated debris from the main pipeline by operating the b/o valves under pressurized and flowing conditions. For b/o valve operation procedures, see Appendix A-2.

Changes in water chemistry and pipeline pressure can cause dissolved gas to come out of solution. The gas usually becomes trapped in the high spots along the main pipeline. These trapped pockets of gas reduce pipeline efficiency. The high spots in the pipeline are tapped with 2-inch diameter tubing. These tubing segments stub up above grade along the margin of the roadway and are fitted with an air-vac valve. The air-vac valve allows dissolved gasses to escape during a pressurized condition and allows atmosphere to enter the pipeline during draining operations. The air-vac is designed to operate passively. Occasionally an air-vac will not seat correctly. Visual inspection by the IRSO will determine a leak. Leaks are usually the result of a faulty seat. To reseat an air-vac valve, gently tap the valve body with a hammer. This should seat the valve. If the air-vac valve does not seat, it will need to be replaced by the IRSO.

The Mid Basin Injection distribution system is not protected from corrosion using cathodic protection.

GWRS-MBI Pipeline Intertie

All MBI wells inject GWRS product water exclusively. Unlike the Talbert Barrier, there are no imported water connections that feed MBI wells. A 78-inch cement lined and coated steel pipe runs along the west levee of the Santa Ana River transferring GWRS product water from the Advanced Water Purification Facility (AWPF) in Fountain Valley to the spreading grounds in Anaheim. A 30-inch tee into the 78-inch GWRS pipeline at the Edinger Avenue bridge (GWRS-MBI Intertie) provides the injection water for MBI recharge. Figure 3 show an engineer’s drawing of the GWRS-MBI Intertie.

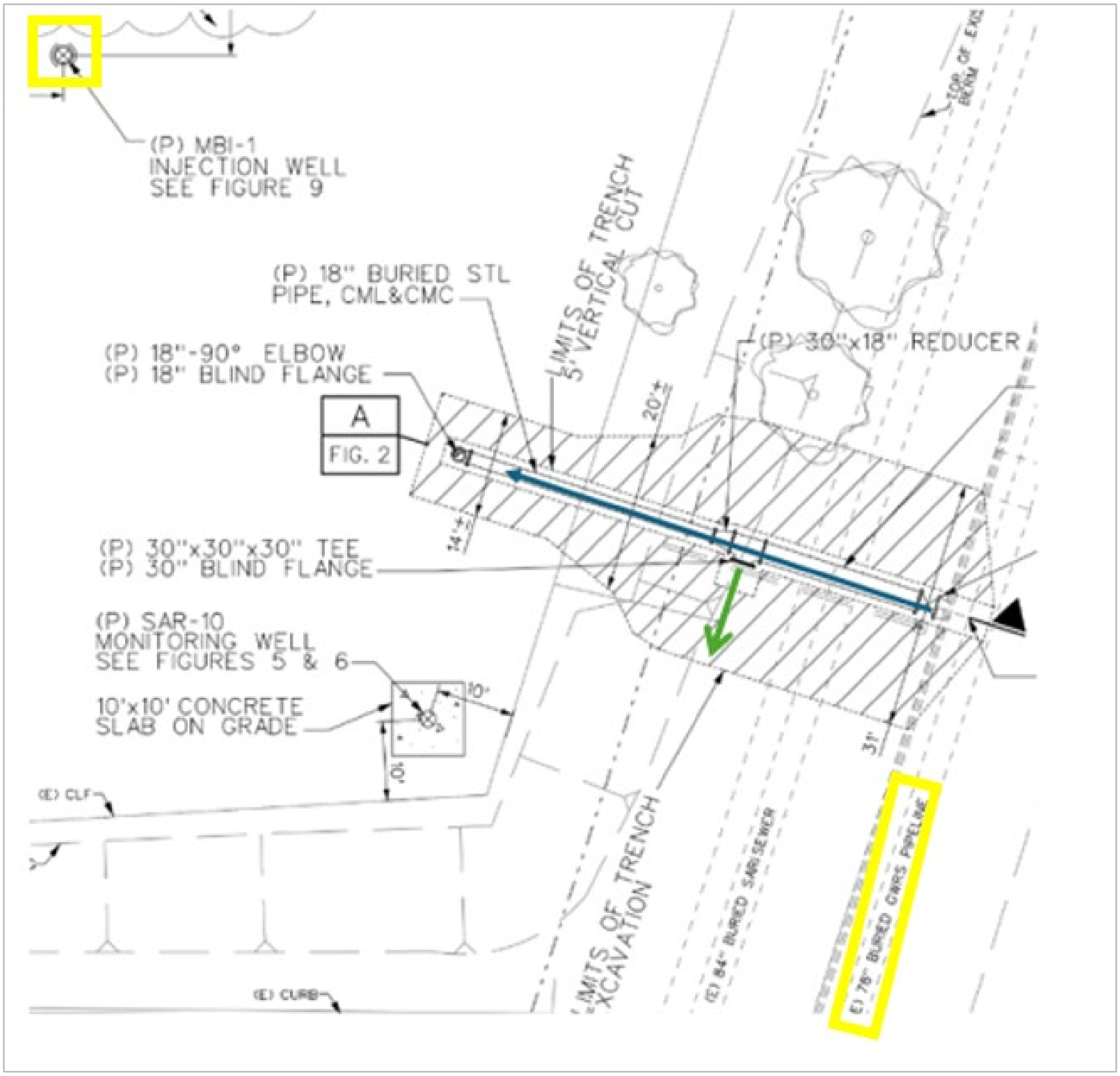


Figure 3

Engineer's drawing showing the GWRS-MBI Intertie connecting the 78-inch GWRS Pipeline to the Mid-Basin Injection Wells. The blue arrow indicates flow from the 78-inch GWRS pipeline into the MBI well-field. The green arrow shows flow heading towards Centennial Park. Injection well MBI-1 is located in the upper-left hand corner of the drawing. Injection wells MBI-2 through 5 are located to the southeast, outside of the area shown.

Two critical valves are operated by the IRSO at the GWRS-MBI Intertie. The first valve is at the 30-inch tee with the 78-inch GWRS Pipeline, this is a 30-inch gate valve for MBI-1 only and requires over 300 turns to change the valve position from fully open to fully closed. Downstream, a 30-inch butterfly valve at the 30-inch x 30-inch tee sends water over the Edinger Avenue bridge to MBI-2 through 5. Figure 4 shows the location of these two critical valve actuators at the surface.

Figure 4

Image looking North (upstream) along the Santa Ana River of the GWRS-MBI Pipeline Intertie. A Location of valve actuator for the gate valve at the Tee connecting the 78-inch GWRS Pipeline with the 30-inch MBI pipeline. ***B*** *Location of valve actuator for the butterfly valve at the 30-inch by 30-inch tee. Opening this butterfly valve will send flow to the injection well in Centennial Park.*

The Edinger Avenue bridge attracts human habitation. These human inhabitants often times engage in nefarious activities that can result in damage to District equipment (for this reason IRSO's should not visit the MBI well field alone). To protect the valve actuator shown as "A" in Figure 4 a rock is rolled over the valve cover as shown in Figure 5.

Figure 5

Valve actuator lid for the 30-inch gate valve at the tee with the GWRS covered with a rock marked with a red paint dot. The IRSO conceals the valve lid this way to discourage damage from local human inhabitants.

Additionally, the 30-inch butterfly valve actuator that sends water across the river into Centennial Park had been modified with a metal cover secured by tamper resistant fasteners as shown in Figure 6.

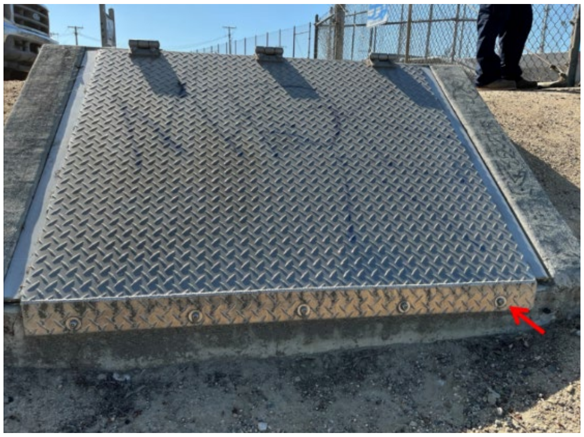


Figure 6
Protective enclosure for the valve actuator to send GWRS water over Edinger Avenue into Centennial Park. Tamper resistant fasteners are used to secure the enclosure (red arrow). The IRSO will be working on a sloped surface when accessing and operating this valve.

To unfasten this cover, a special tool is required. The special tool is a T55 Torx bit socket that attaches to a 3/8-inch rachet-driver. The socket tool is stored inside the MBI-1 electrical room as shown in Figure 7.

Figure 7
The anti-theft T55 Torx bit (red oval) used to access the valve enclosure shown above is stored inside the MBI-1 electrical building near the light switch, in the clear plastic folder tray. This tool will fit any 3/8-inch rachet-driver. It is important that the IRSO return the tool after each use and lock the electrical building door when leaving the MBI-1 site.

Once the anti-theft fasteners have been removed, the IRSO shall don a pair of sturdy gloves to swing the lid upward. If a lot of debris and insects are beneath the cover, the area should be swept. Also, it is common to find drug paraphernalia under the cover. The IRSO shall not directly touch drug paraphernalia, even with sturdy gloves on. Always use the grabbing tool in the back of your pickup truck to touch drug paraphernalia and follow procedures outlined in Appendix A-3 to properly dispose of field sharps.

Beneath the protective stainless-steel cover, the IRSO will find two circular cast iron lids covering two risers (Figure 8). The riser marked **A** in Figure 8 contains cathodic protection test leads. The riser marked **B** in Figure 8 contains the operator nut that actuates the butterfly valve sending GWRS product water over the Santa Ana River and into the Centennial Park well field (injection wells MBI-2 through MBI-5).

Figure 8
*Inside the protective cover. Riser marked **A** contains cathodic protection test leads. Riser marked **B** contains the actuator nut for the butterfly valve controlling GWRS flow into Centennial Park. Debris, insects and drug paraphernalia (red oval) are often found under the cover. The IRSO should use extreme caution when working under this cover and understand that the footing is sloped and unpaved. The handle of an IRSO's grabbing tool is visible in the upper right-hand corner of the image. The grabbing tool is the <u>only</u> method the IRSO shall use to handle drug paraphernalia.*

Injection Well MBI-1 Distribution System

A flow distribution diagram of the MBI-1 injection and waste piping is presented in Figure 9 below.

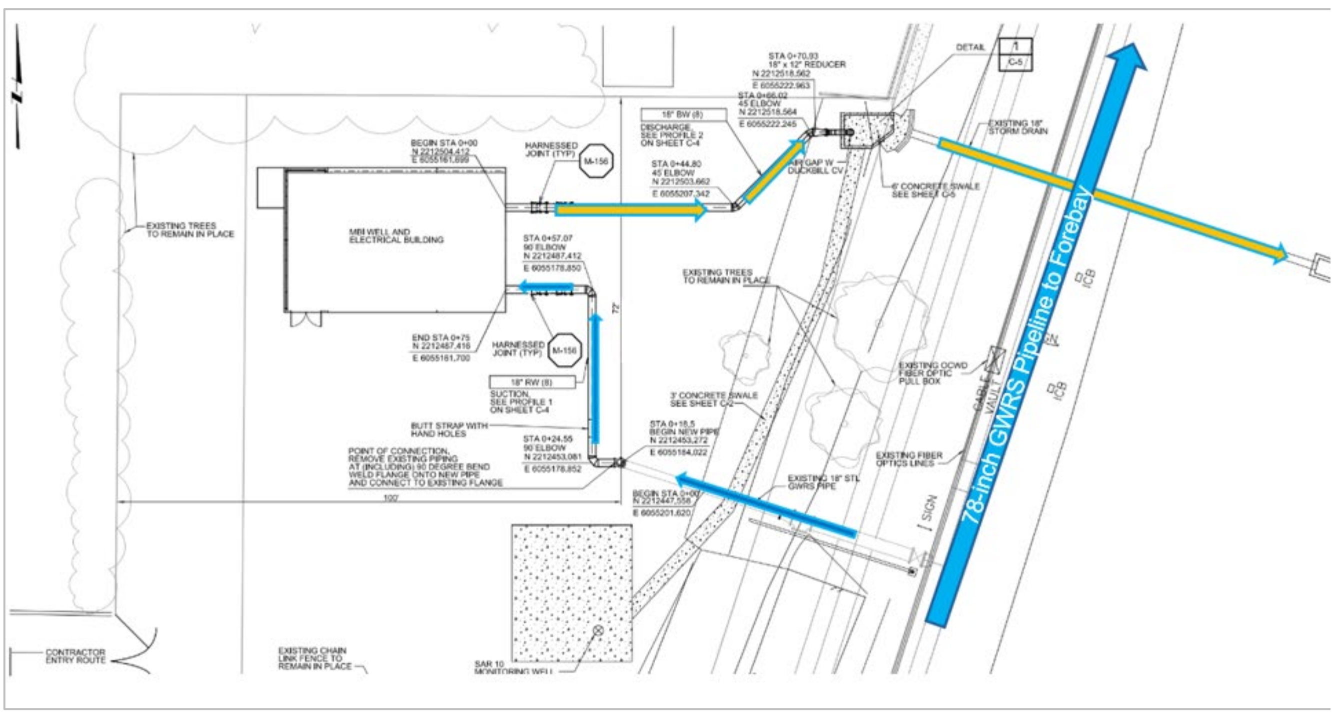


Figure 9
Generalized flow overview of the MBI-1 site. Blue arrows indicate the GWRS recharge water flow paths. Orange arrows represent the backwash discharge flow path out to the Santa Ana River channel.

Downstream of the GWRS-MBI Pipeline Intertie, the undeflected 18-inch pipe continues west and further reduces to 12-inch just prior to daylighting onto the MBI-1 well slab. Figure 10 shows the above-ground flow paths of GWRS recharge water and backwash discharge on the MBI-1 well slab.

Figure 10

MBI-1 well slab looking north-west. Blue arrows indicate the GWRS recharge water flow path. Orange arrows indicate the backwash discharge flow path. The short vertical side-by-side blue and orange arrows indicate the approximate location of the MBI-1 injection well casing. The tan metal building behind the injection piping contains the pump motor control panel, Baski valve control panel and the Delta V process control system electronics. The square structure between the injection and backwash piping is an abandoned shed that was installed for a discontinued project managed by the OCWD Research and Development department.

Backwash discharge from injection well MBI-1 flows east above ground on the MBI-1 well slab and then dives below ground surface. The MBI-1 discharge surfaces in the north-east corner of the site where it breaks to atmosphere and drops into a concrete discharge containment (Figure 11).

Figure 11

Looking west toward the MBI-1 concrete backwash discharge break structure. Backwash discharge breaks to atmosphere at this location, then flows east via gravity into the Santa Ana River channel. Purge flow from nearby monitoring well SAR-10 can enter this break structure through a penetration in the southern wall.

The concrete discharge structure also receives purge discharge from nearby monitoring well SAR-10. SAR-10 flow enters the concrete discharge containment at the base of the southern concrete wall (Figure 12). An aluminum flap has been installed to keep injection well discharge flow of approximately 3,000 gallons per minute (gpm) from flowing out of the containment and towards the monitoring well. For this reason, it is important that the IRSO ensures that the aluminum flap door seals tightly with the concrete wall by placing a couple of heavy rocks against it (Figure 12).

Figure 12
Looking southward at the dry concrete backwash discharge break structure. Note the swinging aluminum door that receives flow from nearby monitoring well SAR-10. Prior to backwashing MBI-1, this door must be in the closed position and secured with a few heavy rocks as shown.

From the concrete discharge containment, MBI-1 discharge flows via gravity under the west levee and into the Santa Ana River channel (Figure 13).

Figure 13
Looking west from the bottom of the Santa Ana River channel. MBI-1 backwash discharge is shown entering the Santa Ana River channel via gravity from the MBI-1 concrete discharge backwash break structure and flowing south to the ocean. A portion of the MBI-1 backwash flow may be intercepted at OC San Plant 1 and pumped into the GWRS headworks.

Because MBI-1 backwash discharge enters the Santa Ana River - a “Waterway of America”, the California Regional Water Quality Control Board, Santa Ana Region (Regional Board) requires the District to obtain and comply with a National Pollution Discharge Elimination System (NPDES) permit. The permit requires the IRSO to perform frequent field monitoring of the discharge water quality. These monitoring results are presented to the Regional Board monthly in a letter report. Inaccuracies in field monitoring results are considered by the government as being fraudulent and negligent, and punishable by jail time for the report author and large fines for the District. ***It is extremely important that the IRSO take accurate and complete notes in the field to avoid penalties for NPDES permit non-compliance.*** NPDES permit field monitoring procedures for the IRSO are presented later in this manual.

Injection Wells MBI-2 through MBI-5 (Centennial Park) Distribution System

Centennial Park Wells- Influent Supply Distribution System

Injection wells MBI-2 through MBI-5 (Centennial Park wells) receive flow from the GWRS pipeline as described earlier in this chapter. Injection supply leaves the GWRS-MBI Pipeline Intertie and heads east over the Santa Ana River along the Edinger bridge. A 30-inch diameter epoxy lined steel pipe is suspended along the north side of the bridge as shown in Figure 14.

Figure 14

Image looking South of the Edinger Bridge across the Santa Ana River. The 30-inch epoxy lined steel pipe is concealed behind architectural panels. The pipe rests on top of the large concrete support piers.

At the peak of the 30-inch pipe traversing the Edinger Bridge are two small air vacuum and release (air-vac) valves that tap the top of the pipe (Figure 15). The two air-vac valves are unaccessible to the IRSO. The IRSO should visually monitoir these two air-vac valves and report any leakage to the Injeciton Well Supervisor.

Figure 15

Looking west from the mid point of the Edinger bridge. Two small air-vac valves tap the apex of the 30-inch GWRS supply pipeline distributing water to the Centennial Park injection wells. The IRSO can not access these valves but should visually inspect for leakage.

After crossing the Santa Ana River, the Centennial Park Mid Basin Injection Wells supply pipline upsizes to a 36-inch epoxy lined and cement mortar coated steel pipeline. The 36-inch pipeline heads east underground along Edinger Avenue. At the intesection of Edinger Avenue and S. Mohawk Drive, the 36-inch pipline turns 90° to the south and enters Centennial Park. The 36-inch pipeline tees into two 16-inch pipelines that head east and west. The west branch feeds MBI-3 and then reduces to 12-inch until it terminates at MBI-2. The east branch feeds MBI-4 then reduces to 12-inch until it terminates at MBI-5. Figure 16 is a map showing the Centennial Park injection supply distribution system including all apertnances.

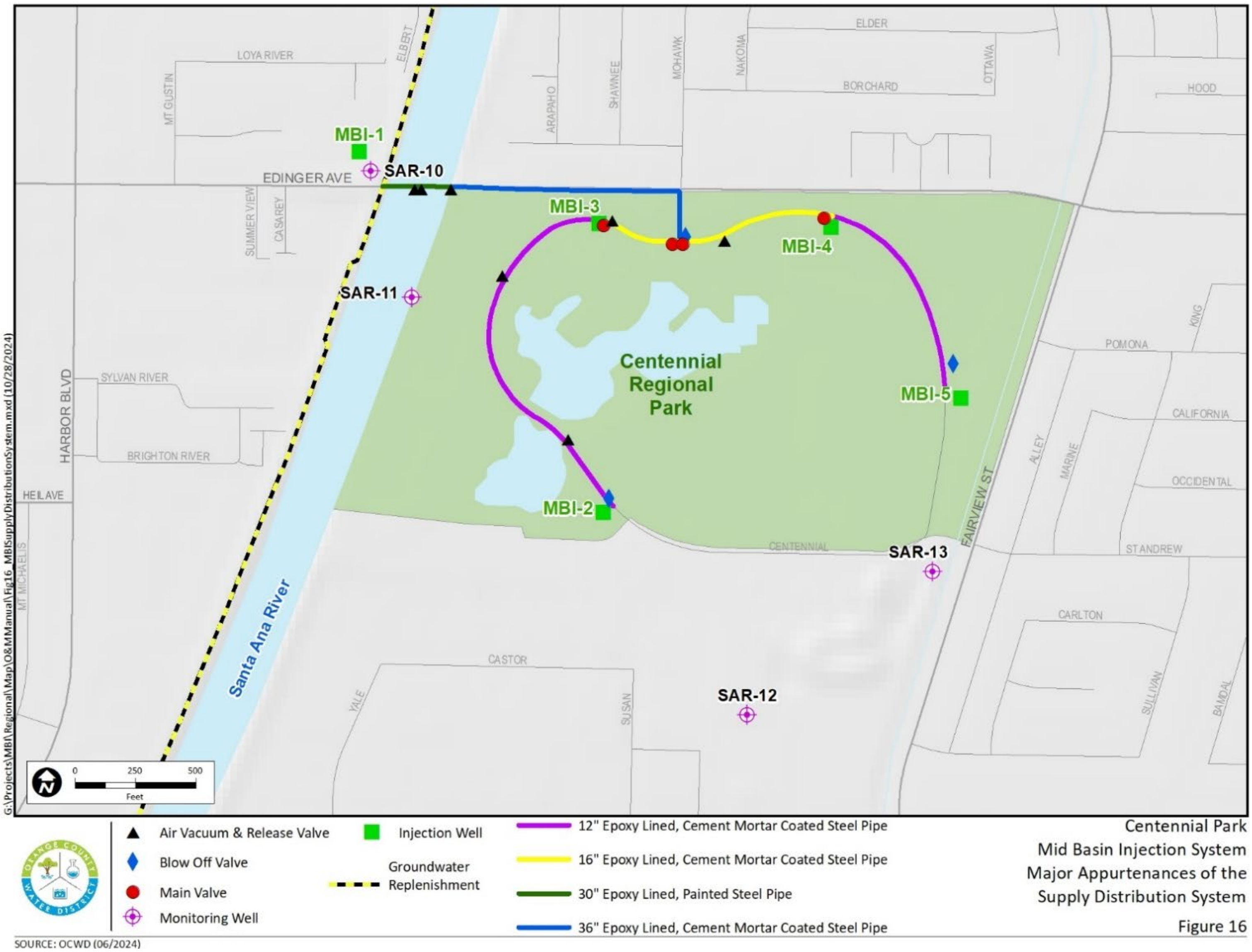


Figure 16

Map of the Centennial Park injection supply distribution system.

All Centennial Park injection wellheads are completed underground in vaults as shown in Figure 17.

Figure 17
View inside thel MBI-5 vault. The MBI-5 wellhead flange is seen in the foreground.

Centennial Park injection flow enters the well and backwash discharge leaves the well site as shown in Figure 18.

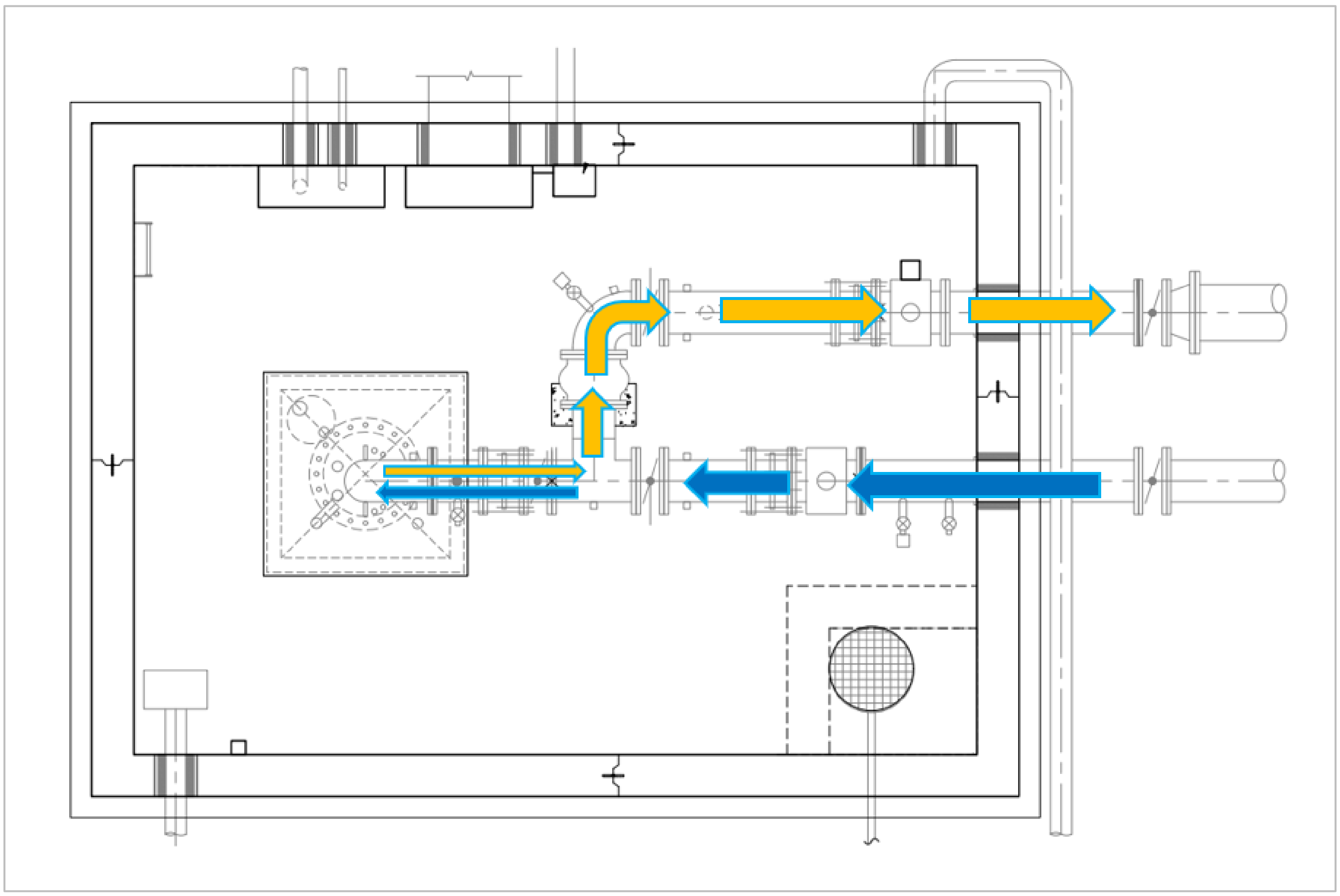


Figure 18
Drawing of a typical Centennial Park injection well vault. Blue arrows indicate the injection supply pathway into the well. Orange arrows indicate backwash discharge flows path leaving the injection well and vault.

Centennial Park Wells- Backwash Discharge Distribution System

Centennial Park injection wells MBI-2 through MBI-5 all share a common 16-inch cement mortar lined and coated steel discharge waste pipeline. The waste pipeline has two different discharge points. The IRSO has the option to send backwash discharge to Centennial Park Lake or to the storm drain. Figure 19 shows the Centennial Park discharge waste line and the two discharge points, the lake and the storm drain.

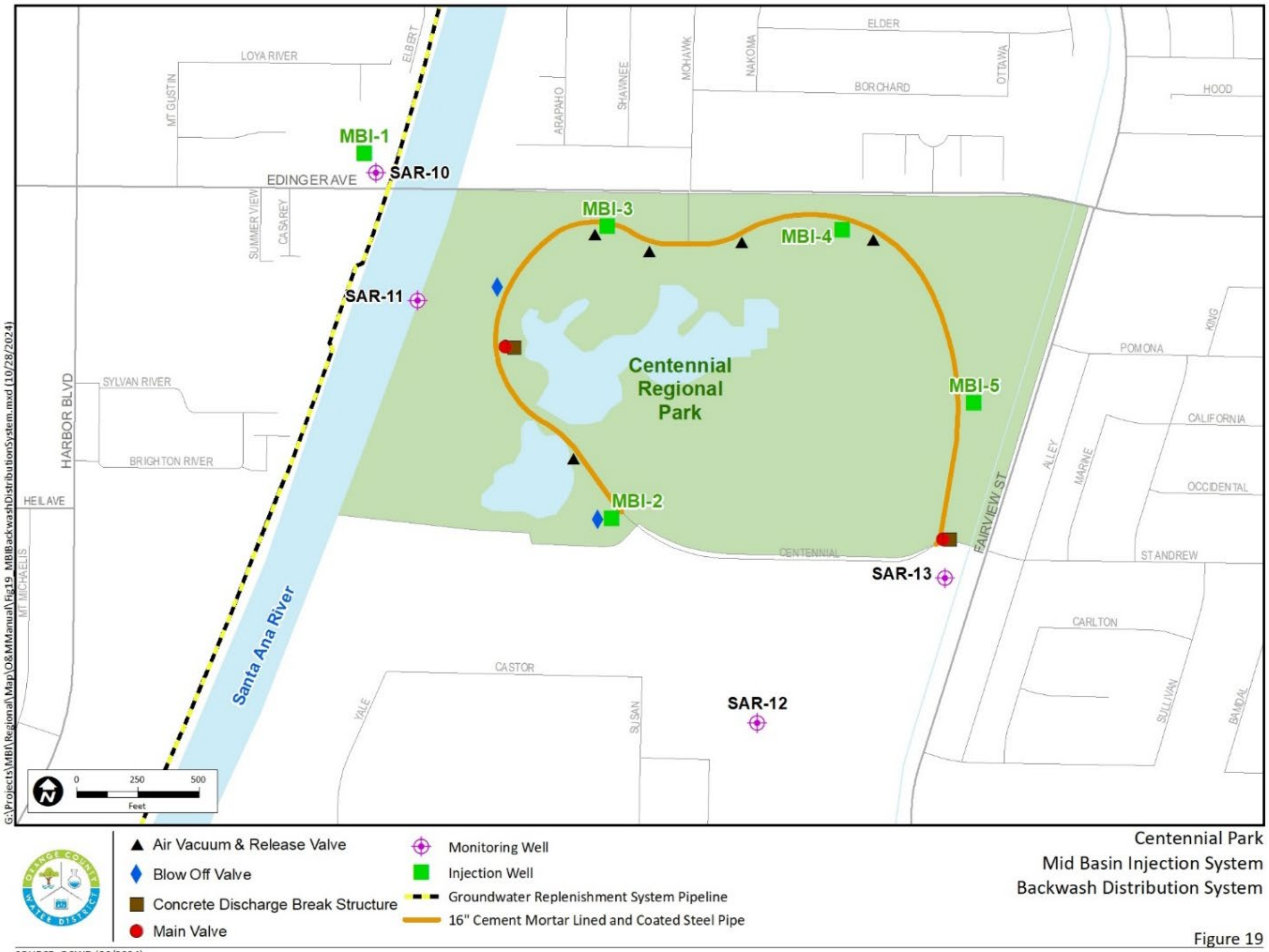


Figure 19

Map showing Centennial Park discharge waste line and discharge points.

Lake Discharge Terminus

The lake discharge point contains a high lake level float switch that could be triggered during backwashing (Figure 20). If activated, the switch will kill the backwash pump motor. Ending a backwash event early at sand producing injection wells MBI-3 and MBI-5 could result in sand locking the down-well check valve. For this reason the IRSO typically discharges to the storm drain.

Figure 20
*Inside the vault containing the lake discharge float switch (labeled **A**) and the analog level transducer (labeled **B**). This vault is located north of the lake discharge building on the shoreline of the lake.*

The City of Santa Ana owns the building that contains the lake discharge drop structure. The building is shown in Figure 21.

Figure 21
The building that houses the backwash discharge point into the lake

Figure 22 shows the MBI discharge pipe entering the lake discharge drop structure and the isolation valve.

Figure 23 shows the lake discharge drop structure inside the building.

Figure 22
Outside the lake backwash break structure building. The red arrow points to the lake discharge isolation valve.

Figure 23
Inside the lake discharge building. This building is not owned by OCWD. The only OCWD equipment inside this building is the lake discharge break structure shown inside the red oval.

Storm Drain Discharge Terminus

Under normal operating procedures, the IRSO will send backwash discharge to the storm drain system. The storm drain discharge point is located approximately 600 feet south of MBI-5 at the eastern end of the discharge waste line and discharges into the Greenville-Banning channel located near the intersection of Centennial Road and Fairview Street.

The Greenville-Banning channel joins the Santa Ana River channel downstream of Centennial Park. Discharging to the storm drain requires the IRSO to comply with the NPDES permit requirements. Monitoring discharge backwash for NPDES compliance is discussed in Appendix A-4. Figure 24 shows the storm drain discharge break structure inside the storm drain discharge building. Figure 25 shows discharge leaving the drop structure and entering the Greenville-Banning channel

Figure 24
Storm drain discharge break structure inside the storm drain discharge building.

Figure 25
Backwash discharge entering the Greenville-Banning channel. The storm drain discharge building is visible in the upper background with "3002" and "Hector G Godinez" displayed on the outside of the building.

The storm drain system isolation valve is located in front of the storm drain discharge drop structure building (Figure 26).

Figure 26

Storm drain discharge drop structure building. The valve that allows or isolates storm drain discharges is identified with the red arrow.

Appurtenances of the Centennial Park Distribution System

Both the Centennial Park supply and backwash discharge pipelines contain the following appurtenances:

- Main line valves
- Blow off valves
- Air vacuum & release valves (air-vacs)

Main Line Valves

Main line valves are butterfly valves that the IRSO tries to exercise at a minimum of once a year. Actuator operators for these valves are typically located in roadways with moving traffic. Ideally the IRSO picks a time to exercise these valves when vehicle traffic is light and when the pipeline is unpressurized (i.e. GWRS plant shut-down). If exercising during a pressurized condition, the IRSO must turn these valves slowly to prevent water hammer. For safety, the IRSO should always try to use the work truck as a barrier to oncoming traffic when working in the street. For details on exercising main line valves see Appendix A-1.

Blow Off Valves

Debris accumulates in the low spots of the pipeline and needs to be removed periodically to maintain pipeline efficiency. Located at the deep spots along the main pipeline is a tee with an 8-inch diameter pipe and an 8-inch diameter butterfly valve. The 8-inch pipe terminates in a shallow vault at ground surface near the curb and gutter. Inside the shallow vault the 8-inch pipe is blind flanged and tapped with a threaded fire hose fitting. When the 8-inch valve is opened and the firehouse fitting cap is removed, water and debris flow from the main and discharge to the curb and gutter. This assembly is called a blow-off (b/o) valve. The IRSO can successfully remove accumulated debris from the main pipeline by operating the b/o valves under pressurized and flowing conditions. For b/o valve operational procedures, see Appendix A-2.

Air Vacuum and Release Valves

Changes in water chemistry and pipeline pressure can cause dissolved gas to come out of solution. The gas usually becomes trapped in the high spots along the pipeline. These trapped pockets of gas reduce pipeline efficiency. The high spots in the pipeline are tapped with 2-inch diameter tubing. These tubing segments stub up, above grade along the margin of the roadway and are fitted with an air-vac valve. The air-vac valve allows dissolved gasses to escape during a pressurized condition and allows atmosphere to enter the pipeline during draining operations. The air-vac is designed to operate passively. Occasionally an air vac will not seat correctly. Visual inspection by the IRSO will determine a leak. Leaks are usually the result of a faulty seat. To reseat an air-vac valve, gently tap the valve body with a hammer. This should seat the valve. If the air-vac valve does not seat, it will need to be replaced by the IRSO. Air-vac replacement is done utilizing at least two IRSOs and the auto crane mounted in the bed of T-89. First, close the ball valve below the air-vac. Then unthread the defective air-vac at the nipple below the air-vac and above the insolation ball valve and remove air-vac with crane. Team lift the new air-vac into place using the crane and thread onto the nipple. Lastly, open the ball valve below the air-vac.

Appurtenances of the Centennial Park Injection Well Vault

Land use restriction imposed by the land owner forced the District to place the MBI-2 through MBI-5 injection well heads below ground surface in concrete vaults. Vaults are equipped with various appurtenances for efficient distribution of liquids and to accommodate safe human occupancy.

Vault Ventilation

The vaults are equipped with a ventilation system and a staircase, qualifying each vault as a non-permit required confined space. Personnel entering the Centennial Park Injection well vaults must complete the OCWD confined space training prior to entry. Figure 27 is a drawing of a typical Centennial Park injection well vault. Ventilation risers can be seen near and above each Centennial Park injection well vault. A fan mounted to the vault wall draws air into the vault while the riser discharges air from the vault. Prior to entering the vault, the IRSO should feel for air leaving the exhaust riser. The IRSO should then use their 4-gas monitoring instrument to determine if the air inside the vault is safe.

Occasionally the ventilation fans will fail. When the fan fails, the IRSO uses a portable auxiliary blower with a snorkel to ventilate the vault from the surface. Replacing a failed ventilation fan is the responsibility of the IRSO. Replacement fans are stocked in the Fountain Valley warehouse.

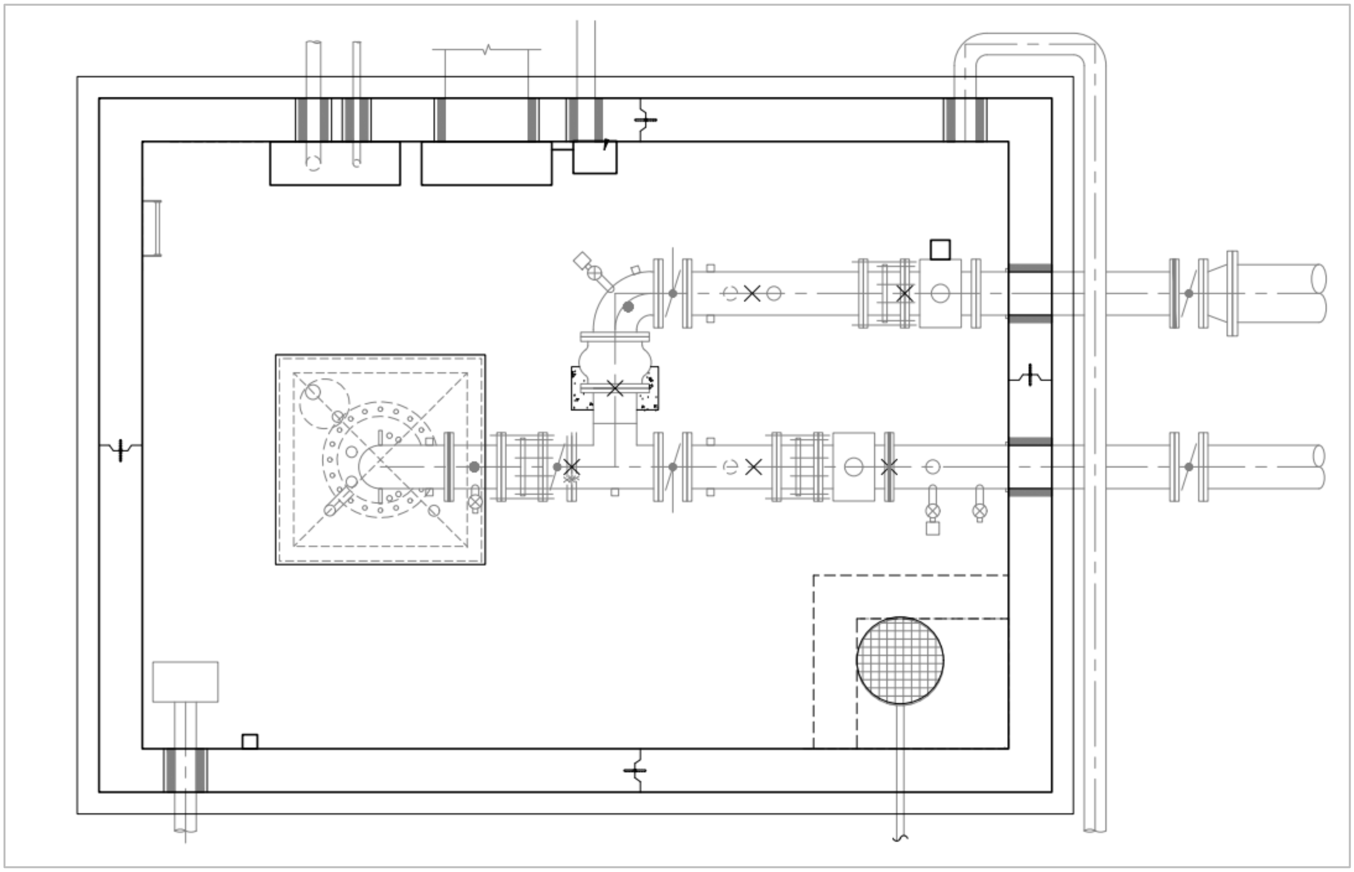


Figure 27

Layout of typical Centennial Park injection well vault. Buried 12-inch butterfly valves for the injection supply pipeline and the backwash discharge pipeline are located just outside the vault as shown. The vault sump and sump pump are shown in the lower right-hand corner of the figure.

Vault Isolation Valves

Just outside each Centennial Park injection well vault are buried 12-inch butterfly valves on the injection supply pipeline and the backwash discharge pipeline as shown in Figure 28. The IRSO can secure these valves to isolate individual injection well vaults from the Centennial Park Injection well system.

Other Important Features of The Injection Well Vaults

Vault Sump Pump

To reduce the potential for flooding, each Centennial Park injection well vault is equipped with a sump and sump pump. Vault sump pumps discharge to the nearby landscaping through a polyvinyl chloride (PVC) discharge line with a diffuser attached to the end. The diffuser daylights just outside the vault and is contained underneath an air-vac cover.

The lead sump pump resides inside the sump while the supporting pump lies on the vault floor. Both sump pumps are equipped with float switches. Occasionally these pumps and sump pump float switches fail, requiring replacement by the IRSO. The OCWD Fountain Valley warehouse stocks sump pumps and float switches.

Sump pump discharge diffusers and other appurtenances visible outside of a typical Centennial Park Mid-Basin Injection Well Vault is identified in Figure 28.

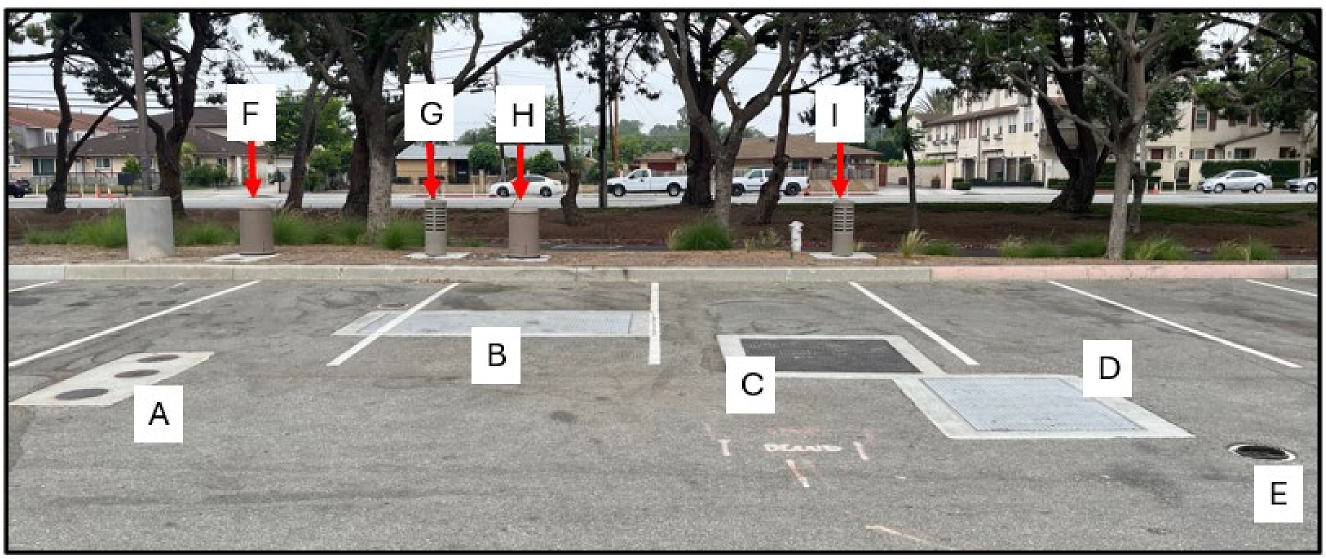


Figure 28

*Outside of a typical Centennial Park Mid Basin Injection Well site. **A** Three valve cans. One houses the influent valve (lid labeled "I"), the second houses the discharge valve (lid labeled "D") and the third can housed a cathodic protection test lead and labeled "CP Test". **B** Staircase hatch to access the vault. **C** Well access hatch. **D** Ladder hatch to access the vault. **E** Grounding rod access. **F** Air-vacuum and release valve servicing the lateral influent line to the well. **G** Vault ventilation system riser (1 of 2). **H** Vault sump pump diffuser. **I** Vault ventilation system riser (2 of 2).*

Cathodic Protection

Both the Centennial Park injection supply pipeline and the discharge waste pipeline do not have a cathodic protection system.

Electronic Water Atlas

At the time this manual was prepared, the OCWD Engineering Department is pursuing an electronic water atlas for the Mid Basin Injection system. This software will utilize the geographical information system and the internet. Once completed, the IRSO will be able to pull up on their smart phone water distribution appurtenances relative to the user's geographic location. It is currently uncertain when this water atlas will be available for IRSO use.

Distribution System Leaks

Occasionally leaks develop along distribution systems. The IRSO should always be looking for leaks in the field. Should a leak surface, the IRSO should take an electrical conductivity (EC) measurement of the leaked water using a field meter to determine the source of the leak using the following guidelines. Values listed below are microsiemens per centimeter (μS/cm).

- **~150:** GWRS final product water; rainwater
- **~600-900:** municipal drinking water
- **>1,200:** Green Acres Project (GAP) water

If the water chemistry fits an OCWD source, the IRSO shall try to determine the location of the leak, then isolate the leak if possible. The Centennial Park distribution system is not a looped system so isolating a small portion of the main eliminates flow downstream. Determining the location of the leak can be challenging. A specialty contractor like American Leak Detection may be contracted to employ acoustic technology to accurately locate the leak. Once the leak is located and isolated, a repair contractor can be dispatched. The IRSO shall notify the Distribution & Injection Well Supervisor immediately after discovering a leak.

MID BASIN INJECTION WELLS

Background

The Mid Basin Injection wells were completed in two phases. MBI-1 was commissioned in 2015 as a demonstration well. MBI-2 through MBI-5 were commissioned in 2020. Because MBI-2 through MBI-5 are located in Centennial Park, these wells are often referred to the "Centennial Park Wells."

The Mid Basin injection wells are all similar in design; however, the Centennial Park wellheads are completed below ground surface in vaults while the MBI-1 wellhead is above ground. Additionally, the MBI-1 well is equipped with a vertical turbine backwash pump while the Centennial Park Wells are equipped with submersible backwash pumps.

Although there are some differences between MBI-1 and the Centennial Park wells, all Mid Basin Injection Wells (MBI-1 through MBI-5) operate the same.

MBI Operational Goal

The IRSO takes a different approach to operating the Mid Basin Injection Wells versus the Talbert Barrier Injection Wells. Flow to the Talbert Barrier Wells is adjusted by the IRSO to maintain protective elevations along the coast. Once protective elevations are met, flow is maintained to hold protective elevations.

