Non-Domestic Water Audit Report

Laundry Services
Massachusetts

INTRODUCTION

The Massachusetts Water Resources Authority (MWRA) has developed a program to audit the water use of some of its largest industrial and institutional users as part of its mission to preserve the supply of fresh water to the Metropolitan Boston area. The purpose of this program is to identify cost effective water saving measures and encourage conservation among those users. Pequod Associates, Inc. is a consulting engineering firm under contract to MWRA to conduct those audits and assist users in implementing the savings measures recommended.

This report documents an audit conducted for Services, in , Massachusetts. Our findings are based on a site visit made in June, 1989 and discussions with plant engineers. The profile section contains a description of the buildings and their use, the facility's historical water use and an inventory of water using equipment. Following the profiles are measures we recommend for implementation or further study, with cost and savings estimates.

Pequod and a representative of MWRA will meet with the staff shortly after this report has been delivered to discuss our findings and recommendations.

EXECUTIVE SUMMARY

In a recently issued corporate memorandum, Boston branch was recognized for its reduced utility rates and, in particular, its decreased water consumption of 11.6% from the previous year with an increase of laundry output. Their index of water usage for 1988 was 3.36 gallons per pound of laundry. Annual billed water consumption from March, 1988 was 19,400,000. At present water and sewer rates, the equivalent usage would cost the facility $83,300.

The following table is a summary of the water conservation measures we were able to identify. Payback periods are based on current water and sewer charges which have risen by nearly 60% since April 1, 1988. Because these rate increases are likely to continue over the next few years, items with present paybacks of

two years or more should be reviewed periodically. Our investigations have revealed measures that would save an estimated 25% of this water usage with a payback period of less than 1.5 years.

SUMMARY OF WATER CONSERVATION MEASURES

	Gallons Saved	Dollars Saved	Cost	Payback
Reduced Fill Loads	377,800	$ 1,600	$ 500	.3 yrs
Recycle Rinse Water	4,700,000	$53,700	$ 95,000	1.8 yrs
Reclaim Waste Water	13,650,000	$60,300	$250,000	4.1 yrs
Toilet Retrofit	131,250	$ 535	$ 300	.6 yrs

FACILITY PROFILE

General

Services, provides complete laundry services for linens and uniforms from hotels, restaurants and catering services. The facility occupies a two-story building with a ground floor area of approximately 20,757 square feet. They operate a single twelve hour shift with staggered starting hours five days per week with approximately 130 employees.

Both process and space heating are generated by a single 400 hp gas-fired Kewanee high pressure steam boiler. Lighting is primarily fluorescent.

Water

Water is supplied by the Water and Sewer Commission through two separately metered 4 inch lines extending from Avenue and Street, respectively. A 6 inch sewer line extends directly out to Avenue and an 8 inch line extends to Street.

Primary water usage is from the 8 commercial wash machines (6 at 800 pounds, 1 at 400 pounds and 1 at 250 pounds). "Cold" water

used for the washing process is tempered by the effluent waste water in two parallel Pozzi turbine heat exchangers. At the time of our site visit, the incoming water was preheated by approximately 40°F, while the temperature of the effluent stream dropped from 130°F to approximately 90°F. Effluent water is pH adjusted in a holding tank prior to being pumped to the Pozzi exchanger.

Regulation of the effluent flow rate through the exchanger is controlled by a manual valve and must be checked frequently to avoid overflow of the water in the exchanger. The result has been inconsistent heat recovery and spillage, and consideration is now being given to replacement of the exchanger. (In addition, as shown below, the flow of tempered water on average is less than half of the effluent flow. Consequently, the temperature rise of the incoming stream should be twice the temperature drop of the effluent. Under these conditions, the entering water may be heated more than is desired or necessary and some of the effluent heat would be better used to preheat the hot water stream as well.)

After passing through the heat exchanger, the waste water flows by gravity back to the basement level where it passes through a shaker screen for lint removal prior to discharge into the sanitary sewer. The preheated water is metered at the location of the exchanger and is stored in a 3,000 gallon tank.

