



APPENDIX F

Comparison of SBA Wellhead Treatment Approaches for Centralized Regeneration



Three different approaches were evaluated for SBA with centralized regeneration, including:

1. Ion Exchange Trailers
2. Fixed Ion Exchange Vessels with Resin Transport
3. Mobile Ion Exchange Vessels

Additional details comparing each option are provided in Appendix XX. Discussion that follows provides a summary of the analysis.

Ion Exchange Trailers

This approach includes road-worthy trailers that contain a number of ion exchange vessels, interconnecting piping and valves are arranged fixed inside an insulated and heated semi-trailer box.

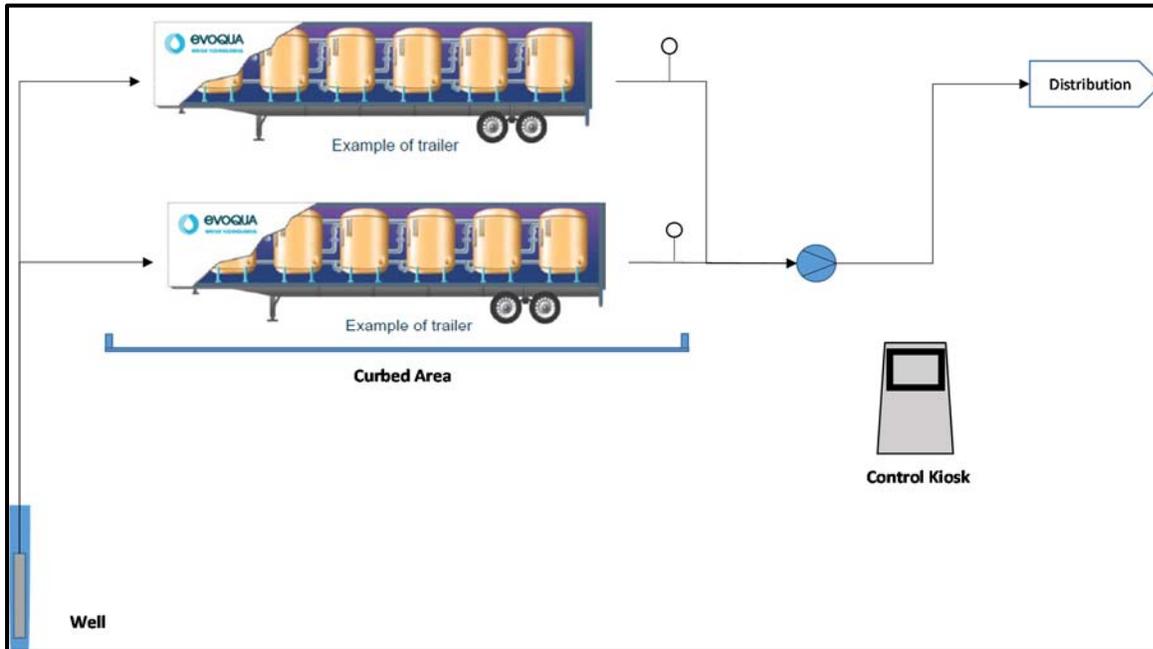
Figure 1 provides example photos of a trailer approach.



Figure 1. Example of Ion Exchange Trailers

The trailers can be based on standard designs that are currently used by a number of companies such as Evoqua (formerly Siemens) among others. Commonly mobile trailers are applied to address temporary plant shut downs and maintenance of permanent water treatment systems.

The trailers are driven to site by road tractor, and situated on curbed concrete hardstand (Figure 2). Once on site, the vessels are connected to system pipework that is located at each well treatment site. The pipework connects the vessels to the well pump, which provides driving pressure through the resin and an inlet strainer (bag filter) to remove any sand or debris from the wells. If required, additional pumping could be provided to yield sufficient head to meet distribution system requirements. The water is disinfected as currently done at each well site.



Note: Bag filters, disinfection, and pH adjustment are not shown.

Figure 2. Typical Configuration of an Ion Exchange Trailer

When the resin is exhausted at the well site and requires regeneration, the pipework would be disconnected and the trailer reconnected to the road tractor and taken to a centralized regeneration facility.

The potential advantages of providing a standard mobile trailer capacity were compared with trailers tailored to individual treatment sites. Mobile trailers could be constructed identically for simplicity and consistency of design, with 20 vessels in each trailer providing a capacity of up to 1,400 gpm per trailer. Wellhead sites would have either one or two trailers depending on the necessary treatment capacity, which is a function of Cr6 concentration. Other advantages of a standard trailer capacity include maximum flexibility in use of trailers at different sites and redundancy in equipment.