The IRSO operates the Mid Basin Injection Wells with the goal of trying to deliver the maximum amount of water into the aquifer and the IRSO will only lower flow in a Mid Basin Injection Well if the injection level (or pressure) inside the casing becomes concerning. The Mid Basin Injection Wells purpose is strictly recharge and the IRSO uses the five Mid Basin Injection Wells to maximize recharge into this portion of the groundwater basin.

MBI-1 Well Head Anatomy

Injection flow enters the MBI-1 well site and MBI-1 backwash discharge leaves the MBI site as described in Figure 10 in the Distribution section of this manual.

Figures 29a and 29b show the influent pathway leading to the MBI-1 injection casing and label the important appurtenances.

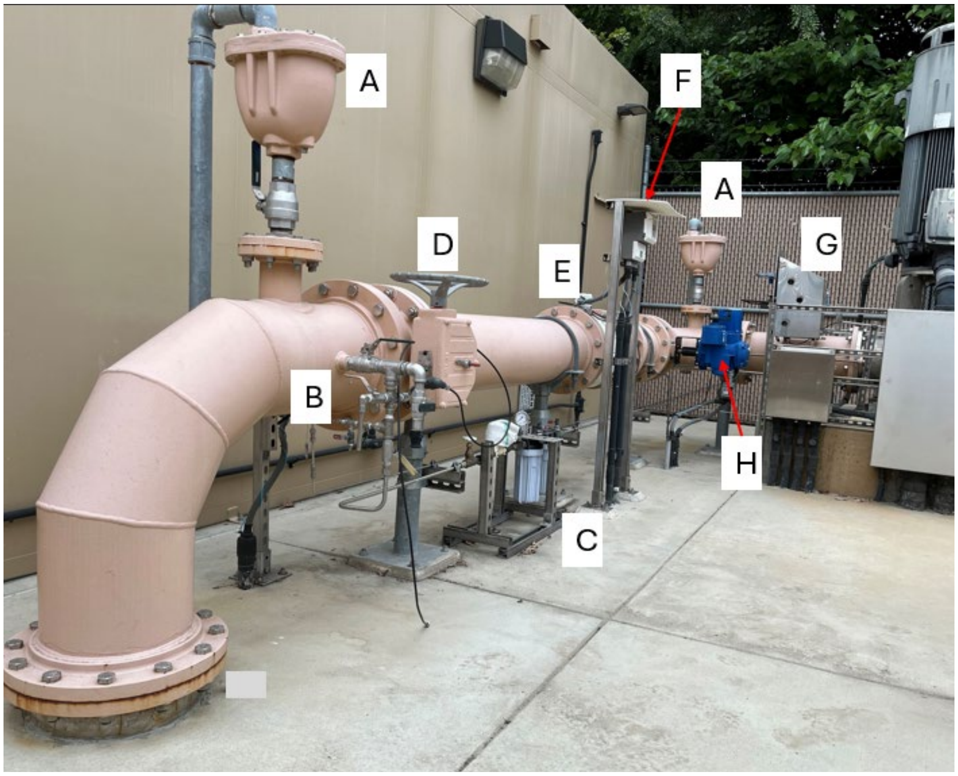


Figure 29a

*Injection (influent) pipe leading to MBI-1 injection well. **A** air vacuum and release valve, **B** Sample tap, **C** 5 & 1 micron bypass filter skid, **D** manual butterfly valve, **E** Flow meter, **F** flow meter local display and transmitter [FIC 3400], **G** laser turbidity meter, **H** motor operated butterfly valve and actuator.*

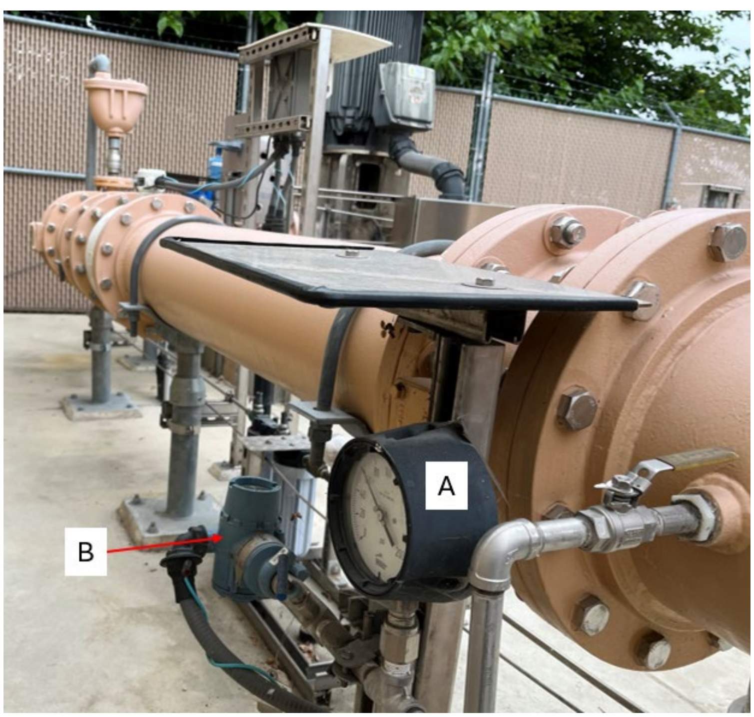


Figure 29b

*Back side of injection (influent) pipe leading to MBI-1 injection well. **A** influent pressure gauge, **B** influent pressure indicating transmitter [PIT 3401].*

Figure 30 labels the MBI-1 well head pedestal appurtenances.

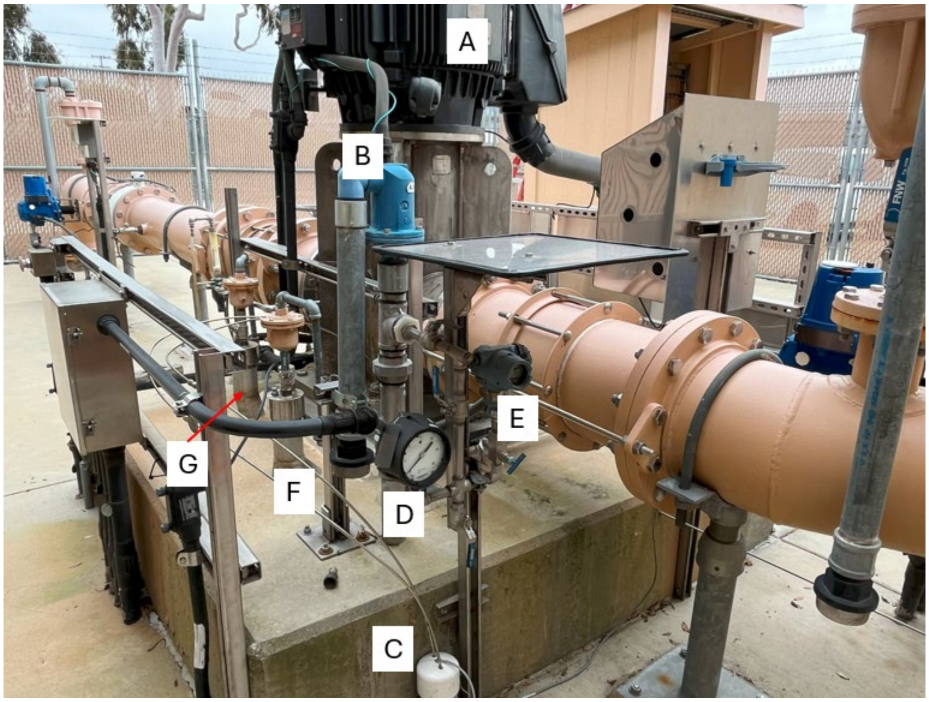


Figure 30
View of MBI-1 well pedestal looking southeast. ***A*** *backwash pump motor,* ***B*** *Air-vacuum and release valve,* ***C*** *Baski valve driving fluid influent and effluent tubing,* ***D*** *injection wellhead flange pressure gauge,* ***E*** *flange pressure indicating transmitter [PIT 3425],* ***F*** *vented camera tube (note transducer [LI 3420] cable is visible leading into the tube),* ***G*** *vented gravel feed tube.*

Figure 31 identifies and labels the MBI-1 backwash discharge piping.

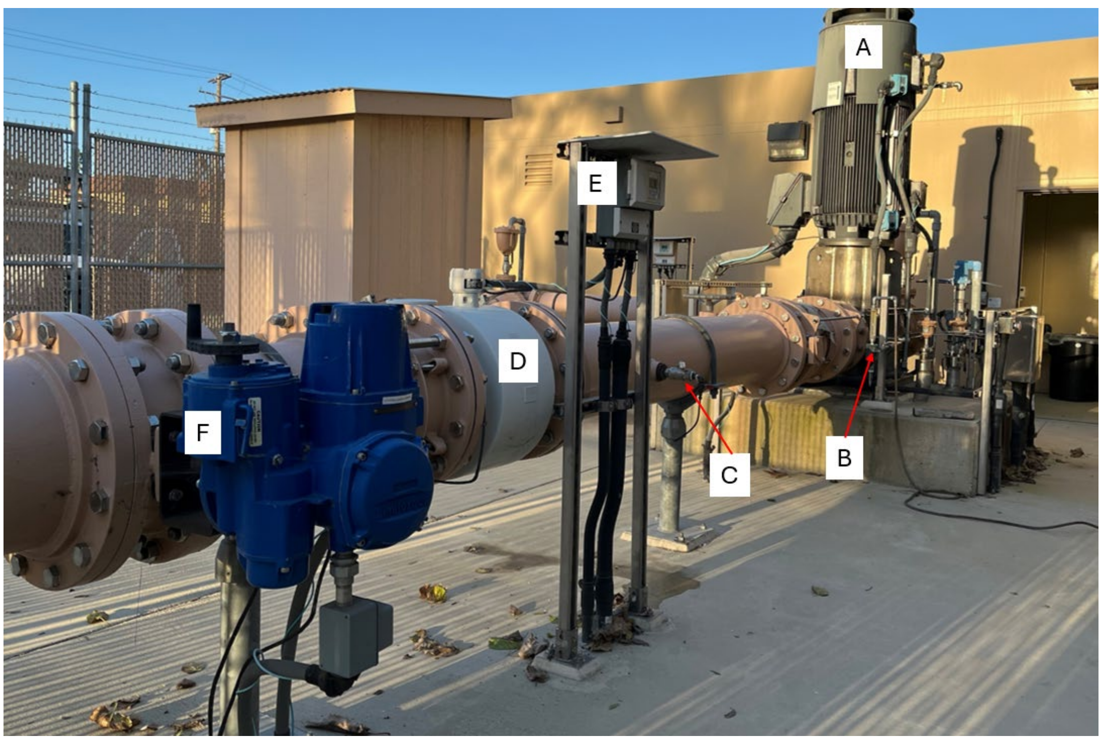


Figure 31
View looking northwest of the MBI-1 discharge piping and appurtenances. ***A*** *backwash motor,* ***B*** *Rossum sand tester,* ***C*** *sample spigot,* ***D*** *flow meter,* ***E*** *discharge flow meter local display,* ***F*** *motor operated butterfly valve (pump discharge valve) and actuator.*

Backwash discharge flow enters the MBI-1 backwash discharge break structure shown in Figure 32 prior to gravity flowing into the Santa Ana River Channel.

Figure 32
MBI-1 backwash discharge break structure during a backwash event. The rectangular portal on the far side of the structure drains the backwash water into the Santa Ana River Channel via gravity.

Baski Valve Panel

The Baski down well flow control valve panel and associated nitrogen cylinder is housed along the north wall of the MBI-1 electrical building as shown in Figure 33. The building also contains the backwash pump motor control panels, process control system equipment, the uninterruptible power supply, housekeeping supplies, a garbage can and the specialty tool to open the cover on the MBI-1/Centennial Park distribution valve as shown on Figure 7 in the Distribution section of this manual. This building is labeled “PCS-1” on the Delta V overview map of the Mid Basin Injection System.

Figure 33
Inside the MBI-1 electrical room looking North. The Baski Valve control panel and nitrogen cylinder are visible in the background. The backwash pump electrical panels are visible in the foreground.

MBI-1 Well Completion

The below ground completion of MBI-1 and all Centennial Park wells are illustrated on as-built drawings. As-built drawings for all Mid Basin Injection wells are located in Appendix A-5 and include information regarding screen depths, total depth, gravel tube depth, casing diameters, camera tube transitions, gravel envelopes and seals.

Centennial Park Wells (MBI-2 through MBI-5) Wellhead Anatomy

Injection flow enters the MBI-2 through MBI-5 vaults and MBI-2 through MBI-5 backwash discharge leaves the vaults as described in Figure 18 in the Distribution section of this manual.

Figure 34 shows a typical Centennial Park Injection wellhead with the important influent appurtenances labeled.

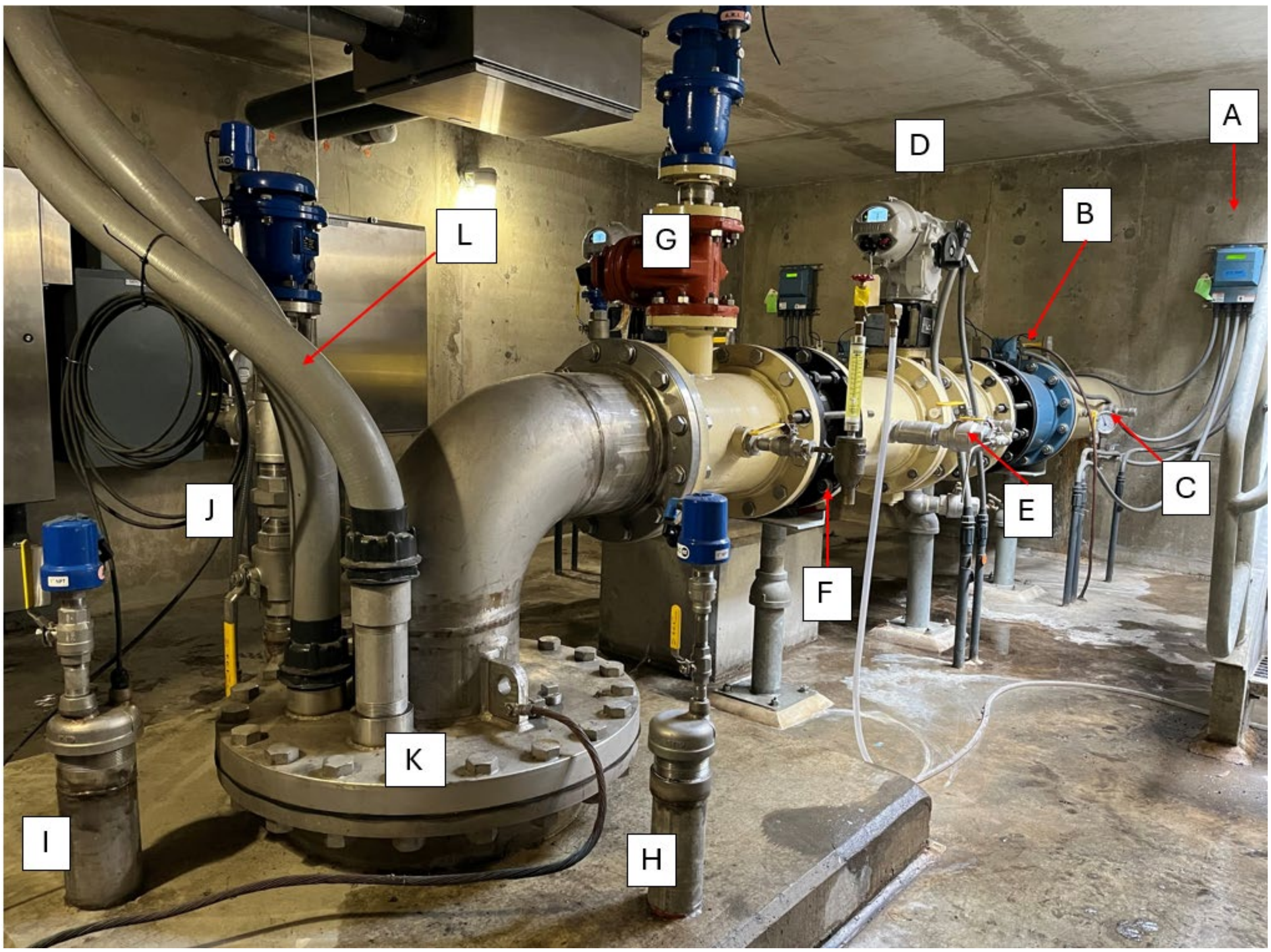


Figure 34

*View inside MBI-5 vault. Wellhead and injection piping are visible. **A** influent flow meter local display and flow transmitter [FIC 3415], **B** influent flow meter, **C** influent pressure gauge [PIT 3401], **D** motor operated butterfly valve and actuator **E** sample spigot, **F** Rossum sand tester, **G** air vacuum and release valve (air-vac), **H** gravel feed tube, **I** camera tube (level transducer cable LIT 3420 visible), **J** air-vac venting the injection casing and well casing pressure gauge and associated pressure transmitter [PIT 3425], **K** injection well casing, **L** electric conductors feeding submersible pump motor.*

Figure 35 shows a typical Centennial Park wellhead with the important discharge appurtenance labeled.

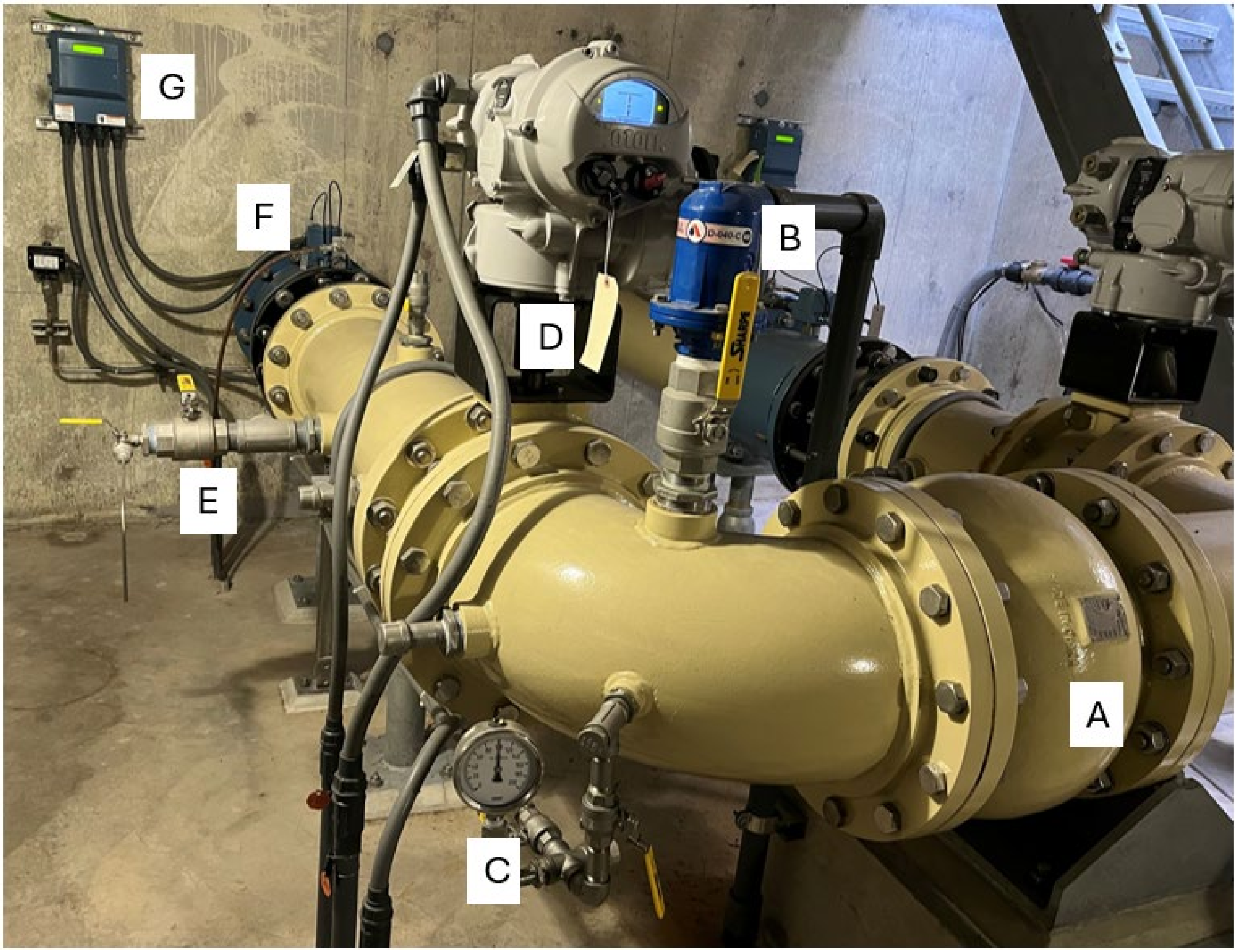


Figure 35
*Typical Centennial Park Well head – discharge side. **A** check valve, **B** air-vac, **C** injection/backwash pressure gauge, **D** Motor operated butterfly valve, **E** sample port, **F** flow meter, **G** flow meter local display.*

Centennial Park Well Completions

The below ground completion of the Centennial Park wells are illustrated on as-built drawings. As-built drawings and pump-setting diagrams for all Mid Basin Injection wells are located in Appendix A-5 and include information regarding screen depths, total depth, gravel tube depth, casing diameters, camera tube transitions, gravel envelopes and seals.

Centennial Park Vaults

Centennial Park vaults are reinforced concrete subgrade structures approximately 10 feet deep and measure 22 feet by 16 feet. All Centennial Park vaults are equipped with continuous ventilation fans and are considered C-5 non-permit required confined spaces. The IRSO is required to test the vault atmosphere and complete the appropriate paperwork prior to entry. The IRSO uses a 4-gas detection meter to test air quality. The District's Maintenance Department is responsible for the calibration on the personal 4-gas detection equipment. Each IRSO has its own meter. A copy of the manufacturers owner's manual for the 4-gas meter is presented as Appendix A-6. Vault entries require 2 people - an entrant and an attendant outside the vault. The confined space entry form guides the IRSO step by step and can be found here:

- WP > Shared Files > Water Prod > Barrier > Talbert Barrier O&M Manual > Forms

The entry form must be completed for each vault entry. The IRSO is to return completed vault entry forms to their supervisor weekly.

Preventing Vault Flooding

To prevent flooding, each Centennial Park Mid Basin Injection Well vault contains a sump as shown in Figure 36.

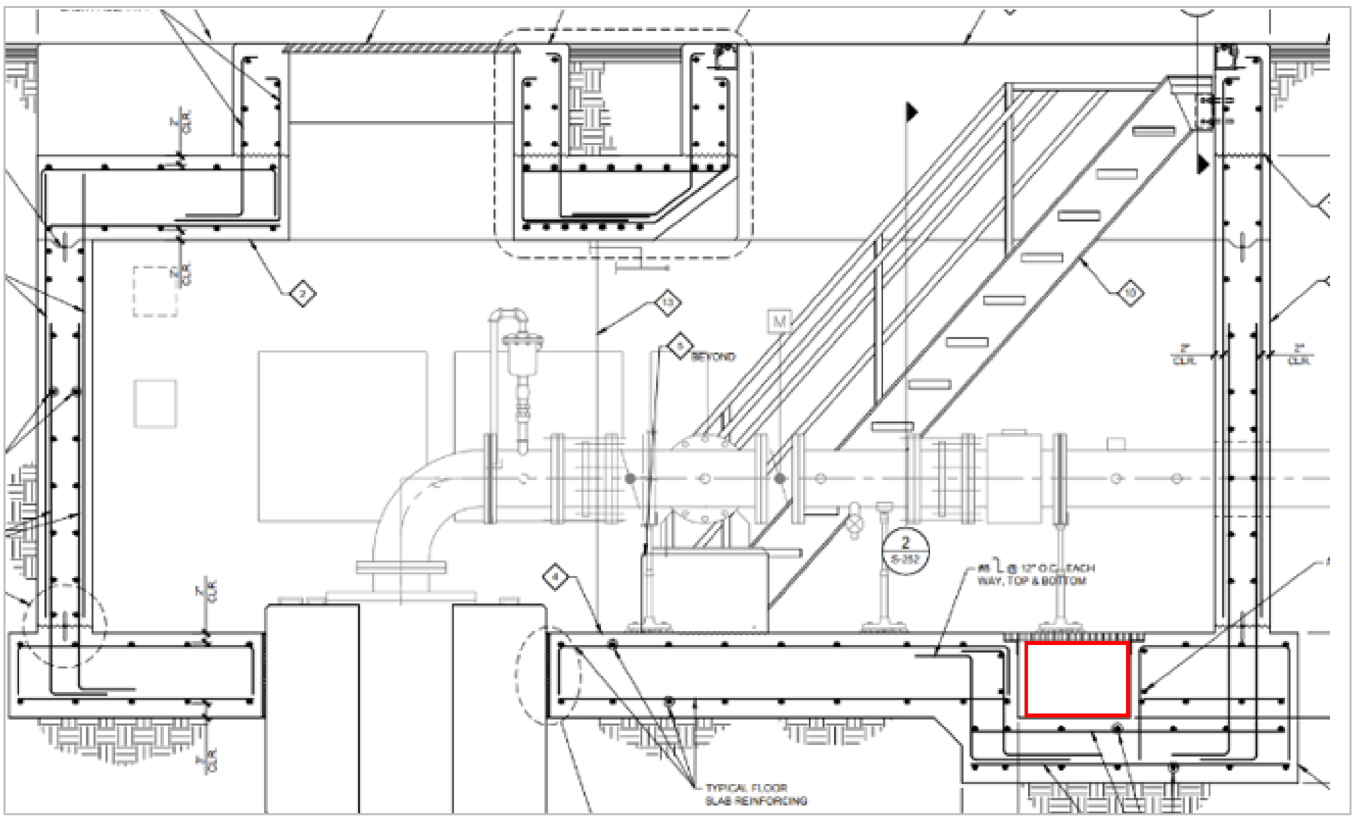


Figure 36
Cross-sectional view of a typical Centennial Park Mid-Basin Injection Well vault. The sump is outlined in red.

Each sump is equipped with a primary and secondary submersible sump pump. These Grundfos submersible sump pumps are powered by 110V AC power and discharge to atmosphere through a diffuser located above ground surface (see Figure 28(H)). The primary pump is located inside the sump, while the secondary pump is located on the vault floor adjacent to the sump as shown in (Figure 37).

Figure 37
Typical Centennial Park vault sump pump assembly. The primary pump is in the sump while the secondary pump lies on the vault floor. Both pumps are wired with float switches that operate the pump passively.

These pumps are the same as those in the Talbert Barrier Legacy Well vaults. Occasionally these pumps fail. The IRSO is responsible for replacing failed sump pumps. The OCWD Fountain Valley warehouse stocks the Grundfos submersible sump pumps.

If the primary and secondary pump cannot keep up with the water flow entering the vault, a float switch will be triggered and a flood alarm banner will appear in the Delta V process control system software. Figure 38 shows a typical Centennial Park vault flood alarm float switch.

Figure 38
Typical Centennial Park vault flood alarm float switch. The stainless steel ball inside the red oval floats upward with water pressure to send a flood alarm banner to the Fountain Valley control room via Delta V.

If faced with a flooded vault situation, the IRSO should notify their supervisor and I&E staff immediately and not enter into a flooded vault. The IRSO should work above ground surface to isolate the source of flooding and pump down the vault.

Vault Intrusion Alarm

Each Centennial Park vault is equipped with an intrusion alarm system that utilizes a proximity switch (Figure 39). The proximity switch utilizes magnets to detect a change in hatch position and sends an alarm banner to the Fountain Valley control room via the process control system software – Delta V. Because an alarm is sent to Delta V, ***the IRSO must call the control room (x3240) and announce entry prior to opening the vault hatch.***

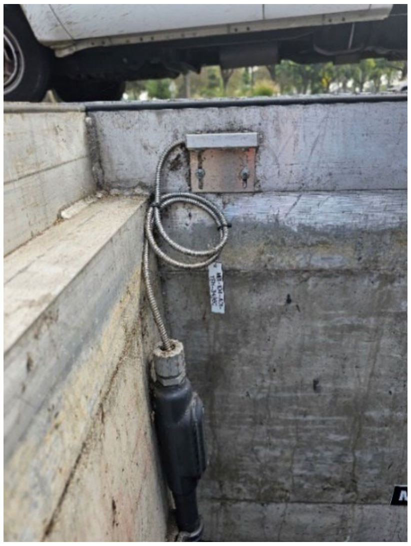


Figure 39
Typical Centennial Park vault proximity switch.

E-call Button

The “e-call” button, if pushed, creates a red banner alarm in Delta V alerting the viewers that assistance is needed and identifies the vault location. This button should be used by the IRSO when assistance from outside is required beyond the confined space attendant’s ability to help. The e-call button is labeled “Emergency Call Switch” and is typically located at the bottom of the vault staircase (Figure 40). Some Centennial Park vaults are equipped with a second e-call button. ***The IRSO should try not to accidentally bump into this button.***

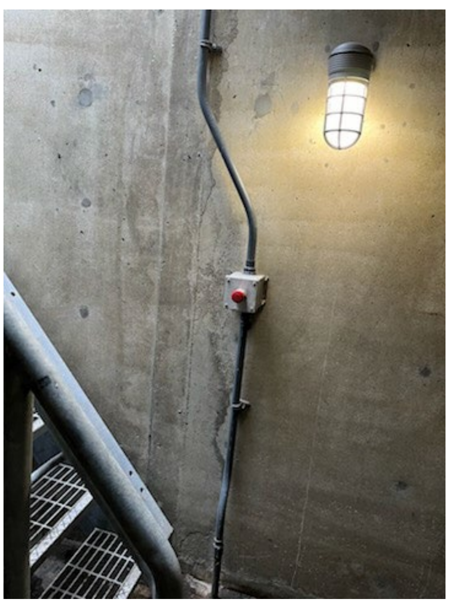


Figure 40
E-call button located at the bottom of the vault staircase. If pushed, this button will send a distress alarm to the control room in Fountain Valley through Delta V. The IRSO should try not to accidentally bump into this switch and send a false signal of distress.

Auto Stop Button

Each Centennial Park vault is equipped with an “Auto-Stop” button or Local Off Stop (LOS) button (Figure 41). This button is also commonly referred to as the “kill switch”. When pushed, this button will automatically secure the backwash pump. For this reason, the IRSO should be very careful not to accidentally bump into this button and inadvertently shut down backwashing prematurely. ***The Auto Stop button is identified by the code “LOS 3450”.***

Figure 41
The "kill switch" or "Auto Stop Button." If pressed, the backwash pump will stop abruptly. The IRSO must try to avoid bumping into this switch accidentally.

Figure 42 show the locations of the "E-call" and Auto Stop buttons within a typical Centennial Park vault.

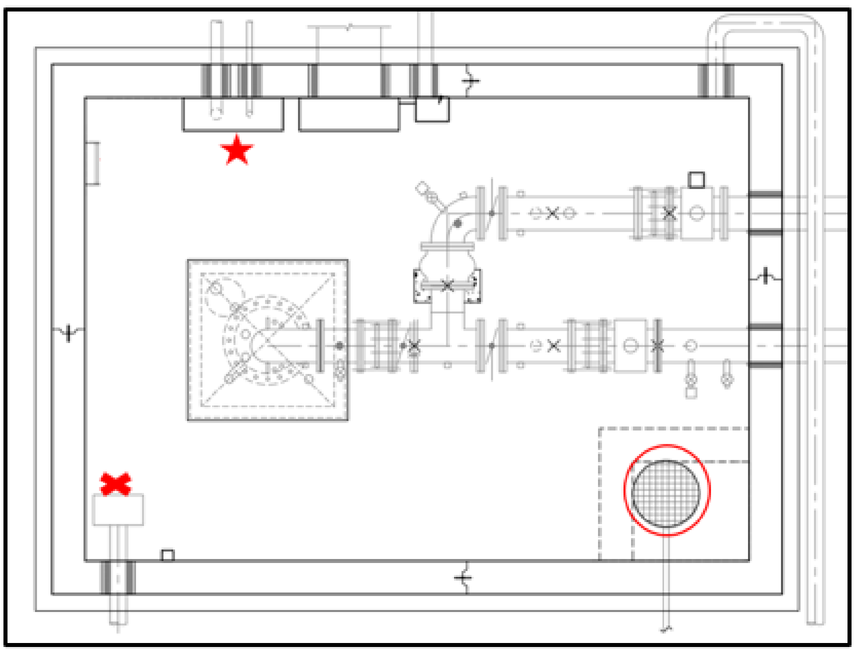


Figure 42
Interior layout of a typical Centennial Park Wellhead vault. The red star indicates the location of the "auto stop" button (aka "kill switch"). The red "x" shows the location of the e-call button and the red circle inscribes the vault sump location.

Centennial Park Vault Ventilation

All Centennial Park vaults are equipped with ventilation fans. These fans mount to the vault wall (Figure 43). Occasionally these ventilation fans fail. The OCWD Electrical and Instrumentation (I&E) Department replaces these fans. An I&E request is required to initiate fan replacement. Replacement fans are stocked in the OCWD Fountain Valley warehouse.

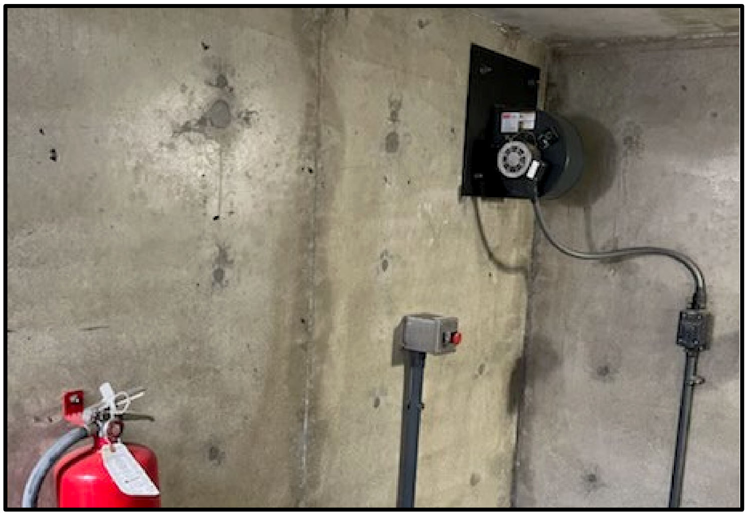


Figure 43
A typical Centennial Park vault ventilation fan is visible in the upper right-hand quadrant of this image. An additional (2nd) "e-call" button can be seen in the middle of the image. All Centennial Park vaults contain a fire extinguisher as seen in the lower left-hand corner of the photograph.

Centennial Park Vault Housekeeping

IRSO's are responsible for the maintenance and operation of sump pumps, sump pump float switches and replacing the ceiling light bulb. I&E staff maintains all other electrical components of the Centennial Well vaults. It is the IRSO's responsibility to keep the vaults clean and free from debris. While visiting a Centennial Park vault, if the IRSO notices anything unusual about the condition of the vault, the IRSO should notify their supervisor immediately.

Uninterruptable Power Supply

In the event of an electrical power interruption, Mid-Bain injection wells MBI-1 through MBI-5 are equipped with an uninterruptable power supply (UPS) that can provide enough power during a black-out to allow Delta V to automatically shut down the well properly. The OCWD I&E Department is responsible for maintaining and replacing UPS units for Mid Basin Injection wells.

Centennial Park Shared Structures

Centennial Park Mid Basin Injection Wells vaults do not contain the electrical panels that power the submersible pumps, nor do these vaults contain the Baski valve panel and associated nitrogen gas cylinders. These items are stored in two separate stand-alone above ground structures called Shared Structures. Figure 44 shows the locations of shared structures 1 and 2 at Centennial Park.

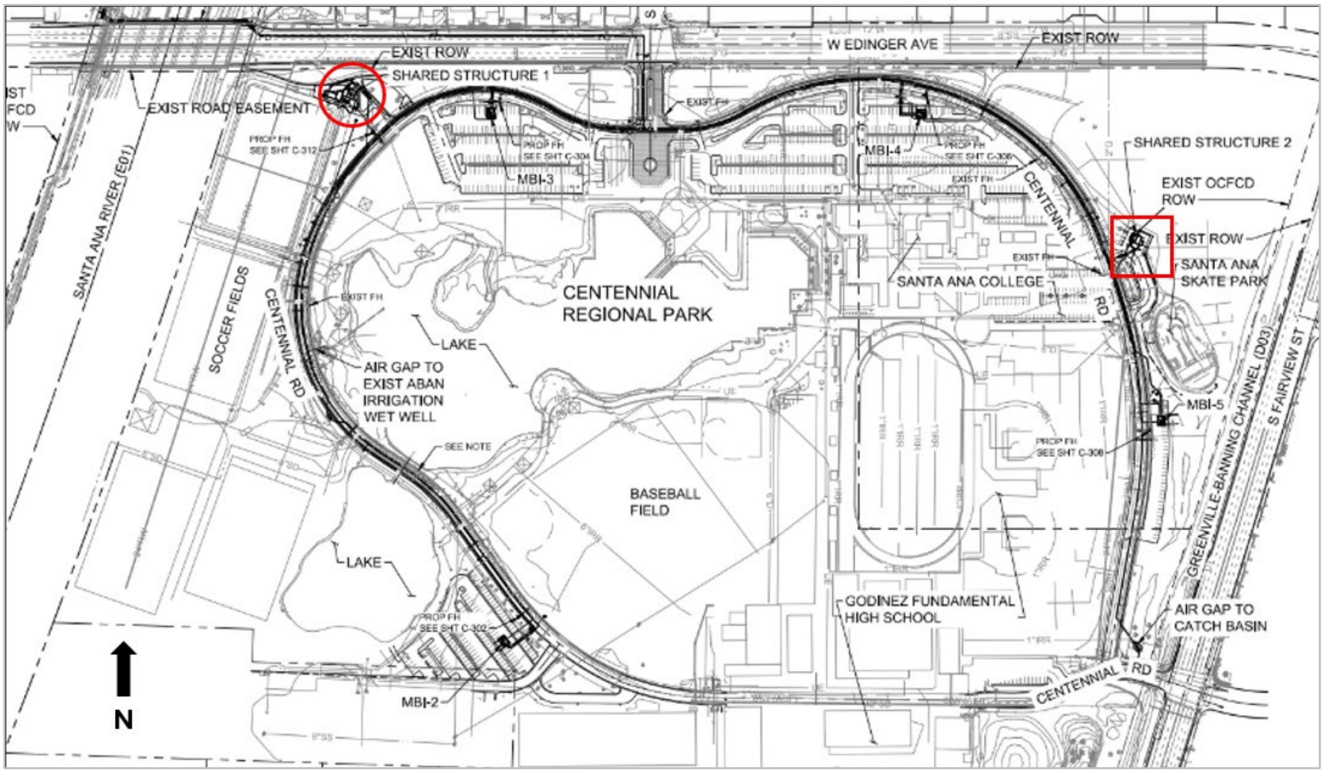


Figure 44

Engineer's drawing of Centennial Park. Shared structure 1 is shown inside the red circle and serves injection wells MBI-2 and MBI-3. Shared structure 2 is shown inside the red square and serves injection wells MBI-4 and MBI-5.

The shared structures are concrete block structures that serve as both public restrooms and a facility to store the backwash pump motor electrical panels, process control system equipment the Baski panel and associated nitrogen cylinders. Shared Structure 1 provides the backwash pump electrical panels, communication equipment, Baski valve panels and associated nitrogen cylinders for injection wells MBI-2 and MBI-3 while Shared Structure 2 serves injection wells MBI-4 and MBI-5 (Figure 45). On the Delta V Mid Basin Injection System overview map, Shared Structure 1 is labeled "PCS-2" and Shared Structure 2 is labeled "PCS-3". The IRSO enters into the shared structures through the tall double leaf blue metal doors. A common key opens the two shared structures and the electrical building at MBI-1. Every IRSO should have a copy of this key.

Figure 45
Shared Structure 1 (left) and Shared Structure 2 (right). The double doors are used to access the shared structures

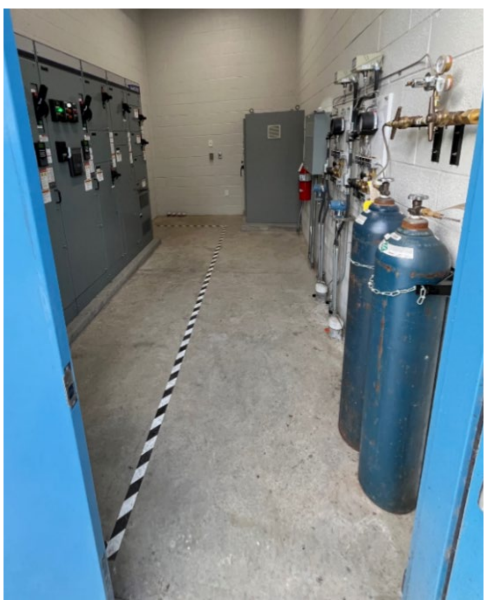


Figure 46
View inside Shared Structure 2. The submersible pump electrical panels are on the left. The Baski valve panel, nitrogen gas cylinders and associated tubing are located along the right. Note that Shared Structure 1 contains the same equipment laid out in a similar fashion.

MBI WELL OPERATION

All Mid Basin injection wells are similar in design and operational theory as the Modern Wells of the Talbert Barrier. Modern Well operations are explained in OCWD's Talbert Seawater Intrusion Barrier Operations and Maintenance Manual, available on-line at ocwd.com/wp-content/uploads/Talbert-Barrier-OM-Manual.pdf. A down-well flow control valve is key to operating these wells.

All Mid-Basin Injection well are equipped with a down-well flow control valve mounted to the end of the eductor pipe. All MBI Wells are equipped with an 12-inch Baski down-well flow control valve (Baski Valve) manufactured and tested by Baski Inc., Denver Colorado. The Baski Valve operates on the principle of an inflatable /deflatable rubber bladder inside a stainless steel body. Nitrogen gas is used to inflate the bladder to stop flow. Conversely, when nitrogen gas is bled from the Baski Valve, flow initiates. Pressure on the bladder determines the flowrate of water passing through the Baski Valve. The entire assembly is encased inside a stainless steel housing (Figure 47). Factory information about the Baski Valve can be found in Appendix A-7**.** The Baski Valve communicates directly with Delta V.

Figure 47
Baski Valve identified by the red bracket in the left image. A close-up of the valve discharge port is shown in the right image.

MBI Well Operational Choices

The IRSO uses Delta V to operate MBI Wells. Delta V provides the IRSO three different operation choices for MBI Wells. The IRSO has the choice to operate an MBI Well based on:

- Flow
- Flow and Level
- Flow and Pressure

Flow Mode

Delta V allows the IRSO to input a flow setpoint in flow mode. The Baski Valve will modulate to maintain the flow setpoint regardless of injection level inside the well casing and pressure that builds up underneath the injection well-head.

Operating MBI wells in flow mode long term can potentially damage the well by pushing fine grained particles far away from the well into areas of the aquifer that are unrecoverable during backwashing. For this reason, MBI Wells are only operated in flow mode when the well level instrument is malfunctioning.

Flow and Level Mode

Delta V allows the IRSO to input setpoints for flow and level. When a set point is triggered, a certain action is initiated. For example, in a “flow and level” scenario the IRSO may input a flow rate of 100 gpm and a level setpoint of 5 feet below ground surface (bgs). Under these conditions Delta V tells the well to inject 100 gpm until the water level inside the casing reaches 5 feet below top of casing. When this input level is reached the Baski Valve partially closes gradually until the flow leaving the Baski Valve is low enough to maintain the level setpoint. Over time, as the aquifer fills and the well clogs, the well will continue to ramp down flow to maintain the desired setpoint level. Note: 100 gpm and 5 feet bgs were randomly selected, the IRSO has a wide range of flows and levels available for setpoint input. Injection wells MBI-2 through MBI-5 typically have a high level set point of 10 feet below the top of the well casing. MBI-1, not in a vault, has a high setpoint of 10 feet below top of casing.

The majority of the time MBI Wells operate in flow and level mode. This operational mode reduces the risk of surfacing water (and the potential to damage nearby buried infrastructure).

Flow and Pressure Mode

If desired, Delta V allows the IRSO to input setpoints for flow and pressure. In a “flow and pressure” scenario the IRSO can, for example, input a flow rate of 100 gpm and a pressure setpoint of 5 pounds per square inch (psi). Under these conditions Delta V tells the well to inject 100 gpm until the pressure underneath the well-head flange reaches 5 psi. When the 5 psi input pressure is reached, the Baski Valve partially closes until the flow leaving the down-well flow control valve is low enough to maintain the pressure setpoint. Over time, the well will continue to ramp down flow to maintain the desired setpoint pressure. Note: 100 gpm and 5 psi were randomly selected, the IRSO has a wide range of flows and pressures available for setpoint input.

The majority of the time MBI Wells operate in “flow and level” mode. Operating MBI Wells in flow and pressure mode long term can potentially damage the well by pushing fine grained particles far away from the well into areas of the aquifer that are unrecoverable during backwashing. For this reason, MBI Wells are rarely operated in flow and pressure mode.

For instructions on how to operate MBI Wells see Appendix A-8.

MID BASIN INJECTION WELL MAINTENANCE

Mid Basin Injection Well Backwashes

Injection rates at the MBI wells are maintained by completing routine backwashes. The IRSO is responsible for backwashing the MBI wells. Centennial Park MBI wells are backwashed monthly while MBI-1 is backwashed weekly. Appendix A-4 explains the backwash procedure for all MBI wells.

Gravel Feed Tubes

The IRSO is responsible for monitoring and maintaining the gravel feed tube levels at all MBI wells. Wells MBI-3 and MBI-5 were constructed using silica beads while MBI-1, MBI-2 and MBI-4 were constructed using natural gravel pack. Wells MBI-3 and MBI-5 produce sand during pumping. For this reason it is important that the IRSO monitor all gravel tubes often. Gravel tubes should be replenished to a level between 470 – 600 feet below the top of the tube.

MBI-1 Backwash Pump Maintenance

The backwash pump at MBI-1 is a vertical turbine pump. Occasionally the packing around the line shaft wears out. Water will continuously spit out from the wellhead while pumping with worn packing. It is the IRSO’s responsibility to replace worn packing. Appendix A-9 explains how to replace the packing at MBI-1.

Housekeeping

It is the IRSOs responsibility to maintain neat and orderly wells sites. The MBI wells are located in areas of high nefarious activity. For this reason, it is important that the IRSO monitor the overall condition of the MBI well sites. The IRSO is required to report any unusual findings, including damaged property, to their supervisor immediately.

BEHAVIOR AND PERFORMANCE TRENDS OF MBI WELLS

The goal of the Mid Basin Injection project is to maximize recharge through 5 injection wells located upgradient of a heavily pumped portion of the Orange County Groundwater Basin. Each of these 5 injection wells behave differently. This section discusses each MBI wells nuances to maximize recharge and minimize potential for well damage.

The IRSO has an MBI well electronic reference, OCWD's Geocortex Viewer: Geocortex Viewer for HTML5 (Geocortex). Geocortex provides general well information for MBI wells. Information includes as-built drawings, geology logs and state well completion reports.

Monitoring and Documenting Well Performance

Monitoring the performance of MBI wells is a very important task the IRSO is responsible for. The metric for describing well performance is called the well "efficiency" or "yield". Well efficiency is defined as the pumping rate divided by the measured drawdown in a pumping well (mathematically described below).

