# Priming the Pump: Polymer Use Increases Lift Station Capacity

*Eric Peters*

Flows to the Metro Wastewater Reclamation District's Lower South Platte Basin in Denver, Colorado, are increasing rapidly because of development. While adequate capacity exists for average flows, projections indicated that the district's Brantner Gulch Lift Station would be unable to meet peak capacity requirements within a few years. Major capital investments would be required to handle the projected peak flows, including an additional 4.5-mile force main, larger pumps, and a possible flow equalization basin.

The reclamation district is considering the construction of a new regional wastewater treatment plant, which, if built, would eliminate the lift station; however, the earliest year the new plant could be in operation is 2007. To increase pumping capacity in the near term, the district experimented with adding polymer to the lift station's force mains during peak flow events.

The district had successfully added polymer to increase collection system and siphon capacity, but whether it would work with pumping systems was unknown. If capacity could be increased to meet peak demand, the district could eliminate major capital investments in the lift station until the new regional plant was operational.

A preliminary test of a single polymer, conducted in October 2000, indicated that applying the polymer to the wet well could increase pumping capacity by 18 percent, warranting further investigation. The district began comprehensive testing of various liquid polymers in the summer of 2001. Through these tests, the facility's pumping capacity increased by more than 30 percent. Because of this success, a full-scale polymer feed system was installed in the fall of 2002.

## Pilot Testing

When pilot tests were conducted, the lift station was arranged in a dry well-wet well configuration and consisted of four pumps—two rated at 3 mgd each and two rated at 6 mgd each. Each pump was equipped with a variable frequency drive.

The station's discharge piping consisted of two piping headers. One connected all four pumps to an 18-inch ductile-iron pipe force main, and the other connected them to a 14-inch ductile-iron pipe force main. Each header contained a magnetic flowmeter to measure flow discharged to the force mains. The 18-inch force main was used under normal operating conditions, and both force mains were used simultaneously during peak flow events.

To begin full-scale testing, various polymer manufacturers were contacted to determine which polymers were suited for the intended application. Each manufacturer recommended dosage rates that they anticipated would provide the best increase in capacity. These estimates ranged from 0.5 to 100 mg/L. Based on discussions within the district and recommendations from the manufacturers, three polymers were selected for testing (see Table 1).

Polymer in a 55-gallon drum (foreground) is fed directly to a variable-speed, progressive-cavity pump before being discharged directly to the 14-inch force main.

Polymer was injected into the force mains by feeding it directly from a 55-gallon drum to a variable-speed, progressive-cavity pump. Discharge from the pump was piped directly to the 14-inch force main.

Along with the 55-gallon drum and the progressive-cavity metering pump, testing equipment included reinforced tubing for suction and discharge piping and a one-gallon graduated cylinder for pump calibration. The dosage rates for pilot testing ranged from 35 to 100 mg/L. Additional tests were completed at lower dosages of 15 to 35 mg/L.

Polymer addition would be implemented only during peak hourly flow events at the lift station. A testing protocol was developed to simulate the full-scale application of polymer to the 14-inch force main.

The protocol was based on two different responses to polymer addition that were observed during the pilot test: The flow rate either increased immediately or shortly after polymer addition, or showed little or no increase until the polymer had been fed long enough to saturate the entire force main.

To test the second scenario, enough influent was required to provide continuous pumping until the entire length of the 24,000-foot force main was saturated with polymer. Testing began at mid-morning when flows to the lift station typically increased.

Before starting each test, the station's 13,500-gallon wet well was allowed to fill to its capacity, and wastewater was also stored in the receiving interceptor by closing the wet well's inlet gate to ensure sufficient volume for continuous pumping during testing. When starting the test, a pump was turned on and the inlet gate was opened.

The selected polymer was manually mixed in the 55-gallon drum and then connected to the suction line. The feed pump was calibrated at various speeds using the calibration cylinder to establish a feed pump curve.

One 6-mgd pump was started with all flow directed through the 14-inch force main. The pump was operated until a steady baseline flow rate was achieved, after which the polymer was added at a selected dosage rate. Flow rate, pressure, and wet-well levels were recorded approximately every five minutes during testing. The polymer feed rate was adjusted with changes in flow rate to maintain a constant dosage rate throughout each test.

Each test was completed when the recorded flow rate leveled off after polymer had saturated the entire force main. The polymer feed

| Polymer | Type | Charge | Density (lb/gal) |
|---|---|---|---|
| Cytec Superfloc A-1820 | Emulsion | Anionic | 7.1 |
| Nalco Nalclear 7763 | Emulsion | Anionic | 8.8 |
| Ciba Alcomer 175L | Liquid Dispersion | Anionic | 8.0 |

Table 1 – Polymers Selected for Testing

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rate was then adjusted for the next dosage rate and the same testing pattern was repeated.

## Analysis

Impacts on the lift station's capacity from each tested polymer are summarized in Table 2. The pilot testing showed that the flow rate could be increased between 10 percent and 37 percent above baseline pumping conditions when polymer was applied at various dosages.

The 37-percent increase was observed using a 175L polymer from Ciba Specialty Chemicals (Tarrytown, N.Y.) at a 75-mg/L dose rate. When evaluating how quickly the flow rate responded to polymer addition, the 175L polymer showed the best results at doses between 35 and 100 mg/L. On average, the polymer provided a flow increase of approximately 15 percent in the first 30 minutes of application. In addition, the 175L polymer displayed the most consistent flow rate increases at the 35 to 75-mg/L dose rates.

One of the testing program's objectives was to estimate how long polymer addition could delay major capital investments at the lift station. At the time of pilot testing, the station's firm capacity was 9 mgd. Based on a 25 to 30-percent capacity increase, projected peak flows could be met through 2008.

| Polymer | Dose (mg/L) | Capacity Increase (%) |
|---|---|---|
| Cytec Superfloc A-1820 | 15 | 17 |
| | 35 | 22 |
| | 75 | 29 |
| | 100 | 35 |
| Nalco Nalclear 7763 | 15 | 10 |
| | 35 | 20 |
| | 75 | 23 |
| | 100 | 16 |
| Ciba Alcomer 175L | 15 | 16 |
| | 35 | 32 |
| | 75 | 37 |
| | 100 | 30 |

Table 2 – Polymer Addition Impacts on BGLS Capacity

## Implementation

The Metro Wastewater Reclamation District replaced the two smaller pumps, which will increase the firm capacity to 10.6 mgd. Based on the polymer test results, the district concluded that the lift station's capacity could be increased from 10.6 mgd to about 12 mgd. This would meet peak flow projections through 2005. If the results obtained during the testing could be applied to both force mains, capacity would increase to approximately 13.5 mgd, which would meet projected peak flows through 2007.

On a full-scale operation, polymer would be applied only during peak events. Historical lift station data showed that these peak events could last up to five hours. The polymer feed system was designed to start prior to the peak capacity and stop after flows returned from peak levels. After installation, the new polymer feed was operated to compare full-scale results with pilot results. Full-scale testing confirmed that a 30-percent increase in flow rate could be achieved when adding polymer to both force mains.

Since installing the new pumps and polymer feed system in 2002, no peak event has been observed at the Brantner Gulch Lift Station. The polymer system is exercised and maintained on a routine basis so that when needed, the system will operate reliably.

These improvements will increase the peak-flow capacity until a final decision is made on the new regional wastewater treatment plant. At that time, some or all flow could be directed by gravity to a new regional wastewater treatment plant, or further capacity improvements will be required at the lift station.