Hot water is generated at the basement level with two steam heat exchangers off of the main boiler. The water is heated to between 165°F and 170°F and is stored in an 8,000 gallon tank in the mezzanine for gravity feed. Flow data taken for June 26, 1989 and thought to be representative of normal operation show the following metered usage:

A.	City Water	76,000 gal
B.	Wash Floor (i.e. total for washing)	66,500 gal
C.	Tempered Water (i.e. tempered wash water)	26,000 gal
D.	Boiler Makeup Water	1,800 gal

The following flows can be deduced from these meter readings:

B-C.	Total hot water used for washing	40,500 gal
A-B-D.	Domestic and other	7,700 gal

The above referenced memorandum reports an average weekly output of 106,780 pounds of laundry and a water index of 3.36 gallons per hundred pounds. These data indicate an average daily water usage of 71,750 gallons (the data of June 26 is in agreement with this).

The "domestic and other" category of usage breaks down as follows. Domestic use for the 120 employees should average out to approximately 40 gal/person/day, or 5,000 gallons. Additional daily water consumption for production of various solutions is estimated by facility engineers as follows:

Starch Production	3[illegible]0 gal
Alkaline Solution	[illegible]0 gal
Bleach Production	[illegible]00 gal

Spray water for the dryer stack lint remover probably accounts for the remainder of the 7,700 gallons, or approximately 1,400 gal/day.

Water is billed quarter-annually at the present rate of $1.49/ccf for water and $1.73/ccf for sewage, for a total of $3.22/ccf. For the period of March, 1988 through March, 1989, the annual billed water consumption was 25,870 ccf or 19,400,000 gallons at an average of 77,600 gal/day. At current rates, the annual water cost is $83,300.

Laundry applied for and received a sewerage rebate of 10.5% of the total water billing (or 12% of the wash water) for water retained in the laundry and removed in the drying process. They also received an additional 5.2% for boiler makeup presumably due to direct steam injection.

Based on the above data for June 26, daily water flow patterns break down as follows:

City Water Entry	76,000 gal
Wash Water (including alk, soap, etc.)	68,000 gal
Wash Water Effluent (based on 12% retention)	60,000 gal
Domestic Water to Sewer	5,000 gal
Water Evaporated (dryer, lint removal)	9,500 gal
Boiler Makeup	1,500 gal

Conservation Measures in Place

The major process water consumption is from the wash machines. Wash water is conserved through programming for each load both the number of cycles and the water fill level per cycle, depending on whether the fabrics are light, medium or heavy soiled. In addition, the two Pozzi turbine heat exchangers conserve thermal energy.

WATER CONSERVATION OPPORTUNITIES

REDUCE WATER FILL FOR REDUCED LOADS

Discussion

The formulas that control the sequence of operation of the wash cycles take into account the soil condition of the load (i.e. whether it is a light, medium or heavy soil). In addition, the formulas account for the fact that the machine fill level for synthetic garments is only from 1/2 to 2/3 full in order to prevent compression wrinkles. For other materials, however, the formulas are established based on full loads. Although loads of whites are generally run full, there are often insufficient colors to fill a washer.

Recommendation

There is adequate software capacity for additional programming to accommodate partial loads. Additional formulas should be created for 2/3 full loads for all colored washes.

Savings

It is estimated that approximately 1/3 of the average 25 loads per day are for colored laundry and that, of these, an estimated 20% are run at approximately 2/3 capacity. Reprogramming of the colored loads to 2/3 of the present water usage would therefore save the following:

68,000 gal/day * 250 day/yr * 1/3 color * 20% at reduced load * 1/3 savings = 377,800 gal/yr

377,800 gal/ 7.5/100 = 500 ccf

500 ccf * $3.22 = $1,600

The cost for additional software programming is an estimated $500 for a payback period of .3 years.

RECYCLE RINSE WATER

Discussion

The formulas for each type of wash load consist of numerous fill events, the majority of which are either flushes or rinses. The flush and rinse events for several of the formulas are outlined in Figure 1 in Appendix A. The distinction between these two events is that flushes contain the majority of fats, oils and greases (FOG), while the rinses have a FOG level of approximately 15 to 25 ppm. With the exception of the rinse cycles from red colored laundry, initial rinse cycles from other loads are suitable for reuse in either the break or suds cycles. In most cases, it is not desirable to reuse the final rinse, since it often contains softeners, starches, etc.

