Water Recycling within the Facility (Arc 3.4115)

(The analysis below was extracted from one of the assessment reports by the Clemson University Industrial Assessment Center (IAC). This is only an example recommendation and hence, not all the background information and sources for numbers are included here.)

Est Water Consumption Savings	= ***14,559,120 gal/year***
Est. Water Consumption Cost Savings	= ***$31,006 /yr***
Est. Implementation Cost	= ***$ 0***
Simple Payback Period	= ***0 months***

Recommended Action:
It is recommended to use the existing (not used yet) water-recycling infrastructure within the plant facility to convert the wastewater into water that can be reused for other purposes and decrease the water demand.

Background:
Recycled water can satisfy most water demands if it is adequately treated to ensure water quality appropriate for the use. Recycled water is most commonly used for non-potable purposes, such as cooling, washing and toilet flushing. The two buildings in the plant are currently using 16,176,000 gallons of water annually, which is equivalent to 44,320 gallons per day. Current annual water bills are $36,562. U.S. Environmental Protection Agency (EPA) has developed Guidelines for Water Reuse, which provides a list of state requirements, and guidelines for the treatment and uses of recycled water [1]. The company has installed (but never used) a water recycling facility. During the audit, water usage was identified as an area of potential savings, particularly implementing the recycle tank, T30 (shown in the Figure 1 below), into the wastewater treatment process as it is currently being unused.

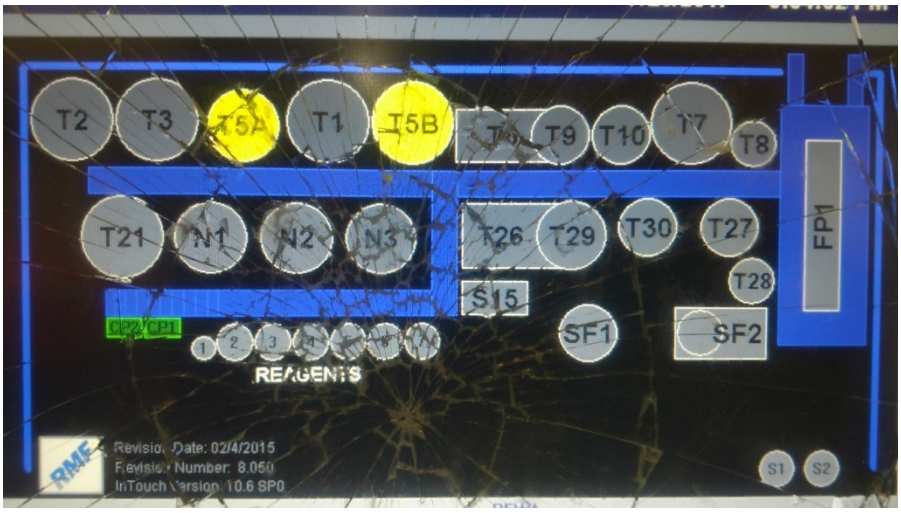

Figure 1. Process flow diagram for water recycling

Anticipated Savings:
Savings are estimated based on the amount of water recycled by the water recycling facility. Most industrial water recycling plants recycle more than 90% of the water. Monthly water consumption of the plant is listed below in the Table 1.

Table 1. Water bills and design excess effluent

Period	Days	Gallons (1000 Gal)	Gal/ hour	Excess effluent (gal/hr.)
5/5/16-6/9/16	35	1,377.8	1640.2	0
6/9/16-7/7/16	28	1,672.8	2489.3	642.6
7/7/16-8/4/16	28	1,321.6	1966.7	120.0
8/4/16-9/8/16	35	1,546.4	1841.0	0
9/8/16-10/6/16	28	1,176.4	1750.6	0
10/6/16-11/3/16	28	1,160.1	1726.3	0
11/3/16-12/8/16	35	1,581.3	1882.5	35.8
12/8/16-1/5/17	28	884.5	1316.2	0
1/5/17-2/2/17	28	1,204.7	1792.7	0
2/2/17-3/9/17	35	1615	1922.6	76.0
3/9/17-4/6/17	28	1,237.8	1842.0	0
4/6/17-5/4/17	28	1,398.4	2081.0	234.3
Annual Sum		16,176.8		1,108.7