Pumping Well Efficiency (Yield) = pumping flow rate (gpm)/drawdown (ft)

For an injection well, efficiency is the injection rate divided by the measured updrawn or mound (mathematically described below).

Injection Well Efficiency (Yield) = injection flow rate (gpm)/updraw (ft)

In general, an excellent pumping well efficiency (yield) is 100 gpm/ft, while a poor pumping well efficiency would be less than 20 gpm/ft. Because the aquifer gives up water easier than it receives water, injection efficiency is generally lower than pumping efficiency. The IRSO collects both pumping and injection well efficiency data for MBI wells.

Important field monitoring data is collected by the IRSO during the MBI well backwash process and entered into the MBI well performance database. The information in this database is used by the District's managing staff to make operational decisions affecting budget and overall health of the groundwater basin. For this reason it is extremely important that the IRSO collect and enter MBI well data accurately.

- The database is located at: WP > Shared Files > WaterProd > Barrier > Mid Basin Well Field

The database contains an Excel spreadsheet for each MBI well. Each excel spreadsheet contains multiple worksheets (tabs located at the bottom of the page). There is a worksheet for entering injection data, backwash (pumping) data and sand production data. Additionally, there are worksheets for injection, pumping and sand production graphs. The graphs automatically populate from data entered by the IRSO into excel worksheets. The IRSO does not need to work directly with the graphs; however, if the IRSO enters inaccurate data into the "injection" and "pumping" spreadsheets, the graphs will also display inaccurate data. For this reason, it is important that the IRSO double-check the data entered.

The IRSO conducting the office activities for an MBI well backwash event completes the MBI well "Injection/Backwash" form as shown in Appendix A-4 (Figure 2) of this manual. The IRSO then enters the data from the "Injection / Backwash" form into the MBI well excel database worksheets.

The first worksheet is entitled “MBI-(#)” Injection/Backwash Sheet” (Figure 1). The “MBI-(#)” Injection/Backwash Sheet” is identified by the worksheet tab labeled by the well I.D. as shown inscribed inside the red oval in Figure 48. Date and time entries must be consistent with the format already established for the worksheet. The worksheet is programmed to automatically calculate the change in level (∆) and yield. The “Recovery (short term),” “Recovery (mid term)” and “Recovery (long term)” data is taken directly off the PCS screen and entered by the IRSO at 0.5 hours, 2 hours and the following day at 6:00am, respectively.

MBI-2 Injection/Backwash Sheet

		Initial Conditions (INJECTING)						Backwash (PUMPING)				
Date	Time	ative Vol (MG)	Q (gpm)	Inj. level (ft)	static (ft)	△ (ft)	Yield (gpf)	Q (gpm)	Level (ft)	△ (ft)	Yield (gpf)	Volume (gal)
4/7/2020	11:14	32.6	1214	53.0	72.7	19.7	61.6	3553	135.1	62.4	56.9	124,000
4/28/2020	8:45	32.3	0	0.0	93.8	93.8	0.0	3190	148.5	54.7	58.3	130,000
6/9/2020	6:00	52.3	1400	60.3	86.6	26.3	53.2	3220	144.9	58.3	55.2	130,000
7/14/2020	8:30	76.1	1554	60.9	93.6	32.7	47.5	3246	145.0	51.4	63.2	129,000
8/18/2020	9:46	75.2	1642	65.8	100.5	34.7	47.3	3182	155.4	54.9	58.0	127,000
10/1/2020	8:50	91.2	1619	59.6	103.0	43.4	37.3	3406	162.7	59.7	57.1	136,000
11/19/2020	11:09	108.0	1520	46.1	95.4	49.3	30.8	3460	157.8	62.4	55.4	138,000
12/22/2020	9:32	72.3	1637	33.6	93.2	59.6	27.5	3440	159.3	66.1	52.0	137,000
1/27/2021	7:13	77.5	1553	21.7	82.6	60.9	25.5	3446	157.0	74.4	46.3	207,000
2/24/2021	12:00	59.7	1424	12.7	83.4	70.7	20.1	3430	158.5	75.1	45.7	200,000
3/24/2021	10:02	57.5	1208	23.2	88.2	65.0	18.6	3451	158.3	70.1	49.2	207,000
4/20/2021	6:30	56.3	1243	17.7	100.8	83.1	15.0	3305	167.3	66.5	49.7	200,000
5/18/2021	9:08	54.1	1188	14.0	101.8	87.8	13.5	3371	171.7	69.9	48.2	202,000
6/16/2021	8:30	58.7	1433	14.9	104.3	89.4	16.0	3362	173.8	69.5	48.4	201,000
7/14/2021	8:51	52.7	1268	20.6	106.8	86.2	14.7	3337	177.1	70.3	47.5	250,000
8/3/2021	8:55	35.7	1056	16.7	113.7	97.0	10.9	3344	183.3	69.6	48.0	251,000
9/29/2021	9:17	51.7	1515	26.4	114.4	88.0	17.2	3320	179.6	65.2	50.9	199,000
10/20/2021	9:11	44.2	1416	41.7	106.5	64.8	21.9	3350	174.0	67.5	49.6	210,000
11/10/2021	9:37	41.1	923	18.8	106.2	87.4	10.6	3340	175.9	69.7	47.9	200,000
12/1/2021	9:10	31.6	934	14.0	102.6	88.6	10.5	3355	175.1	72.5	46.3	200,000
12/22/2021	10:00	30.4	812	15.9	91.9	76.0	10.7	3325	163.8	71.9	46.2	200,000
1/11/2022	9:00	25.4	763	14.5	86.5	72.0	10.6	3320	162.0	75.5	44.0	199,000
2/2/2022	9:00	29.6	860	15.4	91.1	75.7	11.4	3316	164.1	73.0	45.4	199,000
3/2/2022	3:00	37.7	748	11.5	102.7	91.2	8.2	3315	175.6	72.9	45.5	199,000
3/30/2022	9:00	38.2	720	14.2	95.0	80.8	8.9	3393	168.2	73.2	46.4	254,000
4/20/2022	10:30	23.8			98.3	98.3	0.0	3391	167.9	69.6	48.7	254,000
5/11/2022	9:00	27.8	1323	34.1	83.3	49.2	26.9	3388	151.4	68.1	49.8	254,000
6/1/2022	9:27	31.3	640	19.1	88.4	69.3	9.2	3345	159.9	71.5	46.8	301,000
6/15/2022	9:50	21.7	1154	15.2	94.4	79.2	14.6	3329	163.9	69.5	47.9	299,000
7/6/2022	8:30	29.7	916	14.4	107.6	93.2	9.8	3347	176.1	68.5	48.9	200,000

	Recovery (short term)						Recovery (medium term)						Recovery (long term)			
Date	Time hours	Static Level (ft)	Q (gpm)	Inj. Level (ft)	△ (ft)	Yield (gpf)	Time hours	Static Level (ft)	Q (gpm)	Inj. Level (ft)	△ (ft)	Yield (gpf)	Time hours	Static Level (ft)	Q (gpm)	Inj. Level (ft)
4/7/2020	0.5	77.9	1235	62.7	15.2	81.3	2	77.9	1234	55.8	22.1	55.8	13	77.9	1249	50.1
4/28/2020					0.0	#DIV/0!		0.0			0.0	#DIV/0!		93.9		
6/9/2020	0.5	96.9	1393	78.1	18.8	74.1	2	96.9	1408	68.9	28.0	50.3	18	96.9	1404	63.1
7/14/2020	0.5	94.4	1525	73.9	20.5	74.4	2	94.4	1581	63.3	31.1	50.8	19	94.4	1579	60.5
8/18/2020	0.5	102.2	1462	82.5	19.7	74.2	2	102.2	1515	73.2	29.0	52.2	18	102.2	1671	65.9
10/1/2020	0.5	105.9	1563	84.8	21.1	74.1	2	105.9	1627	72.9	33.0	49.3	18	105.9	1624	67.8
11/19/2020	0.5	98.3	1474	77.8	20.5	71.9	2	98.3	1504	62.7	35.6	42.2	17	98.3	1557	60.3
12/22/2020	0.5	96.5	1480	75.0	21.5	68.8	2	96.5	1545	63.3	33.2	46.5	16	96.5	1547	57.2
1/27/2021	0.5	94.0	1469	73.6	20.4	72.0	2	94.0	1520	58.9	35.1	43.3	14	94.0	1505	49.9
2/24/2021	0.5	93.6	1429	70.1	23.5	60.8	2	93.6	1458	58.9	34.7	42.0	15	93.6	1461	47.5
3/24/2021	0.5	91.4	1270	72.7	18.7	67.9	2	91.4	1365	61.7	29.7	46.0	16	91.4	1643	47.5
4/20/2021	0.5	104.4	1465	77.8	26.6	55.1	2	104.4	1563	68.1	36.3	43.1	17	104.4	1520	46.2
5/18/2021	0.5	106.7	1602	81.1	25.6	62.6	2	106.7	1026	79.0	27.7	37.0	21		0	
6/16/2021	0.5	109.8	1524	87.7	22.1	69.0	2	109.8	1552	78.1	31.7	49.0	22	109.8	1574	66.4
7/14/2021	0.5	113.1	1280	95.7	17.4	73.6	2	113.1	1313	86.4	26.7	49.2	21	113.1	1345	74.4
8/3/2021	0.5	119.1	1523	98.1	21.0	72.5	2	119.1	1577	84.1	35.0	45.1	17	119.1	1566	58.2
9/29/2021	0.5	119.7	1458	98.9	20.8	70.1	2	119.7	1539	88.9	30.8	50.0	18	119.7	1540	81.0
10/20/2021	0.5	111.5	1490	89.9	21.6	69.0	2	111.5	1517	80.2	31.3	48.5	21	111.5	1506	68.7
11/10/2021	0.5	110.3	1547	84.5	25.8	60.0	2	110.3	1530	75.5	34.8	44.0	18	110.3	1442	50.8
12/1/2021	0.5	105.9	1171	87.8	18.1	64.7	2	105.9	1224	79.7	26.2	46.7	16	105.9	1223	69.7
12/22/2021	0.5	94.8	1191	75.2	19.6	60.8	2	94.8	1226	69.0	25.8	47.5	20	94.8	1267	51.1
1/11/2022	0.5	90.7	947	76.5	14.2	66.7	2	90.7	1006	69.5	21.2	47.5	18	90.7	985	61.8
2/2/2022	0.5	95.0	1010	80.4	14.6	69.2	2	95.0	1063	73.0	22.0	48.3	18	95.0	1050	64.9
3/2/2022	0.5	105.5	848	81.8	23.7	35.8	2	105.5	1068	80.1	25.4	42.0	16	105.5	1094	71.5
3/30/2022	0.5	98.6	1003	84.2	14.4	69.7	2	98.6	1057	78.1	20.5	51.6	15	98.6	990	67.1
4/20/2022	0.5	101.7			101.7	0.0		101.7			101.7	0.0				
5/11/2022	0.5	87.3	1296	68.6	18.7	69.3	2	87.3	1313	61.9	25.4	51.7	18	87.3	1254	55.0
6/1/2022	0.5	93.6	1262	75.9	17.7	71.3	2	93.6	1320	66.2	27.4	48.2	17	93.6	1370	53.6
6/15/2022	0.5	100.4	945	87.0	13.4	70.5	2	100.4	1052	80.1	20.3	51.8	17	100.4	1080	71.5
7/6/2022	0.5	112.5	1176	95.3	17.2	68.4	2	112.5	1216	87.5	25.0	48.6	16	112.5	1173	78.2

MBI Pumping Data | MBI Pumping Graph | MBI-2 | MBI-2 Injection Data | MBI 2 Injection Graph | Rosur

Figure 48

The “MBI-2 Injection/Backwash Sheet” excel worksheet. This work sheet is called up by selecting the tab with the red oval. Data from the hand-completed “Injection / Backwash” form is used to complete the “Initial Conditions (INJECTING)” and “Backwash (Pumping)” sections of this worksheet. Excel will automatically calculate the change in level (△) and yield values. Short,medium and long term recovery data is taken directly from the PCS screen once injection resumes.

The second MBI database worksheet is the injection data worksheet (Figure 49). The IRSO retrieves this worksheet by selecting the tab inside the red oval shown in Figure 49. The injection data worksheet contain a lot of the same information as the “MBI (#) Injection/backwash” sheet. The IRSO enters the injection data just prior to taking the well off-line and also 2 hours after the well has resumed injection (following a backwash). Data from within this worksheet is used to produce the injection well performance graph (Figure 50).

			MBI-2					
	Inj Rate	Inj tote daily sum	Static	Inj level	Up draw	Yield	DELTA per day	NOTES
10/6/2024 6:00	1012	1.52	102.0	15.7	86.3	11.73	4.40	
10/7/2024 6:00	1015	1.49	102.0	16.0	86.0	11.80	-0.30	
10/8/2024 6:00	1042	1.50	102.0	12.8	89.2	11.68	3.20	
10/9/2024 6:00	1072	1.53	102.0	10.7	91.3	11.74	2.10	
10/10/2024 6:00	1072	1.51	102.0	10.5	91.5	11.72	0.20	
10/11/2024 6:00	1007	1.49	102.0	14.0	88.0	11.44	-3.50	
10/12/2024 6:00	1012	1.47	102.0	13.4	88.6	11.42	0.60	
10/13/2024 6:00	936	1.45	102.0	16.3	85.7	10.92	-2.90	
10/14/2024 6:00	976	1.50	102.0	20.5	81.5	11.98	-4.20	
10/15/2024 6:00	1014	1.42	102.0	12.7	89.3	11.35	7.80	
10/16/2024 6:00	966	1.20	102.0	23.0	79.0	12.23	-10.30	
10/17/2024 6:00	1146	1.61	98.6	15.7	82.9	13.82	3.90	
10/18/2024 6:00	1057	1.54	98.6	14.6	84.0	12.58	1.10	
10/19/2024 6:00	1055	1.46	98.2	11.6	86.6	12.18	2.60	
10/20/2024 6:00	1111	1.65	98.2	18.0	80.2	13.85	-6.40	
10/21/2024 6:00	1019	1.55	98.2	24.6	73.6	13.85	-6.60	
10/22/2024 6:00	1080	1.63	98.2	26.5	71.7	15.06	-1.90	
10/23/2024 6:00	1161	1.72	98.2	19.4	78.8	14.73	7.10	Backwash today
10/23/2024 13:22	1201		105.7	79.5	26.2	45.84	-52.60	After two hours with new static
10/24/2024 6:00	1213	1.75	105.7	71.0	34.7	34.96	8.50	
10/25/2024 6:00	1261	1.65	105.7	64.0	41.7	30.24	7.00	
10/26/2024 6:00	1115	1.61	105.7	65.7	40.0	27.88	-1.70	
10/27/2024 6:00	1110	1.67	105.7	62.5	43.2	25.69	3.20	
10/28/2024 6:00	1053		105.7	58.5	47.2	22.31	4.00	

MBI Pumping Data | MBI Pumping Graph | MBI-2 | MBI-2 Injection Data | MBI 2 Injection Graph | Rosur

Figure 49
Injection Data" worksheet for injection well MBI-2.

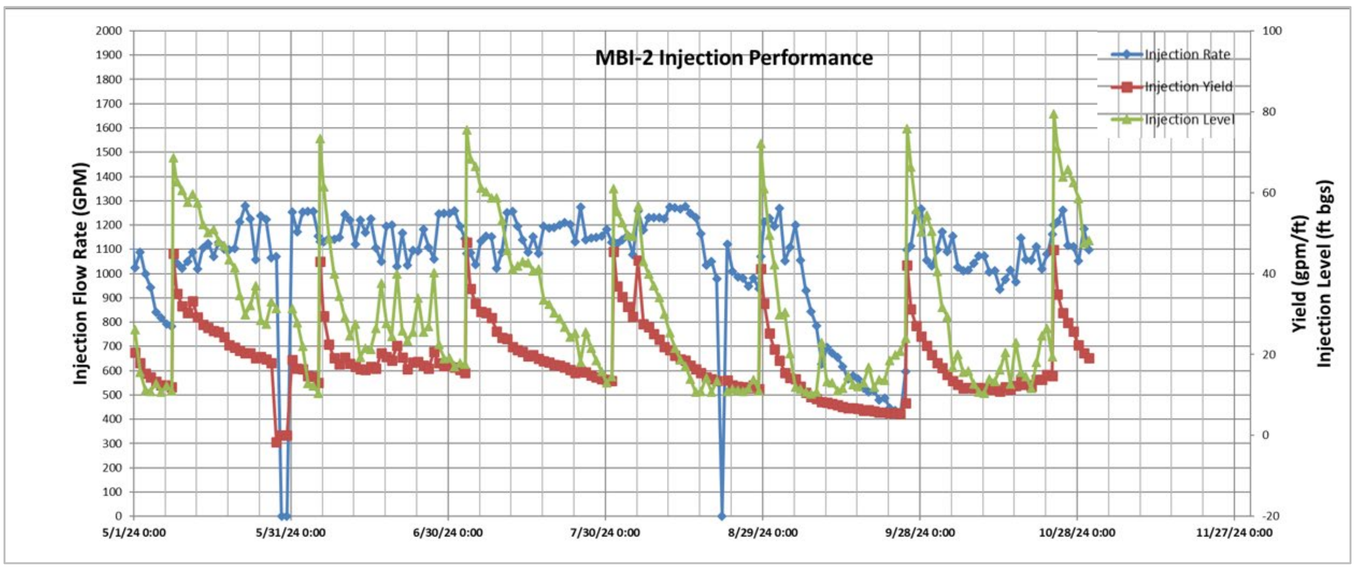


Figure 50
Injection Performance worksheet for injection well MBI-2. This graph will auto populate using data entered from the "Injection Data" worksheet above.

Backwash pumping efficiency is important to document. The IRSO enters backwash pump data into a "Pumping Data" worksheet (Figure 51). The "Pumping Data" worksheet can be retrieved by selecting the tab inside the red oval in Figure 51. The pumping water level (pwl) is taken from the Delta V screen during a backwash event. The discharge pressure ("dis psi") is taken on-site at the gauge. The worksheet is formulated to automatically calculate the change in level (∆) and the yield. Data entered into this worksheet is used to generate the MBI well "Pumping Performance" graph (Figure 52).

MBI-2

cycle	date/time	rate	static	pwl	dis psi	delta	yield	TOTCL2	Comments
	4/12/23 9:45	3345	79.4	160.1	38.0	80.7	41.45		
	5/10/23 9:26	3320	91.1	167.1	37.0	76.0	43.68		
	6/7/23 8:45	3215	98.1	166.4	30.0	68.3	47.07		
	7/3/23 6:00	3307	102.1	178.8	30.0	76.7	43.12		
	8/2/23 9:00	3317	107.0	179.8	30.0	72.8	45.56		
	8/28/23 0:00	3325	104.4	179.7	30.0	75.3	44.16		
	9/27/23 9:15	2840	102.3	155.5	30.0	53.2	53.38		
	10/25/23 8:54	3320	96.4	163.5	35.0	67.1	49.48		
	11/21/23 9:20	3356	91.3	159.1	35.0	67.8	49.50		
	12/20/23 9:10	3343	87.6	160.2	35.0	72.6	46.05		
	1/17/24 9:00	3387	75.8	153.7	36.0	77.9	43.48		
	2/14/24 9:10	3328	80.0	162.4	35.0	82.4	40.39		
	3/13/24 9:20	3396	71.9	150.8	36.0	78.9	43.04		
	4/10/24 9:00	3342	67.4	132.4	46.0	65.0	51.42		
	5/8/24 9:08	3331	86.5	162.2	36.0	75.7	44.00		
	6/5/24 9:06	3361	93.5	159.8	34.0	66.3	50.69		
	7/3/24 9:32	3344	92.9	162.1	38.0	69.2	48.32		
	7/31/24 9:40	3272	82.3	144.3	36.0	62.0	52.77		
	8/28/24 10:36	3344	95.1	162.4	34.0	67.3	49.69		
	9/25/24 9:20	3364	98.4	172.7	28.0	74.3	45.28		
	10/23/24 9:23	3374	100.9	172.8	28.0	71.9	46.93		

MBI Pumping Data | MBI Pumping Graph | MBI-2 | MBI-2 Injection Data | MBI 2 Injection Graph | Rosur ...

Figure 51
MBI "Pumping Data" worksheet.

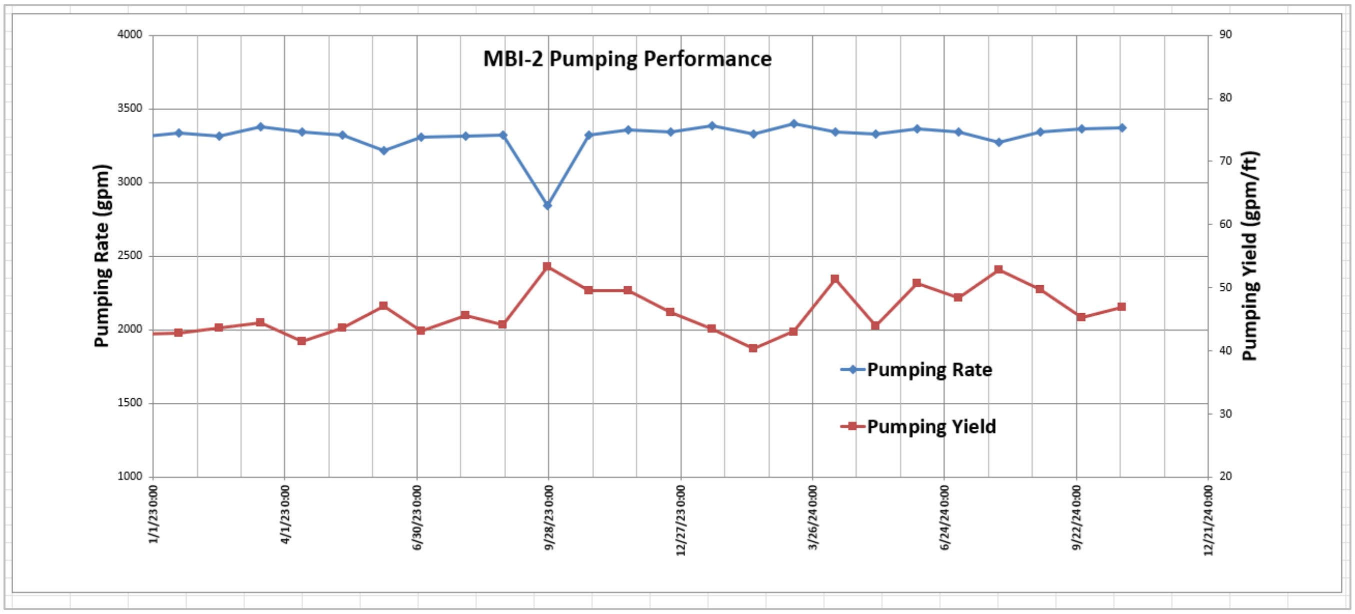


Figure 52
MBI "Pumping Data" graph.

During the backwash process, the IRSO in the field is recording sand concentrations in the discharge stream using the Rossum Sand Tester (Appendix A-10) and recording them on field forms (Figure 53).

Blank forms can be found on the Water Production SharePoint site at:

- WP > Shared Files > WaterProd > Barrier > Forms > Rossum Text.xlsx

Injection wells MBI-3 and MBI-5 produce appreciable amounts of sand and subsequently require longer backwashes. For this reason a longer (2 hour) form was created.

Rossum Sand Tests Well #__ ____				DATE ___________
time	ml	color		
5				
10				
15				
20				
25				
30				
35				
40				
45				
50				
55				
60				
				DATE ___________
5				
10				
15				
20				
25				
30				
35				
40				
45				
50				
55				
60				

Rossum Sand Tests Well #__ ____				DATE ___________
time	ml	color		
5				
10				
15				
20				
25				
30				
35				
40				
45				
50				
55				
60				
65				
70				
75				
80				
85				
90				
95				
100				
105				
110				
115				
120				

Figure 53

Rossum Sand Test field forms. The form on the left is used for MBI-1, MBI-2 and MBI-4 and contains space for 60 minutes of backflushing. The form on the right is used to record sand concentrations at MBI-3 and MBI-5 and contains space for 120 minutes of backflushing.

Sand concentration field data is then transferred from the field forms into the excel worksheet denoted by the "Rossum Sand Test" tab at the bottom of the screen inside the red oval in Figure 54. Data entered into the "Rossum Sand Test" worksheet is used to generate the wells' "sand graph" (Figure 55). The "sand graph" generates automatically from the data entered into the "Rossum Sand Test" worksheet.

A	B	C	D	E	F	G	H	I	J	K	L	M
MBI-102	date:time	sample	ml/H2O	min		PPM	flow rate	note				
		45	0	5	0	0						
		50	0	5	0	0						
		55	0	5	0	0						
		60	0	5	0	0						
18	10/20/2021 9:11	5	0	5	0	0						
		10	0	5	0	0						
		15	0	5	0	0						
		20	0	5	0	0						
		25	0	5	0	0						
		30	0	5	0	0						
		35	0	5	0	0						
		40	0	5	0	0						
		45	0	5	0	0						
		50	0	5	0	0						
		55	0	5	0	0						
		60	0	5	0	0						
19	11/10/2021 10:18	5	0	5	0	0						
		10	0	5	0	0						
		15	0	5	0	0						
		20	0	5	0	0						
		25	0	5	0	0						

MBI-2 | MBI-2 Injection Data | MBI 2 Injection Graph | Rosum Sand Tests | sand graph | inject average

Figure 54
"Rossum Sand Test" worksheet

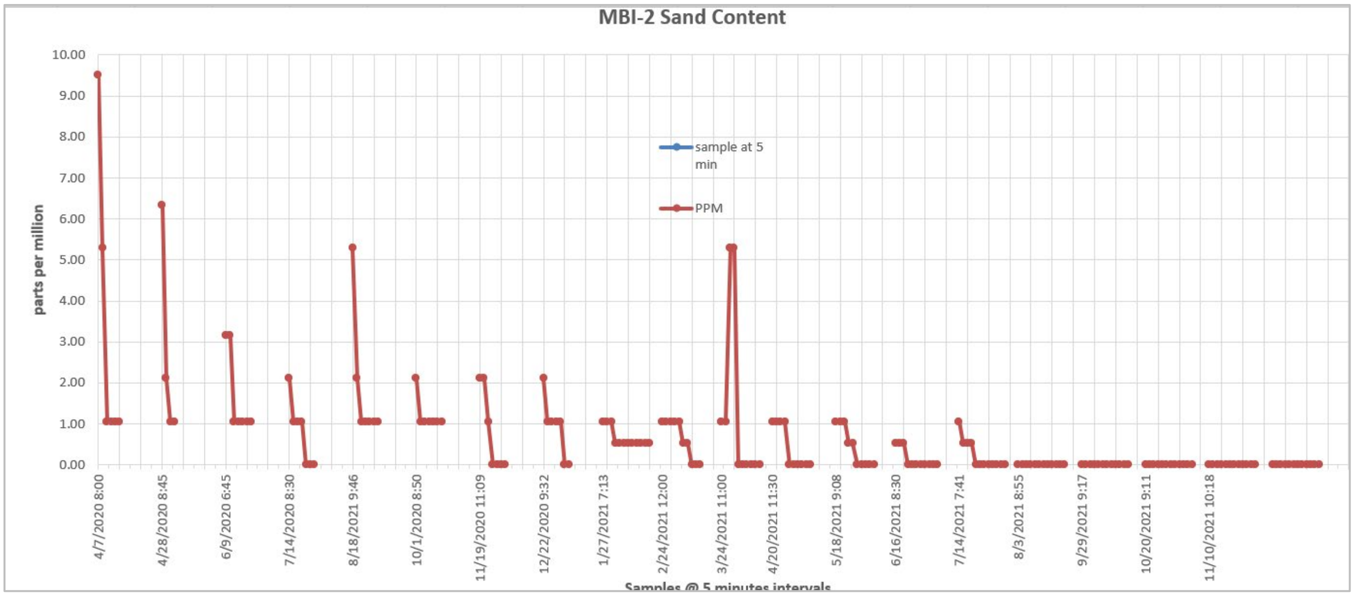


Figure 55

Sand graph generated automatically from data entered into the “Rossum Sand Test” worksheet.

MBI Well Performances and Unique Characteristics

This section will describe the performance history of each MBI well and identify unique characteristics of each MBI well.

MBI-1

Well Performance

Injection Flow Setpoint:	1,200-1,300 GPM
Average Injection Yield:	22 gpm/ft
High / Low Injection Yield:	51/9 gpm/ft
Average Pumping Yield:	39 gpm/ft
High / Low Pumping Yield:	49/27 gpm/ft
Gravel Feed Tube Status:	Stable and does not take water (cement in tube)
Sand Production:	mild
Backwash Frequency:	weekly
Baski Timers (operating):	1/30 minutes
Baski Timers (start/stop):	10/30 minutes

Unique Characteristics

MBI-1 is backwashed weekly. The backwash pump is started before 7:00 am to avoid demand charges from the electrical utility.

The MBI-1 backwash pump is a vertical turbine pump and the packing needs to be replaced periodically. See Appendix A-9 for packing replacement instructions.

The 800-830 feet bgs screened interval at MBI-1 was swaged (blanked) off during initial pump testing due to large amounts of very fine sand coming from this zone.

MBI-1 is located in area where homeless gather and engage in nefarious activities. The site's perimeter fence does a good job of protecting the well site; however, the IRSO should be very vigilant when working at MBI-1. It is best not to visit MBI-1 alone after dark.

- On rare occasions an ideal injection yield can be sustained for periods longer than a week. When this happens, the backwash frequency is extended. It is uncertain why this phenomenon occurs; however, it is speculated that local pumping is likely the cause.

MBI-2

Well Performance

Injection Flow Setpoint:	1,000-1,300 GPM
Average Injection Yield:	15 gpm/ft
High / Low Injection Yield:	46/5 gpm/ft
Average Pumping Yield:	50 gpm/ft
High / Low Pumping Yield:	78/40 gpm/ft
Gravel Feed Tube Status:	stable, takes water
Sand Production:	minimal
Backwash Frequency:	monthly
Baski Timers (operating):	2/120
Baski Timers (start/stop):	10/30

Unique Characteristics

- MBI-2 was constructed using natural filter pack material and does not produce much sand when backwashed.
- Occasionally a car will park over the manway hatch, requiring the IRSO to use the ladder (or come back another time).

MBI-3

Well Performance

Injection Flow Setpoint:	575-950 GPM
Average Injection Yield:	6 gpm/ft
High / Low Injection Yield:	19/4 gpm/ft
Average Pumping Yield:	42 gpm/ft
High / Low Pumping Yield:	64/30 gpm/ft
Gravel Feed Tube Status:	unstable, takes water
Sand Production:	heavy
Backwash Frequency:	monthly
Baski Timers (operating):	2/120
Baski Timers (start/stop):	10/30

Unique Characteristics

- MBI-3 was constructed using artificial filter pack material (silica beads) and produces lots of sand during pumping.
- The gravel feed tube at MBI-3 is unstable and requires replenishment often.
- Backwash takes about 2 times longer due to sand production.
- The MBI-3 backwash flow rate is reduced considerably to manage the sand production.

MBI-4

Well Performance

Injection Flow Setpoint: 1,000-1,300 GPM
Average Injection Yield: 14 gpm/ft
High / Low Injection Yield: 61/3 gpm/ft
Average Pumping Yield: 50 gpm/ft
High / Low Pumping Yield: 84 / 40 gpm/ft
Gravel Feed Tube Status: stable, takes water
Sand Production: minimal
Backwash Frequency: monthly
Baski Timers (operating): 2/120
Baski Timers (start/stop): 10/30

Unique Characteristics

- MBI-4 was constructed using natural filter pack material and does not produce much sand when backwashed.

MBI-5

Well Performance

Injection Flow Setpoint: 1,000-1,300 GPM
Average Injection Yield: 16 gpm/ft
High / Low Injection Yield: 48/9 gpm/ft
Average Pumping Yield: 56 gpm/ft
High / Low Pumping Yield: 82/45 gpm/ft
Gravel Feed Tube Status: stable, takes water
Sand Production: moderate
Backwash Frequency: monthly
Baski Timers (operating): 2/120
Baski Timers (start/stop): 10/30

Unique Characteristics

MBI-5 should be backwashed as early as possible because people tend to park on top of the vault access hatches as the day progresses.

- MBI-5 contains an artificial filter pack (silica beads) and produces moderate amounts of sand when pumped.

APPENDICES

Appendix A1

MAIN LINE AND LATERAL VALVE EXERCISING

APPENDIX A1

Exercising Main and Lateral Valves

Background

Annually all main line and lateral valves are exercised. This consists of stopping water flow and fully closing and then reopening each valve. Many times, the valve can, and riser needs to be cleaned of debris that block the valve key from contacting the valve nut. A shop vacuum or spring-loaded grabbing device can be used to remove dirt and rocks or asphalt chunks. These tools can be found in the Barrier Shop. Valve exercising procedures are described below. While following the procedures it is important that the IRSO operate all valves *slowly* to prevent the potential for water hammer. When exercising valves in heavy traffic, the IRSO should try to place a pickup truck between the work area and oncoming traffic. After valve exercising has been completed water flow is returned to normal.

Procedures

- Mobilize to the valve operator, if in heavy traffic try to position a pick-up truck between the work area and oncoming traffic. Remove the valve can lid to access the valve actuator nut.
- Inspect the valve can condition. If debris is present remove with shop vacuum or spring-loaded grabbers.
- Place the “Tee Handle” securely on the valve actuator nut.
- Exercise the main or lateral butterfly valve by *slowly* turning the tee handle in a clockwise direction.
- When the valve operator nut is no longer able to be turned clockwise, the valve is fully closed.
- Once the valve is fully closed, *slowly* turn the Tee Handle on the valve actuator nut in a counterclockwise direction.
- When the valve operator nut is no longer able to be turned counterclockwise, the valve is fully open.
- With the valve fully open, remove the Tee Handle from the valve actuator nut and place the valve can lid securely onto the valve can.
- Cautiously demobilize from the site.

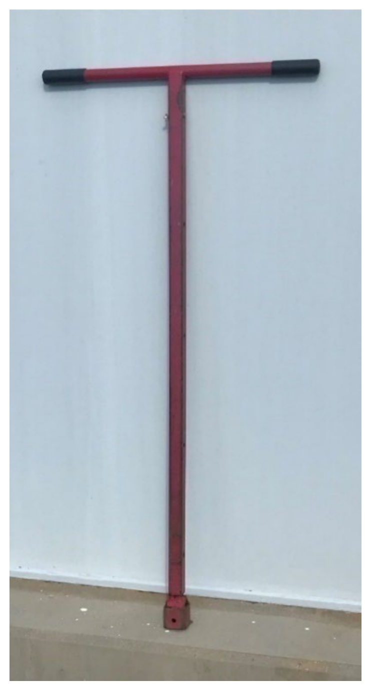


Figure 1
“Tee Handle” tool that is placed on the valve actuator nut and manually turned to operate the valve. This tool is extendable. The tool is in the shortest position possible for this photograph.

Appendix A2

BLOW OFF VALVE OPERATION PROCEDURES

APPENDIX A2

Blow Off Valve Operation Procedures

Background

Annually blow off valves are partially opened to remove sediment and debris from low lying portions of a distribution pipeline. Valves may be in traffic lanes requiring traffic control to gain access. The IRSO should try and place a pick-up truck between the work area and oncoming traffic whenever possible. Once the work area is secured a fire hose or standpipe is added to the blow off discharge to divert the flow of water away from traffic or pedestrians. The valve is then opened slightly to allow water and debris to exit the pipeline. The discharge is observed, and the color and type of debris is noted in the IRSO's field book. After the water runs clear, the valve is closed, the discharge point is sealed and the cover is replaced. If traffic control was used, it is then taken down so the flow of traffic can return to normal.

Procedures

- Mobilize to the site, locate the blow off valve actuator can and the blow off valve discharge vault.
- Remove the discharge vault lid
- Locate the flange tab (Figure 1, **A**) and connect one end of a whip-check restraint device to the tab using a shackle.
- Unthread the cap from the fire hose fitting.
- Connect the other end of the whip-check restraint device to the 2-inch steel pipe riser (snorkel) (Figure 1, **B**).
- Thread 2-inch steel pipe riser (snorkel) onto fire hose fitting. Align the horizontal portion of the snorkel in the direction you want the discharge to flow. Lay flat hose can be threaded onto the horizontal end of the snorkel to deliver discharge longer distances (like into nearby vegetation). Ensure that the discharge flow does not affect pedestrians or vehicle traffic.
- Carefully mobilize to the blow off valve actuator can. If traffic control is required, work with at least one other IRSO to set-up the lane closure per the Watchbook (Appendix A-1). If possible, place a pick-up truck between the work area and oncoming traffic.
- Remove the valve can lid and locate the blow off valve actuator nut.
- Remove any debris from the valve can using a shop vacuum or spring-loaded grabbers.
- Securely place the "Tee Handle" tool (same tool used for main and lateral valve exercising, see Appendix A-1) on the blow off valve actuator nut (Figure 2).
- Slowly begin to turn the "Tee Handle" counterclockwise. The valve will begin to unseat and water will begin discharging out the lay-flat house (Figure 3).

- Continue turning the valve actuator counterclockwise until the velocity of the discharge water is high enough to carry solid material from the pipeline.
- Monitor the discharge color and content. Record the observations in your field book.
- When discharge water becomes clear and particle free, close the blow off valve by slowly turning the “Tee Handle” clockwise. When the “Tee Handle” can no longer be turned clockwise the valve should seat and discharge will stop flowing.
- Remove the “Tee Handle” from the blow off valve actuator nut and securely place the lid back onto the blow off valve actuator can.
- Cautiously remove traffic control (if applicable) and demobilize.
- Mobilize back to the discharge vault.
- Unthread the 2-inch steel pipe riser (and lay flat hose, if applicable) from the fire hose fitting. Thread the fire hose cap back onto the fire hose fitting.
- Securely place the lid back onto the blow off valve discharge vault.
- Clean up any deposits of material that may be on the sidewalk, gutter or street.

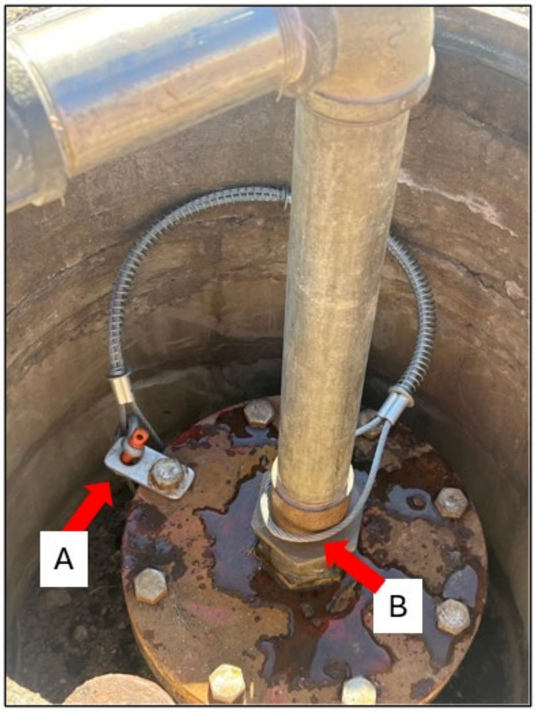


Figure 1
*Proper connection for correct blow off procedure. The Flange tab (**A**) provides a solid anchor to shackle one end of the whip-check. The other end of the whip-check is placed around the 2-inch steel pipe riser (snorkel), then the snorkel is threaded into the brass fire hose fitting (**B**).*

Figure 2

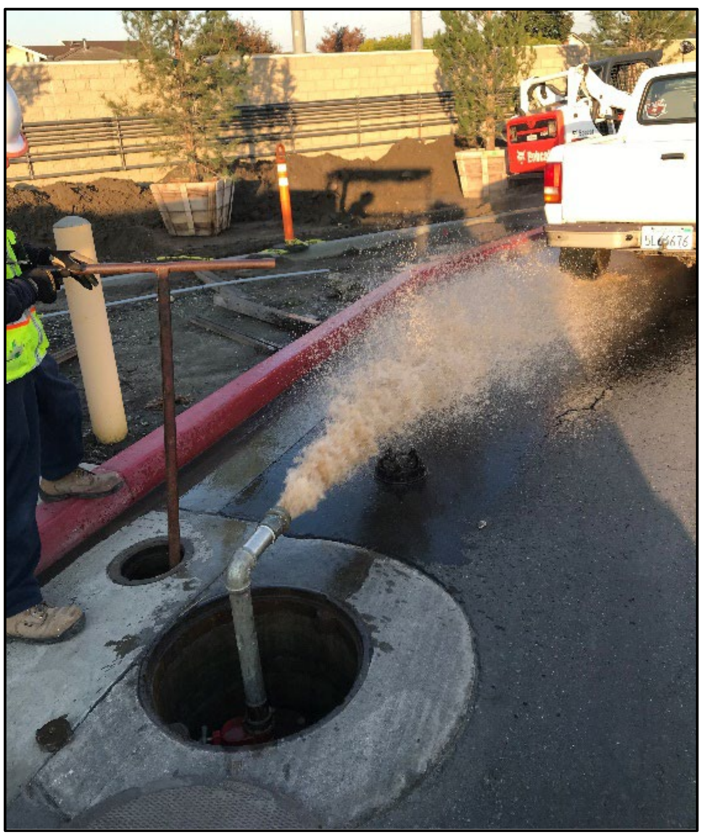


Figure 3

Appendix A3

FIELD SHARPS SOP

	ORANGE COUNTY WATER DISTRICT	Procedure No: SP-3.3
	Sharps Safety for Field Operations	Date: 2025

1 Purpose

1.1. This document describes the general guidelines for handling and disposal of sharps including syringes. The term "sharps" refers to any instrument that can puncture, cut or scrape body parts. Use of this term includes, but is not limited to, needles, syringes, broken glass, scalpel and other blades. The use of sharps should be restricted to trained personnel and to those cases in which no alternative is available. Contaminated sharps additionally comprise a regulatory waste classification and must not be disposed of in the regular waste stream.

2 Safety Precautions

2.1. The most effective method of preventing cuts and sticks is to minimize contact by handling sharps safely and disposing of them immediately.

2.2. Avoid Direct Contact with Non-Visible Areas. Never reach into areas where visibility is obstructed. Always have available sharps disposal container, a grabber or pliers, and Personal Protective Equipment (PPE) on hand. Ensure that sharps disposal containers are approved, puncture-resistant, and equipped with a secure closure.

3 Risk

3.1. The potential safety risks for those exposed to sharps are:

- Puncturing, cutting or scraping
- Exposure to contamination (infectious microorganisms) from used sharps via puncture, cut or scrape
- Exposure to contamination from creation of aerosols

4 Responsibilities

4.1. Managers/supervisors are responsible for providing employees with PPE, a puncture resistant sharps container and grabber/pliers.

4.2. Managers/supervisors are responsible for notifying Risk & Safety to schedule Bloodborne Pathogens training for employees with potential exposure to sharps in the field.

4.3. Employees are responsible for wearing the required PPE and following safe procedures.

5 Procedure

5.1. Assess the scene and ensure it is safe prior to starting work.

5.2. Wear puncture resistant gloves, safety glasses, and safety shoes.

Safety Procedure: *Document No.:* **SP-3.3**

5.1. It is recommended that syringes be picked up using pliers, tongs, grabber or similar tool. Additionally, heavy leather or canvas gloves should be worn when attempting to pick up the syringe. Pick up the syringe so that the sharp end is pointing away from you.

5.2. Immediately place used needles and other sharps in a sharps disposal container to reduce the risk of needle sticks, cuts or punctures from loose sharps.

5.3. Do not eat, drink, or smoke, while in the area.

5.4. Do not touch your eyes, mouth, or nose after touching any surface that may potentially be contaminated.

5.5. If you observe illicit powder like drugs, leave the area. Avoid performing any task that may cause the powder to become airborne and enter the airway. If safe to do, take a picture and leave the area. Get to a safe location and notify your supervisor and law enforcement.

5.6. Avoid direct skin contact with a syringe or any sharp object. If this occurs, immediately wash the area with soap and water and notify your supervisor.

5.7. If you observe someone who has overdosed, call 911 and notify your supervisor. Keep a distance and avoid close contact with the person.

5.8. Report a problem associated with sharps and disposal containers to your supervisor or Risk & Safety.

5.9. DON'T throw loose needles and other sharps into the trash.

5.10. DON'T flush needles and other sharps down the toilet.

5.11. DON'T put needles and other sharps in the recycling bin -- they are not recyclable.

5.12. DON'T try to remove, bend, break, or recap needles. This can lead to accidental needle sticks, which may cause serious infections.

6 Training

6.1. Manager/supervisor shall notify Risk & Safety of employees with potential exposure to sharps in the field. Risk & Safety will provide them with Bloodborne Pathogens training.

7 Exposure

7.1. If you are exposed to blood, body fluid, or needle stick, notify your supervisor immediately. The supervisor will inform Risk & Safety. Wash the affected area thoroughly with soap and water.

Safety Procedure: *Document No.:* **SP-3.3**

SAMPLE ITEMS BELOW:

SHARPS CONTAINERS



GRABBER

EP90 Easy Pick-Up Grabber 90cm: https://idcmedical.com/biohazard-waste-management/ep90-easy-pick-up-grabber-90cm/



Appendix A4

MBI WELL BACKWASH
PROCEDURES

APPENDIX A4

MBI Well Backwash Procedures

Backwashing the MBI wells requires multiple IRSO's to complete both office and field procedures simultaneously. This appendix describes the procedures followed by the IRSO to perform both the office and field procedures.

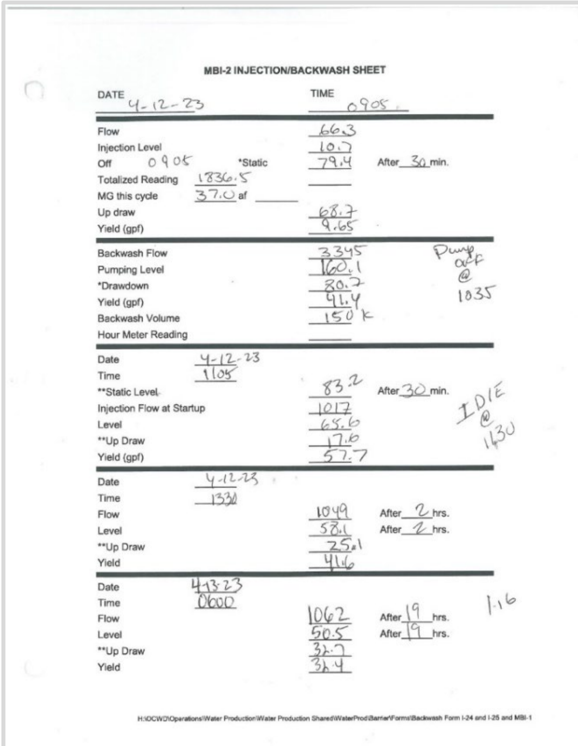
Office Procedures

All MBI wells are equipped with dedicated backwash pumps. The backwash pumps are controlled by Delta V using any of the Delta V terminals on the OCWD Fountain Valley campus. The IRSO in the office communicates with the IROS's at the well site to coordinate the timing of the backwash pump operation. This section of the Appendix describes the procedures for the IRSO in the office in Fountain Valley operating the backwash pump.

