Rinconada Water Treatment Plant Reliability Improvement Project (RIP) Filter Pilot Study

AWWA 2014 Fall Conference

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Presentation Outline

- Background of Rinconada WTP
- Objectives of filter media pilot study
- Pilot system and test plan
- Data analyses
- Study conclusions
- Acknowledgements
RWTP Background

Surface Water Sources

- Sacramento-San Joaquin Delta via South Bay Aqueduct (SBA)
  - Lake Del Valle
  - Dyer Reservoir
- San Luis Reservoir
- Local reservoirs
  - Calero
  - Anderson
83 MGD Conventional WTP

- Operating since 1968
  - 4 up-flow clarifiers
  - 6 dual-media filters
  - Primary disinfection
  - Back-up disinfection
Reliability Improvement Project

- Major treatment process overhaul starting in 2015
- Increase the capacity to **105 MGD**
- Includes:
  - Addition of *raw water ozone*
  - Conversion from up-flow clarifiers to *flocculation* and *sedimentation basins*
  - 12 new biologically active dual-media filters
  - Post-filter *chlorine contactor*
Reliability Improvement Project

New Facilities on-line in 2018
Pilot Study Objectives

- Evaluate the performance of different dual-media configurations using **anthracite** with various raw water qualities at varying filtration rates.

- Select the best-performing media configuration to recommend for the RWTP RIP final design documentation.
Pilot Plant

- 1760 ft² building
- Start-up in 1993
- Located in Vasona Pumping Plant
Pilot Plant

Ozonation

Raw water

Holding Tank

Ozonation

10 Filter Columns

Effluent

4 Filter Columns

SPENT BACKWASH WATER

AIR SCOUR

BACKWASH WATER

FILTER POLY

PROGRESSING CAVITY PUMP

HEADLOSS TRANSDUCER

TURB TURIDIMETER

HACH 1720C

FI ROTAMETER

HL

From backwash system

FLOW INDICATING TRANSMITTER

PROCESS CONTROLLER

PC

VSC

M

backwash system

AIR SCOUR
Pilot Plant
Flocculation and Sedimentation

- Raw water
- Holding Tank
- Ozonation
  - Ozone
  - Alum
  - Cat poly
- Flocculation basins
  - Floc poly
- Sedimentation basin
- Effluent
- Backwash system
  - AIR SCOUR
  - SPENT BACKWASH WATER
  - PC PROCESS CONTROLLER
  - FLOW INDICATING TRANSMITTER
  - TURBIDIMETER
  - HACH 1720C
  - FI ROTAMETER
  - HL
  - BACKWASH WATER
  - FILTER POLY
  - PROGRESSING CAVITY PUMP
  - HEADLOSS TRANSDUCER
  - Progressing cavity pump
  - Headloss transducer

- Filter Columns
- Alum
- Cat poly

\[ M \\]
Pilot Plant

**Filtration**

- Raw water
- Holding Tank
- Ozonation
  - Ozone
  - Alum
- Flocculation
  - Floc poly
  - Cat poly
- Sedimentation
- From backwash system
  - AIR SCOUR
- SPENT BACKWASH WATER
- PC PROCESS CONTROLLER
- FLOW INDICATING TRANSMITTER
- TURB TURBIDIMETER
  - HACH 1720C
- FI ROTAMETER
  - HL
- BACKWASH WATER
- FILTER POLY
- PROGRESSING CAVITY PUMP
- HEADLOSS TRANSDUCER

4 Filter Columns

Effluent
Termination parameters

- Filter effluent turbidity ≥ 0.1 NTU
- Net headloss > 96 inches

Note: If a filter run is terminated by turbidity breakthrough, filter poly will be increased during the next run. If a filter run is terminated by headloss, the filter poly dose may be reduced or stopped entirely in the next run.
## Backwash Sequence

<table>
<thead>
<tr>
<th>Step</th>
<th>Parameter</th>
<th>Set Point</th>
<th>Duration</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drain water to approximately 6” above media level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Air</td>
<td>3 scfm</td>
<td>4 min</td>
<td>4 min</td>
</tr>
<tr>
<td>3</td>
<td>Air with Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>8 gpm/sf</td>
<td>2 min</td>
<td>6 min</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td>3 scfm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Low Rate Water</td>
<td>8 gpm/sf</td>
<td>3 min</td>
<td>9 min</td>
</tr>
<tr>
<td>5</td>
<td>High Rate Water</td>
<td>Determined by the 20% target media bed expansion percentage, ranging from 18 to 23 gpm/sf.</td>
<td>6 min</td>
<td>15 min</td>
</tr>
<tr>
<td>6</td>
<td>Low Rate Water</td>
<td>8 gpm/sf</td>
<td>4 min</td>
<td>19 min</td>
</tr>
<tr>
<td>7</td>
<td>Settling</td>
<td>na</td>
<td>1 min</td>
<td>20 min</td>
</tr>
</tbody>
</table>
Filter Media Configurations

