McCafferty Brinson consulting

**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.

**Contact**
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**Start Date**
03/2016

**Completion Date**
05/2020

**Construction Cost**
$1,098,000

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

**Key Features**
- New membranes started up at a feed pressure of 73 psi, approximately 17 psi lower than the original membranes, resulting in a substantial operating power cost savings.
- Reduction cost of chemical pretreatment of approximately $218,000 per year.

# 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-staged, 36:16 array, and the system was designed to operate at an 85% recovery rate with an average flux of 13.7 gallons per square foot per day (gfd). 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 replacing the existing NF membrane elements

Under this project the City was interested in investigating the possibility of reducing operating costs by taking advantage of advances in membrane technology to reduce power costs and eliminate chemical pretreatment of feedwater. To facilitate this, 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.

These LOI's requested membrane selections from the MEM's, in preparation for prequalification pilot testing, to verify that the membrane selections meet the City's specified permeate quality and membrane performance requirements. Meeting these 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.

To facilitate pilot testing the City and MBC designed, permitted, and constructed a pilot unit that utilized 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.

Pilot testing with the pilot unit was conducted in two phases. Phase 1 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 (acid and antiscalant chemical pretreatment, 85% recovery rate, and 13.7 gfd average flux). The objective of Phase 2 was to evaluate the performance of the membrane selection and potential fouling tendencies under modified operating conditions (no chemical pretreatment, an 82% recovery rate, and a 12.2 gfd average flux).

In short, the membrane elements provided by both MEM's met the specified permeate quality and membrane performance requirements under Phase 1 and 2 operating conditions which prequalified the proposed membrane element selections for installation in the City's full-scale NF process skids. 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, when the first unit was started-up, it was found that this loading configuration did not meet the specified permeate quality requirements. Hydranautics elected to modify the loading configuration as follows:

- First-stage: 3 ESPA 4-LD and 4 ESNA-LF2-LD Elements
- Second-stage: 7 ESNA-LF2-LD Elements

This modified loading configuration allowed the full-sized NF process to meet specified performance and permeate quality requirements. The project was completed in May 2020, 6 months ahead of schedule. All the membrane units were started-up under modified operating conditions (no chemical pretreatment, an 82% recovery rate, and a

12.2 gfd average flux) and the average feed pressure of the NF process skids was 73 psi with the new membrane elements, approximately 17 psi lower than the start-up pressure of the City's previous membrane elements, resulting in an estimated operating power cost savings of approximately $27,000 per year. The NF process continues to operate effectively without chemical pretreatment, which results in an estimated chemical cost savings of approximately $218,000 per year.

## 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.