MINTO ENERGY MANAGEMENT
IN COOPERATION WITH
CITY OF TORONTO AND CMHC

PRESENT

DOMESTIC COLD WATER BOOSTER PUMP CONTROL MONITORING PILOT PROGRAM

FINAL REPORT
FEBRUARY 2001

REPORT PREPARED BY:

VERITEC Consulting Inc.

minto

Executive Summary

Domestic Cold Water Booster Pump Control Pilot Program
High Park Village

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Minto Developments Inc., The City of Toronto and Canada Mortgage & Housing Corporation, in connection with their corporate initiatives to promote water and energy efficiency, were interested in the concept of domestic water booster pump control and wished to complete a pilot program to confirm the energy and water savings associated which such controls in a multi-residential high rise complex.

Minto, with their corporate goal of reducing energy and water costs in their multi-residential units, had contemplated using variable speed drive technology to control the domestic cold-water booster pumps at their High Park Village community.

A detailed monitoring program was developed for the seven building complex located directly across from High Park north of Bloor St. W. in Toronto. Veritec Consulting Inc. was retained by Minto to complete the monitoring program.

The monitoring consisted of using sophisticated datalogging equipment to record, at 15 minute intervals, water consumption, pressure (critical, city and boosted), and booster pump energy in all seven buildings for a four week baseline period, prior to any control, and a four week performance period following the implementation of the control system.

Prior to the implementation of booster pump control, Minto had successfully implemented a water management program at all seven High Park Village buildings in March 1999. The management program consisted of the installation of low flow toilets, showerheads and faucet aerators. Water savings of approximately 40% were tracked and verified across the portfolio with a simple payback of less than 3 years.

The following table illustrates the size and make up for each of the seven buildings:

Building	# Suites	# Floors	Booster Pump HP	Technology Implemented
35 High Park	201	26	30	PRV
65 High Park	321	22	25	VSD
95 High Park	218	17	7.5	VSD
66 Pacific Ave.	229	16	10	VSD
111 Pacific Ave.	242	17	7.5	VSD
66 Oakmount Ave.	171	12	5	VSD
255 Glenlake Ave.	336	23	15	VSD

The following table illustrates the results of the monitoring program for both the pre and post implementation for each building.

Building	Pre Water	Post Water	Pre Energy	Post Energy
35 High Park	444	428	357	108
65 High Park	429	437	239	86
95 High Park	374	445	84	20
66 Pacific Ave.	406	443	168	122
111 Pacific Ave.	357	359	76	55
66 Oakmount Ave.	270	286	47	36
255 Glenlake Ave.	330	304	138	118
Units	l/unit/day	l/unit/day	kWh/day	kWh/day

Pre monitoring was completed in March 2000 and post monitoring was completed in April – May 2000 (35 & 95 High Park post monitoring was delayed to early fall 2000).

Based on the tracked water consumption the overall water savings achieved at High Park Village was, on average, non-existent. Only two buildings – 255 Glenlake Ave. (8%) and 35 High Park (4%) - showed a reduction in water demand during the post monitoring. However, it must be noted that 66 Pacific Ave. showed a 10% increase and 95 High Park showed a 19% increase in consumption during the post monitoring. It is believed that the difference between pre and post demand is more likely due to standard demand variation rather than the VSD control (for both the increases and decreases in demands).

The energy savings achieved were very apparent. The overall booster pump energy consumption was 1109 kWh/day pre vs. 545 kWh/day post – a 51% global reduction in energy consumption in the seven buildings. This energy savings equates to a yearly savings of $14,822 in energy costs based on a rate of $0.072 per kWh. This gives a simple payback of 3.4 years based on a system installation cost of $35,000 for each of the seven buildings and including the pump replacement costs for 35 & 95 High Park.

In conclusion, this study has identified that water savings may not always be achieved through the use of VSD technology on domestic cold water booster pumps in well maintained multi-residential high rise buildings.

Based on these results, it is our opinion that the VSD technology on a domestic cold water booster pump high rise application should be evaluated based solely on the energy merits. While we believe that water savings may be achieved in buildings with extensive leaks, fixture replacement or retrofit programs should provide a more cost effective solution to high water consumption rather then lowering the pressure in leaky buildings.

For proper water efficiency we conclude that building owners should:

1. *Trend water use in their buildings.*
2. *Implement cost effective water conversions.*
3. *Install VSD technology on the booster pumps.*
4. *Continuously track and monitor performance.*
5. *Evaluate cost effectiveness of proper pump sizing.*

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1.0 PROJECT BACKGROUND

With growing utility costs, aging infrastructure and environmental awareness, most public and private sector organizations are looking at demand side management (DSM) initiatives to reduce utility costs and to reduce the strain on production.

Minto Developments Inc. has adopted an aggressive demand side management philosophy and was considering the implementation of variable speed drives to regulate domestic cold water booster pumps in their high-rise buildings. With the cooperation of CMHC and the City of Toronto, Minto opened its doors to testing and publishing the results of a booster pump pilot project.

The program was drafted such that two different control technologies were to be tested and monitored for water, energy and gas savings. These control systems were as follows:

- Variable Speed Drive Motors – booster pump speed is controlled by a VSD which changes the speed of the pump motor in order to maintain a set pressure at the top floor (penthouse) of the building. For the test an ABB ACS400 series drive was installed on a relatively new motor.

- Variable Pressure Reducing Valve – the building pressure is controlled by a variable PRV which is constantly adjusting to maintain a set pressure at the top floor (penthouse) of the building. The PRV is controlled by a small motor, which increases or decreases the PRV pilot valve setting based on an actual pressure signal from the penthouse. A new Cla-Val (Model 130-01) PRV with motorized actuator & integral controller was used.

2.0 BOOSTER PUMP MONITORING METHODOLOGY

The building monitoring consisted of installing flow and pressure recorders for a four week period prior to the control system installation and four weeks following the installation of the system. In all seven buildings of the High Park Village, flow was recorded at the main municipal meter and pressure was recorded at the City supply, the booster pump outlet and the top floor of each building. Booster pump power consumption was also recorded in each building.

In addition, two particular buildings (35 High Park and 95 High Park) underwent a more "in depth" monitoring program. The booster pump control system which was implemented in 95 High Park was the variable speed drive conversion system and in 35 High Park it was the motorized pressure reducing valve. In these buildings, in addition to the main flow, an ultrasonic strap-on flowmeter and datalogger was used to monitor the hot water supply.

A full engineering report was prepared on the data collected during the pre and post installation stages. In addition, water, and energy savings were established to calculate a project payback period. The final report was also prepared in accordance with the requirements of both the City of Toronto and CMHC, which have requested that a set of parameters be established to determine the effectiveness of these control systems on other multi-residential buildings.

The equipment used for the monitoring program utilized the latest in technology and provided highly accurate information for the design or evaluation of efficiency measures. The following equipment was used on this project:

Domestic Cold Water
Newly installed 2" positive displacement meters with pulse generators to record the domestic cold water consumption at 15 minute intervals. All meters installed were installed by a licensed contractor and they were tested and met AWWA specifications for meter accuracy.

Domestic Hot Water
Ultrasonic strap-on water meters were utilized to record the domestic hot water in 35 and 95 High Park. The ultrasonic meters have been tested for accuracy and provided results that were within +/- 5% based on the installation parameters at the sites. Logging was completed at a 15 minute interval.

Building Pressures
Building water pressures were recorded by high resolution pressure recorders, which were recently calibrated and provided accuracy to within 0.5%. Logging was completed at a 15 minute interval.

Booster Pump Power Consumption
The booster pump power consumption was recorded with the use of actual power monitors installed on each pump. Actual kW usage was recorded as opposed to the traditional amperage monitoring to allow for very accurate calculations of the energy. Logging was completed at a 15 minute interval.

3.0 BUILDING MONITORING & RESULTS

3.1 High Park Village General Description

High Park Village is a cluster of seven multi-residential high rise buildings located in the City of Toronto directly north of the prestigious High Park.

The high rise buildings that form the High Park Village include 35 High Park, 65 High Park, 95 High Park, 66 Pacific Ave., 111 Pacific Ave., 66 Oakmount Ave. and 255 Glenlake Ave.

The High Park Village Buildings managed by Minto Management Limited, have undergone several improvements, which included water management, and domestic water plumbing improvements.

In April 1999, Minto completed a water management program for all seven buildings of the High Park Village. All existing water closets, showerheads and faucet aerators were replaced with low flow water efficient fixtures. Initially the water savings achieved from the water management program were below expectations and over the first 4 months the savings eroded to less then 15%. A lengthy investigation revealed that the lost water savings were due to the creeping of the ballcock assembly used in most of the replacement water closets. The faulty ballcocks were replaced with new assemblies and water savings in every building increased to 35% to 45%. These savings achieved a simply payback for the water management program at High Park Village of less than 3 years.

Following the water management program, Minto was interested in initiating more advanced water and energy management programs which included constant monitoring of system pressure and flow, and domestic cold water booster pump control. Following discussions with the City of Toronto and CMHC, in December 1999, Minto entered into an agreement to undertake a "*Domestic Cold Water Booster Pump Control Pilot Program*".

The following describes, in detail, each building and the level of control and results obtained from the monitoring of the booster pump control pilot program.

3.2 35 High Park

3.2.1 Building Description

Located at 35 High Park, this multi-residential high rise building is the tallest in the High park portfolio. The building is 26 floors and encompasses a total of 201 suites. The building is hot water heated. Both the domestic hot water and heating hot water is heated from central gas fired boilers located in 65 High Park. There is an additional central boiler system located at 35 High Park which provides additional hot water heating in the winter months only.

3.2.2 Building Plumbing System

The plumbing system at 35 High Park prior to the completion of the monitoring program was as follows (please refer to the plumbing system schematic at the end of this section):

Domestic Cold Water
Domestic cold water is provided from the City of Toronto through a service line that enters the boiler room at 35 High Park. The service line tees into the fire protection or sprinkler system and the domestic cold water system where it passes through the City billing meter. Immediately downstream from the City billing meter is the Minto control meter which was used to collect the demand information for this building.

Prior to the booster pump assembly, there is a feed to the building's lawn irrigation system. The domestic cold water booster pump assembly is comprised of the following:

Primary Pump:	30HP motor with base mount suction pump with fluid coupled transmission.
Secondary Pump:	7.5HP motor with base mount suction pump.

The secondary pump was not in operation and was valved off prior to the monitoring program due to a faulty check valve causing water to circulate backwards through the secondary pump. The primary pump was also in poor condition requiring constant refilling of the transmission fluid. The pump motor was also clearly oversized for this building.

Following the booster pump assembly, the domestic cold water is divided into a high pressure and low pressure zone. The high pressure zone is fed directly from the booster pump discharge pressure (140 psi) and services floors 14 to 26. The low pressure zone is fed from the booster pump and the pressure is reduced through a pressure reducing valve (100 psi) and services floors 1 to 14. Both zones are top fed meaning that the water is pumped to the top floor of each zone and distributed along a central main at that floor and then fed downwards through individual risers.

Domestic Hot Water
The domestic hot water system is also divided into the same two zones as the domestic cold water system. The hot water system is however constantly re-circulated to ensure a constant temperature. There is a hot water make up feed for each zone from the matching domestic cold water system.

3.2.3 Water Demand & Water Management History

Prior to any water management, the average daily consumption recorded at 35 High Park between June 1998 and February 1999 was 173 m^3/day or 860 l/suite/day. Following the replacement of water closets and showerheads in March 1999, the water consumption was reduced 20%. After the replacement of the faulty ballcocks in late 1999, the consumption reduced to 90 m^3/day or 448 l/suite/day in January 2000. This represented a savings of 45%.

3.2.4 Pre Booster Pump Control Monitoring

In order to establish the baseline pre-control water and energy demand, a detailed monitoring program was completed at 35 High Park from March 1 to March 28, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post Low Zone PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy
- Hot Water Consumption

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of the recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	17	43	97	69	15	15
Maximum	30	51	110	71	154	15
Average	25	47	104	70	59	15
Units	m	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	19	44	99	69	17	14
Maximum	30	51	109	71	136	15
Average	25	47	104	70	69	15
Units	m	m	m	m	l/min	kWh/h

The average daily consumption recorded at 35 High Park during the pre control monitoring was as follows:

Parameter	Water Demand	Hot Water	Booster Pump Energy
Weekday	424	157	358
Weekend	496	193	357
Units	l/unit/day	l/unit/day	KVA/day

3.2.5 Post Booster Pump Control Monitoring

The control system implemented at 35 High Park was a motorized PRV control system manufactured by Cla-Val Co. The PRV pilot valve is constantly adjusted by a small motor which in turn is controlled by adjusting the set point of the valve to control the critical point pressure.

During the course of the pre monitoring, the condition of the primary booster pump became critical. With limited secondary pump capacity, Minto was concerned with the security of water supply at the building. It was therefore decided to install a new pump assembly at the building prior to starting the post monitoring.

With the data collected during the pre monitoring (consumption and pressure), a properly sized pump assembly was designed. The new pump was downsized from the original 30HP motor to a 10HP motor with 100% redundant backup. This pump installation delayed the implementation of the post monitoring.

The new pump design was as follows:

Primary Pump: 10HP motor with base mount suction pump.
Secondary Pump: 10HP motor with base mount suction pump.

Based on the pre-monitoring results, the set point of the PRV controller was adjusted to 14 m or 20 psi pressure at the critical point. The post-control monitoring program was completed at 35 High Park from August 8 to August 29, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post Low Zone PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy
- Hot Water Consumption

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of the recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	14	42	96	69	13	3.9
Maximum	15	52	98	71	148	5.5
Average	15	48	97	70	56	4.5
Units	m	m	m	m	l/min	KVA/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	14	44	93	69	15	4.0
Maximum	16	50	94	71	128	5.2
Average	15	46	94	70	68	4.6
Units	m	m	m	m	l/min	KVA/h

The average daily consumption recorded at 35 High Park during the post control monitoring was as follows:

Parameter	Water Demand	Hot Water	Booster Pump Energy
Weekday	404	146	108
Weekend	487	185	109
Units	l/unit/day	l/unit/day	kWh/day

3.2.6 Water & Energy Savings Calculations

Based on the results obtained from the pre & post control monitoring the following savings were obtained.

Critical Pressure

Average Pre Pressure: 25 m
Average Post Pressure: 15 m
Reduction Percentage: 40 %

Water Demand

Average Pre Demand: 445 l/suite/day
Average Post Demand: 428 l/suite/day
Reduction in Water Demand: 4%

Booster Pump Energy

Average Pre Demand: 358 kWh/day
Average Post Demand: 108 kWh/day
Reduction in Energy: 70%[1]

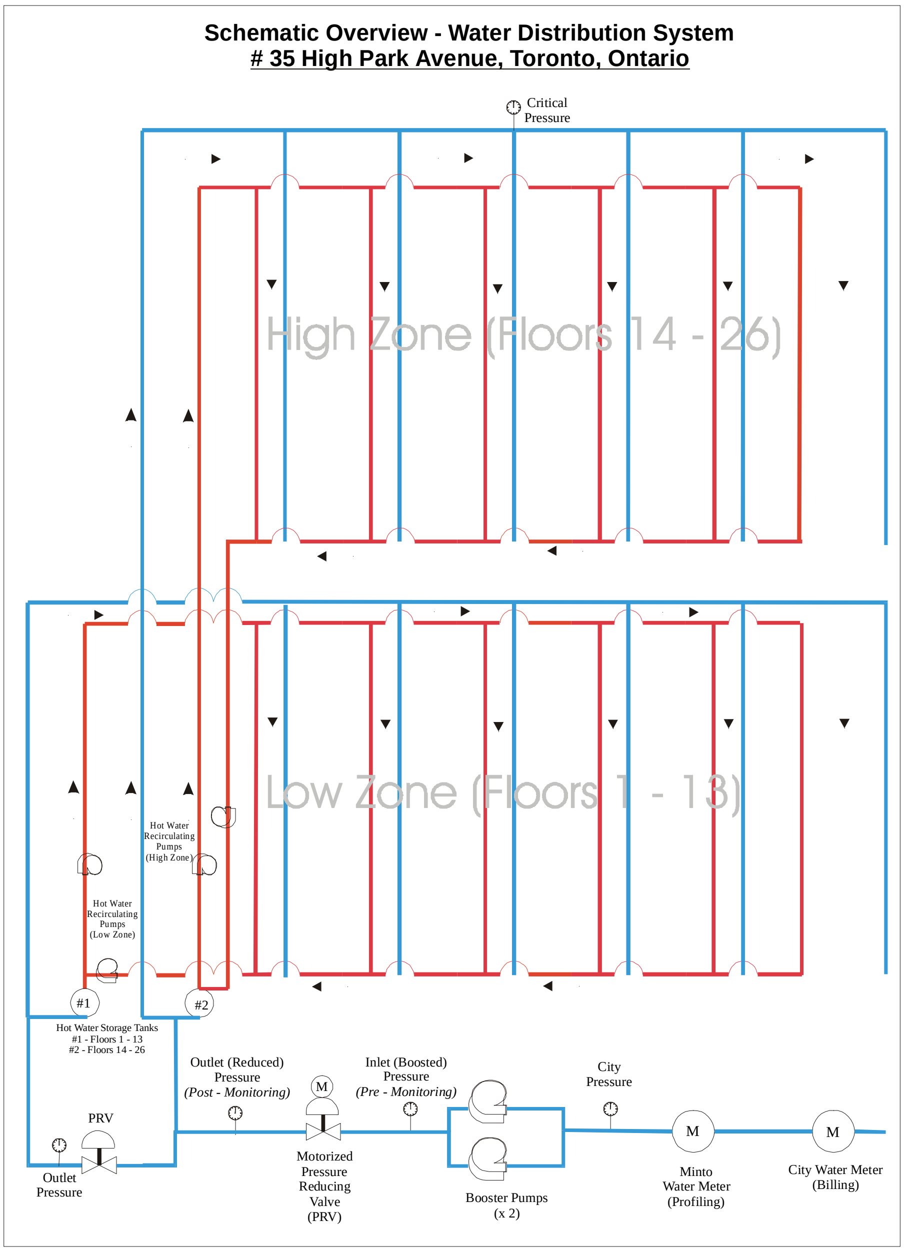
[1] Please note that the energy savings is due to the proper sizing of the new pumps from 30HP to 10HP. The PRV valve does not contribute energy savings.

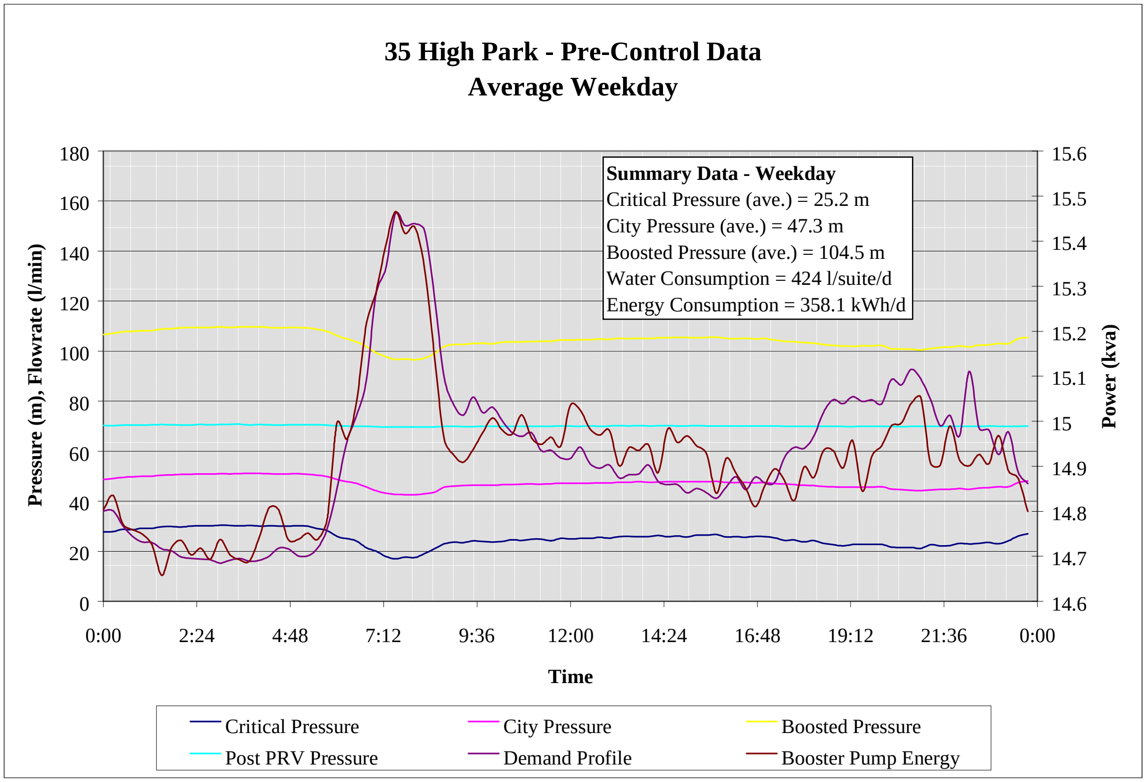
In order to complete a simple payback calculation the following rates were used:

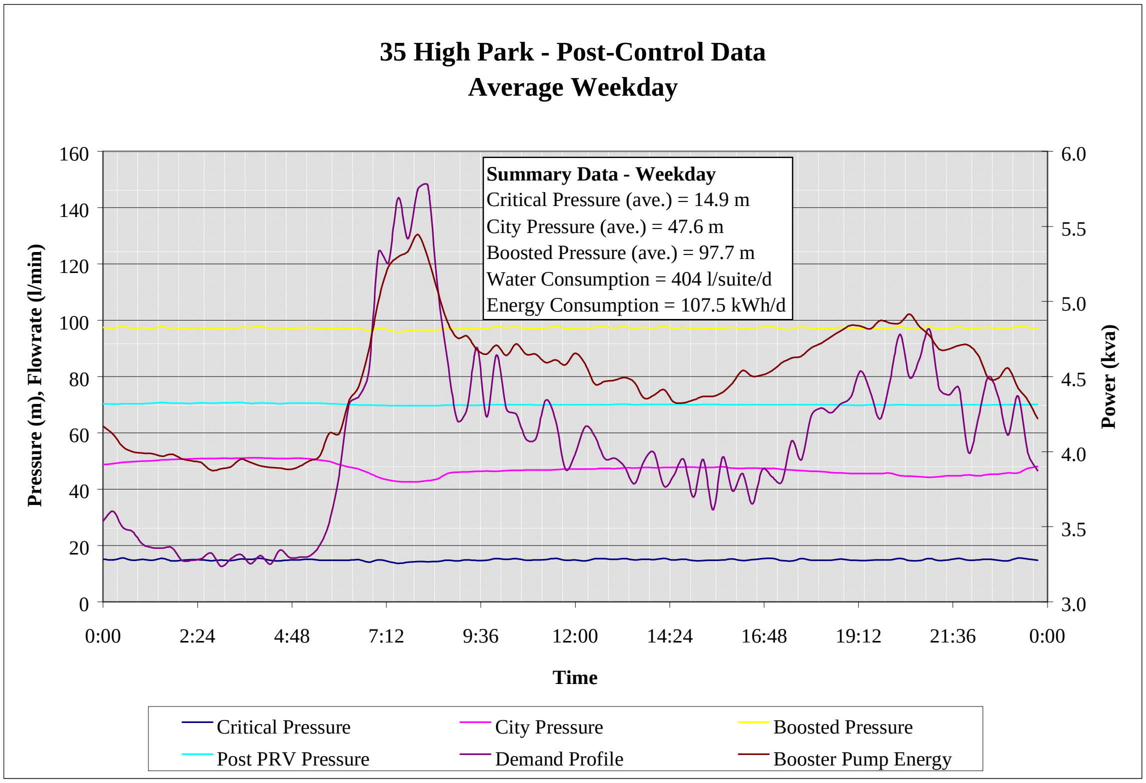
Cost of Water:	$0.96 per m^3
Cost of Energy:	$0.072 per kWh
Cost of PRV:	$5,500
Cost of New Pumps:	$10,000

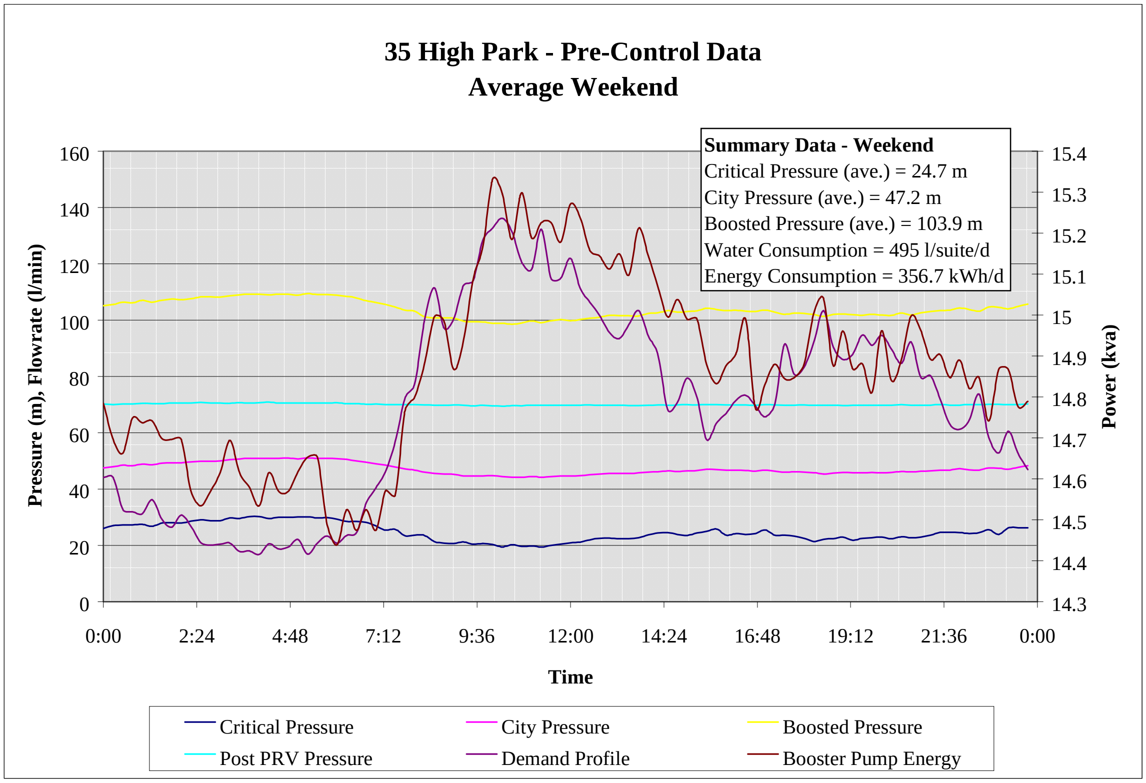
Estimated yearly water savings:	$1,250.00
Estimated yearly energy savings:	$6,570.00
Total Savings	**$6,570.00**

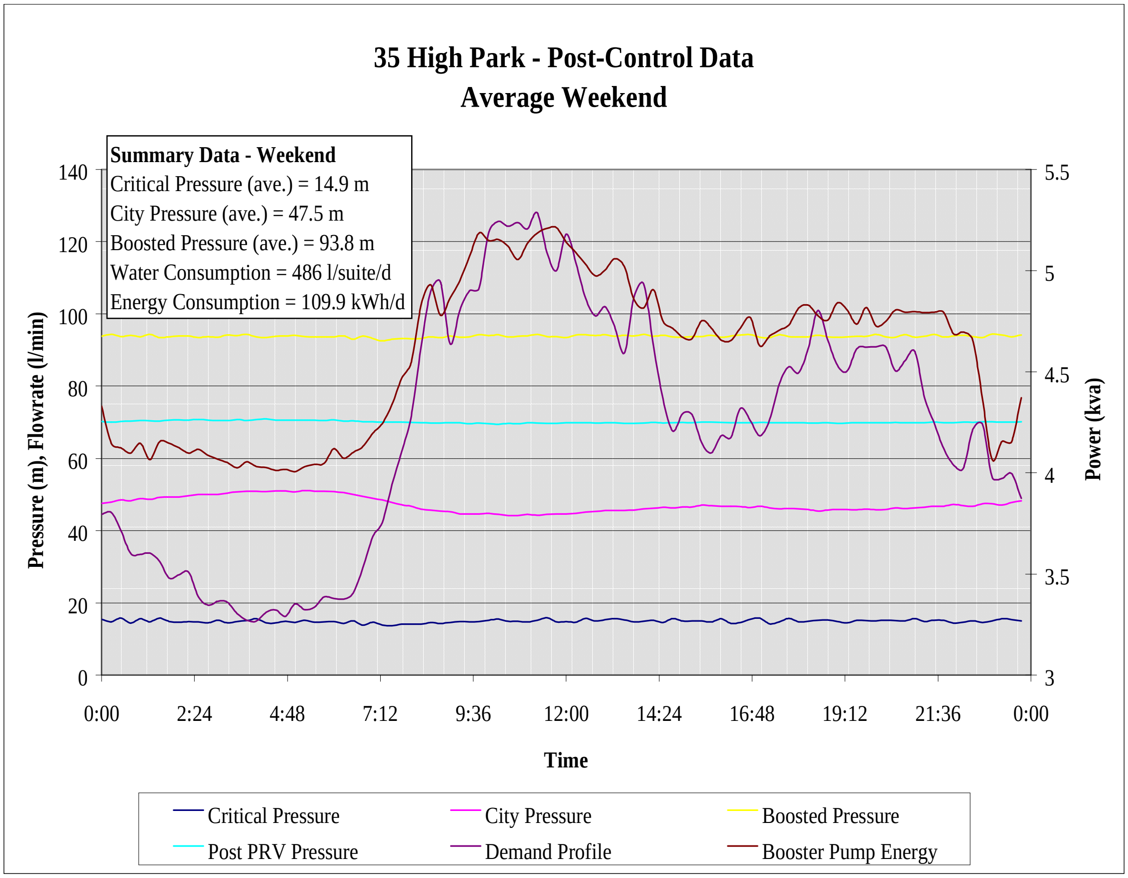
Simply Payback Calculation: **2.4 years**

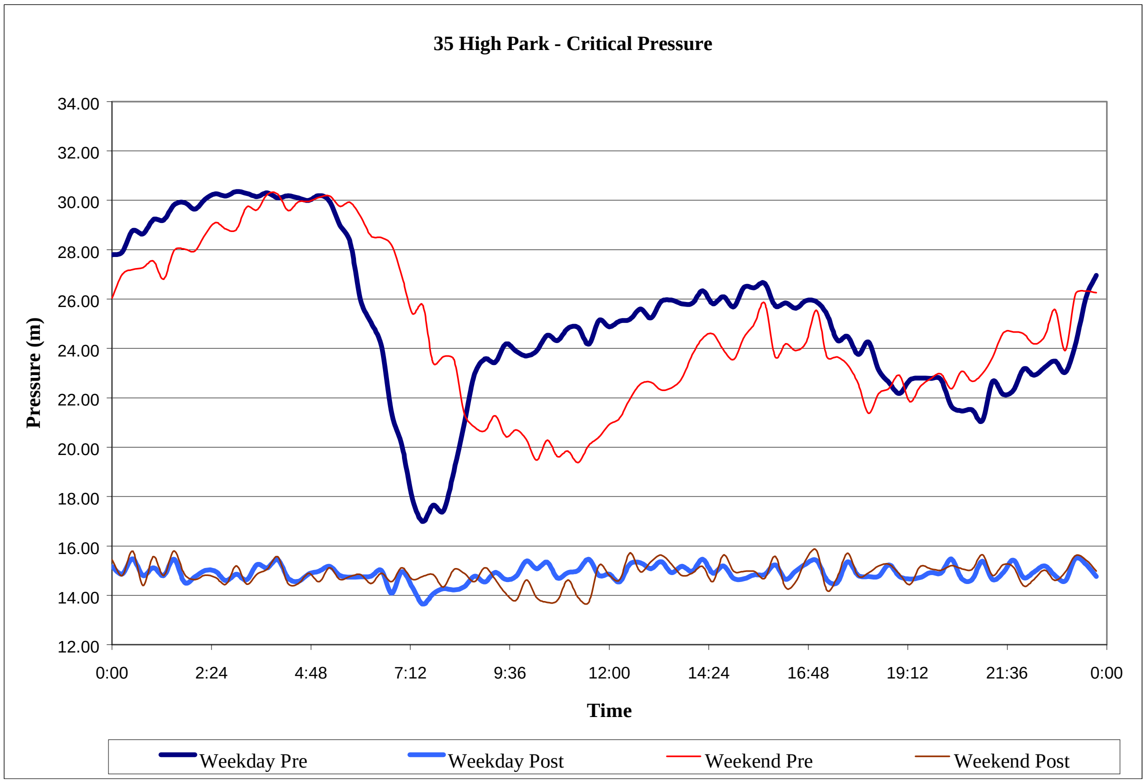


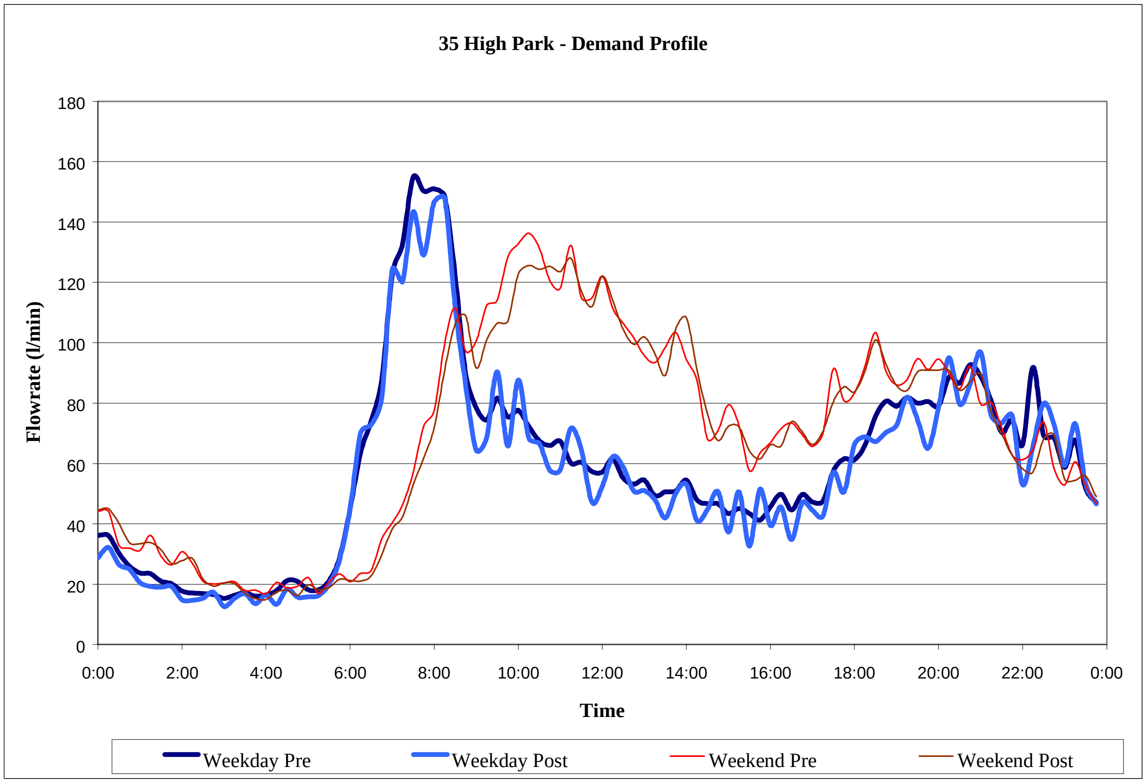

35 High Park - Pre-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 25.2 m
City Pressure (ave.) = 47.3 m
Boosted Pressure (ave.) = 104.5 m
Water Consumption = 424 l/suite/d
Energy Consumption = 358.1 kWh/d
Pressure (m), Flowrate (l/min)
Power (kva)
Time
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy

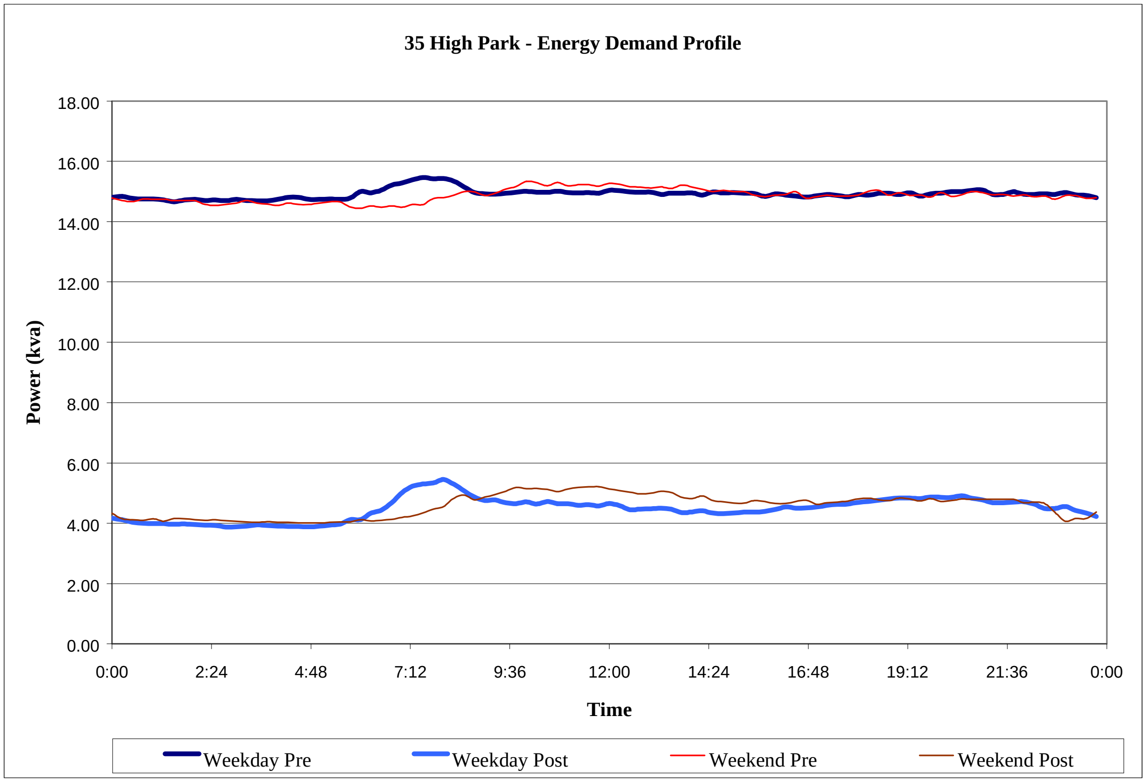

35 High Park - Post-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 14.9 m
City Pressure (ave.) = 47.6 m
Boosted Pressure (ave.) = 97.7 m
Water Consumption = 404 l/suite/d
Energy Consumption = 107.5 kWh/d
Pressure (m), Flowrate (l/min)
Power (kva)
Time
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


35 High Park - Pre-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 24.7 m
City Pressure (ave.) = 47.2 m
Boosted Pressure (ave.) = 103.9 m
Water Consumption = 495 l/suite/d
Energy Consumption = 356.7 kWh/d
Pressure (m), Flowrate (l/min)
Power (kva)
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


35 High Park - Post-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 14.9 m
City Pressure (ave.) = 47.5 m
Boosted Pressure (ave.) = 93.8 m
Water Consumption = 486 l/suite/d
Energy Consumption = 109.9 kWh/d
Pressure (m), Flowrate (l/min)
Power (kva)
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


35 High Park - Critical Pressure
Pressure (m)
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


35 High Park - Demand Profile
Flowrate (l/min)
180
160
140
120
100
80
60
40
20
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


35 High Park - Energy Demand Profile
Power (kva)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post

3.3 65 High Park

3.3.1 Building Description

65 High Park is the second largest multi-residential high-rise at High Park Village. The building is 22 floors and encompasses a total of 321 suites. In addition, 65 High Park also services a health and fitness club with an indoor swimming pool. The building is hot water heated. Both the domestic hot water and heating hot water is heated from gas-fired boilers located in 65 High Park.

3.3.2 Building Plumbing System

The plumbing system at 65 High Park prior to the completion of the monitoring program was as follows (please refer to the plumbing system schematic at the end of this section):

Domestic Cold Water

Domestic cold water is provided from the City of Toronto through a service line that enters the boiler room at 65 High Park. The service line tees into the fire protection or sprinkler system and the domestic cold water system where it passes through the City billing meter. Immediately downstream from the City billing meter is the Minto control meter which was used to collect the demand information for this building.

Prior to the booster pump assembly, there is a feed to the buildings lawn irrigation system. The domestic cold water booster pump assembly is comprised of the following:

Primary Pump:	25HP motor with base mount suction pump.
Secondary Pump:	-Out of Service

Following the booster pump assembly a PRV reduces the boosted pressure to approximately 130 psi. The domestic cold water is divided into a high pressure and low pressure zone. The high pressure zone is fed directly from post booster pump PRV pressure (130 psi) and services floors 14 to 23. The low pressure zone is fed from a second pressure reducing valve and services floors 1 to 12. Both zones are top fed meaning that the water is pumped to the top floor of each zone and distributed along a central main at that floor and then fed downwards through individual risers.

Domestic Hot Water

The domestic hot water system is also divided into the same two zones as the domestic cold water system. The hot water system is however constantly re-circulated to ensure a constant temperature. There is a hot water make up feed to each zone from the domestic cold water system.

3.3.3 Water Demand & Water Management History

Prior to any water management, the average daily consumption recorded at 65 High Park between March 1998 and February 1999 was 239 m^3/day or 745 l/suite/day. Immediately following the replacement of water closets and showerheads in March 1999, the water consumption was reduced 20%. Following the replacement of the faulty ballcocks in late 1999, the consumption reduced to 137 m^3/day or 427 l/suite/day in February 2000. This represented a savings of 40%.

3.3.4 Pre Booster Pump Control Monitoring

In order to establish the baseline pre-control water and energy demand, a detailed monitoring program was completed at 65 High Park from March 1 to March 28, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Post Boosted Pressure PRV
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Water Demand	Energy Demand
Minimum	21	38	89	33	9
Maximum	24	47	91	248	12
Average	23	43	90	95	10
Units	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Water Demand	Energy Demand
Minimum	19	40	90	16	9
Maximum	24	47	91	194	11
Average	23	43	90	98	10
Units	m	m	m	l/min	kWh/h

The average daily consumption recorded at 65 High Park during the pre control monitoring was as follows:

Parameter	Water Demand	Booster Pump Energy
Weekday	426	237
Weekend	440	244
Units	l/unit/day	kWh/day

In addition, meter readings from the 65 High Park health club were also taken. During the test, the average daily usage at the club was less than 1% of the total building consumption. Since this number is insignificant it was not deducted from the total results for both pre and post monitoring.

3.3.5 Post Booster Pump Control Monitoring

The control system implemented at 65 High Park was an ABB variable speed drive on the existing primary booster pump's 25HP inverter duty motor. Based on the pre monitoring results and location of the pressure transducer, it was determined that the set point for the critical pressure would be 21 m or 30 psi.

The post control monitoring program was completed at 65 High Park from April 7 to May 8, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Post Boosted Pressure PRV
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Water Demand	Energy Demand
Minimum	19	38	86	23	3
Maximum	22	47	90	243	5
Average	21	43	88	95	3
Units	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Water Demand	Energy Demand
Minimum	20	41	88	22	3
Maximum	22	47	89	190	5
Average	21	43	88	103	4
Units	m	m	m	l/min	kWh/h

The average daily consumption recorded at 65 High Park during the post control monitoring was as follows:

Parameter	Water Demand	Booster Pump Energy
Weekday	427	80
Weekend	461	101
Units	l/unit/day	kWh/day

3.3.6 Water & Energy Savings Calculations

Based on the results obtained from the pre & post control monitoring the following savings were obtained.