For a given machine, both flushes and rinses are dumped to the same floor drain and treated the same. Washers 1 and 6 have separate drain systems. Washers 2 and 3, 4 and 5, and 7 and 8 have paired drain systems. In order to recycle the rinse water, the drain systems will have to be separated for each paired machine and additional piping, valves and storage provided to separate the rinse from flush water.

Aside from the mechanics of separating the streams, another concern for recycling the rinse water is that the FOG level of the effluent will increase with less dilution. Present MWRA standards for FOG are 100 ppm. On average, the effluent tests out at this level and at times rises to 200 ppm. Recycling of the rinse water may lead to a FOG level in excess of the MWRA limits. Since the total level of contaminants will remain constant, the increased concentration may not be a problem. However, to bring the system into compliance may require the use of a dissolved air flotation system (DAF) followed by rotary drum vacuum filters for dewatering. At the time of engineering and system design, MWRA should be contacted regarding the potential increase in FOG concentration.

Additional consideration must also be given to the temperature of the rinse water. For example, a high temperature in the initial wash may set stains. From the formulas now used, the temperature of the initial rinse cycles averages approximately 140^{o}F to 150^{o}F. This water should be utilized for wash and flush cycles that call for temperatures in this range.

The rinse recovery system should be optimized to the particular formulas employed by the laundry. The number of rinses to be recovered will depend on both the number that can be used and the

desired mix temperature. Recovery of only hotter rinses may permit reduction in the number of operations in the cycle and the further reduction of water consumption. In addition, the chemicals recovered with the rinse water will save on the chemicals added at the early wash or flush stages.

Recommendation

With the exception of red wash loads, we recommend recycling the high level hot rinses from all washers for use in wash and drain cycles.

Implementation

An insulated rinse water holding tank should be provided along with additional drain piping from each machine to the tank. The drain troughs for paired washers should be partitioned and drain piping separated. Automatic diverting valves should be provided and controlled by the existing computerized wash controls in order to route flush water to the existing effluent holding tank and the desired rinse water to the new recycling tank.

New pumps and supply piping should be provided from the recycling tank to a new wash machine supply header. Piping and solenoid valves shall be provided with automatic controls to utilize recycled rinse water for the initial flush cycles and fresh water for the final rinse cycles. At the time of detailed engineering, it should be determined whether or not it will be cost effective to repipe the waste water from the extractors to the recycling tank as well. City water makeup shall be provided to the new recycled water tank. Tank location shall be in basement space made available in an upcoming renovation.

Recycling of water in commercial laundries has encountered some failures in the past. We understand that problems have been encountered when water has been allowed to stand in sump areas located at the washers and sediment has been allowed to build up. Commercially available packaged systems are available that address this problem by careful placement of pumps and valves, and by draining all holding tanks from the bottom.

Savings

Roughly 85% of the annual water consumption is utilized in the washing process. From the formulas analyzed, we estimate that 30% of this water is utilized for the initial rinse cycles. Red

colors account for one wash load per day so that less than 5% of the daily wash load results in non-recoverable rinse water. We assume for this analysis that all of the rinse water can be used in the initial wash phases. Accordingly, annual water savings from recycling of rinse water is estimated as follows:

25,870 ccf *.85 * .3 * .95 = 6,270 ccf

6,270 ccf * $3.22 = $20,200

Hot water for the wash and flush cycles is produced by steam heat exchangers off of the main boiler. Utilization of the recycled water will save heating of city water from an average temperature of 50°F to the storage temperature of approximately 145°F. Final temperature can be achieved at the washer with existing steam injectors. The amount of thermal savings that can be achieved will depend on the relative quantity of hot wash and flush water as compared with the hot rinse water recycled. The formulas analyzed indicate that all of the hot rinse water can be used to replace heated wash and flush water. Based on this assumption, thermal savings are as follows:

6,270 ccf * 7.5 * 100 = 4,700,000 gal

4,700,000 * 8.5 lb/ gal * 95 deg /1,000,000 = 3,795 MMBtu

3,795 MMBtu / .75 eff * 10 therm/MMBtu = 50,650 therm

At an average annual price of $0.52 /therm, the annual savings is:

50,650 therm * $.52 $/therm = $26,320

Finally, according to data from existing recycling installations, approximately 15% of the costs of chemicals can be saved. At an estimated monthly cost of $4,000 for chemicals, the additional annual savings is $7,200.