Average daily discharge can be calculated as follows:

$$\text{Average daily discharge} = \text{Annual Discharge (gal/year)} \div 365 \text{ (day/year)}$$

$$\text{Average daily discharge} = 16{,}176.8 \times 1000\text{(gal/year)} \div 365 \text{ (day/year)}$$

Average daily discharge = 44,320 (gal/day)

Similarly, hourly discharge can be estimated as follows:

$$\text{Average hourly discharge} = \text{Average Daily Discharge} \div 24 \text{ (hours/day)}$$

Average hourly discharge = 1846.7 (gal/hour)

Currently, all discharged water goes to city effluent. On average, 1,846.7 gallons of water goes to wastewater treatment plant in the form of effluent. Tank T30 (Figure 1) has a total tank capacity of 2,500 gallons. If water is redirected to the recycle tank, average recycle tank fill is estimated as:

Average Recycle tank fill time

$$= \text{T 30 tank capacity} \times 1\text{(hour)} \div \text{Average hourly discharge (gallons)}$$

$$= 2500 \text{ gallons} \times 1(\text{hour}) \div 1846.7 \text{ gallons}$$

$$\boldsymbol{= 1 \text{ hour } 21 \text{ minutes}}$$

On average, a recycling tank can be filled in an hour and a half. The flow of water may be higher in some days while it may be lower in some days and the fill time may change accordingly. We assume that the recycle tank (T30) can operate at full load, 1846.7 gallons of discharged water per hour or up to 2500 gallons of water per hour if there is a peak demand.

With 1846.7 gal/hour being the design capacity of the water recycling facility, the water that need to go to city effluent will be equal to the difference of hourly discharge for June and the design discharge. Upon comparing average hourly discharge (design discharge of water recycling facility) with hourly discharge in Table 1, the excess city effluent is calculated as:

Excess city effluent for the month of June = Hourly discharge for June – Average hourly discharge

$$= 2489.3 \text{ (gal/hour)} - 1846.7 \text{ (gal/hour)}$$

$$= 642.6 \text{ (gal/hour)}$$

$$\boldsymbol{= 15{,}422.4 \text{ (gal/day)}}$$

Compared to the original average discharge of 44320 gallons per day of required effluent, 15,422.4 is a significant improvement. Excess effluent for other months were also estimated using same approach and are presented in Table 1.

The water recycling facility is designed to recover 90% water from the effluent. Therefore, the water savings can be estimated as follows:

Water savings = 90% × Average daily discharge

$$= 0.90 \times 44{,}320 \text{ (gal/day)}$$

$$= \mathbf{39{,}888 \text{ (gal/day)}}$$

Cost Savings from water recycling = Water Savings × Per unit water cost

$$= 39{,}888(\text{gal/day}) \times 2.26 \times 10^{-3}$$

$$= \$90.1 \text{ per day}$$

$$\boldsymbol{= \$32{,}889 \text{ per year}}$$

The cost of excess city effluent is calculated as:

$$\text{Cost of city effluent} = \text{Sum of excess effluent} \times \text{Per unit water cost}$$

$$= 1{,}108.7(\text{gal/hour}) \times 2.259 \times 10^{-3} \times 24 \times 30$$

$$= \boldsymbol{\$1{,}803.2}$$

Therefore, net savings from water recycling = Cost savings – Cost of excess effluent

$$= \$32{,}889 - \$1{,}803.2$$

$$= \boldsymbol{\$\ 31{,}005.8}$$

Implementation Cost:
Since RMF had the water recycling facility already, we recommended using the existing facility. Therefore, no installation cost was considered.

Implementation Cost (IC) = $0

Simple Payback Period:
The *simple payback period, SPP*, is the time required to pass before the estimated total cost savings equal the estimated implementation cost, and is calculated by:

$$SPP = \frac{IC}{TCS} \times 12\ months/year$$

$$SPP = \frac{\$0}{\$31{,}005/yr.} \times 12\ months/year$$

SPP = 0 months

References:

1. Use Available online from: https://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf