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Water Sector Supply Chain Issues and Lessons

Daniel Nix and Enoch Nicholson

During the COVID-19 pandemic, the Bachman Water Treatment Plant was one of many Texas facilities that had to find ways to minimize the effect of limited liquid oxygen supplies. *© 2022 City of Dallas Water Utilities*

Editor's note: *Having completed its inaugural Water Quality Matters column series focusing on the theme "Hot Topics in Water Quality," the AWWA Water Quality and Technology Division's committees look to extend the conversation by responding to a common question: What keeps your committee members up at night?*

Supply chain disruptions have become a common occurrence in the water sector during the COVID-19 pandemic. Early on, pandemic-related shortages in the United States and Canada included toilet paper, food, and other personal products and consumer goods. In 2021 and into 2022, we have experienced more widespread failures up and down the global supply chain. Multiple sectors have been strained from raw-material droughts, worker shortages, manufacturing plant failures, and transportation bottlenecks. Supply chain issues, compounded by inflation, are rippling through the water industry.

Widespread Concerns

According to an October 2021 AWWA COVID-19 water sector impact survey, 70% of utilities are facing supply chain issues for pipe and other infrastructure components, with 46% experiencing delays for electronic equipment and 45% seeing delays in availability of chemicals. The chemicals that utilities anticipate presenting the most supply difficulties are the disinfectants liquid chlorine and sodium hypochlorite.

Although there is room for optimism that these supply chain issues will be resolved, it might be the end of 2022 or early 2023 before things resemble pre-pandemic normalcy. Meanwhile, now that events over the past two years have exposed cracks in our normal supply chains, it is important to understand how the water industry needs to reduce its risks of operational shortages and project delays.

How Did We Get Here?

Industries can typically buffer against a single type of risk and maybe as many as two at a time. However, a situation in which there are multiple challenges happening at the same time is like a perfect storm for cascading dependency failure. Like most others, the water sector supply chain is composed of several layers of providers that work in concert to deliver products to utilities. As shown in Figure 1, the water sector supply can be separated into five layers to consider the factors weakening the supply chain: raw materials, suppliers, manufacturing, transportation, and retail storage.

Raw Materials

Panic buying has exacerbated shortages in copper, iron, semiconductors, plastics, etc., as companies attempt to stockpile raw materials to meet a recovering demand or stave off expected price increases. The supply chain is also influenced by staffing shortages, rising commodity prices, and transportation issues.

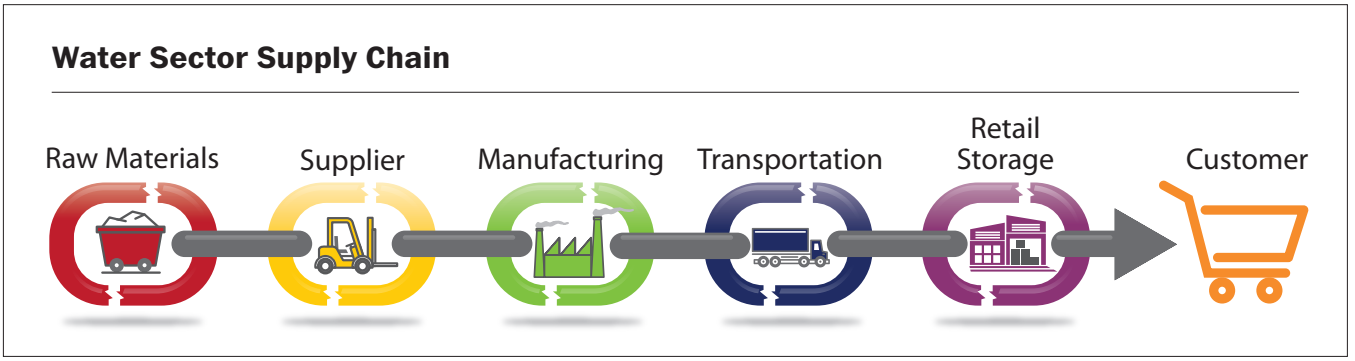

Figure 1

Suppliers

Before the pandemic, demand forecasting for multiple "priority" customers had created an era of "just in time" delivery. This approach left suppliers with little guidance on how to account for changing market conditions in their demand projections. In addition, companies generally stay as lean as possible to save on inventory holding costs.

Supplier shortages have been compounded by a history of shifting production to low-wage countries, each of which has faced the pandemic with its own limited means and vaccination capabilities. In the end, suppliers have been hurt by the lack of domestic capacity to manufacture critical components and products, along with not establishing multiple sources of materials ahead of time.

Manufacturing

Manufacturing plants worldwide were closed as a result of government-ordered quarantine requirements during initial COVID-19 outbreaks. Bringing manufacturing plants back online is not easy, and as they have come back online, they have been hit with challenges such as personnel shortages, plant failures, and COVID-19 outbreaks among staff.

Transportation

Truck driver shortages were already an issue before COVID-19 across North America. Consumer and supply chain–member panic buying increased the strain on the transportation part of the supply chain. This chain is also influenced by the availability of shipping containers and carriages, rising fuel prices, and international border delays due to quarantine and entry requirements.

Retail Storage

Delays in deliveries continue to disrupt the retail side of the supply chain, especially with companies that maintain small inventories. Globally, supplies are also being influenced by back-ordering of material in inventories due to upstream issues and all-time lows in warehouse space.

Case Studies

The following case studies describe challenges that three different US water suppliers faced during the past year and some insights that will benefit the broader water industry. In a filtration plant, any loss of chemicals can severely affect the filtration process, but chemical shortages can be mitigated by changing the coagulation and filtration processes.