Obtain the MBI backwash binders, note MBI-1 forms are contained in one binder and MBI-2 through 5 are in a separate binder (Figure 1). The binders are typically kept in the Delta V cubicle located on the second floor of the 540 Building.

Figure 1
MBI Well backwash binders. These binders are typically stored in the Delta V cubicle on the 2nd floor of Bldg. 540 and contain the backwash form that is completed by the IRSO conducting the office portion of an MBI well backwash.

- The IRSO conducting the office portion of the MBI backwash will need to complete the MBI Well "Injection/Backwash Sheet" (the Sheet, the form) Figure 2. This form has been designed to guide the IRSO systematically through the MBI well backwash office procedures. Data entered onto this form is later transferred into an electronic database that documents well performance. Blank forms are in the back of both binders.
  The electronic form template is located at: WP > Shared Files > WaterProd > Barrier > Forms > Backwash Form I-24, I-5 and MBI-1-5.xls



MBI-2 INJECTION/BACKWASH SHEET

DATE 4-12-23 TIME 0905

Flow 66.3
Injection Level 10.7
Off 0905 *Static 79.4 After 30 min.
Totalized Reading 1836.5
MG this cycle 37.0 af
Up draw 68.7
Yield (gpf) 9.65

Backwash Flow 3345 Pump off @ 1035
Pumping Level 160.1
*Drawdown 80.7
Yield (gpf) 41.4
Backwash Volume 150 k
Hour Meter Reading

Date 4-12-23
Time 1105
**Static Level 83.2 After 30 min.
Injection Flow at Startup 1017 IDLE @ 1430
Level 65.6
**Up Draw 17.6
Yield (gpf) 57.7

Date 4-12-23
Time 1330
Flow 1049 After 2 hrs.
Level 58.1 After 2 hrs.
**Up Draw 25.1
Yield 41.6

Date 4-13-23
Time 0600
Flow 1062 After 19 hrs. 1.16
Level 50.5 After 19 hrs.
**Up Draw 32.7
Yield 32.4

H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Forms\Backwash Form I-24 and I-25 and MBI-1

Figure 2

Completed Mid Basin Injection Well Backwash Sheet for MBI-2 on April 12, 2023. This form will guide the IRSO through the office backwash procedures. The IRSO can make observational notes along the margin of the form. Data from this form is later transferred to an electronic database that documents well performance. A trailer at the bottom of the form shows the electronic pathway to the blank form template on the OCWD SharePoint site.

- Select the sheet for the well to be backwashed. Fill in the date and time at the top of the form. Using Delta V, bring up the well to be backwashed. Using information from Delta V screen complete the injection flow and injection level section at the top of section 1 of the form.

- Secure injection to the well. After 30 minutes record the static water level and volume totalizer displayed on Delta V in section 1 of the form (Figure 3).

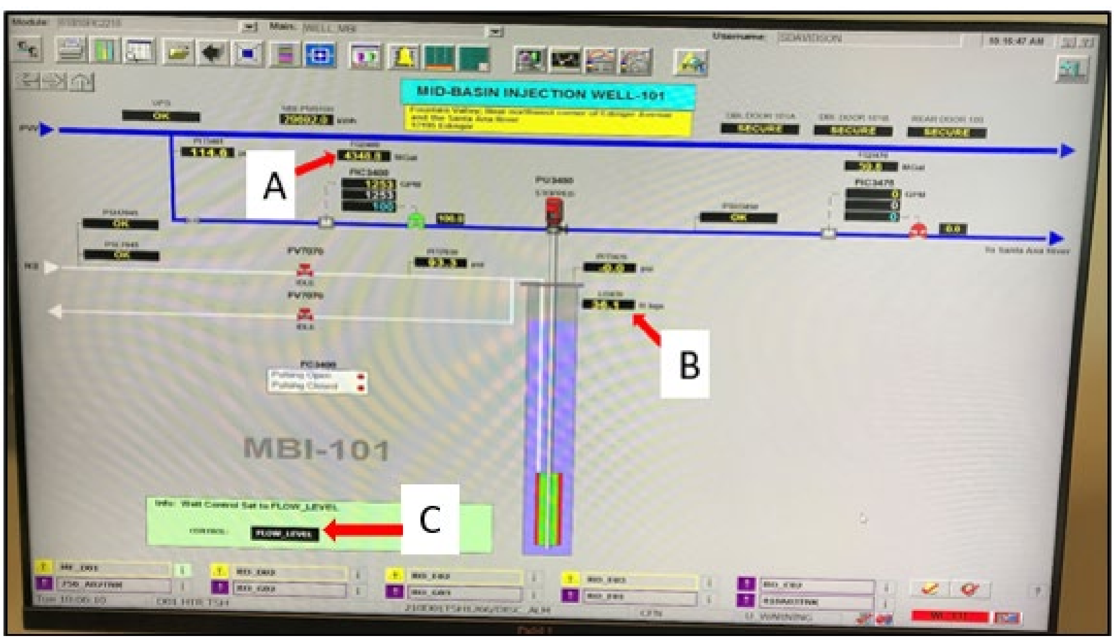


Figure 3

*Delta V Mid Basin Injection well screen showing volume totalizer (red arrow "**A**") and water level (red arrow "**B**"). Red arrow "**C**" indicated the selection box used to change the well operational mode. Operational modes to choose from include: "off", "flow", "flow and level", "flow and pressure" and "backwash".*

- Start the pump by locating the green banner in the lower left portion of the Delta V Mid Basin Injection Well screen. Inside the green banner is a black rectangle. From inside the black rectangle select "backwash" (Figure 3, red arrow "**C**"), then select "confirm". The screen should then look like Figure 4 below:

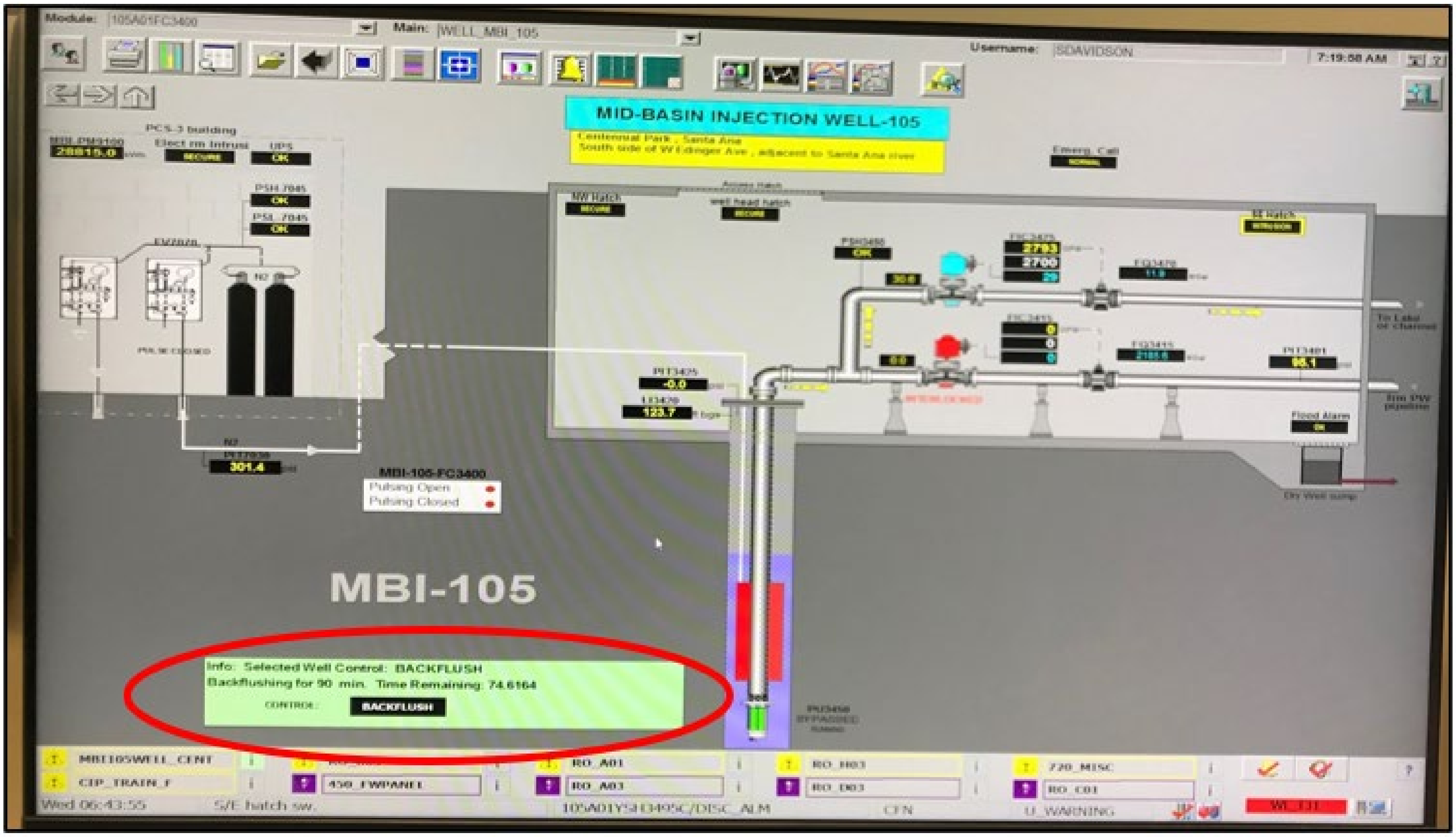


Figure 4

Delta V screen showing Mid Basin Injection Well in backwash mode as indicated by the status message inside the red oval.

Note:

When starting a backwash, if the pump doesn't start, the lake level may be too high. Because the well can discharge to the lake, a predetermined lake level setpoint may prevent pump from starting. To correct this issue the IRSO can place the lake level indicator in "simulate" or "sim" mode by navigating to the MBI Well page in Delta V and selecting the "Lake Level" icon as shown below in Figure 5.

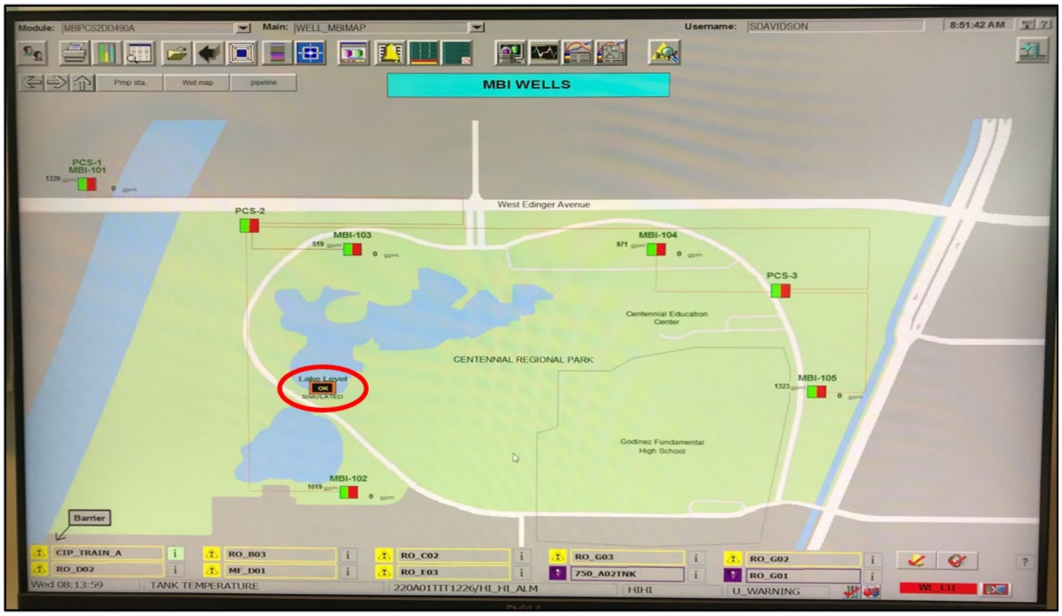


Figure 5
The MBI Well page in Delta V. The IRSO can click the "Lake Level" tab shown inside the red oval to begin placing the lake water level transmitter in "simulate" or "sim" mode.

Once "Lake Level" is selected, face plate "MBIPCS2DI3490A" will appear. From this face plate select the "detail" icon at the lower left as indicated by the red arrow in Figure 6 below.

Figure 6
MBI Wells Delta V page. The IRSO can simulate the lake level by selecting the "details" icon at the bottom of face plate "MBIPCS2DI3490A" as indicated by the red arrow.

- After selecting the "details" icon from face plate MBIPCS2DI3490A, the MBIPCS2DI3490A detail face plate will populate. From the detail face plate, the IRSO can simulate the lake level by enabling simulation as indicated by the two red arrows in Figure 7 below.

Figure 7

Detail" face plate MBIPCS2DI3490A. The IRSO can enable lake level simulation by selecting the two red arrows.

Note:

The backwash pump run time interval and flow rate is preprogrammed for each individual well. These settings are determined to minimize sand production during pumping. If necessary, the IRSO can manually adjust these settings by selecting face plate "FC 3400" and selecting "adjust limit" as shown by the red oval in Figure 8 below and manually changing the pump flow rate (red arrow "**A**") and pump timer (red arrow "**B**"). Length of time can be increased to mitigate sand production; however, flow rate cannot be changed after starting pump. For this reason, MBI-3 (which produces a lot of sand) is started manually and locally as described in the "Field Operations" section of this appendix.

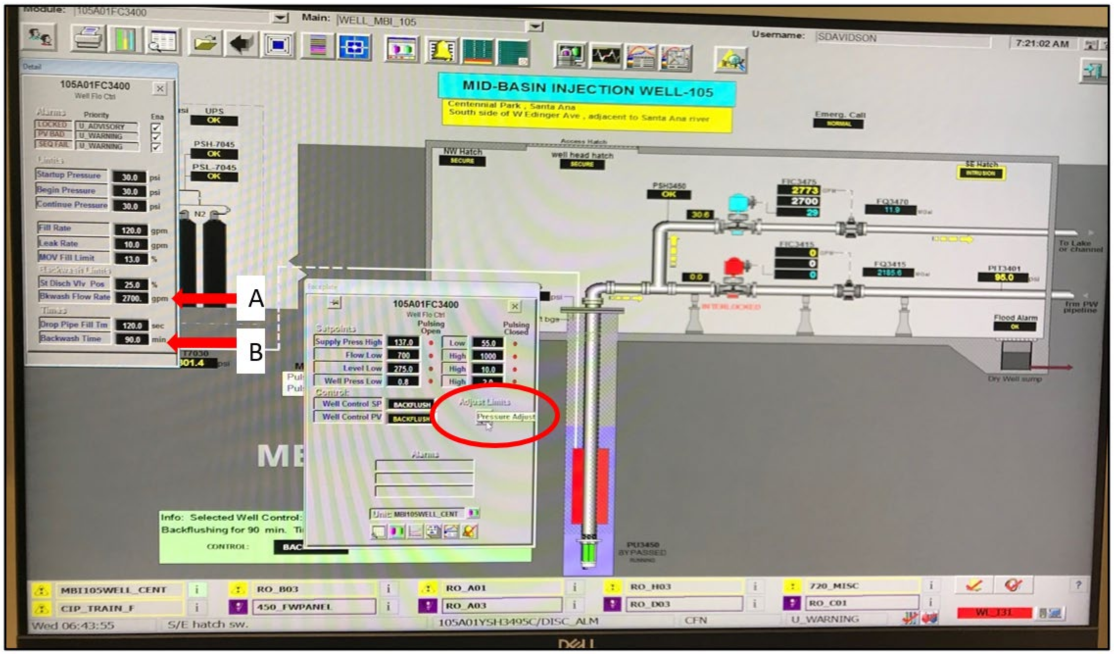


Figure 8

*The IRSO can manually change the preset backwash timer and flow rate by selecting "Adjust Limits" in faceplate FC3400 (red oval) and then adjusting the flow at red arrow "**A**" and the pump timer at red arrow "**B**".*

- As the backwash progresses, keep an eye on time. The next well to be backwashed needs to be taken off-line 30 minutes prior to starting to capture a good static water level.
- As the backwash progresses, trend the level on Delta V periodically to observe drawdown.

Field Procedures

1. Secure flow to the mid-basin injection well 30 minutes prior to starting the backwash pump. Record the static water level.

   Note: Sometimes vehicles park over the manway hatch into the MBI well vaults. Starting early in the morning, prior to 7:00 am will usually insure well access. MBI-5 is the most difficult well to access. It's a good idea to start at MBI-5. Cones can be placed at other Centennial Park wells to insure access later.

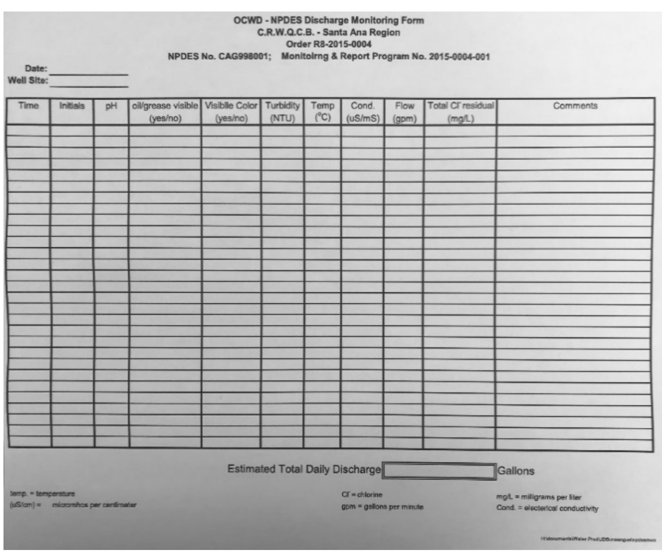
2. Drive to Mid Basin injection well

   Note: Mid Basin Injection Wells MBI-1, MBI-3 and MBI-5 produce formation sand while back wash pumping. The IRSO must use the Rossum sand tester (Appendix A-10) to monitor sand production and determine the appropriate time to end the backwash cycle. To prevent problematic sand accumulation on top of the wells check-valve, the measured sand accumulation must be below 0.02 parts per million prior to completing the backwash.

   Note: MBI well vaults are equipped with intrusion alarms. IRSO must call control room and announce entry prior to opening hatch.

3. Have the IRSO in the office start the backwash pump for MBI-1, MBI-2, MBI-4, MBI-5. MBI-3 produces large amounts of sand and requires a local and manual start. *Item # 4 describes how to backwash MBI-3.* During back wash operation, monitor discharge per the District's NPDES permit using the NPDES discharge monitoring form. Discharge monitor reading should be taken every 10 minutes. During the backwash monitor water quality (EC, pH, Chlorine, and settleable solids) and record parameters on NPDES discharge form (Figure 9).

   This form is located at:
   WP > Shared Files > WaterProd > Talbert Barrier Operations and Maintenance Manual > Forms >NPDES Monitoring Form 2016.xls (Figure 9).



OCWD - NPDES Discharge Monitoring Form
C.R.W.Q.C.B. - Santa Ana Region
Order R8-2015-0004
NPDES No. CAG998001; Monitoirng & Report Program No. 2015-0004-001

Date: ____________
Well Site: ____________

Time	Initials	pH	oil/grease visible (yes/no)	Visiblle Color (yes/no)	Turbidity (NTU)	Temp (°C)	Cond. (uS/mS)	Flow (gpm)	Total Cl^- residual (mg/L)	Comments

Estimated Total Daily Discharge ______ Gallons

temp. = temperature
(uS/cm) = micromhos per centimeter
Cl^- = chlorine
gpm = gallons per minute
mg/L = milligrams per liter
Cond. = electerical conductivity

Figure 9
NPDES Discharge Monitoring Form.

4. The IRSO initiates a backwash event at MBI-3 by changing the mode from "remote" to "local" on the discharge MOV (Figure 10). Once in "local" mode, engage the MOV clutch and manually turn the valve actuator wheel until a valve position of 24% open is displayed. Next, walk to the MBI-1 pump control panel located inside Shared Structure 2. From the MBI-3 pump control panel (Figure 11) switch modes from "remote" to "local", then push the "start" button and the

MBI-3 backwash pump will start up “locally”. If the flow rate is still too high (from a sand production perspective), The IRSO can go back to the discharge MOV and manually adjust the valve position to a percent open less than 24% until sand production decreases to a desirable point. To end the MBI-3 backwash, repeat the start-up procedure (described above) in reverse order, making sure that the Discharge MOV is in “remote” mode and the MBI-3 pump control panel is in “remote” mode.

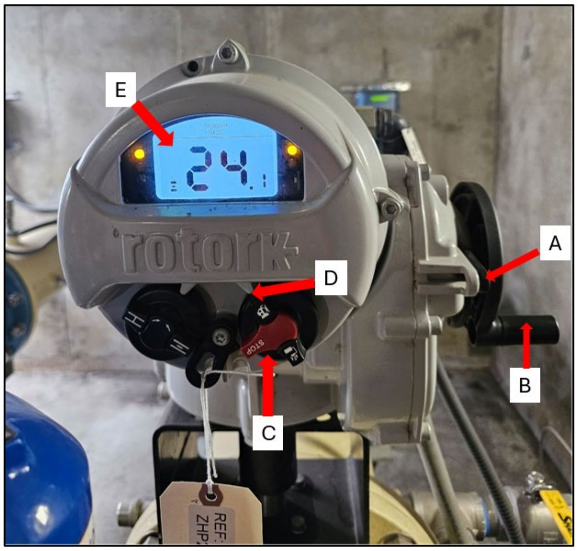
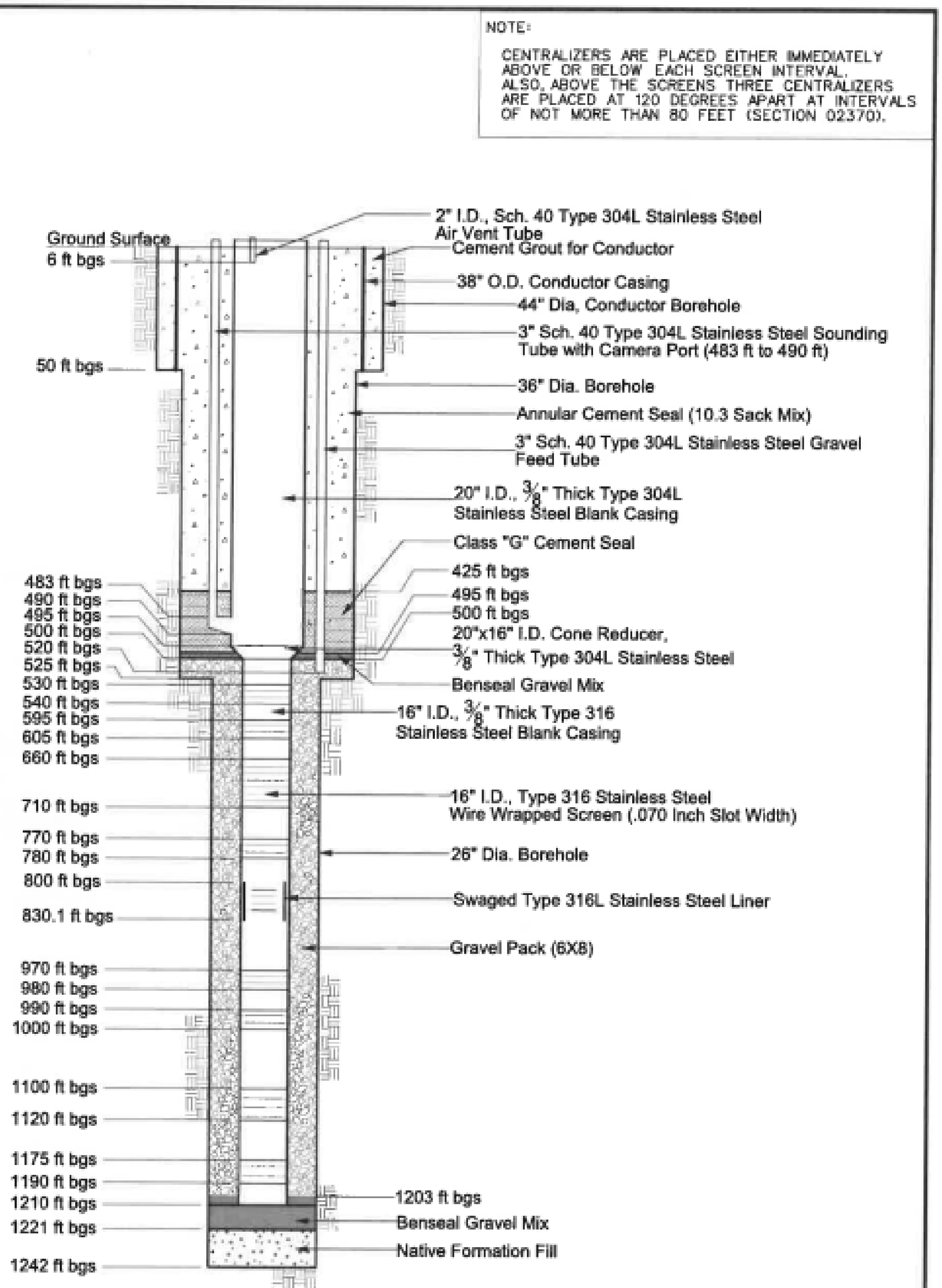


Figure 10
*MBI-3 discharge MOV. **A** clutch lever, **B** manual actuator handle **C** remote control dial – note: in this image the valve is displayed in “local” mode **D** remote control dial position indicator **E** valve % open indication display.*

Figure 11
MBI-3 backwash pump motor control panel inside Shared Structure 2. The panel is identified by the plate located inside the yellow rectangle (upper left-hand corner of the image). The “start” and “stop” buttons are shown inside the red oval. The “local”/“remote” control dial is inside the red rectangle.

Appendix A5

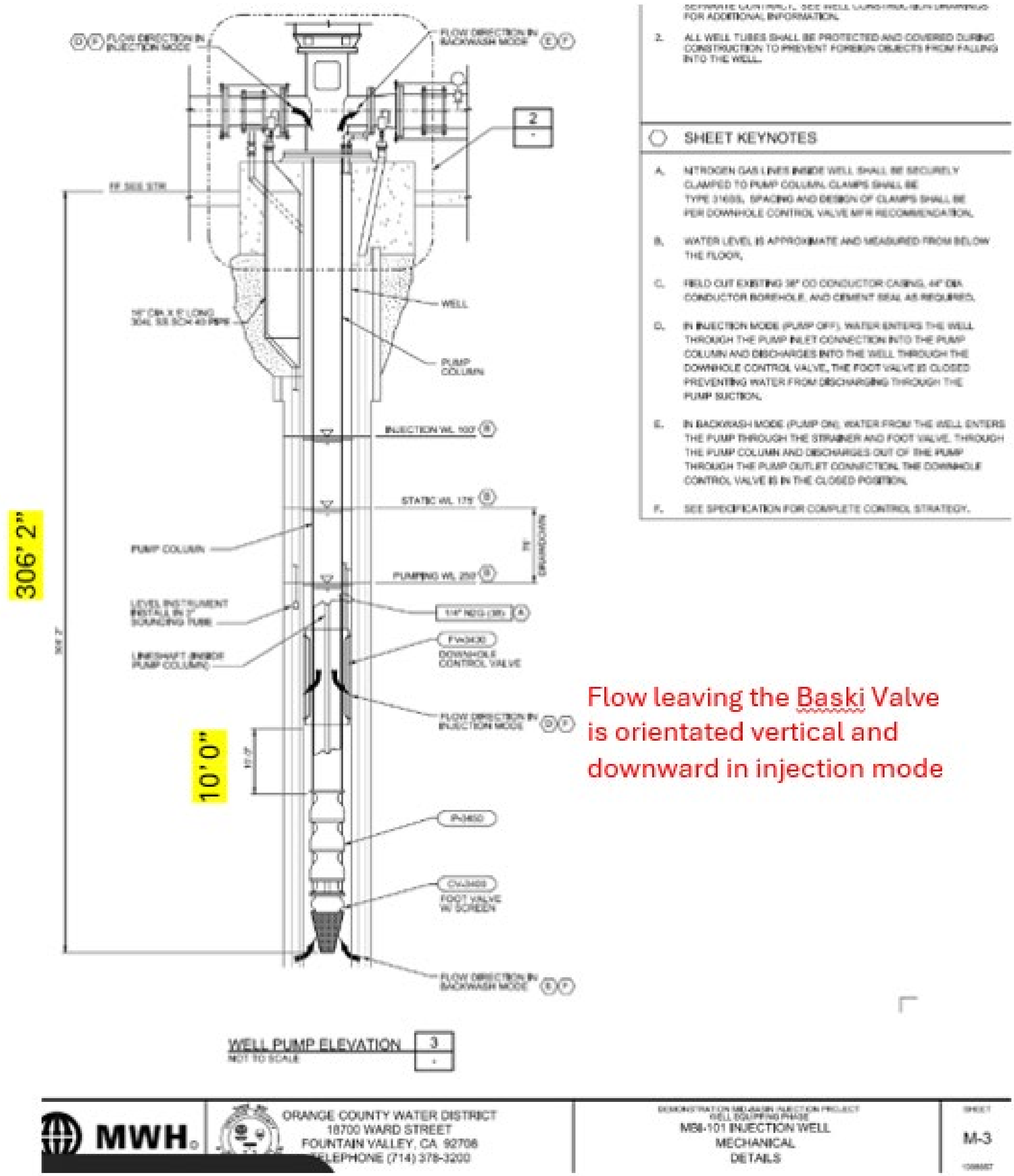
Mid-Basin Injection Well As-Built Drawings And Pump Setting Diagrams

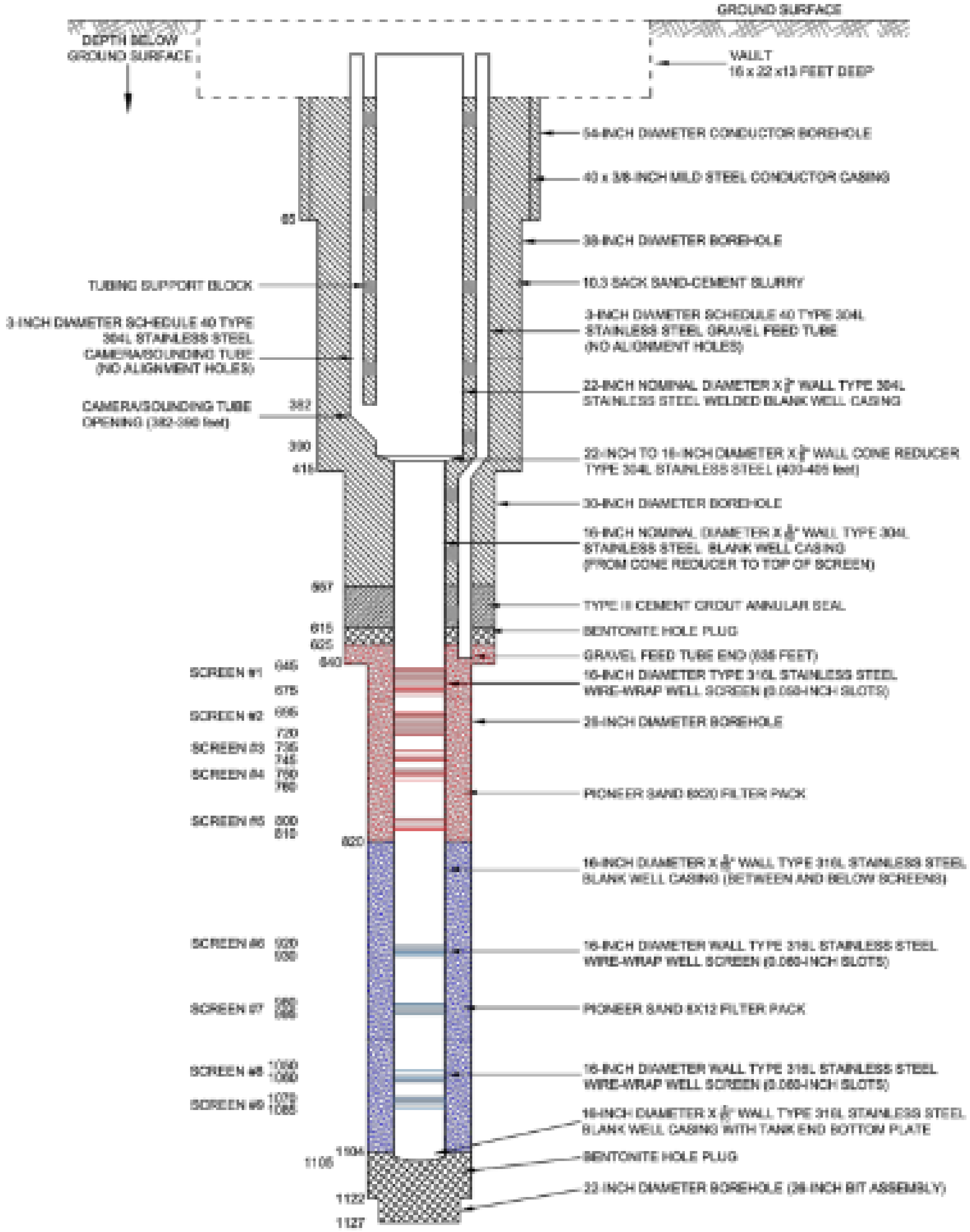


WELL DETAIL
NOT TO SCALE

MWH	ORANGE COUNTY WATER DISTRICT DEMONSTRATION MID-BASIN INJECTION PROJECT	MBI-1 AS-BUILT DRAWING	FIGURE 2-5 1008657

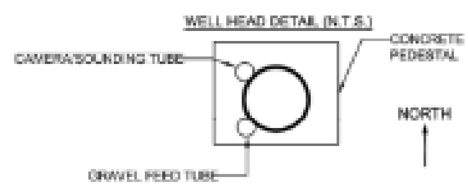
MBI-1 Pump Setting





NOTES:
1. 308L rod and 316L rod were used when welding type 304L and type 316L stainless steel, respectively. 316L rod was used when welding type 304L to type 316L stainless steel.
2. Casing centralizers installed approximately every 100 ft.
3. 304L stainless steel centralizers were welded to 304L stainless steel casing. 316L stainless steel centralizers were welded to 316L stainless steel casing.
4. Casing and screen depths are based on well completion video X/XX/18.
5. Depths are in feet below ground surface.
6. Constructed in June 2018 by Best Drilling and Pump, Inc.

NOT TO SCALE

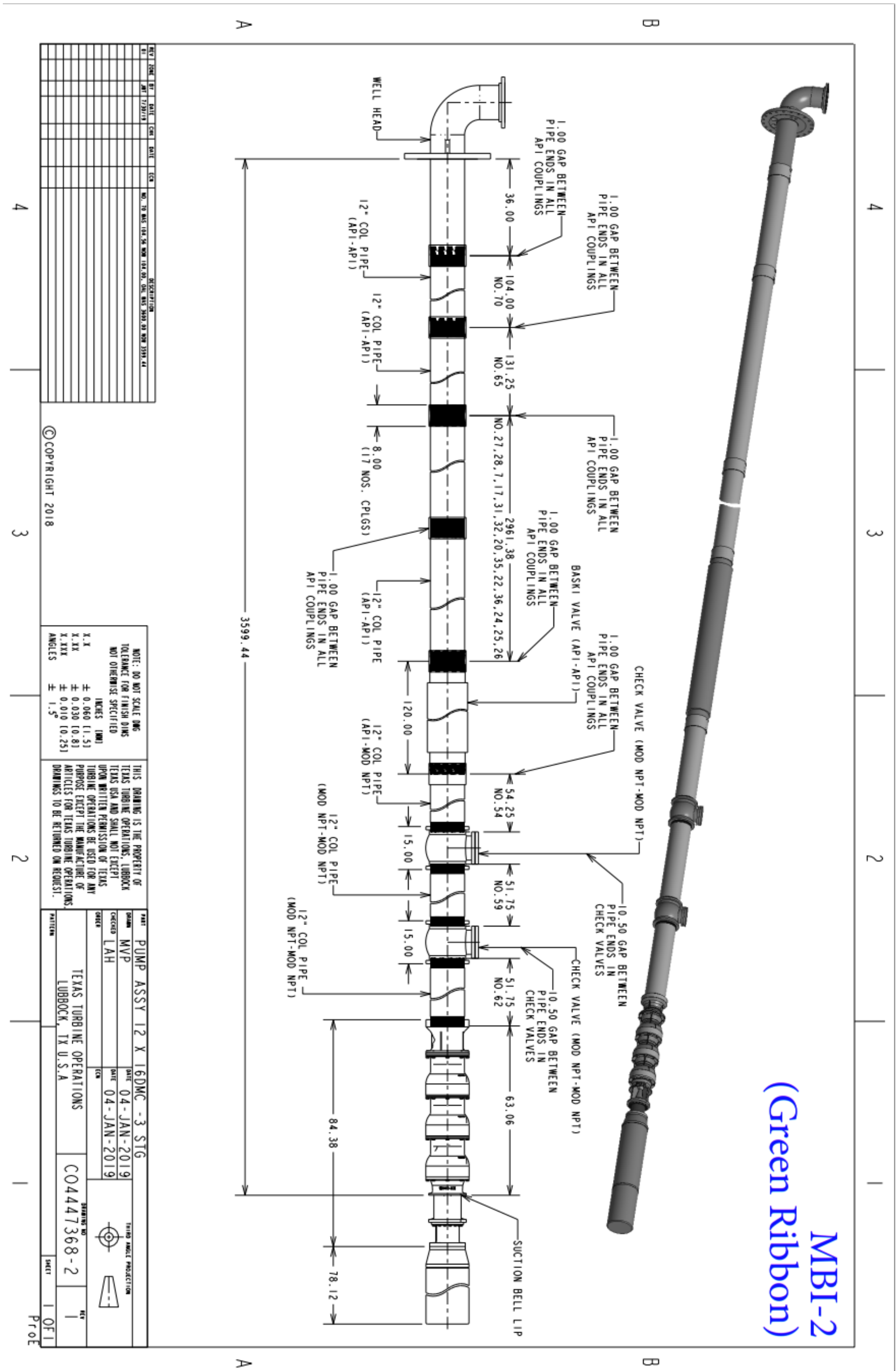


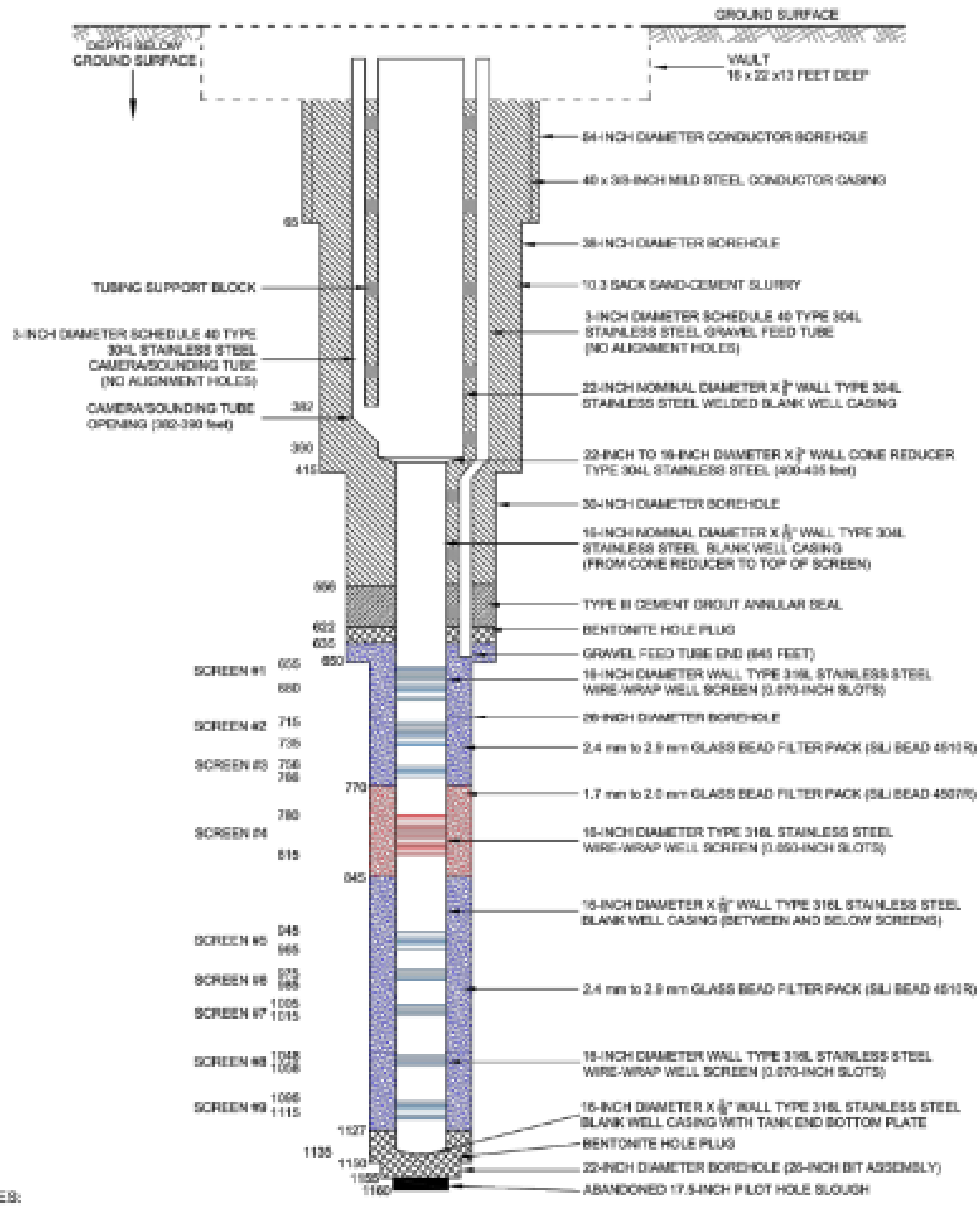
GTC

MBI-2 INJECTION WELL
AS-BUILT WELL SCHEMATIC

MID-BASIN INJECTION PROJECT
CONTRACT NO. MBI-2017-01

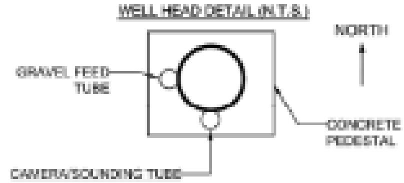
MBI-2 Pump Setting





NOTES:

1. 308L rod and 316L rod were used when welding type 304L and type 316L stainless steel, respectively. 316L rod was used when welding type 304L to type 316L stainless steel.
2. Casing centralizers installed approximately every 100 ft.
3. 304L stainless steel centralizers were welded to 304L stainless steel casing. 316L stainless steel centralizers were welded to 316L stainless steel casing.
4. Casing and screen depths are based on well completion video 7/09/18.
5. SILI 4510R beads from 635-770 and 845-1127 ft bgs includes up to 3 super sacks of SILI 4511R beads (mislabeled by SILI).
6. SILI 4508R beads were placed in the gravel feed tube during pumping development.
7. Depths are in feet below ground surface.
8. Constructed in April 2018 by Best Drilling and Pump, Inc.