<table>
<thead>
<tr>
<th></th>
<th>Anthracite</th>
<th></th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Depth (inch)</td>
<td>Effective Size (mm)</td>
<td>Depth (inch)</td>
</tr>
<tr>
<td>Filter 1</td>
<td>42</td>
<td>1.0</td>
<td>10</td>
</tr>
<tr>
<td>Filter 2</td>
<td>48</td>
<td>1.2</td>
<td>10</td>
</tr>
<tr>
<td>Filter 3</td>
<td>54</td>
<td>1.3</td>
<td>10</td>
</tr>
<tr>
<td>Filter 4</td>
<td>60</td>
<td>1.4</td>
<td>12</td>
</tr>
</tbody>
</table>

L/d ratio (Kawamura, 2000)
L = depth of filter bed
\(d\) = effective size of the filter medium

“The same filtration efficiency can be achieved with a variety of different filter beds (i.e., media sizes and depths) if they have the same L/d ratio.”
Optimal Media Configuration

- Maintain excellent **filter effluent water quality**
- Maintain **high UFRVs** for all filtration rates and source changes
- **Maximize** available filter **headloss** throughout the filter run
- **Reduce** recycled **water** volume
- **Use less** treatment **chemicals** while maintaining high performance
• Completed 292 Filter Runs in total in six months!

<table>
<thead>
<tr>
<th>Raw Water Source</th>
<th>Filter Loading Rate</th>
<th>Filter 1</th>
<th>Filter 2</th>
<th>Filter 3</th>
<th>Filter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Finest</td>
<td></td>
<td></td>
<td>Coarsest</td>
</tr>
<tr>
<td>SBA</td>
<td>6.3 gpm/sf</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5.5 gpm/sf</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>4.1 gpm/sf</td>
<td>26</td>
<td>25</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>2.75 gpm/sf</td>
<td>14</td>
<td>17</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Anderson</td>
<td>5.5 gpm/sf</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>4.1 gpm/sf</td>
<td>7</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
Sample Data Analysis

Anderson Water

Unit Filter Run Volume (gal/sf)

Filter Loading Rate (gpm/sf)

Filter 1
Filter 2
Filter 3
Filter 4

Santa Clara Valley Water District
Evaluation Criteria

- A Two-tiered Rating System with weighting factors
- For each criterion, a scale of 1 (worst) to 4 (best)

<table>
<thead>
<tr>
<th>no.</th>
<th>Evaluation Criteria</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Average filter run time</td>
<td>Longer filter run time is preferable</td>
</tr>
<tr>
<td>2</td>
<td>Average unit filter run volume</td>
<td>Higher UFRV means more water production</td>
</tr>
<tr>
<td>3</td>
<td>Filter effluent turbidity</td>
<td>Lower filter effluent turbidity is preferable</td>
</tr>
<tr>
<td>4</td>
<td>Headloss accumulation rate</td>
<td>A slow and steady headloss buildup is preferable</td>
</tr>
<tr>
<td>5</td>
<td>Backwash water rate</td>
<td>Lower backwash water rate means saving water and energy</td>
</tr>
<tr>
<td>6</td>
<td>Filter-to-waste time</td>
<td>A short and consistent FTW time is preferable</td>
</tr>
</tbody>
</table>
Average Filter Run Time

**SBA**

- Filter 1: 35 hours (N=61)
- Filter 2: 36 hours (N=62)
- Filter 3: 40 hours (N=56)
- Filter 4: 55 hours (N=55)

**Anderson**

- Filter 1: 30 hours (N=17)
- Filter 2: 40 hours (N=16)
- Filter 3: 50 hours (N=13)
- Filter 4: 60 hours (N=12)
Average UFRV

SBA

Anderson

Avg. UFRV (gal/sf) in Thousands

Filter 1  Filter 2  Filter 3  Filter 4

N=61  N=62  N=56  N=55

N=17  N=16  N=13  N=12
Average UFRV

**Scores:**

**SBA**

- Filter 1: N=61
- Filter 2: N=62
- Filter 3: N=56
- Filter 4: N=55

**Scores:**

**Anderson**

- Filter 1: N=17
- Filter 2: N=16
- Filter 3: N=13
- Filter 4: N=12

**Avg. UFRV (gal/sf)**

**Thousands**


**Filter Legend:**

- Filter 1: Purple
- Filter 2: Green
- Filter 3: Orange
- Filter 4: Blue
Filter Effluent Quality

**Data Analysis**

**SBA**

<table>
<thead>
<tr>
<th>Filter 1</th>
<th>Filter 2</th>
<th>Filter 3</th>
<th>Filter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=61</td>
<td>N=62</td>
<td>N=56</td>
<td>N=55</td>
</tr>
</tbody>
</table>