Critical Pressure

Average Pre Pressure: 23 m
Average Post Pressure: 21 m
Reduction Percentage: 9 %

Water Demand

Average Pre Demand: 430 l/suite/day
Average Post Demand: 437 l/suite/day
Reduction in Water Demand: 0%

Booster Pump Energy

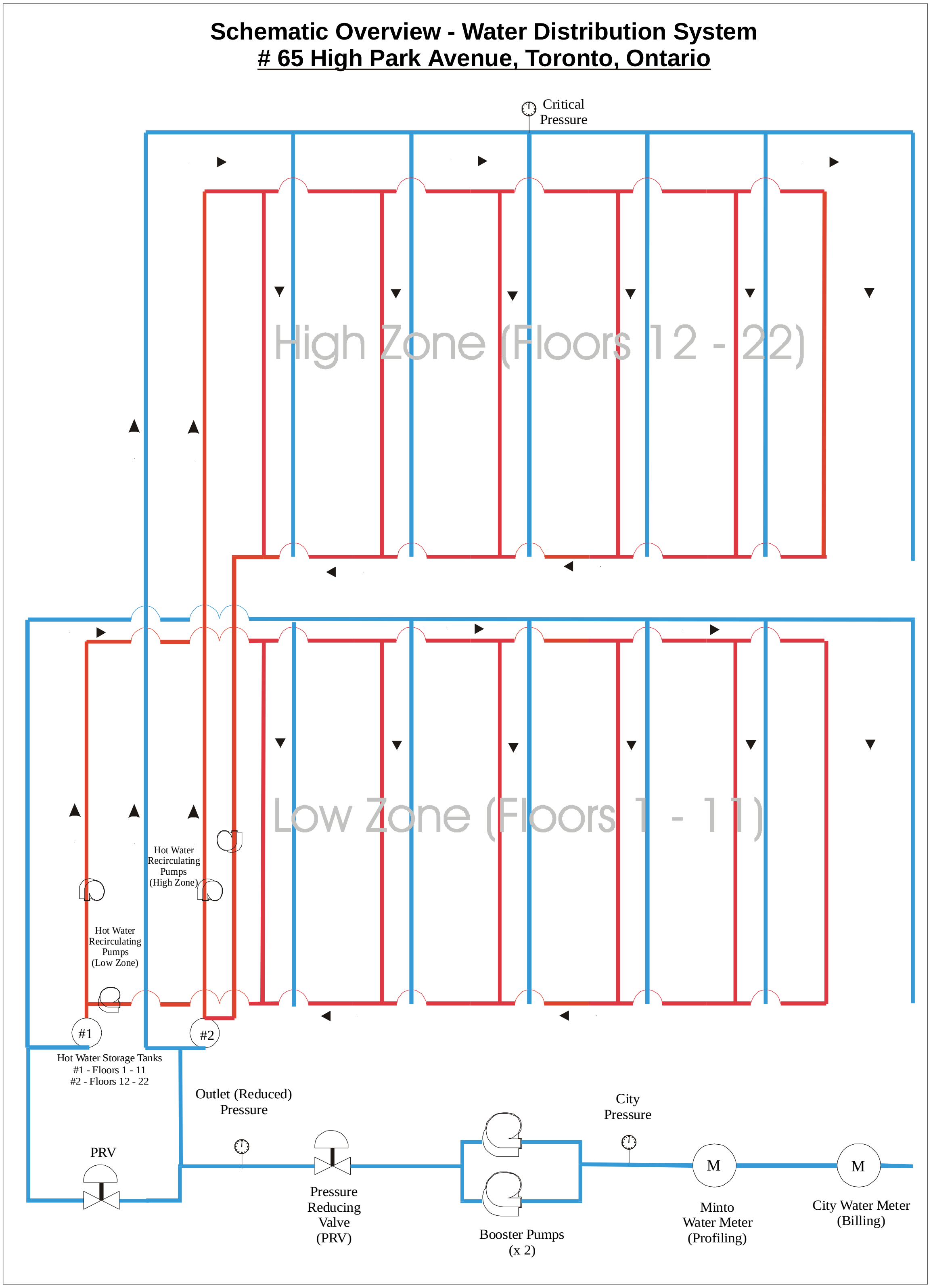
Average Pre Demand: 239 kWh/day
Average Post Demand: 86 kWh/day
Reduction in Energy: 64%

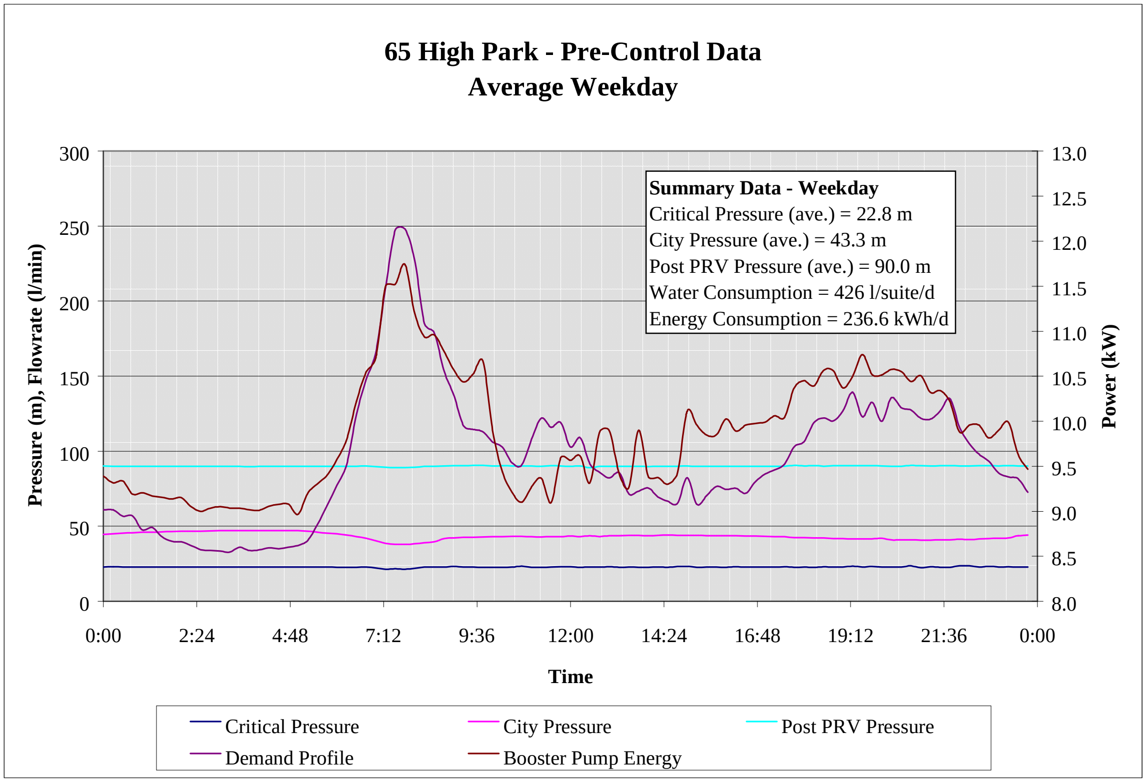
In order to complete a simple payback calculation the following rates were used:

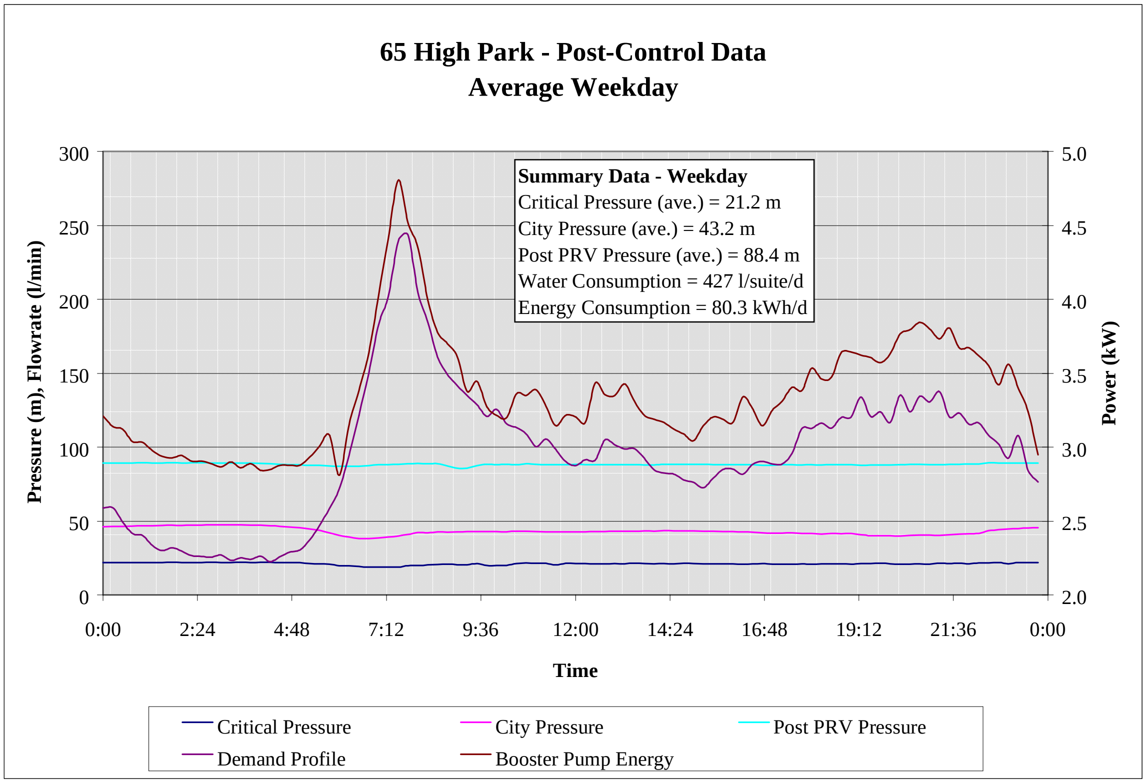
Cost of Water: \$0.96 per m^3
Cost of Energy: \$0.072 per kWh
Cost of VSD: \$5,000

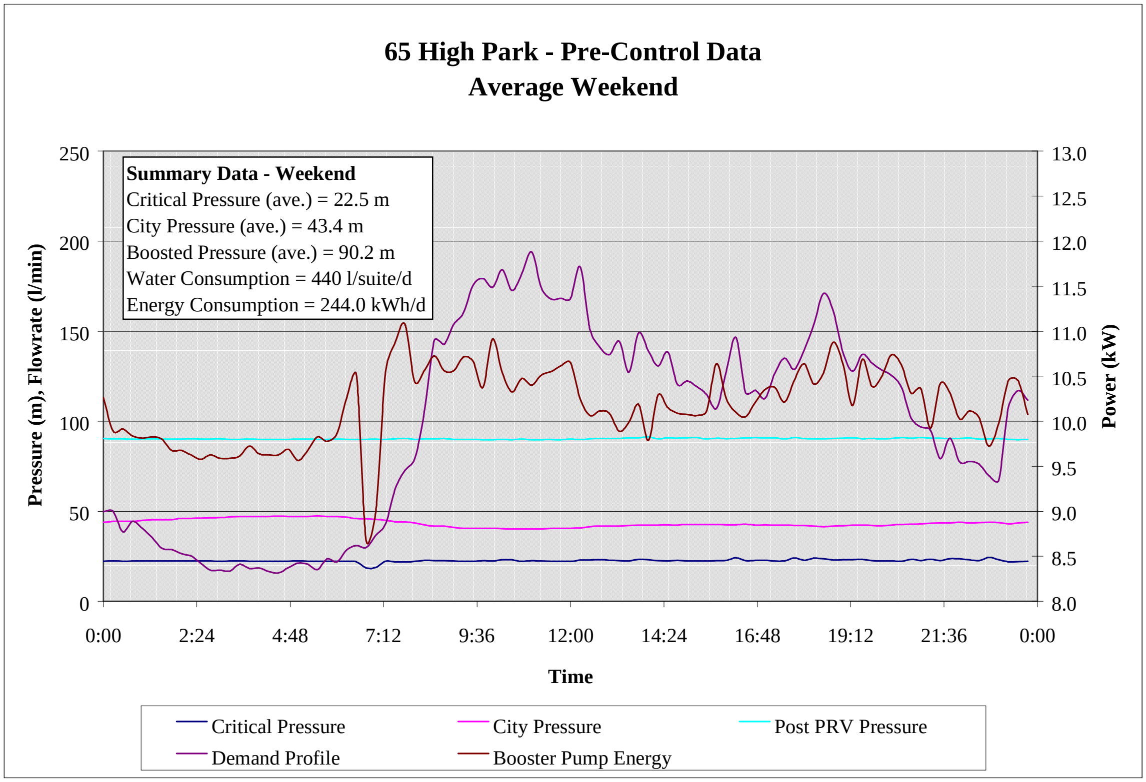
Estimated yearly water savings: $ 0.00
Estimated yearly energy savings: $4,020.00
Total Savings **$4,020.00**

Simply Payback Calculation: **1.2 years**

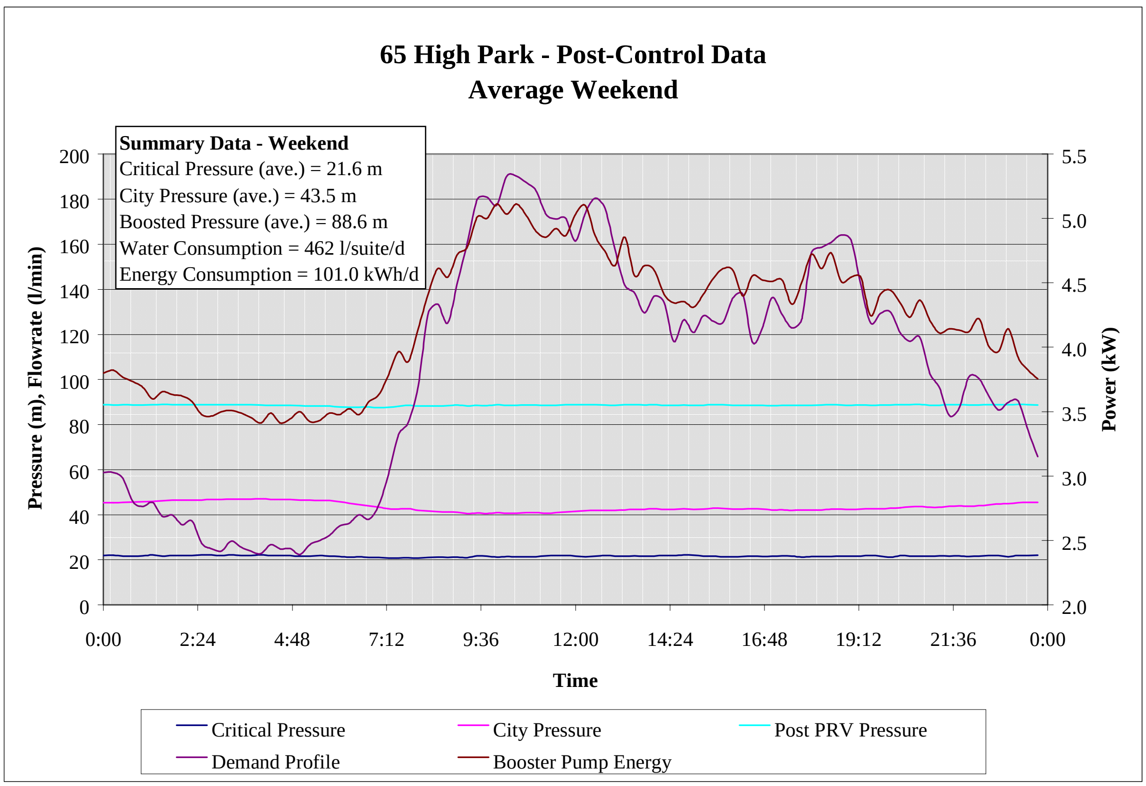

Schematic Overview - Water Distribution System
65 High Park Avenue, Toronto, Ontario
Critical Pressure
High Zone (Floors 12 - 22)
Low Zone (Floors 1 - 11)
Hot Water Recirculating Pumps (High Zone)
Hot Water Recirculating Pumps (Low Zone)
#1
#2
Hot Water Storage Tanks
#1 - Floors 1 - 11
#2 - Floors 12 - 22
PRV
Outlet (Reduced) Pressure
Pressure Reducing Valve (PRV)
Booster Pumps (x 2)
City Pressure
M
Minto Water Meter (Profiling)
M
City Water Meter (Billing)


65 High Park - Pre-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 22.8 m
City Pressure (ave.) = 43.3 m
Post PRV Pressure (ave.) = 90.0 m
Water Consumption = 426 l/suite/d
Energy Consumption = 236.6 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0
50
100
150
200
250
300
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy

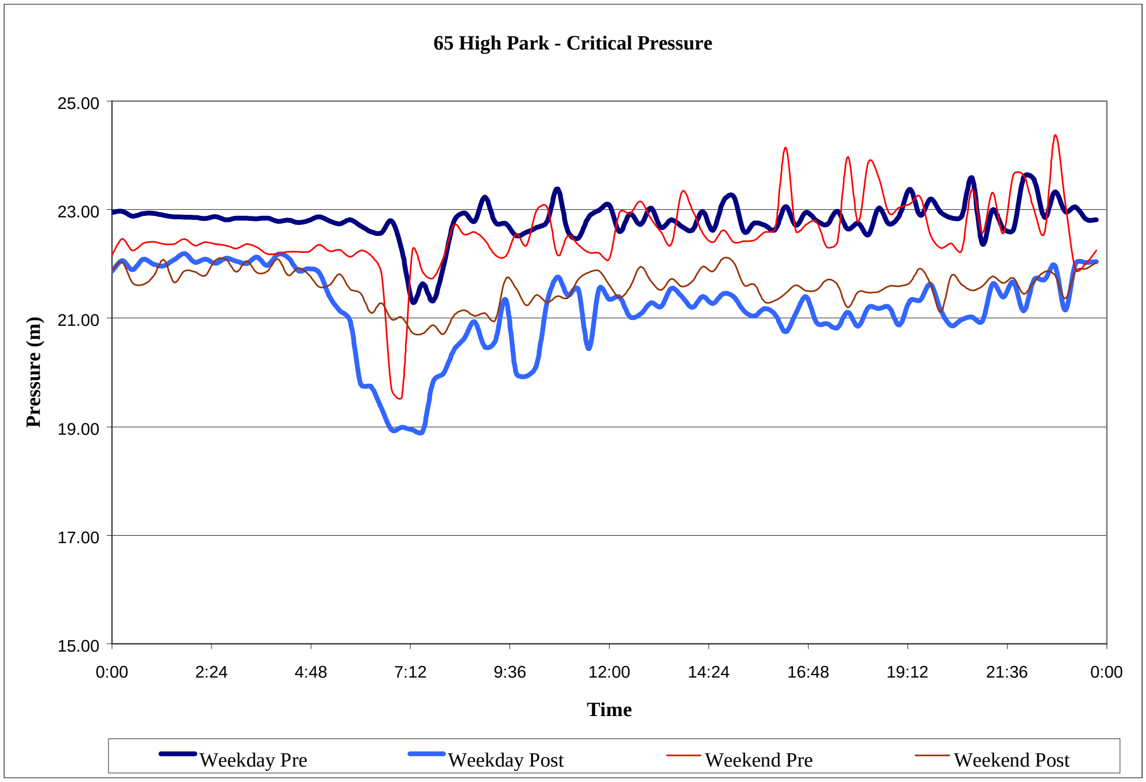

65 High Park - Post-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 21.2 m
City Pressure (ave.) = 43.2 m
Post PRV Pressure (ave.) = 88.4 m
Water Consumption = 427 l/suite/d
Energy Consumption = 80.3 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0
50
100
150
200
250
300
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy

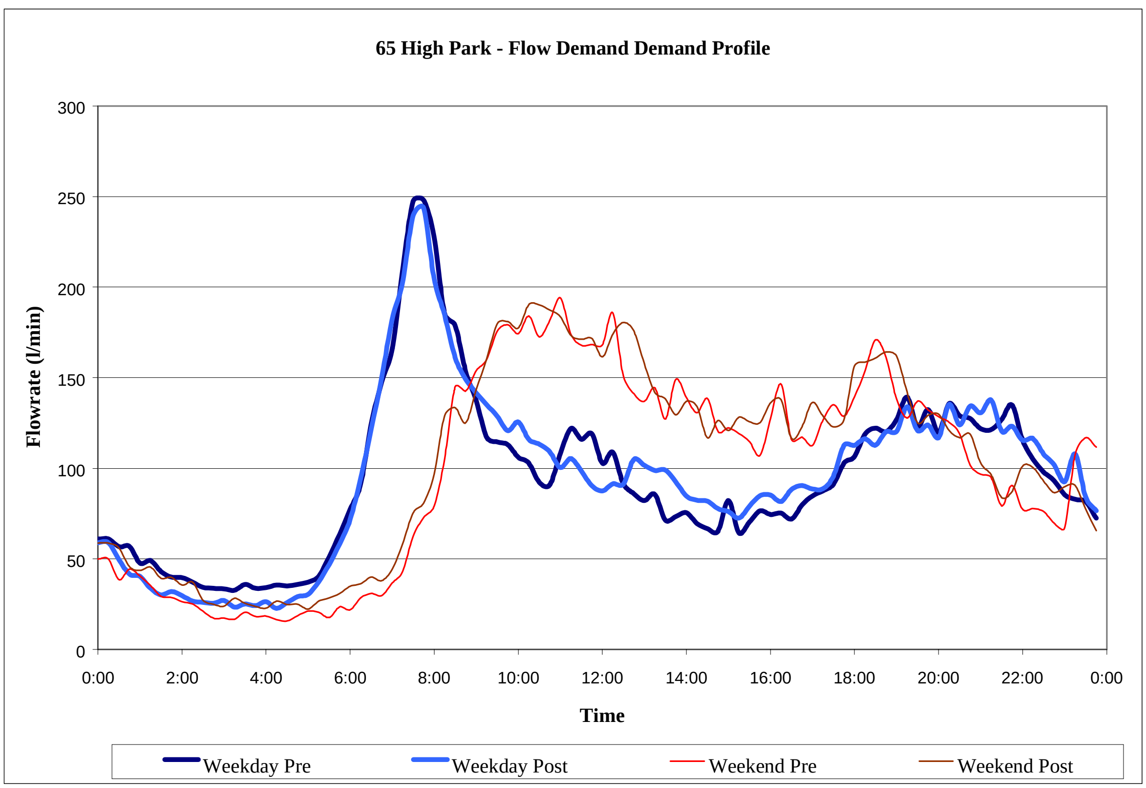


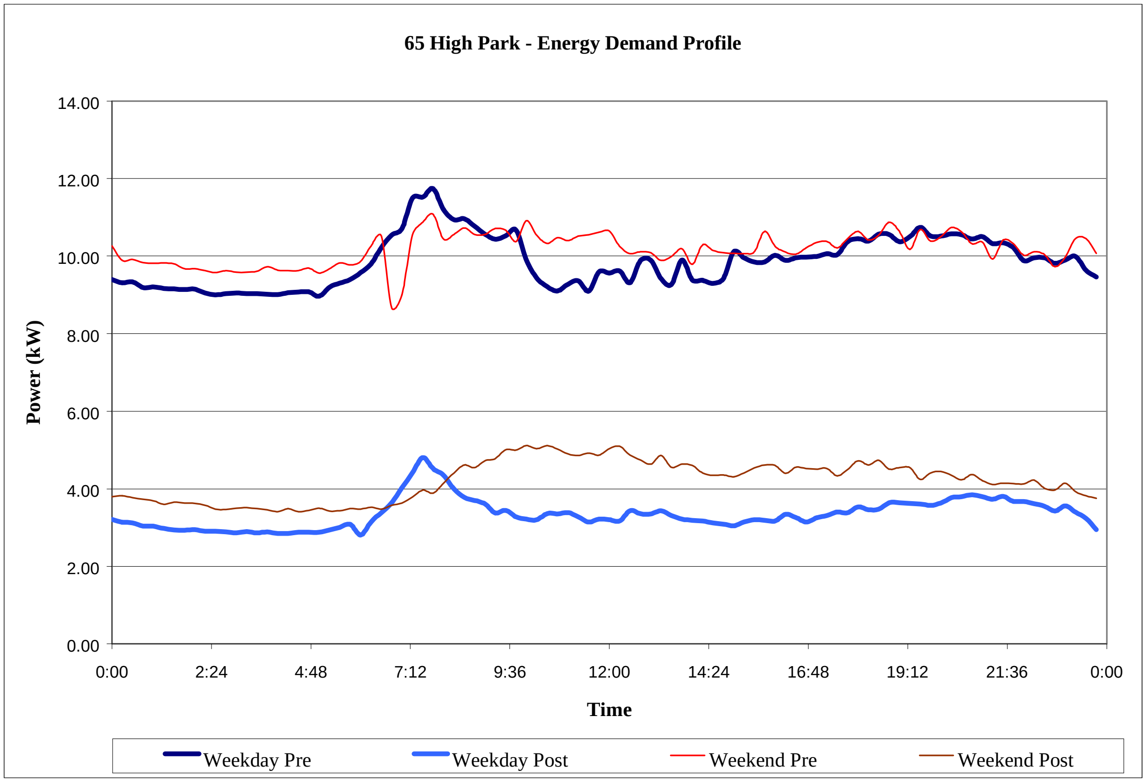
65 High Park - Pre-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 22.5 m
City Pressure (ave.) = 43.4 m
Boosted Pressure (ave.) = 90.2 m
Water Consumption = 440 l/suite/d
Energy Consumption = 244.0 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
250
200
150
100
50
0
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Critical Pressure
City Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy



65 High Park - Post-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 21.6 m
City Pressure (ave.) = 43.5 m
Boosted Pressure (ave.) = 88.6 m
Water Consumption = 462 l/suite/d
Energy Consumption = 101.0 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
200
180
160
140
120
100
80
60
40
20
0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Critical Pressure
City Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


65 High Park - Critical Pressure
25.00
23.00
21.00
19.00
17.00
15.00
Pressure (m)
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


65 High Park - Flow Demand Demand Profile
300
250
200
150
100
50
0
Flowrate (l/min)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


65 High Park - Energy Demand Profile
Power (kW)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post

3.4 95 High Park

3.4.1 Building Description

95 High Park is a multi-residential high rise building with 17 floors and a total of 218 suites. The building is hot water heated. Both the domestic hot water and heating hot water is heated from gas fired boilers located in 65 High Park.

3.4.2 Building Plumbing System

The plumbing system at 95 High Park prior to the completion of the monitoring program was as follows (please refer to the plumbing system schematic at the end of this section):

Domestic Cold Water
Domestic cold water is provided from the City of Toronto through a service line that enters the sprinkler room at 95 High Park. The service line tees into the fire protection or sprinkler system and the domestic cold water system where it passes through the City billing meter. Immediately downstream from the City billing meter is the Minto control meter which was used to collect the demand information for this building.

The domestic cold water booster pump assembly is comprised of the following:

Primary Pump:	7.5HP motor with base mount suction pump.
Secondary Pump:	7.5HP motor with base mount suction pump.

Following the booster pump assembly, the domestic cold water pressure is reduced through an existing PRV to 102 psi. There is only one zone in this building. Water in the building is top fed meaning that the water is pumped to the top floor and distributed along a central main at that floor and then fed downward through individual risers.

Domestic Hot Water
The domestic hot water system is also one zone. The hot water system is however constantly re-circulated to ensure a constant temperature. There is a hot water make up feed from the domestic cold water system.

3.4.3 Water Demand & Water Management History

Prior to any water management, the average daily consumption recorded at 95 High Park between March 1998 and February 1999 was 137 m^3/day or 628 l/suite/day. Following the replacement of water closets and showerheads in March 1999, the water consumption was reduced 10%. Following the replacement of the faulty ballcocks in late 1999, the measured consumption was 86 m^3/day or 394 l/suite/day in January 2000. This represented a savings of 37%.

3.4.4 Pre Booster Pump Control Monitoring

In order to establish the baseline pre-control water and energy demand, a detailed monitoring program was completed at 95 High Park from March 1 to March 28, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy
- Hot Water Consumption

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	20	42	85	70	12	3
Maximum	22	49	92	73	127	4
Average	21	46	89	71	53	3
Units	m	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	19	43	86	70	12	3
Maximum	22	49	92	73	116	4
Average	20	46	89	71	63	4
Units	m	m	m	m	l/min	kWh/h

The average daily consumption recorded at 95 High Park during the pre control monitoring was as follows:

Parameter	Water Demand	Hot Water	Booster Pump Energy
Weekday	355	113	84
Weekend	421	147	84
Units	l/unit/day	l/unit/day	kWh/day

3.4.5 Post Booster Pump Control Monitoring

The control system implemented at 95 High Park was a variable speed drive assembly on the primary booster pump. Based on the pre monitoring results and location of the pressure transducer, it was determined that the set point for the critical pressure would be 15 m or 22 psi.

During the course of the pre monitoring, Minto was considering the installation of new pumps at 95 High Park. It was therefore decided to install a new pump assembly at the building prior to starting the post monitoring. The new pump design was as follows:

Primary Pump: 5HP motor with base mount suction pump.
Secondary Pump: 5HP motor with base mount suction pump.

With the data collected during the pre monitoring (consumption and pressure), a properly sized pump assembly was designed. The new pump was downsized from the original 7.5HP motor to a 5HP motor. This pump delayed the implementation of the post monitoring.

Based on the pre-monitoring results, the set point of the VSD drive was adjusted to 15m or 22psi pressure. The post-control monitoring program was completed at 95 High Park from October 1 to October 29, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy
- Hot Water Consumption

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of the recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	15	42	85	70	10	0.6
Maximum	16	49	92	73	178	1.5
Average	16	46	89	71	68	0.9
Units	m	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	15	43	86	70	22	0.6
Maximum	16	49	92	73	218	1.3
Average	16	46	89	71	96	0.8
Units	m	m	m	m	l/min	kWh/h

The average daily consumption recorded at 95 High Park during the post control monitoring was as follows:

Parameter	Water Demand	Hot Water	Booster Pump Energy
Weekday	451	142	20
Weekend	633	220	19
Units	l/unit/day	l/unit/day	kWh/day

3.4.6 Water & Energy Savings Calculations

Based on the results obtained from the pre & post control monitoring the following savings were obtained.

Critical Pressure

Average Pre Pressure: 21 m
Average Post Pressure: 16 m
Reduction Percentage: 24 %

Water Demand

Average Pre Demand: 374 l/suite/day
Average Post Demand: 445 l/suite/day
Reduction in Water Demand: -19 % (increase in water demand)[2]

Booster Pump Energy

Average Pre Demand: 84 kWh/day
Average Post Demand: 20 kWh/day
Reduction in Energy: 76 %[3]

In order to complete a simple payback calculation the following rates were used:

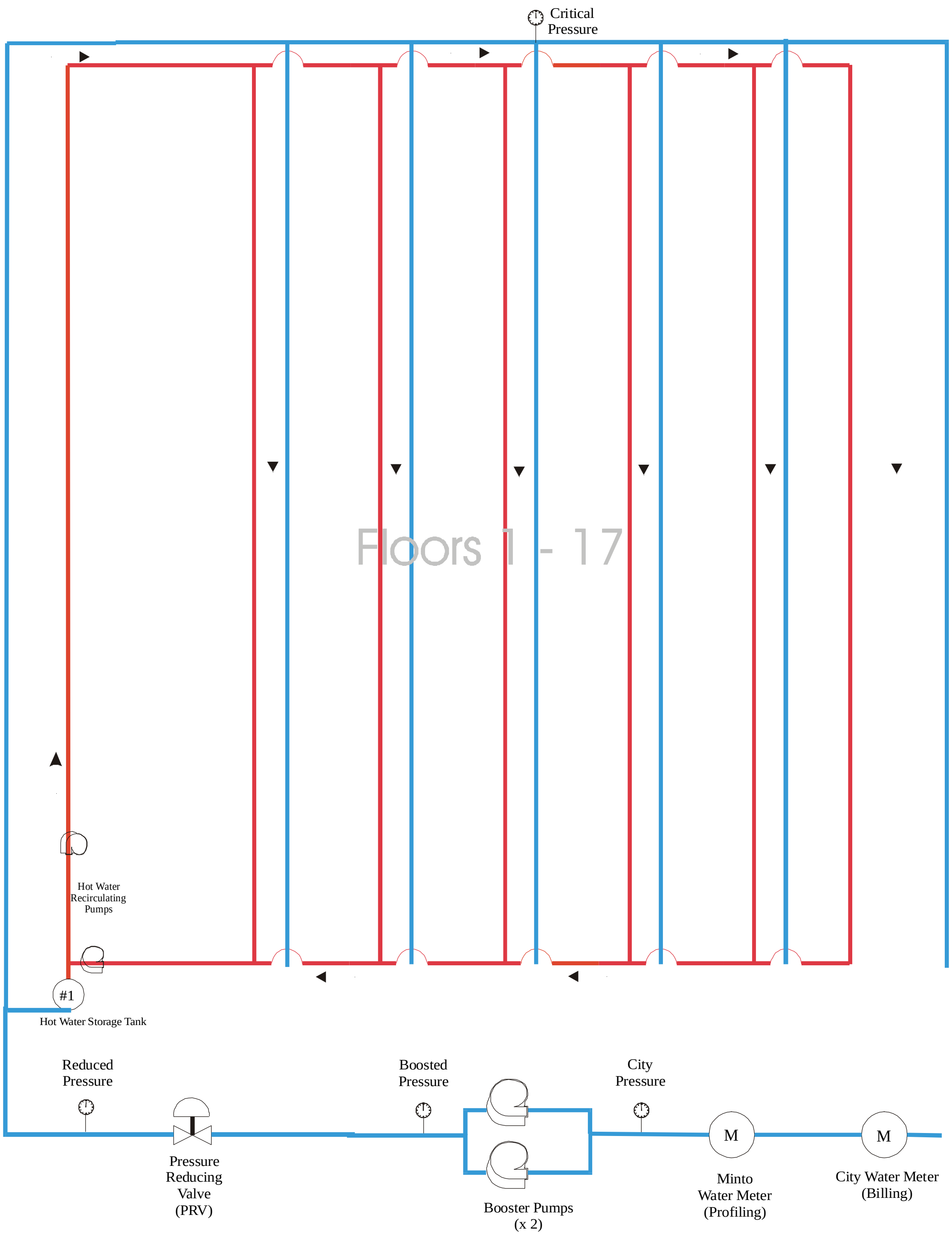
Cost of Water: $0.96 per m^3
Cost of Energy: $0.072 per kWh
Cost of VSD: $5,000
Cost of New Pump: $6,500

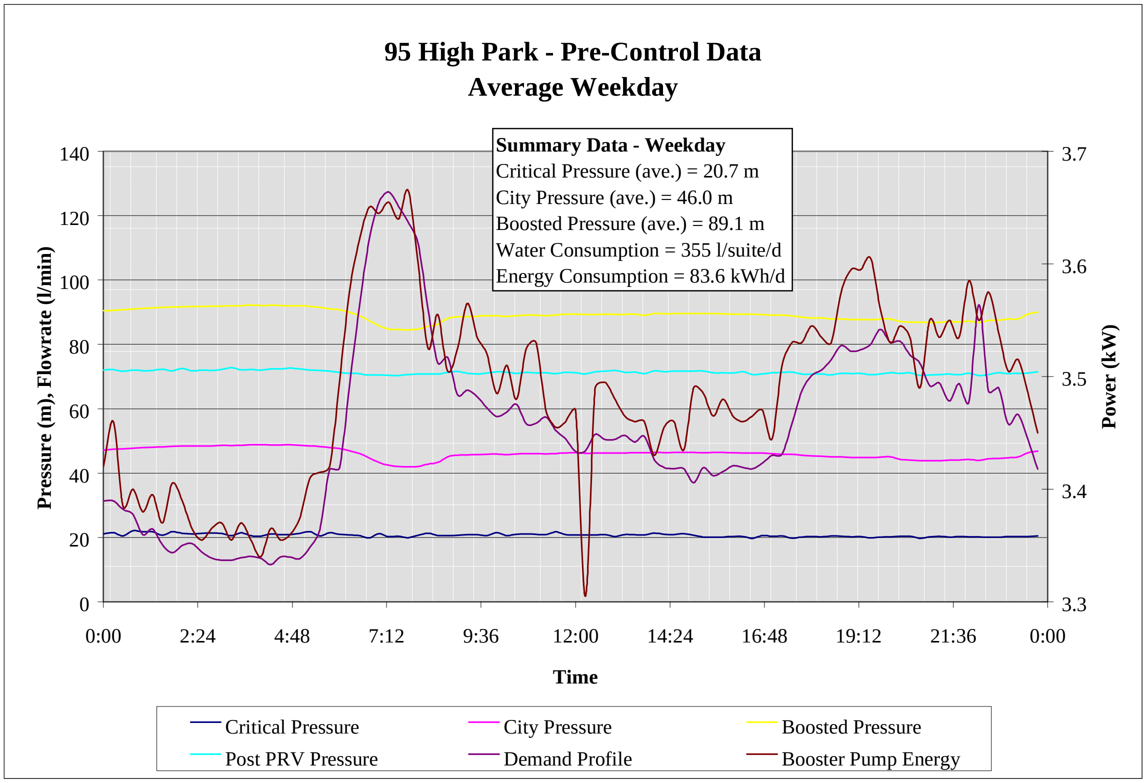
Estimated yearly water savings: $ 0.00
Estimated yearly energy savings: $1,682.00
Total Savings **$1,682.00**

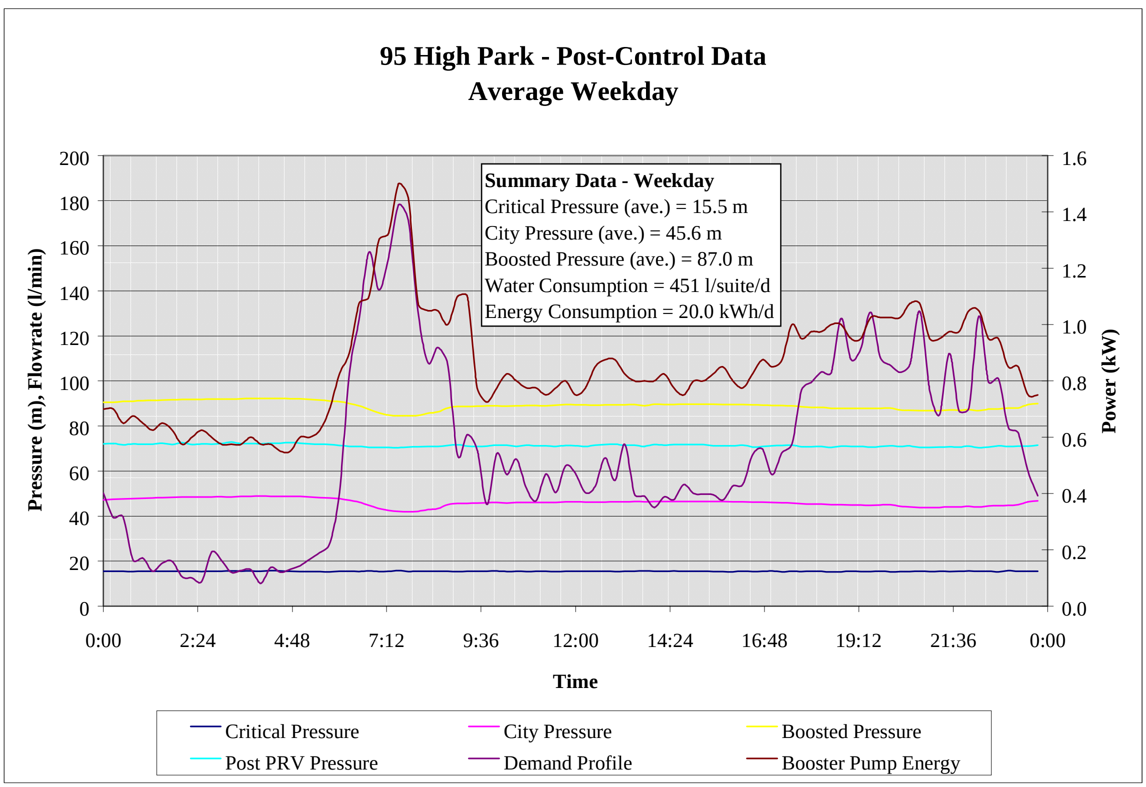
Simply Payback Calculation: 6.8 years

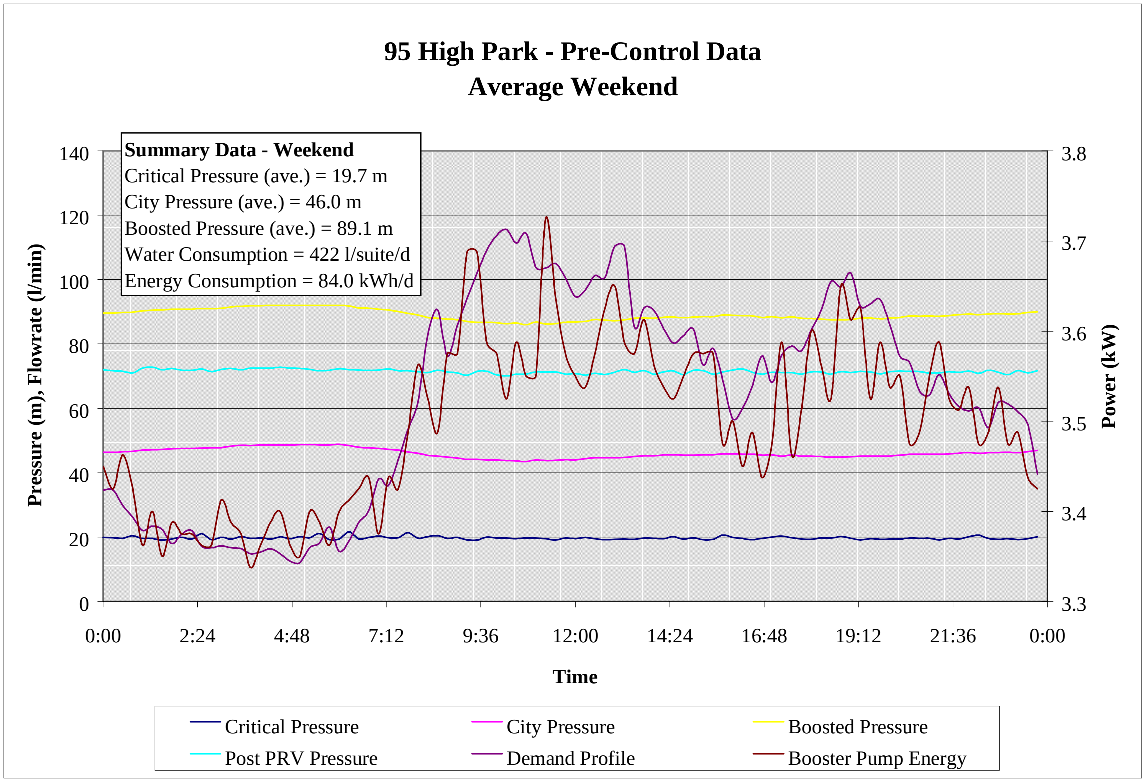
[2] The cause for the increase in demand has not yet been determined at 95 High Park. However, the increase is due to an increase in legitimate demand and not baseflow leakage since the demand profile minimum flow post is equal to the pre minimum flow.
[3] Please note that the energy savings is due to both the reduction in sizing of the pump motor from 7.5HP to 5HP and the installation of the VSD drive.

