

***Revised* Final Remediation Plan**



**Fairview Station
Española, New Mexico
Facility #28779 RID #4657**

April 15, 2022



Souder, Miller & Associates
Engineering ♦ Environmental ♦ Surveying

2904 Rodeo Park Drive East, Bldg. 100 ♦ Santa Fe, NM 87505
(505) 473-9211 ♦ fax (505) 471-6675 ♦ www.soudermiller.com

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REVISED FINAL REMEDIATION PLAN
FAIRVIEW STATION STATE LEAD SITE
1626 NORTH RIVERSIDE DRIVE
ESPAÑOLA, NEW MEXICO

FACILITY #28779 RID #4657

April 8, 2022

1.0 Introduction

This Final Remediation Plan (FRP) has been prepared for the New Mexico Environment Department, Petroleum Storage Tank Bureau (NMED PSTB) by Souder, Miller & Associates (SMA) for the Fairview Station State Lead Site (Site) petroleum storage tank (PST) release site located at 1626 and 1702 North Riverside Drive in Española, New Mexico. This FRP has been prepared pursuant to 20.5.119.1923 NMAC and in accordance with the SMA workplan dated September 6, 2019 and approved by the NMED PSTB in a letter dated September 27, 2019. This FRP utilizes the results of recent well installation, slug testing, and NAPL recovery completed by SMA to develop the approach to remediation at the Site.

1.1 Site Background

The Site, illustrated on Figure 1, is located at 1626 and 1702 North Riverside Drive (NM Highway 68) in on the southeastern and northeastern corners of the intersection of North Riverside Drive and Calle Ranchitos in Española, New Mexico (located in Township 21 North, Range 8 East, Section 26). The former Fairview Station location (1626 N. Riverside Dr.) has been a known PST release site since the confirmation of release by NMED PSTB on August 9, 2012. During investigation of the release, the adjacent property to the north (1702 N. Riverside Dr., now a Dairy Queen) was determined to be an additional release site. Contaminated soil and groundwater are present on the site and extend off-site to the south and southwest. Non-aqueous phase petroleum liquid (NAPL) is present in many wells at the Site. NAPL hand bailing and pumping is the only mitigation of the contamination conducted at the site thus far. The information presented in Sections 1.2 through 1.5 of this FRP was obtained from reports prepared by previous consultants and SMA.

The Fairview Station portion of the site was a retail fuel facility from the 1970's to removal of the underground storage tanks (USTs) in July 2012. The property, currently a Dairy Queen, appears to have had fuel dispensers and aboveground storage tanks (ASTs) in aerial photographs taken from 1961 to 1978. The table below summarizes investigative activity at this site.

Fairview Station Site History		
Date	Worker	Event
August 2012	NMED	Confirmation of Release following removal of USTs in July 2012.
March 2013	Terracon	MSA completed, MWs advanced, analytical laboratory data revealed extensive soil and groundwater contamination on the Fairview Station property
June to November 2013	Terracon	Six NAPL bailing events
December 2013	Terracon	Addendum to MSA, completion of five additional monitoring wells, four wells on Fairview Station property, one well (MW-8) installed on Dairy Queen property.
June 2014	Terracon	NAPL Bail-down and recovery test on three monitoring wells.
July 2014	Terracon	Geophysical survey of Dairy Queen property. Possible relic piping identified. No USTs identified
October 2014	Terracon	Addendum to MSA, completion of six additional monitoring wells, four wells on Dairy Queen property, one well (MW-12) west of Riverside Drive, one well (MW-13) on vacant lot south of Fairview Station property.
January 2015	Terracon	Groundwater monitoring event
February 2016	EA	Annual groundwater monitoring and NAPL recovery event
September 2016	EA	Groundwater monitoring, plume delineation and NAPL recovery Report. Seven additional monitoring wells installed to delineate contaminant plume. NAPL bailed from nine monitoring wells.
December 2016	EA	Groundwater monitoring and NAPL recovery report
September 2017	EA	Groundwater monitoring and NAPL recovery report
July 2019	SMA	Monitoring well installation report. Eight monitoring wells and three soil borings drilled to better define contaminant plume.
July 2019	SMA	Groundwater monitoring and NAPL recovery report
August 2019	SMA	Aquifer slug test report. Slug tests conducted on six monitoring wells to determine aquifer properties near the center of the plume.
November 2019 to March 2020	SMA	Six monthly NAPL recovery events
March 2020	SMA	Monitoring well installation report. Two wells installed on the Wendy's property to complete down-gradient plume definition.



1.2 Soil Contamination

Soil contamination in the unsaturated zone at this site is present in the vicinity of the former dispenser and UST locations. On the Fairview Station property shallow soil contamination was present in borings nearest the former dispenser locations (MW-2, MW-3, MW-7). Vadose zone contamination was also identified in borings near the former USTs (SB-1, MW-30). On the Dairy Queen property, shallow vadose zone soil contamination is present in borings near the former dispensers and piping run to the ASTs (MW-9, MW-28). Soil contamination in the saturated zone is present over nearly the entirety of the Dairy Queen property except the easternmost portion. On the Fairview Station property, saturated zone soil contamination is present across the property except the eastern edge and much of the southeastern quadrant of the property. The soil contamination extends into the highway right-of-way west of the Fairview Station property. Figure 2 depicts the approximate areal extent of soil contamination. Figures 6a and 6b are cross sections of the site and depict field and laboratory soil contamination data.

Analytical laboratory data from borings SB-1 and B-4 and well completion logs for MW-1 and MW-30 reveal higher soil contaminant concentrations in the area of the former tank pit from approximately seven to ten feet below ground surface (bgs) and continuing below the water table. Analytical laboratory data from well completion logs near the former dispensers on the Fairview Station property (MW-3 and MW-7) reveal higher soil contamination concentrations at the water table. On the Dairy Queen property, the highest soil concentrations are located near the former AST location (MW-11), the former piping run from AST (MW-28) and near the former dispensers (MW-9). The soil contamination observed in monitoring well MW-11 is only present at and below the water table indicating the AST likely was not a significant point of release.

Based on this information and the locations of the borings and wells, the horizontal extent of source area soil contamination is approximately 12,500 square feet (ft²). The horizontal extent of smear zone soil contamination is approximately 44,300 ft² (including the source area).

Assuming a contaminant thickness in the source areas of 15 feet and an average contaminant thickness of five feet in the remaining area of the site, the total contaminated soil volume is approximately 346,500 cubic feet (ft³, equivalent to 12,833 yd³). Figure 2 shows the approximate extent of soil contamination at the site. Two generalized geologic and contamination cross-sections along the north-south axes of the site are provided in Figure 6a. Figure 6b illustrates three cross-sections across the contaminant plume from west to east.

1.3 Groundwater Contamination & Monitoring

1.3.1 Hydrocarbon Contamination

Dissolved phase groundwater contamination in excess of 20.6.2.3103 NMAC standards is undefined to the north (up-gradient) at this site. One up-gradient well, monitoring well MW-19, most recently contained benzene at 5.7 µg/L which is slightly above the 5 µg/L standard. The other up-gradient well, monitoring well MW-18, has contained NAPL intermittently over the last year. The recently installed monitoring wells MW-22, MW-23, MW-24 and MW-25 have defined the down-gradient edges of the



plume. Monitoring wells MW-26 and MW-27 have better defined the cross-gradient edge of the contaminant plume along the east side of the Dairy Queen property.

The Site does not have a long history of groundwater monitoring. However, the dissolved phase groundwater contamination observed does not suggest the plume is migrating. Monitoring wells located down-gradient of the NAPL plume (MW-5, MW-7 and MW-13) exhibit fluctuating dissolved phase contaminant concentrations. The dissolved phase contamination is close to the NAPL plume in the up-gradient directions (north and east). The dissolved phase contaminant plume extends 100 to 140 feet down gradient of the NAPL plume to the south and west.

Based on the currently available data, the dissolved phase groundwater contamination plume is estimated to be approximately 500 feet long and approximately 92,500 ft² in areal extent. Groundwater monitoring events conducted to date have shown typical petroleum hydrocarbon contaminants such as BTEX, MTBE, EDB, EDC, and total naphthalenes. The contaminants of concern observed at the Site indicate both leaded and unleaded gasoline were released. The distribution of contaminants indicate only leaded gasoline was released on the Dairy Queen Property and both leaded and unleaded gasoline were released on the Fairview Station property. The aerial extent of benzene and total naphthalenes dissolved-phase contamination based on the most recent monitoring event at the site is illustrated in Figures 4a and 4b.

1.3.2 Aquifer Data

Depending on the specific monitoring well measured, groundwater was encountered at depths between 14 and 18 feet bgs during the most recent monitoring events. Groundwater elevations have fluctuated approximately three feet at the Site since monitoring began. Groundwater elevation data from older PST sites along Riverside Drive (Thriftway #183, Brewer Shell, A's 7-11 Mini Mart) have experienced similar fluctuations of two to three feet with no long-term change in water table elevation.

The groundwater gradient direction at the site appears relatively stable over time and is typically to the southwest and south-southwest. This gradient direction is consistent in wells without NAPL. Attempts have been made to calculate the potentiometric surface elevation in wells with NAPL, however, these adjustments have resulted in irregular surfaces across the wells with NAPL. The gradient calculated for this site during the most recent monitoring event was 0.0031 ft/ft to the south-southwest. Figure 3 depicts the potentiometric surface from the most recent monitoring event.

The site is underlain by Quaternary sedimentary material predominantly consisting of interbedded sand, silt, clays and gravels in varying proportions. The sedimentary beds tend to be laterally discontinuous and variable in thickness. The sediments are typically uncemented and unconsolidated, however, discontinuous zones of sediments with caliche cement have been observed in several wells. The sediments between ground surface and 10 to 15 feet bgs are highly variable across the site and generally consist of sand, silt and clay layers that are several feet thick. The sediments between approximately 15 to 20 feet bgs are typically clay and occasionally silt. This clay/silt is underlain by sand and gravel across the site. All of the wells located west of Riverside Drive (MW-12, MW-20, MW-21, MW-24, and MW-25) have the clay/silt to sand and gravel transition at approximately 27 feet bgs or deeper. The deeper clay

to sand and gravel contact west of the Site may be the cause of the contaminant plume being oriented more north-south than the typical groundwater gradient.

SMA conducted slug tests on six site monitoring wells in May 2019. The results of the slug tests provided estimates of hydraulic conductivity which ranged from 1.0 to 12.7 ft/day. Most of the wells had results in the range of 1.0 to 2.8 ft/day. Each of the wells are screened predominantly in silt and clay with some sand and gravel towards the bottom of the screens. Therefore, the measured hydraulic conductivities overestimate the conductivity of the silt/clay sediments.

1.4 Observed NAPL

NAPL has been found in fourteen existing monitoring wells on site. NAPL is typically found in seven wells (MW-2, MW-3, MW-8, MW-11, MW-15, MW-28, and MW-30). NAPL is intermittently found in seven wells (MW-6, MW-9, MW-10, MW-14, MW-18, MW-29, MW-31). NAPL first appeared in MW-1, MW-2, and MW-3 as soon as they were installed in February 2013. The apparent thickness of NAPL in the site wells has been as much as 7.95 feet (MW-3), but typically is three to five feet in the most wells containing NAPL.

NAPL has periodically been recovered from site wells by hand bailing, passive skimmers, absorbent socks and pumped using a portable NAPL pump. Individual monitoring wells have had NAPL recovered from them as few as four times and as many as 24 times. These NAPL recovery efforts have removed 378 gallons of NAPL.

The horizontal extent of NAPL is defined in all directions. The size and shape of the NAPL plume varies over time depending on the intermittent appearance of NAPL in wells on the perimeter of the plume. The maximum areal extent of NAPL at the site is 29,900 ft². The NAPL plume has been as small as 17,200 ft².

The volume of NAPL at the site has been estimated using the most recent well gauging data (March 2020). The areas of the apparent NAPL thickness contours (Figure 5) were multiplied by the average apparent NAPL thickness, then multiplied by a correction factor of 0.1 to determine the volume of NAPL saturated soil. The correction factor for adjusting the apparent NAPL thickness to the true thickness typically ranges from 0.5 to 0.1 with smaller factors correlating with finer grained sediments. The volume of NAPL saturated soil was multiplied by an average porosity of 0.3 to yield an estimated NAPL volume of 9,880 gallons (1,321 ft³).

Contour	Total Area	Area of Interval	Average Apparent Thickness	Volume of Apparent Thickness	Correction Factor	Volume of NAPL Saturated Soil	Average Porosity	Volume of NAPL	Volume of NAPL
Ft	Ft ²	Ft ²	Ft	Ft ³		Ft ³		Ft ³	Gallons
0	23,005	7,548	0.5	3,774	0.1	377	0.3	113	847
1	15,457	4,935	1.5	7,403	0.1	740	0.3	222	1,661
2	10,522	3,973	2.5	9,933	0.1	993	0.3	298	2,229
3	6,549	6,549	3.5	22,922	0.1	2,292	0.3	688	5,144
Totals				44,031		4,403		1,321	9,880

There is substantial uncertainty with the estimation of NAPL at the site including: relatively few data points in the northern portion of the plume and uncertainty of the correction factor and porosity. Furthermore, some fraction of the NAPL will remain adsorbed to soil and will not be extractable via wells. Therefore, the remediation plan includes NAPL extraction via wells as a liquid, removal of NAPL via soil vapor extraction, and excavation of a portion of the plume.

2.0 Remediation Goals And Approach

2.1 Remediation Goals

The remediation goal for the site is focused on the removal or mitigation of identified site-specific health and nuisance conditions and reduction of contaminant levels to acceptable regulatory standards. The site-specific health and nuisance conditions include:

1. The presence of NAPL in excess of the action level of one-eighth inch (20.5.119.1922.A.1 NMAC) in any well.
2. The presence of contaminant saturated soil at the site as demonstrated by the presence of NAPL (20.5.119.1922.A.2 NMAC) in a well.
3. The presence of dissolved phase contaminant concentrations in excess of NMWQCC or EIB Standards (20.5.119.1922.A.3 NMAC).

The target concentrations for volatile and semi-volatile contaminants of concern in groundwater are NMWQCC standards:

Site Specific Contaminant of Concern	Groundwater Concentration (µg/L)
Benzene	5
Toluene	1,000
Ethylbenzene	700
Total Xylenes	620
Total Naphthalenes	30
MTBE	100
EDB	0.05
EDC	5

The remediation goal for NAPL is a measured thickness below the NMED action level of less than 1/8 inch in all monitoring wells. Currently, there are no regulatory standards for total petroleum hydrocarbon (TPH) concentrations in soil gas. Therefore, SMA will consider practical and economic parameters to evaluate and determine when operation of the remediation system will cease. Typically, operation of remediation systems is discontinued when TPH concentrations display asymptotic behavior, although this can be a poor measure of actual remediation being accomplished particularly where the geologic conditions promote diffusion-limited conditions. When observed, this condition will be verified through pulsed operation of the system and subsequent monitoring of TPH concentration rebound, if observed.

2.2 Remediation Approach

The proposed approach to remediate the site is as follows:

- Install a cement-bentonite barrier wall along the north boundary of the Fairview Station property to aid excavation of the site and provide a hydraulic barrier for remediation of the Dairy Queen Property and the area underlying Calle Ranchitos;
- Pump total fluids (NAPL/water) from three, four-inch monitoring wells north of the barrier wall to maintain hydraulic control of the plume during construction;
- Excavate the contaminated soil and remove NAPL from the Fairview Station property;
- Install two sets horizontal wells through the cement-bentonite barrier wall and beneath Calle Ranchitos and Dairy Queen for NAPL/contaminated water recovery and soil vapor extraction;
- Operate NAPL/contaminated water treatment and soil vapor extraction systems to remediate the area north of the barrier wall
- After mobile NAPL is removed from the site, transition NAPL/water collector system to passive flow-through conditions with dissolved phase treatment by air sparging and nutrient metering in the collector sump.

Through these methods, SMA will directly address the site specific health and nuisance conditions.

2.3 Current and Anticipated Future Property Use

The Fairview Station property is currently undeveloped and the property with the additional release is currently a fast-food restaurant (Dairy Queen). The properties located near the site along Riverside Drive are primarily commercial with few undeveloped lots. The properties along adjacent side streets are a mix of commercial, residential, and municipal (Ranchitos Park). The structure and facilities currently on the Dairy Queen will likely remain in place with a similar use. The Fairview Station property will likely be redeveloped and remain commercial given the location on a main arterial highway.

2.4 Potential Receptor Wells/Surface Water Bodies

There are six wells registered with the New Mexico Office of the State Engineer (NMOSE) within a 1,000-foot radius of the site. Nine additional supply wells and two conversion/change of ownership permit applications for wells are located between 1,000 and 1,200 feet. All well locations are shown on Figure 7. One of the wells within 1,000 feet (RG-29035) was an exploratory well drilled in 1977 by the City of Española. All of the other wells are domestic wells installed prior to 1977. The locations of all of the wells and applications are based on quarter section descriptions as was the norm at their time of filing. The accurate locations of the wells are not known or whether the wells are in use. All of the properties in the vicinity of the site are provided water by the City of Española.

According to the San Juan Pueblo, New Mexico USGS 7.5-minute quadrangle (Figure 7) there are no surface water features within 1,000 feet of the site. The nearest surface water features are several ponds and side channels adjacent to the Rio Grande located approximately 1,400 to 1,600 feet to the west and southwest of the site. Groundwater monitoring at this site shows groundwater flow direction to typically be toward the south-southwest.

3.0 Proposed Implementation Methodology

Based on the approved design from this document and the engineering Plans and Specifications (P&S), SMA proposes to complete: barrier wall installation, an interim total fluids recovery system, excavation of petroleum contaminated soil, installation of horizontal fluids recovery and soil vapor extraction wells, and operation of the SVE/fluids treatment system using PSTB-owned equipment. These systems are designed to:

- Utilize, where possible, all existing infrastructure in the most cost-effective manner possible.
- Eliminate the presence of NAPL at the site.
- Remediate soil contamination in the source area to concentrations below Risk-Based Screening Levels (RBSL).
- Sufficiently reduce groundwater contaminant concentrations through SVE and fluids treatment to move the site to monitored natural attenuation.

3.1 Existing Fluids Extraction Well Construction Details

Three, four-inch diameter monitoring/fluids extraction wells exist on site (MW-29, MW-30, MW-31). The wells were completed to a total depth of 27 feet bgs with screen from 11.5 to 26.5 feet bgs. The wells were cased with 4-inch diameter Schedule 40 PVC and 0.010" slot screen. Monitoring/extraction wells MW-29, MW-30, and MW-31 were installed in March 2018. The wells are located north of the proposed barrier wall for the purpose of maintaining hydraulic control of the northern portion of the plume during construction of the permanent system.

3.2 Completion of the Interim Fluids Treatment System

Based on the approved design from the FRP and P&S, SMA will complete installation of an interim total fluids pumping and treatment system. The three wells discussed above in Section 3.1 will be incorporated into the interim fluids treatment system. Geotech AR4 Auto-Reclaimer pneumatic total fluids pumps will be installed in the three wells. The top-loading pumps will recover NAPL and contaminated groundwater along the north side of the Fairview Station property. The total fluids will be pumped during the remediation construction activities to maintain a cone of depression in the water table up-gradient of the barrier wall. The pumping will recover mobile NAPL and contaminated groundwater while maintaining groundwater flow towards the center of the plume.

The total fluids will be treated using a Newterra multi-phase extraction (MPE) system owned by NMED to treat the fluids. The MPE system will be placed along the eastern edge of the Fairview Station property. The MPE system will be retrofitted with a Geotech HR10-12I 10-horsepower (Hp) air compressor to power the total fluids pumps. A series of piping will be installed in trenches from the MPE system along the east and north side of the property to monitoring wells MW-29, MW-30, and MW-31. The series of piping will include: a one-inch diameter double-wall pipe for discharge of mixed NAPL/water to the MPE system's oil-water separator, a 1.5-inch double-wall pipe for discharge of mixed fluids to the MPE system's air stripper, a one-inch schedule 80 compressed air line, and a four-inch schedule 40 pipe for discharge of treated water to the City sewer. The double-wall pipes are OPW FlexWorks pipes made of Kynar polyvinylidene fluoride (PVDF). The PVDF piping is designed for petroleum products and water and is typically used at gasoline stations.

The groundwater modelling (Appendix E) determined the total flow of water/NAPL required to maintain groundwater flow towards the wells is three to six gallons per minute (gpm). The three total fluids pumps are expected to generate a maximum of six to seven gpm each at site conditions and will be plumbed to a single discharge pipe. The pumps will initially be operated to generate a combined flow of ten or more gpm to establish a cone of depression in the water table adjacent to the barrier wall. The flow rate is expected to decrease as the cone of depression widens and approaches steady-state conditions. The oil-water separator (Maple Leaf Equipment OWS-4) of the MPE system is rated to separate gasoline from water at up to 28 gpm. However, the oil-water separator most efficiently separates the NAPL at lower flow rates. The air stripper (QED 2.4P) of the MPE system is rated for up to 25 gpm.

3.3 Completion of the Cement-Bentonite Barrier Wall

The cement-bentonite barrier wall is designed to maximize the amount of petroleum contaminated soil (PCS) that can be excavated and provide a hydraulic barrier between the excavation area and the remaining contamination beneath Calle Ranchitos and the Dairy Queen property. The main east-west barrier wall will be 110 feet long, 25 feet deep and 5 feet wide. A north-south barrier wall will be constructed along the west side of the excavation area due to the sanitary sewer and natural gas utilities located immediately west of the shallow soil contamination near the former dispensers. The barrier wall along the west side of the excavation area will be 140 feet long, 25 feet deep, and 3 feet wide. An additional wing wall 25 feet long, 25 feet deep and 3 feet wide will be constructed near the eastern end of the main east-west wall to provide additional shoring for the work to be conducted in the excavation.

The cement-bentonite slurry wall will be constructed by trenching the wall location while continuously filling the trench with cement-bentonite slurry to maintain trench wall stability. This construction method allows for deep vertical walls without shoring or dewatering the trench. The slurry sets to solid in about one day and typically attains 75% of its ultimate strength in 28 days. Test cylinders of the slurry material will be collected and tested at 14 days, 28 days, and longer as necessary to assess the curing of the barrier wall. It is anticipated the test cylinders will be tested by Geo-Test, Inc. The target parameters for the cement-bentonite slurry are 200-300 pounds per square inch (psi) compressive strength and permeability of 1×10^{-7} centimeters per second (cm/s) (2.8×10^{-4} ft/day). The trench spoils consisting of PCS mixed with some cement-bentonite slurry will be stockpiled on site and disposed during the excavation task.

Engineering design calculations for the barrier wall are included in Appendix B. These include two sets of design calculations for different dewatering scenarios with one foot of groundwater head against the wall and six feet of groundwater head against the wall. The design calculations indicate the wall stability is within acceptable limits across the anticipated water levels and is therefore, insensitive to dewatering conditions. Point loads on the wall caused by vehicle traffic will be prevented by placing traffic control measures and construction fencing adjacent to the wall. Traffic will be allowed to drive over the walls after completion of excavation and backfill activities.

According to GeoSolutions, Inc., a slurry wall contractor in Colorado, directional drilling through slurry walls is a common practice. GeoSolutions indicated drilling through the wall is not likely to cause significant cracking, spalling or other structural issues. In order to provide additional margin of safety, SMA has specified the east-west wall be five feet wide. The additional width beyond the three foot minimum allows for potential damage caused by the directional drilled horizontal wells.

3.4 Source Soil Excavation

The proposed area of excavation (depicted on Figures 8 and 9) has been selected to remove as much NAPL saturated soil from the Fairview Station property as possible. In addition, the goal is to excavate enough petroleum contaminated soil that additional remediation is not required south of the barrier



wall other than monitored natural attenuation. The total depth of the excavation will be 20 feet. This depth will remove the overlying clay and silt layers which contain the majority of contaminants. It is expected a small amount of the underlying sand and gravel will be excavated.

The volume of the proposed excavation is 6,300 cubic yards. The volume of soil excavated for construction of the barrier wall is an additional 920 cubic yards. The combined total volume of soil excavated is 7,220 cubic yards. The proposed excavation is anticipated to remove at least 3,000 (in situ) cubic yards of contaminated soil. The expanded volume of the excavation as drawn in the plans is approximately 10,108 cubic yards (40% expansion factor). Approximately, 4,220 cubic yards of clean soil and mildly impacted soil will be excavated to access the impacted soil (58% of total excavation). Clean soil from the excavation will not be used as backfill due to its high clay content. The clean soil will therefore be hauled off site for disposal. It is anticipated this soil will be disposed at a landfill as clean fill if acceptable to the facility. In the event no regional facility will accept this material, the soil may need to be disposed as PCS.

All excavation work will be completed pursuant to Occupational Safety and Health Administration Specific Excavation Requirements (29 CFR 1926.651). Excavation work will commence by removing soil from the northwestern portion of the excavation area. Sidewalls not faced by the barrier wall (south and east sides) will be maintained at 1:1 slopes initially. Side slopes may be as steep as 2:1 if safety permits. A 1:1 slope of unexcavated soil or clean backfill will be maintained against the barrier wall system at all times. Daily inspection of the excavation by a "Competent Person" will be conducted to ensure the excavation side slopes are stable and safe for site workers. PCS will be either be stockpiled on unexcavated PCS or on visqueen plastic sheeting where stockpiled on clean soil. At the end of each day, the gates to the construction fencing surrounding the open excavation will be closed and locked to prevent unauthorized public from entering the work area.

In order to maintain the integrity of the barrier wall, soil adjacent to it will be excavated and backfilled using stacked trench boxes. Individual trench box dimensions 10 feet tall, 10 feet wide, length to be determined by availability. Figure 8 depicts the excavation area with a ten-foot sample location grid superimposed. A 1:1 slope of backfill will be maintained against the barrier wall from the top of the wall to total depth of the excavation or to a line of trench boxes installed as temporary shoring as shown in Figure 9, Section A-A' to ensure the integrity of the wall.

The initial cut adjacent to the barrier wall will be excavated to total depth and backfilled to the surface with pit-run sand and gravel (grid cells A1 through J1, A2 through A13, and J2 through J3). A second cut, adjacent to the first, will be completed again using stacked trench boxes to total depth and partially backfilled. The upper trench box will be removed and backfill from the initial cut will be allowed to fall to angle of repose. The lower trench box will be left in place while the remaining excavation is completed. As excavation progresses from north to south and west to east, the lower trench boxes will be removed to facilitate backfill. This area will likely be excavated in two columnar areas columns B through E and F through I in order to create ramps of unexcavated soil and later compacted fill to maintain access into the excavation. Pit run sand and gravel will be placed in the bottom of the remainder



of the excavation with clean fill placed and compacted above. The pit run backfill will be partially backfilled to approximately 17 feet bgs in the north-central portion of the excavation (grid cells C2 to H2 and C3 to H3) to facilitate drilling of the horizontal wells and installation of the collector sump. Once the horizontal wells, sump and associated piping are installed, the remainder of the excavation will be backfilled.

Groundwater is expected to infiltrate into the excavation. However, we do not anticipate that groundwater will infiltrate into the excavation to the extent that excavation of soil is significantly hampered. Given the dense nature of the clay soils on site we anticipate that excavation can extend up to eight feet below static water levels. Dewatering and treatment of water during excavation is not planned. In the event that NAPL collects on the water within the excavation with a thickness greater than 1/8", absorbant booms will be placed in the excavation to mitigate the NAPL. Any used absorbent booms will be placed in 55 gallon drums and disposed of at a regulated facility. Dewatering during the drilling of the horizontal wells and installation of the collector sump within the open excavation is anticipated. Water pumped from the excavation during these activities will be pumped into settling tanks. Water will be treated by the MPE system and discharged to the City sewer. SMA anticipates the amount of water will likely exceed the capacity of the treatment equipment during peak dewatering periods. During these periods untreated water will be hauled and disposed at a regulated facility.

Clean backfill will be placed and compacted in lifts not to exceed one foot above the pit run gravel. Compaction testing will be completed at a frequency of two tests per lift (24 tests total anticipated). Backfill will be compacted to 90% standard proctor density. This compaction is sufficient to prevent subsidence and is appropriate for future construction on site. Backfill material (clean backfill, pit run gravel, and base course) will be analyzed for standard proctor properties and results will be submitted to NMED PSTB for approval prior to placement of any backfill. A top dressing of four inches of base course will be placed on the final ground surface.

Pit run gravel backfill will be a mix of sand and gravel with little fines (less than 5%). Imported clean backfill shall conform to AASHTO classes A-1-a, A-1-b, A-3, A-2-4, or A-2-5 and have a subgrade rating of excellent to good. Base course material shall meet the requirements of NMDOT Standard Specifications

for Highway and Bridge Construction Specification 303.2. Either Type I or Type II materials are acceptable for base course.

Soil samples will be collected for field headspace analysis by PID at an estimated interval of one sample per fifty cubic yards. Sample locations will be identified using a sample grid. A field headspace concentration of 100 ppm or greater is considered to be contaminated.

Soil Analytical Methods: SMA proposes to collect eight (8) composite samples of impacted soil removed, and ten (10) soil samples from excavation sidewalls and bottom, with analysis by the following methods:

- EPA Method 8260 for benzene, toluene, ethylbenzene, total xylenes (BTEX), methyl tertiary butyl ether (MTBE), 1,2-dichloroethane (EDC), and total naphthalenes
- EPA Method 8015 for total petroleum hydrocarbons, gasoline range organics (GRO), diesel range organics (DRO), and motor oil range organics (MRO)

Soil will be transported using trucks permitted for special waste transport. A few trucks may be staged on the closed shoulder approaching the site; however, staging will be minimized by staggering truck arrivals. It is anticipated soil will be disposed of at the Waste Management Inc. facility in Rio Rancho, New Mexico. Stockpiling of contaminated soil will be permitted in designated areas only. Contaminated soil stockpiling will be limited to approximately one day’s worth of transportation. Clean backfill materials may be stockpiled in areas on the southern portion of the site. Transportation and disposal of soil will be tracked on a per ton basis. The disposed quantities will be easier to track on a weight basis since the trucks will be weighed at the disposal site.

Contingencies for potential conditions during excavation are included in the table below:

Condition	Contingency
NAPL floating on groundwater in excavation	Deploy absorbant booms where possible to recover NAPL
Air monitoring results exceed safety limits	Evacuate excavation, contact safety manager Resume work if air quality meets standards spontaneously Use ventilation and cabin filters if air quality remains poor
Slumps or extension cracks along sidewalls	Lessen sidewall slopes or use trench boxes along sides
Cracks in barrier wall observed	Cease work in excavation until inspected by engineer
Flash fire occurs during excavation	Evacuate excavation, contact safety manager
Sidewall, barrier wall cave in	Evacuate excavation, call 911, contact safety manager

3.5 Horizontal Well Installation

Once the excavation has been completed and partially backfilled, the directional drilling of the horizontal wells will be completed. SMA anticipates the partial backfill will include nearly all pit run backfill placed and much of the southern portion of the excavation backfilled as a ramp to the work zone. Three horizontal wells will be installed below the potentiometric surface extending north from the barrier wall



and beneath Dairy Queen, sloped to the south. The wells will be drilled approximately two feet below the average water table elevation. Four horizontal wells will be installed to the north of the barrier wall above the water table for SVE remediation of immobile NAPL and adsorbed soil contamination. The wells will be maintained approximately two to three feet above the water table in the most contaminated portion of the vadose zone. Furthermore, both types of wells will extend beneath buried utilities in the Calle Ranchitos street right-of-way, the Dairy Queen building, and other less accessible portions of the Dairy Queen property (drive through lane, near the entrance, utility connections, etc.). The wells will terminate at the ground surface in the southern portion of the Floral Expressions property north of Dairy Queen. The driller selected for installation of the horizontal wells will be a New Mexico licensed driller.

The wells will be relatively closely spaced at the barrier wall penetration and fan out towards the north as depicted in Figure 8. The fluids collection wells are spaced 12 to 14 feet apart at the barrier wall and 38 to 40 feet apart at their termination. The horizontal SVE wells will be spaced 12 to 16 feet apart at the barrier wall and 34 to 40 feet apart at their termination. The spacing of the wells is closest at the narrowest and most contaminated portion of the plume and widest in the less contaminated portion of the site. The path of each well will avoid intersecting existing monitoring wells as much as possible.

The horizontal fluids collection and SVE wells will consist of approximately 200 feet of slotted high density polyethylene (HDPE) pipe with 20 feet of unslotted pipe on both ends of the slotted section. The HDPE pipe will be four-inch diameter, standard dimension ratio (SDR) 11 pipe. The slotted sections will have 1/10" wide and 4" long slots on 120 degree centers around the circumference of the pipe every two inches down the length of the pipe. Pipe sections will be joined by the butt fusion method. The well casing will be jetted following installation to clean the wells of drilling mud.

3.6 Remediation System Installation

Following construction of the horizontal wells, a HDPE collector sump will be installed in the open excavation. The three fluids collection wells will be plumbed into the sump. An infiltration gallery will be constructed south of the sump and will consist of 40 feet of schedule 80 PVC well screen with 0.050" slots. Each of the four lines plumbed into the sump will have a flanged gate valve to control flow into and out of the sump. The valve to the infiltration gallery will be closed during operation of the remediation system.

The collector sump will have an explosion-proof sump pump installed in it to move fluids to the MPE treatment system. The sump pump will be a Zoeller model X165 which can pump at a minimum of 25 gpm to the treatment system. The sump pump will discharge to the MPE system via a 1.5-inch double-wall pipe. One-inch discharge line and compressed air piping will also be plumbed into the collector sump. In the event significant NAPL accumulates in the collector sump, a pneumatic total fluids pump can be installed to pump the NAPL/water from near the surface of the fluids level to the oil-water separator. The sump pump inlet and float switch are configured to pump from below the fluid surface. The high concentration (mixed NAPL/water) fluid from the pneumatic pump will be discharged into the



oil-water separator and the lower concentration (primarily water) fluid from the sump pump will be discharged to the air stripper. This separation of streams maximizes the efficiency of the oil-water separator.

Each horizontal SVE well will be plumbed into a four-inch schedule 40 PVC riser. The riser will plumb into SVE conveyance lines in the shallow subsurface and will have a sump below the well connection to allow for removal of condensate. Approximately 150 ft of trenching (not including the trenching to be installed for the interim fluids treatment) and 400 ft of four-inch PVC pipe will be used to connect the extraction wells to the MPE system. The four-inch conveyance lines will transition to two-inch PVC at the MPE system manifold. The proposed layout of the SVE system is provided in Figure 10. The top of piping will be buried to a minimum of 18" bgs. The lines will slope towards the well/sump with a 0.5% or greater slope. Prior to installation of the conveyance lines, backfilling of the excavation will resume around the collector sump and SVE well risers.

SMA proposes utilization of a MPE system and thermal oxidizer from NMED's inventory, if available, for completion of the Fairview Station remediation system. The selected equipment includes a NewTerra MPE system in a modified shipping container (Asset 16264) and a Baker Furnace thermal oxidizer (Asset 16268). All equipment for the system will be kept within a chain-link fenced enclosure with vinyl privacy slats and will be located on the east side of the Fairview Station property. Schematics and system information are included as Appendix A. A layout of the remediation wells, piping, and equipment is provided as Figure 10.

The Newterra MPE system includes two Busch Mink 1502 BV claw vacuum blowers (25 Hp) in parallel. The blowers are rated for 135 scfm at 17 inches of mercury (in. Hg) each. The fluids treatment portion of the MPE system includes a Maple Leaf Equipment OWS-4 oil-water separator with ½" media rated for 28.2 gpm with gasoline as the contaminant. The water discharged from the oil-water separator will be treated by a QED Environmental 2.4P air stripper rated for 1 to 25 gpm. The air stripper has a New York Blower model 1804A blower rated for 140 scfm at 20 inches of water. The Baker Furnace thermal oxidizer model TX-100 will be used to treat the SVE and air stripper air effluent to mitigate odors. The thermal oxidizer has a Roots 56 URAI positive displacement blower (15 Hp) which is rated for over 500 scfm with inlet air at atmospheric pressure. The anticipated air flow rate of the SVE and air stripper blowers combined is approximately 380 scfm. At this flow rate the thermal oxidizer will likely operate with a destruction efficiency less than 99% but greater than 90%

Calculations showing the anticipated head loss for the proposed system are included as Appendix B. These calculations assess expected flow vacuum conditions for this site; including the SVE manifold and with 4 SVE wells operating with flows of 67.5 scfm each. It is not known what the actual flow will be so the calculations were completed using a higher than expected flow. Head loss was assessed individually for the SVE manifold and each SVE well. The conveyance lines to the SVE wells had head losses of 1.29

to 1.38 inches of water. The head loss through the manifold was estimated to be 3.15 inches of water. The combined head loss of 8.5 inches of water represents 4% of the blowers anticipated vacuum.

Calculations of head loss for the various pumps included in the system are also included in Appendix B. Three AR-4 pneumatic pumps running simultaneously and discharging to a single, one inch discharge line are expected to pump at 6 to 7 gpm depending on the compressed air pressure. The Zoeller X165 sump pump is expected to pump 30 to 40 gpm depending on how dirty the bag filter is. The MPE system includes two Goulds IST transfer pumps which discharge the oil-water separator to the air stripper and air stripper to the City sewer. The pump from the oil-water separator is estimated to pump 35 gpm with a fouled bag filter (10 psi head pressure). The same pump is expected to discharge more than 40 gpm from the air stripper.

Final installation and connections of the remediation system will be completed by SMA, which is a Construction Industries Division registered contractor, and under the supervision of a New Mexico P.E. The registered P.E. will make visits as required during remediation system construction.

3.7 Health and Safety, Site Security, Traffic Control

All field and construction activities will be conducted under a site specific health and safety plan (HASP). The HASP was developed in accordance with OSHA regulations and the SMA Corporate Health and Safety program. A copy of the Health and Safety Plan is included as Appendix D.

Air quality monitoring will be completed as part of the health and safety procedures. Monitoring will consist of continuous monitoring using a Lower Explosive Limit (LEL) detector calibrated to pentane and alarm set for 10% LEL. The LEL detector will be placed in the breathing zone of the workers on site. Air monitoring will also be conducted using a photo-ionization detector (PID) calibrated to 100 ppm isobutylene. In addition to continuous monitoring of the worker breathing zone, air monitoring surveys of the excavation perimeter will be conducted at least three times per day. A reading of 10% LEL or 25 ppm by PID will trigger cessation of work and workers will go to an up-wind rally point. Air monitoring will continue to determine when work may resume. If the LEL and PID readings remain high or if the alarm limits are reached repeatedly within a shift, work will cease until weather conditions change, engineering controls are implemented or respiratory protection is employed. It is anticipated that any directional drilling conducted within trench boxes will be actively ventilated using a confined space blower and ducting system in addition to the above air monitoring.

During excavation activities workers will not be permitted to enter the excavation except those operating machinery. Soil sampling will be conducted by collecting grab samples from the excavator bucket at the ground surface.

SMA will comply with 29 CFR 1926, Safety and Health Requirements for Construction. This includes daily inspection of the excavation by a "Competent Person" to ensure the excavation side slopes are stable and safe for site workers. SMA employs "Competent Persons" in our Albuquerque and Santa Fe offices.

A traffic control plan to control vehicle and pedestrian access to the site will be implemented. Site access will be controlled using temporary chain-link fencing around the work zone. Traffic control will utilize appropriate signage and traffic barricades located between the excavation and the adjacent state highway. Traffic control is anticipated to include signage along North Riverside Drive to the north and south of the site as well as on Calle Ranchitos. The traffic control plan will be submitted to NMED PSTB at least 72 hours prior to commencement of the excavation. The traffic control plan will also be submitted to NMDOT as part of a work permit.

3.8 As-Built Report and Drawings

The as-built report for construction of the remediation system will include, at a minimum:

- Any deviations from the drawings and specifications.
- A tabulation of pertinent data including flow rates, pressures, temperatures, contaminant concentrations, groundwater elevations, and NAPL measurements.
- An inventory of purchased capital equipment including, where available, serial number and purchase price.
- Descriptions of past site conditions, implementation of the remediation system, and waste handling.
- Soil and water disposal manifests
- Soil characterization results (field and laboratory)
- Backfill details and compaction test results
- Photo log documenting all site activities
- As-built drawings will be signed and sealed by a New Mexico Professional Engineer (NMPE).

3.9 Anticipated Operation Conditions & Flows From System

Based on the groundwater modelling conducted for the site (Appendix E), the minimum amount of fluids that need to be pumped to maintain hydraulic control of the plume during interim pumping is 0.75 to 1.5 gpm. The interim fluids recovery from the three monitoring wells during system construction is expected to be 10 or more gpm during the first few days then stabilizing to 3 to 6 gpm. SMA anticipates a maximum fluids treatment and discharge of 25 gpm is likely to occur periodically during construction dewatering for the horizontal well drilling and system construction.

Since the horizontal SVE wells have not been installed and pilot tested, it is not known what the flow and vacuum conditions will be for these wells. The two Busch Mink claw blowers are rated for 135 scfm at 17 in. Hg each. SMA currently anticipates that the SVE system will initially operate near this vacuum at flows less than rated maximum due to the clayey soils at the site. Therefore, the system will likely operate on all four wells simultaneously for much of the system operation. Periodic effluent air monitoring of individual SVE wells will help determine if wells should be closed to assist in focusing remediation in more concentrated areas of the site.

4.0 System Operation & Maintenance

4.1 SVE/Fluids Treatment Remediation System Operation (*Phase 5, Tasks 1a – 1d*)

The overall operation and maintenance strategy is to ensure the remediation system is operating as designed in the approved FRP and is meeting or exceeding all remedial objectives. SMA's experience is that frequent site visits are needed to ensure that remediation system downtime is kept to a minimum. Operation of the remediation system will be performed under the supervision of a New Mexico P.E.



Quarterly groundwater monitoring and remediation system operation and monitoring will be performed in accordance with 20.5.119.1926 NMAC, including an annual evaluation of remediation system performance as specified in 20.5.119.1927 NMAC.

Based on the remediation strategy, the following approach and specific tasks to address operation and maintenance of the remediation system at the Fairview Station site:

1. Operation and maintenance of the remediation system
2. Disposal of Recovered NAPL
3. Electrical and natural gas consumption and telephone service costs
4. Conduct quarterly monitoring to assess attenuation of NAPL and dissolved-phase groundwater contamination

4.1.1 System Startup Sampling

Recommended SVE startup testing will include the collection of air samples using new Tedlar® bags from each SVE well and cumulatively for laboratory analysis at startup (day zero; time zero), for the 1st day of SVE system operation, and at the conclusion of the 1st and 2nd weeks of system operation. The air samples will be analyzed for a variety of gasoline and diesel fuel constituents using EPA Method 8260B and for TPH GRO using EPA Method 8015. SMA will also complete PID field evaluation on vapor from each extraction line, total influent and total effluent to assess field hydrocarbon concentrations, and multi-gas meter evaluation for O₂ and CO concentrations and percent LEL during these events.

After the first two weeks of operation, the extraction lines and the cumulative influent will be sampled using a calibrated PID and multi-gas meter on a monthly basis. Cumulative effluent air samples will be collected into new Tedlar® bags at the conclusion of each month of operation for analysis using EPA Method 8015. A summary of anticipated activities are provided in the table below.

Time After Startup	Each SVE Well	Cumulative Total Effluent
Day 0, Day 1, Day 7, Day 14	VOCs by PID, O ₂ , CO, LEL EPA Methods 8015 & 8260B	VOCs by PID, O ₂ , CO, LEL, EPA Methods 8015 & 8260B
Monthly	VOCs by PID, O ₂ , CO, LEL	VOCs by PID, O ₂ , CO, LEL, EPA Method 8015
Quarterly	VOCs by PID, O ₂ , CO, LEL EPA Methods 8015 & 8260B EL	VOCs by PID, O ₂ , CO, LEL, EPA Method 8015

System optimization will be conducted by balancing flow rates through individual SVE wells. PID, LEL, CO, and O₂ measurements will be used to monitor each well’s performance and to adjust flows accordingly. System optimization will be completed as part of normal O&M activities.

Startup testing of the fluids treatment portion of the system will include collection of untreated water (before air stripper) and treated water (after air stripper) samples on start up (Day 0) and at the end of the first two weeks (Day 7 and 14). The air samples will be analyzed for a variety of gasoline and diesel fuel



constituents using EPA Method 8260B and for TPH GRO using EPA Method 8015. Following the first two weeks of system operation, untreated and treated water samples will be collected and analyzed on a monthly basis. The City of Española has indicated to SMA that these data do not need to be submitted to them. However, we believe these data are important to monitor the removal efficiency of the air stripper and for documentation of the water quality discharged to the City sewer.

In accordance with current NMED PSTB policy, SMA will submit collected data after every site visit to NMED PSTB by fax or by email correspondence. In addition, a written monthly summary letter on the current and past system performance of the remediation system will be submitted to NMED and the responsible party. Specific items to be included in the monthly letter reports include:

- Brief narrative of general system performance and observations
- Summary table of applied vacuums
- Observed and calculated air flow rates of each extraction line and total influent (table format)
- Summary table of dilution air flow rates
- Summary table of PID readings of extraction wells, and total effluent
- Summary table of NAPL recovered
- Summary table of quantities of water pumped and discharged
- Summary table of laboratory data
- Graph of cumulative TPH removed vs. time
- Graph of pounds of TPH removed per hour vs. time
- Graph of fuel consumption vs. time
- Pertinent field sheets for the month
- System schematic & data locations

Each quarter, a more comprehensive report will be submitted to NMED and the responsible party and the property owner. The content of the quarterly report will be pursuant to NMAC 20.5.119.1926 and, at a minimum, will include:

- Tabulation of the current and historical results of all water quality analysis and water elevation data
- Evaluation of the remediation system performance using PID, LEL and laboratory sample data
- Review to determine that remediation meets the operating standards outlined in the Final Remediation Plan
- Verification of the schedule for source area contaminant mass removal, protection of actual and potential receptors, and achievement of target concentrations
- Quarterly and cumulative contaminant mass reduction totals to date in pounds and gallons, including supporting calculations and documentation
- Records of system operation including field sheets, periods of system malfunctions or shut-down, a maintenance schedule with procedures performed including the names of the individuals performing the maintenance
- An operation and maintenance schedule for the next quarter
- The amount of NAPL recovered, both cumulatively and quarterly
- Influent and effluent vapor concentrations over time
- Untreated and treated water dissolved phase concentrations over time
- Evaluation and recommendations for improving the performance of the system to achieve remedial goals



- Copies of field data sheets
- Copies of analytical laboratory reports
- Remediation system schematic identifying sampling and data gathering locations

In addition to the above described system monitoring, SMA will conduct biweekly site visits to ensure proper system operation and maintenance. Biweekly site visit tasks will include adjustment of the remediation system, adjusting air sparging timers, conducting any necessary equipment maintenance (belt replacements, oil changes, greasing blower and motors, etc.) and other tasks as necessary. Operation of the remediation system will be performed under the supervision of a New Mexico P.E.

4.2 Recovered NAPL Disposal (*Phase 5, Task 2a-d*)

This task will be used solely to track and pay for disposal of NAPL recovered by the remediation system.

4.3 Electricity and Natural Gas Consumption and Telephone Service (*Phase 5, Task 3a-d*)

This task will be used solely to track and pay for actual electricity and natural gas consumption and telephone costs for operation of the remediation system.

4.4 Quarterly Groundwater Monitoring (*Phase 5, Task 4a-d*)

Quarterly groundwater monitoring will be conducted during remediation system operation at the site. Each sampling event will include measurement of depth to water and NAPL in all site monitoring wells. The 1st through 3rd quarters of groundwater monitoring will include laboratory sampling of site wells would generally include ten (10) monitoring wells (MW-4, MW-5, MW-7, MW-10, MW-13, MW-16, MW-19, MW-21, MW-24, and MW-27) for analysis of BTEX, MTBE and EDC by EPA Method 8260B. The 4th quarter of groundwater monitoring will include sampling all site monitoring. For each monitoring event, all samples will be collected using new disposable bailers and will be labeled, custody sealed and immediately placed on ice for shipment to Hall Environmental Analysis Laboratory (HEAL) under standard chain of custody procedures.

For each quarterly event SMA will prepare a report using the appropriate NMED standard monitoring report form. This report will include all data gathered during monitoring activities as well as any general site observations or recommendations. This report will also include a discussion of any known horizontal and vertical extents of groundwater impact; characteristics, extent and thickness of NAPL (if any); elevation, gradient, and direction of the potentiometric surface and any nearby surface water; rate and direction of contaminant migration; aquifer properties; biotic parameters; and known impacts to underground utilities. Annually, this report will also include an evaluation of the effectiveness of the overall remediation system. A SMA drafting technician II will prepare site maps and contaminant contour maps for the report. All maps will be drawn at a scale of no more than 1"=60' unless specifically requested otherwise by NMED.



5.0 Anticipated System Effectiveness & Schedule for Source Area Remediation

The proposed approach to remediation includes multiple methods to address the site conditions. The excavation of the Fairview Station property will directly affect adsorbed phase contamination in the soil and the known NAPL plume there. The cement-bentonite barrier wall will facilitate maximizing the excavation while protecting adjacent utilities and infrastructure and preventing re-contamination from unexcavated areas. The excavation allows installation of horizontally drilled fluids extraction and soil vapor extraction wells. Extraction of NAPL and impacted groundwater allows for direct remediation of mobile NAPL and dissolved phase contamination. Simultaneous soil vapor extraction will directly remediate the immobile NAPL and adsorbed soil contamination. Once mobile NAPL has been removed and dissolved phase concentrations decrease, the horizontal well and collector sump system can be converted to a passive pass-through mode by opening infiltration gallery. The collector sump may be used to oxygenate the water by air sparging or enhancing biodegradation by metering nutrient solutions into the sump. Areas not directly addressed by the remediation system will also be indirectly remediated by enhanced natural attenuation due to the increase in oxygen concentrations in the soil and groundwater as a result of operation of the remediation systems.

Prediction of the amount of time necessary to effectively remediate the source area of a petroleum storage tank release site is difficult due to many uncharacterized factors. The vapor concentrations and flow rates for the SVE portion of the system are unknown. Therefore, it is not possible to estimate recovery rates for the vapor phase. It is anticipated the SVE portion of the system will need to operate for two years or more due to the clayey soils. It is expected the clayey soils will become diffusion limited in a short period of time. Such conditions typically extend SVE operation into multiple years of operation.

The groundwater modeling allows for some estimation of the volume of fluids that may be recovered. Assuming the area of the plume north of the barrier wall is approximately 30,000 square feet and the majority of NAPL and highly contaminated groundwater is within five feet of the water table and an average porosity of 0.3, the volume of the most contaminated portion of the plume is 336,600 gallons. An average pumping rate of 3 to 6 gpm (4,320 to 8,640 gallons per day) results in a pore volume exchange every 39 to 78 days (4.7 to 9.4 exchanges per year). Based on these modest fluids pumping results, it is expected the majority of the mobile NAPL will be recovered within the first six months of operation and all mobile NAPL removed in approximately one year.

6.0 Remediation Contingencies

In the event of changes in site conditions that further threaten public health, safety and welfare or the environment, the system can be expanded in capacity. The total fluids pumping and treatment equipment has a larger capacity than the estimated minimum requirements. If the water table depression is less than anticipated the fluids treatment system can be operated at double or more of the expected flows. In the event insufficient fluid is recovered via the horizontal wells, the pneumatic pumps installed in the four-inch monitoring wells may be operated to increase fluid recovery. If the horizontal



SVE wells have insufficient flow of soil vapor, vertical SVE wells may be added to the system. Any remediation contingency will not be implemented without prior discussion and approval from NMED.

7.0 Property Restoration

Following the completion of remediation activities, the site will be restored to conditions generally similar to those found prior to beginning remediation activities. Property that is found to be damaged or destroyed by the remediation activities will be returned to original conditions within 30 days after the damage or destruction has been identified.

8.0 Timeline

The estimated timeline for the implementation of the remediation system at the Fairview Station, as proposed by SMA, is presented in Table 1.

9.0 Equipment Inventory

A list of the anticipated equipment inventory is presented in Table 2.

10.0 Anticipated Subcontractor Services

SMA is a licensed contractor and will be performing and overseeing construction of the remediation system, although several tasks are anticipated to be subcontracted to other specialty contractors. It should be noted that final selection of specialty subcontractors has not been performed, as it will depend heavily on availability when construction activities are anticipated to commence. The following table lists anticipated potential subcontractors to SMA:

Task Description	Potential Subcontractors
Trenching, Excavation and Transportation	<ul style="list-style-type: none"> ● Rhino Environmental Services
Fencing	<ul style="list-style-type: none"> ● Rhino Environmental Services
Soil/debris disposal	<ul style="list-style-type: none"> ● Rhino Environmental Services
Cement-Bentonite Slurry Wall Construction	<ul style="list-style-type: none"> ● Geo-Solutions
MPE Remediation System Equipment & Service	<ul style="list-style-type: none"> ● Newterra
Thermal Oxidizer Equipment & Service	<ul style="list-style-type: none"> ● Baker Furnace
Electrical service and wiring	<ul style="list-style-type: none"> ● Four Corners Electric

11.0 Public Notice

A copy of the public notice document is provided in Appendix C. This document has been, and will be published in the Rio Grande Sun pursuant to NMAC 20.5.119.1923 Section D, sub-section (10), paragraph (a) and will be provided to all adjacent property owners pursuant to NMAC 20.5.119.1923 Section D, sub-section (10), paragraph (c). The public notice document will also be posted at the site as required by pursuant to NMAC 20.5.119.1923 Section D, sub-section (10), paragraph (d).

12.0 Access Agreement and Operational Permits

Remediation installation activities will be conducted on three properties including the Fairview Station, Dairy Queen, and Floral Expressions properties. Each of these properties have access agreements with NMED. Revised access agreements may be necessary from the owners of these properties.

The permit to connect to the City of Española sewer is included as Appendix F. A traffic control permit will be obtained from the New Mexico Department of Transportation prior to conducting the barrier wall and excavation activities. The traffic control permits cannot be obtained until the dates of work are known. Additional Construction permits will be obtained by subcontractors as necessary during remediation system construction. A building permit from the New Mexico Construction Industries Division will likely be required for the electrical service connection and associated panels and wiring.

NMED PSTB commented on the original FRP submittal that NMOSE may require water rights for the project given the discharge of water to the City sewer. NMOSE determined that water rights would be required given the quantity of groundwater involved. Electronic mail correspondence between SMA and NMOSE is included in Appendix G.



13.0 Site Specific Health & Safety Plan

A site specific health and safety plan for the Fairview Station petroleum storage tank release site is included as Appendix D.

14.0 Statement of Familiarity

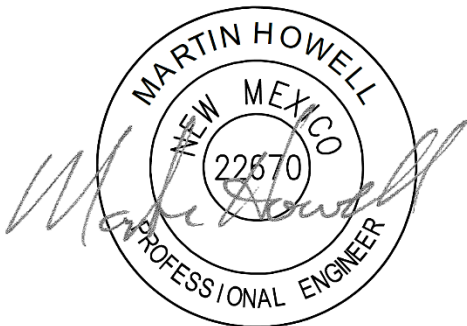
This report was prepared by SMA on behalf of the NMED Petroleum Storage Tank Bureau. Completion of the workplan and Final Remediation Plan was conducted under the direction and supervision of personnel with the prior approval of NMED PSTB. The undersigned hereby acknowledges personal knowledge of the information submitted in this report and the attached documents.



Alan J. Eschenbacher, P.G.
Senior Scientist

4/15/2022

Date

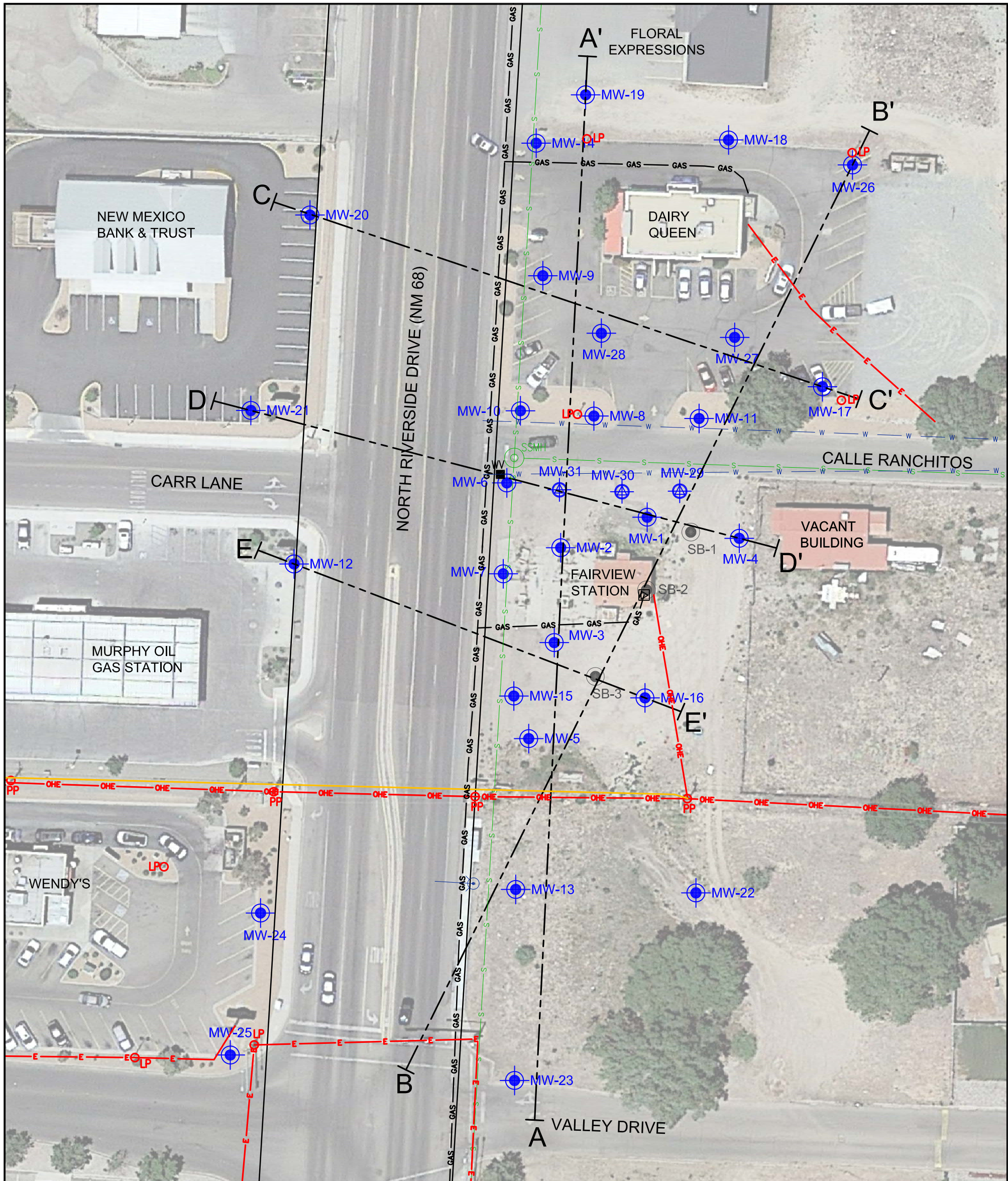


Marty Howell, P.E.
Senior Engineer

4/15/2022

Date

Figures



LEGEND

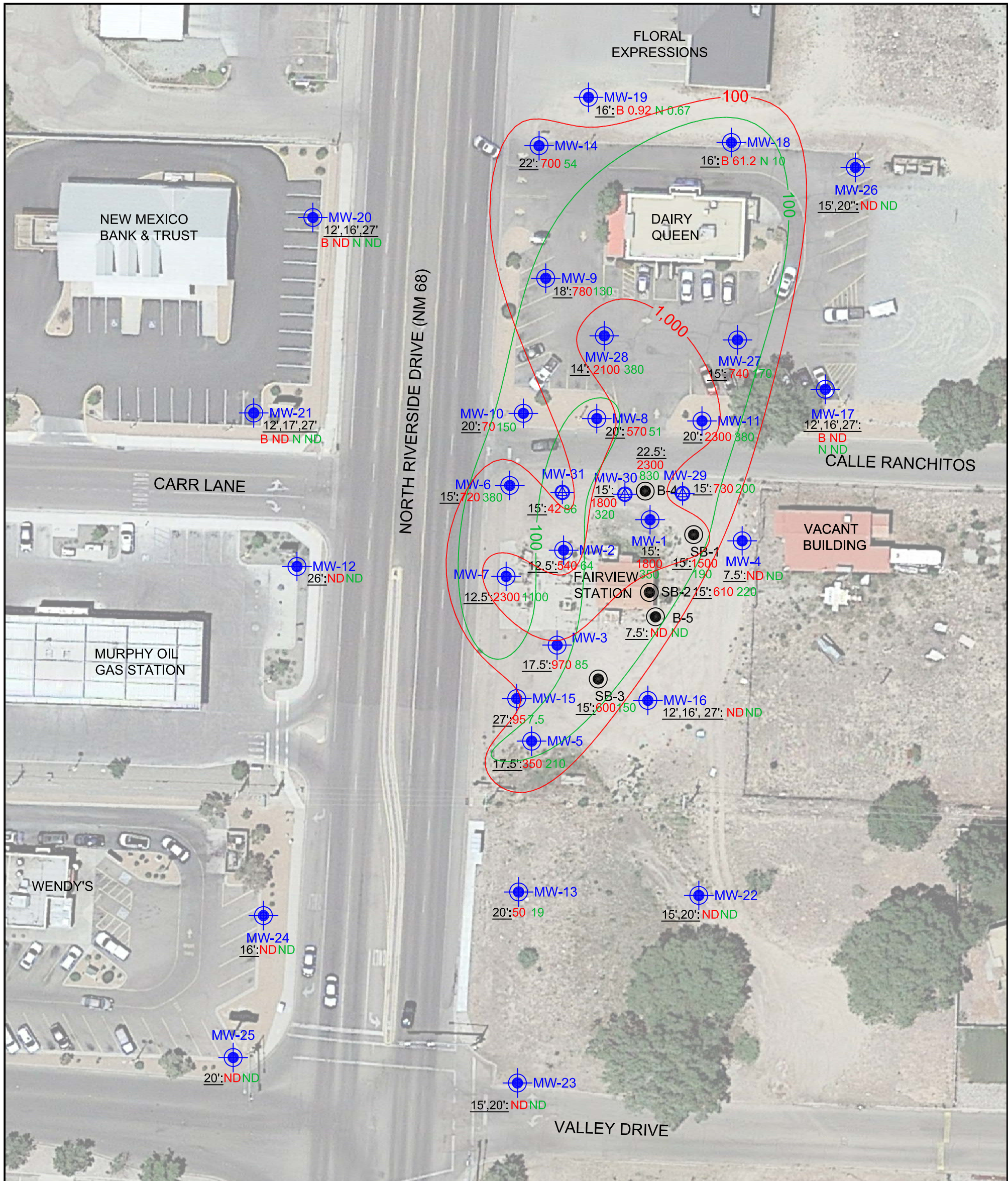
- MW-7 2" MONITORING WELL
- MW-30 4" MONITORING WELL
- SB-1 SOIL BORING LOCATION
- SSMH SANITARY SEWER MAN HOLE
- WV WATER VALVE
- FIRE HYDRANT
- NATURAL GAS METER
- PPO POWER POLE
- LPO LIGHT POLE
- A---A' LINE OF CROSS SECTION
- w WATER LINE
- FIBER OPTIC LINE
- OHE OVERHEAD ELECTRIC LINE
- E UNDERGROUND ELECTRIC LINE
- s SEWER PIPE
- GAS NATURAL GAS LINE
- NMDOT RIGHT-OF-WAY



SOUDER, MILLER & ASSOCIATES
 2904 Rodeo Park Drive East, Bldg 100
 Santa Fe, NM 87505
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**SITE MAP
 FAIRVIEW STATION
 ESPAÑOLA, NEW MEXICO**

Designed AJE	Drawn AJE	Checked SAM
Date: NOVEMBER 2020		
Scale: Horiz: 1" = 50' Vert: N/A		
Project No:		
Sheet: Figure 1		



LEGEND

- MW-7 2" MONITORING WELL
- MW-30 4" MONITORING WELL
- SB-1 SOIL BORING LOCATION

- ND ANALYTICAL LABORATORY RESULT BELOW PRACTICAL QUANTITATION LIMIT
- B 0.62** BENZENE CONCENTRATION IN mg/kg FOR SAMPLES WITHOUT GRO/DRO RESULTS
- N 10** NAPHTHALENE CONCENTRATION IN mg/kg FOR SAMPLES WITHOUT GRO/DRO RESULTS

- 15': DEPTH OF SOIL SAMPLE WITH HIGHEST CONTAMINANT CONCENTRATION ALL DEPTHS GIVEN FOR NON-DETECT RESULTS
- 50** TOTAL PETROLEUM HYDROCARBONS, GASOLINE RANGE ORGANICS CONCENTRATION IN mg/kg
- 85** TOTAL PETROLEUM HYDROCARBONS, DIESEL RANGE ORGANICS CONCENTRATION IN mg/kg

- 100** GASOLINE RANGE ORGANICS CONCENTRATION CONTOUR IN mg/kg
- 100** DIESEL RANGE ORGANICS CONCENTRATION CONTOUR IN mg/kg

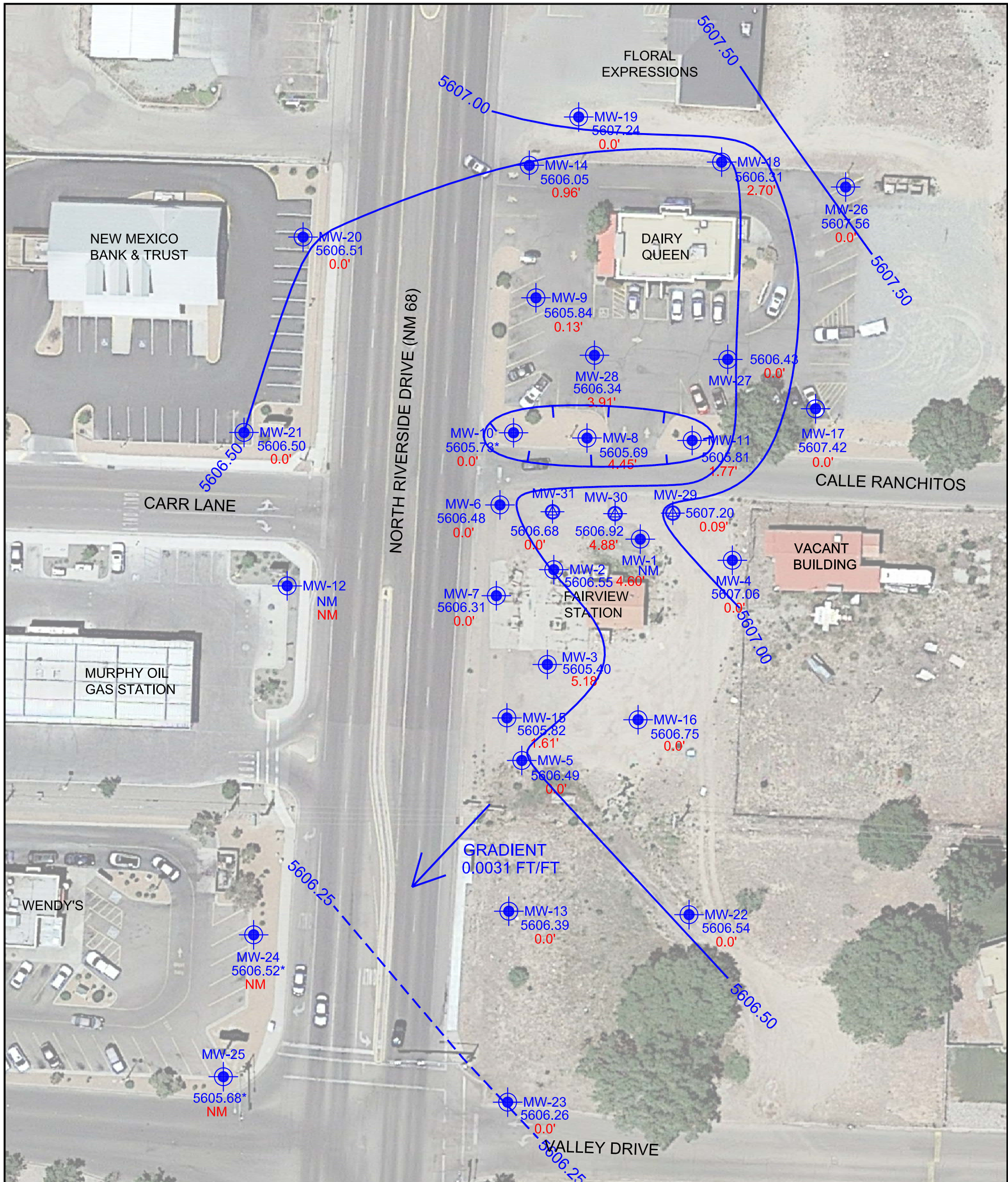


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**SOIL CONTAMINATION MAP
 FAIRVIEW STATION
 ESPAÑOLA, NEW MEXICO**

Designed AJE	Drawn AJE	Checked SAM
Date: NOVEMBER 2020		
Scale: Horiz: 1" = 50' Vert: N/A		
Project No:		
Sheet: Figure 3		

THIS DRAWING IS INCOMPLETE AND NOT TO BE USED FOR CONSTRUCTION UNLESS IT IS STAMPED, SIGNED AND DATED



LEGEND

- MW-7 2" MONITORING WELL
- MW-30 4" MONITORING WELL
- 5605.17 POTENTIOMETRIC SURFACE ELEVATION IN FEET ABOVE SEA LEVEL
- 0.0' NAPL THICKNESS IN FEET
- POTENTIOMETRIC SURFACE CONTOUR IN FEET ABOVE SEA LEVEL

* DATA COLLECTED JANUARY 2020 - NOT INCLUDED IN SURFACE CONTOURS

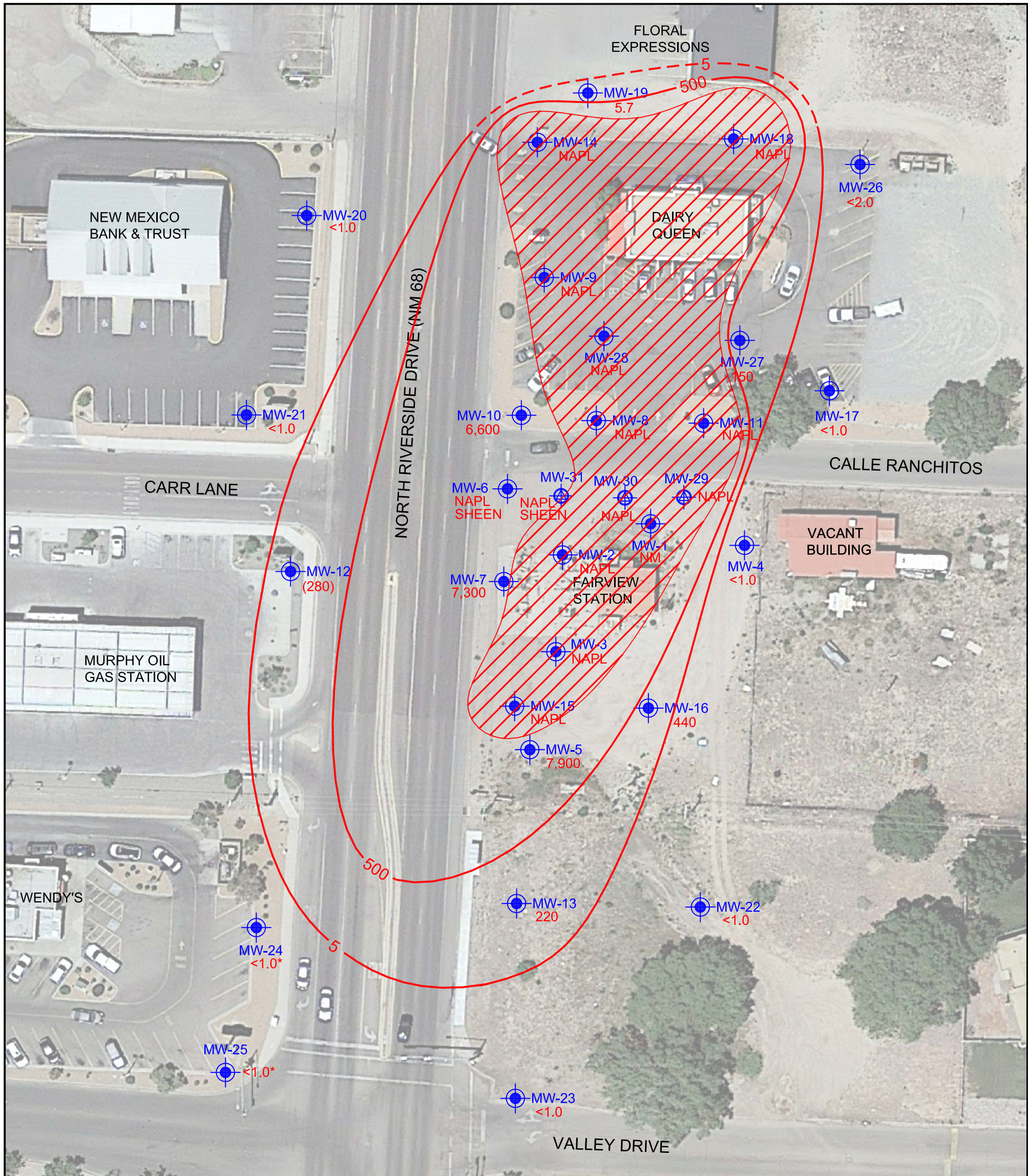
NOTE: POTENTIOMETRIC ELEVATIONS HAVE BEEN CALCULATED IN WELLS WITH NAPL. IRREGULAR SURFACE CONTOURS MAY BE CAUSED BY WELLS WITH NAPL AND THE CALCULATED ELEVATIONS.



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POTENTIOMETRIC SURFACE MAP - MARCH 2019
 FAIRVIEW STATION
 ESPAÑOLA, NEW MEXICO

Designed AJE	Drawn AJE	Checked SAM
Date: NOVEMBER 2020		
Scale: Horiz: 1" = 50' Vert: N/A		
Project No:		
Sheet: Figure 3		



LEGEND

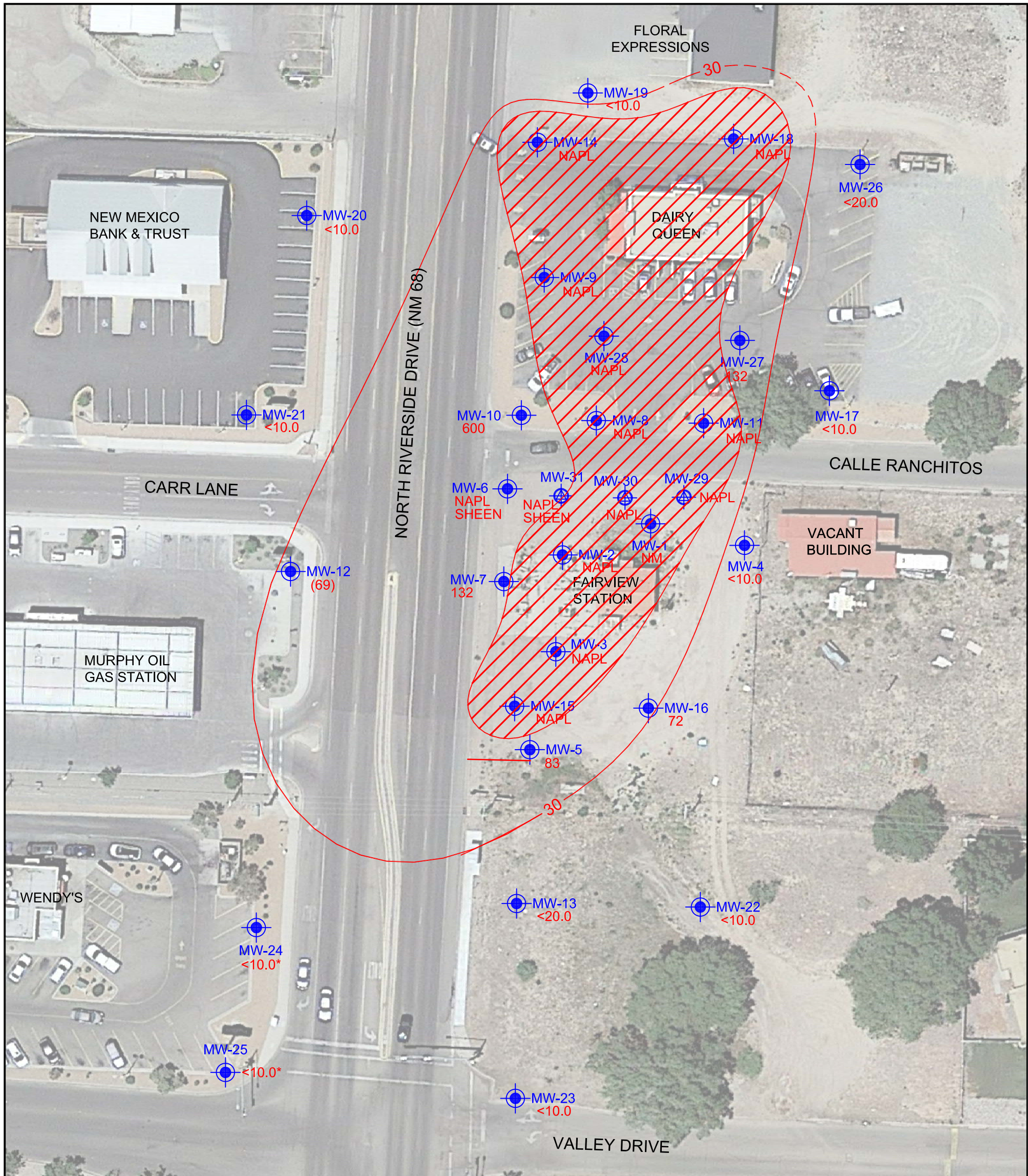
- 2" MONITORING WELL
- 4" MONITORING WELL
- DISSOLVED PHASE BENZENE CONCENTRATION IN ug/L DATA IN PARENTHESES FROM 2017
- DISSOLVED PHASE BENZENE PLUME CONTOURS IN ug/L DASHED WHERE INFERRED
- AREA OF NAPL PLUME
- WATER SAMPLE COLLECTED JANUARY 2020



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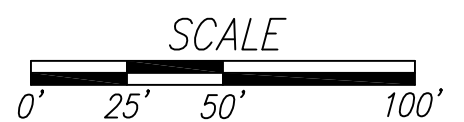
DISSOLVED PHASE BENZENE MAP - MARCH 2019
FAIRVIEW STATION
ESPAÑOLA, NEW MEXICO

Designed AJE	Drawn AJE	Checked SAM
Date: DECEMBER 2020		
Scale: Horiz: 1" = 50'		
Vert: N/A		
Project No:		
Sheet: Figure 4a		



LEGEND

- 2" MONITORING WELL
- 4" MONITORING WELL
- DISSOLVED PHASE TOTAL NAPHTHALENES CONCENTRATION IN ug/L DATA IN PARENTHESES FROM 2017
- DISSOLVED PHASE TOTAL NAPHTHALENES CONTOUR IN ug/L DASHED WHERE INFERRED
- AREA OF NAPL PLUME
- WATER SAMPLE COLLECTED JANUARY 2020



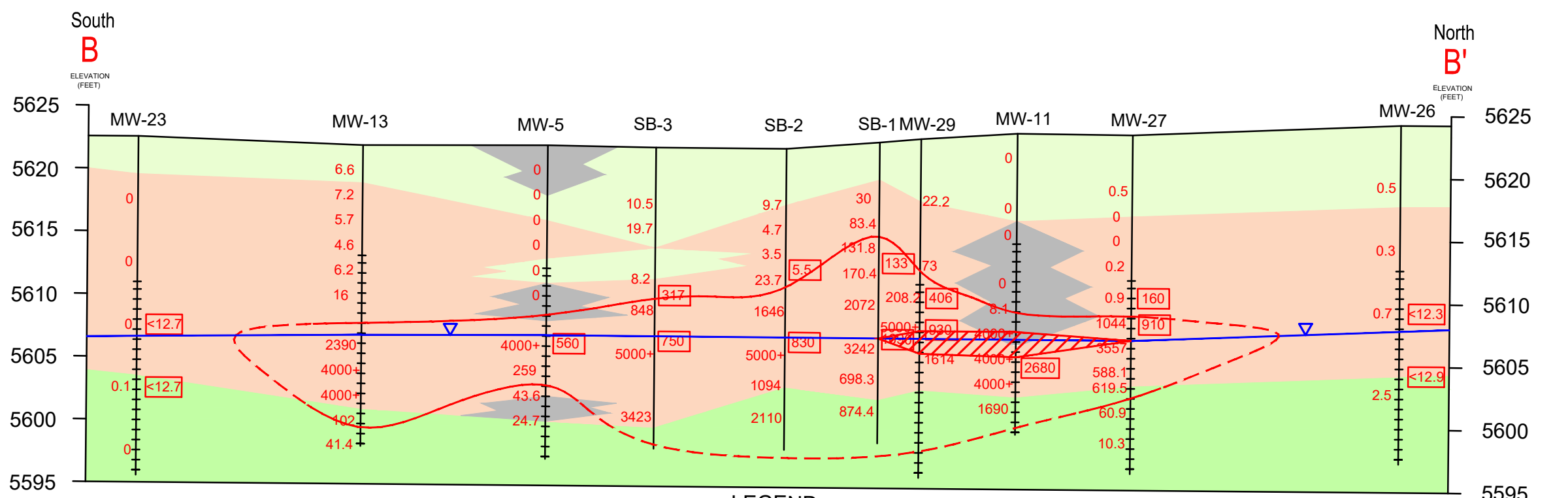
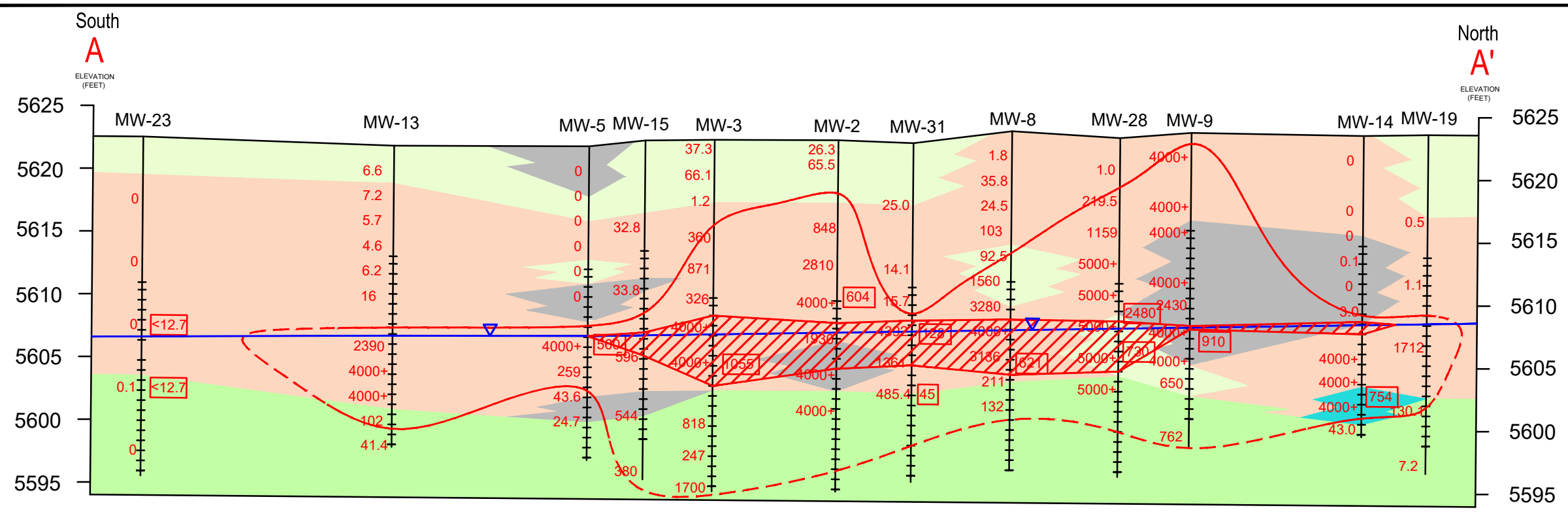
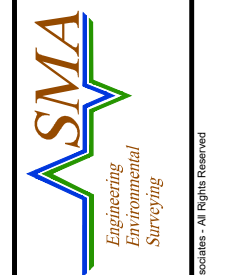
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DISSOLVED PHASE TOTAL NAPHTHALENES MAP - MARCH 2019
FAIRVIEW STATION
ESPAÑOLA, NEW MEXICO

Designed AJE	Drawn AJE	Checked SAM
Date: DECEMBER 2020		
Scale: Horiz: 1" = 50' Vert: N/A		
Project No:		
Sheet: Figure 4B		

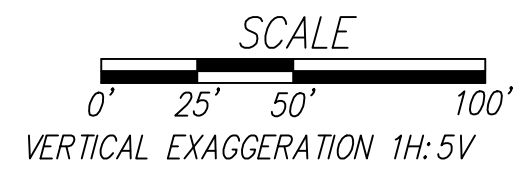
GENERALIZED GEOLOGIC / CONTAMINATION CROSS SECTIONS
 FAIRVIEW STATION
 ESPAÑOLA, NEW MEXICO

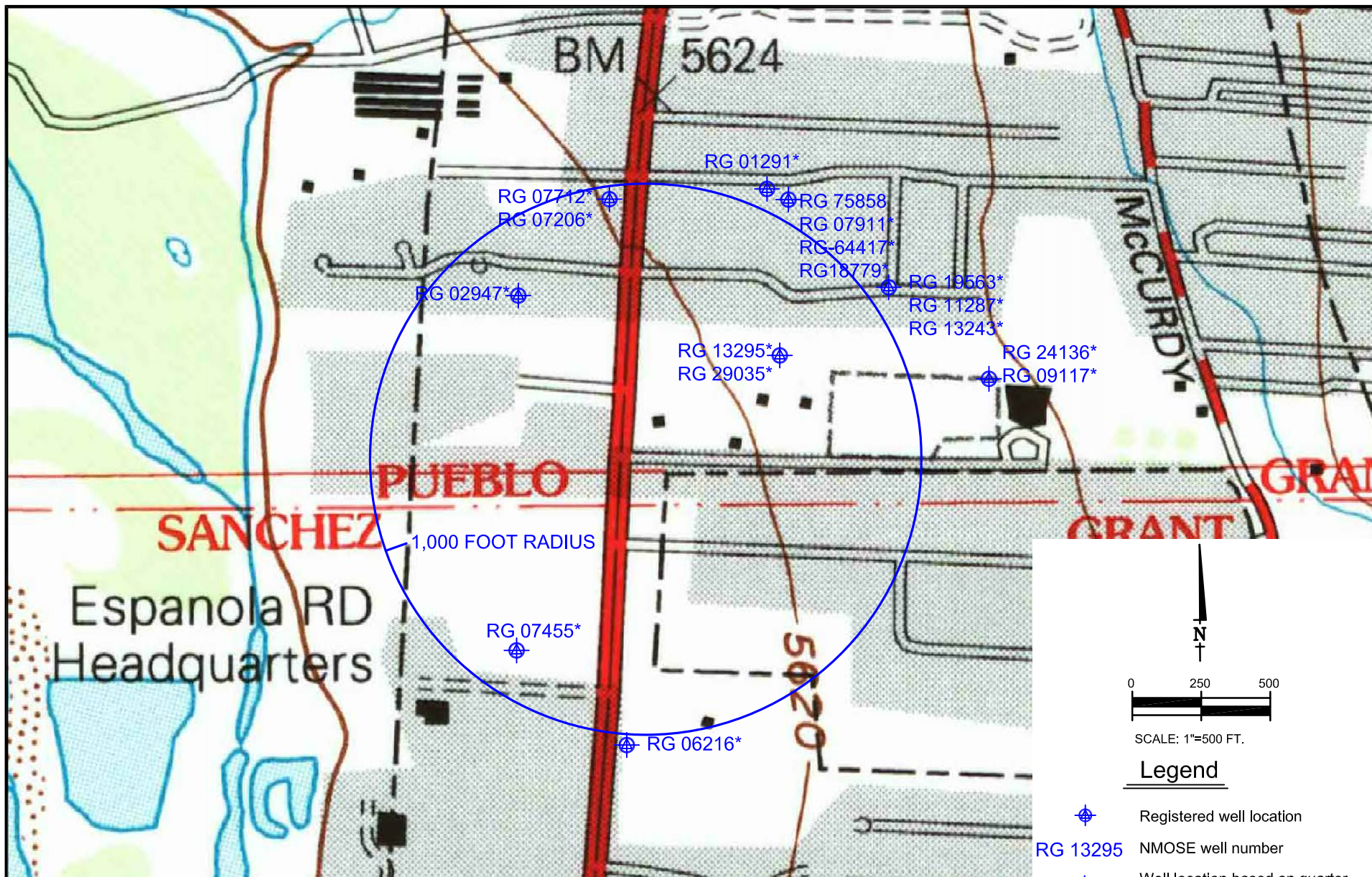
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LEGEND


	Predominantly Clay		Total petroleum hydrocarbon concentration (GRO and DRO)(mg/kg)
	Predominantly Sand		Field headspace measurement by photo-ionization detector (ppm)
	Predominantly Silt		Approximate extent of non-aqueous phase liquid
	Predominantly Sand and Gravel		Approximate extent of soil contamination
	Sediment with Caliche Cement		
	Approximate potentiometric surface elevation		





Basemap from San Juan Pueblo, NM, USGS Quadrangle (2002)

Legend

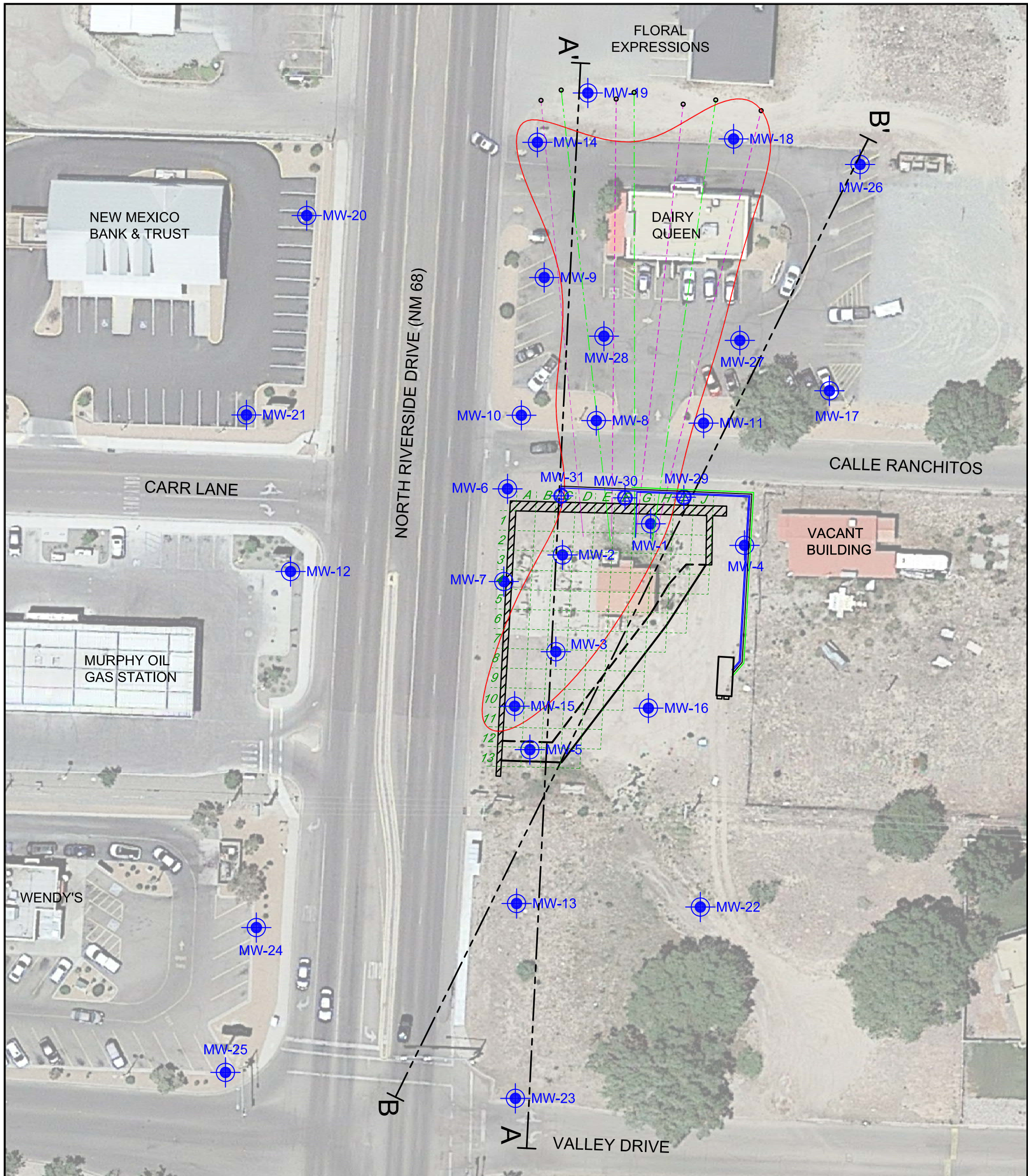
-  Registered well location
- RG 13295** NMOSE well number
- *** Well location based on quarter section descriptions



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VICINITY MAP WITH RECEPTOR LOCATIONS
 FAIRVIEW STATION STATE LEAD SITE
 ESPAÑOLA, RIO ARRIBA COUNTY, NEW MEXICO

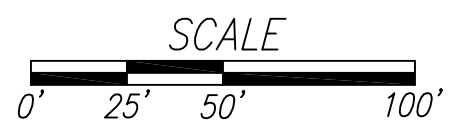
Drawn AJE	Checked SAM	Approved SAM
Date:		DECEMBER 2020
Scale:		Horiz: 1"= 500' Vert: NA
Project No:		.
Sheet:		FIGURE 7



LEGEND

- MW-7 2" MONITORING WELL
- MW-30 4" MONITORING WELL
- B-4 SOIL BORING LOCATION
- EXTENT OF NAPL PLUME
- FLUIDS RECOVERY PIPING
- COMPRESSED AIR PIPING
- TREATED WATER PIPING TO CITY SEWER

- CEMENT-BENTONITE BARRIER WALL
- AREA OF PROPOSED EXCAVATION (DASHED AT BOTTOM)
- HORIZONTAL SOIL VAPOR EXTRACTION WELLS
- HORIZONTAL NAPL/WATER COLLECTOR WELLS
- LINE OF CROSS SECTION



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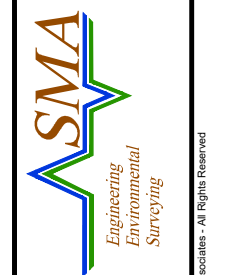
**PROPOSED BARRIER WALL, INTERIM FLUIDS TREATMENT AND EXCAVATION
 FAIRVIEW STATION
 ESPAÑOLA, NEW MEXICO**

Designed AJE	Drawn AJE	Checked SAM
Date: SEPT. 2021		
Scale: Horiz: 1" = 50' Vert: N/A		
Project No:		
Sheet: Figure 8		

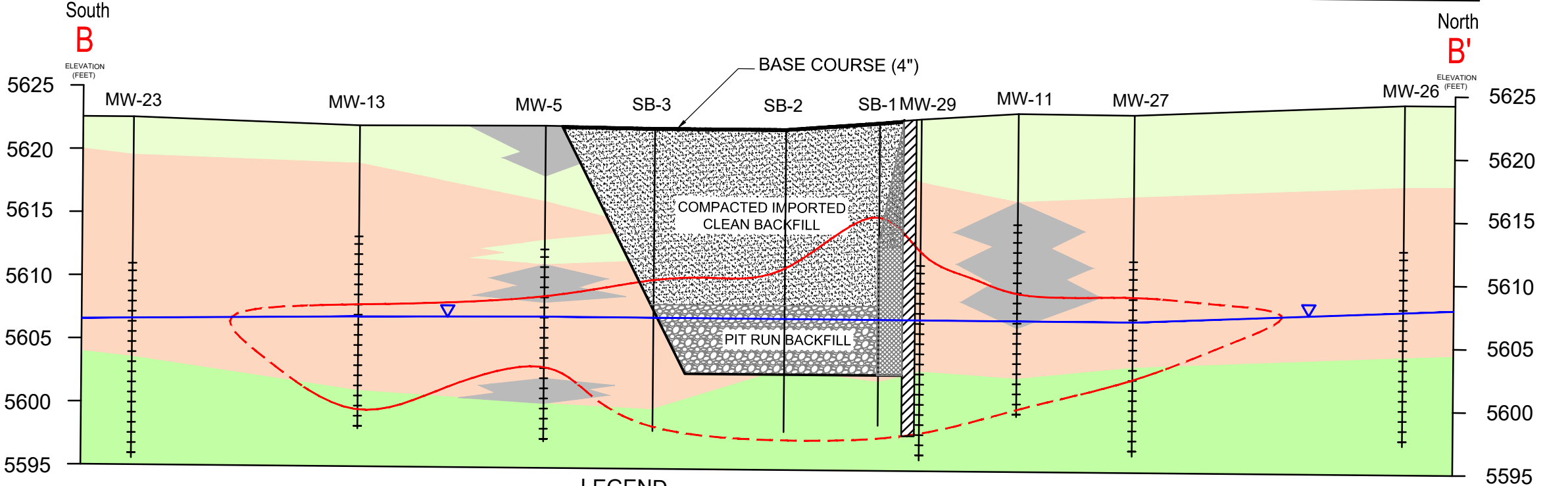
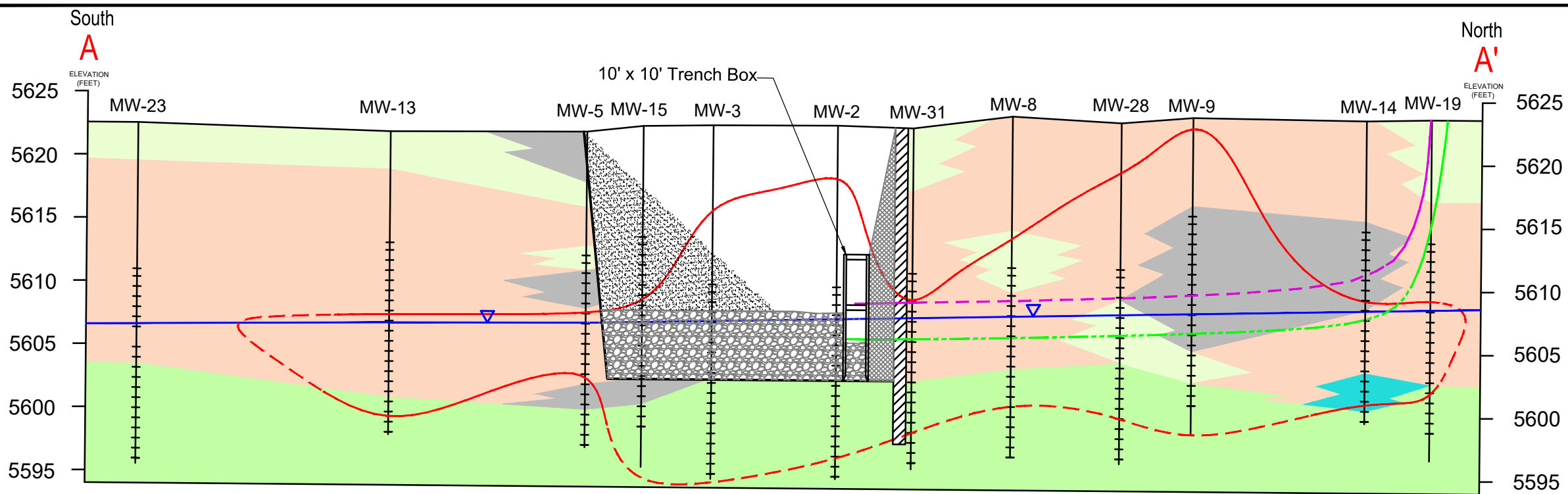
Checked	SAWI
Drawn	AJE
Designed	AJE
Date:	FEBRUARY 2022
Scale:	Horiz: 1" = 50' Vert: 1" = 10'
Project No.:	
Sheet:	Figure 9

**CROSS SECTIONS WITH EXCAVATION AND HORIZONTAL WELLS
FAIRVIEW STATION
ESPAÑOLA, NEW MEXICO**

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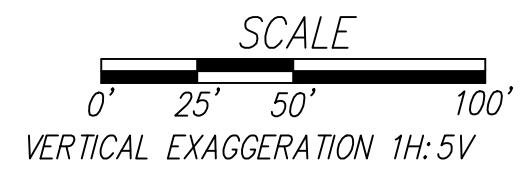


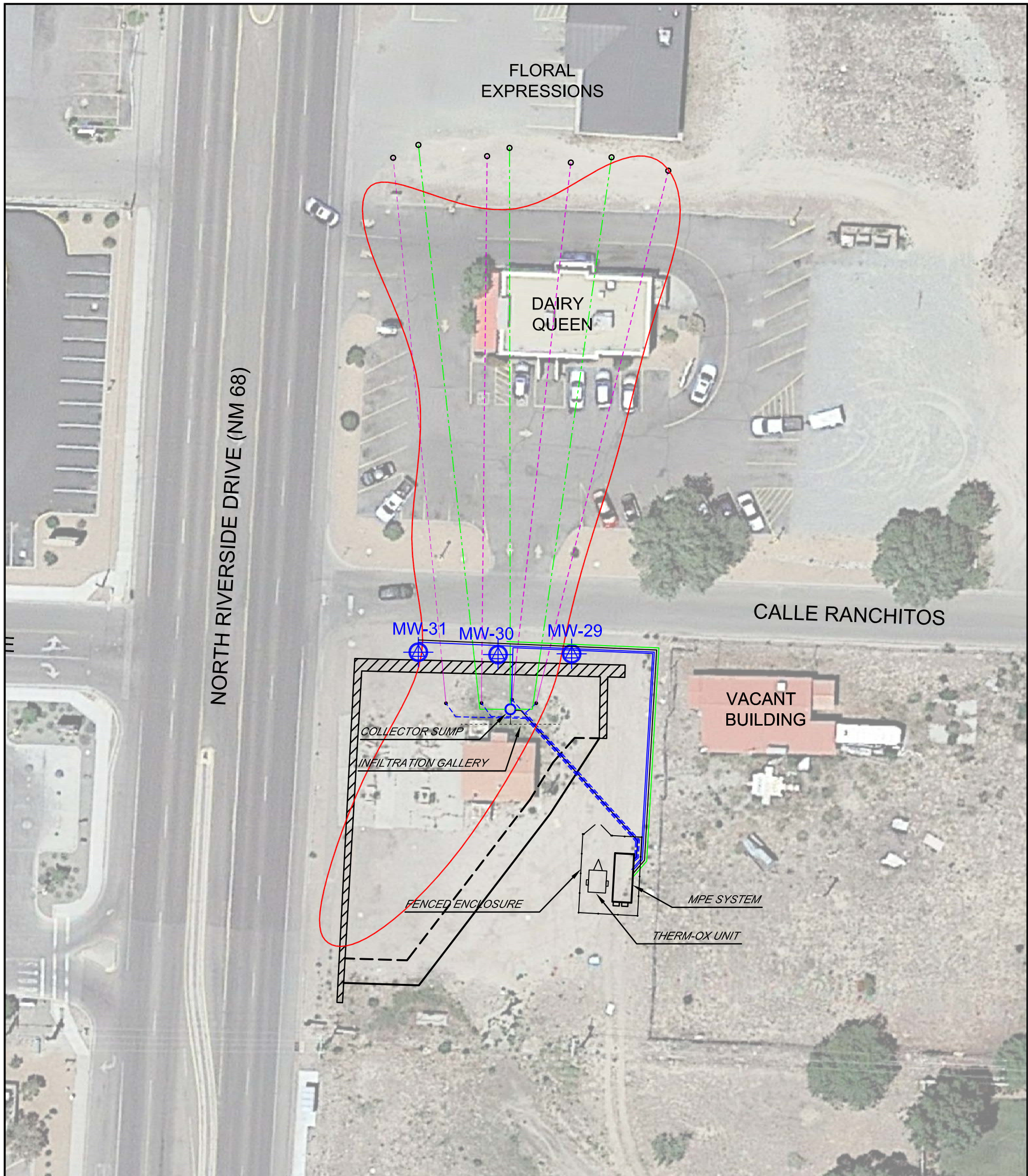
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LEGEND

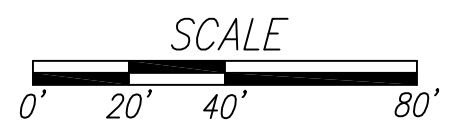
- | | |
|--|---|
| Predominantly Clay | Pit Run Sand and Gravel Backfill |
| Predominantly Sand | Zone of Trench Box Excavation and Backfill |
| Predominantly Silt | Clean Backfill |
| Predominantly Sand and Gravel | Base Course |
| Sediment with Caliche Cement | Cement-Bentonite Barrier Wall |
| Approximate potentiometric surface elevation | Soil Vapor Extraction Well Casing, slotted where dashed |
| Approximate extent of soil contamination dashed where inferred | Fluids Extraction Well Casing, slotted where dashed |





LEGEND

- MW-30 4" MONITORING WELL
- EXTENT OF NAPL PLUME
- FLUIDS RECOVERY PIPING
- COMPRESSED AIR PIPING
- TREATED WATER PIPING TO CITY SEWER
- CEMENT-BENTONITE BARRIER WALL
- AREA OF PROPOSED EXCAVATION (DASHED AT BOTTOM)
- HORIZONTAL SOIL VAPOR EXTRACTION WELLS
- HORIZONTAL NAPL/WATER COLLECTOR WELLS
- SOIL VAPOR EXTRACTION PIPING



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**REMEDIATION SYSTEM LAYOUT
 FAIRVIEW STATION
 ESPAÑOLA, NEW MEXICO**

Designed AJE	Drawn AJE	Checked SAM
Date: SEPTEMBER 2021		
Scale: Horiz: 1" = 40' Vert: N/A		
Project No:		
Sheet: Figure 10		

Tables



**Table 2
Major Equipment List
Fairview Station State Lead Site
Española, New Mexico**

Item Description	Unit	Quantity	Purchase / NMED Owned
Newterra MPE Remediation System - Project #201594		1	
Busch Mink 1502 BV Blower		2	
Vapor-Liquid Separator with high level switches		1	
Moyno 344 Transfer Pump		1	
Maple Leaf Equipment Oil-Water Separator OWS-4	Each	1	NMED Owned
Goulds IST Transfer Pump		2	
QED 2.4 Air Stripper		1	
New York Blower 1804A		1	
Various sensors, actuated valves, logic controller, power distribution and controls		1	
Modified Shipping Container with heater, ventilation		1	
Baker Furnace Thermal/Catalytic Oxidizer TX-300		1	
Roots 556 URAI Positive-Displacement Blower with 15 Hp TEFC Motor		1	
Vapor-Liquid Separator with high level switches		1	
Carbon Steel Shell Insulated with High Temperature Insulation	Each	1	NMED Owned
U.L Classified Nema 4 Control Panel		1	
Gas-Fired Fully Modulating Fuel Train.		1	
Mounted on Steel Trailer Chasis		1	
Geotech HR10-12I 10 Hp Air Compressor		1	
ASCO Solenoid Valve 8210G054 1", NC, 0-150 PSI, 120V, 60HZ	Each	1	Purchase
Combination air filter, moisture trap		1	
Geotech AR4 4" Auto-Reclaimer Pump, Short Top-Filling		3	
Pneumatic Cycle Counter GEOPC350	Each	3	Purchase
Air Pressure Regulator		3	
Slip Well Caps with Hose Adapters		3	
Zoeller Explosion-Proof Sump Pump X165	Each	1	Purchase
Fenced Enclosure - 24x32 Feet, 12 Foot Double-Gate, Barbed Wire x3, Privacy Slats	Job	1	Purchase
Electrical Meter Loop, Service Panel, conduit connections to equipment, installed	Job	1	Purchase

Appendix A: Remediation Equipment Information

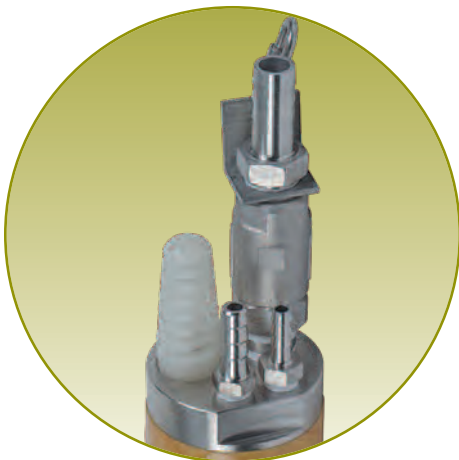
Total Fluids Recovery Pump

Geotech AR4 4" Auto-Reclaimer

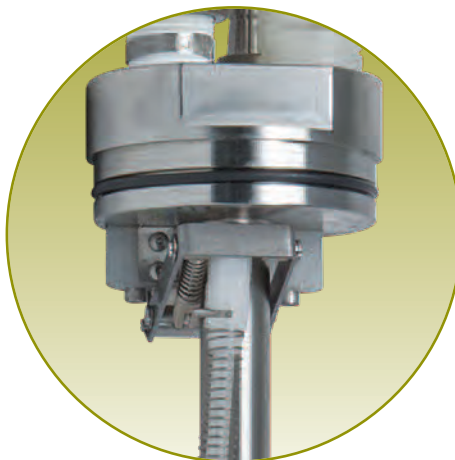
The AR4 is designed to pump floating hydrocarbons, leachate, and condensate in total fluids applications. The AR4 is operated automatically, and needs no controller. Everything needed to operate the system is built into the pump. The design withstands the harshest and most corrosive environments such as landfills or mines.

FEATURES

- Intrinsically safe design and approved for hazardous environments
- Fits 4" or larger diameter wells
- Ability to pump from 250' below ground
- Can pump particles up to 1/8" diameter
- Consistently pumps fluids as light as 0.70 SpG reliably
- New adjustment-free valve mechanism – no magnets
- Improved float design for maximum buoyancy and chemical compatibility
- Optimal working pressures as low as 1 psi above head pressure
- Standard light-weight composite housing, corrosive resistant 316 stainless steel and PVDF parts for less maintenance
- Fast and simple disassembly for easy maintenance



Pump Head



Pump Valve



Composite
Housing

Stainless
Steel
Housing

CALL GEOTECH TODAY (800) 833-7958

Geotech Environmental Equipment, Inc.

