

Client
City of Pompano Beach

Scope of Services
Membrane pilot testing, permitting, preparation of contract documents for direct procurement of membranes as well as membrane element loading, bidding, contract administration, on-site observation during loading, and review of membrane performance testing.

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Start Date
03/2016

Completion Date
05/2020

Initial Construction Cost
\$1.098 million

Change Orders & Cost
None

Final Construction Cost
\$1.098 million

Key MBC Staff
Frank A. Brinson, P.E.
Andrew H. Barba, P.E.

- Key Features**
- Reduced feed pressure and elimination of chemical pretreatment resulted in a realized annual operating cost savings of \$600,000.

Nanofiltration Membrane Element Pilot Testing and Replacement

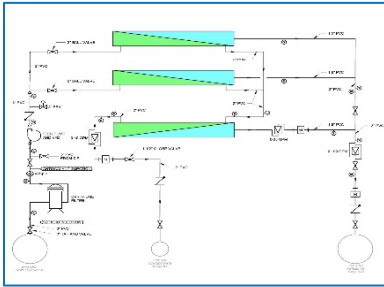
Pompano Beach, Florida



Background

The City of Pompano Beach owns and operates a 50 million gallon per day (mgd) capacity Water Treatment Plant (WTP) which consists of a 10 mgd capacity nanofiltration (NF) process in parallel with a 40 mgd conventional lime softening process. The NF process includes five 2 mgd NF units arranged in a two-stage, 36:16 array, and the system was designed to operate at an 85% recovery rate. The NF units were populated with a hybrid of 1,820 membrane element models (Hydranautics ESNA1-LF and ESNA1-LF2), which were installed in 2009. NF membrane elements typically have a useful service life of 5 to 7 years. In 2016, the City was ready to begin pilot testing to prepare for replacing the existing NF membrane elements.

In preparation for the membrane element replacement, the City and MBC designed, permitted, and constructed a pilot unit that utilized three full-size (8-inch diameter, 7-element) pressure vessels in a 2:1 array with independent cartridge filters and pre-treatment chemical feed systems. The pilot unit was permitted to withdraw feedwater from the NF process raw water header and discharge permeate and concentrate to the plant's respective headers.



The City requested letters of interest (LOI) from three leading nanofiltration membrane element manufactures (MEM); Hydranautics, Dow Water and Process Solutions, Inc. (Dow), and Koch Membrane Systems, Inc. The City received responses from Hydranautics and Dow.

Membrane element selections from both MEMs were pilot tested in two phases:

- Phase 1: This phase was aimed at confirming that the City could meet the specified permeate quality and membrane performance requirements with the replacement membrane elements under the current operating conditions of full-scale NF process (with acid and antiscalant chemical pretreatment). Meeting these specified permeate quality and membrane performance requirements during pilot testing allowed the MEM's proposed membrane element selections to prequalify for installation in the City's full-scale NF process skids under the Nanofiltration Membrane Element Replacement Project.
- Phase 2: This phase was conducted to evaluate the performance of the membrane element selection and potential fouling tendencies under modified operating conditions with a goal of eliminating acid and antiscalant chemical pretreatment.

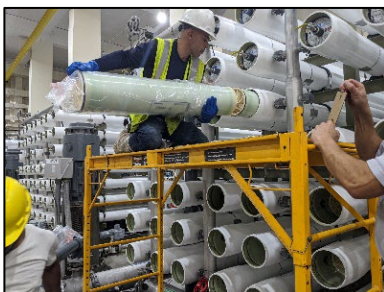


The membrane elements provided by both MEM's met the specified permeate quality and membrane performance requirements under Phase 1 operating conditions which prequalified the proposed membrane element selections for installation in the City's full-scale NF process skids. Pilot testing of the Hydranautics membranes demonstrated stable operation under Phase 2 operating conditions. In May 2019 the City advertised bid documents for the Nanofiltration Membrane Element Replacement Project and following evaluation of bid packages, Hydranautics was identified as the low bidder and the City issued a notice to proceed in December 2019.



The initial new membrane element loading configuration used on the full-sized was consistent with the pilot unit (first-stage: 7 ESPA 4-LD elements, second-stage: 7 ESNA-LF2-LD elements). However, during performance acceptance testing (start-up) of the first membrane full-scale NF unit, it was found that this loading configuration did not meet the specified permeate quality requirements. Hydranautics elected to modify the loading configuration, as allowed in the contract.

The modified loading configuration allowed the full-scale NF process to meet specified performance and permeate quality requirements, with no acid and antiscalant chemical pretreatment. The project was completed in May 2020, six months ahead of schedule with no change orders.



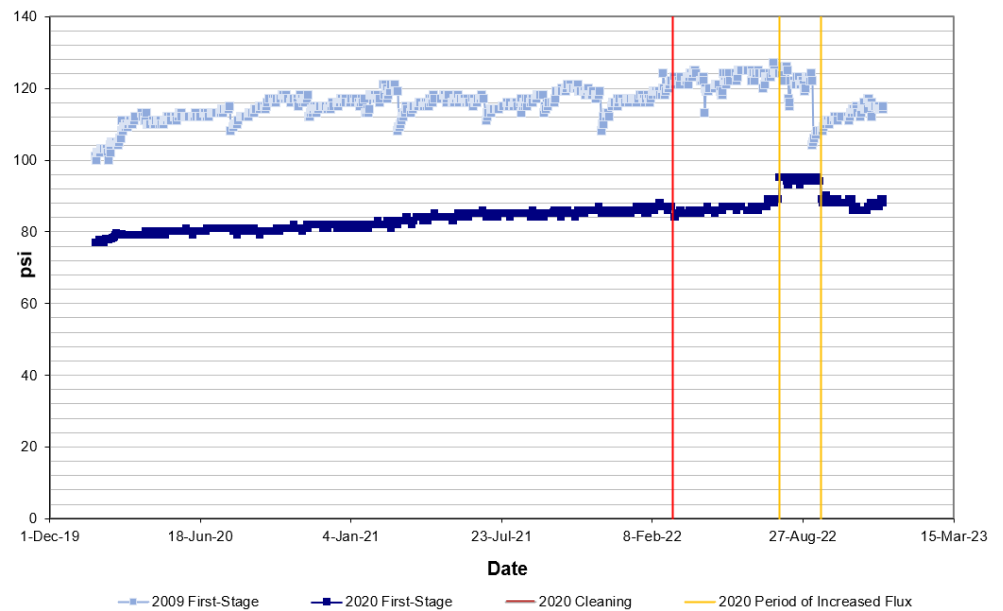
At start-up, the average feed pressure of the NF units was 73 psi with the new membrane elements, approximately 17 psi lower than the start-up pressure of the City's previous membrane elements. As of February 2023, the new membrane elements have been in service for three years with no chemical pretreatment, meeting all water quality goals,

and with one routine cleaning to-date (after 48-months of runtime). The elimination of acid and antiscalant chemical pretreatment, coupled with the reduction in feed pressure, resulted in a realized total annual operating cost savings to the City of \$600,000.

The Project

MBC’s scope of services for the project included the following:

- Design of a 2:1 array full-size element (8-inch diameter, 7-element) pilot plant.
- Development of technical specifications for the replacement membrane elements and membrane performance requirements, and negotiations with the membrane element manufacturer for direct purchase of the elements.
- Development of technical specifications and bidding documents for a separate membrane loading contract by a qualified membrane systems contractor.
- Permitting and bidding services.
- Contract administration during the loading period.
- On-site observation of membrane loading.
- Review and approval of membrane performance acceptance testing.



Comparison of Start-Up Feed Pressure: 2009 vs. 2020