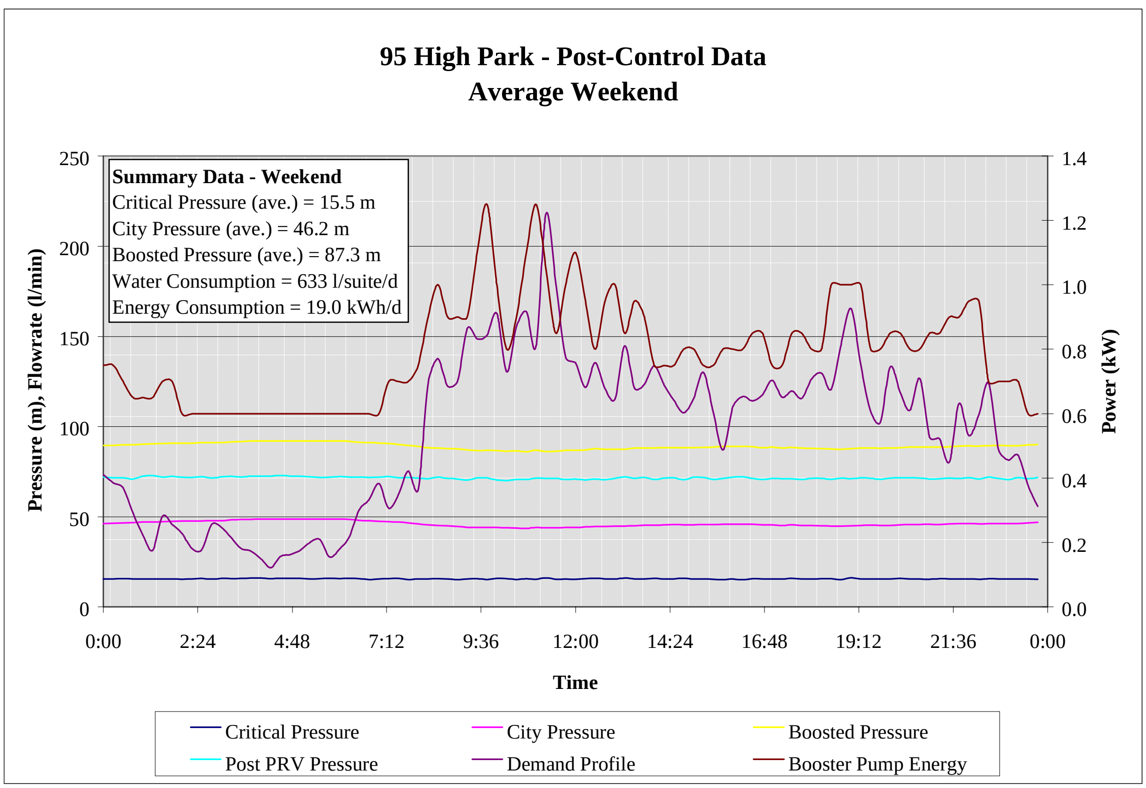
Schematic Overview - Water Distribution System
 # 95 High Park Avenue, Toronto, Ontario

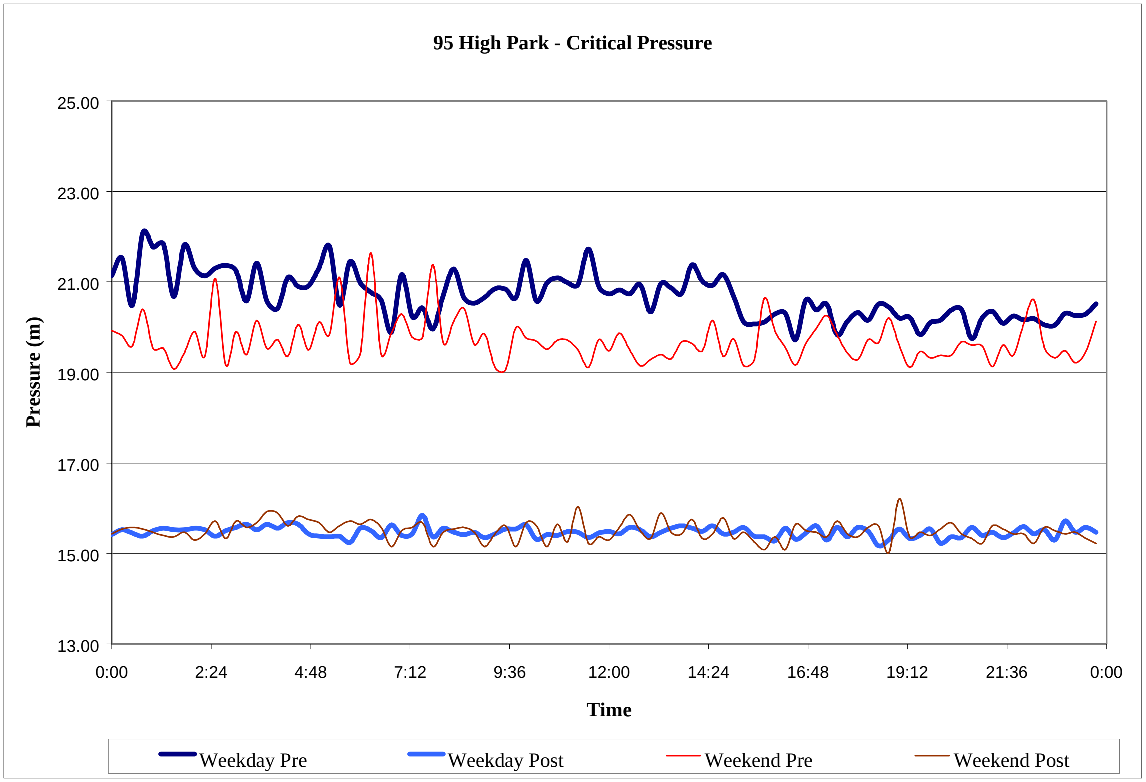


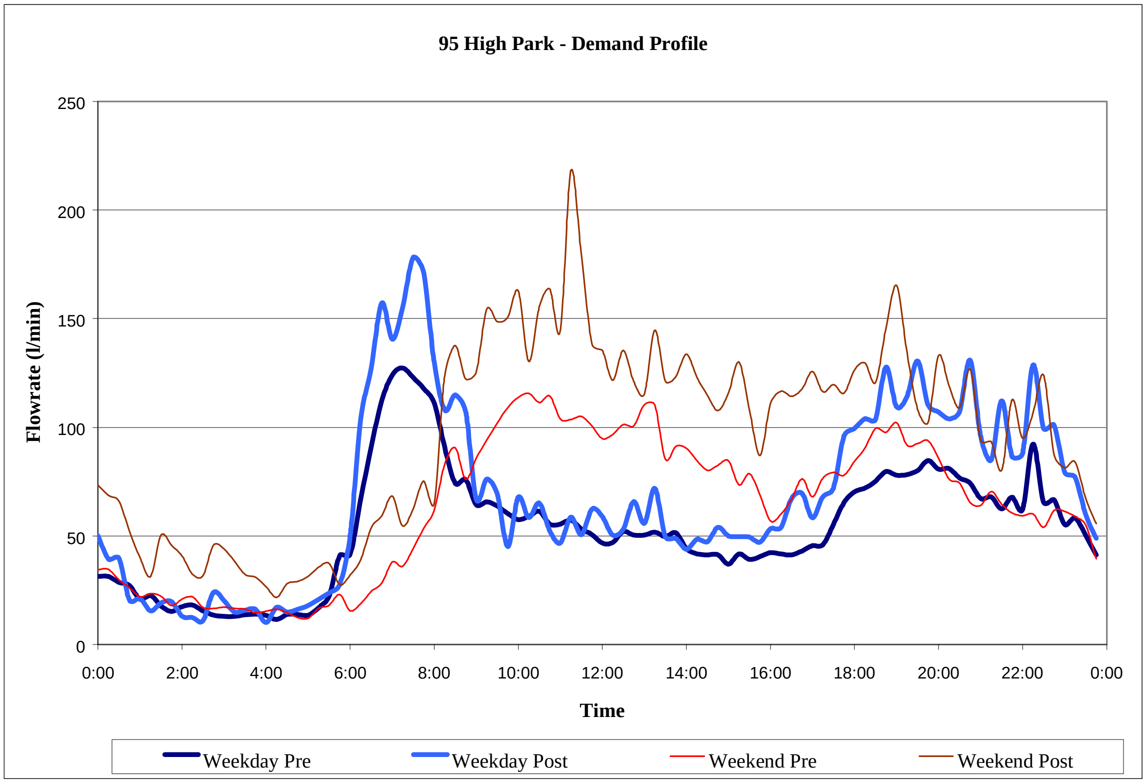

95 High Park - Pre-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 20.7 m
City Pressure (ave.) = 46.0 m
Boosted Pressure (ave.) = 89.1 m
Water Consumption = 355 l/suite/d
Energy Consumption = 83.6 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
140
120
100
80
60
40
20
0
3.7
3.6
3.5
3.4
3.3
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy

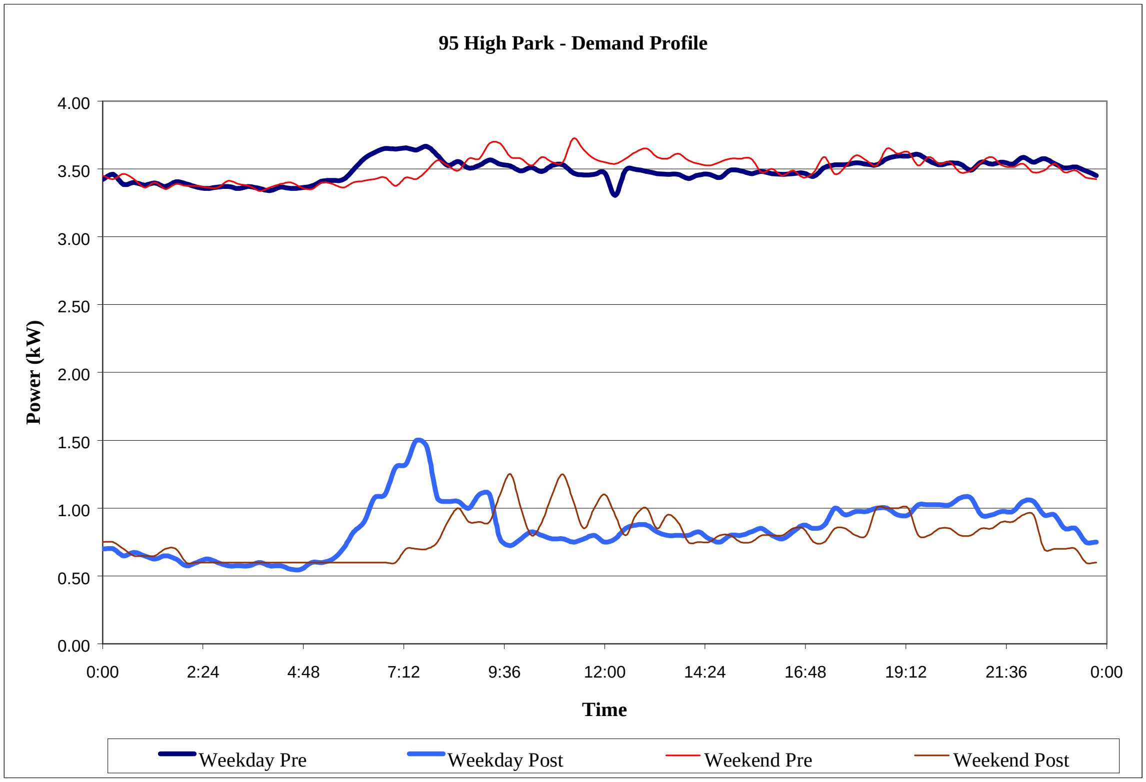

95 High Park - Post-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 15.5 m
City Pressure (ave.) = 45.6 m
Boosted Pressure (ave.) = 87.0 m
Water Consumption = 451 l/suite/d
Energy Consumption = 20.0 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
200
180
160
140
120
100
80
60
40
20
0
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


95 High Park - Pre-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 19.7 m
City Pressure (ave.) = 46.0 m
Boosted Pressure (ave.) = 89.1 m
Water Consumption = 422 l/suite/d
Energy Consumption = 84.0 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


95 High Park - Post-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 15.5 m
City Pressure (ave.) = 46.2 m
Boosted Pressure (ave.) = 87.3 m
Water Consumption = 633 l/suite/d
Energy Consumption = 19.0 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


95 High Park - Critical Pressure
25.00
23.00
21.00
19.00
17.00
15.00
13.00
Pressure (m)
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


95 High Park - Demand Profile
250
200
150
100
50
0
Flowrate (l/min)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


95 High Park - Demand Profile
Power (kW)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post

3.5 66 Pacific Ave.

3.5.1 Building Description

66 Pacific Ave. is a multi-residential high-rise at High Park Village with 16 floors and encompasses a total of 229 suites. The building is hot water heated. Both the domestic hot water and heating hot water is heated from gas-fired boilers located in 65 High Park. There is an additional central boiler system located at 35 High Park which provides additional hot water heating in the winter months only.

3.5.2 Building Plumbing System

The plumbing system at 66 Pacific Ave. prior to the completion of the monitoring program was as follows (please refer to the plumbing system schematic at the end of this section):

Domestic Cold Water
Domestic cold water is provided from the City of Toronto through a service line that enters the sprinkler room at 66 Pacific Ave. The service line tees into the fire protection or sprinkler system and the domestic cold water system where it passes through the City billing meter. Immediately downstream from the City billing meter is the Minto control meter which was used to collect the demand information for this building.

The domestic cold water booster pump assembly is comprised of the following:

Primary Pump:	10HP motor with base mount suction pump.
Secondary Pump:	10HP motor with base mount suction pump.

Following the booster pump assembly, the domestic cold water pressure is reduced through an existing PRV to 102 psi. There is only one zone in this building. Water in the building is top fed meaning that the water is pumped to the top floor and distributed along a central main at that floor and then fed downward through individual risers.

Domestic Hot Water
The domestic hot water system is also one zone. The hot water system is constantly re-circulated to ensure a constant temperature. There is a hot water make up feed from the domestic cold water system.

3.5.3 Water Demand & Water Management History

Prior to any water management, the average daily consumption recorded at 66 Pacific Ave. between March 1998 and February 1999 was 150 m^3/day or 655 l/suite/day. Following the replacement of water closets and showerheads in March 1999, the water consumption was reduced 5%. Following the replacement of the faulty ballcocks in late 1999, the consumption was reduced to 95 m^3/day or 415 l/suite/day in February 2000. This represented a savings of 37%.

3.5.4 Pre Booster Pump Control Monitoring

In order to establish the baseline pre-control water and energy demand, a detailed monitoring program was completed at 66 Pacific Ave. from March 1 to March 28, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	18	42	83	71	19	7
Maximum	22	52	95	73	143	7
Average	21	47	90	73	62	7
Units	m	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	20	44	85	72	21	7
Maximum	22	52	94	73	133	7
Average	21	47	89	73	72	7
Units	m	m	m	m	l/min	kWh/h

The average daily consumption recorded at 66 Pacific Ave. during the pre control monitoring was as follows:

Parameter	Water Demand	Booster Pump Energy
Weekday	387	168
Weekend	454	168
Units	l/unit/day	kWh/day

3.5.5 Post Booster Pump Control Monitoring

The control system implemented at 66 Pacific Ave. was a variable speed drive assembly on the primary booster pump. Based on the pre monitoring results and location of the pressure transducer, it was determined that the set point for the critical pressure would be 14 m or 20 psi.

The post control monitoring program was completed at 66 Pacific Ave. from April 18 to May 15, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	14	42	71	65	23	4
Maximum	17	51	74	67	155	6
Average	16	47	72	66	69	5
Units	m	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	14	44	71	65	24	4
Maximum	17	51	74	67	130	6
Average	16	47	73	66	74	5
Units	m	m	m	m	l/min	kWh/h

The average daily consumption recorded at 66 Pacific Ave. during the post control monitoring was as follows:

Parameter	Water Demand	Booster Pump Energy
Weekday	436	122
Weekend	462	123
Units	l/unit/day	kWh/day

3.5.6 Water & Energy Savings Calculations

Based on the results obtained from the pre & post control monitoring the following savings were obtained.

Critical Pressure

Average Pre Pressure: 21 m
Average Post Pressure: 16 m
Reduction Percentage: 24 %

Water Demand

Average Pre Demand: 406 l/suite/day
Average Post Demand: 444 l/suite/day
Reduction in Water Demand: 0% (actually a 10% increase)

Booster Pump Energy

Average Pre Demand: 168 kWh/day
Average Post Demand: 122 kWh/day
Reduction in Energy: 27%

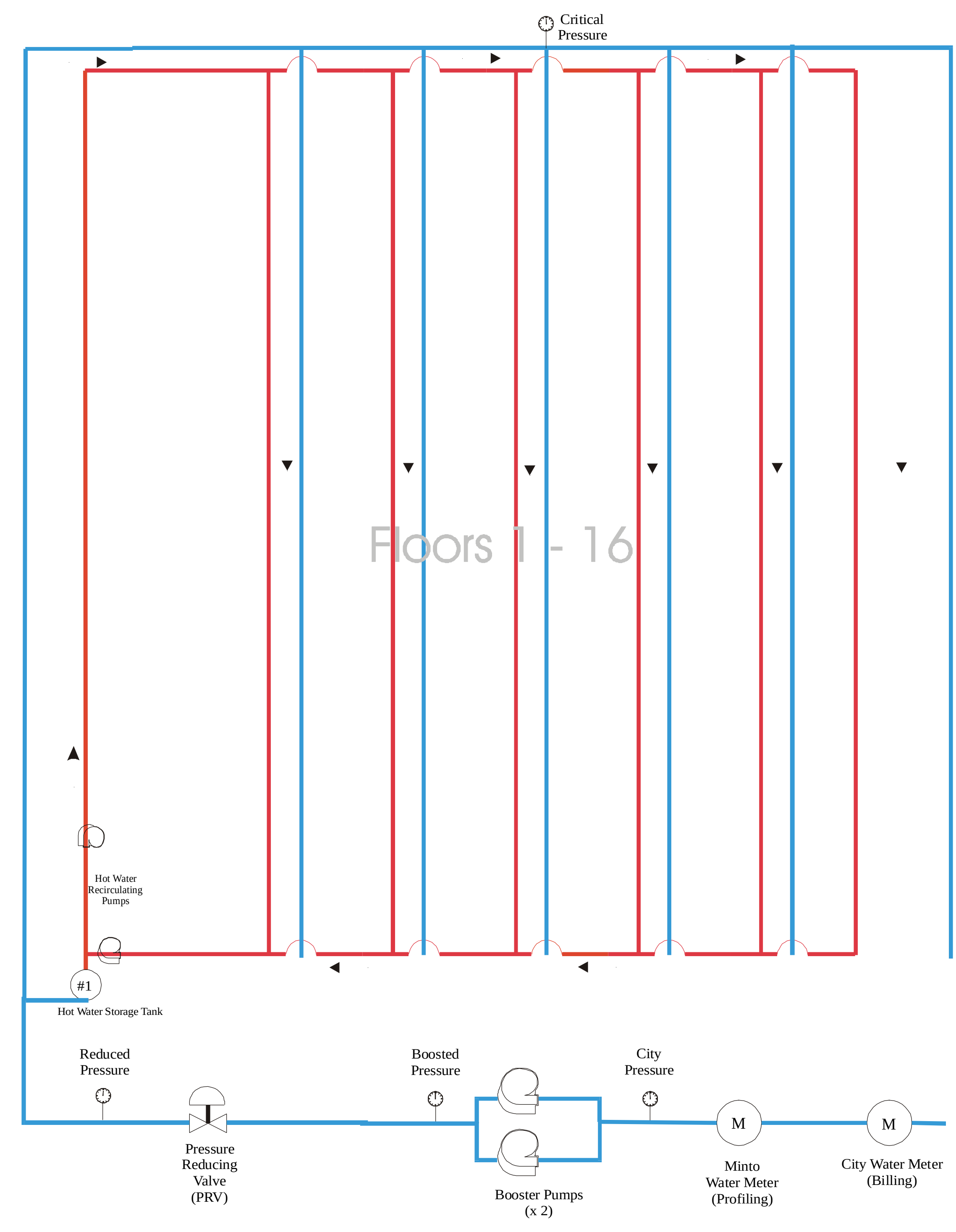
In order to complete a simple payback calculation the following rates were used:

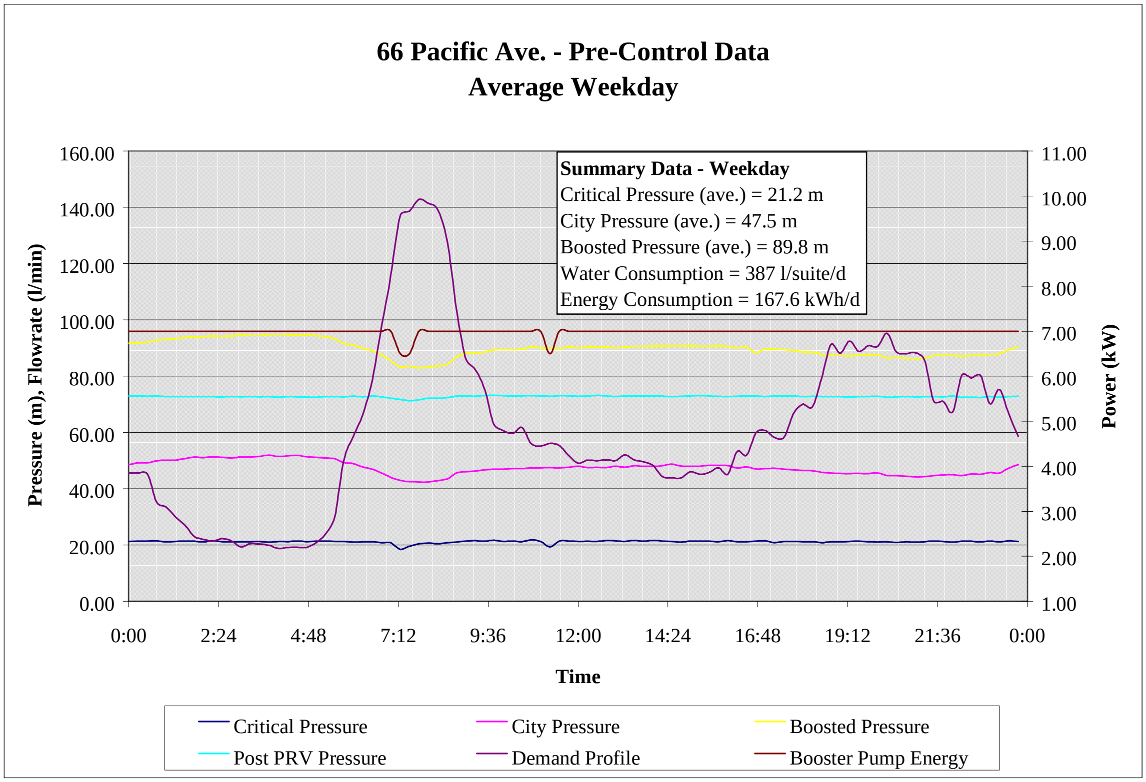
Cost of Water: \$0.96 per m^3
Cost of Energy: \$0.072 per kWh
Cost of VSD: \$5,000