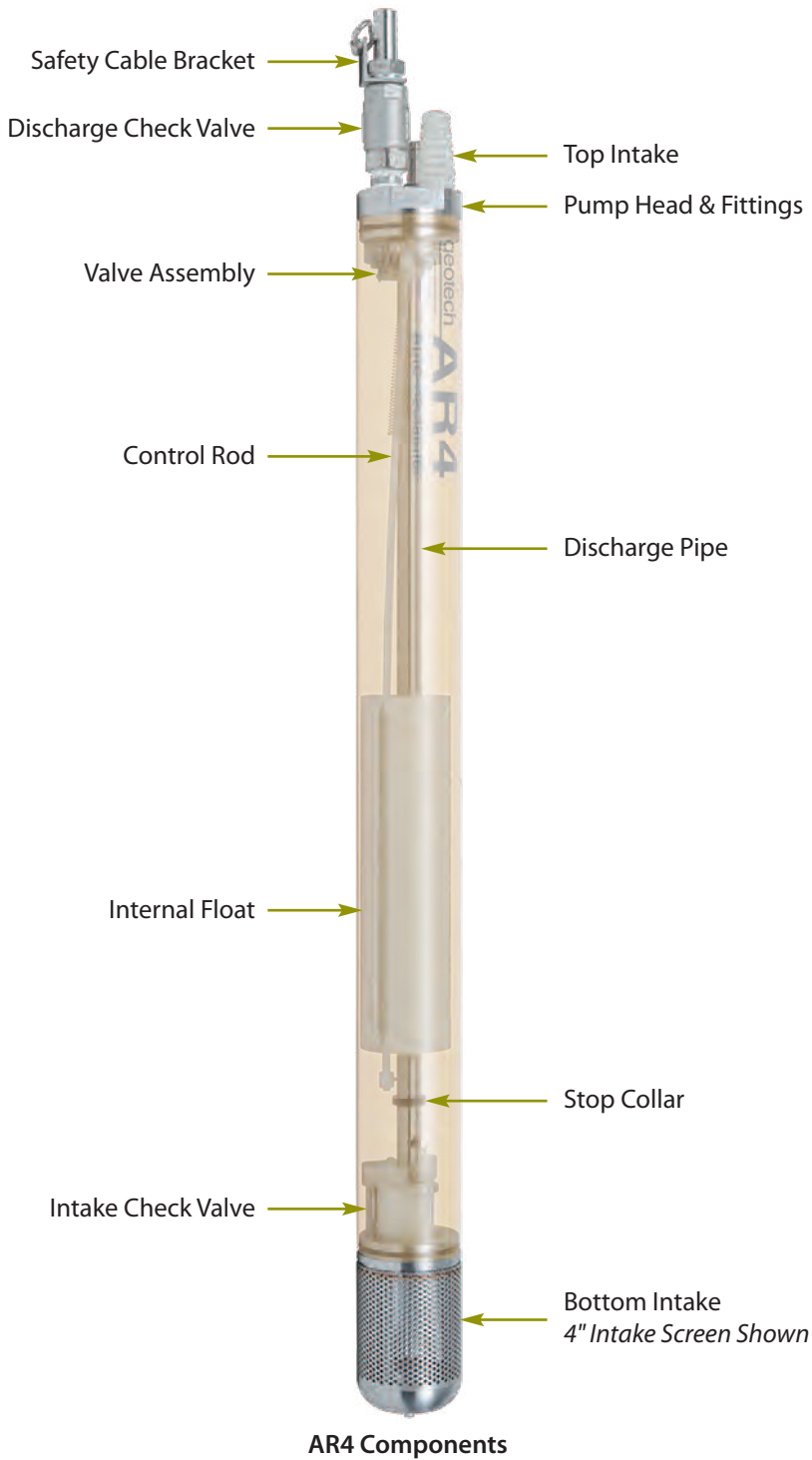
2650 East 40th Avenue • Denver, Colorado 80205

(303) 320-4764 • **(800) 833-7958** • FAX (303) 322-7242

email: sales@geotechenv.com website: www.geotechenv.com

Total Fluids Recovery Pump

Geotech AR4 4" Auto-Reclaimer



Top Intake



Optional Quick-Connect Fittings

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Total Fluids Recovery Pump

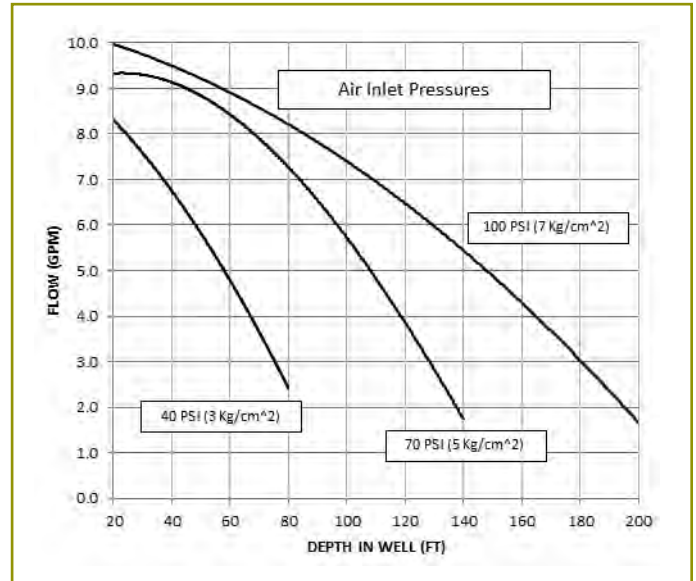


Geotech AR4 4" Auto-Reclaimer

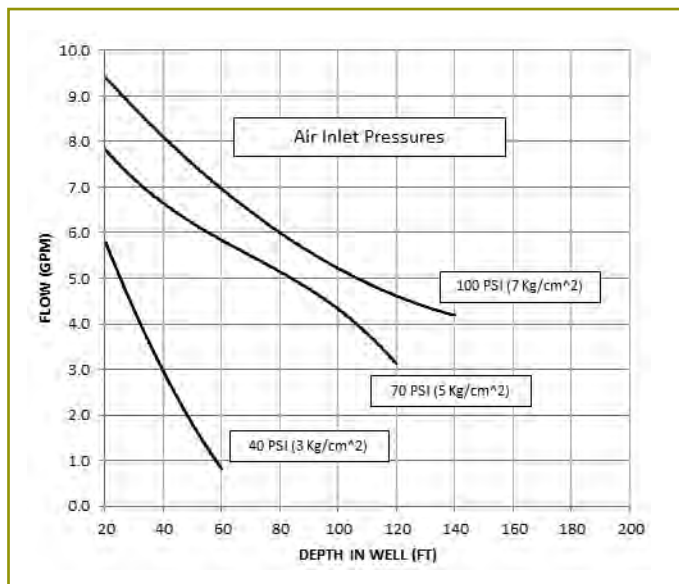
SPECIFICATIONS

	SHORT	LONG	EXT
Outside Diameter:	3.5" (8.9 cm)		
Lengths Up To:	48" (122 cm)	60" (152 cm)	72" (183 cm)
Weight:	13.5 lbs. (6 kg)	15.6 lbs. (7 kg)	17.7 lbs. (8 kg)
Min. Activation Level:	35" (89 cm)	47" (119 cm)	59" (150 cm)
Operating Pressure Range:	10-120 psi (0.7-8.5 kg/cm ²)		
Max. Operating Temp:	220°F (104°C)		
Fluid Volume/Cycle*:	.7 gal. (2.6 liter)	1.0 gal. (3.8 liter)	1.5 gal. (5.6 liter)
Max. Flow Rate**:	8.5 gpm (32 lpm)		
Standard Fittings:	SS Barb		
Fluid Discharge	¾" x ¾" MPT		
Air Supply	¾" x ¾" MPT		
Air Exhaust	½" x ¾" MPT		
Materials of Construction:	Includes: SS316, FRP, FPM, PVDF, HDPE, PTFE, Viton®		

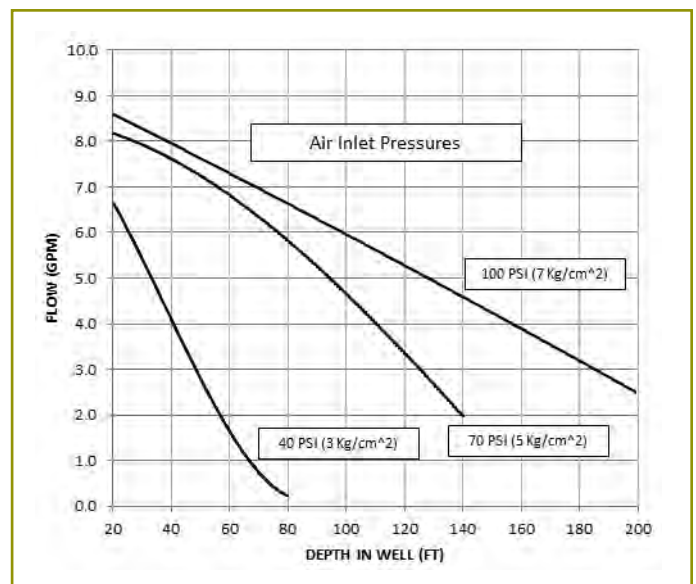
*Specific gravity and viscosities will alter specifications
 **Flow rates will vary with site conditions



AR4 Short, Bottom Inlet
 10' (3m) Submergence, ¾" (19mm) ID Hose



AR4 Long, Bottom Inlet
 10' (3m) Submergence, ¾" (19mm) ID Hose



AR4 Extended, Bottom Inlet
 10' (3m) Submergence, ¾" (19mm) ID Hose

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Total Fluids Recovery Pump

Geotech AR4 Accessories

PNEUMATIC CYCLE COUNTER

The Pneumatic Cycle Counter is mounted inline after the filter and allows you to total the volumes pumped and determine service and maintenance schedules.

Specifications:

Model	GEOPC350	
Material	464 Naval Brass	
Size	5" L x 2" W	
Thread Type	¼" FPT	
Pressure Range	40-275 psi	
No. of Counts Before Rollover	999,999	
Air Supply Tubing Sizes:	¾" ID	½" ID
Minimum Distance To Pump	15'	15'
Maximum Distance From Pump	350'	300'



COMPRESSORS & REGULATORS

Geotech can provide the compressed air equipment required for your Auto-Reclaimers.

Air Compressors

Geotech offers electric powered and gas powered compressors, selected for dependability, low maintenance and oil-free high performance.

Air Regulators

A variety of types for your air supply line requirements.



TUBING

Nylon 12:

Air Supply	¾" ID x ½" OD
Exhaust	½" ID x 5/8" OD
Discharge	¾" ID x 1" OD
Min. Bend Radius	24"
Max. Pressure	330 psig @ 70°F
Max. Continuous Length	500'

Poly:

Air Supply	¾" ID x ½" OD
Exhaust	½" ID x 5/8" OD
Discharge	¾" ID x 1" OD
Min. Bend Radius	24"
Max. Pressure	120 psig @ 70°F
Max. Continuous Length	300'



WELL CAPS AND ACCESSORIES

A Standard Slip

Penetrations, with safety cable hanger
Available for 2, 3, 4, 6, and 8 inch diameter wells

B Compression Slip

Compression fittings, with safety cable hanger
Available for 2, 3, 4, 6, and 8 inch diameter wells

C Vacuum Caps

Potted well cap for a complete vacuum seal
Barbed style fittings, with safety cable hanger
Available with quick-connect fittings
Available for 2, 3, 4, 6, and 8 inch diameter wells

Standard Fittings Provided:

- Air – ¾" Barb
- Exhaust – ½" Barb
- Discharge – ¾" Barb

Custom well caps and quick-connect fittings available upon request.



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email: sales@geotechenv.com website: www.geotechenv.com

Reciprocating (Piston) Air Compressor

Geotech offers an oil lubricated, two stage, tank-mounted, reciprocating (piston) air compressor to provide positive air pressure for powering pneumatic equipment for intermittent use applications. Contact Geotech for proper sizing of systems to meet your air flow and air pressure requirements.

FEATURES

- Integral cylinder head; gasketless design
- Disc-type valves, corrosion resistant Swedish steel for long life
- Balanced pistons, weight matched for smooth operation
- Intercoolers for greatest cooling effect for maximum compressor efficiency
- Oversized main bearing, taper roller design for longest possible life
- Balanced crankshaft, constructed of rugged ductile iron with large diameter throws
- Large capacity crankcase, cast iron oil reservoir has convenient sight glass
- Loadless starting governor-type centrifugal unloader assures longer motor life
- 5-Year Warranty on compressor pump
- ISO 9001 Standards
- Up to six standard, pre-installed accessories:
 - Air-cooled After Cooler
 - Magnetic Starter
 - Auto Tank Drain
 - Vibration Mounts
 - Low Oil Monitor
 - Dual Control (on units 10 hp and larger) Available upon Request

GENERAL PRINCIPLE

In a reciprocating air compressor, inlet air enters the first stage of the compressor pump where a piston compresses the air and then transfers the air to the second stage where the second piston compresses the air further until the final pressure is sent down stream to the air receiver tank.

APPLICATIONS

- Sampling Pumps
- Groundwater Extraction Pumps
- Total Fluids Extraction Systems
- Hydrocarbon Skimming Systems

CALL GEOTECH TODAY (800) 833-7958

Geotech Environmental Equipment, Inc.
 2650 East 40th Avenue • Denver, Colorado 80205
 (303) 320-4764 • FAX (303) 322-7242
 email: sales@geotechenv.com • website: www.geotechenv.com



Model VR5-8

SPECIFICATIONS*

Model	HP	Working Pressure (PSIG)	Air Delivery (ICFM)
VR2-6	2	125	5.6
		175	4.2
VR5-8	5	125	19.1
		175	17.3
VR7.F-8	7.5	125	23.9
		175	23.1
HR10-12I	10	125	37.3
		175	34.8
HRA15-12	15	125	50.2
		175	49.0
HRA25-12	25	125	102.1
		175	90.1

*Call to discuss other model sizes.

Features

- Wide range of pressure ratings, sizes, and resilient materials provide long service life and low internal leakage
- High flow valves for liquid, corrosive, and air/inert gas service
- Lead-free versions available for Safe Drinking Water Act Compliance
- Industrial applications include:
 - Car wash
 - Laundry equipment
 - Air compressors
 - Industrial water control
 - Pumps

Construction

Valve Parts in Contact with Fluids		
Body	Brass	304 Stainless Steel*
Seals and Discs	NBR or PTFE	
Disc-Holder	PA	
Core Tube	305 Stainless Steel	
Core and Plugnut	430F Stainless Steel	
Springs	302 Stainless Steel	
Shading Coil	Copper	Silver

*Catalog Numbers 8210G127, 8210G129, 8210G132, 8210G133 have 316L Stainless Steel bodies.

Electrical

Standard Coil and Class of Insulation	Watt Rating and Power Consumption				Spare Coil Part Number			
	DC Watts	AC			General Purpose		Explosionproof	
		Watts	VA Holding	VA Inrush	AC	DC	AC	DC
F	-	6.1	16	40	238210	-	238214	-
F	11.6	10.1	25	70	238610	238710	238614	238714
F	15.8	-	-	-	-	501695	-	501696
F	16.8	16.1	35	180	272610	97617	272614	97617
F	-	17.1	40	93	238610	-	238614	-
F	-	20	43	240	99257	-	99257	-
F	-	20.1	48	240	272610	-	272614	-
F	30.8	-	-	-	-	501695	-	501696
H	11.6	-	-	-	-	238910	-	238914
H	40.6	-	-	-	-	238910	-	238914

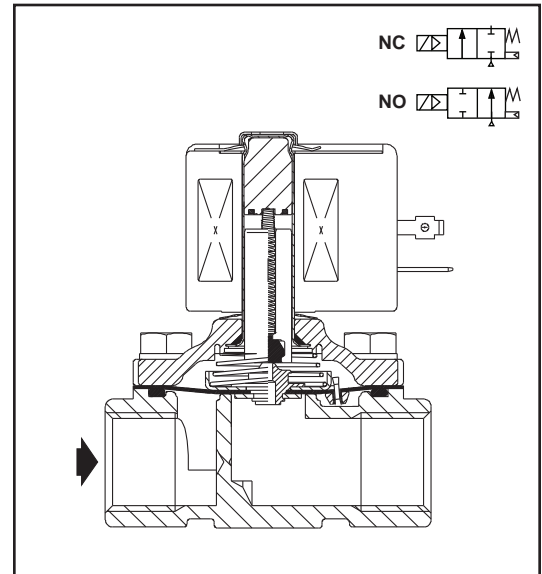
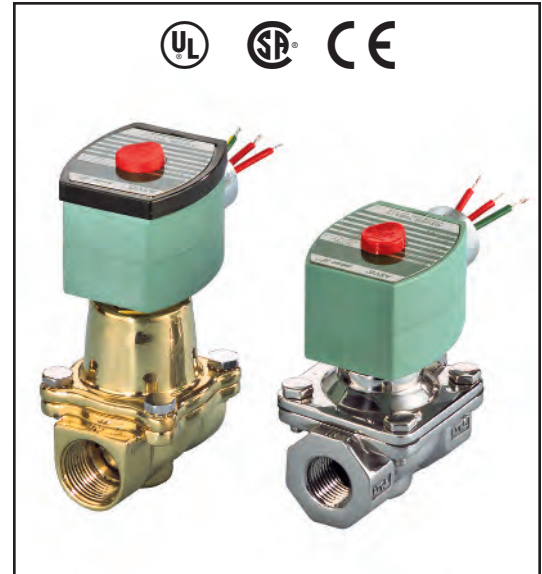
Standard Voltages: 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220 volts AC, 50 Hz). 6, 12, 24, 120, 240 volts DC. Must be specified when ordering.
 Other voltages available when required.

Solenoid Enclosures

Standard: RedHat II - Watertight, Types 1, 2, 3, 3S, 4, and 4X; RedHat - Type 1.

Optional: RedHat II - Explosionproof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9; Red-Hat - Explosionproof and Watertight, Types 3, 4, 4X, 7, and 9.

(To order, add prefix "EF" to catalog number, except Catalog Numbers 8210B057, 8210B058, and 8210B059, which are not available with Explosionproof enclosures.)
 See *Optional Features Section* for other available options.



Nominal Ambient Temp. Ranges

RedHat II/RedHat AC: 32°F to 125°F (0°C to 52°C)

RedHat II DC: 32°F to 104°F (0°C to 40°C)

RedHat DC: 32°F to 77°F (0°C to 25°C)
 (104°F/40°C occasionally)

8210G227 AC: 32°F to 130°F (0°C to 54°C)

DC: 32°F to 90°F (0°C to 32°C)

Refer to *Engineering Section* for details.

Approvals

UL listed as indicated. CSA certified.
 RedHat II meets applicable CE directives.

Refer to *Engineering Section* for details.

ATEX/IECEx certified with prefix "EV" as listed. Refer to *Optional Features Electrical Section* for details.

Specifications (English units)

Pipe Size (in)	Orifice Size (in)	Cv Flow Factor	Operating Pressure Differential (psi)								Max. Fluid Temp. °F		Brass Body			Stainless Steel Body			Watt Rating/Class of Coil Insulation ⑦	
			Max. AC				Max. DC						Catalog Number	Const. Ref. ④	UL ⑤ Listing	Catalog Number	Const. Ref. ④	UL ⑤ Listing		
			Min.	Air-Inert Gas	Water	Light Oil @ 300 SSU	Air-Inert Gas	Water	Light Oil @ 300 SSU	AC	DC									
NORMALLY CLOSED (Closed when de-energized), NBR or PTFE ② Seating																				
3/8	3/8	1.5	①	150	125	-	40	40	-	180	150	8210G073 ③	1P	●	8210G036 ③	1P	●	6.1/F	11.6/F	
3/8	5/8	3	0	150	150	-	40	40	-	180	150	8210G093	5D	○	-	-	-	10.1/F	11.6/F	
3/8	5/8	3	5	200	150	135	125	100	100	180	150	8210G001 ▼	6D	○	-	-	-	6.1/F	11.6/F	
3/8	5/8	3	5	300	300	300	-	-	-	175	-	8210G006 ✓	5D	○	-	-	-	17.1/F	-	
1/2	7/16	2.2	①	150	125	-	40	40	-	180	150	8210G015 ③	2P	●	8210G037 ③	2P	●	6.1/F	11.6/F	
1/2	5/8	4	0	150	150	-	40	40	-	180	150	8210G094 ✓/♠	5D	○	-	-	-	10.1/F	11.6/F	
1/2	5/8	4	0	150	150	125	40	40	-	175	150	-	-	-	8210G087 ✓	7D	●	17.1/F	11.6/F	
1/2	5/8	4	5	200	150	135	125	100	100	180	150	8210G002 ▼/♠	6D	○	-	-	-	6.1/F	11.6/F	
1/2	5/8	4	5	300	300	300	-	-	-	175	-	8210G007	5D	○	-	-	-	17.1/F	-	
1/2	3/4	4	5	-	300	-	-	300	-	130	90	8210G227	5D	○ †	-	-	-	17.1/F	40.6/H	
3/4	5/8	4.5	0	150	150	125	40	40	-	175	150	-	-	-	8210G088 ✓	7D	●	17.1/F	11.6/F	
3/4	3/4	5	5	125	125	125	100	90	75	180	150	8210G009 ▼/♠	9D	○	-	-	-	6.1/F	11.6/F	
3/4	3/4	5	0	150	150	-	40	40	-	180	150	8210G095 ✓/♠	8D	○	-	-	-	10.1/F	11.6/F	
3/4	3/4	6.5	5	250	150	100	125	125	125	180	150	8210G003 ▼	11D	○	-	-	-	6.1/F	11.6/F	
3/4	3/4	6	0	350	300	200	200	200	200	200	180	8210G026 ② † ◆	40P/10D	●	-	-	-	16.1F	30.8/F	
1	1	13	0	150	125	125	135	120	120	180	180	8210G054 † ◆	41D/31D	●	8210G089 † ◆	45D/15D	●	16.1/F	30.8/F	
1	1	13	5	150	150	100	125	125	125	180	150	8210G004 ▼/♠	12D	○	-	-	-	6.1/F	11.6/F	
1	1	13.5	0	300	225	115	-	-	-	200	-	8210G027	42P	●	-	-	-	20.1/F	-	
1	1	13.5	10	300	300	300	-	-	-	175	-	8210G078 ②	13P	-	-	-	-	17.1/F	-	
1 1/4	1 1/8	15	0	150	125	125	135	120	120	180	180	8210G055 † ◆	43D/32D	●	-	-	-	16.1/F	30.8/F	
1 1/4	1 1/8	15	5	150	150	100	125	125	125	180	150	8210G008 ▼	16D	○	-	-	-	6.1/F	11.6/F	
1 1/2	1 1/4	22.5	0	150	125	125	135	120	120	180	180	8210G056 † ◆	44D/33D	●	-	-	-	16.1/F	30.8/F	
1 1/2	1 1/4	22.5	5	150	150	100	125	125	125	180	150	8210G022 ▼	18D	○	8210G127	52D	●	6.1/F	11.6/H	
2	1 3/4	43	5	150	125	90	50	50	50	180	150	8210G100	20P	●	8210G129	53P	●	6.1/F	11.6/H	
2 1/2	1 3/4	45	5	150	125	90	50	50	50	180	150	8210G101	21P	●	-	-	-	6.1/F	11.6/F	
NORMALLY OPEN (Open when de-energized), NBR Seating (PA Disc-Holder, except as noted)																				
3/8	5/8	3	0	150	150	125	125	125	80	180	150	8210G033	23D	●	-	-	-	10.1/F	11.6/F	
3/8	5/8	3	5	250	200	200	250	200	200	180	180	8210G011 ⑥ ⑧	39D	●	-	-	-	10.1/F	11.6/F	
1/2	5/8	4	0	150	150	125	125	125	80	180	150	8210G034 ✓	23D	●	-	-	-	10.1/F	11.6/F	
1/2	5/8	3	0	150	150	100	125	125	80	180	150	-	-	-	8210G030 ✓	37D	●	10.1/F	11.6/F	
1/2	5/8	4	5	250	200	200	250	200	200	180	180	8210G012 ⑥ ⑧	39D	●	-	-	-	10.1/F	11.6/F	
3/4	3/4	5.5	0	150	150	125	125	125	80	180	150	8210G035 ✓	25D	●	-	-	-	10.1/F	11.6/F	
3/4	5/8	3	0	150	150	100	125	125	80	180	150	-	-	-	8210G038 ✓	38D	●	10.1/F	11.6/F	
3/4	3/4	6.5	5	250	200	200	250	200	200	180	180	8210G013	46D/52D	●	-	-	-	16.1/F	15.8/F	
1	1	13	0	125	125	125	-	-	-	180	-	8210B057 ⑥ ⑧	34D	●	-	-	-	20/F	-	
1	1	13	5	150	150	125	150	150	125	180	180	8210G014	47D/53D	●	-	-	-	16.1/F	15.8/F	
1 1/4	1 1/8	15	0	125	125	125	-	-	-	180	-	8210B058 ⑥ ⑧	35D	●	-	-	-	20/F	-	
1 1/4	1 1/8	15	5	150	150	125	150	150	125	180	-	8210G018	48D/54D	●	-	-	-	16.1/F	15.8/F	
1 1/2	1 1/4	22.5	0	125	125	125	-	-	-	180	-	8210B059 ⑥ ⑧	36D	●	-	-	-	20/F	-	
1 1/2	1 1/4	22.5	5	150	150	125	150	150	125	180	180	8210G032	49D/55D	●	8210G132	29D	●	16.1/F	15.8/F	
2	1 3/4	43	5	150	125	125	150	150	125	180	180	8210G103	50P/56P	●	8210G133	30P	●	16.1/F	15.8/F	
2 1/2	1 3/4	45	5	150	125	125	150	150	125	180	180	8210G104	51P/57P	●	-	-	-	16.1/F	15.8/F	

① 5 psi on Air; 1 psi on Water.

② Valve provided with PTFE main disc.

③ Valve includes Ultem (G.E. trademark) piston.

④ Letter "D" = diaphragm construction; "P" = piston construction.

⑤ ○ Safety Shutoff Valve; ● General Purpose Valve.

Refer to Engineering Section (Approvals) for details.

⑥ Valves not available with Explosionproof enclosures.

⑦ On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.

⑧ AC construction also has PA seating.

⑨ No disc-holder.

⑩ Stainless steel disc-holder.

† UL listed for fire protection systems per UL429A 120/60,

110/5024VDC, no prefix and voltage options offered.

‡ DC constructions must have solenoid mounted vertical and upright.

✓ ATEX/IECEx certified with prefix "EV".

▼ ATEX/IECEx certified for DC only with prefix "EV".

◆ Not available in 6 Volt DC. EF and HB prefix only.

♠ Valve available with lead-free brass body and bonnet using suffix "LF". The term "Lead-Free" for brass materials is defined by SDWA 1417 as having a maximum weighted average lead content of 0.25% on the wetted surface area.

Product information presented here reflects conditions at time of publication. Consult factory regarding discrepancies or inconsistencies.

Patent No. 8,535,014
Automatic model only

TECHNICAL DATA SHEET

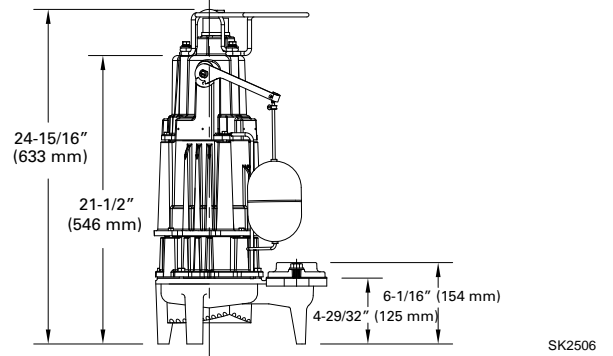
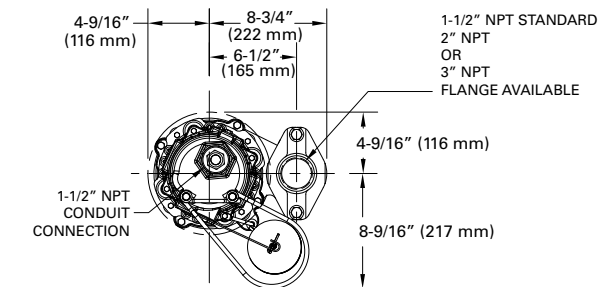
HIGH HEAD FLOW-MATE SERIES

Models X161, X163, X165 Effluent Pumps For Hazardous Location
Class I, Division 1, Groups C & D Rated
Class I, Zone 1, Groups IIA & IIB

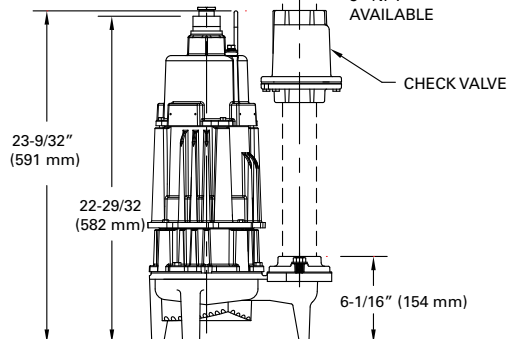
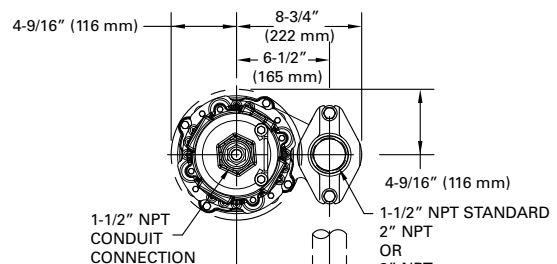
PRODUCT SPECIFICATIONS

MOTOR	Horse Power	1/2 (X161, X163) or 1 (X165)
	Voltage	115 - 575
	Phase	1 or 3 Ph
	Hertz	60 Hz
	RPM	3450
	Type	Permanent split capacitor or 3 Ph
	Insulation	Class B
	Amps	2.4 - 15.5
PUMP	Operation	Automatic or nonautomatic
	Auto On/Off Points	19-1/2" (495 mm) / 9-3/4" (248 mm)
	Discharge Size	1-1/2" NPT (optional 2" or 3" flange)
	Solids Handling	3/4" (19 mm) spherical solids
	Cord Length	20' (6 m) standard
	Cord Type	UL listed 5-wire (1 Ph) or 8-wire (3 Ph) SOOW
	Max. Head	86.5' (26 m)
	Max. Flow Rate	100 GPM (379 LPM)
	Max. Operating Temp.	104° F (40° C)
	Cooling	Oil filled
	Motor Protection	Auto reset thermal overload (1 Ph) or thermal sensor (3 Ph)
	MATERIALS	Upper Bearing
Lower Bearing		Ball bearing
Mechanical Seals		Carbon and ceramic with stainless steel parts
Impeller Type		Non-clogging vortex
Impeller		Bronze
Hardware		Stainless steel
Gasket		Neoprene square rings

AUTOMATIC



NONAUTOMATIC



All Class 30 cast iron construction.

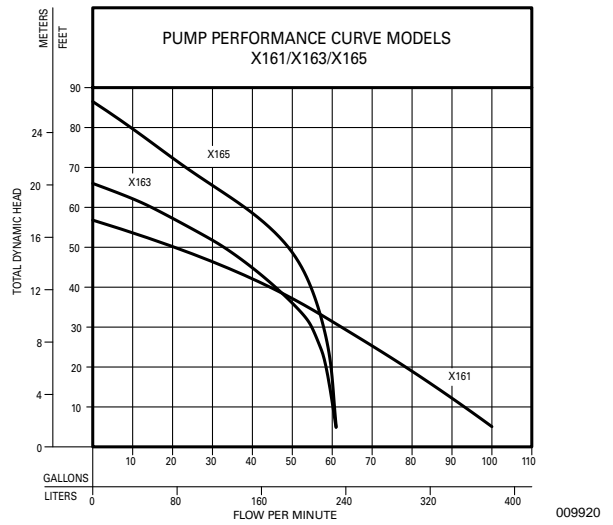
NOTE: The sizing of effluent systems normally requires variable level float(s) controls and properly sized basins to achieve required pumping cycles or dosing timers with nonautomatic pumps.

NOTE: See model comparison chart for specific details.



TOTAL DYNAMIC HEAD FLOW PER MINUTE

MODELS		X161		X163		X165	
Feet	Meters	Gal.	Liters	Gal.	Liters	Gal.	Liters
5	1.5	100	379	61	231	61	231
10	3.0	93	352	60	227	60.5	229
15	4.6	86	326	60	227	60.3	228
20	6.1	79	299	59	223	60	227
25	7.6	71	267	57	216	59	223
30	9.1	62	235	55	208	58	220
40	12.2	45	170	46	174	55	208
50	15.2	20	76	33	125	50	189
60	18.3	--	--	15	57	39	148
70	21.3	--	--	--	--	22.5	85
80	24.4	--	--	--	--	10	38
Shut-off Head:		56 ft. (17.1m)		66 ft. (20.1m)		86.5 ft. (26.4m)	



Model	MODEL COMPARISON										
	Seal	Mode	Volts	Ph	Amps	HP	Hz	Lbs	Kg	Simplex	Duplex
MX161	Single	Auto	115	1	15.5	1/2	60	123	55	3 & 4	---
NX161	Single	Non	115	1	15.5	1/2	60	114	51	1 & 2	1 & 2
DX161	Single	Auto	230	1	7.5	1/2	60	123	55	3 & 4	---
EX161	Single	Non	230	1	7.5	1/2	60	114	51	1 & 2	1 & 2
HX161	Single	Auto	200	1	8.8	1/2	60	123	55	3 & 4	---
IX161	Single	Non	200	1	8.8	1/2	60	117	53	1 & 2	1 & 2
JX161	Single	Non	200	3	6.4	1/2	60	117	53	1 & 2	1 & 2
FX161	Single	Non	230	3	5.2	1/2	60	117	53	1 & 2	1 & 2
GX161	Single	Non	460	3	2.9	1/2	60	117	53	1 & 2	1 & 2
BAX161	Single	Non	575	3	2.4	1/2	60	117	53	1 & 2	1 & 2
MX163	Single	Auto	115	1	15.0	1/2	60	123	55	3 & 4	---
NX163	Single	Non	115	1	15.0	1/2	60	114	55	1 & 2	1 & 2
DX163	Single	Auto	230	1	7.5	1/2	60	123	55	3 & 4	---
EX163	Single	Non	230	1	7.5	1/2	60	117	53	1 & 2	1 & 2
HX163	Single	Auto	200	1	8.5	1/2	60	123	55	3 & 4	---
IX163	Single	Non	200	1	8.5	1/2	60	117	53	1 & 2	1 & 2
JX163	Single	Non	200	3	6.0	1/2	60	117	53	1 & 2	1 & 2
FX163	Single	Non	230	3	4.8	1/2	60	117	53	1 & 2	1 & 2
GX163	Single	Non	460	3	2.9	1/2	60	117	53	1 & 2	1 & 2
BAX163	Single	Non	575	3	2.4	1/2	60	117	53	1 & 2	1 & 2
DX165	Single	Auto	230	1	10.2	1	60	124	56	3 & 4	---
EX165	Single	Non	230	1	10.2	1	60	114	51	1 & 2	1 & 2
HX165	Single	Auto	200	1	12.6	1	60	124	56	3 & 4	---
IX165	Single	Non	200	1	12.6	1	60	117	53	1 & 2	1 & 2
JX165	Single	Non	200	3	7.5	1	60	117	53	1 & 2	1 & 2
FX165	Single	Non	230	3	7.4	1	60	117	53	1 & 2	1 & 2
GX165	Single	Non	460	3	3.7	1	60	117	53	1 & 2	1 & 2
BAX165	Single	Non	575	3	3.0	1	60	117	53	1 & 2	1 & 2

Additional cords lengths are available in 25' (8 m), 35' (11 m), and 50' (15 m).

All models are FM and cCSAus approved.

Tested to FM Standards 3600 & 3615 by CSA

SELECTION GUIDE

1. See FM1705 for correct intrinsically-safe simplex or duplex panel
2. See FM0526 for variable level control switches rated 30VDC are used as a control activator. Quantity required dependent upon panel selection.
3. Integral float-operated mechanical switch; no external control required
4. Automatic pumps: Use the optional seal-failure panel (10-1031) to enable the moisture sensor circuit if required by local codes

CAUTION All installation of controls, protection devices and wiring should be done by a qualified licensed electrician. All electrical and safety codes should be followed including the most recent National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA).

FlexWorks Supply Piping

Why flex pipe?

OPW developed FlexWorks Pipe in response to customer feedback. You asked and we delivered! The pipe is more flexible, lighter and has reduced memory. Pipe can also be replaced without breaking concrete.

Elimination of potential underground leak points

- ◆ No underground fittings or joints
- ◆ No hand-built field joints
- ◆ All termination points are contained safely inside sumps
- ◆ Termination joints precision swaged to simulate factory made assemblies

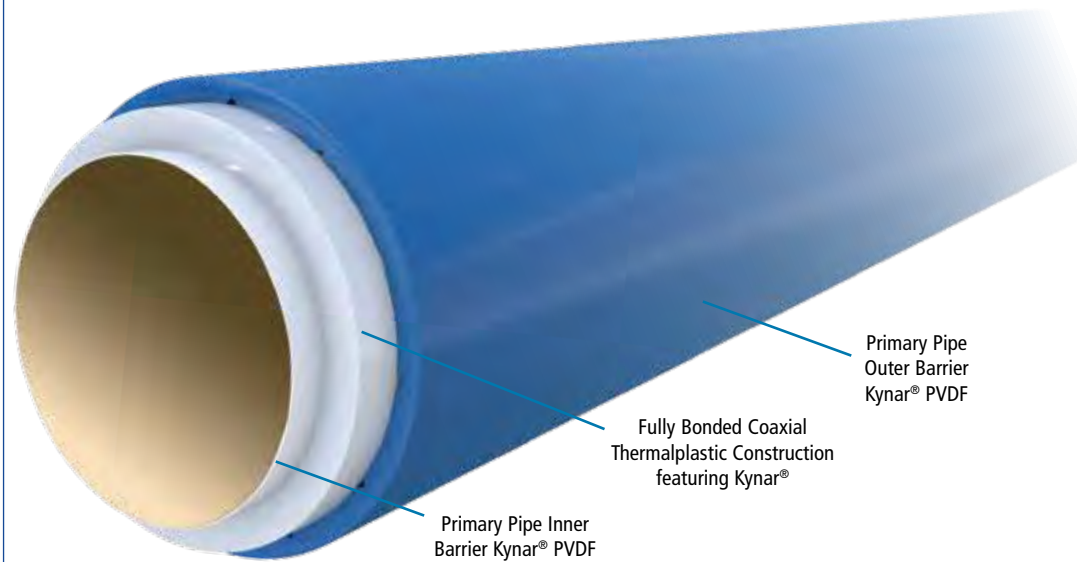
Light, Flexible, & Easy to Install. ULC Approved for All Fuels

ULC APPROVAL

- ✓ Motor Vehicle Fuels
- ✓ High Blend Fuels
- ✓ Concentrated Fuels
- ✓ Aviation and Marine

FlexWORKS

Celebrating Over 20 Years of Success Through Piping Excellence



What Makes This Pipe Different? Lower installation costs

- ◆ **Eliminates the hassles** – installation time and potential leak points of rigid pipe installations
- ◆ **No adhesives** – heat assists, curing problems or electrofusion welding of joints
- ◆ **Fast and easy installation** – results in less installation labor, time and cost
- ◆ **Easy to bend** – no special fittings to install in order to make bends
- ◆ Eliminates burdensome cutting, fitting, and cleaning

FlexWorks Supply Piping

OPW's FlexWorks Pipe is more flexible, lighter and has reduced memory to aid installation and is UL approved for all fuels.

Ordering Specifications - Sizing Matrix

Double Wall Pipe					
Part #	Description	Packaged		Specifications	
C075A-250	3/4" Double Wall Primary Pipe	250 ft	Box		
C075A-1000	3/4" Double Wall Primary Pipe	1000 ft	Reel		
C075A-CLXXX	3/4" Double Wall Primary Pipe	10-990 ft	Box	Custom Box/ Reel 10-990 ft (XXX enter feet in 10 ft increments)	
C10A-250	1" Double Wall Primary Pipe	250 ft	Box		
C010A-CLXXX	1" Double Wall Primary Pipe	10-990 ft	Box	Custom Box/Reel 10-990 ft (XXX enter feet in 10 ft increments)	
C15A-250	1.5" Double Wall Primary Pipe	250 ft	Reel		
C15A-500	1.5" Double Wall Primary Pipe	500 ft	Reel		
C15A-1000	1.5" Double Wall Primary Pipe	1000 ft	Reel		
C15A-1400	1.5" Double Wall Primary Pipe	1400 ft	Reel		
C15A-1225	1.5" Stick Pipe Double Wall - 25 ft	25 ft each	12 per Box	Sold Box of 12 – Minimum order 300 ft	
C15A-1228	1.5" Stick Pipe Double Wall - 28 ft	28 ft each	12 per Box	Sold Box of 12 – Minimum order 336 ft	
C15A-1233	1.5" Stick Pipe Double Wall - 33 ft	33 ft each	12 per Box	Sold Box of 12 – Minimum order 396 ft	
C15A-1240	1.5" Stick Pipe Double Wall - 40 ft	40 ft each	12 per Box	Sold Box of 12 – Minimum order 480 ft	
C20A-250	2" Double Wall Primary Pipe	250 ft	Reel		
C20A-500	2" Double Wall Primary Pipe	500 ft	Reel		
C20A-800	2" Double Wall Primary Pipe	800 ft	Reel		
C20A-1225	2" Stick Pipe Double Wall - 25 ft	25 ft each	12 per Box	Sold Box of 12 – Minimum order 300 ft	
C20A-1228	2" Stick Pipe Double Wall - 28 ft	28 ft each	12 per Box	Sold Box of 12 – Minimum order 336 ft	
C20A-1233	2" Stick Pipe Double Wall - 33 ft	33 ft each	12 per Box	Sold Box of 12 – Minimum order 396 ft	
C30A-100	3" Double Wall Primary Pipe	100 Ft	Reel		
C30A-250	3" Double Wall Primary Pipe	250 Ft	Reel		
C30A-500	3" Double Wall Primary Pipe	500 Ft	Reel		
C30A-600	3" Double Wall Primary Pipe	600	Reel		
C30A-0528	3" Stick Pipe Double Wall - 28 ft	28 ft each	Box	Maximum 6 pieces to a box	
Single Wall Pipe					
Part #	Description	Packaged		Specifications	
S20-250	2" Single Wall Primary Pipe	250 ft	Box	If no stock, minimum 2,500 ft run.	
S20-750	2" Single Wall Primary Pipe	750 ft	Reel		

Note: Discounted short runs available while supplies last. Please contact Customer Service for availability and pricing.

Flexible Supply Piping

OPW FlexWorks flexible piping utilizes fully bonded, premium Kynar® PVDF construction throughout to offer complete peace-of-mind protection, performance, installation ease and advantages over rigid and semi-rigid pipe.

Features & Benefits:

- ◆ **Lower installation costs**
 - ◆ **Eliminates the hassles** – installation time and potential leak points of rigid pipe installations
 - ◆ **Easy installation** – results in less installation time
 - ◆ **Eliminates burdensome cutting, fitting, and cleaning**
 - ◆ **No adhesives** – heat assists, curing problems or electrofusion welding of joints
 - ◆ **Easy to bend** – no special fittings to install in order to make bends
- Eliminates potential underground leak points:**
- ◆ **No underground** – fittings or joints
 - ◆ **No hand-built field joints**
 - ◆ **All termination points are contained in sumps**
 - ◆ **Termination joints precision swaged to simulate factory-made assemblies**

Double Wall Flexible Piping:

UL 971 Listed, Integral Primary/Secondary, Normal Vent & Vapor Piping, Gasoline, Aviation & Marina Fuels:

A UL-listed, double-wall, flexible supply piping system is designed for installation within Access piping (not required but recommended). The outer containment pipe includes inner stand-off ribs to create a small interstitial space which allows for optimum fluid migration, continuous monitoring and easy periodic testing. This piping features an enhanced construction that meets the new UL971 standard. OPW's FlexWorks double-wall piping has both the primary and secondary containment pipe UL-listed and is labeled as follows: INTEGRAL PRIMARY/SECONDARY FOR MOTOR VEHICLE FUELS.

Ordering Specifications* - FlexWorks Double-Wall Product Piping

Part #	Application	Minimum Bend Radius		Packaging		Dimensions				Box/Reel Size (in.)	Box/Reel Weight	
		in.	mm			I.D.	O.D.	in.	mm		lbs.	kg
C075A-250	Double-Wall Primary Pipe, ¾"	18	457	Box	250 ft	.75	19	1.18	29	44x44x25	134	61
C075A-1000	Double-Wall Primary Pipe, ¾"	18	457	Reel	1000 ft	.75	19	1.18	29	58x58x48	527	239
C10A-250	Double-Wall Primary Pipe, 1"	18	457	Box	250 ft	1.0	25	1.50	38	44x44x25	169	77
C10A-1000	Double-Wall Primary Pipe, 1"	18	457	Reel	1000 ft.	1.0	25	1.50	38	58x58x48	605	274
C15A-250	Double-Wall Primary Pipe, 1.5"	24	610	Box	250 ft.	1.5	38	2.00	51	38x45x30	240	109
C15A-500	Double-Wall Primary Pipe, 1.5"	24	610	Reel	500 ft.	1.5	38	2.00	51	58x58x48	605	274
C15A-1000	Double-Wall Primary Pipe, 1.5"	24	610	Reel	1000 ft.	1.5	38	2.00	51	58x58x48	980	444
C20A-250	Double-Wall Primary Pipe, 2"	36	914	Box	250 ft	2	51	2.50	63.5	63x63x33	192	87
C20A-500	Double-Wall Primary Pipe, 2"	36	914	Reel	500 ft.	2	51	2.50	63.5	68x68x48	770	349
C30A-200	Double-Wall Primary Pipe, 3"	72	1828	Reel	200 ft	3	76	3.50	88	63x63x33	652	296

* OPW also offers short and custom lengths of pipe, as well as pipe packaged and shipped on Mega Reels. Please contact our Customer Service department at 1-800-422-2525, or visit us on the web at www.opwglobal.com for the most up-to-date information.

Flexible Piping Manual
Order Number: **UPM-0001**



JMM HIGH DENSITY POLYETHYLENE (HDPE) PE4710 PRODUCT SPECIFICATION

Description:

JMM manufactures High Density Polyethylene (HDPE) water pressure pipes for municipal and industrial transmission systems. Our pressure pipe is used in many types of applications such as potable water, sewer, drain, mining, irrigation, slip lining, and reclaimed water.

Materials:

JMM HDPE pressure pipe is manufactured with premium, highly engineered PE4710 resin that provides maximum performance benefits to service today's municipal and industrial water needs. The PE4710 material conforms to ASTM D3350 with the cell classification of 445574C/E and is listed with the Plastic Pipe Institute's (PPI) TR4. It is formulated with carbon black and/or ultraviolet stabilizer for maximum protection against UV rays for added assurance.

Size	Type	DR	Standard (If Applicable)
4" – 63"	IPS / DIPS	7 – 41	ASTM F714

Quality Assurance:

JMM takes great pride in the quality and workmanship of all of our products. JMM quality control programs monitor three critical aspects of the manufacturing process: the raw material, pipe production, and the finished goods. Incoming raw material is inspected and tested to ensure the material meets all applicable requirements before its release for production. During production, the pipe will be examined and pipe samples will be collected for physical verification and testing for compliance. The finished product is subjected to further visual inspection to ensure it has met all the appropriate specifications and packaging requirements. Our pipes are continuously monitored throughout the entire manufacturing process to validate that they are in accordance with all applicable specifications. Certificates of Compliance are available upon request.

Lengths & Bending Radius:

Standard laying lengths of HDPE pressure water pipe is 40/50 foot lengths. Pipe sizes under 6" may be coiled at continuous longer lengths upon request.

Marking:

The standard markings printed on JMM pipes generally consist of the JMM logo, nominal size and OD base, material code, dimension ratio, pressure class, current AWWA C906 (if applicable), ASTM F714 (if applicable), and production date (day, month, & year).



Website:

Please visit our website at www.jmm.com for more information.

Note: Information provided here is a general guideline of JMM PE products. JMM reserves the right to modify any information as necessary. For more detailed information, please contact your JMM sales representative. Always follow project specifications and adhere to local rules, codes and regulations

HDPE IRON PIPE SIZE (IPS) PRESSURE PIPE PE4710

Pipe Size	Avg OD	DR 7 (333 psi)			DR 7.3 (318 psi)			DR 9 (250 psi)			DR 9.3 (241 psi)			DR 11 (200 psi)			DR 13.5 (160 psi)		
		Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft
1/2	0.840	0.120	0.59	0.12	0.115	0.60	0.11	0.093	0.64	0.10	0.090	0.65	0.09	0.076	0.68	0.08	0.062	0.71	0.07
3/4	1.050	0.150	0.73	0.19	0.144	0.75	0.18	0.117	0.80	0.15	0.113	0.81	0.15	0.095	0.85	0.12	0.078	0.88	0.10
1	1.315	0.188	0.92	0.29	0.180	0.93	0.28	0.146	1.01	0.23	0.141	1.02	0.23	0.120	1.06	0.20	0.097	1.11	0.16
2	2.375	0.339	1.66	0.95	0.325	1.69	0.91	0.264	1.82	0.77	0.255	1.83	0.74	0.216	1.92	0.64	0.176	2.00	0.53
3	3.500	0.500	2.44	2.06	0.479	2.48	1.98	0.389	2.68	1.66	0.376	2.70	1.61	0.318	2.83	1.39	0.259	2.95	1.16
4	4.500	0.643	3.14	3.40	0.616	3.19	3.28	0.500	3.44	2.75	0.484	3.47	2.67	0.409	3.63	2.30	0.333	3.79	1.91
5 3/8	5.375	0.768	3.75	4.85	0.736	3.81	4.68	0.597	4.11	3.92	0.578	4.15	3.81	0.489	4.34	3.29	0.398	4.53	2.73
5	5.563	0.795	3.88	5.20	0.762	3.95	5.02	0.618	4.25	4.20	0.598	4.29	4.08	0.506	4.49	3.52	0.412	4.69	2.92
6	6.625	0.946	4.62	7.36	0.908	4.70	7.12	0.736	5.06	5.96	0.712	5.11	5.79	0.602	5.35	4.99	0.491	5.58	4.15
7	7.125	0.976	5.06	8.23	0.976	5.06	8.23	0.792	5.45	6.89	0.766	5.50	6.70	0.648	5.75	5.78	0.528	6.01	4.80
8	8.625	1.232	6.01	12.48	1.182	6.12	12.06	0.958	6.59	10.09	0.927	6.66	9.81	0.784	6.96	8.46	0.639	7.27	7.03
10	10.750	1.536	7.49	19.40	1.473	7.63	18.74	1.194	8.22	15.68	1.156	8.30	15.24	0.977	8.68	13.14	0.796	9.06	10.92
12	12.750	1.821	8.89	27.28	1.747	9.05	26.36	1.417	9.75	22.07	1.371	9.84	21.44	1.159	10.29	18.49	0.944	10.75	15.36
14	14.000	2.000	9.76	32.90	1.918	9.93	31.78	1.556	10.70	26.61	1.505	10.81	25.85	1.273	11.30	22.30	1.037	11.80	18.52
16	16.000	2.286	11.15	42.97	2.192	11.35	41.51	1.778	12.23	34.75	1.720	12.35	33.76	1.455	12.92	29.12	1.185	13.49	24.19
18	18.000	2.571	12.55	54.37	2.466	12.77	52.53	2.000	13.76	43.97	1.935	13.90	42.73	1.636	14.53	36.84	1.333	15.17	30.61
20	20.000	2.857	13.94	67.13	2.740	14.19	64.85	2.222	15.29	54.28	2.151	15.44	52.77	1.818	16.15	45.49	1.481	16.86	37.79
24	24.000	3.429	16.73	96.68	3.288	17.03	93.39	2.667	18.35	78.18	2.581	18.53	75.98	2.182	19.37	65.52	1.778	20.23	54.44
26	26.000							2.889	19.88	91.75	2.796	20.07	89.17	2.364	20.99	76.89	1.926	21.92	63.89
28	28.000							3.111	21.40	106.40	3.011	21.62	103.42	2.545	22.60	89.15	2.074	23.60	74.09
30	30.000							3.333	22.93	122.13	3.226	23.16	118.72	2.727	24.22	102.35	2.222	25.29	85.04
32	32.000													2.909	25.83	116.46	2.370	26.98	96.76
34	34.000													3.091	27.45	131.48	2.519	28.66	109.26
36	36.000													3.273	29.06	147.41	2.667	30.35	122.49



Pipe Size	Avg OD	DR 15.5 (138 psi)			DR 17 (125 psi)			DR 19 (111 psi)			DR 21 (100 psi)			DR 26 (80 psi)			DR 32.5 (64 psi)		
		Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft
1/2	0.840	0.054	0.73	0.07	0.062	0.71	0.07	0.044	0.75	0.05	0.062	0.71	0.07	0.062	0.71	0.07	0.062	0.71	0.07
3/4	1.050	0.068	0.91	0.09	0.062	0.92	0.08	0.055	0.93	0.08	0.062	0.92	0.08	0.062	0.92	0.08	0.062	0.92	0.08
1	1.315	0.085	1.14	0.14	0.077	1.15	0.13	0.069	1.17	0.12	0.063	1.18	0.11	0.062	1.18	0.11	0.062	1.18	0.11
2	2.375	0.153	2.05	0.47	0.140	2.08	0.43	0.125	2.11	0.39	0.113	2.14	0.35	0.091	2.18	0.29	0.073	2.22	0.23
3	3.500	0.226	3.02	1.02	0.206	3.06	0.94	0.184	3.11	0.84	0.167	3.15	0.77	0.135	3.21	0.63	0.108	3.27	0.51
4	4.500	0.290	3.88	1.68	0.265	3.94	1.55	0.237	4.00	1.39	0.214	4.05	1.27	0.173	4.13	1.03	0.138	4.21	0.83
5 3/8	5.375	0.347	4.64	2.40	0.316	4.71	2.21	0.283	4.78	1.99	0.256	4.83	1.81	0.207	4.94	1.48	0.165	5.03	1.19
5	5.563	0.359	4.80	2.58	0.327	4.87	2.36	0.293	4.94	2.13	0.265	5.00	1.94	0.214	5.11	1.58	0.171	5.20	1.27
6	6.625	0.427	5.72	3.65	0.390	5.80	3.35	0.349	5.89	3.02	0.315	5.96	2.74	0.255	6.08	2.24	0.204	6.19	1.81
7	7.125	0.460	6.15	4.23	0.419	6.24	3.88	0.375	6.33	3.49	0.340	6.40	3.18	0.274	6.54	2.59	0.219	6.66	2.09
8	8.625	0.556	7.45	6.19	0.507	7.55	5.68	0.454	7.66	5.12	0.411	7.75	4.66	0.332	7.92	3.80	0.265	8.06	3.06
10	10.750	0.694	9.28	9.62	0.632	9.41	8.82	0.566	9.55	7.95	0.512	9.66	7.24	0.413	9.87	5.90	0.331	10.05	4.77
12	12.750	0.823	11.01	13.53	0.750	11.16	12.41	0.671	11.33	11.18	0.607	11.46	10.17	0.490	11.71	8.30	0.392	11.92	6.69
14	14.000	0.903	12.09	16.31	0.824	12.25	14.97	0.737	12.44	13.49	0.667	12.59	12.28	0.538	12.86	10.00	0.431	13.09	8.08
16	16.000	1.032	13.81	21.30	0.941	14.01	19.55	0.842	14.21	17.61	0.762	14.38	16.03	0.615	14.70	13.07	0.492	14.96	10.54
18	18.000	1.161	15.54	26.95	1.059	15.75	24.75	0.947	15.99	22.29	0.857	16.18	20.28	0.692	16.53	16.54	0.554	16.83	13.36
20	20.000	1.290	17.26	33.28	1.176	17.51	30.53	1.053	17.77	27.52	0.952	17.98	25.03	0.769	18.37	20.43	0.615	18.70	16.47
24	24.000	1.548	20.72	47.92	1.412	21.01	43.99	1.263	21.32	39.63	1.143	21.58	36.06	0.923	22.04	29.42	0.738	22.44	23.72
26	26.000	1.677	22.44	56.24	1.529	22.76	51.61	1.368	23.10	46.51	1.238	23.38	42.31	1.000	23.88	34.53	0.800	24.30	27.86
28	28.000	1.806	24.17	65.22	1.647	24.51	59.87	1.474	24.88	53.94	1.333	25.17	49.07	1.077	25.72	40.05	0.862	26.17	32.33
30	30.000	1.935	25.90	74.87	1.765	26.26	68.74	1.579	26.65	61.92	1.429	26.97	56.36	1.154	27.55	45.98	0.923	28.04	37.09
32	32.000	2.065	27.62	85.23	1.882	28.01	78.18	1.684	28.43	70.45	1.542	28.73	64.11	1.231	29.39	52.31	0.985	29.91	42.22
34	34.000	2.194	29.35	96.21	2.000	29.76	88.27	1.790	30.21	79.54	1.619	30.57	72.36	1.308	31.23	59.06	1.046	31.78	47.63
36	36.000	2.323	31.08	107.86	2.118	31.51	98.98	1.895	31.98	89.17	1.714	32.37	81.12	1.385	33.06	66.22	1.108	33.65	53.42

HDPE IRON PIPE SIZE (IPS) PRESSURE PIPE PE4710

Pipe Size	Avg OD	DR 17 (125 psi)			DR 19 (111 psi)			DR 21 (100 psi)			DR 26 (80 psi)			DR 32.5 (64 psi)			DR 41 (50 psi)		
		Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft
36	36.000	2.118	31.510	98.98	1.895	31.983	89.17	1.714	32.366	81.12	1.385	33.064	66.22	1.108	33.651	53.42	0.878	34.139	42.63
42	42.000	2.471	36.761	134.72	2.211	37.314	121.37	2.000	37.760	110.43	1.615	38.576	90.08	1.292	39.261	72.68	1.024	39.830	58.03
48	48.000	2.824	42.013	175.97	2.526	42.644	158.52	2.286	43.154	144.25	1.846	44.086	117.68	1.477	44.869	94.95	1.171	45.517	75.79
54	54.000	3.177	42.265	222.64	2.842	47.975	200.63	2.571	48.549	182.51	2.077	49.597	148.95	1.622	50.477	120.20	1.317	51.208	95.92
63	63.000							3.000	56.640	248.46	2.423	57.863	202.72	1.938	58.891	163.53	1.537	59.742	130.56



HDPE DUCTILE IRON PIPE SIZE (DIPS) PRESSURE PIPE PE4710

Pipe Size	DR 7 (333 psi)				DR 9 (250 psi)			DR 11 (200 psi)			DR 13.5 (160 psi)			DR 17 (125 psi)		
	Avg OD	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft
4	4.800	0.686	3.346	3.87	0.533	3.670	3.13	0.436	3.876	2.62	0.356	4.045	2.18	0.282	4.202	1.76
6	6.900	0.946	4.894	7.99	0.767	5.274	6.46	0.627	5.571	5.41	0.511	5.817	4.50	0.406	6.039	3.64
8	9.050	1.293	6.309	13.75	1.006	6.917	11.12	0.823	7.305	9.32	0.670	7.630	7.74	0.532	7.922	6.25
10	11.100	1.586	7.738	20.68	1.233	8.486	16.72	1.009	8.961	14.01	0.822	9.357	11.64	0.653	9.716	9.41
12	13.200	1.886	9.202	29.24	1.467	10.090	23.65	1.200	10.656	19.82	0.978	11.127	16.47	0.776	11.555	13.30
14	15.300	2.186	10.666	39.29	1.700	11.696	31.77	1.391	12.351	26.63	1.133	12.898	22.12	0.900	13.392	17.88
16	17.400	2.486	12.130	50.81	1.933	13.302	41.09	1.582	14.046	34.44	1.289	14.667	28.61	1.024	15.229	23.13
18	19.500	2.786	13.594	63.82	2.167	14.906	51.61	1.773	15.741	43.25	1.444	16.439	35.92	1.147	17.068	29.04
20	21.600				2.400	16.512	63.32	1.964	17.436	53.07	1.600	18.208	44.09	1.271	18.905	35.64
24	25.800				2.867	19.722	90.34	2.345	20.829	75.69	1.911	21.749	62.90	1.518	22.582	50.84
30	32.000							2.909	25.833	116.46	2.370	26.976	96.76	1.880	28.014	78.18
36	38.300										2.837	32.286	138.62	2.253	33.524	112.02
42	44.500													2.618	38.950	151.24
48	50.800													2.988	44.465	197.05

Pipe Size	DR 19 (111 psi)				DR 21 (100 psi)			DR 26 (80 psi)			DR 32.5 (64 psi)		
	Avg OD	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft	Min Wall	Avg ID	Weight lb/ft
4	4.800	0.253	4.264	1.59	0.229	4.315	1.44	0.185	4.408	1.18	0.148	4.486	0.95
6	6.900	0.363	6.130	3.28	0.329	6.203	2.98	0.265	6.338	2.43	0.212	6.451	1.96
8	9.050	0.476	8.041	5.64	0.431	8.136	5.13	0.348	8.312	4.18	0.278	8.461	3.37
10	11.100	0.584	9.862	8.48	0.529	9.979	7.72	0.427	10.195	6.29	0.342	10.375	5.08
12	13.200	0.695	11.727	11.99	0.629	11.867	10.91	0.508	12.123	8.91	0.406	12.339	7.18
14	15.300	0.805	13.593	16.11	0.729	13.755	14.66	0.588	14.053	11.95	0.471	14.301	9.65
16	17.400	0.916	15.458	20.83	0.829	15.643	18.96	0.669	15.982	15.46	0.536	16.264	12.49
18	19.500	1.026	17.325	26.16	0.929	17.531	23.81	0.750	17.910	19.42	0.600	18.228	15.67
20	21.600	1.137	19.190	32.10	1.029	19.419	29.22	0.831	19.838	23.84	0.665	20.190	19.24
24	25.800	1.358	22.921	45.80	1.229	23.195	41.68	0.992	23.697	33.99	0.794	24.117	27.44
30	32.000	1.684	28.430	70.45	1.524	28.769	64.11	1.231	29.390	52.31	0.985	29.912	42.22
36	38.300	2.016	34.026	100.93	1.824	34.433	91.84	1.473	35.177	74.92	1.179	35.801	60.43
42	44.500	2.342	39.535	136.25	2.119	40.008	123.96	1.712	40.871	101.17	1.370	41.596	81.59
48	50.800	2.674	45.131	177.55	2.419	45.672	161.55	1.954	46.658	131.83	1.563	47.486	106.34



PE 4710 JMM HDPE Typical Primary Properties

Property	Unit	Test Procedure	Typical Value
Material Designation	---	PPI-TR4	PE 4710
Cell Classification	---	ASTM D3350	** 445574C
Density [4]	g/cm ³	ASTM D1505	0.959
Melt Index [4]	g/10 minutes	ASTM D1238	<0.15
Flexural Modulus [5]	psi	ASTM D790	> 120,000
Tensile Strengt [5]	psi	ASTM D638	> 3,600
SCG (PENT) [7]	Hours	ASTM F1473	>100
HDB @ 73.4°F (23°C)[4]	psi	ASTM D2837	1600
HDB @ 140°F (60°C)	psi	ASTM D2837	1000
HDS (hydrostatic design stress) @ 73.4°F	psi	PPI-TR4	1000
HDS @ 140°F	psi	PPI-TR4	630
Color; UV Stabilize [C]	---	---	Black with minimum 2% carbon black
Brittleness Temperature	°F	ASTM D746	<-180

** Note: Cell Classification is 445576E for all Blue / Green / Gray Polyethylene Pipes.

Specifications for High Density Polyethylene Manholes and Structures

1. SCOPE OF WORK

This specification covers the material, fabricators, joining methods, and general installation practice for high density polyethylene pipe (HDPE) manholes and structures. Manholes shall be fabricated by ISCO Industries, Inc. or other approved manufacturer holding an ISO 9001 quality system certificate.

2. SUBMITTALS AND QUALITY ASSURANCE

2.1. DOCUMENTATION-

- 2.1.1. The manhole fabricator shall submit certification that the HDPE material meets the specifications.
- 2.1.2. The fabricator of the manholes shall submit shop drawings for approval as part of the submittal data showing the position of the inlets, outlets and the overall dimensions along with any other special features such as manways, ladders, internal piping, valves, etc.
- 2.1.3. The fabricator shall submit calculations for review by the project engineer, or owner, indicating that the vertically installed manholes have been analyzed using the guidance of ASTM F1759, "Design of High Density Polyethylene (HDPE) Manholes for Subsurface Applications". The data shall contain information related to the following areas: Ring Compressive Strain, Combined Ring Compressive and Ring Bending Strain, Ring Buckling, Axial Stain, Axial Buckling, and the thickness of the bottom based on depth and groundwater. Thickness should be based on acceptable stress and deflection limits. Data and calculations are supplied for informational purposes and will be part of the submittal package that are reviewed and approved by the project engineer. The project engineer will review any data/calculations submitted for accuracy, including any site specific variables, and confirm the structure is suitable for the intended service including installation and operating conditions.
- 2.1.4. When requested, the fabricator shall submit the ISO 9001:2008 Certificate of Registration for the manufacturing facility and/or the written quality assurance program used during fabrication of the manholes, including documentation that personnel responsible for fabrication have been trained and qualified. The fabricator may be required to submit their QA/QC program for fabricating thermoplastic structures prior to beginning work and the qualifications of the fabrication technician upon beginning of work on the structure.
- 2.1.5. When required, the manholes and pipe shall be tested in accordance with section 4.11 of this specification. A written certification shall be sent as an addendum to original submittal package, certifying the manholes are leak free. The test results shall become part of the submittals. When requested, an identification plate indicating, the job number, testing data, and when built and by whom, shall be attached to the manhole.

2.2. Approval or Rejection

- 2.2.1. Engineer of record (or owner) will review submittal information and provide written approval or rejection of submittal data, shop drawings, and verify proposed manhole will meet installation and service requirements.
- 2.2.2. ENGINEER reserves the right to require changes to the proposed product so as to meet intended installation and service conditions.
- 2.2.3. In the event such changes impact price or timing, the purchase contract will be adjusted to reflect those changes.

3. HDPE MATERIALS

The material for the manholes shall be made from HDPE resins meeting the following requirements:

- 3.1. HDPE Extruded Solid Wall Pipe Material – Solid wall pipe under this specification shall be a minimum grade of PE 3608 with a minimum cell classification value of 345464C as defined in ASTM D3350. Pipe sizes 3” and larger shall have a manufacturing standard of ASTM F 714, while pipe smaller than 3” shall be manufactured to the dimensional requirements listed in ASTM D 3035. Dimension Ratio (DR) and Outside Diameter (IPS/DIPS) shall be as specified on plans.
- 3.2. HDPE Profile Wall Pipe Material – Profile wall pipe supplied under this specification shall be manufactured to the dimensions and material requirements of ASTM F894 with a minimum cell classification value of 334433C as defined in ASTM D3350.
- 3.3. HDPE sheet and fittings material- Sheet, plate and other HDPE materials under this specification shall be pipe grade material with a minimum designation of PE 3608 along with a minimum cell classification value of 345464C as defined in ASTM D3350.

4. HDPE MANHOLE FABRICATION

- 4.1. The HDPE manholes shall be constructed of cylinder with a nominal OD of _____ (or nominal ID of _____) and a wall thickness (or DR/RSC) of _____. Design service conditions, including installation environment and operating parameters, will determine the wall thickness, Pipe DR, and/or RSC of pipe and shall be specified or verified by the project engineer or the owner.
- 4.2. The bottom thickness of the manholes will meet the required limits for stress and deflection as required in ASTM F1759. Bottom or top plates may have additional support ribs, gussets or and bracing as methods to reduce stress and deflection to acceptable levels.
- 4.3. The inlets and outlets shall be extrusion welded on the inside and outside of the structure, where access is available. Gussets shall be attached at 90 degrees, 180 degrees, 270 degrees, and 360 degrees around the inlets and outlets unless impractical.
- 4.4. All manhole connections larger than 4” nominal OD pipe shall be butt fusion welded, electrofusion welded, or flanged connections. For 4” OD pipe and smaller threaded transition fittings can also be used as well as the acceptable connections listed. Mechanical connections may be employed when approved by the project engineer.
- 4.5. All butt fusion welds shall be made as described in ASTM F2620 and all butt fusion welds performed with hydraulically operated butt fusion equipment shall be recorded using a McElroy Manufacturing DataLogger. The fabricator shall maintain records of the temperature, pressure, and graph of the fusion cycle for a minimum of 3 years.
- 4.6. The ladders in the manholes, if specified, shall conform to OSHA requirements. Ladders will be of fiberglass material with stainless steel hardware, and will be mechanically affixed to HDPE braces welded to the manhole body.
- 4.7. Except for when impractical, lifting eyes will be integral to the manhole body and located on shop drawings.
- 4.8. Manhole structures and outlets should not be used as anchor points when axial loads or movement is anticipated. Where large changes in temperature are expected, restraints shall be designed to isolate the structure and prevent strain at the inlets or outlets. These restraints shall be cast into a concrete block or collar around the pipe. Anti-flotation and/or anti-settling measures such as anchor lugs, rings, or collars, if required, shall be provided as an integral part of the manhole by the fabricator/manufacturer of the manhole.
- 4.9. The top of the structure and/or manway of the manhole shall be built to the meet the requirements of contract drawings. If testing is required, flanged tops or manways may be required, and additional bolts may be needed to withstand test conditions.
- 4.10. Reinforced concrete pads at surface level spanning the HDPE manhole footprint will be required when HDPE manholes are used in traffic areas. The pad shall transfer live loads to the surrounding fill and remove direct loading to the manhole riser or manway. A traffic rated frame and cover will be

required. A professional engineer shall approve the design of the concrete pad. Integration of the pad with the manhole will be coordinated with the HDPE manhole manufacturer.

- 4.11. When practical and required, manholes shall be factory tested with water or with air. The hydrostatic test shall be conducted by filling the structure with water and checking for leaks. Minimum test duration will be one hour. If air is used, a minimum of 1 PSI shall be used for 30 minutes. Structures with a 72" inside diameter or smaller may be tested to 2 PSI. Data showing the structure to be leak-free will be supplied, when testing requirements are agreed to prior to fabrication. The owner or his representative may request to observe the test.

5. SITE HANDLING AND CONNECTIONS

- 5.1. Handling of Manholes. During loading, transportation, and unloading, every precaution should be taken to prevent damage to the pipe. HDPE manholes shall be stored on clean, level, and dry ground to prevent undue scratching or gouging of the pipe. The handling of HDPE manholes shall be done in such a manner that there is no damage. Nylon slings are often used. PPI Handbook of Polyethylene Pipe (2nd Edition), Chapter 2 offers guidance on handling of HDPE pipe/fittings and is appropriate to consider for HDPE manholes and structures.
- 5.2. Pipe Joining. HDPE pipe shall be joined using butt fusion. All butt fusion welds shall be made as described in ASTM F 2620. Electrofusion welding can be used for making pipe welds. All connections to the structure made butt fusion welds using hydraulically operated butt fusion equipment shall be recorded using a McElroy Manufacturing DataLogger. The contractor shall maintain records of the temperature, pressure, and graph of the fusion cycle for all welds joining the pipe to the structure at the jobsite.
- 5.3. Handling of Fused Pipe- The handling of the pipeline shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Sections of the pipes with cuts and gouges exceeding 10 percent of the pipe wall thickness or kinked sections shall be removed and the ends rejoined. Limit bending of the pipe welded to fittings or manholes. Nylon slings are preferred. Refer to the PPI Material Handling Guide for HDPE Pipe and Fittings for recommendations, guidelines and instructions regarding the handling, lifting, loading, storing and installing polyethylene pipe and fittings
- 5.4. Flanged Connections. Flange adapters (where shown in the drawings) shall be attached to HDPE manhole inlets and outlet stubs during fabrication by butt fusion welding per ASTM F2620. A metal back up ring will be used with each flanged connection. The rings will use a standard ANSI 150# bolt pattern. Check the drawings for materials required for corrosive conditions such as SS rings or bolts. Bolted connections should follow recommendations for Plastic Pipe Institute (www.plasticpipe.org) TN-38, Bolt Torques For Polyethylene Flanged Joints, including the following recommendations:
 - 5.4.1. Bolts shall be tightened in a "star pattern" to recommended torque values.
 - 5.4.2. Bolts should be tightened a second time after 8-24 hours to insure a positive seal.
 - 5.4.3. Gaskets may not be required between HDPE to HDPE flanged connections.
- 5.5. Equipment Mounting- Special provisions must be made when mounting pumps in an HDPE manhole. Bolting directly to the wall of the HDPE structure is not recommended.

6. DIRECT BURIAL INSTALLATION

- 6.1. Trench Construction- The trench and trench bottom shall be constructed in accordance with ASTM D 2321- Section 6, Trench Excavation, and Section 7, Installation. The HDPE manhole shall be installed on a stable base consisting of 12" of Class I materials compacted to 95% proctor density per ASTM F 1759, Section 4.2. All required safety precautions for manhole installation are the responsibility of the contractor.
- 6.2. Embedment materials- Embedment materials shall be Class I or Class II materials as defined by ASTM D 2321- Section 5, Materials. Class I materials are preferred. Backfill and bedding materials shall be free of debris.
- 6.3. Bedding of the manhole shall be preformed in accordance with ASTM D 2321- Section 7.2. Compaction shall conform to Section 7.5 and 7.51.
- 6.4. Backfilling shall be done to conform to the ASTM F1759, Section 4.2, "Design Assumptions". This Specification indicates that backfill shall extend at least 3.5 feet beyond the edge of the manhole for the full height of the manhole and extend laterally to undisturbed soils. Compaction shall be minimum 90% proctor density with a minimum fill modulus of 1000 psi.

6.5. H-20 Highway Loads- When section 4.10 applies to the project and HDPE manholes are used in traffic areas, reinforced concrete pads with a traffic rated frame and cover shall be required. A drawing showing the pad, including thickness, and the location in relation to the HDPE manhole must be submitted to the engineer by the contractor.

ISCO Industries, Inc. has taken every effort to check the accuracy and standards used in the preparation of these sample specifications, ISCO does not guarantee or warranty piping or manhole installations, nor their final design. Sample specifications are to be used as a guide to assist engineers and owners of piping systems containing HDPE manholes or structures. Sample specifications do not cover all situations or applications. These specifications are not intended to provide installation training or instructions. Since every job is different, a trained professional engineer should be used to determine the needs of a particular job.

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Technical Manual

**Schedule 80 PVC and CPVC
Schedule 40 PVC
Piping Systems**



+GF+

**GEORG FISCHER
PIPING SYSTEMS**

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Introduction: PVC and CPVC Piping Systems

Product Summary

Thermoplastics PVC (Polyvinyl Chloride) and CPVC (Chlorinated Polyvinyl Chloride) are light, flexible, tough and provide exceptional corrosion resistance. Because of these and other properties of a high quality engineered thermoplastic, the savings that can be realized in initial installation and continuing maintenance costs are substantial.

Temperature

PVC can handle temperatures up to 140°F (60°C). CPVC handles temperatures up to 210°F (99°C).

Chemical Resistance

PVC and CPVC thermoplastics are highly resistant to acids, alkalis, alcohols and many other corrosive materials. Both materials are ideal for process piping installation and most service piping applications. For details, please consult our Chemical Resistance Chart or contact your local sales representative.

Maintenance Free Service

PVC and CPVC thermoplastics will not rust, scale, pit or corrode, nor are they subject to electrolysis. You are assured many years of leak-free, maintenance-free service. For buried applications, PVC and CPVC are not affected by soil conditions or galvanic corrosion..

Painting is not required for indoor non-exposed installations. For outdoor installation where the piping may be exposed to significant sunlight, we recommend painting; two coats of a white or light-colored, water-base, outdoor latex paint provides added protection.

Lower Installed Cost

Both PVC and CPVC have installed costs substantially lower than steel alloys or lined steel and are usually more competitive than carbon steel. Solvent cemented connections contribute to this lower installed cost while the much lighter weight (about one-sixth as much as steel) speeds and simplifies handling during installation.

Applications: Versatility and Dependability

PVC and CPVC fittings, pipe and valves have been found suitable for more than 50% of the corrosive and non-corrosive applications within the Chemical Process Industries. Vinyl piping systems have been sold into industrial applications for over 50 years. The establishment of strong industry standards and specifications, plus a third party certification through NSF, provides the specifying engineer, contractor and end user with a tested and accepted piping system to solve their corrosion problems.



Material Data

Physical Properties of Rigid PVC and CPVC Thermoplastic Materials

The following table lists typical physical properties of PVC and CPVC thermoplastic materials. Variations may exist depending on specific compounds and product.

Mechanical

Properties	Unit	PVC	CPVC	Remarks	ASTM Test
Specific Gravity	g/cm ³	1.40 ± .02	1.55 ± .02		D-792
Tensile Strength @ 73°F	PSI	7,200	8,000	Same in Circumferential Direction	D-638
Modules of Elasticity Tensile @ 73°F	PSI	430,000	360,000	Ratio of Stress on Bent Sample at Failure	D-638
Compressive Strength @ 73°F	PSI	9,500	10,100		D-695
Flexural Strength @ 73°F	PSI	13,000	15,100	Tensile Stress/Strain on Bent Sample at Failure	D-790
Izod Impact @ 73°F	Ft-Lbs/In of Notch	1.0	1.5	Impact Resistance of a Notched Sample to a Sharp Blow	D-256
Relative Hardness @ 73°F	Durometer "D" Rockwell "R"	80 ± 3 110-120	— 119	Equivalent to Aluminum —	D-2240 D-785

Thermodynamics

Properties	Unit	PVC	CPVC	Remarks	ASTM Test
Coefficient of Thermal Linear Expansion per °F	in/in/°F	2.8 x 10 ⁻⁵	3.4 x 10 ⁻⁵		D-696
Thermal Conductivity	BTU/hr/ft ² / F/in	1.3	0.95	Average Specific Heat of 0-100°C	C-177
Specific Heat	CAL/g/°C	0.20-0.28		Ratio of Thermal Capacity to that of Water at 15°C	
Maximum Operating Temperature	°F	140	210	Pressure Rating is Directly Related to Temperature	
Heat Distortion Temperature @ 264 PSI	°F	158	217	Thermal Vibration and Softening Occurs	D-648
Decomposition Point	°F	400+	400+	Scorching by Carbonization and Dehydrochloration	

Flammability

Properties	Unit	PVC	CPVC	Remarks	Test Method
Average Time of Burning	sec.	<5	<5		D-635
Average Extent of Burning	mm	<10	<10		
Flame Spread Index		<10	<10		E-162
Flame Spread		10-25	4-18		E-84
Flash Ignition	°F	730	900		D-1929
Smoke Developed*		1000	285		
Flammability (.062")		V-0	V-0, 5VB 5VA		UL-94
Softening Starts, approx.	°F	250	295		
Material Become Viscous	°F	350	395		
Material Carbonizes	°F	425	450		
Limiting Oxygen Index (LOI)	Vol. %	43	60		D-2863

Other

Properties	Unit	PVC	CPVC	Remarks	ASTM Test
Water Absorption	%	+0.05	+0.03 @ 73°F +0.55 @ 212°F	Weight Gain in 24 Hours	D-570
Poisson's Ratio @ 73°F		0.38	0.27		
ASTM Cell Classification		12454-B	23447-B		D-1784
Industry Standard Color		Dark Gray/ White	Medium Gray		
NSF Potable Water Approved		Yes	Yes		

Note: This data is based on information supplied by the raw material manufacturers. It should be used as a general recommendation only and not as a guarantee of performance or longevity. The determination of the suitability of any material for a specific application is the responsibility of the end user.

Engineering Data

In the engineering of thermoplastic piping systems, it is necessary to have not only a working knowledge of piping design but also an awareness of a number of the unique properties of thermoplastics.

In addition to chemical resistance, important factors to be considered in designing piping systems employing thermoplastics are

1. Pressure ratings
2. Water hammer
3. Temperature-Pressure relationships
4. Thermal expansion and contraction
5. Friction-loss characteristics

These factors are considered in detail in this manual.

Pressure Rating

Determining pressure-stress pipe relationships

ISO Equation: The pressure rating of a pipe is determined by the circumferential stress which results from internal pressure. The relationship between internal pressure, circumferential stress, wall thickness, and diameter is governed by an ISO equation. In various forms this equation is:

$$P = \frac{2S}{R-1} = \frac{2St}{D_o-t} \quad \frac{2S}{P} = \left(\frac{D_o}{t}\right) - 1$$

$$\frac{2S}{P} = R - 1 \quad S = \frac{P(R-1)}{2}$$

Where:

- P = Internal Pressure, psi
- S = Circumferential Stress, psi
- t = Wall Thickness, in.
- D_o = Outside Pipe Diameter, in.
- R = D_o/t

Long-Term Strength: To determine the long-term strength of thermoplastic pipe, lengths of pipe are capped at both ends (see Fig. 1-C) and subjected to various internal pressures, to produce circumferential stresses that will produce failure within 10 to 10,000 hours. The test is run according to ASTM D 1598 — Standard Test for Time Hydrostatic Pressure. The resulting failure points are used in a statistical analysis (outlined in ASTM D 2837) to determine the

characteristic regression curve that represents the stress/time-to-failure relationship for the particular thermoplastic pipe compound under test. This curve is represented by the equation:

$$\text{Log } T = a + b \text{ log } S$$

Where:

a and b are constants describing the slope and intercept of the curve, and T and S are time-to-failure and stress, respectively.

The regression curve may be plotted on a log-log paper, as shown in the Regression Curve figure below, and extrapolated from 10,000 to 100,000 hours (11.4 years). The stress at 100,000 hours is known as the Long Term Hydrostatic Strength (LTSH) for that particular thermoplastic compound. From this (LTSH) the Hydrostatic Design Stress (HDS) is determined by applying the service factor multiplier, as shown on page 8.

Long-Term Strength Test per ASTM D-1598

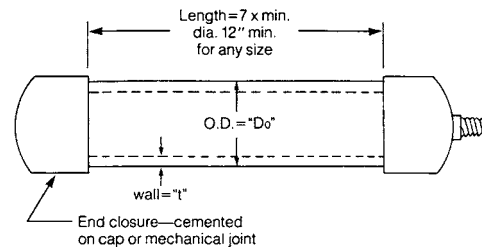
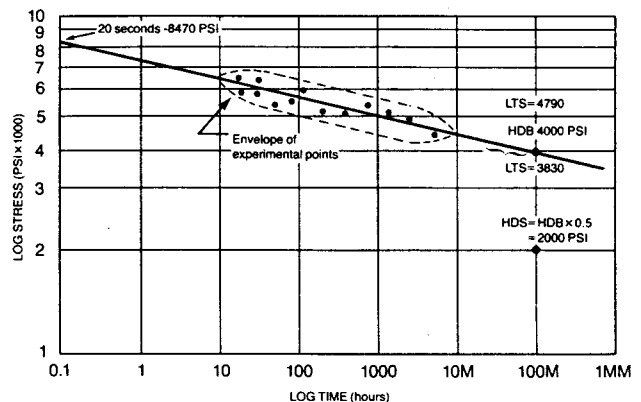


Figure 1-C

Pipe test specimen per ASTM D-1598 for "Time-to-Failure of Plastic Pipe Under Long-Term Hydrostatic Pressure"

Regression Curve — Stress/Time-to-Failure for PVC Type 1



Service Factor: The Hydrostatic Stress Committee of the Plastics Pipe Institute (PPI) has determined that a service (design) factor of one-half the Hydrostatic Design Basis would provide an adequate safety margin for use with water to ensure useful plastic-pipe service for a long period of time. While not stated in the standards, it is generally understood within the industry that this “service life” is a minimum of 50 years.

Accordingly, the standards for plastic pipe, using the 0.5 service factor, required that the pressure rating of the pipe be based upon this Hydrostatic Design Stress, again calculated with the ISO equation.

While early experience indicated that this service factor, or multiplier, of 0.5 provided adequate safety for many if not most uses, some experts felt that a more conservative service factor of 0.4 would better compensate for water hammer pressure surges, as well as for slight manufacturing variations and damage suffered during installation.

The PPI has issued a statement recommending this 0.4 service factor. This is equivalent to recommending that the pressure rating of the pipe should equal 1.25 times the system design pressure for any particular installation. Based upon this calculation, many thousands of miles of thermoplastic pipe have been installed in the United States without failure.

It is best to consider the actual surge conditions, as outlined later in this section. In addition, reductions in working pressure should be considered when handling aggressive chemical solutions and in high-temperature service.

Numerical relationships for service factors and design stresses of PVC and CPVC are shown in the table below.

Service Factors and Hydrostatic Design Stress (HDS)*

(Hydrostatic Design Basis equal 4000 psi) (27.6 MPa)

Service Factor	HDS
0.5	2000 psi (13.8 MPa)
0.4	1600 psi (11 MPa)

*Material: PVC Type I & CPVC

Maximum Pressures: The pressure ratings of thermoplastic pipe represent the maximum allowable operating pressure within a piping system for water at 73°F (22.8°C) based upon a service factor of 0.5.

Maximum Pressure Rating for Schedule 80 PVC/CPVC Pipe at 73°F

Size	PSI	Bar
½"	848	57.7
¾"	688	46.8
1"	630	42.9
1¼"	520	35.4
1½"	471	32.0
2"	404	27.5
2½"	425	28.9
3"	375	25.5
4"	324	22.0
6"	279	19.0
8"	246	16.7
10"	234	15.9
12"	228	15.5

External Pressures — Collapse Rating

Thermoplastic pipe is frequently specified for situations where uniform external pressures are applied to the pipe, such as underwater applications. In these applications, the collapse rating of the pipe determines the maximum permissible pressure differential between external and internal pressures. The basic formulas for collapsing external pressure applied uniformly to a long pipe are:

1. For thick wall pipe where collapse is caused by elastic instability of the pipe wall:

$$P_c = \frac{O}{2D_o^2} (D_o^2 - D_i^2)$$

2. For thin wall pipe where collapse is caused by elastic instability of the pipe wall:

$$P_c = \frac{2cE}{1-\nu^2} \left(\frac{t}{D_m} \right)^3$$

Where:

P_c = Collapse Pressure (external minus internal pressure), psi

O = Compressive Strength, psi

ν = Poisson's Ratio

E = Modulus of Elasticity, psi

D_o = Outside Pipe Diameter, in.

D_m = Mean Pipe Diameter, in.

D_i = Inside Pipe Diameter, in.

t = Wall Thickness, in.

c = Out of Roundness Factor, Approximately 0.66

Choice of Formula: By using formula 2 on thick wall pipe an excessively large pressure will be obtained. It is therefore necessary to calculate, for a given pipe size, the collapse pressure using both formulas and use the lower value as a guide to safe working pressure. See the following table for short term collapse pressures at 73°F. For long term loading conditions, appropriate long term data should be used.

Vacuum Service

As implied by the collapse rating, thermoplastic pipe is suitable for vacuum or negative pressure conditions that are found in many piping applications.

Laboratory tests have been conducted on Schedule 80 PVC pipe to determine performance under vacuum at temperatures above recommended operating conditions. A 6" pipe showed slight deformation at 165°F and 20 inches of mercury. Above this temperature, failure occurred due to thread deformation.

Conclusion: All sizes of Schedule 80 PVC and CPVC thermoplastic pipe are suitable for vacuum service up to 140°F and 30 inches of mercury. In addition, CPVC may be used up to 210°F. Solvent cemented joints are required for vacuum applications.

Short Term Collapse Pressure in psi at 73°F

1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	3"	4"	6"	8"	10"	12"
Schedule 40 PVC											
2095	1108	900	494	358	211	180	109	54	39	27	29
Schedule 80 PVC/CPVC											
2772	2403	2258	1389	927	632	521	335	215	147	126	117

Note: These are short term ratings; long term should be reduced by 1/3 to 1/2 of the short term ratings.

Water Hammer

Surge pressures due to water hammer are a major factor contributing to pipe failure in liquid transmission systems. A column of moving fluid within a pipeline, owing to its mass and velocity, contains stored energy. Since liquids are essentially incompressible, this energy cannot be absorbed by the fluid when a valve is suddenly closed.

The result is a high momentary pressure surge called water hammer. The five factors that determine the severity of water hammer are:

1. Velocity
(The primary factor in excessive water hammer; see discussion of "Velocity" and "Safety Factor" below)
2. Modulus of elasticity of pipe material
3. Inside diameter of pipe
4. Wall thickness of pipe
5. Valve closing time

Maximum pressure surges caused by water hammer can be calculated by using the equation below. This surge pressure should be added to the existing line pressure to arrive at a maximum operating pressure figure.

$$P_s = V \left(\frac{E t 3960}{E t + 3 \times 10^6 D_i} \right)^{1/2}$$

Where:

- P_s = Surge Pressure, in psi
- V = Liquid Velocity, in feet per second
- D_i = Inside Pipe Diameter, inch
- E = Modulus of Elasticity of Pipe Material, psi
- t = Wall Thickness, inch

Calculated surge pressure, which assumes instantaneous valve closure, can be calculated for any material using the values for E (Modulus of Elasticity).

However, to keep water hammer pressures within reasonable limits, it is common practice to design valves for closure times considerably greater than 2L/c.

$$T_c > \frac{2L}{c}$$

Where:

- T_c = Valve Closure Time, second
- L = Length of Pipe Run, feet
- c = Sonic Velocity of the Pressure Wave = 4720 ft/second

Velocity

Thermoplastic piping has been successfully installed in systems with a water velocity in excess of 10 feet per second. Thermoplastic pipe is not subject to erosion caused by high velocities and turbulent flow and in this respect is superior to metal piping systems, particularly where corrosive or chemically aggressive fluids are involved. The accepted industry position is that while the maximum safe water velocity in a thermoplastic piping system depends on the specific details of the system and the operating conditions, five feet per second is considered safe. Higher velocities may be used in systems where the operating characteristics of the valves and pumps are known and sudden changes in flow velocity can be controlled. It is important that the total pressure in the system at any time (operating plus surge or water hammer) not exceed 150 percent of the pressure rating for the system.

Safety Factor

Since the duration of any pressure surges due to water hammer is extremely short — seconds, or more likely, fractions of a second — the calculations used in determining the Safety Factor, the maximum fiber stress due to internal pressure must be compared to some very short-term strength value. Referring to the “Regression Curve” chart on page 7, it shows that the failure stress for very short time periods is very high when compared to the Hydrostatic Design Stress.

Using this premise, the calculation of Safety Factor may be based, very conservatively, on the 20-second strength value given in the “Regression Curve” chart (page 7) — 8470 psi for PVC Type I.

A sample calculation is shown below, based upon the listed criteria:

Pipe = 1¼” Schedule 80 PVC I
O.D. = 1.660; Wall = 0.191

HDS = 2000 psi

The calculated surge pressure for 1¼” Schedule 80 PVC pipe at a velocity of 1 ft/sec. is 26.2 psi/ft/sec. (see next page)

$$\begin{aligned}\text{Water Velocity} &= 5 \text{ feet per second} \\ \text{Static Pressure in System} &= 300 \text{ psi} \\ \text{Total System Pressure} &= \text{Total Static} + \text{Surge Pressure} \\ P_t &= P + P_S \\ &= 300 + 5 \times 26.2 \\ &= 431.0 \text{ psi}\end{aligned}$$

Maximum circumferential stress is calculated from a variation of the ISO Equation:

$$S = \frac{P_t (D_o - t)}{2t} = \frac{431 (1.660 - 0.191)}{2 \times 0.191} = 1657.4$$

$$\begin{aligned}\text{Safety Factor} &= \frac{\text{20-second strength}}{\text{Maximum stress}} \\ &= \frac{8470}{1657} = 5.11\end{aligned}$$

Surge Pressure, Ps in psi at 73°F

water velocity (ft./sec.)	½"	¾"	1"	1¼"	1½"	2"	3"	4"	6"	8"	10"	12"
Schedule 40 PVC												
1	27.9	25.3	24.4	22.2	21.1	19.3	18.9	17.4	15.5	14.6	13.9	13.4
2	55.8	50.6	48.8	44.4	42.2	38.6	37.8	34.8	31.0	29.2	27.8	26.8
3	83.7	75.9	73.2	66.6	63.3	57.9	56.7	52.2	46.5	43.8	41.7	40.2
4	111.6	101.2	97.6	88.8	84.4	77.2	75.6	69.6	62.0	58.4	55.6	53.6
5	139.5	126.5	122.0	111.0	105.5	96.5	94.5	87.0	77.5	73.0	69.5	67.0
6	167.4	151.8	146.4	133.2	126.6	115.8	113.4	104.4	93.0	87.6	83.4	80.4
Schedule 80 PVC/CPVC												
1	32.9	29.9	28.7	26.2	25.0	23.2	22.4	20.9	19.4	18.3	17.3	17.6
2	65.6	59.8	57.4	52.4	50.0	46.4	44.8	41.8	38.8	36.6	35.6	35.2
3	98.7	89.7	86.1	78.6	75.0	69.6	67.2	62.7	58.2	59.9	53.4	52.8
4	131.6	119.6	114.8	104.8	107.0	92.8	89.6	83.6	77.6	73.2	71.2	70.4
5	164.5	149.5	143.5	131.0	125.0	116.3	112.0	104.5	97.0	91.5	89.0	88.0
6	197.4	179.4	172.2	157.2	150.0	133.2	134.4	125.4	116.4	109.8	106.8	105.6

The "Safety Factors vs. Service Factors" table (see below) gives the results of Safety Factor calculations based upon Service Factors of 0.5 and 0.4 for the 1¼" PVC I Schedule 80 pipe of the example shown on page 10 using the full pressure rating calculated from the listed Hydrostatic Design Stress. In each case, the Hydrostatic Design Basis = 4000 psi, and the water velocity = 5 feet per second.

Safety Factors vs. Service Factors — PVC Type I Thermoplastic Pipe

Pipe Class	Service Factor	HDS, psi	Pressure Rating psi	Surge Pressure at 5 ft./sec.	Maximum Pressure psi	Maximum Stress psi	Safety Factor
1¼" Sch. 80	0.5	2000	520	131.0	651.0	2503.5	3.38
1¼" Sch. 80	0.4	1600	416	131.0	547.0	2103.5	4.03

Pressure Rating values are for PVC I pipe, and for most sizes are calculated from the experimentally determined Long Term Strength of PVC I extrusion compounds. Because molding compounds may differ in Long Term Strength and elevated temperature properties from pipe compounds, piping systems consisting of extruded pipe and molded fittings may have lower pressure ratings than those shown here, particularly at the higher temperatures. Caution should be exercised in design of systems operating above 100°F.

Comparing Safety Factors for this 1¼" Schedule 80 pipe at different Service Factors, it should be noted that changing from a Service Factor of 0.5 to a more conservative 0.4 increases the Safety Factor only by 16%.

Cyclic Fatigue in Vinyl Piping Systems

When discussing water hammer or pressure surge in a piping systems, one should also be aware of a failure mode termed "Cyclic Fatigue." A piping system that has frequent and significant changes in flow conditions or pressure, creating a fluctuating surge, can have an effect on the structural integrity of a thermoplastic fitting. This condition has been observed in golf course irrigation systems that experience tens of thousands of water pressure surges over the course of a year. The resultant failure from cyclic fatigue is very similar in ap-

pearance to long-term static failure and it may be very difficult to ascertain the exact cause of such failures.

However, the design engineer should consider this phenomenon when designing a GF Piping System with frequent pressure changes, particularly if the surge pressure exceeds 50% of the systems working pressure. Based on some testing by Keller-Bliesener Engineering, the engineer may want to consider devaluing the fitting by 40% from the published pipe burst pressure. Keeping the flow velocity to 5 fps or less will also have an effect on pressure surges. Other considerations would be to use actuated valves that can be set to provide a slow opening or to install "soft start" pumps, as both of these will limit the water hammer and the resultant pressure surges.

Temperature-Pressure Relationship

Pressure ratings for thermoplastic pipe are generally determined using water at room temperature (73°F). As the system temperature increases, the thermoplastic pipe becomes more ductile, increases in impact strength and decreases in tensile strength. The pressure ratings of thermoplastic pipe must, therefore, be decreased accordingly.

The effects of temperature have been exhaustively studied and correction (derating) factors developed for each thermoplastic piping material. To determine the maximum operating pressure at any given temperature, multiply the pressure rating for the pipe size and type found in the following table by the temperature derating factor (f).

Solvent-Welded Pressure Rating vs. Service Temperature — PVC and CPVC

Nom. Size (inch)	D Outside Dia	t Wall	DR = D/t	P																			
				73°F		90°F		100°F		110°F		120°F		130°F		140°F		150°F	160°F	180°F	200°F	210°F	
				PVC	CPVC	PVC	CPVC	PVC	CPVC	PVC	CPVC	PVC	CPVC	PVC	CPVC	PVC	CPVC	CPVC	CPVC	CPVC	CPVC	CPVC	CPVC
				f=1.00 s=2000	f=1.00 s=2000	f=0.75 s=1500	f=0.92 s=1840	f=0.62 s=1240	f=0.85 s=1700	f=0.50 s=1000	f=0.77 s=1540	f=0.40 s=800	f=0.70 s=1400	f=0.30 s=600	f=0.62 s=1240	f=0.22 s=440	f=0.50 s=1000	f=0.47 s=940	f=0.40 s=800	f=0.25 s=500	f=0.18 s=400	f=0.16 s=320	
½	0.84	0.15	5.71	848	848	636	780	526	721	424	653	339	594	254	526	187	466	399	339	212	153	136	
¾	1.05	0.15	6.82	688	688	516	633	426	585	344	530	275	482	206	427	151	378	323	275	172	124	110	
1	1.32	0.18	7.35	630	630	473	580	390	536	315	485	252	441	189	391	139	347	296	252	158	113	101	
1¼	1.66	0.19	8.69	520	520	390	478	322	442	260	400	208	364	156	322	114	286	244	208	130	94	83	
1½	1.90	0.20	9.50	471	471	353	433	292	400	236	363	188	330	141	292	104	259	221	188	118	85	75	
2	2.38	0.22	10.89	404	404	303	372	251	343	202	311	162	283	121	250	89	222	190	162	101	73	65	
2½	2.88	0.28	10.42	425	425	319	391	263	361	213	327	170	298	128	264	94	234	200	170	106	77	68	
3	3.50	0.30	11.67	375	375	281	345	233	319	188	289	150	263	113	233	83	206	176	150	94	68	60	
4	4.50	0.34	13.35	324	324	243	298	201	275	162	249	130	227	97	201	71	178	152	130	81	58	52	
6	6.63	0.43	16.34	279	279	209	257	173	237	140	215	112	195	84	173	61	153	131	112	70	50	45	
8	8.63	0.50	17.25	246	246	185	226	153	209	123	189	98	172	74	153	54	135	116	98	62	44	39	
10	10.75	0.59	18.13	234	234	175	215	145	199	117	180	94	164	70	145	51	129	110	94	59	42	37	
12	12.75	0.69	18.56	228	228	171	210	141	194	114	176	91	160	68	141	51	125	107	91	57	41	36	

$$P = \frac{2St}{D-t} = \frac{2S}{DR-1} = P_{73°F} \cdot f$$

P = Pressure rating of pipe at service temperatures (psi)

S = Hydrostatic design stress (psi)

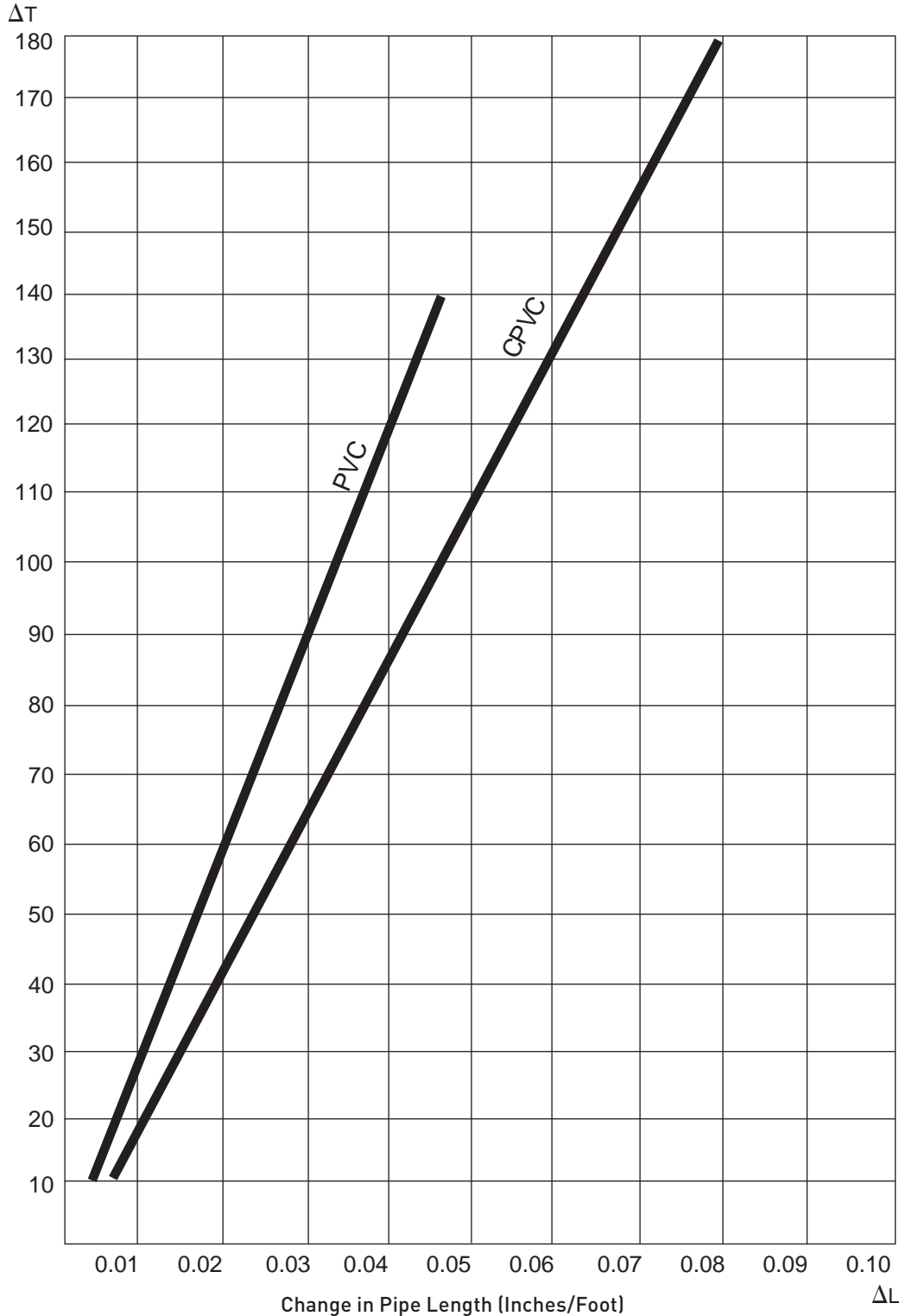
D = Outside diameter of pipe (inches)

- Figures for pressure rating at 73°F are rounded off from actual calculated values. Pressure ratings for other temperatures are calculated from 73°F values.
- Pressure rating values are for PVC (12454-B) and CPVC (23447-B) pipe and for most sizes are calculated from the experimentally determined long-term strength of PVC1 and CPVC extrusion compounds. Because molding compounds may differ in long-term strength and elevated temperature properties from pipe compounds, piping systems consisting of extruded pipe and molded fittings may have lower pressure ratings than those shown here, particularly at the higher temperatures. Caution should be exercised when designing PVC systems operating above 100°F and CPVC systems operating above 180°F.
- The pressure ratings given are for solvent-cemented systems. When adding valves, flanges or other components, the system must be derated to the rating of the lowest component. (Pressure ratings: molded or cut threads are rated at 50% of solvent-cemented systems; flanges and unions are 150 psi; for valves, see manufacturer's recommendation.)

Thermal Expansion and Contraction

Thermoplastics exhibit a relatively high coefficient of thermal expansion — as much as ten times that of steel. When designing plastic piping systems, expansion of long runs must be considered. Installation temperature versus working temperature or summer to winter extremes must be considered.

Linear Expansion and Contraction



Coefficient of Thermal Linear Expansion

PVC = 2.8×10^{-5} in/in/°F

CPVC = 3.4×10^{-5} in/in/°F

To Calculate:

ΔL = Change in pipe length due to thermal changes.

L = Straight runs of pipe with no changes in direction.

Y = Coefficient of thermal expansion (see above).

ΔT = maximum change in temperature between installation and operation (T MAX. - T. MIN.)

$\Delta L = Y \times L \times \Delta T$

Example:

- A system has 350 feet (4,200") of straight run (L) with no direction change.
- Pipe material is CPVC. Coefficient (Y) is 3.4×10^{-5} (0.000034").
- Pipe is installed at an ambient temperature of 60°F. Maximum anticipated operating temperature is 140°F. The difference (ΔT) is 80°F.

$\Delta L = 0.000034 \times 4200 \times 80$

$\Delta L = 11.4"$ of linear expansion in 350 ft. in pipe.

1. **Offsets:** Most piping systems have occasional changes in direction which will allow the thermally induced length changes to be taken up in offsets of the pipe beyond the bends. Where this method is employed, the pipe must be able to float except at anchor points.

2. **Expansion Joints:** Piston type expansion joints can be an effective means of compensating for expansion or contraction when the system has critical dimensions with no room for movement, or where appearance is important. It is important to follow the manufacturers recommendations regarding support, anchoring and the proper setting of the expansion joint.

Tables for expansion loops, offsets and expansion joints have been generated for elevated temperatures as noted beneath each table. If the change in temperature and working temperatures are lower than those used to derive expansion loop and offset tables, the figures will be conservative. These tables can be generated for any temperature and expansion by using the following equations and the modulus of elasticity and working stress at the given temperature.

Assume the pipe to be a cantilevered beam.

For a beam, the bending stress can be calculated by **“Equation 1:”**

$$S = \frac{M * C}{I}$$

Where:

- S = Stress (psi)
- M = Moment (in lbs.)
- C = Distance from neutral axis (in.)
- I = Moment of Inertia (in⁴)

For application to pipe, the maximum stress occurs where C equals the radius of the pipe. Substituting the radius for C and rearranging the equation to solve for the Moment is shown in **“Equation 2:”**

$$M = \frac{2 * S * I}{OD}$$

Where:

- OD = Pipe Outer Diameter (in)
- C = Radius of pipe = OD/2 (in)

The free body diagram which most closely approximates the deflected pipe in an expansion loop, offset or change in direction is shown in Figure A (see page 16). This is not a cantilever beam but rather a guided cantilever beam. For a guided cantilever, the moment induced by an imposed deflection is calculated by **“Equation 3:”**

$$M = \frac{6 * E * I * y}{DPL^2}$$

Where:

- E = Modulus of Elasticity (psi)
- y = imposed deflection (in)
- DPL = deflected pipe length (in)

By equating “2” and “3,” the equation for the deflected beam length (DPL) can be solved:

$$\frac{2 * S * I}{OD} = \frac{6 * E * I * y}{DPL^2}$$

“Equation 4:”

$$DPL = \sqrt{\frac{3 * E * OD * y}{S}}$$

After determining the proper allowable stress, “Equation 4” gives an estimate of the minimum deflected pipe length (DPL) required to sustain a piping thermal movement of length y normal to the piping.

“Equation 4” can be used to calculate the minimum deflected pipe length for expansion loops, offsets and change of directions:

Note: In some cases, a stress intensification factor (i) is added as shown in “Equation 5.” The stress intensification factor is used as a safety factor to account for the effect of localized stresses on piping under repetitive loading. For example, the stress intensification factor for socket welded joints is 1.3 and for threaded joints the factor is 2.3 per ANSI/ASME B31.3, B31.4, B31.5 and B31.8 codes.

“Equation 5:”

$$DPL = \sqrt{\frac{3 * E * OD * y * i}{S}}$$

“Equation 6” is used to calculate the change in length caused by thermal expansion:

$$\Delta L = 12 * e * L * \Delta T$$

Where:

- ΔL = Change in length (in)
- e = Coefficient of Thermal Expansion (in/in °F)
- L = Length of Straight Pipe Run (ft)
- ΔT = Change in Temperature (°F)

For the expansion loop, shown in Figure B (see page 16), the imposed deflection is one-half the change in length as represented in “Equation 7”:

$$y = \frac{\Delta L}{2}$$

“Equation 4” can be modified to replace the deflection (y) with equation 6 for the change in length (ΔL) according to the relationship shown in “Equation 7.”

“Equation 8:” Expansion Loop

$$DPL = 4.243 * \sqrt{\frac{E * OD * e * L * \Delta T}{S}}$$

Where:

- DPL = Deflected Pipe Length (in)
- E = Modulus of Elasticity (psi)
- OD = Pipe Outer Diameter (in)
- e = Coefficients of Thermal Expansion (in/in °F)
- L = Length of Straight Pipe Run (ft)
- ΔT = Change in Temperature (°F)
- S = Allowable Stress (psi)

For the offset shown in Figure C (see page 17) and the change in direction shown in Figure D (page 17), the imposed deflection is equal to the change in length caused by thermal expansion.

“Equation 9:”

$$y = \Delta L$$

“Equation 4” can be modified to replace the deflection (y) with “Equation 6” for the change in length ΔL according to the relationship shown in “Equation 9.”

“Equation 10:” Offsets and Change of Direction

$$DPL = 6.0 * \sqrt{\frac{E * OD * e * L * \Delta T}{S}}$$

Where:

- DPL = Deflected Pipe Length (in)
- E = Modulus of Elasticity (psi)
- OD = Pipe Outer Diameter (in)
- e = Coefficient of Thermal Expansion (in/in °F)
- L = Length of Straight Pipe Run (ft)
- ΔT = Change in Temperature (°F)
- S = Allowable Stress (psi)

“Equation 11” Piston Type Expansion Joints

$$Px = \frac{T_{max} - T_{amb}}{T_{max} - T_{min}} * \Delta L$$

Where:

- Px = Piston Installation Position
- T_{max} = Maximum temperature
- T_{min} = Minimum Temperature
- T_{amb} = Ambient Temperature
- ΔL = Length of Expansion Joint (6” or 12”)

Note: In the tables to follow (see page 16), we have chosen to use values for the allowable stress (S) and the modulus of elasticity (E) at the upper temperature limit.

Many calculations (in other manufacturers’ literature) are based on the allowable stress and the modulus of elasticity at ambient conditions. This simplification is allowed because for most plastics (S) and (E) vary with temperature at approximately the same rate.

PVC Expansion Loops

PVC		Length of Run (feet)									
		10	20	30	40	50	60	70	80	90	100
Pipe Size (in.)	O.D. of Pipe (in.)	Minimum Deflected Pipe Length (DPL) (inches)									
1/2	0.840	11	15	19	22	24	27	29	31	32	34
3/4	1.050	12	17	21	24	27	30	32	34	36	38
1	1.315	14	19	23	27	30	33	36	38	41	43
1 1/4	1.660	15	22	26	30	34	37	40	43	46	48
1 1/2	1.900	16	23	28	33	36	40	43	46	49	51
2	2.375	18	26	32	36	41	45	48	51	55	58
3	3.500	22	31	38	44	49	54	58	62	66	70
4	4.500	25	35	43	50	56	61	66	71	75	79
6	6.625	30	43	53	61	68	74	80	86	91	96
8	8.625	35	49	60	69	78	85	92	98	104	110
10	10.750	39	55	67	77	87	95	102	110	116	122
12	12.750	42	60	73	84	94	103	112	119	127	133

PVC Offsets and Change of Directions

PVC		Length of Run (feet)									
		10	20	30	40	50	60	70	80	90	100
Pipe Size (in.)	O.D. of Pipe (in.)	Minimum Deflected Pipe Length (DPL) (inches)									
1/2	0.840	15	22	27	31	34	37	41	43	46	48
3/4	1.050	17	24	30	34	38	42	45	48	51	54
1	1.315	19	27	33	38	43	47	51	54	57	61
1 1/4	1.660	22	30	37	43	48	53	57	61	65	68
1 1/2	1.900	23	33	40	46	51	56	61	65	69	73
2	2.375	26	36	45	51	58	63	68	73	77	81
3	3.500	31	44	54	62	70	77	83	88	94	99
4	4.500	35	50	61	71	79	87	94	100	106	112
6	6.625	43	61	74	86	96	105	114	122	129	136
8	8.625	49	69	85	98	110	120	130	139	147	155
10	10.750	55	77	95	110	122	134	145	155	164	173
12	12.750	60	84	103	119	133	146	158	169	179	189

Figure A: Guided Cantilever Beam

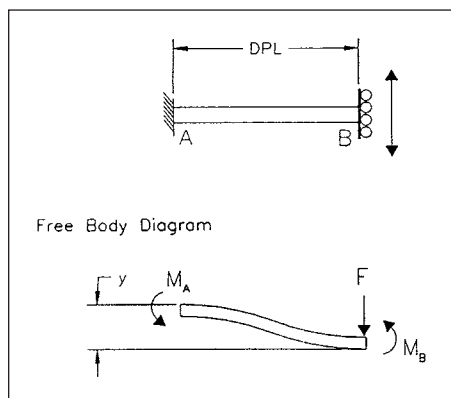
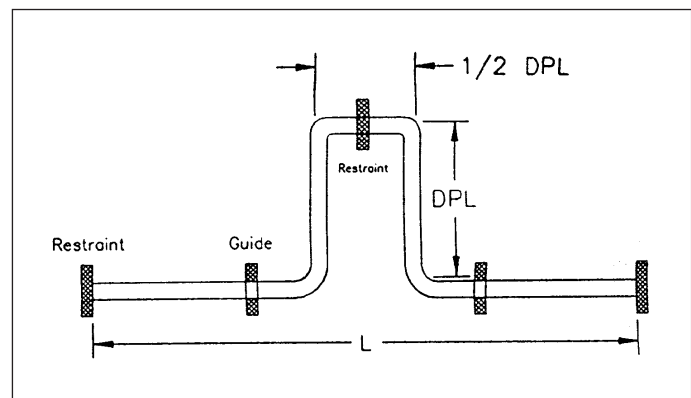


Figure B: Expansion Loop



CPVC Expansion Loops

CPVC		Length of Run (feet)									
		10	20	30	40	50	60	70	80	90	100
Pipe Size (in.)	O.D. of Pipe (in.)	Minimum Deflected Pipe Length (DPL) (inches)									
1/2	0.840	15	21	26	30	33	36	39	42	44	47
3/4	1.050	17	23	29	33	37	40	44	47	50	52
1	1.315	18	26	32	37	41	45	49	52	55	58
1 1/4	1.660	21	29	36	42	46	51	55	59	62	66
1 1/2	1.900	22	31	39	44	50	54	59	63	67	70
2	2.375	25	35	43	50	56	61	66	70	75	79
3	3.500	30	43	52	60	67	71	80	85	91	95
4	4.500	34	48	59	68	77	84	91	97	103	108
6	6.625	42	59	72	83	93	102	110	117	125	131
8	8.625	47	67	82	95	106	116	125	134	142	150
10	10.750	53	75	92	106	118	130	140	150	159	167
12	12.750	58	81	100	115	129	141	152	163	173	182

CPVC Offsets and Change of Directions

CPVC		Length of Run (feet)									
		10	20	30	40	50	60	70	80	90	100
Pipe Size (in.)	O.D. of Pipe (in.)	Minimum Deflected Pipe Length (DPL) (inches)									
1/2	0.840	21	30	36	42	47	51	55	59	63	66
3/4	1.050	23	33	40	47	52	57	62	66	70	74
1	1.315	26	37	45	52	58	61	69	74	78	83
1 1/4	1.660	29	42	51	59	66	72	78	86	88	93
1 1/2	1.900	31	44	54	63	70	77	83	89	94	99
2	2.375	35	50	61	70	79	86	93	99	105	111
3	3.500	43	60	74	85	95	105	113	121	128	135
4	4.500	48	68	84	97	108	119	128	137	145	153
6	6.625	59	83	102	117	131	144	155	166	176	186
8	8.625	67	95	116	134	150	164	177	189	201	212
10	10.750	75	106	130	150	167	183	198	212	224	237
12	12.750	81	115	141	163	182	200	216	230	244	258

Figure C: Expansion Offset

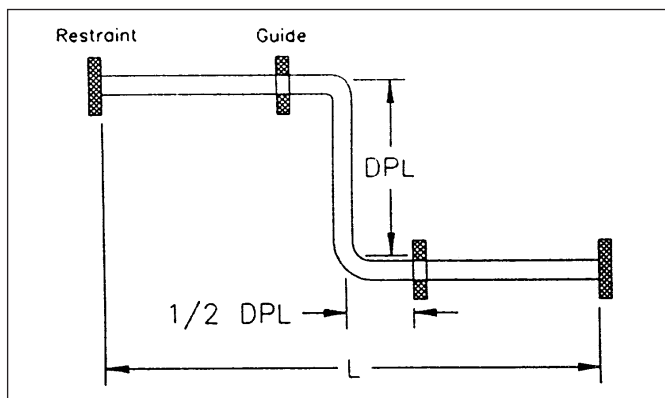
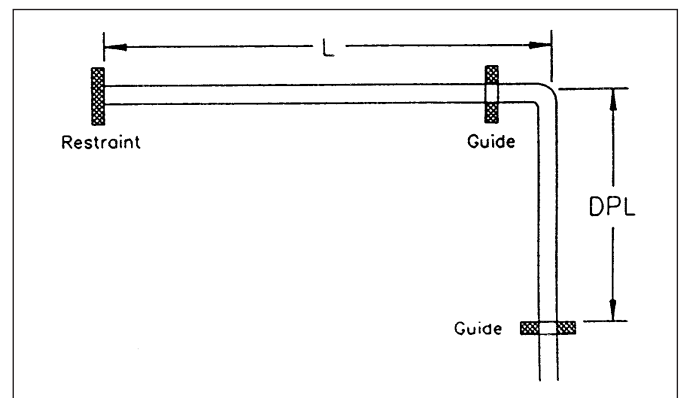


Figure D: Change of Direction



Friction-Loss Characteristics

Introduction

A major advantage of thermoplastic pipe is its exceptionally smooth inside surface area, which reduces friction loss compared to other materials.