**Anderson**

<table>
<thead>
<tr>
<th>Filter 1</th>
<th>Filter 2</th>
<th>Filter 3</th>
<th>Filter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=17</td>
<td>N=16</td>
<td>N=13</td>
<td>N=12</td>
</tr>
</tbody>
</table>
Filter Effluent Quality

SBA

Scores:

Anderson

Scores:

Avg. Filter Effluent Turbidity (NTU)

Filter 1  Filter 2  Filter 3  Filter 4

N=61  N=62  N=56  N=55

N=17  N=16  N=13  N=12
2nd Tier Criteria

Headloss Accumulation Rate

SBA

Anderson

Headloss Accumulation Rate (in/hr)

Filter 1  Filter 2  Filter 3  Filter 4

N=61  N=62  N=56  N=55

N=17  N=16  N=13  N=12

Data Analysis
2nd Tier Criteria

Headloss Accumulation Rate

**SBA**

Scores:

```
Headloss Accumulation Rate (in/hr)

<table>
<thead>
<tr>
<th>Filter 1</th>
<th>Filter 2</th>
<th>Filter 3</th>
<th>Filter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=61</td>
<td>N=62</td>
<td>N=56</td>
<td>N=55</td>
</tr>
</tbody>
</table>
```

**Anderson**

Scores:

```
Headloss Accumulation Rate (in/hr)

<table>
<thead>
<tr>
<th>Filter 1</th>
<th>Filter 2</th>
<th>Filter 3</th>
<th>Filter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=17</td>
<td>N=16</td>
<td>N=13</td>
<td>N=12</td>
</tr>
</tbody>
</table>
```
This parameter correlates with media size, not the raw water source.
This parameter correlates with media size, not the raw water source.
2nd Tier Criteria

Filter-to-Waste Time

SBA

Anderson

Filter-to-waste Time (min)

Filter 1  Filter 2  Filter 3  Filter 4

N=61  N=62  N=56  N=55

N=17  N=16  N=13  N=12

Data Analysis
## Rating Table – SBA Water

<table>
<thead>
<tr>
<th>no</th>
<th>Evaluation Criteria</th>
<th>Weighting factor</th>
<th>Filter 1</th>
<th>Filter 2</th>
<th>Filter 3</th>
<th>Filter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>filter run time</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>UFRV</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>effluent water quality</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>HL accumulation rate</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Backwash water rate</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>FTW time</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Weighted Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>22</strong></td>
<td><strong>22</strong></td>
<td><strong>25</strong></td>
<td><strong>21</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Rating Table – Anderson Water

<table>
<thead>
<tr>
<th>no</th>
<th>Evaluation Criteria</th>
<th>Weighting factor</th>
<th>Filter 1</th>
<th>Filter 2</th>
<th>Filter 3</th>
<th>Filter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>filter run time</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>UFRV</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>effluent water quality</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>HL accumulation rate</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Backwash water rate</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>FTW time</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Weighted Total</strong></td>
<td></td>
<td>21</td>
<td>23</td>
<td>25</td>
<td>21</td>
</tr>
</tbody>
</table>
Conclusions

- Filter 3 (54” of 1.3 mm anthracite and 10” of 0.65 mm sand) is the recommended media configuration for the project final design documents.

- Next steps:
  - Project construction will start in late 2015;
  - New filters will be installed in 2017-2018;
  - Existing filters will be demolished in 2018-2019.
Acknowledgement

- Four Units within the District
- CDM Smith
- All in all, to run this study 24-7:
  - 5 WQ engineers + 3 interns + 1 WTP operator
ANY QUESTIONS?

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lhong@valleywater.org
408-630-2761
# Pilot Study Timeline

<table>
<thead>
<tr>
<th>Raw Water Source</th>
<th>Duration</th>
<th>Filter Loading Rate</th>
<th>Testing Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3/28 – 4/10</td>
<td>6.3 gpm/sf</td>
<td>Stressed flow rate</td>
</tr>
<tr>
<td></td>
<td>4/10 – 4/22</td>
<td>4.1 gpm/sf</td>
<td>75% design flow rate</td>
</tr>
<tr>
<td></td>
<td>4/22 – 6/11</td>
<td>2.75 gpm/sf</td>
<td>50% design flow rate</td>
</tr>
<tr>
<td></td>
<td>6/11-7/15</td>
<td>5.5 gpm/sf</td>
<td>100% design flow rate</td>
</tr>
<tr>
<td></td>
<td>7/15-8/25</td>
<td>4.1 gpm/sf</td>
<td>75% design flow rate</td>
</tr>
<tr>
<td>Anderson</td>
<td>8/25-9/16</td>
<td>5.5 gpm/sf</td>
<td>100% design flow rate</td>
</tr>
<tr>
<td></td>
<td>9/16-10/2</td>
<td>4.1 gpm/sf</td>
<td>75% design flow rate</td>
</tr>
</tbody>
</table>