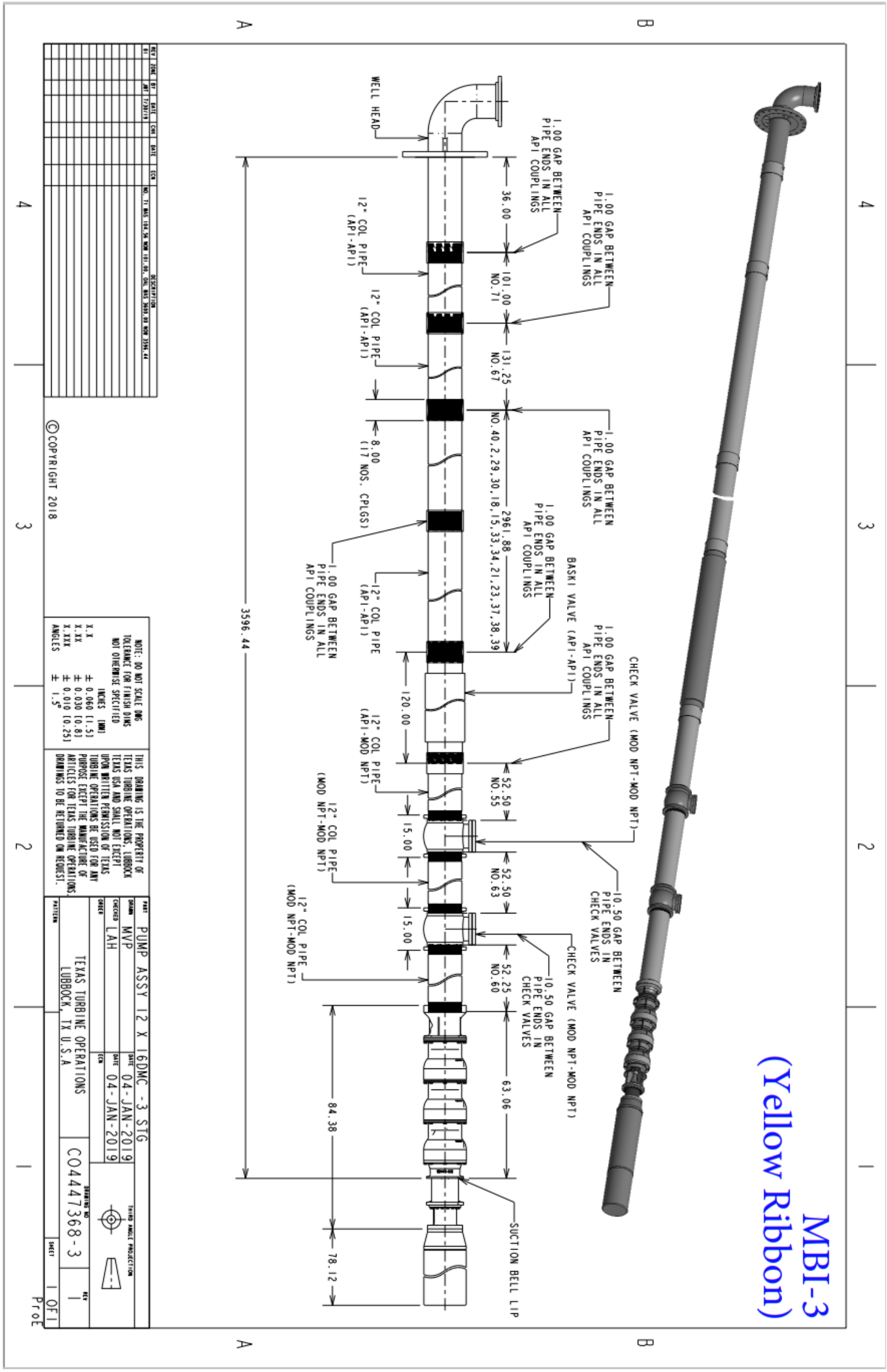


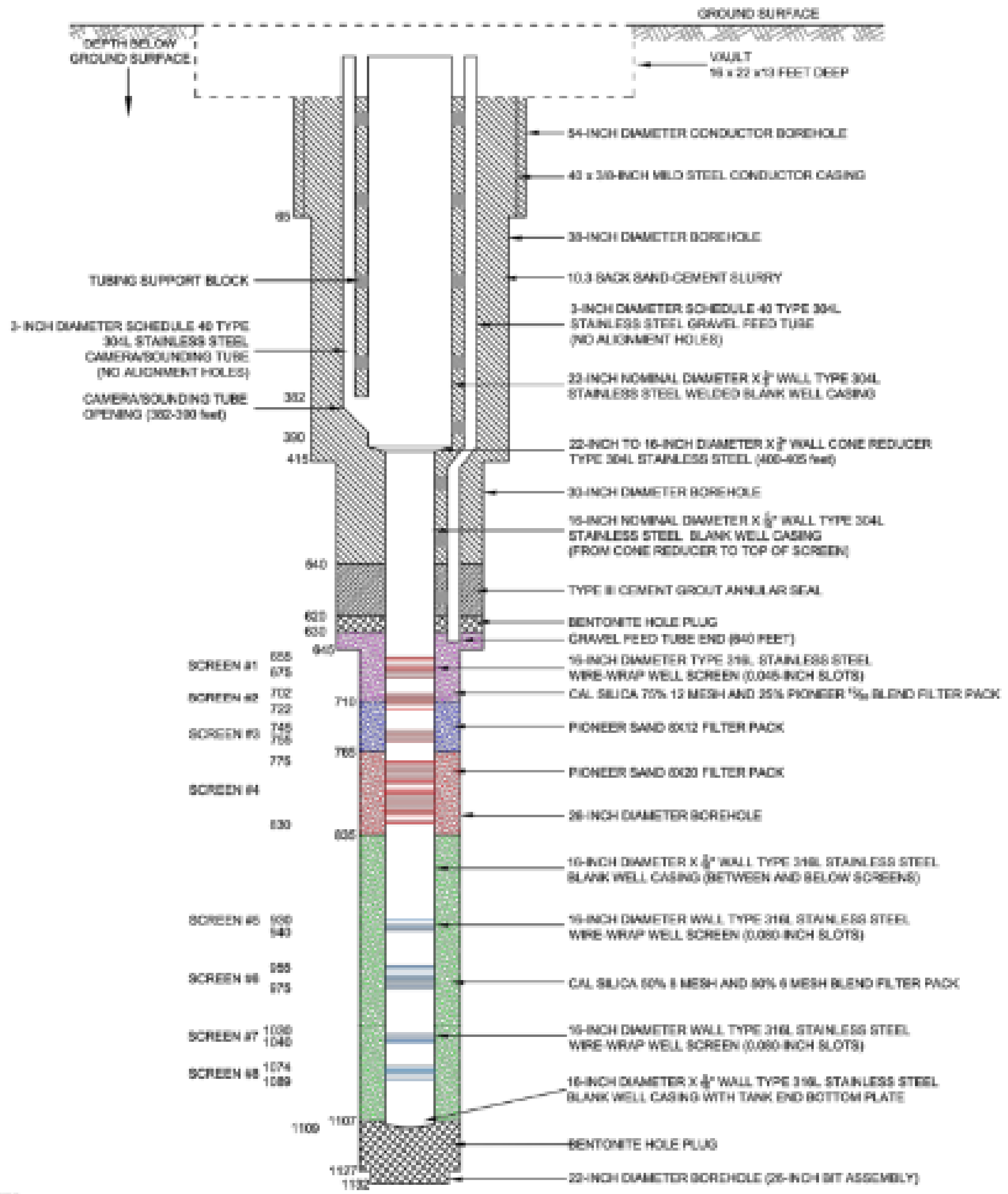
NOT TO SCALE

MBI-3 INJECTION WELL
AS-BUILT WELL SCHEMATIC

MID-BASIN INJECTION PROJECT
CONTRACT NO. MBI-2017-01

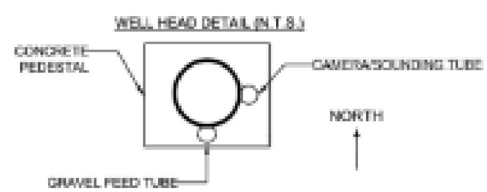
MBI-3 Pump Setting





NOTES:

1. 308L rod and 316L rod were used when welding type 304L and type 316L stainless steel, respectively. 316L rod was used when welding type 304L to type 316L stainless steel.
2. Casing centralizers installed approximately every 100 ft.
3. 304L stainless steel centralizers were welded to 304L stainless steel casing. 316L stainless steel centralizers were welded to 316L stainless steel casing.
4. Casing and screen depths are based on well completion video X/XX/18.
5. Depths are in feet below ground surface.
6. Constructed in September 2018 by Best Drilling and Pump, Inc.

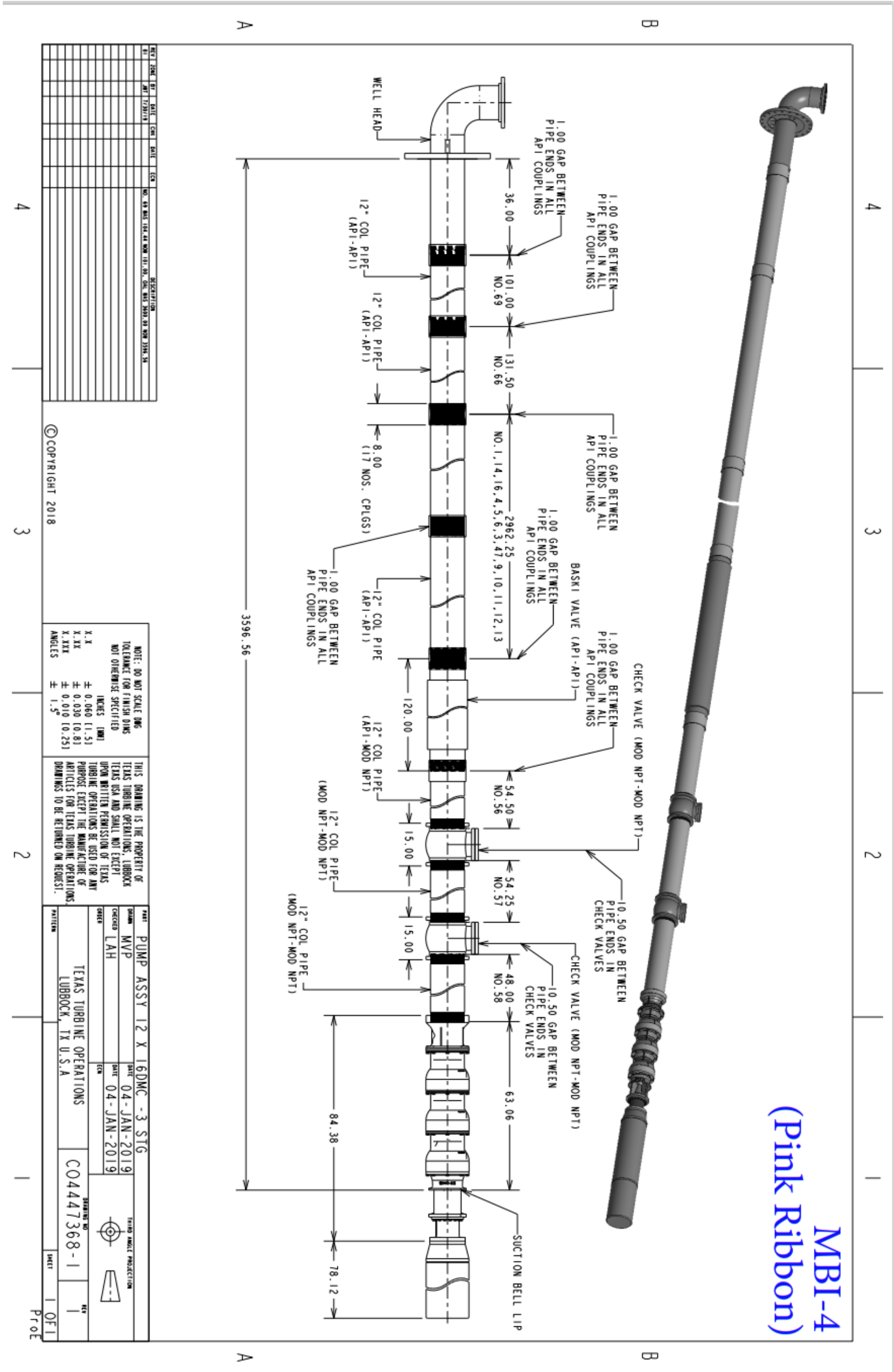


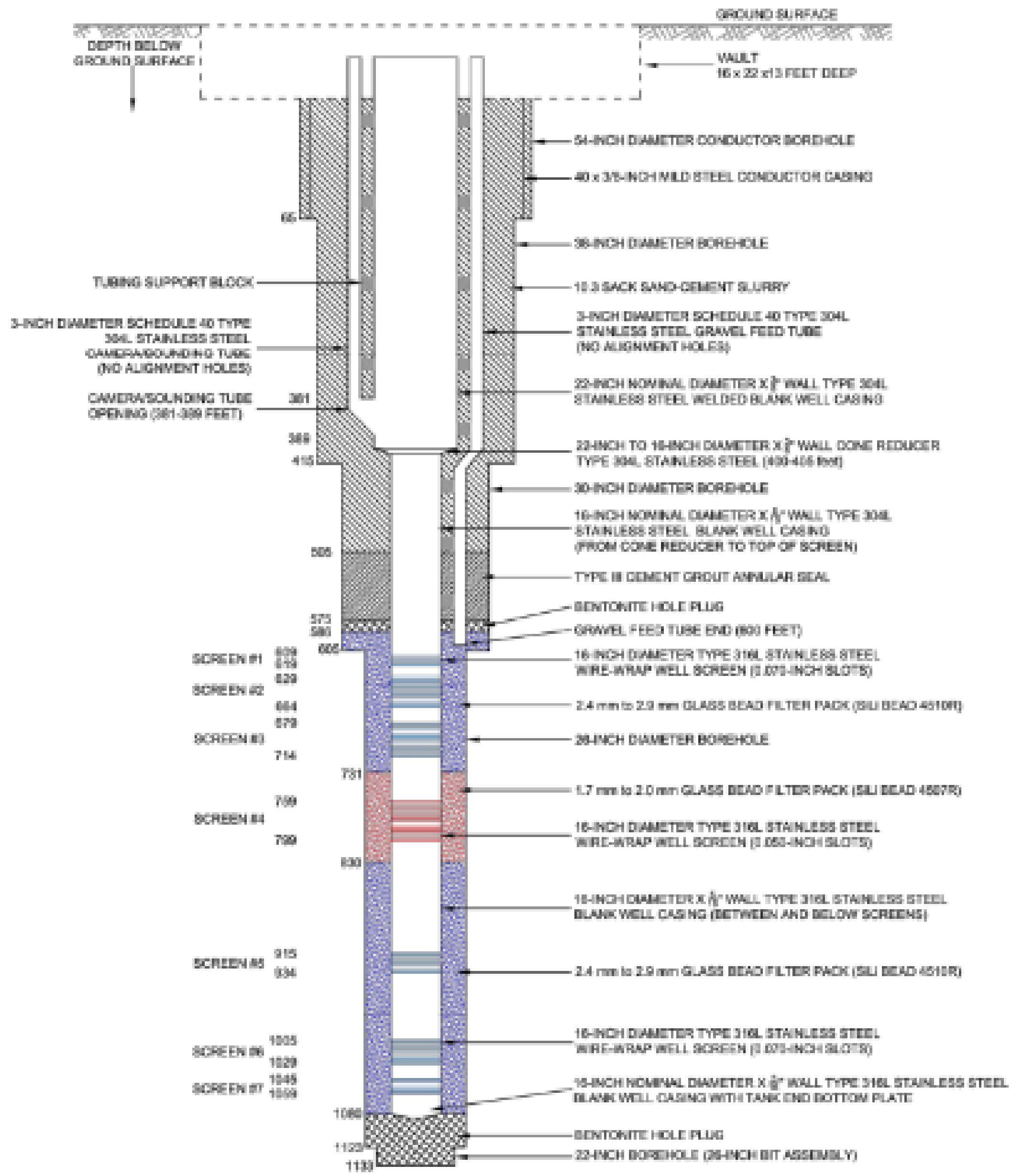
NOT TO SCALE

MBI-4 INJECTION WELL
AS-BUILT WELL SCHEMATIC

MID-BASIN INJECTION PROJECT
CONTRACT NO. MBI-2017-01

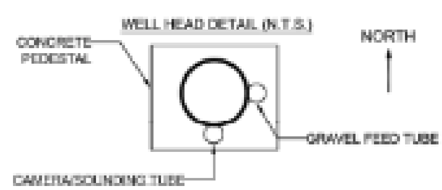
MBI-4 Pump Setting





NOTES:

1. 308L rod and 316L rod were used when welding type 304L and type 316L stainless steel, respectively. 316L rod was used when welding type 304L to type 316L stainless steel.
2. Casing centralizers were installed approximately every 100 ft.
3. 304L stainless steel centralizers were welded to 304L stainless steel casing. 316L stainless steel centralizers were welded to 316L stainless steel casing.
4. Casing and screen depths are based on well completion video 4/10/18.
5. Depths are in feet below ground surface.
6. Constructed in February 2018 by Best Drilling and Pump, Inc.

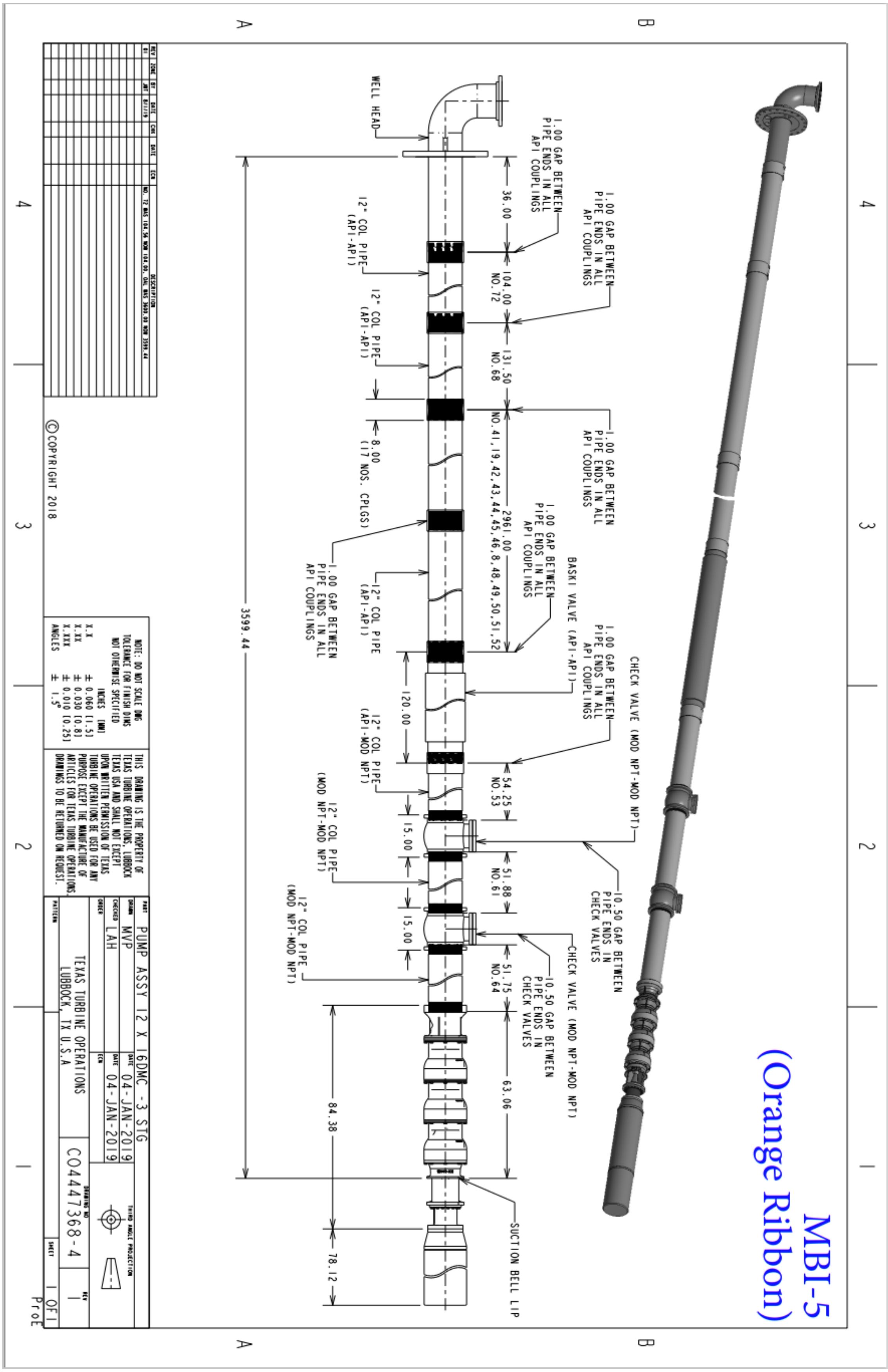


NOT TO SCALE

MBI-5 INJECTION WELL
AS-BUILT WELL SCHEMATIC

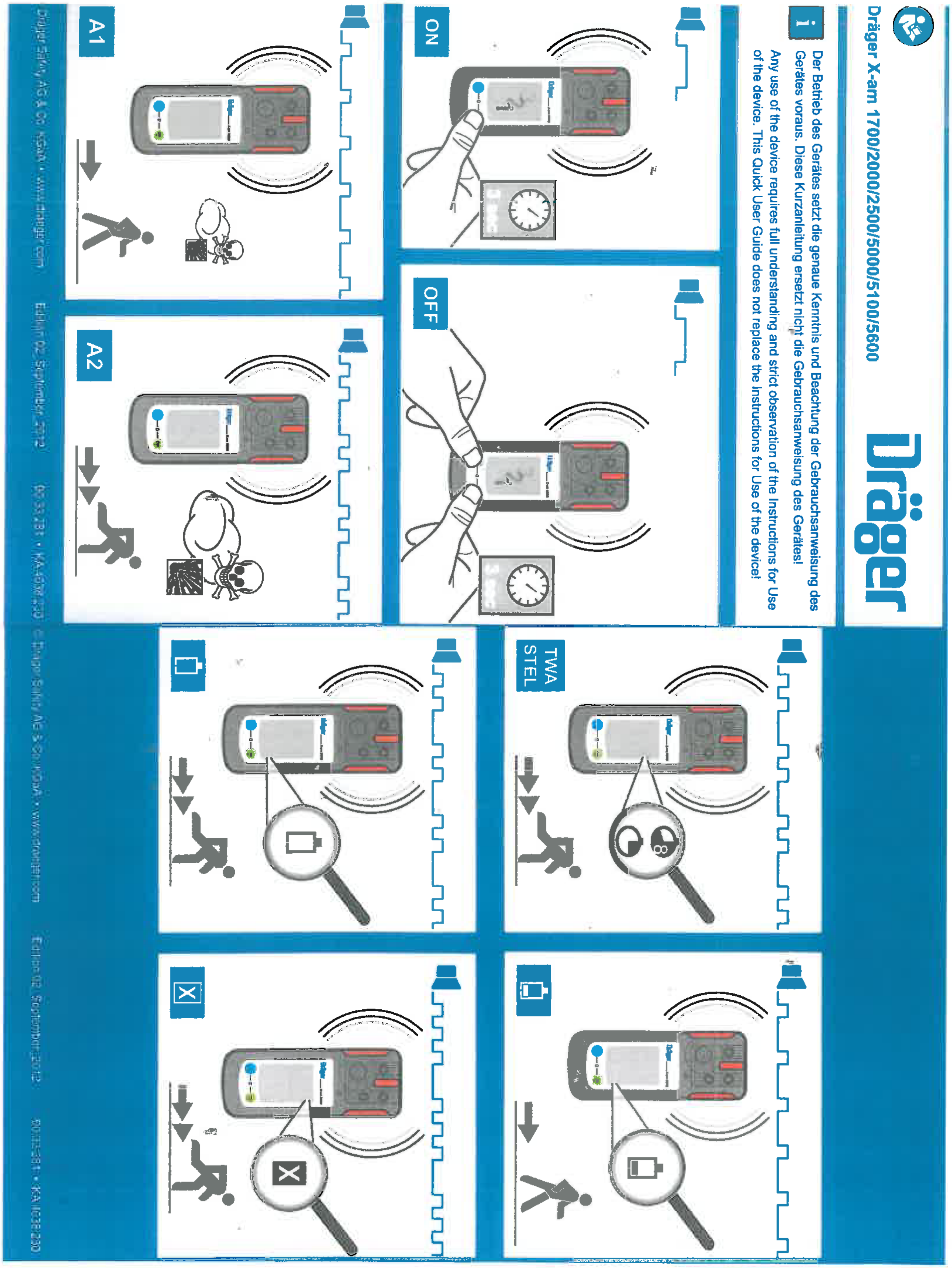
MID-BASIN INJECTION PROJECT
CONTRACT NO. MBI-2017-01

MBI-5 Pump Setting



Appendix A6

GAS METER O&M MANUAL


Dräger X-am 1700/2000/2500/5000/5100/5600
Dräger
Der Betrieb des Gerätes setzt die genaue Kenntnis und Beachtung der Gebrauchsanweisung des Gerätes voraus. Diese Kurzanleitung ersetzt nicht die Gebrauchsanweisung des Gerätes!
Any use of the device requires full understanding and strict observation of the Instructions for Use of the device. This Quick User Guide does not replace the Instructions for Use of the device!
ON
OFF
A1
A2
TWA
STEL
Dräger Safety AG & Co. KGaA • www.draeger.com
Edition 02 September 2012

Dräger

Dräger X-am® 2500 (MQG 0011)

Software 7.n (≥ 7.0)

Dräger. Technology for Life®

1 For your safety

- Before using this product, carefully read these Instructions for Use and those of the associated products.
- Strictly follow the Instructions for Use. The user must fully understand and strictly observe the instructions. Use the product only for the purposes specified in the Intended use section of this document.
- Do not dispose of the Instructions for Use. Ensure that they are retained and appropriately used by the product user.
- Only trained and competent users are permitted to use this product.
- Comply with all local and national rules and regulations associated with this product.
- Only trained and competent personnel are permitted to inspect, repair and service the product as detailed in these Instructions for Use (see chapter 5 on page 34). Further maintenance work that is not detailed in these Instructions for Use must only be carried out by Dräger or personnel qualified by Dräger. Dräger recommend a Dräger service contract for all maintenance activities.
- Use only genuine Dräger spare parts and accessories, or the proper functioning of the product may be impaired.
- Do not use a faulty or incomplete product. Do not modify the product.
- Notify Dräger in the event of any component fault or failure.

Safe coupling with electrical device
Electrical connections to devices which are not listed in these Instructions for Use should only be made following consultation with the respective manufacturers or an expert.

Use in areas subject to explosion hazards
Devices or components for use in explosion-hazard areas which have been tested and approved according to national, European or international Explosion Protection Regulations may only be used under the conditions specified in the approval and with consideration of the relevant legal regulations. The devices or components may not be modified in any manner. The use of faulty or incomplete parts is forbidden. The appropriate regulations must be observed at all times when carrying out repairs on these devices or components.

1.1 Definitions of alert icons

The following alert icons are used in this document to provide and highlight areas of the associated text that require a greater awareness by the user. A definition of the meaning of each icon is as follows:

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

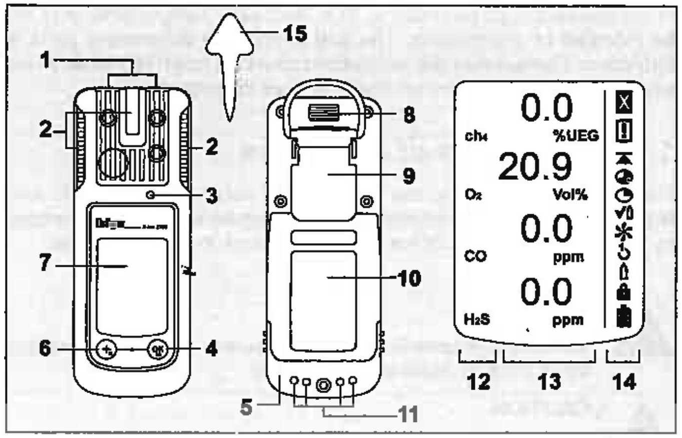
Indicates a potentially hazardous situation which, if not avoided, could result in physical injury, or damage to the product or environment. It may also be used to alert against unsafe practices.

NOTICE

Indicates additional information on how to use the product.

2 Description

2.1 Product overview



00133365.eps

1	Gas entry	8	IR interface
2	Alarm LED	9	Fastening clip
3	Horn	10	Model plate
4	**[OK]** key	11	Charging contacts
5	Power pack	12	Measured gas display
6	**[+]** key	13	Measuring value display
7	Display	14	Special symbols
		15	Tool for sensor change

Special symbols:

- Fault message
- Warning
- Display peak value
- Display TWA
- Show STEL
- Bump test mode
- Fresh air calibration
- 1-button adjustment
- Single-gas adjustment
- Password necessary
- Battery 100 % full
- Battery 2/3 full
- Battery 1/3 full
- Battery empty

2.2 Intended use

Portable gas detection instrument for the continuous monitoring of the concentration of several gases in the ambient air within the working area and in explosion-hazard areas.
Independent measurement of up to 4 gases, in accordance with the installed Dräger sensors.

Areas subject to explosion hazards, classified by zones
The instrument is intended for the use in explosion-hazard areas of Zone 0, Zone 1 or Zone 2 or in mines at risk due to fire damp. It is intended for use within a temperature range of –20 °C to +50 °C, and for areas in which gases of explosion groups IIA, IIB or IIC and temperature class T3 or T4 (depending on the batteries and rechargeable battery) may be present. If used in mines, the instrument is only to be used in areas known to have a low risk of mechanical impact.

Areas subject to explosion hazards, classified by divisions.
The instrument is intended for use in explosion-hazard areas according to Class I & II, Div. 1 or Div. 2 within a temperature range of –20 °C to +50 °C, and for areas where gases or dusts of groups A, B, C, D, E, F, G and temperature class T3 or T4 may be present (depending on the rechargeable battery and batteries).

WARNING

CSA requirement: Measured values over the full scale value may indicate an explosive atmosphere.

Only applies for class II certification. CSA standard C22.2 no. 152 does not contain any requirements for class II hazard areas. Therefore this device was not tested for class II by the CSA. The sensor may become blocked and not measure the gas correctly or not warn the user that gas measurement is not possible.

WARNING

CSA requirement: The sensitivity must be tested every day before first use using a known concentration of the gas being measured corresponding to 25 to 50 % of the full concentration value. The accuracy must be 0 to +20 % of the daily value. The accuracy may be corrected via calibration.

NOTICE

CSA requirement: Only the combustible gas detection portion of this instrument has been assessed for performance.
The instrument has not been classified by the CSA for use in mines.

2.3 Approvals

Copies of the name plate and the declaration of conformity are provided in the enclosed supplementary documentation (order no. 90 33 890).
Do not stick anything on the name plate on the gas detector. The technical suitability tests are valid for the X-am 2500 gas detection instrument and the calibration cradle. The explosion-protection approvals are only valid for the X-am 2500 gas detection instrument; the calibration cradle must not be used in the Ex zone.
The BVS 10 ATEX E 080 X technical suitability test is based on the adjustment with the target gas.

3 Configuration

NOTICE

Only trained persons are permitted to carry out modifications to the instrument configuration.

To individually configure an instrument with standard configuration, the instrument must be connected to a PC via the USB infrared cable (order no. 83 17 409). The configuration work is carried out using the PC software Dräger CC-Vision. The PC software Dräger CC Vision can be downloaded from the following web address free of charge: www.draeger.com/software.

- Change configuration: see Technical Manual.

Standard Instrument configuration:

Dräger X-am® 2500[1]	
Bump test mode [2]	Extended bump test
Fresh air calibration[2]	ON
Operating signal [2 3]	ON
Capture range	ON
Switch off [2]	allowed
LEL factor [2] (ch_4)	4.4 (vol. %) (4.4 Vol. % corresponds to 100 %LEL)
STEL [2 4 5] (short-term average)	STEL function - disabled Average value duration = 15 minutes
TWA [2 5 6] (shift average)	TWA function - disabled Average value duration = 8 hours
Alarm A1 [7]	can be acknowledged, non-latching, pre-alarm, rising flank
Alarm A1 at O_2 sensor [7]	cannot be acknowledged, latching, like main alarm, falling flank
Alarm A2 [7]	cannot be acknowledged, latching, main alarm, rising flank

1) X-am® is a registered trademark of Dräger.
2) Different settings can be selected to meet customer requirements on delivery. The current setting can be checked and changed with the Dräger CC Vision software.
3) A periodic short flashing indicates the operating capacity of the instrument. If there is no operating signal, correct operation cannot be guaranteed.
4) STEL: average value of an exposure over a short period, generally 15 minutes.
5) Interpretation only if the sensor is designed for this.
6) TWA: shift averages are workplace limit values for generally eight hours per day of exposure for five days a week during a working life.
7) Latching and acknowledgement of alarms A1 and A2 can be configured with the Dräger CC Vision PC software.

Selecting or disabling the capture ranges (only applies for the measuring mode):
The capture range is selected in the measuring mode (factory setting) and permanently disabled in calibration mode.
The CC-Vision PC software can be used to select or disable the capture ranges for the measuring mode.

3.1 Instrument settings

The following parameters can be changed on an instrument:

Name	Range
Password	Numerical range (3-digit)
Operating signal LED [1]	Yes / No
Horn operating signal [1]	Yes / No
Switch-off mode	"switch-off allowed" or "switch-off prohibited" or "switch-off prohibited at A2"
Shift length (TWA)[2]	60 - 14400 (in minutes) (Setting for exposure alarm)
Short-term exposure level (STEL) [3 4]	0 - 15 (in minutes) (Setting for exposure alarm)

1) At least one of the two operating signals must be switched on.
2) Corresponds to averaging time and is used to calculate the TWA exposure value.
3) Interpretation only if the sensor is designed for this.
4) Corresponds to averaging time and is used to calculate the STEL exposure value.

3.2 Sensor settings

The following parameters can be changed on the sensors:

Name	Range
Alarm threshold A1 (in measuring unit)	0 - A2
Alarm threshold A2 (in measuring unit)	A1 – measuring range end value
Interpretation type[1]	Inactive, TWA, STEL, TWA+STEL
Alarm threshold STEL (in measuring unit)[1]	0 – measuring range end value
Alarm threshold TWA (in measuring unit)[1]	0 – measuring range end value

1) Interpretation only if the sensor is designed for this.

3.3 Check of parameters

To ensure that the values were correctly transferred to the gas detection instrument:

1. Press the **data from X-am 1/2/5x00** in Dräger CC Vision.
2. Check parameters.

4 Operation

4.1 Preparations for operation

WARNING

To reduce the risk of ignition of a flammable or explosive atmosphere, strictly adhere to the following warning statements:

Only use power pack types ABT 01xx, HBT 00xx or HBT 01xx. See the marking on the rechargeable battery for permitted rechargeable batteries and the corresponding temperature class.

Substitution of components may impair intrinsic safety.

- Before using the instrument for the first time, insert a charged NiMH T4 power pack or batteries approved by Dräger, see chapter 4.9.1 on page 30.
- The instrument is now ready for operation.

4.2 Switching on the instrument

1. Hold down the **[OK]** key for approx. 3 seconds until the countdown » **3 . 2 . 1** « shown on the display has elapsed.
   - o All the display segments, including the visual, audible and vibration alarms, are activated for a short time.
   - o The software version is displayed.
   - o The instrument performs a self-test.
   - o The sensor that is up next for adjustment is displayed with the remaining days until the next adjustment, e.g. **ch4 %LEL CAL 20.**
   - o The time until the bump test interval elapses is displayed in days, e.g. **bt 123.**
   - o All alarm thresholds A1 and A2 as well as (TWA)[1] and (STEL)[1] for all toxic gases (e.g. H_2S or CO) are displayed consecutively.

   During the sensor warm-up phase:
   - o The display for the measured value flashes
   - o The special symbol » « is displayed.
   - o No alarms are issued during the warm-up phase.
   - o The red LEDs flash.
   - o The gas detector is ready to measure when the measured values no longer flash and the red LEDs are no longer illuminated. The special symbol » « may continue to be displayed if corresponding warnings (e.g. not yet ready for calibration) are active (to view the warnings, see the technical manual).
2. Press the OK key to cancel the display of the activation sequence.

4.3 Switching off the instrument

- Press and hold the OK key and [+] key at the same time until the countdown **3 . 2 . 1** shown in the display has elapsed.
  Before the instrument is switched off, the visual, audible and vibration alarms are activated for a short time.

4.4 Before entering the workplace

WARNING

Before any measurements relevant to safety are made, check the adjustment with a bump test, adjust if necessary and check all alarm elements. If national regulations apply, a bump test must be performed according to the national regulations. Faulty adjustment may result in incorrect measuring results, with possible serious consequences.

CAUTION

The CatEx sensor is intended for measurements of flammable gases and vapours mixed with air (i.e. O_2 content ≈ 21 vol.%). Incorrect measured values may be displayed in the case of oxygen deficient or oxygen enriched environments.

NOTICE

If the gas detector is used for offshore applications, a distance of 5 m to a compass must be complied with.

1. Switch on the instrument. The current measured values are shown in the display.

1) Only when activated in the instrument configuration. Delivery condition: not activated.

2. Observe any warning ▯ or fault ⊠ messages.
   ▯ The instrument can be operated normally. If the warning message does not disappear automatically during operation, the instrument must be serviced after the end of use.
   ⊠ The instrument is not ready to measure and requires maintenance.
3. Check that the gas inlet opening on the instrument is not covered or dirty.

WARNING

Explosion hazard! To reduce the risk of ignition of a flammable or explosive atmosphere, strictly adhere to the following warning statements:

- Fractions of catalytic poisons in the measuring gas (e.g. volatile silicium, sulphur, heavy metal compounds or halogenated hydrocarbon) can damage the Cat Ex sensor. If the CatEx sensor can no longer be calibrated to the target concentration, the sensor must be replaced.
- In case of measurements in oxygen-deficient atmosphere (<12 vol.-% O_2) the CatEx sensor may show incorrect displays; in this case, a reliable measurement with a CatEx sensor is not possible.
- In an oxygen enriched atmosphere (>21 vol.-% O_2), the explosion protection cannot be guaranteed; remove instrument from the explosion-hazard area.
- High off-scale readings may indicate an explosive concentration.

4.5 During operation

- During operation, the measured values for every measured gas are displayed.
- In the event of an alarm, the corresponding displays, including the visual, audible and vibration alarms, are activated, see chapter 4.6 on page 28.
- If a measuring range is exceeded or not reached, the following displays are shown instead of the measured value display:

» ┌ ┌ « **(measuring range exceeded) or**

» └ └ « **(below measuring range) or**

» ┌┘ « **(blocking alarm)**

- If an O_2 sensor is fitted and this sensor measures an O_2 concentration of below 12 vol.-%, an error is indicated with » - « on the ex-channel instead of a measured value if the measured value is below the pre-alarm threshold.
- After the measuring range of the TOX measuring channels has been exceeded temporarily (up to one hour), checking the measuring channels is not necessary.

NOTICE

Special states in which there is no measuring operation (quick menu, calibration menu, warm-up of sensors, password input) are indicated by a visual signal (slow flashing of the alarm LED ┘‾‾└┘‾‾└┘‾‾└).

WARNING

If the DrägerSensor CatEx 125 PR is used in the gas detector, a zero point and span calibration must be carried out after experiencing an impact load that results in a non-zero display when exposed to fresh air. This warning does not apply if the DrägerSensor CatEx 125 PR Gas is used.

4.6 Identifying alarms

An alarm is displayed visually, audibly and through vibration in a specific pattern.

NOTICE

At low temperatures the legibility of the display can be improved by switching on the backlight.

4.6.1 Concentration pre-alarm A1

Intermittent alarm:

- Alternating display of **A1** and measured value. Not for O_2!
- The pre-alarm A1 is not latching and stops when the concentration has dropped below the alarm threshold A1.
- In case of A1, a single tone is audible and the alarm LED flashes.
- In case of A2, a double tone is audible and the alarm LED flashes twice.
- Acknowledge pre-alarm: Press the OK key. Only the audible alarm and the vibration alarm are switched off.

4.6.2 Concentration main alarm A2

WARNING

Risk of fatal injury! Leave the area immediately. A main alarm is self-retaining and cannot be acknowledged or cancelled.

Intermittent alarm:

- Alternating display of **A2** and measured value.
  For O_2: **A1** = lack of oxygen
  A2 = excess oxygen

After leaving the area, when the concentration has dropped below the alarm threshold:

- Press the OK key. The alarm messages are switched off.

If the measuring range is exceeded significantly at the CatEx channel (very high concentration of flammable materials), a blocking alarm is triggered. This CatEx blocking alarm can be manually acknowledged by switching the instrument off and on in fresh air.

4.6.3 STEL / TWA exposure alarm

CAUTION

Health hazard! Leave the area immediately. After this alarm, the deployment of personnel is subject to the relevant national regulations.

NOTICE

The STEL alarm can be triggered with a maximum delay of one minute.

Intermittent alarm:

- Display **A2** and (STEL) or respectively (TWA) and measured value alternating:
- The STEL and TWA alarm cannot be acknowledged or cancelled.
- Switch off the instrument. The values for the exposure evaluation are deleted after the instrument is switched on again.

4.6.4 Battery pre-alarm

Intermittent alarm:

- Flashing special symbol on the right side of the display.
- Acknowledge pre-alarm: Press the OK key. Only the audible alarm and the vibration alarm are switched off.
- The battery still lasts approx. 20 minutes after the first battery pre-alarm.

4.6.5 Battery main alarm

Intermittent alarm:

- Flashing special symbol on the right side of the display:
- The battery main alarm cannot be acknowledged or cancelled.
- The instrument is automatically switched off again after 10 seconds.
- Before the instrument is switched off, the visual, audible and vibration alarms are activated for a short time.

4.6.6 Instrument alarm

Intermittent alarm:

- Special symbol displayed on the right side of the display:
- The instrument is not ready for operation.
- Contact maintenance or Draeger Service to rectify the problem.

4.7 Info Mode

4.7.1 Activating the Info mode

- In measuring mode, press the OK key for approx. 3 seconds.
- If any warning or fault messages exist, the corresponding note or error codes are displayed (see Technical Handbook).
  Press the OK key successively for the next display. The peak values and the exposure values TWA and STEV will be displayed.
- If no key is pressed for 10 seconds, the instrument returns automatically to measuring mode.

4.7.2 Info Off mode

- Press the [+] key when the instrument is turned off.
  The name of the gas, measuring unit, and measuring range limit value are displayed for all channels.
- Press the [+] key again to exit the Info Off Mode (or via timeout).

4.8 Calling the Quick Menu

- In measuring mode, press the [+] key three times.
- If functions in the quick menu are activated using the PC software "Dräger CC Vision", you can select these functions using the [+] key. If no functions have been activated in the quick menu, the instrument remains in measuring mode.

Possible functions:

1. Bump test (configuration for bump test, see technical manual)
2. Fresh air calibration
3. Delete peak values
4. Display pump information, see technical manual
5. Activate or deactivate pump, see technical manual

- Press the OK key to activate the selected function.
- Press the [+] key to cancel the active function and to switch to measuring mode.
- If no key is pressed for 60 seconds, the instrument returns automatically to measuring mode.

4.9 Common user tasks

4.9.1 Replacing the batteries / rechargeable batteries

WARNING

Explosion hazard! To reduce the risk of ignition of a flammable or explosive atmosphere, strictly adhere to the following warning statements:
Do not throw used batteries into fire or try to open them by force.
Do not replace or charge batteries in potentially explosive areas.
Do not use new batteries with used batteries, and do not mix batteries from different manufacturers or of different types.
Remove batteries before maintenance work.
Batteries / rechargeable batteries are part of the Ex approval.

Only the following types may be used:

- Alkaline batteries – T3 – (non rechargeable!)
  Panasonic LR6 Powerline
  Varta Type 4106 ([1]power one) or
  Varta Type 4006 [1] (industrial)
- Alkaline batteries – T4 – (non rechargeable!)
  Duracell Procell MN1500 [1]
- NiMHy rechargeable batteries – T3 – (rechargeable)
  GP 180AAHC [1] (1800 mAh) max. 40 °C ambient temperature.

Only charge NiMH power packs T4 (type HBT 0000) or T4 HC (type HBT 0100) with the appropriate Dräger charger. Charge NiMH single cells for ABT 0100 battery holder as directed by the manufacturer. Ambient temperature during charging: 0 to +40 °C.

1) Not part of the BVS10 ATEX E 080X and PFG 10 G 001X technical suitability test.

1. Switching off the instrument: Press and hold OK key and [+] key simultaneously.
2. Loosen the screw on the power pack and remove the power pack.
- Battery holder (order no. 83 22 237): Replace alkaline batteries or NiMHy rechargeable batteries. Ensure correct polarity.
- NiMH power pack T4 (Type HBT 0000) / T4 HC (Type HBT 0100): replace complete power pack.
3. Insert the power pack into the instrument and tighten the screw, the instrument switches on automatically.

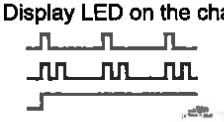
4.9.2 Charge instrument with NiMH power pack T4 (Type HBT 0000) / T4 HC (Type HBT 0100)

WARNING

Explosion hazard! To reduce the risk of ignition of a flammable or explosive atmosphere, strictly adhere to the following warning statements:
Do not charge underground or in explosion hazard areas! The chargers are not designed in accordance with the regulations for fire damp and explosion protection.
Charge NiMH power packs T4 (type HBT 0000) or T4 HC (type HBT 0100) with the appropriate Dräger charger. Ambient temperature during charging: 0 to +40 °C.

- Insert the switched off instrument into the charger module.

Display LED on the charger module:



To protect the battery charge only in the temperature range of 5 to 35 °C. Outside this temperature range, the charging process is automatically interrupted and automatically continued after the temperature range has been reached again. The charging time is typically 4 hours. A new NiMH power pack reaches its full capacity after three complete charge / discharge cycles. Never store the instrument for extended periods without being connected to a power source (maximum of 2 months) because the internal buffer battery will drain.

4.9.3 Carry out manual bump test

NOTICE

The automatic bump test with the Bump Test Station is described in the Technical Handbook.

1. Prepare a test gas cylinder, the volume flow must be 0.5 l/min and the gas concentration must be higher than the alarm threshold concentration that is to be tested.
2. Connect the test gas cylinder with the calibration cradle (order no. 83 18 752).

WARNING

CSA requirement: carry out a bump test before use. It should be carried out in the measuring range 25-50 % of the full scale value, whereby the displayed measured value may deviate from the actual measured value by 0-20 %. Accuracy may be corrected via calibration.

CAUTION

Never inhale the test gas. Health hazard!
Observe the hazard warnings of the relevant Safety Data Sheets.

3. Switch on the instrument and insert it into the calibration cradle – press downwards until it engages.
4. Open the test gas cylinder valve to let test gas flow over the sensors.

5. Wait until the instrument displays the test gas concentration with sufficient tolerance –
   Ex: ±20 % of the test gas concentration [1]
   O_2: ±0.6 vol. %[1]
   TOX: ±20 %. of the test gas concentration [1]
   If the alarm thresholds are exceeded, the instrument displays the gas concentration in alternation with **A1** or **A2** depending on the test gas concentration.
6. Close the test gas cylinder valve and remove the instrument from the calibration cradle.

NOTICE

To check the measured value response times, apply t90 test gas to the X-am via the calibration cradle. Check the results in accordance with the information in the table in the enclosed supplementary documentation (order no. 90 33 890) until 90 % of the end display is reached.

NOTICE

After the bump test (menu), the display shows a printer icon even if there is no printer connected to the bump test station.

If the displays are outside of the above-mentioned ranges:

- Have the instrument adjusted by the service personnel.

1) During application of the Dräger mixed gas (order no. 68 11 130) the displays should be within this range.

4.9.4 Calibration

Calibration may not be possible due to instrument and channel errors.

NOTICE

Dräger recommends using the extended bump test for cross calibrations (Dräger X-dock technical manual).

Carrying out the fresh air calibration

Calibrate the instrument to fresh air, free of measured gases or other interfering gases. During the fresh air calibration the zero point of all sensors (with the exception of the DrägerSensor XXSO_2) are set to 0. In the case of the DrägerSensor XXS O_2, the display is set to 20.9 vol. %.

1. Switch on instrument.
2. Press the [+] key 3 times, the symbol for fresh air calibration ✲ appears.
3. Press the OK key to start the fresh air calibration function.
   - o The measured values flash.

   When the measured values have stabilized:

   a. Press the [OK] key to perform the calibration.
      The display containing the current gas concentration changes with the display **OK**.
   b. Press the OK key to exit the calibration function or wait for approx. 5 seconds.

If a fault has occurred during the fresh air calibration:

a. The fault message ☒ appears and - - is displayed for the respective sensor instead of the measured value.
b. In this case, repeat the fresh air calibration.
   If necessary, have the sensor replaced by qualified personnel.

Adjusting the sensitivity for an individual measuring channel

- The span calibration can be carried out selectively for individual sensors.
- In the case of the span calibration, the sensitivity of the selected sensor is set to the value of the test gas used.
- Use a standard test gas.

Allowed test gas concentration:

Ex: 40 to 100 %LEL
O_2: 10 to 25 vol. %
CO: 20 to 999 ppm
H_2S: 5 to 99 ppm

Test gas concentrations of other gases: see Instructions for Use of the respective DrägerSensors.

1. Connect the test gas cylinder with the calibration cradle.
2. Vent the test gas into a fume cupboard or into the open air (with a hose connected to the second connector of the calibration cradle).

CAUTION

Never inhale the test gas. Health hazard!
Observe the hazard warnings of the relevant Safety Data Sheets.

3. Switch on the instrument and insert it into the calibration cradle.
4. Press the [+] key and keep it pressed for 5 seconds to open the calibration menu, enter the password (password on delivery = 001).
5. Use the [+] key to select the single gas adjustment function. The symbol for span calibration ⍝ flashes.
6. Press the OK key to start the channel selection. The display flashes the gas of the first measuring channel, e.g. **ch4 %LEL**.
7. Press the OK key to start the calibration function of this measuring channel, or use the [+] key to select another measuring channel (O_2 - vol. %, H_2S - ppm or CO - ppm, etc.). The test gas concentration is displayed.
8. Press the OK key to confirm the test gas concentration or use the [+] key to change the test gas concentration and complete the process by pressing the OK key. The measurement value flashes.
9. Open the test gas cylinder valve to let gas flow over the sensor with a volume flow of 0.5 l/min. The displayed, flashing measurement value changes to the value according to the supplied test gas.

When the displayed measurement value is stable (after at least 120 seconds):

a. Press the OK key to perform the calibration. The display containing the current gas concentration changes with the display **OK**.
b. Press the OK key or wait for approx. 5 seconds to end the adjustment of this measuring channel. The next measuring channel is displayed for adjustment if necessary. After the adjustment of the last measuring channel, the instrument changes to the measuring mode.
c. Close the test gas cylinder valve and remove the instrument from the calibration cradle.

If a fault has occurred during the span calibration:

- The fault message ⊠ appears and - - is displayed for the respective sensor instead of the measured value.
- In this case, repeat the calibration.
- Change the sensor if necessary.