Friction loss in plastic pipe remains constant over extended periods of time, in contrast to many traditional materials where the value of the Hazen and Williams C factor (constant for inside roughness) decreases with time. As a result, the flow capacity of thermoplastics is greater under fully turbulent flow conditions like those encountered in water service.

C Factors

Tests made both with new pipe and pipe that had been in service revealed C factor values for plastic pipe between 160 and 165. Thus, the factor of 150 recommended for water in Equation 12 is on the conservative side. On the other hand, the C factor for metallic pipe varies from 65 to 125, depending upon age and interior roughening. A benefit with plastic piping systems is that it is often possible to achieve the desired flow rate using a smaller diameter pipe, resulting in less initial cost for pipe, valves, fitting and pumps, and still maintain the same or even lower friction losses. A longer term benefit would be the resultant savings in energy required to operate the system.

Hazen and Williams Formula

The head losses resulting from various water flow rates in plastic piping may be calculated by means of the Hazen and Williams formula:

“Equation 12:”

$$f = 0.2083 \left(\frac{100}{C} \right)^{1.852} \times \frac{g^{1.852}}{D_i^{4.8655}}$$
$$= 0.0983 \frac{g^{1.852}}{D_i^{4.8655}} \text{ for } C = 150$$
$$P = 4335f$$

Where:

- f = Friction Head in ft. of Water per 100 ft. of Pipe
- P = Pressure Loss in psi per 100 ft. of Pipe
- D_i = Inside Pipe Diameter, in.
- g = Flow Rate in U.S. gal./min.
- C = Constant for Inside Roughness
(C equals 150 for thermoplastics)

Friction Loss — Schedule 40 Pipe

Carrying capacity, friction loss and flow data for Schedule 40 thermoplastic pipe are presented in tabular form in the table below. This table is applicable to pipe made of any of the thermoplastic piping materials as all have equally smooth interior surfaces.

Carrying Capacity and Friction Loss — Schedule 40 Thermoplastics Pipe

Independent variables: Gallons per minute and nominal pipe size O.D. (Min. I.D.)

Dependent variables: Velocity, friction head and pressure drop per 100 feet of pipe, interior smooth.

Gallons per minute	½ in.			¾ in.			1 in.			1¼ in.			1½ in.			2 in.			3 in.			
	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	
1	1.13	2.08	0.90	0.63	0.51	0.22																
2	2.26	4.16	1.80	1.26	1.02	0.44	0.77	0.55	0.24	0.44	0.14	0.06	0.33	0.07	0.03							
5	5.64	23.44	10.15	3.16	5.73	2.48	1.93	1.72	0.75	1.11	0.44	0.19	0.81	0.22	0.09	0.49	0.066	0.029	0.03	0.015	0.007	
7	7.90	43.06	18.64	4.43	10.52	4.56	2.72	3.17	1.37	1.55	0.81	0.35	1.13	0.38	0.17	0.69	0.11	0.048	0.49	0.021	0.009	
10	11.28	82.02	35.51	6.32	20.04	8.68	3.86	6.02	2.61	2.21	1.55	0.67	1.62	0.72	0.31	0.98	0.21	0.091	0.68	0.03	0.013	
15		4 in.			9.48	42.46	18.39	5.79	12.77	5.53	3.31	3.28	1.42	2.42	1.53	0.66	1.46	0.45	0.19	1.03	0.07	0.030
20	0.51	0.03	0.013	12.65	72.34	32.32	7.72	21.75	9.42	4.42	5.59	2.42	3.23	2.61	1.13	1.95	0.76	0.33	1.37	0.11	0.048	
25	0.64	0.04	0.017		5 in.			9.65	32.88	14.22	5.52	8.45	3.66	4.04	3.95	1.71	2.44	1.15	0.50	1.71	0.17	0.074
30	0.77	0.06	0.026	0.49	0.02	0.009	11.58	46.08	19.95	6.63	11.85	5.13	4.85	5.53	2.39	2.93	1.62	0.70	2.05	0.23	0.10	
35	0.89	0.08	0.035	0.57	0.03	0.013				7.73	15.76	6.82	5.66	7.36	3.19	3.41	2.15	0.93	2.39	0.31	0.13	
40	1.02	0.11	0.048	0.65	0.03	0.013				8.84	20.18	8.74	6.47	9.43	4.08	3.90	2.75	1.19	2.73	0.40	0.17	
45	1.15	0.13	0.056	0.73	0.04	0.017		6 in.			9.94	25.10	10.87	7.27	11.73	5.80	4.39	3.43	1.49	3.08	0.50	0.22
50	1.28	0.16	0.069	0.81	0.05	0.022	0.56	0.02	0.009	11.05	30.51	13.21	8.08	14.25	6.17	4.88	4.16	1.80	3.42	0.60	0.26	
60	1.53	0.22	0.095	0.97	0.07	0.030	0.67	0.03	0.013				9.70	19.98	8.65	5.85	5.84	2.53	4.10	0.85	0.37	
70	1.79	0.30	0.13	1.14	0.10	0.043	0.79	0.04	0.017							6.83	7.76	3.36	4.79	1.13	0.49	
75	1.92	0.34	0.15	1.22	0.11	0.048	0.84	0.05	0.022							7.32	8.82	3.82	5.13	1.28	0.55	
80	2.05	0.38	0.16	1.30	0.13	0.056	0.90	0.05	0.022		8 in.					7.80	9.94	4.30	5.47	1.44	0.62	
90	2.30	0.47	0.20	1.46	0.16	0.069	1.01	0.06	0.026							8.78	12.37	5.36	6.15	1.80	0.78	
100	2.56	0.58	0.25	1.62	0.19	0.082	1.12	0.08	0.035	0.65	0.03	0.012				9.75	15.03	6.51	6.84	2.18	0.94	
125	3.20	0.88	0.38	2.03	0.29	0.125	1.41	0.12	0.052	0.81	0.035	0.015		10 in.						8.55	3.31	1.43
150	3.84	1.22	0.53	2.44	0.40	0.17	1.69	0.16	0.069	0.97	0.04	0.017							10.26	4.63	2.00	
175	4.48	1.63	0.71	2.84	0.54	0.235	1.97	0.22	0.096	1.14	0.055	0.024								6.16	2.67	
200	5.11	2.08	0.90	3.25	0.69	0.30	2.25	0.28	0.12	1.30	0.07	0.030	0.82	0.027	0.012		12 in.				7.88	3.41
250	6.40	3.15	1.36	4.06	1.05	0.45	2.81	0.43	0.19	1.63	0.11	0.048	1.03	0.035	0.015					11.93	5.17	
300	7.67	4.41	1.91	4.87	1.46	0.63	3.37	0.60	0.26	1.94	0.16	0.069	1.23	0.05	0.022							
350	8.95	5.87	2.55	5.69	1.95	0.85	3.94	0.79	0.34	2.27	0.21	0.091	1.44	0.065	0.028	1.01	0.027	0.012				
400	10.23	7.52	3.26	6.50	2.49	1.08	4.49	1.01	0.44	2.59	0.27	0.12	1.64	0.09	0.039	1.16	0.04	0.017				
450				7.31	3.09	1.34	5.06	1.26	0.55	2.92	0.33	0.14	1.85	0.11	0.048	1.30	0.05	0.022				
500				8.12	3.76	1.63	5.62	1.53	0.66	3.24	0.40	0.17	2.05	0.13	0.056	1.45	0.06	0.026				
750							8.43	3.25	1.41	4.86	0.85	0.37	3.08	0.28	0.12	2.17	0.12	0.052				
1000							11.24	5.54	2.40	6.48	1.45	0.63	4.11	0.48	0.21	2.89	0.20	0.087				
1250										8.11	2.20	0.95	5.14	0.73	0.32	3.62	0.31	0.13				
1500										9.72	3.07	1.33	6.16	1.01	0.44	4.34	0.43	0.19				
2000													8.21	1.72	0.74	5.78	0.73	0.32				
2500													10.27	2.61	1.13	7.23	1.11	0.49				

Friction Loss — Schedule 80 Pipe

Carrying capacity, friction loss and flow data for Schedule 80 thermoplastic pipe are presented in tabular form in the table below. This table is applicable to pipe made of any of the thermoplastic piping materials as all have equally smooth interior surfaces.

Friction Loss — Schedule 80 Fittings

The table "Friction Loss in Equivalent Feet of Pipe" gives the estimated friction loss in equivalent feet of pipe, through thermoplastic fittings of various sizes and configurations.

Carrying Capacity and Friction Loss — Schedule 80 Thermoplastics Pipe

Independent variables: Gallons per minute and nominal pipe size O.D. (Min. I.D.)

Dependent variables: Velocity, friction head and pressure drop per 100 feet of pipe, interior smooth.

Gallons per minute	1/2"			3/4"			1"			1 1/4"			1 1/2"			2"			2 1/2"			3"		
	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch	Velocity feet per second	Friction head feet	Friction loss pounds per square inch
1	1.43	4.02	1.74	0.74	0.86	0.37																		
2	2.95	8.03	3.48	1.57	1.72	0.74	0.94	0.88	0.33	0.52	0.21	0.09	0.38	0.10	0.041									
5	7.89	45.23	19.59	3.92	9.67	4.19	2.34	2.78	1.19	1.30	0.66	0.29	0.94	0.30	0.126	0.56	0.10	0.040	0.39	0.05	0.022	0.25	0.02	0.009
7	10.34	83.09	35.97	5.49	17.76	7.59	3.23	5.04	2.19	1.82	1.21	0.53	1.32	0.55	0.24	0.78	0.15	0.088	0.54	0.07	0.032	0.35	0.023	0.013
10				7.84	33.84	14.65	4.68	9.61	4.16	2.60	2.30	1.00	1.88	1.04	0.45	1.12	0.29	0.13	0.78	0.12	0.052	0.50	0.04	0.017
15				11.76	71.70	31.05	7.01	20.36	8.82	3.90	4.87	2.11	2.81	2.20	0.95	1.63	0.62	0.27	1.17	0.26	0.11	0.75	0.09	0.039
20	0.57	0.04	0.017				9.35	34.68	15.02	5.20	8.30	3.59	3.75	3.75	1.62	2.23	1.06	0.46	1.56	0.44	0.19	1.00	0.15	0.055
25	0.72	0.06	0.026				11.69	52.43	22.70	6.50	12.55	5.43	4.69	5.67	2.46	2.79	1.60	0.69	1.95	0.67	0.29	1.25	0.22	0.095
30	0.86	0.08	0.035	0.54	0.03	0.013	14.03	73.48	31.62	7.80	17.59	7.62	5.63	7.95	3.44	3.35	2.25	0.97	2.34	0.94	0.41	1.49	0.31	0.13
35	1.00	0.11	0.048	0.63	0.04	0.017				9.10	23.40	10.13	6.57	10.58	4.58	3.91	2.99	1.29	2.73	1.25	0.64	1.74	0.42	0.13
40	1.15	0.14	0.061	0.72	0.04	0.017				10.40	29.97	12.98	7.50	13.55	5.87	4.47	3.86	1.66	3.12	1.60	0.89	1.99	0.54	0.23
45	1.29	0.17	0.074	0.81	0.05	0.020				11.70	37.27	16.14	8.44	16.85	7.30	5.03	4.76	2.07	3.51	1.90	0.86	2.24	0.67	0.29
50	1.43	0.21	0.091	0.90	0.07	0.030	0.63	0.03	0.013	13.00	45.30	19.61	9.38	20.48	8.87	5.58	5.79	2.51	3.90	2.42	1.05	2.49	0.81	0.35
60	1.72	0.30	0.13	1.08	0.10	0.043	0.75	0.04	0.017				11.26	28.70	12.43	6.70	8.12	3.52	4.68	3.39	1.47	2.98	1.14	0.49
70	2.01	0.39	0.17	1.26	0.13	0.056	0.88	0.05	0.022							7.82	10.80	4.68	5.46	4.51	1.35	3.49	1.51	0.65
75	2.15	0.45	0.19	1.35	0.14	0.061	0.94	0.06	0.026							8.38	12.27	5.31	5.85	5.12	2.22	3.74	1.74	0.74
80	2.29	0.50	0.22	1.44	0.16	0.069	1.00	0.07	0.030							8.93	13.83	5.99	6.24	6.77	2.50	3.99	1.94	0.84
90	2.58	0.63	0.27	1.62	0.20	0.087	1.13	0.08	0.035							10.05	17.20	7.45	7.02	7.18	3.11	4.48	2.41	1.04
100	2.87	0.76	0.33	1.80	0.24	0.10	1.25	0.10	0.043							11.17	20.90	9.05	7.80	8.72	3.78	4.98	2.93	1.27
125	3.59	1.16	0.50	2.25	0.37	0.16	1.57	0.16	0.068	0.90	0.045	0.019							9.75	13.21	5.72	6.23	4.43	1.92
150	4.30	1.61	0.70	2.70	0.52	0.23	1.88	0.22	0.095	1.07	0.05	0.022							11.70	18.48	8.00	7.47	6.20	2.68
175	5.02	2.15	0.93	3.15	0.69	0.30	2.20	0.29	0.12	1.25	0.075	0.033										8.72	8.26	3.58
200	5.73	2.75	1.19	3.60	0.88	0.38	2.51	0.37	0.16	1.43	0.09	0.039	0.90	0.036	0.015							9.97	10.57	4.58
250	7.16	4.16	1.81	4.50	1.34	0.58	3.14	0.56	0.24	1.79	0.14	0.61	1.14	0.045	0.02							12.46	16.00	8.93
300	8.60	5.33	2.52	5.40	1.87	0.81	3.76	0.78	0.34	2.14	0.20	0.087	1.36	0.07	0.03									
350	10.03	7.76	3.35	6.30	2.49	1.08	4.39	1.04	0.45	2.50	0.27	0.12	1.59	0.085	0.037	1.12	0.037	0.016						
400	11.47	9.93	4.30	7.19	3.19	1.38	5.02	1.33	0.68	2.86	0.34	0.15	1.81	0.11	0.048	1.28	0.05	0.022						
450				8.09	3.97	1.72	5.64	1.65	0.71	3.21	0.42	0.18	2.04	0.14	0.061	1.44	0.06	0.026						
500				8.99	4.82	2.09	6.27	2.00	0.87	3.57	0.51	0.22	2.27	0.17	0.074	1.60	0.07	0.030						
750							9.40	4.25	1.84	5.36	1.08	0.47	3.40	0.36	0.16	2.40	0.15	0.065						
1000							12.54	7.23	3.13	7.14	1.84	0.80	4.54	0.61	0.26	3.20	0.20	0.11						
1250										8.93	2.78	1.20	5.67	0.02	0.40	4.01	0.40	0.17						
1500										10.71	3.89	1.68	6.80	1.29	0.56	4.81	0.55	0.24						
2000													9.07	2.19	0.95	6.41	0.84	0.41						
2500													11.34	3.33	1.44	8.01	1.42	0.62						
3000																9.61	1.99	0.86						
3500																11.21	2.65	1.15						
4000																12.82	3.41	1.48						

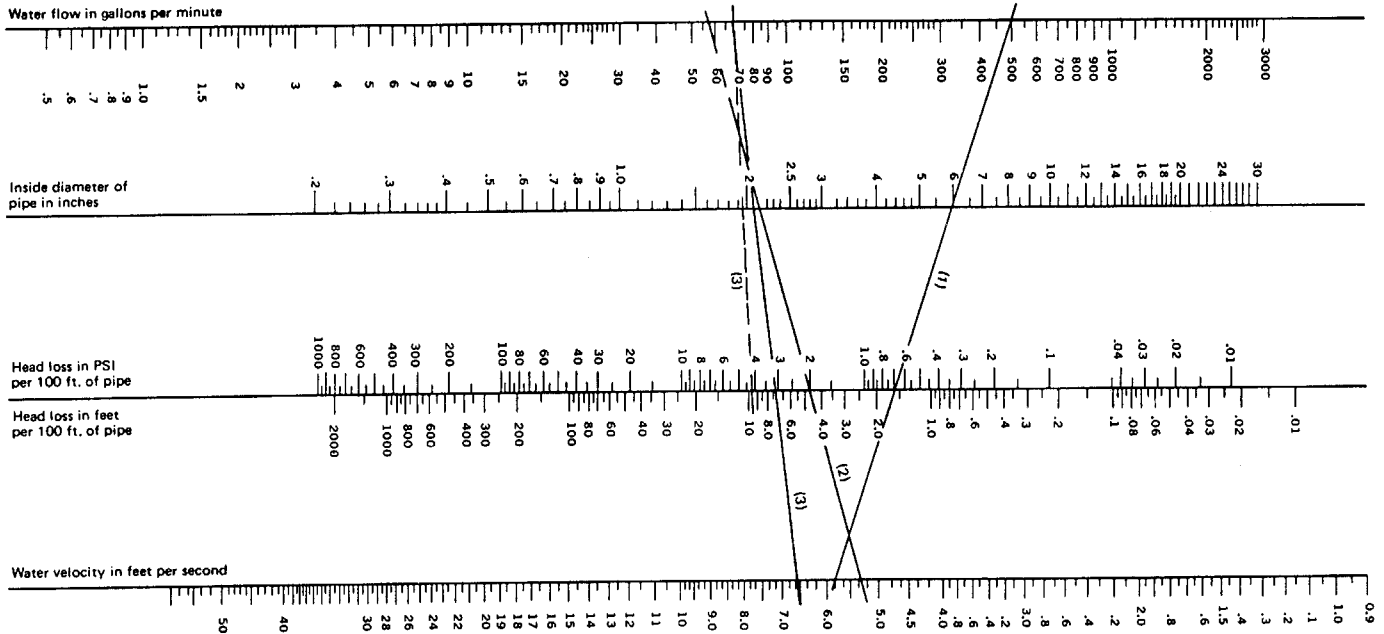
Friction Loss in Equivalent Feet of Pipe — Schedule 80 Thermoplastics Fittings

Nominal Pipe Size, In.	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	6	8
Tee, Side Outlet	3	4	5	6	7	8	12	15	16	20	22	32	38
90° Ell	1 1/2	1 1/2	2	2 3/4	4	4	6	8	8	10	12	18	22
45° Ell	3/4	3/4	1	1 3/8	1 3/4	2	2 1/2	3	4	4 1/2	5	8	10
Insert Coupling	—	1/2	3/4	1	1 1/4	1 1/2	2	3	3	—	4	6 1/4	—
Male-Female Adapters	—	1	1 1/2	2	2 3/4	3 1/2	4 1/2	—	6 1/2	—	9	14	—

Head Loss Characteristics of Water Flow Thru Rigid Plastic Pipe

This nomograph provides approximate values for a wide range of plastic pipe sizes. More precise values should be calculated from the Hazen and Williams formula. Experimental test value of C (a constant for inside pipe

roughness) ranges from 155 to 165 for various types of plastic pipe. Use of a value of 150 will ensure conservative friction loss values.



The values of this chart are based on the Hazen & Williams formula:

$$f = 0.2083 \left(\frac{100}{C} \right)^{1.852} \times \frac{g^{1.852}}{D_i^{4.8655}}$$

$$= 0.0983 \frac{g^{1.852}}{D_i^{4.8655}} \text{ for } C = 150$$

$$P = 4335f$$

Where:

- f = Friction Head in ft. of Water per 100 ft. of Pipe
- P = Pressure Loss in psi per 100 ft. of Pipe
- D_i = Inside Pipe Diameter, in.
- g = Flow Rate in U.S. gal./min.
- C = Constant for Inside Roughness
[C equals 150 for thermoplastics]

The nomograph is used by lining up values on the scales by means of a ruler or straight edge. Two independent variables must be set to obtain the other values. For example: line (1) indicates that 500 gallons per minute may be obtained with a 6-inch inside diameter pipe at a head loss of about 0.65 pounds per square inch at a velocity of 6.0 feet per second. Line (2) indicates that a pipe with 2.1 inch inside diameter will give a flow of about 60 gallons per minute at a loss in head of 2 pounds per square inch per 100 feet of pipe. Line (3) and dotted line (3) show that in going from a pipe 2.1 inch inside diameter to one of 2 inches inside diameter, the head loss goes from 3 to 4 pounds per square inch in obtaining a flow of 70 gallons per minute. Remember, velocities in excess of 5.0 feet per second are not recommended.

Nomograph courtesy of Plastics Pipe Institute, a division of The Society of The Plastics Industry.

Installation Instructions

Storage and Handling

GF thermoplastics have excellent resistance to weathering and can be stored outside for long periods. However, it is recommended that any plastic pipe stored outside be covered with a light tarpaulin, or kept under cover in a warehouse or shed that is well ventilated to prevent excessive temperature buildup and possible warping. Care should also be exercised to keep the product away from exposure to UV from direct sunlight. The storage area should not be located near steam lines or other heat sources.

To prevent sagging or "draping," particularly of the longer sections, pipe should be stored on racks that provide close or continuous support. Any sharp edges or burrs on the racks should be removed or covered. To prevent excessive deflection, loose stacks of pipe should not exceed a height of three feet. Bundled pipe can be stacked twice as high.

Fittings and flanges should be kept in their original packaging or in separate bins until they are needed. They should never be mixed with metal piping components.

Since plastic pipe has lower impact strength and resistance to mechanical abuse than steel, it requires somewhat more care in handling. Pulling a length of pipe off a truck bed and letting the free end plummet to the ground should be avoided. Also to be avoided is dragging the pipe over rough ground, dropping heavy objects on it, or using any kind of chains. The resulting scratches, splits or gouges can reduce the pressure rating.

If damage from careless handling does occur, one of the advantages of plastic pipe is readily apparent. The damaged section can be quickly cut out and the pipe ends rejoined using the cutting and joining techniques described below.

Solvent Welding PVC and CPVC Pipe and Fittings

Basic Principles

The solvent cemented connection in thermoplastic pipe and fittings is the last vital link in a plastic pipe instal-

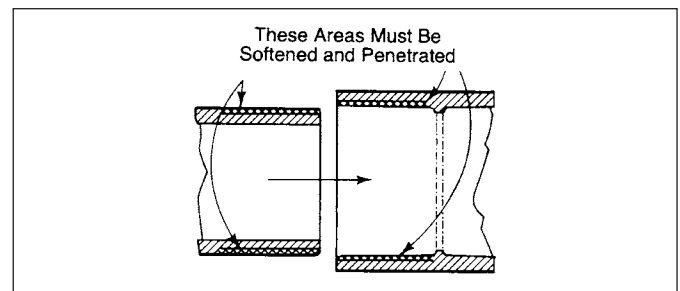
lation. It can mean the success or failure of the system as a whole. Accordingly, it requires the same professional care and attention given to other components of the system.

There are many solvent cementing techniques published covering step by step procedures on just how to make solvent cemented joints. However, we feel that if the basic principles involved are explained, known and understood, a better understanding would be gained, as to what techniques are necessary to suit particular applications, temperature conditions, and variations in sizes and fits of pipe and fittings.

To consistently make good joints the following should be clearly understood:

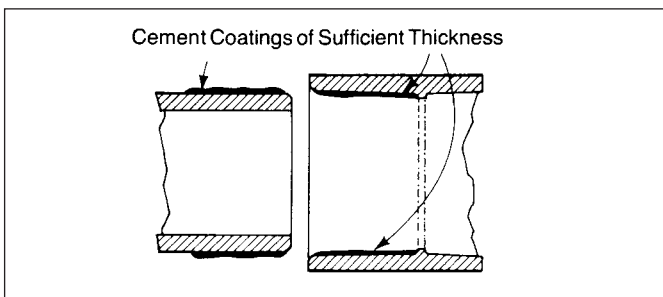
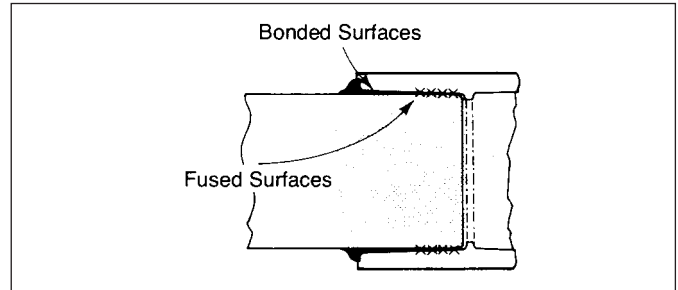
1. The joining surfaces must be dissolved and made semi-fluid.
2. Sufficient cement must be applied to fill the gap between pipe and fitting.
3. Assembly of pipe and fittings must be made while the surfaces are still wet and fluid.
4. Joint strength develops as the cement dries. In the tight part of the joint the surfaces will tend to fuse together, in the loose part the cement will bond to both surfaces.

Penetration and dissolving can be achieved by a suitable primer, or by the use of both primer and cement. A suitable primer will penetrate and dissolve the plastic more quickly than cement alone. The use of a primer provides a safety factor for the installer for he can know, under various temperature conditions, when he has achieved sufficient softening.

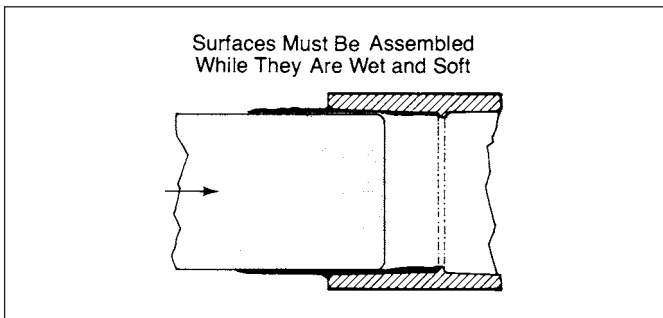


More than sufficient cement to fill the loose part of the joint must be applied. Besides filling the gap, adequate cement layers will penetrate the surface and also remain wet until the joint is assembled. Prove this for yourself. Apply on the top surface of a piece of pipe two separate layers of cement. First apply a heavy layer of cement, then alongside it, a thin brushed out layer. Test the layers every 15 seconds or so by a gentle tap with your finger. You will note that the thin layer becomes tacky and then dries quickly (probably within 15 seconds). The heavy layer will remain wet much longer. Check for penetration a few minutes after applying these layers. Scrape them with a knife. The thin layer will have achieved little or no penetration. The heavy one, much more penetration.

As the solvent dissipates, the cement layer and the dissolved surfaces will harden with a corresponding increase in joint strength. A good joint will take the required working pressure long before the joint is fully dry and final strength will develop more quickly than in the looser (bonded) part of the joint.



If the cement coatings on the pipe and fittings are wet and fluid when assembly takes place, they will tend to flow together and become one cement layer. Also, if the cement is wet the surfaces beneath them will still be soft, and these softened surfaces in the tight part of the joint will tend to fuse together.



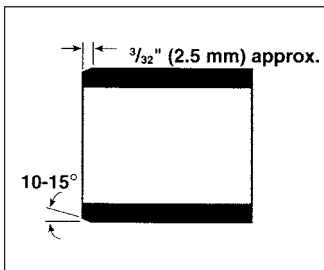
Making the Joint

1. Cutting: Pipe must be squarely cut to allow for the proper interfacing of the pipe end and the fitting socket bottom. This can be accomplished with a miter box saw or wheel type cutter. For saw cuts on pipe too large for a miter box, a pipe wrap should be used and a line drawn with marker. If using a wheel cutter, it must have a cutting blade specifically designed for plastic pipe.

Note: Power saws should be specifically designed to cut plastic pipe.

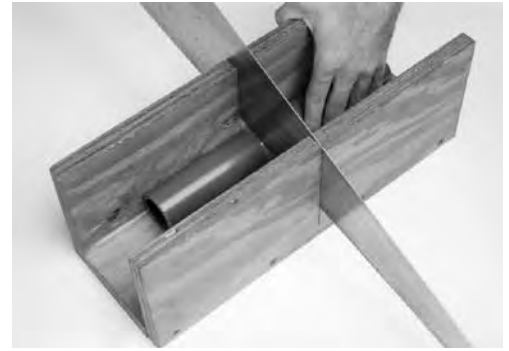
2. Deburring: Use a plastic deburring tool or file to remove burrs from the end of small diameter pipe. Be sure to remove all burrs from around the inside as well as the outside of the pipe. A slight chamfer (bevel) of about 10°-15° should be added to the end to permit easier insertion of the pipe into the fitting. Failure to chamfer the edge of the pipe may remove cement from the fitting socket, causing the joint to leak. For pressure pipe systems of 2" and above, the pipe must be end-treated with a 15° chamfer cut to a depth of approximately 3/32." Commercial power bevelers are recommended.

3. Test Dry Fit of the Joint: Tapered fitting sockets are designed so that an interference fit should occur when the pipe is inserted about 1/3 to 2/3 of the way into the socket. Occasionally, when pipe and fitting dimensions are at the tolerance extremes, it will be possible to fully insert dry pipe to the bottom of the fitting socket. When this happens, a sufficient quantity of cement must be applied to the joint to fill the gap between the pipe and fitting. The gap must be filled to obtain a strong, leak-free joint.



A 15° chamfer cut to a depth of approx. $\frac{3}{32}$."

Step 1:



Step 2:



Step 3:



4. Inspection, Cleaning, Priming: Visually inspect the inside of the pipe and fitting sockets and remove all dirt, grease or moisture with a clean, dry rag or cloth. If wiping fails to clean the surfaces, a chemical cleaner must be used. Check for possible damage such as splits or cracks and replace if necessary.

Depth-of-Entry Mark: Marking the depth of entry is a way to check if the pipe has reached the bottom of the fitting socket in step #6. Measure the fitting socket depth and mark this distance on the pipe O.D. We recommend that you add a second mark 2" above this mark as the primer and cement may destroy the first mark and this second line can be used to ensure that the pipe is fully inserted into the fitting socket.

Apply primer to the surface of the pipe and fitting socket using an approved applicator, working the primer in the surface of both the fitting socket and pipe O.D. You should continue to vigorously work the primer into these surfaces until you can feel the applicator start to "drag" indicating a softening of the material. It may take several applications of the primer to effectively break down the surface of the material, but this is a critical step in the cementing process. Move quickly, without hesitation, to the cementing procedure **while the surfaces are still wet** with primer.

Caution: Primers and cements are extremely flammable and must not be stored or used near heat or open flame. Read all warnings on primer and cement cans.

5. Application of Solvent Cement: A critical part of the solvent cementing process is to make sure the cement is well mixed. Periodically cover the container and shake the cement to make sure it stays mixed and uniform. Apply the solvent cement evenly and quickly around the outside of the pipe and at a width a little greater than the depth of the fitting socket while the primer is still wet.

Apply a lighter coat of cement evenly around the inside of the fitting socket. Avoid puddling. Apply a second coat of cementing to the pipe end.

Step 4:



Note: Individual scrape tests may be needed for pipes and fittings from different manufactures or even for pipes of different surface finishes to determine satisfactory penetration and softening of the material.

Step 5:



For sizes 6" and above, and possibly 4" in hot weather, we recommend the consideration of two-man crews to effectively prime both pipe and fitting surfaces and apply the cement while the material is still wet with primer.

Note: When cementing bell-end pipe, be careful not to apply an excessive amount of cement to the bell socket. This will prevent solvent damage to the pipe. For buried pipe applications, do not throw empty primer or cement cans into the trench along side the pipe. Cans of cement and primer should be closed at all times when not in use to prevent evaporation of chemicals and hardening of cement.

6. Joint Assembly: Working quickly, squarely insert the pipe into the fitting socket, giving the pipe or fitting a ¼ turn during insertion to evenly distribute the cement. Do not continue to rotate the pipe after it has hit the bottom of the fitting socket. A good joint will have sufficient cement to form a uniform bead all the way around the outside of the fitting hub. The fitting will have a tendency to slide back on the pipe while the cement is setting, so hold the joint tightly together for about 30 seconds. Please use the cement manufacturer's written recommendations regarding joint set time, for initial movement of a joint, and cure time before a pressure test. For pipe sizes 4" and above, greater axial forces are necessary for the assembly of interference fit joints. Mechanical forcing equipment may be needed to join the pipe and hold the joint until the cement "sets." The joint may have to be held together for up to 3 minutes. Consult the factory for specifics.

Note: Always wait at least 24 hours before pressure testing a piping system to allow cemented joints to cure properly. For colder temperatures, it may be necessary to wait a longer period of time. Please reference the solvent cement manufacturer's curing time.

Note: When using mechanical joining equipment, it will not be possible to apply the ¼ turn as the pipe is inserted into the fitting.

7. Clean-up and Joint Movement: Remove all excess cement from around the pipe and fitting with a dry, cotton rag or cloth. This must be done while the cement is still soft.

The joint should not be disturbed immediately after the cementing procedure and sufficient time should be allowed for proper curing of the joint. Exact drying time is difficult to predict because it depends on variables such as temperature, humidity and cement integrity. For more specific information, contact your solvent cement manufacturer.

Step 5: (cont.)



Note: It may be necessary for two workers to perform this operation for larger sizes of pipe.

Step 6:



Step 7:



Joining Plastic Pipe in Hot Weather

There are many occasions when solvent cementing plastic pipe in 95°F temperatures and over cannot be avoided. At surface temperatures exceeding 110°F, we recommend that the solvent cement manufacturer be contacted. If special precautions are taken, problems can be avoided.

Solvent cements for plastic pipe contain high-strength solvents which evaporate faster at elevated temperatures. This is especially true when there is a hot wind blowing. If the pipe is stored in direct sunlight, surface temperatures may be 20°F to 30°F above air temperature. Solvents attack these hot surfaces faster and deeper, especially inside a joint. Thus it is very important to avoid puddling inside socket and to wipe off excess cement outside.

By following our standard instructions and using a little extra care, as outlined below, successful solvent cemented joints can be made in even the most extreme hot weather conditions.

Tips to Follow When Solvent Cementing in High Temperatures

1. Store solvent cements and primers in a cool or shaded area prior to use.
2. If possible, store fitting and the pipe, or at least the ends to be solvent welded, in shady area before cementing.
3. Cool surfaces to be joined by wiping with a damp rag. Be sure that surfaces dry prior to applying solvent cement.
4. Try to do the solvent cementing in cooler morning hours.
5. Make sure that both surfaces to be joined are still wet with cement when putting them together. With large size pipe, more people on the crew may be necessary.
6. Use a heavier, high viscosity cements since they will provide a little more working time.

As you know, during hot weather there can be a greater expansion-contraction factor.

Joining Plastic Pipe in Cold Weather

Working in freezing temperatures is never easy. But sometimes the job is necessary. If that unavoidable job includes cementing plastic pipe, you can do it successfully with regular cements.

Good Joints Can Be Made at Sub-Zero Temperatures

By following standard instructions and using a little extra care and patience, successful solvent cemented joints can be made at temperatures even as low as -15°F. In cold weather, solvents penetrate and soften the surfaces more slowly than in warm weather. Also the plastic is more resistant to solvent attack. Therefore, it becomes more important to pre-soften surfaces with a primer. And, because of slower evaporation, a longer cure time is necessary. Cure schedules already allow a wide margin for safety. For colder weather, simply allow more time.

Tips to Follow in Solvent Cementing During Cold Weather

1. Prefabricate as much of the system as possible in a heated working area.
2. Store cements and primers in a warmer area when not in use and make sure they remain fluid.
3. Take special care to remove moisture including ice and snow.
4. Use a primer to soften the joining surfaces before applying cement.
5. Allow a longer cure period before the system is used.
6. Read and follow all of our directions carefully before installation.

Regular cements are formulated to have well balanced drying characteristics and to have good stability in sub-freezing temperatures. Some manufacturers offer special cements for cold weather because their regular cements do not have that same stability.

For all practical purposes, good solvent cemented joints can be made in very cold conditions with existing products, provided proper care and a little common sense are used.

Guideline on Cement Usage

Pipe Size	½"	¾"	1"	1¼"	1½"	2"	2½"	3"	4"	6"	8"	10"	12"
No. of Joints	300	200	125	105	90	60	50	40	30	10	5	2-3	1-2

Note: This information is provided as a general guideline. Recommendation is for the number of joints per quart. A Tee will have 3 joints, an Ell will have 2 joints. Our recommendation for primer is to use 150% of the cement number.

Threading

While threaded thermoplastic systems are not recommended for high-pressure systems, piping layouts where leaks would be dangerous, or for larger pipe sizes (more than two inches), they have two definite advantages. They quickly can be dismantled for temporary or take-down applications; and they can be used to join plastic to nonplastic materials.

Following are recommendations for making threaded joints with thermoplastic pipe and fittings.

1. Thread only pipes that have wall thicknesses equal to or greater than those of Schedule 80 pipe.
2. For pressure-rated pipes of PVC and CPVC reduce the pressure rating of threaded pipe to one-half that of unthreaded pipe.
3. To cut the threads, use only pipe dies designed for plastic pipes. Keep the dies clean and sharp. Do not cut other materials with them.
4. Vises for holding the pipe during thread cutting and pipe wrenches should be designed and used in such a manner that the pipe is not damaged. Strap wrenches are recommended. Wooden plugs can be inserted into the end of the pipe, if needed to prevent distortion of the pipe walls and cutting of off-center threads.
5. The following general procedure for cutting threads may be used:
 - A. Use a die stock with a proper guide so the die will start and go on square to the pipe axis. Any burrs or sharp edges on the guide that can scratch the pipe must be removed.
 - B. Do not use cutting oil. However, a drop of oil may be rubbed onto the chasers occasionally. This prevents tearing and helps to promote clean, smooth threads.
 - C. If lubrication is necessary, it is best to use a water based lubricant.
6. Before assembly, the threads should be lubricated and sealed with a non-hardening pipe dope or wrapped with Teflon® tape.
7. The proper threading of plastic parts requires some cautions and concerns to maintain the integrity of the threads. Since plastic threads can be easily damaged or cross threaded, it is important that these threads

be properly lubricated using a pipe dope, which is compatible with the materials being threaded, or TFE tape.

TFE taped must be installed in a clockwise direction, starting at the bottom of the thread and overlapping each pass. Do not employ more than 3 wraps.

The starting of the thread is critical, to avoid thread damage which could result in a leak. Product must never be installed more than ½ - 1 turn past hand tight and only strap wrenches should be used to tighten plastic connections.

8. In general, applications for threaded plastic pipe fittings fall into two categories:
 - A. Fittings for use in an all-plastic system where both the male and female parts are plastic.
 - B. Fittings for use as transition fittings from plastic to metal.

Theoretically, it is possible to use any combination of threaded parts such as:

1. Metal male to plastic female.
2. Plastic male to plastic female.
3. Metal female to plastic male.

Practical experience, however, suggests that the METAL MALE TO PLASTIC FEMALE combination is more susceptible to premature failure than the other two applications.

The reason for this is due to the incompressibility of metal. Standard instructions call for the male part to be run in hand tight and then tightened ½ turn more. It has been our observation, however, that it is very common to find male metal parts screwed in for a total of 7 to 8 threads. This results in excessively high stress levels in the plastic female part.

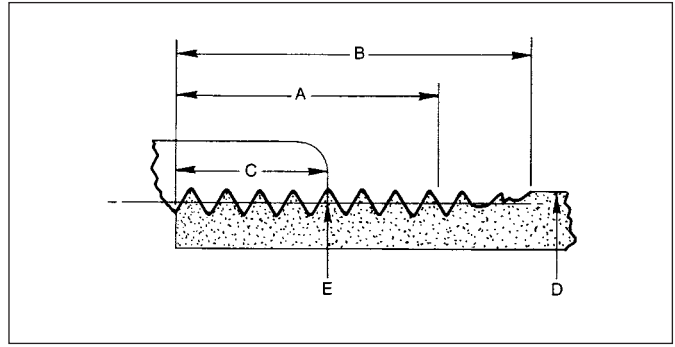
The tensile strength of the Type I PVC is 7200 psi. However, all fittings have knit lines (where the melted material joins together after flowing around the core which forms the waterway) which are the weakest portions of the fitting. The tensile strength at the knit lines is therefore lower than the minimum of 7200 psi. A metal nipple screwed in 7½ turns will generate a stress

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of approximately 6600 psi. This means that if the fitting doesn't crack open immediately, there will probably be a small crack initiated on the inside which will ultimately cause failure. It is for this reason that George Fischer Piping Systems recommends that its threaded plastic pipe fittings be used only in the following two combinations:

1. PLASTIC MALE TO PLASTIC FEMALE
2. PLASTIC MALE TO METAL FEMALE

If it is absolutely necessary to use a plastic female thread for transition to metal nipple, then it is IMPERATIVE that the nipple not be turned more than 1/2 turn past HANDTIGHT ("fingertight" for strong hands). To insure a leakproof joint, a good sealant is recommended (Teflon® tape or Teflon® pipe dope).



Note: Angle between sides of thread is 60 degrees. Taper of thread, on diameter, is 3/4 inch per foot. The basic thread is 0.8 x pitch of thread and the crest and root are truncated an amount equal to 0.033 x pitch, excepting 8 threads per inch which have a basic depth of 0.788 x pitch and are truncated 0.045 x pitch at the crest and 0.033 x pitch at the root.

American Standard Taper Pipe Thread Dimensions

Nominal Size (in.)	Pipe		Thread				
	Outside Diameter (in.) D	Number of Threads Per Inch	Normal Engagement by hand (in.) C	Length of Effective Thread (in.) A	Total Length End of Pipe to Vanish Point (in.) B	Pitch Diameter at End of Internal Thread (in.) E	Depth of Thread (Max.) (in.)
1/8	.405	27	.180	.2639	.3924	.39476	.02963
1/4	.540	18	.200	.4018	.5946	.48989	.04444
3/8	.675	18	.240	.4078	.6006	.62701	.04444
1/2	.840	14	.320	.5337	.7815	.77843	.05714
3/4	1.050	14	.339	.5457	.7935	.98887	.05714
1	1.315	11 1/2	.400	.6828	.9845	1.23863	.06957
1 1/4	1.660	11 1/2	.420	.7068	1.0085	1.58338	.06957
1 1/2	1.900	11 1/2	.420	.7235	1.0252	1.82234	.06957
2	2.375	11 1/2	.436	.7565	1.0582	2.29627	.06957
2 1/2	2.875	8	.682	1.1375	1.5712	2.76216	.10000
3	3.500	8	.766	1.2000	1.6337	3.38850	.10000
3 1/2	4.000	8	.821	1.2500	1.6837	3.88881	.10000
4	4.500	8	.844	1.3000	1.7337	4.38713	.10000
5	5.563	8	.937	1.4063	1.8400	5.44929	.10000
6	6.625	8	.958	1.5125	1.9472	6.50597	.10000
8	8.625	8	1.063	1.7125	2.1462	8.50003	.10000
10	10.750	8	1.210	1.9250	2.3587	10.62094	.10000
12	12.750	8	1.360	2.1250	2.5587	12.61781	.10000

Flanging

The use of flanges in a PVC/CPVC piping system may have an advantage if there is a need to dismantle the pipe, when the system is temporary and mobility is required or when transitioning to dissimilar materials. Flanging should also be considered when it is environmentally impossible to make solvent cemented joints on location.

Selection of Materials

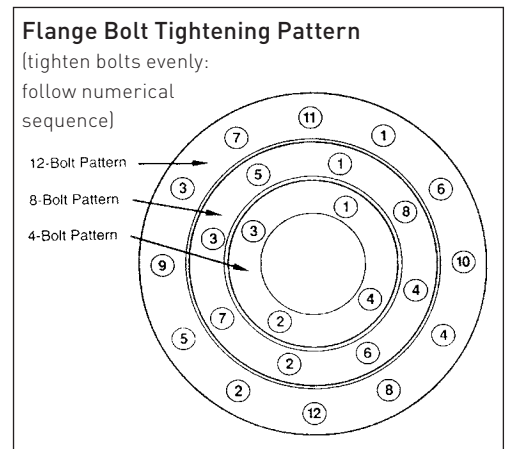
1. **Gasket:** full faced elastomeric material (Durometer "A" Scale of 55 to 80) usually 1/8" thick. Gasket material must be resistant to the media in the pipe.
2. **Fasteners:** All nuts, bolts and flat washers must be resistant to the chemical environment. All listed torque values are using well lubricated bolt threads. Flat washers are required for both the nut and the bolt head to minimize point loading on the flange. We recognize that some facilities do not allow lubrication, but the variables to determine torque values in such situations are beyond the scope of this document and require specific engineering considerations.
3. **Torque Wrench:** A necessity for tightening bolts to prevent excessive or uneven torque.

Flange Assembly

1. **Join the flange to the pipe.** Solvent cemented joints must be allowed sufficient cure time per the manufacturer's written recommendations prior to any movement or assembly
2. **Align the flanges and gasket** by inserting all the bolts through the matching bolt holes. Proper mating of flanges and gaskets is very important for a positive seal. Misalignment of flanges (Cold Springing), pulling the flanges together, as well as uneven torque can result in premature, possibly catastrophic, failure.
3. **Use a torque wrench:** The proper torque, as well as the gradual tightening of the bolts, is necessary to secure an effective seal and minimize those conditions which could lead to premature failure.

Note:

1. Do not over-torque flange bolts.
2. Use the proper bolt tightening sequence.
3. Make sure the system is in proper alignment.
4. Flanges should not be used to draw piping assemblies together.
5. Flat washers must be used under every nut and bolt head.



Recommended Torque

Pipe Size (IPS)	No. Bolt Holes	Bolt Diameter	Approx. Bolt Length*	Recommended Torque ft/lbs
1/2	4	1/2	2 1/2	10-15
3/4	4	1/2	2 1/2	10-15
1	4	1/2	2 1/2	10-15
1 1/4	4	1/2	3	10-15
1 1/2	4	1/2	3	10-15
2	4	5/8	3	20-30
2 1/2	4	5/8	3 1/2	20-30
3	4	5/8	3 3/4	20-30
4	8	5/8	4	20-30
6	8	3/4	4 3/4	33-50
8	8	7/8	5 1/4	33-50
10	12	7/8	6	53-75
12	12	7/8	6 1/2	53-75

*Bolt lengths were calculated using two flanges. Additional accessories or different mating surfaces will alter these numbers.

Note: Flange bolt hole pattern meets ANSI B16.5.

Above-Ground Installation

Support Spacing

When thermoplastic piping systems are installed above-ground, they must be properly supported to avoid unnecessary stresses and possible sagging.

Horizontal runs require the use of hangers as described on the next page, spaced approximately as indicated in the table below. Note that additional support is required as temperatures increase. Continuous support can be accomplished by the use of smooth structural angle or channel.

Where the pipe is exposed to impact damage, protective shields should be installed.

Tables are based on the maximum deflection of a uniformly loaded, continuously supported beam calculated from:

$$y = .00541 \frac{wL^4}{EI}$$

Where:

- y = Deflection or sag (in.)
- w = Weight per unit length (lb./in.)
- L = Support spacing (in.)
- E = Modulus of elasticity at given temperature (lb./in.²)
- I = Moment of inertia (in.⁴)

If 0.100 in. is chosen arbitrarily as the permissible sag (y) between supports, then:

$$L^4 = 18.48 \frac{EL}{w}$$

Where:

- w = Weight of pipe + weight of liquid (lb./in.)

$$\text{For a pipe } I = \frac{\pi}{64} (D_o^4 - D_i^4)$$

Where:

- D_o = Outside diameter of the pipe (in.)
- D_i = Inside diameter of the pipe (in.)

Then:

$$L = \left(.907 \frac{E}{W} (D_o^4 - D_i^4) \right)^{1/4}$$

$$= .976 \left(\frac{E}{W} D_o^4 - D_i^4 \right)^{1/4}$$

Recommended Support Spacing* (In Feet)

Nom. Pipe Size (In.)	PVC Pipe										CPVC Pipe					
	Schedule 40					Schedule 80					Schedule 80					
	Temp. °F					Temp. °F					Temp. °F					
	60	80	100	120	140	60	80	100	120	140	60	80	100	120	140	180
1/2	4 1/2	4 1/2	4	2 1/2	2 1/2	5	4 1/2	4 1/2	3	2 1/2	5 1/2	5 1/2	5	4 1/2	4 1/2	2 1/2
3/4	5	4 1/2	4	2 1/2	2 1/2	5 1/2	5	4 1/2	3	2 1/2	5 1/2	5 1/2	5 1/2	5	4 1/2	2 1/2
1	5 1/2	5	4 1/2	3	2 1/2	6	5 1/2	5	3 1/2	3	6	6	6	5 1/2	5	3
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3	7	7	6	4	3 1/2	8	7 1/2	7	4 1/2	4	8	8	8	7 1/2	7	4
4	7 1/2	7	6 1/2	4 1/2	4	9	8 1/2	7 1/2	5	4 1/2	9	9	9	8 1/2	7 1/2	4 1/2
6	8 1/2	8	7 1/2	5	4 1/2	10	9 1/2	9	6	5	10	10 1/2	9 1/2	9	8	5
8	9	8 1/2	8	5	4 1/2	11	10 1/2	9 1/2	6 1/2	5 1/2	11	11	10 1/2	10	9	5 1/2
10	10	9	8 1/2	5 1/2	5	12	11	10	7	6	11 1/2	11 1/2	11	10 1/2	9 1/2	6
12	11 1/2	10 1/2	9 1/2	6 1/2	5 1/2	12	11	10	7	6	12 1/2	12 1/2	12 1/2	11	10 1/2	6 1/2
14	12	11	10	7	6	13 1/2	13	11	8	7						
16	12 1/2	11 1/2	10 1/2	7 1/2	6 1/2	14	13 1/2	11 1/2	8 1/2	7 1/2						

Note: This data is based on information supplied by the raw material manufacturers. It should be used as a general recommendation only and not as a guarantee of performance or longevity.

*Chart based on spacing for continuous spans and for uninsulated lines conveying fluids of specific gravity up to 1.00.

Hangers

There are many hangers and supports suitable for use in plastic piping systems, although some may require modification. It is important in a plastic piping system to provide a wide load-bearing surface and that any restraints recognize that vinyl piping systems are somewhat notch sensitive. Also, if the thermal movement of a plastic piping system might cause the pipe-line to abrade on a rough surface, such as concrete, some means of isolating the pipe should be considered. Wear pads of plastic can be fashioned from the pipe or wooden isolators can be used.

It is also important to recognize the thermal movement in any plastic piping system and the hangers and support structures should allow for, or direct, the expansion that may be in a particular system. Pipe hangers must be carefully aligned and must have no rough or sharp edges that could contact and potentially damage the pipe. The hanger or support system should recognize the thermal expansion in a plastic pipe system and pipe should be allowed to move.

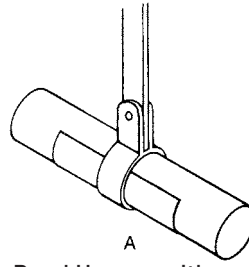
Vertical lines must also be supported at intervals so that the fittings at the lower end of a riser or column are not overloaded. The supports should not exert a compressive strain on the pipe, such as riser-type clamps that squeeze the pipe. A double bolt type, in conjunction with using a fitting shoulder, may afford the best method for supporting vertical systems.

Sunlight and Plastics

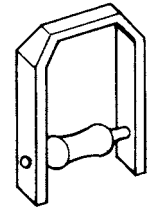
Plastic pipe and fittings have been used extensively outdoors and are resistant to weathering, but may have some surface degradation from intense and prolonged exposure to the ultraviolet (UV) rays in sunlight. This degradation is a surface effect, reducing the impact rating but has no affect on the temperature capability as well as the chemical resistance or pressure rating of the pipe. This reduced impact rating can be eliminated by removal of the affected surface area and covering with a good bonding exterior latex paint.

The latex paint must be applied thick enough, probably several coats, to create an opaque covering. If the pipe and fittings are prepared properly for painting (cleaning and very light sanding), a good grade of exterior latex should last for many years. White or light colored pigment is suggested, which offers a more reflective surface.

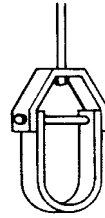
Recommended Hangers for Plastic Piping Systems



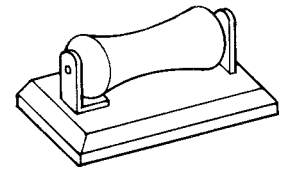
A
Band Hanger with Protective Sleeve



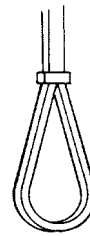
E
Roller Hanger



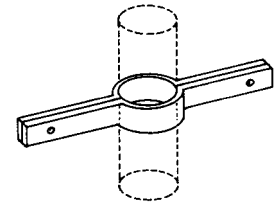
B
Clevis



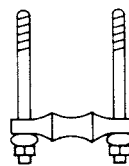
F
Pipe Roll and Plate



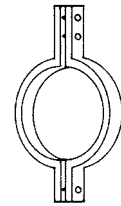
C
Adjustable Solid Ring Swivel Type



G
Riser Clamp

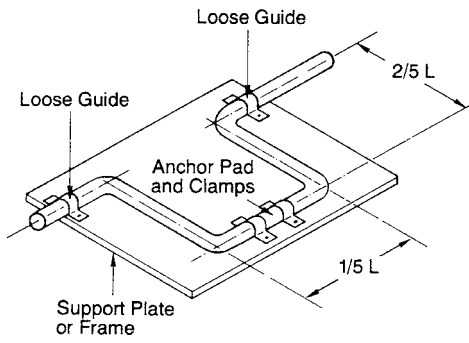


D
Single Pipe Roll

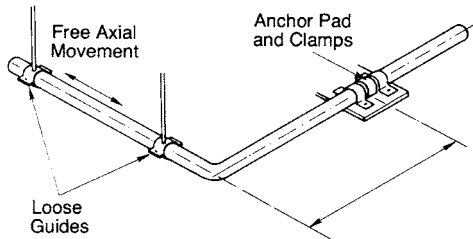


H
Double-Bolt Clamp

A Typical Method of Anchorage of a Change in Direction

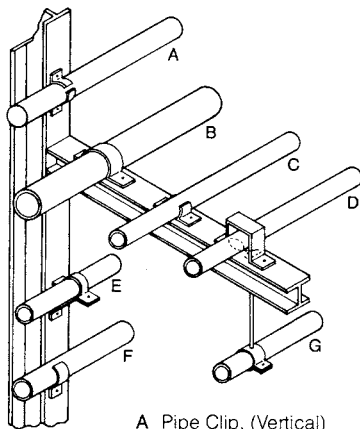


Typical Method of Anchorage



Typical Method of Anchorage

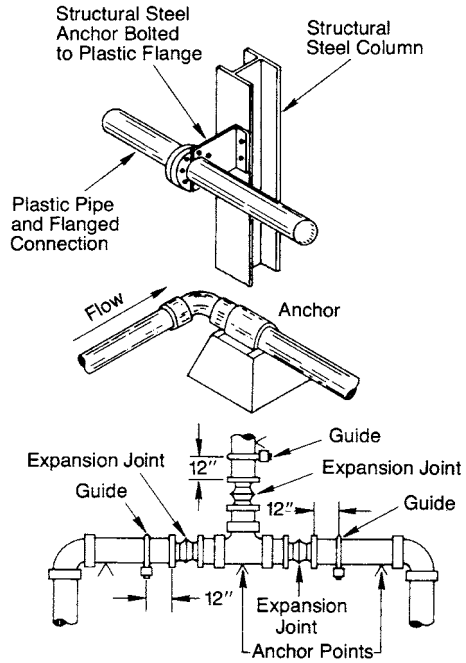
Typical Support Arrangements



Note 1:
Pipes Must Be Free
to Move Axially

- A Pipe Clip, (Vertical)
- B U-Type Clamp
- C Pipe Clip, (Horizontal)
- D Roller Carrier
- E Angle Bracket with U-Clamp
- F Clamp (Vertical)
- G Suspended Ring Clamp

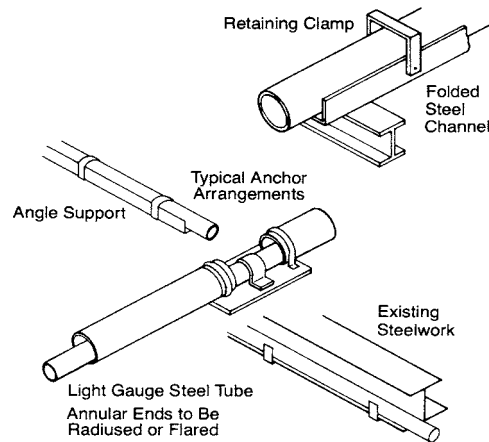
Anchors and Guides



Anchors in a piping system direct movement of pipe within a defined reference frame. At the anchoring point, there is no axial or transverse movement. Guides are used to allow axial movement of pipe but prevent transverse movement. Anchoring and guides should be engineered to provide the required function without point loading the plastic pipe.

Guides and anchors are used whenever expansion joints are used and are also on long runs and directional changes in piping.

Continuous Support Arrangements



Below-Ground Installation

Trenching and Bedding

1. Depth: When installing underground piping systems, the depth of the trench is determined by the intended service and by local conditions (as well as by local, state and national codes that may require a greater trench depth and cover than are technically necessary).

Underground pipes are subjected to external loads caused by the weight of the backfill material and by loads applied at the surface of the fill. These can range from static to dynamic loads.

Static loads comprise the weight of the soil above the top of the pipe plus any additional material that might be stacked above ground. An important point is that the load on a flexible pipe will be less than on a rigid pipe buried in the same manner. This is because the flexible conduit transfers part of the load to the surrounding soil and not the reverse. Soil loads are minimal with narrow trenches until a pipe depth of 10 feet is attained.

Dynamic loads are loads due to moving vehicles such as trucks, trains and other heavy equipment. For shallow burial conditions, live loads should be considered and added to static loads, but at depths greater than 10 feet, live loads have very little effect.

For static and dynamic soil loading tables, refer to specific materials sections, PVC and CPVC.

Pipe intended for potable water service should be buried at least 12 inches below the maximum expected frost penetration.

2. Bedding: The bottom of the trench should provide a firm, continuous bearing surface along the entire length of the pipe run. It should be relatively smooth and free of rocks. Where hardpan, ledge rock or boulders are present, it is recommended that the trench bottom be cushioned with at least four (4) inches of sand or compacted fine-grained soils.

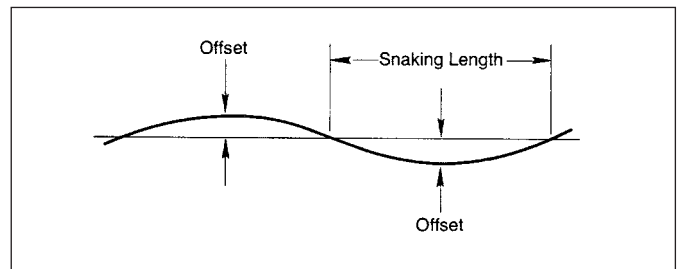
3. Snaking: To compensate for thermal contraction, the snaking technique of offsetting the pipe with relation to the trench centerline is recommended.

Example: Snaking is particularly important when laying small diameter pipe in hot weather. For example, a 100-foot length of PVC Type I pipe will expand or contract about 3/4" for each 20°F temperature change. On a hot summer day, the direct rays of the sun on the pipe can drive the surface temperature up to 150°F. At night, the air temperature may drop to 70°F. In this hypothetical case, the pipe would undergo a temperature change of 80°F — and every 100 feet of pipe would contract 3". This degree of contraction would put such a strain on newly cemented pipe joints that a poorly made joint might pull apart.

Installation: A practical and economical method is to cement the line together at the side of the trench during the normal working day. When the newly cemented joints have dried, the pipe is snaked from one side of the trench to the other in gentle, alternative curves. This added length will compensate for any contraction after the trench is backfilled (see "Snaking of Pipe Within Trench" illustration below).

The "Snaking Length" table below gives the required loop length, in feet, and offset in inches, for various temperature variations.

Snaking of Pipe Within Trench



Snaking of thermoplastic pipe within trench to compensate for contraction.

Snaking Length vs. Offset (in.) to Compensate for Thermal Contraction

Snaking Length, (ft.)	Maximum Temperature Variation (°F) Between Time of Cementing and Final Backfilling									
	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
	Loop Offset, (in.)									
20	2.5	3.5	4.5	5.20	5.75	6.25	6.75	7.25	7.75	8.00
50	6.5	9.0	11.0	12.75	14.25	15.50	17.00	18.00	19.25	20.25
100	13.0	18.0	22.0	26.00	29.00	31.50	35.00	37.00	40.00	42.00

Anchors and Other Connections

Plastic pipe is not designed to provide structural strength beyond sustaining internal pressures up to its designed hydrostatic pressure rating and normal soil loads. Anchors, valves and other connections must be independently supported to prevent added shearing and bending stresses on the pipe.

Risers: The above piping design rule applies also where pipe is brought out of the ground. Above-ground valves or other connections must be supported independently. If pipe is exposed to external damage, it should be protected with a separate, rigidly supported metal pipe sleeve at the danger areas. Thermoplastic pipe should not be brought above ground where it is exposed to high temperatures. Elevated temperatures can lower the pipe's pressure rating below design levels.

Backfilling

Before making the final connections and backfilling, the pipeline should be cooled to near the temperature of the soil. During hot weather, for example, backfilling should be done early in the morning, when the solvent-cemented joints are completely dried and the line is fully contracted.

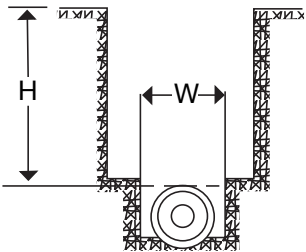
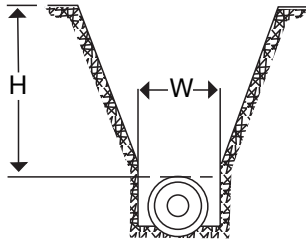
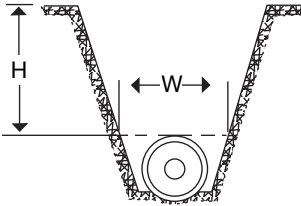
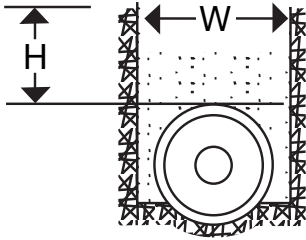
Assuming that the pipe is uniformly and continuously supported over its entire length on firm, stable material, it should first be covered with 6 to 8 inches of soil that is free of debris and rocks larger than one-half inch in diameter. This initial layer should be compacted by hand or, preferably, by mechanical tamper so that it acts as a protective cushion against the final backfill. Any large, sharp rocks that could penetrate the tamped layer around the pipe should be removed from the final backfill.

Heavy Traffic: When plastic pipe is installed beneath streets, railroads or other surfaces that are subjected to heavy traffic and resulting shock and vibration, it should be run within a protective metal or concrete casing.

Locating Buried Pipe: The location of plastic pipelines should be accurately recorded at the time of installation. Since pipe is a non-conductor, it does not respond to the electronic devices normally used to locate metal pipelines. However, a copper or galvanized wire can be spiraled around, taped to or laid alongside or just above the pipe during installation to permit the use of a locating device.

Note: For additional information, see ASTM D-2774, "Underground Installation of Thermoplastic Piping."

Trench Widths for PVC



Note: W = Trench Width at Top of Pipe.

Soil Load and Pipe Resistance for Flexible Thermoplastic Pipe — PVC Schedule 80 Pipe

Nom. Size	Wc' = Load Resistance of Pipe (lb./ft.)		H=Height of fill above pipe (ft.)	Wc = Soil Loads at Various Trench Widths at Top of Pipe (lb./ft.)			
	Schedule 80 Pipe			2 ft	3 ft.	4 ft.	5 ft.
	E' = 200	E' = 700	2 ft	3 ft.	4 ft.	5 ft.	
1½	1375	1561	10	106	125	136	152
			20	138	182	212	233
			30	144	207	254	314
			40	—	214	269	318
2	1161	1400	10	132	156	170	190
			20	172	227	265	291
			30	180	259	317	392
			40	—	267	337	398
2½	1593	1879	10	160	191	210	230
			20	204	273	321	352
			30	216	306	377	474
			40	—	323	408	482
3	1416	1772	10	196	231	252	280
			20	256	336	392	429
			30	266	266	384	469
			40	—	394	497	586
3½	1318	1731	10	223	266	293	320
			20	284	380	446	490
			30	300	426	524	660
			40	—	450	568	670
4	1266	1735	10	252	297	324	360
			20	328	432	540	551
			30	342	493	603	743
			40	—	506	639	754
5	1206	1796	10	310	370	407	445
			20	395	529	621	681
			30	417	592	730	918
			40	—	625	790	932
6	1323	2028	10	371	437	477	530
			20	484	636	742	812
			30	503	725	888	1093
			40	—	745	941	1110
8	1319	2250	10	483	569	621	690
			20	630	828	966	1057
			30	656	945	1156	1423
			40	—	970	1225	1415
10	1481	2649	10	602	710	774	860
			20	785	1032	1204	1317
			30	817	1177	1405	1774
			40	—	1209	1527	1801
12	1676	3067	10	714	942	919	1020
			20	931	1225	1429	1562
			30	969	1397	1709	2104
			40	—	1434	1811	2136

Note 1: Figures are calculated from minimum soil resistance values (E' = 200 psi for uncompacted sandy clay foam) and compacted soil (E' = 700 for side-fill soil that is compacted to 90% or more of Proctor Density for distance of two pipe diameters on each side of the pipe). If Wc' is less than Wc at a given trench depth and width, then soil compaction will be necessary.

Note 2: These are soil loads only and do not include live loads.

Standards

Standards allow an engineer to develop a specification which will provide accepted material and product performance. Having strong industry standards provides the market with the necessary criteria to determine the suitability of a specific material and/or product for a specific application. Within the plastics industry the primary source of these standards is ASTM which are usually the basis of most specifications.

Manufacturers may also subscribe to other standards, such as IAPMO, NSF, ANSI, ASME and UL. For the purposes of this manual we will restrict our listing of standards to those that are relevant to Schedule 80 PVC and CPVC.

ASTM (American Society for Testing and Materials)

D-1784: "Standard Specification for Rigid Poly(vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds"

This specification covers the compound materials physical requirements for PVC and CPVC pipe, valves and fittings based on several physical and chemical properties.

D-1785: "Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120"

This specification covers poly(vinyl chloride) (PVC) pipe made in Schedule 40, 80 and 120 sizes and pressure-rated for water. Included are criteria for classifying PVC plastic pipe materials and PVC plastic pipe, a system of nomenclature for PVC plastic pipe and requirements and test methods for materials, workmanship, dimensions, sustained pressure, burst pressure, flattening, and extrusion quality.

D-2466: "Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40"

This specification covers poly(vinyl chloride) (PVC) Schedule 40 pipe fittings. Included are requirements for material, workmanship, dimensions, and burst pressure.

D-2467: "Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80"

This specification covers poly(vinyl chloride) (PVC) Schedule 80 pipe fittings. Included are requirements for

materials, workmanship, dimensions, and burst pressure.

D-2672: "Standard Specification for Joints for IPS PVC Pipe using Solvent Cement"

This specification covers the socket produced for solvent cements joints on both pressure and non-pressure IPS pipe. It also covers the testing of the joints on both pressure and non-pressure pipe, and includes requirements for socket dimensions, burst pressure, and joint tightness tests of the solvent cemented joints. The tests described are not intended for routine quality control, but rather to evaluate the performance characteristics of the joint.

D-2855: "Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings"

This recommended practice describes, in detail, procedures for making solvent cemented joints. Preparation of the surfaces, applying the cement, making the assembly, handling after assembly, testing and a schedule of drying times related to temperature and pipe sizes are covered.

F-1498: "Standard Specification for Taper Pipe Threads 60° for Thermoplastic Pipe and Fittings"

This specification established requirements for dimensions and gauging of taper pipe threads used on threaded plastic pipe and fittings.

F-402: "Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings"

This recommended practice covers procedures for the safe handling of solvent cements containing solvents which may be flammable, toxic or irritants. It recommends precautions and safeguards against the hazards of fire.

F-437: "Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80"

This specification covers chlorinated poly(vinyl chloride) (CPVC) threaded Schedule 80 pipe fittings. Included are requirements for materials, workmanship, dimensions,

and burst pressure.

F-439: “Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80”

This specification covers chlorinated poly(vinyl chloride) (CPVC) Schedule 80 pipe fittings. Included are requirements for materials, workmanship, dimensions, and burst pressure.

F-441: “Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80”

This specification covers chlorinated poly(vinyl chloride) (CPVC) pipe made in Schedule 40 and 80 sizes and pressure-rated for water. Included are criteria for classifying CPVC plastic pipe materials and CPVC plastic pipe, a system of nomenclature for CPVC materials, workmanship, dimensions, sustained pressure, burst pressure, flattening and extrusion quality. Methods of marking are also given.

ASME/ANSI (American Society of Mechanical Engineers / American National Standards Institute)

These standards were developed for metal pipe systems and some or all of the components have been adopted by the plastic piping industry. It is extremely important for the engineer or specifying influence to understand the scope of these standards and the extent to which plastic piping will conform.

B16.6: Flanges and Flanged Piping

In plastic piping systems, this standard is used to establish the flange O.D., bolt hole pattern and bolt hole size.

B1.20.1: National Pipe Thread Taper - Pipe Thread Dimensions

This is a dimensional specification covering standard tapered pipe threads, identified by GF Piping Systems as FPT (Female Pipe Thread) and MPT (Male Pipe Thread).

NSF/ANSI (National Sanitation Foundation / American National Standards Institute)

This company acts as the third-party certification agency for the plastics industry, as well as providing a certification regarding the acceptability of product for certain applications, such as potable water or chemical waste.

Standard 14: Plastic Piping Systems Components and Related Materials

This standard applies to inspection for compliance with all relevant industry standards. This primarily relates to ASTM but NSF will certify compliance with any standards the company publicly claims to meet.

Standard 61: Drinking Water Systems Components – Health Effects

This standard relates to the suitability of product in potable water systems.

Sample Specification

PVC Schedule 40 Pipe and Fittings

Scope: This sample specification covers the manufacturer's requirements for PVC Schedule 40 pipe and fittings manufactured of Rigid Poly (Vinyl chloride) (PVC). All pipe and fittings shall be as manufactured by Georg Fischer Piping Systems, Little Rock, Arkansas.

Materials: All materials shall be PVC type I, Grade I, meeting, or exceeding, the requirements of ASTM D-1784, cell classification 12454-B. All compound components shall be listed with NSF and meet the requirements of ANSI/NSF Standard 61 as suitable for Potable Water.

Pipe: All PVC Schedule 40 pipe shall meet, or exceed, the requirements of ASTM D-1785. Any pipe bells shall meet the requirements of ASTM D-2672. All piping shall be listed with NSF under Standards 14/61 and shall carry the NSF seal for suitability with Potable Water.

Fittings: All PVC Schedule 40 fittings shall meet, or exceed the requirements of ASTM D-2466 and shall be listed with NSF under standards 14/61. Product shall carry the NSF seal for suitability with Potable Water.

Installation: Installation and testing shall be in accordance with accepted engineering and installation practices as noted in the Georg Fischer Piping Systems Technical Manual as well as the solvent cement manufacturer's written instructions. To ensure compatibility all pipe, valves and fittings shall be manufactured and supplied by Georg Fischer Piping Systems.

******* CAUTION *******
Do not test with Air or Air over Water.



GEORG FISCHER
PIPING SYSTEMS

Sample Specification

CPVC Schedule 80 Pipe and Fittings

Scope: This sample specification covers the manufacturer's requirements for CPVC Schedule 80 pipe and fittings manufactured of Rigid Chlorinated Poly (Vinyl Chloride) (CPVC). All pipe, valves and fittings shall be as manufactured and supplied by Georg Fischer Piping Systems, Little Rock, Arkansas.

Materials: All materials shall be CPVC Type IV, Grade I, cell classification 23447-B, and shall meet, or exceed, the requirements of ASTM D-1784. All compound components shall be listed with NSF under Standard 61 and be certified as suitable for potable water systems.

Pipe: All CPVC Schedule 80 pipe shall meet, or exceed, the requirements of ASTM F-441. Any pipe bells shall meet the requirements of ASTM D-2672. All pipe shall be listed with NSF under Standards 14/61 and shall carry the NSF seal for Potable Water. Any threaded PVC 80 pipe shall meet the requirements of ASME/ANSI B1.20.1 and shall be accomplished with pipe dies specifically designed for use with plastic pipe.

Fittings:

Socket: All CPVC Schedule 80 fittings shall meet, or exceed, the dimensional and tolerance requirements of ASTM F-439

Threads: All PVC Schedule 80 threaded fittings shall meet, or exceed, the dimensional and tolerance requirements of ASTM F-437

All fittings shall meet, or exceed, the requirements of ASTM F 439 and shall be listed with NSF under standards 14/61 and shall carry the NSF seal for Potable Water.

Valves: All valves shall be of compatible materials utilizing EPDM or FPM O-rings and seals with TFE seats as manufactured and supplied by Georg Fischer Piping Systems.

Installation: Installation and testing shall be in accordance with accepted engineering and installation practices as noted in the Georg Fischer Piping Systems Technical Manual as well as the solvent cement manufacturer's written instructions. To ensure compatibility all pipe, valves and fittings shall be manufactured and supplied by Georg Fischer Piping Systems.

******* CAUTION *******
Do not test with Air or Air over Water.



GEORG FISCHER
PIPING SYSTEMS

Sample Specification

PVC Schedule 80 Pipe and Fittings

Scope: This sample specification covers the manufacturer's requirements for PVC Schedule 80 pipe and fittings manufactured of Rigid Poly (Vinyl Chloride) (PVC). All pipe, valves and fittings shall be as manufactured and supplied by Georg Fischer Piping Systems, Little Rock, Arkansas.

Materials: All materials shall be PVC Type I, Grade I, with a cell classification of 12424-B, and shall meet, or exceed, the requirements of ASTM D-1784. All compound components shall be listed with NSF and meet the requirements of NSF Standard 61 as suitable for potable water.

Pipe: All PVC Schedule 80 pipe shall meet, or exceed, the requirements of ASTM D-1785. Any pipe bells shall meet the requirements of ASTM D-2672. All pipe shall be listed with NSF under Standards 14/61 and shall carry the NSF seal for Potable Water. Any threaded PVC 80 pipe shall meet the requirements of ANSI B1.20.1 and shall be accomplished with pipe dies specifically designed for use with plastic pipe.

Fittings:

Socket: All PVC Schedule 80 fittings shall meet, or exceed, the dimensional and tolerance requirements of ASTM D-2467

Threads: All PVC Schedule 80 threaded fittings shall meet, or exceed, the dimensional and tolerance requirements of ASTM D-2464

All fittings shall be listed with NSF under standards 14/61 and shall carry the NSF seal for Potable Water.

Valves: All valves shall be of compatible materials utilizing EPDM or FPM O-rings and seals with TFE seats. Valves shall be manufactured and supplied by Georg Fischer Piping Systems, Little Rock, AR.

Installation: Installation and testing shall be in accordance with accepted engineering and installation practices as noted in the Georg Fischer Piping Systems Technical Manual as well as the solvent cement manufacturer's written instructions. To ensure compatibility, all pipe, valves and fittings shall be manufactured and supplied by Georg Fischer Piping Systems.

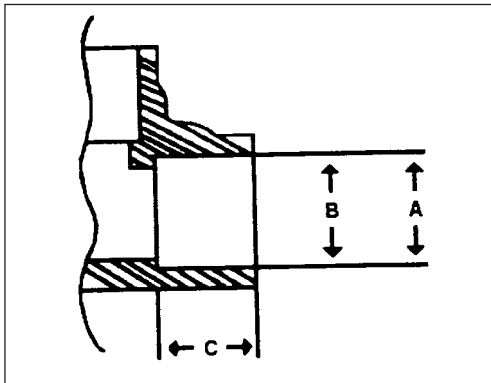
******* CAUTION *******
Do not test with Air or Air over Water.



GEORG FISCHER
PIPING SYSTEMS

PVC IPS Schedule 40/80 Socket Dimensions

Size	Pipe O.D.	Entrance (A)		Bottom (B)		Max. out of round	Schedule 40 socket depth (C) (min.)	Schedule 80 socket depth (C) (min.)
		Max.	Min.	Max.	Min.			
1/4	0.540	0.556	0.548	0.540	0.532	0.016	0.500	0.625
3/8	0.675	0.691	0.683	0.675	0.667	0.016	0.594	0.750
1/2	0.840	0.852	0.844	0.840	0.832	0.016	0.688	0.875
3/4	1.050	1.062	1.054	1.050	1.042	0.020	0.719	1.000
1	1.315	1.330	1.320	1.315	1.305	0.020	0.875	1.125
1 1/4	1.660	1.675	1.665	1.660	1.650	0.024	0.938	1.250
1 1/2	1.900	1.918	1.906	1.900	1.888	0.024	1.094	1.375
2	2.375	2.393	2.381	2.375	2.363	0.024	1.156	1.500
2 1/2	2.875	2.896	2.882	2.875	2.861	0.030	1.750	1.750
3	3.500	3.524	3.508	3.500	3.484	0.030	1.875	1.875
3 1/2	4.000	4.024	4.008	4.000	3.984	0.030	2.000	
4	4.500	4.527	4.509	4.500	4.482	0.030	2.000	2.250
5	5.563	5.593	5.573	5.563	5.543	0.060	3.000	
6	6.625	6.658	6.636	6.625	6.603	0.060	3.000	3.000
8	8.625	8.670	8.640	8.625	8.595	0.090	4.000	4.000
10	10.750	10.795	10.765	10.750	10.720	0.100	5.000	5.000
12	12.750	12.795	12.765	12.750	12.720	0.120	6.000	6.000



Weld Lines (Knit Lines) in Molded Fittings

Injection molding is the forcing of a viscous material, under pressure, to fill a space, forming a part. In the injection molding of fittings there are two basic components, a mold, which forms the outside of the part, and a core, which forms the inside of the part. The injection molding process forces the molten plastic material into this interstitial space where the material is cooled and then released. Inherent in this process, for most geometries, is the flowing together of the material and the development of a weld line.

The point where the plastic material is forced into the mold is termed the gate. The plastic material flows through this gate, and when it hits the core it will flow around it in both directions. At the point where the material flows back together there will usually be a line, termed a weld line or a knit line. This point of the material flowing back together is usually located about 180° from the gate and, since the weld line is visible on both the OD and ID, it can sometimes be thought to be a crack.

This knit line is a surface phenomenon and does not indicate a weakness or a defect in the part. Fittings are subject to some significant pressure tests, using ASTM Specifications, assuring the user of a quality molded component.



The melted plastic material is introduced to the mold and starts to flow around the core. Notice how the material tends to flow fairly evenly.



The plastic will continue to flow around the core.



As the material flows together, a knit line starts to form. This knit line is fairly obvious at this point in the molding process.



However, as the mold cavity starts to fill, the material tends to flow together and the knit lines become less obvious.



When the mold is completely full, the knit lines are still there, as they are part of the process. This is just how the part is manufactured.

Conversion Charts

Decimal and Millimeter Equivalents of Fractions

Inches		Milli- meters	Inches		Milli- meters	Inches		Milli- meters	Inches		Milli- meters
Fractions	Decimals		Fractions	Decimals		Fractions	Decimals		Fractions	Decimals	
1/64	.015625	.397	17/64	.265625	6.747	33/64	.515625	13.097	49/64	.765625	19.447
1/32	.03125	.794	9/32	.28125	7.144	17/32	.53125	13.494	25/32	.78125	19.844
3/64	.046875	1.191	19/64	.296875	7.541	35/64	.546875	13.891	51/64	.796875	20.241
1/16	.0625	1.588	5/16	.3125	7.938	9/16	.5625	14.288	13/16	.8125	20.638
5/64	.078125	1.984	21/64	.328125	8.334	37/64	.578125	14.684	53/64	.828125	21.034
3/32	.09375	2.381	11/32	.34375	8.731	19/32	.59375	15.081	27/32	.83475	21.431
7/64	.109375	2.778	23/64	.359375	9.128	39/64	.609375	15.478	55/64	.859375	21.828
1/8	.125	3.175	3/8	.375	9.525	5/8	.625	15.875	7/8	.875	22.225
9/64	.140625	3.572	25/64	.390625	9.922	41/64	.640625	16.272	57/64	.890625	22.622
5/32	.15625	3.969	13/32	.40625	10.319	21/32	.65625	16.669	29/32	.90625	23.019
11/64	.171875	4.366	27/64	.421875	10.716	43/64	.671875	17.066	59/64	.921875	23.416
3/16	.1875	4.763	7/16	.4375	11.113	11/16	.6875	17.463	15/16	.9375	23.813
13/64	.203125	5.159	29/64	.453125	11.509	45/64	.703125	17.859	61/64	.953125	24.209
7/32	.21875	5.556	15/32	.46875	11.906	23/32	.71875	18.256	31/32	.96875	24.606
15/64	.234375	5.953	31/64	.484375	12.303	47/64	.734375	18.653	63/64	.984375	25.003
1/4	.250	6.350	1/2	.500	12.700	3/4	.750	19.050	1	1.000	25.400

Length Conversion

Units of Length	Multiply units in left column by proper factor below							
	in.	ft.	yd.	mile	mm	cm	m	km
1 inch	1	0.0833	0.0278	—	25.4	2.540	0.0254	—
1 foot	12	1	0.3333	—	304.8	30.48	0.3048	—
1 yard	36	3	1	—	914.4	91.44	0.9144	—
1 mile	—	5280	1760	1	—	—	1609.3	1.609
1 millimeter	0.0394	0.0033	—	—	1	0.100	0.001	—
1 centimeter	0.3937	0.0328	0.0109	—	10	1	0.01	—
1 meter	39.37	3.281	1.094	—	1000	100	1	0.001
1 kilometer	—	3281	1094	0.6214	—	—	1000	1

(1 micron = 0.001 millimeter)

Weight Conversion

Units of Weight	Multiply units in left column by proper factor below						
	grain	oz.	lb.	ton	gram	kg	metric ton
1 grain	1	—	—	—	0.0648	—	—
1 ounce	437.5	1	0.0625	—	28.35	0.0283	—
1 pound	7000	16	1	0.0005	453.6	0.4536	—
1 ton	—	32,000	2000	1	—	907.2	—
1 gram	15.43	0.0353	—	—	1	0.001	—
1 kilogram	—	35.27	2.205	—	1000	1	—
1 metric ton	—	35,274	2205	1.1023	—	1000	1

Density Conversion

Units of Density	Multiply units in left column by proper factor below				
	lb./in. ³	lb./ft. ³	lb./gal.	g/cm ³	g/liter
1 pound/in. ³	1	1728	231.0	27.68	27,680
1 pound/ft. ³	—	1	0.1337	0.0160	16.019
1 pound/gal.	0.00433	7.481	1	0.1198	119.83
1 gram/cm ³	0.0361	62.43	8.345	1	1000.0
1 gram/liter	—	0.0624	0.00835	0.001	1

Area Conversion

Units of Area	Multiply units in left column by proper factor below						
	in. ²	ft. ²	acre	mile ²	cm ²	m ²	hectare
1 inch ²	1	0.0069	—	—	6.452	—	—
1 foot ²	144	1	—	—	929.0	0.0929	—
1 acre	—	43,560	1	0.0016	—	4047	0.4047
1 mile ²	—	—	640	1	—	—	259.0
1 centimeter ²	0.1550	—	—	—	1	0.0001	—
1 meter ²	1550	10.76	—	—	10,000	1	—
1 hectare	—	—	2.471	—	1	10,000	1

Volume Conversion

Units of Volume	Multiply units in left column by proper factor below							
	in. ³	ft. ³	yd. ³	cm. ³	meter ³	liter	U.S. gal.	Imp. gal.
1 inch ³	1	—	—	16.387	—	0.0164	—	—
1 foot ³	1728	1	0.0370	28,317	0.0283	28.32	7.481	6.229
1 yard ³	46,656	27	1	—	0.7646	764.5	202.0	168.2
1 centimeter ³	0.0610	—	—	1	—	0.0010	—	—
1 meter ³	61,023	35.31	1.308	1,000,000	1	999.97	264.2	220.0
1 liter	61.025	0.0353	—	1000.028	0.0010	1	0.2642	0.2200
1 U.S. gallon	231	0.1337	—	3785.4	—	3.785	1	0.8327
1 Imp. gallon	277.4	0.1605	—	4546.1	—	4.546	1.201	1

Pressure Conversion

Units of Pressure	Multiply units in left column by proper factor below							
	lbs./in. ²	lb./ft. ²	Int. etc.	kg/cm ²	mm Hg at 32°F	in. Hg at 32°F	ft. water at 39.2°F	kPa
lb./in. ²	1	144	-	0.0703	51.713	2.0359	2.307	6.894
lb./ft. ²	0.00694	1	-	-	0.3591	0.01414	0.01602	0.04788
Int. etc.	14.696	2116.2	1	1.0333	760	29.921	33.90	-
kg/cm ²	14.223	2048.1	0.9678	1	735.56	28.958	32.81	98.066
mm Hg	0.0193	2.785	-	-	1	0.0394	0.0446	0.1333
in Hg	0.4912	70.73	0.0334	0.0345	25.400	1	1.133	3.386
ft H ₂ O	0.4335	62.42	-	0.0305	22.418	0.8826	1	2.988
kPa	0.00145	20.89	-	0.010169	7.5006	0.2953	0.3346	1

Temperature Conversion

°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
-459.4	-273	1	-17.2	61	16.1	300	149	900	482
-450	-268	2	-16.7	62	16.7	310	154	910	488
-440	-262	3	-16.1	63	17.2	320	160	920	493
-430	-257	4	-15.6	64	17.8	330	166	930	499
-420	-251	5	-15	65	18.3	340	171	940	504
-410	-246	6	-14.4	66	18.9	350	177	950	510
-400	-240	7	-13.9	67	19.4	360	182	960	516
-390	-234	8	-13.3	68	20	370	188	970	521
-380	-229	9	-12.8	69	20.6	380	193	980	527
-370	-223	10	-12.2	70	21.1	390	199	990	532
-360	-218	11	-11.7	71	21.7	400	204	1000	538
-350	-212	12	-11.1	72	22.2	410	210	1020	549
-340	-207	13	-10.6	73	22.8	420	215	1040	560
-330	-201	14	-10	74	23.3	430	221	1060	571
-320	-196	15	-9.4	75	23.9	440	227	1080	582
-310	-190	16	-8.9	76	24.4	450	232	1100	593
-300	-184	17	-8.3	77	25	460	238	1120	604
-290	-179	18	-7.8	78	25.6	470	243	1140	616
-280	-173	19	-7.2	79	26.1	480	249	1160	627
-273	-169	20	-6.7	80	26.7	490	254	1180	638
-270	-168	21	-6.1	81	27.2	500	260	1200	649
-260	-162	22	-5.6	82	27.8	510	266	1220	660
-250	-157	23	-5	83	28.3	520	271	1240	671
-240	-151	24	-4.4	84	28.9	530	277	1260	682
-230	-146	25	-3.9	85	29.4	540	282	1280	693
-220	-140	26	-3.3	86	30	550	288	1300	704
-210	-134	27	-2.8	87	30.6	560	293	1350	732
-200	-129	28	-2.2	88	31.1	570	299	1400	760
-190	-123	29	-1.7	89	31.7	580	304	1450	788
-180	-118	30	-1.1	90	32.2	590	310	1500	816
-170	-112	31	-0.6	91	32.8	600	316	1550	843
-160	-107	32	0	92	33.3	610	321	1600	871
-150	-101	33	0.6	93	33.9	620	327	1650	899
-140	-96	34	1.1	94	34.4	630	332	1700	927
-130	-90	35	1.7	95	35	640	338	1750	954
-120	-84	36	2.2	96	35.6	650	343	1800	982
-110	-79	37	2.8	97	36.1	660	349	1850	1010
-100	-73	38	3.3	98	36.7	670	354	1900	1038
-90	-68	39	3.9	99	37.2	680	360	1950	1066
-80	-62	40	4.4	100	37.8	690	366	2000	1093
-70	-57	41	5	110	43	700	371	2050	1121
-60	-51	42	5.6	120	49	710	377	2100	1149
-50	-46	43	6.1	130	54	720	382	2150	1177
-40	-40	44	6.7	140	60	730	388	2200	1204
-30	-34	45	7.2	150	66	740	393	2250	1232
-20	-29	46	7.8	160	71	750	399	2300	1260
-10	-23	47	8.3	170	77	760	404	2350	1288
0	-17.8	48	8.9	180	82	770	410	2400	1316
		49	9.4	190	88	780	416	2450	1343
		50	10	200	92	790	421	2500	1371
		51	10.6	210	99	800	427	2550	1399
		52	11.1	212	100	810	432	2600	1427
		53	11.7	220	104	820	438	2650	1454
		54	12.2	230	110	830	443	2700	1482
		55	12.8	240	116	840	449	2750	1510
		56	13.3	250	121	850	454	2800	1538
		57	13.9	260	127	860	460	2850	1566
		58	14.4	270	132	870	466	2900	1593
		59	15	280	138	880	471	2950	1621
		60	15.6	290	143	890	477	3000	1649

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Tel. (501) 490-7777, Toll Free (800) 423-2686
Fax (501) 490-7100
e-mail: sloane.ps@georgfischer.com
www.gfpiping.com

Australia

George Fischer Pty Ltd
Kingsgrove NSW 2008
Phone +61(0)2-9554 3977
australia.ps@georgfischer.com
www.georgfischer.com.au

Austria

George Fischer Rohrleitungssysteme GmbH
3130 Herzogenburg
Phone +43(0)2782-856 430
austria.ps@georgfischer.com
www.georgfischer.at

Belgium/Luxembourg

George Fischer NV/SA
1070 Bruxelles/Brüssel
Phone +32(0)2-556 40 20
be.ps@georgfischer.com
www.georgfischer.be

Brazil

George Fischer Ltda
04795-100 São Paulo
Phone +55(0)11-5687 1311
br.ps@georgfischer.com
www.georgfischer.com.br

China

George Fischer Piping Systems Ltd Shanghai
Pudong, Shanghai 201319
Phone +86(0)21-5813 3333
china.ps@georgfischer.com
www.cn.piping.georgfischer.com

Denmark/Iceland

Georg Fischer A/S
2630 Taastrup
Phone +45 (0)70 22 19 75
info.dk.ps@georgfischer.com
www.georgfischer.dk

France

George Fischer S.A.S.
93208 Saint-Denis Cedex 1
Phone +33(0)1-492 21 34 1
fr.ps@georgfischer.com
www.georgfischer.fr

Germany

George Fischer GmbH
73095 Albershausen
Phone +49(0)7161-302-0
info.de.ps@georgfischer.com
www.rts.georgfischer.de

Georg Fischer DEKA GmbH
35232 Dautphetal-Mornshausen
Phone +49(0)6468-915-0
deka.ps@georgfischer.com
www.dekapipe.de

Greece

Georg Fischer S.p.A.
10434 Athens
Phone +30(0)1/882 04 91
office@piping-georgfischer.gr

India

George Fischer Piping Systems Ltd
400 093 Mumbai
Phone +91(0)22-2821 7749
in.ps@georgfischer.com

Italy

George Fischer S.p.A.
20063 Cernusco S/N (MI)
Phone +39 02-921 861
it.ps@georgfischer.com
www.georgfischer.it

Japan

George Fischer Ltd
556-0011 Osaka
Phone +81(0)6-6635 2691
jp.ps@georgfischer.com
www.georgfischer.jp

Malaysia

Georg Fischer (M) Sdn. Bhd.
47500 Subang Jaya
Phone +603-8024 7879
conne.kong@georgfischer.com.my

Netherlands

Georg Fischer N.V.
8161 PA Epe
Phone +31(0)578-678 222
nl.ps@georgfischer.com
www.georgfischer.nl

Norway

Georg Fischer AS
1351 Rud
Phone +47 67 18 29 00
no.ps@georgfischer.com
www.georgfischer.no

Poland

George Fischer Sp. z o.o.
02-226 Warszawa
Phone +48(0)22-313 10 50
poland.ps@georgfischer.com
www.georgfischer.pl

Romania

George Fischer
Rohrleitungssysteme AG
70000 Bucharest - Sector 1
Phone +40(0)21-222 91 36
ro.ps@georgfischer.com

Singapore

George Fischer Pte Ltd
417 845 Singapore
Phone +65(0)67-47 06 11
sgp.ps@georgfischer.com
www.georgfischer.com.sg

Spain/Portugal

Georg Fischer S.A.
28009 Madrid
Phone +34(0)91-781 98 90
es.ps@georgfischer.com
www.georgfischer.es

Sweden/Finland

Georg Fischer AB
12523 Älvsjö-Stockholm
Phone +46(0)8-506 775 00
se.ps@georgfischer.com
www.georgfischer.se

Switzerland

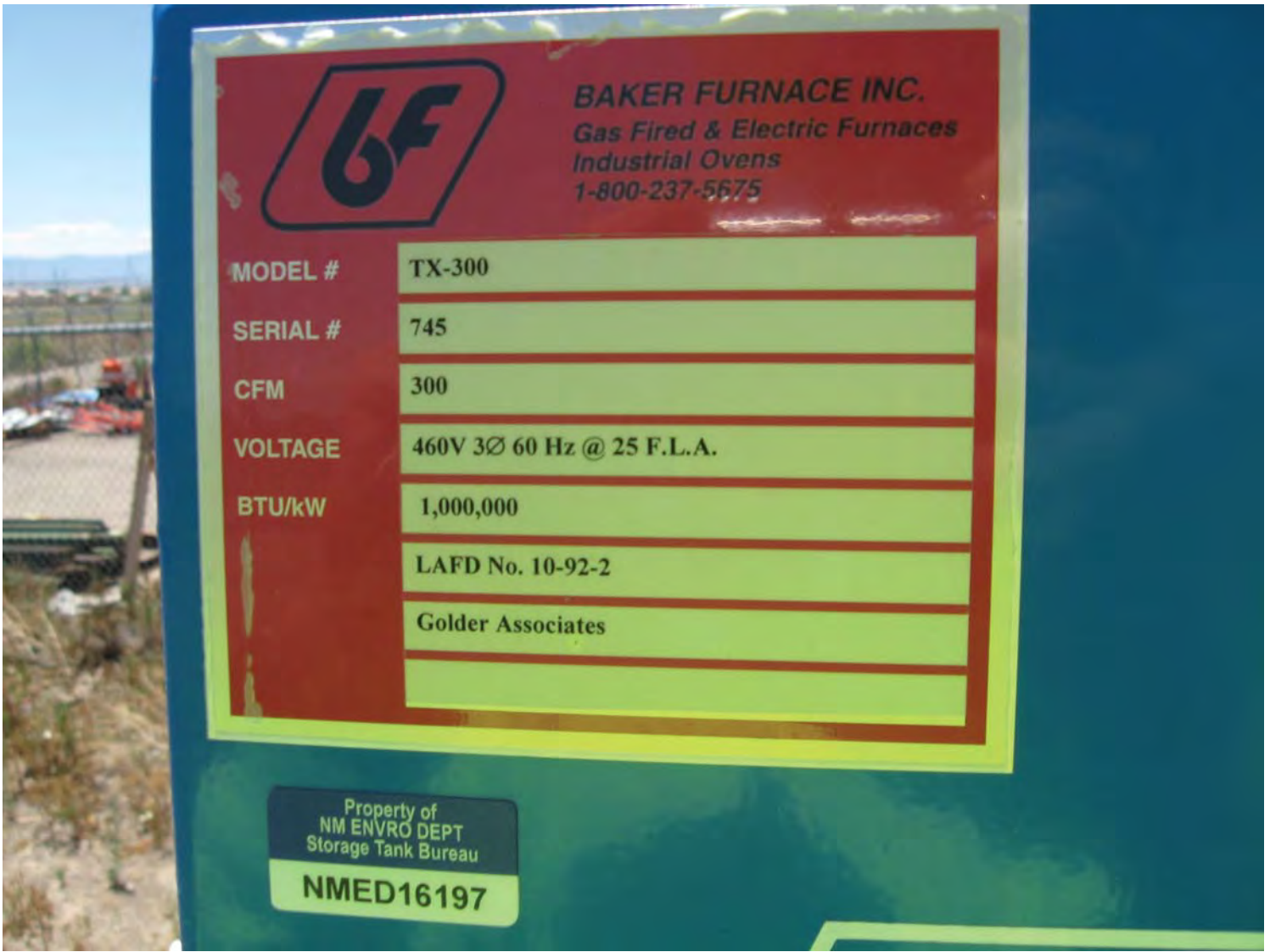
Georg Fischer Rohrleitungssysteme (Schweiz) AG
8201 Schaffhausen
Phone +41(0)52-631 30 26
ch.ps@georgfischer.com
www.piping.georgfischer.ch

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George Fischer Sales Limited
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Facility Name: North Urban Patrol Yard Facility Number: 2001 Photograph Number: IMG_5208

Photographer: Christopher Holmes Date Taken: June 24, 2014 Time Taken: _____

Description:

Equipment Inventory Number: NMED16197
Manufacturer: Baker Furnace Inc.
Model: TX-300 (250 cfm unit)
Serial Number: 745



Facility Name: North Urban Patrol Yard

Facility Number: 2001

Photograph Number: IMG_5233

Photographer: Christopher Holmes

Date Taken: Jun 24, 2014

Time Taken: _____

Description:

Equipment Inventory Number: NMED16197

Manufacturer: Baker Furnace Inc.

Model: TX-300 (250 cfm unit)

Serial Number: 745



QUOTATION #6765 Revision 1

Baker Furnace, Inc.

March 18, 2009
Mr. Todd Stein
Golder Associates (505) 821-3043
5200 Pasadena Ave. E. Suite C
Albuquerque, NM 87113
Re: 250 CFM Thermal Oxidizer Mikes Auto Detail



250-CFM Thermal/Catalytic Oxidizer General Specifications

Baker Furnace, Inc. is pleased to present this proposal to **GOLDER ASSOCIATES** for a Gas Fired 250-CFM Thermal/Catalytic Oxidizer System. This Oxidizer would be constructed as a “turnkey” system ready for operation and would have all the necessary instrumentation and controls to meet applicable Air Quality Standards. We are sure you will find our quality, value and services exceptional!

One (1) Gas Fired Thermal/Catalytic Oxidizer rated at **250 SCFM @ 8” hg vacuum**. **Trailer** Mounted System includes a Knock-Out Tank/Entrainment Separator with High Water Level Switch, Site Glass and In-Line Filter, LEL Auto-Dilution Valving based on temperature, Roots 56 URAI P-D Vacuum Blower with 15 hp TEFC Motor, FM Approved Flame Arrester, Air Pressure Switch, Pitot Tube with Pressure Transmitter, Carbon Steel Shell Insulated with High Temperature Insulation with Catalyst “Ready” Design, U.L Classified Nema 4 Control Panel, Eclipse Package Burner with integrated combustion blower, Fully Modulating FM Fuel Train, and misc. Wiring and Piping. **Note-Catalytic Cell is offered as an option.**

250 CFM Thermal/Catalytic Oxidizer Technical Specifications

Parameter	Thermal Mode	Catalytic Mode
Destruction Efficiency	99%+	98%+
Operating Temperature	1450 Degrees F	750 Degrees F
Supplemental Fuel	Propane or Natural Gas	Propane or Natural Gas
Maximum Concentration to Oxidizer	50% of LEL	25% of LEL
Vacuum available	14” hg.	14” hg.
Stack Height (Discharge height)	Min. 13.5 feet	Min. 13.5 feet
Exit Velocity	600 feet/min	480 feet/min.
Chart Recorder Measurements (3 pens)	Temperature & Flow	Temperature & Flow
Overall Dimensional Footprint	8’ wide x 15’ long x 13.5’ high	8’ wide x 15’ long x 13.5’ high
Approximate Shipping Weight	5,600 lbs.	5,600 lbs.
Inlet Pipe size for VES.	3” N.P.T.	3” N.P.T.
Inlet pipe size for Nat. Gas or Propane	1” N.P.T.	1” N.P.T.
Inlet Gas pressure required	5 PSI (Medium Pressure)	5 PSI (Medium Pressure)
Fuel Supply Requirement (at meter)	800 ft ³ /hr.	350 ft ³ /hr.
Horsepower, VES Blower	15 H.P. @ 14” hg.	15 H.P. @ 14” hg.
Electrical Service	230/460VAC, 3Ø,	230/460VAC, 3Ø,
Residence Time for Vapors Oxidized	1-second residence time.	N/A

250 CFM Thermal/Catalytic Oxidizer Pricing

Description	Price
250 CFM Skid Mounted Thermal/Catalytic "Ready" Oxidizer with PD blower	\$58,570.00
Add for Dual Axle Trailer with Corner Jacks and surge brakes	\$3,800.00
50% Efficient Stainless Steel Shell and Tube Heat Exchanger (Designed for 8 PSIG service)	Included
200 CFM Blower for Air Injection	Included
Options	
Catalytic Cell with Stainless Steel Monolith, Mounting ring and Thermocouple	\$5,300.00
Auto drain knockout pump and controls	\$1,630.00
Fully Insulated PD Blower Sound Enclosure	\$1,480.00
Total with Options	\$70,780.00

Pricing does not include Taxes, installation or permitting

- ❑ This proposal is valid for 60 days from March 18, 2009.
- ❑ Terms: Payment 40% Down, 50% at shop completion, 10% net 30 from completion
- ❑ Shipping Point – EXW, Yorba Linda, CA.
- ❑ Delivery - Approximately 10-12 weeks from receipt of purchase order.

Additional Technical Specifications

- **VES Blower and Motor:** Roots 56 URAI positive displacement blower connected via pulley/belt system to 15 H.P. TEFC, 3Ø, electric motor with adjustable slide base for belt tension adjustments. . Estimated noise level with Silence Plus VES blower configuration, **3 feet** from source is 77 dBa. Based on Roots modeling, noise level with no silencing options for this blower is 85 dBa. Best practices for silencing will achieve a maximum of 8-10-dBa reduction from bare blower baseline. (Noise estimate is *without* sparge)
- **Sparge Blower and Motor:** Skid mounted with Roots 53 URAI positive displacement blower connected via pulley/belt system to 10 H.P. TEFC, 3Ø, electric motor with adjustable slide base for belt tension adjustments. Separate starter panel interlocked to oxidizer.
- **Combustion Chamber:** Square plate steel with 5" ceramic refractory insulation rated to 1700 ° F. Combustion chamber is sized to provide 1+ seconds residence time and 99%+ DRE in thermal mode at a maximum 250 SCFM.
- **Heat Exchanger:** 304 SS designed to withstand 8 PSIG pressure from the sparge blower. Piping to convert the heat exchanger to oxidizer pre-heat service is included once the sparge system is removed.
- **Combustion burner:** Eclipse 1.0 mm BTU/hour package burner with 35:1 turndown and integrated combustion blower. Burner will be fully proportioning for automatic, precise temperature control.
- **Fuel Train:** FM approved fuel train with double blocking valve, inlet gas pressure regulator, high-low gas pressure switch and Eclipse-Dungs proportioning valve.

- **Moisture Knockout Tank:** Nominal **40 gallon** working capacity with corrosion resistant epoxy coating on interior. Standard offering includes high water level shutdown interlock. Auto drain option to include high capacity Ebara stainless steel pump and activation switches. The Ebara pump has proven itself a reliable performer capable of pumping off the knockout tank even at the high vacuum levels generated by liquid ring blowers.
- **Electrical Control Panel:** NEMA 4 rating, U.L. classified as flame control panel and industrial control panel. Panel includes heavy duty, appropriately sized main disconnect.
- **Instrumentation and Controls:** Yokagawa FX103 series paperless chart recorder, Honeywell flame safety, and West digital controllers for process control (temperature and dilution air control) and high temperature shutdown. Baker oxidation systems utilize **PLC logic** and feature automatic supplemental fuel modulation (as a function of BTU content of process stream). LEL Auto-Dilution Valving based on temperature and controlled via Honeywell Modutrol drive motor and dilution valve comprised of stainless steel butterfly valve in heavy duty, corrosion proof, PVC housing.
- **Safety Interlocks/Shutdowns:** Standard safety interlocks and shutdowns on all Baker oxidation systems are comprised of High-low gas pressure, VES blower air pressure, high temperature, combustion blower air pressure, high water level in moisture knockout tank, and flame failure. In the event any of these interlocks is not met, the oxidizer will not proceed past the limits complete step in the ignition sequence (*flame failure is not an interlocks in startup sequence*). In the event that any of these interlocks are breached during operation, the main gas valve closes in .3 seconds, the dilution valve closes to wells and VES and combustion blowers shut down after a time out delay to allow for purging of combustion chamber.
- **Third Party Certifications and Approvals:** Baker Furnace, Inc. has the following approvals and certifications (all are current in force and good standing): U.L. Classification files as “Enclosed Industrial Control Panel” and “Enclosed Flame Control Panel”, City of Los Angeles Fire Department General Approval and City of Los Angeles Mechanical Testing Laboratory General Approval, SCAQMD Certified Equipment Permit. The Baker Oxidizer as proposed meets the approval guidelines of CSA International.
- **Catalyst:** Baker oxidation systems are “catalytic ready”. The catalyst provided for use with a Baker system is platinum bead in a metallic monolith as manufactured by Johnson Matthey. It is generally recommended that the unit not be converted from thermal to catalytic operation until hydrocarbon levels are below 25% of the LEL (approximately 3,475 ppmv for BTEX). This is the level at which the temperature rise created by the exothermic reaction of the process constituents and the catalyst will not exceed safe catalyst operation levels. *Actual temperature rise across the catalyst is a function of BTU value of constituents. A significant risk of catalyst de-activation is associated with processing of high sulphur content diesel, chlorinated or fluorinated compounds.*

Installation, Start-Up and Training

Baker Furnace, Inc. can provide onsite field assistance at the rate of \$1,050.00/day plus per diem expenses (Per diem expenses are marked up 20%).

Equipment Warranty

Baker Furnace, Inc.'s Standard Warranty guarantees that all equipment manufactured by **Baker Furnace, Inc.** will be free from defects in materials and workmanship for a period of twelve (12) months from the date of completion. Components and/or sub-assemblies not manufactured by **Baker Furnace, Inc.** will be covered by each individual warranty; typically twelve (12) months in length from the date of manufacturing completion. **Baker Furnace, Inc.** will replace warranted components that may fail within the designated warranty period at "No Charge". All warranted parts are FOB factory.

Operation Manual

An operation manual, with complete documentation will be provided with instructions detailing how to install, operate, and maintain the Baker Oxidizer and its ancillary equipment.

Thank you for this opportunity to quote **GOLDER ASSOCIATES** on this project. If you have any questions or would like additional information, please don't hesitate to contact me. We look forward to the opportunity to work with you on this project.

Best Regards,
Ernie Bacon - Owner
Baker Furnace, Inc.



250 CFM on Trailer with Heat Exchanger



Baker Furnace, Inc., 3780 Prospect Ave., Yorba Linda, CA. 92886
Phone: 714-223-7262 • Fax: 714-223-7283 • sales@bakerfurnace.com

PROCESS TREATMENT SYSTEM

PROJECT # 201594

Site:

SPRINGER MR. GAS REMIATIION PROJECT

Prepared For:

Golder Associates
5200 Pasadena Avenue, NE
Albuquerque, New Mexico

Operation and Maintenance Manual

Prepared by:
newterra

CARBON STEEL HEADER - HEAD SERIES

Application:

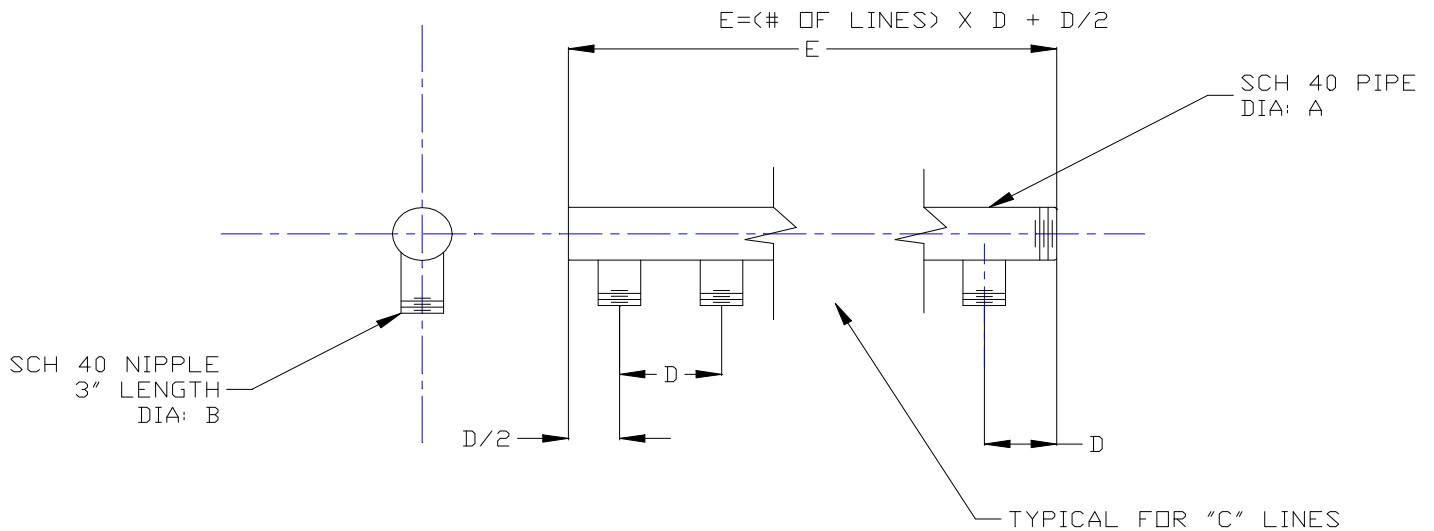
newterra Carbon Steel Headers are fabricated manifolds used to distribute air or water in discharge applications and to collect air and water on inlet applications. These headers can be fabricated with any combination of inlet line sizes and main header sizes. Fabricated inlet headers are only cost effective if the main header is 1-1/2" or larger and there are at least 4 lines on the header. Headers that are smaller than 1-1/2" or with fewer than 4 lines can be ordered but are piped together with threaded or glued pipe fittings.