Fixed Ion Exchange Vessels with Resin Transport

Another SBA approach with central regeneration is fixed ion exchange vessels at each well site, with resin removed from the vessels and transported offsite for regeneration. With this approach, either one or two fixed ion exchange vessels would be located at each well treatment site along with necessary instrumentation, interconnecting pipework, and components. Resin would be removed from the vessels by sluicing, transported by tanker truck to a central regeneration facility, and then returned to the



vessels. A typical 12 foot diameter vessel, such as that shown in Figure 3, holds up to 600 ft³ of resin (depending on the amount of freeboard desired, if backwashing capability is planned).

Water can be driven through the vessels via the well head pump, which provides driving pressure through the resin. Bag filters (strainers) are commonly used to remove any sand or debris from the wells and protect the ion exchange resin. If required, additional pumping could be provided to yield sufficient head to meet distribution system requirements. The water is disinfected as currently done at each well site.



Figure 3. Typical 12-foot Diameter Resin Vessels

When resin regeneration is required, a resin transport tanker will be driven to site by a resin transfer operators. The tanker will be positioned on a curbed concrete hard stand area adjacent to the fixed vessels (Figure 4). A combination of water and compressed air can be used to sluice the resin from the vessels into the tanker, or an alternative approach such as peristaltic pumping may be used. The motive water requirements would be provided at the well treatment site with compressed air provided by a truck mounted compressor. The water required for sluicing is drained from both the vessels and the tanker at each site.

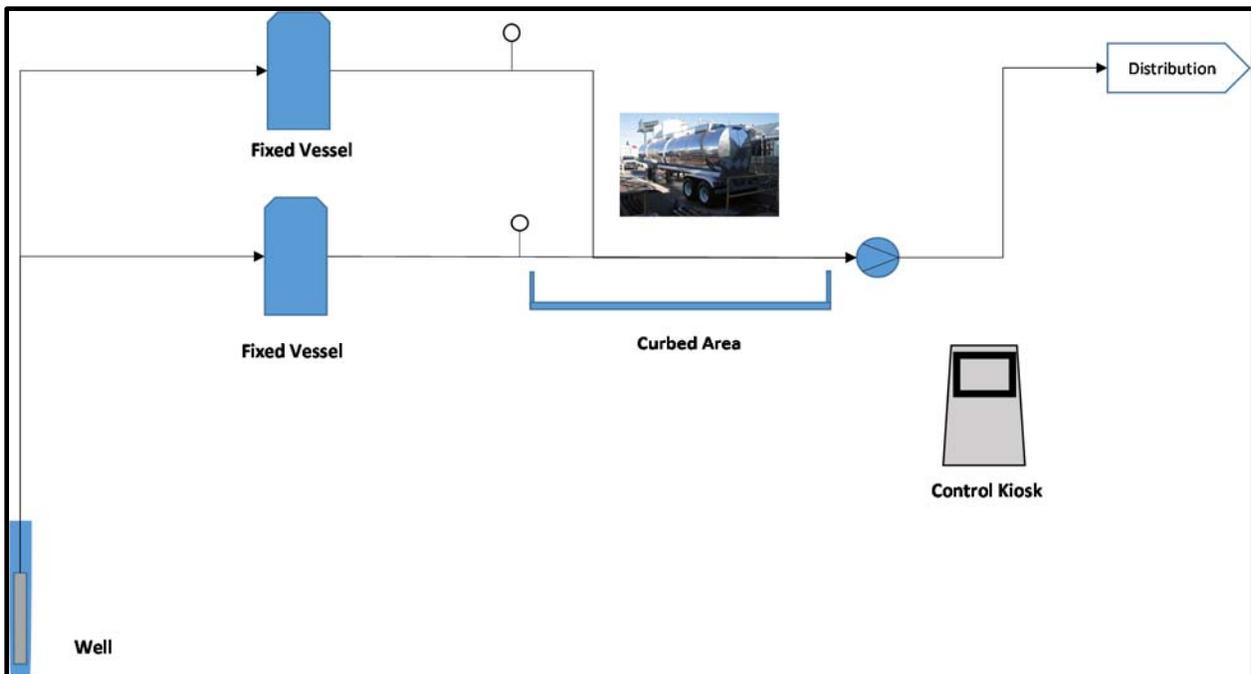
The sluicing truck may be compartmentalized, with a freshly regenerated volume arriving with the truck to replace resin that is taken away for regeneration. Pending regulatory approval of moving resin between different sites, this will provide significant flexibility and minimize downtime during high demand periods.

In July 2014, CVWD along with Hazen and Sawyer observed a sluicing operation conducted by Purolite at a fixed ion exchange vessel site in Pomona, CA. The crew consisted of 3 people, with one supervisor and two operators. A review of the steps in the process and approximate times is shown in Table 1.



Table 1. Approximate Time Required for Resin Sluicing and Fills, Pomona, CA

Task	Time Required
Arrive and Set Up	45 min
Removal of Resin from Vessels	15 min
Clean and Inspect Vessel/Dewater Resin	2 hours
Refill Resin (Fresh Resin)	15 mins (estimated)
Final Clean up and Depart Site	45 mins (estimated)



Note: Bag filters, disinfection, and pH adjustment are not shown.

Figure 4. Typical Configuration of a Fixed Ion Exchange Vessel Configuration

Mobile Vessels

A third option considered in this analysis was the use of mobile ion exchange vessels. A larger number of small individual vessels would be transported to site on a flat-bed truck and put into place by forklift (Figure 5). This option would operate similar to a “swap and go” operation in which vessels with exhausted resin are replaced with fresh vessels while the exhausted vessels are sent for regeneration. An example vessel size for mobile vessels is 3.5 ft diameter, holding 42 ft³ of resin, which can be transported onto and off of the truck using a forklift. The number of vessels at each site could be customized, and was estimated to range from 5 to 12 vessels per site depending on the treatment flow rate.



Water can be driven through the vessels via the well head pump, which provides driving pressure through the resin. Bag filters (strainers) are commonly used to remove any sand or debris from the wells and protect the ion exchange resin. If required, additional pumping could be provided to yield sufficient head to meet distribution system requirements. The water is disinfected as currently done at each well site.



Figure 5. Example of Mobile Ion Exchange System

When resin regeneration is required at a site, a flatbed truck will be driven to site by operators. The flatbed would be positioned a driveway area adjacent to the fixed vessels. Vessels would be picked up by forklift, placed on the truck, and brought to the regeneration facility where resin. Vessel manufacturers recommended removing the resin and performing regeneration in separate vessels to prolong resin contactor life. Once regenerated, the mobile vessels would be returned to the well site.

Comparison of SBA with Central Regeneration Options

Table 2 summarizes the relative pros and cons of each potential SBA approach with central regeneration.



Table 2. SBA with Central Regeneration Options Comparison

	Trailer	Fixed Vessels	Mobile Vessels
Level of Engineering Required	All trailers would be identical design for each site. Sizing would be matched with either one or two trailers depending on plant capacity requirements.	Plants will be either one or two fixed vessels. More site design will be required to accommodate systems.	Plants will be more tailored to capacity, and as a result there will be designs for between 7 and 12 vessel sites.
Resin Volume Matched to Capacity	Standard trailer design will result in overcapacity at some well sites. This results in higher capital costs, however longer operation between regenerations.	One or two fixed vessels would be used, resulting in better matching of size to capacity is possible.	Resin capacity is more closely matched to site requirements with a greater number of smaller vessels.
Handling at Regeneration	Trailers are disconnected and driven to the centralized regeneration site. Resin sluicing is only required at the centralized regeneration facility.	Resin must be sluiced from both at the site and at the regeneration facility.	Multiple smaller vessels will require more handling for vessel pick up and transport and more handling for resin transfer at the centralized facility.
Regeneration Event Frequency	Larger resin volumes will result in less frequent regenerations.	Larger resin volumes will result in less frequent regenerations.	Resin is better matched to capacity and as a result will require more frequent regenerations.
Trailer/Truck Permitting Licensing	Each trailer will require roadworthiness inspection, licensing and registration.	Sluicing trucks will require roadworthiness, licensing and registration; however there are a fewer number of trucks than trailers.	Flatbed trucks will require roadworthiness, licensing and registration; however there are a fewer number of trucks than trailers.
System Commonality	Trailer designs are identical with identical parts and spares.	Fixed vessels have two standard designs for use on site.	Mobile vessels are all identical; however each site will be tailored with a different number of vessels to match capacity.
Risk of Equipment in Transit	This option risks IX vessels and trailers during road transit.	This option only risks resin during road transit.	This option risks IX vessels during road transit.

Legend:



Most favored



Neutral



Less Favored



Cost estimates of each of these three approaches revealed that costs differed by approximately 15% among the options, which was within the +30%, -50% level of project development. Based on these estimates and the findings in Table 2, CVWD staff agreed that fixed vessels with resin transport was operationally preferred. Conceptual design was based on a fixed vessel approach for many of the well sites.