Combining water, thermal and chemical savings, we estimate a total annual savings of $53,700.

Laundry has asked Simex Corporation to evaluate the feasibility of recycling rinse water. They have determined a budget estimate of the installation cost to be $95,000 (this includes drain separation, piping, pumps, valves and insulated storage tank). Using their estimate, the payback period is 1.8 years.

If it is required to reduced the FOG content to maintain compliance with the 100 ppm concentration limit, the economics

change dramatically. We have determined that the least expensive way to remove the FOG would be to install a DAF clarifier together with a rotary drum vacuum dewaterer. It should be noted that the DAF clarifier may be applicable only to laundries of this nature with light animal fats (not heavy industrial petroleum and greases) in the wash. For the latter contaminants, a more expensive chemical treatment followed by a membrane system may be necessary. The equipment cost for clarifier and dewaterer alone is estimated at $100,000 and system installation cost (including equalization tanks, etc.) is estimated at $180,000. Under this scenario, the total system cost is $275,000 and the payback period increases to 5.4 years.

RECLAIM WASH WATER

Discussion

As an alternative to recycling the rinse water, we considered total waste treatment and reclamation of the effluent stream. This is a viable alternative if FOG removal becomes an issue as discussed in the previous measure.

For ease of maintenance and minimal cost, we recommend a packaged system for waste water treatment. In particular, we looked at a packaged system capable of recycling up to 150 gpm of effluent. The equipment utilizes a dissolved air flotation (DAF) cell for separation of liquids and solids after pH adjustment and introduction of polymers to coagulate and flocculate solids. The water is passed through a sand filtration system prior to recycling. The slurry should be dewatered with a rotary drum vacuum system.

Savings

Manufacturers of the above system estimate that approximately 80% of the effluent could be recycled. Accordingly, the water savings would be:

25,870 ccf * .88 (dragout) * .80 (recycle) = 18,200 ccf

18,200 * $3.22 = $58,600

Assuming 40,000 of the 66,000 gallons of water used daily is for hot water, annual thermal energy for hot water consumption is:

40,000 gal/day * 250 day * 95 deg * 8.5 = 8,075 MMBtu

At $.52/therm and 75% boiler efficiency, and assuming 70% of the total heat is recoverable, the annual savings are:

80,750 therm * .70 / .75 * $.52/therm = $39,200

The costs for chemicals and electricity for such a system will be at least $2 per thousand gallons of water processed, or an annual cost of:

$2/1,000 gal * 60,000 gal/day * 250 day = $30,000

Maintenance costs at 2 hour/day adds $7,500 annually, for a final net savings of $60,300.

At an estimated cost of $250,000 for the DAF system and dewatering apparatus, the payback period is 4.1 years.

If FOG control is required, an alternative scheme which may be considered at the time of engineering is to recycle the rinse stages and apply a smaller DAF system to the reduced effluent scheme. Our preliminary rough analysis indicates a cost reduction of the DAF system of perhaps $50,000 and an increase in savings from reduced chemical use of approximately $7,500. At a total cost of $300,000 for the DAF and rinse recycle system and a net savings of $68,000, the payback period is 4.4 years.

REDUCE DOMESTIC CONSUMPTION

Discussion

There are approximately 15 toilets with standard Sloan flushometers in the laundry area, both in production and office space. We recommend providing retrofit flushometer kits to reduce the flow per flush by 1 gallon.

Savings

Based on 130 people and 4 flushes/person/day, the estimated savings is 175 ccf annually, or $535. At a cost of $20 per retrofit, the total cost is $300 for a payback period of .6 years.