Construction:

The headers are fabricated from Carbon Steel Pipe and are epoxy coated with **newterra** blue epoxy paint. They can be bolted to a wall with standard pipe clamps.

Standard Features:

- Epoxy Coated Exterior
- MNPT threaded ends on all fittings



Dimensions Chart:

Line Diameter ("B")	Typical "D" Dimension
1"	4"
1-1/2"	5"
2"	6"
3"	9"
4"	10"
6"	12"

* All other dimensions are determined when header is ordered.

CARBON STEEL HEADER - HEAD SERIES

Specifications Chart:

Specification	newterra Carbon Steel Header		
Maximum Pressure:	20 psi		
Maximum Vacuum:	30" Hg		
Weight:	Depends on size		
Connection Fittings:	Male - National Pipe Thread		
Maximum Rated Flow Rate through the Main Header or Inlet Lines:	Line Size	Air Flow (CFM)	Water Flow (GPM)
	1-1/2"	75	30
	2"	140	60
	3"	300	170
	4"	520	350
	6"	1200	
Minimum Number of Lines:	4		
Minimum Header size:	1-1/2"		
Pressure Drop at Maximum Flow:	8"wc		

Options Table:

Option	Description
Header Size (DIM "A")	Any header size can be chosen from 1-1/2" and up. Note: Header is required to be a minimum of one size larger than the lines to simplify fabricating process.
Line Size (DIM "B")	Any line size can be chosen from 3/4" and up.
Number of Lines (DIM "C")	Any number of lines can be chosen.
Sample Ordering Format	
HEAD Series Header Header Size: 4" Line Size: 2" Number of Lines:6	



MTH

Multijet meter

for hot water up to 130 °C

DN 15, 20, 25, 32, 40, 50

PN 16 / 25

Our strength > Your benefit

- Robust, high grade wear resistant materials
> Excellent measuring stability and reliability
- Measurement of low flow rates
> Increase in the value of the system

Application

- The multijet hot water meter is suited for central heating installations and district heating applications.

Features

- Multijet impeller wheel, super dry-dial with magnetic coupling
- Register can be turned for best readout position
- Maximum operating pressure: PN16 (Threaded) / PN25 (Flanged)
- Maximum operating temperature 130 °C
(can be overloaded to 150 °C for short period of time)
- Horizontal or vertical (MTH-V...) installation
- Flanged configuration only for horizontal installation
- Reed pulser IPG14
- High grade wear resistant and corrosion proof materials
- Inlet strainer
- Reconditionable and recyclable execution
- Magnetic protective cover against external influences
- Swiss Approval and PTB Type Approval according to EN 1434
- **CE** Conformity according to European Measuring Instruments Directive (MID)
- Environmental class B, Accuracy class 3

Options

- Flanged variant PN16 and PN25
- US Gallon register
- Different pulse values
- NPSM threaded connection
- ☐ Documentation: Pulse generator IPG14 - EPd40217

MTH Multijet meter
EPe20311 - 10.2007 - Subject to modification

GWF MessSysteme AG

Obergrundstrasse 119, CH-6002 Luzern
Tel. +41 41 319 50 50, Fax +41 41 310 60 87
gwf@gwf.ch, www.gwf.ch



Technical Data

Execution			MTH (horizontal)								MTH-VS or -VF (vertical) ¹⁾				
Nominal diameter	DN	mm	15	20	20	25	25	32	40	50	20	20	25	32	40
Operating pressure	PN	bar	16	16	16	16	16	16	16	16	16	16	16	16	16
Operating pressure (flanged)	PN	bar	-	25	25	25	25	25	25	25	-	-	-	-	-
Connection thread on meter	G...B	Inch	3/4	1	1	1 1/4	1 1/4	1 1/2	2	2 3/8	1	1	1 1/4	1 1/2	2
Connection thread on coupling	R...	Inch	1/2	3/4	3/4	1	1	1 1/4	1 1/2	2	3/4	3/4	1	1 1/4	1 1/2
Nominal flow rate	qp	m ³ /h	1,5	1,5	2,5	3,5	6	6	10	15	1,5	2,5	3,5	6	10
Maximum flow rate	qs	m ³ /h	3	3	5	7	12	12	20	30	3	5	7	12	20
Minimum flow rate	qi	l/h	30	30	50	70	120	120	200	300	30	50	70	120	200
Kvs-valve		m ³ /h	3,5	5	5	10	12	12	20	30	5	5	10	12	20
Temperature		max. °C	130	130	130	130	130	130	130	130	130	130	130	130	130
Measuring range	qi / qp		1:50	1:50	1:50	1:50	1:50	1:50	1:50	1:50	1:50	1:50	1:50	1:50	1:50

Dimensions and weights

Length without couplings	A	mm	165	220 ²⁾	220 ²⁾	260	260	260	300	300	105	105	150	150	200
Length with couplings		mm	244	318	318	378	378	378	438	438	203	203	268	268	338
Total height	B	mm	143	149	149	159	159	159	185	199	-	-	-	-	-
Meter height from pipe centre line	C	mm	100	109	109	116	116	116	139	142	-	-	-	-	-
Meter depth	D	mm	-	-	-	-	-	-	-	-	148	148	171	171	186
Meter depth from pipe centre line	E	mm	-	-	-	-	-	-	-	-	130	130	145	146	162
Meter width	F	mm	-	-	-	-	-	-	-	-	95	95	100	103	134
Length with flanges PN 16 / 25		mm	-	190	190	260	260	260	300	300 ³⁾	-	-	-	-	-
Height with flanges	H	mm	-	156	156	168	168	178	208	220	-	-	-	-	-
Flange external dimension ⁴⁾		mm	-	105	105	115	115	140	150	165	-	-	-	-	-
Hole circle diameter ⁴⁾		mm	-	75	75	85	85	100	110	125	-	-	-	-	-
Number of screws ⁴⁾	Pcs.		-	4	4	4	4	4	4	4	-	-	-	-	-
Weight without couplings		app. kg	1,8	2,1	2,1	2,7	2,7	2,8	5,3	5,8	-	-	-	-	-
Weight without couplings MTH-VS		app. kg	-	-	-	-	-	-	-	-	2,0	2,0	2,3	2,3	5,8
Weight without couplings MTH-VF		app. kg	-	-	-	-	-	-	-	-	2,1	2,1	3,5	3,7	7,1
Weight with couplings		app. kg	2,1	2,4	2,4	3,2	3,2	3,5	6,4	7,4	-	-	-	-	-
Weight with couplings MTH-VS		app. kg	-	-	-	-	-	-	-	-	2,3	2,3	2,8	3,0	6,9
Weight with couplings MTH-VF		app. kg	-	-	-	-	-	-	-	-	2,4	2,4	4,0	4,4	8,2
Weight with flanges		app. kg	-	3,8	3,8	5,0	5,0	5,0	9,9	10,4	-	-	-	-	-

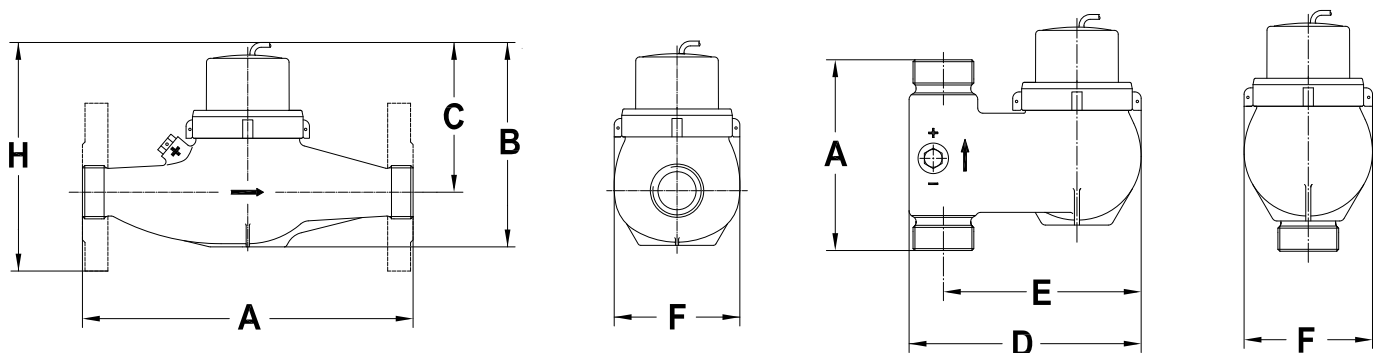
¹⁾ -VS = Vertical riser / -VF = Vertical down pipe

²⁾ Also supplied in lengths 165 mm and 190 mm

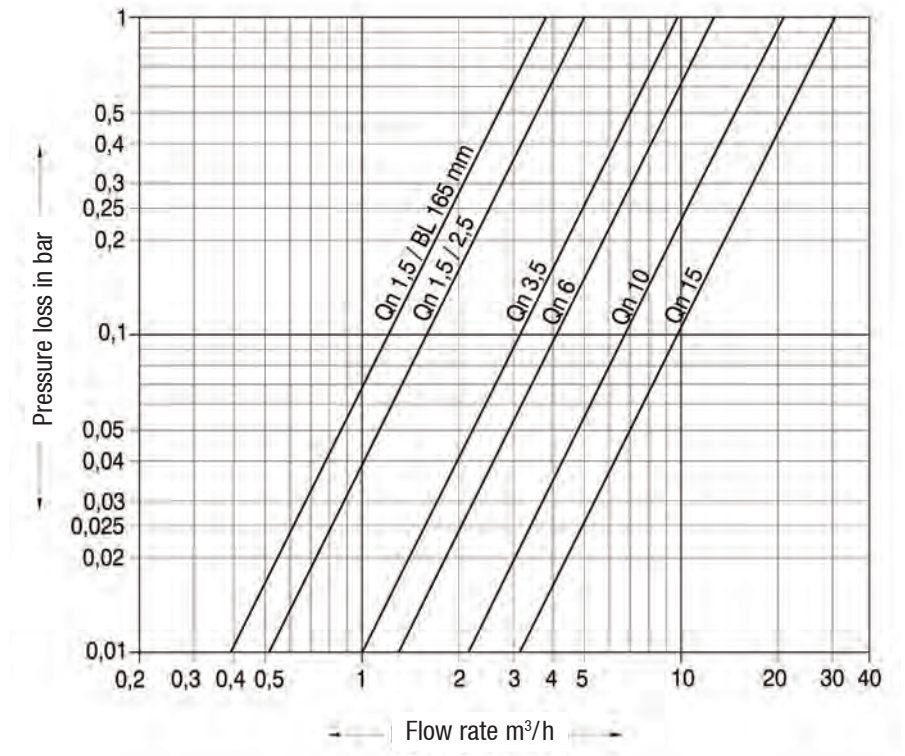
³⁾ Also supplied in length 270 mm

⁴⁾ DIN EN 1092-2

Dimension Diagram



Typical Head Loss Curve



Pulse value table

Pulse values (1 Pulse = ...Liter)	qp 1,5-15	2,5	10	25	100	250
-----------------------------------	-----------	-----	----	----	-----	-----

Installation

Pipeline	horizontal	—
	vertical	
Meter head	upwards	↑

Materials

Housing with screwed connection	Brass
Housing with flanged connection	Cast iron
Sealing plate	Brass
Impeller / head piece	High grade synthetic material
Bearings	Hard metal, sapphire, Chrome nickel steel
Seal material	EPDM

MTH Multijet meter
EPe20311 - 10.2007 - Subject to modification

GWF MessSysteme AG

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Multiple-Stage Switches: **Vertical Mount**

Innovative Solutions



L312 Series Custom Switches with a Maximum Length of 4'

The L312 series level switches are individually designed from over 360 component parts to create a custom switch available in lengths of from six inches (152 mm) to four feet (1.2m).



L312

Product Configuration Choices:

Mounting & Materials: Select mounting size, mount and stem material, float material, switch type, and optional enclosure from **Table A**.

Float Size: Select float from **Table B**.

Switch Wiring: Select switch wiring from **Table C**.

Actuation Levels: Select switch actuation level(s) from **Table D**.

A. Component Choices L312:

Series	Mounting Types		Mounting & Stem Materials		Float Materials		Switch Types		Enclosures	
L312	00	No mounting	01	Brass	02	Polypropylene (hollow)	20	20 VA SPST	00	No enclosure
	01	1/8" NPT	02	Polypropylene	03	Polypropylene (solid)	03	50 VA SPST (standard)	01	Polypropylene NEMA 4
	02	1/4" NPT	04	Kynar (PVDF)	04	Kynar (PVDF)	04	100 VA SPST	02	Cast aluminum
	03	3/8" NPT	05	PVC	05	PVC	06	3 VA SPDT		NEMA 4/7/9
	04	1/2" NPT	08	316 SS	08	316 SS			03	Cast Iron NEMA 4/7/9
	05	3/4" NPT	15	Teflon (PFA)	15	Teflon (PFA)				
	06	1" NPT	18	Nylon	16	Teflon PTFE (hollow)				
	07	1 1/4" NPT	21	Acetal (Delrin)	20	Buna-N				
08	1 1/2" NPT	22	Polysulfone	22	Polysulfone					

Example: L312-0401-2003-00 = 1/2" NPT mounting; brass mounting & stem material; Buna-N float; 50VA SPST switches; no enclosure



Multiple-Stage Switches: **Vertical Mount**

**Innovative
Solutions**



L312 Series Custom Switches with a Maximum Length of 4'

B. Float Sizes and Operating Specifications

Float Materials	Dimensions	Available Mount Types	Temperature	Pressure	Minimum Specific Gravity
Polypropylene (hollow)	1" x 1"	00, 01, 02, 03, 04, 06, 07, 08	-40° to +150° F	50 psig	.70
Polypropylene (solid)	1" x 1"	00, 01, 02, 03, 04, 06, 07, 08	-40° to +150° F	150 psig	.90
Kynar	1" x 1"	00, 01, 02, 03, 04, 06, 07, 08	-40° to +150° F	50 psig	1.1
PVC	1" x 1"	00, 01, 02, 03, 04, 06, 07, 08	-40° to +140° F	50 psig	.95
316 stainless steel	1" x 1"	00, 01, 02, 03, 04, 06, 07, 08	-40° to +300° F	300 psig	.95
316 stainless steel	1.5" x 1"	00, 01, 02, 03, 08	-40° to +300° F	100 psig	.70
316 stainless steel	1" ball	00, 01, 02, 03, 04, 06, 07, 08	-40° to +300° F	275 psig	.80
316 stainless steel	.90" x 1½"	00, 01, 02, 03, 04, 05, 06, 07, 08	-40° to +300° F	200 psig	.85
Teflon (PFA)*	1" x 1"	00, 01, 02, 03, 04, 06, 07, 08	-40° to +300° F	1000 psig	.90*
Teflon (hollow)	1.125" x 1.250"	00, 01, 02, 03, 04, 06, 07, 08	-40° to +300° F	100 psig	1.0
Buna-N	1" x 1"	00, 01, 02, 03, 04, 06, 07, 08	-40° to +180° F	150 psig	.80
Polysulfone	1" x 1"	00, 01, 02, 03, 04, 06, 07, 08	-40° to +225° F	50 psig	.90

C. Switch Wiring and Electrical Specifications

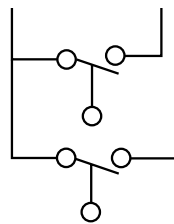
Each switching point requires one float. For special applications, a single float can be used to activate two switch points, though these points must have a minimum separation of 1/8" (3mm). The maximum number of actuation levels depends on the wiring type selected.

Ratings: 20 VA @ 120 VAC SPST
50 VA @ 240 VAC SPST
3 VA @ 30 VAC/VDC SPDT

Connection: 24" Free Leads
#22 AWG, PVC jacketed.

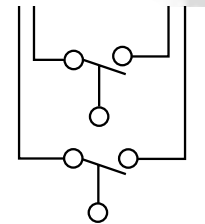
Mounting Attitude: Vertical ± 30°

Group 1 SPST
One Common Wire



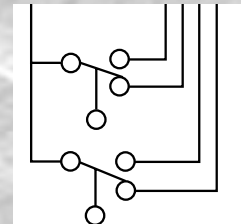
1 to 5 switch points

Group 2 SPST
Independent Circuits



1 to 3 switch points

Group 3 SPDT
One Common Wire



1 or 2 switch points

Switch Wiring Code			
Wiring Options	Group 1 SPST	Group 2 SPST	Group 3 SPDT
Common Wire	Black	None	Black
	NO or NC	NO or NC	NO/NC
L1	Red	Red/Red	Red/White-Red
L2	Yellow	Yellow/Yellow	Yellow/White-Yellow
L3	Blue	Blue/Blue	
L4	Brown		
L5	Orange		

Notes: All SPST switches are set normally open in their "dry", "no level" condition unless specified otherwise.
"White-Red" and "White-Yellow" denote single white wire with red or yellow stripes.



Multiple-Stage Switches: **Vertical Mount**

**Innovative
Solutions**



L312 Series Custom Switches with a Maximum Length of 4'

D. Actuation Level Dimensions

A = Minimum distance from actuation point to bottom of mounting.

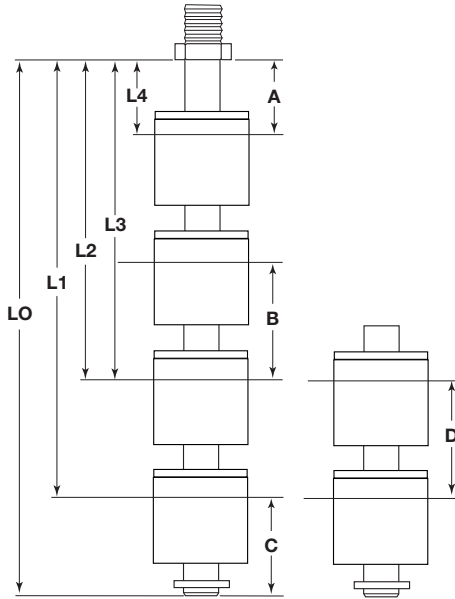
B = Minimum distance between actuation levels.

C = Minimum distance from end of unit to lowest actuation point.

D = Minimum distance between actuation points when a single float is used to actuate two switches.

Notes:

1. A, B, and C dimensions are based on a specific gravity of 1.0.
2. When using one float for two actuation positions, contact the factory for available switch ratings.
3. Actuation levels are calibrated on descending fluid level, with water as the fluid, unless otherwise specified.
4. Standard tolerance on actuation levels is $\pm 1/8"$ (3mm).



Dimensions				
Float Type	A	B	C	D
1" x 1"	1"	1 3/4"	1"	1/8"
1.5" x 1"	1"	1 3/4"	1"	1/8"
1" ball	1"	1 3/4"	1"	1/8"
.9 x 1.5"	1"	2 1/2"	1 1/2"	1/8"



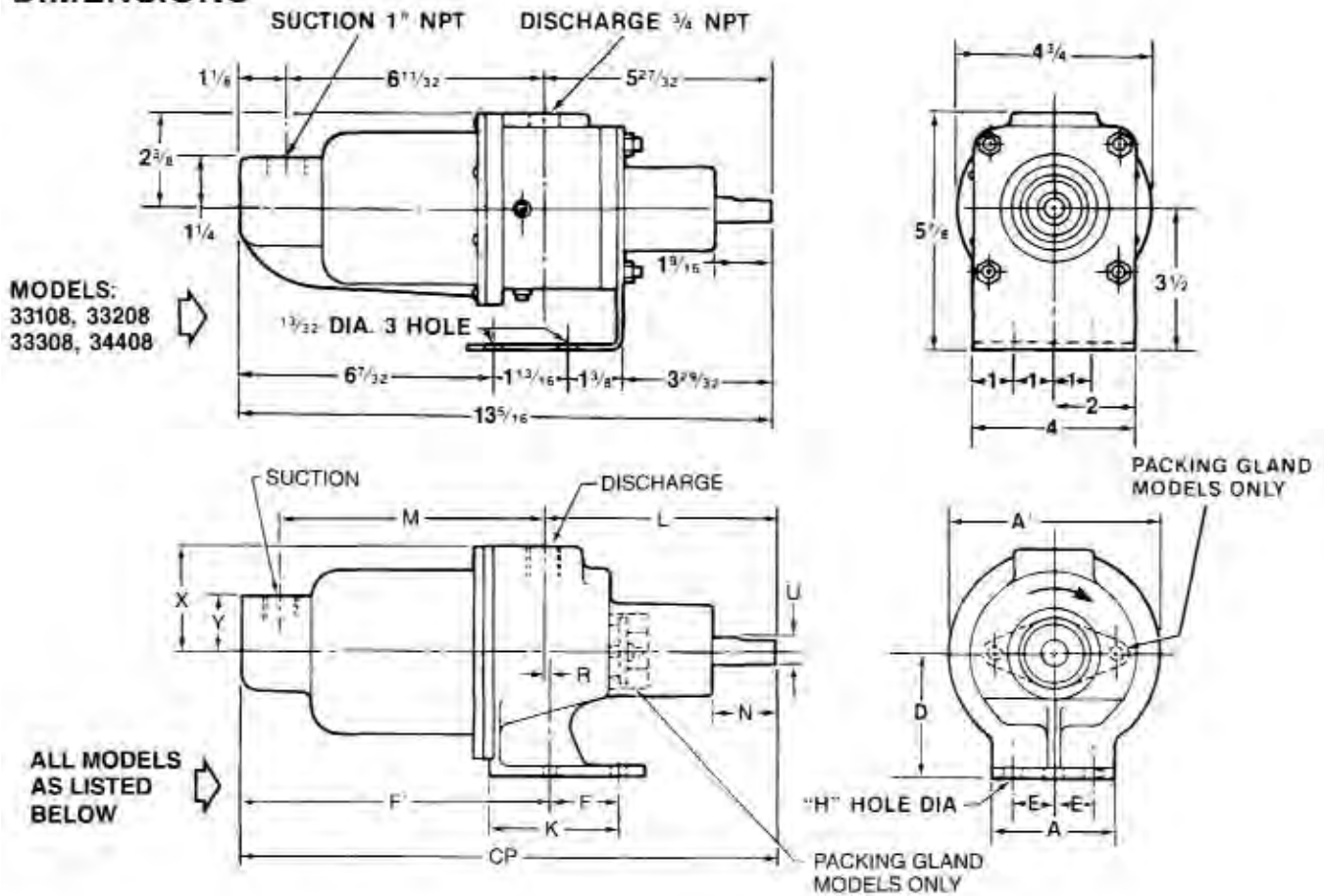
Always the Right Solution™

Section:
MOYNO® 500 PUMPS
 Page: 1 of 4
 Date: March 30, 1996

SPECIFICATION DATA
MOYNO® 500 PUMPS

300 SERIES
 331, 332, 333, 344, 356 AND 367 MODELS

DIMENSIONS

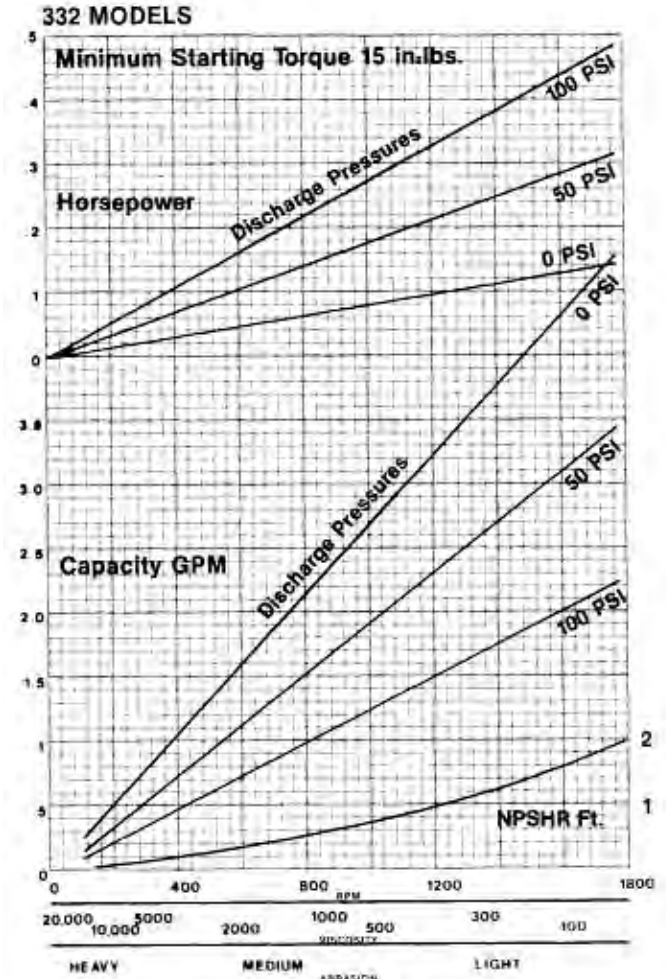
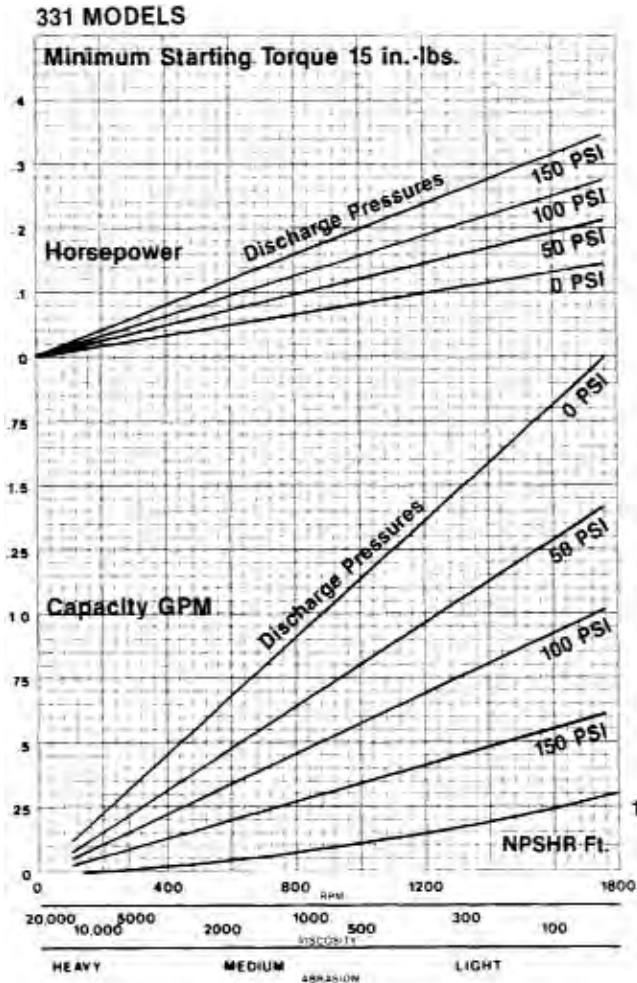


MODELS	CP	A	A ¹	D	E	F	F ¹	H	K	L	M	N	R	U	X	Y	SUCT (NPT)	DISCH (NPT)
33101, 33201 33301, 33104 33204, 33304 34401, 34404	12 5/8	3 1/8	4 3/4	2 3/4	1	1 13/16	6 15/16	13/32	3 1/32	5 11/16	6 1/16	1 7/16	—	5/8	2 3/8	1 1/4	3/4	3/4
*34411	13 15/16	3 1/4	4 3/4	2 3/4	1 1/8	—	7 3/16	13/32	2 7/8	7	6 1/16	1 3/8	1/4	5/8	2 5/16	1 1/4	3/4	3/4
35601, 35604	17 1/2	6 1/2	7 9/16	4 9/32	1 3/4	2	10 19/32	13/32	4 1/2	7 3/8	8 5/8	2 3/8	15/32	3/4	3 28/32	2 1/8	1 1/2	1 1/4
*35611, *35613	19 3/8	6 1/2	7 9/16	4 9/32	1 3/4	2 1/2	10 19/32	13/32	4	9 11/32	8 5/8	2 13/32	9/16	3/4	3 28/32	2 1/8	1 1/2	1 1/4
36701, 36704	20 15/16	5 1/4	8	4 1/2	2	2 5/16	13	9/16	4 1/16	7 15/16	11 3/16	2 1/8	—	1	4	2 1/2	2	2

* Packing Gland Model

All dimensions are in inches. Specifications subject to change without notice.

**331, 332, 333 and 344 MODELS
PERFORMANCE (water at 70°F)**

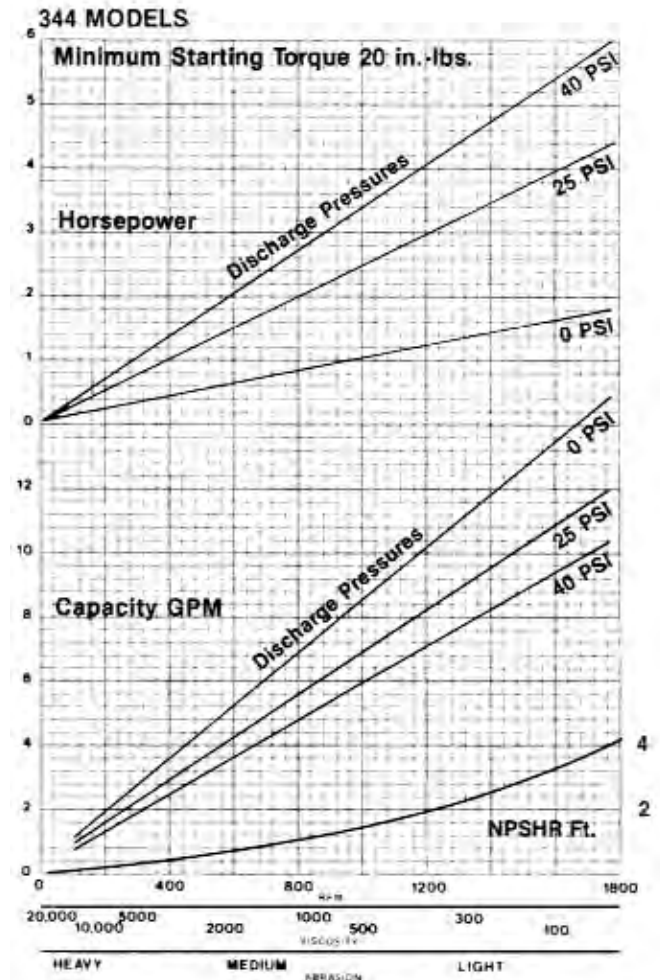
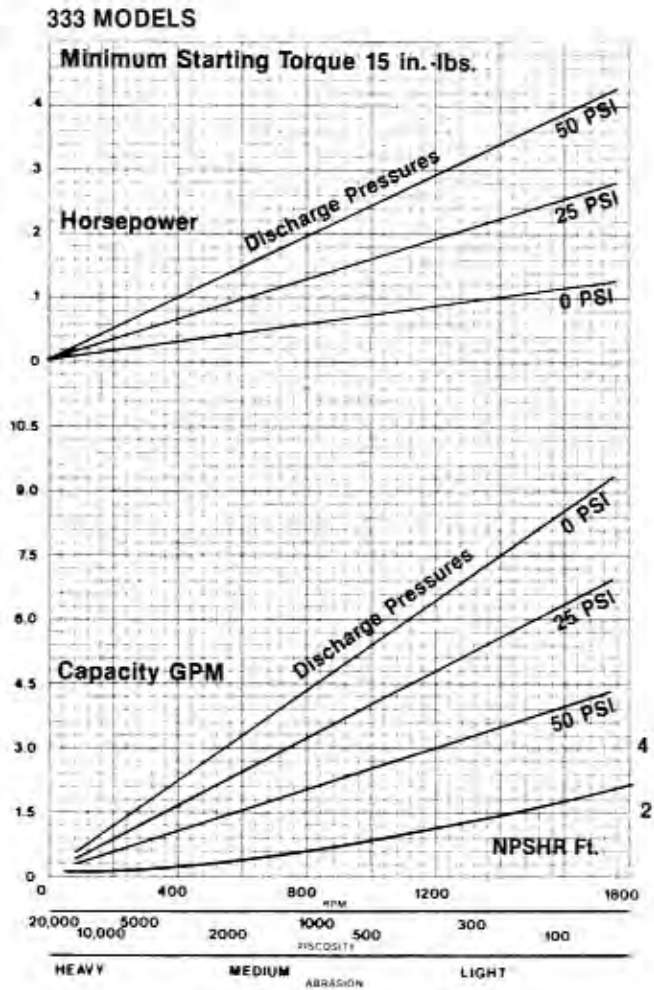


NOTE: For fluids with viscosity over 200 CP (1000 SSU), pump capacity is reduced by 20%.

MATERIALS OF CONSTRUCTION

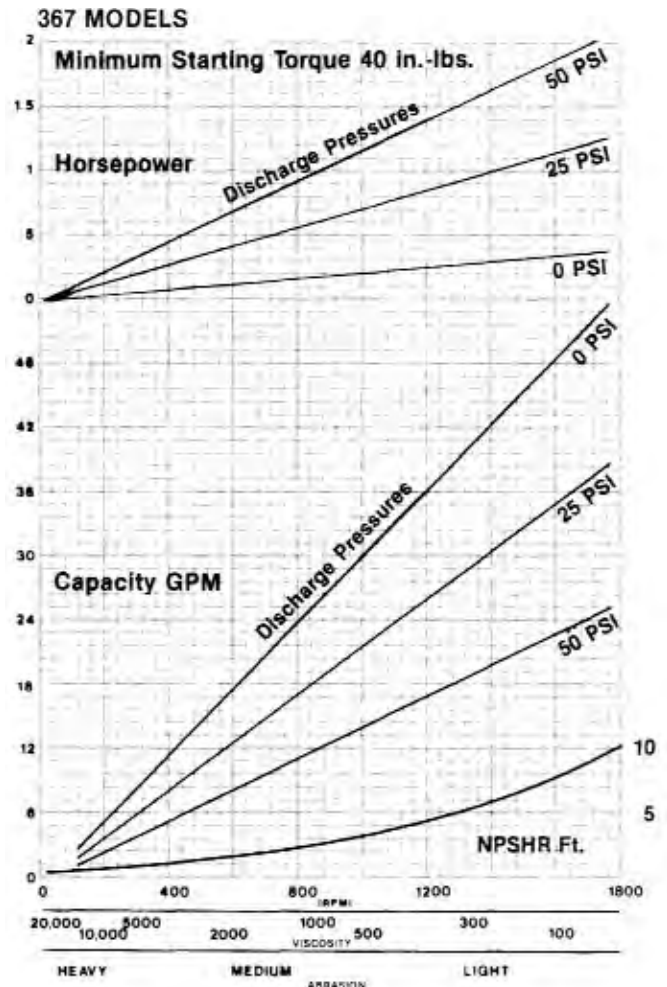
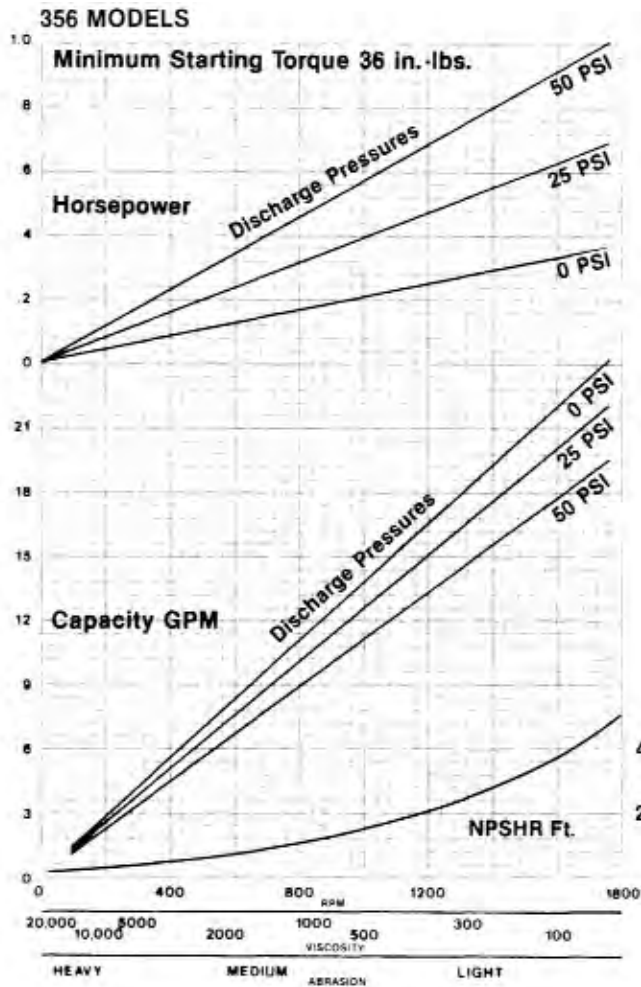
COMPONENT	MODELS			
	33101, 33201 33301, 34401	33104, 33204 33304, 34404	33108, 33208 33308, 34408	*34411
Housing	Cast iron	316 SS	Nylon	Cast iron
Rotor	416 SS/CP	316 SS/CP	416 SS/CP	416 SS/CP
Stator	NBR (Nitrile)	NBR (Nitrile)	NBR (Nitrile)	NBR (Nitrile)
Weight (lbs)	16	16	8	16

* Packing Gland Model
CP = Chrome plated



NOTE: For fluids with viscosity over 200 CP (1000 SSU), pump capacity is reduced by 20%.

356 and 367 MODELS PERFORMANCE (water at 70°F)



NOTE: For fluids with viscosity over 200 CP (1,000 SSU), pump capacity is reduced by 20%.

MATERIALS OF CONSTRUCTION

COMPONENT	MODELS					
	35601, 35611		35604, 35613		36701	36704
Housing	Cast iron		316 SS		Cast iron	316 SS
Rotor	416 SS/CP		316 SS/CP		416 SS/CP	316 SS/CP
Stator	NBR (Nitrile)		NBR (Nitrile)		NBR (Nitrile)	NBR (Nitrile)
Weight (lbs)	37	40	37	40	54	54

CP=Chrome plated

KUNKLE

Non-code Bronze Liquid Relief Valves

Features

- **Both inlet and outlet connections are cast integral with body** to permit easy inspection and servicing without disconnecting piping.
- **Beveled seats lapped** for optimum performance.
- **SS spring** for optimum corrosion resistance.

Model Descriptions

Model 19: All bronze, equipped with handwheel for easy adjustment within spring ranges.

Model 19M: Same as Model 19 except SS trim (seat and disc). (Available 2½-inch and 3-inch only). For higher pressure settings or severe applications.

Model 20: All bronze, with pressure-tight cap. Suitable for maximum back pressure of 50 psig.

Model 20M: Same as Model 20 except SS trim (available in 2½-inch and 3-inch only) (seat and disc). For higher pressure settings or severe applications. Maximum back pressure of 50 psig.

Model 20P: Same as Model 20 except with packed lift lever. Suitable for maximum back pressure of 50 psig.

Model 20MP: Same as Model 20M except with packed lift lever. Maximum back pressure of 50 psig.

Model 200A: Special non-chattering design. Recommended for light oils and continuous by-pass or pressure regulation. UL listed for light oil service. Available ¾-inch through 1½-inch sizes. Female NPT connections only.

Model 200H: Same as Model 20. UL listed for use with fuel oils. Available ¾-inch through 2-inch sizes.



Model 20

Applications

- Non-code liquid relief.
- Overpressure relief and protection of pumps, tanks, lines and hydraulic systems.
- Pressure regulation.
- Continuous by-pass relief.

Options

- Available with optional female NPT inlet or flanged inlet and outlet connections.
- **Model 20-D only**
Variation 05: 50 to 150 psig spring range
Variation 06: 100 to 300 psig

Pressure and Temperature Limits

Models 19, 20:
1 to 300 psig
-60° to 406°F

Models 19M, 20M:
1 to 500 psig
-60° to 406°F

Models 200A, 200H:
10 to 200 psig
-60° to 406°F

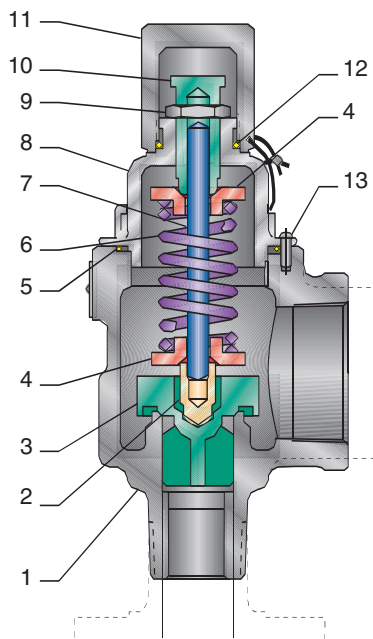
tyco / Flow Control

Total Flow Control Solutions™

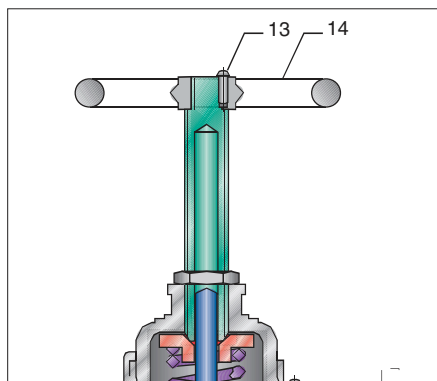
Kunkle is either a trademark or registered trademark of Tyco International Services AG or its affiliates in the United States and/or other countries. All other brand names, product names, or trademarks belong to their respective holders.

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

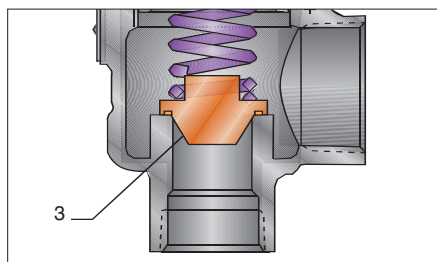
Parts and Materials



**Models 20, 200H
with Pressure Tight Cap**



Model 19, 19M



Model 200A

Parts and Materials

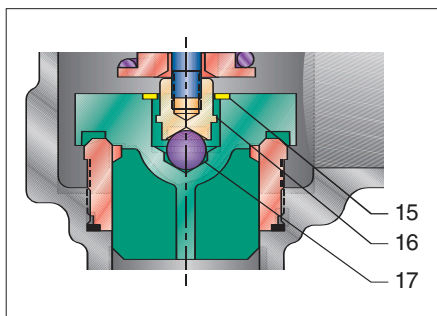
No.	Part Name	19, 19M	20, 20M, 20P, 20MP, 200A, 200H
1	Body ⁷	Bronze B62	Bronze B62
2	Stem Retainer	Brass B16	Brass B16
3	Disc	Bronze B584 Alloy 84400 ^{2,3}	Bronze B584 Alloy 84400 ^{2,3}
4	Spring Step	Brass B16	Brass B16
5	O-ring	Teflon [®]	Teflon [®]
6	Spring	SS 316 or 17-7	SS 316 or 17-7
7	Stem	Brass B16	Brass B16
8	Bonnet	Bronze B584 Alloy 84400	Bronze B584 Alloy 84400
9	Jam Nut	Steel A108 Zinc Plated	Brass B16
10	Compression Screw	Brass B16	Brass B16
11	Cap	N/A	Brass B16
12	O-ring	N/A	BUNA-N
13	Drive Screw ⁶	SS Commercial	SS Commercial
14	Handwheel	Iron A126 Zinc Plated ⁵	N/A

Notes

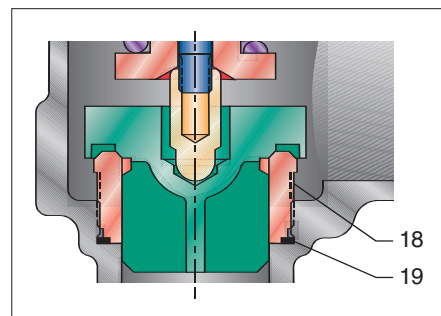
1. Flanged connections optional.
2. Models 19, 20, 20P, 200H are brass, B283, Alloy 485, for 1/2-, 3/4-, and 1-inch.
3. Models 19M, 20M, and 20MP are SS A743-CF8.
4. Model 200A is brass B16.
5. Bronze B584 Alloy 84400 for 1/2-, 3/4-, 1 1/4-inch.
6. Not used on bonnet for 2 1/2- and 3-inch.
7. Teflon[®] is a registered trademark of E.I. du Pont de Nemours Company.

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

Parts and Materials



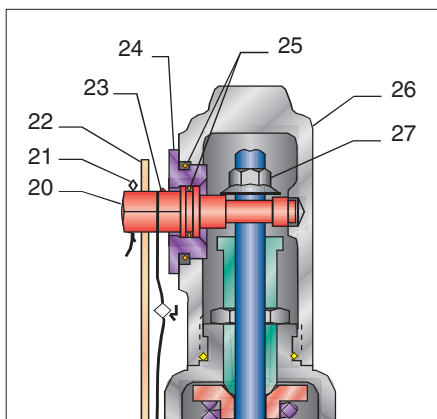
Models 19M, 20M and 20MP
2 1/2" Seat Configuration



Models 19M, 20M and 20MP
3" Seat Configuration

Parts and Materials

No.	Part Name	Material
15	Retainer Washer	SS PH15-7MO
16	Stem End	SS A582-303
17	Ball	SS A756-440
18	Insert	SS A743 GR CF8
19	O-ring	Teflon®



Models 20MP and 20P With Lever

Parts and Materials

No.	Part Name	20P, 20MP
20	Lift Cam	SS A743-316
21	Cotter Pin	Steel
22	Lever	Steel A108 Zinc Plated
23	Drive Screw	SS Commercial
24	Retainer Cam	Brass B16
25	O-ring	BUNA-N
26	Cap	Bronze B584 Alloy 84400
27	Lift Nut	Steel A108

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

Liquid Relief Valves

Specifications

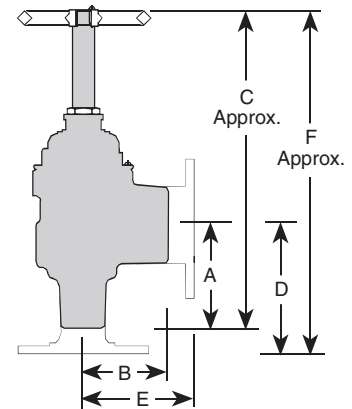
Size Inlet/Outlet NPT, (in)	Min/Max Set Pressure, (psig ¹)		Min/Max Temp. (°F)	Approximate Wt., (lb)
	19, 20, 20P	200A, 200H 19M, 20M, 20MP		
1/2 ²	1/300	—	-60/406	2 1/4
3/4	1/300	1/200	-60/406	2 1/4
1	1/300	1/200	-60/406	3 1/2
1 1/4	1/300	1/200	-60/406	5
1 1/2	1/300	1/200	-60/406	6 1/4
2	1/300	1/200	-60/406	11
2 1/2	1/300	—	-60/406	16
3	1/300	—	-60/406	25

Dimensions

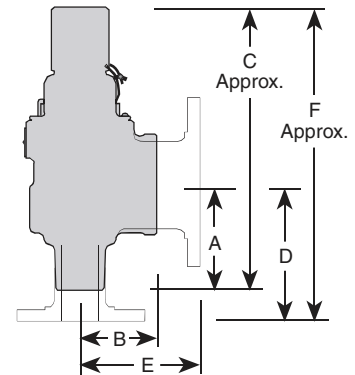
Valve Model	Threaded			150/300 Flange		
	A	B	C	D	E	F
1/2-inch Size						
19	2	1 5/8	6 1/8	3 5/16	3 5/16	7 3/8
20	2	1 5/8	5 7/8	3 5/16	3 5/16	7 1/4
20P	2	1 5/8	7 3/8	N/A	N/A	N/A
3/4-inch Size						
19	2	1 5/8	6 1/8	3 5/16	3 5/16	7 3/8
20	2	1 5/8	5 7/8	3 5/16	3 5/16	7 1/4
20P	2	1 5/8	7 3/8	3 5/16	3 5/16	8 3/4
200A	2	1 5/8	5 7/8	N/A	N/A	N/A
200H	1 15/16	1 5/8	5 7/8	3 5/16	3 5/16	7 3/8
1-inch Size						
19	2 1/4	1 7/8	7 1/8	3 7/16	3 7/16	8 1/4
20	2 1/4	1 7/8	6 3/4	3 7/16	3 7/16	7 7/8
20P	2 1/4	1 7/8	8 3/4	3 7/16	3 7/16	9 1/2
200A	2 1/4	1 7/8	6 3/4	N/A	N/A	N/A
200H	2 1/4	1 7/8	6 11/16	3 7/16	3 7/16	8

Notes

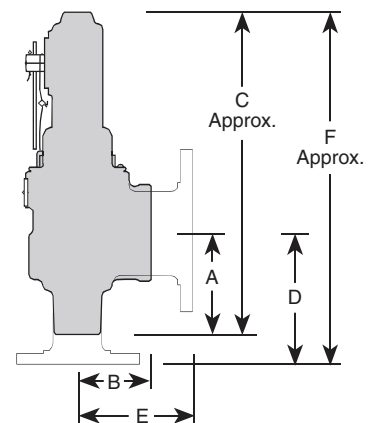
1. All flanges rated per ANSI B16.24.
2. Standard with 3/4-inch outlet - 1/2-inch outlet optional.



Models 19, 19M



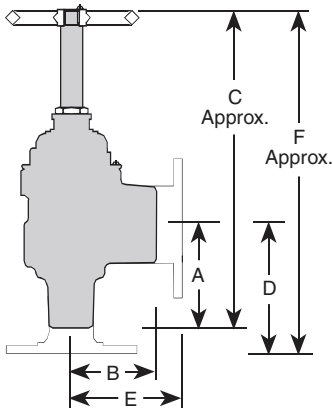
Models 20, 20M, 200A, 200H



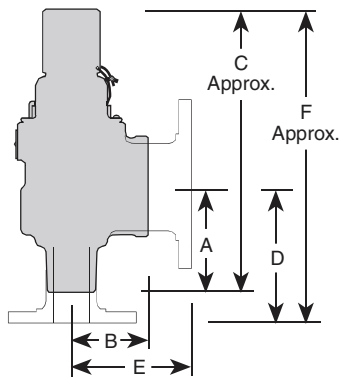
Models 20P, 20MP

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

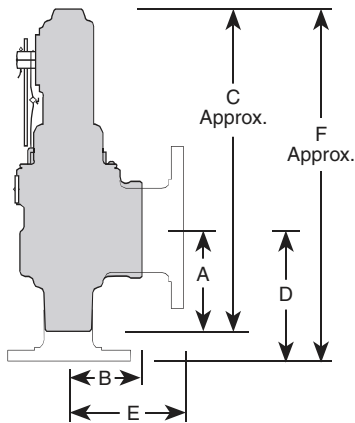
Liquid Relief Valves



Models 19, 19M



Models 20, 20M, 200A, 200H



Models 20P, 20MP

Dimensions, inches

Valve Model	Threaded			150/300 Flange		
	A	B	C	D	E	F
1 1/4-inch Size						
19	2 ⁵ / ₈	2 ¹ / ₁₆	8 ¹ / ₈	3 ¹¹ / ₁₆	3 ¹¹ / ₁₆	9 ¹ / ₈
20	2 ⁵ / ₈	2 ¹ / ₁₆	8 ¹ / ₈	3 ¹¹ / ₁₆	3 ¹¹ / ₁₆	8 ³ / ₈
20P	2 ⁵ / ₈	2 ¹ / ₁₆	9	3 ¹¹ / ₁₆	3 ¹¹ / ₁₆	10
200A	2 ⁵ / ₈	2 ¹ / ₁₆	7 ³ / ₈	N/A	N/A	N/A
200H	2 ⁵ / ₈	2 ¹ / ₁₆	7 ³ / ₈	3 ¹¹ / ₁₆	3 ¹¹ / ₁₆	8 ⁵ / ₈
1 1/2-inch Size						
19	2 ¹¹ / ₁₆	2 ¹ / ₈	8 ⁵ / ₈	4 ¹ / ₈	4 ¹ / ₈	10 ¹ / ₈
20	2 ¹¹ / ₁₆	2 ¹ / ₈	8 ⁵ / ₈	4 ¹ / ₈	4 ¹ / ₈	9 ¹ / ₄
20P	2 ¹¹ / ₁₆	2 ¹ / ₈	9 ¹ / ₄	4 ¹ / ₈	4 ¹ / ₈	10 ³ / ₄
200A	2 ¹¹ / ₁₆	2 ¹ / ₈	7 ⁷ / ₈	N/A	N/A	N/A
200H	2 ¹¹ / ₁₆	2 ¹ / ₈	7 ⁷ / ₈	4 ¹ / ₈	4 ¹ / ₈	9 ¹ / ₂
2-inch Size						
19	3 ¹ / ₂	2 ¹¹ / ₁₆	10 ⁵ / ₈	4 ¹ / ₄	4 ¹ / ₄	11 ¹ / ₄
20	3 ¹ / ₂	2 ¹¹ / ₁₆	10 ⁵ / ₈	4 ¹ / ₄	4 ¹ / ₄	10 ⁵ / ₈
20P	3 ¹ / ₂	2 ¹¹ / ₁₆	12 ¹ / ₂	4 ¹ / ₄	4 ¹ / ₄	13 ¹ / ₈
200H	3 ¹ / ₂	2 ¹¹ / ₁₆	9 ¹⁵ / ₁₆	4 ¹ / ₂	4 ¹ / ₄	10 ¹⁵ / ₁₆
2 1/2-inch Size						
19	3 ⁷ / ₈	3	11 ¹ / ₈	4 ³ / ₄	4 ³ / ₄	12
19M	3 ⁷ / ₈	3	11 ¹ / ₈	4 ³ / ₄	4 ³ / ₄	12 ¹ / ₄
20	3 ⁷ / ₈	3	10	4 ³ / ₄	4 ³ / ₄	13 ⁵ / ₁₆
20M	3 ⁷ / ₈	3	10	4 ³ / ₄	4 ³ / ₄	13 ⁹ / ₁₆
20P	3 ⁷ / ₈	3	12 ¹ / ₂	4 ³ / ₄	4 ³ / ₄	15 ³ / ₄
20MP	3 ⁷ / ₈	3	12 ¹ / ₂	54 ³ / ₄	4 ³ / ₄	16 ¹ / ₁₆
3-inch Size						
19	4 ⁵ / ₈	3 ⁷ / ₈	12 ¹ / ₄	5	5	12 ⁵ / ₈
19M	4 ⁵ / ₈	3 ⁷ / ₈	12 ¹ / ₄	5	5	13 ¹ / ₈
20	4 ⁵ / ₈	3 ⁷ / ₈	12 ¹ / ₄	5	5	14 ³ / ₄
20M	4 ⁵ / ₈	3 ⁷ / ₈	12 ¹ / ₄	5	5	15 ¹ / ₈
20P	4 ⁵ / ₈	3 ⁷ / ₈	14 ³ / ₈	5	5	16 ⁷ / ₈
20MP	4 ⁵ / ₈	3 ⁷ / ₈	14 ³ / ₈	5	5	17 ¹ / ₄

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

Models 19, 19M, 20, 20M, 20MP, 20P and 200H Capacities Liquid Relief Valves

Non-code Liquid Capacity - 25% Accumulation (GPM)

Set Pressure (psig)	Valve Inlet and Outlet Size							
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"
1	1	2	4	6	10	19	31	45
5	2	5	8	14	22	42	68	100
10	3	7	11	20	31	59	97	141
20	4	9	16	28	43	84	137	200
30	5	11	20	34	53	102	168	244
40	6	13	23	39	61	118	193	282
50	7	15	25	44	68	132	216	315
60	7	16	28	48	75	145	237	346
70	8	17	30	52	81	156	256	373
80	8	19	32	55	87	167	274	399
90	9	20	34	59	92	177	290	423
100	9	21	36	62	97	187	306	446
110	10	22	37	65	102	196	321	468
120	10	23	39	68	106	205	335	489
130	11	24	41	71	110	213	349	509
140	11	25	42	73	115	221	362	528
150	11	25	44	76	119	229	375	546
160	12	26	45	78	123	236	387	564
170	12	27	47	81	126	244	399	582
180	13	28	48	83	130	251	410	599
190	13	29	49	86	134	258	422	615
200	13	29	50	88	137	264	433	631
210	14	30	52	90	140	271	443	646
220	14	31	53	92	144	277	454	662
230	14	32	54	94	147	284	464	677
240	14	32	55	96	150	290	474	691

Note

1. Liquid Overpressure Factors

To determine capacities at other than 25% overpressure/accumulation, multiply capacity shown by:

10% Acc. = 0.6

15% Acc. = 0.8

20% Acc. = 0.9

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

Models 19, 19M, 20, 20M, 20MP, 20P and 200H Capacities Liquid Relief Valves

Non-code Liquid Capacity - 25% Accumulation (GPM)								
Set Pressure (psig)	Valve Inlet and Outlet Size							
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"
250	15	33	56	98	153	296	484	705
260	15	34	58	100	156	301	493	719
270	15	34	59	102	159	307	503	733
280	16	35	60	104	162	313	512	746
290	16	35	61	106	165	318	521	760
300	16	36	62	107	168	323	530	773
310	—	—	—	—	—	—	539	785
320	—	—	—	—	—	—	547	798
330	—	—	—	—	—	—	556	810
340	—	—	—	—	—	—	564	823
350	—	—	—	—	—	—	572	835
360	—	—	—	—	—	—	580	846
370	—	—	—	—	—	—	588	858
380	—	—	—	—	—	—	596	870
390	—	—	—	—	—	—	604	881
400	—	—	—	—	—	—	612	892
410	—	—	—	—	—	—	619	903
420	—	—	—	—	—	—	627	914
430	—	—	—	—	—	—	634	925
440	—	—	—	—	—	—	642	936
450	—	—	—	—	—	—	649	946
460	—	—	—	—	—	—	656	957
470	—	—	—	—	—	—	663	967
480	—	—	—	—	—	—	670	977
490	—	—	—	—	—	—	677	987
500	—	—	—	—	—	—	684	998

Note

1. Liquid Overpressure Factors

To determine capacities at other than 25% overpressure/accumulation, multiply capacity shown by:

10% Acc. = 0.6

15% Acc. = 0.8

20% Acc. = 0.9

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

200A Inlet Capacities at 25%, 50% 75% and 100% Accumulation (GPM)

Model 200A "D" - 3/4"

psi	Overpressure			
	25%	50%	75%	100%
5	1.2	1.9	2.7	3.7
10	1.2	2.0	2.8	4.4
15	1.3	2.0	2.9	4.7
20	1.5	2.2	3.0	5.2
25	1.5	2.2	3.0	6.0
30	1.5	2.2	3.1	6.5
35	1.5	2.5	3.3	7.4
40	1.7	2.6	3.5	8.5
45	1.9	2.8	3.6	9.6
50	2.0	3.0	3.8	11.0
55	2.2	3.2	4.0	12.2
60	2.3	3.4	4.2	13.5
65	2.4	3.5	4.4	14.8
70	2.5	3.7	4.5	16.0
75	2.6	4.0	4.7	17.1
80	2.8	4.2	5.0	18.2
85	2.9	4.4	5.1	19.3
90	3.0	4.6	5.4	20.2
95	3.1	4.7	5.5	21.0
100	3.1	4.8	5.7	21.4
105	3.3	5.0	6.0	21.5
110	3.4	5.1	6.1	21.4
115	3.4	5.3	6.2	21.0
120	3.5	5.5	6.4	20.5
125	3.5	5.6	6.5	20.2
130	3.5	5.8	6.7	19.8
135	3.7	6.0	6.9	20.0
140	3.7	6.1	7.0	20.2
145	3.8	6.2	7.0	20.8
150	3.8	6.3	7.2	21.5
155	4.0	6.5	7.4	22.0
160	4.0	6.5	7.5	22.9
165	4.0	6.5	7.6	23.7
170	4.0	6.6	7.8	24.6
175	4.1	6.8	8.2	25.5
180	4.2	6.9	8.5	26.8
185	4.3	6.9	9.0	28.5
190	4.4	7.0	10.0	30.5
195	4.4	7.0	11.5	33.5
200	4.5	7.0	12.9	36.2

Model 200A "E" - 1"

psi	Overpressure			
	25%	50%	75%	100%
5	0.7	1.0	1.3	2.5
10	1.1	1.5	2.0	4.2
15	1.5	2.0	2.7	5.9
20	1.7	2.5	3.5	7.5
25	2.0	2.9	4.1	9.5
30	2.2	3.2	4.6	11.0
35	2.5	3.6	5.0	12.9
40	2.6	4.0	5.5	14.5
45	2.8	4.2	5.8	16.5
50	2.9	4.5	6.0	18.4
55	3.0	4.8	6.4	20.1
60	3.2	5.0	6.6	22.0
65	3.4	5.2	6.8	24.0
70	3.5	5.5	7.1	26.0
75	3.5	5.7	7.3	27.8
80	3.6	6.1	7.5	29.5
85	3.8	6.4	7.7	31.0
90	3.9	6.7	8.1	32.7
95	4.0	6.9	8.2	34.2
100	4.1	7.0	8.5	35.5
105	4.3	7.2	8.7	37.0
110	4.4	7.4	9.0	38.0
115	4.5	7.5	9.1	39.0
120	4.5	7.6	9.2	39.8
125	4.7	7.7	9.5	40.2
130	4.8	7.8	9.6	40.5
135	4.8	8.0	9.7	40.5
140	4.9	8.0	9.8	40.1
145	5.0	8.4	10.0	39.5
150	5.0	8.5	10.0	38.3
155	5.0	8.5	10.2	37.2
160	5.1	8.7	10.4	36.0
165	5.2	9.0	10.5	34.8
170	5.4	9.2	10.8	33.7
175	5.5	9.4	10.9	33.0
180	5.5	9.5	11.0	33.0
185	5.5	9.5	11.2	34.2
190	5.4	9.5	11.3	37.5
195	5.2	9.5	11.5	43.5
200	5.0	9.5	11.6	48.8

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

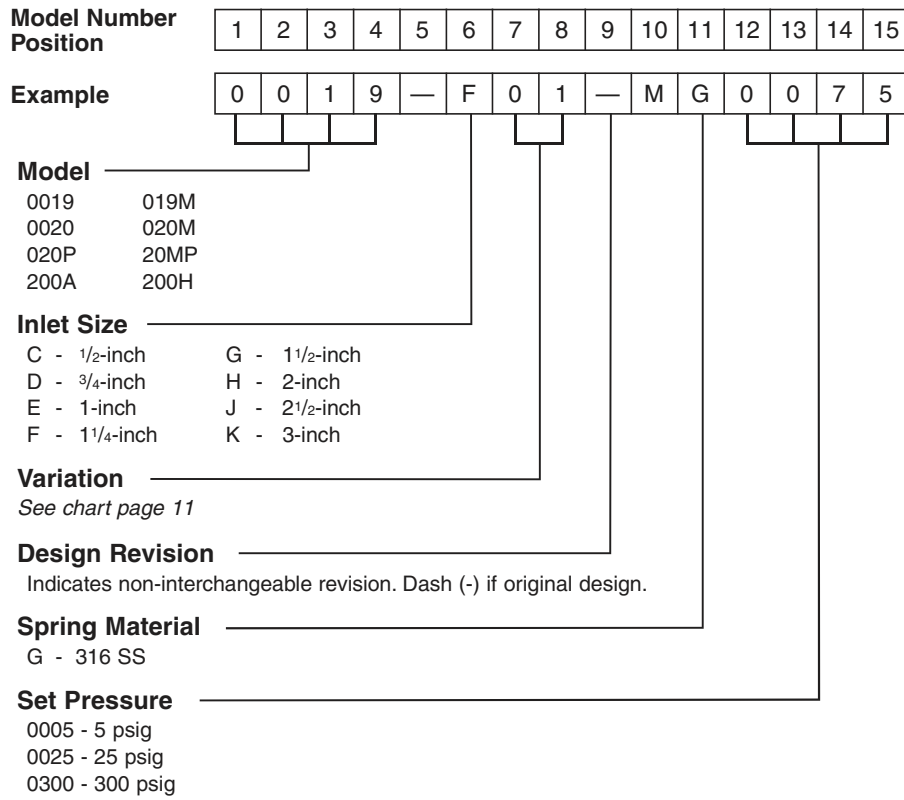
200A Inlet Capacities at 25%, 50% 75% and 100% Accumulation (GPM)

Model 200A "F" - 1 1/4"				
psi	Overpressure			
	25%	50%	75%	100%
5	1.0	4.0	5.0	7.0
10	2.5	7.0	7.0	13.5
15	4.0	10.0	12.5	20.0
20	5.0	14.0	16.5	27.5
25	7.5	18.0	21.5	35.0
30	8.0	20.2	25.0	41.5
35	9.5	25.5	29.5	48.5
40	10.0	27.0	33.5	54.5
45	11.0	28.2	38.0	60.0
50	11.8	30.0	42.5	66.5
55	12.5	31.5	47.5	73.0
60	13.0	33.0	52.0	79.0
65	14.0	34.5	56.5	85.5
70	14.8	36.0	61.0	92.0
75	15.5	37.7	65.5	97.5
80	16.2	39.0	69.5	102.7
85	17.0	40.0	73.0	108.0
90	18.0	41.0	76.0	112.0
95	18.5	42.0	78.0	115.5
100	17.5	42.0	78.5	116.7
105	16.5	41.0	77.5	115.7
110	15.5	39.5	74.5	113.0
115	14.5	37.5	70.5	108.5
120	13.5	35.0	66.0	103.5
125	12.5	33.7	62.7	99.8
130	11.5	33.0	60.0	98.0
135	10.5	33.5	60.5	99.0
140	11.8	35.0	63.0	103.0
145	13.0	37.5	66.5	109.0
150	14.5	40.0	71.0	116.0
155	16.0	43.5	76.0	123.7
160	17.2	47.0	81.5	132.0
165	18.8	50.5	87.0	140.0
170	20.0	54.0	92.5	148.0
175	21.5	57.8	97.5	155.5
180	23.0	61.0	102.0	160.5
185	24.0	63.5	105.0	163.0
190	25.0	65.5	106.0	160.0
195	26.2	67.5	106.5	153.5
200	27.5	69.0	106.8	147.5

Model 200A "G" - 1 1/2"				
psi	Overpressure			
	25%	50%	75%	100%
5	1.5	2.2	4.5	8.5
10	2.0	3.2	8.7	18.0
15	2.8	4.3	13.0	27.9
20	3.4	5.3	17.0	37.0
25	3.8	6.2	20.8	44.5
30	4.0	6.8	24.0	51.8
35	4.5	7.5	27.0	57.7
40	5.0	8.0	30.0	62.5
45	5.0	8.3	32.5	67.5
50	5.5	8.5	35.0	72.0
55	5.7	8.9	37.7	76.5
60	6.0	9.5	40.0	80.5
65	6.5	9.5	42.5	84.5
70	6.5	9.7	45.0	88.3
75	6.7	9.8	47.0	91.7
80	6.7	10.0	49.0	94.7
85	6.8	10.0	51.0	97.5
90	7.0	10.3	53.0	99.5
95	7.2	10.5	54.0	100.6
100	7.2	11.0	55.0	100.3
105	7.5	11.0	54.0	97.5
110	7.5	11.3	53.0	93.0
115	7.5	11.7	51.0	87.0
120	7.5	11.8	49.0	80.5
125	7.7	12.0	47.5	75.5
130	7.9	12.0	46.8	73.0
135	8.0	12.2	47.2	73.5
140	8.0	12.2	48.7	77.0
145	8.0	12.4	50.7	83.0
150	8.0	12.4	53.0	90.0
155	8.0	12.4	56.0	98.0
160	8.0	12.4	59.0	106.5
165	8.0	12.5	62.3	115.7
170	8.0	12.7	65.5	124.5
175	8.0	13.0	69.0	133.5
180	8.5	14.0	73.0	140.5
185	9.0	15.8	77.0	146.0
190	10.0	19.0	82.5	150.0
195	11.8	23.5	89.0	152.2
200	13.5	27.7	95.5	154.7

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

Model Number/Order Guide



Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

Model - Orifice	Variation	1/2" Male x 3/4" Female		1/2" Male x 1/2" Female		1/2" Female x 3/4" Female		1/2" Female x 1/2" Female		1/2" 150 Flg x 1/2" 150 Flg		1/2" 300 Flg x 1/2" 150 Flg		Male x Female		Female x Female (200A)		Female x Female		150 Flg x 150 Flg		300 Flg x 150 Flg (200H)		300 Flg x 150 Flg		150 Flg x 150 Flg (200H)		
		01	02	03	04	05	06	01	01	02	03	03	04	04	01	01	02	03	03	04	04							
19-C, 20-C, 20P-C	1/2" x 1/2" (3/4")	X	X	X	X	X	X																					
19-D, 20-D, 20P-D	3/4" x 3/4"													X		X	X								X			
200A-D	3/4" x 3/4"														X													
200H-D	3/4" x 3/4"													X		X			X						X			
19-E, 20-E, 20P-E	1" x 1"													X		X	X							X				
200A-E	1" x 1"														X													
200H-E	1" x 1"													X		X			X					X				
19-F, 20-F, 20P-F	1 1/4" x 1 1/4"													X		X	X							X				
200A-F	1 1/4" x 1 1/4"														X													
200H-F	1 1/4" x 1 1/4"													X		X			X					X				
19-G, 20-G, 20P-G	1 1/2" x 1 1/2"													X		X	X							X				
200A-G	1 1/2" x 1 1/2"														X													
200H-G	1 1/2" x 1 1/2"													X		X			X					X				
19-H, 20-H, 20P-H	2" x 2"													X		X	X							X				
200H-H	2" x 2"													X		X			X					X				
19-J, 19M-J, 20J, 20P-J, 20M-J, 20MP-J	2 1/2" x 2 1/2"													X		X	X							X				
19-K, 19M-K, 20-K, 20P-K, 20M-K, 20MP-K	3" x 3"													X		X	X							X				

Models 19, 19M, 20, 20M, 20P, 20MP, 200A and 200H

Facility Phone: 828-669-3700

Tyco Valves & Controls

www.kunklevalve.com

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VAPOR LIQUID SEPARATOR – VLW SERIES

Application:

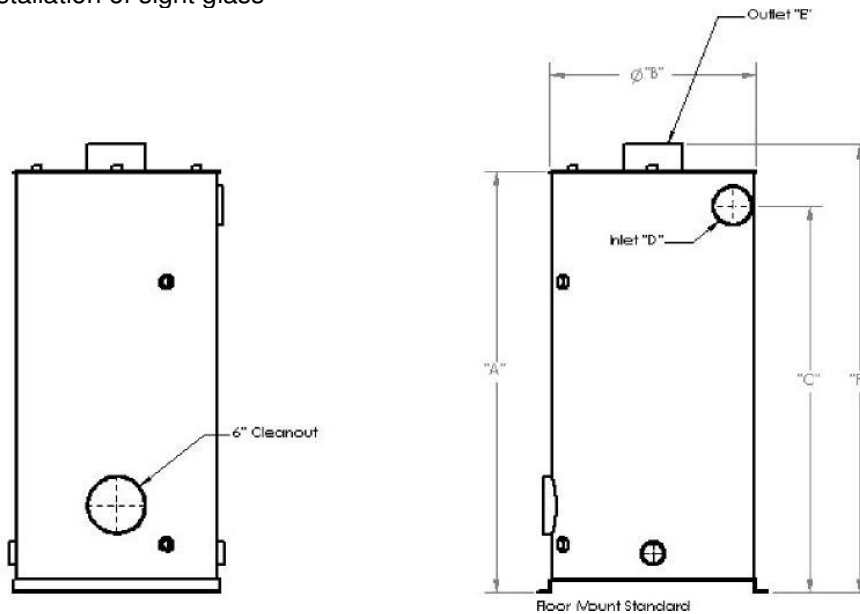
newterra VLW Series Vapor Liquid Separators are capable of capturing entrained water from a process air stream. The separators are designed with a tangential inlet to utilize centrifugal forces to aid in the air/water separation. The water collects in the bottom of the separator while the air exits the large discharge pipe at the top.

Construction:

The Vapor Liquid Separator is fabricated from 1/8" and 3/16" carbon steel. The exterior is epoxy coated. The separator is built standard with a 6" cleanout in the bottom to allow access to the separator interior.

Standard Features:

- Carbon steel construction
- 6" cleanout with plug
- **newterra** blue urethane exterior
- Floor mounting brackets
- 1.5" drain coupling
- Baffle welded into base to reduce cyclonic swirling of water
- 1/2" FNPT coupling on top of separator for vacuum gauge
- Brackets are standard to mount an optional demister element
- 1" couplings for installation of sight glass



Dimension Chart:

Part Number	A	B	C	D Dia.	E Dia.	F	Total Volume (Gal Imp)	Storage Volume (Gal Imp)	Shipping Weight (Lbs)
VLW-90 (CW, CCW)	46.5"	24"	42.5"	4"	6"	50.5"	90	56	250
VLW-140 (CW, CCW)	59"	27"	55"	6"	6"	63"	140	74	320
VLW-240 (CW, CCW)	59"	38"	53"	8"	8"	63"	240	118	500

VAPOR LIQUID SEPARATOR – VLW SERIES

Specifications Chart:

Specification:	VLW-90	VLW-140	VLW-240
Inlet	4" MNPT	6" Flange	8" Flange
Outlet	6" Flange	6" Flange	8" Flange
Maximum Air Flow Rate	630 ACFM	1050 ACFM	2020 ACFM
Maximum Water Flow Rate	20 GPM	50 GPM	100 GPM
Maximum Operating Vacuum	29" HG	29" HG	29" HG
Pressure Drop at Maximum Air Flow ($\Delta P = \text{constant} \times \text{velocity}^2$)	10"wc	15"wc	20"wc
Removal Efficiency without Demister*	96%	96%	96%
Removal Efficiency with Demister*	99.9%	99.9%	99.9%

*Note: Removal Efficiency is measured as a % of the total incoming water that is larger than 20 microns in size.

Optional Features:

Option	Description
Orientation: CW or CCW	This determines which side of the separator the inlet pipe comes in on. CW indicates that the air flows around the separator in a clockwise motion. CCW indicates counter clockwise motion.
Demister	A demister pad is installed in the separator. This will capture an additional 98% of the water droplets greater than 20 microns that would otherwise be entrained in the air stream leaving the separator. The pad must be purchased for this option but the standard separator comes with the mounting brackets so the pad can be retrofitted afterwards if needed.
Sight Glass	Addition of a sight glass to the VLW assembly, including isolation valves for removal during cleaning.
Level Control	Includes a sight glass as described above with a column style level switch mounted inside (one to four position switch available).
Adaptor Connections	Adaptor connections for inlet and outlet connections are available to make the transition easier. Available sizes include 6" flange x 4" FNPT and 8" flange x 6" FNPT.
Materials of Construction	Each separator can be purchased in various grades of stainless steel as well as the standard carbon steel.



SMALL COMPACT FILTER SILENCERS

w/ "Hockey Puck" *Patented* Element

"FS" Series 1/4" - 1" BSPT

FILTER SILENCERS
QB, FS, BBF, LQB, PS, SLCR Series

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Piston Compressors
- Screw Compressors
- Blowers - Side Channel & Roots
- Hydraulic Breathers – fine filtration
- Engines
- Construction\Contractor Industry
- Workshop
- Medical\Dental Industry
- Hobby
- Pneumatic Conveying
- Waste Water Aeration
- Nailers and Staplers

FEATURES & SPECIFICATIONS

- Patented high grade element w/**Built-in** Butterfly gasket seal
Creates positive seal between housing hemispheres
New seal with each element, Minimizes parts
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable **Compact** carbon steel construction with black powder coated finish
- Ability to mount vertically, horizontally
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H₂O over initial delta P
- A single noise attenuation graph is insufficient; please inquire for your specific requirement

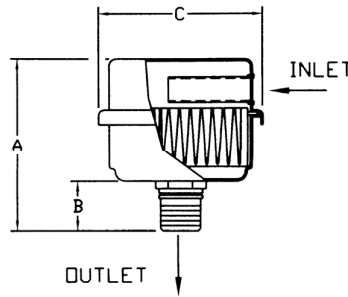
OPTIONS (Inquiries Encouraged)

- Various media available
- Epoxy coated housings
- Straight Through Design (Vertical)
- Custom connections

CONFIGURATION

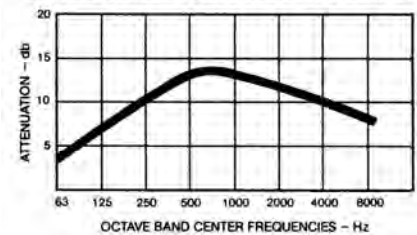


DRAWING



Dimension tolerance ± 6 mm

TYPICAL NOISE ATTENUATION – FS SERIES



• Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm			Rated Flow m ³ /h			No. of Silencing Tubes	Approx. Wt. Kg
				A	B	C	Piston	Screw, Blower, Fan	Element Rating		
I	FS-05-025	FS-04-025	1/4"	70	16	64	7	7	14	1	0.11
I	FS-05-038	FS-04-038	3/8"	70	16	64	10	14	14	1	0.11
S	FS-07-038	FS-06-038	3/8"	90	16	83	14	14	20	1	0.23
I	FS-05-050	FS-04-050	1/2"	76	22	64	10	14	14	1	0.11
I	FS-07-050	FS-06-050	1/2"	97	22	83	17	20	20	1	0.23
S	FS-11-050	FS-10-050	1/2"	105	22	105	20	20	60	1	0.45
I	FS-07-075	FS-06-075	3/4"	106	32	83	20	20	20	1	0.23
I	FS-11-075	FS-10-075	3/4"	114	32	105	34	43	60	1	0.45
I	FS-11-100	FS-10-100	1"	114	32	105	43	60	60	1	0.45

Note: Model offerings and design parameters may change without notice.

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1151 Ardmore Ave. • Itasca, IL 60143 USA

Tel: +1 630 616 4900 • Fax: +1 630 773 2643

E-mail: sales@solbergmfg.com • Web Site: www.solbergmfg.com



SMALL COMPACT FILTER SILENCERS

w/ Standard Filter Design

"FS" Series 1/2" - 3" BSPT

FILTER SILENCERS
QB, FS, BBF, LQB, PS, SLCR Series

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
 - Piston Compressors
 - Screw Compressors
 - Blowers - Side Channel & Roots
 - Hydraulic Breathers – fine filtration
- Engines
 - Construction\Contractor Industry
 - Workshop
 - Medical\Dental Industry
 - Pneumatic Conveying
- Waste Water Aeration
 - Nailers and Staplers
 - Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

- Fully drawn weatherhood - no welds to rust or vibrate apart
 - Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
 - Durable carbon steel construction with baked enamel finish and powder coated weatherhood
 - Polyester: 99%+ removal efficiency standard to 5 micron
 - Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
 - Several element sizes available per given connection (safety factor)
 - Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
 - Filter change out differential: 255-380 mm H₂O over initial delta P
 - Pressure drop graphs available upon request

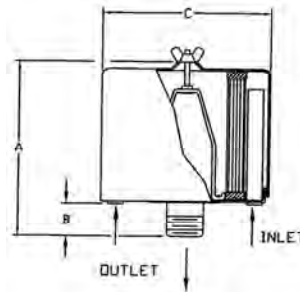
OPTIONS (Inquiries Encouraged)

- 1/8" tap holes
 - Pressure Drop Indicator
- Available in **Stainless Steel**
 - Epoxy coated housings
- Various media available
 - Custom connections, MPT

CONFIGURATION

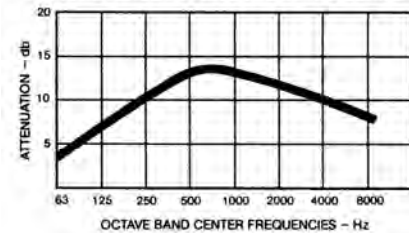


DRAWING



Dimension tolerance ± 6 mm

TYPICAL NOISE ATTENUATION – FS SERIES



• Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm			Rated Flow m ³ /h			No. of Silencing Tubes	Approx. Wt. Kg
				A	B	C	Piston	Screw, Blower, Fan	Element Rating		
I	FS-15-050	FS-14-050	1/2"	102	38	152	17	17	60	1	0.8
I	FS-15-075	FS-14-075	3/4"	102	38	152	34	43	60	2	0.9
I	FS-15-100	FS-14-100	1"	102	38	152	43	60	60	3	0.9
S	FS-19P-100	FS-18P-100	1"	168	41	152	60	94	170	3	1.4
I	FS-19P-126	FS-18P-126	1 1/4"	168	41	152	94	119	170	5	1.5
I	FS-19P-151	FS-18P-151	1 1/2"	168	41	152	119	145	170	5	2
I	FS-31P-201	FS-30P-201	2"	184	57	254	145	230	332	5	4
S	FS-231P-201	FS-230P-201	2"	311	57	254	230	230	510	5	6
I	FS-31P-251	FS-30P-251	2 1/2"	191	64	254	170	332	332	5	4
S	FS-231P-251	FS-230P-251	2 1/2"	318	64	254	332	332	510	9	7
I	FS-231P-301	FS-230P-301	3"	330	76	254	340	510	510	9	7

Note: Model offerings and design parameters may change without notice.

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1151 Ardmore Ave. • Itasca, IL 60143 USA
Tel: +1 630 616 4900 • Fax: +1 630 773 2643

E-mail: sales@solbergmfg.com • Web Site: www.solbergmfg.com



COMPACT FILTER SILENCERS

"FS" Series 3" - 6" BSPT

FILTER SILENCERS
QB, FS, BBF, LQB, PS, SLCR Series

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
 - Blowers - Side Channel & Roots
 - Piston Compressors
 - Screw Compressors
 - Hydraulic Breathers – fine filtration
- Engines
 - Fans
 - Construction\Contractor Industry
 - Medical
 - Pneumatic Conveying
- Waste Water Aeration
 - Sparging
 - Factory Air
 - Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

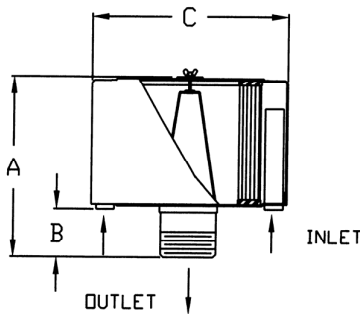
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- Low pressure drop center bracket and outlet pipe design
- 1/8" tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380mm H₂O over initial delta P
- Pressure drop graphs available upon request

OPTIONS (Inquiries Encouraged)

- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in **Stainless Steel**
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

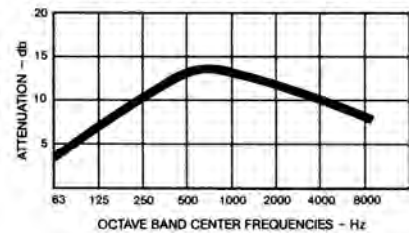
CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm

TYPICAL NOISE ATTENUATION – FS SERIES



• Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

		with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm			Rated Flow m ³ /h			No. of Silencing Tubes	Approx. Wt. Kg
					A	B	C	Piston	Screw, Blower, Fan	Element Rating		
S	FS-235P-301	FS-234P-301	3"	330	76	406	340	510	970	9	13	
S	FS-245P-301	FS-244P-301	3"	330	76	406	340	510	1500	9	14	
E	FS-275P-301	FS-274P-301	3"	330	76	406	340	510	1870	9	15	
I	FS-235P-401	FS-234P-401	4"	356	102	406	510	885	970	9	14	
S	FS-245P-401	FS-244P-401	4"	356	102	406	765	885	1500	9	14	
E	FS-275P-401	FS-274P-401	4"	356	102	406	765	885	1870	9	15	
I	FS-245P-501	FS-244P-501	5"	356	102	406	850	1360	1500	14	15	
S	FS-275P-501	FS-274P-501	5"	356	102	406	1105	1360	1870	14	16	
I	FS-275P-601	FS-274P-601	6"	394	133	406	1105	1870	1870	18	17	

Note: Model offerings and design parameters may change without notice.

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1151 Ardmore Ave. • Itasca, IL 60143 USA

Tel: +1 630 616 4900 • Fax: +1 630 773 2643

E-mail: sales@solbergmfg.com • Web Site: www.solbergmfg.com



COMPACT FILTER SILENCERS

"FS" Series DN80 - DN150 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- ♦ Industrial & Severe Duty
 - ♦ Blowers - Side Channel & Roots
 - ♦ Piston Compressors
 - ♦ Screw Compressors
 - ♦ Hydraulic Breathers – fine filtration
- ♦ Engines
 - ♦ Fans
 - ♦ Construction\Contractor Industry
 - ♦ Medical
 - ♦ Pneumatic Conveying
- ♦ Waste Water Aeration
 - ♦ Sparging
 - ♦ Factory Air
 - ♦ Vacuum Vent Breathers

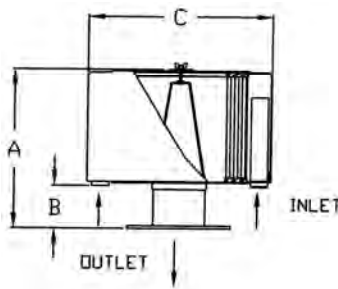
FEATURES & SPECIFICATIONS

- ♦ Fully drawn weatherhood - no welds to rust or vibrate apart
- ♦ Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- ♦ Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- ♦ Low pressure drop center bracket and outlet pipe design
- ♦ 1/8" tap hole
- ♦ Polyester: 99%+ removal efficiency standard to 5 micron
- ♦ Paper: 99%+ removal efficiency standard to 2 micron
- ♦ Interchangeable media: Polyester, Paper, HEPA
- ♦ Several element sizes available per given connection (safety factor)
- ♦ Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- ♦ Filter change out differential: 255-380 mm H₂O over initial delta P
- ♦ Pressure drop graphs available upon request

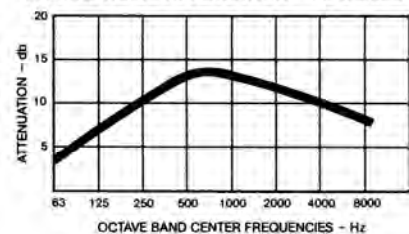
OPTIONS (Inquiries Encouraged)

- ♦ Various media available
- ♦ Pressure Drop Indicator
- ♦ Epoxy coated housings
- ♦ Available in **Stainless Steel**
- ♦ Custom connections, NPT
- ♦ Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION



TYPICAL NOISE ATTENUATION - FS SERIES



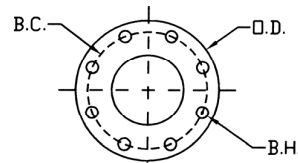
♦ Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

Dimension tolerance ± 6 mm

	with Polyester Element	with Paper Element	Flange Outlet	DIMENSIONS - mm			Rated Flow m ³ /h			No. of Silencing Tubes	Approx. Wt. Kg
				A	B	C	Piston	Screw, Blower, Fan	Element Rating		
S	FS-235P-DN80	FS-234P-DN80	DN80	330	76	406	340	510	970	9	13
S	FS-245P-DN80	FS-244P-DN80	DN80	330	76	406	340	510	1500	9	14
E	FS-275P-DN80	FS-274P-DN80	DN80	330	76	406	340	510	1870	9	15
I	FS-235P-DN100	FS-234P-DN100	DN100	356	102	406	510	885	970	9	15
S	FS-245P-DN100	FS-244P-DN100	DN100	356	102	406	765	885	1500	9	16
E	FS-275P-DN100	FS-274P-DN100	DN100	356	102	406	765	885	1870	9	18
I	FS-245P-DN125	FS-244P-DN125	DN125	356	102	406	850	1360	1500	14	17
S	FS-275P-DN125	FS-274P-DN125	DN125	356	102	406	1105	1360	1870	14	18
I	FS-275P-DN150	FS-274P-DN150	DN150	394	133	406	1105	1870	1870	18	19

PN10 Pattern Flg	DIMENSIONS - mm			No. of Holes	Thickness Flg - mm
	O.D.	B.C.	B.H.		
DN80	200	160	18	8	10
DN100	220	180	18	8	10
DN125	250	210	18	8	10
DN150	285	240	22	8	10



Note: Model offerings and design parameters may change without notice.

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1151 Ardmore Ave. ♦ Itasca, IL 60143 USA

Tel: +1 630 616 4900 ♦ Fax: +1 630 773 2643

E-mail: sales@solbergmfg.com ♦ Web Site: www.solbergmfg.com



"BIG BOY" FILTER SILENCERS

"FS" Series DN200-DN300 PN10 Pattern Flange

FILTER SILENCERS
QB, FS, BBF, LQB, PS, SLCR Series

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Cement
- Power Plants
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish
- Low pressure drop center bracket and outlet pipe design
- 1/8" tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Several element sizes available per given connection (safety factor)
- Interchangeable media: Polyester, Paper, HEPA
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H₂O over initial delta P
- Pressure drop graphs available upon request

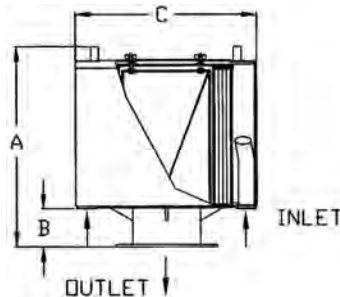
OPTIONS (Inquiries Encouraged)

- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in **Stainless Steel**
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

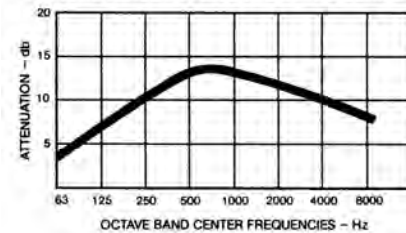
CONFIGURATION



DRAWING



TYPICAL NOISE ATTENUATION - FS SERIES



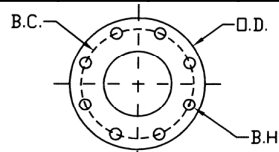
• Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

Dimension tolerance ± 6 mm

	with Polyester Element	with Paper Element	Flange Outlet	DIMENSIONS - mm			Rated Flow m ³ /h			No. of Silencing Tubes	Approx. Wt. Kg
				A	B	C	Piston	Screw, Blower, Fan	Element Rating		
I	FS-377P-DN200	FS-376P-DN200	DN200	584	152	572	2450	3060	3105	12	54
S	FS-385P-DN200	FS-384P-DN200	DN200	584	152	724	2450	3060	5605	12	56
E	FS-485P-DN200	FS-484P-DN200	DN200	787	152	724	3060	3060	8000	12	62
I	FS-385P-DN250	FS-384P-DN250	DN250	584	152	724	3060	5610	5610	16	59
S	FS-485P-DN250	FS-484P-DN250	DN250	787	152	724	4420	5610	8000	16	64
E	FS-685P-DN250	FS-384P(2)-DN250	DN250	965	152	724	4900	5610	11220	16	74
I	FS-385P-DN300	FS-384P-DN300	DN300	584	152	724	4420	5610	5610	24	61
S	FS-485P-DN300	FS-484P-DN300	DN300	787	152	724	4420	7990	8000	24	70
E	FS-685P-DN300	FS-384P(2)-DN300	DN300	965	152	724	5950	7990	11220	24	79
E	FS-485P(2)-DN300	FS-484P(2)-DN300	DN300	1346	152	724	7345	7990	16000	24	88

PN10 Pattern Flg	DIMENSIONS - mm			No. of Holes	Thickness Flg - mm
	O.D.	B.C.	B.H.		
DN200	340	295	22	8	14
DN250	395	350	22	12	14
DN300	445	400	22	12	14



Note: Model offerings and design parameters may change without notice.

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1151 Ardmore Ave. • Itasca, IL 60143 USA

Tel: +1 630 616 4900 • Fax: +1 630 773 2643

E-mail: sales@solbergmfg.com • Web Site: www.solbergmfg.com



SMALL COMPACT INLET VACUUM FILTERS

"CSL" Series 3/8" - 3" BSPP

APPLICATIONS & EQUIPMENT

- ♦ Vacuum Pumps & Systems – Roots, Side Channel, Rotary Vane, Screw, Piston
- ♦ Vacuum Packaging Equipment
- ♦ Vacuum Lifters
- ♦ Blowers - Side Channel & Roots
- ♦ Intake Suction Filters
- ♦ Pneumatic Conveying Systems
- ♦ Soil Venting/Remediation
- ♦ Remote Installations for Piston & Screw Compressors
- ♦ Printing Industry
- ♦ Factory Automation Equip
- ♦ Leak Detection Systems
- ♦ Woodworking
- ♦ Medical Industry

FEATURES & SPECIFICATIONS

- ♦ **Vacuum level:** Typically 1×10^{-3} mmHg (1.3×10^{-3} mbar)
- ♦ Seamless drawn housings
- ♦ Brazed fittings for **High** vacuum duty
- ♦ Stainless steel torsion clips for durability
- ♦ Low pressure drop
- ♦ Positive engagement O-ring seal system
- ♦ **Large** dirt holding capacity and **Easy** field cleaning, especially when mounted horizontally or inverted
- ♦ Rugged all steel construction w/baked enamel finish
- ♦ Polyester: 99%+ removal efficiency standard to 5 micron
- ♦ Paper: 99%+ removal efficiency standard to 2 micron
- ♦ Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- ♦ Filter change out differential: 255 - 380 mm H₂O over initial delta P
- ♦ Pressure drop graphs available upon request

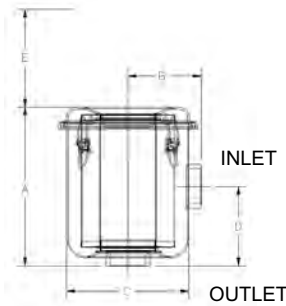
INLET VACUUM FILTERS
CSL, CT, VL, VS, LRS Series

OPTIONS (Inquiries Encouraged)

- ♦ Vacuum gauge available
- ♦ Dome hood for high holding capacity
- ♦ Available in **Stainless Steel**
- ♦ Epoxy coated housings
- ♦ Activated carbon prefilter for odor
- ♦ Support brackets
- ♦ Alternate top-to-canister fastening system for low pressure or pulsating systems

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPP Inlet & Outlet	DIMENSIONS - mm					Rated Flow m ³ /h		Approx. Wt. Kg
				A	B	C	D	E	Nominal Rating	Element Rating	
I	CSL-825-039HC	CSL-824-039HC	3/8"	92	57	95	48	76	31	43	0.40
I	CSL-825-050HC	CSL-824-050HC	1/2"	92	57	95	48	76	31	43	0.40
I	CSL-843-050HC	CSL-842-050HC	1/2"	111	76	149	64	83	34	94	1.4
I	CSL-825-075HC	CSL-824-075HC	3/4"	95	57	95	48	76	41	43	0.40
S	CSL-843-075HC	CSL-842-075HC	3/4"	111	76	149	64	83	43	94	1.4
I	CSL-843-100HC	CSL-842-100HC	1"	111	83	149	67	83	60	94	1.4
S	CSL-849-100HC	CSL-848-100HC	1"	171	105	186	114	133	68	196	2.3
I	CSL-843-126HC	CSL-842-126HC	1 1/4"	111	83	149	67	83	94	94	1.4
S	CSL-849-126HC	CSL-848-126HC	1 1/4"	171	105	186	114	133	102	196	2.3
I	CSL-849-151HC	CSL-848-151HC	1 1/2"	171	105	186	114	133	136	196	2.3
I	CSL-851-201HC	CSL-850-201HC	2"	260	116	222	127	235	298	493	6.8
I	CSL-851-251HC	CSL-850-251HC	2 1/2"	267	130	222	140	235	357	493	6.8
I	CSL-239-301C*	CSL-238-301C*	3"	400	226	337	222	279	510	969	15

*1/4" taps standard on inlet and outlet



INLET VACUUM FILTERS

"CSL" Series 3" - 6" BSPT

APPLICATIONS & EQUIPMENT

- Vacuum Pumps & Systems – Roots, Side Channel, Rotary Vane, Screw, Piston
- Vacuum Packaging Equipment
- Vacuum Furnaces
- Blowers - Side Channel & Roots
- Intake Suction Filters
- Pneumatic Conveying Systems
- Remote Install for Piston, Screw & Centrifugal Compressors
- Factory Automation Equip
- Ash Handling
- Food Industry
- Paper Processing
- Glass, Ceramic Processing
- Waste Water Treatment
- Woodworking
- Cement
- Bag House Systems
- Envelope Manufacturing
- Medical Industry
- Chemical Processing

FEATURES & SPECIFICATIONS

- **Vacuum level:** Typically 1×10^{-3} mmHg (1.3×10^{-3} mbar)
- Heavy duty T bolts for easy maintenance
- Rugged all steel construction w/baked enamel finish
- Low pressure drop
- Positive engagement O-ring seal system
- **Large** dirt holding capacity and **Easy** field cleaning, especially when mounted horizontally or inverted
- Inlet/outlet 1/4" gauge taps
- Hydrostatically tested to 0.5 bar pressure for vacuum tightness
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255 - 380 mm H₂O over initial delta P
- Pressure drop graphs available upon request

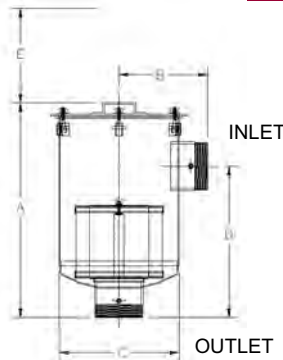
OPTIONS (Inquiries Encouraged)

- Straight-Through Configurations
- Various media
- Larger sizes available
- Available in **Stainless Steel**
- Epoxy coated housings
- Support brackets
- Custom connections
- Activated carbon prefilters to reduce order

CONFIGURATION



DRAWING



Dimension tolerance ± 6 mm

I = Industrial Duty S = Severe Duty E = Extreme Duty

	with Polyester Element	with Paper Element	BSPP Inlet & Outlet	DIMENSIONS - mm					Rated Flow m ³ /h		Approx. Wt. Kg
				A	B	C	D	E	Nominal Rating	Element Rating	
I	CSL-235P-301	CSL-234P-301	3"	689	229	356	470	254	510	970	21
S	CSL-335P-301	CSL-334P-301	3"	689	229	356	470	381	510	1360	23
I	CSL-235P-401	CSL-234P-401	4"	689	229	356	470	254	885	970	23
S	CSL-335P-401	CSL-334P-401	4"	689	229	356	470	381	885	1360	25
I	CSL-245P-501	CSL-244P-501	5"	714	279	470	495	254	1360	1500	37
S	CSL-345P-501	CSL-344P-501	5"	714	279	470	495	381	1360	1870	40
I	CSL-275P-601	CSL-274P-601	6"	740	305	470	521	254	1870	1870	43
S	CSL-375P-601	CSL-374P-601	6"	740	305	470	521	381	1870	2550	44

INLET VACUUM FILTERS
CSL, CT, VL, VS, LRS Series



INLET VACUUM FILTERS

"CSL" Series DN80-DN150 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- Vacuum Pumps & Systems – Roots, Side Channel, Rotary Vane, Screw, Piston
- Vacuum Packaging Equipment
- Vacuum Furnaces
- Blowers - Side Channel & Roots
- Intake Suction Filters
- Pneumatic Conveying Systems
- Remote Install for Piston, Screw & Centrifugal Compressors
- Factory Automation Equip
- Ash Handling
- Food Industry
- Paper Processing
- Glass, Ceramic Processing
- Waste Water Treatment
- Woodworking
- Cement
- Bag House Systems
- Envelope Manufacturing
- Medical Industry
- Chemical Processing

FEATURES & SPECIFICATIONS

- **Vacuum level:** Typically 1×10^{-3} mmHg (1.3×10^{-3} mbar)
- Heavy duty T bolts for easy maintenance
- Rugged all steel construction w/baked enamel finish
- Low pressure drop
- Positive engagement O-ring seal system
- **Large** dirt holding capacity and **Easy** field cleaning, especially when mounted horizontally or inverted
- Inlet/outlet 1/4" gauge taps
- Hydrostatically tested to 0.5 bar pressure for vacuum tightness
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255 - 380 mm H₂O over initial delta P
- Pressure drop graphs available upon request

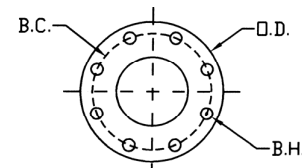
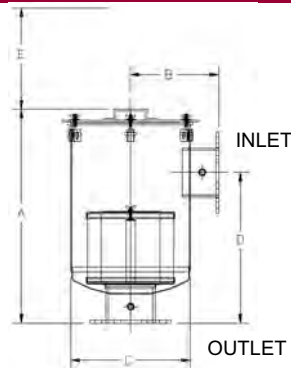
OPTIONS (Inquiries Encouraged)

- Straight-Through Configurations
- Various media
- Larger sizes available
- Available in **Stainless Steel**
- Epoxy coated housings
- Support brackets
- Custom connections
- Activated carbon prefilters to reduce order

CONFIGURATION



DRAWING



Flange Orientation

Note: All side inlet to outlet flanges are orientated "split center".

Dimension tolerance ± 6 mm

I = Industrial Duty S = Severe Duty E = Extreme Duty

	with Polyester Element	with Paper Element	Flange Inlet & Outlet	DIMENSIONS - mm					Rated Flow m ³ /h		Approx. Wt. Kg
				A	B	C	D	E	Nominal Rating	Element Rating	
I	CSL-235P-DN80	CSL-234P-DN80	DN80	689	229	356	470	381	885	970	28
S	CSL-335P-DN80	CSL-334P-DN80	DN80	689	229	356	470	508	885	1360	29
I	CSL-235P-DN100	CSL-234P-DN100	DN100	689	229	356	470	381	885	970	28
S	CSL-335P-DN100	CSL-334P-DN100	DN100	689	229	356	470	508	885	1360	29
I	CSL-245P-DN125	CSL-244P-DN125	DN125	714	279	470	495	381	1360	1500	40
S	CSL-345P-DN125	CSL-344P-DN125	DN125	724	279	470	495	508	1360	1870	41
I	CSL-275P-DN150	CSL-274P-DN150	DN150	740	305	470	521	381	1870	1870	50
S	CSL-375P-DN150	CSL-374P-DN150	DN150	740	305	470	521	508	1870	2550	51

PN10 Pattern Flg	DIMENSIONS - mm			No. of Holes	Thickness Flg - mm
	O.D.	B.C.	B.H.		
DN80	200	160	18	8	10
DN100	220	180	18	8	10
DN125	250	210	18	8	10
DN150	285	240	22	8	10

INLET VACUUM FILTERS
CSL, CT, VL, VS, LRS Series



INLET VACUUM FILTERS

"CSL" Series DN200-DN300 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- Vacuum Pumps & Systems – Roots, Side Channel, Rotary Vane, Screw, Piston
- Vacuum Packaging Equipment
- Vacuum Furnaces
- Blowers - Side Channel & Roots
- Intake Suction Filters
- Pneumatic Conveying Systems
- Remote Install for Piston, Screw & Centrifugal Compressors
- Factory Automation Equip
- Ash Handling
- Food Industry
- Paper Processing
- Glass, Ceramic Processing
- Waste Water Treatment
- Woodworking
- Cement
- Bag House Systems
- Envelope Manufacturing
- Chemical Processing

FEATURES & SPECIFICATIONS

- **Vacuum level:** Typically 1×10^{-3} mmHg (1.3×10^{-3} mbar)
- Heavy duty T bolts for easy maintenance
- Rugged all steel construction w/baked enamel finish
- Low pressure drop
- Positive engagement O-ring seal system
- **Large** dirt holding capacity and **Easy** field cleaning, especially when mounted horizontally or inverted
- Inlet/outlet 1/4" gauge taps
- Hydrostatically tested to 0.5 bar pressure for vacuum tightness
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255 - 380 mm H₂O over initial delta P
- Pressure drop graphs available upon request

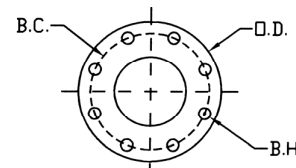
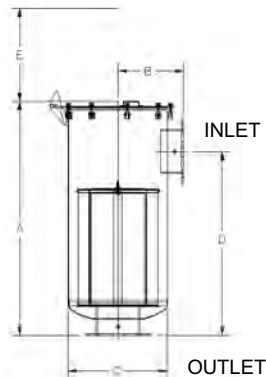
OPTIONS (Inquiries Encouraged)

- Straight-Through Configurations
- Various media
- Larger sizes available
- Available in **Stainless Steel**
- Epoxy coated housings
- Support brackets
- Custom connections
- Activated carbon prefilters to reduce order

CONFIGURATION



DRAWING



Flange Orientation

Note: All side inlet to bottom outlet flanges are orientated "split center".

Dimension tolerance ± 6 mm

I = Industrial Duty S = Severe Duty E = Extreme Duty

	with Polyester Element	with Paper Element	Flange Inlet & Outlet	DIMENSIONS - mm					Rated Flow m ³ /h		Approx. Wt. Kgs
				A	B	C	D	E	Nominal Rating	Element Rating	
I	CSL-377P-DN200	CSL-376P-DN200	DN200	965	356	572	648	508	3060	3105	83
S	CSL-385P-DN250	CSL-384P-DN250	DN250	1130	410	686	864	381	4930	5610	115
S	CSL-485P-DN300	CSL-484P-DN300	DN300	1130	410	686	864	559	7990	8000	125
S	*CSL-685P-DN250	CSL-384P(2)-DN250	DN250	1461	406	672	1143	838	4930	11220	171
S	*CSL-685P-DN300	CSL-384P(2)-DN300	DN300	1461	406	672	1143	838	8415	11220	171
S	*CSL-485P(2)-DN300	CSL-484P(2)-DN300	DN300	1765	406	672	1448	635	8415	16000	209

* Options: Double stack housings are available. Please contact representative for more information.

PN10 Pattern Flg	DIMENSIONS - mm			No. of Holes	Thickness Flg - mm
	O.D.	B.C.	B.H.		
DN200	340	295	22	8	10
DN250	395	350	22	12	13
DN300	445	400	22	12	13

INLET VACUUM FILTERS
CSL, CT, VL, VS, LRS Series

Mink MI 1124 – 2122 BV

Mink MI 1124 – 1502 BP



MI 1502 BV

Description

The Busch Mink is a rotary claw-type, positive displacement, dry pump designed for either pressure or vacuum applications. The Mink is available as a single-stage or two-stage vacuum pump.

Vacuum or pressure is produced by two non-contacting rotors in an oil-free pumping chamber. The dry, non-contacting design makes the Mink ideal for pneumatic conveying, printing, soil remediation, and any application

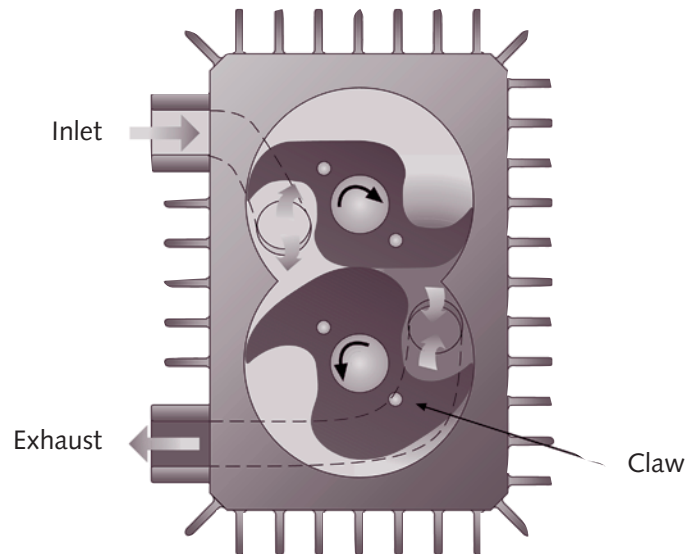
where dust particles may be present. Wearing parts are separated from the pumping chamber which leads to a longer pump life with low maintenance.

Features

- Non-contacting design
- Dry (oil-free) pumping chamber
- Air-cooled
- Low maintenance – no wear in pumping chamber
- Simple, modular construction
- Suitable for variable speed applications
- Discharge silencers on vacuum models; inlet silencers on pressure models
- Frame rails on models MI 1354-1502
- Suitable for dusty environments
- Integral relief valve (where necessary)
- Inlet filters on pressure models

Dry Rotary Claw Pressure or Vacuum Pumps

Operating Principle



Operating Principle

Inside the pump housing, two claw shaped rotors take in air as they rotate in opposite directions. The air is compressed by the rotors, then discharged through a silencer to atmosphere. The non-return valve incorporated into the inlet flange prevents air from back flowing into the pumping

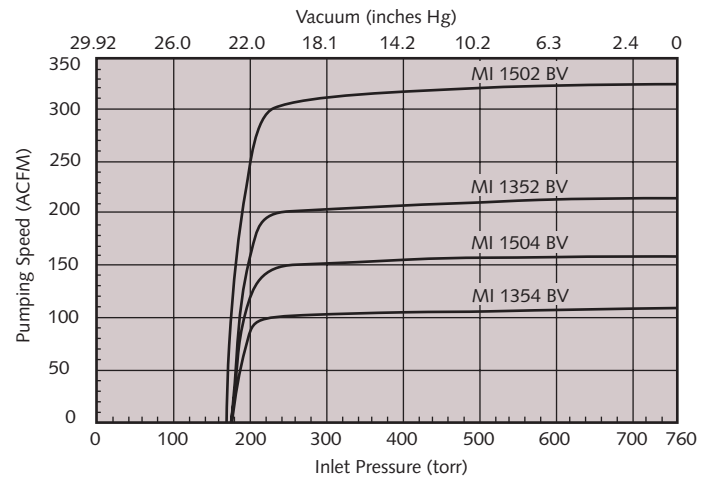
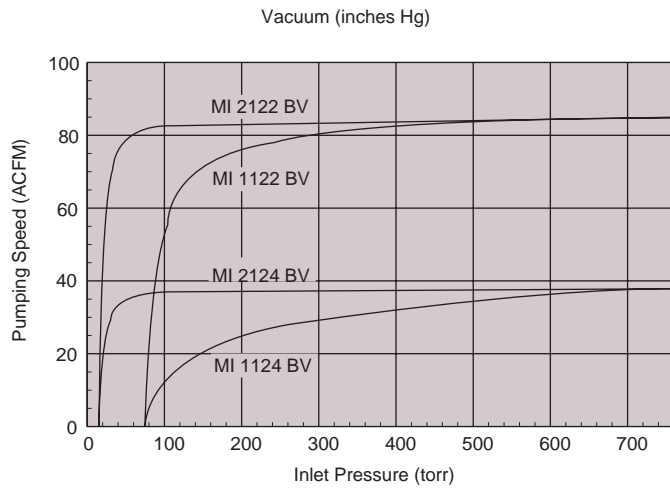
chamber when the pump is turned off. Mink MI dry rotary claw direct drive pumps are driven by a C-face motor, and the two rotors are synchronized by gears. A wide range of accessories allows optimum adaptation to many applications.

Applications

- Wood Industry
- Pneumatic conveying
- Transport and lifting systems
- Medical technology
- Central vacuum systems
- Packaging industry
- Plastics industry
- Food industry
- Printing industry
- Ceramics and brick industry
- Environmental technology
- Vacuum sewage
- Textile industry
- Paper industry
- Beverage industry

Technical Data

Pumping Speed vs. Inlet Pressure

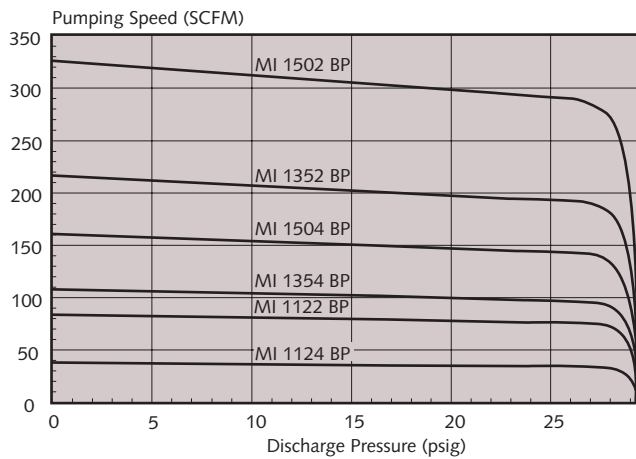


Model MI (Vacuum)		1124 BV	1122 BV	1354 BV	1504 BV	1352 BV	1502 BV	2124 BV*	2122 BV*
Nominal pumping speed	ACFM	38	85	108	160	216	325	38	85
Free air displacement	CFM	50	100	125	188	250	376	50	100
End vacuum	"Hg	26.9	26.9	23.1	23.1	23.1	23.4	29.3	29.3
End vacuum	torr	75	75	173	173	173	165	15	15
Motor rating	HP	3.0	5.0	5.0	7.5	10	15	3	7.5
Motor speed	RPM	1800	3600	1800	1800	3600	3600	1800	3600
Approx. weight	Lbs	231	253	680	760	775	950	325	352
Inlet pipe connection	Inches	1 ¹ / ₄	1 ¹ / ₄	2	2	2	3	1 ¹ / ₄	1 ¹ / ₄
Discharge pipe connection	Inches	1 ¹ / ₂	1 ¹ / ₂	2	2	2	3	1 ¹ / ₂	1 ¹ / ₂
Sound rating	dBA	78	84	81	81	85	85	77	84

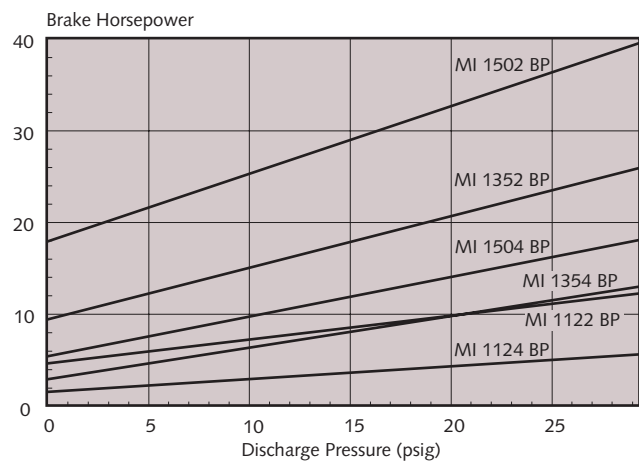
*Two stage models



Pumping Speed vs. Discharge Pressure



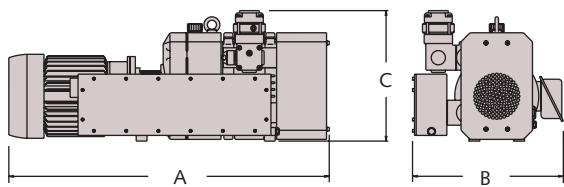
Brake Horsepower vs. Discharge Pressure



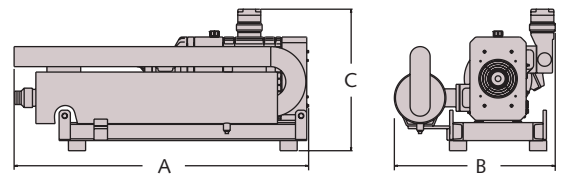
Model MI (Pressure)		1124 BP	1122 BP	1354 BP	1504 BP	1352 BP	1502 BP
Nominal pumping speed	SCFM	38	85	108	160	216	325
Free air displacement	CFM	50	100	125	188	250	376
Maximum pressure	psig	29.4	29.4	29.4	29.4	29.4	29.4
Motor rating	HP	7.5	15	15	20	30	40
Motor speed	RPM	1800	3600	1800	1800	3600	3600
Approx. weight	Lbs	243	297	1025	1075	1195	1350
Discharge pipe connection	Inches	1 ¹ / ₄	1 ¹ / ₄	2	2	2	3
Sound rating	dB(A)	76	84	85	85	86	87



Dimensions



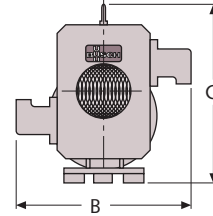
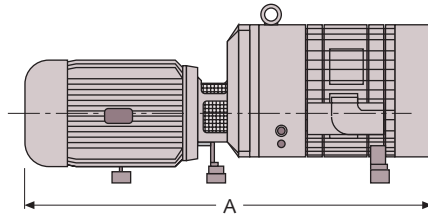
Models 1124 BV, 1122 BV, 2122 BV, 2124 BV



Models 1354 BV, 1504 BV, 1352 BV, 1502 BV

Model MI	1124 BV	1122 BV	1354 BV	1504 BV	1352 BV	1502 BV	2124 BV*	2122 BV*
A length	35 ³ / ₈	35 ³ / ₈	51	52 ¹ / ₈	51	52 ¹ / ₈	39 ¹ / ₄	42 ⁵ / ₁₆
B width	16 ⁵ / ₈	16 ⁵ / ₈	28 ¹ / ₈	29 ¹ / ₄	29 ¹ / ₈	31 ⁵ / ₁₆	17 ¹ / ₄	20 ⁷ / ₈
C height	14 ³ / ₈	14 ³ / ₈	25 ⁷ / ₈	24 ³ / ₄	25 ⁷ / ₈	28 ⁵ / ₈	15 ¹¹ / ₁₆	15 ¹¹ / ₁₆

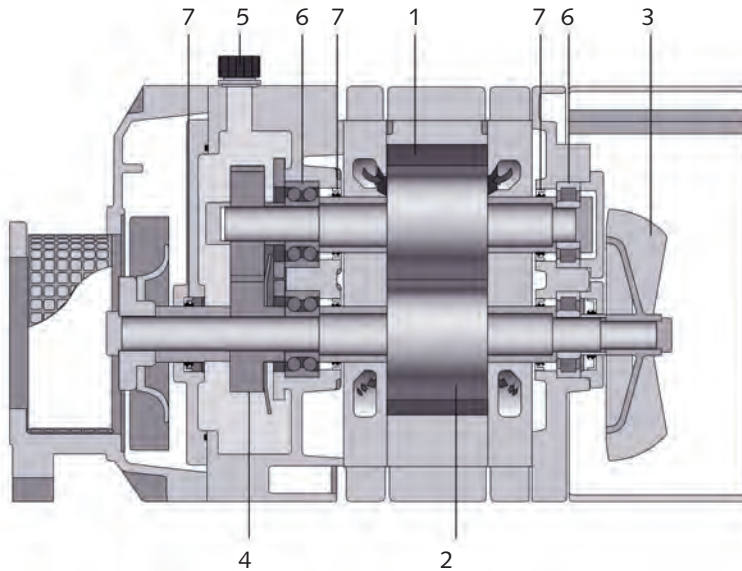
All dimensions in inches unless otherwise noted. *Two stage models



Model MI	1124 BP	1122 BP	1354 BP	1504 BP	1352 BP	1502 BP
A length	39 ¹ / ₈	39 ¹ / ₈	44 ¹¹ / ₁₆	43 ⁵ / ₁₆	48 ⁵ / ₁₆	49 ¹⁵ / ₁₆
B width	22 ¹ / ₂	22 ¹ / ₂	19 ¹ / ₁₆	19 ¹ / ₂	19 ¹ / ₁₆	25 ¹⁵ / ₁₆
C height	16 ³ / ₄	16 ³ / ₄	17 ³ / ₄	16 ³ / ₄	20 ¹⁵ / ₁₆	20 ³ / ₄

All dimensions in inches unless otherwise noted.

Mink Cutaway



- 1. Pumping chamber
- 2. Rotors
- 3. Cooling fan*
- 4. Timing gears
- 5. Oil fill plug
- 6. Bearings
- 7. Shaft seals

*33 watt, 115 volt, 1 phase, 60 Hz, electric cooling fan on models 1354-1502



Busch - all over the world in industry

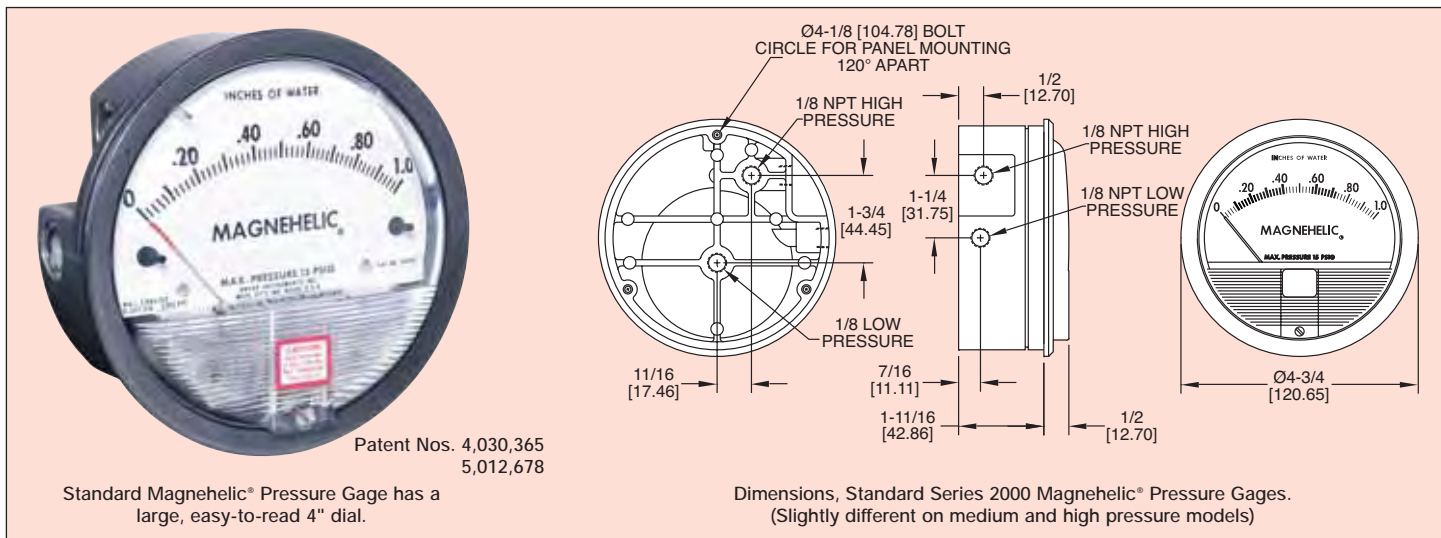
Busch Vacuum Technics Inc., Boisbriand, Québec, Canada
Phone (450) 435-6899 FAX (450) 430-5132

www.busch.ca
1-800-363-6360



Series 2000 Magnehelic® Differential Pressure Gages

Indicate Positive, Negative or Differential, Accurate within 2%



Select the Dwyer® Magnehelic® gage for high accuracy – guaranteed within 2% of full scale – and for the wide choice of 81 models available to suit your needs precisely. Using Dwyer's simple, frictionless Magnehelic® gage movement, it quickly indicates low air or non-corrosive gas pressures – either positive, negative (vacuum) or differential. The design resists shock, vibration and over-pressures. No manometer fluid to evaporate, freeze or cause toxic or leveling problems. It's inexpensive, too.

The Magnehelic® gage is the industry standard to measure fan and blower pressures, filter resistance, air velocity, furnace draft, pressure drop across orifice plates, liquid levels with bubbler systems and pressures in fluid amplifier or fluidic systems. It also checks gas-air ratio controls and automatic valves, and monitors blood and respiratory pressures in medical care equipment.

Note: May be used with Hydrogen. When ordering a Buna-N diaphragm pressures must be less than 35 psi.

MOUNTING. A single case size is used for most models of Magnehelic® gages. They can be flush or surface mounted with standard hardware supplied. With the optional A-610 Pipe Mounting Kit they may be conveniently installed on horizontal or vertical 1/4" - 2" pipe. Although calibrated for vertical position, many ranges above 1" may be used at any angle by simply re-zeroing. However, for maximum accuracy, they must be calibrated in the same position in which they are used. These characteristics make Magnehelic® gages ideal for both stationary and portable applications. A 4% hole is required for flush panel mounting. Complete mounting and connection fittings plus instructions are furnished with each instrument.



Flush ...Surface...or Pipe Mounted

VENT VALVES

In applications where pressure is continuous and the Magnehelic® gage is connected by metal or plastic tubing which cannot be easily removed, we suggest using Dwyer A-310A vent valves to connect gage. Pressure can then be removed to check or re-zero the gage.

HIGH AND MEDIUM PRESSURE MODELS

Installation is similar to standard gages except that a 4 13/16" hole is needed for flush mounting. The medium pressure construction is rated for internal pressures up to 35 psig and the high pressure up to 80 psig. Available for all models. Because of larger case, the medium pressure and high pressure models will not fit in a portable case size. Installation of the A-321 safety relief valve on standard Magnehelic® gages often provides adequate protection against infrequent overpressure.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases. (Natural Gas option available.)

Wetted Materials: Consult factory.

Housing: Die cast aluminum case and bezel, with acrylic cover. Exterior finish is coated gray to withstand 168 hour salt spray corrosion test.

Accuracy: ±2% of full scale (±3% on -0, -100 Pa, -125 Pa, 10MM and ±4% on -00, -60 Pa, -6MM ranges), throughout range at 70°F (21.1°C).

Pressure Limits: -20" Hg. to 15 psig.† (-0.677 bar to 1.034 bar); MP option: 35 psig (2.41 bar), HP option: 80 psig (5.52 bar).

Overpressure: Relief plug opens at approximately 25 psig (1.72 bar), standard gages only.

Temperature Limits: 20 to 140°F.* (-6.67 to 60°C).

Size: 4" (101.6 mm) Diameter dial face.

Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.

Process Connections: 1/8" female NPT duplicate high and low pressure taps - one pair side and one pair back.

Weight: 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g).

Standard Accessories: Two 1/8" NPT plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapter and three flush mounting adapters with screws. (Mounting and snap ring retainer substituted for 3 adapters in MP & HP gage accessories.)

*Low temperature models available as special option.

†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options at lower left.

OPTIONS AND ACCESSORIES

Transparent Overlays

Furnished in red and green to highlight and emphasize critical pressures.



Adjustable Signal Flag

Integral with plastic gage cover. Available for most models except those with medium or high pressure construction. Can be ordered with gage or separate.



LED Setpoint Indicator

Bright red LED on right of scale shows when setpoint is reached. Field adjustable from gage face, unit operates on 12-24 VDC. Requires MP or HP style cover and bezel.



Portable Units

Combine carrying case with any Magnehelic® gage of standard range, except high pressure connection. Includes 9 ft. (2.7 m) of 3/8" I.D. rubber tubing, standhang bracket and terminal tube with holder.



Air Filter Gage Accessory Package

Adapts any standard Magnehelic® gage for use as an air filter gage. Includes aluminum surface mounting bracket with screws, two 5 ft. (1.5 m) lengths of 1/2" aluminum tubing two static pressure tips and two molded plastic vent valves, integral compression fittings on both tips and valves.

Quality design and construction features

Bezel provides flange for flush mounting in panel.

Clear plastic face is highly resistant to breakage. Provides undistorted viewing of pointer and scale.

Precision litho-printed scale is accurate and easy to read.

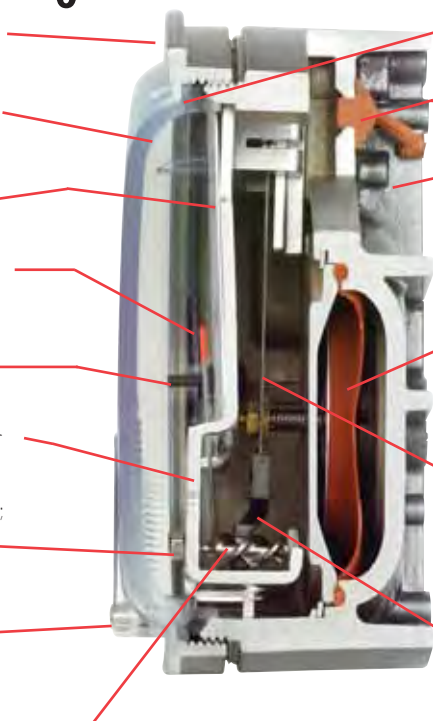
Red tipped pointer of heat treated aluminum tubing is easy to see. It is rigidly mounted on the helix shaft.

Pointer stops of molded rubber prevent pointer over-travel without damage.

“Wishbone” assembly provides mounting for helix, helix bearings and pointer shaft.

Jeweled bearings are shock-resistant mounted; provide virtually friction-free motion for helix. Motion damped with high viscosity silicone fluid.

Zero adjustment screw is conveniently located in the plastic cover, and is accessible without removing cover. O-ring seal provides pressure tightness.



O-ring seal for cover assures pressure integrity of case.

Blowout plug of silicone rubber protects against overpressure on 15 psig rated models. Opens at approximately 25 psig.

Die cast aluminum case is precision made and iridite-dipped to withstand 168 hour salt spray corrosion test. Exterior finished in baked dark gray hammerloid. One case size is used for all standard pressure options, and for both surface and flush mounting.

Silicone rubber diaphragm with integrally molded O-ring is supported by front and rear plates. It is locked and sealed in position with a sealing plate and retaining ring. Diaphragm motion is restricted to prevent damage due to overpressures.

Calibrated range spring is flat spring steel. Small amplitude of motion assures consistency and long life. It reacts to pressure on diaphragm. Live length adjustable for calibration.

Samarium Cobalt magnet mounted at one end of range spring rotates helix without mechanical linkages.

Helix is precision made from an alloy of high magnetic permeability. Mounted in jeweled bearings, it turns freely, following the magnetic field to move the pointer across the scale.

SERIES 2000 MAGNEHELIC® GAGE — MODELS AND RANGES

The models below will fulfill most requirements. Page V also shows examples of special models built for OEM customers. For special scales furnished in ounces per square inch, inches of mercury, metric units, etc., contact the factory.

Dual Scale English/Metric Models		
Model Number	Range, In. W.C.	Range, Pa or kPa
2000-0D	0-0.5	0-125 Pa
2001D	0-1.0	0-250 Pa
2002D	0-2.0	0-500 Pa
2003D	0-3.0	0-750 Pa
2004D	0-4.0	0-1.0 kPa
2006D	0-6.0	0-1.5 kPa
2008D	0-8.0	0-2.0 kPa
2010D	0-10	0-2.5 kPa

Model Number	Range Inches of Water	Model Number	Range Zero Center Inches of Water	Dual Scale Air Velocity Units		Model Number	Range, CM of Water	Model Number	Range, Pascals
				Model Number	Range in W.C. Velocity, F.P.M.				
2000-00N†••	.05-0-.2	2300-0†•	.25-0-.25	2000-00AV†••	0-.25/300-2000	2000-15CM	0-15	Zero Center Ranges	
2000-00†••	0-.25	2301	.5-0-.5	2000-00V†••	0-.50/500-2800	2000-20CM	0-20	2300-60PA	30-0-30
2000-0†•	0-.50	2302	1-0-1	2001AV	0-1.0/500-4000	2000-25CM	0-25	2300-100PA	50-0-50
2001	0-1.0	2304	2-0-2	2002AV	0-2.0/1000-5600	2000-50CM	0-50	2300-120PA	60-0-60
2002	0-2.0	2310	5-0-5	2010AV	0-10/2000-12500	2000-80CM	0-80	2300-250PA	125-0-125
2003	0-3.0	2320	10-0-10	For use with pitot tube.		2000-100CM	0-100	2300-500PA	250-0-250
2004	0-4.0	2330	15-0-15			2000-150CM	0-150		
2005	0-5.0					2000-200CM	0-200		
2006	0-6.0	Model Number	Range PSI	Model Number	Range MM of Water	2000-250CM	0-250		
2008	0-8.0					2000-300CM	0-300		
2010	0-10	2201	0-1	2000-6MM†••	0-6	Zero Center Ranges		Model Number	Range, Kilopascals
2015	0-15	2202	0-2	2000-10MM†••	0-10	2300-4CM	2-0-2	2000-1KPA	0-1
2020	0-20	2203	0-3	2000-25MM†••	0-25	2300-10CM	5-0-5	2000-1.5KPA	0-1.5
2025	0-25	2204	0-4	2000-50MM†••	0-50	2300-30CM	15-0-15	2000-2KPA	0-2
2030	0-30	2205	0-5	2000-80MM†••	0-80			2000-3KPA	0-3
2040	0-40	2210*	0-10	2000-100MM†••	0-100			2000-4KPA	0-4
2050	0-50	2215*	0-15	Zero Center Ranges				2000-5KPA	0-5
2060	0-60	2220*	0-20	2300-20MM†	10-0-10	Model Number	Range, Pascals	2000-8KPA	0-8
2080	0-80	2230**	0-30			2000-100PA†••	0-100	2000-10KPA	0-10
2100	0-100					2000-125PA†••	0-125	2000-15KPA	0-15
2150	0-150					2000-250PA	0-250	2000-20KPA	0-20
						2000-300PA	0-300	2000-25KPA	0-25
						2000-500PA	0-500	2000-30KPA	0-30
						2000-750PA	0-750	Zero Center Ranges	
								2300-1KPA	.5-0-.5
								2300-3KPA	1.5-0-1.5

Scale Overlays — Red, Green, Mirrored or Combination. Specify Locations

† These ranges calibrated for vertical scale position.

• Accuracy +/-3%. •• Accuracy +/-4%

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PITOT TUBE AIR FLOW METERS PFLOW SERIES

Application:

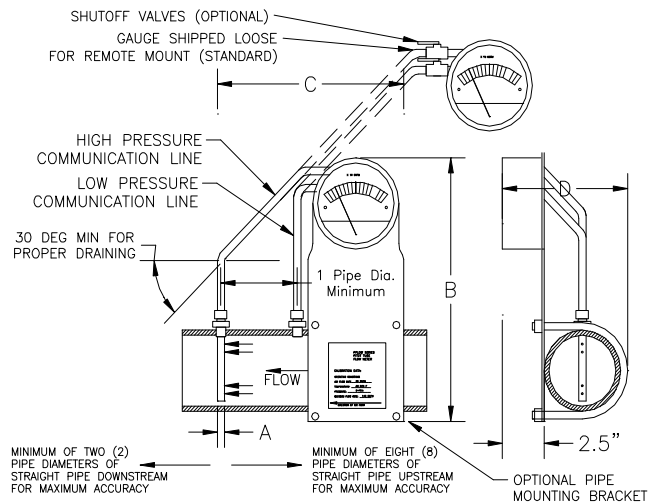
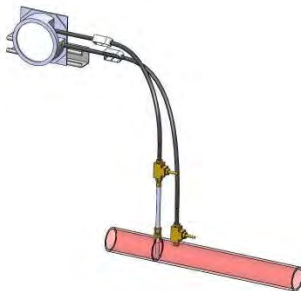
newterra Pitot Tube Air Flow Meters are designed to be a cost effective, accurate flow meters that are calibrated for your site-specific conditions. The unique self draining design allows the meter to function in process lines with high humidity and moisture content as well as dry air lines. The PFLOW meter takes two pressure readings in your process line, one at a high-pressure, zero velocity and one at a low-pressure, full velocity. The pressure differential is used to calibrate the meter for a desired flow and operating conditions. When ordering the flow meter, it is critical to supply: operating temperature, pressure or vacuum in psia, and the pipe ID. The PFLOW meter can be supplied with any scale range required in scfm (25deg C, 14.7psia) or acfm at your listed operating conditions.

Construction:

The high, static pressure is measured using a 304 Stainless Steel probe inserted into the process line. The probe is designed with 4 measurement ports that provide an average reading for flow through your process pipe. Multiple ports on the static pressure line ensure that you can maintain an accurate reading while the tube is self-draining. The low pressure point is measured by tapping a 1/4" hole in the process line ahead of the high-pressure port. This tapping is completed on the top of the pipe to minimize moisture collection in the pressure communication lines. The differential pressure gauge is connected to the pressure ports using 3/8" Buna-N and the brass connections are capable of handling temperatures as high as 250 deg F. The Dwyer Magnehelic® gauge provides a large, clear and accurate display of your airflow reading.

Standard Features:

- 304SS static pressure probe
- Brass compression fittings and Buna-N pressure communication tubing
- Direct read display can be calibrated for your specific operating conditions. Display can read ACFM or SCFM but SCFM is recommended as there is less error when the meter is operating above or below the calibrated pressure. Other units are available on request.
- Large 4" display for accurate reading
- Standard gauges are shipped loose for installation in an existing pipeline. The gauges can be wall mounted in site-specific locations. A pipe bracket can be purchased.



Dimensions Chart:

Part Number	A	B	C	D	Pipe
1" PFLOW	1/4"	12"	12"	4.75"	1"
1-1/2" PFLOW	3/8"	12"	12"	5.25"	1.5"
2" PFLOW	3/8"	12"	12"	5.75"	2"
3" PFLOW	1/2"	12"	12"	6.75"	3"
4" PFLOW	1/2"	14"	14"	7.75"	4"
6" PFLOW	1/2"	14"	14"	9.75"	6"
8" PFLOW	1/2"	14"	14"	12"	8"

Larger pitot tubes can be supplied as required.



PITOT TUBE AIR FLOW METERS PFLOW SERIES

Specifications:

Maximum Air Temperature:	250 °F (standard) 300 °F (high temp version)	Accuracy:	2.5 % of scale at calibration point
Max. Operating Pressure:	15 psig (standard unit) 35 psig (medium pressure unit) 80 psig (high pressure unit)	Pressure Drop:	Less than 2" WC pressure drop in high flow applications
Repeatability:	1% of scale at calibration point		

The following table provides recommended flow rates for each meter at a given operating pressure range. These values are suitable for temperatures between 70-100 deg F. For meter applications outside this temperature range and outside of the operating pressure ranges listed below please contact our sales department for help in choosing a suitable meter.

Operating pressure	Recommended Operating Flow rates (SCFM)				
	0-5 psi	5-10 psi	0-10" Hg	10-20" Hg	20-26" Hg
PFLOW 1"	15-40	17-50	12-35	8-25	6-20
PFLOW 1-1/2"	35-90	40-115	25-75	20-60	15-50
PFLOW 2"	60-160	70-200	50-150	30-100	25-80
PFLOW 3"	135-360	150-450	100-300	75-250	50-180
PFLOW 4"	250-650	275-800	200-550	120-450	100-320
PFLOW 6"	550-1500	600-1800	450-1200	275-1000	200-750
PFLOW 8"	1000-2500	1100-3200	750-2250	500-1750	350-1250

Calibration and Correction Factors:

Each PFLOW pitot tube is calibrated for a specific operating temperature and pressure. If the pitot tube operates at a different pressure or temperature than the original design, the flow measurement can be adjusted with the following equation: (Units of Flow₁ and Flow₂ will be the same)

$$Flow_1 = Flow_2 \times (P_2/P_1 \times ((T_1+460) / (T_2+460)))^{1/2}$$

Pressure units: psia, Temperature units: °F

Options Table:

Option	Description
Orientation:	The flow meter gauge can be oriented for flows from Left to Right, Right to Left, Up or Down as required for your specific application.
Site Specific Calibration and Gauge Range:	The following information is required to calibrate the flow meter for your specific application: Operating Pressure (psia): Operating Temperature (°F or °C): Operating Flow Rate (acfm or scfm or other scales as required): Maximum Flow rate (better accuracy is achieved when the operating flow rate is approximately ¾ of the scale range of the flow meter)
4-20ma Option	Flow meters can be ordered with 4-20ma outputs for control systems. Three versions are available: Nema 7 (Class 1 Div 1) FM or CSA approved Two Wire Connection: 24VDC+, Signal Output Power Consumption: 20mA 316SS Wetted parts Nema 4 (Weatherproof) or Nema 1 (General Purpose) Three Wire Connection: 24VDC+, 24VDC-, Signal Output Accuracy on all 4-20ma outputs: 2.5% of full scale for meter Aluminum with Silicon diaphragm
Shutoff Valves	The pressure gauges are not designed to operate with water collecting within the internal components. If you will be operating with hot wet air or condensing air streams, then it is recommended that we install shutoff valves in the pressure communication lines to isolate the gauge from the process lines when the operator is not taking a flow reading.
Pre Installed Section of Pipe	The flow meters can be preinstalled in a section of pipe with any configuration of material and fittings on the end. This will allow the PFLOW meter to be factory installed and tested in this section of pipe before leaving our facility.
Pipe Mounting Bracket	A pipe-mounting bracket can be supplied to allow the gauge to mount directly on the pipe as shown in the above picture.



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smart technology. sustainable solutions.™

PITOT TUBE AIR FLOW METERS PFLOW SERIES

Company Name: _____ Purchase Order Number: _____

Contact Name: _____ Contact Number (PH/FAX): _____ / _____

(Note: Please include relevant credit information to set up an account if required.)

Ship to Address: _____

Billing Address: _____

Credit Card Orders (Please check card type)

VISA

MASTERCARD

Credit Card Number: _____ Expiry Date (m/y): _____ / _____

Meter Size: (please check box)

1"

2"

4"

8"

1-1/2"

3"

6"

Process Pipe Material and Schedule: (please check box)

Schedule 40 PVC

Schedule 40 Steel

Schedule 80 PVC

Schedule 80 Steel

For other Materials and Schedule Specify Inner Diameter of Pipe: _____

Orientation: (please check box)

Flow from Left to Right

Flow Up

Flow from Right to Left

Flow Down

4-20mA Output (please check box)

Nema 7, Class 1 Div 1, 316SS, with flow gauge

Nema 7, Class 1 Div 1, 316SS, no direct read display

Nema 4, Weatherproof, with flow gauge

Nema 4, Weatherproof, no direct read display

Nema 1, General Purpose, with flow gauge

Nema 1, General Purpose, no direct read display

None

Calibration Information (Required Information):

Operating Pressure: _____ Operating Temperature: _____

Elevation or Atmospheric Pressure: _____

Operating Flow Rate: _____ Maximum Flow Rate*: _____

Scfm units are preferred but any flow units can be provided. The operating flow rate should be approximately ¾ of full scale to allow for an accurate reading at that flow rate. Note Lowest accurate reading is at ¼ of full scale.

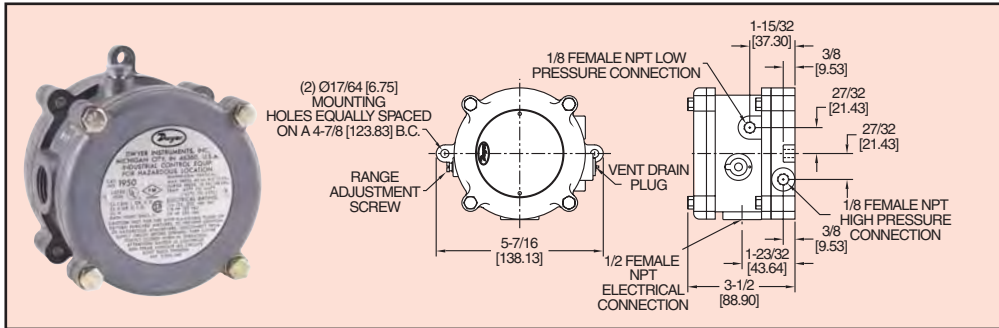
*Options for Maximum Flow Rates include: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100 and any scale can be multiplied by 10, 100, 1000, 10000



Series 1950

Explosion-Proof Differential Pressure Switches

Compact, Low Cost, Explosion-proof and Weatherproof



SPECIFICATIONS

Service: Air and non-combustible, compatible gases.

Wetted Materials: Consult factory.

Temperature Limits: -40 to 140°F (-40 to 60°C); 0 to 140°F (-17.8 to 60°C) for 1950P-8, 15, 25, and 50. -30 to 130°F (-34.4 to 54.4°C) for 1950-02.

Pressure Limits:

Continuous: 1950's - 45" w.c. (0.11 bar); 1950P's - 35 psi (2.41 bar); 1950P-50 only - 70 psi (4.83 bar).

Surge: 1950's - 10 psi (0.69 bar), 1950P's - 50 psi (3.45 bar), 1950P-50 only - 90 psi (6.21 bar).

Enclosure Rating: IP64, NEMA 3, 7 and 9.

Switch Type: Single-pole double-throw (SPDT).

Electrical Rating: 15 A @ 125, 250, 480 VAC, 60 Hz. Resistive 1/8 HP @ 125 VAC, 1/4 HP @ 250 VAC, 60 Hz.

Electrical Connections: 3 screw type, common, normally open and normally closed.

Process Connections: 1/8" female NPT.

Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.

Set Point Adjustment: Screw type on top of housing.

Weight: 3.25 lb (1.5 kg); 1950-02 model, 4.4 lb (2 kg).

Agency Approvals: CE, UL, CSA, FM.

Model 1950 Explosion-Proof Differential Pressure Switch combines the best features of the popular Dwyer series 1900 with an integral explosion-proof and weather-proof housing, making it an exceptional value for either application. It is CE, UL and CSA listed, FM approved for use in Class I, Div 1, Groups C and D, Class II Groups E, F, and G and Class III hazardous atmospheres (NEMA 7 & 9), Raintight (NEMA 3). Weatherproof features include a drain plug and O-ring seal in cover. Electrical connections are easily made by removing front cover. For convenience the set point adjustment screw is located on the outside of the housing. Twelve models offer set points from .03 to 20" w.c. (7.5 to 5 kPa) and from .5 to 50 psi (0.035 to 3.5 bar). The unit is very light and compact – about half the weight and bulk of other explosion-proof or weather-proof switches with separate enclosures.

SERIES 1950 SWITCHES - MODELS, OPERATING RANGES AND DEAD BANDS

Model Number	Range, Inches W.C.	Approximate Dead Band at	
		Min. Set Point	Max. Set Point
1950-02-2S	.03 to .10	.025	.05
1950-00-2F	.07 to .15	.04	.05
1950-0-2F	.15 to .50	.10	.15
1950-1-2F	.4 to 1.6	.15	.20
1950-5-2F	1.4 to 5.5	.30	.40
1950-10-2F	3 to 11	.40	.50
1950-20-2F	4 to 20	.40	.60

Model* Number	Range, PSID	Approximate Dead Band at	
		Min. Set Point	Max. Set Point
1950P-2-2F	0.5 to 2	.3	.3
1950P-8-2F	1.5 to 8	1.0	1.0
1950P-15-2F	3 to 15	.9	.9
1950P-25-2F	4 to 25	.7	.7
1950P-50-2F	15 to 50	1.0	1.5

CAUTION: For use only with air or compatible gases. Applications with hazardous atmospheres and a single positive pressure may require special venting.

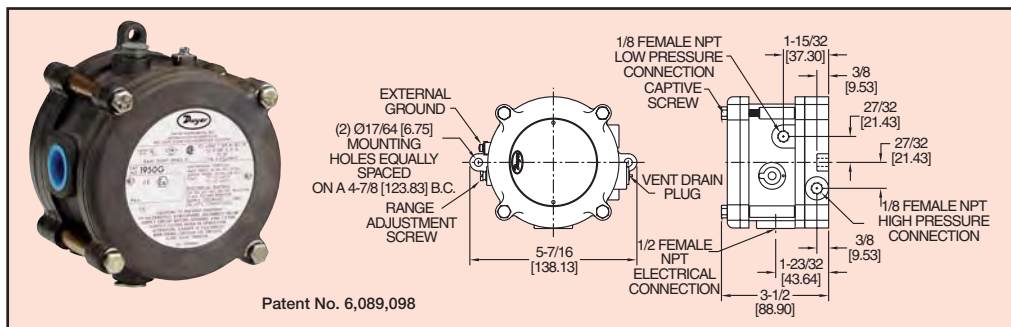
*P=PSID range models



Series 1950G

Explosion-Proof Differential Pressure Switch

Explosion-Proof, Weatherproof, Compatible with Natural Gases



SPECIFICATIONS

Service: Air and compatible combustible gases.

Wetted Materials: Contact Factory.

Temperature Limits: 0 to 140°F (-17 to 60°C). Note: Set point drift may occur with ambient temperature changes.

Pressure Limits: 45" w.c. (11.2 kPa) continuous; 10 psig (68.95 kPa) surge.

Enclosure Rating: IP64, NEMA 3, 7 and 9.

Switch Type: 1 Form C relay (SPDT).

Electrical Rating: 10A, 120/240 VAC, 28 VDC. Resistive 50mA, 125 VDC.

Power Requirements: 24 VDC ±10%. 120 or 240 VAC ±10% optional.

Electrical Connections: Internal terminal block.

Process Connections: 1/8" female NPT.

Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.

Set Point Adjustment: Screw type on top of housing.

Weight: 2 lb, 15.7 oz (1.35 kg).

Agency Approvals: CE, UL, CSA, FM, ATEX.

The Model 1950G Explosion-Proof Switch combines the best features of the popular Dwyer Series 1950 Pressure Switch with the benefit of natural gas compatibility. Units are rain-tight for outdoor installations, and are UL listed for use in Class I, Groups A, B, C, & D; Class II, Groups E, F, & G and Class III atmospheres, Directive 94/9/EC (ATEX) Compliant for **CE** 11 2 G EExd IIB & Hydrogen T6 and CSA & FM approved for Class I, Div 1, Groups B, C, D; Class II, Div 1, Groups E, F, G and Class III atmospheres. The 1950G is very compact, about half the weight and bulk of equivalent conventional explosion-proof switches.

Easy access to the SPDT relay and power supply terminals is provided by removing the top plate of the aluminum housing. A supply voltage of 24 VDC, 120 or 240 VAC is required. A captive screw allows the cover to swing aside while remaining attached to the unit. Adjustment to the set point of the switch can be made without disassembly of the housing.

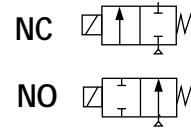
MODELS

Model Number ¹	Range, Inches W.C.	Approximate Dead Band at	
		Min. Set Point	Max. Set Point
1950G-00-B-24	.07 to .15	.04	.06
1950G-0-B-24	.15 to .50	.06	.11
1950G-1-B-24	.4 to 1.6	.11	.29
1950G-5-B-24	1.4 to 5.5	.4	.9
1950G-10-B-24	3 to 11	.9	1.8
1950G-20-B-24	4 to 20	1.2	3.0

¹Note: For alternate supply voltages change 24 to 120 or 240. Example: 1950G-00-B-120.



Direct Acting
General Service Solenoid Valves
 Brass or Stainless Steel Bodies
 1/8" to 3/8" NPT



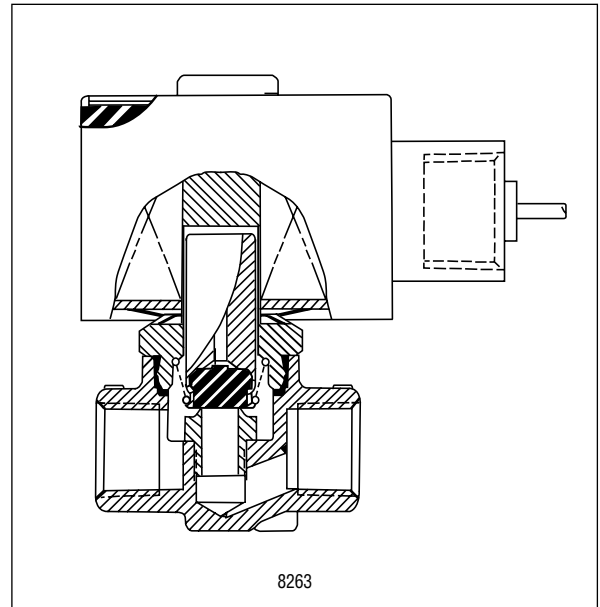
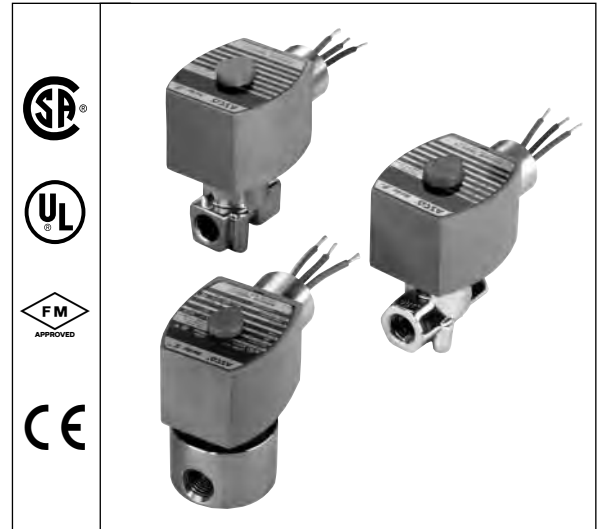
2/2
 SERIES
8262
8263

Features

- Reliable, proven design with high flows.
- Small poppet valves for tight shutoff.
- Wide range of elastomers for specialty service.
- Mountable in any position.
- Brass body construction for general atmospheres; Stainless Steel for corrosive atmospheres.

Construction

Valve Parts in Contact with Fluids		
Body	Brass	303/304 Stainless Steel
Seals and Discs	NBR or Cast UR	
Core Tube	305 Stainless Steel	
Core and Plugnut	430F Stainless Steel	
Springs	302 Stainless Steel	
Shading Coil	Copper	Silver
Stem	PA (Normally Open)	
Note: All 1/8" NPT Normally Open valves contain CA. All 1/4" NPT Normally Open valves contain PA.		



Electrical

Standard Coil and Class of Insulation	Watt Rating and Power Consumption				Spare Coil Part No.			
	DC Watts	AC			General Purpose		Explosionproof	
		Watts	VA Holding	VA Inrush	AC	DC	AC	DC
F	10.6	6.1	16	30	238210	238310	238214	238314
F	11.6	10.1	25	50	238610	238710	238614	238714
F	22.6	17.1	40	70	238610	238710	238614	238714
Standard Voltages 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220 volts AC, 50 Hz). 6, 12, 24, 120, 240 volts DC. Must be specified when ordering. Other voltages available when required.								

Nominal Ambient Temperature Ranges:

AC: 32°F to 125°F (0°C to 52°C)

DC: 32°F to 104°F (0°C to 40°C)

Refer to Engineering Section for details.

Solenoid Enclosures

Standard: Watertight, Types 1, 2, 3, 3S, 4, and 4X.
Optional: Explosionproof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9.
 (To order, add prefix "EF" to catalog number)
 See Optional Features Section for other available options.

Approvals:

CSA certified. UL listed, as indicated. Normally Closed Valves FM approved. Meets applicable CE directives.
 Refer to Engineering Section for details.

Specifications (English units)

Pipe Size (ins.)	Orifice Size (ins.)	Cv Flow Factor	Operating Pressure Differential (psi)						Max. Fluid Temp. °F		Brass Body			Stainless Steel Body			Watt Rating/ Class of Coil Insulation ②	
			Max. AC			Max. DC			AC	DC	Catalog Number	Constr. Ref. No.	UL ③ Listing	Catalog Number	Constr. Ref. No.	UL ③ Listing	AC	DC
			Air-Inert Gas	Water	Lt. Oil @ 300 SSU	Air-Inert Gas	Water	Lt. Oil @ 300 SSU										
NORMALLY CLOSED (Closed when de-energized), NBR Disc																		
1/8	3/64	.06	750	750	530	650	640	550	180	120	8262G1	1	○	8262G12	1	○	6.1/F	10.6/F
1/8	3/32	.20	275	290	130	150	140	145	180	120	8262G14	1	○	8262G15	1	○	6.1/F	10.6/F
1/8	1/8	.34	155	180	140	80	80	80	180	120	8262G2	1	○	8262G6	1	○	6.1/F	10.6/F
1/4	3/64	.06	750	750	500	500	500	500	180	120	8262G19	16	○	8262G80	11	○	6.1/F	10.6/F
1/4	3/64	.06	1500	1500	1100	475	475	450	140	140	8262G200	17	●	-	-	-	10.1/F	11.6/F
1/4	3/64	.06	2200	2000	1100	-	-	-	140	140	-	-	-	8262G214	12	●	10.1/F	-
1/4	3/32	.17	360	340	160	150	125	125	180	120	8262G20	16	○	8262G86	11	○	6.1/F	10.6/F
1/4	1/8	.35	140	165	90	65	60	60	180	120	8262G22	16	○	8262G7	11	○	6.1/F	10.6/F
1/4	1/8	.35	300	300	200	75	70	70	180	150	8262G232	17	○	-	-	-	10.1/F	11.6/F
1/4	5/32	.50	180	200	145	40	40	45	180	150	8262G202	4	○	8262G220	12	○	10.1/F	11.6/F
1/4	7/32	.72	90	100	100	25	25	25	180	150	8262G208	4	○	8262G226	12	○	10.1/F	11.6/F
1/4	7/32	.85	40	50	40	17	20	21	180	120	8262G13	2	○	8262G36	11	○	6.1/F	10.6/F
1/4	9/32	.88	60	75	60	18	15	18	180	150	8262G210	4	○	-	-	-	10.1/F	11.6/F
1/4	9/32	.88	90	100	90	25	20	22	180	150	8262G212	6	○	8262G230	13	○	17.1/F	22.6/F
1/4	9/32	.96	27	36	28	15	16	16	180	120	8262G90	2	○	8262G38	11	○	6.1/F	10.6/F
3/8	1/8	.35	160	150	90	65	60	60	180	120	8263G2	3	○	8263G330	3	○	6.1/F	10.6/F
3/8	5/32	.52	100	100	100	35	35	35	180	150	8263G200	5	○	8263G331	5	○	10.1/F	11.6/F
3/8	7/32	.72	100	100	100	25	25	25	180	150	8263G206	5	○	8263G332	5	○	17.1/F	11.6/F
3/8	9/32	.85	100	100	70	-	-	-	180	—	8263G210	7	○	8263G333	7	○	17.1/F	-
NORMALLY OPEN (Open when de-energized), NBR Disc (except where noted)																		
1/8	1/16	.09	500	300	225	400	250	150	180	120	8262G91	8	●	8262G92	8	●	6.1/F	10.6/F
1/8	3/32	.15	275	200	150	190	110	110	180	120	8262G93	8	●	8262G94	8	●	6.1/F	10.6/F
1/8	1/8	.21	125	100	85	80	60	50	180	120	8262G31	8	●	8262G35	8	●	6.1/F	10.6/F
1/4	3/64	.06	750	700	700	500	500	500	140	140	8262G260 ①	9	●	8262G130 ①	14	●	10.1/F	11.6/F
1/4	3/32	.17	300	250	230	200	150	125	140	140	8262G261 ①	9	●	8262G134 ①	14	●	10.1/F	11.6/F
1/4	1/8	.35	130	110	100	80	60	60	180	150	8262G262	9	●	8262G138	14	●	10.1/F	11.6/F
1/4	5/32	.49	85	75	60	45	30	30	180	150	8262G263	4	●	8262G142	14	●	10.1/F	11.6/F
1/4	7/32	.83	45	45	40	25	20	20	180	150	8262G264	4	●	8262G148	14	●	10.1/F	11.6/F
1/4	9/32	.96	30	25	20	15	15	15	180	150	8262G265	4	●	8262G152	14	●	10.1/F	11.6/F
Notes: ① Cast UR disc supplied as standard. ② On 50 hertz service, the rating for the 6.1/F solenoid is 8.1 watts. ③ ○ Safety Shutoff Valve; ● General Purpose Valve. Refer to Engineering Section (Approvals) for details.																		

Specifications (Metric units)

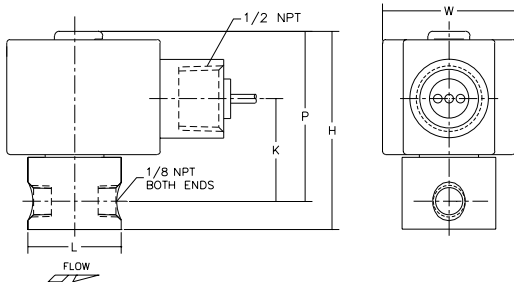
Pipe Size (ins.)	Orifice Size (mm)	Kv Flow Factor (m3/h)	Operating Pressure Differential (bar)						Max. Fluid Temp. °C		Brass Body			Stainless Steel Body			Watt Rating/ Class of Coil Insulation ②	
			Max. AC			Max. DC			AC	DC	Catalog Number	Constr. Ref. No.	UL ③	Catalog Number	Constr. Ref. No.	UL ③	AC	DC
			Air-Inert Gas	Water	Lt. Oil @ 300 SSU	Air-Inert Gas	Water	Lt. Oil @ 300 SSU										
NORMALLY CLOSED (Closed when de-energized), NBR Disc																		
1/8	1.2	.05	52	52	37	45	44	38	81	48	8262G1	1	○	8262G12	1	○	6.1/F	10.6/F
1/8	2.4	.17	19	20	9	10	10	10	81	48	8262G14	1	○	8262G15	1	○	6.1/F	10.6/F
1/8	3.2	.29	11	12	10	6	6	6	81	48	8262G2	1	○	8262G6	1	○	6.1/F	10.6/F
1/4	1.2	.05	52	52	34	34	34	34	81	48	8262G19	16	○	8262G80	11	○	6.1/F	10.6/F
1/4	1.2	.05	103	103	76	33	33	31	60	60	8262G200	17	●	-	-	-	10.1/F	11.6/F
1/4	1.2	.05	152	138	76	-	-	-	60	60	-	-	-	8262G214	12	●	10.1/F	-
1/4	2.4	.15	25	23	11	10	9	9	81	48	8262G20	16	○	8262G86	11	○	6.1/F	10.6/F
1/4	3.2	.30	10	11	6	4	4	4	81	48	8262G22	16	○	8262G7	11	○	6.1/F	10.6/F
1/4	3.2	.30	21	21	14	5	5	5	81	65	8262G232	17	○	-	-	-	10.1/F	11.6/F
1/4	4.0	.43	12	14	10	3	3	3	81	65	8262G202	4	○	8262G220	12	○	10.1/F	11.6/F
1/4	5.6	.62	6	7	7	2	2	2	81	65	8262G208	4	○	8262G226	12	○	10.1/F	11.6/F
1/4	5.6	.73	3	3	3	1	1	1	81	48	8262G13	2	○	8262G36	11	○	6.1/F	10.6/F
1/4	7.1	.75	4	5	4	1	1	1	81	65	8262G210	4	○	-	-	-	10.1/F	11.6/F
1/4	7.1	.75	6	7	6	2	1	2	81	65	8262G212	6	○	8262G230	13	○	17.1/F	22.6/F
1/4	7.1	.82	2	2	2	1	1	1	81	48	8262G90	2	○	8262G38	11	○	6.1/F	10.6/F
3/8	3.3	.30	11	10	6	4	4	4	81	48	8263G2	3	○	8263G330	3	○	6.1/F	10.6/F
3/8	4.0	.45	7	7	7	2	2	2	81	65	8263G200	5	○	8263G331	5	○	10.1/F	11.6/F
3/8	5.6	.62	7	7	7	2	2	2	81	65	8263G206	5	○	8263G332	5	○	17.1/F	11.6/F
3/8	7.1	.73	7	7	5	-	-	-	81	-	8263G210	7	○	8263G333	7	○	17.1/F	-
NORMALLY OPEN (Open when de-energized), NBR Disc (except where noted)																		
1/8	1.6	.08	34	21	16	28	17	10	81	48	8262G91	8	●	8262G92	8	●	6.1/F	10.6/F
1/8	2.4	.13	19	14	10	13	8	8	81	48	8262G93	8	●	8262G94	8	●	6.1/F	10.6/F
1/8	3.2	.18	9	7	6	6	4	3	81	48	8262G31	8	●	8262G35	8	●	6.1/F	10.6/F
1/4	1.2	.05	52	48	48	34	34	34	59	59	8262G260 ①	9	●	8262G130 ①	14	●	10.1/F	11.6/F
1/4	2.4	.15	21	17	16	14	10	9	59	59	8262G261 ①	9	●	8262G134 ①	14	●	10.1/F	11.6/F
1/4	3.2	.30	9	8	7	6	4	4	81	65	8262G262	9	●	8262G138	14	●	10.1/F	11.6/F
1/4	4.0	.42	6	5	4	3	2	2	81	65	8262G263	4	●	8262G142	14	●	10.1/F	11.6/F
1/4	5.6	.71	3	3	3	2	1	1	81	65	8262G264	4	●	8262G148	14	●	10.1/F	11.6/F
1/4	7.1	.82	2	2	1	1	1	1	81	65	8262G265	4	●	8262G152	14	●	10.1/F	11.6/F
Notes: ① Cast UR disc supplied as standard. ② On 50 Hertz service, the rating for the 6.1/F solenoid is 8.1 watts. ③ ○ Safety Shutoff Valve; ● General Purpose Valve. Refer to Engineering Section (Approvals) for details.																		

Dimensions: inches (mm)

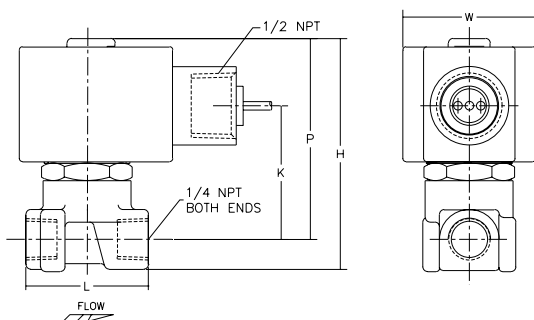
Constr. Ref. No.		H	K	L	P	W
1	ins.	2.52	1.30	1.19	2.16	1.69
	mm	64	33	30	55	43
2	ins.	2.98	1.71	1.56	2.57	1.69
	mm	76	43	40	65	43
3	ins.	3.07	1.63	1.88	2.49	1.69
	mm	78	41	48	63	43
4	ins.	3.20	1.78	1.56	2.79	1.95
	mm	81	45	40	71	50
5	ins.	3.25	1.70	2.00	2.77	1.95
	mm	83	43	51	70	50
6	ins.	3.16	1.78	1.56	2.75	1.95
	mm	80	45	40	70	50
7	ins.	3.25	1.70	2.00	2.67	1.95
	mm	83	43	51	68	50
8	ins.	3.15	1.32	1.19	2.18	1.69
	mm	80	34	30	55	43
9	ins.	3.23	1.67	1.25	2.81	1.95
	mm	82	42	32	71	50
11	ins.	2.94	1.71	1.56	2.57	1.69
	mm	75	43	40	65	43
12	ins.	3.12	1.78	1.56	2.75	1.95
	mm	79	45	40	70	50
13	ins.	3.12	1.78	1.56	2.75	1.95
	mm	79	45	40	70	50
14	ins.	3.16	1.65	1.56	2.79	1.95
	mm	80	42	40	71	50
16	ins.	3.01	1.73	1.25	2.59	1.69
	mm	76	44	32	66	43
17	ins.	3.19	1.80	1.25	2.77	1.95
	mm	81	46	32	70	50

IMPORTANT: Valves may be mounted in any position.

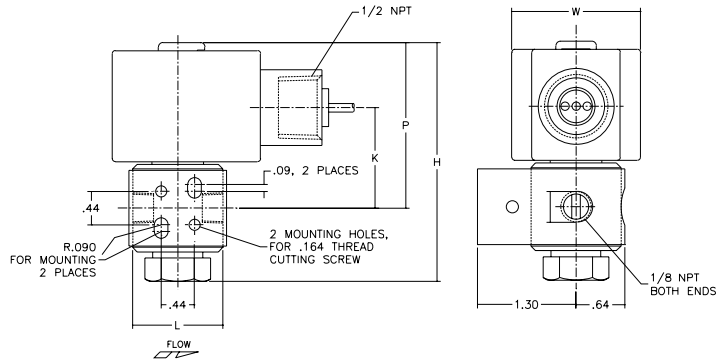
Constr. Refs. 1



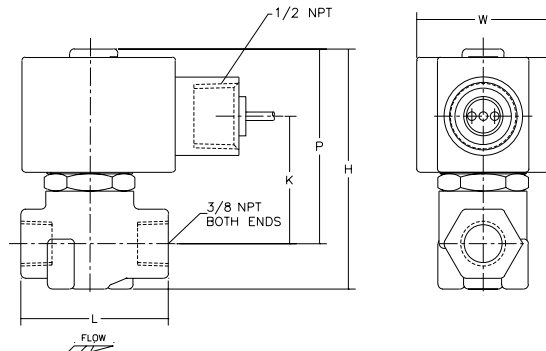
Constr. Refs. 2, 4, 6, 9



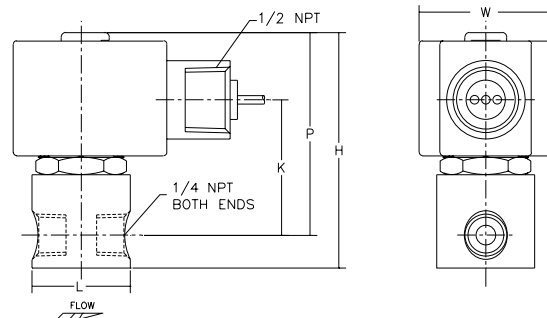
Constr. Refs. 8



Constr. Refs. 3, 5, 7

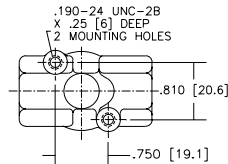


Constr. Refs. 11-14, 16, 17



Mounting Details

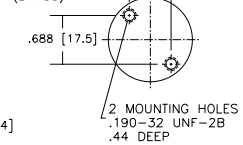
MOUNTING HOLES IN VALVE BODY
BRASS-CONSTR. REFS. 3, 5, 7



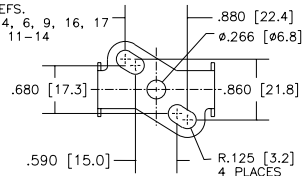
CONSTR. REF. 9, 16, 17



CONSTR. REF. 1 (BRASS)



MOUNTING BRACKET
CONSTR. REFS. BRASS: 2, 4, 6, 9, 16, 17
ST. ST.: 1, 11-14



OIL WATER SEPARATORS – OWS SERIES

Application:

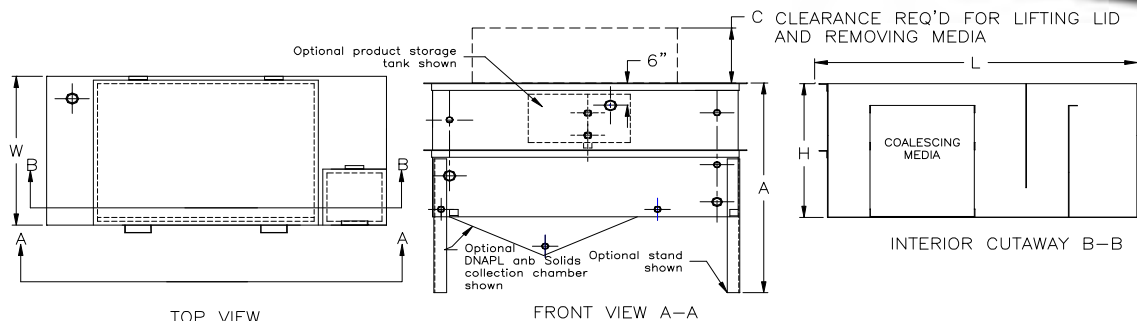
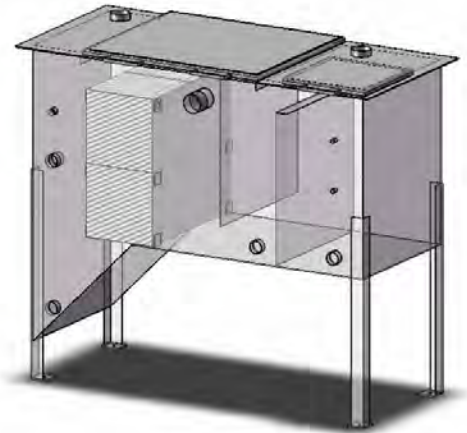
newterra Oil Water Separators are designed to remove oil from a liquid phase inlet stream. As the oil/water mixture is passed through the coalescing oil/water separator, larger oil droplets migrate to the surface to be collected and skimmed off. The media collects the smaller droplets until they are large and buoyant enough to float to the surface.

Construction:

The standard OWS Series are fabricated from carbon steel. For corrosion resistance, the interior is epoxy coated and the exterior is painted. Optional stainless steel construction is also available. A large lid allows access to the coalescing media and oil skimmer while a small lid allows access to the pump-out tank.

Standard Features:

- Standard finish: Interior is epoxy coated. Exterior is painted **newterra** blue over zinc primer (except stainless steel option)
- Sacrificial anode to prevent corrosion of tank.
- 11 AWG carbon steel construction
- Sludge containment section
- Adjustable oil skimmer
- Water underflow/overflow weir design
- Easy removal of coalescing media for cleaning
- High Alarm Level Coupling and Pump High/Low Level Coupling in the pump-out chamber



Dimension Chart:

Part Number	Width "W"	Standard Height "H"	Standard Overall Length	Length with Extended Pump-out	Height with Elevated Pump-out "A"	Overhead Clearance "C"	Standard Pump-out Volume	Extended Pump-out Volume	Elevated Pump-out Volume	Product Tank Volume
OWS-2	16"	30"	64"	76"	n/a	14"	23 Gal	41 Gal	n/a	8.1 Gal
OWS-4	28"	30"	64"	76"	n/a	26"	46 Gal	81 Gal	n/a	8.1 Gal
OWS-8	28"	30"	76"	88"	n/a	26"	46 Gal	81 Gal	n/a	8.1 Gal
OWS-12	40"	30"	76"	88"	n/a	38"	70 Gal	122 Gal	n/a	8.1 Gal
OWS-18	40"	30"	88"	n/a	60"	24"	70 Gal	n/a	130 Gal	12.2 Gal
OWS-24	52"	30"	88"	n/a	60"	24"	93 Gal	n/a	173 Gal	12.2 Gal
OWS-36	52"	42"	88"	n/a	72"	24"	133 Gal	n/a	212 Gal	17.8 Gal
OWS-45	64"	42"	88"	n/a	72"	24"	166 Gal	n/a	265 Gal	17.8 Gal
OWS-72	100"	42"	88"	n/a	72"	24"	266 Gal	n/a	425 Gal	17.8 Gal

OIL WATER SEPARATORS – OWS SERIES

Specification Chart:

Part Number	HQ PAC		½" Packing		¾" Packing		1 ¼" Packing		Slant Plate	
	Oil (0.9)	Gas (0.72)	Oil (0.9)	Gas (0.72)	Oil (0.9)	Gas (0.72)	Oil (0.9)	Gas (0.72)	Oil (0.9)	Gas (0.72)
OWS-2	9.7	27.0	5.0	14.1	3.5	9.8	2.3	6.3	0.9	2.5
OWS-4	19.3	54.0	10.1	28.2	7.0	19.7	4.5	12.7	1.8	4.9
OWS-8	38.6	108.1	20.2	56.5	14.0	39.3	9.1	25.4	3.5	9.8
OWS-12	57.9	162.1	30.3	84.7	21.1	59.0	13.6	38.1	5.3	14.7
OWS-18	86.9	243.2	45.4	127.1	31.6	88.4	20.4	57.1	7.9	22.1
OWS-24	115.8	324.2	60.5	169.5	42.1	117.9	27.2	76.1	10.5	29.5
OWS-36	159.2	445.8	68.1	190.7	47.4	132.6	30.6	85.7	11.8	33.2
OWS-45	199.0	557.3	85.1	238.4	59.2	165.8	38.2	107.1	14.8	41.5
OWS-72	318.5	891.7	136.2	381.4	94.7	265.3	61.2	171.3	23.7	66.3

Rated US GPM (Based on 25 micron particles at 65 deg F and design safety factor of 1.25)

Larger spaced packing will not plug as quickly as closely spaced packing allowing longer intervals between maintenance requirements. The coalescing slant plate should be used in applications with heavy sludge loads because it does not foul quickly.

Options Table:

Option	Description
Stand	The separator will be elevated above ground to assist in gravity discharge or to provide room underneath the separator for blowers and pumps. This replaces the standard foot mounts. The maximum stand height for 8" clearance is 36" for OWS-18 and OWS-24 and 24" for OWS-36 and larger.
Oversize Pump-out (Extended)	OWS-2, OWS-4, OWS-8 and OWS-12 only. The final section of the separator can be oversized to allow a greater water pump-out volume. For the OWS-2, OWS-4, OWS-8 and OWS-12 the oversized pump-out will be an extended length of the final section of the separator.
Oversize Pump-out (Elevated)	OWS-18, OWS-24, OWS-36 and OWS-45 only. The final section of the separator can be oversized to allow a greater water pump-out volume. For the OWS-18, OWS-24, OWS-36 and OWS-45 the separator will be raised on a stand and the final section will extend to the ground to give the oversized volume.
Top Inlet	A top mounted option is available to allow for pre-separation of air and liquid at the inlet to the separator.
Product Storage Tank	A tank may be mounted on the front of the separator to collect the oil from the skimmer. The volume of the product storage tank is: OWS-2, OWS-4, OWS-8 and OWS-12: 8.1 US Gal OWS-18, OWS-24 12.2 US Gal OWS-36, OWS-45 17.8 US Gal
Telerette Basket	A telerette basket may be added to allow for a high surface area polishing media for final hydrocarbon removal.
Oversize Inlet and Outlet	The inlet and outlet couplings may be increased by one size to allow for higher flow through the separator.
Stainless Steel	Each separator can be purchased with Stainless Steel construction instead of the standard Carbon Steel.
Main Tank Low Coupling	Additional couplings may be added to allow for the installation of a low level switch in the main separator tank. NOTE: This option covers only the cost of installing the coupling, the switches must be purchased separately.
Main Tank High High Coupling	Additional couplings may be added to allow for the installation of a high high level switch in the main separator tank. NOTE: This option covers only the cost of installing the coupling, the switches must be purchased separately.
Custom Size	A custom sized separator can be designed to meet specific project needs.
Media	Custom media available for contaminants other than oil/BTEX such as chlorinated solvents and other DNAPL products.
DNAPL Separation	The separator can be supplied with a DNAPL sump to capture heavy fluids and solids and allow collection below the media of the oil water separator.
Sample Ordering Format:	
OWS-4 with ½" Packing	
SG: 0.9	
Temp: 65 deg F	
Minimum Micron Size: 25	
Design Safety Factor: 1.25	
Options:	
Oversize Pumpout (Extended)	
Product Storage Tank	
Stand: 24"	

G&L Series NPE



316L SS

**NPE Series End Suction
Centrifugal Pumps**
*Bombas Centrífugas de
Succión Final Serie NPE*

www.goulds.com

Goulds Pumps

A Full Range of Product Features Una Gama Total de Características del Producto

Superior Materials of Construction:

Complete AISI 316L stainless steel liquid handling components and mounting bracket for corrosion resistance, quality appearance, and improved strength and ductility.

High Efficiency Impeller:

Enclosed impeller with unique floating seal ring design maintains maximum efficiencies over the life of the pump without adjustment.

Casing and Adapter Features:

Stainless steel construction with NPT threaded, centerline connections, easily accessible vent, prime and drain connections with stainless steel plugs. Optional seal face vent/flush available.

Mechanical Seal: Standard John Crane Type 21 with carbon versus silicon-carbide faces, Viton elastomers, and 316 stainless metal parts. Optional high temperature and chemical duty seals available.

Motors: NEMA standard open drip-proof, totally enclosed fan cooled or explosion proof enclosures. Rugged ball bearing design for continuous duty under all operating conditions.

Materiales Superiores de Construcción:

Componentes completos para manejo de líquidos en acero inoxidable AISI 316L y consola para el montaje para resistencia a la corrosión, apariencia de calidad, y fuerza y ductilidad mejoradas.

Impulsor de Eficiencia Superior:

El impulsor encerrado con un diseño único de anillo del sello flotante, mantiene sin ajustes, la eficiencia máxima sobre la vida de la bomba.

Características de la Carcasa y del Adaptador:

Construcción en acero inoxidable con NPT roscado, conexiones centrales, válvulas de fácil acceso, conexiones de cebado y drenaje con enchufes de acero inoxidable. Cara del sello válvula/chorro opcional disponible.

Sello Mecánico: Estándar John Crane Tipo 21 con carbón en contraste con caras de silicón-carbide, elastómeros de Viton, y partes metálicas de acero inoxidable 316. Sellos de alta temperatura y productos químicos están disponibles.

Motores: Estándar NEMA a prueba de goteo, ventilador totalmente encerrado o recintos a prueba de explosión. Diseño robusto de balineras de bolas para trabajo continuo en todas las condiciones de funcionamiento.

The various versions of the NPE are identified by a product code number on the pump label. This number is also the catalog number for the pump. The meaning of each digit in the product code number is shown at left.

Las diferentes versiones de la NPE se identifican con un número de código del producto en la etiqueta de la bomba. Este número es también el número del catálogo para la bomba. El significado de cada dígito en el número de código del producto se muestra a la izquierda.

NPE Product Line Numbering System Línea de Producto NPE Sistema de Numeración

Example Product Code, Ejemplo Código del Producto

1 ST 2 C 1 A 4 F

Seal Vent/Flush Option, Opción de Sello Válvula/Chorro Seal Ven
Mechanical Seal and O-ring

4 = Pre-engineered standard
For optional mechanical seal modify catalog order no. with seal code listed below.

Sello Mecánico y Anillo 'O'

4 = Estándar aprobado
Para sello mecánico opcional modificar el número de orden del catálogo con el código del sello anotado abajo.

John Crane Type 21 Mechanical Seal (3/8" seal), Sello Mecánico John Crane Tipo 21 (sello de 3/8")					
Seal Code, Código del Sello	Rotary, Rotativo	Stationary, Estacionario	Elastomers, Elastómeros	Metal Parts, Partes Metálicas	Part No., Pieza Número
2	Carbon	Silicon Carbide	EPR	316 SS	10K18
4			Viton		10K55
5	Silicon Carbide	EPR	10K81		
6		Viton	10K62		

Impeller Option . . . No Adder Required

For optional impeller diameters modify catalog order no. with impeller code listed. Select optional impeller diameter from pump performance curve.

Código del Impulsor Opcional

Para impulsores con diámetros opcionales modificar el número de orden del catálogo con el código del impulsor anotado. Escoger el impulsor con diámetro opcional de la curva de funcionamiento de la bomba.

Impeller Code, Código del Impulsor	Pump Size, Tamaño de la Bomba		
	1 x 1 1/4 - 6	1 1/4 x 1 1/2 - 6	1 1/2 x 2 - 6
	Diameter	Diameter	Diameter
K	—	6 1/8	—
G	—	5 1/16	5 3/8
H	—	5 1/2	5
A	6 1/8	5 1/4	4 3/4
B	5 3/4	5 1/16	4 7/8
C	5 3/16	4 7/8	4 3/8
D	4 3/4	4 5/8	4 1/16
E	4 1/16	4 1/4	3 3/8
F	4 1/16	3 7/8	—

Driver, Conductor

1 = 1 PH, ODP 7 = 3 PH, XP
2 = 3 PH, ODP 8 = 575 V, XP
3 = 575 V, ODP 9 = 3 PH, TEFC
4 = 1 PH, TEFC Premium Eff.
5 = 3 PH, TEFC 0 = 1 PH, XP
6 = 575 V, TEFC

HP Rating, HP Potencia

C = 1/2 HP E = 1 HP G = 2 HP J = 5 HP
D = 3/4 HP F = 1 1/2 HP H = 3 HP

Driver: Hertz/Pole/RPM, Conductor: Hercios/Polos/RPM

1 = 60 Hz, 2 pole, 3500 RPM
2 = 60 Hz, 4 pole, 1750 RPM
3 = 60 Hz, 6 pole, 1150 RPM
4 = 50 Hz, 2 pole, 2900 RPM
5 = 50 Hz, 4 pole, 1450 RPM

Material

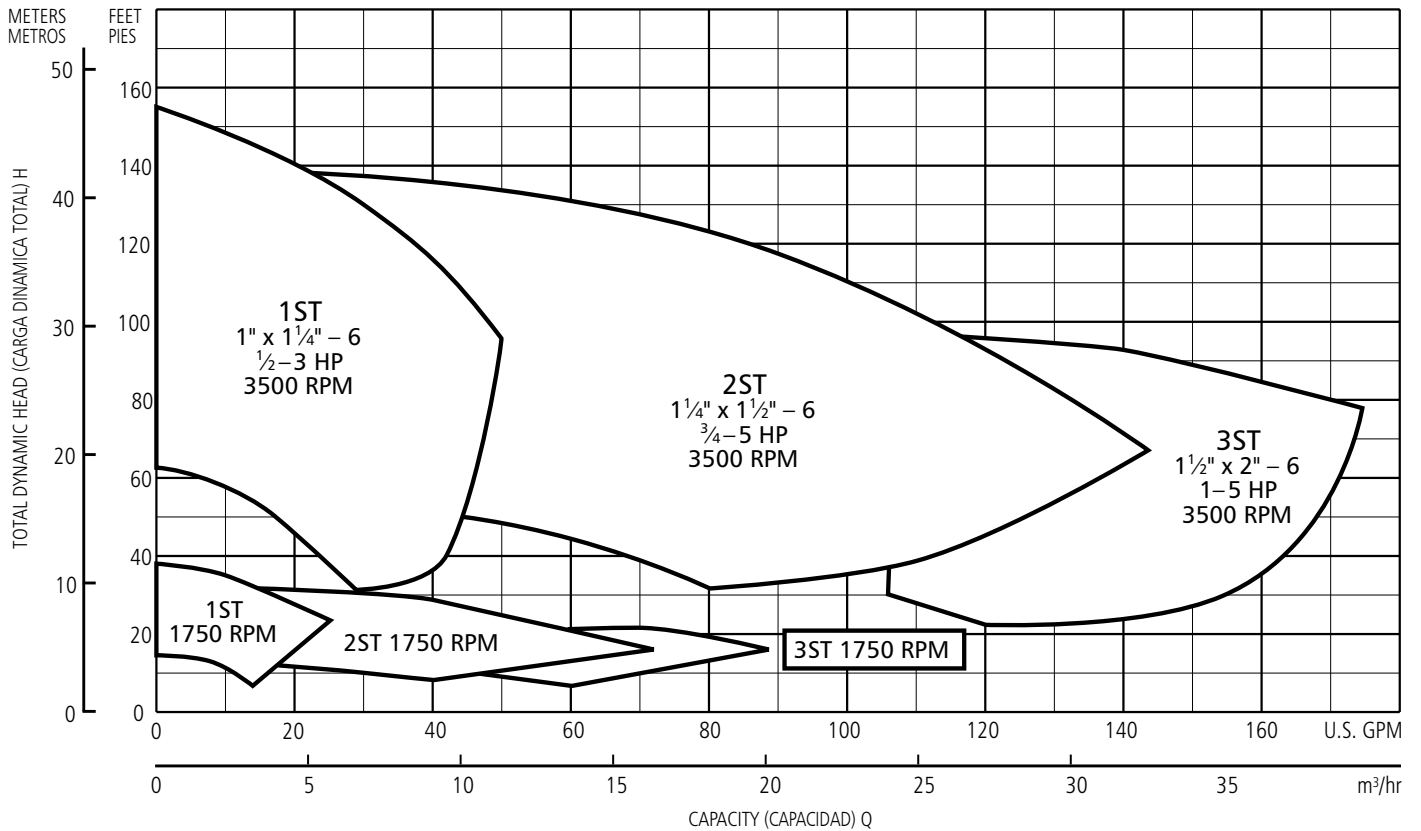
ST = Stainless steel, Acero inoxidable

Pump Size, Tamaño de la Bomba

1 = 1 x 1 1/4 - 6 2 = 1 1/4 x 1 1/2 - 6 3 = 1 1/2 x 2 - 6

For frame mounted version, substitute the letters "FRM" in these positions.
Para la versión con el armazón montado, sustituya las letras "FRM" en estas posiciones.

Performance Coverage (60 Hz)
Alcance de Funcionamiento (60 Hz)



NOTES:

Not recommended for operation beyond printed H-Q curve.

For critical application conditions consult factory.

Not all combinations of motor, impeller and seal options are available for every pump model. Please check with G&L on non-cataloged numbers.

All standard 3500 RPM ODP and TEFC motors supplied by Goulds Pumps, have minimum of 1.15 service factor. Standard catalog units may utilize available service factor. Any motors supplied other than Goulds Pumps check available service factor.

NOTAS:

No se recomienda para funcionamiento superior al impreso en la curva H-Q.

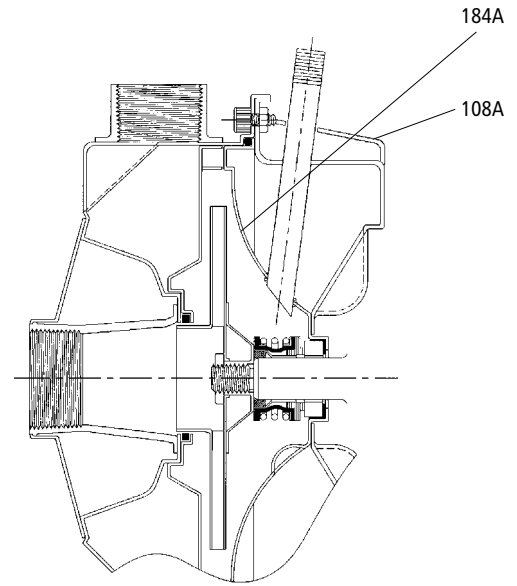
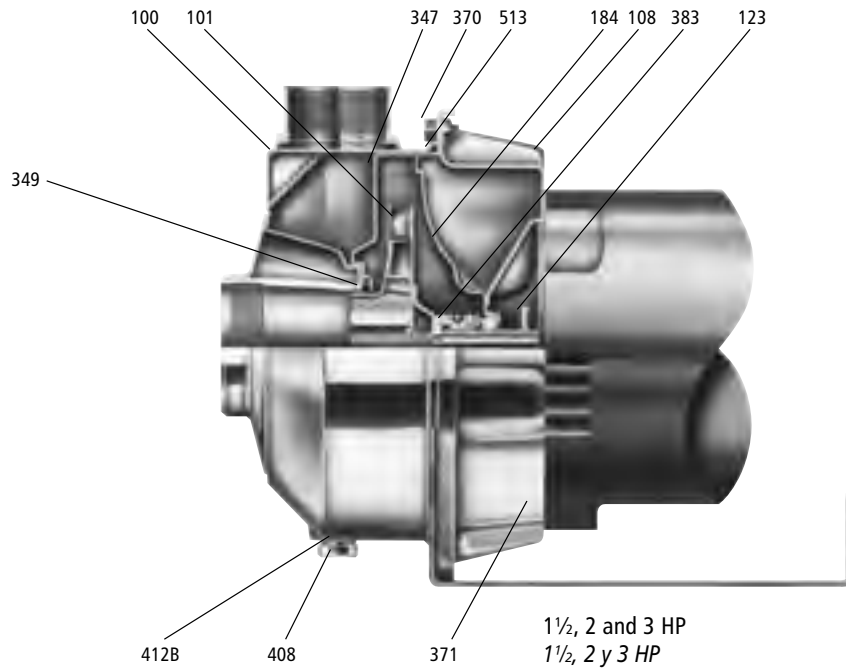
Para condiciones de aplicaciones críticas consultar con la fábrica.

No todas las combinaciones de las opciones de motor, impulsor y sello están disponibles para cada modelo de bombas. Por favor verifique con G&L en los números no catalogados.

Todos los motores estándar de 3500 RPM, ODP (abiertos resguardados) y TEFC (totalmente encerrados con enfriamiento forzado) provistos por Goulds Pumps tienen un factor mínimo de servicio de 1,15. Las unidades estándar de catálogo pueden utilizar el factor de servicio disponible. Verificar el factor de servicio disponible de todo motor no provisto por Goulds Pumps.

NPE Close Coupled Pump Major Components: Materials of Construction

Bomba Cerrada Acoplada NPE Componentes Principales: Materiales de Construcción



Seal Face Vent/Flush Option,
Opción Cara del Sello Válvula/Chorro

Item No., Parte No.	Description, Descripción	Materials, Materiales
100	Casing, Carcasa	
101	Impeller, Impulsor	
108	Motor adapter, Adaptador del motor	AISI 316L SS, AISI 316L Acero inoxidable
108A	Motor adapter seal vent/flush, Sello válvula/chorro del adaptador del motor	
123	Deflector, Deflector	BUNA-N
184	Seal housing, Alojamiento del sello	
184 A	Seal housing seal vent/flush, Sello válvula/chorro del alojamiento del sello	AISI 316L SS, AISI 316L Acero inoxidable
347	Guidevane, Difusor	
349	Seal ring, guidevane; Anillo del sello, difusor	Viton
370	Socket head screws, casing; Encajes cabezas de tornillos, carcasa	AISI 410 SS, AISI 410 Acero inoxidable
371	Bolts, motor; Tornillos, motor	Plated steel, Acero chapeado
383	Mechanical seal, Sello mecánico	**see chart, ver tabla
408	Drain and vent plug, casing; Enchufes de drenaje y válvula, carcasa	AISI 316L SS, AISI 316L Acero inoxidable
412B	O-ring, drain and vent plug; Anillo 'O', enchufe de drenaje y válvula	Viton (standard)
513	O-ring, casing; Anillo 'O', carcasa	EPR (Optional)
Motor	NEMA standard, 56J flange;	
Motor	NEMA estándar, brida 56J	



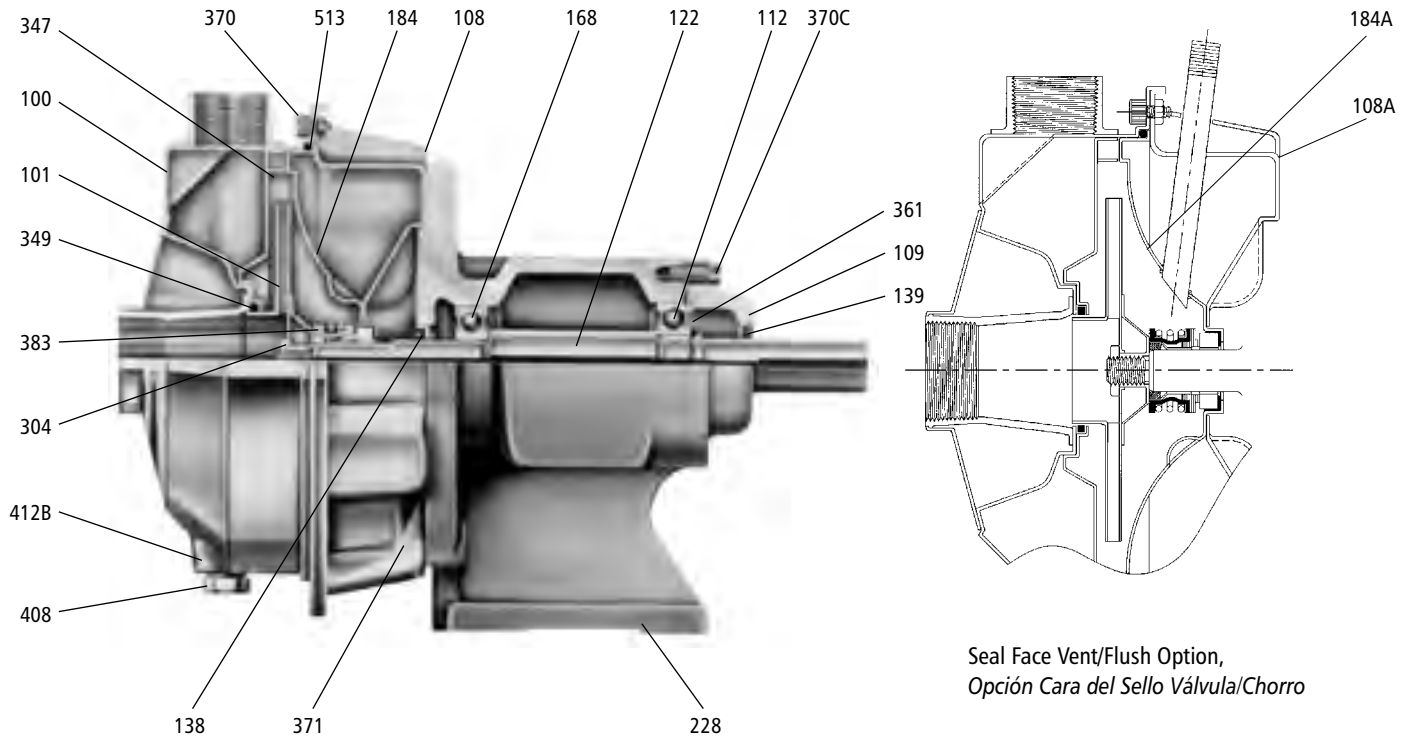
1/2, 3/4 and 1 HP
1/2, 3/4 y 1 HP

Footed motor for 5 HP ODP and TEFC, all explosion proof motors, see page 13.

Motor con pie para 5 HP ODP y TEFC, a prueba de explosiones motores, en la página 13.

NPE Frame Mounted Pump Major Components: Materials of Construction

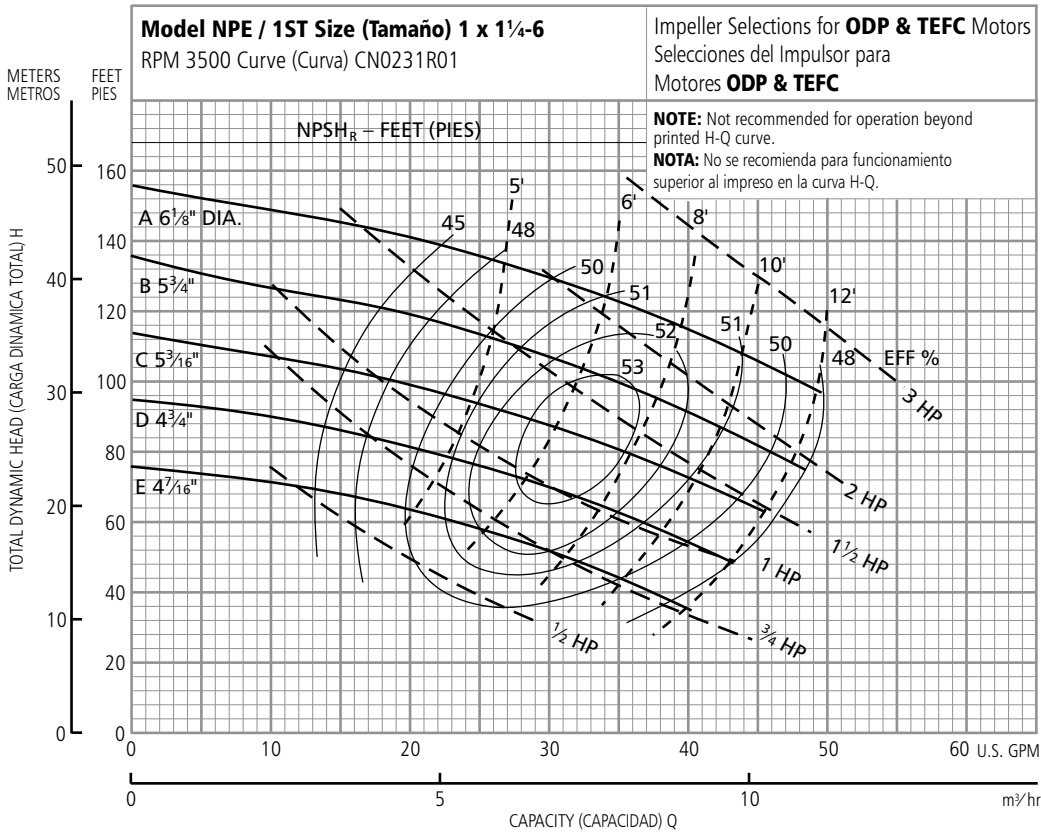
Bomba NPE de Armazón Montado Componentes Principales: Materiales de Construcción



Item No., Parte No.	Description, Descripción	Materials, Materiales
100	Casing, <i>Carcasa</i>	
101	Impeller, <i>Impulsor</i>	
108	Adapter, <i>Adaptador</i>	AISI 316L SS, AISI 316L Acero inoxidable
108A	Motor adapter seal vent/flush, <i>Sello válvula/chorro del adaptador del motor</i>	
109	Bearing cover, <i>Cubierta de balineras</i>	Cast iron, <i>Hierro fundido</i>
112	Ball bearing (outboard), <i>Balineras de bolas (exterior)</i>	Steel, Acero
122	Shaft, <i>Eje</i>	AISI 316 SS, AISI 316 Acero inoxidable
138	Lip-seal (inboard), <i>Sello cubierto (interior)</i>	BUNA/steel, <i>BUNA/acero</i>
139	Lip-seal (outboard), <i>Sello cubierto (exterior)</i>	BUNA/steel, <i>BUNA/acero</i>
168	Ball bearing (inboard), <i>Balineras de bolas (interior)</i>	Steel, Acero
184	Seal housing, <i>Alojamiento del sello</i>	
184 A	Seal housing seal vent/flush, <i>Sello válvula/chorro del alojamiento del sello</i>	AISI 316L SS, AISI 316L Acero inoxidable
228	Bearing frame, <i>Armazón de balineras</i>	Cast iron, <i>Hierro fundido</i>

Item No., Parte No.	Description, Descripción	Materials, Materiales
304	Impeller locknut, <i>Contratuercas del impulsor</i>	AISI 316 SS,
347	Guidevane, <i>Difusor</i>	AISI 316 Acero inoxidable
349	Seal ring, guidevane; <i>Anillo del sello, difusor</i>	Viton
361	Retaining ring, <i>Anillo de retención</i>	Steel, Acero
370	Socket head screws, casing; <i>Encaje cabeza del tornillo, carcasa</i>	AISI 410 SS, AISI 410 Acero inoxidable
370C	Hex head screw, bearing cover; <i>Tornillo de cabeza hexagonal, cubierta de balineras</i>	Plated steel, Acero chapeado
371	Hex head screw, bearing frame; <i>Tornillo de cabeza hexagonal, armazón de balineras</i>	Plated steel, Acero chapeado
383	Mechanical seal, <i>Sello mecánico</i>	**see chart, ver tabla
400	Shaft key, <i>Llave del eje</i>	Steel, Acero
408	Drain and vent plug, casing; <i>Enchufes de drenaje y válvula, carcasa</i>	AISI 316 SS, AISI 316 Acero inoxidable
412B	O-ring, drain and vent plug; <i>Anillo 'O', enchufe de drenaje y válvula</i>	Viton (standard)
513	O-ring, casing; <i>Anillo 'O', carcasa</i>	EPR (Optional)

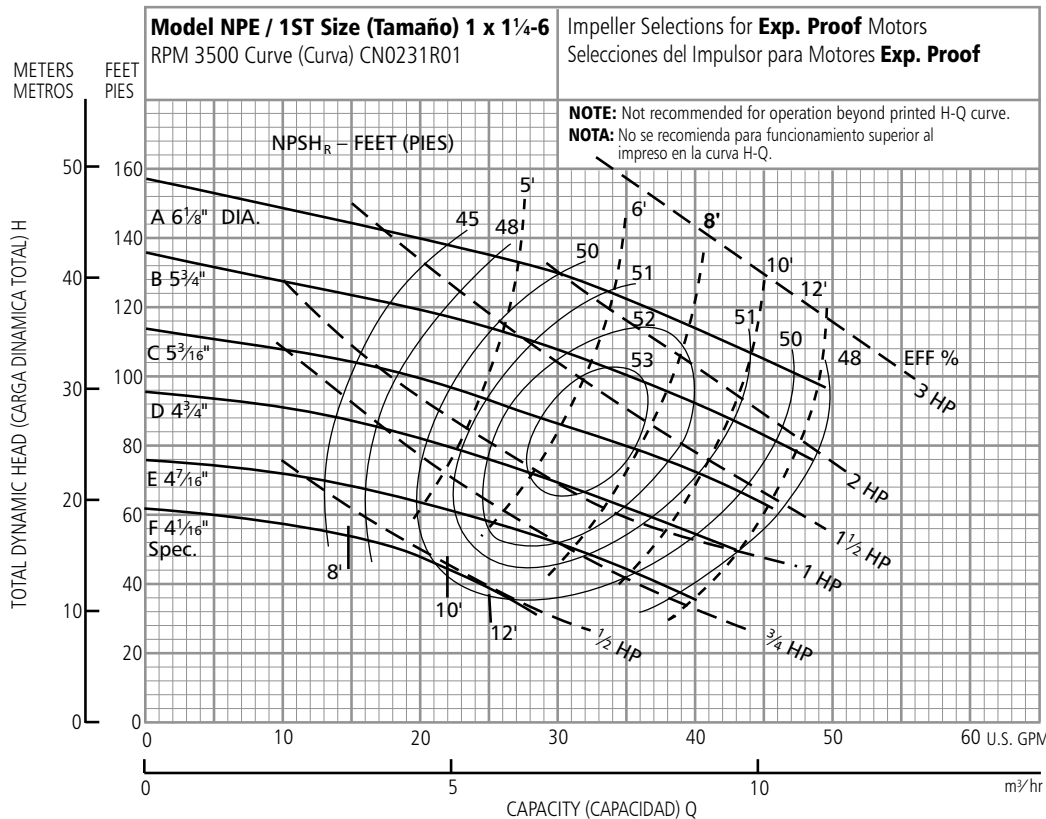
Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM



Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
E	1/2	4 7/16"
D	3/4	4 3/4"
C	1	5 3/16"
B	1 1/2	5 3/4"
A	2	6 1/8"

NOTE: Although not recommended, the pump may pass a 1/16" sphere.

NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de 1/16".

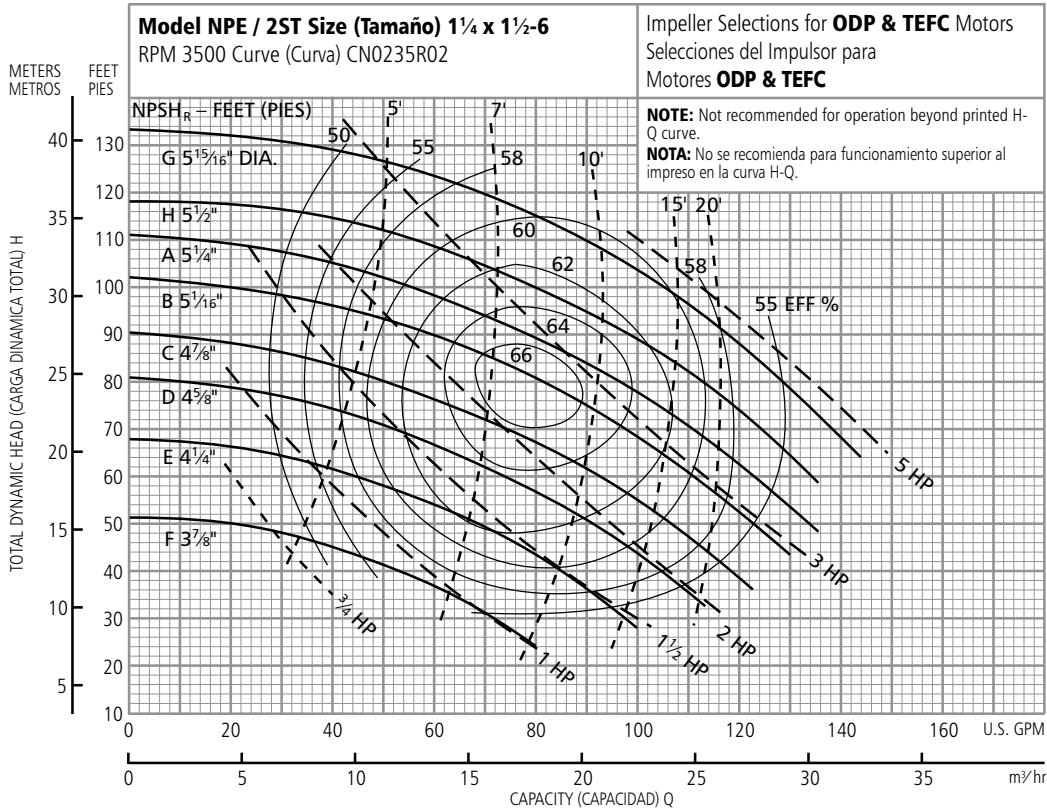


Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
F	1/2	4 1/16" spec.
E	3/4	4 7/16"
D	1	4 3/4"
C	1 1/2	5 3/16"
B	2	5 3/4"
A	3	6 1/8"

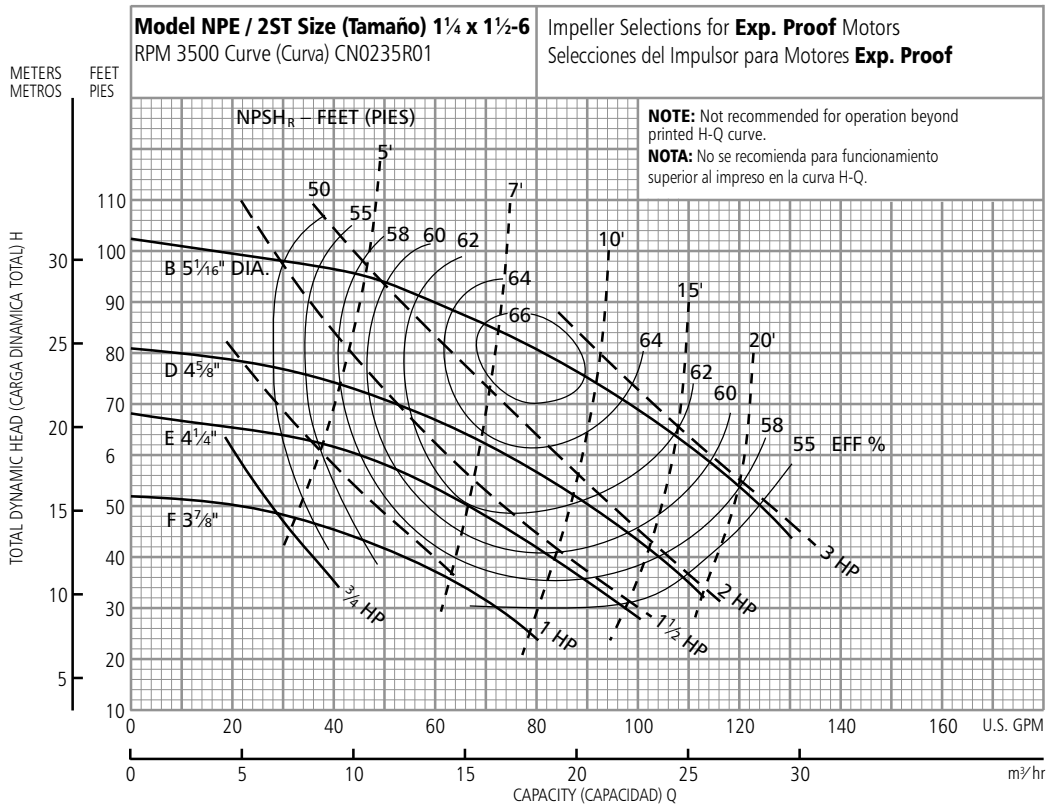
NOTE: Although not recommended, the pump may pass a 1/16" sphere.

NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de 1/16".

Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM

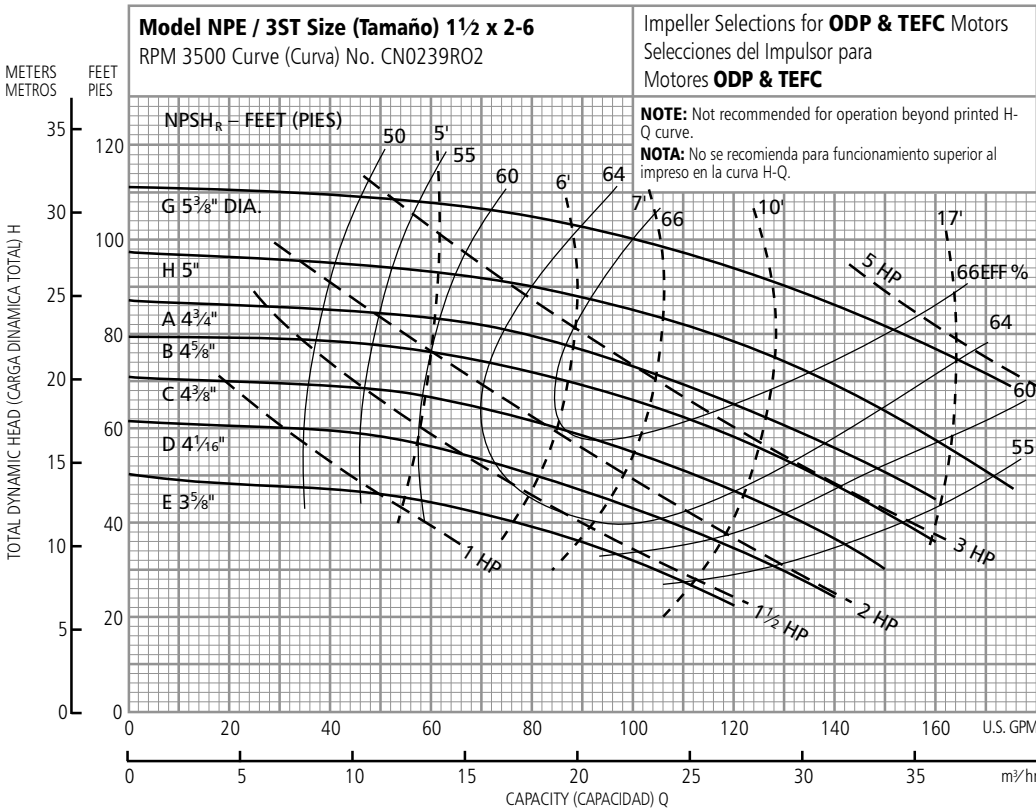


NOTE: Although not recommended, the pump may pass a ⅜" sphere.
NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de ⅜".



NOTE: Although not recommended, the pump may pass a ⅜" sphere.
NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de ⅜".

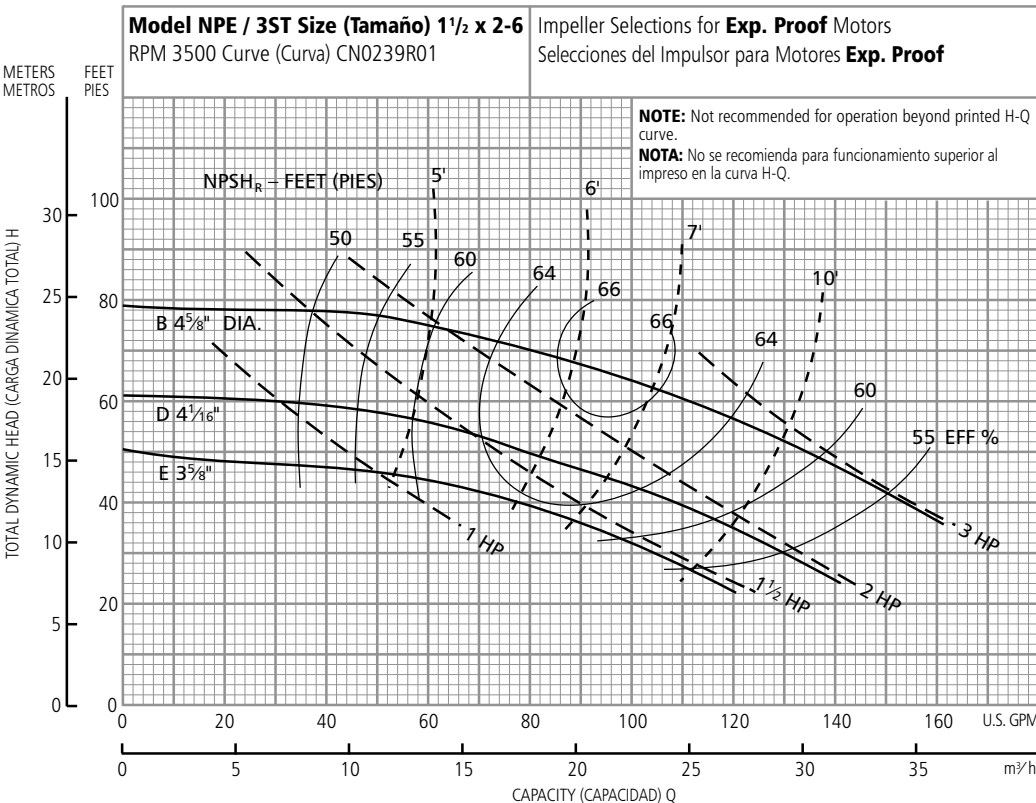
Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM



Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
E	1	3 5/8"
D	1 1/2	4 1/16
C	2	4 3/8
B	3	4 5/8
A	3	4 3/4
H	5	5
G	5	5 3/8

NOTE: Although not recommended, the pump may pass a 1 1/32" sphere.

NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de 1/32".



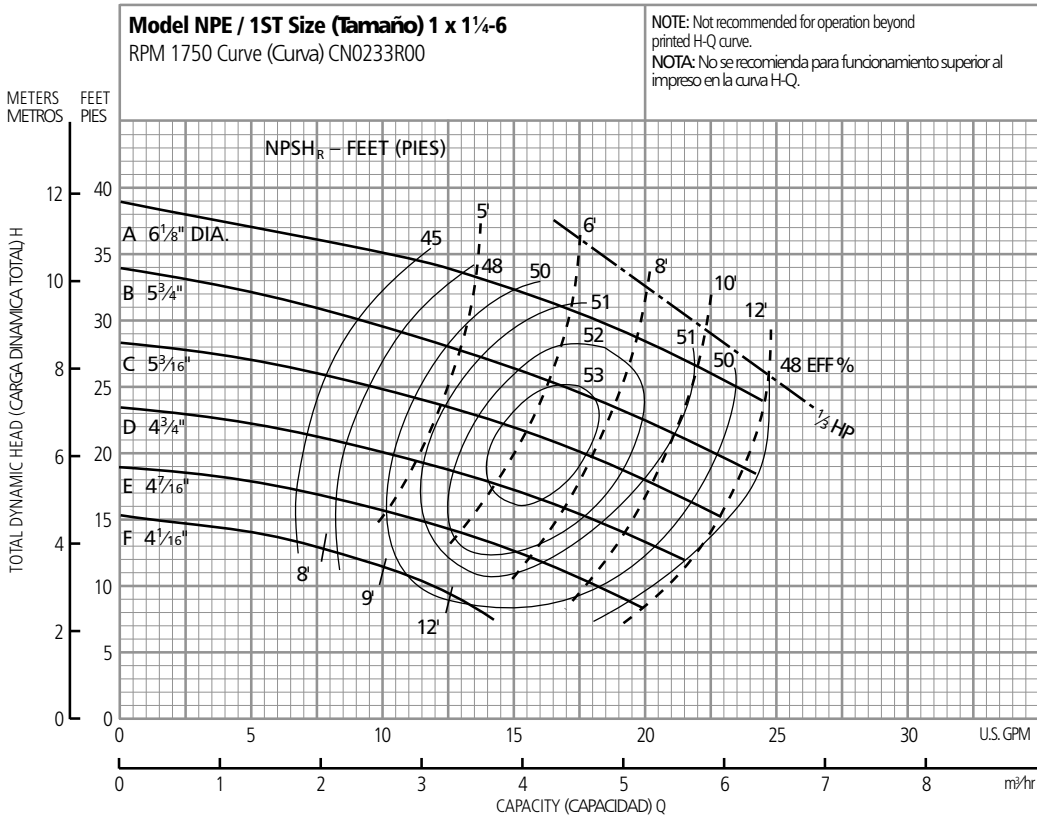
Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
E	1 1/2	3 5/8"
D	2	4 1/16
B	3	4 5/8

NOTE: Although not recommended, the pump may pass a 1 1/32" sphere.

NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de 1/32".

Performance Curves – 60 Hz, 1750 RPM

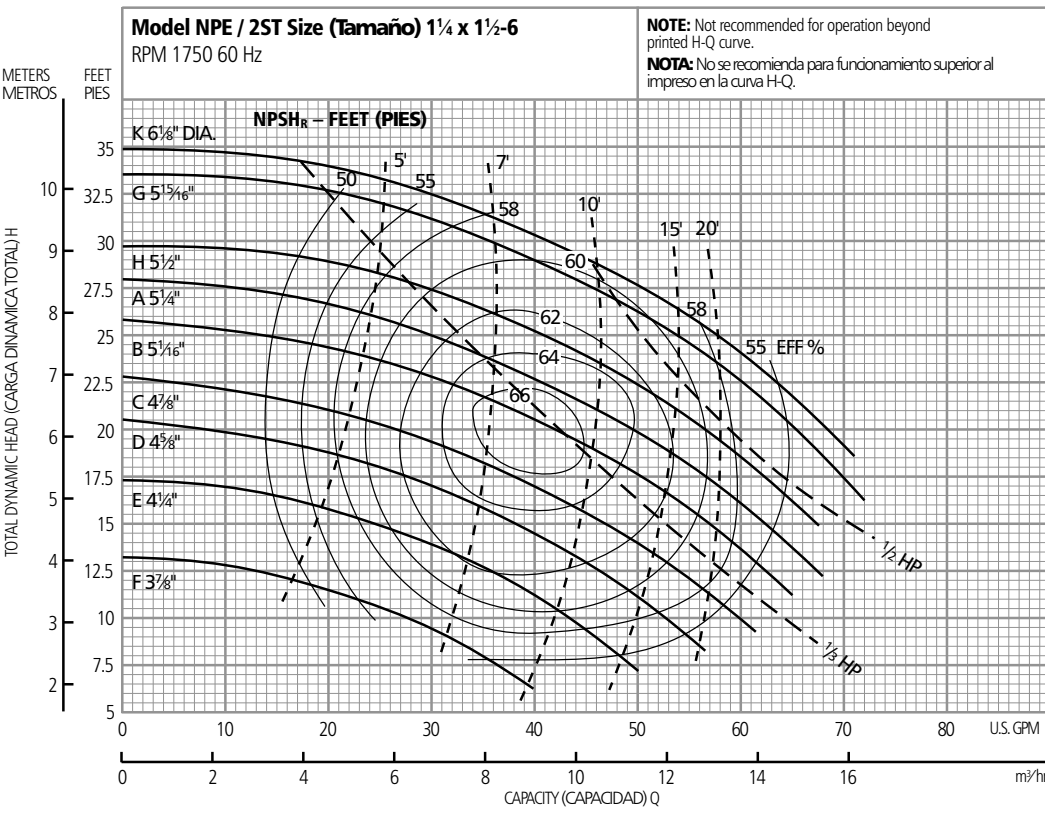
Curvas de Funcionamiento – 60 Hz, 1750 RPM



Optional Impeller, Impulsor Opcional	
Ordering Code, Código de Pedido	Dia.
A	6 1/8"
B	5 3/4"
C	5 3/16"
D	4 3/4"
E	4 7/16"
F	4 1/16"

NOTE: Although not recommended, the pump may pass a 1/16" sphere.

NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de 1/16".

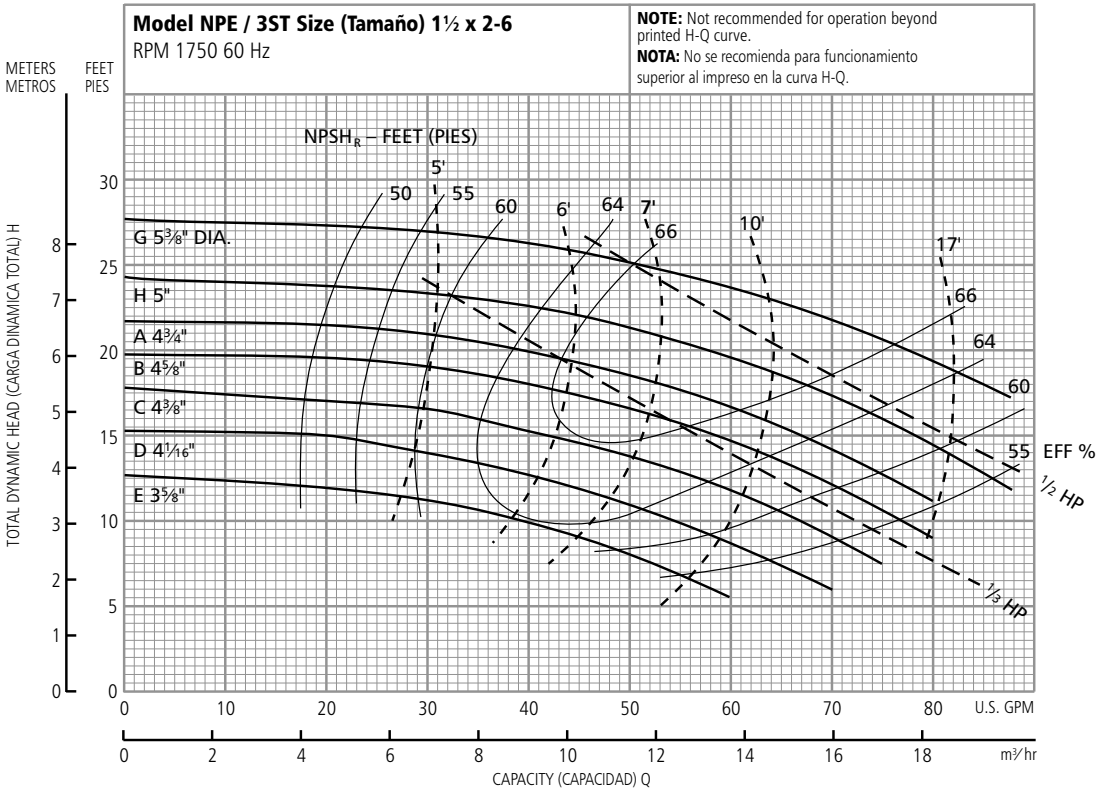


Optional Impeller, Impulsor Opcional	
Ordering Code, Código de Pedido	Dia.
K	6 1/8"
G	5 15/16"
H	5 1/2"
A	5 1/4"
B	5 1/16"
C	4 7/8"
D	4 5/8"
E	4 1/4"
F	3 7/8"

NOTE: Although not recommended, the pump may pass a 3/16" sphere.

NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de 3/16".

Performance Curves – 60 Hz, 1750 RPM
Curvas de Funcionamiento – 60 Hz, 1750 RPM

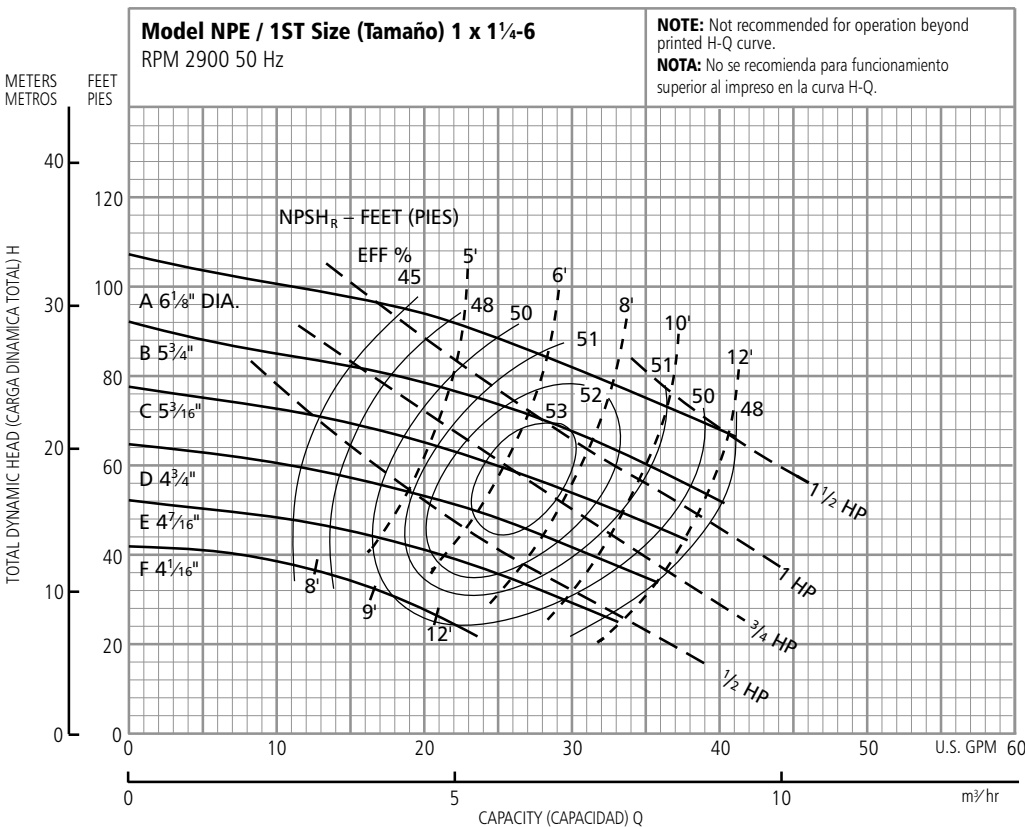


Optional Impeller, Impulsor Opcional

Ordering Code, Código de Pedido	Dia.
G	5 3/8"
H	5
A	4 3/4
B	4 5/8
C	4 3/8
D	4 1/16
E	3 5/8

NOTE: Although not recommended, the pump may pass a 1 1/32" sphere.
NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de 1 1/32".

Performance Curves – 50 Hz, 2900 RPM
Curvas de Funcionamiento – 50 Hz, 2900 RPM



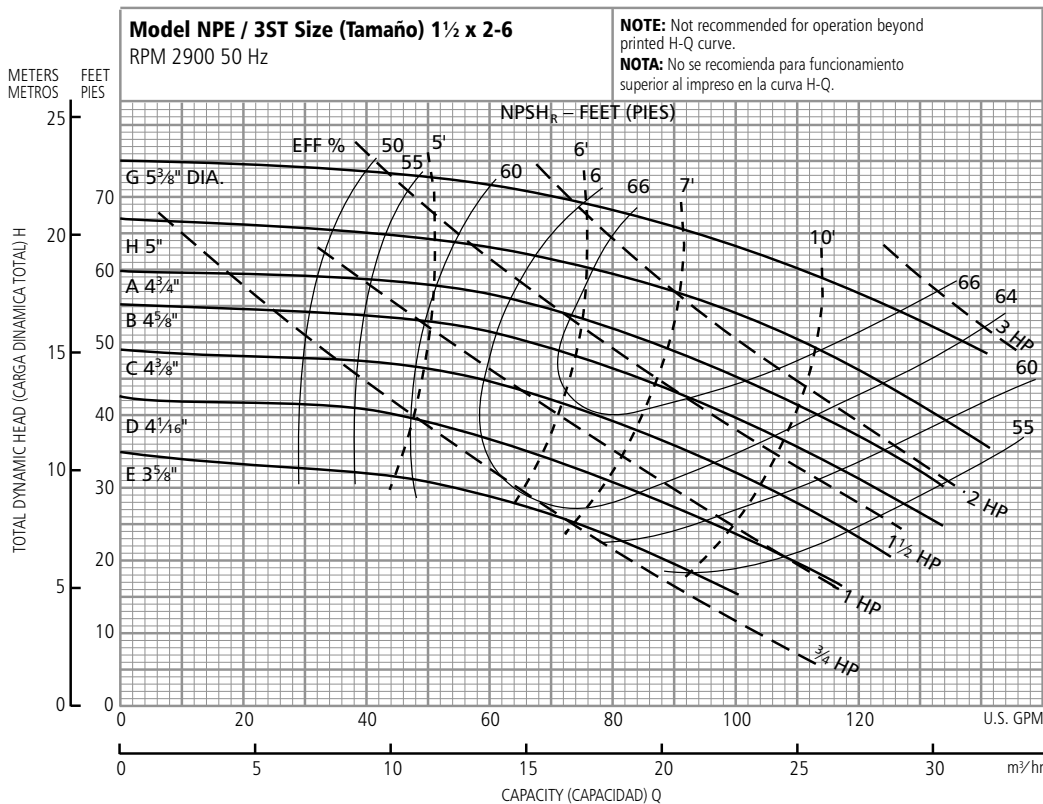
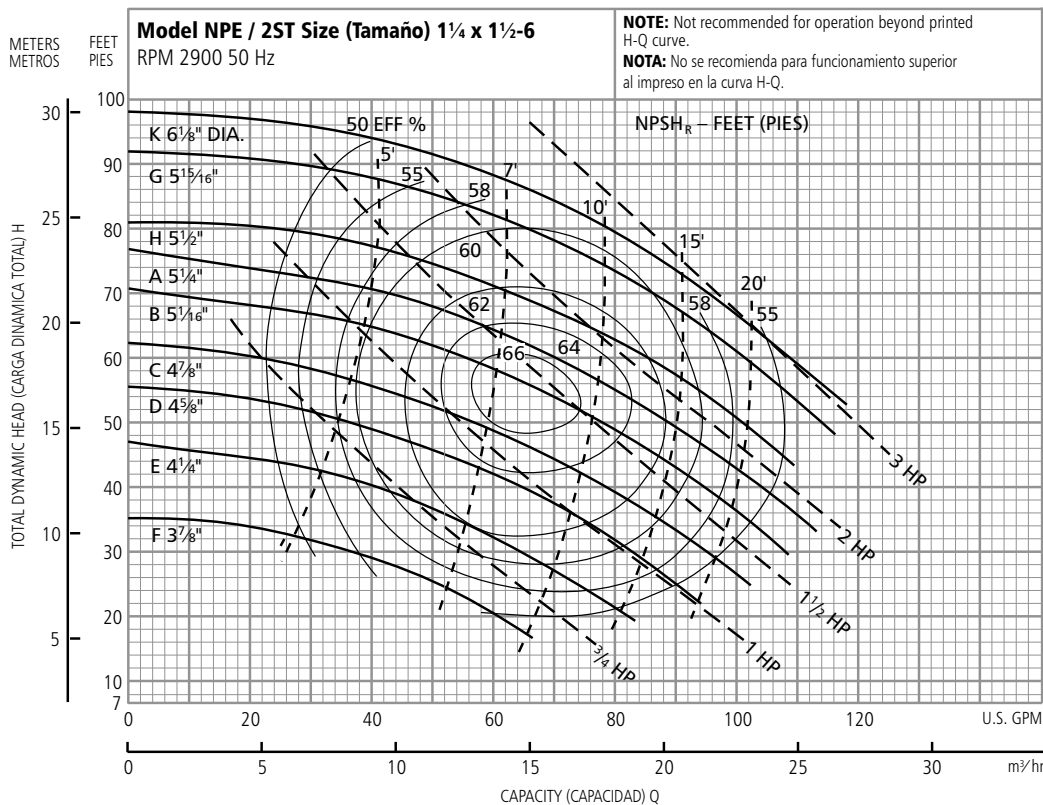
Optional Impeller, Impulsor Opcional

Ordering Code, Código de Pedido	Dia.
A	6 1/8"
B	5 3/4
C	5 3/16
D	4 3/4
E	4 7/16
F	4 1/16

NOTE: Although not recommended, the pump may pass a 1/16" sphere.
NOTA: Si bien no se recomienda, la bomba puede pasar una esfera de 1/16".

Performance Curves – 50 Hz, 2900 RPM

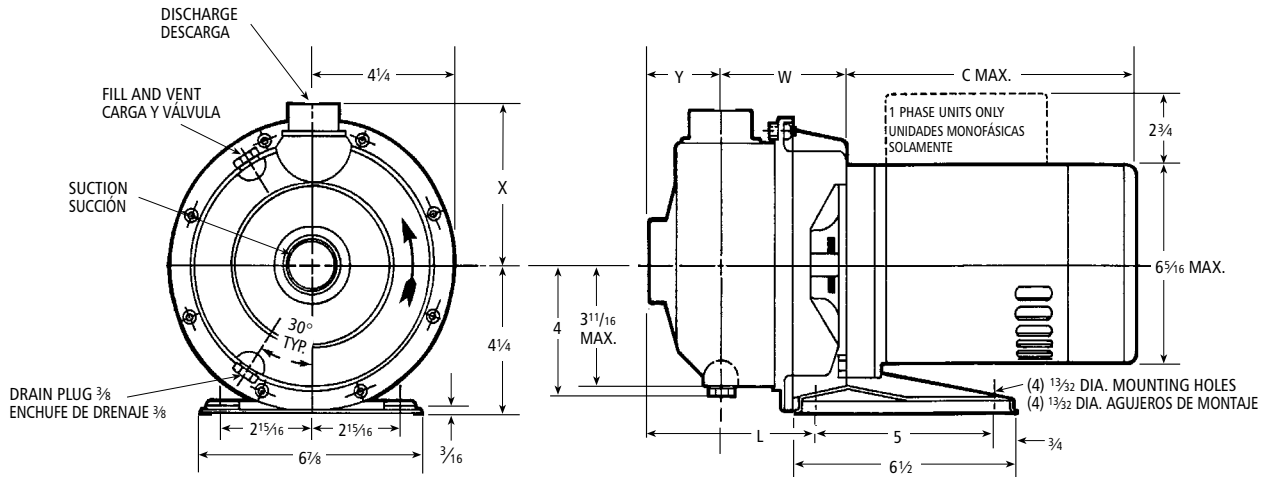
Curvas de Funcionamiento – 50 Hz, 2900 RPM



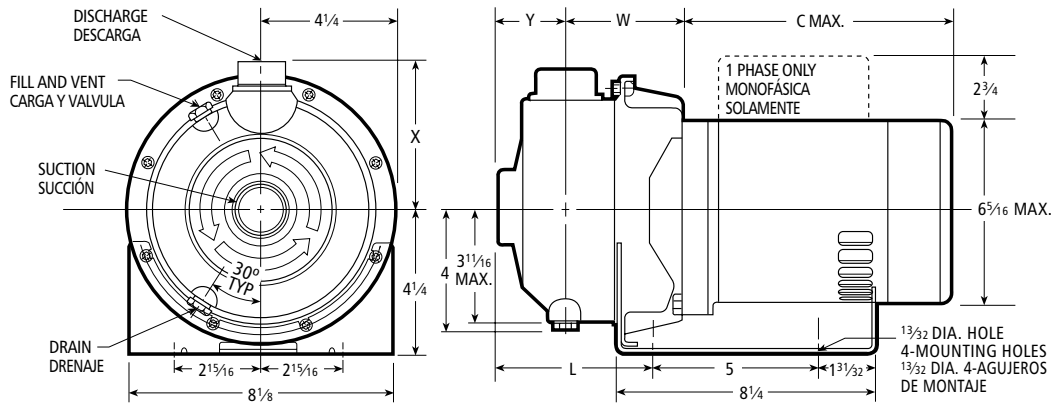
NPE Close Coupled – Dimensions, Weights and Specifications NPE Acople Cerrado – Dimensiones, Pesos y Especificaciones

Clockwise Rotation Viewed from Drive End

Rotación en Dirección de las Agujas del Reloj Visto desde el Extremo del Motor



ODP and TEFC 1/2, 3/4 and 1 HP (standard), ODP y TEFC 1/2, 3/4 y 1 HP (estándar)



ODP and TEFC 1 1/2, 2 and 3 HP (standard), ODP y TEFC 1 1/2, 2 y 3 HP (estándar)

Specifications Especificaciones

Capacities to:

85 GPM (322L/min) at 1750 RPM
170 GPM (643L/min) at 3500 RPM

Heads to:

39 feet (12 m) at 1750 RPM
150 feet (46 m) at 3500 RPM

Working pressures to:

125 PSIG (9 bars)

Maximum temperatures to:

212° F (100° C) with standard seal
or 250° F (121° C) with optional
high temperature seal.

Direction of rotation:

Clockwise when viewed from
motor end.

Motor specifications:

NEMA 56J frame, 1750 RPM,
1/2 HP. 3500 RPM 1/2 through
5 HP. Open drip-proof, totally
enclosed fan-cooled or explosion
proof enclosures. Stainless steel
shaft with ball bearings.

Single phase: Voltage 115/230
ODP and TEFC. (3 and 5 HP model
– 230 V only) Built-in overload
with auto-reset provided.

Three phase: Voltage 208-
230/460 ODP, TEFC and EX
PROOF.

NOTE: For three phase motors,
overload protection must be
provided in starter unit. Starter
and heaters must be ordered
separately.

Capacidades:

85 GPM (322L/min) a 1750 RPM
170 GPM (643L/min) a 3500 RPM

Cargas:

39 pies (12 m) a 1750 RPM
150 pies (46 m) a 3500 RPM

Presión de trabajo:

125 PSIG (9 bars)

Temperatura máxima:

212° F (100° C) con sello estándar
o 250° F (121° C) con sello opcio-
nal para alta temperatura.

Dirección de rotación:

En dirección de las agujas del reloj
visto desde el extremo final del
motor.

Motores:

Armazón 56J NEMA, 1750 RPM
1/2 HP. 3500 RPM 1/2 a 5 HP.

Cubiertas abiertas resguardadas,
totalmente encerradas enfriadas
por ventilador o a prueba de ex-
plosiones. Eje de acero inoxidable
con balineras de bolas.

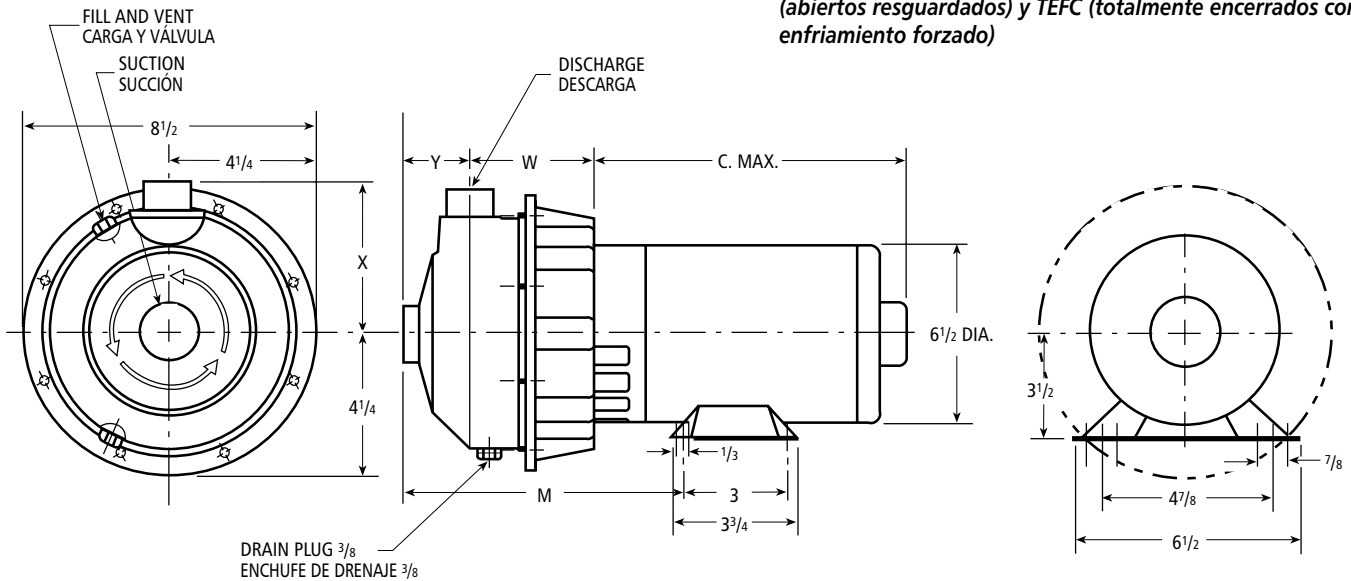
Monofásicos: Voltaje 115/230
ODP y TEFC. (modelo 3 y 5 HP
– 230 voltios solamente) Se
proporciona protección térmica
contra sobrecarga construida con
reseteo automático.

Trifásicos: Voltaje 208-230/460
ODP, TEFC y EX PROOF.

NOTA: Para motores trifásicos se
debe de proporcionar la protección
térmica contra sobrecarga en la unidad
de arranque. El arrancador y los calen-
tadores se deben pedir por separado.

NPE Close Coupled with Footed Motor, Explosion-proof and 5 HP Motors
NPE Acople Cerrado con Motor con Patas, Motores a Prueba de Explosión Y 5 HP

All Explosion Proof Motors and 5 HP ODP and TEFC
 Todos los motores son a prueba de explosiones, 5 HP, ODP (abierto resguardado) y TEFC (totalmente encerrados con enfriamiento forzado)



Dimensions – Determined by Pump,
Dimensiones – Determinadas por la Bomba

Pump, Bomba	Suction, Succión	Discharge, Descarga	HP	W	X	Y	L	M
1ST	1 1/4	1	1/2 – 3	3 5/16	4 3/8	2	4 9/16	7 5/16
2ST	1 1/2	1 1/4	3/4 – 5	3 3/4	4 1/2	2 1/8	5 1/8	7 7/8
3ST	2	1 1/2	1 – 5	3 3/4	4 5/8	2 1/8	5 1/8	7 7/8

Available Motor Weights and Dimensions,
Pesos y Dimensiones Disponibles del Motor

HP	Motor Weights, Pesos del Motor						C Max. Length, (Longitud)
	1 Phase, Monofásicos			3 Phase, Trifásicos			
	ODP	TEFC	EXP	ODP	TEFC	EXP	
1/2	16	21	47	19	18	27	9 15/16
3/4	19	24	41	21	21	30	10 1/4
1	22	26	49	23	21	30	11
1 1/2	28	35	56	27	27	37	11 5/16
2	33	39	60	32	33	44	12 1/16
3	40	43	—	41	37	—	12 1/16
5	42	—	—	42	45	—	14 1/4

Dimensions in inches, weights in pounds.
 Dimensiones en pulgadas, pesos en libras.

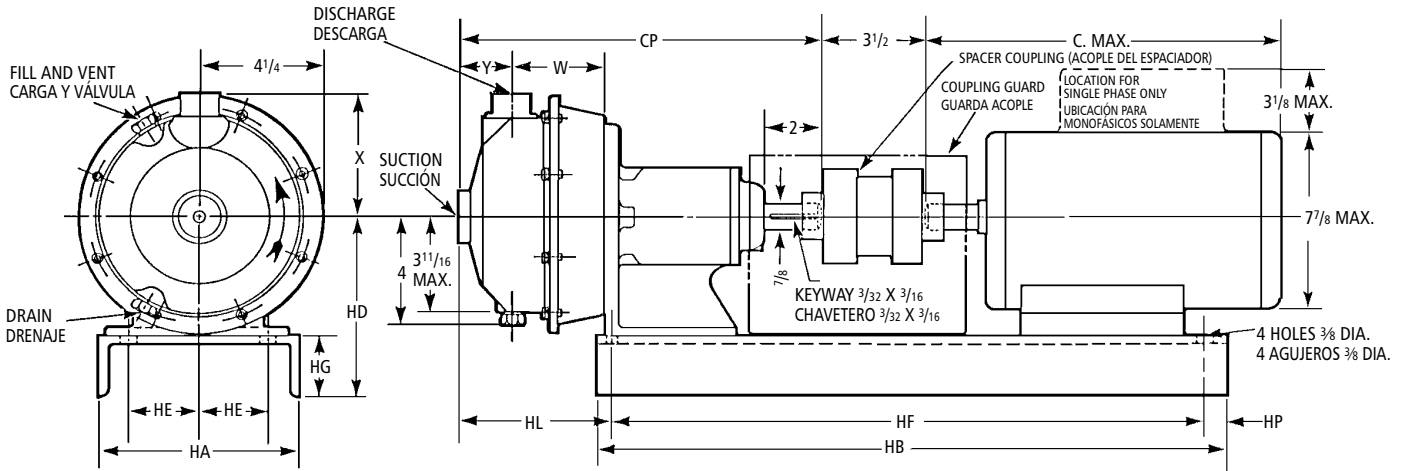
NOTES:

- Pump will be shipped with top vertical discharge position as standard. For other orientations, remove casing bolts, rotate discharge to desired position, replace and tighten 6mm bolts to 5 – 6 lbs.-ft.
- Motor dimensions may vary with motor manufacturers.
- Dimensions in inches, weights in pounds.
- For explosion proof motor dimensions consult factory for information.
- Not to be used for construction purposes unless certified.

NOTAS:

- Las bombas se transportarán con la descarga vertical superior como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y reemplazar y apretar los tornillos de 6mm a 5 – 6 libras-pies.
- Las dimensiones del motor puede que varíen con los fabricantes.
- Dimensiones en pulgadas, pesos en libras.
- Para las dimensiones de los motores a prueba de explosión consultar con la fábrica para información.
- No usar para propósitos de construcción sin certificar.

NPE Frame Mounted – Dimensions, Weights and Specifications
NPE Armazón Montado – Dimensiones, Pesos y Especificaciones



Specifications
Especificaciones

Capacities to:
 85 GPM (322L/min) at 1750 RPM
 170 GPM (643L/min) at 3500 RPM

Heads to:
 39 feet (12 m) at 1750 RPM
 150 feet (47 m) at 3500 RPM

Working pressures to:
 125 PSIG (9 bars)

Maximum temperatures to:
 212°F (100°C) with standard seal
 or 250°F (121°C) with optional
 high temperature seal.

Direction of rotation:
 Clockwise when viewed from
 motor end.

Motor specifications:
 T-frame single and three phase.
 Open drip-proof, TEFC or explosion
 proof enclosures are available
 for 60 Hz, 3500 and 1750 RPM
 operation.

For three phase motors, overload
 protection must be provided in
 starter unit. Starter and heaters
 must be ordered separately.

Capacidades:
 85 GPM (322L/min) a 1750 RPM
 170 GPM (643L/min) a 3500 RPM

Cargas:
 39 pies (12 m) a 1750 RPM
 150 pies (47 m) a 3500 RPM

Presión de trabajo:
 125 PSIG (9 baras)

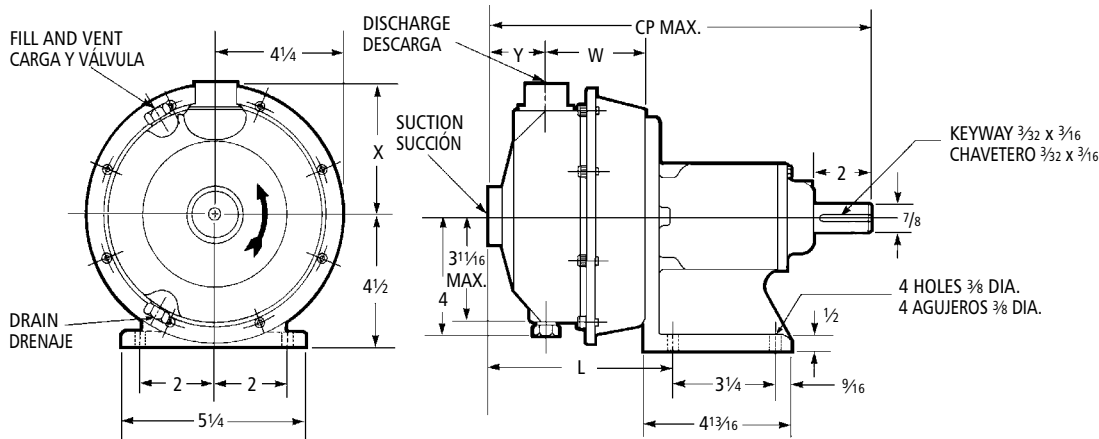
Temperatura máxima:
 212°F (100°C) con sello estándar
 o 250°F (121°C) con sello opcional
 para alta temperatura.

Dirección de rotación:
 En dirección de las agujas del reloj
 visto desde el extremo final del
 motor.

Motores:
 Armazón T- monofásico y
 trifásico. A prueba de goteo, TEFC
 o recintos a prueba de explosión
 están disponibles para funciona-
 miento de 60 Hz, 3500 y 1750
 RPM.

Para motores trifásicos se debe de
 proporcionar la protección térmica
 contra sobrecarga en la unidad
 de arranque. El arrancador y los
 calentadores se deben pedir por
 separado.

NPE-F



**Dimensions and Weights – Determined by Pump,
Dimensiones y Pesos – Determinados por la Bomba**

Dim. "HL" Determined by Pump and Motor,
Dim. "HL" Determinadas por la Bomba y el Motor

Pump, Bomba	Suct. NPT, Succión NPT	Disch. NPT, Descarga NPT	CP	L	W	X	Y	Wt., Peso	Frame, Armazón		
									56	140	180
1ST	1¼	1	12 ¹⁵ / ₁₆	6 ⁷ / ₁₆	3 ⁵ / ₁₆	4 ³ / ₈	2	22½	4 ⁹ / ₁₆	6 ⁷ / ₁₆	
2ST	1½	1¼	13½	7	3¾	4½	2 ¹ / ₈	23	5½	7	
3ST	2	1½				4 ⁵ / ₈					

**Available Motor and Bedplate Dimensions and Weights,
Pesos y Dimensiones Disponibles de la Fundación y del Motor**

Motor Frame, Armazón del Motor	HA	HB	HD	HE	HF	HG	HP	Wt. Max., Peso Máx	Shims, Deflector
56 143T 145T	8	26	6 ⁷ / ₈	3 ³ / ₈	22 ³ / ₈	2 ³ / ₈	1	30	1"
182T 184T	10	26	7¼	3¾	24	2¾	7/8	43	—

Frame Size, Tamaño del Armazón	Horsepower, Fuerza				C Max.	Wt. Max., Peso Máx.
	3500 RPM					
	Single Phase, Monofásicos		Three Phase, Trifásicos			
	ODP	TEFC	ODP	TEFC		
56	½ – 1½	½ – 1½	½ – 1	½ – 1	13	45
143T	—	—	1½	1½	13 ³ / ₈	45
145T	2	2	1½ – 3	1½ – 2	14¼	52
182T	3	3	5	3	16 ³ / ₈	63
184T	5	5	—	5	18½	112

NOTES:

- Pump will be shipped with top vertical discharge position as standard. For other orientations, remove casing bolts, rotate discharge to desired position, replace and tighten 6mm bolts to 5 – 6 lbs.-ft.
- Motor dimensions may vary with motor manufacturers.
- Dimensions in inches, weights in pounds.
- For explosion proof motor dimensions consult factory for information.
- Not to be used for construction purposes unless certified.

NOTAS:

- Las bombas se transportarán con la descarga vertical superior como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y reemplazar y apretar los tornillos de 6mm a 5 – 6 libras-pies.
- Las dimensiones del motor puede que varíen con los fabricantes.
- Dimensiones en pulgadas, pesos en libras.
- Para las dimensiones de los motores a prueba de explosión consultar con la fábrica para información.
- No usar para propósitos de construcción sin certificar.

Typical Applications *Aplicaciones Típicas*

Specifically designed for a broad range of general applications traditionally requiring various materials such as all iron, bronze fitted or all bronze construction.

- Water circulation
- Booster service
- Liquid transfer
- Spray system
- Chillers
- Washing/cleaning systems
- Injection molding cooling
- Reverse osmosis
- Air scrubbers
- Heat exchangers
- Filtration systems
- Jockey pumps
- OEM applications
- General water services

Diseñadas específicamente para una amplia variedad de aplicaciones generales, requiriendo tradicionalmente varios materiales, tales como hierro, bronce empotrado o todas las construcciones de bronce.

- *Circulación de agua*
- *Aumento de presión*
- *Transferencia de líquidos*
- *Sistemas de aspersión*
- *Enfriadores*
- *Sistemas de lavado/limpieza*
- *Enfriamiento con molde por inyección*
- *Osmosis reversa*
- *Depuradores de aire*
- *Termopermutadores*
- *Sistemas de filtración*
- *Bombas auxiliares*
- *Aplicaciones OEM*
- *Servicios generales de agua*



**Brewery,
Fábrica de
Cerveza**



**Pure Water/
OEM,
Agua Pura/
OEM**



**Car Wash,
Lavadero
de Autos**



**Chiller,
Enfriador**



**Pressure
Booster
System,
Sistema de
Aumento
de Presión**

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Goulds Pumps son una marca de fábrica de ITT Water Technology, Inc. - un subsidiario de ITT Industries, inc.

Goulds Pumps y el símbolo ITT Engineered Blocks son marcas registradas y marcas comerciales de ITT Industries.

ATB 3 and ATS3 Series Spec Sheet Level Switch - Small Size - Heavy Duty



The ATB3 is designed for high or low level alarm or switch point applications in rugged situations similar to oil tank reservoirs or industry vessels that require a more robust level switch. Notice the larger brass one piece machined hex to get a wrench on - this model also has an optional brass set screw locking collar in place of the clip.

Internal reed switch selection is the same Almeg quality standard but we've beefed up the external part as well as fully encapsulated the reed switch to maintain a complete moisture free environment. The leads are wire wrapped (not clipped) soldered and heat shrink sealed to the reed switch before encapsulating.

The TRUE closed cell Buna float will not swell or take on moisture - even if cut or drilled. It is designed like a tight bee hive or honey comb construction.

100% of our controls are tested before shipping.

The ATB3 is available in a single order or OEM applications.

PRODUCT DATA SHEET
POLYESTER FILTER BAGS

PE P1P(S) / PE P2P(S)

PE LFB1 / PE LFB2

Polyester needle felt features a three dimensional structure of high porosity. This results in a much higher solids loading capacity over the equivalent area of mesh fabric. The outer surfaces on all filter bags have been heat treated to give a glazed finish to help reduce fiber migration.



Filter Medium:	Polyester
Handle:	Optional, Twill Tape
Micron Ratings:	1, 3, 5, 10, 15, 25, 50, 75, 100, 150, 200 Nominal
Ring:	Polypropylene or Steel, Zinc plated
Options:	Covers
Maximum Differential Pressure:	50 PSID (3.5 kg/cm ²) in restrainer basket
Maximum Temperature:	300°F (135°C)
Dimension:	

Model	Size	Dimensions (D x L)
PE- LFB1	P3	4 1/8" X 8"
PE- LFB2	P4	4 1/8" X 15"
PE- P1P	P1	7 1/16 " X 16 1/2 "
PE-P2P	P2	7 1/16" X 32"

Model 88, 100 PSI Liquid Bag Housing

flow rates to 220 g.p.m.

Krystil Klear's 100 PSI Liquid Bag Housing offers a quality vessel for lower pressure applications. Our 100 PSI vessel has a flat base and includes all of the favorable features of our standard 150 PSI vessel.

FEATURES

- ▶ Carbon or 304 stainless steel construction
- ▶ 100 PSI pressure rating
- ▶ Low pressure drop
- ▶ Quick swing closure with eye nuts
- ▶ Buna seals - lid & basket
- ▶ Differential, drain, and vent ports
- ▶ Adjustable support legs
- ▶ 304 stainless steel strainer basket
- ▶ 2 inch female NPT connection

Our 100 PSI vessel effectively removes dirt, pipe scale, and other contaminants from process liquids such as water, chemical and petroleum products. Quality construction and design assure protection for all down-stream equipment.

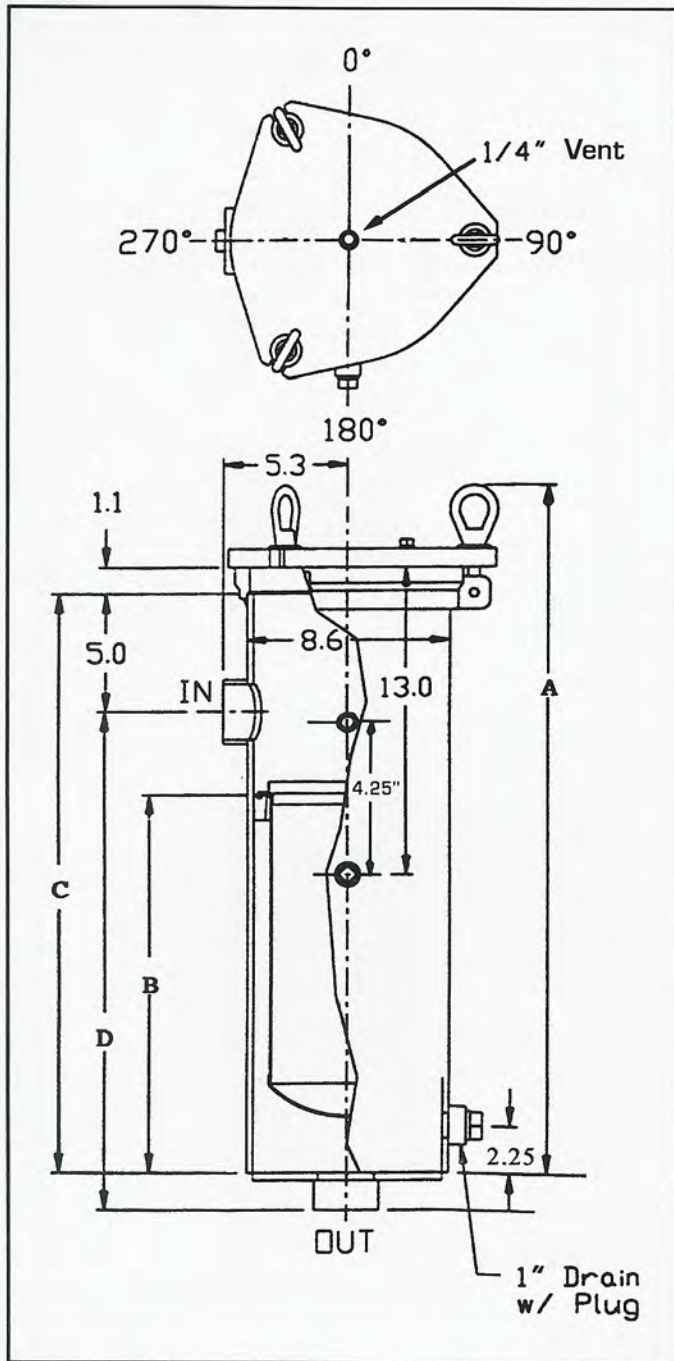
VESSEL CONSTRUCTION: Our model 88, 100 PSI vessel is designed for operating up to 100 PSI at 300°F. The housing design provides a large sump area at the bottom of the basket for dirt and scale accumulation. This design utilizes the filter more efficiently and prolongs the element life.

The **basket** seals onto an o-ring to eliminate particulate bypass between the basket and seat. Optional **mesh-lined strainer baskets** and **o-rings** are available. Please refer to their individual brochures in our liquid catalog.

A **vent** in the housing lid and a **drain port** in the housing speed evacuation and filling. **Gauge ports** are located on the body of the housing to install gauges for monitoring the differential pressure across the bag or strainer basket. Permanently piped housings are opened with simple tools without disturbing the piping. **Swing bolts** with eye-nuts allow easy opening and closing of the swing-lid. No need to remove any hardware.

As a standard finish, all vessels are blast cleaned and painted inside and out with a **2-part epoxy**. Stainless steel vessels are supplied with a satin finish.





All dimensions are approximate.

	Basket Depth	
	15"	30"
A	30.6	42.1
B	16.0	27.5
C	24.5	36.0
D	21.0	32.6

SPECIFICATIONS

Housing lid has a 3-bolt swing closure with a vent and gauge port. Connections are 2 inch NPT with a side inlet and bottom outlet. Housing is supplied with two differential pressure ports to measure the differential pressure across the filter bag. A two-part epoxy finish is applied on the carbon steel vessels to maximize the life of the housing; stainless steel vessels are supplied with a satin finish. Basket material is manufactured from 304 stainless steel with 9/64" perforations to act as a strainer or to accept a #1 or #2 size liquid bag. Basket seals onto a Buna o-ring in the basket support. Adjustable tripod leg assembly is supplied with housing. Vessels are rated at a 100 pounds per square inch design.

Building a Part Number for Model 88-100PSI: EX: **L88152NAC10**

Description: Model 88, 15" basket, 2" NPT connection, outlet style A (bottom), carbon steel construction and 100 PSI rating.

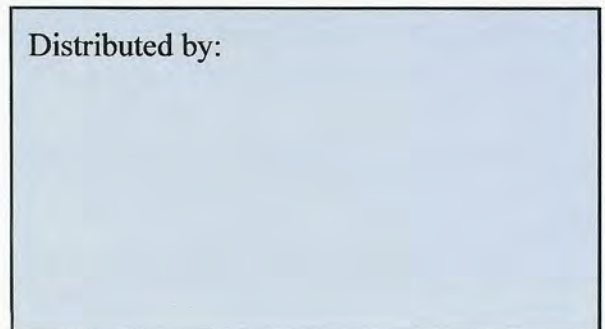
Adjustable support legs have 12" bolt circle and a 16" height adjustment.

HOUSING	15 BASKET	2 CONN SIZE	N CONN TYPE	A CONN	C MATERIAL	10 PSI
L88	15 (#1) 30 (#2)	2	NPT=N	A	CARBON=C 304SS=4	100

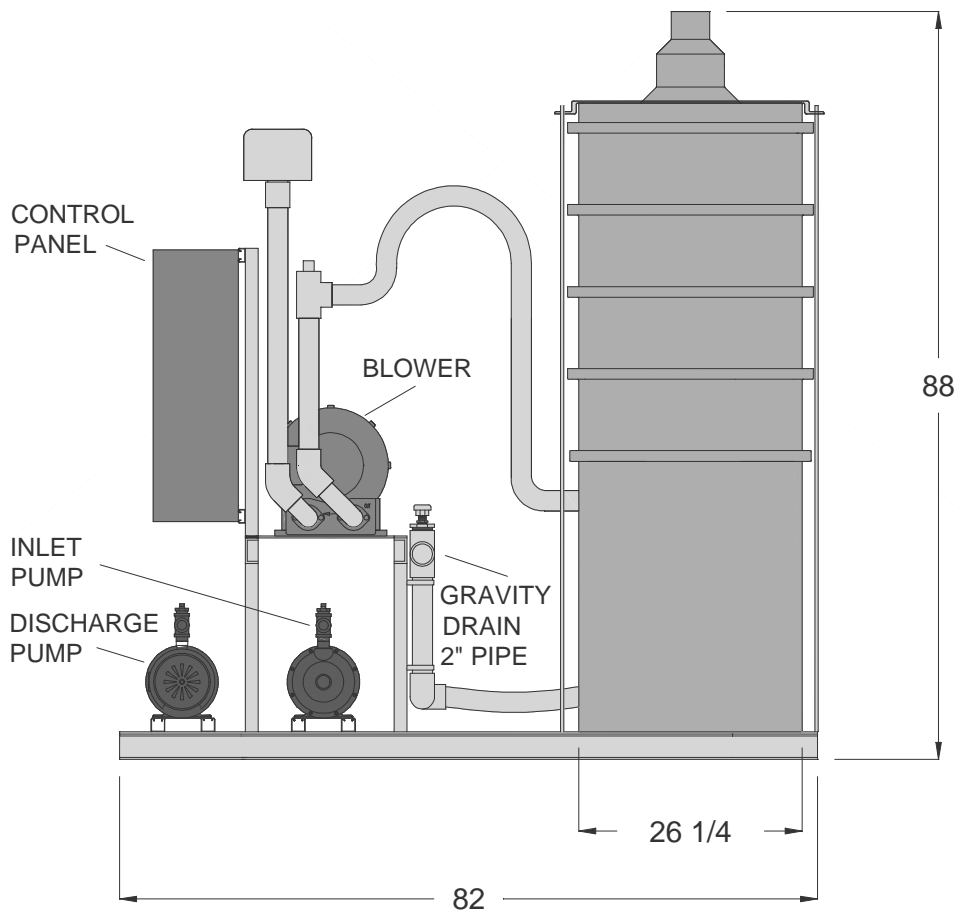
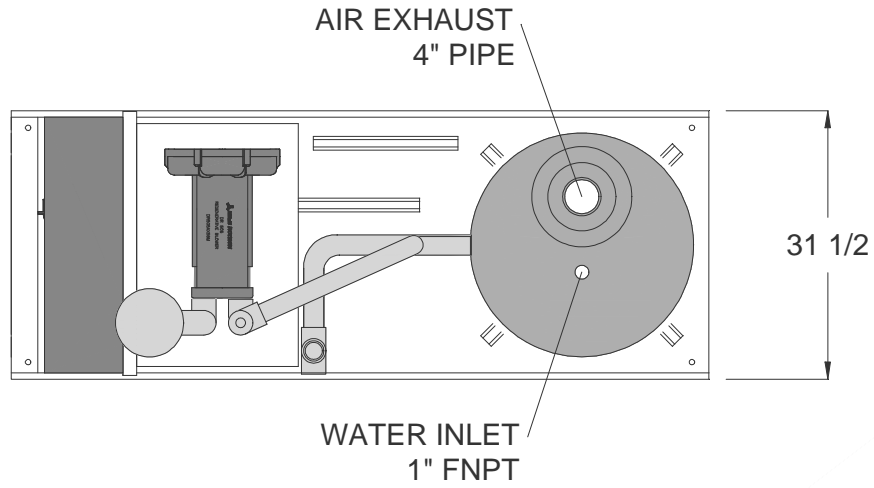
Krystil Klear Filtration

Div. Of Geyer's Mfg. & Design, Inc.
 9449 S. 550 W. Phone: 800-869-0325 219-278-7161
 Winamac, IN 46996 Fax: 219-278-7115
 kkfilter@pwrtec.com web site: KrystilKlear.com

Distributed by:



QED EZ-Stacker Model 2.4P



SPECIFICATIONS

U.S. standard sheet gauge to 7 gauge. Dimensions in inches. Weights in pounds. WR² in lb.-ft.².

WHEEL SPECIFICATIONS

Size	Aluminum		Steel	
	Wt.	WR ²	Wt.	WR ²
1403	10.1	0.96	19.7	2.74
1404	8.5	1.43	18.0	3.04
1406	11.7	2.40	20.5	3.46
1503	10.8	1.23	21.8	3.59
1504	8.8	1.69	19.0	3.68
1506, 1508	11.8	2.40	21.5	4.16
1603	11.5	1.53	23.9	4.56
1604	9.0	1.98	20.0	4.41
1606, 1608	12.1	2.50	23.0	5.07
1703	12.3	1.93	26.3	5.79
1704	9.3	2.30	21.0	5.22
1706, 1708	12.2	2.60	24.5	6.09
1803	13.0	2.36	28.6	7.16
1804	9.5	2.65	22.0	6.13
1806, 1808	12.4	2.60	26.0	7.25
1903	14.2	2.92	31.1	8.42
1904, 1906	12.0	3.73	29.5	9.16
1908, 1910	15.1	5.10	34.5	10.72
2003	15.1	5.02	33.7	10.23
2004, 2006	12.3	4.22	31.0	10.67
2008, 2010	15.3	5.20	36.5	12.56
2103	16.0	4.24	36.5	12.31
2104, 2106	12.5	4.74	32.5	12.33
2108, 2110	15.5	5.30	38.0	14.42
2203	17.1	5.02	39.3	14.70
2204, 2206	12.8	5.31	34.0	14.16
2208, 2210	15.6	5.40	40.0	16.66
2303	18.3	6.07	49.4	20.83
2304	19.8	6.50	52.5	22.27
2306, 2308	18.5	8.42	45.0	20.93
2310, 2312	21.7	10.60	53.5	24.35
2403	19.4	7.16	53.1	24.50
2404	20.9	7.80	56.4	26.14
2406, 2408	18.8	9.29	48.0	23.79
2410, 2412	21.9	10.80	56.0	27.75
2503	20.5	8.33	56.9	28.64
2504	22.0	9.00	60.4	30.49
2506, 2508	19.0	10.22	50.0	26.89
2510, 2512	21.9	11.00	58.5	31.46
2603	21.8	9.63	60.9	33.27
2604	23.1	10.30	64.5	35.36
2606, 2608	19.3	11.20	52.0	30.24
2610, 2612	22.3	11.20	61.0	35.48

MATERIAL SPECIFICATIONS

HOUSING				
Wheel diameter	Sides	Scroll	Inlet plate	Drive plate
14-18	10	10	1/4	10
19-22	10	10	1/4	10
23-26	10	10	1/4	10

SHAFT DIAMETER				
Wheel diameter	Arrangement 1		Arrangement 8	
	Standard	Heat Fan with Shaft Seal	Standard	Heat Fan with Shaft Seal
14-18	1 ⁷ / ₁₆	1 ⁷ / ₁₆	1 ⁷ / ₁₆	1 ⁷ / ₁₆
19-22	1 ⁷ / ₁₆	1 ¹¹ / ₁₆	1 ⁷ / ₁₆	1 ⁷ / ₁₆
23-26	1 ¹¹ / ₁₆	1 ¹⁵ / ₁₆ †	1 ⁷ / ₁₆	1 ¹¹ / ₁₆

SHAFT DIAMETER				
Wheel diameter	Arrangement 9		Arrangement 10	
	Standard	Heat Fan with Shaft Seal	Standard	Heat Fan
14-18	1 ⁷ / ₁₆	1 ⁷ / ₁₆	1 ⁷ / ₁₆	1 ⁷ / ₁₆
19-22	1 ¹¹ / ₁₆	1 ¹¹ / ₁₆	1 ⁷ / ₁₆	1 ⁷ / ₁₆
23-26	1 ¹⁵ / ₁₆	1 ¹⁵ / ₁₆	1 ¹¹ / ₁₆	1 ¹¹ / ₁₆

BEARINGS*				
Wheel diameter	Arrangement 1/9		Arrangement 8	Arrangement 10
	Inboard	Outboard		
14-18	A	A‡	A	A
19-22	B	B	A	B
23-26	C	B‡	A	B

A-200 Series ball bearing. B-22400 Series roller bearing. C-300 Series ball bearing.

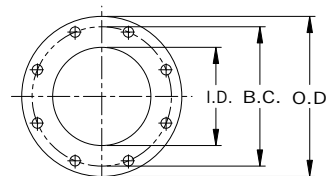
*nyb reserves the right to substitute bearings of equal rating.

‡ Fans with heat fan construction and shaft seal:

Arr. 1: Sizes 23-26 include a shaft turndown at the outboard bearing, with a bearing size of 1¹¹/₁₆". Inboard bearing size is 1¹⁵/₁₆".

Arr. 9: Sizes 14-18 include a Type B outboard bearing, in lieu of the standard Type A.

FLANGE				
DIMENSIONS [INCHES]				
Size	I.D.	O.D.	Bolt circle	Holes† No. - size
03	3	7 ¹ / ₂	6	4 - 3/4"
04	4	9	7 ¹ / ₂	8 - 3/4"
05	5	10	8 ¹ / ₂	8 - 7/8"
06	6	11	9 ¹ / ₂	8 - 7/8"
08	8	13 ¹ / ₂	11 ³ / ₄	8 - 7/8"
10	10	16	14 ¹ / ₄	12 - 1"
12	12	19	17	12 - 1"



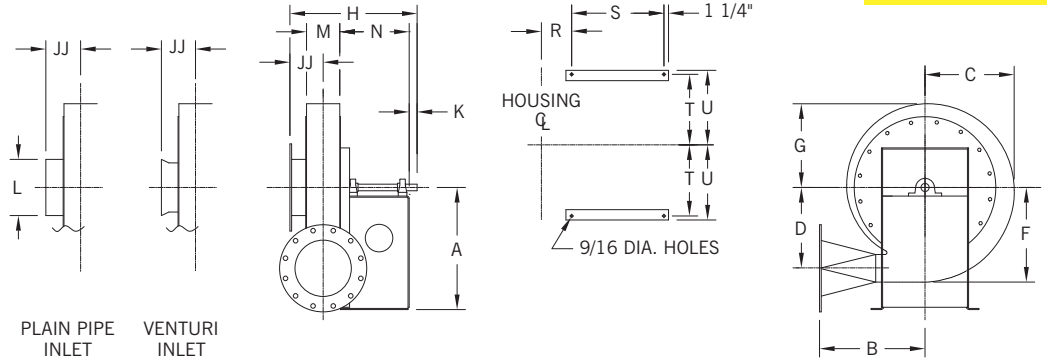
† Holes straddle centerline. ANSI Class 125/150 hole pattern. Flange thickness 3/8"

ARRANGEMENTS

1/9

PRESSURE BLOWERS

Maximum Airstream Temperature:
200°F. – aluminum wheel.
300°F. – steel wheel.
600°F. – heat fan.

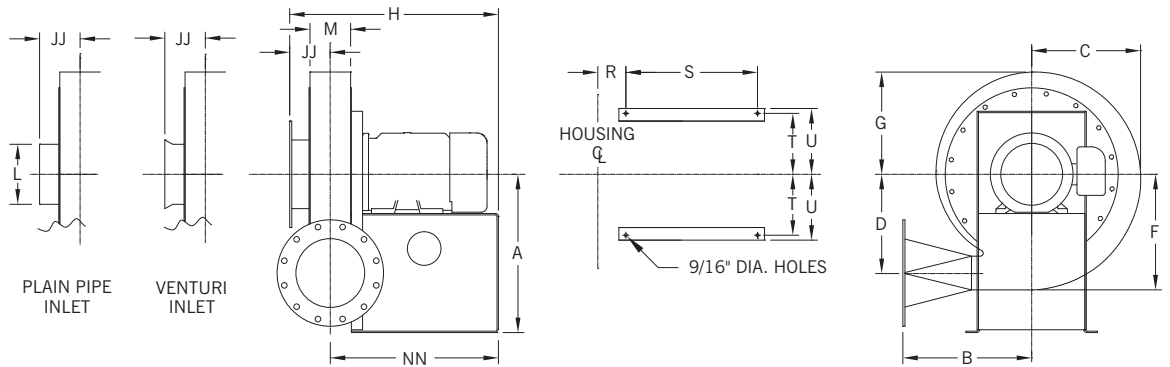


ARRANGEMENT

4

PRESSURE BLOWERS

Maximum Airstream Temperature:
180°F.

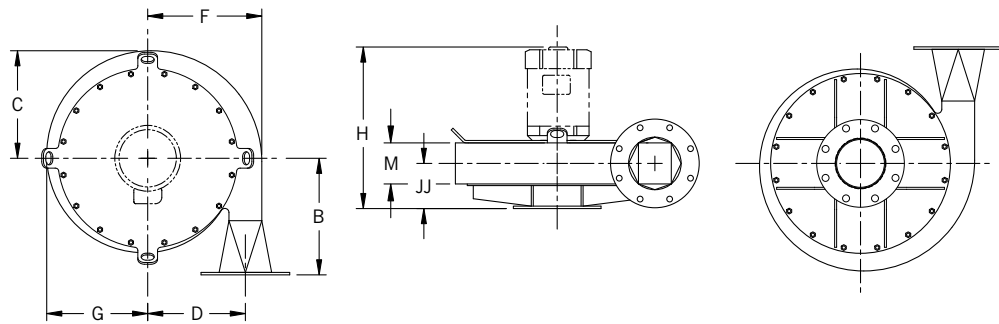


ARRANGEMENT

4-V

PRESSURE BLOWERS

Maximum Airstream Temperature:
120°F.

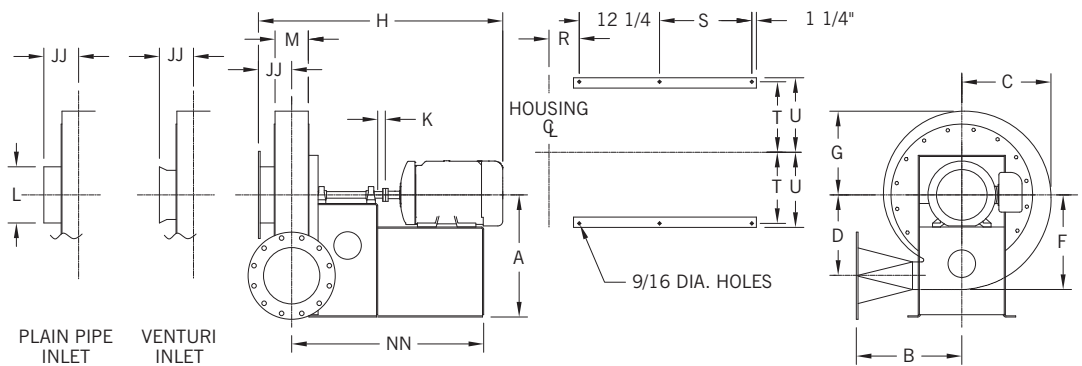


ARRANGEMENT

8

PRESSURE BLOWERS

Maximum Airstream Temperature:
200°F. – aluminum wheel.
300°F. – steel wheel.
600°F. – heat fan.

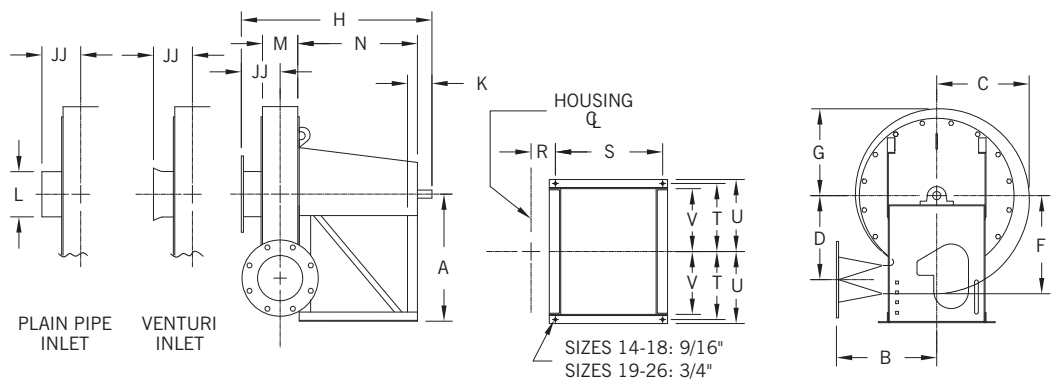


ARRANGEMENT

10

PRESSURE BLOWERS

Maximum Airstream Temperature:
200°F. – aluminum wheel.
300°F. – steel wheel.
600°F. – heat fan.



ARRANGEMENTS 1, 4, 4-V, 8, 9, 10

Dimensions not to be used for construction unless certified. Bare fan weight does not include wheel or motor. Weights in pounds. Wheel weights on page 11.

HOUSING DIMENSIONS [INCHES]

Fan Size	Outlet Size	Inlet Size	B	C	D	F	G	M	JJ [Inlet types]			L
									Flanged	Plain pipe	Venturi	
14-18	03	05	18 1/4	13 5/8	11 3/4	14 3/8	12 3/4	27/8	5 1/8	4 3/4	4 5/8	5 5/8
	04	06						37/8	5 5/8	5 1/4	4 7/8	6 5/8
	06	08						6 1/4	6 3/4	6 3/8	6 3/8	8 5/8
	08	08										
19-22	03	05	17 3/4	16 1/2	14 7/8	17 1/2	15 1/2	27/8	5 5/8	5 1/4	5 1/4	5 5/8
	04	06						37/8	6 1/8	5 3/4	5 3/8	6 5/8
	06	06						6 1/4	6 3/4	6 3/8	6 3/8	8 5/8
	08	08										
23-26	10	10	21 3/4					3 5/8	6 3/8	6	5 5/8	5 5/8
	03	05	19	19 1/2	17 5/8	20 5/8	18 1/4	5	7	6 5/8	6 5/8	6 5/8
	04	06						7 1/4	7 1/4	6 7/8	6 7/8	10 3/4
	06	08										
	08	08										
	10	10						23				
12	12											

BARE FAN WEIGHTS AND MOTOR LIMITATIONS

Tolerance: ± 1/8"

Fan Size	Outlet Size	Inlet Size	Arr. 1 Wt.	Motor Frame Size (Arr. 4, 8)	Weight		Arr. 4-V		
					Arr. 4	Arr. 8	Motor Frame Size	Weight	
14-18	03	05	200	143T-145T	145	285	182TC-184TC	130	
				182T-184T	170				
	04	06	205	143T-145T	150	290	182TC-184TC	135	
				182T-184T	175				
	06	08	220	143T-145T	165	305	182TC-184TC	150	
				182T-184T	190				
213T-215T				310	213TC-215TC				
15-18	08	08	220	182T-184T	190	305	182TC-184TC	155	
				213T-215T	310	213TC-215TC			
19-22	03	05	270	143T-145T	235	380	182TC-184TC	180	
				182T-184T					
	04	06	275	143T-145T	245	385	182TC-184TC	185	
				182T-184T					
	06	06	275	143T-145T	245	390	182TC-184TC	190	
				182T-184T					
				213T-215T			395		213TC-215TC
	08	08	290	182T-184T	260	405	182TC-184TC	205	
				213T-215T			410		213TC-215TC
				254T-256T			290		425
	10	10	300	213T-215T	270	415	213TC-215TC	215	
				254T-256T			300		435
284TS-286TS				300			430		284TCS-286TCS
23-26	03	05	350	182T-184T	270	400	182TC-184TC	235	
				213T-215T		445	213TC-215TC		
				254T-256T		300	450		254TC-256TC
	04	06	350	182T-184T	275	445	182TC-184TC	245	
				213T-215T		450	213TC-215TC		
				254T-256T		300	470		254TC-256TC
	06	08	365	182T-184T	285	460	182TC-184TC	245	
				213T-215T		465	213TC-215TC		
				254T-256T		315	485		254TC-256TC
	08	08	365	213T-215T	290	470	213TC-215TC	250	
				254T-256T		320	485		254TC-256TC
				284TS-286TS		320	490		284TCS-286TCS
10	10	385	254T-256T	335	505	254TC-256TC	265		
			284TS-286TS		335	505		284TCS-286TCS	
			324TS-326TS		360	510		324TCS-326TCS	
12	12	395	284TS-286TS	345	515	284TCS-286TCS	280		
			324TS-326TS		370	520		324TCS-326TCS	

Fan Size	Outlet Size	Arr. 9		Arr. 10			
		Pedestal Number	Weight	Weight	Max. Motor Size		
					ODP	TEFC	C-NW
14-18	03	1	201	190	215T	215T	16 5/8
		2	215				
		3	246				
		4	286				
	04	1	206	200			
		2	220				
		3	251				
		4	291				
	06,08	1	221	215			
		2	235				
		3	266				
		4	306				
19-22	03	5	270	305			
		6	287				
		7	330				
	8	345					
	9	354					
	04,06	5	275		315		
		6	292				
		7	335				
		8	350				
9		359					
08,10	5	300	335				
	6	317					
	7	360					
	8	375					
	9	384					
23-26	03,04	10	417	355			
		11	433				
		12	443				
	06,08	10	432		370		
		11	448				
		12	458				
10,12	10	462	400				
	11	478					
	12	488					

Tolerance: ± 1/8"

N/A: Not Available due to motor shaft/wheel fit.

ARRANGEMENTS 4, 4-V, 8

Dimensions not to be used for construction unless certified. Note: See page 12 for dimensional drawings.

Wheel dia.	Outlet Size	Inlet flange	Arr. 4 & 8 Motor Frame Size	A		H*		Arr. 4-V Motor Frame Size	H*	K	NN		R	S		T		U		
				Arr. 4	Arr. 8†	Arr. 4	Arr. 8				Arr. 4	Arr. 8		Arr. 4	Arr. 8	Arr. 4	Arr. 8	Arr. 4	Arr. 8	
14-18	03	05	143T-145T	17¾	19½	18	38½	182TC-184TC	20⅞	3⅜	13	31⅜	2⅞	8⅝	15	8⅞	9⅞	9¾	10	
			182T-184T	19		23½	40⅞				17⅞	32⅞		14⅞	16½					
	04	06	143T-145T	17¾		19	39½	182TC-184TC	21⅞		13½	31⅞	3⅜	8⅝	15					
			182T-184T	19		24½	41⅞				18⅜	33⅜		14⅞	16½					
	06	08	143T-145T	17¾		21⅜	41⅞	182TC-184TC	24¼		14⅝	33	4½	8⅝	15					
			182T-184T	19		26⅞	44⅜				20⅞	34½		14⅞	16½					
		213T-215T	19¾	47⅞	213TC-215TC	25½	2⅞	20⅞	36¾	14⅞	18¾									
15-18	08	08	182T-184T	19	19½	26⅞	44⅜	182TC-184TC	24¼	3⅜	20⅞	34½	4½	14⅞	16½					
			213T-215T	19¾												47⅞	213TC-215TC	25½	2⅞	20⅞
19-22	03	05	143T-145T	23	23⅝	24	38⅞	182TC-184TC	21⅜	3⅜	18½	31⅜	2⅞	14⅞	15					
			182T-184T	24			41½					32⅞			16½					
	04	06	143T-145T	23		25	39⅞	182TC-184TC	22⅜		19	31⅞	3⅜	14⅞	15	16½				
			182T-184T	24			42⅞					33⅜					16½			
	06	06	143T-145T	23		25	39⅞	182TC-184TC	22⅜		19	31⅞	3⅜	14⅞	15	16½				
			182T-184T	24			42⅞					33⅜					16½			
			213T-215T	24¾		45⅝	213TC-215TC	23⅝	2⅞		19	36⅝	4½	14⅞	18¾	10⅞	10⅞	11¾	11¾	
	08	08	182T-184T	24		26⅞	44⅜	182TC-184TC	24¼		3⅜	20⅞								34½
			213T-215T	24¾			47⅞					213TC-215TC	25½	20⅞	36¾	19½	24⅞			
			254T-256T	26		32¼	51¾	254TC-256TC	26⅝		25½	25½	42⅞	19½	24⅞					
	10	10	213T-215T	24¾		26⅞	47⅞	213TC-215TC	25½		2⅞	20⅞	36¾			14⅞	18¾			
			254T-256T	26			32¼	51¾	254TC-256TC		26⅝	25½	42⅞	19½	24⅞					
		284TS-286TS	26¾	54⅜	284TCS-286TCS	33⅜	33⅜	25½	42⅞	19½	24⅞									
23-26	03	05	182T-184T	24	25½	43⅞	182TC-184TC	22½	3⅞	18¾	33¾	3¼	14⅞	17						
			213T-215T	24¾		46¼	213TC-215TC	N/A			36			19¼	24⅝					
			254T-256T	26		30½	50½	254TC-256TC			N/A			24¼	41⅜	19½	24⅝			
	04	06	182T-184T	24	26½	44½	182TC-184TC	23⅞	3⅞	19½	34⅜	3⅞	14⅞	17						
			213T-215T	24¾		47⅞	213TC-215TC	N/A			36⅝			19¼	24⅝					
			254T-256T	26		31⅞	51⅞	254TC-256TC			N/A			24⅞	42	19½	24⅝			
	06	08	182T-184T	24	26½	44½	182TC-184TC	23⅞	3⅞	19½	34⅜	3⅞	14⅞	17						
			213T-215T	24¾		47⅞	213TC-215TC	25½			36⅝			19¼	24⅝					
			254T-256T	26		31⅞	51⅞	254TC-256TC			26¼			24⅞	42	19½	24⅝			
	08	08	182T-184T	24	26½	44½	182TC-184TC	23⅞	3⅞	19½	34⅜	3⅞	14⅞	17						
			213T-215T	24¾		47⅞	213TC-215TC	25½			36⅝			19¼	24⅝					
			254T-256T	26		31⅞	51⅞	254TC-256TC			26¼			24⅞	42	19½	24⅝			
			284TS-286TS	26¾	53	284TS-286TS	33	33	24⅞	42¾	5	19½	25⅝							
	10	10	254T-256T	26	33¼	53¼	254TC-256TC	27⅝	26	43⅞				23½	27⅞					
			284TS-286TS	26¾		54⅜	284TCS-286TCS	34⅜	43⅞	25⅝										
			324TS-326TS	29¼	37¼	56⅞	324TCS-326TCS	36⅜	30		46⅜	23½	27⅞							
	12	12	284TS-286TS	28¼		37¼	54⅜	284TCS-286TCS	34⅜	30	43⅞			23½	27⅞					
			324TS-326TS	29¼	56⅞		324TCS-326TCS	36⅜	46⅜											

N/A = Not Available

Tolerance: ± 1/8"

* Dimensions may vary slightly depending on motor manufacturer. Given "H" dimensions were based on the larger of those motors most frequently used by nyb. † On fan Sizes 23-26 with Size 12 outlet and Bottom Horizontal discharge, the flange extends 1/2" below the floorline.

The New York Blower Company has a policy of continuous product development and reserves the right to change designs and specifications without notice.

ARRANGEMENTS 1, 9, 10

Dimensions not to be used for construction unless certified. Note: See page 12 for dimensional drawings.

ARRANGEMENTS 1, 9, & 10 DIMENSIONS [INCHES]

Wheel dia.	Outlet Size	Inlet flange	A†		H		K		N		R		S		T		U		V
			Arr. 1	Arr. 10	Arr. 1	Arr. 10	Arr. 1/9	Arr. 10	Arr. 1	Arr. 10	Arr. 1/9	Arr. 10	Arr. 1	Arr. 10	Arr. 1/9	Arr. 10	Arr. 1/9	Arr. 10	Arr. 10
14-18	03 05	19 1/2	21	24 5/8	30 1/8	3	3 1/2	15 1/8	22	27 7/8	37 7/8	12 1/4	17 3/8	9 1/8	9 3/8	10	10 1/4	8 1/4	
	04 06			25 5/8	31 1/8					33 7/8	43 7/8								
	06 08			28	33 1/2					41 1/2	51 1/2								
15-18	03 05	23 5/8	27 5/8	26 1/8	35 1/8	4	4 1/2	15 1/8	26	27 7/8	45 7/8	19 7/8	107 7/8	12 1/4	11 3/4	13	11		
	04 06			27 1/8	36 1/8					33 7/8	51 7/8								
	06 06			29	38					41 1/2	61 4								
	08 08			28 1/4	36 1/4					31 4	41 4								
19-22	03 05	26 5/8	27 7/8	28 1/4	36 1/4	5	4 1/2	15 1/8	26	31 4	41 4	19 7/8	107 7/8	12 1/4	11 3/4	13	11		
	04 06			29 5/8	37 5/8					37 7/8	55 7/8								
	06 08			31	39					5	6 3/4								
	08 08																		
	10 10																		
12 12																			

† On fan sizes 12, outlet and Bottom Horizontal discharge, the flange extends 1/2" below the floorline.

Tolerance: ± 1/8"

ARRANGEMENT 9 DIMENSIONS [INCHES]

Fan Size	Outlet Size	Pedestal Number	H	Fan Size	Outlet Size	Pedestal Number	H	Fan Size	Pedestal Number	Max. C-NW	Max. Frame Size	A	N	S				
14-18	03	1	24 5/8	19-22	08,10	5	29	14-18	1	13 5/8	256T	19 1/2	15 1/8	12 1/4				
		2	28 3/8			6	32 3/4		2	17 3/8			18 7/8	16				
		3	32 1/8			7	36 1/2		3	21 1/8			22 5/8	19 3/4				
		4	35 1/4			8	39 5/8		4	24 1/4			284T	23 1/2	25 3/4	22 7/8		
	04	1	25 5/8			03	10		35 3/4	19-22			5	13 5/8	286T	23 5/8	15 1/8	12 1/4
		2	29 3/8				11		38 7/8				6	17 3/8			18 7/8	16
		3	33 1/8		12		40 7/8	7	21 1/8		22 5/8	19 3/4						
		4	36 1/4		13		42 7/8	8	24 1/4		25 3/4	22 7/8						
	06,08	1	28		04,06,08		10	37 1/8	23-26		9	26 1/4	326T	26 5/8			27 3/4	24 7/8
		2	31 3/4				11	40 1/4			10	21 1/8					22 5/8	19 3/4
		3	35 1/2			12	42 1/4	11		24 1/4	25 3/4	22 7/8						
		4	38 5/8			13	44 1/4	12		26 1/4	27 3/4	24 7/8						
19-22	03	5	26 1/8	23-26		04,06,08	10	37 1/8		14-18	1	13 5/8			256T	19 1/2	15 1/8	12 1/4
		6	29 7/8				11	40 1/4									2	17 3/8
		7	33 5/8		12		42 1/4	3	21 1/8				22 5/8	19 3/4				
	8	36 3/4	13		44 1/4		4	24 1/4	25 3/4				22 7/8					
	9	38 3/4	10		37 1/8		5	13 5/8	286T				23 5/8	22 5/8			19 3/4	
	5	27 1/8	11		40 1/4		6	17 3/8	256T				19 1/2	18 7/8			16	
	04,06	6	30 7/8		10,12	10	38 1/2	19-22	7	21 1/8	286T	23 5/8	22 5/8	19 3/4				
		7	34 5/8			11	41 5/8		8	24 1/4			25 3/4	22 7/8				
		8	37 3/4			12	43 5/8		9	26 1/4			27 3/4	24 7/8				
9		39 3/4	13	45 5/8		10	21 1/8		326T	26 5/8			22 5/8	19 3/4				
			11	40 1/4		11	24 1/4		25 3/4	22 7/8								
			12	42 1/4		12	26 1/4		27 3/4	24 7/8								

Tolerance: ± 1/8"

FAN DISCHARGES – VIEWED FROM DRIVE SIDE



Clockwise—angular discharges at 45°

Counterclockwise—angular discharges at 45°

Housings are reversible and rotatable in 22 1/2° increments except Down Blast and Bottom Angular Down which require special construction. Arrangement 10 fans Sizes 19–22 are not rotatable in the field.

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Series M Mechanical Tilt Float Level Switch

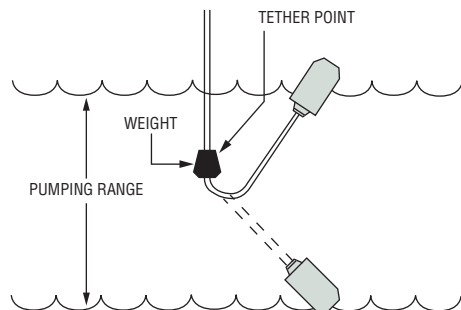
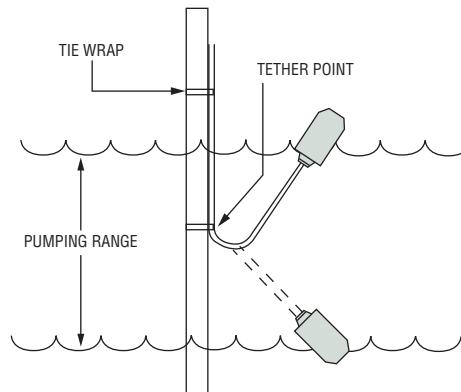
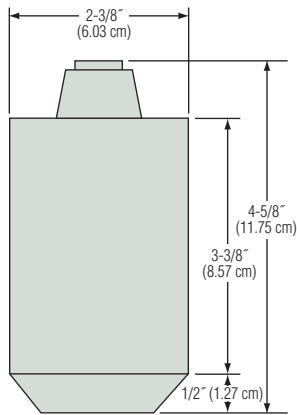
- ▶ Non-Mercury Switch
- ▶ Sealed Cable
- ▶ Impact & Corrosion Resistant ABS Shell
- ▶ N.O., N.C., SPDT Contacts
- ▶ Various Cable Lengths
- ▶ Color Coded Body

Designed for level control and alarm applications in difficult liquids such as sewage and waste water. Series M mechanical tilt floats are ideal for applications where the presence of mercury is a concern. Series M Switches have impact resistant ABS shell and neoprene jacketed cable.

Specifications

Cord	2 or 3 conductor 16 AWG wire SJOW Oil Resistant CPE
Contact Rating	13 amp @ 120/240 VAC 1/2 hp
Contact Design	SPST, Normally Open or Normally Closed Common with N.O. & N.C. (form C)
Temperature Rating	
Dry	32°F to 194°F (0°C to 90°C)
Water Resistant	32°F to 140°F (0°C to 60°C)
Overall Weight	1.0 lbs. (not including weight)
Tether Method	Tie-wrap nylon, weight: 2.5 lbs.
Approvals	U.L. Recognized, CSA Cert.

Dimensions

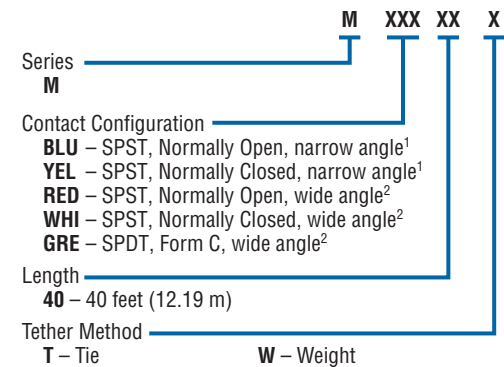


Applications

- Level Control
- Alarms
- Sewage Lift Systems
- Slurries
- Drainage Sumps
- Wastewater Treatment
- Holding Tanks

How to Order

Use the **Bold** characters from the chart below to construct a product code.



Tether Method	Part Number
Tie Wrap	7762360
Weight	7762381

Notes:

1. Narrow angle pumping range approximately 2 in. to 8 in.
2. Wide angle pumping range approximately 5 in. to 18 in.



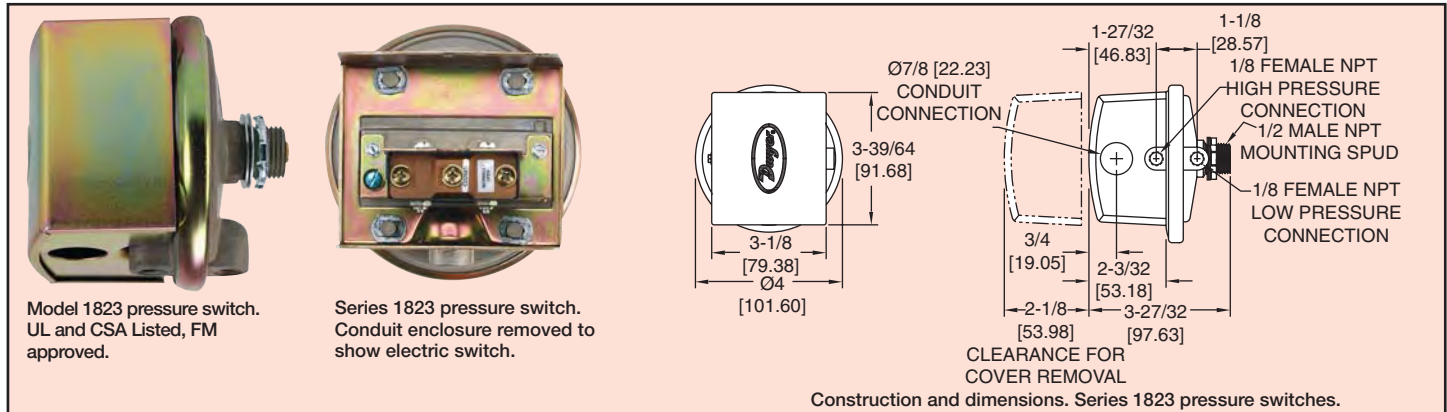
Series 1800

Low Differential Pressure Switches for General Industrial Service

Set Points from 0.07" to 85" w.c. Repetitive Accuracy within 2%



Pressure



Essential for industrial environments, the Series 1800 combines small size and low price with 2% repeatability for enough accuracy for all but the most demanding applications. Set point adjustment inside the mounting stud permits mounting switch on one side of a wall or panel with adjustment easily accessible on the opposite side. UL and CSA listed, FM approved.

SPECIFICATIONS

- Service:** Air and non-combustible, compatible gases.
- Wetted Materials:** Consult Factory.
- Temperature Limits:** -30 to 180°F (-34 to 82.2°C). 1823-00, -20 to 180°F (-28.9 to 82.2°C).
- Pressure Limits:** 10 psig (68.95 kPa) continuous, 25 psig (172.4 kPa) surge.
- Switch Type:** Single-pole double-throw (SPDT).
- Repeatability:** ±2%.
- Electrical Rating:** 15 A @ 120-480 VAC, 60 Hz. Resistive 1/8 HP @125 VAC, 1/4 HP @ 250 VAC, 60 Hz. De-rate to 10 A for operation at high cycle rates.
- Electrical Connections:** 3 screw type, common, normally open and normally closed.
- Process Connections:** 1/8" female NPT.
- Mounting Orientation:** Diaphragm in vertical position. Consult factory for other position orientations.
- Set Point Adjustment:** Screw type inside mounting spud.
- Weight:** 1 lb, 5 oz (595 g).
- Agency Approvals:** CE, UL, CSA, FM.

CAUTION: FOR USE ONLY WITH AIR OR COMPATIBLE GASES.

SERIES 1823 SWITCHES — MODELS OPERATING RANGES & DEADBANDS

Model Number	Operating Range, Inches W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1823-00	0.07 to 0.22	0.05	0.05
1823-0	0.15 to 0.5	0.06	0.06
1823-1	0.3 to 1.0	0.08	0.08
1823-2	0.5 to 2.0	0.10	0.12
1823-5	1.5 to 5.0	0.14	0.28
1823-10	2.0 to 10	0.18	0.45
1823-20	3 to 22	0.35	0.70
1823-40	5 to 44	0.56	1.10
1823-80	9 to 85	1.30	3.0

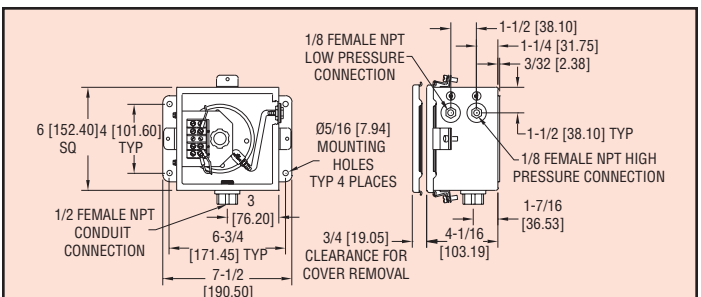
SPECIAL MODELS AVAILABLE

ATEX (Approval Pending) Housing: Cast iron base with brass cover. Explosion-proof housing, EExd and NEMA-7&9 rated; Change base number to 1824 and add -CN suffix. Example: 1824-1-CN



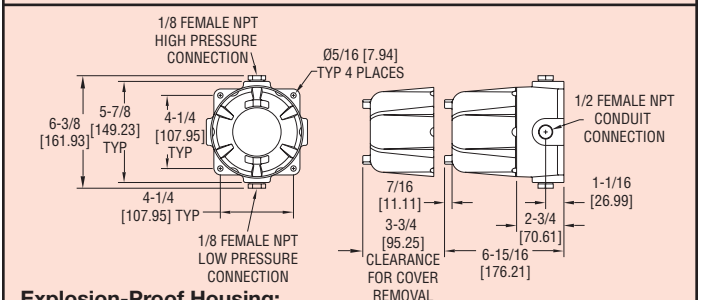
MIL Environmental Construction — Unlisted Model 1820 can be furnished with a special sealed snap switch for protection against high humidity, fungus and/or military applications. Similar to Model 1823 except dead band is slightly greater and some lower setpoints may not be possible. To order, add suffix -MIL. Example: 1820-2-MIL.

No. A-389 Mounting Bracket is 16 ga. steel, zinc plated and dichromate dipped for corrosion resistance. Provides rugged, permanent mounting and speeds installation.



Weatherproof Housing:

16 ga. steel enclosure with gasketed cover (NEMA 4, IP66) for wet or oily conditions. Withstands 200 hour salt spray test. Wt. 5 1/2 lbs. (2.5 kg). Switch must be factory installed. Change 1823 base number to 1824 and add -WP suffix. Example: 1824-1-WP



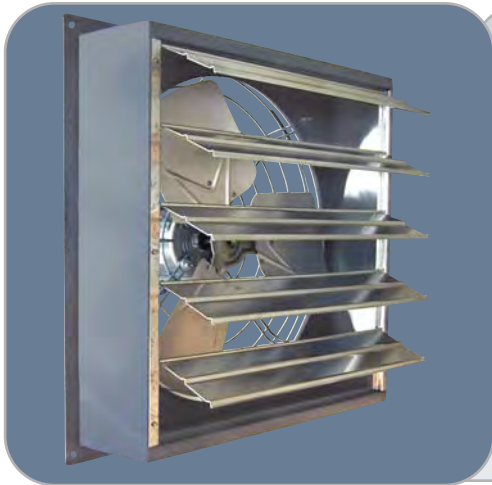
Explosion-Proof Housing:

Cast iron base with aluminum cover. Rated Class I, Div. 1 & 2, Group D; Class II, Div. 1 & 2, Groups E, F, G; Class III and NEMA 7 CD, 9 EFG. Wt. 7 1/2 lbs. (3.4kg). Switch must be factory installed. Change base number to 1824 and add -EXPL suffix. Example: 1824-1-EXPL



Efficient • Low Maintenance • Easy Installation

Canarm's Standard Fans follow a tradition of quality in design, materials and construction.



Features

- Available in 8" to 36" sizes.
- Single, two and variable speed models are available.
- All fans use a totally enclosed, ball bearing motor with thermal overload protection.
- The motor mount is manufactured with heavy welded rods and has a powder coated finish.
- The fan blades are well-balanced, heavy gauge aluminum.
- The rugged steel welded box housing has a durable powder coated finish.
- Aluminum louver shutters are supported by long life nylon bushings (30" and 36" have PVC louvers).
- All fans are shipped completely assembled.

General Information

Canarm's Standard Fans follow a tradition of quality in design, materials and construction. All our Standard Fans are developed to be efficient and economically priced. All variable speed Standard Fans use an energy efficient variable speed, dual voltage motor and blade combination.

To determine the proper Canarm Fan for your applications, use the following formula.

Number of cubic feet in room / Number of minutes per air change = Required C.F.M. Capacity

****Example****

A general office, (see chart) which requires an air change every ten minutes, would require the following fan capacity. If office is 100' x 40' x 10' = 40,000 cubic feet

40,000 cubic feet / 10 minutes per air change = 4000 Required C.F.M.

From the "Performance Data" section on the back of this page, you would select a fan that is rated at 4000 C.F.M. at 1/8" S.P. (Static Pressure)



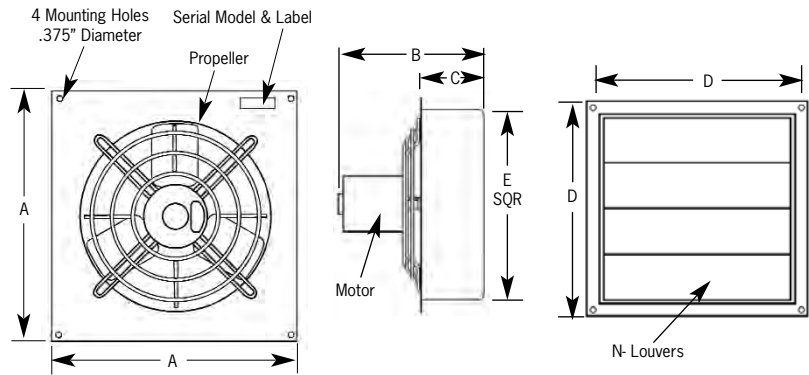
Fan Selection Chart

Application	Minutes per Air Change	Application	Minutes per Air Change	Application	Minutes per Air Change
Assembly Hall	7	Department Store	6	Plating Room	3
Auditorium	10	Dry Cleaning	5	Pressing Room	1
Bakery	3	Engine Room	6	Projection Booth	2
Barber Shop	6	Forge Room	3	Restaurant	6
Basement	8	Foundry	4	School	7
Battery Room	4	Garage	5	Summer Cooling	1
Boiler Room	1	General Office	10	Store	8
Bowling Alley	5	Gymnasium	8	Tavern	3
Church	15	Hospital	8	Toilet	3
Cocktail Bar	3	Kitchen	2	Transformer Room	1
Corridor	10	Laundry	2	Warehouse	12
Dairy	4	Locker Room	3	Welding Shop	2
		Machine Shop	8		



Fan Dimensions

Fan Auto	A	B	C	D (c/c)	E	N
8"	13 1/4"	10"	4"	12"	10 3/4"	2
10"	15 1/4"	10"	4"	14"	12 3/4"	2
12"	17 1/4"	14"	6"	16"	14 3/4"	3
14"	19 1/4"	14"	6"	18"	16 3/4"	3
16"	21 1/4"	14"	6"	20"	18 3/4"	4
18"	23 1/4"	15"	6"	22"	20 3/4"	4
20"	25 1/4"	16"	6"	24"	22 3/4"	5
24"	29 1/4"	16"	6"	28"	26 3/4"	5
30"	35 1/4"	19"	6"	34"	32 3/4"	16
36"	41 1/4"	16"	6"	40"	38 3/4"	20



Performance Data & Specifications

Model Number	Fan Size	Motor HP	Operation Speed	Fan RPM	Current Load Amps		Input Watts	Airflow Capacity - CFM				CFM Watts	Sound Level Decibel (A)	Framing Dimensions	Shipping Weight Lbs.		
					@ 115V	@ 230V		0" S.P.	10" S.P.	125" S.P.	25" S.P.						
S8-B2	8"	1/20	Two	High 1550	0.95	-	109	360	270	230	0	2.5	48	11" x 11"	12		
				Low 1300	0.45	-		300	150	110	0		43				
S10-B2	10"	1/20	Two	High 1550	1.2	-	125	690	590	570	0	4.72	56	13" x 13"	13		
				Low 1300	0.7	-		580	460	390	0		50				
S12-E1	12"	1/4	Single	1750	3.5	-	245	1,640	1,540	1,510	1,390	6.00	63	15" x 15"	28		
Two			High 1760	3.4	-	230	1,650	1,550	1,520	1,390	6.74	64					
			Low 1180	2.3	-	132	1,090	950	930	-	7.31	50					
SD12-EV	12"	1/4	Variable	Max 1625 Min 600	2.2	1.1	205	1,650 560	1,540 440	1,510 420	1,390	7.50	60	15" x 15"	32		
S14-E1			Single	1740	3.6	-	257	2,170	2,070	2,030	1,860	8.05	67			17" x 17"	30
S14-E2			Two	High 1740	3.8	-	253	2,180	2,080	2,060	1,890	8.22	65				
	Low 1170	2.2		-	137	1,350	1,190	1,160	-	8.69	53						
S16-E1	16"	1/4	Single	1740	3.7	-	274	2,370	2,270	2,210	2,060	8.28	68	19" x 19"	33		
Two			High 1740	3.7	-	270	2,380	2,280	2,230	2,070	8.44	69					
			Low 1170	2.3	-	152	1,640	1,490	1,430	-	9.80	55					
SD16-EV	16"	1/4	Variable	Max 1625 Min 450	2.6	1.3	248	2,370 610	2,270 580	2,210 570	2,063	9.15	63	19" x 19"	36		
S18-F1			Single	1700	4.8	-	448	3,200	3,090	3,040	2,920	6.89	73			21" x 21"	37
				Two	High 1700	5.7	-	446	3,200	3,090	3,040	2,920	6.93				
S18-F2	Two	Low 1140	3.1		-	250	2,100	1,890	1,820	-	7.56	64	21" x 21"	43			
		SD18-FV	Variable	Max 1625 Min 390	3.7	1.9	378	3,150 700	3,050 650	2,980 630	2,860	8.07			74		
S20-F1	20"	1/3	Single	1735	4.8	-	322	3,420	3,220	3,170	2,920	10.00	77	23" x 23"	41		
Two			High 1745	4.3	-	315	3,440	3,240	3,180	2,930	10.20	77					
			Low 1165	2.6	-	190	2,300	2,000	1,950	-	10.52	67					
SD24-F1	24"	1/3	Single	1075	4.3	-	370	5,000	4,500	4,300	3,600	12.80	70	27" x 27"	46		
SD24-GV			Variable	Max 1100 Min 310	4.2	2.1	290	5,050 800	4,940 710	4,810 650	4,400	13.2	72				
SD30-G1D	30"	1/2	Single	1075	4.6	2.3	600	8,000	7,000	6,000	5,000	11.5	82	33" x 33"	72		
SD36-G1D	36"	1/2	Single	850	6.0	3.0	660	12,000	11,000	10,500	9,500	13.0	72	39" x 39"	88		

NOTE: RPM Min (Minimum) is determined when louvers are opened one inch

Note: Wind has a significant effect on exhaust fans. A 10 mph wind creates a 0.05" pressure against the fan. A 20 mph wind creates 0.20" pressure and 30 mph a 0.45" pressure. These pressures are in addition to the static pressure in the building. Wind blocks or hoods should be included in all designs where fans will be subjected to winds above 10 mph.

Warranty

- 1 year on all components

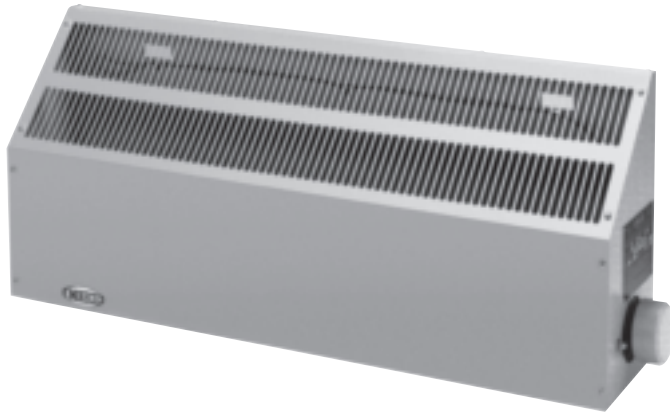
CANARM LTD. - Corporate Office
 2157 Parkedale Ave., Brockville, ON
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 Tel: (613) 342-5424 Fax: 1-800-263-4598

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 E-Mail: agsales@canarm.ca

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 Ogdensburg, New York, USA 13669
 Tel: 1-800-267-4427 Fax: 1-800-263-4598

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 #7686 Concession 16, RR 4 Arthur, ON
 Canada NOG 1A0
 Tel: (519) 848-3910 Fax: (519) 848-3948
 Web Site: www.bsmagri.com
 E-Mail: sales@bsmagri.com

CONVECTOR



Class I, Divisions 1 and 2, Groups B, C and D
Class II, Divisions 1 and 2, Groups E, F and G
Class I, Zones 1 and 2, Group IIC

Applications

- Battery Storage Areas
- Chemical Plants
- Coal Handling Facilities
- Dry Cleaning Plants
- Gasoline Fueling/Storage Areas
- Grain Elevators
- Oil Refineries
- Paint Spraying/Storage Areas
- Petrochemical Plants

INDEECO's explosion-proof convector is designed to provide a heavy duty and corrosion resistant heat source. Features include:

- **Wide Selection of Sizes:** Four compact sizes to fit any space with ratings from 500 to 9,500 watts.
- **Sloped Top Cabinet:** Prevents objects from being set on top of the convector, which can restrict air-flow and cause overheating.
- **Single and Three-Phase:** Unique design provides single and balanced three-phase loads in a single element.
- **Gas and Dust Atmospheres:** Three listings cover the entire field, two for hazardous gases and vapors and one for dust particles.
- **Wet Locations:** All unit sizes available with iridite-coated elements and powder-coated frames for NEMA 3 wet locations.

Standard Construction Features

Element – Grade A Nickel-Chromium heating coils are insulated with ceramics and magnesium oxide from the copper heater tube and fitted with large aluminum fins locked in place.

Cabinet – Heavy gauge galvanized steel cabinet is painted with a beige powder coat for durability. Cabinet should be mounted at least 6 inches (152 mm) above the floor. Factory-furnished wall brackets make installation easy.

Thermal Protection – A linear limit, automatic reset thermal cutout is built into every unit.

Complete Electrical Package – For larger single-phase and all three-phase units, a built-on contactor and transformer option package are available.

Electrical Package Options

All single-phase heaters rated over 22 amps or 277 volts and all three-phase heaters require a magnetic contactor. Some electrical combinations will also require a control transformer. To simplify field

installation, these accessories are factory-mounted on the heater cabinet and factory pre-wired (not available on Size 1 convectors).

Code	Option	Description	Availability Code (2)
B2	Electric Control Option (1) (without thermostat)	Classes I and II, Groups B, C, E, D, F and G includes contactor and transformer (as required). Required for all three-phase and single-phase heaters over 22 amps or 277 volts	AS
B2/S1	Thermostat & Controls (1)	Classes I and II, Groups C, D, E, F and G includes thermostat, contactor and transformer (as required).	AS
B3	Thermostat & Controls (Group B) (1)	Classes I and II, Groups B, C, D, E, F and G includes thermostat, contactor and transformer (as required). Thermostat has internal set point.	AS
S1	Thermostat Only (1)	Classes I and II, Groups C, D, E, F and G single-phase heaters rated up to 22 amps at 120-277 volts. Use remote room thermostat Catalog Number 1007002 for Size 1 convectors.	AS
S2	Thermostat Only (Group B) (1)	Classes I and II, Groups B, C, D, E, F and G single-phase heaters rated up to 22 amps at 120-277 volts. Thermostat has internal set point. Use remote room thermostat Catalog Number 1007022 for Size 1 convectors.	AS

(1) These options are not available on Size 1 Convectors.

Custom Option

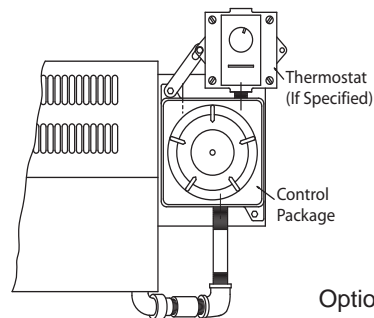
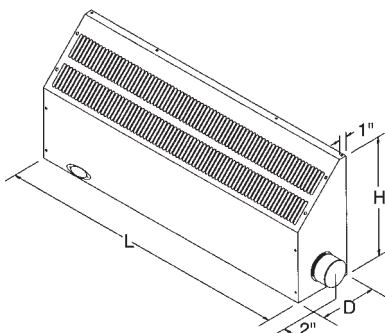
Code	Option	Description	Availability Code (2)
C1	Wet Locations	NEMA 3 rated heater construction not available with S1, B2/S1 and S2 thermostat options.	C

(2) AS = Assembly Stock, C = Custom. Assembly Stock heaters ordered with custom options are subject to longer delivery.

Dimensions and Weights

Unit Size	Dimensions - In. (cm)			Weight - Lb (kg)
	Length (L)	Height (H)	Depth (D)	Without Controls
1	26 (66)	6 (15)	4 ½ (11)	13 (5.9)
2	26 (66)	16 (41)	8 (20)	27 (12.2)
3	39 (99)	16 (41)	8 (20)	36 (16.3)
4	67 ½ (171)	16 (41)	8 (20)	60 (27.2)

Remote Room Thermostat - See page 98.



CONVECTOR

Convector Heater Listing

Class I, Divisions 1 and 2, Groups B, C and D
Class I, Zones 1 and 2, Group IIC



American
Bureau of
Shipping

Ignition Temperature Code °F (°C)	KW	Volts/Phase	Heater Amps	Unit Size	Catalog Number	Availability Code (2)
T2A 536 (280)	0.5	120/1	4.2	1	254-F0310052B	AS
		208/1	2.4	1	254-F0310052C	
		240/1	2.1	1	254-F0310052J	
	1	120/1	8.3	1	254-F0310102B	
		208/1	4.8	1	254-F0310102C	
		240/1	4.2	1	254-F0310102J	
	1.8	120/1	15.0	2	254-F0320182B	
		208/1	8.7	2	254-F0320182C	
		240/1	7.5	2	254-F0320182J	
		480/3▲	1.3	2	254-F0320182U	
	2.5	208/1	12.0	2	254-F0320252C	
		240/1	10.4	2	254-F0320252J	
		208/3★	6.9	2	254-F0320252D	
		480/3▲	3.0	2	254-F0320252U	
	3.6	208/1	17.3	3	254-F0330362C	
		240/1	15.0	3	254-F0330362J	
		208/3★	10.0	3	254-F0330362D	
		480/3▲	4.3	3	254-F0330362U	
	4.4	240/1	18.3	3	254-F0330442J	
		208/3★	12.2	3	254-F0330442D	
		480/3★	5.3	3	254-F0330442U	
	6.5	240/1★	27.1	4	254-F0340652J	
		208/3★	18.0	4	254-F0340652D	
		480/3▲	7.8	4	254-F0340652U	
	7.5	240/1★	31.3	4	254-F0340752J	
		208/3★	20.8	4	254-F0340752D	
		480/3▲	9.0	4	254-F0340752U	
		600/3▲	7.2	4	254-F0340752Z	
	9.5	240/1★	39.6	4	254-F0340852J	
		208/3★	26.4	4	254-F0340962D	
		480/3▲	11.4	4	254-F0340952U	
		600/3▲	9.1	4	254-F0340952Z	

★Magnetic contactor required.

▲Magnetic contactor and control transformer required.

These accessories may be field mounted. For factory mounting, see Electrical Package Options on page 18.

(2) AS = Assembly Stock, C = Custom. Assembly Stock heaters ordered with custom options are subject to longer delivery.

Other voltages available. Consult factory.

CONVECTOR

Convector Heater Listing

Class I, Divisions 1 and 2, Groups B, C and D
Class I, Zones 1 and 2, Group IIC



American
Bureau of
Shipping

Ignition Temperature Code °F (°C)	KW	Volts/Phase	Heater Amps	Unit Size	Catalog Number	Availability Code (2)
T3A 356 (180)	0.5	120/1	4.2	1	254-F0610052B	AS
		208/1	2.4	1	254-F0610052C	
		240/1	2.1	1	254-F0610052J	
	1.4	120/1	11.7	2	254-F0620142B	
		208/1	6.7	2	254-F0620142C	
		240/1	5.8	2	254-F0620142J	
	2.3	120/1	19.2	3	254-F0630232B	
		208/1	11.1	3	254-F0630232C	
		240/1	9.6	3	254-F0630232J	
		208/3★	6.4	3	254-F0630232D	
	3.2	480/3▲	2.8	3	254-F0630232U	
		208/1	15.4	4	254-F0640322C	
		240/1	13.3	4	254-F0640322J	
		208/3★	8.9	4	254-F0640322D	
	5	480/3▲	3.8	4	254-F0640322U	
240/1		20.8	4	254-F0640502J		
208/3★		13.9	4	254-F0640502D		
480/3▲		6.0	4	254-F0640502U		

Class I, Divisions 1 and 2, Groups B, C and D
Class II, Divisions 1 and 2, Groups E, F and G

Ignition Temperature Code °F (°C)	KW	Volts/Phase	Heater Amps	Unit Size	Catalog Number	Availability Code (2)
T3C 320 (160)	0.5	120/1	4.2	1	254-F0810054B	AS
		208/1	2.4	1	254-F0810054C	
		240/1	2.1	1	254-F0810054J	
	1	120/1	8.3	2	254-F0820104B	
		208/1	4.8	2	254-F0820104C	
		240/1	4.2	2	254-F0820104J	
	1.7	120/1	14.2	3	254-F0830174B	
		208/1	8.2	3	254-F0830174C	
		240/1	7.1	3	254-F0830174J	
		480/3▲	2.0	3	254-F0830174U	
	3.2	208/1	15.4	4	254-F0840324C	
		240/1	13.3	4	254-F0840324J	
		208/3★	8.9	4	254-F0840324D	
480/3▲		3.8	4	254-F0840324U		

★ Magnetic contactor required.

▲ Magnetic contactor and control transformer required.

These accessories may be field mounted. For factory mounting, see Electrical Package Options on page 18.

(2) AS = Assembly Stock, C = Custom. Assembly Stock heaters ordered with custom options are subject to longer delivery.

Other voltages available. Consult factory.

A19 Series Utility Thermostats for Farm, Industrial and Commercial Use

Application

These temperature controls are designed to cover a broad range of uses for heating and general purpose requirements. See "Application" column, "Specifications" Page 2, for typical uses. Controls have SPST contacts which open on temperature increase or they may be supplied in single-pole, double-throw contact action.

Various control ranges are available to cover working temperatures from -30 to 550° F (-34 to 288° C). Closed tank fittings and bulb wells are available for immersion applications.

These controls are designed for open low and open high applications. Where critical or high value products are to be maintained within a specific temperature differential, a single control should not be applied to function as both an open low and open high control. In these applications, a separate back-up control with alarm contacts should be wired to indicate when the back-up control operates.

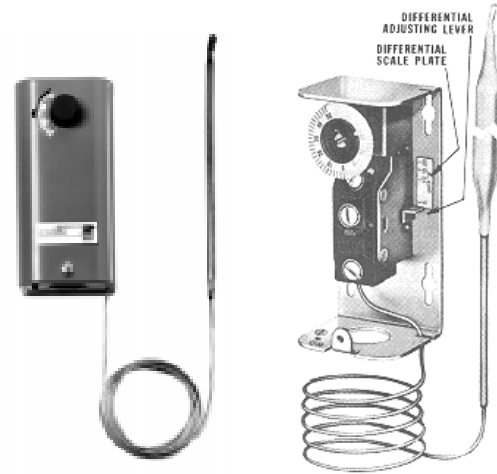


Fig. 1: (Left) Control with external range scale, knob adjustment. (Right) Interior of model with adjustable differential.



Fig. 2: Space thermostat with Style 3 coiled bulb and finger-tip adjusting knob.

Features

- Dependability -- precision snap-acting dusttight contacts.
- Dependability -- low volume, responsive liquid filled sensing elements.
- Wide choice of temperature control functions with a minimum number of models.
- Precision "repeat" accuracy which is unaffected by barometric pressure and cross ambient problems.
- Special close differential models available.

General Description

The Series A19 is a small, compact control with adjustable or fixed differential. Controls supplied with adjustable differential have an internal scale plate indicating increments of differential. The controls are supplied with adjusting lever at minimum differential stamped on the control. To adjust move the lever to the differential required. Models are available with or without external range adjustment and visible scale. External range adjustment may be by screwdriver slot or range adjusting knob (Fig. 2).

A built-in high cutout stop is an integral part of these controls and may be adjusted quickly and easily in the field. Product Number A19BAG-1 is especially designed for portable heaters. It is supplied with a 6 ft cord, 120 V.A.C. polarized plug, and a chain hanger kit.

Optional Constructions

Note: For most prompt service, select controls listed under "Specifications," below. If these are not entirely suitable for your application, then the following variations are available.

Adjustable Differential: Available at extra cost.

Armored Capillary: Single braided copper armor may be supplied at extra cost.

Capillary Tube: Additional length of capillary over 6 ft available at extra cost. Extra length in 2 ft increments from 6 ft to 10 ft; over 10 ft in 5 ft increments.

Contact Unit: Close differential or special close differential may be supplied.

Mounting Bracket: Optional at extra cost.

Types A19AAB, A19AAC, A19BAB, A19BAC

Volts AC	120	208	240
Full Load Amps.	16.0	9.2	8.0
Locked Rotor Amps.	96.0	55.2	48.0
Non-inductive or Resistance Load Amps. (Not Lamp Load)	* 22 Amps. 120 to 277 VAC		
Pilot Duty - 125 VA @ 24 to 600 VAC			

* SPST Rating

Types A19AAE

Volts AC	120	208	240
Full Load Amps.	6.0	3.4	3.0
Locked Rotor Amps.	36.0	20.4	18.0
Non-inductive or Resistance Load Amps. (Not Lamp Load)	10 Amps. 120 to 277 VAC		
Pilot Duty - 125 VA @ 24 to 277 VAC			

Types A19AAB, A19AAC, A19ADB (Hot Water Models)

Volts AC	120	240
Full Load Amps.	10.0	6.0
Locked Rotor Amps.	60.0	36.0
Non-inductive or Resistance Load Amps.	10.0	6.0
Pilot Duty - 125 VA @ 24 to 600 VAC		

Specifications

Product Number	Appl.	Action	Range °F (°C)	Diff. °F (°C)	*Max. Bulb Temp. °F (°C)	Bulb Style	Bulb Size (in.)	Bulb Well	Cap. Length (ft.)	Bulb Support (in.)	Cover		Range Adjuster	
											Plain	Scale	Screw-driver	Knob
A19AAB-4	Fluid Cutout	Opens on rise	30 to 110 (-1 to 43)	3 (1.7)	140 (60)	1	3/8 x 4-15/16	WEL14A-602R	6	3		X	X	
A19AAB-7	Industrial Oven	Opens on rise	100 to 300 (38 to 149)	7 (3.9)	350 (177)	1	3/16 x 10-1/8		6			X		X
A19AAB-10	Industrial Oven	Opens on rise	200 to 550 (93 to 288)	10 (5.6)	620 (327)	1	3/16 x 5-5/8		6			X		X
A19AAC-1	Dual Fuel Change-over	SPDT	-30 to 50 (-34 to 10)	5 (2.8)	140 (60)	1	3/8 x 4-1/16	Outdoor Shield Supplied	6	3	X		X	
A19AAC-9	Fluid Cutout	SPDT	100 to 240 (38 to 121)	6 (3.3)	290 (143)	1	3/8 x 3-9/16	WEL14A-602R	6	3		X	X	
A19AAE-3	Crop Drying	Opens on rise	80 to 180 (27 to 82)	2 (1.1)	200 (93)	7	1-1/8 x 1-1/4 Copper Coil		10			X		X
A19ADB-2	Hot Water Cutout; Manual Reset	Opens on rise	100 to 240 (38 to 121)	Lockout	290 (143)	2	0.290 x 2-11/16	Direct Immersion 1/2 in. NPT Conn.	None			X		X
A19ADN-1	Warm Air; Manual Reset	Opens on rise	100 to 240 (38 to 121)	Lockout	290 (143)	1	3/8 x 3	WEL14A-602R	6	3		X	X	
A19ADP-1	Warm Air; Manual Reset	SPDT	100 to 240 (38 to 121)	Lockout	290 (143)	1	3/8 x 3	WEL14A-602R	6	3		X	X	
A19BAB-3	Heating	Opens on rise	30 to 95 (0 to 35)	3 (1.7)	140 (60)	3	Coil		None			X		X
A19BAC-1	Farm Thermostat at Heat or Ventilate	SPDT	30 to 110 (0 to 43)	3 (1.7)	140 (60)	3	Coil		None			X		X
A19BAG-1	Portable Heater	Opens on rise	35 to 95 (0 to 35)	3 (1.7)	140 (60)	3	Coil		None			X		X

* Maximum bulb temperature which the element can withstand at infrequent intervals during life of control, such as shipping conditions. This is not the temperature at which the control can withstand on repeat cycles.

Packing Nut: Part No. FTG13A-600R is available for closed tank applications where the temperature does not fall below -35°F (-37°C) or exceed +250°F (121°C). Maximum liquid pressure limit is 150 psig (1034 kPa). For applications where the temperature or liquid pressure exceeds these limits specify Style 4 element with all metal packing nut as an integral part of the control.

Range Adjustments: Concealed dial with screwdriver slot (plain cover), exposed dial with screwdriver slot, dial and knob adjustment or models with factory sealed setting may be supplied.

Ranges: For ranges other than those shown in "Specifications" table, contact Customer Service.

Sealed Stop: Available at extra cost.

Miscellaneous Specifications

Case: .062 in. cold rolled steel. Gray baked enamel finish.

Cover: .025 in. cold rolled steel. Gray baked enamel finish.

Contact Unit: Precision Pennswitch. Snap acting dust-tight contacts.

Shipping Weights

Shipping weights shown below are approximate. Weights vary depending upon construction. Generally, overpack will contain 25 individually packed controls.

Individual pack: 1.0 lb.

Overpack containing 25 individually packed units: 26.0 lbs.

Ordering Information

1. Specify Product Number only, if available (see the "Specifications" chart).
2. If Product Number is not available specify Type Number.
 - a. Capillary length.
 - b. Range.
 - c. Bulb style.
 - d. Bulb well, if required.
 - e. Packing nut, if required.
 - f. Any other miscellaneous specifications.

Repairs and Replacement

Repairs must not be made in the field other than replacement of the cover, well assembly and packing nut assembly. When ordering replacement parts, give Product and Serial Numbers. Controls requiring attention should be returned to the factory or nearest Johnson Controls representative for inspection and service.

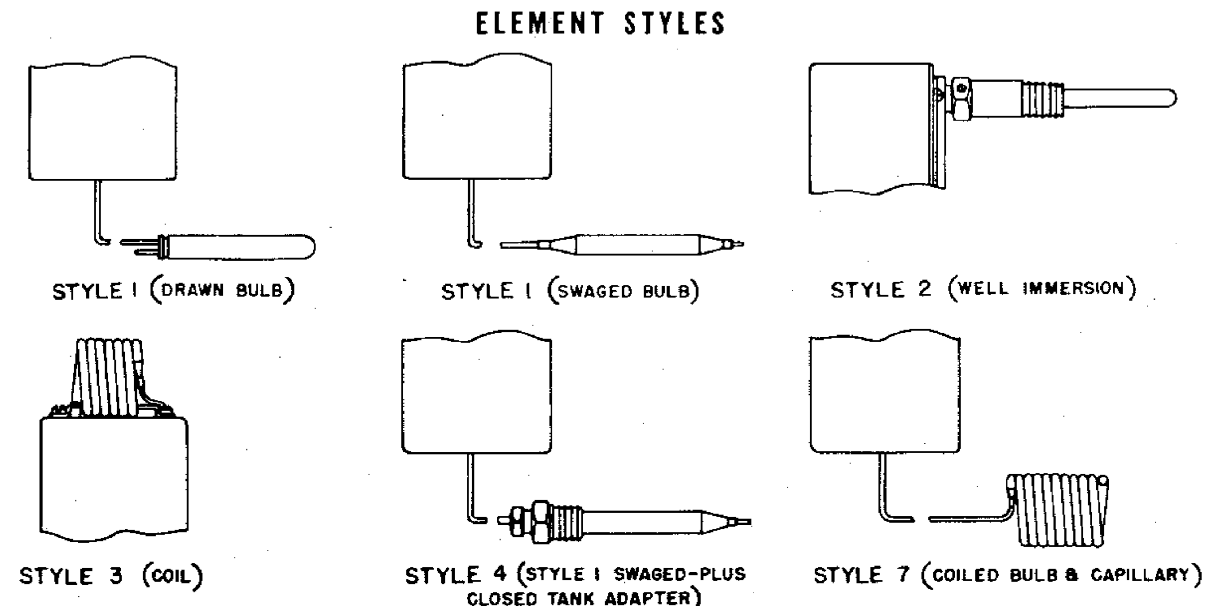
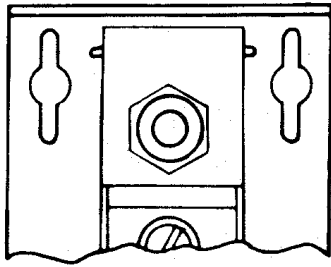
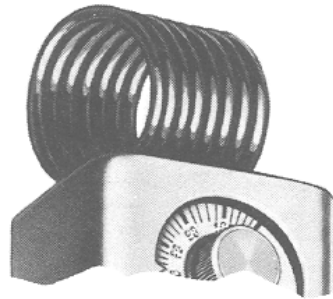


Fig. 3: Element Styles available on Series A19

Bulb and Bulb Accessories



Optional factory sealed setting available on quantity orders.

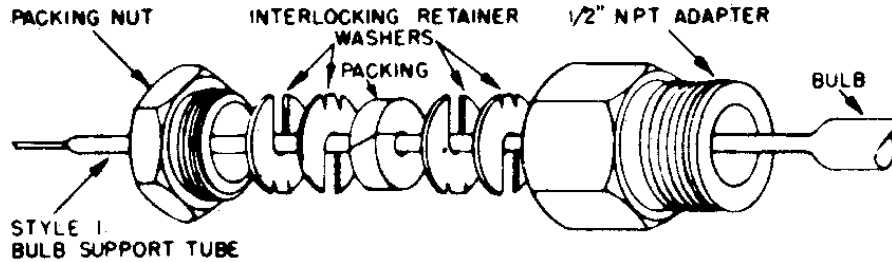


Style 3 element attached to the case.

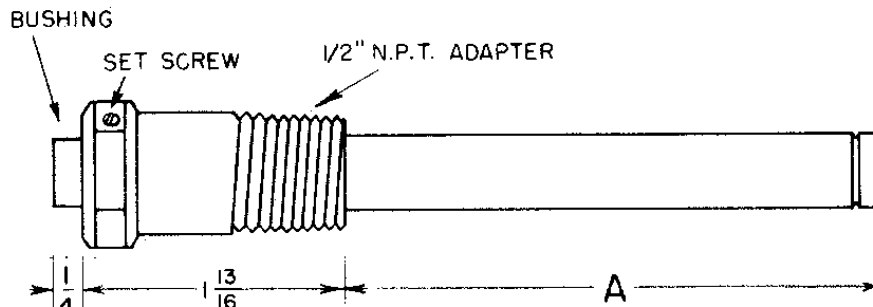
Bulb support tube



Style 1 swaged bulb with support tube.

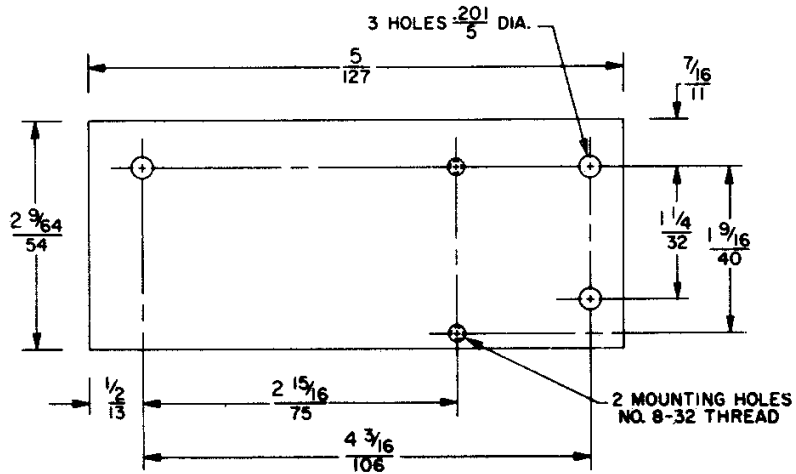
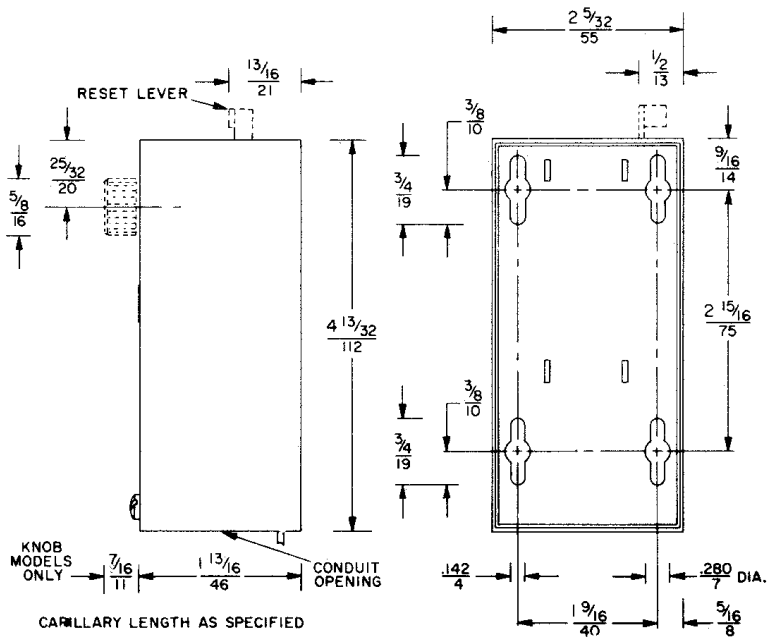


Part No. FTG13A-600R packing nut assembly. (Use with Style 1 bulb with support tube for direct immersion application.)

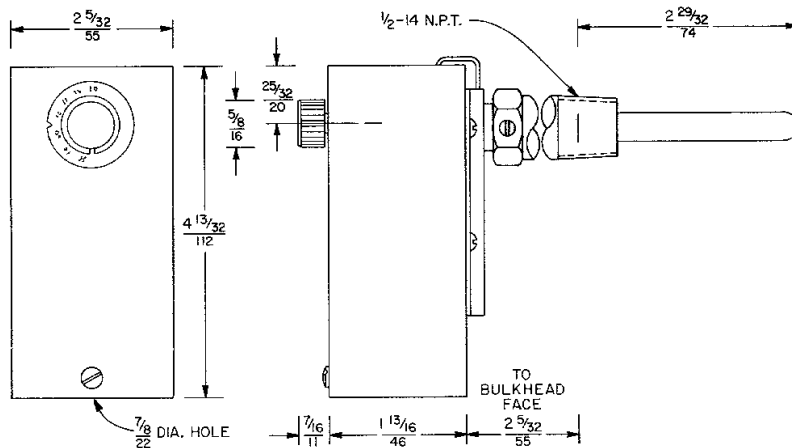


BULB WELL ASSEMBLY	DIMENSION "A"
PART NO. WEL14A-600R (MONEL)	4 3/4 (121mm)
PART NO. WEL14A-602R	4 15/16 (125mm)
PART NO. WEL14A-603R	5 13/16 (148mm)
PART NO. WEL16A-601R	2 13/16 (71mm)

Bulb well dimensions.



Optional mounting bracket.



Dimensions $\frac{\text{in.}}{\text{mm}}$

Performance specifications appearing herein are nominal and are subject to accepted manufacturing tolerances and application variables.

Notes

Notes

Notes



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P.O. Box 423
Milwaukee, WI 53202

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In Store for You!*

REPLACEMENT ELEMENTS



TABLE OF CONTENTS

Full line of replacement elements for Solberg products and many nonstandard and competitive elements available. Call for assistance.

PATENTED SERIES:

Compact "Hockey Puck" style patented filter element

- Up to 35 SCFM pg. 2

SMALL COMPACT SERIES:

- Up to 300 SCFM pg. 3

COMPACT/BIG BOY SERIES:

- 275 to 6600 SCFM pg. 4

INTERNATIONAL 800 SERIES:

pg. 5

ODD SIZED ELEMENTS:

pg. 6

OIL MIST EXHAUST SERIES:

- Coalescing Elements pg. 7

ELEMENTS FOR SPECIAL APPLICATIONS

pg. 8

Includes HEPA, high temperature, ultra low particle retention, food grade and mild corrosive media. Stainless steel elements and configurations available.

Bulletin EL-151



SMALL COMPACT "HOCKEY PUCK" STYLE *PATENTED* ELEMENTS

Up to 35 SCFM and FS Series 1/4" - 1"

FEATURES & SPECIFICATIONS

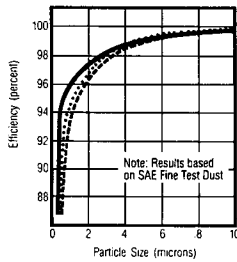
- ♦ **Patented** High grade filter element
- ♦ **Built-in** Vacuum Tight Butterfly Gasket Seal
 - Positive seal between housing hemispheres
 - New seal with each element
 - Minimizes parts
- ♦ Optimal surface area per given size
- ♦ Pleated Media for **High Dirt Holding Capacity**
- ♦ Temp: (continuous):
 - min -15°F (-26°C) max 220°F (104°C)
- ♦ Filter change out differential:
 - 10" – 15" H₂O Over Initial Delta P

POLYESTER ELEMENTS

- ♦ **99%+** removal efficiency standard to 5 micron

Particle Size vs. Filter Efficiency on polyester media at indicated face velocity:

15 cfm/ft² media —————
 30 cfm/ft² media •••••
 45 cfm/ft² media - - - - -

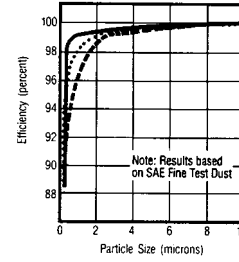


PAPER ELEMENTS

- ♦ **99%+** removal efficiency standard to 2 micron

Particle Size vs. Filter Efficiency on paper media at indicated face velocity:

10 cfm/ft² media —————
 15 cfm/ft² media •••••
 20 cfm/ft² media - - - - -



ADVANTAGES

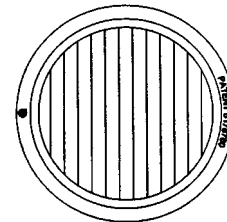
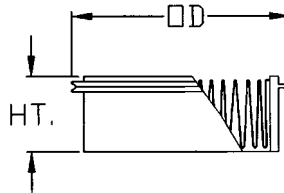
- ♦ Patented design
- ♦ Washable - lukewarm water & mild detergent
- ♦ Less maintenance & more durable
- ♦ Moisture resistant
- ♦ Handles hot air and oil mist from unload cycle of reciprocating/piston compressor

ADVANTAGES

- ♦ Patented design
- ♦ Heavy duty industrial strength paper
- ♦ Higher efficiency than many alternative media
- ♦ Cost effective

OPTIONS (Inquiries Encouraged)

- ♦ Multiple Configurations-Elliptical, Round, Special Shapes
- ♦ HEPA media-99.97% D.O.P. efficiency to 0.3 micron
- ♦ Activated carbon prefilter



Dimension tolerance ± 1/4"

Polyester Element	Paper Element	DIMENSIONS - inches		Surface Area ft ²	Rated Flow SCFM
		OD	HT		
05	04	2 1/4	1	0.2	8
07	06	3	1 3/8	0.58	12
11	10	4	1 3/8	1.1	35

Note: Element construction is of Injection Molded Santoprene

Note: Model offerings and design parameters may change without notice.

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SMALL COMPACT POLYESTER & PAPER ELEMENTS

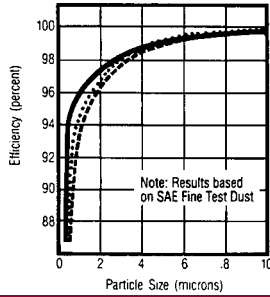
Up to 570 SCFM and Housings up to 3"

POLYESTER ELEMENTS

- 99%+ removal efficiency to 5 micron
- Pleated Media for **High Dirt Holding Capacity**
- Reinforced with epoxy coated steel wire on both sides of cloth
- Washable - lukewarm water & mild detergent
- Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- Optimal sealing surface & design

Particle Size vs. Filter Efficiency on polyester media at indicated face velocity:

- 15 cfm/ft² media ———
- 30 cfm/ft² media ·····
- 45 cfm/ft² media - - - - -

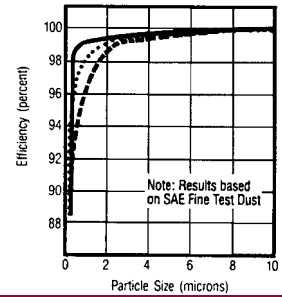


PAPER ELEMENTS

- 99%+ removal efficiency to 2 micron
- Pleated Media for **High Dirt Holding Capacity**
- Heavy duty industrial strength paper surrounded by heavy gauge galvanized expanded metal
- Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- Optimal sealing surface & design

Particle Size vs. Filter Efficiency on paper media at indicated face velocity:

- 10 cfm/ft² media ———
- 15 cfm/ft² media ·····
- 20 cfm/ft² media - - - - -



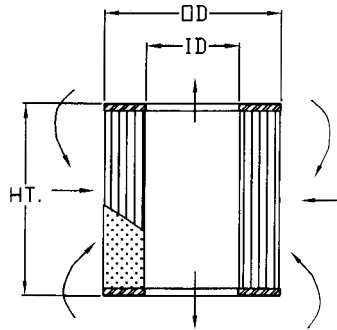
ADVANTAGES

- Less maintenance
- More durable
- Moisture resistant
- Handles hot air and oil mist from unload cycle of reciprocating/piston compressor
- Optimal surface area per given size
- Higher efficiency than many alternative media
- Cost Effective

CONFIGURATION

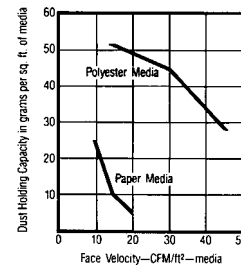


DRAWING



Dimension tolerance ± 1/4"

Face Velocity vs. Dust Holding Capacity



Polyester Elements	Paper Elements	STD Endcap Features	DIMENSIONS - inches			Polyester Surface Area ft ²	Paper Surface Area ft ²	Rated Flow SCFM
			ID	OD	HT			
15P	14P	M	3	4 3/8	2 5/16	0.50	1.12	35
19P®	18P	M	3	4 3/8	4 3/4	1.5	3.0	100
31P	30P	M	3 5/8	5 3/4	4 3/4	2.3	6.2	195
231P	230P	M	3 5/8	5 3/4	9 1/2	4.5	11.8	300

Legend

- B= Closed one end w/ Bolt hole, open on other end
- C= Closed one end, open on other end
- F= Felt gaskets on open end(s)
- G= Galvanized metal endcaps
- I= Injection molded santoprene
- M= Molded plastisol
- N= Neoprene gaskets on open end(s)
- R= Mixed Rubber/cork gasket on open ends
- T= Tin plated metal endcaps

See back page for information about media for special applications.

P = Polyurethane Prefilter Included

Note: Model offerings and design parameters may change without notice.

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REPLACEMENT ELEMENTS



COMPACT/BIG BOY POLYESTER & PAPER ELEMENTS

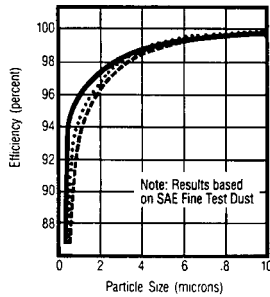
Up to 6600 SCFM and Housings up to 12"

POLYESTER ELEMENTS

- 99%+ removal efficiency to 5 micron
- Pleated Media for **High Dirt Holding Capacity**
- Reinforced with epoxy coated steel wire on both sides of cloth
- Washable - lukewarm water & mild detergent
- Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- Optimal sealing surface & design

Particle Size vs. Filter Efficiency on polyester media at indicated face velocity:

- 15 cfm/ft² media ———
- 30 cfm/ft² media •••••
- 45 cfm/ft² media - - - - -

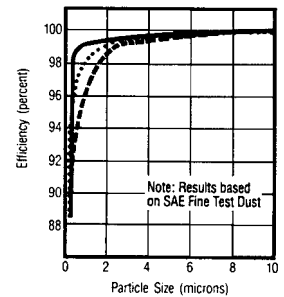


PAPER ELEMENTS

- 99%+ removal efficiency to 2 micron
- Pleated Media for **High Dirt Holding Capacity**
- Heavy duty industrial strength paper surrounded by heavy gauge galvanized expanded metal
- Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- Optimal sealing surface & design

Particle Size vs. Filter Efficiency on paper media at indicated face velocity:

- 10 cfm/ft² media ———
- 15 cfm/ft² media •••••
- 20 cfm/ft² media - - - - -



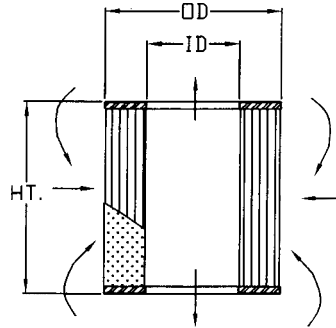
ADVANTAGES

- Less maintenance
- More durable
- Moisture resistant
- Handles hot air and oil mist from unload cycle of reciprocating/piston compressor
- Optimal surface area per given size
- Higher efficiency than many alternative media
- Cost Effective

CONFIGURATION

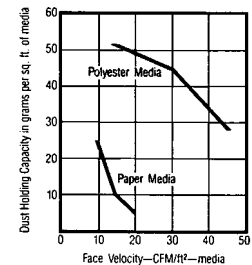


DRAWING



Dimension tolerance ± 1/4"

Face Velocity vs. Dust Holding Capacity



REPLACEMENT ELEMENTS

Polyester Models	Paper Models	STD Endcap Features	DIMENSIONS - inches			Polyester Surface Area ft ²	Paper Surface Area ft ²	Rated Flow SCFM
			ID	OD	HT			
35P	34P	M	4 3/4	7 7/8	4 13/16	4.0	11.0	275
235P	234P	M	4 3/4	7 7/8	9 5/8	8.3	22.8	570
335P	334P	M	4 3/4	7 7/8	14 1/2	12	34	800
239P	238P	GBN	4 7/8	9 1/4	10	11.5	52	570
245P	244P	GN M	6	9 3/4	9 5/8	14	35.5	880
345P	344P	GN	6	9 3/4	14 1/2	22.1	57	1100
275P	274P	GN	8	11 3/4	9 5/8	19	45.4	1100
375P	374P	GN	8	11 3/4	14 1/2	28	68.1	1500
377P	376P	GN	9	14 5/8	14 1/2	50	125	1825
385P	384P	GN	14	19 5/8	14 1/2	50	140	3300
485P	484P	GN	14	19 5/8	21 1/2	75	200	4705
685P		GN	14	19 5/8	28 1/2	100		6600

Legend

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- G= Galvanized metal endcaps
- I= Injection molded santoprene
- M= Molded plastisol
- N= Neoprene gaskets on open end(s)
- R= Mixed Rubber/cork gasket on open ends
- T= Tin plated metal endcaps

See back page for information about media for special applications.

P = Polyurethane Prefilter Included

Note: Model offerings and design parameters may change without notice.

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pg. 4

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INTERNATIONAL 800 SERIES ELEMENTS

Polyester & Paper Elements

POLYESTER ELEMENTS

- ♦ 99%+ removal efficiency to 5 micron
- ♦ Pleated Media for **High Dirt Holding Capacity**
- ♦ Reinforced with epoxy coated steel wire on both sides of cloth
- ♦ Washable - lukewarm water & mild detergent
- ♦ Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- ♦ Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- ♦ Optimal sealing surface & design

PAPER ELEMENTS

- ♦ 99%+ removal efficiency to 2 micron
- ♦ Pleated Media for **High Dirt Holding Capacity**
- ♦ Heavy duty industrial strength paper surrounded by heavy gauge galvanized expanded metal
- ♦ Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- ♦ Temp (continuous): min: -15°F (-26°C) max 220°F (104°C)
- ♦ Optimal sealing surface & design

APPLICATIONS

- ♦ Vacuum Pumps
- ♦ Air Compressors
- ♦ Printing Industry
- ♦ Medical Field

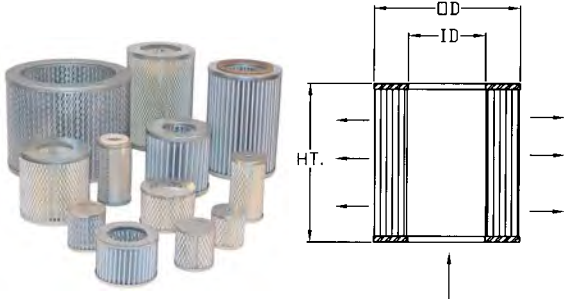
ADVANTAGES-POLYESTER

- ♦ Less maintenance
- ♦ More durable than paper media
- ♦ Moisture resistant
- ♦ Handles hot air and oil mist from unload cycle of reciprocating/piston compressor

ADVANTAGES-PAPER

- ♦ Maximum holding capacity
- ♦ Higher efficiency than many alternative media
- ♦ Cost Effective
- ♦ Stock Quantities

CONFIGURATION DRAWING



Dimension tolerance $\pm 1/4"$

Legend

- B= Closed one end w/ Bolt hole, open on other end
 C= Closed one end, open on other end
 F= Felt gaskets on open end(s)
 G= Galvanized metal endcaps
 I= Injection molded santoprene
 M= Molded plastisol
 N= Neoprene gaskets on open end(s)
 R= Mixed Rubber/cork gasket on open ends
 T= Tin plated metal endcaps

See back page for information about media for special applications.

Paper Element	Mann No.	STD Endcap Features	DIMENSIONS - inches			Surface Area ft ²	Rated Flow SCFM
			ID	OD	HT		
800	C31	TB	3/8	1 1/8	1 1/6	0.14	3
802	C31/1	TB	3/8	1 1/8	1 1/2	0.22	5
804	C32	TB	3/8	1 1/8	2 7/16	0.35	9
806	C42/1	TB	1/2	1 1/2	1 1/2	0.33	8
808	C42/2	TB	1/2	1 1/2	1 1/8	0.18	4
810	C43	TB	1/2	1 1/2	2 7/16	0.55	13
812	C44	TC	1/2	1 1/2	1 1/2	0.33	8
814	C64/1	TB	11/16	2 5/16	1 9/16	0.55	13
816	C64/3	TC	11/16	2 5/16	1 9/16	0.55	13
818	C66	TB	11/16	2 5/16	2 7/16	0.89	20
820	C66/1	TB	11/16	2 5/16	2	0.76	18
822	C74	TF1	1	2 11/16	1	0.29	7
824	C75	TC	1 1/2	2 1/2	2 11/16	0.92	25
826	C75/2	TCF	1 1/2	2 1/2	2 13/16	0.86	20
828	C76/2	TC	1 1/2	2 1/2	1 3/4	0.48	12
830	C79/1	TB	1	2 1/2	2 7/8	0.91	24
832	C79/2	TCF	1 1/2	2 1/2	2 11/16	0.82	19
834	C713	TBHF	1 1/2	2 1/2	4 1/2	1.5	40
836	C718	TBHF	1 1/2	2 1/2	6 9/16	1.8	48
838	C912	TCF	2 3/8	3 5/16	2 3/4	1.2	30
840	C1049	T	1 3/4	3 5/8	5 5/8	3.5	80
842	C1112	T	2 3/8	3 7/8	2 3/4	1.7	55
844	C1112/2	TCF	2 3/8	3 7/8	2 3/4	1.8	55
846	C1132	T	2 3/8	3 7/8	3 15/16	2.7	62
848	C1337	T	2 9/16	5	4 3/4	5.0	115
850	C15124/1	TR	3 1/2	5 7/8	8 3/4	14	290
852	C711/1	TC	1 1/2	2 11/16	2 3/4	0.97	24
854	C411	TB	1/2	1 1/2	5 1/3	1.1	27
856	C26240	T	7 11/16	10	7 11/16	17	375
858	C1574	T	3 1/2	5 7/8	4 7/8	1.3	110
862	C21138/1	T	5 11/16	8 3/8	6 7/16	14	322
868	N/A	M	2 3/8	3 11/16	2 15/16	1	25
870	C69/1	TB	1 1/8	1 15/16	5 5/8	1.2	30
872	C75/2	TBF	1 1/2	2 1/2	2 13/16	0.93	24
874	N/A	TCF	6	8 1/2	3 1/2	-	-
878	N/A	TB	2 9/16	5	4 3/4	5.0	115

Polyester Element	Ref. Mann No.	STD Endcap Features	DIMENSIONS - inches			Rated Flow SCFM
			ID	OD	HT	
821	C66/1	TB	11/16	2 5/16	2	18
825	C75	TC	1 1/2	2 1/2	2 11/16	25
827	C75/2	TCF	1 1/2	2 1/2	2 13/16	20
841	C1049	T	1 3/4	3 5/8	5 5/8	80
843	C1112	T	2 3/8	3 7/8	2 3/4	55
845	C1112/2	TCF	2 3/8	3 7/8	2 3/4	55
847	C1132	T	2 3/8	3 7/8	3 15/16	62
849	C1337	T	2 9/16	5	4 3/4	115
851	C15124/1	TR	3 1/2	5 7/8	8 3/4	290
857	C26240	T	7 11/16	10	7 11/16	375
859	C1574	T	3 1/2	5 7/8	4 7/8	110
863	C21138/1	T	5 11/16	8 3/8	6 7/16	322
879	N/A	TB	2 9/16	5	4 3/4	115

Note: Model offerings and design parameters may change without notice.

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ODD SIZED ELEMENTS

FEATURES & SPECIFICATIONS

Polyester Elements:

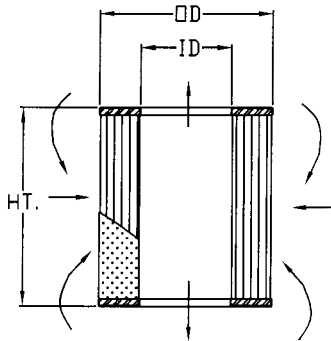
- ♦ **99%+** removal efficiency standard to 5 micron
- ♦ Reinforced with epoxy coated steel wire on **Both** sides of the cloth
- ♦ Washable - lukewarm water & mild detergent

Paper Elements:

- ♦ **99%+** removal efficiency standard to 2 micron
- ♦ Heavy duty industrial strength paper surrounded by heavy gauge galvanized expanded metal

Specifications:

- ♦ Pleated Media for **High Dirt Holding Capacity**
- ♦ Optimal surface area per given size
- ♦ Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- ♦ Temp: (continuous):
min -15°F (-26°C) max 220°F (104°C)
- ♦ Filter change out differential:
10"-15" H₂O Over Initial Delta P



Dimension tolerance $\pm 1/4"$

Legend

- B= Closed one end w/ Bolt hole, open on other end
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- F= Felt gaskets on open end(s)
- G= Galvanized metal endcaps
- I= Injection molded santoprene
- M= Molded plastisol
- N= Neoprene gaskets on open end(s)
- R= Mixed Rubber/cork gasket on open ends
- T= Tin plated metal endcaps

See back page for information about media for special applications.

Polyester Element	Paper Element	STD Endcap Features	DIMENSIONS - inches			Surface Area ft ²		Rated Flow SCFM
			ID	OD	HT	Polyester	Paper	
09	08	GN	1 1/8	2 1/4	2 1/4	0.25	0.45	15
903	-	M	4 3/4	6 3/16	5 3/8	1.5	-	70
21NP**	-	M	2 3/8	4 1/4	4 3/4	1.7	-	80
25	24	M	3 5/8	5 7/8	4	2.0	4.7	105
-	C475538	GN	4	5 3/8	4 3/4	-	6.5	150
-	80P	M	4 1/8	7 7/8	3	-	7.1	175
-	84P	M	4 1/8	7 7/8	4	-	10.3	255
45P	44P	M	6	9 3/4	4 3/4	6.9	17.2	430
-	74P	M	8	11 3/4	5	-	21.0	560
371P	370P	GN	10	13 3/4	14 1/2	-	72.2	1800
391	390	GN	22 1/4	27 7/8	14 1/2	100	275	5500
491	490	GN	22 1/4	27 7/8	21 1/2	145	400	8000
545P	-	GN	6	9 3/4	24 1/2	56	-	1700
571P	-	GN	10	13 3/4	24 1/2	100	-	3000
575P	-	GN	8	11 3/4	24 1/2	84	-	2500
585P	-	GN	14	19 5/8	24 1/2	195	-	5000
-	100	M	1 1/4	3 7/8	2 3/4	-	2.3	50
-	101	M	4 1/2	6 5/8	5 1/8	-	5.7	120
-	102	M	5 11/16	7 3/4	3	-	3.3	85
-	103	M	7 1/4	9 3/4	5 15/16	-	13.4	520
-	104	M	5 1/8	7 1/4	5 3/8	-	7.1	150
-	105	M	5 3/32	6 15/16	5 13/16	-	8.1	205
-	106	M	7 3/4	12	4 1/2	-	19.4	400
-	107P	M	1 3/16	2 3/4	2 1/2	-	0.7	20
-	108	M	3 5/8	5 3/4	2 3/4	-	3.0	60
-	109	M	5 5/8	7 3/4	4	-	6.8	170
-	120	GN	4 7/8	8 1/2	4 5/8	-	11.5	250
-	121	M	4	5 3/8	4 7/8	-	3.1	60
-	122	GN	5 1/4	10 3/16	5 3/8	-	20.0	450
-	123	M	11 1/2	13 5/8	3	-	5.9	150
-	124	M	11 1/2	13 5/8	4 1/8	-	7.8	195
-	125	GN	1 7/16	3	4 15/16	-	1.6	90
-	126	GN	4 3/4	6 1/2	2 1/8	-	2.1	100
-	135	M	11 1/2	13 5/8	8 5/8	-	21	1100

* 4 micron media

Note: Model offerings and design parameters may change without notice.

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REPLACEMENT ELEMENTS



OIL MIST COALESCING ELEMENTS

For "HDL", "VPST", "EE", & "EF" Series Housings

FEATURES & SPECIFICATIONS

- ♦ 99.97% D.O.P. efficiency on 0.3 micron diameter particles
- ♦ Reinforced with epoxy coated steel wire.
- ♦ Expanded metal support on both sides of cloth
- ♦ Temperatures (continuous):
min: 40°F (4°C) max: 220°F (104°C)
- ♦ Filter change out differential: Please refer to Vacuum Pump Manufacturer's specifications

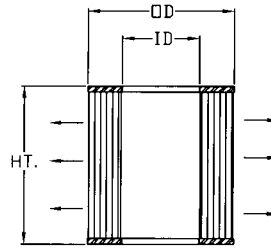
ADVANTAGES

- ♦ High efficiency at low pressure drop
- ♦ **Increased Surface Area** in a given volume allows low velocity separation of ultra-fine oil mists
- ♦ High gravimetric efficiency means low oil carryover
- ♦ Pleated media for high holding capacity
- ♦ Environmentally friendly sealing material

CONFIGURATION



DRAWING



Dimension tolerance $\pm 1/4"$

Coalescing Element	STD Endcap Features	DIMENSIONS - inches			Rated Flow SCFM
		ID	OD	HT	
FG3	M	1 1/4	2 1/4	2 1/8	4
FG5	M	1 1/4	2 1/4	3	4.5
FG7	M	1 1/4	2 1/4	4	7
FG9	M	3	4	4	16
FG10	M	3	4	6	24
FG11	M	3 7/8	5	4 1/4	30
FG20	M	8	9	4 3/4	44
FG24	M	8	9	6	55
GL910	GC	1/2	1 13/16	1 7/16	4
GL915	GB	3/4	2 5/16	2 3/8	10
GL925	GB	1 1/2	3	4 7/8	20
PSG848	G	2 9/16	5	4 3/4	50
PSG850/1	GB	3 1/2	5 7/8	8 3/4	125
PSG145	G	2 9/16	5	14 1/4	175
PSG860/1	GB	3 1/2	5 7/8	14	200
PSG294	GB	6	9 3/4	9 5/8	300
PSG344/2	GB	6	9 3/4	14 1/2	500
PSG374/2	GB	8	11 3/4	14 1/2	800
PSG474/2	GB	8	11 3/4	21 1/2	1100
PSG476	G	9	14 5/8	21 1/2	1800

Legend

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- I= Injection molded santoprene
- M= Molded plastisol
- N= Neoprene gaskets on open end(s)
- R= Mixed Rubber/cork gasket on open ends
- T= Tin plated metal endcaps

See back page for information about media for special applications.

Note: Model offerings and design parameters may change without notice.

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pg. 7

REPLACEMENT ELEMENTS



MEDIA FOR SPECIAL APPLICATIONS

INCREASED EFFICIENCY

4 Micron Polyester Elements "N" Series

- ♦ 99.9+% removal efficiency to 4 µm
Nomenclature: i.e. 19N

1 Micron Polyester Elements "Z" Series

- ♦ 99.9+% removal efficiency to 1 µm
Nomenclature: i.e. 235Z

Specifications

- ♦ Reinforced with epoxy coated steel wire on both sides of cloth
- ♦ Washable - lukewarm water & mild detergent
- ♦ Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- ♦ Optimal sealing surface & design

HEPA Elements "HE" Series

- ♦ 99.97% D.O.P. efficiency to 0.3 µm
Nomenclature: i.e. HE30
- ♦ Heavy duty industrial strength glass surrounded by heavy gauge galvanized expanded metal
- ♦ Maximum oversizing required to minimize pressure drop
- ♦ Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- ♦ Optimal surface area per given size

CHEMICAL ADSORPTION

Activated Carbon "AC" Series

- ♦ Wound activated carbon impregnated polyester media
- ♦ Dual filtration, stops both particulate matter and gas or vapor odors and contaminants
- ♦ Available as:
 - Replacement element
Nomenclature: i.e. AC234
 - Activated Carbon wrap for standard elements
Nomenclature: i.e. Wrap only: ACP30
 - Std Element with activated carbon wrap: 484ACP or 485ACP

Activated Carbon Granulate, "ACG" Series and Activated Alumina, "AA" Series also available. Contact Solberg for more information.

COARSE EFFICIENCY

25 Micron Polyester Elements "U" Series

- ♦ 99+% removal efficiency to 25 µm
Nomenclature: i.e. 377U

100 Micron Polyester Elements "W" Series

- ♦ 99+% removal efficiency to 100 µm
Nomenclature: i.e. 485W

Specifications

- ♦ Reinforced with epoxy coated steel wire on both sides of cloth
- ♦ Washable - lukewarm water & mild detergent
- ♦ Dust loading capacity is increased 40 - 50% with polyurethane prefilter
- ♦ Optimal sealing surface & design

Stainless Steel Wire Mesh Elements "S2" Series

- ♦ Stainless steel wire mesh
Nomenclature: i.e. 244S2
- ♦ Corrosive Applications
 - Mosquito abatement
 - Chemical processing
 - Hydraulic
- ♦ Low maintenance

Epoxy Coated Wire Mesh Elements "S" Series

STAINLESS STEEL SERIES

"J", "K", "Q", "R", and "D" Options

- ♦ Stainless Steel I.D. and O.D. construction
- ♦ Silicone endcaps available
- ♦ Special Gaskets/Sealing
- ♦ Chemically resistant
- ♦ High Temperature applications

CHEMICAL GRADE MEDIA

Polypropylene "Y" Series

- ♦ 99+% removal efficiency to 5 µm
Nomenclature: i.e. 685Y
- ♦ Chemical resistant media
- ♦ Low pressure drop
- ♦ Reinforced with epoxy coated steel wire on both sides of media

PTFE Media available. Contact Solberg for more information.

**INQUIRES ENCOURAGED
CONTACT YOUR LOCAL
SOLBERG REPRESENTATIVE
FOR YOUR SPECIFIC APPLICATION**

COALESCING MEDIA FOR OIL MIST

- ♦ 99.97% D.O.P. efficiency on 0.3 µm diameter particles
- ♦ Custom internal multi-stage layering to meet specific application needs

Specifications

- ♦ Reinforced with epoxy coated steel wire on both sides of cloth
- ♦ High efficiency at low pressure drop
- ♦ Increased surface area in a given Volume allows low velocity separation of ultra-fine oil mists
- ♦ High D.O.P. efficiency
 - low oil carryover
- ♦ Environmentally friendly sealing material
- ♦ Temperature (continuous):
 - minimum 40°F (4°C)
 - maximum 220°F (104°C)
- ♦ Filter change out differential: Please refer to Vacuum Pump Manufacturer's specifications

HIGH TEMPERATURE

Nomex Cloth Elements "MX" Series

- ♦ 99+% removal efficiency to 5 µm
Nomenclature: i.e. 275MX
- ♦ Food grade silicone adhesive
- ♦ Reinforced with epoxy coated steel wire on both sides of cloth
- ♦ Washable - lukewarm water & mild detergent
- ♦ Temperature (continuous):
 - minimum -15°F (-26°C)
 - maximum 385°F (196°C)

Nomex Cloth Elements "MXD" Series

- ♦ 99+% removal efficiency to 5 µm
Nomenclature: i.e. 345MXD
- ♦ Food grade silicone adhesive
- ♦ Reinforced with stainless steel wire mesh on both sides of cloth and stainless steel endcaps
- ♦ Washable - lukewarm water & mild detergent
- ♦ Temperature (continuous):
 - minimum -15°F (-26°C)
 - maximum 385°F (196°C)

REPLACEMENT ELEMENTS

1151 Ardmore Ave. ♦ Itasca, IL 60143 USA
Tel: 630/773-1363 ♦ Fax: 630/773-0727
E-mail: sales@solbergmfg.com
Web Site: www.solbergmfg.com

EMD-401

pg. 8

Solberg Manufacturing Inc. – Where the Best is in Store for You!



Vacuum Pumps and Systems

MATERIAL SAFETY DATA SHEET



SECTION I PRODUCTION IDENTIFICATION AND USE

TRADE NAME: **M-220**

CHEMICAL NAME AND SYNONYMS: MIXTURE

MANUFACTURER/ DISTRIBUTOR'S NAME: BUSCH VACUUM TECHNICS INC.
1740 Lionel-Bertrand blvd
Boisbriand, Québec
J7H 1N7 www.busch.ca
Tél.: (450) 435-6899 ou 1-800-363-6360

24 HOURS EMERGENCY: Call CHEMTREC 1-800-424-9300 or 703-527-3887

PRODUCT USE: Synthetic Gear Fluid

WHMIS CLASS AND DESCRIPTION

This product is not regulated by the WHMIS.

TRANSPORTATION (TDG)

SHIPPING NAME: None
UN NUMBER: None
CLASS DESCRIPTION: None

SECTION #2 COMPOSITION/INFORMATION ON INGREDIENTS

NOM	%	No CAS
---	--	---

ADDITIONAL REGULATORY INFORMATION

- No hazardous ingredients as defined by the Canadian Hazardous Products Act (BILL C70) or by OSHA 29 CFR 1910.1200.
- Canadian DSL status: All ingredients are listed.
- * No components of this product have been found carcinogenic or potential carcinogen. Does not contain ingredients that are listed as carcinogenic or potential carcinogen by OSHA, IARC or the U.S. National Toxicology Program (NTP). This product or its components have no teratogenic or mutagenic effects known.

Vacuum Pumps and Systems

MATERIAL SAFETY DATA SHEET



SECTION #3 PHYSICAL DATA

PHYSICAL STATE AT 25°C	liquid
INITIAL BOILING POINT:	> 300°C
POUR POINT:	-20°C minimum
DENSITY (g/cm ³ at 15°C):	0,87 to 0,89
VAPOR PRESSURE (mm Hg at 20°C):	Negligible
VISCOSITY (cSt at 100°C):	5,5 to 42
EVAPORATION RATE:	Negligible
SOLUBILITY IN WATER:	Negligible
APPEARANCE ET ODOR:	Yellowish with bland odor

SECTION #4 STABILITY AND REACTIVITY

STABILITY:	Stable
CONDITIONS TO AVOID:	Avoid excessive heat, open flames and formation of oil mist.
PRODUCTS TO AVOID:	Oxidizing agents, strong acids and bases.
HAZARDOUS DECOMPOSITION PRODUCTS:	N/A
POLYMERIZATION:	Will not occur

SECTION #5 FIRE FIGHTING MEASURES

FLASH POINT (COC):	> 220°C
FLAMMABILITY LIMITS IN AIR:	LEL: N/A
(% PER VOLUME)	UEL: N/A
AUTOIGNITION TEMPERATURE (°C):	N/A
EXTINGUISHING MEDIA:	Foam, Dry chemical and CO ₂
HAZARDOUS COMBUSTION PRODUCTS:	Normal combustion products, CO and CO ₂ .
SPECIAL FIRE FIGHTING PROCEDURES:	Do not enter confined fire space without adequate protective clothing and an approved positive self-contained breathing apparatus. Use water to cool fire exposed containers.

Vacuum Pumps and Systems

MATERIAL SAFETY DATA SHEET



SECTION #6 TOXICOLOGICAL INFORMATION

SPECIES	LD ₅₀ ORAL	LD ₅₀ DERMAL	LC ₅₀ INHALATION	HRS
Rat	> 5000 mg/Kg	> 2000 mg/Kg	N/A	---

INHALATION: Prolonged exposure to high vapor concentration of this product can cause headache, dizziness and nausea. Short-term overexposure can cause an irritation to the respiratory passages.
Exposure limit to the mist = 5 mg/m³ (TLV/TWA, ACGIH).

CONTACT WITH EYES: This product should not cause eye irritation. However repeated contact may cause eye irritation.

SKIN CONTACT: This product should not cause skin irritation. However, prolonged and repeated contact with this product can cause skin drying, which may result in skin irritation and dermatitis.

INGESTION: May cause nausea.

SECTION #7 ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK PROCEDURES: Eliminate all ignition sources. Stop leak only if safe to do so. Absorb residue or small spills with absorbent material and remove to non-leaking containers for disposal.

SECTION #8 HANDLING AND STORAGE

STORAGE AND HANDLING: Store in cool, dry, ventilated area, away from heat and ignition sources. Use good personal hygiene. Always keep the container close.

SECTION #9 EXPOSURE CONTROLS / PERSONAL PROTECTION

VENTILATION: Mechanical ventilation is recommended.

RESPIRATORY PROTECTION: If mist present, chemical cartridge respirator is recommended.

GLOVES: Resistant gloves (Viton, Nitrile, Neoprene) are recommended when handling this material.

EYE PROTECTION: Chemical safety goggles are recommended.

OTHER PROTECTION: In confined spaces or where the risk of skin exposure is higher, resistant clothing or apron should be worn.

Vacuum Pumps and Systems

MATERIAL SAFETY DATA SHEET



SECTION #10 DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHODS: Consult relevant local authorities. Reclaim or dispose of at a licensed waste disposal company. Incinerate with approval of appropriate local authority.

SECTION #11 FIRST AID

INHALATION: Remove person to fresh air. See a physician if irritation persists.

CONTACT WITH EYES: Flush immediately with water for at least 15 minutes.

CONTACT WITH SKIN: Wash contaminated skin with mild soap and water. See a physician if irritation persists.

INGESTION: This product has a low toxicity. May cause nausea and have a laxative effect. Do not induce vomiting. Contact an Anti-Poison Center (1-800-463-5060).

SECTION #12 HAZARDS IDENTIFICATION

INHALATION: Prolonged exposure to high vapor concentration of this product can cause headache, dizziness and nausea. Short-term overexposure can cause an irritation to the respiratory passages.
Exposure limit to the mist = 5 mg/m³ (TLV/TWA, ACGIH).

CONTACT WITH EYES: This product should not cause eye irritation. However repeated contact may cause eye irritation.

SKIN CONTACT: This product should not cause skin irritation. However, prolonged and repeated contact with this product can cause skin drying, which may result in skin irritation and dermatitis.

INGESTION: May cause nausea.

SECTION #13 ECOLOGICAL INFORMATION

ENVIRONMENTAL EFFECTS:

Do not allow product or runoff from fire control to enter storm or sanitary sewers, lakes, rivers, streams, or public waterways. Block off drains and ditches. Provincial regulations require and federal regulations may require that environmental and/or other agencies be notified of a spill incident. Spill area must be cleaned and restored to original condition or to the satisfaction of authorities.

BIODEGRADABILITY: NOT READILY BIODEGRADABLE.

Vacuum Pumps and Systems

MATERIAL SAFETY DATA SHEET



SECTION #14 TRANSPORTATION INFORMATION

TRANSPORTATION (TDG)

SHIPPING NAME:	None
UN NUMBER:	None
CLASS DESCRIPTION:	None

SECTION #15 REGULATORY INFORMATION

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

THIS PRODUCT IS NOT A WHMIS CONTROLLED SUBSTANCE.

DSL/NDSL Status: This product, or all components, are listed on the Domestic Substances List, as required under the Canadian Environmental Protection Act. This product and/or all components are listed on the U.S. EPA TSCA Inventory.

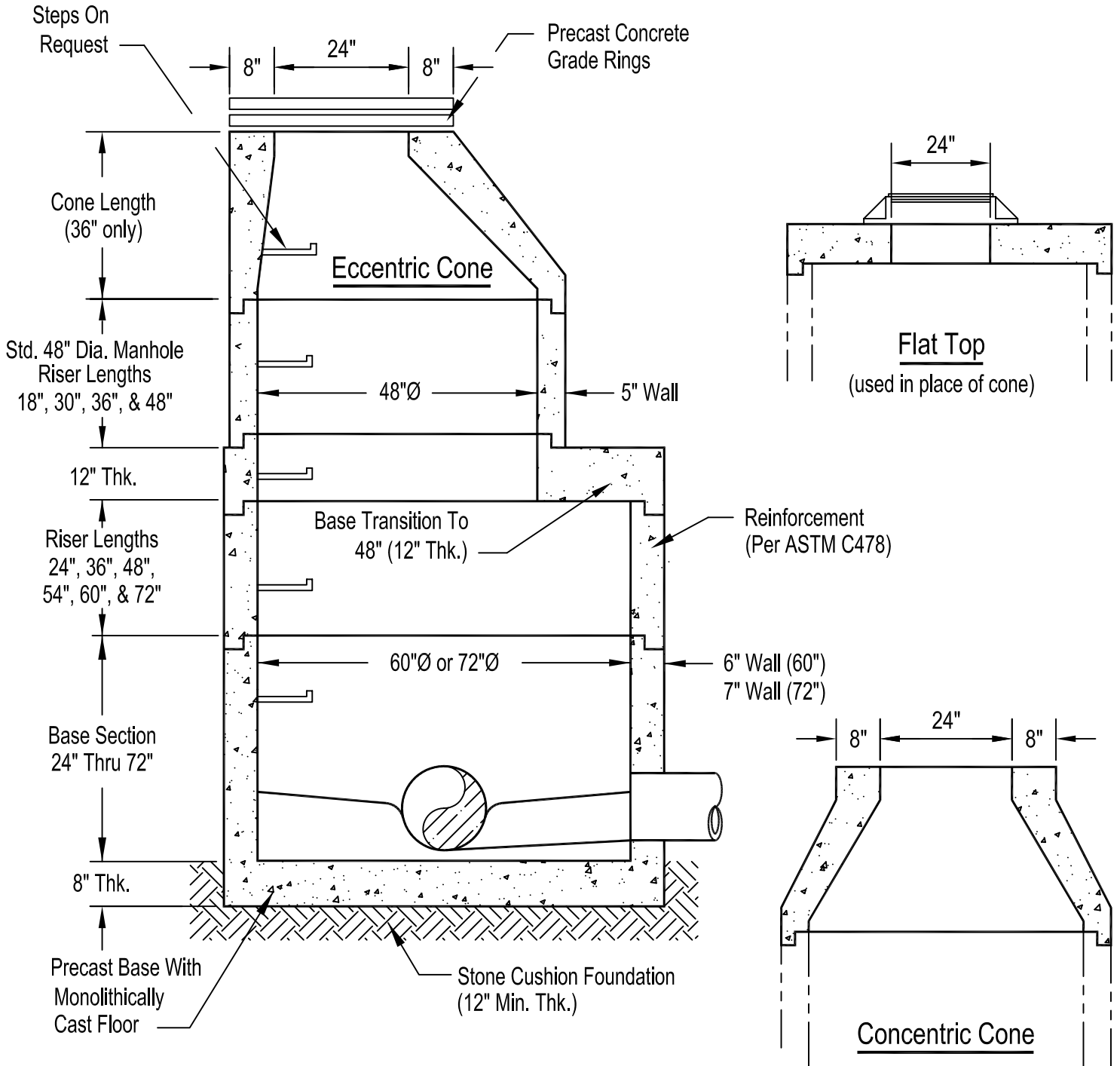
Other Regulatory Status: No Canadian federal standard; however, for general discharge guidance, federal installations limited to 15 mg/L for total oil and grease. Provincial criteria are likely and should be requested when notifying provincial authorities.

SECTION #16 ADDITIONAL INFORMATION

Revised on 8 NOVEMBER 2008

We believe that technical information and recommendations contained herein to be reliable and accurate. However, we provide these data without warranty or guarantee of any kind, expressed or implied. We assume no responsibility for any loss, damage, or expense, direct or consequential, arising from the use of products described herein.

Typical 60" or 72" Diameter Manhole



Typical Section Thru Manhole

Notes:

1. Produced to meet ASTM specifications.
2. Cones available eccentric or concentric.
3. Additional manhole sizes are available.
4. Contact a Concrete Pipe Division representative for details not listed on this sheet.

Appendix B: Barrier Wall Design and System Head Loss Calculations



April 15, 2022

#3426622

Susan von Gonten, Project Manager
New Mexico Environment Department
Petroleum Storage Tank Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505
susan.vongonten@state.nm.us

Katherine MacNeil, P.E.
Engineer
New Mexico Environment Department
Petroleum Storage Tank Bureau
121 Tijeras Avenue NE, Suite 1000
Albuquerque, NM 87102
katherine.macneil@state.nm.us

RE: Final Remediation Plan, Engineering Plans and Specifications – Response to Request for Additional Information, Fairview Station, Española, New Mexico
Facility #28779 SID #4657 WPID #3997-3

Dear Ms. Von Gonten and Ms. MacNeil:

In response to email from Jim Gibb of April 11, 2022, please find attached the applicable calculations for the design and evaluation of the project slurry wall.

As provided previously, the following summary of design considerations is provided for your review. These are:

- The ENERCALC software package, Version 12.20.8.24, Cantilevered Retaining Wall module was used to prepare this analysis. This software is industry-standard for basic civil and structural engineering calculations. The software package has been widely used by the engineering community since originally released in 1983.
- Although the subject structure is not a cantilever retaining wall, this program was used to calculate lateral earth forces, which is consistent with commonly applied engineering practice.
- Although the computer output files reference reinforcement, in fact the structure is constructed of unreinforced concrete slurry. The reinforcement shown is based on a minimum amount as required by ACI of 0.0018 percent. The minimal reinforcement included does not change the lateral earth forces calculated by the software.
- It is assumed that existing in-situ soils on the outside of the structure and placed compacted fill soils on the inside of the structure, along with adequately sized trench box sections, will be simultaneously used to provide adequate balanced loading to the slurry wall.
- Based on record soils information and soil physical properties, an allowable soil unit weight of 110 pounds per cubic foot (pcf) with a soil friction angle of 30 degrees is used.
- Backfill soils behind the slurry wall are level.
- For this project, Coulombs Soil Pressure methodology is used to compute lateral earth pressures.

- Calculations are provided for a water table depth of 1' and 6' above the bottom of the wall. This represents the expected and worst-case scenarios.
- Calculation assume that the adjacent vehicular traffic is barricaded significantly back from the excavation so no additional loading to the structure, which is consistent with the plan for site work.
- According to GeoSolutions, Inc., SMA's slurry wall contractor in Colorado, directional drilling through slurry walls is a common practice. GeoSolutions indicated drilling through the wall is not likely to cause significant cracking, spalling or other structural issues. In order to provide additional margin of safety, SMA has specified the east-west wall be five feet wide. The additional width beyond the three-foot minimum allows for potential damage caused by the directional drilled horizontal wells.

Specific comments received on January 26, 2022 via email are restated with responses italicized below:

- Please provide the calculations for the construction of the slurry wall to ensure that the strength is appropriate for the time that the excavation would be open while at the same time addressing the following concerns:

The strength on the slurry wall is a function of appropriate mix design strength and density to prevent water filtration. As the wall will be supported on both sides during project, the soil loading on both sides is balanced therefore a slurry wall is appropriate for this applications with a lower compressive strength of 200-300 psi versus reinforced concrete with strength ranging from 3,000 psi to 5,000 psi that would be required if the structure was design to carry cantilever type loads.

- Will the directional drilling of the horizontal SVE and horizontal NAPL/water collector wells through the newly installed east-west cement-bentonite barrier wall cause cracks or impact its strength?

No. See response above. Also, after the cement slurry wall is placed and cured, a directional drilling equipment with a rock bit will be utilized to drill through the wall. This will not damage the wall or cause a loss of strength to the structure.

- Despite the dewatering that is ongoing while the FRP design is being implemented does the barrier wall design take into consideration effects of water pressure?

Yes. Calculations provided include the existing water table and the lowered water table.

- If there are point loads on the top of the cement-bentonite wall (e.g. heavy vehicle traffic) does the design demonstrate that these loads would not crack the barrier wall?

No point loads allowed directly adjacent to the wall, so no calculations are provided for this type of loading.

- Also include the name of the PE or company that designed the slurry wall. The calculations must be reviewed by the PE of Record, Marty Howell, before the FRP is finalized.

Provided.

- All engineering plans & specs and calculations in Appendix B must be signed and sealed by the PE of Record, Marty Howell.

Provided.

Specific comments received on April 11, 2022 via email are restated with response below:

- A separate page of inputs, and constants beyond what is in the input, output sheets from the program could have been provided (e.g. resultant eccentricity, the Gamma (the bulk density of the backfill material), the coefficients of pressure for active and passive pressures etc that were entered into the civil engineering software program etc. It appears they performed only one active pressure calculation for each dewatering scenario.

Documentation of the Coulomb Earth Pressure Theory and associated calculation methodology from Foundation Analysis and Design (Boles 2017), is shown in the attached pages. All required input parameters are included in the attached calculations. The value of the Friction Coefficient between concrete and soil is from record soil data information for the specific site from the USDA Web Soil database (<https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>). The statement that one active pressure calculation was completed for each dewatering scenario is correct.

- The rationale behind choosing the Coulombs Soil Pressure Methodology as opposed to Rankine Methodology or the Equivalent Fluid Pressure Method for calculating active pressures and the basic elements of these methods. Does the Coulombs Soil Pressure Methodology provide the most conservative calculation of active pressures?

There are 3 generally excepted methods for calculating lateral earth pressures, Coulombs, Rankine and Fluid Earth Pressure (EFP). Based on education, training and experience, Coulombs Methods is the most applicable method of calculation for this application.

- Pg. 3 and 7 of calculation –
 - Under Stem Construction what is the significance of Top Stem, 2nd and 3rd (Top stem is 25'ft high (height of slurry wall), but what is 2nd and why is it 13')?

The program using a maximum stem height that will not allow only one stem to be analyzed. The stem was separated into two different sections in order to meet/exceed the 25' value

- The rationale behind the following statement: "Axial Load is NOT included in total displayed, or used for overturning resistance, but is included in soil pressure calculation."

Axial loading is not included in these calculations. Vertical axial loads, if applied, can act to resist overturning moments and that is not the case for this application

- Specify what fb/FB , fa/FA, S and Fr denote?

These are ratios used to analyze the structural stability of the structure. As the project is not utilizing structural reinforced concrete, these values, although provided, are not applicable for this project.

- Under the Sliding Calculations, why the Vertical Component is not included and why it is okay to not include.

As the wall will be supported on both sides during project, the soil loading on both sides is balanced. Therefore, sliding of the slurry wall, as a complete structure, is not a concern so this value was not included.

- Provide reference for the specified Load factors Dead, Live, Earth, Wind and Seismic in the calculation.

As required by ASCE 7-10 "Minimum Design Loads for Buildings and Other Structures"

- Provide a calculation for the Vertical Load used for Soil Pressure showing how they came up with a total bearing load of 19,687.5 lbs (e.g. stem weight 19,500 lbs and footing weight -187.5 lbs)

This soil pressure is calculated under the assumption that the structure is a cantilever retaining structure. Based on the specific design parameters of this site, the wall will be mostly supported on both sides during project and therefore the soil loading on both sides will be virtually balanced. Therefore, as this calculation is provided, the actual slurry wall loading exerted on the underlying soil layers is limited to the actual weight of the wall, or approximately 3,500 psf.

- Why is it whether considering the expected (likely) dewatering scenario or the worst-case scenario (e.g dewatering to 1 ft or 6ft above the bottom of the wall/or above the heel) the Ratio of Resisting Moment to Overturning Moment is the same (1.51) and the inputs only slightly different for the calculation of Overturning Moment when water has a tremendous effect on the actual magnitude of the lateral forces? The overturning moment for the dewatering scenario of 6' of water above bottom of wall was only slightly more than the dewatering scenario of 1' of water above bottom of wall. Given these results, are the assumption that were made appropriate/valid?

There is little impact due to the change of the water table level because the change in elevation is limited to only 5' and the over burden pressure exerted by the 25' layer of soil above the wall bottom controls the design.

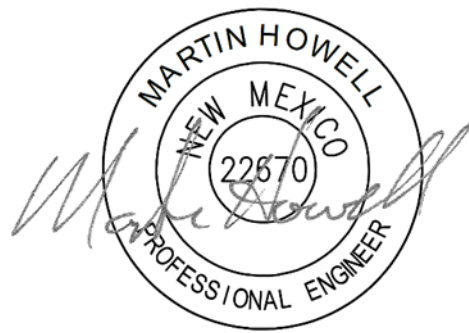
If, after reviewing this letter, you have any questions or require any further information, please do not hesitate to contact our office.

Sincerely,

MILLER ENGINEERS, INC. d/b/a
SOUDER, MILLER & ASSOCIATES



Paul J. Pompeo, P.E.
Senior Design Manager III
paul.pompeo@soudermiller.com



Marty Howell, P.E.
Senior Engineer II
marty.howell@soudermiller.com



Souder, Miller & Associates
 3500 Sedoma Hills Parkway
 Las Cruces, New Mexico 88011

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Printed: 6 APR 2022, 5:05PM

Cantilevered Retaining Wall

File: FairviewAA.ec6
 Software copyright ENERCALC, INC. 1983-2020, Build:12.20.8.24
SOUDER MILLER & ASSOCIATES

Lic. #: KW-06013881

DESCRIPTION: Fairview - Slurry Wall with Sloped Supporting Backfill & WT at 1' Above Foundation

Calculations per ACI 318-11, ACI 530-11, IBC 2012, CBC 2013, ASCE 7-10

Criteria

Retained Height	=	26.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00 : 1
Height of Soil over Toe	=	271.50 in
Water height over heel	=	1.0 ft
Vertical component of active Lateral soil pressure options:		
USED for Soil Pressure.		
NOT USED for Sliding Resistance.		
NOT USED for Overturning Resistance.		

Soil Data

Allow Soil Bearing	=	16,000.0 psf
Coulomb Soil Pressure calculation		
Soil Friction Angle	=	30.0 deg
Active Pressure:Ka*Gamma	=	32.0 psf/ft
Passive Pressure:Kp*Gamma	=	330.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Friction Coeff btwn Ftg & Soil	=	0.400
Soil height to ignore for passive pressure	=	0.00 in

Design Summary

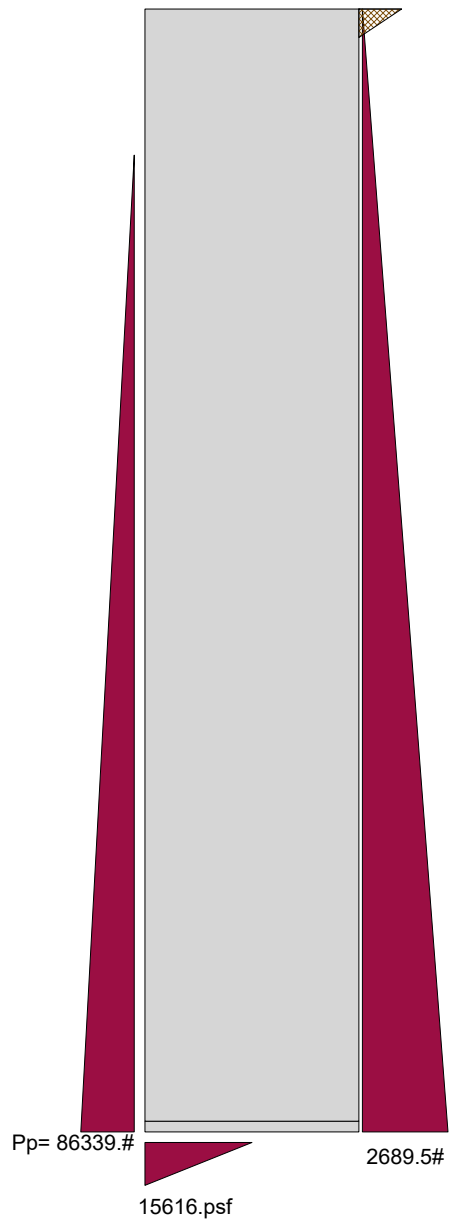
Wall Stability Ratios		
Overturning	=	1.51 OK
Sliding	=	35.03 OK
Total Bearing Load	=	19,688 lbs
...resultant ecc.	=	19.91 in
Soil Pressure @ Toe	=	15,616 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	16,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	18,739 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	0.0 psi OK
Footing Shear @ Heel	=	0.0 psi OK
Allowable	=	75.0 psi
Sliding Calcs (Vertical Component NOT Used)		
Lateral Sliding Force	=	2,689.5 lbs
less 100% Passive Force	= -	86,338.8 lbs
less 100% Friction Force	= -	7,876.0 lbs
Added Force Req'd	=	0.0 lbs OK
...for 1.5 : 1 Stability	=	0.0 lbs OK

Stem Construction

	Top Stem	2nd	3rd
Design Height Above Ftg	ft = 25.00	Stem OK 13.00	As < Min % 0.00
Wall Material Above "Ht"	= Concrete	Concrete	Concrete
Thickness	in = 60.00	60.00	60.00
Rebar Size	= # 4	# 4	# 4
Rebar Spacing	in = 18.00	18.00	32.00
Rebar Placed at	= Edge	Edge	Edge
Design Data			
fb/FB + fa/Fa	= 0.000	0.320	-1.000
Total Force @ Section	lbs = 25.6	1,956.4	4,240.0
Moment.....Actual	ft-l = 8.5	11,147.9	51,206.3
Moment.....Allowable	ft-l = 34,832.0	34,832.0	19,644.4
Shear.....Actual	psi = 0.0	2.8	6.1
Shear.....Allowable	psi = 67.1	67.1	106.1
Wall Weight	psf = 750.0	750.0	750.0
Rebar Depth 'd'	in = 58.25	58.25	58.25
Lap splice if above	in = 20.93	20.93	13.24
Lap splice if below	in = 20.93	20.93	5.04
Hook embed into footing	in = 20.93	20.93	5.04
Concrete Data			
f'c	psi = 2,000.0	2,000.0	5,000.0
Fy	psi = 60,000.0	60,000.0	60,000.0

Load Factors

Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000

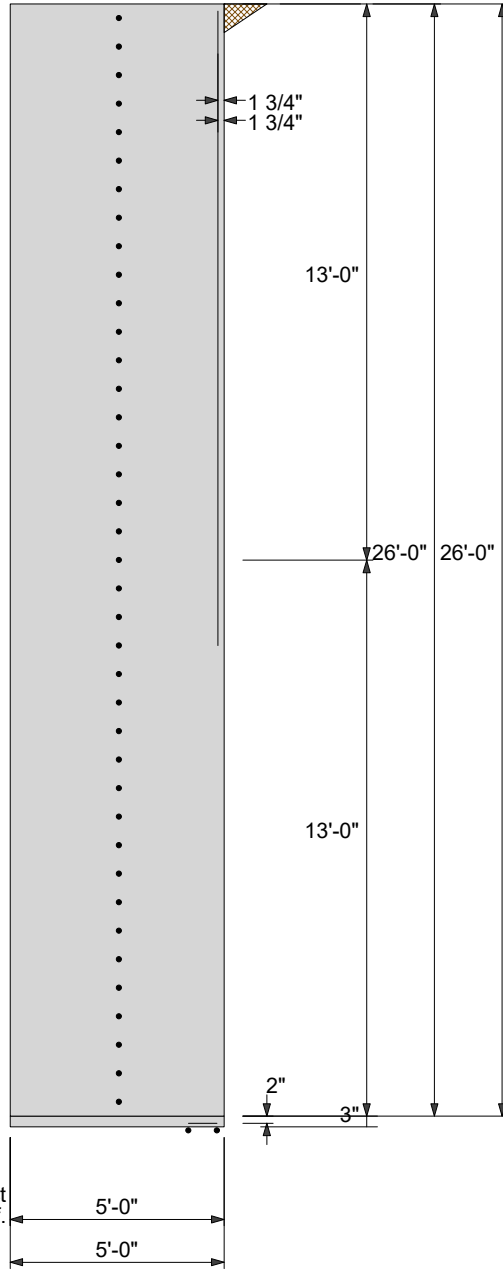


60.in Conc w/ #4 @ 18.in o/c

60.in Conc w/ #4 @ 18.in o/c

#0@18.in
@ Heel

Designer select
all horiz. reinf.





Souder, Miller & Associates
 3500 Sedoma Hills Parkway
 Las Cruces, New Mexico 88011

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Printed: 6 APR 2022, 5:01PM

Cantilevered Retaining Wall

File: FairviewA.ec6
 Software copyright ENERCALC, INC. 1983-2020, Build:12.20.8.24
SOUDER MILLER & ASSOCIATES

Lic. #: KW-06013881

DESCRIPTION: Fairview - Slurry Wall with Sloped Supporting Backfill & WT at 6' Above Foundation

Calculations per ACI 318-11, ACI 530-11, IBC 2012, CBC 2013, ASCE 7-10

Criteria

Retained Height	=	26.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00 : 1
Height of Soil over Toe	=	274.00 in
Water height over heel	=	6.0 ft
Vertical component of active Lateral soil pressure options:		
		USED for Soil Pressure.
		NOT USED for Sliding Resistance.
		NOT USED for Overturning Resistance.

Soil Data

Allow Soil Bearing	=	16,000.0 psf
Coulomb Soil Pressure calculation		
Soil Friction Angle	=	30.0 deg
Active Pressure:Ka*Gamma	=	32.0 psf/ft
Passive Pressure:Kp*Gamma	=	330.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Friction Coeff btwn Ftg & Soil	=	0.400
Soil height to ignore for passive pressure	=	0.00 in

Design Summary

Wall Stability Ratios		
Overturning	=	1.51 OK
Sliding	=	28.46 OK
Total Bearing Load		
...resultant ecc.	=	19,688 lbs
	=	19.93 in
Soil Pressure @ Toe	=	15,638 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	16,000 psf
		Soil Pressure Less Than Allowable
ACI Factored @ Toe	=	18,766 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	0.0 psi OK
Footing Shear @ Heel	=	0.0 psi OK
Allowable	=	75.0 psi
Sliding Calcs (Vertical Component NOT Used)		
Lateral Sliding Force	=	3,365.5 lbs
less 100% Passive Force	= -	87,918.6 lbs
less 100% Friction Force	= -	7,876.0 lbs
Added Force Req'd	=	0.0 lbs OK
....for 1.5 : 1 Stability	=	0.0 lbs OK

Stem Construction

	Top Stem	2nd	3rd
Design Height Above Ftg	ft = 25.00	Stem OK 13.00	As < Min % 0.00
Wall Material Above "Ht"	= Concrete	Concrete	Concrete
Thickness	in = 60.00	60.00	60.00
Rebar Size	= # 4	# 4	# 4
Rebar Spacing	in = 18.00	18.00	32.00
Rebar Placed at	= Edge	Edge	Edge
Design Data			
fb/FB + fa/Fa	= 0.000	0.306	-1.000
Total Force @ Section	lbs = 25.6	1,852.5	5,235.9
Moment.....Actual	ft-l = 8.5	10,642.7	50,984.8
Moment.....Allowable	ft-l = 34,832.0	34,832.0	19,644.4
Shear.....Actual	psi = 0.0	2.7	7.5
Shear.....Allowable	psi = 67.1	67.1	106.1
Wall Weight	psf = 750.0	750.0	750.0
Rebar Depth 'd'	in = 58.25	58.25	58.25
Lap splice if above	in = 20.93	20.93	13.24
Lap splice if below	in = 20.93	20.93	5.04
Hook embed into footing	in = 20.93	20.93	5.04
Concrete Data			
fc	psi = 2,000.0	2,000.0	5,000.0
Fy	psi = 60,000.0	60,000.0	60,000.0

Load Factors

Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000



Souder, Miller & Associates
 3500 Sedoma Hills Parkway
 Las Cruces, New Mexico 88011

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Printed: 6 APR 2022, 5:01PM

Cantilevered Retaining Wall

File: FairviewA.ec6
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SOUDER MILLER & ASSOCIATES

Lic. #: KW-06013881

DESCRIPTION: Fairview - Slurry Wall with Sloped Supporting Backfill & WT at 6' Above Foundation

Footing Dimensions & Strengths

Toe Width	=	0.00 ft
Heel Width	=	5.00
Total Footing Width	=	5.00
Footing Thickness	=	3.00 in
Key Width	=	12.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.00 ft
f'_c	=	2,500 psi
F_y	=	60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0000
Cover @ Top	2.00	@ Btm. = 3.00 in

Footing Design Results

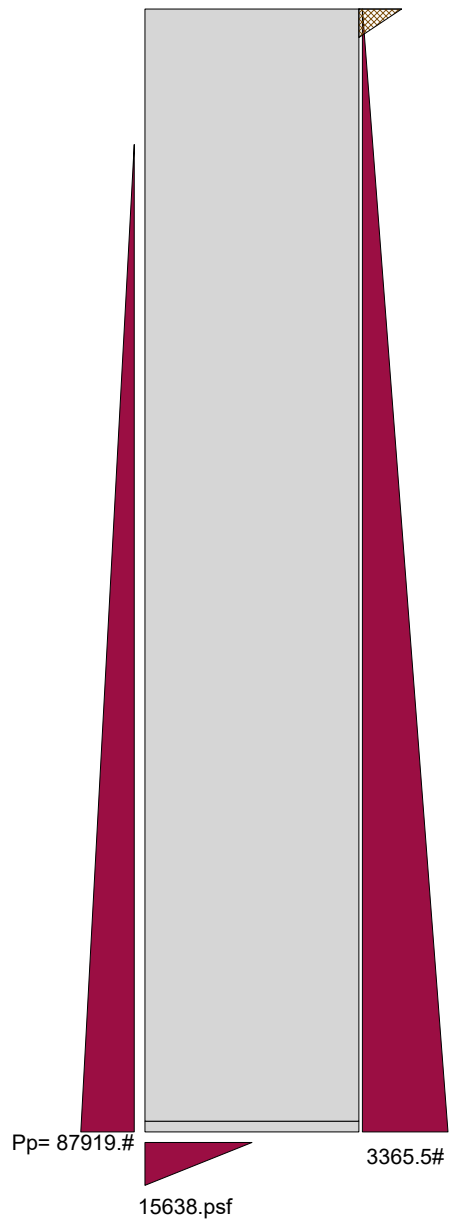
		Toe	Heel
Factored Pressure	=	18,766	0 psf
Mu' : Upward	=	0	0 ft-lb
Mu' : Downward	=	0	0 ft-lb
Mu: Design	=	0	0 ft-lb
Actual 1-Way Shear	=	0.00	0.00 psi
Allow 1-Way Shear	=	0.00	0.00 psi
Toe Reinforcing	=	None Spec'd	
Heel Reinforcing	=	None Spec'd	
Key Reinforcing	=	None Spec'd	
Other Acceptable Sizes & Spacings			
Toe:	Not req'd, $M_u < S * F_r$		
Heel:	Not req'd, $M_u < S * F_r$		
Key:	Not req'd, $M_u < S * F_r$		

Summary of Overturning & Resisting Forces & Moments

ItemOVERTURNING.....		RESISTING.....		
	Force lbs	Distance ft	Moment ft-lb	Force lbs	Distance ft	Moment ft-lb
*Heel Active Pressure	=	11,897.9	8.27	98,347.2		
Surcharge over Heel	=				5.00	
Toe Active Pressure	=	-8,532.4	7.69	-65,652.0		
Surcharge Over Toe	=					
Adjacent Footing Load	=					
Added Lateral Load	=					
Load @ Stem Above Soil	=					
Total	=	3,365.5	O.T.M. =			32,695.2
Resisting/Overturning Ratio			=			1.51
Vertical Loads used for Soil Pressure	=				19,687.5 lbs	
Soil Over Heel	=					
Sloped Soil Over Heel	=					
Surcharge Over Heel	=					
Adjacent Footing Load	=					
Axial Dead Load on Stem	=					
* Axial Live Load on Stem	=					
Soil Over Toe	=					
Surcharge Over Toe	=					
Stem Weight(s)	=			19,500.0	2.50	48,750.0
Earth @ Stem Transitions	=					
Footing Weight	=			187.5	2.50	468.8
Key Weight	=				2.50	
Vert. Component	=					
Total	=			19,687.5 lbs	R.M. =	49,218.8

*Includes water table effect

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

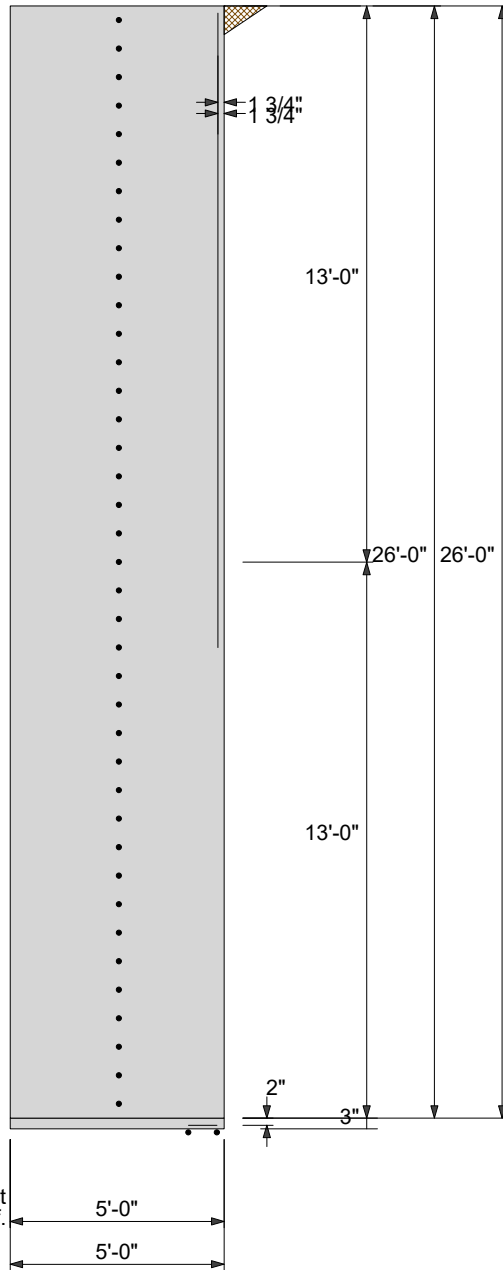


60.in Conc w/ #4 @ 18.in o/c

60.in Conc w/ #4 @ 18.in o/c

#0@18.in
@ Heel

Designer select
all horiz. reinf.



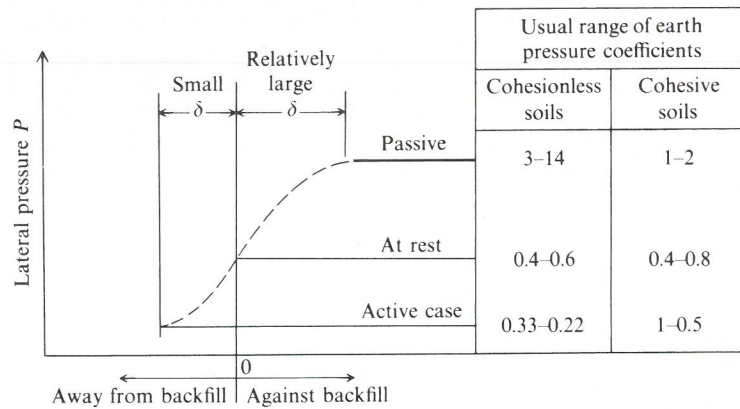


FIGURE 11-3 Illustration of active and passive pressures with usual range of values for cohesionless and cohesive soil.

This discussion has been on a theoretical basis. We must now have a means to apply these principles in a general way to evaluate what the earth pressure will be for specific applications. There are currently two general procedures for soil masses and a theory of elasticity method for loads on the soil mass that is to be resisted by the wall. These methods will be considered in the following several sections.

11-4 COULOMB EARTH PRESSURE THEORY

One of the earliest methods for estimating earth pressures against walls is credited to C. A. Coulomb (ca 1776) which made a number of assumptions as follows:

1. Soil is isotropic, homogeneous, and has both internal friction and cohesion.
2. The rupture surface is a plane surface (as BC of Fig. 11-2b) and the backfill surface is planer (it may slope but is not irregularly shaped).
3. The friction resistance is distributed uniformly along the rupture surface and the soil-to-soil friction coefficient $f = \tan \phi$.
4. The failure wedge is a rigid body undergoing translation.
5. There is wall friction, i.e., as the failure wedge moves with respect to the backface of the wall a friction force is developed between soil and wall. This friction angle is usually termed δ .
6. Failure is a plane strain problem—consider a unit slice from an infinitely long wall.

The principal deficiencies in the Coulomb theory are in the assumption of an ideal soil and that the rupture zone is a plane (although for clean sand in the active pressure case photographs of model walls indicates the rupture zone is very nearly a plane as BC of Fig. 11-2b).

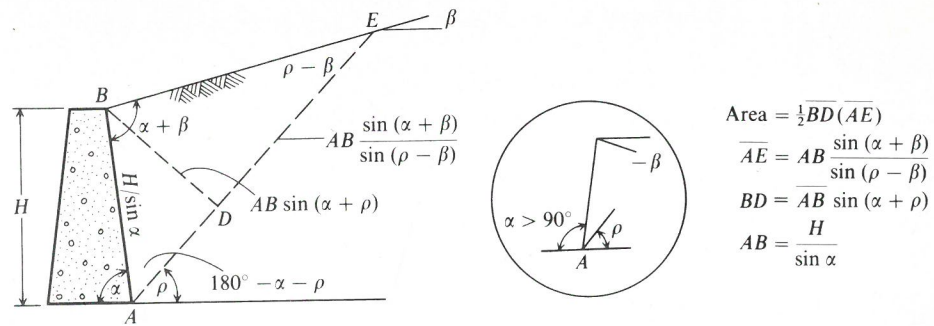


FIGURE 11-4 Failure wedge used in deriving the Coulomb equation for active pressure. Note β may be \pm and $0 < \alpha < 180^\circ$.

The equations based on the Coulomb theory for a cohesionless soil can be derived from Figs. 11-4 and 11-5 and using a substantial amount of trigonometric relationships. The weight of the soil wedge ABE of Fig. 11-4 is

$$W = \gamma A(1) = \frac{\gamma H^2}{2 \sin^2 \alpha} \left[\sin(\alpha + \rho) \frac{\sin(\alpha + \beta)}{\sin(\rho - \beta)} \right] \quad (a)$$

The active force P_a is a component of the weight vector as illustrated in Fig. 11-5c. Applying the law of sines, we obtain

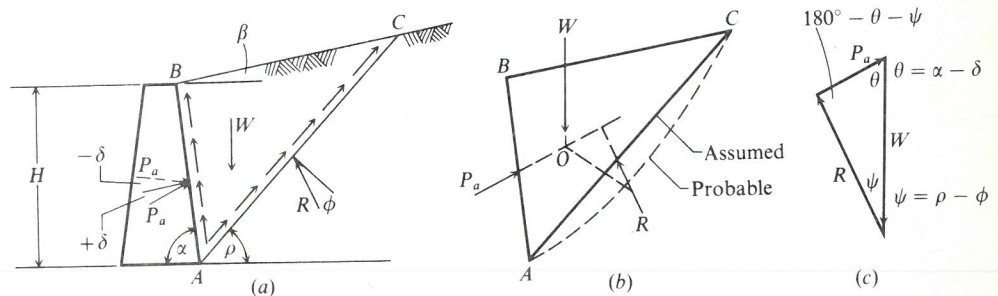
$$\frac{P_a}{\sin(\rho - \phi)} = \frac{W}{\sin(180 - \alpha - \rho + \phi + \delta)}$$

or

$$P_a = \frac{W \sin(\rho - \phi)}{\sin(180 - \alpha - \rho + \phi + \delta)} \quad (b)$$

From Eq. (b) it can be seen that the value of $P_a = f(\rho)$; that is, all other terms for a given problem are constant, and the value of P_a of primary interest is the largest

FIGURE 11-5 (a) Assumed conditions for failure; (b) indicates all force vectors may not pass through point O ; hence static equilibrium is not satisfied; (c) force triangle to establish P_a .



possible value. Combining Eqs. (a) and (b), we obtain

$$P_a = \frac{\gamma H^2}{2 \sin^2 \alpha} \left[\sin(\alpha + \rho) \frac{\sin(\alpha + \beta)}{\sin(\rho - \beta)} \right] \frac{\sin(\rho - \phi)}{\sin(180 - \alpha - \rho + \phi + \delta)} \quad (c)$$

the maximum active wall force P_a is found from setting $dP_a/d\rho = 0$ to give

$$P_a = \frac{\gamma H^2}{2} \frac{\sin^2(\alpha + \phi)}{\sin^2 \alpha \sin(\alpha - \delta) \left[1 + \sqrt{\frac{\sin(\phi + \delta) \sin(\phi - \beta)}{\sin(\alpha - \delta) \sin(\alpha + \beta)}} \right]^2} \quad (11-1)$$

If $\beta = \delta = 0$ and $\alpha = 90^\circ$ (a smooth vertical wall with horizontal backfill), Eq. (11-1) simplifies to

$$P_a = \frac{\gamma H^2}{2} \frac{(1 - \sin \phi)}{(1 + \sin \phi)} = \frac{\gamma H^2}{2} \tan^2 \left(45 - \frac{\phi}{2} \right) \quad (11-2)$$

which is also the Rankine equation for active earth pressure considered in the next section. Equation (11-2) takes the general form

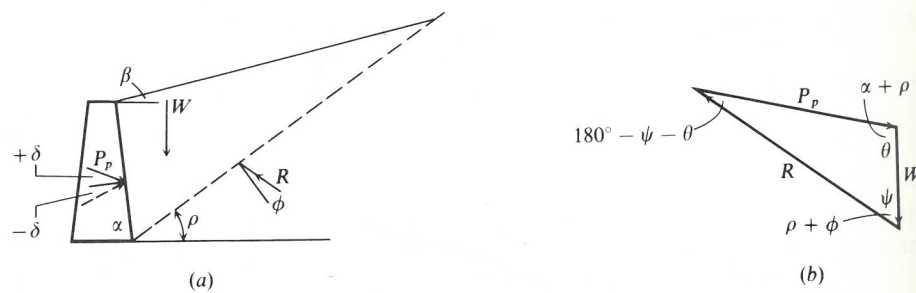
$$P_a = \frac{\gamma H^2}{2} K_a$$

where
$$K_a = \frac{\sin^2(\alpha + \phi)}{\sin^2 \alpha \sin(\alpha - \delta) \left[1 + \sqrt{\frac{\sin(\phi + \delta) \sin(\phi - \beta)}{\sin(\alpha - \delta) \sin(\alpha + \beta)}} \right]^2} \quad (11-3)$$

and is a coefficient which considers α , β , δ , and ϕ , but is independent of γ and H . Table 11-1 gives values of K_a for selected angular values, and a computer program can easily be written to solve for values of K_a for other angle combinations.

Passive earth pressure is derived similarly except that the inclination at the wall and the force triangle will be shown as in Fig. 11-6.

FIGURE 11-6 (a) Failure wedge and acting forces for passive pressure; (b) force polygon for computation of passive pressure.



From Fig. 11-6 the weight of the assumed failure mass is

$$W = \frac{\gamma H^2}{2} \sin(\alpha + \rho) \frac{\sin(\alpha + \beta)}{\sin(\rho - \beta)} \tag{d}$$

and from the force triangle, using the law of sines

$$P_p = W \frac{\sin(\rho + \phi)}{\sin(180 - \rho - \phi - \delta - \alpha)} \tag{e}$$

Setting the derivative $dP_p/d\rho = 0$ gives the minimum value of P_p as

$$P_p = \frac{\gamma H^2}{2} \frac{\sin^2(\alpha - \phi)}{\sin^2 \alpha \sin(\alpha + \delta) \left[1 - \sqrt{\frac{\sin(\phi + \delta) \sin(\phi + \beta)}{\sin(\alpha + \delta) \sin(\alpha + \beta)}} \right]^2} \tag{11-4}$$

For a smooth vertical wall with horizontal backfill ($\delta = \beta = 0$ and $\alpha = 90^\circ$), Eq. (11-4) simplifies to

$$P_p = \frac{\gamma H^2}{2} \frac{1 + \sin \phi}{1 - \sin \phi} = \frac{\gamma H^2}{2} \tan^2 \left(45 + \frac{\phi}{2} \right) \tag{11-5}$$

Equation (11-4) can also be written

$$P_p = \frac{\gamma H^2}{2} K_p$$

where
$$K_p = \frac{\sin^2(\alpha - \phi)}{\sin^2 \alpha \sin(\alpha + \delta) \left[1 - \sqrt{\frac{\sin(\phi + \delta) \sin(\phi + \beta)}{\sin(\alpha + \delta) \sin(\alpha + \beta)}} \right]^2} \tag{11-6}$$

Table 11-2 gives values for K_p for selected angular values of ϕ , α , δ , and β .

Figure 11-1 displays that earth pressure is dependent on the *effective* stresses in the soil and not total stresses. It necessarily follows that the wall pressure below the water table is the sum of the hydrostatic pressure and the effective lateral earth pressure from using the effective unit weight γ' of the soil.

Example 11-1. What is the total active force per meter of wall for the soil-wall system shown in Fig. E11-1, using the Coulomb equations? Where does P_a act?

Solution. Take wall friction $\delta = 2\phi/3 = 20^\circ$ (a common estimate). For $\phi = 30^\circ$ obtain $K_a = 0.34$ from Table 11-1.

$$p_a = \gamma z K_a$$

$$P_a = \int_0^H \gamma z K_a (dz) = \frac{1}{2} \gamma H^2 K_a$$

$$P_a = \frac{1}{2}(17.52)(5)^2(0.34) = 74.5 \text{ kN/m}$$

TABLE 11-1
Coulomb active earth pressure coefficients K_a using
Eq. (11-3)

δ	ALPHA = 90								ALPHA = 90							
	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	0.354	0.328	0.304	0.281	0.259	0.239	0.220	0.201	0.184	0.166	0.148	0.131	0.114	0.097	0.080	0.063
16	0.311	0.290	0.270	0.252	0.234	0.216	0.200	0.184	0.170	0.153	0.136	0.120	0.104	0.088	0.072	0.056
17	0.309	0.289	0.269	0.251	0.233	0.216	0.200	0.184	0.169	0.152	0.135	0.119	0.103	0.087	0.071	0.055
20	0.306	0.286	0.267	0.249	0.231	0.214	0.198	0.183	0.169	0.152	0.135	0.119	0.103	0.087	0.071	0.055
22	0.304	0.285	0.266	0.248	0.230	0.214	0.198	0.183	0.168	0.151	0.134	0.118	0.102	0.086	0.070	0.054
	ALPHA = 90								ALPHA = 90							
	BETA = -5								BETA = -5							
δ	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	0.371	0.343	0.318	0.293	0.270	0.249	0.228	0.209	0.191	0.173	0.155	0.137	0.120	0.103	0.086	0.069
16	0.328	0.306	0.284	0.264	0.245	0.226	0.209	0.192	0.176	0.158	0.140	0.122	0.105	0.088	0.071	0.054
17	0.327	0.305	0.283	0.263	0.244	0.226	0.208	0.192	0.176	0.158	0.140	0.122	0.105	0.088	0.071	0.054
20	0.324	0.302	0.281	0.261	0.242	0.224	0.207	0.191	0.175	0.157	0.139	0.121	0.104	0.087	0.070	0.053
22	0.322	0.301	0.280	0.260	0.242	0.224	0.207	0.191	0.175	0.157	0.139	0.121	0.104	0.087	0.070	0.053
	ALPHA = 90								ALPHA = 90							
	BETA = 0								BETA = 0							
δ	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	0.390	0.361	0.333	0.307	0.283	0.260	0.238	0.217	0.198	0.179	0.160	0.141	0.122	0.103	0.084	0.065
16	0.349	0.324	0.300	0.278	0.257	0.237	0.218	0.201	0.184	0.165	0.146	0.127	0.108	0.089	0.070	0.051
17	0.348	0.323	0.299	0.277	0.256	0.237	0.218	0.200	0.183	0.164	0.145	0.126	0.107	0.088	0.069	0.050
20	0.345	0.320	0.297	0.276	0.255	0.235	0.217	0.199	0.183	0.164	0.145	0.126	0.107	0.088	0.069	0.050
22	0.343	0.319	0.296	0.275	0.254	0.235	0.217	0.199	0.183	0.164	0.145	0.126	0.107	0.088	0.069	0.050
	ALPHA = 90								ALPHA = 90							
	BETA = 5								BETA = 5							
δ	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	0.414	0.382	0.352	0.323	0.297	0.272	0.249	0.227	0.206	0.187	0.168	0.149	0.130	0.111	0.092	0.073
16	0.373	0.345	0.319	0.295	0.272	0.250	0.229	0.210	0.192	0.173	0.154	0.135	0.116	0.097	0.078	0.059
17	0.372	0.344	0.318	0.294	0.271	0.249	0.229	0.210	0.192	0.173	0.154	0.135	0.116	0.097	0.078	0.059
20	0.370	0.342	0.316	0.292	0.270	0.248	0.228	0.209	0.191	0.172	0.153	0.134	0.115	0.096	0.077	0.058
22	0.369	0.341	0.316	0.292	0.269	0.248	0.228	0.209	0.191	0.172	0.153	0.134	0.115	0.096	0.077	0.058
	ALPHA = 90								ALPHA = 90							
	BETA = 10								BETA = 10							
δ	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	0.443	0.407	0.374	0.343	0.314	0.286	0.261	0.238	0.216	0.197	0.178	0.159	0.140	0.121	0.102	0.083
16	0.404	0.372	0.342	0.314	0.288	0.265	0.242	0.221	0.201	0.182	0.163	0.144	0.125	0.106	0.087	0.068
17	0.404	0.371	0.342	0.314	0.288	0.265	0.242	0.221	0.201	0.182	0.163	0.144	0.125	0.106	0.087	0.068
20	0.402	0.370	0.340	0.313	0.287	0.263	0.241	0.220	0.201	0.182	0.163	0.144	0.125	0.106	0.087	0.068
22	0.401	0.369	0.340	0.312	0.287	0.263	0.241	0.220	0.201	0.182	0.163	0.144	0.125	0.106	0.087	0.068
	ALPHA = 90								ALPHA = 90							
	BETA = 15								BETA = 15							
δ	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	0.482	0.440	0.402	0.367	0.334	0.304	0.276	0.251	0.227	0.208	0.189	0.170	0.151	0.132	0.113	0.094
16	0.447	0.408	0.372	0.340	0.310	0.283	0.258	0.234	0.213	0.194	0.175	0.156	0.137	0.118	0.099	0.080
17	0.447	0.408	0.372	0.340	0.310	0.283	0.258	0.234	0.213	0.194	0.175	0.156	0.137	0.118	0.099	0.080
20	0.446	0.406	0.372	0.339	0.310	0.282	0.257	0.234	0.212	0.193	0.174	0.155	0.136	0.117	0.098	0.079
22	0.446	0.406	0.371	0.338	0.309	0.282	0.257	0.234	0.212	0.193	0.174	0.155	0.136	0.117	0.098	0.079

TABLE 11-2
Coulomb passive earth pressure coefficients K_p using
Eq. (11-6)

δ	ALPHA = 90								ALPHA = 90							
	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	1.914	2.053	2.204	2.369	2.547	2.743	2.957	3.193	3.452	3.723	4.007	4.304	4.614	4.937	5.274	5.625
16	2.693	2.956	3.247	3.571	3.934	4.344	4.807	5.335	5.940	6.613	7.354	8.164	9.044	9.994	11.014	12.104
17	2.760	3.034	3.339	3.679	4.062	4.493	4.983	5.533	6.187	6.954	7.814	8.764	9.794	10.894	12.064	13.304
20	2.990	3.294	3.645	4.041	4.488	4.997	5.581	6.255	7.039	7.924	8.914	10.014	11.234	12.574	14.034	15.614
22	3.145	3.490	3.878	4.317	4.816	5.389	6.050	6.819	7.720	8.764	9.924	11.204	12.614	14.154	15.834	17.654
	ALPHA = 90								ALPHA = 90							
	BETA = -5								BETA = -5							
δ	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	2.223	2.392	2.577	2.781	3.004	3.250	3.523	3.826	4.163	4.534	4.940	5.382	5.860	6.374	6.924	7.514
16	3.367	3.709	4.094	4.529	5.024	5.591	6.243	7.000	7.883	8.894	10.044	11.344	12.794	14.404	16.174	18.114
17	3.469	3.828	4.234	4.694	5.218	5.820	6.516	7.326	8.277	9.364	10.594	11.974	13.514	15.214	17.084	19.134
20	3.806	4.226	4.704	5.250	5.879	6.609	7.462	8.468	9.665	11.054	12.644	14.444	16.464	18.714	21.204	24.044
22	4.064	4.532	5.067	5.684	6.399	7.236	8.222	9.397	10.809	12.464	14.374	16.544	19.074	21.974	25.264	29.044
	ALPHA = 90								ALPHA = 90							
	BETA = 0								BETA = 0							
δ	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	2.561	2.770	3.000	3.255	3.537	3.852	4.204	4.599	5.045	5.534	6.067	6.644	7.264	7.924	8.624	9.364
16	4.195	4.652	5.174	5.775	6.469	7.279	8.229	9.356	10.704	12.294	14.144	16.264	18.664	21.354	24.344	27.644
17	4.346	4.830	5.385	6.025	6.767	7.636	8.661	9.882	11.351	13.084	15.084	17.364	19.944	22.834	26.044	29.584
20	4.957	5.436	6.105	6.886	7.804	8.892	10.194	11.771	13.705	15.914	18.414	21.214	24.344	27.834	31.704	35.964
22	5.253	5.710	6.465	7.374	8.441	9.719	11.266	13.164	15.426	18.064	21.004	24.264	27.874	31.874	36.284	41.104
	ALPHA = 90								ALPHA = 90							
	BETA = 5								BETA = 5							
δ	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	2.943	3.203	3.492	3.815	4.177	4.585	5.046	5.572	6.173	6.844	7.584	8.394	9.274	10.224	11.244	12.334
16	5.250	5.878	6.609	7.464	8.474	9.678	11.128	12.894	15.076	17.614	20.444	23.584	27.044	30.844	35.004	39.544
17	5.475	6.146	6.929	7.850	8.942	10.251	11.836	13.781	16.001	18.544	21.434	24.684	28.314	32.344	36.784	41.644
20	6.447	7.078	8.049	9.212	10.613	12.321	14.433	17.083	20.468	24.614	29.544	35.384	41.144	47.844	55.484	64.124
22	6.684	7.369	8.460	9.760	11.334	13.211	15.403	18.065	21.143	25.404	30.544	36.584	43.544	51.444	60.284	70.124
	ALPHA = 90								ALPHA = 90							
	BETA = 10								BETA = 10							
δ	26	28	30	32	34	36	38	40	26	28	30	32	34	36	38	40
0	3.385	3.712	4.080	4.496	4.968	5.507	6.125	6.840	7.673	8.624	9.704	10.924	12.294	13.824	15.514	17.364
16	6.652	7.585	8.605	9.764	11.074	12.574	14.274	16.194	18.344	20.744	23.494	26.594	30.054	33.894	38.144	42.804
17	6.992	7.956	9.105	10.492	12.183	14.124	16.344	18.864	21.694	24.844	28.314	32.144	36.384	41.044	46.144	51.704
20	8.164	9.274	10.613	12.211	14.063	16.183	18.594	21.314	24.344	27.704	31.404	35.444	40.004	45.004	50.464	56.304
22	8.464	9.614	11.004	12.614	14.444	16.514	18.944	21.744	24.874							

Summing moments about the top we have

$$P_a \bar{y}' = \int_0^H \gamma z K_a(z) (dz) = \frac{\gamma H^3}{3} K_a$$

Using the symbolic P_a and equating obtain

$$\bar{y}' = \frac{2\gamma H^3 K_a}{3\gamma H^2 K_a} = \frac{2}{3} H \quad \text{from top or}$$

$$\bar{y} = H - \frac{2H}{3} = \frac{H}{3} \quad \text{from bottom (value usually used)}$$

For $\delta = 20^\circ$ a force polygon would show that P_a will act on the wall as shown in Fig. E11-1.

////

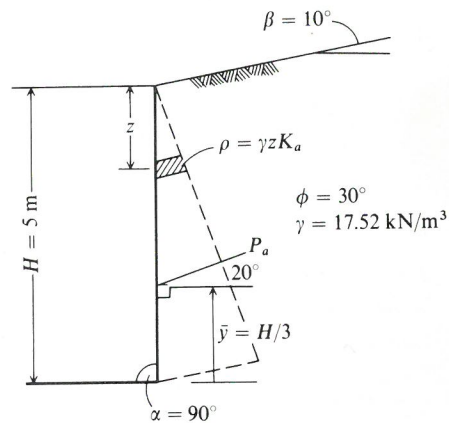


FIGURE E11-1

Example 11-2. What is the total force/unit width of wall and the location of the resultant for the system shown in Fig. E11-2a? Use the Coulomb equations and take a smooth wall so $\delta = 0^\circ$.

Solution. We have a surcharge which is seen by the wall at $z = 0$ as a pressure q (which could be caused by a fictitious soil depth of γz_o). There will be K_a values for each soil of

$$K_{a1} = 0.307 \quad K_{a2} = 0.333 \quad (\text{Table 11-1})$$

At $z = 0$ (top of wall where surcharge acts) we have:

$$p_1 = \gamma z_o K_a = q K_a = 100(0.307) = 30.7 \text{ kPa}$$

At the interface (interpreted as $z - dz$) of top stratum $z = 3.5$ m and noting the surcharge q carries through to give the effect of $q_z = \gamma z_o + \gamma z$ we have

$$\begin{aligned} p_2 &= (q + \gamma z_1) K_a = (100 + 16.5(3.5)) 0.307 \\ &= 30.7 + 17.7 = 48.4 \text{ kPa} \end{aligned}$$

Pressure Loss Calculation - Pneumatic Pumps

Project: Fairview Station
 Date: 12/22/2020 c=
 Piping Material: FlexWorks (Kynar PVDF) 150

Imperial Units

Section	Pipe Size (inches)	Flow (gal/min)	Pressure Loss (ft/100ft)	System Components	Equivalent Length of Component (ft)	No. Components	Equivalent Length (ft)	Section Pressure Loss (ftH2O)	Total Pressure Loss (ftH2O)
1				90 deg Elbows	5.2	4.0	20.8		
				Check Valve	11.0	1.0	11.0		
							0.0		
				Straight Pipe	1.0	144.0	144.0		
SUM 1	1	15.0	14.8				175.8	26.0	26.0
2				90 deg Elbows	5.2	1.0	5.2		
				Check Valve	11.0	1.0	11.0		
				Tee_line	3.2	0.0	0.0		
				Tee_branch	6.6	1.0	6.6		
				Straight Pipe	1.0	30.0	30.0		
SUM 2	1	10.0	7.0				52.8	3.7	3.7
3				90 deg Elbows	5.2	2.0	10.4		
				Check Valve	11.0	1.0	11.0		
				Tee_line	3.2	1.0	3.2		
				Tee_branch	6.6	0.0	0.0		
				Straight Pipe	1.0	12.0	12.0		
SUM 2	1	5.0	1.9				36.6	0.7	0.7
Total SUM									30.4



Pressure Loss Calculation - Sump Pump

Project: Fairview Station
 Date: 12/22/2020 c=
 Piping Material: FlexWorks (Kynar PVDF) 150

Imperial Units

Section	Pipe Size (inches)	Flow (gal/min)	Pressure Loss (ft/100ft)	System Components	Equivalent Length of Component (ft)	No. Components	Equivalent Length (ft)	Section Pressure Loss (ftH2O)	Total Pressure Loss (ftH2O)
1				90 deg Elbows	2.7	4.0	10.8		
				Check Valve	15.0	1.0	15.0		
							0.0		
				Straight Pipe	1.0	189.0	189.0		
SUM 1	1.5	25.0	5.3				214.8	11.4	11.4
2				90 deg Elbows	5.2	1.0	5.2		
				Gate Valve	0.8	1.0	0.8		
							0.0		
							0.0		
				Straight Pipe	1.0	12.0	12.0		
SUM 2	1	25.0	38.2				18.0	6.9	6.9
Total SUM									18.3

Feet of Elev. 24
 Filter head 23.1
 Total Head **65.4**

Hazen-Williams equation :

$$h_{100ft} = 0.2083 (100 / c)^{1.852} q^{1.852} / dh^{4.8655}$$

where

h100ft = friction head loss in feet of water per 100 feet of pipe (ftH2O/100 ft pipe)

c = Hazen-Williams roughness constant

q = volume flow (gal/min)

dh = inside hydraulic diameter (inches)



Pressure Loss Calculation - Oil-Water Separator Transfer Pump

Project: Fairview Station
 Date: 12/22/2020 c=
 Piping Material: Schedule 40 PVC 150

Imperial Units

Section	Pipe Size (inches)	Flow (gal/min)	Pressure Loss (ft/100ft)	System Components	Equivalent Length of Component (ft)	No. Components	Equivalent Length (ft)	Section Pressure Loss (ftH2O)	Total Pressure Loss (ftH2O)
1				90 deg Elbows	2.7	0.0	0.0		
				Tee Line	3.2	1.0	3.2		
				Tee branch	6.6	1.0	6.6		
				Check Valve	15.0	1.0	15.0		
				Gate Valve	0.8	2.0	1.6		
				Straight Pipe	1.0	6.0	6.0		
SUM 1	1	30.0	53.5				32.4	17.3	17.3
Total SUM									17.3

Feet of Elev. 5
 Filter head 23.1
 Total Head 45.4

Hazen-Williams equation :

$$h_{100ft} = 0.2083 (100 / c)^{1.852} q^{1.852} / dh^{4.8655}$$

where

h100ft = friction head loss in feet of water per 100 feet of pipe (ftH2O/100 ft pipe)

c = Hazen-Williams roughness constant

q = volume flow (gal/min)

dh = inside hydraulic diameter (inches)



Fairview Station - Española, New Mexico
 Summary of Total Vacuum Losses

SVE Recovery Well	Diameter (inches)	Total Vacuum Losses (inches/water)	Comments
SVE-1 pipe run to SVE manifold	4	1.38	Assume 138 feet of 4-inch pipe between well and SVE manifold (w/ 2" reducer) Assume 126 feet of 4-inch pipe between well and SVE manifold (w/ 2" reducer) Assume 115 feet of 4-inch pipe between well and SVE manifold (w/ 2" reducer) Assume 115 feet of 4-inch pipe between well and SVE manifold (w/ 2" reducer)
SVE-2 pipe run to SVE manifold	4	1.35	
SVE-3 pipe run to SVE manifold	4	1.29	
SVE-4 pipe run to SVE manifold	4	1.32	
SVE Manifold	6" Header, 2" Legs	3.15	
Total (4 wells)		8.5	Includes 4 wells at average head loss of 1.33 in-H ₂ O
Blower Vacuum (in H ₂ O)		231	
Remaining Capacity		222.7	
% vacuum drop		3.7	

Notes: Assume blower capacity is 135 SCFM at 17 in Hg (231 in H₂O) per manufacturer specifications
 120 SCFM = 2 CFS
 Gate valves at manifold and branched lines assumed to be full open.



HEADLOSS CALCULATION
Fairview Station - SVE Manifold
Española, NM

DARCY-WEISBACH EQUATION

Medium: AIR

Pipe headloss (hL)

US Units:

		Enter following:	
gravity	g = 32.2	flow	Q (cfs) = 4.5
kinematic viscosity	Enter nu = 1.77E-04	dia. pipe	d (ft) = 0.500
	nu water = 1.22E-05	roughness	ks (e) = 0.000005
	nu air = 1.77E-04	pipe length	L (ft) = 16
		flow	Q (cfs) = 4.5
		dia. pipe	d (ft) = 0.333
		roughness	ks (e) = 0.000005
		pipe length	L (ft) = 12

		Intermediate Calcs:	
Reynolds No.	Re =	6.47E+04	
roughness factor Swam-Jan	f =	1.96E-02	

Answer:	
hL =	34.46741 ft air
hL =	0.04213 ft water
hL =	0.50555 in. water
hL =	0.01826 psi

Total Headloss = 3.1505 in. water

Blower rating: 135 cfm @ 17 in. mercury

Selected Blowers = 2 parallel blowers: 135 SCFM @ 17 inches Hg vacuum

1 inch Hg = 13.60 inches H₂O

0.0735 inches H₂O = 1 inch Hg

air kinematic viscosity = $V = \mu/\rho$

where: $V = 3.74 \times 10^{-7}$ slug/ft-sec / 0.002111 slug/ft³ = 1.77×10^{-4} ft²/sec

$\mu = 3.74 \times 10^{-7}$ slug/ft-sec

1 foot /air = 0.00122279 feet/water

10 inches Hg = 136 inches water

Minor Losses

Enter following:

valve/fitting	dia.	K	Qty	hL (ft.)
tee - run	0.333	0.07	1	2.90
tee - branch	0.333	1.02	1	42.28
gate valve	0.333	0.14	0	0.00
reducer	0.333	0.07	1	2.90
90 deg ell	0.333	0.51	2	42.28
tee - run	0.5	0.07	1	0.57
tee - branch	0.5	1.02	2	16.64
gate valve	0.5	0.14	2	2.22
reducer	0.5	0.07	0	0.00
90 deg ell	0.5	0.51	2	8.32

Answer:	
hL =	118.11990 ft air
hL =	0.22041 ft water
hL =	2.64494 in. water
hL =	0.09555 psi



HEADLOSS CALCULATION
Fairview Station - SVE-1
Española, NM

DARCY-WEISBACH EQUATION

Medium: AIR

Pipe headloss (hL)

US Units:

gravity g = 32.2
 kinematic viscosity Enter nu = 1.77E-04
 nu water = 1.22E-05
 nu air = 1.77E-04

flow Q (cfs) = 1.125
 dia. pipe d (ft) = 0.333
 roughness ks (e) = 0.000005
 pipe length L (ft) = 138

Intermediate Calcs:
 Reynolds No. Re = 2.43E+04
 roughness factor Swam-Jan f = 2.46E-02

Answer:

hL = 26.31564 ft air
 hL = 0.03217 ft water
 hL = 0.38598 in. water
 hL = 0.01394 psi

Minor Losses

Enter following:

valve/fitting	dia.	K	Qty	hL (ft.)
tee - branch	0.333	1.02	2	5.29
45 deg ell	0.333	0.272	4	2.82
90 deg ell	0.333	0.51	1	1.32
reducer	0.167	0.07	1	2.87
90 deg ell	0.167	0.51	1	20.89
tee - run	0.167	0.07	2	5.73
gate valve	0.167	0.14	1	5.57

Flow meter assumed to be equivalent to gate valve

Answer:

hL = 44.48881 ft air
 hL = 0.08302 ft water
 hL = 0.99619 in. water
 hL = 0.03599 psi

Total Headloss = 1.3822 in. water

Blower rating: 135 cfm @ 17 in. mercury

Selected Blowers = 2 parallel blowers: 135 SCFM @ 17 inches Hg vacuum
 1 inch Hg = 13.60 inches H₂O
 0.0735 inches H₂O = 1 inch Hg

air kinematic viscosity = $V = \mu/\rho$
 where: $V = 3.74 \times 10^{-7} \text{ slug/ft-sec} / 0.002111 \text{ slug/ft}^3 = 1.77 \times 10^{-4} \text{ ft}^2/\text{sec}$

$\mu = 3.74 \times 10^{-7} \text{ slug/ft-sec}$
 1 foot /air = 0.00122279 feet/water
 10 inches Hg = 136 inches water



HEADLOSS CALCULATION
Fairview Station - SVE-2
Española, NM

DARCY-WEISBACH EQUATION

Medium: AIR

Pipe headloss (hL)

US Units:

gravity g = 32.2
 kinematic viscosity Enter nu = 1.77E-04
 nu water = 1.22E-05
 nu air = 1.77E-04

flow Q (cfs) = 1.125
 dia. pipe d (ft) = 0.333
 roughness ks (e) = 0.000005
 pipe length L (ft) = 126

Intermediate Calcs:
 Reynolds No. Re = 2.43E+04
 roughness factor Swam-Jan f = 2.46E-02

Answer:

hL = 24.02732 ft air
 hL = 0.02937 ft water
 hL = 0.35242 in. water
 hL = 0.01273 psi

Minor Losses

Enter following:

valve/fitting	dia.	K	Qty	hL (ft.)
tee - branch	0.333	1.02	2	5.29
45 deg ell	0.333	0.272	4	2.82
90 deg ell	0.333	0.51	1	1.32
reducer	0.167	0.07	1	2.87
90 deg ell	0.167	0.51	1	20.89
tee - run	0.167	0.07	2	5.73
gate valve	0.167	0.14	1	5.57

Flow meter assumed to be equivalent to gate valve

Answer:

hL = 44.48881 ft air
 hL = 0.08302 ft water
 hL = 0.99619 in. water
 hL = 0.03599 psi

Total Headloss = 1.3486 in. water

Blower rating: 135 cfm @ 17 in. mercury

Selected Blowers = 2 parallel blowers: 135 SCFM @ 17 inches Hg vacuum
 1 inch Hg = 13.60 inches H₂O
 0.0735 inches H₂O = 1 inch Hg

air kinematic viscosity = $V = \mu/\rho$
 where: $V = 3.74 \times 10^{-7}$ slug/ft-sec / 0.002111 slug/ft³ = 1.77×10^{-4} ft²/sec

$\mu = 3.74 \times 10^{-7}$ slug/ft-sec
 1 foot /air = 0.00122279 feet/water
 10 inches Hg = 136 inches water



HEADLOSS CALCULATION
Fairview Station - SVE-3
Española, NM

DARCY-WEISBACH EQUATION

Medium: AIR

Pipe headloss (hL)

US Units:

gravity g = 32.2
 kinematic viscosity Enter nu = 1.77E-04
 nu water = 1.22E-05
 nu air = 1.77E-04

flow Q (cfs) = 1.125
 dia. pipe d (ft) = 0.333
 roughness ks (e) = 0.000005
 pipe length L (ft) = 115

Intermediate Calcs:
 Reynolds No. Re = 2.43E+04
 roughness factor Swam-Jan f = 2.46E-02

Answer:

hL = 21.92970 ft air
 hL = 0.02680 ft water
 hL = 0.32165 in. water
 hL = 0.01162 psi

Minor Losses

Enter following:

valve/fitting	dia.	K	Qty	hL (ft.)
tee - branch	0.333	1.02	2	5.29
45 deg ell	0.333	0.272	2	1.41
90 deg ell	0.333	0.51	1	1.32
reducer	0.167	0.07	1	2.87
90 deg ell	0.167	0.51	1	20.89
tee - run	0.167	0.07	2	5.73
gate valve	0.167	0.14	1	5.57

Flow meter assumed to be equivalent to gate valve

Answer:

hL = 43.07932 ft air
 hL = 0.08039 ft water
 hL = 0.96463 in. water
 hL = 0.03485 psi

Total Headloss = 1.2863 in. water

Blower rating: 135 cfm @ 17 in. mercury

Selected Blowers = 2 parallel blowers: 135 SCFM @ 17 inches Hg vacuum
 1 inch Hg = 13.60 inches H₂O
 0.0735 inches H₂O = 1 inch Hg

air kinematic viscosity = $V = \mu/\rho$
 where: $V = 3.74 \times 10^{-7}$ slug/ft-sec / 0.002111 slug/ft³ = 1.77×10^{-4} ft²/sec

$\mu = 3.74 \times 10^{-7}$ slug/ft-sec
 1 foot /air = 0.00122279 feet/water
 10 inches Hg = 136 inches water



HEADLOSS CALCULATION
Fairview Station - SVE-4
Española, NM

DARCY-WEISBACH EQUATION

Medium: AIR

Pipe headloss (hL)

US Units:

gravity g = 32.2
 kinematic viscosity Enter nu = 1.77E-04
 nu water = 1.22E-05
 nu air = 1.77E-04

flow Q (cfs) = 1.125
 dia. pipe d (ft) = 0.333
 roughness ks (e) = 0.000005
 pipe length L (ft) = 115

Intermediate Calcs:
 Reynolds No. Re = 2.43E+04
 roughness factor Swam-Jan f = 2.46E-02

Answer:

hL = 21.92970 ft air
 hL = 0.02680 ft water
 hL = 0.32165 in. water
 hL = 0.01162 psi

Minor Losses

Enter following:

valve/fitting	dia.	K	Qty	hL (ft.)
tee - branch	0.333	1.02	2	5.29
45 deg ell	0.333	0.272	2	1.41
90 deg ell	0.333	0.51	2	2.64
reducer	0.167	0.07	1	2.87
90 deg ell	0.167	0.51	1	20.89
tee - run	0.167	0.07	2	5.73
gate valve	0.167	0.14	1	5.57

Flow meter assumed to be equivalent to gate valve

Answer:

hL = 44.40071 ft air
 hL = 0.08285 ft water
 hL = 0.99422 in. water
 hL = 0.03592 psi

Total Headloss = 1.3159 in. water

Blower rating: 135 cfm @ 17 in. mercury

Selected Blowers = 2 parallel blowers: 135 SCFM @ 17 inches Hg vacuum
 1 inch Hg = 13.60 inches H₂O
 0.0735 inches H₂O = 1 inch Hg

air kinematic viscosity = $V = \mu/\rho$
 where: $V = 3.74 \times 10^{-7}$ slug/ft-sec / 0.002111 slug/ft³ = 1.77×10^{-4} ft²/sec

$\mu = 3.74 \times 10^{-7}$ slug/ft-sec
 1 foot /air = 0.00122279 feet/water
 10 inches Hg = 136 inches water



Appendix C: Public Notice Information

NOTICE OF SUBMISSION OF REMEDIATION PLAN

Date of Notice: January 7, 2021

Notice is hereby given by Souder, Miller and Associates of the submission of a Remediation Plan to the Petroleum Storage Tank Bureau (PSTB), New Mexico Environment Department, as follows:

1. The Remediation Plan proposes actions to remediate a release of petroleum or petroleum products into the environment.
2. The release occurred at: 1626 N. Riverside Drive and 1702 N. Riverside Drive, Española, New Mexico 87532.
3. The Remediation Plan proposes that the corrective action system and related equipment be located at the following site(s): 1626 N. Riverside Drive and 1702 N. Riverside Drive, Española, New Mexico 87532.
4. A copy of the Remediation Plan can be viewed by interested parties at the NMED office at the address below, or at the NMED field office located at: 712 La Joya Street, Española, New Mexico 87532.
5. Comments on the plan may be sent to the PSTB Project Manager: Ms. Susan von Gonten at the following address: New Mexico Environment Department, Petroleum Storage Tank Bureau 2905 Rodeo Park Drive East, Bldg. 1, Santa Fe, NM 87505 .
6. Comments must be received within 21 days of the date of this notice.