Chlorine Disruption

The Joint Water Commission (JWC) is the primary drinking water supplier in Washington County, Ore., and is responsible for treating, transmitting, and storing potable water for about 450,000 customers. The primary water supply source for these customers is an 85-mgd conventional water treatment plant in Forest Grove, Ore., which uses gas chlorine for preoxidation and disinfection. The Pacific Northwest has only one gas chlorine supplier, so utilities in that region are aware of the potential risk if something happens to the chlorine supplier's facility.

On June 10, 2021, the JWC received a force majeure letter from the supplier, stating it might not be able to meet chlorine demand (both gas chlorine and bulk sodium hypochlorite) because of a major power failure at its production facility. Repairs were expected to be completed by the end of June, but there was significant uncertainty about the ability to fulfill the needs of water and wastewater utilities until that time.

The JWC developed plans to reduce consumption or shift to alternative disinfection strategies and took the following actions to prepare for a worst-case scenario:

- Discussed with partners potential options to reduce or shift production to other facilities
- Contacted the League of Oregon Cities to coordinate with other utilities and the governor's office

- Stayed in contact with the sole regional chlorine supplier to understand the restoration time frame
- Eliminated prechlorination to reduce overall chlorine usage
- Developed plans to add powdered activated carbon (normally used for taste and odor events) to the water to further reduce chlorine demand
- Developed public communication strategies for all potential outcomes, including curtailment and boil water notices
- Acquired additional chlorine supplies from other suppliers across the United States
- Provided gas chlorine as part of a mutual aid agreement to a neighboring utility that was running dangerously low

There were three key lessons:

- Reliance on a single chemical supplier for critical treatment chemical is a significant risk to the community.
- Chemical supply chain disruptions need to be included in emergency response plans.
- Utilities may not have staff with hazardous materials endorsements for their commercial driver's license, which makes it challenging to share chemicals even if utilities can do so.

Coagulant Disruption

In Farmington, N.M., Jacobs operates two water treatment plants that provide 30 mgd to more than 50,000 people. Both plants take water from the Animas River via Farmington Lake. In July 2021, operators received a force majeure letter from their chemical supplier because of shortages in chlorine needed to produce ferric chloride, which was the primary coagulant used at the plants.

In 2015, a study had been completed to evaluate switching from ferric chloride to aluminum chlorohydrate (ACH). The results were promising, but the cost prohibited making a switch at that time. On the basis of the previous study's results and in coordination with the state of New Mexico, jar testing was completed in 2021 to confirm ACH performance and dosage. The state requested increased total organic carbon (TOC) monitoring to evaluate any effects on disinfection byproduct precursors, and it issued an emergency authorization to use the alternative chemical, which can be converted to permanent approval once a permanent ACH feed system is installed.

Project Manager Jacob Smith and Lead Operator Derek Jara said that the temporary system is much more labor intensive than a permanent system because of the need to swap out totes (large, heavy chemical transfer tanks) multiple times per week. However, the operations team was relieved that it no longer needed to deal with messy ferric chloride, and there were fewer clogged lines and analyzers. There have been more stable effluent TOC levels, longer filter runs, and lower filter effluent turbidity. The longer filter runs have resulted in a 10% reduction in backwash pumping and water usage, which has offset the increased cost of coagulation chemicals.

Liquid Oxygen Disruption

Numerous utilities in Texas use liquid oxygen (LOX) to produce ozone, which is applied as a disinfectant in many water treatment plants. As utilities were in the midst of summer demands in 2021, LOX vendors began to report limited supplies and delivery restrictions because hospitals were requiring more LOX to treat COVID-19 patients.

Some utilities, not identified as high-priority or critical customers when they should have been, began receiving allocation restrictions. While they had the added complication of remedying the categorization and ensuring adequate supplies were received, many more utilities began anticipating how they would work through any potential reduced or nonexistent LOX supplies.

According to Sally Mills-Wright, assistant director of Dallas Water Utilities, city staff reviewed their emergency action plans to find ways to minimize the effect of limited LOX supplies. Options that were considered included increasing the free and combined chlorine portion of disinfection, reevaluating $C \times T$ (concentration × time) credit calculations to determine if ozone concentrations could be lowered with the increased summer temperatures, and reducing production.

In the end, the vendors were able to sustain supplies and ensure that all high-priority customers, hospitals, and utilities received their LOX orders. Ultimately, as Mills-Wright stated, "The review of the procedures and plans was an extremely valuable exercise for the Dallas Utilities staff in problem-solving and preparation for such an event."

Additional Steps

As these case studies demonstrate, utilities have been successful in proactively working through supply chain issues. Utilities can also take these actions to mitigate supply chain disruptions:

- Evaluate what supply risks pose the greatest threat to maintaining operations.
- Communicate with key vendors before and during an event, considering your utility's situation and the water industry's health and safety components.
- Communicate with other utilities to understand what they are doing and collaborate when possible.
- Consider other vendors with replacement products or alternatives, even potentially at a higher cost.
- For alternative products, fully evaluate the potential trade-offs and unintended consequences of using something different (e.g., chemicals, parts).

- Plan for operational changes to reduce consumption of chemicals in limited supply.
- In the United States, engage your state Water and Wastewater Agency Response Network, which can assist with coordinating supplies, equipment, and even staff (www.awwa.org/warn).

US water systems have another alternative if they experience shortages of chemicals or other critical supplies. If staff have already tried the approaches provided here, it is possible to seek relief under Section 1441 of the Safe Drinking Water Act (SDWA) or the Defense Production Act. SDWA Section 1441 authorizes the Department of Commerce to issue an order to a vendor to provide the necessary amount of the chemical or product to a public water system or publicly owned treatment works.

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