Estimated yearly water savings: \$ 0.00
Estimated yearly energy savings: \$1,209.00
Total Savings **\$1,209.00**

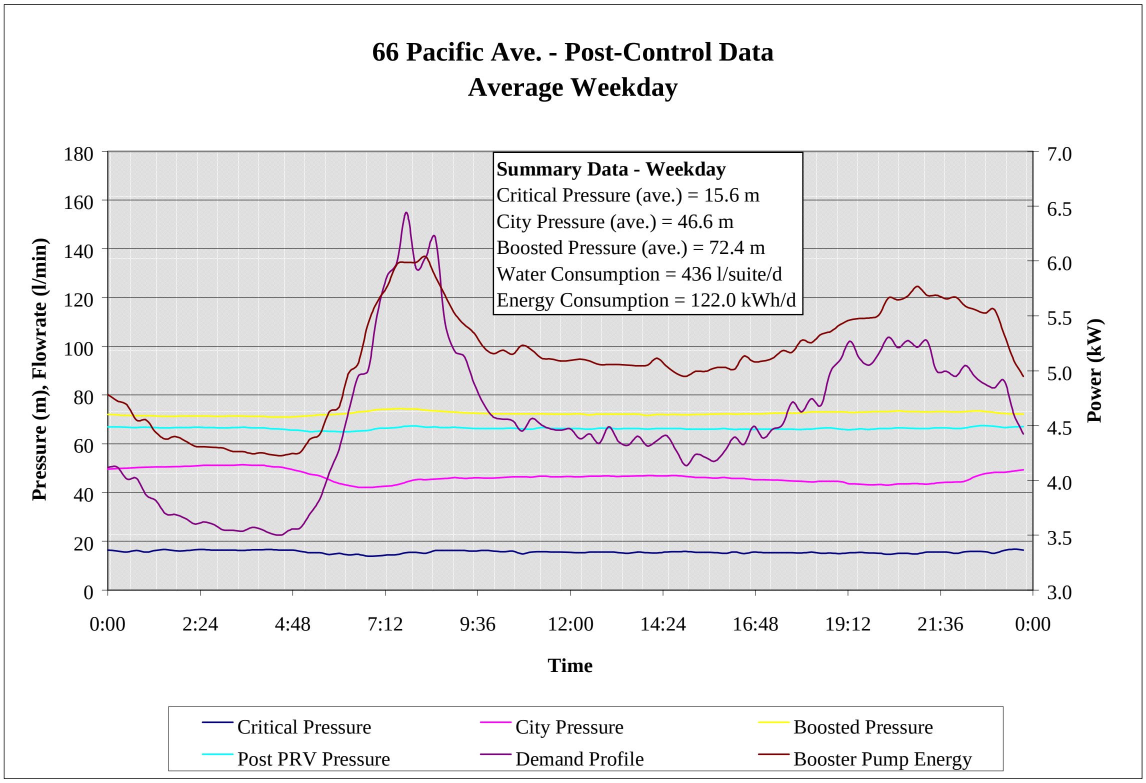
Simply Payback Calculation: 4.1 years

Schematic Overview - Water Distribution System
 # 66 Pacific Avenue, Toronto, Ontario

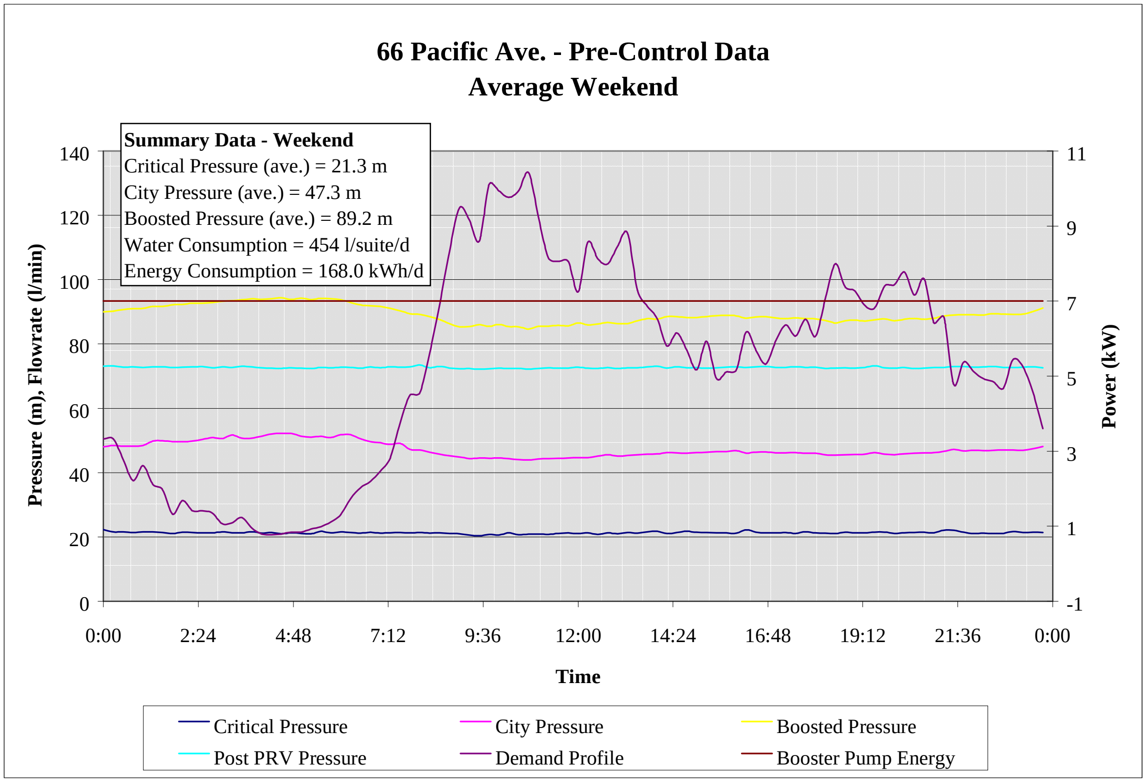


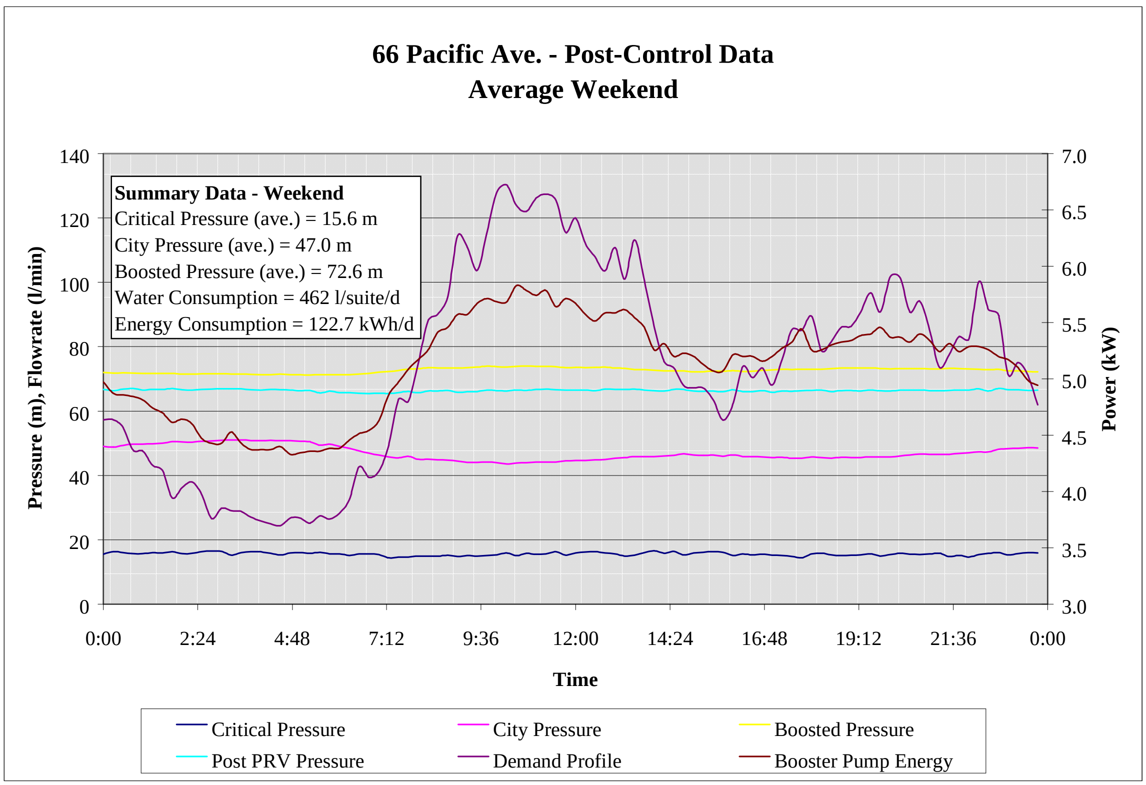


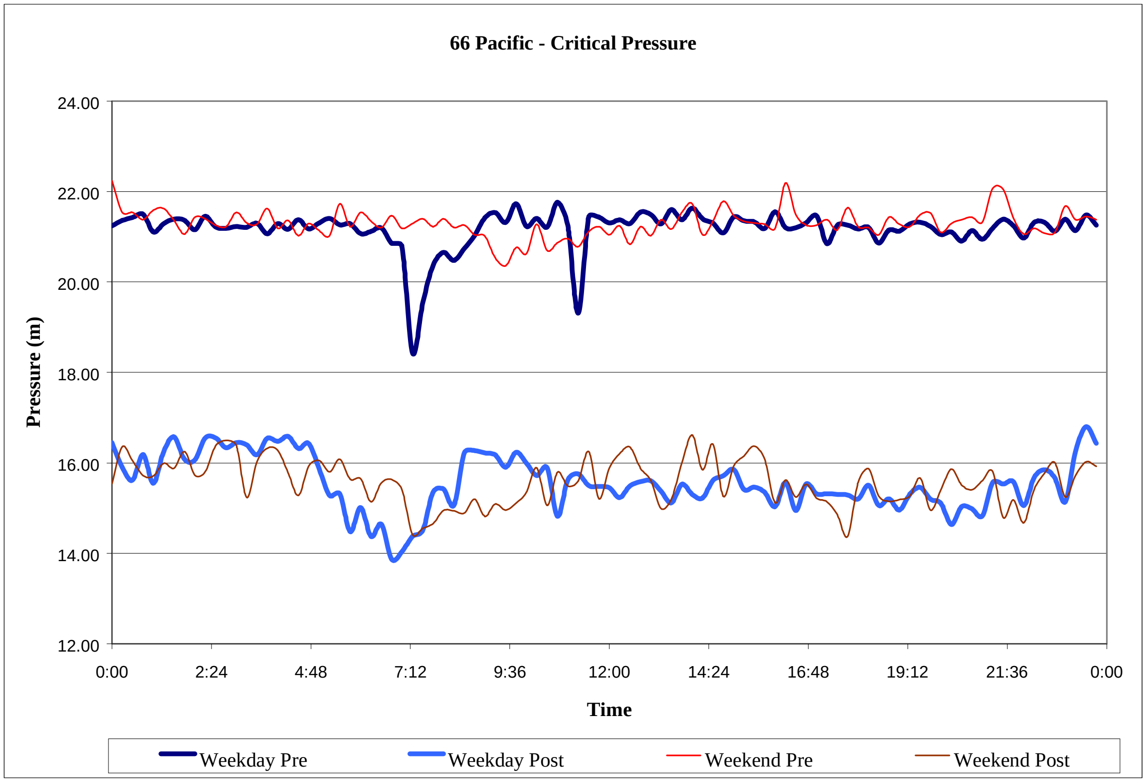
66 Pacific Ave. - Pre-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 21.2 m
City Pressure (ave.) = 47.5 m
Boosted Pressure (ave.) = 89.8 m
Water Consumption = 387 l/suite/d
Energy Consumption = 167.6 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy

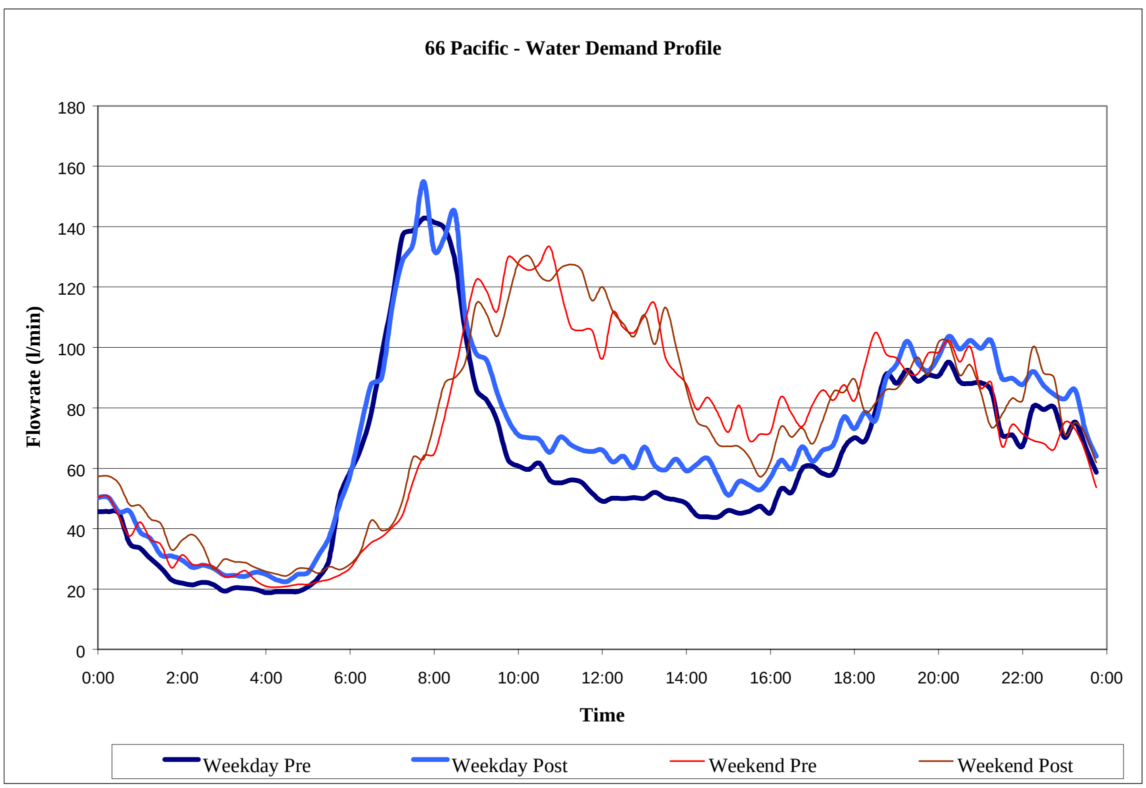


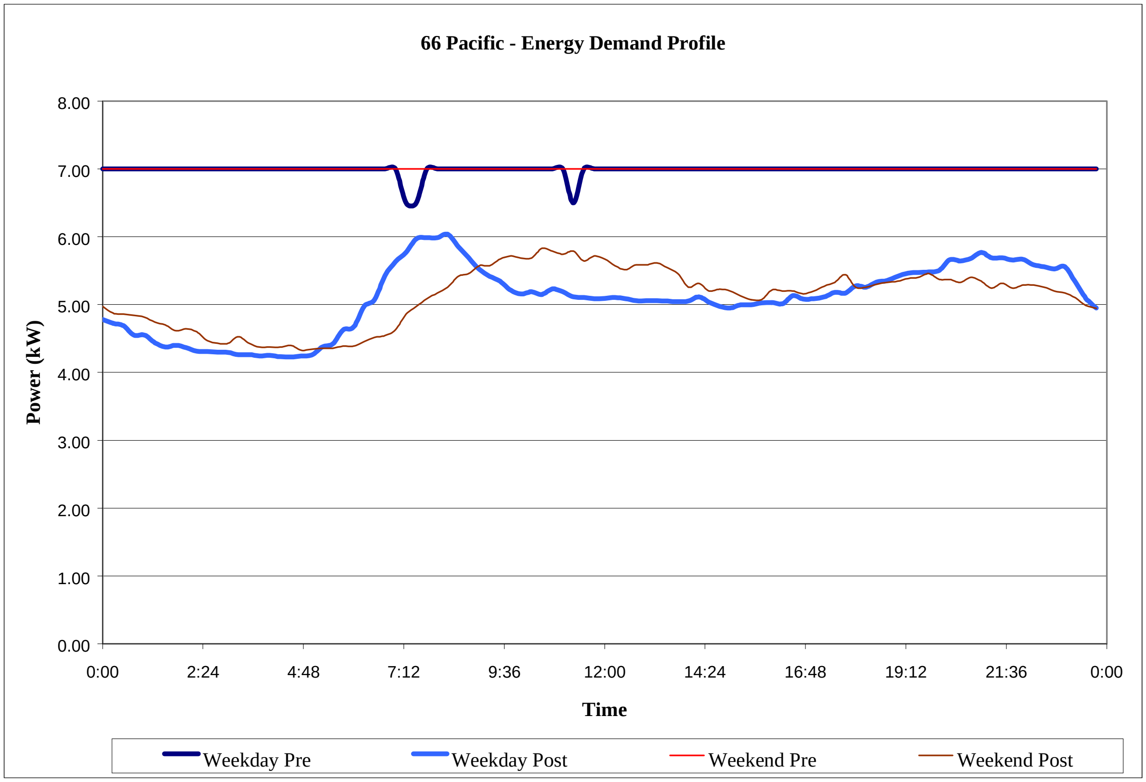
66 Pacific Ave. - Post-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 15.6 m
City Pressure (ave.) = 46.6 m
Boosted Pressure (ave.) = 72.4 m
Water Consumption = 436 l/suite/d
Energy Consumption = 122.0 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


66 Pacific Ave. - Pre-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 21.3 m
City Pressure (ave.) = 47.3 m
Boosted Pressure (ave.) = 89.2 m
Water Consumption = 454 l/suite/d
Energy Consumption = 168.0 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0
20
40
60
80
100
120
140
-1
1
3
5
7
9
11
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


66 Pacific Ave. - Post-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 15.6 m
City Pressure (ave.) = 47.0 m
Boosted Pressure (ave.) = 72.6 m
Water Consumption = 462 l/suite/d
Energy Consumption = 122.7 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0
20
40
60
80
100
120
140
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


66 Pacific - Critical Pressure
Pressure (m)
24.00
22.00
20.00
18.00
16.00
14.00
12.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


66 Pacific - Water Demand Profile
Flowrate (l/min)
180
160
140
120
100
80
60
40
20
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post



66 Pacific - Energy Demand Profile
Power (kW)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post

3.6 111 Pacific Ave.

3.6.1 Building Description

111 Pacific Ave. is a multi-residential high-rise at High Park Village with 17 floors and a total of 242 suites. The building is hot water heated. Both the domestic hot water and heating hot water is heated from gas-fired boilers located in 111 Pacific Ave.

3.6.2 Building Plumbing System

The plumbing system at 111 Pacific Ave. prior to the completion of the monitoring program was as follows (please refer to the plumbing system schematic at the end of this section):

Domestic Cold Water
Domestic cold water is provided from the City of Toronto through a service line that enters the boiler room at 111 Pacific Ave. The service line tees into the fire protection or sprinkler system and the domestic cold water system where it passes through the City billing meter. Immediately downstream from the City billing meter is the Minto control meter which was used to collect the demand information for this building.

Prior to the booster pump assembly, there is a feed to the buildings lawn irrigation system. The domestic cold water booster pump assembly is comprised of the following:

Primary Pump:	10HP motor with base mount suction pump.
Secondary Pump:	7.5HP motor with base mount suction pump.

Following the booster pump assembly, the domestic cold water is divided into a high pressure and low pressure zone. The high pressure zone is fed directly from the booster pump discharge pressure (100 psi) and services floors 10 to 18. The low pressure zone is fed from the booster pump and the pressure is reduced through a pressure reducing valve and services floors 1 to 9. Both zones are top fed meaning that the water is pumped to the top floor of each zone and distributed along a central main at that floor and then fed downwards through individual risers.

Domestic Hot Water
The domestic hot water system is also divided into the same two zones as the domestic cold water system. The hot water system is however constantly re-circulated to ensure a constant temperature. There is a hot water make up feed for each zone from the associated domestic cold water system.

3.6.3 Water Demand & Water Management History

Prior to any water management, the average daily consumption recorded at 111 Pacific Ave. between March 1998 and February 1999 was 201 m^3/day or 830 l/suite/day. Following the replacement of water closets and showerheads in March 1999, the water consumption was reduced by only 15% in the summer of 1999. Following the replacement of the faulty ballcocks in late 1999, the savings returned with recorded consumption of 100 m^3/day or 413 l/suite/day in February 2000. This represented a savings of 50%.