Property Owners Adjacent to Fairview Station Site

Name	Address	City	State	Zip
ROYBAL, LIZ & LUCILLE & CARMEN MARY	3307 CALLE DE DANIEL N.W.	ALBUQUERQUE	NM	87104
CASADOS, JOANN	938 N. RIVERSIDE DR.	ESPANOLA	NM	87532
ARCHULETA, CELSO R	PO BOX 397	DIXON	NM	87527
GARCIA, LUPE L. GARCIA, GLORIA D.	REVOCABLE TRUST, PO Box 16	SANTA CRUZ	NM	87567
NEW MEXICO BANK & TRUST	1592 ST. MICHAELS DR.	SANTA FE	NM	87505
MURPHY OIL USA INC A DELAWARE CORPORATION C/O TIFFANY PRINCE	200 PEACH STREET	EL DORADO	AR	71730
WREST 58 NM RIVERSIDE LLC	6401 CONGRESS AVE SUITE 230-240	BOCA RATON	FL	33496
RAJPAL, SURJIT S. TRUST RAJPAL MARY SINGH LIVIN	460 ASH ST	WINNETKA	IL	60093
MARTINEZ, VERONICA S. & JERRY D.	PO BOX 4733	FAIRVIEW	NM	87533
MARTINEZ, PRISCILLA BAL	P.O. BOX 285	CORDOVA	NM	87523
TRUJILLO, MARK & TRUJILLO, MARY P TRUJILLO, RE	P.O. BOX 5064	FAIRVIEW	NM	87533
VIGIL, OLIVIA	P.O. BOX 592	ESPANOLA	NM	87532
MADRID, JOSEPH MADRID, FRANCES	PO BOX 4203	FAIRVIEW	NM	87533

Appendix D: Site Specific Health & Safety Plan

**SITE SAFETY AND HEALTH PLAN
PETROLEUM CONTAMINATED SOIL EXCAVATION
REMEDATION SYSTEM CONSTRUCTION**

**Location:
Fairview Station State Lead Site
1626 North Riverside Drive
Española, New Mexico**

**PREPARED FOR:
State of New Mexico Environment Department
Petroleum Storage Tank Bureau**

**PREPARED BY:
SOUDER, MILLER & ASSOCIATES
5454 Venice Avenue NE, Suite D
Albuquerque, NM 87113
505-299-0942
FAX 505-293-3430**

DATE: January 7, 2021

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I. Introduction:

The health and safety of **Souder, Miller & Associates** employees, subcontractors, and the general public is of the utmost importance, and is our primary concern. The inherent dangers involved in the handling of hazardous materials or waste, and hazards associated with any job site require that all participants in this project become familiar with the contents of this Health and Safety plan.

II. SITE DESCRIPTION

Date: January 7, 2021

Location: Fairview Station State Lead Site, 1626 North Riverside Drive
(Address)
Espanola, NM
(City, State)

Hazards: Potential hazards may include; heavy equipment, exposure to asbestos, overhead hazards, and falling tripping hazards, underground lines, flammable liquids and vapors

Area affected:

Affected work zones consist of three properties: 1626 N. Riverside Drive (Fairview Station), 1702 N. Riverside Drive (Dairy Queen), 1711 N. Riverside Drive (Floral Expressions). Proximity to N. Riverside Drive and Calle Ranchitos will require traffic control measures during portions of the work.

Surrounding population: The surrounding area will consist of one or more of the following: Rural, Rural Residential, Residential, Commercial, Industrial.

III. ENTRY OBJECTIVES

- A. Task 1 Interim water pumping & treatment system installation
- B. Task 2 Cement-Bentonite slurry wall installation
- C. Task 3 Source soil excavation, transport & disposal
- D. Task 4 Remediation system installation

IV. ON-SITE ORGANIZATION & COORDINATION

The following personnel are designated to carry out the stated job functions on site. (Note: one person may carry out more than one job function.)

HEALTH & SAFETY PLAN:

Souder, Miller & Associates:

PROJECT TEAM LEADER: Alan Eschenbacher
FIELD TEAM LEADER: Cassie Parker
ALTERNATES: Emme Mayle

Subcontractors:

SITE CREW CHIEF: Rhino Environmental Services

Owner: : Steve Dyer

FEDERAL AGENCIES: EPA _____

STATE AGENCIES: NMED PSTB
NMDOT

Other Agencies: _____

ON-SITE CONTROL

The occupancy of the area will be minimal. Only key personnel will be in attendance.

Representatives of ***Souder, Miller & Associates*** may include the following: Cassie Parker, Emme Mayle. EPA or State Agency personnel will be varied with the contact person being Ms. Susan von Gonten, NMED PSTB.

Control boundaries will be established and prior to Task 1, and the Exclusion Zone (the contaminated area), Contamination Reduction (decontamination) Zone, and Support Zone (clean area) will be identified as noted.

All personnel involved in the project will be required to adhere to all boundaries and rules regarding the project. All personnel will be required to show proof of 40 Hour HAZWOPER and other applicable training.

Boundaries to be marked:

Containment:	Chainlink construction fencing.
Traffic/Hotline:	Orange Cones.
Decontamination:	Orange Cones & White Tape.
Support/Staging area:	Vehicles & As needed.

V. HAZARDS EVALUATION

Table 1 and 2 list several potential hazards that might be associated with execution of this project. This list is by no means all inclusive and other unforeseen hazards may be contingent upon conditions.

**Table 1
Possible Chemicals**

Substances Involved	Concentration	Fire	Eyes	Skin	Respiratory
Anti-Freeze	Ethylene Glycol Variable				
Used Oil	Petroleum Hydrocarbons Variable				
Gasoline	Variable				
Diesel	Variable				
Grease	Variable				
Solvent/Cleaners pH Approximate Range 3.5 To 11 (Irritating Liquids) and possible Chlorinated Hydrocarbons	Variable				
Off-Spec Paint (Liquid/Solid)	Lead And Chromium Variable 8% - 15%				
Tar & MC 250 & MC-70	Variable				
Polychlorinated Biphenyl (PCB)	Variable, Halogens				
Organic Solvents	Variable				
Acids	Variable				
Bases	Variable				
Organic Peroxides	Variable				

Legend :

- Slt. Slight Mod Moderate
- Hi. High IDLH Immediately Dangerous to Life and Health
- NA Not Applicable

Table 2
Potential Health And Safety Hazards

Hazard	Task 1:	Task 2:	Task 3	Task 4
Inhalation Hazard	X			
Contaminated Soil/Liquid Contact	X			
Noise	X			
Heat/Cold Stress	X			
Electrical (Transformers And Buried Powerlines)				
Potential Fire/Explosion	X			
High Pressure Liquids				
Collapsing Of Sidewalls				
Confined Spaces				
Physical Injury	X			
Overhead Powerlines	X			
Buried Piping/Tanks	X			
Skin Hazards	X			
Ventilation Problems				
Vandalism				
Heavy Equipment/Trucking/ Traffic	X			
Level Of Protection	D			
Air Monitoring	NA			
Buried Line Detection	One-Call 48 hr Notice			

VI. PERSONAL PROTECTIVE EQUIPMENT

Based on the OVM (PID) readings in the breathing zone, the criteria for levels of protection are as follows:

Background-25 (PPM)	Level D
25-50(PPM)	Level C
50-100(PPM)	Level B
>100 (PPM)	Level A

NOTE: Deviations from these levels will be based on the types of products and constituents. No changes to the specified levels given in table 1 and the above table shall be made without the approval of the site safety officer and the project team leader.

A. Personal Protective Equipment Matrix:

	COVERALL	HARDHAT	GLOVES	SAFETY BOOTS	NOMEX	HEARING PROTECTION	SAFETY GLASSES W/SIDE	LEVEL C	LEVEL B	LEVEL A	OTHER
DAILY ROUTINE		X	X	X		X	X				
SAMPLING (OIL FIELD)											1
SAMPLING (NON-OIL FIELD)											
EXCAVATION (OIL FIELD)											1
EXCAVATION (NON OIL FIELD)											
DRILLING (INVESTIGATION)											
FACILITY INVENTORY											
CHEMICAL INVENTORY											2
UNDERGROUND STORAGE TANK REMOVAL											
EMERGENCY RESPONSE											2

1. Minimum required will be determined by Client’s current policy
2. MSDS will be consulted to determine proper Personal Protective Equipment.

VII. PROTOCOL

The following briefly describes the protocol to be followed for any soil and water samples to be taken at a site. A working knowledge of applicable EPA SW-846, sampling and analytical procedures and proper use of field testing equipment is necessary. New disposable Nitrile gloves shall be worn for all water and soil sampling activities.

A. Water samples:

Volatile Organic Analysis (VOA)- Use of a 40 mL VOA glass vial with Teflon closure, leave no airspace present, and preserve as required; keep cool with ice in cooler, use chain-of-custody sample handling procedures, and transport to Laboratory. For other analyses, see detailed procedures.

B. Soil samples for assessment/verification:

Field vapor headspace - 475 mL wide mouth glass container, fill 1/2 full, seal with aluminum foil, or use heavy zip-locking plastic bags.

Laboratory analysis for hydrocarbons (standard) - Use laboratory supplied sterile glass container, with Teflon closure. Fill completely, keep cool with ice in cooler, use chain-of custody sample handling procedures, transport to Laboratory. For NMED USTB Methanol Extraction, see detailed procedure.

C. Air Monitoring:

Air monitoring for the site will be accomplished with an MHPA approved LEL continuous meter, calibrated to pentane, and with an alarm at 10% LEL. An OVM (PID) calibrated to isobutylene can be substituted to an LEL. All air monitoring for exposure is to be in breathing area. (for frequencies, see Section VI, Table 2).

VIII. SITE WORK PLAN

This project will be completed in the Tasks outlined in Section B. The following outlines the key personnel and their responsibilities:

Project Team Leader:

Cassie Parker
Souder, Miller & Associates
Albuquerque, NM (505) 299-0942

Alternates:

Emme Mayle

Alan Eschenbacher

The Project Team Leader will function as the Project Manager, Site Health & Safety Officer, Site Supervisor, and sampler for this Project.

Tailgate safety meetings will be held and all personnel will be briefed on the contents of this plan prior to initiating any efforts. Tailgates will also cover any safety and/or health issues not anticipated or addressed in this plan. The Project Manager will be responsible for briefing and record keeping.

IX. COMMUNICATION PROCEDURES

Radio communication is not anticipated to be essential for this project. Personnel in the Exclusion Zone should be in visual contact of the Project Team Leader.

The following standard hand signals will be used:

Hand gripping throat	Out of air, can't breathe
Grip partner's wrist or both hands around waist	Leave area immediately
Hands on top of head	Need assistance
Thumbs up	OK, I'm all right, I understand
Thumbs down	NO, Negative

Others as needed while handling, moving, or loading materials, are acceptable provided that all personnel involved agree to their meaning.

Telephone communication will be available in the Staging Area by mobile phone.

X. DECONTAMINATION PROCEDURES

The following are a brief summary of decontamination procedures. Common sense should be used at all times.

A. Personal Decontamination:

The following procedure assumes level "D" Personal Protective Equipment (PPE). Prior to entering a vehicle and leaving the site, coveralls are to be doffed and placed in appropriate laundry/duffel bags in the reduction zone, and hands and face are to be washed.

For all other levels of PPE, PPE to be doffed in the reduction zone, Tyvek and other disposables will be placed with the waste for off-site disposal, and all other reusable PPE will be washed with brushes or soapy rags and rinsed by hand sprayers. All exposed skin to be washed in reduction zone also.

B. Excavation/Exploratory Equipment:

All equipment will be decontaminated by high pressure wash, and/or steam cleaned as necessary, initially in the exclusion zone and final rinsed in the reduction zone. Rinse and wash media to be disposed of with contaminated soil/groundwater.

C. Sampling Equipment:

Reusable sampling equipment is to be triple rinsed withalconox soap, tap water and deionized water. Disposable sampling equipment is to be consolidated with waste for off-site disposal.

XI. CONTINGENCIES

A. FIRST AID MEASURES/MEDICAL EMERGENCIES

The nearest hospital is located at:

Presbyterian Espanola Hospital
1010 Spruce St. Espanola, NM 87532

In the event that personnel exposure symptoms occur, the following procedures will be used:

B. PETROLEUM PRODUCTS / IRRITATING LIQUIDS:

1. Eye contact:

Flush eye immediately with copious amounts of water and repeat until irritation is eliminated. If prolonged irritation occurs for more than 15 minutes, seek medical attention.

2. Skin contact:

Wash exposed area with soap and water. If dermatitis or severe reddening occurs, seek medical attention.

3. Inhalation:

Remove person into fresh air. If symptom occurs for more than 15 minutes, seek medical attention.

4. Ingestion:

Do not induce vomiting, seek medical attention.

C. PHONE LIST:

AMBULANCE	<u>911</u>
POLICE, FIRE & RESCUE	<u>911</u>
STATE POLICE	<u>505-841-9256</u>
POISON CONTROL	1-800-362-0101
CHEMTREC	1-800-424-8802

First aid and emergency fire equipment will be available in **Souder, Miller & Associates** vehicles.

D. ENVIRONMENTAL MONITORING

The following environmental monitoring instruments will be used on site:

The following instruments will be used continuously to monitor air quality.

Combustible gas Indicator: Trigger level will be 10%. The alarm will be audible or vibratory in the event of extreme noise levels.

FID/OVA: Will measure in the parts per million. It will indicate organic volatiles.

HEALTH & SAFETY PLAN:

pH meter. The pH meter will be used to indicate the pH of each separate sample.

E. EMERGENCY PROCEDURES (to be modified as required for project or incident)

The following standard emergency procedures will be used by on site personnel. The Site Safety Officer shall be notified of any on site emergencies and be responsible for ensuring that the appropriate procedures are followed.

1. Personal Injury in the Exclusion Zone:

Upon notification of an injury in the Exclusion Zone, all site personnel shall assemble in the Reduction Zone. The rescue team will enter the Exclusion Zone (if required) to remove the injured person to the hotline. The Site Safety Officer and Project Team Leader shall evaluate the nature of the injury, prior to movement to the Support Zone. Appropriate first aid will be initiated, and contact should be made for an ambulance and with the designated medical facility (if required). No persons shall reenter the Exclusion Zone until the cause of the injury or symptoms is determined.

2. Personal Injury in the Support Zone:

Upon notification of an injury in the Support Zone, the Project Team Leader and Site Safety Officer will assess the nature of the injury. If the cause of the injury or loss of the injured person does not affect the performance of remaining personnel, operations may continue. If the injury increases the risk to others, the designated emergency signal horn shall be sounded and all site personnel shall move to the Reduction Zone for further instructions.

In any case, the appropriate first aid will be initiated and necessary follow-up as stated above.

3. Fire / Explosion:

Upon notification of a fire or explosion on site, the designated emergency signal horn shall be sounded and all site personnel assembled at the Reduction Zone. The fire department shall be alerted and all personnel moved to a safe distance from the involved area. *Fire extinguishers shall be used with discretion to minimize the risk of fire and explosion that would result in injuries.*

4. Personal Protective Equipment Failure:

If any site worker experiences a failure or alteration of protective equipment that affects the protection factor, that person and his/her buddy shall immediately leave the Exclusive Zone. Reentry shall not be permitted until the equipment has been repaired or replaced.

5. Other Equipment Failure:

If any other equipment on site fails to operate properly, the Project Team Leader and Site Safety Officer shall be notified and then determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of the Work Plan tasks, all personnel shall leave the Exclusion Zone until the situation is evaluated and appropriate actions taken.

In all situations, when an on site emergency results in evacuation of the Exclusion Zone, personnel shall not reenter until:

- 1. The hazards have been reassessed.***
- 2. The conditions resulting in the emergency have been corrected.***
- 3. The Site Safety Plan has been reviewed.***
 - 3. Site personnel have been briefed on any changes in the Site Safety Plan.***

XII. CLOSURES AND SIGNATURES

This plan has been reviewed and has the full approval of the following Management.

Owner:

NAME: _____
TITLE: _____
DATE: _____

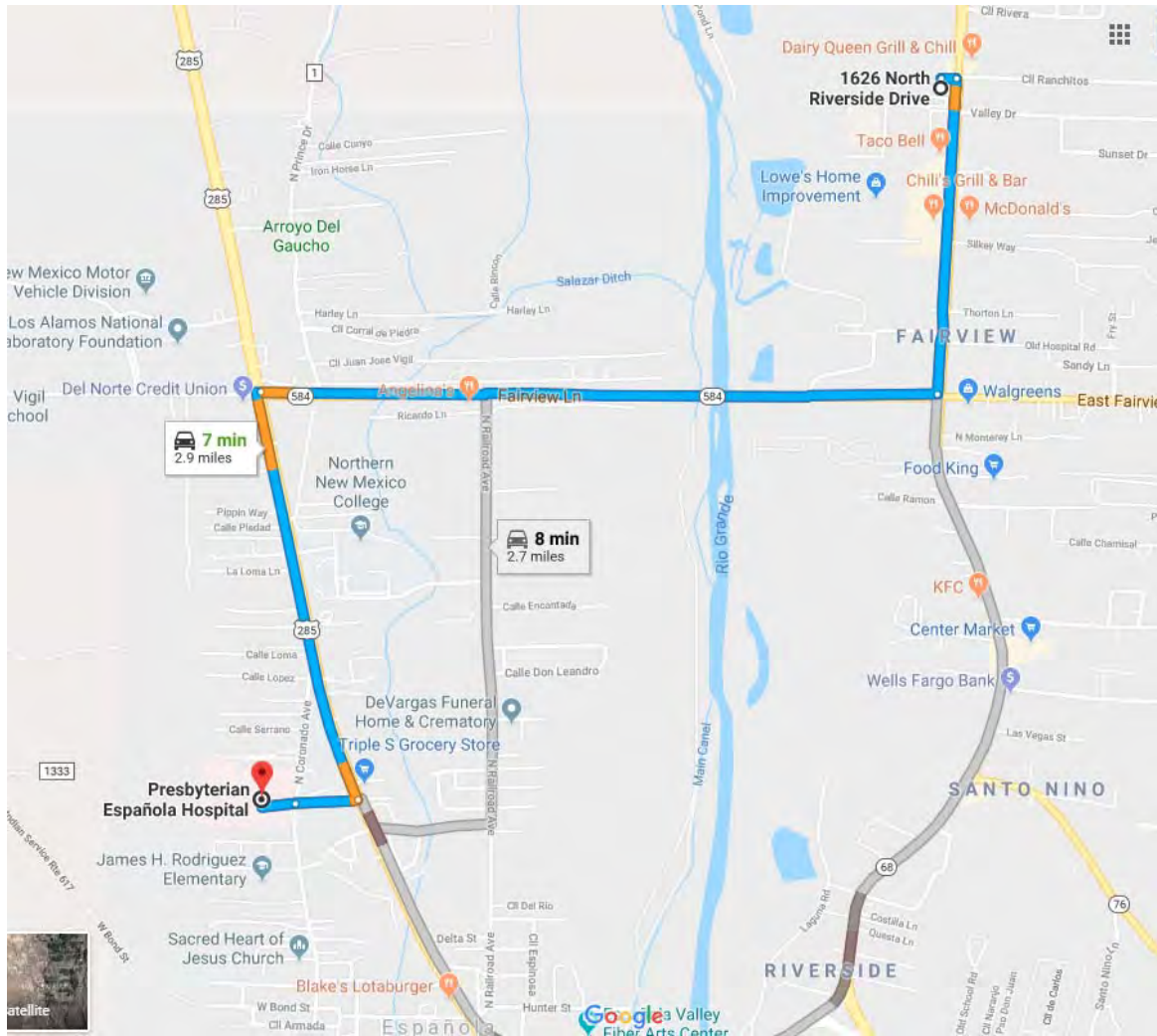
Consultant ***Souder, Miller & Associates.***

NAME: _____
TITLE: _____
DATE: _____

All site personnel have read the above plan and are familiar with its provisions.

	Print Name	Signature
Site Safety Officer	_____	_____
Project Team Leader	_____	_____
Other Site Personnel	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
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HEALTH & SAFETY PLAN:



Appendix E: Groundwater Model Information

Groundwater Modeling of Fairview Station Remediation

1.0 Introduction

The proposed remediation of the Fairview Station site includes installation of a cement-bentonite slurry wall, interim total fluids pumping during system construction, and fluids recovery via horizontal wells installed to the area north of the barrier wall. The barrier wall will hydraulically separate portions of the site where different remediation approaches will be implemented. The area south of the barrier wall will be excavated to remove contaminated soil and non-aqueous phase petroleum liquid (NAPL). The open excavation will facilitate installation of horizontal wells into the contaminant plume north of the barrier wall. During remediation system construction fluids recovery will be completed using pumps installed in three monitoring wells north of the barrier wall (MW-29, MW-30, MW-31). Once construction is completed, fluids recovery will shift to a series of horizontal wells installed below the water table north of the barrier wall.

The purpose of this groundwater modeling is to determine the minimum flow rate for the interim pumping and horizontal wells to maintain hydraulic control of the contaminant plume north of the barrier wall. In addition, the modeling was conducted to estimate the drawdown achieved by the systems at various flow rates above the minimum flow rates.

2.0 Model Procedures and Methodology

2.1 Groundwater Modeling using MODFLOW

The Visual MODFLOW Flex version 6.1 computer program was used to develop a groundwater flow model for the Fairview Station remediation plan. This program is based on the finite-difference groundwater flow model developed for the U.S. Geological Survey (MODFLOW-2005). The physical parameters of the study area and aquifer properties were defined in the model using data collected during site investigations or reference values and are discussed below.

Typically, groundwater models are constructed using a balance of aquifer inputs and outputs. The inputs often include groundwater flow from outside the model area, precipitation and leakage from surface water to groundwater. The outputs typically include evapotranspiration, flow into rivers and loss to pumping wells. Given the small size of this particular groundwater model, balancing of these inputs and outputs is difficult and can create significant error. Therefore, the model was constructed using published values where available. In addition, boundary conditions were selected that yield conditions that are similar to observed conditions such as groundwater gradient and depth to groundwater from the surface.

Once the aquifer parameters are selected and the boundary conditions are set, the model area is subdivided into a three-dimensional grid of block elements. Aquifer parameters are assigned to each block and the software calculates the hydraulic heads, flow rates and volumetric changes in each block element at steps in time.

1.2 Model Framework

The area covered by the model was determined based on the locations of existing monitoring wells, locations of future horizontal extraction wells. The model extents were developed to cover the expected extent of pumping effects. The model area is 800 feet by 800 feet. The maximum grid spacing within the model area is twenty feet. The grid spacing is smaller near the barrier wall, three monitoring wells used for pumping and the proposed horizontal wells where more precision is desired.

The groundwater model is composed of six layers to represent the sedimentary layers in the shallow aquifer at the site. The ground elevation of the highest wellhead elevation at the site (MW-26) was used as the reference elevation for the entire site. The elevations of aquifer layers, water table, hydraulic head data were normalized to this elevation. The model layer depths used were: surface to 15 feet, 15 to 17.5 feet, 17.5 to 21 feet, 21 to 23 feet, 23 to 25 feet, and 25 to 30 feet.

1.3 Boundary Conditions

The model is oriented in the north-south direction, perpendicular and parallel to the proposed barrier walls. A constant-head boundary with head values that approximate the head values and groundwater elevations observed as the site was located along the northeast quadrant of the model area. A general head boundary was located along the southwestern edge (down-gradient) of the model area.

1.4 Hydraulic Parameters

The lithologic data collected from the various well drilling investigations and slug tests were used to define the hydraulic properties of the layers. The three uppermost layers represent the interbedded sand, silt, and clay sediments present between the ground surface and the underlying sand and gravel generally present 20 to 21 feet below ground surface. The three lowest layers were sand and gravel which transition to silt and clay layers west of Riverside Drive. The hydraulic conductivities used for the various soil types are indicated in the table below:

Soil Type	Hydraulic Conductivity (cm/s)
Sand and Gravel	1×10^{-2}
Fine Grained Sand	5×10^{-2}
Silt	1×10^{-3}
Sandy Clay	5×10^{-4}
Silty Clay	1×10^{-4}
Clay	1×10^{-5}
Cement-Bentonite Barrier Wall	1×10^{-7}

The boundary conditions and hydraulic parameters assigned were tested by comparing water elevations predicted by the model (without pumping) to actual water elevations observed during groundwater monitoring events. The model predicted values of potentiometric surface elevation, gradient, and flow directions are similar to recent monitoring data of wells not containing NAPL (Image 1 below). The models do not include the separate NAPL phase and assume NAPL is hydrostatically in equilibrium with the water in the aquifer.

Once the model was calibrated to existing conditions, the barrier wall was added to the model. The barrier wall as designed includes a primary east-west wall south of Calle Ranchitos and monitoring wells MW-29, MW-30, and MW-31 that is 110 feet long, 25 feet deep, and 5 feet thick. A north-south wall extends from the west end of the east-west wall and is 140 feet long, 25 feet deep, and 3 feet thick.

1.5 Wells and Pumping Rates

The three wells used for interim pumping were located and designed as constructed using 15 feet of 0.010" slot screen fully penetrating the upper sand/silt/clay layers and partially penetrating the underlying sand and gravel. The screen intervals were from approximately -13 to -28 feet (model datum). Model runs were completed using the same pumping rates from all three wells simultaneously and were run to equilibrium. The pumping rates were adjusted to achieve varying drawdowns and cones of depression in the water table near the wells/barrier wall.

The three proposed horizontal wells were modeled as drains since MODFLOW does not allow for horizontal wells with specific pumping rates. The elevation and hydraulic properties of the drains was adjusted to achieve varying flow/discharge rates and water table depressions. The software only allows for horizontal drains whereas the proposed horizontal wells will be gently sloped to be roughly the same slope as the water table. As a result, the drains in the model have a smaller depth below water table at the barrier wall than at their ends to the north. The flow from the horizontal wells will be controlled using valves and the pumping level in the collector sump. The modeling runs are intended to determine the effects of varying pumping rates though the methods for controlling flow are different in the model versus the proposed system.

2.0 Discussion and Conclusions

2.1 Interim Fluids Pumping Models

Model runs were performed with the barrier wall in place and with varying pumping rates from monitoring wells MW-29, MW-30, and MW-31. The pumping rates modeled were 0.25, 0.5, 1.0, and 2.0 gpm. At a pumping rate of 0.25 gpm (0.75 gpm total) the water table was depressed approximately 0.3 feet in the area immediately north of the barrier wall (model output image 2). This represents the estimated minimum pumping rate required to maintain hydraulic control of the contaminant plume north of the barrier wall. At a pumping rate of 0.5 gpm (1.5 gpm total) the water table was depressed approximately 0.6 feet in the area immediately north of the barrier wall (Image 3). A pumping rate of 1.0 gpm (3.0 gpm total) achieved a cone of depression of

approximately 1.2 feet in the area north of the barrier wall (Image 4). A pumping rate of 2.0 gpm (6.0 gpm total) achieved a cone of depression of approximately 2.6 feet in the area north of the barrier wall (Image 5).

2.2 Horizontal Well / Drain Models

The results of six model runs of the barrier wall with three horizontal wells/drains are included in the table below and output images 6 through 11. The depth of the wells/drains and the combined fluids collection rate were varied to determine flows required to maintain hydraulic control of the contaminant plume. The table below summarizes the results.

Horizontal Well/Drain Depth Below Water Table (feet)	Total Flow of Fluids Recovery (gpm)	Water Table Drawdown Achieved at Wall (feet)	Corresponding Model Output Image
1.2 to 1.5	3.6	0.4	6
1.2 to 1.5	5.3	1.0	7
2.2 to 2.5	4.2	0.6	8
2.2 to 2.5	7.2	1.6	9
3.2 to 3.5	4.8	1.0	10
3.2 to 3.5	9.1	2.4	11

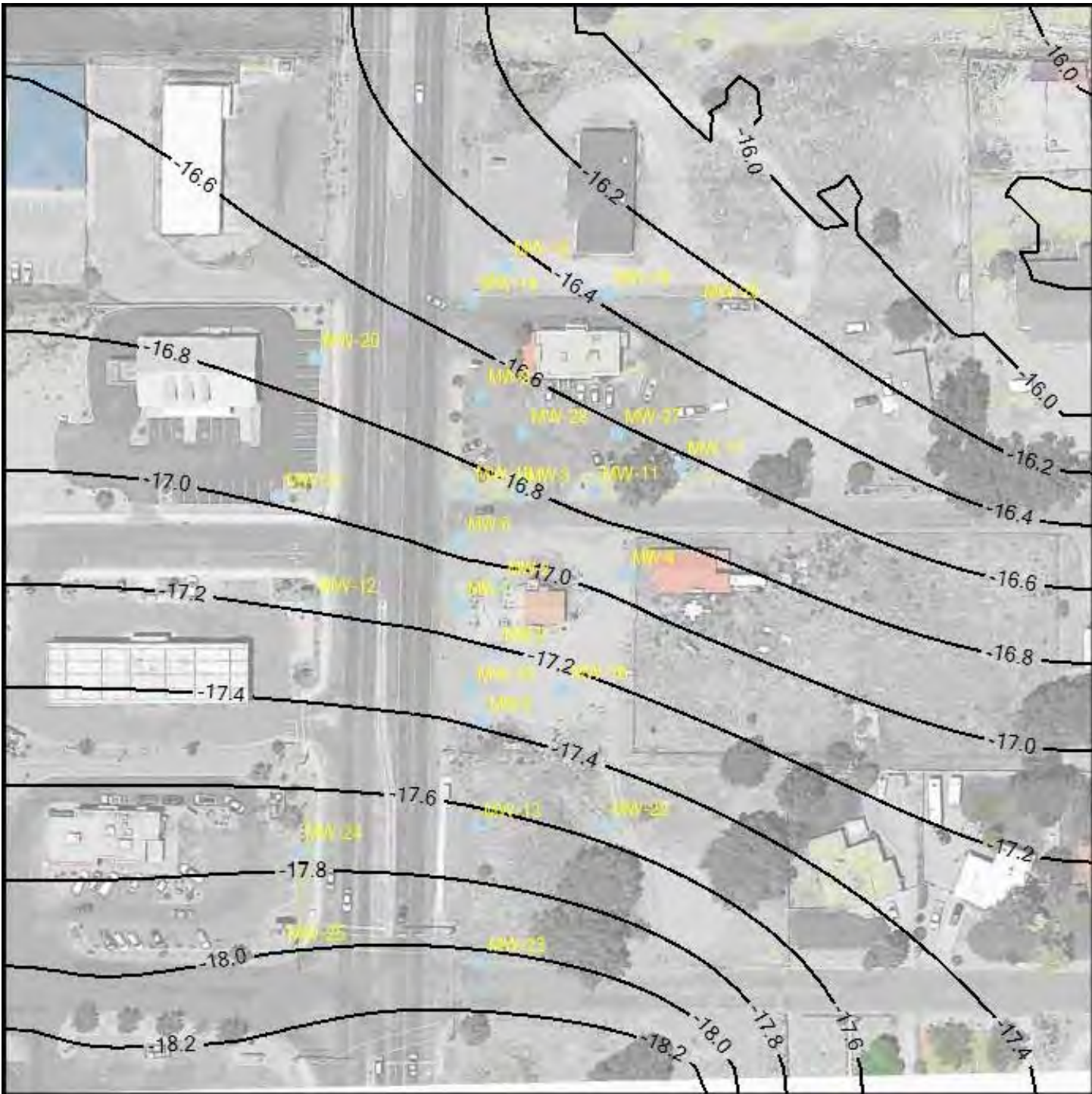
2.3 Conclusions

The groundwater models presented are intended to evaluate the minimum pumping rates required during interim fluids pumping during construction or the barrier wall and remediation system and during operation of the remediation system. Where possible, data derived from previous investigation and slug testing were used to build the models in this study. Conservative values were used where reliable, site-specific data could not be found.

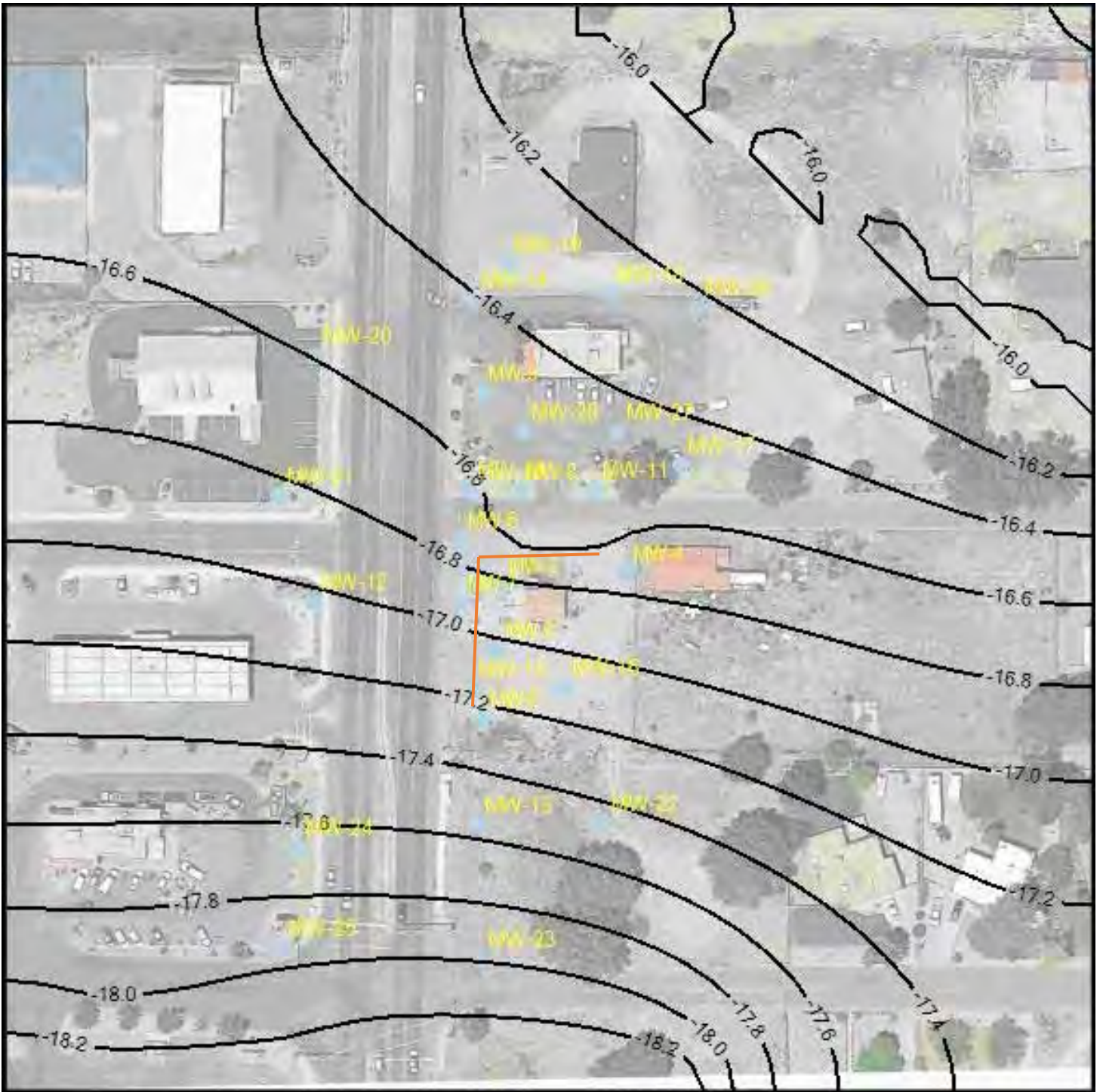
The models were used to estimate the magnitude and area of cones of depression at various flow rates. During the interim phase of fluids recovery the modeled minimum flow rate required to maintain control of the contaminant plume is 0.75 to 1.5 gpm. SMA is recommending a minimum flow rate of 3 gpm to provide a margin of safety and to create a larger cone of depression to encourage flow of groundwater and NAPL towards the center of the plume adjacent to the barrier wall. The anticipated average flow rate during the interim fluids recovery is 3 to 6 gpm (1-2 gpm per well). The combined flow during the first few days of fluids pumping will likely exceed 10 gpm until water table elevations stabilize.

Several model runs were conducted on the horizontal wells/drains to estimate the flow required to create a cone of depression within the plume and the optimal depth of the wells relative to the water table elevation. The water table elevation has been observed to fluctuate slightly more than 3 feet at the site. The placement of the horizontal wells should be below the anticipated water table fluctuations while remaining as close as possible to the highly contaminated smear zone.

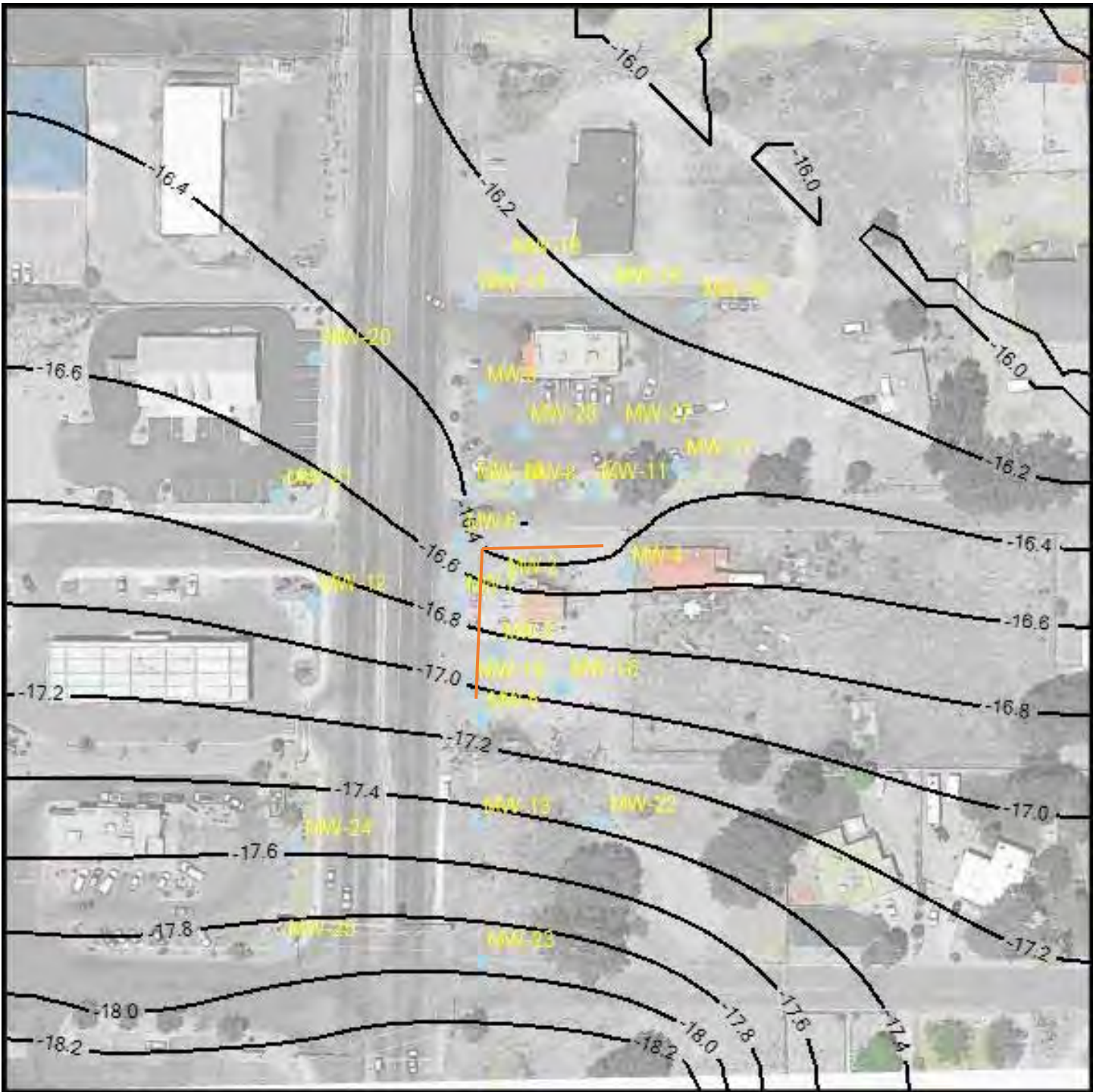
Placing the wells 2 to 2.5 beneath the median water table elevation ensures the wells can recover fluids throughout the range of water table fluctuations. Since the depths of the horizontal wells are substantially less than the monitoring wells used during interim fluids recovery and cover a larger areal extent, the estimated pumping rate is greater for the horizontal well system. The anticipated minimum flow rate for the horizontal well system is 4 to 5 gpm depending on water table elevation. Such flows could be achieved using one or two horizontal wells, however, utilizing three wells provides a shorter flow path for NAPL and contaminated water through clayey soils and a deeper cone of depression with the wells as close as possible to the highly contaminated smear zone.



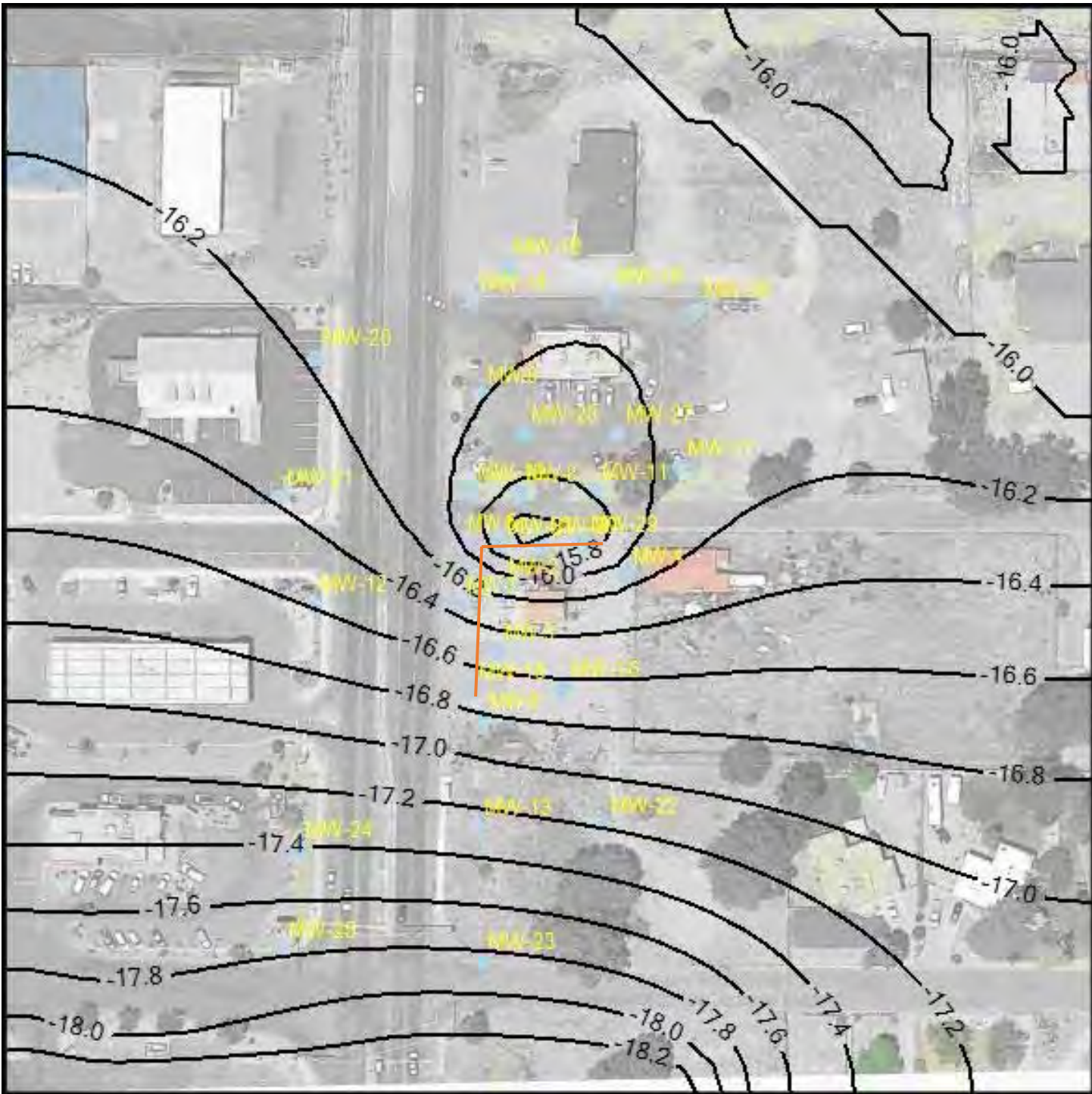
1. Model Potentiometric Surface – Current Conditions



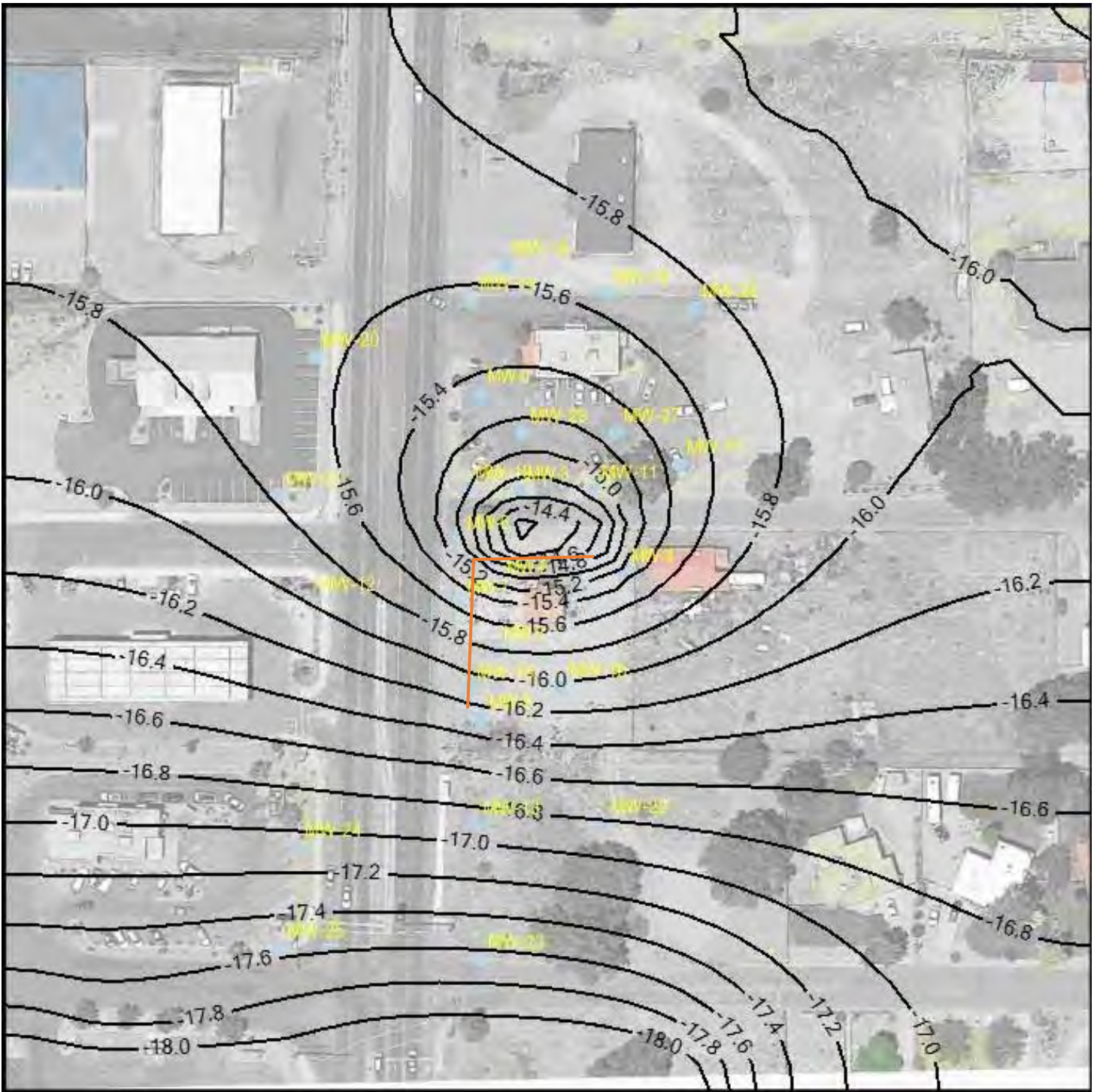
2. Interim Fluids Pumping – 0.75 gpm (0.25 gpm per well)



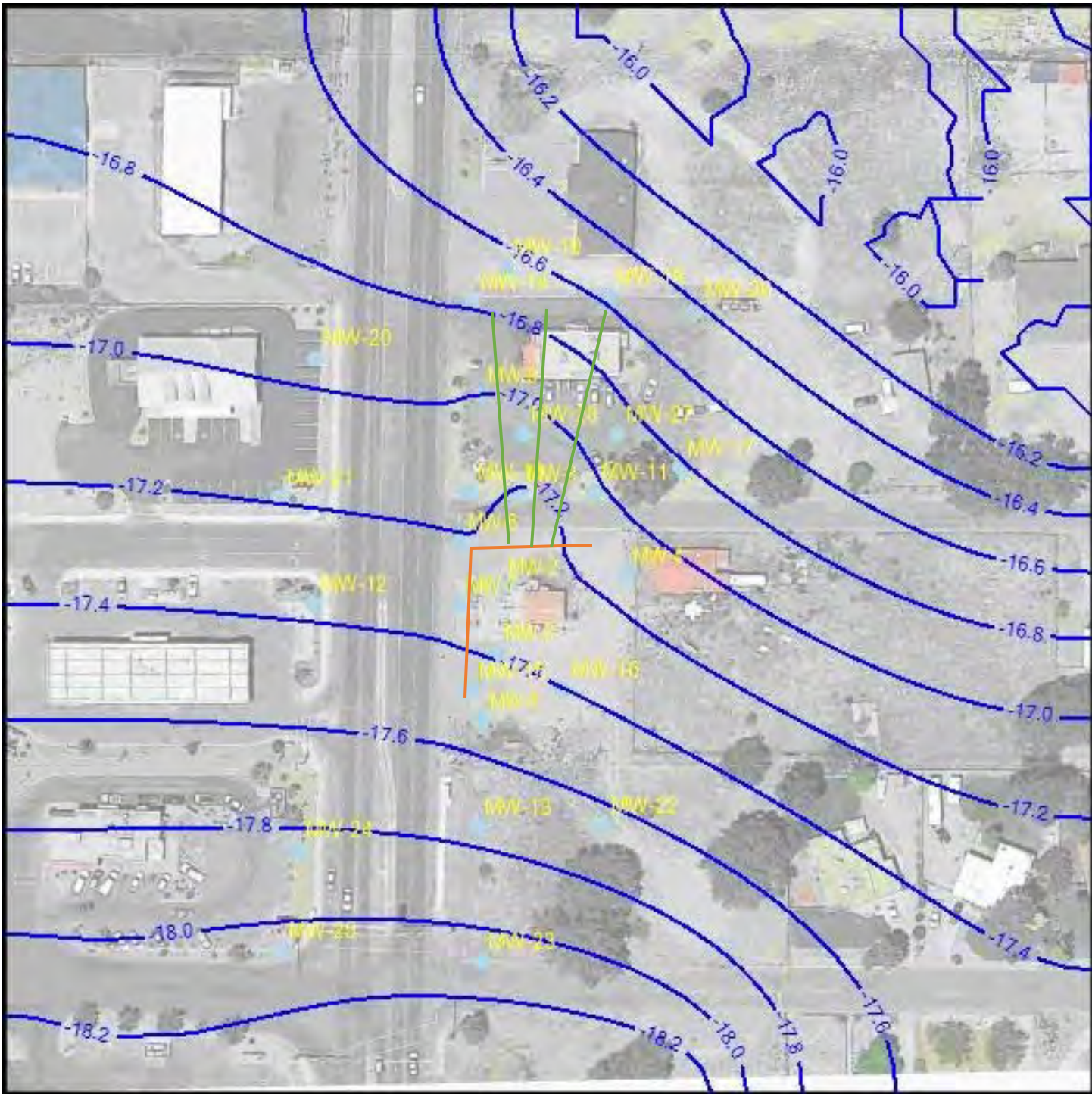
3. Interim Fluids Pumping – 1.5 gpm (0.5 gpm per well)



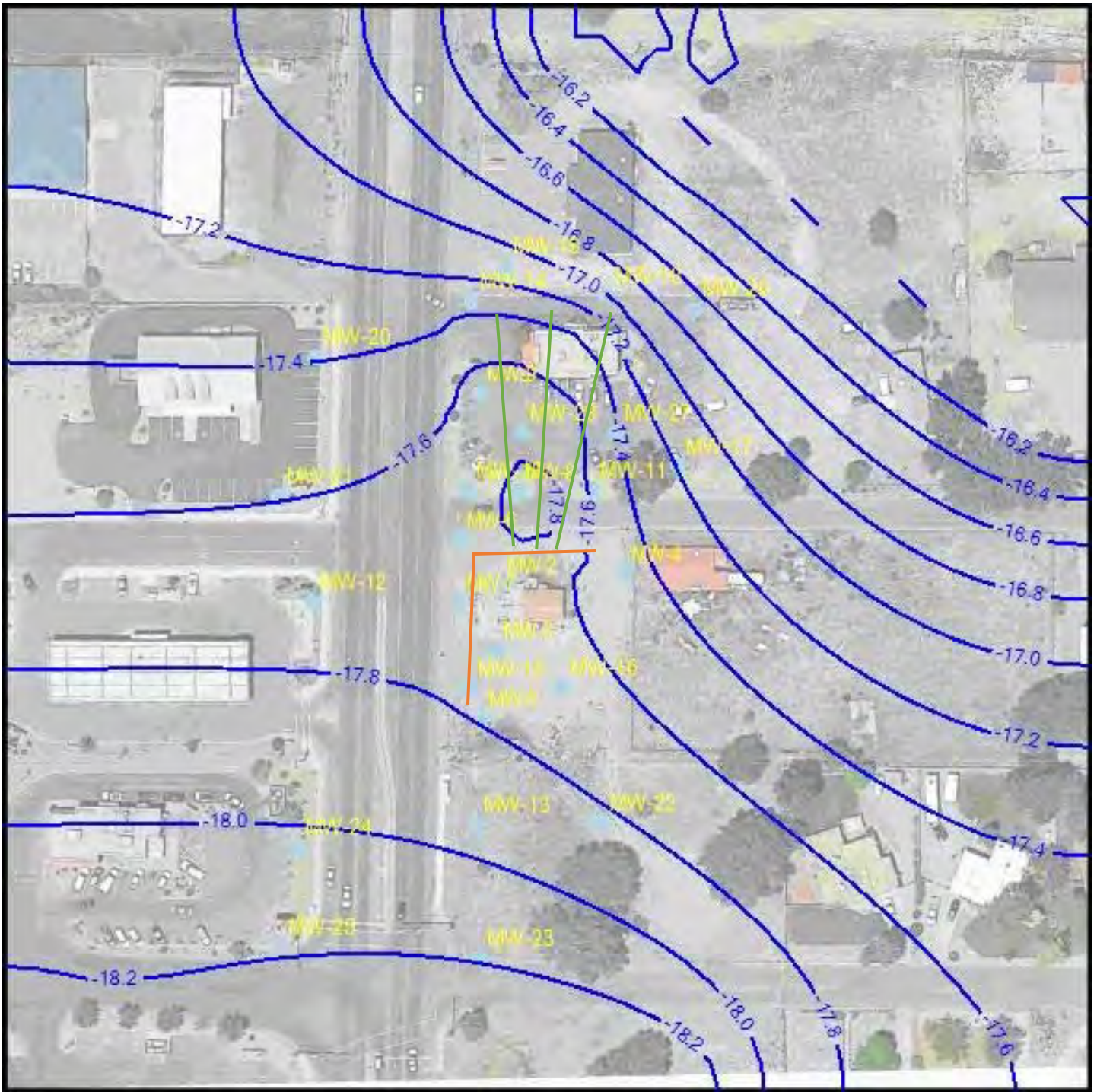
4. Interim Fluids Pumping – 3.0 gpm (1.0 gpm per well)



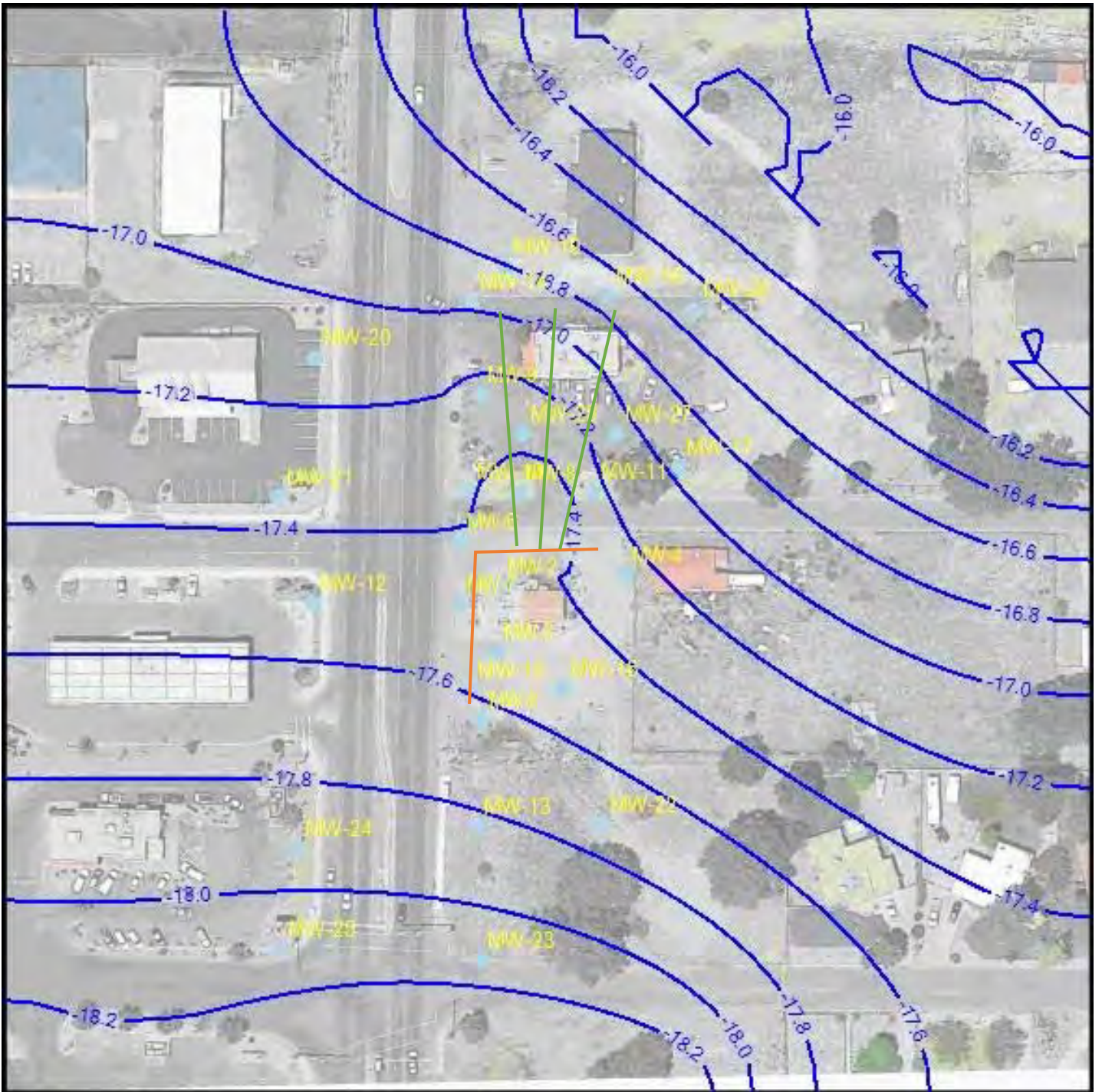
5. Interim Fluids Pumping – 6.0 gpm (2.0 gpm per well)



6. Horizontal Drains 1.2 to 1.5 feet below water table – 3.6 gpm



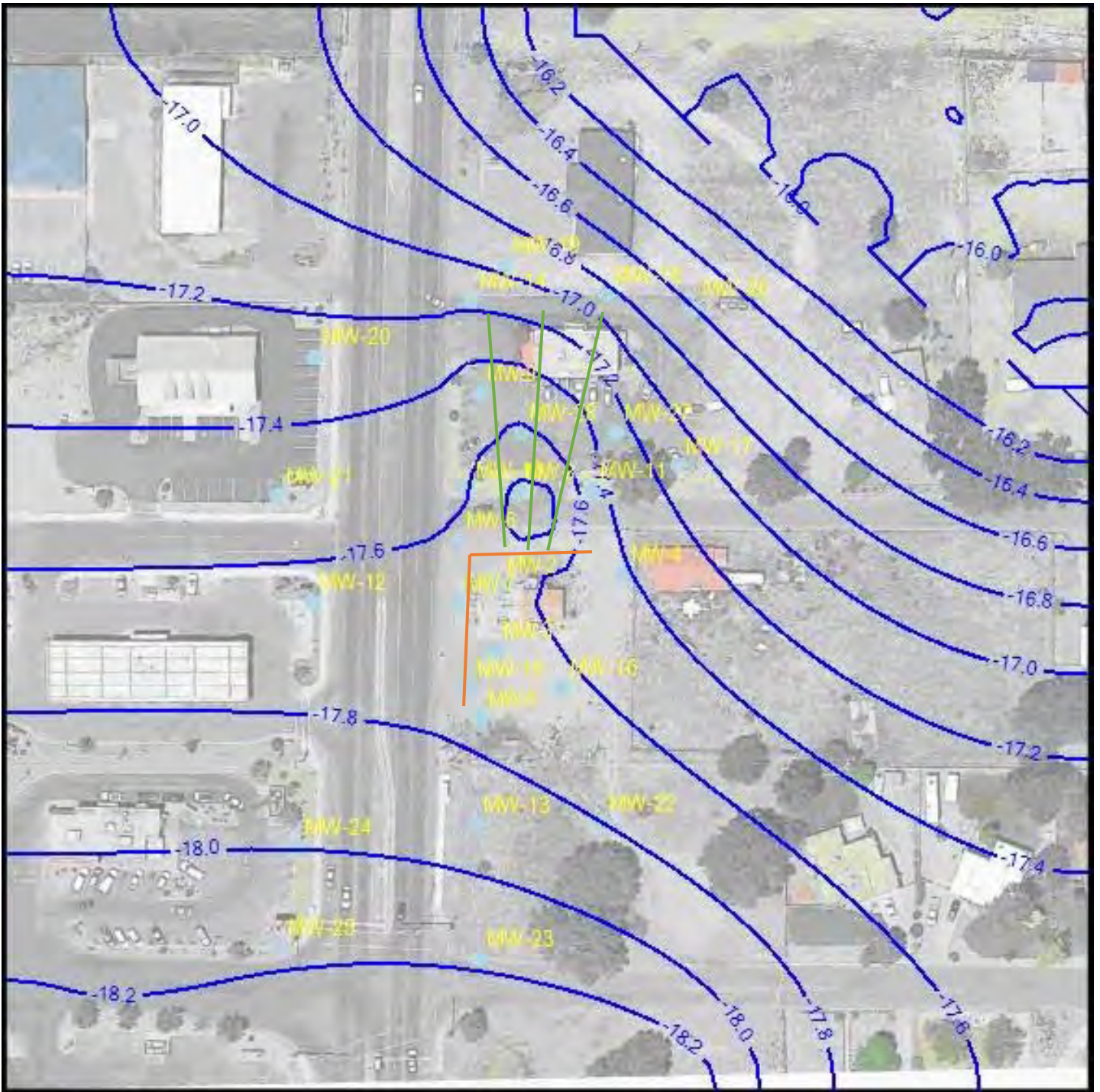
7. Horizontal Drains 1.2 to 1.5 feet below water table – 5.3 gpm



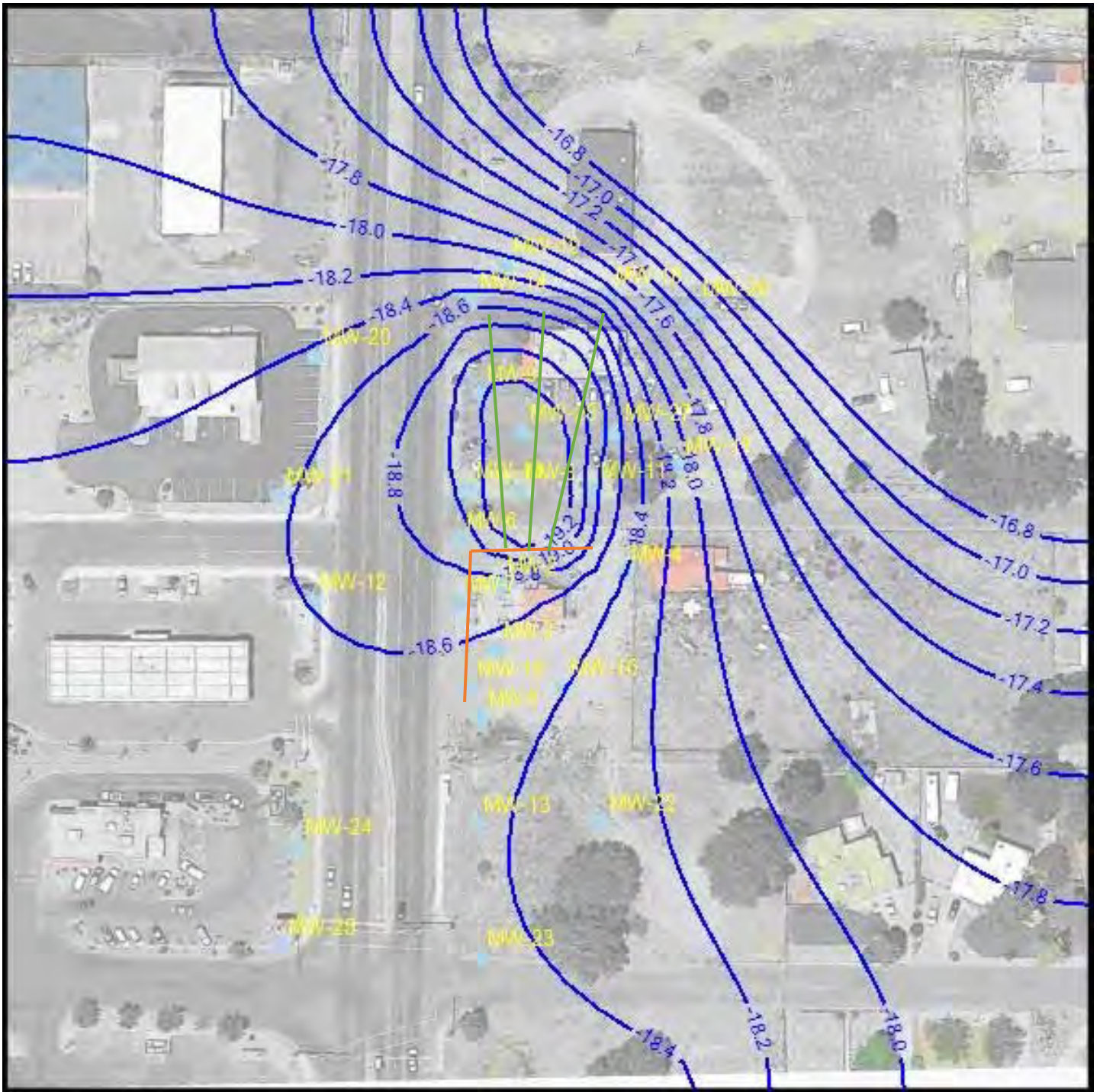
8. Horizontal Drains 2.2 to 2.5 feet below water table – 4.2 gpm



9. Horizontal Drains 2.2 to 2.5 feet below water table – 7.2 gpm



10. Horizontal Drains 3.2 to 3.5 feet below water table – 4.8 gpm



11. Horizontal Drains 3.2 to 3.5 feet below water table – 9.1 gpm

Appendix F: City of Española Utility Connection Permit



City of Española

405 N. Paseo de Oñate
Española, NM 87532
(505) 747-6045 ofc • (505) 747-6084 fax

Utility Permit Application New Connection Commercial

Permit No. _____

Receipt No. _____

Daily Report _____

Amt. Pd: _____

Rec'd By: _____

Entered by: _____

Billing Information (Print Only)

Official Service Address:

Applicant: Scott A. McKittrick

DBA: Souder, Miller + Associates

Driver's License: 035425403 State NM

Exp: 9/25/23 DOB: 8/26/63 Copy DL

SSN: _____

Billing Address: 2904 Rodeo Park Dr E. 2105

Santa Fe Zip: 87505

Phone No.: 505473-9211 Cell No.: _____

Unofficial Service Address: 1027 N. Riverside Dr.

Property Owner's Information (Print Only)

Property Owner: _____

Spouse/Co-owner: _____

Mailing Address: _____

_____ Zip _____

Phone No.: _____ Cell No. _____

Property ID No. R021168

City Limits: Yes No (OCL) RAC SFC

Credit Application (submitted)

Business License Registration (attached if applicable)

Project Type: Commercial

Class I Class II Class III

Credit Deposit: Water \$ _____ Wastewater \$ 150.- (Non Taxable) \$ 150.-

Water Rights (Non Taxable) \$ _____

Municipal Water Size _____ Type _____ \$ _____

Water Materials Cost (see attachment) \$ _____

Fire Protection Size _____ Type _____ \$ _____

Municipal Wastewater Size 4" Type _____ \$ 500.-

\$100.00 Pavement Cut Fee 10.00 Cost/Sq. ft. \$ _____

5.125% Tax (mandatory) \$ 25.63

Total Cost \$ 675.63

Private Septic System 150' Required to connect to Sewer

Private Well 150' Required to connect to Water

Application Submittals

Legal Description of Property – Survey (most current) or Warranty Deed **REQ'D FOR NEW SERVICE CONNECTIONS**

I, hereby certify that I am the lawful owner of the parcel of land, which this application concerns, and consent to this action. I hereby permit City of Española officials to enter upon the property for the purpose of inspections relating to this application. I also acknowledge that delinquent and/or unpaid balances are my sole responsibility as the property owner. I, hereby certify that the information and exhibits herewith submitted are true and correct to the best of my knowledge. And that I will accept responsibility for all charges and fees as per Española Municipal Code Chapter 98 Utilities. I further understand that this application may be delayed in processing or denied if the information provided is incomplete or inaccurate.

Owner: _____ / Scott A. McKittrick Date: 6/5/2020

Signature

Printed Name

Planning Department: _____

Date _____

Wastewater Department: [Signature]

Date 6/1/20

Water Department: _____

Date _____

Account # _____ W/O No. (1) _____ (2) _____ (3) _____ (4) _____ Date Completed: _____

Connection Fees established in accordance with Espanola Municipal Ordinance 300-64



May 21, 2020

#3426622

Ms. Danielle Bustos
Public Works
City of Española
405 N. Paseo de Oñate
Española, NM 87532
dnbustos@espanolanm.gov

RE: Sewer Connection for Fairview Station Corrective Action, 1627 N. Riverside Drive, Española

Dear Ms. Bustos:

As discussed today, Souder, Miller & Associates (SMA) is conducting soil and groundwater remediation activities at the Fairview Station petroleum storage tank release site at 1627 N. Riverside Drive in Española. As part of the remediation, we will be removing contaminated groundwater, treating it through a remediation system, and discharging it to the City of Española sewer. All work is being conducted at the requirement of the New Mexico Environment Department, Petroleum Storage Tank Bureau (NMED-PSTB). We have discussed this process in detail with Earl Martinez, WWTP Superintendent.

The NMED-PSTB Project Manager for this site is Susan von Gonten, she may be reached at 505.372.8153, or via email at susan.vongonten@state.nm.us.

Per your request, attached please find the work plan approval and deadline extension issued by the NMED-PSTB, SMA's work plan describing the work, and the contract between NMED-PSTB and SMA, as well as a copy of my identification.

Please let me know what additional information the City requires in order to provide a sewer connection at this location. I can be reached via email at scott.mckitrick@soudermiller.com, or by cell phone at 505.220.6542. SMA appreciates your help.

Sincerely,

MILLER ENGINEERS, INC. d/b/a
SOUDER, MILLER & ASSOCIATES

A handwritten signature in black ink, appearing to read 'Scott A. McKitrick'.

Scott A. McKitrick, P.G.
Senior Geoscientist / Environmental Services Manager

cc: Earl Martinez, WWTP Superintendent, emartinez@espanolanm.gov
Susan von Gonten, PSTB Project Manager, susan.vongonten@state.nm.us

encl.: NMED PSTB Work Plan Approval - September 27, 2019
SMA Work Plan, Fairview Station Site
NMED PSTB Work Plan Extension Approval – May 21, 2020
SMA – NMED PSTB Contract
Copy of McKitrick ID



NEW MEXICO
ENVIRONMENT DEPARTMENT



Petroleum Storage Tank Bureau

Michelle Lujan Grisham
Governor

2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

James C. Kenney
Cabinet Secretary

Howie C. Morales
Lt. Governor

Phone (505) 476-4397 Fax (505) 476-4374
www.env.nm.gov

Jennifer J. Pruett
Deputy Secretary

September 27, 2019

Mr. Alan Eschenbacher
Souder, Miller & Associates
2904 Rodeo Park Drive East, Bldg. 100
Santa Fe, NM 87505

Re: Phase 3 Fixed-Price Workplan Approval for Fairview Station, 1626 North Riverside Drive, Española, New Mexico

Facility #: 28779

Release ID #: 4657

WPID #: 4093

Dear Mr. Eschenbacher:

The New Mexico Environment Department (Department) approves the fixed-price workplan dated September 6, 2019. This workplan is for Phase 3 activities consisting of development of a final remediation plan (FRP) including public notice. Work shall be performed in accordance with contract number 18-667-3200-0009 and the workplan provided.

The total budget approved for this workplan shall not exceed \$104,049.00, which includes New Mexico Gross Receipts Tax. Please refer to the following table for a breakdown of the expected deliverable and date of completion. The date listed in the table is the current deadline in the applicable portion of the corrective action timeline for the subject site. This deliverable documents completion of individual performance criteria.

<u>Deliverable Name</u>	<u>\$ Approved</u>	<u>Estimated Date of Deliverable</u>	<u>Deliverable ID</u>
FRP Development Including Public Notice and submittal	\$104,049.00	11/15/2019	4093-1

You may begin work immediately. Approval of this workplan is contingent upon all work being performed on this site in accordance with all local, state, and federal regulations, including 29 CFR 1910 governing occupational health and safety. The Department expects Souder, Miller & Associates to complete the work as outlined within the approved budget. All change orders must be approved in writing prior to the work being performed.

To facilitate payment, if a deliverable represents a reduced scope of work that requires a reduction in the amount to be claimed, the notification of the modified costs must be submitted to the Department with the deliverable.

If you have any questions, please contact the project manager, Susan von Gonten at (505) 476-4389.

Sincerely,



Dana Bahar
Bureau Chief
Petroleum Storage Tank Bureau

DB:SvG:as

cc: Scott McKittrick, Souder, Miller & Associates (via email)
Stacy Ulrich, Souder, Miller & Associates (via email)
Lorena Goerger, Manager, Remedial Action Program (via email)
Susan von Gonten, Project Manager (via email)
Katherine MacNeil, P.E., Environmental Engineer (via email)
Casey Stavert, Inspector, Prevention and Inspection Program (via email)

cc w/encl: PSTB Master File Santa Fe



September 6, 2019

Ms. Susan von Gonten, Project Manager
New Mexico Environment Department
Petroleum Storage Tank Bureau
2905 Rodeo Park Drive
Santa Fe, New Mexico 87505

**RE: Final Remediation Plan Work Plan,
Fairview Station Site, Española, New Mexico
Facility #28779 RID #4657**

Dear Ms. von Gonten:

Souder, Miller & Associates (SMA) is pleased to submit the attached Phase 4 Final Remediation Plan Work Plan for the Fairview Station State Lead Site. This work plan is submitted in accordance with your direction and applicable Petroleum Storage Tank Regulations.

If you have any questions, please do not hesitate to call me at 505-473-9211 or e-mail me at alan.eschenbacher@soudermiller.com.

Sincerely,
SOUDER, MILLER & ASSOCIATES

Alan Eschenbacher, P.G.
Senior Geoscientist

enclosure

**WORK PLAN AND BUDGET
FINAL REMEDIATION PLAN
FAIRVIEW STATION STATE LEAD SITE
1626 NORTH RIVERSIDE DRIVE
ESPAÑOLA, NEW MEXICO**

FACILITY #28779

RELEASE ID #4657

September 6, 2019

INTRODUCTION

This work plan and budget was prepared pursuant to the contract between New Mexico Environment Department (NMED) Petroleum Storage Tank Bureau (PSTB) and Souder, Miller & Associates (SMA). This work plan is generally consistent with the scope of work described in the NMED PSTB request for proposals (RFP# 18 667 3200 0003) and SMA's proposal and presentation. All aspects of the work plan are designed to ensure compliance with the New Mexico Petroleum Storage Tank Regulations, 20.5 NMAC.

BACKGROUND

The Fairview Station State Lead site consists of comingled releases from two petroleum storage tank (PST) sites. These PST sites include the Fairview Station site located at 1626 North Riverside Drive and a former gas station (currently a Dairy Queen) located north of Fairview Station at 1702 North Riverside Drive in Española, New Mexico. The site is located within the City of Española and on Ohkay Owingeh Pueblo lands.

The Fairview Station was developed in the 1970s. It initially had two underground storage tanks (UST) which were replaced with three USTs in 1989. These USTs were removed in July 2012 with notable soil contamination. PSTB confirmed a release on August 9, 2012. New Mexico Department of Transportation (NMDOT) aerial photographs indicate the former gas station on the Dairy Queen property was present in the 1960s. Two dispensers and a likely aboveground storage tank (AST) are apparent in these photographs.

Terracon Consultants Inc. (Terracon) conducted a Minimum Site Assessment (MSA) investigation in 2013. Non-aqueous phase petroleum liquid (NAPL) was observed in all three wells installed during the MSA. Five additional monitoring wells were installed during an MSA addenda. During this investigation NAPL was observed in the well installed on the Dairy Queen Property (MW-8). Terracon conducted a second MSA Addenda in 2014 that included installation of five monitoring wells. Four of these wells were located on the Dairy Queen property. The findings of NAPL, soil and groundwater contamination on the Dairy Queen property indicated a second, comingled release occurred at the site.

Terracon conducted groundwater monitoring and NAPL recovery events at the site from 2013 to early

2016. During these events NAPL was found in monitoring wells: MW-1, MW-2, MW-3, MW-6, MW-8, MW-11, and MW-14. The maximum apparent thickness of NAPL was 7.51 feet (MW-3). The following dissolved phase contaminants of concern (COC) were detected above applicable regulatory standards: benzene, toluene, ethylbenzene, total xylenes, total naphthalenes, 1,2-dibromoethane (EDB), 1,2-dichloroethane (EDC), and methyl tert-butyl ether (MTBE).

EA Engineering, Science, & Technology, Inc. (EA) conducted additional investigations, groundwater monitoring and NAPL recovery in 2015 and 2016. Seven additional monitoring wells were installed in 2016. During this investigation, NAPL was observed in ten monitoring wells at thicknesses ranging from 0.01 to 7.95 feet.

The most recent groundwater monitoring event was conducted by SMA in March 2019. During this event, 12 monitoring wells contained measurable NAPL. Two monitoring wells, MW-3 and MW-15, contained apparent thicknesses of NAPL greater than five feet. Dissolved phase COCs exceeded NMWQCCR standards in seven monitoring wells. The groundwater gradient was 0.0031 feet per foot to the southwest. The dissolved phase contaminant plume was undefined in the down-gradient direction to the southwest and up-gradient to the northeast.

DELIVERABLE 1 – FINAL REMEDIATION PLAN / ENGINEERING PLANS AND SPECIFICATIONS

The proposed technologies for site remediation include: excavation and disposal of petroleum contaminated soil (PCS) from the Fairview Station property including construction of a barrier wall system, drilling multiple horizontal wells beneath Calle Ranchitos and Dairy Queen property to be used as fluids extraction and soil vapor extraction (SVE) wells, and multiphase extraction via the horizontal wells using equipment located on the Fairview Station property to remove NAPL and reduce groundwater contamination concentrations. After NAPL has been removed from the site and multiphase extraction is no longer cost effective, the groundwater collection system will be converted to a passive pass-through system. Air sparging and/or chemical nutrient injection will likely be conducted in the collector sump to enhance bioremediation.

SMA proposes to prepare and submit three copies of a Final Remediation Plan (FRP) including engineering plans & specifications (P&S). The FRP will meet all requirements of the New Mexico Petroleum Storage Tank Regulations (20.5.119.1923 A, B, C, D, and E NMAC). It will include those items outlined in this workplan, the goals of remediation, an implementation schedule, a contingency plan, copies of all required permits, disposal information for removed media, and information pertaining to public notice.

Per 20.5.119.1923 Subsections D(5) and E NMAC, the FRP will include engineered plans and specifications (P&S), which will be reviewed and sealed by a New Mexico licensed professional engineer. The P&S document will include:

- A site map with utilities, structures (such as buildings and monitoring wells), contamination

sources, and extent and magnitude of contamination drawn at a scale of 1" = 40'

- A cross-sections showing contaminant mass in relation to the remediation systems
- A topographic map showing the site in relation to existing and likely future receptors

The P&S documents will also address:

- A complete and definitive engineering design for all aspects of the mechanical/electrical ("active") remediation systems
- Process and instrumentation diagrams
- Mechanical plans and elevations
- Details for system well construction
- Excavation plans including shoring and barrier wall design and specifications
- Traffic plans indicating material storage areas, truck loading and passageways
- Instrumentation and telemetry plan and equipment
- Detailed mechanical equipment list with specifications, and operation and maintenance information
- Additional detail drawings regarding system construction such as trenching, traffic control, asphalt/concrete repair & replacement, site security, subsurface system location, and property restoration

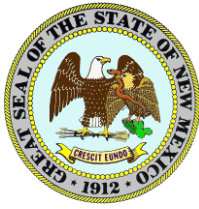
The design and engineering of the project will be completed by SMA with additional subcontracted design and engineering for the barrier wall system and electrical/telemetry system. The barrier wall system will be designed and engineered with assistance from NKE Engineering (NKE), Littleton, Colorado (nkeengineering.com). Sam Otero, P.E. will be the primary NKE engineer designing the barrier wall system. NKE has experience designing similar barrier wall systems installed for utility corridors, transportation and landfills. SMA has previously worked with NKE Engineering on a similar wall system design. An SMA P.E. licensed in New Mexico will supervise and review the design provided by NKE. The subcontracted design and engineering of the electrical and telemetry systems will be completed by The Response Group (TRG), Albuquerque, New Mexico. SMA routinely works with TRG for electrical engineering and telemetry system design for water and wastewater systems. TRG has electrical engineers with New Mexico P.E.s and will stamp applicable electrical plans.

Permitting activities for the proposed remediation system include, at a minimum, submittal of a Notice of Intent to the Air Quality Bureau of the NMED. In the event that an individual air quality permit is required, SMA may request a change order for additional cost for the permitting. Right-of-way work/traffic control permit will likely be required from the New Mexico Department of Transportation given the proximity of the excavation to the right-of-way. A traffic permit may also be required from the City of Española for work near and under Calle Ranchitos. The extraction of groundwater for treatment and disposal will require a permit to appropriate groundwater (WR-05) from the New Mexico Office of the State Engineer. The remediation strategy includes a transition from extraction and discharge of treated water to treatment of groundwater passing through the barrier wall system. This treatment will likely include injection of chemical nutrients to enhance bioremediation. This chemical injection into groundwater will require an Underground Injection Control General Discharge Permit from NMED Ground Water Quality Bureau.

COSTS

Costs for this work plan were developed using a lump sum/unit sum format. A payment schedule listing the specific deliverable from this work plan is provided in the table below. SMA will invoice upon submission of the deliverable.

Lump Sum / Unit Sum Cost Summary Fairview Station, Española, New Mexico				
Deliverable	Description	Anticipated Number of Units	Cost/Unit incl. 8.4375% Gross Receipts Tax	Task Subtotal
1	Final Remediation Plan, Engineering Plans and Specifications	1	\$56,160.00	\$56,160.00
	Subcontracted Engineering - Barrier Wall System Engineering and Design: NKE Engineering	1	\$9,353.00	\$9,353.00
	Subcontracted Engineering - Electrical and Telemetry Engineering and Design: The Response Group, Inc.	1	\$8,106.00	\$8,106.00
	Groundwater Modeling and Dewatering Analysis	1	\$13,104.00	\$13,104.00
	Permitting: NMDOT Utility & Traffic Control, NMED AQB Notice of Intent, NMED GWQB Underground Injection Control, NMOSE Notice of Intent to Appropriate Groundwater, City of Española Utilities	1	\$8,675.00	\$8,675.00
	Site Topologic Survey	1	\$8,651.00	\$8,651.00
			Project Total	\$104,049.00



**NEW MEXICO
ENVIRONMENT DEPARTMENT**



Petroleum Storage Tank Bureau

Michelle Lujan Grisham
Governor

2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313
Phone (505) 476-4397 Fax (505) 476-4374
www.env.nm.gov

James C. Kenney
Cabinet Secretary

Howie C. Morales
Lt. Governor

Jennifer J. Pruett
Deputy Secretary

May 21, 2020

Mr. Alan Eschenbacher
Souder, Miller & Associates
alan.eschenbacher@soudermiller.com

Re: Approval of an Extension of Time from the Initially Approved Corrective Action Deadline for Phase 3 Activities at Fairview Station, 1626 North Riverside Drive, Española, New Mexico

Facility #: 28779 Release ID #: 4657 WPID #: 4093
Contract #: 18-667-3200-0009

Dear Mr. Eschenbacher:

The New Mexico Environment Department (Department) has reviewed a request for extension of time dated May 13, 2020 for the deadline previously approved by the Department in the correspondence dated February 19, 2020. The time extension of 90 days was requested for final remediation plan (FRP) development due to continued work with the City of Española on approval of discharge of water from the remediation system to the city sanitary sewer and continued work on remediation system costs, which are difficult to obtain given the shutdown for COVID-19.

The request for extension of time is approved. The new deadline is:

<u>Deliverable Name</u>	<u>Previous Estimated Date of Deliverable</u>	<u>New Estimated Date of Deliverable</u>	<u>Deliverable ID</u>
FRP Development Including Public Notice	05/14/2020	08/12/2020	4093-1

Mr. Alan Eschenbacher
May 21, 2020
Page 2

Requests for extensions must be made in accordance with 20.5.119.1931 NMAC. If you have any questions, please contact me at the above address or by telephone at (505) 372-8153 or by email at susan.vongonten@state.nm.us.

Sincerely,

Susan von Gonten, C.P.G.
Project Manager
Petroleum Storage Tank Bureau

SvG:tn

cc: Scott McKittrick, Souder, Miller & Associates (via email)
Stacy Ulrich, Souder, Miller & Associates (via email)
Lucille M. Roybal (via email)
Lorena Goerger, Manager, Remedial Action Program (via email)
Katherine MacNeil, P.E. Environmental Engineer (via email)
PSTB Master File Santa Fe



**NEW MEXICO
ENVIRONMENT DEPARTMENT**



SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lt. Governor

2905 Rodeo Park Drive East
Building 1
Santa Fe, New Mexico 87505-6313
Phone (505) 476-4397 Fax (505) 476-4374
www.env.nm.gov

BUTCH TONGATE
Cabinet Secretary
J. C. BORREGO
Deputy Secretary

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

May 18, 2018

Miller Engineers Inc. dba Souder, Miller & Associates
Reid S. Allan, Senior Vice President
5454 Venice Avenue NE, Suite D
Albuquerque, NM 87113
reid.allan@soudermiller.com

RE: Professional Services and Emergency Response RFP #18-667-3200-0018

Dear Mr. Allan:

The New Mexico Environment Department would like to thank you for your response to the request for proposals (RFP) for Professional Services and Emergency Response. The Department has evaluated the proposals received. Several good proposals were received and your firm was selected as a finalist for this request for proposal.

This letter is to advise you that on May 2, 10, 11, 15, & 16, 2018, contracts were awarded to AECOM Technical Services, Inc., Animas Environmental Services, LLC, Daniel B. Stephens & Associates, Inc., EA Engineering, Science, and Technology, Inc., PBC, Haller & Associates, Inc., INTERA Incorporated, Miller Engineers, Inc. dba Souder, Miller & Associates, and Western Technologies Inc. as a result of the referenced procurement. The protest period shall expire at the close of business on June 2, 2018.

On behalf of the Petroleum Storage Tank Bureau and the Evaluation Committee, I want to express my sincere appreciation to you and the other members of your company for the time and effort taken to participate in this important procurement. Enclosed is a signed copy of your contract #18 667 3200 0017.

Sincerely,

Jim Gibb
Geoscientist Supervisor, Remedial Action Program
Petroleum Storage Tank Bureau

Enclosure: Contract #18 667 3200 0017

Certification Number: 7014 2120 0004 6264 2069

STATE OF NEW MEXICO
NEW MEXICO ENVIRONMENT DEPARTMENT
PROFESSIONAL SERVICES CONTRACT # 18 667 3200 0017

THIS AGREEMENT is made and entered into by and between the State of NEW MEXICO, ENVIRONMENT DEPARTMENT, hereinafter referred to as the "Agency," and SOUDER MILLER & ASSOCIATES, hereinafter referred to as the "Contractor," and is effective as of the date set forth below upon which it is executed by the Department of Finance and Administration (DFA).

IT IS AGREED BETWEEN THE PARTIES:

1. **Scope of Work.**

The Contractor shall perform the following work:

The Contractor shall provide professional services required to conduct investigations, emergency responses and other services at leaking petroleum storage tank sites where threats to the public health or the environment exist and/or where public or private water supplies are threatened by petroleum hydrocarbon releases from leaking petroleum storage tank systems. Additional professional services may be required by the Agency during the life of the contract.

Contractor shall submit workplans for work under this Agreement at the request of the Agency, which must be approved in writing by the Agency representatives possessing Signatory Authority as designated by Agency policy prior to the start date of the workplan. The workplan shall be prepared and approved, and the work completed, pursuant to the New Mexico Petroleum Storage Tank Regulations and Corrective Action Fund Payment and Reimbursement Regulations. If there are any inconsistencies between a workplan and this Agreement, this Agreement shall govern.

Any workplan amendments must also be approved in writing by the Agency representatives possessing Signatory Authority as designated by the Agency policy in effect on the date of the amendment. No person other than the person possessing Signatory Authority has actual or apparent authority to amend, modify or change the workplan in any manner. Any written amendment to the workplan signed by a person not possessing Signatory Authority is void and unenforceable.

2. **Compensation.**

A. The Agency shall pay to the Contractor in full payment for services satisfactorily performed, based on deliverables and costs approved through negotiated workplans, such compensation not to exceed **\$2,000,000.00**, including gross receipts tax. The New Mexico gross receipts tax levied on the amounts payable under this Agreement shall be paid by the Agency to the Contractor. The total amount payable to the Contractor under this Agreement,

including gross receipts tax and expenses, shall not exceed **\$2,000,000.00**. This amount is a maximum and not a guarantee that the work assigned to be performed by Contractor under this Agreement shall equal the amount stated herein. The parties do not intend for the Contractor to continue to provide services without compensation when the total compensation amount is reached. Contractor is responsible for notifying the Agency when the services provided under this Agreement reach the total compensation amount. In no event will the Contractor be paid for services provided in excess of the total compensation amount without this Agreement being amended in writing prior to those services in excess of the total compensation amount being provided.

B. The Contractor must submit a detailed report of deliverable(s) accomplished as set forth in the workplan approval letter(s). The Agency will assess the quality of the deliverable(s) and determine, at a minimum, that the deliverable(s) complies with the deliverable requirements as defined in the scope of work and the terms and conditions of the Agreement and meets the performance measures for the deliverable(s). If the Agency finds that the completed work is acceptable, it shall issue a written or electronic certification of acceptance of the work. If the Agency finds that the services are deficient or not acceptable, it shall within 30 days after the date of receipt of written notice from the Contractor that work has been completed, provide the Contractor a written or electronic notice of exception explaining the defect or objection to the services, and outlining steps the Contractor may take to remedy the defect. Upon receipt of a claim and certification by the Agency that the work has been received and accepted, payment shall be tendered to the Contractor within sixty days of receipt of claim submittal and in accordance with the New Mexico Petroleum Storage Tank Regulations (20.5 NMAC). If payment is made by mail, the payment shall be deemed tendered on the date it is postmarked.

3. **Term.**

THIS AGREEMENT SHALL NOT BECOME EFFECTIVE UNTIL APPROVED BY THE DFA. This Agreement shall terminate four years from the date of signature by DFA unless terminated pursuant to paragraph 4 (Termination), or paragraph 5 (Appropriations). In accordance with NMSA 1978, § 13-1-150, no contract term for a professional services contract, including extensions and renewals, shall exceed four years, except as set forth in NMSA 1978, § 13-1-150.

4. **Termination.**

A. **Grounds.** The Agency may terminate this Agreement for convenience or cause. The Contractor may only terminate this Agreement based upon the Agency's uncured, material breach of this Agreement.

B. **Notice; Agency Opportunity to Cure.**

1. Except as otherwise provided in Paragraph (4)(B)(3), the Agency shall give Contractor written notice of termination at least thirty (30) days prior to the intended date of termination.
2. Contractor shall give Agency written notice of termination at least thirty (30) days prior to the intended date of termination, which notice shall (i) identify all the Agency's material breaches of this Agreement upon which the termination

is based and (ii) state what the Agency must do to cure such material breaches. Contractor's notice of termination shall only be effective (i) if the Agency does not cure all material breaches within the thirty (30) day notice period or (ii) in the case of material breaches that cannot be cured within thirty (30) days, the Agency does not, within the thirty (30) day notice period, notify the Contractor of its intent to cure and begin with due diligence to cure the material breach.

3. Notwithstanding the foregoing, this Agreement may be terminated immediately upon written notice to the Contractor (i) if the Contractor becomes unable to perform the services contracted for, as determined by the Agency; (ii) if, during the term of this Agreement, the Contractor is suspended or debarred by the State Purchasing Agent; or (iii) the Agreement is terminated pursuant to Paragraph 5, "Appropriations", of this Agreement.

C. Liability. Except as otherwise expressly allowed or provided under this Agreement, the Agency's sole liability upon termination shall be to pay for acceptable work performed prior to the Contractor's receipt or issuance of a notice of termination; provided, however, that a notice of termination shall not nullify or otherwise affect either party's liability for pre-termination defaults under or breaches of this Agreement. The Contractor shall submit an invoice for such work within thirty (30) days of receiving or sending the notice of termination. *THIS PROVISION IS NOT EXCLUSIVE AND DOES NOT WAIVE THE AGENCY'S OTHER LEGAL RIGHTS AND REMEDIES CAUSED BY THE CONTRACTOR'S DEFAULT/BREACH OF THIS AGREEMENT.*

D. Termination Management. Immediately upon receipt by either the Agency or the Contractor of notice of termination of this Agreement, the Contractor shall: 1) not incur any further obligations for salaries, services or any other expenditure of funds under this Agreement without written approval of the Agency; 2) comply with all directives issued by the Agency in the notice of termination as to the performance of work under this Agreement; and 3) take such action as the Agency shall direct for the protection, preservation, retention or transfer of all property titled to the Agency and records generated under this Agreement. Any non-expendable personal property or equipment provided to or purchased by the Contractor with contract funds shall become property of the Agency upon termination and shall be submitted to the agency as soon as practicable.

5. Appropriations.

The terms of this Agreement are contingent upon sufficient appropriations and authorization being made by the Legislature of New Mexico for the performance of this Agreement. If sufficient appropriations and authorization are not made by the Legislature, this Agreement shall terminate immediately upon written notice being given by the Agency to the Contractor. The Agency's decision as to whether sufficient appropriations are available shall be accepted by the Contractor and shall be final. If the Agency proposes an amendment to the Agreement to unilaterally reduce funding, the Contractor shall have the option to terminate the Agreement or to agree to the reduced funding, within thirty (30) days of receipt of the proposed amendment.

6. Status of Contractor.

The Contractor and its agents and employees are independent contractors performing professional services for the Agency and are not employees of the State of New Mexico. The Contractor and its agents and employees shall not accrue leave, retirement, insurance, bonding, use of state vehicles, or any other benefits afforded to employees of the State of New Mexico as a result of this Agreement. The Contractor acknowledges that all sums received hereunder are reportable by the Contractor for tax purposes, including without limitation, self-employment and business income tax. The Contractor agrees not to purport to bind the State of New Mexico unless the Contractor has express written authority to do so, and then only within the strict limits of that authority.

7. Assignment.

The Contractor shall not assign or transfer any interest in this Agreement or assign any claims for money due or to become due under this Agreement without the prior written approval of the Agency.

8. Subcontracting.

The Contractor shall not subcontract any portion of the services to be performed under this Agreement without the prior written approval of the Agency. No such subcontract shall relieve the primary Contractor from its obligations and liabilities under this Agreement, nor shall any subcontract obligate direct payment from the Procuring Agency.

9. Release.

Final payment of the amounts due under this Agreement shall operate as a release of the Agency, its officers and employees, and the State of New Mexico from all liabilities, claims and obligations whatsoever arising from or under this Agreement.

10. Confidentiality.

Any confidential information provided to or developed by the Contractor in the performance of this Agreement shall be kept confidential and shall not be made available to any individual or organization by the Contractor without the prior written approval of the Agency.

11. Product of Service -- Copyright.

All materials developed or acquired by the Contractor under this Agreement shall become the property of the State of New Mexico and shall be delivered to the Agency no later than the termination date of this Agreement. Nothing developed or produced, in whole or in part, by the Contractor under this Agreement shall be the subject of an application for copyright or other claim of ownership by or on behalf of the Contractor.

12. Conflict of Interest: Governmental Conduct Act.

A. The Contractor represents and warrants that it presently has no interest and, during the term of this Agreement, shall not acquire any interest, direct or indirect, which would conflict in any manner or degree with the performance or services required under the Agreement.

B. The Contractor further represents and warrants that it has complied with, and, during the term of this Agreement, will continue to comply with, and that this Agreement complies with all applicable provisions of the Governmental Conduct Act, Chapter 10, Article 16 NMSA 1978. Without in anyway limiting the generality of the foregoing, the Contractor specifically represents and warrants that:

1) in accordance with NMSA 1978, § 10-16-4.3, the Contractor does not employ, has not employed, and will not employ during the term of this Agreement any Agency employee while such employee was or is employed by the Agency and participating directly or indirectly in the Agency's contracting process;

2) this Agreement complies with NMSA 1978, § 10-16-7(A) because (i) the Contractor is not a public officer or employee of the State; (ii) the Contractor is not a member of the family of a public officer or employee of the State; (iii) the Contractor is not a business in which a public officer or employee or the family of a public officer or employee has a substantial interest; or (iv) if the Contractor is a public officer or employee of the State, a member of the family of a public officer or employee of the State, or a business in which a public officer or employee of the State or the family of a public officer or employee of the State has a substantial interest, public notice was given as required by NMSA 1978, § 10-16-7(A) and this Agreement was awarded pursuant to a competitive process;

3) in accordance with NMSA 1978, § 10-16-8(A), (i) the Contractor is not, and has not been represented by, a person who has been a public officer or employee of the State within the preceding year and whose official act directly resulted in this Agreement and (ii) the Contractor is not, and has not been assisted in any way regarding this transaction by, a former public officer or employee of the State whose official act, while in State employment, directly resulted in the Agency's making this Agreement;

4) this Agreement complies with NMSA 1978, § 10-16-9(A) because (i) the Contractor is not a legislator; (ii) the Contractor is not a member of a legislator's family; (iii) the Contractor is not a business in which a legislator or a legislator's family has a substantial interest; or (iv) if the Contractor is a legislator, a member of a legislator's family, or a business in which a legislator or a legislator's family has a substantial interest, disclosure has been made as required by NMSA 1978, § 10-16-7(A), this Agreement is not a sole source or small purchase contract, and this Agreement was awarded in accordance with the provisions of the Procurement Code;

5) in accordance with NMSA 1978, § 10-16-13, the Contractor has not directly participated in the preparation of specifications, qualifications or evaluation criteria for this Agreement or any procurement related to this Agreement; and

6) in accordance with NMSA 1978, § 10-16-3 and § 10-16-13.3, the Contractor has not contributed, and during the term of this Agreement shall not contribute, anything of value to a public officer or employee of the Agency.

C. Contractor's representations and warranties in Paragraphs A and B of this Article 12 are material representations of fact upon which the Agency relied when this Agreement was entered into by the parties. Contractor shall provide immediate written notice to the Agency if, at any time during the term of this Agreement, Contractor learns that Contractor's

representations and warranties in Paragraphs A and B of this Article 12 were erroneous on the effective date of this Agreement or have become erroneous by reason of new or changed circumstances. If it is later determined that Contractor's representations and warranties in Paragraphs A and B of this Article 12 were erroneous on the effective date of this Agreement or have become erroneous by reason of new or changed circumstances, in addition to other remedies available to the Agency and notwithstanding anything in the Agreement to the contrary, the Agency may immediately terminate the Agreement.

D. All terms defined in the Governmental Conduct Act have the same meaning in this Article 12(B).

13. Amendment.

A. This Agreement shall not be altered, changed or amended except by instrument in writing executed by the parties hereto and all other required signatories.

B. If the Agency proposes an amendment to the Agreement to unilaterally reduce funding due to budget or other considerations, the Contractor shall, within thirty (30) days of receipt of the proposed Amendment, have the option to terminate the Agreement, pursuant to the termination provisions as set forth in Article 4 herein, or to agree to the reduced funding.

14. Merger.

This Agreement incorporates all the Agreements, covenants and understandings between the parties hereto concerning the subject matter hereof, and all such covenants, Agreements and understandings have been merged into this written Agreement. No prior Agreement or understanding, oral or otherwise, of the parties or their agents shall be valid or enforceable unless embodied in this Agreement.

15. Penalties for violation of law.

The Procurement Code, NMSA 1978 §§ 13-1-28 through 13-1-199, imposes civil and criminal penalties for its violation. In addition, the New Mexico criminal statutes impose felony penalties for illegal bribes, gratuities and kickbacks.

16. Equal Opportunity Compliance.

The Contractor agrees to abide by all federal and state laws and rules and regulations, and executive orders of the Governor of the State of New Mexico, pertaining to equal employment opportunity. In accordance with all such laws of the State of New Mexico, the Contractor assures that no person in the United States shall, on the grounds of race, religion, color, national origin, ancestry, sex, age, physical or mental handicap, or serious medical condition, spousal affiliation, sexual orientation or gender identity, be excluded from employment with or participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity performed under this Agreement. If Contractor is found not to be in compliance with these requirements during the life of this Agreement, Contractor agrees to take appropriate steps to correct these deficiencies.

17. **Applicable Law.**

The laws of the State of New Mexico shall govern this Agreement, without giving effect to its choice of law provisions. Venue shall be proper only in a New Mexico court of competent jurisdiction in accordance with NMSA 1978, § 38-3-1 (G). By execution of this Agreement, Contractor acknowledges and agrees to the jurisdiction of the courts of the State of New Mexico over any and all lawsuits arising under or out of any term of this Agreement.

18. **Workers Compensation.**

The Contractor agrees to comply with state laws and rules applicable to workers compensation benefits for its employees. If the Contractor fails to comply with the Workers Compensation Act and applicable rules when required to do so, this Agreement may be terminated by the Agency.

19. **Records and Financial Audit.**

The Contractor shall maintain detailed time and expenditure records that indicate the date; time, nature and cost of services rendered during the Agreement's term and effect and retain them for a period of three (3) years from the date of final payment under this Agreement. The records shall be subject to inspection by the Agency, the Department of Finance and Administration and the State Auditor. The Agency shall have the right to audit billings both before and after payment. Payment under this Agreement shall not foreclose the right of the Agency to recover excessive or illegal payments

20. **Indemnification.**

The Contractor shall defend, indemnify and hold harmless the Agency and the State of New Mexico from all actions, proceeding, claims, demands, costs, damages, attorneys' fees and all other liabilities and expenses of any kind from any source which may arise out of the performance of this Agreement, caused by the negligent act or failure to act of the Contractor, its officers, employees, servants, subcontractors or agents, or if caused by the actions of any client of the Contractor resulting in injury or damage to persons or property during the time when the Contractor or any officer, agent, employee, servant or subcontractor thereof has or is performing services pursuant to this Agreement. In the event that any action, suit or proceeding related to the services performed by the Contractor or any officer, agent, employee, servant or subcontractor under this Agreement is brought against the Contractor, the Contractor shall, as soon as practicable but no later than two (2) days after it receives notice thereof, notify the legal counsel of the Agency and the Risk Management Division of the New Mexico General Services Department by certified mail.

21. **New Mexico Employees Health Coverage.**

A. If Contractor has, or grows to, six (6) or more employees who work, or who are expected to work, an average of at least 20 hours per week over a six (6) month period during the term of the contract, Contractor certifies, by signing this agreement, to have in place, and agree to maintain for the term of the contract, health insurance for those employees and offer that health insurance to those employees if the expected annual value in the aggregate of any and all contracts between Contractor and the State exceed \$250,000 dollars.

B. Contractor agrees to maintain a record of the number of employees who have (a) accepted health insurance; (b) declined health insurance due to other health insurance coverage already in place; or (c) declined health insurance for other reasons. These records are subject to review and audit by a representative of the state.

C. Contractor agrees to advise all employees of the availability of State publicly financed health care coverage programs by providing each employee with, as a minimum, the following web site link to additional information: <http://insurenemexico.state.nm.us/>.

22. Employee Pay Equity Reporting.

Contractor agrees if it has ten (10) or more New Mexico employees OR eight (8) or more employees in the same job classification, at any time during the term of this contract, to complete and submit the PE10-249 form on the annual anniversary of the initial report submittal for contracts up to one (1) year in duration. If contractor has (250) or more employees contractor must complete and submit the PE250 form on the annual anniversary of the initial report submittal for contracts up to one (1) year in duration. For contracts that extend beyond one (1) calendar year, or are extended beyond one (1) calendar year, contractor also agrees to complete and submit the PE10-249 or PE250 form, whichever is applicable, within thirty (30) days of the annual contract anniversary date of the initial submittal date or, if more than 180 days has elapsed since submittal of the last report, at the completion of the contract, whichever comes first. Should contractor not meet the size requirement for reporting at contract award but subsequently grows such that they meet or exceed the size requirement for reporting, contractor agrees to provide the required report within ninety (90 days) of meeting or exceeding the size requirement. That submittal date shall serve as the basis for submittals required thereafter. Contractor also agrees to levy this requirement on any subcontractor(s) performing more than 10% of the dollar value of this contract if said subcontractor(s) meets, or grows to meet, the stated employee size thresholds during the term of the contract. Contractor further agrees that, should one or more subcontractor not meet the size requirement for reporting at contract award but subsequently grows such that they meet or exceed the size requirement for reporting, contractor will submit the required report, for each such subcontractor, within ninety (90 days) of that subcontractor meeting or exceeding the size requirement. Subsequent report submittals, on behalf of each such subcontractor, shall be due on the annual anniversary of the initial report submittal. Contractor shall submit the required form(s) to the State Purchasing Division of the General Services Department, and other departments as may be determined, on behalf of the applicable subcontractor(s) in accordance with the schedule contained in this paragraph. Contractor acknowledges that this subcontractor requirement applies even though contractor itself may not meet the size requirement for reporting and be required to report itself.

Notwithstanding the foregoing, if this Contract was procured pursuant to a solicitation, and if Contractor has already submitted the required report accompanying their response to such solicitation, the report does not need to be re-submitted with this Agreement.

23. Invalid Term or Condition.

If any term or condition of this Agreement shall be held invalid or unenforceable, the remainder of this Agreement shall not be affected and shall be valid and enforceable.

24. Enforcement of Agreement.

A party's failure to require strict performance of any provision of this Agreement shall not waive or diminish that party's right thereafter to demand strict compliance with that or any other provision. No waiver by a party of any of its rights under this Agreement shall be effective unless express and in writing, and no effective waiver by a party of any of its rights shall be effective to waive any other rights.

25. Notices.

Any notice required to be given to either party by this Agreement shall be in writing and shall be delivered in person, by courier service or by U.S. mail, either first class or certified, return receipt requested, postage prepaid, as follows:

To the Agency:

Jim Gibb, Reimbursement Section Manager
New Mexico Environment Department
Petroleum Storage Tank Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505
jim.gibb@state.nm.us


To the Contractor:

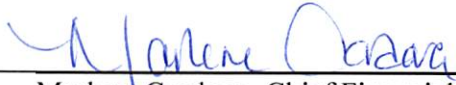
Reid S. Allan, Senior Vice President
Souder Miller & Associates
5454 Venice Ave. NE, Suite D
Albuquerque, NM 87113
reid.allan@soudermiller.com
505-325-7535

26. Authority.

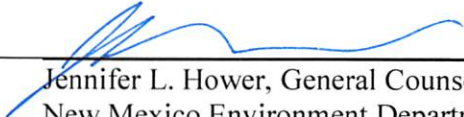
If Contractor is other than a natural person, the individual(s) signing this Agreement on behalf of Contractor represents and warrants that he or she has the power and authority to bind Contractor, and that no further action, resolution, or approval from Contractor is necessary to enter into a binding contract.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the date of signature by the DFA Contracts Review Bureau below.


By:  Date: 4/30/18
Butch Tongate, Cabinet Secretary
New Mexico Environment Department

By:  Date: 4/26/18
Marlene Cordova, Chief Financial Officer
New Mexico Environment Department

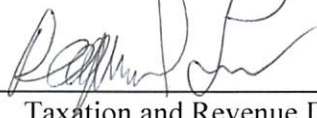
Certifying legal sufficiency:

By:  Date: 4/30/18
Jennifer L. Hower, General Counsel
New Mexico Environment Department

Contractor:

By:  Date: 04/06/18
Reid S. Allan, Senior Vice President
Souder Miller & Associates

The records of the Taxation and Revenue Department reflect that the Contractor is registered with the Taxation and Revenue Department of the State of New Mexico to pay gross receipts and compensating taxes.

ID Number: 02-040132-00-9 Taxation and Revenue is only verifying the registration and will not confirm or deny taxability statements contained in this contract.
By:  Date: 5/1/18
Taxation and Revenue Department

This Agreement has been approved by the DFA Contracts Review Bureau:

By:  Date: 5/15/18
DFA Contracts Review Bureau

1/2/12

Michael J. ...

1/2/12

Michael J. ...

1/2/12

Michael J. ...

Information and Revenue is only verified by the registration
and will not continue to be used for any other purposes
contained in this contract.

1/2/12

Michael J. ...