Notice for the adjustment of the ex-channel to nonane as a measuring gas:

- During the adjustment of the ex-channel, propane can be used as a substitute test gas.
- When using propane to adjust the ex-channel to nonane, the display must be set to twice the used test gas concentration.

Notice for the use in subsurface mining:

- For the adjustment of the ex-channel to the measuring gas methane, the display of the instrument must be set to a value of 5 % (relative) higher than the test gas concentration.

Automatic fresh air calibration in the charging cradle (CatEx sensor only):

Calibrate the gas detector to fresh air, free of measured gases or other interfering gases. If the function is selected, a fresh air calibration of the CatEx sensor is performed automatically as soon as the gas detector is inserted in the charging cradle.
This function can be selected or disabled using the CC-Vision PC software.

No calibration takes place if the warm-up is not yet complete:

- Alarm LED is illuminated red.
- The acoustic signal sounds twice followed by three short tones and the gas detector switches off.

Once the fresh air calibration has been successfully completed:

- Alarm LED is illuminated red.
- The acoustic signal sounds once followed by three short tones and the gas detector switches off.

If a fault has occurred during the fresh air calibration:

- The fault message ☒ appears and - - is displayed for the respective sensor instead of the measured value.
- In this case, repeat the fresh air calibration.
  If necessary, have the sensor replaced by qualified personnel.

5 Maintenance

5.1 Maintenance table

The instrument should be inspected and serviced once a year by suitably qualified persons. Comparisons:

- EN 60079-29-2 – Gas detectors - Selection, installation, use and maintenance of detectors for flammable gases and oxygen
- EN 45544-4 – Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours - Part 4: Guide for selection, installation, use and maintenance
- National regulations

Recommended calibration interval for measuring channels Ex, O_2, H_2S, SO_2, NO_2 and CO: 6 months. Calibration intervals of other gases: see Instructions for Use of the respective DrägerSensors.

See the Technical Manual for details of spare parts.

5.2 Cleaning

The instrument does not need any special care.

- Dirt and deposits can be removed from the instrument by washing it with cold water. A sponge can be used for wiping if necessary.

CAUTION

Abrasive cleaning tools (brushes etc.), cleaning agents and cleaning solvents can destroy the dust and water filters.

- Carefully dry the instrument with a cloth.

6 Storage

- Dräger recommends storing the instrument in the charger module (order no. 83 18 639).
- Dräger recommends checking the charge of the power supply at least every three weeks if the instrument is not stored in the charger module.

7 Disposal

This product is not permitted to be disposed of with household waste. This is indicated by with the adjacent icon.
You can return this product to Dräger free of charge. For information please contact the national marketing organisations and Dräger.

Batteries and rechargeable batteries are not permitted to be disposed of as household waste. This is indicated by the adjacent icon. Dispose of batteries and rechargeable batteries as specified by the applicable regulations and dispose of at battery collection centres.

8 Technical data

Excerpt: See the Technical Handbook for details[1]

Ambient conditions: during operation and storage

Temperature class T4 (–20 to +50 °C):
NiMH power packs type: HBT 0000, HBT 0100
Power pack type: ABT 0100
with alkaline single cell type: Duracell Procell MN 1500[2], Duracell Plus Power MN 1500[2)]

Temperature class T3 (–20 to +40 °C):
Power pack type: ABT 0100
with NiMH single cell type: GP 180AAHC[2)]
with alkaline single cell type: Panasonic LR6 Powerline

Temperature class T3 (0 to +40 °C):
Power pack type: ABT 0100
with alkaline single cell type: Varta 4006[2)], Varta 4106[2)]

Temperature range over a short period [2)]:
–40 to +50 °C
Maximum of 15 minutes with NiMH power pack T4 (HBT 0000) or T4 HC (HBT 0100)
Requirement: storage of the instrument at room temperature (+20 °C) for at least 60 minutes in advance.

Air pressure	700 to 1300 hPa
Humidity	10 to 90 % (to 95 % short-term) rel. hum.
Position of use	any
Storage time	
X-am 2500	1 year
Sensors	1 year

Technical data

Electrical classification	IP 67 for instrument with sensors
Alarm volume	Typically 90 dB (A) at 30 cm distance
Operating time:	
Alkaline battery	Typically 12 hours under normal conditions
NiMH power pack:	
T4 (HBT 0000)	Typically 12 hours under normal conditions
T4 HC (HBT 0100)	Typically 13 hours under normal conditions
Dimensions	approx. 130 x 48 x 44 mm (H x W x D)
Weight	approx. 220 to 250 g
Refresh interval for display and signals	1 s

1) Technical manual, instructions for use/data sheets of the sensors used can be downloaded at www.draeger.com/ifu.
The CC-Vision PC software can be downloaded at www.draeger.com/software.
2) Not part of the BVS 10 ATEX E 080 X and PFG 10 G 001 X technical suitability tests.

Appendix A7

BASKI VALVE O&M MANUAL

BASKI VALVE O&M MANUAL

To: Bonsangue, John <jbonsangue@ocwd.com>
Subject: RE: We have a project

Hey Johnny B,
Attached is the updated O&M manual I put together. I added a bunch of stuff from our existing manual, including a lot more details about installation and testing, operations, and some tips and tricks. I also put in a page near the front with just a quick hitlist of all the details about the FCV which someone reading an O&M manual would want to know.

Just to put real numbers in it, I made it up to be a proper manual for the FCV we most recently made for you guys in 2019, one of the four at Centennial Park, specifically MBI-5. I can't believe it has been 5 years since that project!

Hopefully this will help your larger manual. If you have any questions or have any suggestions on what could be added, please let me know.

Have a great weekend!

Thanks,
Nick Hemenway
BASKI, INC.
303-789-1200
4002 S Clay St.
Sheridan, CO 80110
www.baski.com

Bonsangue, John

From:	Nick Hemenway <nick@baski.com>
Sent:	Monday, October 21, 2024 9:30 AM
To:	Bonsangue, John
Subject:	RE: We have a project

No problem. One thing I wanted to mention is that this new O&M has our latest and greatest procedures and recommendation in it, some of which have changed since we installed those last 4 FCVs at Centennial Park.

One change is, we now recommend applying heat shrink tube over the inflation fittings when the FCV is installed. We started that a few years ago because we had a couple customers experience some pretty significant corrosion in their wells due to very high levels of iron bacteria. Since the inflation fittings are a 'weak point' for crevice corrosion, putting heat shrink (or even just a good layer or two of vinyl tape) will protect the fittings from damage.

I just wanted to mention that in case you or anyone else reads that info in the O&M and says 'Hey, we haven't done that on any of our FCVs.'

Not a big deal for you guys, as you keep a very good eye on your water quality.

Thanks,
Nick

Operations and Maintenance Manual

Baski Downhole Flow Control Valve and Accessories

Orange County Water District

Well MBI-5

FCV Serial Number 30116

Shipped January 2019

BASKI

Table of Contents

Quick Facts

Serial Number: 30116

Model: 16-10-12.75-316SS

Baski Job Number: 12340

Date of Shipment: 1/18/2019

Maximum Diameter: 16”

Overall Length: 119-5/8”

Approximate Weight: 1500 lbs

Materials of Construction: All metal parts made from type 316 or 316L stainless steel, with an internal reinforced natural rubber element. Thread adapters installed on top and bottom made from Nitronic 60 material, a galling resistant stainless steel alloy.

Connection on Top: 12.75” 8-round (modified from API Short Casing Threads)

Connection on Bottom: 12.75” 8-round (modified from Short Casing Threads)

Inflation Fittings: 2 each, Swagelok ¼” Tube x 3/8” NPT Male Compression Fittings

Inflation/Control Lines: 2 each, 0.25” OD x .035w Duplex 2205 tubing

Stretch Pressure: 75 psi

Flow Coefficient: 450 $gpm/\sqrt{ftw}$

Internal Liquid: Propylene Glycol

Liquid Fill Level: 2.5” from top face

Introduction

THIS VALVE IS FILLED WITH LIQUID. DO NOT REMOVE THE CAPS ON THE INFLATION FITTINGS UNLESS THE FCV IS IN THE VERTICAL POSITION WITH THE INFLATION PORTS ON TOP, OR FLUID MAY LEAK OUT OF THE FCV.

SAVE THE CAPS, WHICH PREVENT LEAKAGE DURING SHIPPING.

The Baski Flow Control Valve (FCV) regulates recharge injection flow into wells. This FCV is a unique application of an inflatable rubber element, special passageways, and a downhole gas-over-liquid reservoir for inflation. Full inflation of the element seals off recharge flow into the well; and will allow water to be pumped to the surface if there is a well pump below the FCV. In most cases, a downhole check valve is recommended for use with the well pump. Partial inflation of the element creates an annular area between the outside diameter of the internal orifice column and the inside diameter of the element for flow of water back into the well. This annular area can be adjusted to provide varying amounts of head loss across the valve to control the injection rate, which prevents injected water from cavitating through the column pipe. For applications involving only the injection of water, and no pumping, the threaded bottom of the FCV must be capped off. However, Baski always recommends there be a method of pumping, allowing for occasional backwashing of the well to help maintain well efficiency.

The liquid inflation reservoir within the FCV prevents gas from contacting the rubber element, and, therefore, the risk of decompression blistering of the element is eliminated. To operate properly, this FCV has been filled with a nontoxic antifreeze with silicone oil on top to prevent evaporation. The fill level is 2.5" from the face of the top head when the valve is in the vertical position.

For injection flow the relationship between the flow rate "Q" in gpm, and the driving head "H" through the valve is expressed by the equation $Q = C_v \times \sqrt{H}$. When the valve is all the way open, the value C_v is 450 gpm $/\sqrt{foot\ water}$. Driving head H is the sum of the injection pipeline pressure, plus the distance down to the injection water level in the well (feet of water converted to a pressure), minus the head loss in the column pipe.

Storage

Baski FCVs are typically shipped in a wooden crate, with the stainless steel tubing and control panel packed and strapped on a separate pallet. If possible, store the crate and pallet indoors, either in a building or storage container until you are ready for installation. While they can be kept outdoors in good weather, heavy rain or snow may damage the control panel inside of the cardboard box, as well as paperwork.

If you are storing a used FCV, the best option is to put it in a suitable wooden crate or wooden pallet. It is critical that the threads on top and bottom of the FCV are protected. Damage to the threads may prevent successful re-installation of the FCV into the column pipe. Male threads should be protected by a plastic thread protector, an extra coupling, or with several wraps of heavy duty vinyl tape.

For long term storage (months or years), the ends and injection exit ports should be closed off with black plastic sheeting or equivalent. This eliminates sunlight, and the exchange of air, significantly reducing the three enemies of natural rubber: ozone, oxygen and ultraviolet radiation. Remove any such sheeting before assembly into the column piping.

Installation

Read all instructions before installation.

You will need:

- The FCV, with appropriate connections on top and bottom
- Two lengths of stainless steel tubing, longer than the set depth of the FCV
- Nitrogen Regulator (with 400 psi max delivery or higher)
- Full Nitrogen cylinder
- A spool rack or other method to hold the tubing spools in place near the well
- Open-end wrenches (1/2”, 9/16”, and 11/16”)
- Tubing plug (included in parts and fittings kit)
- Tubing union and test tubing such as ¼” nylon tubing to go from back of tubing spool to regulator. Fittings may vary.
- Snoop or soapy water for detecting leaks
- ¾” heat shrink tube (2 pieces, 2-3 inches long)
- Heat gun or torch

There are no user serviceable parts in the FCV. No attempt should be made to disassemble the valve. Only the factory is capable of repairing the valve. Because there is fluid in the FCV, care should be taken not to introduce contaminants into the FCV. The valve typically has threaded connections and requires no specialized equipment for attaching in-line with the column piping. Thread adapters are installed on both ends of the FCV to match the column pipe being used. For vertical turbine installations, the overall length of the valve is made the same as the length of column pipe, which is normally 10 feet. The joint strength of the FCV exceeds that of the column pipe.

Connecting the Control Lines

All fittings at the FCV should be tested with nitrogen gas for leaks before going into the hole. The FCV should be in the vertical position.

Remove the caps from the inflation fittings on the FCV. Fluid level may be checked by putting a wire or wooden skewer through the port and noting insertion depth, and level indicated on dip stick. **Do not use a wire smaller in diameter than 1/8".** The fill level of the FCV is stamped on the top head, and appears as (for instance) "F5", indicating the level is 5" down from the surface of the top head when the FCV is in the vertical position. If the level is within 0.5" of the stamped fill level, it is ok to proceed. If not, add propylene glycol as needed.

Note: Propylene glycol is most easily found as RV antifreeze at your local auto part store, used for winterizing RVs and other potable water systems. However, in recent years, antifreeze manufacturers have been using ethylene glycol in some blends, so carefully read the label to ensure it is actually propylene glycol, and not ethylene glycol.

In most cases, Baski recommends applying heat shrink tube over the inflation fittings after they have been connected to the FCV. This reduces the chances of crevice corrosion occurring between the nut and tubing, which can occur in wells with aggressive water quality or in applications when the well may not be pumped or backwashed for extended periods of time. In order to do so, the heat shrink tube must be put on/over the stainless steel tube just before the line is attached to the fitting. Typically, the best option is to use a short length (2-3 inches) of ¾" heat tube with the glue lining, which should fit over the hex on the fitting body and still shrink down to the ¼" OD of the stainless steel tubing. This is included in the FCV parts and extra fittings kit. If heat shrink is not available, consider applying vinyl well tape around the fittings.

With the heat shrink tube loosely put over the tubing behind the nut and ferrules, connect each stainless steel line to the FCV, being careful to fully seat the tube and ferrule into the body of the fitting before you install and tighten the nut onto the fitting body.

Both inflation ports on the FCV access the same chamber within the FCV, so they function identically. This means you do not have to keep track of which line goes to which port.

When connecting tubing from Baski with nuts and ferrules already installed, use an 11/16" open end wrench as a backup on the fitting body, then tighten the tubing nut with a 9/16" open end wrench until a sharp increase in torque is felt. If you are installing new ferrules onto the tubing, Swagelok recommends tightening 1.25 turns past finger tight. Repeat the process with the second line.

If using heat shrink tube, bring the heat shrink tube down and over the inflation fittings, covering the fitting body as much as possible down to the flat face on the FCV. Using a heat gun or gas torch, carefully heat up the shrink tube in place, spreading the heat as evenly as possible, allowing the tube to shrink all the way down to the OD of the tubing. If the tube does not shrink all the way down or you encounter problems, we suggest you add some vinyl tape as needed to ensure the fittings and nuts are fully covered, keeping out.

The back end of each line is accessible at the wooden spool upon which the tubing is wound. Just like the front end, there will be a Swagelok compression fitting on the back end of the tubing. Disconnect the fitting body from the tubing nut on each line. Cap one of the lines (provided in your spare parts kit). Connect one line to a nitrogen regulator using a tubing union and test tubing as needed. This end is used for pressurizing with nitrogen to check for leaks at the top of the FCV. Even though you are only connecting to one line, both lines will be pressure tested simultaneously, as they are connected via the inflation chamber inside the FCV. This allows for all connections to be pressured tested together.

All fittings should be saved, along with the caps that hold the fluid in the FCV for shipping, or for future use.

Pressurize the FCV to 400 psi. Snoop, a Swagelok product, or a soapy water solution can be sprayed onto the connections at the FCV to make bubbles visible, which would indicate leakage. If you have installed heat shrink tube or tape over the fittings, you may only be able to check your test fittings for leaks.

Simulate vibration of the stainless lines by jiggling the lines just above the fittings. Hold at this pressure for 30 minutes and continue looking for any bubbles using Snoop. Any fitting that leaks, as indicated by bubbles, should be tightened or replaced. To replace a fitting, thread sealant and any oils must be removed from the female NPT thread; and a new fitting installed with thread sealant. After the 30 minute pressure test is complete, bleed off the nitrogen pressure and remove the test fittings and tube from the back side of the stainless steel tubing. Secure the back end of the tubing back onto the spool.

You are now ready to continue with the downhole installation of the column pipe. During installation of the column pipe, secure the FCV control lines to the column pipe with either stainless steel banding or thick vinyl well tape. Baski recommends the tubing be banded or wrapped at least once in the middle of each column pipe and next to each coupling.

If time allows, repeat the above procedure for leak testing after the downhole installation is complete. This verifies there was no damage during the installation process. After connection of the control lines to the FCV control panel, those fittings should also be checked for leaks.

After installation, any chlorine solution used to sanitize equipment going into the well should be less than 200 ppm chlorine. Following sanitizing, the equipment should be rinsed off. This can be done by adding water to the annulus between the casing ID and the column piping OD; and by pumping water out of the well, until chlorine levels are less than about 1 ppm.

Surface Connections

Depending on the layout of equipment at the surface, it is common to cut the control lines so they can be easily disconnected near the wellhead during future servicing of the well. It is very important that such splices be made outside of the discharge head or within the junction box of a pitless unit. This allows for easy access to the fittings for inspecting and servicing the fittings without the need for a pump rig lifting the whole string. Additionally, it is common to change the alloy of tubing at this location. Whereas Baski typically supplies Duplex 2205 stainless steel tubing for its high corrosion resistance and high strength, using type 316L tubing (also supplied by Baski) at the surface allows for easier pulling of the tubing through conduit and final bending, as the 316L tubing has a lower yield strength.

The run of surface tubing can be pulled through conduit as needed between the wellhead and the location of the control panel. We recommend long sweep elbows be used in the conduit if possible, which will make the pulling process easier.

If connecting to the standard automatic/manual FCV control panel, you can cut the tubing to length, de-burr the end of the tube, then directly insert the end of the tubing into the appropriate fitting on the control panel, then tighten the nut, as the tubing fittings installed in new control panels have ferrules already in them ready to be swaged onto the new tubing ends.

Automatic/Manual FCV Control Panel

Refer to included drawing for valve numbers and port locations.

The standard FCV Control Panel allows for pressurizing or bleeding the nitrogen from the FCV control lines, as well as monitoring inflation pressure. Pressurization or bleeding may be done manually or automatic. The manual pressurization and bleeding of the FCV utilizes standard needle valves. The automatic pressurization and bleeding makes use of solenoid valves actuated by a programmable logic controller (PLC) (not supplied by Baski). To obtain the desired injection flow rate, the PLC/SCADA systems typically monitor: 1) the injection rate; 2) the FCV pressure; 3) injection pipeline pressure (a vacuum or negative pressure must be avoided to prevent possible contamination); 4) well water level; and 5) tank storage or reservoir levels. The FCV pressure may be monitored via the transducer pressure port on the upper right manifold block of the panel. The rate of pressurization or bleeding is regulated by metering valves downstream of the (normally closed) solenoid valves. Note: These metering valves cannot shut off flow. A pressure transmitter may be used at the inlet port of the panel, and another one on the cylinder side of the pressure regulator, to trigger a warning signal at low cylinder pressure.

DO NOT OVER TIGHTEN THE METERING VALVES,
THEY CANNOT SHUT OFF FLOW.

Attachment of the panel

The control panel may be mounted to a wall, or placed in a standard NEMA enclosure that takes the same back panel size.

Hookup

Electrical leads of solenoid valves should be terminated by the electrical contractor adjacent to the valve panel, per national electric codes.

A nitrogen regulator is attached to a cylinder and a line run to the panel. The regulator should not be set to deliver more than 600 psi (except Deep Set™ valves). The manual pressurization valve should be closed, and the (normally closed) solenoid valves should not be powered up. The delivery pressure may now be set on the regulator. The pressure relief valves on the control panel blocks set at the Baski shop to prevent over-pressurization of the FCV and panel should the regulator malfunction. The relief valves are typically adjusted to open 50 psi below the maximum range of the pressure gauge installed on the panel.

A tube, with a discharge muffler, should be attached to the bleed discharge and routed to a point out of the way of personnel. High pressure nitrogen gas can come out of this port, and care must be taken to prevent injury to personnel and prevent nitrogen concentration from building up in an enclosed or confined space.

Normal pressurization and bleeding of the FCV requires that shutoff valve 1 and shutoff valve 2 be open, and the fill/drain valve be closed. When pressurizing the valve, the manual bleed valve should be closed; and when bleeding off pressure from the valve, the manual pressurization valve should be closed. Long inflation lines may require longer times for pressure changes to reach the valve. If the pressurization valve is opened, and then closed, the pressure gauge will slowly rise and then fall to a value which represents the pressure in the valve.

Shutoff valve 1 and shutoff valve 2, and the fill/drain valve, may all be closed to change the pressure gauge without depressurizing the FCV. The Cv for a FCV can be decreased by adding liquid to the control lines. The Cv can later be restored by removing the added liquid. To add liquid, pump liquid in the fill/drain valve (open), with shutoff valves 1 and 2 closed, and the line to the FCV at shutoff valve 1 disconnected. To gas lift liquid out of the valve, add gas through shutoff valve 1, with shutoff valve 2 closed and the fill/drain valve open. Consult the factory before adding or removing any liquid to/from the FCV.

Original makeup of Swagelok tubing nuts (silver colored) are tightened to 1-1/4 turns past finger tight. Stainless control tubing supplied by Baski for the control line of the FCV typically already has the Swagelok nut and ferrule set assembled. To remake, use a wrench, and when the nut starts to tighten up, go an additional 1/16th turn. Hose and tubing supplied by Baski have fittings at both ends. The stainless steel tubing control line fittings are Swagelok, part number SS-400-1-6. However, the ports in the valve are 3/8" NPT and any suitable fitting for the control lines used may be installed in the ports. Hose fittings are a standard size 4 by 37 degree flare.

Preventative Maintenance, Overhaul, Parts

	Qty	Unit	Name	Description
1	2	[ea]	metering valve	Swagelok SS-4MG2-MH
2	2	[ea]	solenoid valve	Parker 71215SN2ENOONO-C111P3 (120VAC)
3	5	[ea]	shutoff valves	Swagelok Needle Valve B-1KF-4
4	11	[ea]	tubing connectors	SS-400-1-4 (Swagelok straight male connector)
5	2	[ea]	tubing connectors	SS-400-7-4 (Swagelok straight female connector)
6	2	[ea]	tubing connectors	SS-400-1-6 (Swagelok straight male connector)
7	1	[ea]	filter	In-Line Air Filter, ¼" NPT
8	1	[ea]	relief valve & cap	Swagelok B-4CPA2-350 with cap P-4CP4-K12-RD
9	1	[ea]	gauge	4-1/2" Face Process gauge, ½% accuracy, ¼" NPT

Ports for control line are 1/4" female NPT. Stainless tubing requires stainless steel straight male connectors. Consult the Baski technical staff before changing to other types of hose or tubing besides what was supplied originally by Baski.

The Flow Control Valve panel requires no regular maintenance. All connections must be clean before assembly. If the filter must be replaced, care must be taken so that dirt does not enter the system while the filter is being replaced. If a leak occurs at one of the connections between the aluminum blocks (except for the pressure gauge and relief valve), the block that has the connection must be removed. We do not recommend that this be done in the field, but, rather, that the panel be returned to the factory. If such a leak occurs, call Baski, Inc. Technical Services at 1.800.55.BASKI. The shutoff valves have packing around the stems. If there is a leak through the stem of the knob of the valve, the packing may be retightened. There are two nuts on the valve. Loosen the lower nut closest to the body of the valve, and tighten the upper nut until the leak stops, then retighten the lower nut. The metering valve must never be over tightened: it cannot shut off flow. Leakage through the solenoid valve may be field repairable: call Baski, Inc. Technical Services at 1.800.55.BASKI. The filter and pressure gauge are the most common spare parts required by the panel. Replacement of the pressure gauge may require removal of the backpanel from the wall. Call Baski, Inc. Technical Services at 1.800.55.BASKI before attempting to replace the gauge.

Valve Operation for Pumping

Pumping is defined as water being pumped by a well pump from below ground to surface piping. This process is also referred to as production. For pumping, the FCV must be closed. The pressure to close the valve is the shutoff pressure, and is equal to the sum of the set depth (converted to psi), plus the column pipe friction loss, plus the uphole pumping pressure, plus the stretch pressure of the valve (see quick facts page). The pumping pressure may not always be known in advance, but may be estimated. For example, if the Flow Control Valve is set at 400 feet, and the pumping pressure at the surface is estimated to be 40 psi, and the column pipe friction loss is ignored, the minimum inflation pressure would be 400 ÷ 2.31 + 40 + 30(stretch pressure example) = 243 psi. (2.31 feet of water equals 1 psi).

Testing for Shutoff Pressure during Pumping

For new installations or after major changes to the well's operating conditions, the shutoff pressure of the FCV should be re-tested. This test empirically determines what the FCV inflation pressure must be during pumping to ensure it is fully closed, preventing recirculation and allowing all of the pumped water to come to the surface.

1. Calculate what the shutoff pressure should be based on the equation given above. Inflate the FCV about 25 psi above the calculated pressure. Using the example above, this would be 268 psi.
2. Start the pump, and let the pumping rate stabilize (for example, 1,000 gpm). This may take 5 to 10 minutes, or longer depending on the application. Also wait to proceed until the water has visually cleaned up, as the water is typically dirty when the pump is first started.
3. With someone carefully watching the flowmeter, slowly bleed off pressure from the FCV. Eventually the pumping rate will suddenly drop, in this example perhaps down to 900 gpm at an inflation pressure of 225 psi. This indicates the FCV is starting to open and some of the water is recirculating back into the well. Make a note of the inflation pressure when this drop in flow occurred.
4. With someone carefully watching the flowmeter, slowly increase the inflation pressure of the FCV. When the pumping rate reaches the original rate, make a note of the FCV inflation pressure. Continuing the example, let's say the pumping rate got back to 1,000 gpm when the FCV was inflated to 250 psi.
5. Increase the inflation pressure by an additional 10 psi. If the pumping rate remains unchanged, your test was successful. If the pumping rate increases, for example to 1,100 gpm, that indicates your original calculated pressure was too low to begin with. Continue to increase the inflation pressure until the pumping rate stays the same. In this case you may consider repeating the steps above.

It is typically recommended to add 15-20 psi above the observed shutoff pressure as a safety factor against any small variations in the well's operating conditions in the future, such as higher pipeline pressures or increased pump speed. From our example, that would lead us to declare the shutoff pressure during pumping is 265 psi.

In normal operation, the pump should not be turned on until the FCV is inflated to this shutoff pressure.

If there is no pressure in the FCV (or an inflation pressure below the shutoff pressure determined above) and the pump is turned on, the water will circulate back into the annulus of the well and back around the pump and motor. If left for very long, the temperature of the water will rise, and can become hot enough to destroy seals in the pump and the FCV.

The required shutoff pressure during pumping will remain the same unless one of the following changes are made to the well: (1) Large changes to the pipeline pressure at the wellhead. (2) the set depth of the FCV is changed, or (3) the column pipe size is changed.

Valve Operation for Recharge/Injection

Recharge is defined as water being injected into the pump column pipe for recharging an aquifer. For injection into the well, the pump is turned off and the FCV's rubber element is partially deflated to control the injection rate as monitored by the water flowmeter. The maximum required inflation pressure of the valve is the sum of the surface injection pressure, plus the FCV set depth converted to psi, plus the stretch pressure of the valve, minus the column pipe friction loss. **For example**, if the injection pressure is 25 psi, and the set depth is 400 feet, and we ignore the head loss in the column pipe, a pressure of 25 + 400 ÷ 2.31 + 30 (228 psi) would shut off injection flow: hence, to inject, the pressure must be less than this. The range of pressures for injection would be between 0 (zero) and 228 psi. For operation of the control valve after the pump has been turned off, the nitrogen gas is bled off, reducing the pressure in the valve so that the water flows through the valve and into the well. The flow rate is adjusted through the control valve by varying the inflation pressure to the valve, while monitoring the flow rate with the water meter. It may take several hours for the flow rate to stabilize due to the stabilization of the injection water level. There is a slight hysteresis effect due to the reinforced rubber element, but it is normally a much shorter time variable than the water level stabilization variable. For increasing the flow rate, the valve inflation pressure would be reduced, but after several hours the flow rates may be slightly higher or lower, and the valve inflation pressure would have to be adjusted to compensate for this. When decreasing flow, the valve inflation would be increased; but after several hours the valve inflation may have to be slightly adjusted up or down to obtain the desired flow.

Testing for Shutoff Pressure during Recharge/Injection

1. Inflate the FCV to the shutoff pressure determined previously while pumping.
2. **Slowly** open all the pipeline valves at the surface required to direct water towards the wellhead.

a. If this procedure is done immediately after pump testing, the column pipe and surface piping should already be water tight.

b. If the column is not full to begin with, slowly opening the surface pipeline valves will start to fill the column pipe. In this case, wait until all the air has been purged out of the air/vac release valve in the pipeline and there is no flow of water.

3. With someone carefully watching the flowmeter, slowly reduce the FCV inflation pressure until the flowmeter first shows a flow of water. Note the Inflation pressure this occurred at.
4. Continue to reduce the inflation pressure until the flowrate reaches your designed rate. Make a note of the inflation pressure.
5. With someone watching the flowmeter, slowly increase the inflation pressure until the flow drops to zero. Make a note of the inflation pressure this occurred at. This is the shutoff pressure during injection.

If this shutoff pressure during injection is lower than the shutoff pressure you found during pumping (this is the most common scenario), then you should consider the shutoff pressure found during pumping to be the overall shutoff pressure for the FCV. If however you found the shutoff pressure during injection to be higher than during pumping, use the higher of the two numbers. This simplifies operations, especially when used in automatic operation with a SCADA system. This allows the programmer to use one single number in their program that will ensure the FCV is closed, regardless of the operational phase.

Checking for Leaks

Before the valve is lowered into the well, the connections on top of the valve should be checked for leaks. Refer to the section on installation of the FCV.

Only personnel familiar with high pressure cylinder gases should be allowed to make connections to the panel or nitrogen cylinder.

After connection of the valve to the panel and the regulator to the panel, the panel should be tested for leaks.

1. The lower four shutoff valves should be closed, and the shutoff valve to the left of the gauge should be opened. Pressurize the panel to 200 psi. All connections to the aluminum

blocks, and between the blocks should be inspected for leaks. This includes the packing at the stem of the shutoff valves. Also, remove the red protective diffusion cap off the pressure relief valve and check to make sure the relief valve is not leaking. Soapy water, or other suitable leak detection fluids or methods may be employed to assure there are no leaks at the NPT connection or the tube connection.

A slight leak at an NPT fitting may be able to be fixed by loosening the tubing nut and tightening the body of the tubing connector into the aluminum block, and retightening the tubing nut. A slight leak at the nut may be able to be fixed by tightening the nut slightly. Do not over tighten connections.

If there are no leaks, the regulator pressure may be backed off and the panel depressurized by opening the shutoff valve for high pressure gas bleed (lower left of the panel). After the pressure in the panel has returned to zero, close the shutoff valve.

2. Open the two shutoff valves for the two control lines of the Flow Control Valve. Pressurize the panel (and Flow Control Valve) to 200 psi. Check for leaks at the two fittings where the stainless control lines enter the panel. Check for leaks at the fittings for the lower center shutoff valve on the bottom aluminum block. The high pressure gas bleed port at the bottom of the panel should have a vent tube attached, to direct bleed gases to a safe area. Check the end of this tube for gas leaking by the solenoid valves. If this is not possible, disconnect the tube, attach another short tube, then put the end of the tube in water and look for bubbles.

3. Now close the shutoff valve just to the left of the pressure gauge and turn the regulator handle counterclockwise to relieve pressure. The panel and Flow Control Valve are now pressurized, and may be left that way for 1 to 2 hours to check for leaks. If there is a leak now, it may be due to a damaged control line in the well. The damage probably occurred during installation. The hose may be detached at the regulator and put in water to see if the back pressure on the PRESSURIZE solenoid is leaking back through the solenoid valve. If there appear to be no leaks at the surface, the valve probably has a damaged control line in the well.

Trouble shooting Flow Control Valve and Panel Operation

The FCV is a simple operational valve. Depressurized, the FCV is in the open position and pumped water will flow back into the well. Pumping requires the proper shutoff pressure. This shutoff pressure is calculated by the methods stated in the operational instructions. If there is no flow to the surface during pumping, and there is sufficient pressure in the system, then the control line may be smashed closed: i.e., the valve was installed with zero pressure, and the line damaged during installation. There is also the unlikely event that pumping is possible even though the pressure in the FCV has been released: the valve sent down pressurized and the lines smashed closed.

A pressure lower than the shutoff pressure will allow injection of water into the well. Zero pressure at the wellhead may indicate cavitation of the water in the well. An increase in pressure in the FCV™ should raise the surface pressure above zero.

A clogged filter can create problems. To check for a clogged filter close the lower four shutoff valves. An increase in pressure at the regulator should be immediately recorded at the gauge on the panel. If the panel gauge is sluggish in response to the regulator, the filter is probably clogged. The regulator may be backed off and the panel may be depressurized (opening the bleed valve) and the sensitivity checked several times.

Other problems are uncommon and the factory should be consulted call Baski, Inc. Technical Services at 1.800.55.BASKI.

Mechanical Safety, Pump Shutdown

Other than specific short-term diagnostic testing, the pump should not be on while the FCV is open. If the FCV is open (inflation pressure lower than its shutoff pressure) and the pump is on, the water will flow up from the pump and recirculate back out through the FCV's injection discharge and back into the well. If this occurs for a long period of time (days or weeks), the water will start to heat up, as energy is continually being added to the water by the pump. The water temperature may rise enough to damage seals in the pump and/or the FCV.

In applications with automatic operation via SCADA, Baski recommends checkpoints are entered into the SCADA program such that the pump will only start if the FCV inflation pressure is at or above the shutoff pressure. For manually controlled applications, a snap action pressure switch (SPDT) may be installed in series with the (emergency) stop switch of the pump's magnetic starter, so that loss of pressure in the FCV turns the pump off, bypassing any computer system.

Warranty

Flow Control Valve[1]

FCV™

Baski, Inc.

Denver, CO USA

Seller warrants the products sold hereunder to be free from defects in material and workmanship at the date of shipment. **No other warranty, whether express or implied, including any warranty of merchantability or fitness for a particular purpose, shall exist in connection with the sale or use of such products.** All claims under this new warranty must be made in writing and delivered to Seller prior to the expiration of five (5) years from the date of shipment to Purchaser.

Upon receipt of a timely claim, the Seller shall repair, or at its option, replace any part or parts which Seller determines to have been defective at the time of shipment from the Seller; provided, however, that if circumstances are such as to preclude the remedying of warranted defects by repair or replacement, Seller shall, upon return of the goods, refund to Purchaser any part of the purchase price of the goods paid to Seller. Inspection shall be performed at the Seller's plant. Pulling and resetting of the valve, and freight for returning products to the plant for inspection, shall be paid by Purchaser. Valves must be returned in original or equivalent crating to prevent damage in shipping. No returns without authorization.

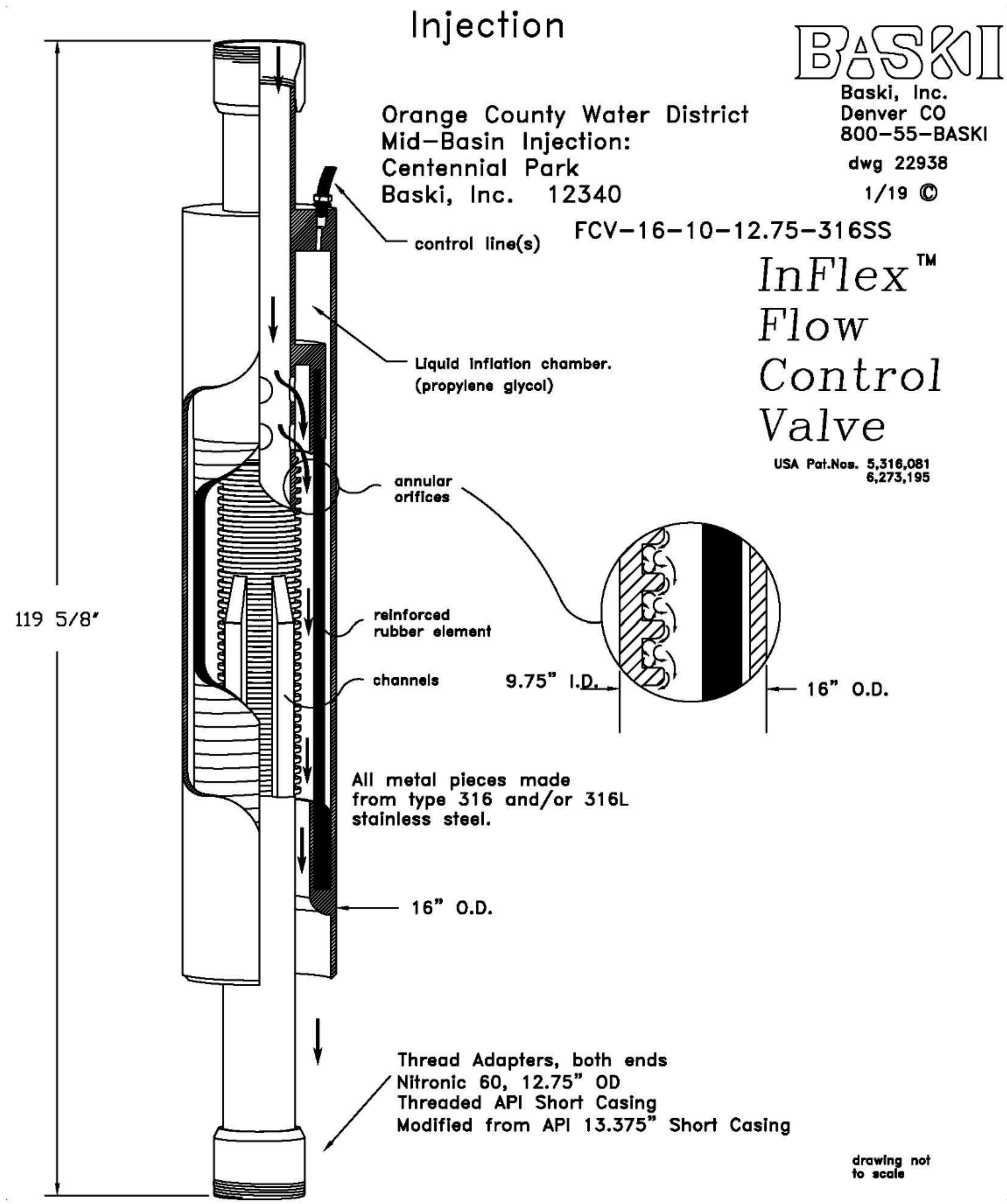
Abuse, over-pressurization, valve wear from vibrating (unbalanced) pump, misuse, acts of God, aggressive and/or non-potable water quality, corrosion, high levels of chlorine, and excessive temperature are specifically excluded from this warranty.

The foregoing states the sole and exclusive remedy for any breach of warranty or for any other claim based on any defect in, or non-performance of, the products whether sounding in contract, warranty or negligence. In particular, labor and costs associated with pulling and resetting the FCV are specifically excluded from warranty. Without limiting the generality of the foregoing, Seller shall under no circumstances be liable for any other charges, labor costs, or any other incidental or consequential loss or damage of any kind or description whatsoever arising out of, or in any way relating to, any such breach of warranty or claimed defect in, or non-performance of, the products.

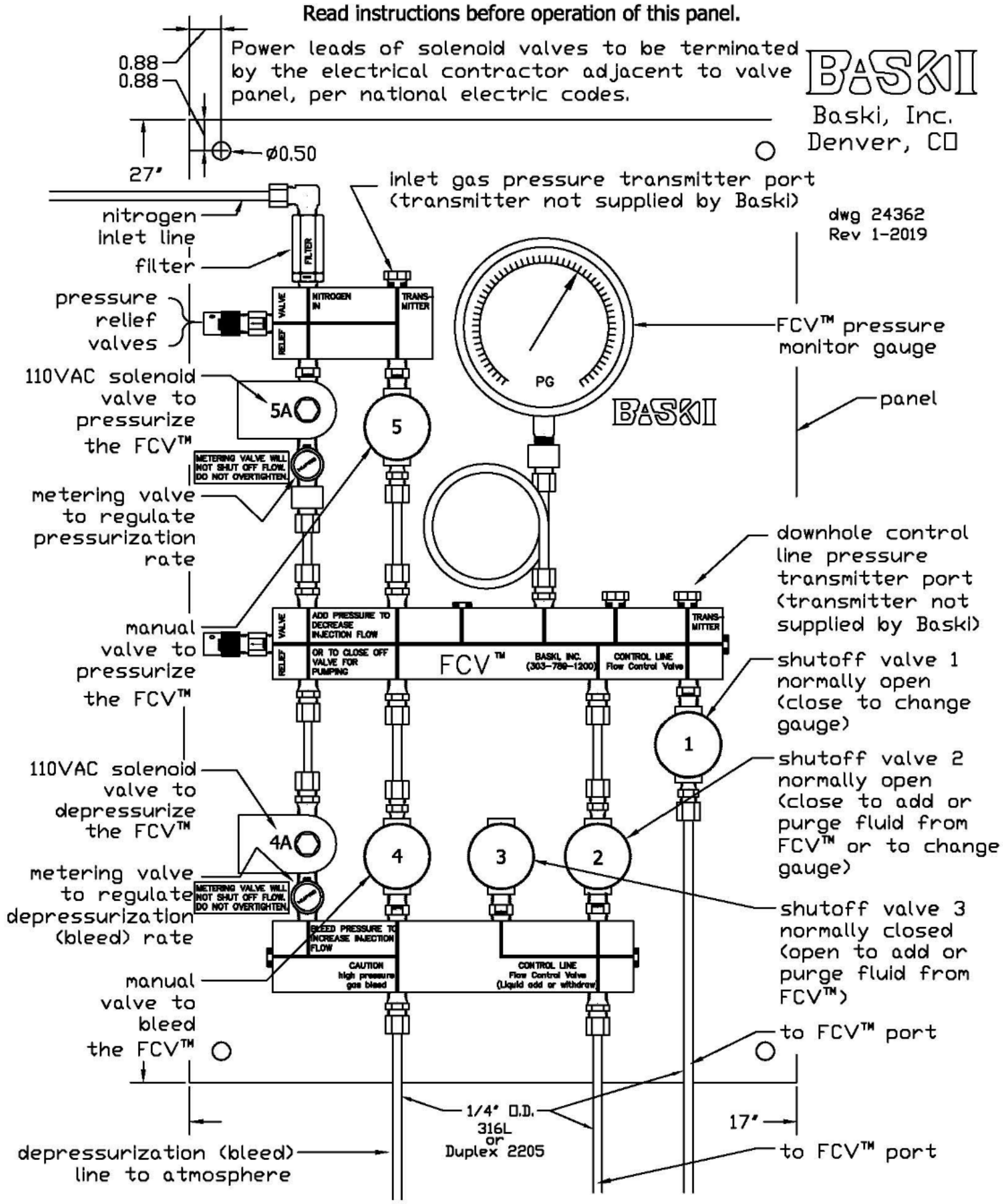
If chlorine is used in the well, prior to installation or after installation, the chlorine concentration must be less than 200ppm. The well must then be flushed with potable water until the residual concentration of the chlorine is less than 1-1/2 ppm.

May 2003, [1]USA pat. no. 5,316,081; 6,273,195

Flow Control Valve Drawing



Automatic/Manual Control Panel Drawing



Appendix

Flow Control Valve Test Report

Date of Tests: 10/10/18

FCV Serial Number: 30116

Tests run by: Nick Hemenway

Witnessed by: Justin McKeever from OCWD

Visual Test Results

The FCV opened and closed properly, with a stretch pressure of approximately 75 psi.

Cv Test Results

When fully open, the FCV showed an average Cv value of 450 $gpm/\sqrt{ftw}$

Full Flow Test Results

Test run at 70 psi upstream and 40 psi downstream

Sample of Data Collected During Test

FCV Inflation Pressure (psi)	Flow Rate (gpm)
0	3780
40	2765
50	2110
60	1510
70	830

Summary: FCV operated properly during all tests. Note that the data points in the table above were taken with the listed upstream and downstream pressures. These numbers will be different during daily operations, based on the well's operating conditions.

Nitrogen Gas Manifold with Regulator

The following pages contain literature from Western Enterprises, the manufacturer of the nitrogen gas manifold, including the regulator.

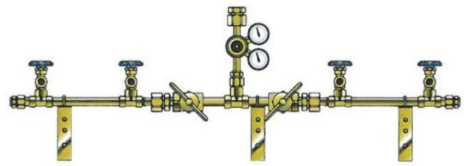
The model number for the manifold we have supplied is SP-MD-7-2. This is one of Western's MD series manifolds that can accommodate two nitrogen cylinders, with 24" stainless steel braided pigtails and check valves. However, the standard regulator that usually comes with the MD series manifold only delivers up to 160 psi, which is not enough for this application. Therefore, another regulator (RS-7-5) was substituted in its place, which can deliver up to 450 psi. This special substitution is why the model number begins with SP.

MD, MS Manual Manifold Systems

Manual manifolds are designed to regulate compressed gases in high pressure cylinders (up to 3,000 psig) and are ideal for manifold applications not requiring automatic changeover from the service to the secondary bank. The MD Series duplex manifold is designed for manual changeover of 2 banks of cylinders. The MS series simplex manifold system allows manifolding of an unlimited number of cylinders in a single bank. This system is often used as a high pressure reserve for bulk, portable bulk and gas generator systems.

specifications

- Manual Systems
- Maximum working pressure: 3000 psig
- Manifold Outlet: 1/2" NPT male
- 24" flexible stainless steel braided pigtails with check valves. Check valve is at header end of pigtail for all gases except Oxygen. Note: Helium and Hydrogen manifolds shipped with synthetic fiber braided pigtails
- Individual header valves at each cylinder location (units with 4 cylinders or larger-all gases except Oxygen)
- Headers constructed of 1/2" brass pipe and tees
- Acetylene manifolds shipped complete with dry flashback arrestor, relief valve and connecting piping. Hydraulic Flashback arrestors are available as an option for an additional charge
- Optional safety kits, flash arrestor and relief valve available for Liquefied Fuel gases
- Heater Kits available for Carbon Dioxide and Nitrous Oxide gases
- Model RM regulator included for most gas services. *Note:* RDM Series used for Oxygen
- An alarm can be added to non fuel gas MD systems to signal changeover from service to reserve banks by adding items WME-4-9 pressure switch, WMS-1-97 adaptor, WMS-9-25C power source and BIA-3 remote A/V alarm.