3.6.4 Pre Booster Pump Control Monitoring

In order to establish the baseline pre-control water and energy demand, a detailed monitoring program was completed at 111 Pacific from March 1 to March 28, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Water Demand	Energy Demand
Minimum	11	39	63	8	4
Maximum	22	49	74	155	4
Average	17	44	70	58	4
Units	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Water Demand	Energy Demand
Minimum	13	40	65	8	4
Maximum	22	49	74	123	4
Average	17	44	69	65	4
Units	m	m	m	l/min	kWh/h

The average daily consumption recorded at 111 Pacific Ave. during the pre control monitoring was as follows:

Parameter	Water Demand	Booster Pump Energy
Weekday	346	89
Weekend	386	90
Units	l/unit/day	kWh/day

3.6.5 Post Booster Pump Control Monitoring

The control system implemented at 111 Pacific Ave. was a variable speed drive assembly on the primary booster pump. Based on the pre monitoring results and location of the pressure transducer, it was determined that the set point for the critical pressure would be 14 m or 20 psi.

The post control monitoring program was completed at 111 Pacific Ave. from April 11 to May 15, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Water Demand	Energy Demand
Minimum	11	38	60	20	1
Maximum	16	48	72	140	3
Average	14	43	67	59	2
Units	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Water Demand	Energy Demand
Minimum	12	39	62	17	2
Maximum	16	48	71	131	3
Average	14	43	66	65	2
Units	m	m	m	l/min	kWh/h

The average daily consumption recorded at 111 Pacific Ave. during the post control monitoring was as follows:

Parameter	Water Demand	Booster Pump Energy
Weekday	349	54
Weekend	384	57
Units	l/unit/day	kWh/day

3.6.6 Water & Energy Savings Calculations

Based on the results obtained from the pre & post control monitoring the following results were obtained.

Critical Pressure

Average Pre Pressure: 17 m
Average Post Pressure: 14 m
Reduction Percentage: 18 %

Water Demand

Average Pre Demand: 357 l/suite/day
Average Post Demand: 359 l/suite/day
Reduction in Water Demand: 0%

Booster Pump Energy

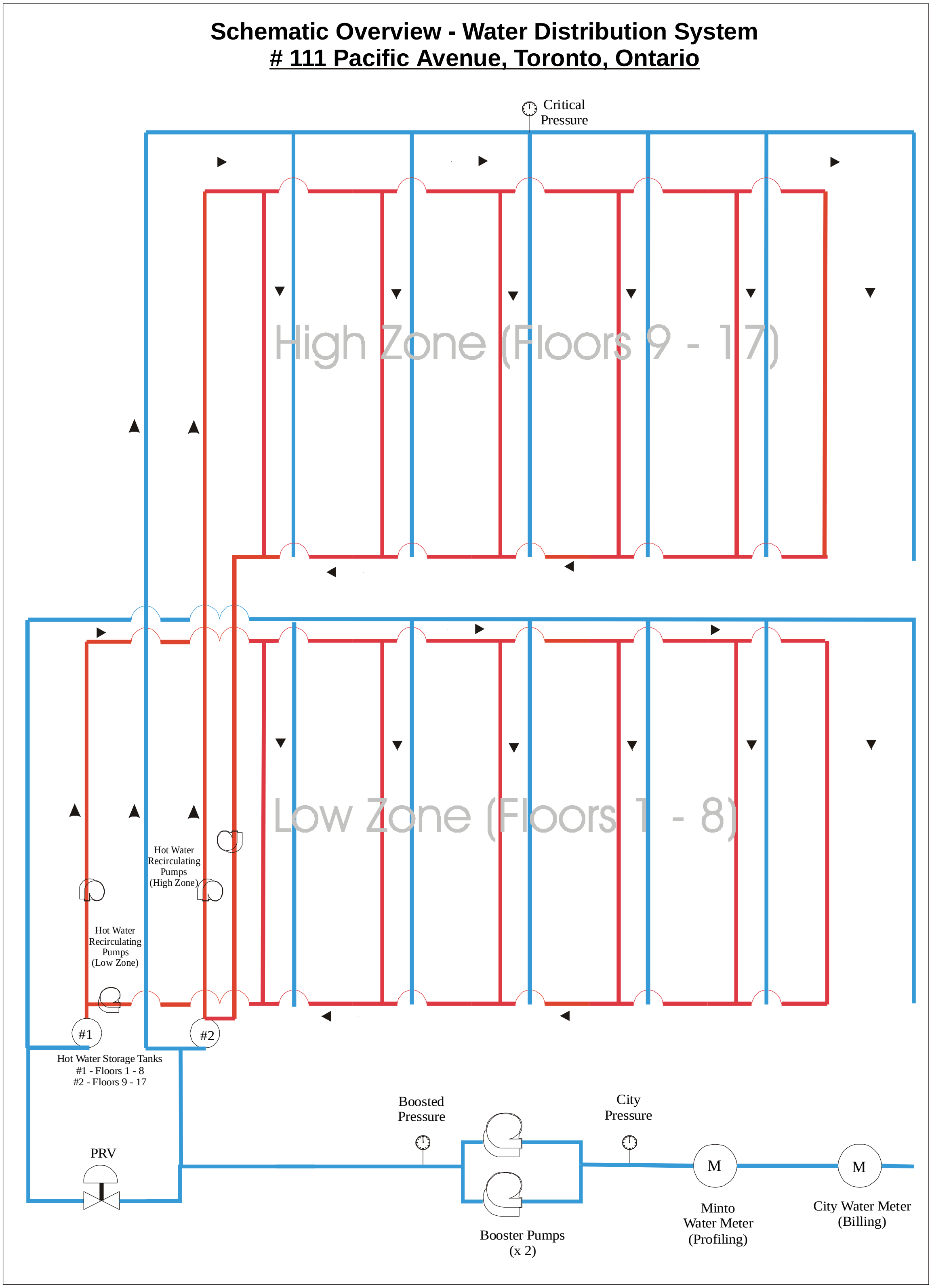
Average Pre Demand: 89 kWh/day
Average Post Demand: 55 kWh/day
Reduction in Energy: 38%

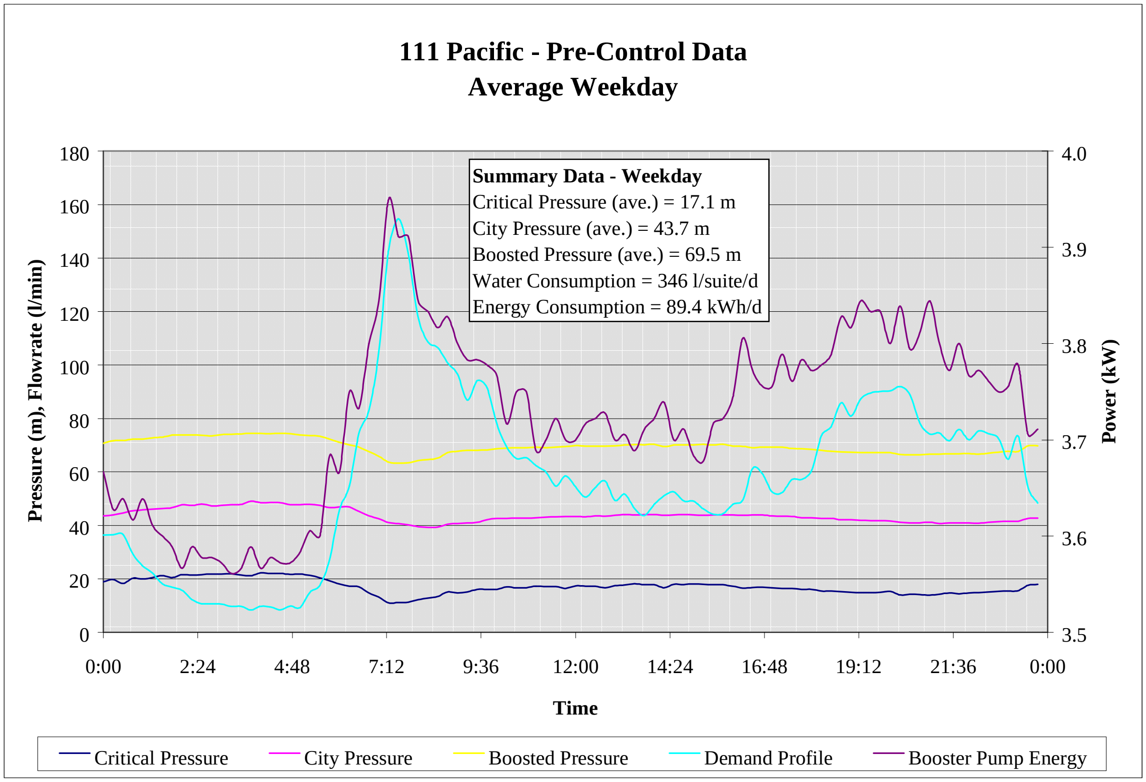
In order to complete a simple payback calculation the following rates were used:

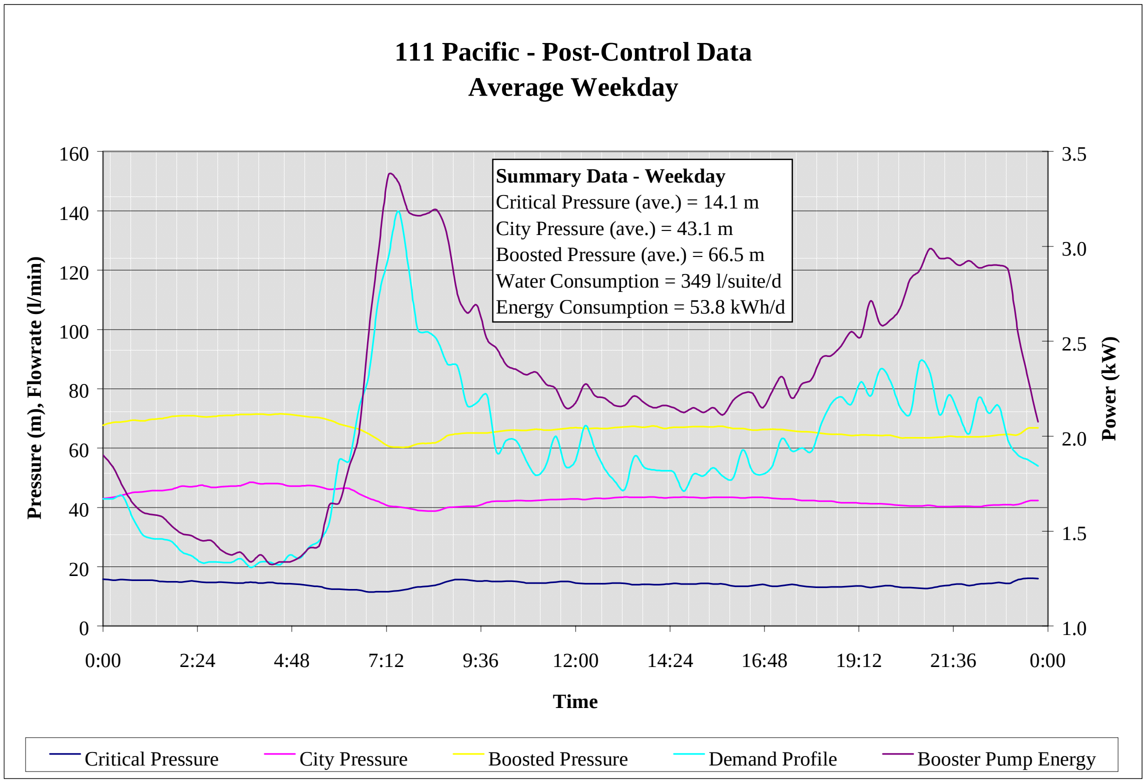
Cost of Water: $0.96 per m^3
Cost of Energy: $0.072 per kWh
Cost of VSD: $5,000

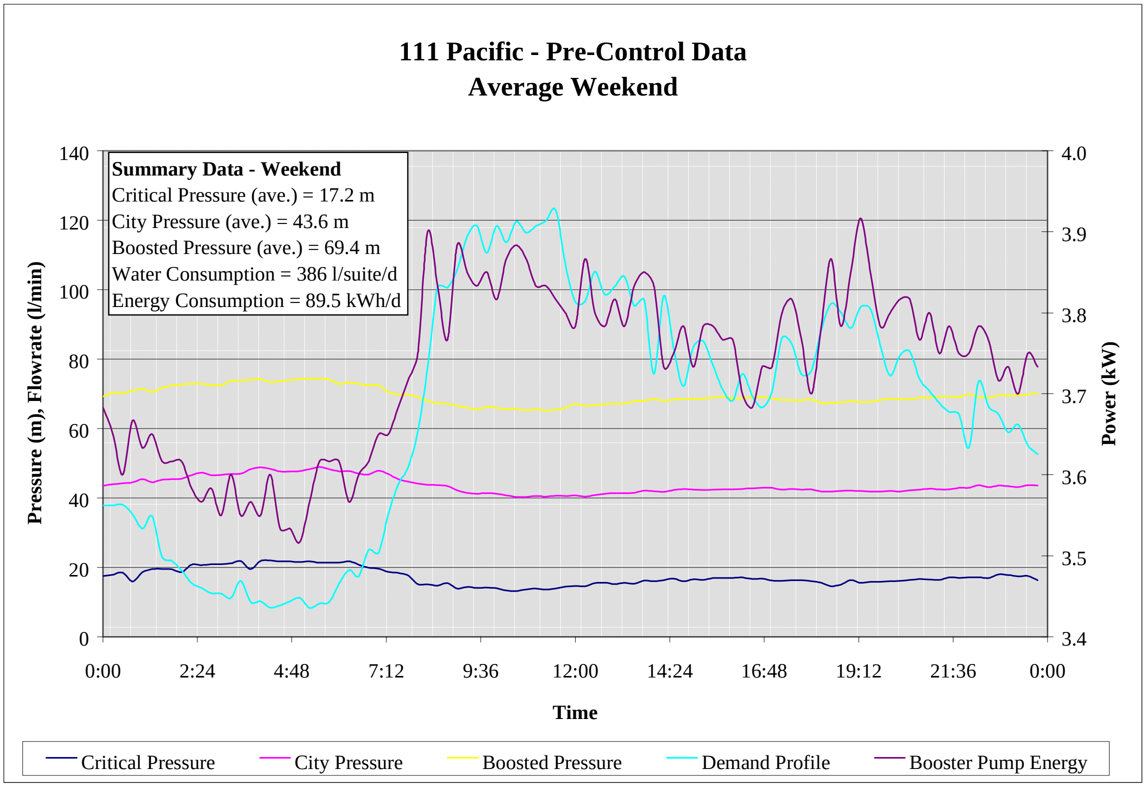
Estimated yearly water savings: $ 0.00
Estimated yearly energy savings: $ 894.00
Total Savings $ 894.00

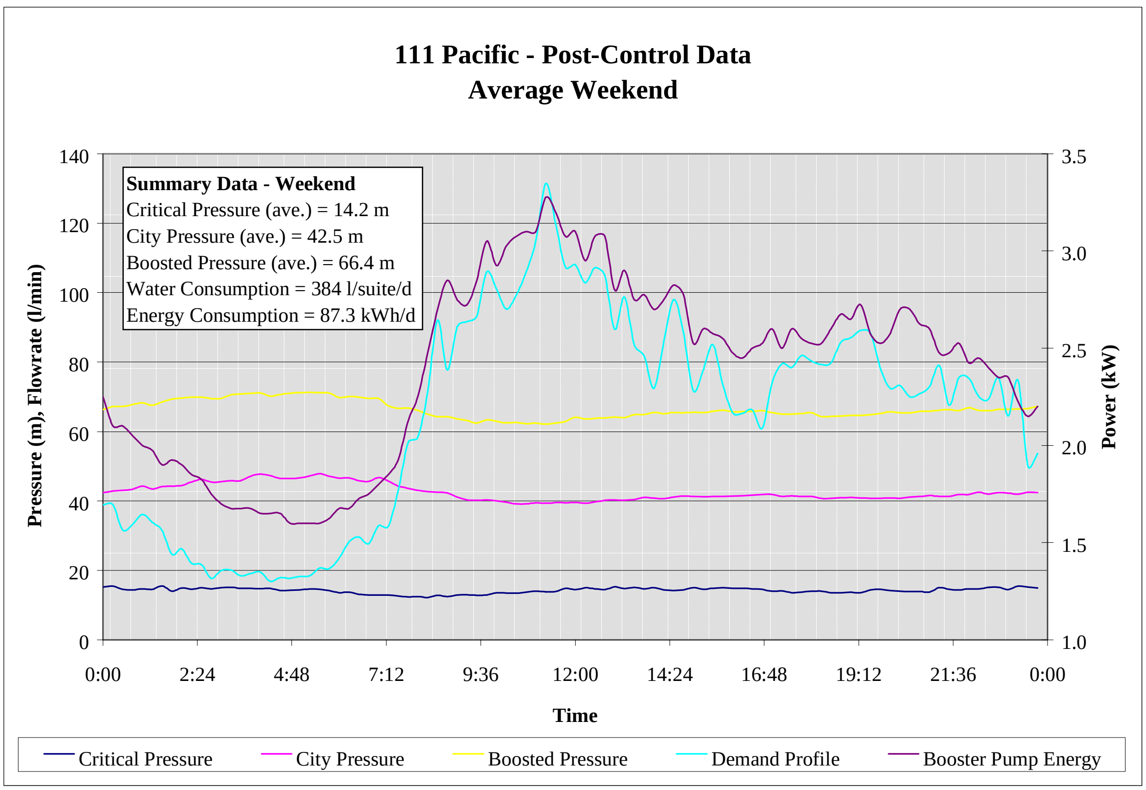
Simply Payback Calculation: 5.6 years

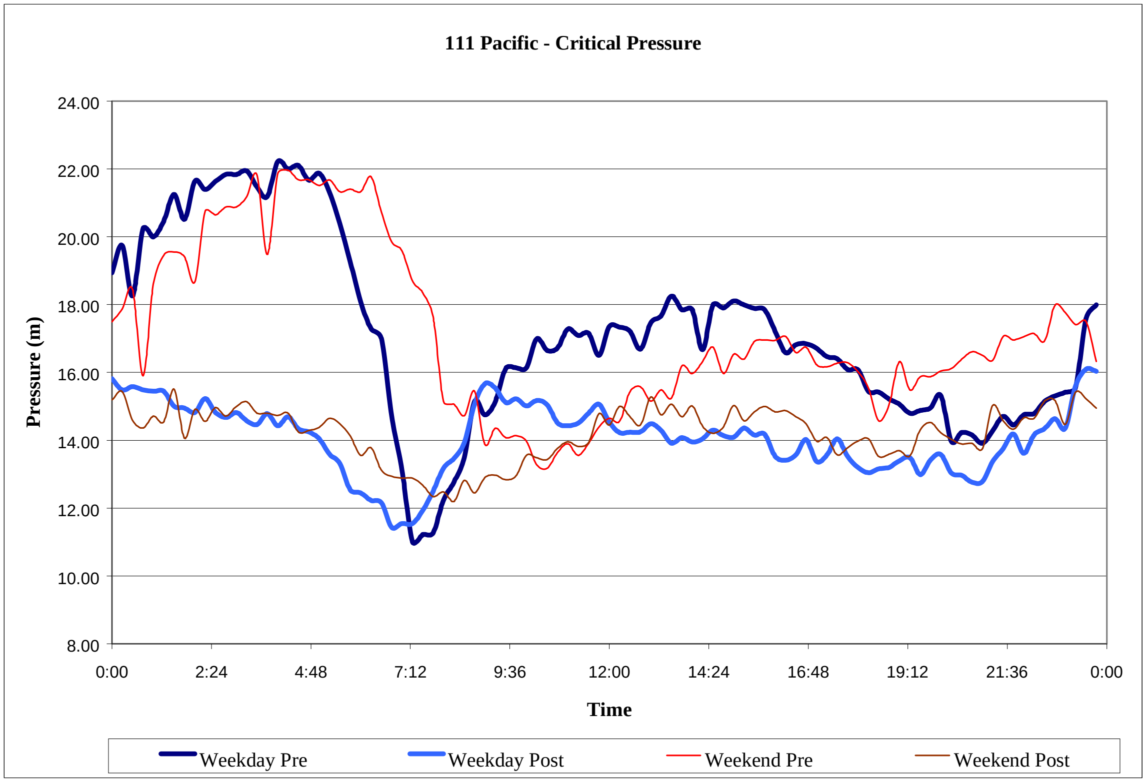

Schematic Overview - Water Distribution System
111 Pacific Avenue, Toronto, Ontario
Critical Pressure
High Zone (Floors 9 - 17)
Low Zone (Floors 1 - 8)
Hot Water Recirculating Pumps (High Zone)
Hot Water Recirculating Pumps (Low Zone)
#1
#2
Hot Water Storage Tanks
#1 - Floors 1 - 8
#2 - Floors 9 - 17
PRV
Boosted Pressure
City Pressure
M
M
Booster Pumps (x 2)
Minto Water Meter (Profiling)
City Water Meter (Billing)