MD-4-4

Example: *MD-4-4 = CO_2 (4=CGA-320) Manifold for 4 Cylinders*

MS-9-4

Example: *MS-9-4 = Oxygen (9=CGA-540) Manifold for 4 cylinders*

HOW TO ORDER

Specify: Control Type (V)–Service (W)–Number of C

Example 1: MD-9-12V represents MD with oxygen gas service and a ver
Example 2: MSHP-7-6 represents MSHP with nitrogen gas service with a s

CONTROL TYPE (V)	GAS SERVICE (W)		# OF CYL'S (X)
MD / MS	**(1)** Acetylene (POL)	CGA-510	
Most gases: 20–160 psig	**(1A)** Acetylene (Commercial)	CGA-300	
Acetylene: (0–15 psig)	**(2)** Compressed Air	CGA-346	
LPG: (0–45 psig)	**(3)** Argon	CGA-580	
	(4) Carbon Dioxide	CGA-320	
MDHP / MSHP	**(5)** Helium	CGA-580	
(only available for non-fuel	**(6)** Hydrogen	CGA-350	
gas services)	**(6A)** Argon/Methane Mixtures	CGA-350	
Most gases: 140–300 psig	**(7)** Nitrogen	CGA-580	
Oxygen: 140–450 psig	**(7A)** Industrial Air/Nitrogen OP	CGA-590	
	(8) Nitrous Oxide	CGA-326	
	(9) Oxygen	CGA-540	
	(10) Liquefied Fuel Gases (LPG)	CGA-510	

Note: *Different regulators may be substituted to achieve higher delivery pressures on all control types.*

WESTERN ENTERPRISES
GLOBAL GAS MANAGEMENT TECHNOLOGY
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For more information, call Western Customer Service at **1-800-783-7890**

Design Lengths

TOTAL NO. OF CYLINDERS	2	3	4	5	6	7	8
MS- Standard (10" Centers) Overall Manifold Length	2'–9" (.84m)	3'–7" (1.09m)	4'–5" (1.35m)	5'–3" (1.60m)	6'–1" (1.85m)	7'–0" (2.13m)	7'–10" (2.39m)
MS- Staggered Design (5" Centers) Overall Manifold Length	2'–4" (.74m)	2'–9" (.84m)	3'–2" (.97m)	3'–7" (1.09m)	4'–0" (1.22m)	4'–5" (1.35m)	4'–10" (1.47m)
MS- Vertical Crossover and Crossover (10" Centers) Overall Manifold Length	1'–11" (.58m)	N/A	2'–9" (.84m)	N/A	3'–7" (1.09m)	N/A	4'–5 (1.35m)
MS- Standard (13" Centers) Overall Manifold Length	3'–0" (.91m)	4'–1" (1.22m)	5'–2" (1.57m)	6'–3" (1.91m)	7'–4" (2.24m)	8'–5" (2.57m)	9'–6" (2.90m)
MS- Staggered Design (6.5" Centers) Overall Manifold Length	2'–5.5" (.75m)	3'–0" (.91m)	3'–6.5" (1.08m)	4'–1" (1.25m)	4'–7.5" (1.41m)	5'–2" (1.57m)	5'–8.5" (1.74m)
MS- Vertical Crossover and Crossover (13" Centers) Overall Manifold Length	1'–11" (.58m)	N/A	3'–0" (.91m)	N/A	4'–1" (1.25m)	N/A	5'–2" (1.57m)
TOTAL NO. OF CYLINDER	**2**	**4**	**6**	**8**	**10**	**12**	**14**
MD- Standard (10" Centers) Overall Manifold Length	2'–4" (.71m)	4'–4" (1.32m)	6'–0" (1.83m)	7'–8" (2.34m)	9'–4" (2.85m)	11'–0" (3.35m)	12'–8" (3.86m)
MD- Staggered Design (5" Centers) Overall Manifold Length	2'–4" (.71m)	3'–6" (1.07m)	4'–4" (1.32m)	5'–2" (1.57m)	6'–0" (1.83m)	6'–10" (2.08m)	7'–8" (2.34m)
MD- Vertical Crossover and Crossover (10" Centers) Overall Manifold Length	N/A	2'–8" (.81m)	N/A	4'–4" (1.32m)	N/A	6'–0" (1.83m)	N/A
MD- Standard (13" Centers) Overall Manifold Length	2'–4" (.71m)	4'–9" (1.471m)	7'–0" (2.13m)	9'–2" (2.79m)	11'–4" (3.45m)	13'–6" (4.11m)	15'–8" (4.77m)
MD- Staggered Design (6.5" Centers) Overall Manifold Length	2'–4" (.71m)	3'–9" (1.14m)	4'–10" (1.47m)	5'–11" (1.80m)	7'–0" (2.13m)	8'–1" (2.46m)	9'–2" (2.79m)
MD- Vertical Crossover and Crossover (13" Centers) Overall Manifold Length	N/A	2'–8" (.81m)	N/A	4'–10" (1.47m)	N/A	7'–0" (2.13m)	N/A

ylinders (X)–Header Configuration (Y)–Mounting (Z)

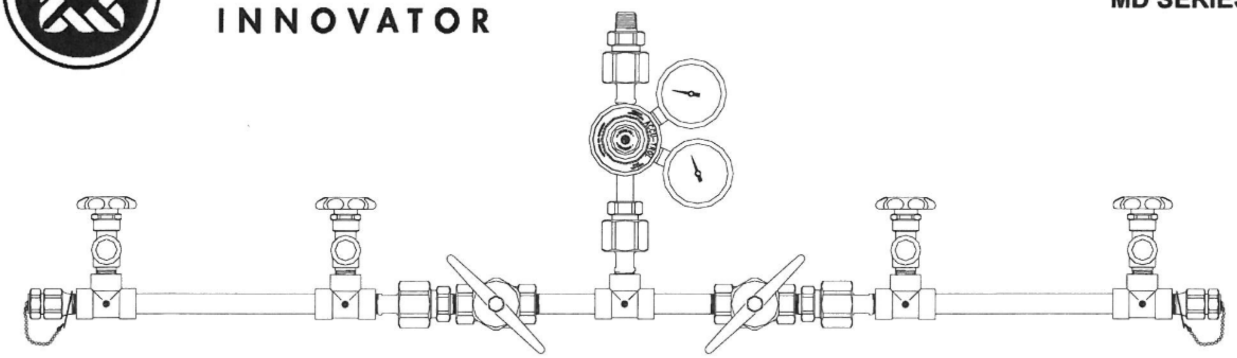
tical crossover bank of 6 cylinders per side which is mounted on the wall.
tandard header configuration of 6 cylinders which is mounted on the wall.

	HEADER CONFIGURATION (Y)	MOUNTING (Z)
	BLANK–Standard 10" on Center 13" on Center for Acetylene & LPG **S**–Staggered 5" on Center 6.5" on Center for Acetylene & LPG **V**–Vertical Crossover 10" on Center or 13" on Center for Acetylene & LPG **C**–Crossover (Floor Mount Only) 10" on Center or 13" on Center for Acetylene & LPG	**BLANK** = Wall mount **F** = Floor mounted

WESTERN INNOVATOR

Installation and Operating Instructions For

MANUAL MANIFOLDS
MD SERIES



INTRODUCTION

Western manifold systems are cleaned, tested and prepared for the indicated gas service and are built in accordance with the National Fire Protection Association and Compressed Gas Association guidelines. The manifold consists of a regulator and two headers, to provide an increased supply of gas for the specific gas application. The manifold is designed and to allow expansion to meet future needs. Pressure gauges show system status and alert the need to replace depleted cylinders. Features of the manifold system include a regulator, flexible pigtails with check valves, wall-mounted headers and complete mounting hardware.

CAUTION

Failure to follow the following instructions can result in personal injury or property damage:

- Never permit oil, grease, or other combustible materials to come in contact with cylinders, manifold, and connections. Oil and grease may react and ignite when in contact with some gases — particularly oxygen and nitrous oxide.
- Cylinder, header, and master valves should always be opened very s-l-o-w-l-y. Heat of recompression may ignite combustible materials.
- Pigtails should never be kinked, twisted, or bent into a radius smaller than 3 inches. Mistreatment may cause the pigtail to burst.
- Do not apply heat. Some materials may react and ignite when in contact with some gases — particularly oxygen and nitrous oxide.
- Cylinders should always be secured with racks, chains, or straps. Unrestrained cylinders may fall over causing physical injury and/or damage or break off the cylinder valve which may propel the cylinder with great force.
- Oxygen manifolds should be grounded. Static discharges and lightning may ignite materials in an oxygen atmosphere, creating a fire or explosive force.
- Welding should not be performed near nitrous oxide piping. Excessive heat may cause the gas to dissociate, creating and explosive force.

WARRANTY

All Western manifolds are warranted against defects in materials and workmanship for the period of one year from date of purchase. See back cover for details of limited warranty.

B20212 9906 ECN-9818

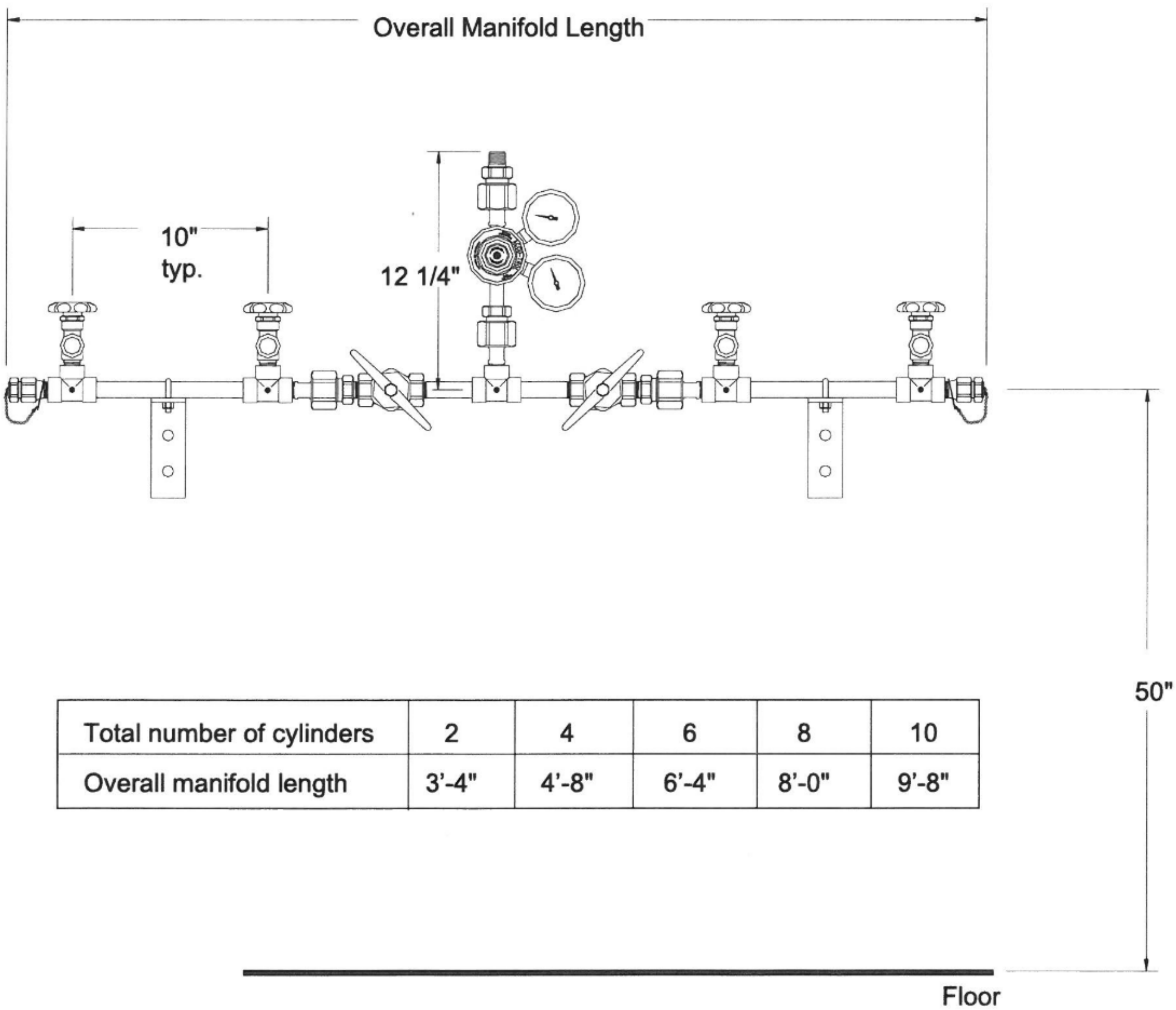
GENERAL INSTRUCTIONS

Manifolds should be installed in accordance with guidelines stated by the National Fire Protection Association, the Compressed Gas Association, OSHA, Canadian Standards Association, and all applicable local codes. The carbon dioxide and nitrous oxide manifolds should not be placed in a location where the temperature will exceed 120°F (49°C) or fall below 20°F (-7°C). The manifolds for all other gases should not be placed in a location where the temperature will exceed 120°F (49°C) or fall below 0°F (-18°C). A manifold placed in an open location should be protected against weather conditions. During winter, protect the manifold from ice and snow. In summer, shade the manifold and cylinders from continuous exposure to direct rays of the sun.

Leave all protective covers in place until their removal is required for installation. This precaution will keep moisture and debris from the piping interior, avoiding operational problems.

CAUTION:

- Remove all protective caps prior to assembly. The protective cap may ignite due to heat of recompression in an oxygen system.



Total number of cylinders	2	4	6	8	10
Overall manifold length	3'-4"	4'-8"	6'-4"	8'-0"	9'-8"

FIGURE 1

TABLE OF CONTENTS

MANIFOLD ASSEMBLY

1. Assemble the regulator to the control section (Figure 2).

2. Assemble the headers to the control section inlets as shown in Figure 2.

NOTE:
- For long headers it may be easier to mount the headers before assembling to the control section.

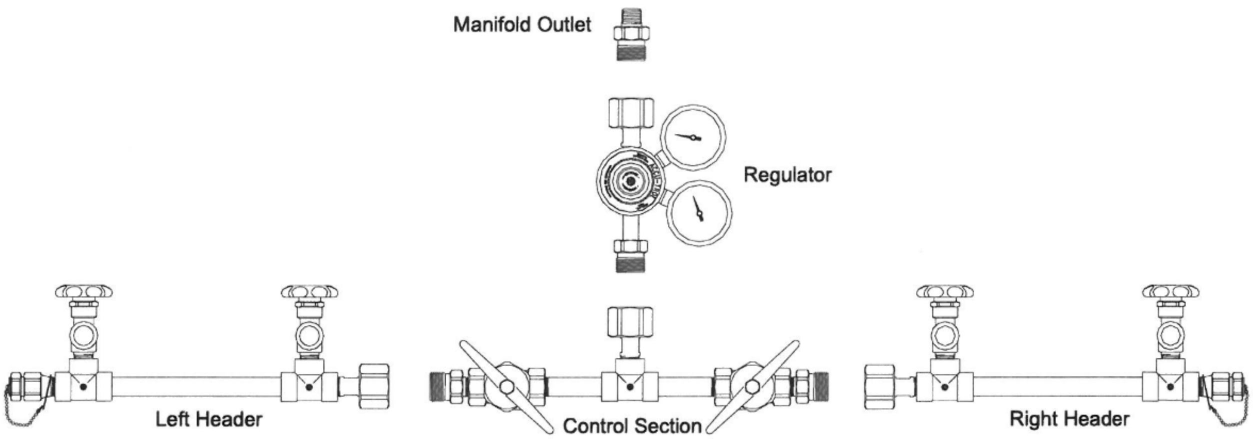


FIGURE 2

MANIFOLD INSTALLATION

1. Determine and mark the vertical center line for installation of the manifold (Figure 3).

2. Measure from the floor to a point 50" in height* of this vertical line. Using a level, mark a horizontal line at this point extending approximately 25" to the left and 25" to the right of center.

   (* — Suggested manifold height. Wall mounting heights may vary from one installation to another depending on available space, cylinder height, etc.)

3. Remove the U-bolt assemblies from the mounting brackets. Position the bracket so that the top of the bracket is aligned with the horizontal line.

4. Mark a distance of 17" to the right and left of the center line. Mark the mounting holes and install brackets using fasteners suitable for the type of wall construction. (Figure 4)

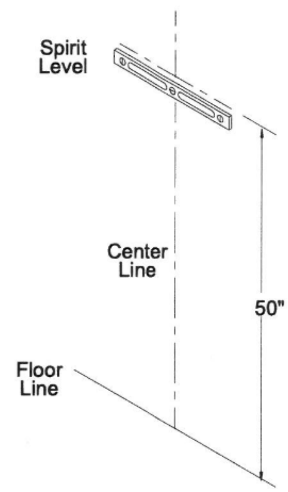


FIGURE 3

NOTE:
- Actual distance may vary, depending on configuration and the number of cylinders.

5. Mount the manifold by placing the header on the bracket. Fit the U-bolt over the header pipe and tighten the mounting nuts. (Figure 5)

6. Using a level, mark the placement of any additional mounting brackets while keeping the header on a horizontal plane. (Figure 5)

7. Remove the U-bolt assemblies from the header mounting brackets. Position the brackets so that the top of the bracket is aligned with the bottom of the headers. Brackets should be equally spaced to provide the most support and stability.

8. Mark the mounting hole and install fasteners suitable for type of wall construction. (Figure 4)

9. Fit the U-bolt over the header piping and tighten the two mounting nuts.

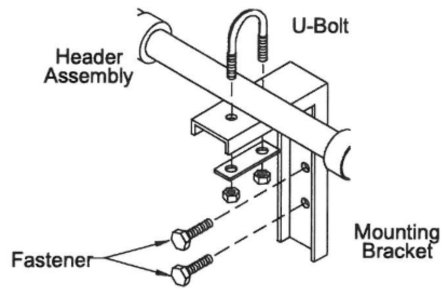


FIGURE 4

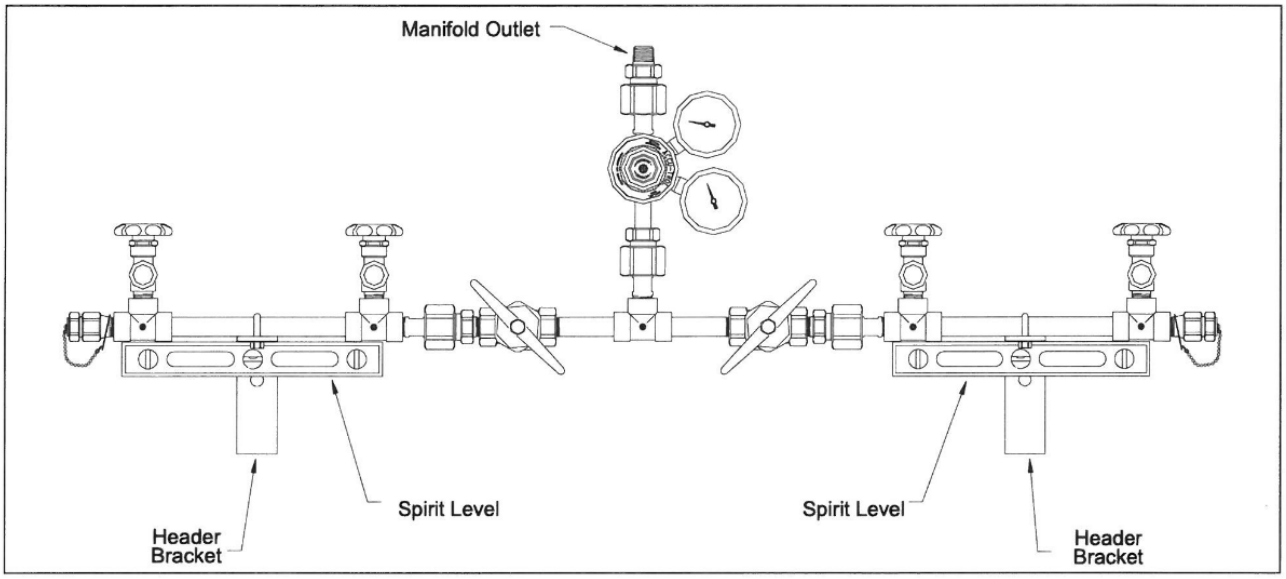


FIGURE 5

PLUMBING

1. A 1/2" NPT male union is supplied with the control and is located at the upper most part of the manifold control. Connect this union to the pipeline system. Sweat joints must be silver soldered. Use BAg series silver solder (DO NOT USE SOFT SOLDER). Heat the entire joint evenly. Apply enough heat favoring heavy sections, so that solder flows freely around the joint leaving no pin holes. The piping shall be purged during the brazing process. (Purging will prevent scale from forming on the inside of the piping during the brazing process). The union provided permits removal of the manifold control for service. (Figure 6)

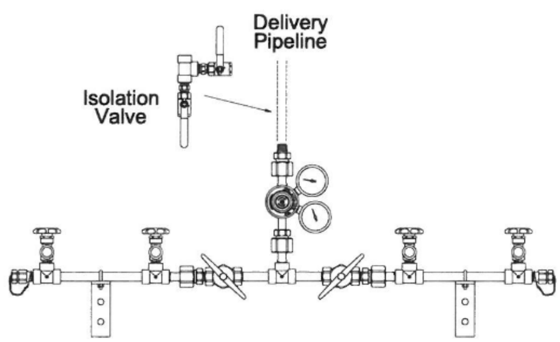


FIGURE 6

CAUTION:

- Brazed piping shall be properly cleaned for the intended gas service. Unclean piping may react and ignite when in contact with some gases - particularly oxygen and nitrous oxide.

2. The piping for oxygen systems should be cleaned for oxygen service prior to connecting oxygen cylinders.

3. If the manifold is installed in a closed area, vent piping should be attached to relief valves.

4. Installation of a shut-off valve to isolate the pipeline during service to the manifold is recommended. (Figure 6)

FUEL GAS MANIFOLDS — FLASHBACK ARRESTORS

GENERAL

A dry flash arrestor is provided with all Western acetylene manifolds. A flash arrestor shall also be used on all fuel gas manifolds (not provided with manifold) used in applications with oxygen. Installed in the main gas line or at the head of each branch line, the arrestor protects the main gas supply from the dangers of reverse flow and flashbacks. The safety relief valve is installed on the outlet side of the flash arrestor. Should excessive pressure occur, the gas is then vented out and away to a safe location.

OPERATION

In normal flow, as shown (figure 7), the flexible sleeve is not in contact with the mandrel. If back pressure occurs, the ball check closes and the sleeve is forced tightly against the ridges on the mandrel, creating what is in effect, a "multi-chamber" barrier. This effectively checks backflow and flashback. The excess pressure is vented through the relief valve.

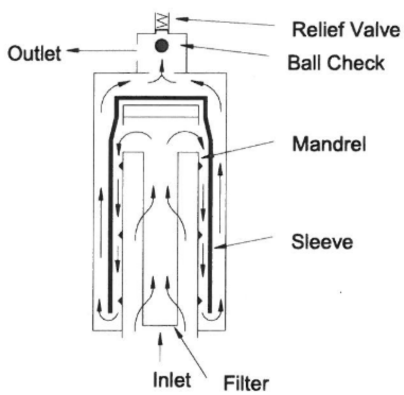


FIGURE 7

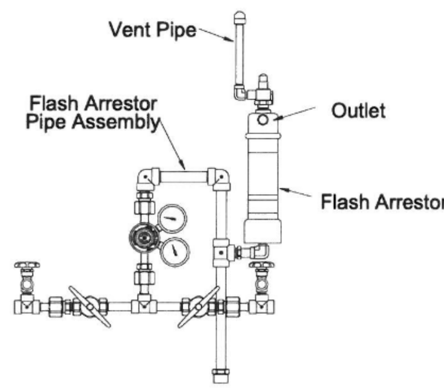


FIGURE 8

FLASH ARRESTOR INSTALLATION

1. Install the flash arrestor to the supplied flash arrestor piping using an approved pipe sealant.
2. Secure the flash arrestor pipe assembly to the manifold outlet (figure 15).
3. The vent piping must be galvanized and have galvanized fittings. It must be at least 3/4 inch pipe size. A 3/4 inch street elbow should be used to connect the vent pipe to the outlet on the side of the relief valve. The vent pipe must extend to the outside of the building and terminate not less than 12 ft. above the ground, remote from any windows or openings in the building, and as far as possible from sources of ignition such as flues or chimneys. Its end must be fitted with a return bend or elbow opening downward, preferably screened to prevent obstruction. The vent pipe must be installed without traps. The vent pipes from two or more back pressure check valves supplied through a common branch of the supply line may be connected to a common vent pipe header.
4. The piping from the "outlet" of the flash arrestor to the distribution system can now be completed. (The National Fire protection Association in its bulletin, NFPA #51 outlines standards for the installation and operation of oxygen/fuel gas systems for welding and cutting.)

TEST FOR LEAKS

1. Connect a torch to the service outlet of the flash arrestor.
2. Close the torch valves.
3. Be sure there is normal operating pressure in the supply line.
4. Open the station shut off valve.
5. Test for leaks around the flash arrestor joints and also the joints in the supply line. Use Westerns leak test solution LT-100 or soapy water to test for leaks. **Never test for leaks with an open flame.**
6. Eliminate all leaks before equipment at the station is used.

MAINTENANCE

1. Periodically, lift the lever on the side of the relief valve slowly and release gas only for an instant. Allow the valve to close on its own spring force. This will assure that the valve is not sticking and will operate properly in case of excess pressure.

2. Check all joints and connections for leakage periodically with leak test solution or any other solution suitable for oxygen service. Also apply a film of the leak solution over the opening of the outlet. Bubbling of the solution will indicate leakage. Do not continue operating until leakage is corrected. If leakage was noted around valve joints or at the outlet, the o-rings in the relief valve should be replaced.

INSTALLING PIGTAILS AND ATTACHING CYLINDERS

1. Establish the flow direction of the check valves in the pigtails.

2. Connect the pigtails to the header valves with the flow direction of the check valve from the cylinder to the header end of the pigtails.

> **NOTE:**
> - If pigtails are installed backwards, gas will not flow from the cylinders.
> - Oxygen and medical mixture (CGA 280) manifolds do not incorporate header valves. Manifolds without header valves are constructed using check valve outlet bushings.

3. Check the master valves to be certain they are closed.

4. Attach full cylinders to the pigtail connections as explained in "Cylinder Replacement & Handling" on page 10.

5. Open header valves (turn counter-clockwise to open).

6. S-L-O-W-L-Y open all cylinders fully (turn counter-clockwise to open). Check all cylinder and pigtail connections for leaks using Western leak detector LT-100 or an oxygen safe solution. (Any bubbles around connections indicate leakage.)

7. Back out the regulator adjusting knob. This will prevent the downstream system from being over-pressurized when opening cylinders.

8. S-L-O-W-L-Y open the master valve on the bank that is to be in service. (turn counter-clockwise to open).

9. Adjust the regulator to deliver the desired line pressure.

START UP AND CHECKING PROCEDURES

The MD series manifold is designed to provide an increased supply of gas as well as higher flow rates than can be achieved using a single cylinder.

1. S-L-O-W-L-Y open the master valve (turn counter-clockwise to open). The high pressure gauge will show the pressure of the bank of cylinders. (Figure 9)

2. Adjust the delivery pressure of the regulator to the desired pressure. The selection of the regulator set pressure may vary due to application requirements. If a pressure setting less than 20 psig is required then a line regulator must be installed at the manifold outlet.

3. Simulate a depleted bank by closing the right valve and creating a flow of gas through the manifold. The pressure readings on the gauges will drop. Any alarms connected to the system monitoring bank pressure will activate.

4. S-L-O-W-L-Y open the master valve (turn counter-clockwise to open) on the service bank.

5. The manifold is now ready to supply your system.

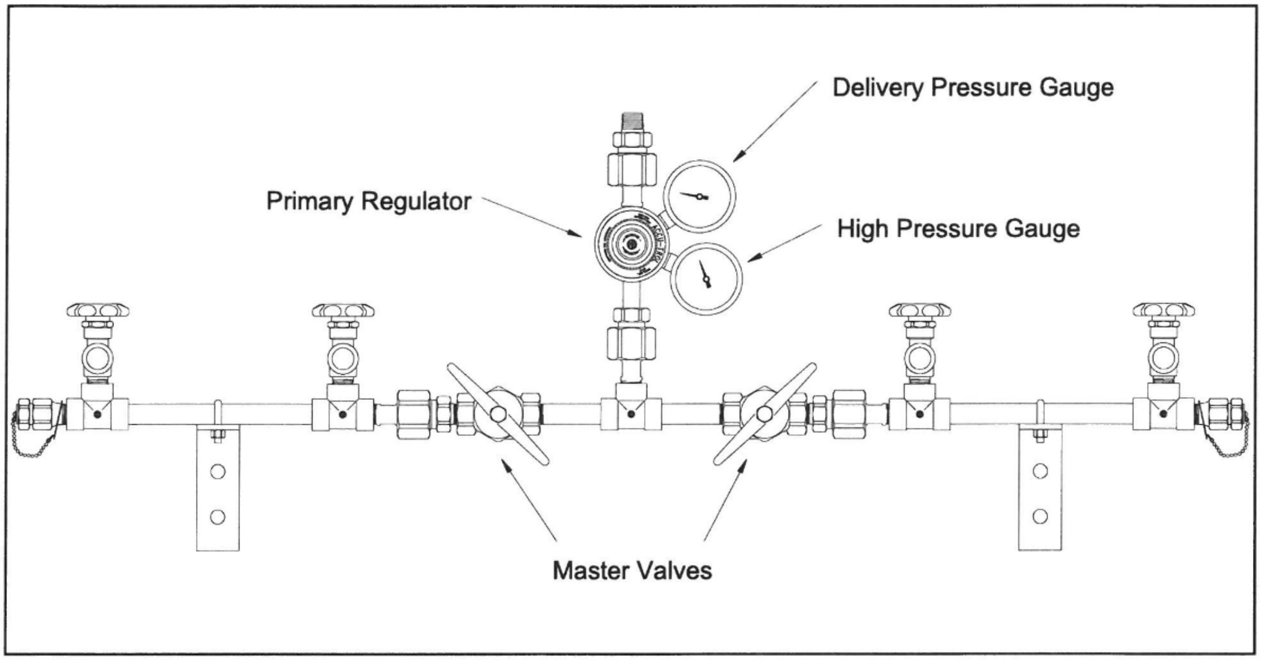


FIGURE 9

MANIFOLD OPERATION

The manifold control includes the following components and features: regulator, flexible stainless steel braided pigtails with check valves, and headers designed to be easily expanded. The manifold is designed to use a line regulator (optional item) which can be mounted on the manifold outlet for delivery pressures less than 20 psig.

Gas flows through the header into the master shut off valve. The gas flows through the open valve to the regulator and then through the line regulator (if installed). Final delivery pressure is controlled by the either the line regulator or by the manifold regulator should the application not require a line regulator. (A line regulator is not provided with the manifold.)

As cylinders deplete the high pressure gauge on the regulator along with any alarm systems installed will indicate that the bank of cylinders should be changed. Just before the supply bank goes empty the master valve on the reserve bank should be S-L-O-W-L-Y opened. This will ensure that the delivery of gas to the application is not interrupted.

Prior to replacing empty cylinders, close the master valve. This will hold your fresh cylinders in reserve until they are needed.

To insure proper operation, observe the following guidelines:

1. Carefully follow all instructions.
2. Establish proper flow direction of check valves.
3. Be sure the header master shut-off valve is fully opened.
4. Be sure cylinder valves are fully opened.
5. Replace empty cylinders as soon as practical after the manifold has depleted.

CYLINDER REPLACEMENT & HANDLING

1. Shut off all cylinder valves and header valves as well as the master valve on the bank with the depleted cylinders.
2. S-L-O-W-L-Y loosen and remove the pigtail connection from the depleted cylinders.
3. Remove depleted cylinders and replace protective caps.
4. Remove protective cylinder caps from full replacement cylinders. With the valve outlet pointed away from you or anyone else, slowly open each cylinder valve slightly to blow out any dirt or contaminants which may have become lodged into the cylinder valve.
5. Place and secure full cylinders into position using chains, belts, or cylinder stands.
6. Connect pigtails to cylinder valves and tighten with wrench.
7. S-L-O-W-L-Y turn each cylinder valve until each cylinder is fully on.
8. The manifold supply bank is now replenished and is being held in reserve. This bank may be put in service by S-L-O-W-L-Y opening the master valve by following instructions on page 7 (START UP AND CHECKING PROCEDURES).

GENERAL MAINTENANCE

1. Main section
   a) Daily - record line pressure.
   b) Monthly
      1) Check regulators and valves for external leakage.
      2) Check valves for closure ability.
   c) Annually - check relief valve pressures.
      - check regulators for crawl (inability to maintain a set delivery pressure).

2. Manifold header
   a) Daily - observe nitrous oxide and carbon dioxide systems for cylinder frosting or surface condensation. Should excessive condensation or frosting occur it may be necessary to increase manifold capacity.
   b) Monthly
      1) Inspect valves for proper closure.
      2) Check cylinder pigtails for cleanliness, flexibility, wear, leakage, and thread damage. Replace damaged pigtails immediately.
      3) Inspect pigtail check valves for closure ability.
   c) Every 4 Years
      1) Replace all pigtails.

TROUBLE-SHOOTING (Only qualified repair personnel should make repairs)

SYMPTOM	PROBABLE CAUSE	REMEDY OR CHECK
SYSTEM DEPLETES PREMATURELY		
Alarms signaling less of line pressure and system has not depleted.	The pressure setting of the pressure switch is too close to the regulator setting.	Increase the pressure differential between the regulator and the pressure switch.
SYSTEM DOES NOT FLOW		
Manifold does not flow and delivery gauges drop to 0.	Master valves closed.	Open master valves.
	Pigtails installed backwards.	Reverse direction of pigtails.
LOSS OF CYLINDER CONTENTS		
Audible or inaudible gas leakage (unknown origin).	Leakage at manifold piping connections.	Tighten, reseal or replace.
	Leakage in downstream piping system.	Repair as necessary.
	Leakage at cylinder valve.	Replace cylinder.
	Gauge leaks.	Reseal or replace.
	Regulator leaks.	Repair or replace.
Venting at relief valve. (optional item)	Regulator setting too high.	Set delivery pressure to specifications.
	Over pressure due to creeping or faulty regulation by regulator.	Replace regulator seat and nozzle components.
	Over pressure due to creeping or faulty regulation by line regulator.	Replace regulator seat and nozzle components.
	Regulator freeze-up. (Nitrous oxide or carbon dioxide)	Reduce the flow demand or increase the number of supply cylinders.
Gas leakage around regulator body or bonnet.	Loose bonnet.	Tighten bonnet.
	Diaphragm leak on regulator.	Replace diaphragm.

MANIFOLD MAINTENANCE & REPAIR PARTS

NOTE:

- Western manifold systems are designed and tested for optimal performance and adherence to safety specifications. We recomend the use of Western components to maintain the standards of performance and the safety of the product.

REPLACEMENT PIGTAILS

24" Stainless Steel Flexible Braid with Check Valves

PF-16CVFA-24R .... CGA 300 with flash arrestor for Acetylene Service
PF-320CV-24R .... CGA 320 for Carbon Dioxide (CO_2) Service
PF-326CV-24R .... CGA 326 for Nitrous Oxide (N_2O) Service
PF-83CV-24R .... CGA 350 (Except Hydrogen Service)
PF-15CVFA-24R .... CGA 510 with flash arrestor for Acetylene Service
PF-15CV-24R .... CGA 510 for Liquid Fuel Gas Service
PF-63CV-24 .... CGA 540 for Oxygen (O_2) Service
PF-92CV-24R .... CGA 580 for Nitrogen (N_2) Service
PF-93CV-24R .... CGA 590 for Industrial Air Service
PF-83CV-24RV .... CGA 350 for Argon/Methane Mixture Service

24" Synthetic Fiber Braid Hose with Check Valve

PFS-83CV-24R .... CGA 350 for Hydrogen Service
PFS-92CV-24R .... CGA 580 for Helium (He) Service

REGULATOR GAUGES — 2 " Diameter, 1/4" NPT Bottom mount

G-25-200W .... 200 psi
G-25-4000W .... 4000 psi
G-25-30RLW 15 psi
G-25-600W 600 psi

REGULATORS AND REGULATOR REPAIR KITS

RM-1-1 .... Regulator for acetylene
RM-2-4 .... Regulator for air
RM-4-4 .... Regulator for CO_2
RM-7-4 .... Regulator for all inert gases (Nitrogen, Helium, and argon)
RM-7A-4 .... Regulator for O/P Nitrogen
RM-8-4 .... Regulator for N_2O
RDM-9-4 .... Regulator for oxygen
RM-10-2 .... Regulator for air
RDM-11-4 .... Regulator for Medical Gas Mixtures
RS-300-MAN .... Regulator for MDHP (Air, Argon, CO_2, Helium, Nitrogen and N_2O)

RWC-3-59 .... Regulator replacement cartridge for RM-1-1 and RM-10-2
RWC-3-49 .... Regulator replacement cartridge for RM-2-4, RM-4-4, RM-7-4, RM-8-4 and RM-7A-4
RWD-2-19 .... 1st stage regulator replacement cartridge for RDM-9-4 and RDM-11-4
RWD-2-36 .... 2nd stage regulator replacement cartridge for RDM-9-4 and RDM-11-4
RK-1020 .... Repair Kit for RS-300-MAN

VALVES AND VALVE REPAIR KITS

WMS-1-53 .... CGA 540 Check Valve Outlet
WMV-2-16 .... Master Valve
RK-1085 .... Repair Kit for WMV-2-16 (430B & C)
WMV-2-31 .... CGA 300 Header Valve
WMV-2-30 .... CGA 510 Header Valve
WMS-1-64 .... CGA 280 Check Valve Outlet
WMV-2-14 .... CGA 326 Header Valve
WMV-2-4 .... CGA 346 Header Valve
WMV-2-3 .... CGA 580 Header Valve
WMV-2-7 .... CGA 320 Header Valve
WMV-2-19 .... CGA 350 Header Valve
WMV-2-32 .... CGA 590 Header Valve

LIMITED WARRANTY

WARRANTY: The Seller expressly warrants that the products manufactured by it will be free from defects in material, workmanship and title at the date of shipment. This Warranty is exclusive and is IN LIEU OF ALL IMPLIED OR STATUTORY WARRANTIES (INCLUDING WITHOUT LIMITATION, WARRANTIES AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR ARISING FROM COURSE OF DEALING OF USAGE OR TRADE) or any other express or implied warranties or representations. All claims under this warranty must be made in writing and delivered to the Seller prior to the expiration of 1 year from the date of shipment from the factory, or be barred. Upon receipt of a timely claim, the Seller shall inspect the item or items claimed to be defective, and Seller shall, at its option, modify, repair, or replace free of charge, any item or items which the Seller determines to have been defective at the time of shipment from the factory, excluding normal wear and tear. Inspection may be performed at the Seller's plant and in such event, freight for returning items to the plant shall be paid by Buyer. Seller shall have no responsibility if such item has been improperly stored, installed, operated, maintained, modified and/or repaired by an organization other than the Seller. adjustments for products not manufactured by Seller shall be made to the extent of any warranty of the manufacturer or supplier thereof. The foregoing shall be the Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for any breach of warranty or for any other claim based on any defect in, or non-performance of, the products whether based on breach of contract or in tort, including negligence or strict liability.

WESTERN INNOVATOR

875 Bassett Road
Westlake, Ohio 44145-1142
(800) 783-7890
FAX: (440) 835-8283

INDUSTRIAL REGULATORS

RS SERIES MEDIUM DUTY, SINGLE STAGE REGULATORS

The RS Series of Medium Duty, Single Stage regulators are the industry standard for applications that require consistent delivery pressure, at high flow rates, over a wide range of inlet pressures. This series of regulators are appropriate for industrial / welding, laboratory and general use applications. Certain models feature a ¼" NPT F outlet for high pressure applications.

- Machined brass body resists corrosion and extends service life
- Nickel chrome plated zinc bonnet
- Durable 2" neoprene diaphragm to maintain consistent delivery pressure
- Dual inlet filters extends regulator service life
- 2" dual scale gauges
- Most models incorporate a self re-seating pressure relief valve
- 450 PSIG models incorporate PCTFE seats
- Three year warranty
- Made in the USA

RS-2-4

MODEL	CGA INLET GAS SERVICE	DELIVERY CAPACITY (PSIG)	FLOW CAPACITY (SCFH)	INLET PRESSURE (PSIG)	OUTLET
RS-1-1*	510 Acetylene	0-15	420	0-400	9/16"-18 LHM
RS-1A-1*	300 Acetylene	0-15	420	0-400	9/16"-18 LHM
RS-2-4	346 Air	0-180	6500	0-3000	¼" NPT F
RS-2-5	346 Air	0-450	10,000	0-3000	¼" NPT F
RS-4-4	320 Carbon Dioxide	0-180	5000	0-3000	9/16"-18 RHM
RS-7-3	580 Inert	0-80	3430	0-3000	9/16"-18 RHM
RS-7-4	580 Inert	0-180	7570	0-3000	9/16"-18 RHM
RS-7-5	580 Inert	0-450	8500	0-3000	¼" NPT F
RS-9-3	540 Oxygen	0-80	3230	0-3000	9/16"-18 RHM
RS-9-4	540 Oxygen	0-180	7100	0-3000	9/16"-18 RHM
RS-9-5	540 Oxygen	0-450	7900	0-3000	¼" NPT F

* Non self re-seating pressure relief valves

Made In The U.S.A.
For more information, call Western Customer Service at **1-800-783-7890**

Appendix A8

HOW TO OPERATE MBI WELLS

APPENDIX A8

How to Operate an MBI Well

Background

All MBI wells are equipped with Baski down-well flow control valves similar to Talbert Barrier "Modern" injection wells and therefore, MBI wells and Modern Talbert Barrier Wells operate the same. These Baski Valves allow the IRSO to start, stop and change flow remotely using the Delta V process control system software. This section describes MBI well operation using Delta V.

Definitions

a. FV7070: Well Flow Baski Valve. The water flow to each well is controlled by the inflation level of the Baski Valve. Nitrogen gas (N_2) is increased to the valve to reduce flow into the well while releasing gas from the valve will allow more water into the well, thus deflating the gland.

b. FV3400: Control tab that allows high and low flow setpoints and sets the maximum water level rise inside the casing during injection.

c. Pulse: Set time (in seconds) that the FV7070 (Baski Valve) will OPEN or CLOSE per Cycle.

d. Cycle: Set time (in seconds) before next Pulse OPEN or CLOSED of Baski Valve (FV7070)

e. Normal: One of two timer modes for FV7070 (Baski Valve) operation. This mode is more conservative and will result in smaller changes in rate with longer periods of time between changes. Normal is used when well is at setpoint – idle.

f. Rapid: One of two timer modes for FV7070 (Baski Valve) operation. This mode will be for shutting off the well quickly and also for restarting a well. Delta V will go into Rapid mode if loss of, level, pressure or flow information.

g. Baski: MBI wells are equipped with this type of valve. N_2 gas is used to control the well flow by changing the inflation level of the valve.

Baski Valve Start Procedure

1. Select the Baski Well to be started.
2. In Delta V navigate to and select the desired well and open the Detail Faceplate for FV7070 ("Detail"). Under the Timers section: Change the **Normal Pulse to 10 seconds** and the **Normal Cycle to 30 seconds**.
3. Reset "First Out" alarm on Detail Faceplate (typ. "MOV Not Open")
4. Change the Well Control Mode from OFF to FLOW_LEVEL. A red banner will appear on the lower portion of the screen.
5. Select "Confirm".

6. Delta V will now send a series of commands to the well to fill the drop pipe of the well before allowing the Baski Valve to Open.
   Steps:

   a. The MOV will crack open (appears on screen as light blue color)

   b. The MOV opens fully after the water flow drops below a pre-set value to ensure the drop pipe is full (Air has been removed from the line)

   c. A wait period will pass as the MOV valve opens

   d. FV7070 will now begin the pulse open cycles.

   The current step will be described in the "Info" section of the control banner at the bottom of the screen.

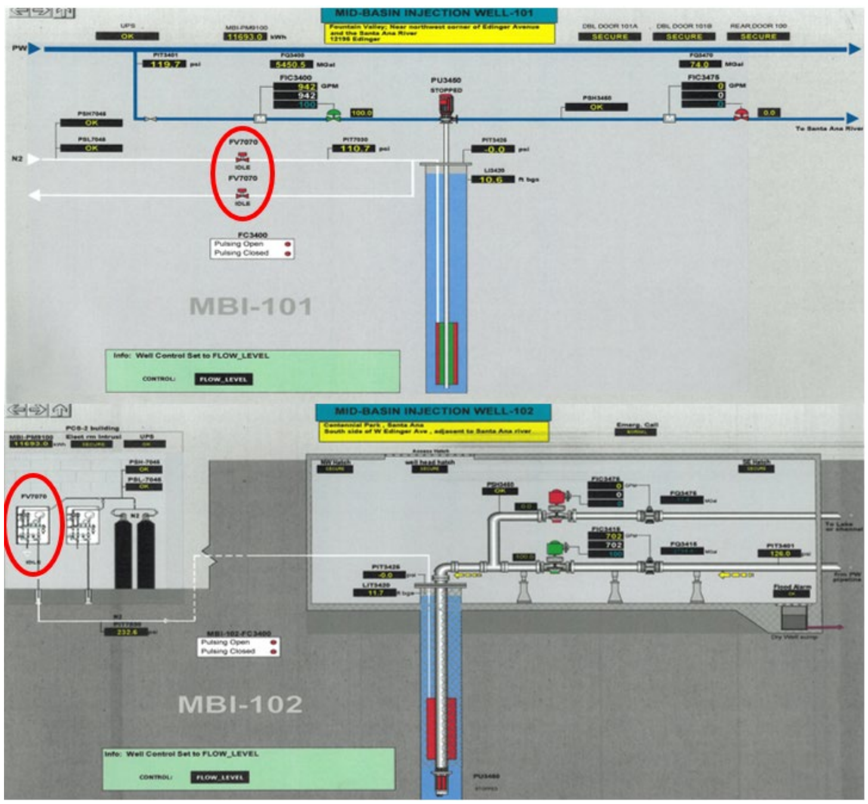
   Note: *It can take several minutes for the well to register flow.*

   If the well fails ("Sequence Failure"), the well should be re-started (click "OK"). Increase pulse timer to get Baski Valve to open sooner so it doesn't time out (15 or 20 seconds). If the failure repeats try a faster setting – 15/30, the well can time out. If the well still fails switch the well to "OFF".

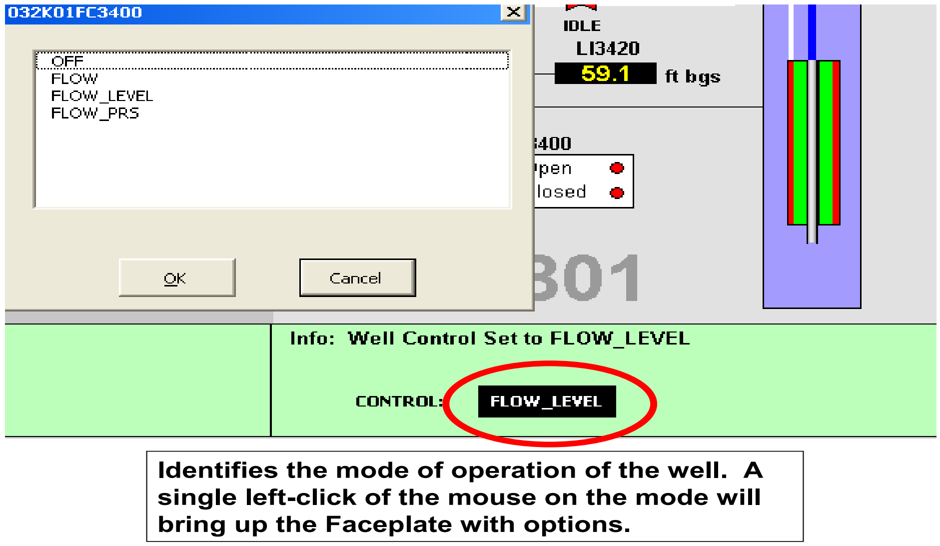
7. When the FC3400 banner no longer shows the green circle next to Pulse Open and/or FV7070 is "idle", the timers should be returned to their original settings (typically a 1 second normal pulse with 30 sec normal cycle at MBI-1. Because of the long tubing runs from the shared structure MBI-2, MBI-3, MBI-4 and MBI-5 a 2 second normal pulse with 120 second normal cycle is used).

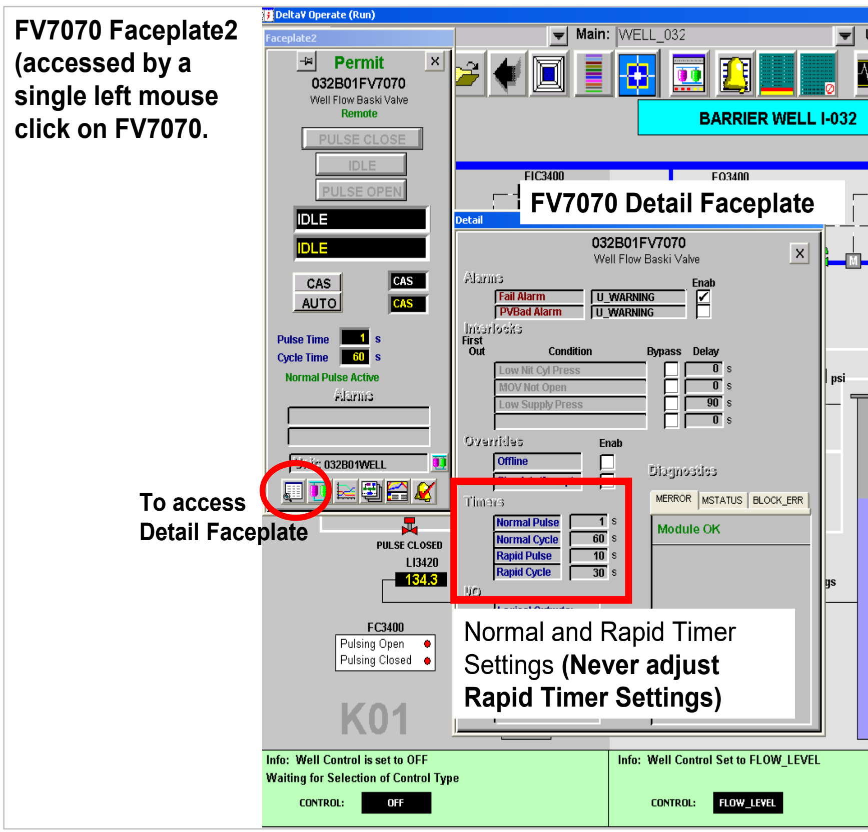
How to stop MBI Well flow

- Navigate to the desired well in Delta V
- Notice the green banner at the bottom of the page
- Within the green banner locate the black box click on black box and select “off”
- Hit “ok”
- Click on FV7070, faceplate will populate
- In lower left-hand corner select the “details” icon (full bottom, full left)
- Change timers to 10 / 30 (or select the rapid button for 10/30).
- At this point the well is off-line and ready to be restarted with the correct timer setting



MBI-1 and Centennial Park (MBI-2) Delta V control screen. The MBI-1 screen and the Centennial Park Wells screen is slightly different. Faceplate FV 7070 is shown inside the red oval. MBI-1 is injecting 942 GPM and MBI-2 is injecting 702 GPM. this


032K01FC3400
OFF
FLOW
FLOW_LEVEL
FLOW_PRS
OK
Cancel
IDLE
LI3420
59.1
ft bgs
Info: Well Control Set to FLOW_LEVEL
CONTROL:
FLOW_LEVEL
Identifies the mode of operation of the well. A single left-click of the mouse on the mode will bring up the Faceplate with options.


FV7070 Faceplate2 (accessed by a single left mouse click on FV7070.
To access Detail Faceplate
FV7070 Detail Faceplate
BARRIER WELL I-032
032B01FV7070
Well Flow Baski Valve
Normal and Rapid Timer Settings (Never adjust Rapid Timer Settings)
Info: Well Control is set to OFF
Waiting for Selection of Control Type
CONTROL: OFF
Info: Well Control Set to FLOW_LEVEL
CONTROL: FLOW_LEVEL

ORANGE COUNTY WATER District

INJECTION WELL DAILY LOG Plant set point

Date: BPS FLOW

Time: BPS PSI

Day:

time	M-26	HydroVu	WSE
	7.86		

	Well No.	Flow	FLOW SET POINTS		Current Water Level	High Set Point WL	Influent PSI	Inflation PSI	Timers	Flange Pressure	Flange PSI Set Pt.	RP
			Low	High								
	24F											23.95
	24K											23.99
	25F											23.66
LO	26H											29.32
	26L											29.29
	26K											29.34
	27H											14.33
	27A											14.29
LO	27K											14.26
LO	28H											13.48
LO	28A											13.55
	28K											13.56
LO	29H											13.43
LO	29A											13.46
	29K											13.45
	30K											57.75
LC	30B											57.73
	30H											57.74
	31H											59.99
	31B											59.87
LO	31K											59.94
LO	32K											61.18
LO	32B											61.15
LC	32H											61.13
LO	33M											17.56
	34M											15.64
	35M											14.89
	36M											14.16
	SEB											
	EV											
	MBI-1											64.86
	MBI-2											45.72
	MBI-3											50.63
	MBI-4											48.95
	MBI-5											42.68
	EW-1											191.98

Notes:

How To Trend in Delta V

Trending Background

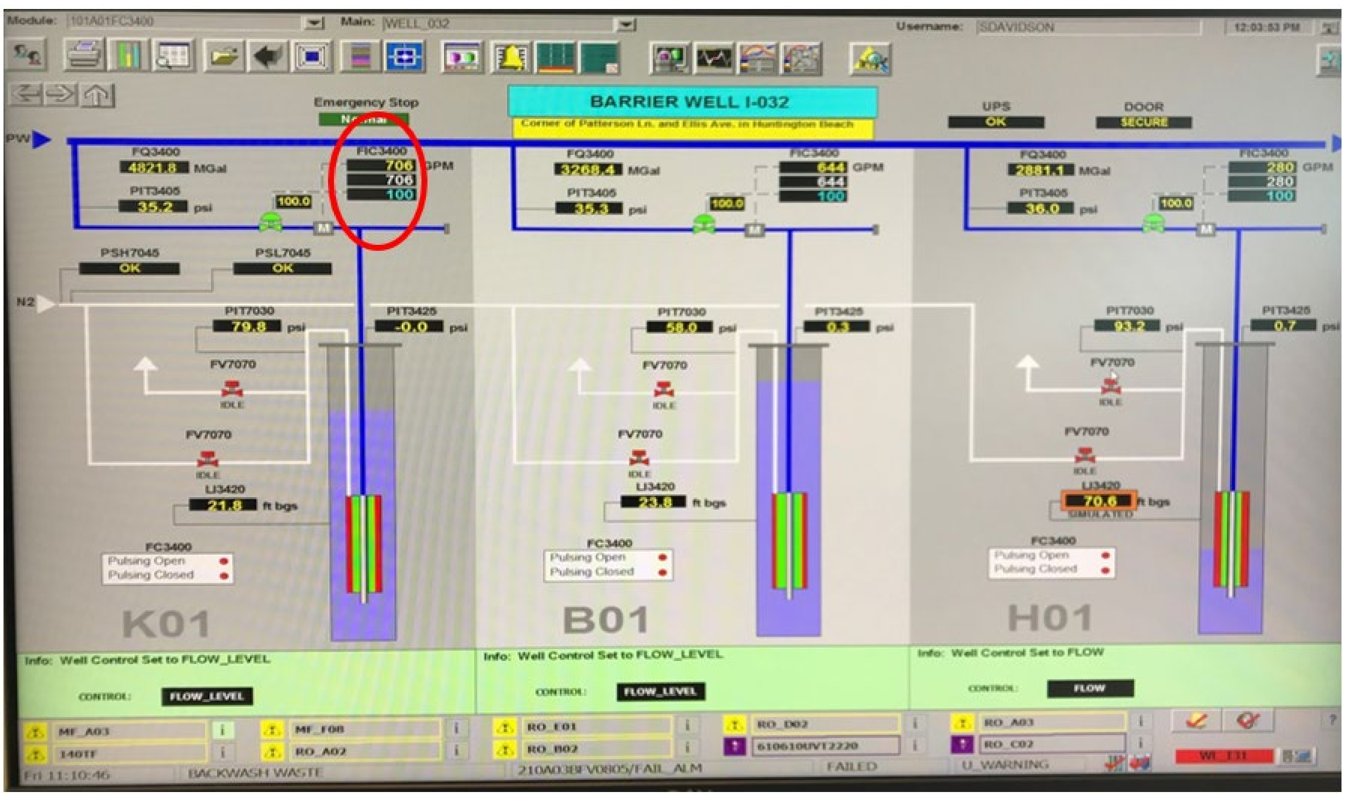
Sometimes it is important for the IRSO to look back in time and observe how certain injection parameters behave. Plotting a graphical representation over time is called trending. The process control software Delta V has a feature that allows the IRSO to trend many operational features including well flow, well level and well pressure.

This module provides procedures for basic trending. Advanced trending can be developed in-person with the IRSO's supervisor after the skills in this module have been mastered.

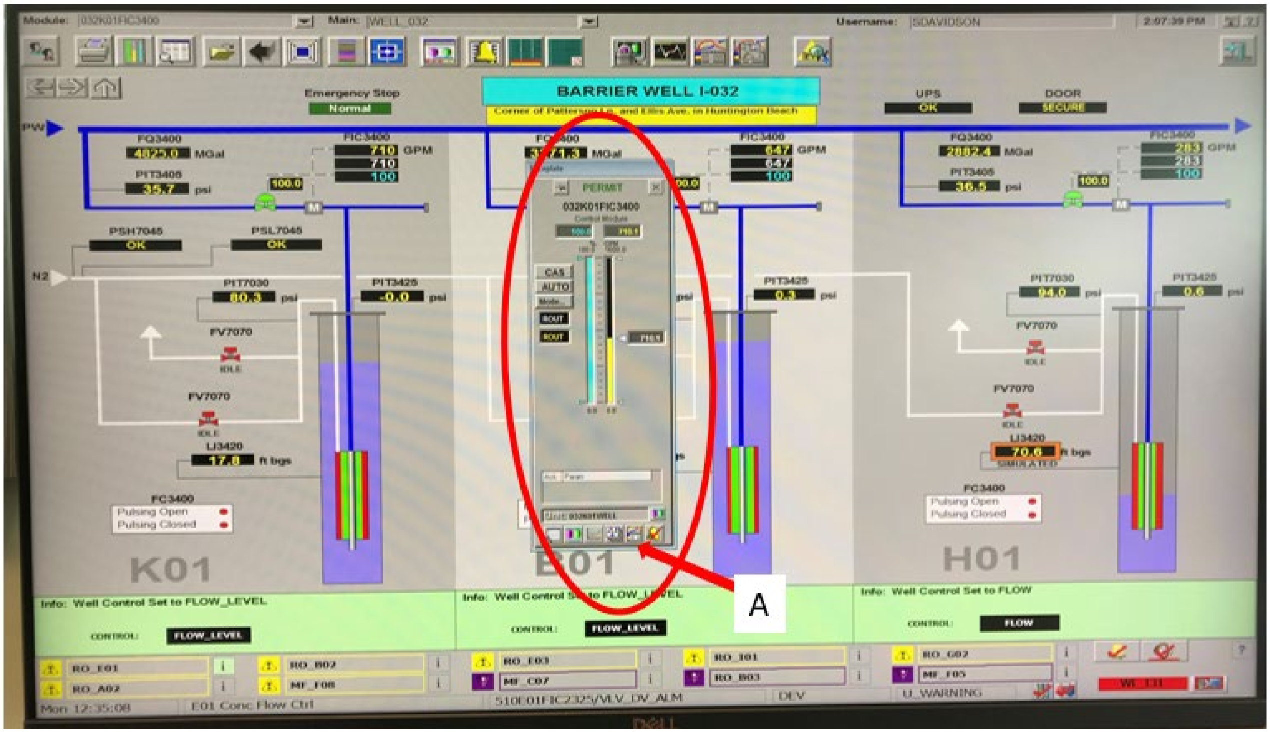
Trending Procedures

From the Delta V OCWD AWTF Control System Page, select the orange rectangle entitled "Area 001-036" and a map showing the location of all the Talbert Barrier Injection wells will appear. Select the well of interest.

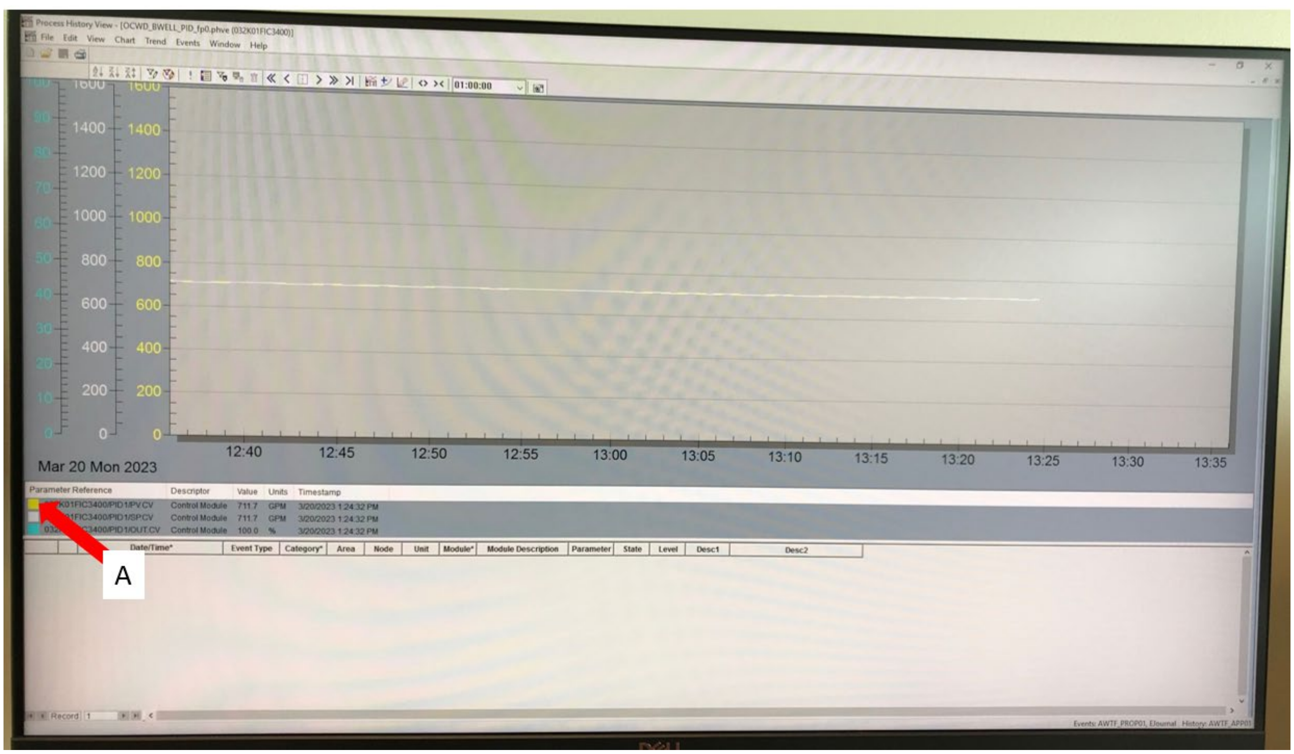
Many parameters can be trended. For this demonstration injection well flow will be used at injection well I-32 K as shown on the screen below. Locate and select the FIC 3400 GPM flow display box (red oval).



Once selected, the 032K01FIC3400 face plate will populate (red oval below). At the bottom of the face plate you will see 6 command icons. Select the icon that is second from the right end (process history view) as shown by the red arrow “**A**” below:

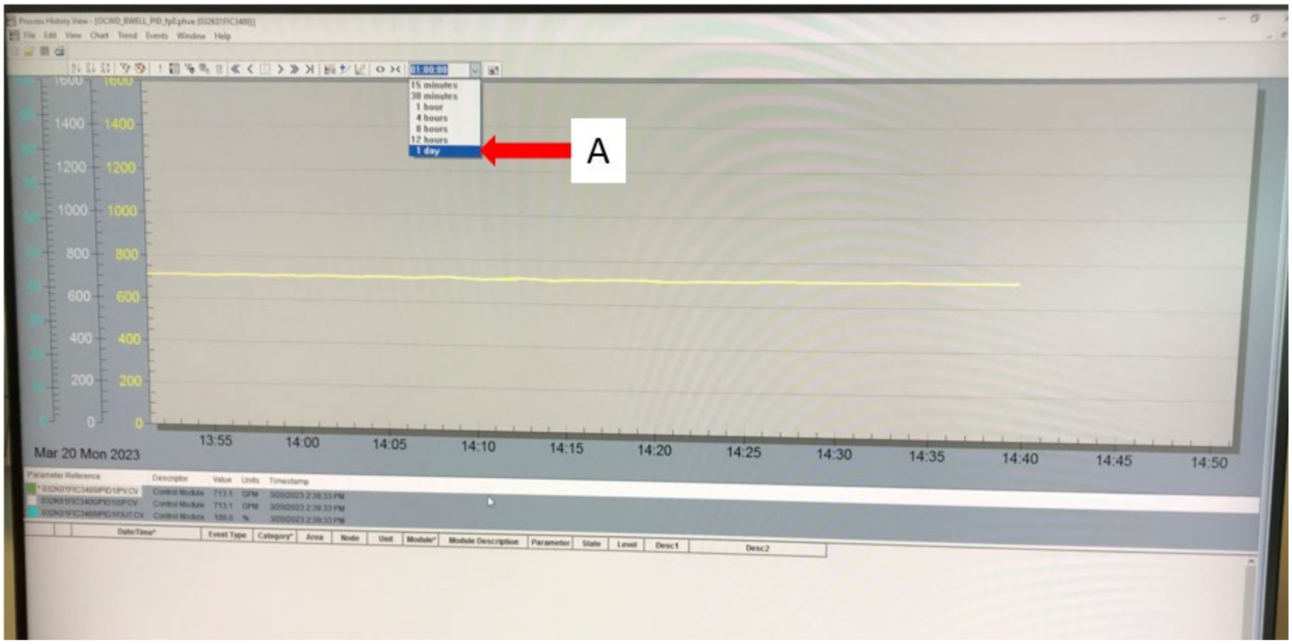


The following screen will appear:

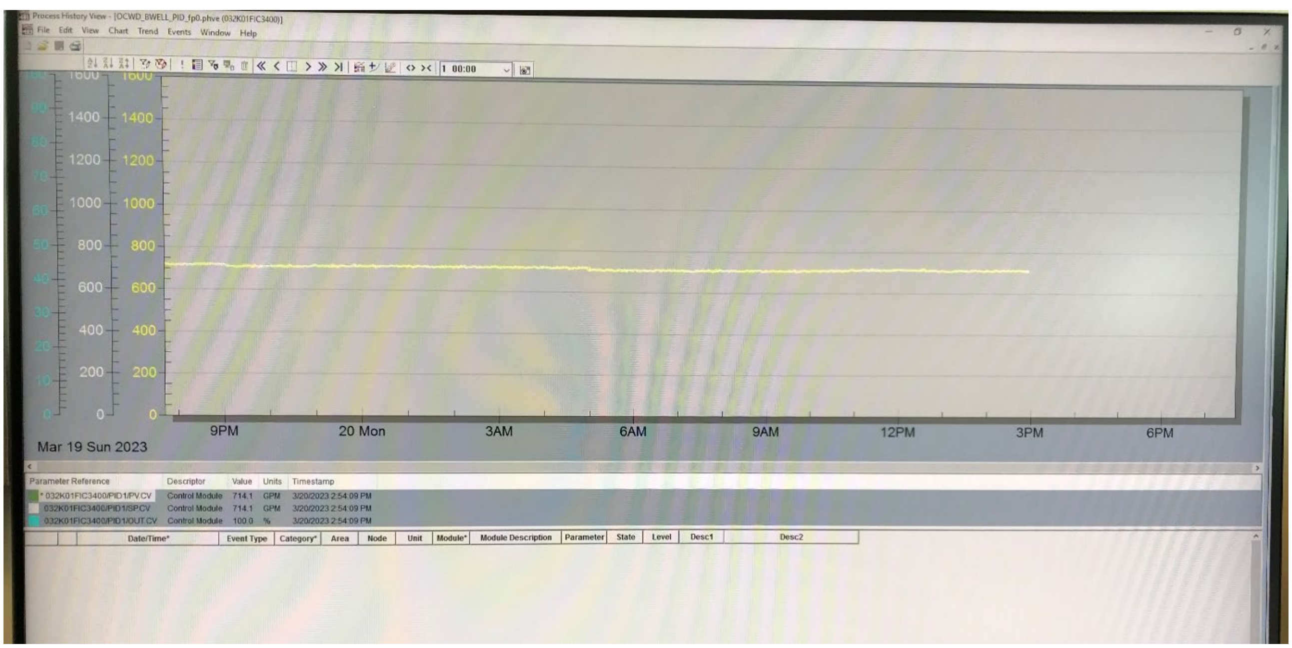


In the lower left-hand corner of the screen locate the 0302K01FIC3400/PID 1/PVCV information line and click as indicated with the red arrow “**A**”. This will darken the line in the graph so it can be seen easier.

Next select the time duration that you would like to trend by focusing on the top of the screen and locating the time duration pulldown menu. For this demonstration 1 day is selected as shown with red arrow "**A**".



Notice once "1 day" is selected the bottom axis (x-axis) shows the time increment of 24-hours as shown below. Also notice that the yellow trend line representing the I-32K flow rate stayed around 700 gpm for the 24-hour period indicating consistent injection during this time period.



We have just completed a trend of the I-32K injection flow rate for the 24-hour time period between 8:00pm March 19 and 8:00pm March 20, 2023.

Multiple parameters can be trended on one plot. For instructions on trending multiple parameters see your supervisor.

Appendix A9

MBI-1 BACKWASH PUMP MAINTENANCE PROCEDURE

APPENDIX A9

MBI-1 Backwash Pump Maintenance Procedure

Proper Pump Packing Installation

Remove all of the used pump packing rings and the lantern ring. Thoroughly clean and inspect the stuffing box.

- Replace worn shaft sleeve if needed.
- Coat each new packing ring with Pak-Lube®, Go-Jo or some type of liquid soap. Never use Anti-Seize or any metallic based compound on the pump packing!
- Stagger the joints of each packing ring 90 degrees, beginning at twelve o’clock, three o’clock, six o’clock, and then nine o’clock.

Install each packing ring individually, carefully seating each packing ring in the bottom of the stuffing box. Use a split bushing or a tamping tool. NEVER use a screwdriver or a sharp tool. It is important to seat the packing rings toward the bottom of the box because of radial expansion. (When the packing rings are properly seated, more packing rings in the set are used to create the seal, leading to longer packing life.)

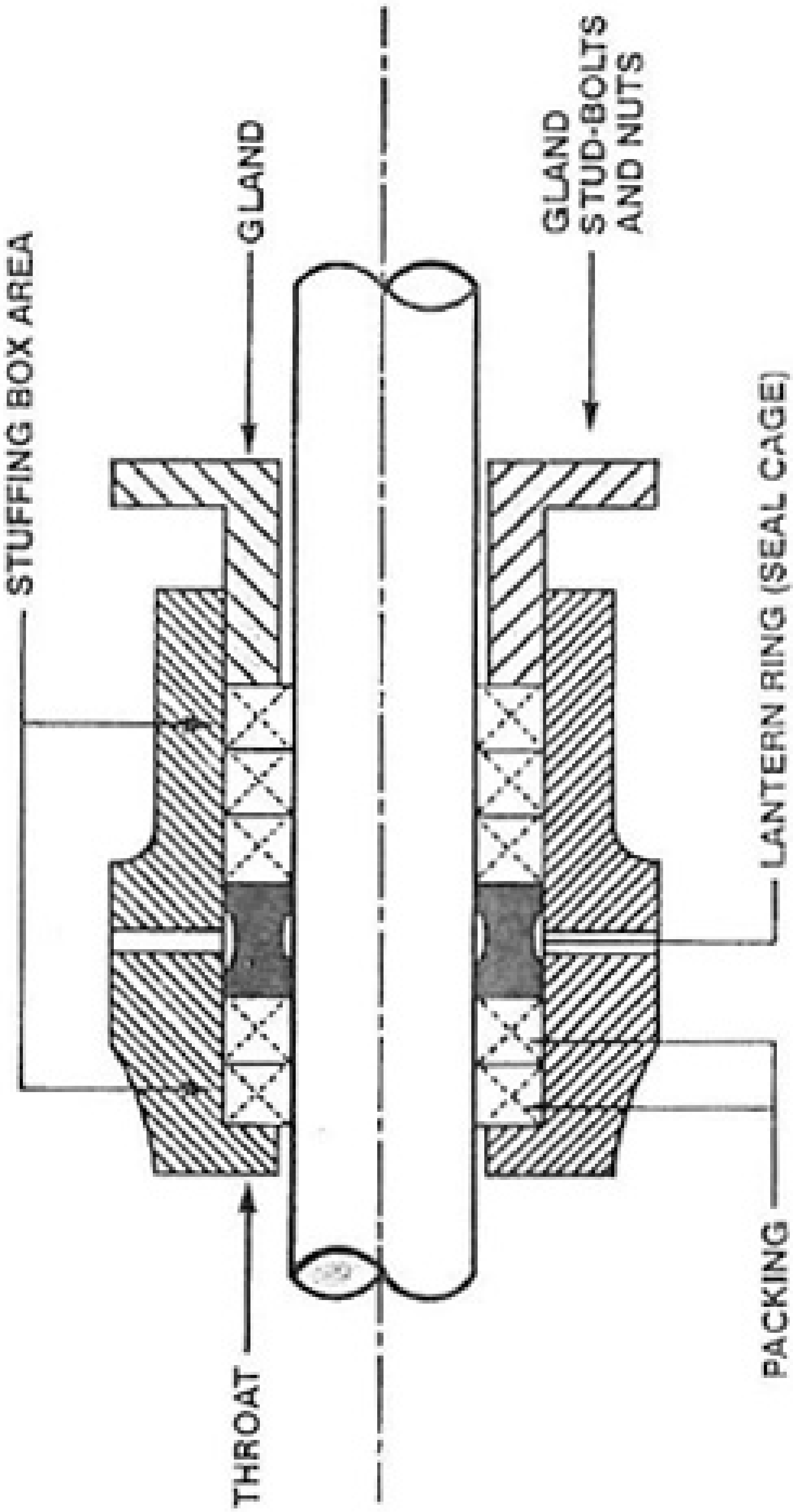
Make sure the lantern ring is properly located. This is done by inserting a small object through the flush port and feeling the lantern ring.

- After the proper amount of rings has been installed, install the gland follower and run the gland nuts up finger tight only.

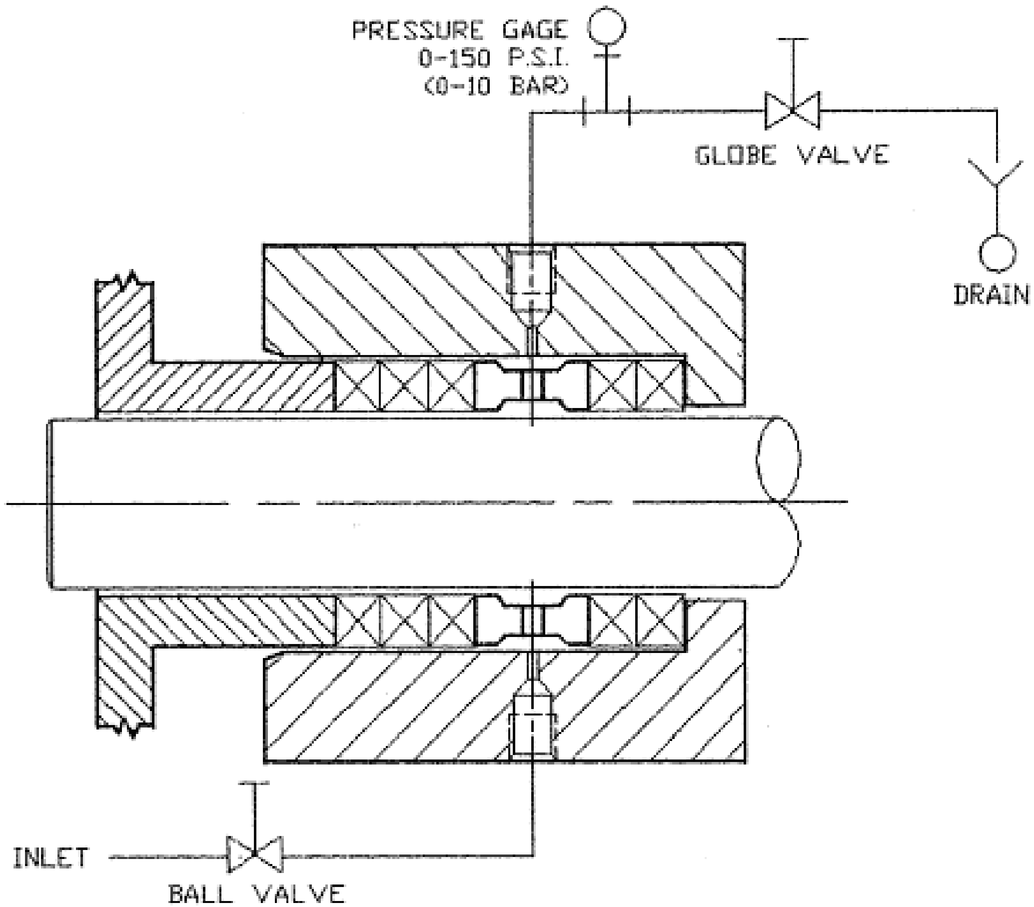
Install the proper flush set-up (see next page) and start flushing the stuffing box. It is important to start the flush before opening the suction and discharging the valves to the pump.

Start the pump and allow the packing to leak freely at start-up. During the break-in period, adjustments should be made gradually (one flat at a time), allowing 5 to 10 minutes between adjustments. Remember, extra consideration during break-in will result in longer packing life.

- After the break-in period, the leakage rate can be controlled to 10 to 12 drops per minute per inch of shaft sleeve diameter.


STUFFING BOX AREA
GLAND
GLAND STUD-BOLTS AND NUTS
LANTERN RING (SEAL CAGE)
PACKING
THROAT

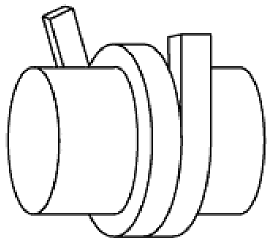
Establishing the Proper Flush Set-Up



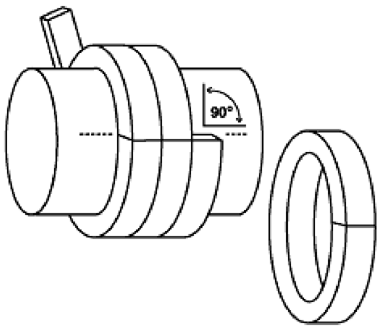
In order to establish the proper flush set-up, you must know the pressures of the stuffing box and of your water line at the equipment. For example, if the stuffing box you are packing has a pressure of 30 psi, you need at least 50 psi of flush water pressure minimum. You must also take into consideration whether you ever valve the discharge down to restrict the flow of product. Remember that when you do this, you are increasing the stuffing box pressure and abrasive product will enter the stuffing box and the packing. You must set your flush pressure high enough to compensate for the extreme. It only takes one time to ruin the life of the packing! A flush is much more than just water running in one side of the box and out the other side. It not only cools and lubricates, but it also keeps the unwanted particles out of the packing. The proper flush set-up is shown in the picture above. You have a ball valve set on the supply line into the stuffing box, and on the exit side of the stuffing box you install a gauge, followed by a needle valve or a globe valve. Set the flow rate with the ball valve, adjust the pressure by throttling down the needle or globe valve. Place your hand under the exit water and if the temperature is too hot, then increase the flow until it is cool, while maintaining the proper pressure. By doing this, you reduce dilution and the amount of water to the drain. You also double the life of your packing!

Proper Packing Cutting Instructions

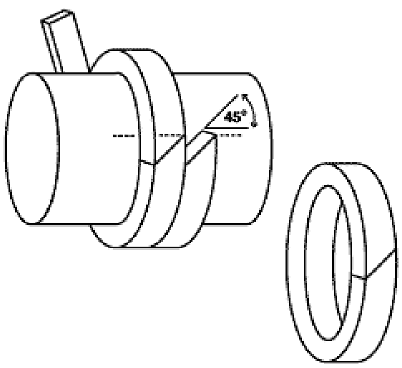
The best way to cut packing rings is to cut them on a mandrel. A mandrel can be fashioned with a pipe and building up wraps of duct tape until it's diameter matches the shaft diameter.



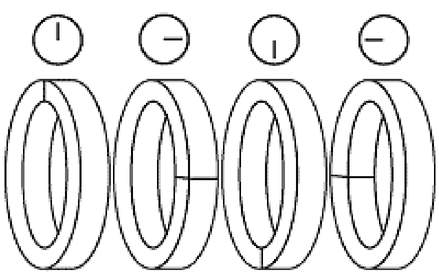
Hold the packing tightly on the mandrel, but do not stretch excessively. Cut the ring(s).



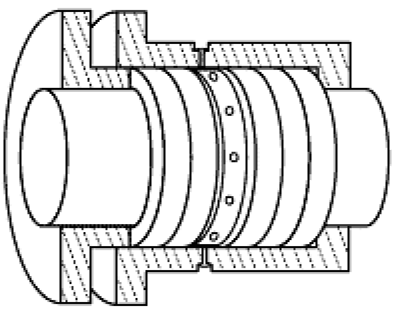
Multiple rings can be Butt Cut / 90° (square).



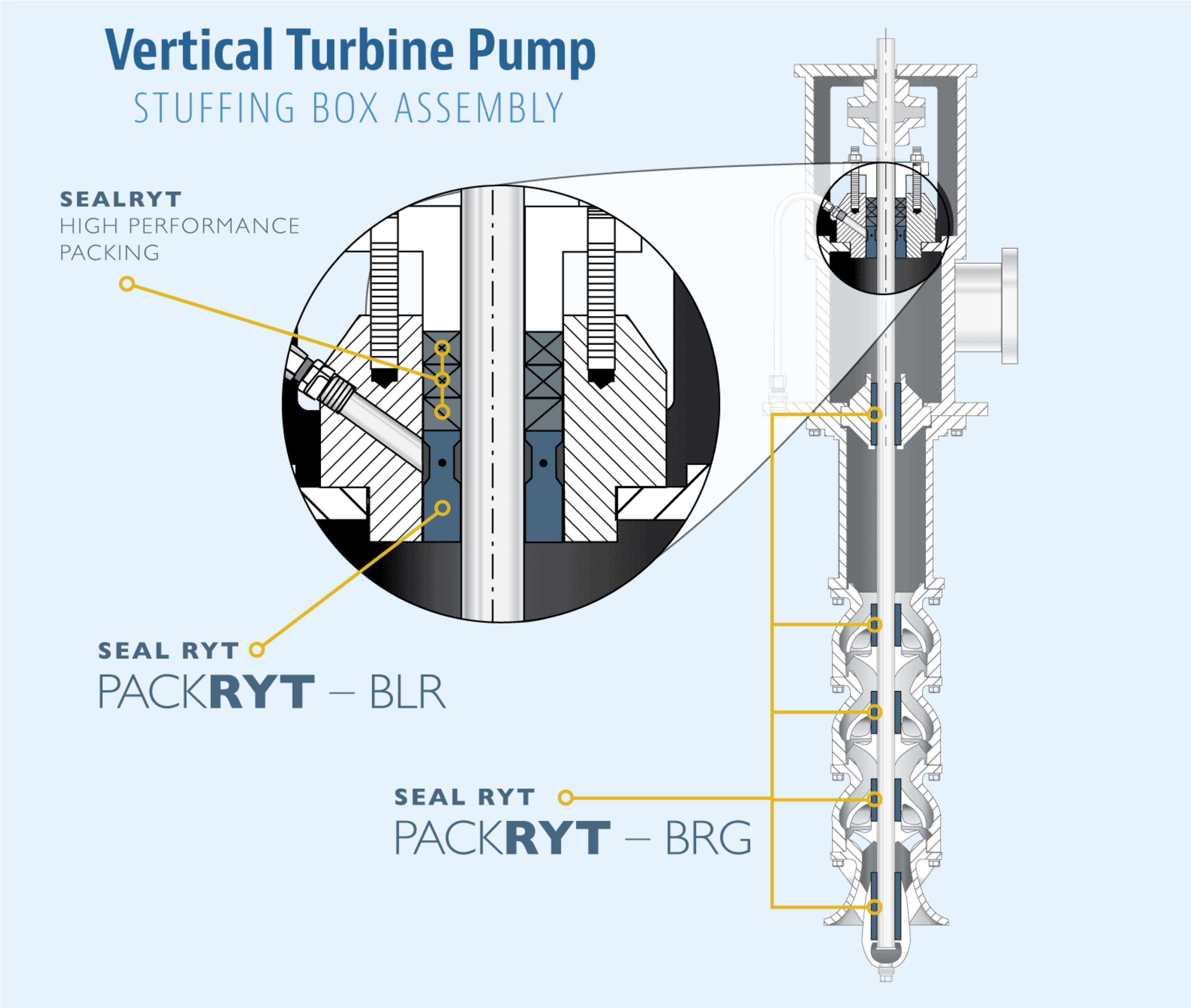
Individual rings can be Skive Cut 45° (diagonally). The best way to cut packing rings is to cut them on a mandrel with the same diameter as the shaft in the stuffing box. If there is no shaft wear, rings can be cut on the shaft outside the stuffing box.



Joints of successive packing should be staggered at 90°. When enough rings have been installed so the nose of the gland will reach them, individual tamping should be supplemented by using the gland.



If the stuffing box has a lantern ring, *make sure that the* lantern ring, *as installed, is slightly behind the fluid inlet so that it will move under the inlet as the follower pressure is applied.*


Vertical Turbine Pump
STUFFING BOX ASSEMBLY
SEALRYT
HIGH PERFORMANCE
PACKING
SEAL RYT
PACKRYT – BLR
SEAL RYT
PACKRYT – BRG

Appendix A10
ROSSUM SAND TESTER

Roscoe Moss Company **Technical Memorandum 005-7**

Monitoring Sand Content: The Rossum Tester

Introduction

The bane of many well operators is sand that is produced during pumping. While it is not uncommon for a small quantity of sand to be discharged during start up, chronic sand production will usually accelerate the normal wear of impellers and other pump parts and clogs meters and valves. If left uncontrolled, sanding also increases the frequency of equipment maintenance and replacements, and causes nuisance problems for pipelines and water storage facilities. Whether the cause for sand production is design related or the result of corrosion, it is important to monitor the quantity of sand that is discharged from the well on a regular schedule.

Sand production is a key criterion of new wells and should be carefully monitored when the well is developed and pump tested. During the early stage of well development, the quantity of sand discharged often exceeds 50 milligrams per liter (mg/l). Such concentrations are expected and even desirable. Precise measurements of sand content during this phase of well completion can be made with an Imhoff cone or other suitable device. However, in the later stage of well development and during performance testing, accurate sand content measurements are needed. In fact, most operators cite a specific criterion in well construction specifications that defines the upper limit of sand production that is acceptable. Generally, this can range from 15 mg/L to less than 1 mg/L.

During a well's life, sand production may increase for various reasons. For example, corrosion of casing and/or screen may allow for passage of sand into the well. Or, a poorly selected gravel pack might be unable to filter fine sand from passing through the well screen. In either case, if routine sand monitoring were conducted, the change in sand content could signal the problem to the well owner.

For monitoring sand content during a pump test or at regular intervals during a well's life, American Water Works Association (AWWA) Standard A-100 suggests the use of the Rossum Sand Tester (RST). An RST is easy to operate, low in cost, reliable, and widely used in the water industry.

Theory and Design of the Rossum Sand Tester

The RST functions like a centrifugal sand separator and is used to measure the quantity of sand in milligrams per liter (mg/L). The recommended setup of the RST is to connect it to ¼-inch diameter pipe at the midline of the discharge line, as shown below on Figure 1. By opening the gate valve on the ¼-inch line, water from the well is directed into the centrifugal cylinder. A constant flow of water should be maintained by a control valve rated at 0.5 gallons per minute (gpm) (Rossum, 1954). Water entering the tester circulates at high speed and spins the sand up against the side of the chamber. As the sand settles out, it collects in a graduated tube that is attached to the bottom of the tester.

Roscoe Moss Company **Technical Memorandum 005-7**

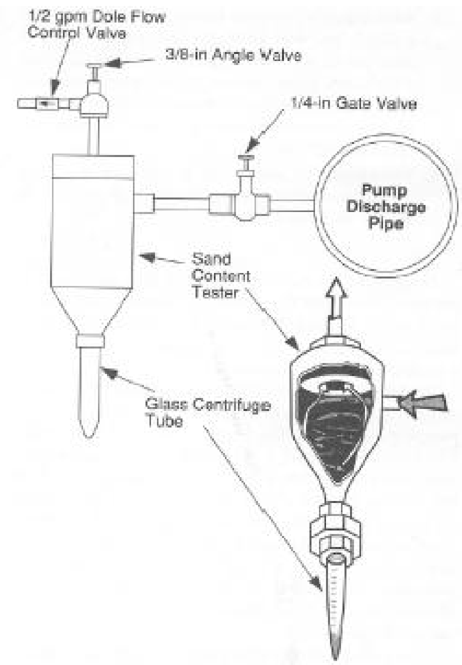


Figure 1

Sand Content Monitoring

The RST is an effective device for measuring sand content at concentrations less than 50 mg/L. This makes it very useful to monitor sand content while pumping a well at a high rate of discharge during development and production testing. The tester can be used to measure sand content in any water system; however the water sample for sand determination must be carefully obtained. A sample connected from a horizontal pipe at a low velocity is unacceptable. The sample may be obtained from a vertical pipe or a horizontal pipe with highly turbulent flow. Samples taken immediately downstream from elbows, tees, and other fittings that create turbulence are generally satisfactory if the water velocity is 5 feet per second or more. Readings taken close to the pump discharge head will have required turbulence.

The sampling procedure is as follows:

1. Install the RST as shown in Figure 1. The inlet should be located on the horizontal centerline of the discharge pipe and positioned as close to the discharge head or other turbulent flow area as possible.

2. Open the inlet valve to the tester wide open. Adjust the outlet valve to 0.5 gpm. A flow of 0.5 gpm will fill a 1 quart container in 30 seconds or 1 gallon container in 2 minutes.

3. Close the inlet valve, remove, clean, and replace the glass tube.

4. When ready to start the sand content test, open the inlet valve wide open and note the time.

5. After 5 minutes, record the accumulated sand. The sand rate is the accumulated sand divided by the time it took to accumulate. The test can be repeated or run for longer periods of time. To see the effects of surging a well, the test is often run following surging and after a period of steady discharge.

6. Check the flow rate through the tester during each run. If the flow rate is not 0.5 gpm, repeat the test.

7. Record the pump discharge rate (in gpm) during each sand test and note whether any surging was done prior to the test.

Calculations

The sand rate in milliliters per minute (ml/min) is used with the flow rate of 0.5 gpm to determine the rate of sand production per unit of water, as shown in Calculation 1. The answer will be milliliters of sand per milliliters of water (ml of sand/mil of water), as shown in Calculation 2. This answer is converted to parts per million (ppm), as shown in Calculation 3.

$$\frac{\text{Sand (ml)}}{\text{Time (min)}} = \text{Sand rate (ml/min)} \qquad (1)$$

$$\frac{\text{Sand rate (ml/min)}}{0.5 \text{ gpm} \times 231 \text{ in}^3 \times 16.387 \text{ ml/in}^3} = \text{ml of sand/ml of water} \qquad (2)$$

$$\text{Conversion to parts per million (ppm)} = \text{ml of sand/ml of water} \times 1{,}000{,}000 \qquad (3)$$

Example:

Measured sand = 0.1 ml

Time of test or accumulation = 10 minutes

$$\text{Sand rate} = \frac{0.1 \text{ ml}}{10 \text{ min}} = 0.01 \text{ ml/min}$$

$$\text{ppm} = \frac{0.01 \text{ ml/min}}{0.5 \text{ gpm} \times 231 \text{ in}^3 \times 16.387 \text{ ml/in}^3} \times 1{,}000{,}000$$

$$= 5.28 \text{ ppm}$$

Summary

The RST makes accurate sand content measurements an easy, straightforward and low cost task. The device can be used for monitoring during later stage of development when sand content is below 50 mg/l, during production testing, and in routine monitoring events conducted during the well's regular operation. The real value of the RST is that it makes it easy to track changes in sand production whenever such data are needed. Noticeable increases in sand production often indicate that further investigation of the well is needed, particularly if the sand content approaches or exceeds the operator's upper limit of tolerance.

References

American Water Works Association, 1997, Standard for Water Wells, A100-97.

California Department of Water Resources, 1981, Water Well Standards: State of California, Bulletin 74-81.

Handbook of Ground Water Development, 1990, Roscoe Moss Company, John Wiley and Sons, New York, NY

Rossum, John R., 1954, Control of Sand in Water Systems, reprinted from Journal American Water Works Association, Vol. 26, No. 2, February 1954.

The Engineer's Manual for Water Well Design, 1985, Roscoe Moss Company.

U.S. Environmental Protection Agency, 1975, Manual of Water Well Construction Practices, EPA-570-75-001.

About the Author

Robert Turnbull is the Chief Hydrogeologist of Roscoe Moss Company. In this capacity he provides technical support, as needed, to consultants, municipalities, and water districts to plan and design water supply wells. He can be contacted for such information or to answer inquires regarding this technical memorandum via email at rturnbull@roscoemoss.com. His website is www.blthydro.com. The corporate website for Roscoe Moss Company is www.roscoemoss.com.

List of Abbreviations

air-vac .... air vacuum and release (valve)
AWPF .... Advanced Water Purification Facility
Baski Valve .... Down Well Flow Control Valve
b/o .... blow-off (valve)
cml .... Cement mortar liner
Delta V .... Process control system software used to operate MBI wells
dis psi .... Discharge pressure
DMBI .... Demonstration Mid Basin Injection
EC .... Electrical Conductivity
ft. .... feet
GAP .... Green Acres Project
GPM .... Gallons per minute
GWRS .... Groundwater Replenishment District
I&E .... Instrumentation and Electrical (Department at OCWD)
IRSO .... Injection Recharge System Operator
LOS .... Local Area Stop
MBI .... Mid Basin Injection
MBI-2 through MBI-5 .. Centennial Park Wells
MOV .... Motor operated valve
N_2 .... Nitrogen gas
NPDES .... National Pollution Discharge Elimination System (Federal law)
OCWD .... Orange County Water District
PCS .... Process Control System (Delta V)
pwl .... Pumping water level
Regional Board .... California Regional Water Quality Control Board, Santa Ana Region
sim .... Simulate
UPS .... Uninterruptable Power Supply
Δ .... Delta