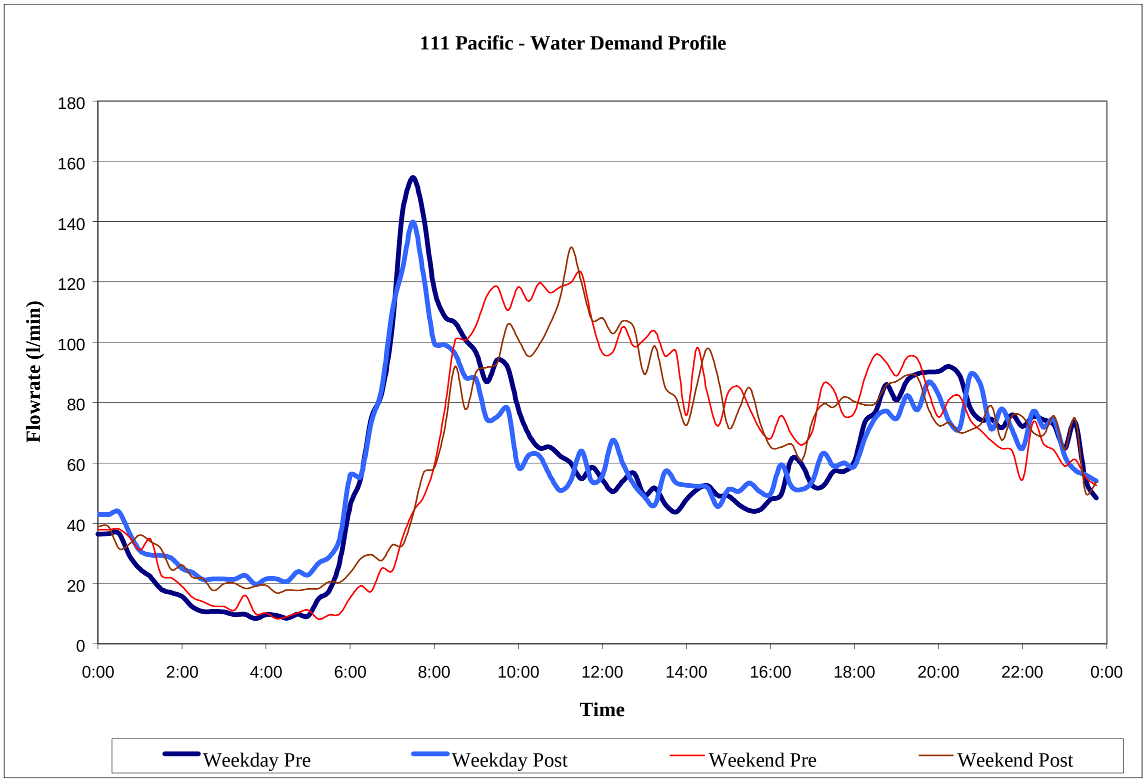

111 Pacific - Pre-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 17.1 m
City Pressure (ave.) = 43.7 m
Boosted Pressure (ave.) = 69.5 m
Water Consumption = 346 l/suite/d
Energy Consumption = 89.4 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Demand Profile
Booster Pump Energy

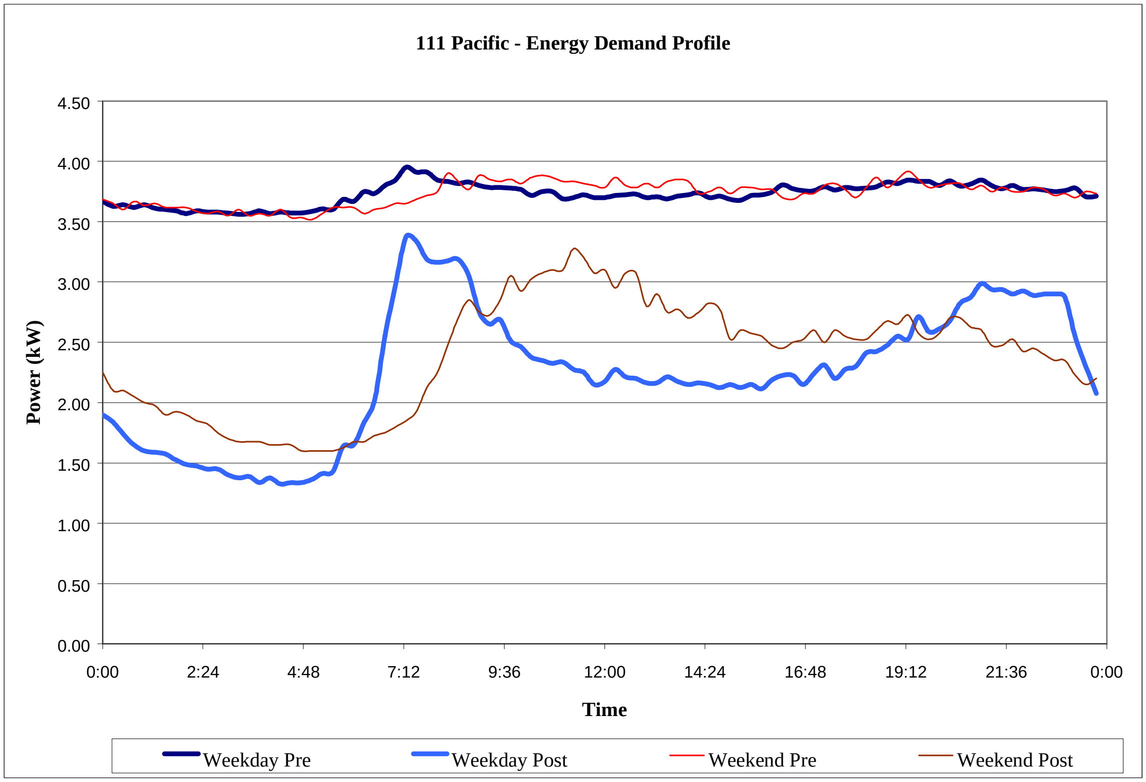

111 Pacific - Post-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 14.1 m
City Pressure (ave.) = 43.1 m
Boosted Pressure (ave.) = 66.5 m
Water Consumption = 349 l/suite/d
Energy Consumption = 53.8 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Demand Profile
Booster Pump Energy


111 Pacific - Pre-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 17.2 m
City Pressure (ave.) = 43.6 m
Boosted Pressure (ave.) = 69.4 m
Water Consumption = 386 l/suite/d
Energy Consumption = 89.5 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0
20
40
60
80
100
120
140
3.4
3.5
3.6
3.7
3.8
3.9
4.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Demand Profile
Booster Pump Energy


111 Pacific - Post-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 14.2 m
City Pressure (ave.) = 42.5 m
Boosted Pressure (ave.) = 66.4 m
Water Consumption = 384 l/suite/d
Energy Consumption = 87.3 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0
20
40
60
80
100
120
140
1.0
1.5
2.0
2.5
3.0
3.5
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Demand Profile
Booster Pump Energy


111 Pacific - Critical Pressure
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
Pressure (m)
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


111 Pacific - Water Demand Profile
180
160
140
120
100
80
60
40
20
0
Flowrate (l/min)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


111 Pacific - Energy Demand Profile
Power (kW)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post

3.7 66 Oakmount Ave.

3.7.1 Building Description

66 Oakmount Ave. is the smallest multi-residential high-rise at High Park Village with 12 floors and a total of 171 suites. The building is hot water heated. Both the domestic hot water and heating hot water is heated from gas-fired boilers located in 111 Pacific Ave.

3.7.2 Building Plumbing System

The plumbing system at 66 Oakmount Ave. prior to the completion of the monitoring program was as follows (please refer to the plumbing system schematic at the end of this section):

Domestic Cold Water
Domestic cold water is provided from the City of Toronto through a service line that enters the sprinkler room at 66 Oakmount Ave. The service line tees into the fire protection or sprinkler system and the domestic cold water system where it passes through the City billing meter. Immediately downstream from the City billing meter is the Minto control meter which was used to collect the demand information for this building.

The domestic cold water booster pump assembly is comprised of the following:

Primary Pump:	5HP motor with base mount suction pump.
Secondary Pump:	5HP motor with base mount suction pump.

Following the booster pump assembly, the domestic cold water pressure is reduced through an existing PRV to 75 psi. There is only one zone in this building. Water in the building is top fed meaning that the water is pumped to the top floor and distributed along a central main at that floor and then fed downwards through individual risers.

Domestic Hot Water
The domestic hot water system is also one zone. The hot water system is however constantly re-circulated to ensure a constant temperature. There is a hot water make up feed from the domestic cold water system.

3.7.3 Water Demand & Water Management History

The water closets and showerheads were replaced a year prior to the other buildings. The water consumption was 52 m^3/day or 304 l/suite/day. This reduction has remained fairly constant since the initial program. The appropriate ballcock assembly was used in this building and therefore no modifications were required and no erosion of savings was apparent.

3.7.4 Pre Booster Pump Control Monitoring

In order to establish the baseline pre-control water and energy demand, a detailed monitoring program was completed at 66 Oakmount Ave. from March 1 to March 28, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	13	39	53	50	4	1
Maximum	21	47	60	57	94	2
Average	17	43	57	54	31	2
Units	m	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	11	40	53	48	4	1
Maximum	22	47	60	58	68	2
Average	17	43	56	53	35	2
Units	m	m	m	m	l/min	kWh/h

The average daily consumption recorded at 66 Oakmount Ave. during the pre control monitoring was as follows:

Parameter	Water Demand	Booster Pump Energy
Weekday	262	48
Weekend	294	46
Units	l/unit/day	kWh/day

3.7.5 Post Booster Pump Control Monitoring

The control system implemented at 66 Oakmount Ave. was a variable speed drive assembly on the primary booster pump. Based on the pre monitoring results and location of the pressure transducer, it was determined that the set point for the critical pressure would be 14 m or 20 psi.

The post control monitoring program was completed at 66 Oakmount Ave. from April 7 to May 8, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	8	38	49	43	3	1
Maximum	16	46	55	52	75	2
Average	14	42	53	49	34	2
Units	m	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	10	40	51	46	3	1
Maximum	16	46	54	51	66	2
Average	14	43	53	49	34	1
Units	m	m	m	m	l/min	kWh/h

The average daily consumption recorded at 66 Oakmount Ave. during the post control monitoring was as follows:

Parameter	Water Demand	Booster Pump Energy
Weekday	287	37
Weekend	283	35
Units	l/unit/day	kWh/day

3.7.6 Water & Energy Savings Calculations

Based on the results obtained from the pre & post control monitoring the following savings were obtained.

Critical Pressure

Average Pre Pressure:	17 m
Average Post Pressure:	14 m
Reduction Percentage:	18 %

Water Demand

Average Pre Demand:	270 l/suite/day
Average Post Demand:	286 l/suite/day
Reduction in Water Demand:	0% (actually a 6% increase)

Booster Pump Energy

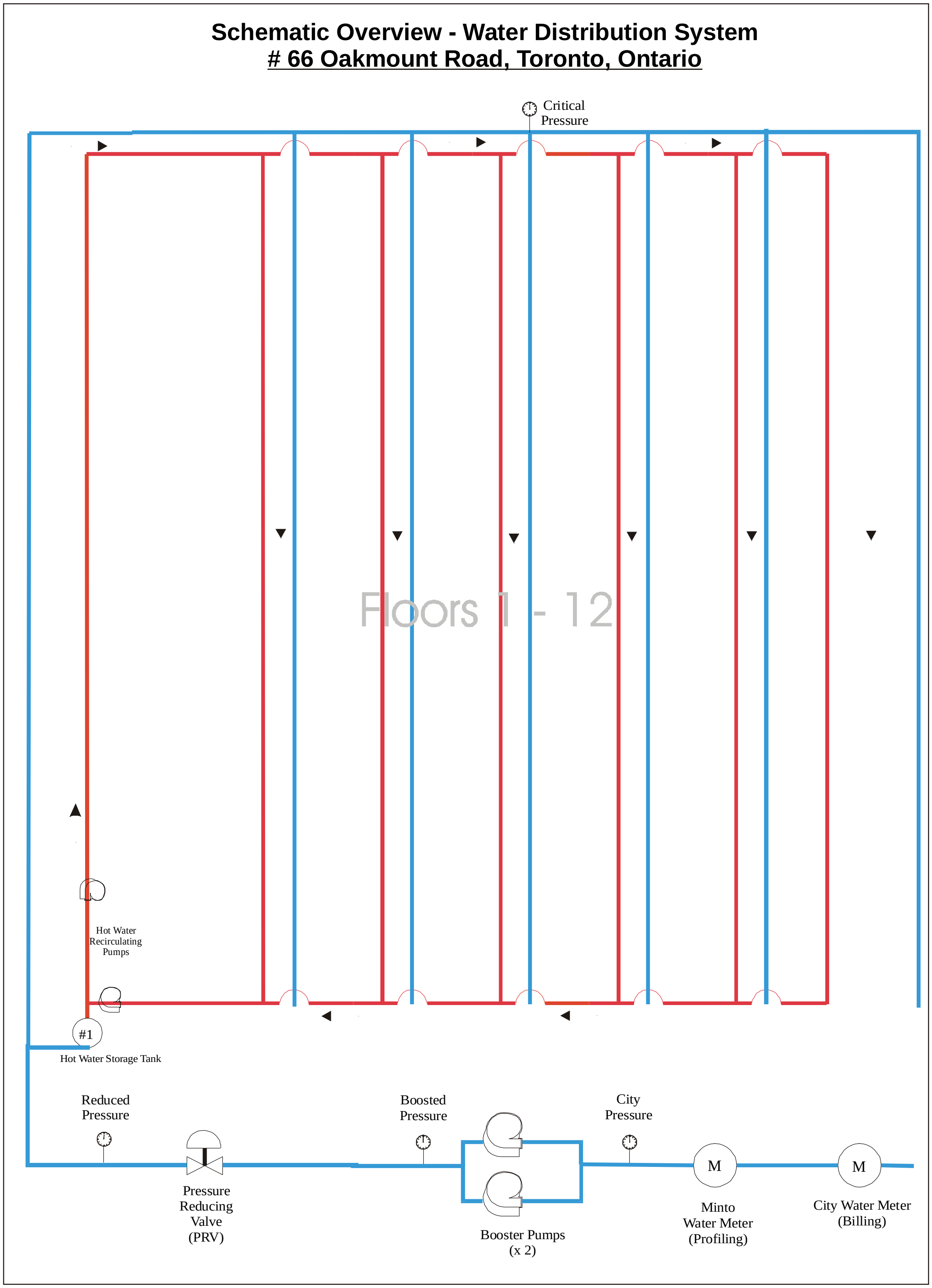
Average Pre Demand:	47 kWh/day
Average Post Demand:	36 kWh/day
Reduction in Energy:	22%

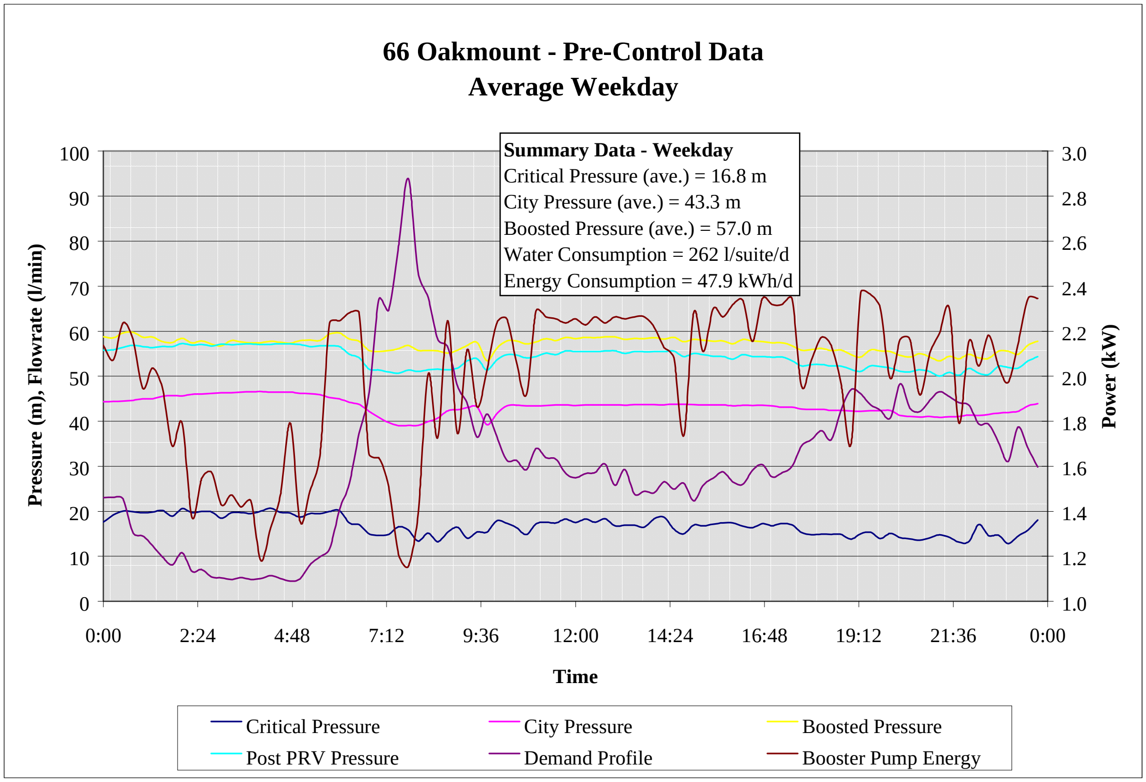
In order to complete a simple payback calculation the following rates were used:

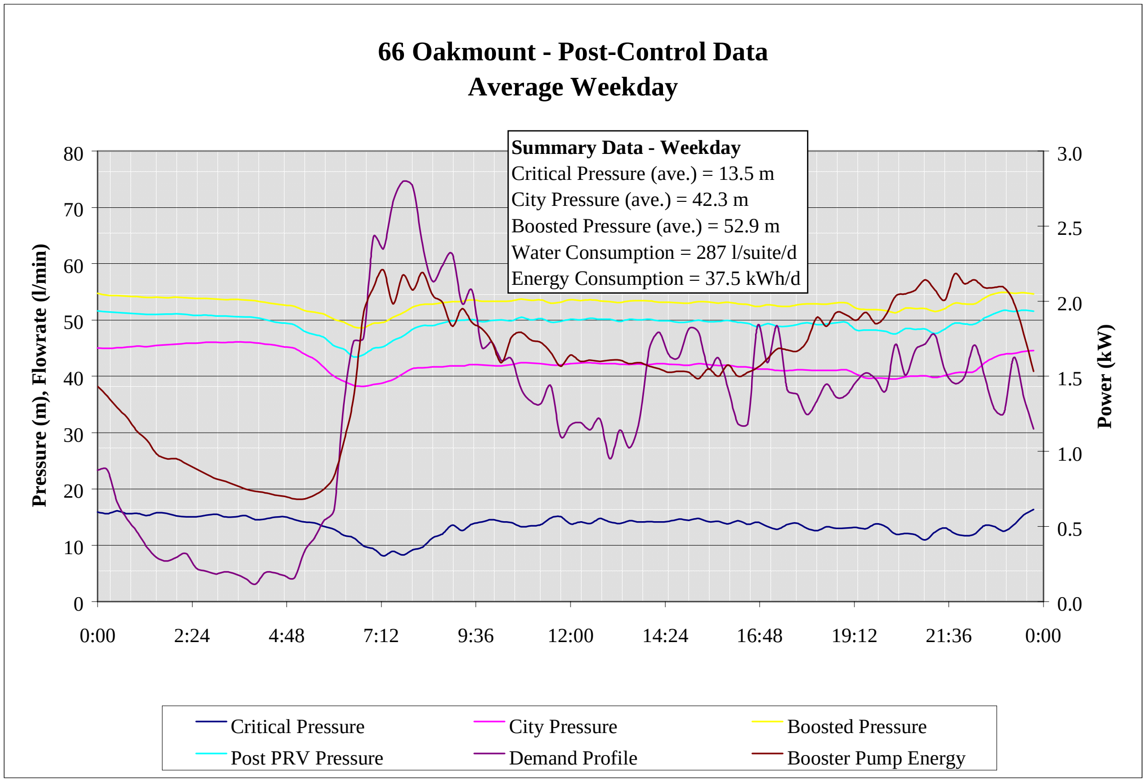
Cost of Water:	\$0.96 per m^3
Cost of Energy:	\$0.072 per kWh
Cost of VSD:	\$5,000

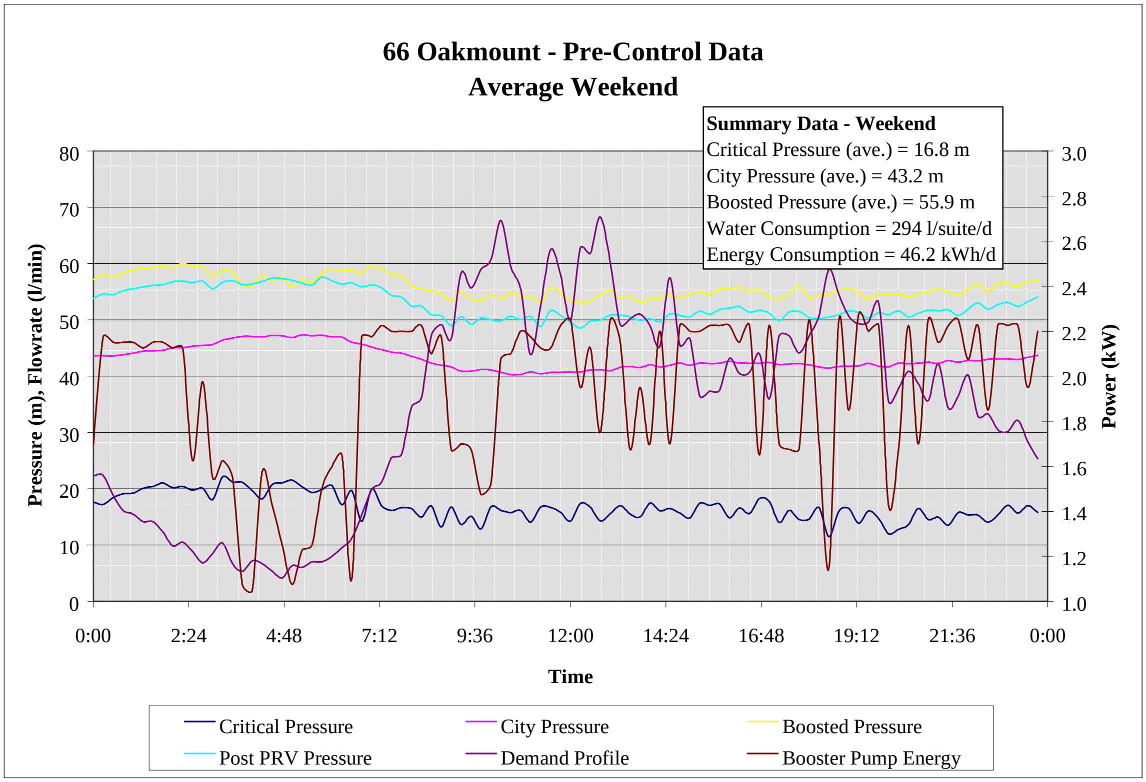
Estimated yearly water savings:	\$ 0.00
Estimated yearly energy savings:	\$ 289.00
Total Savings	**\$ 289.00**

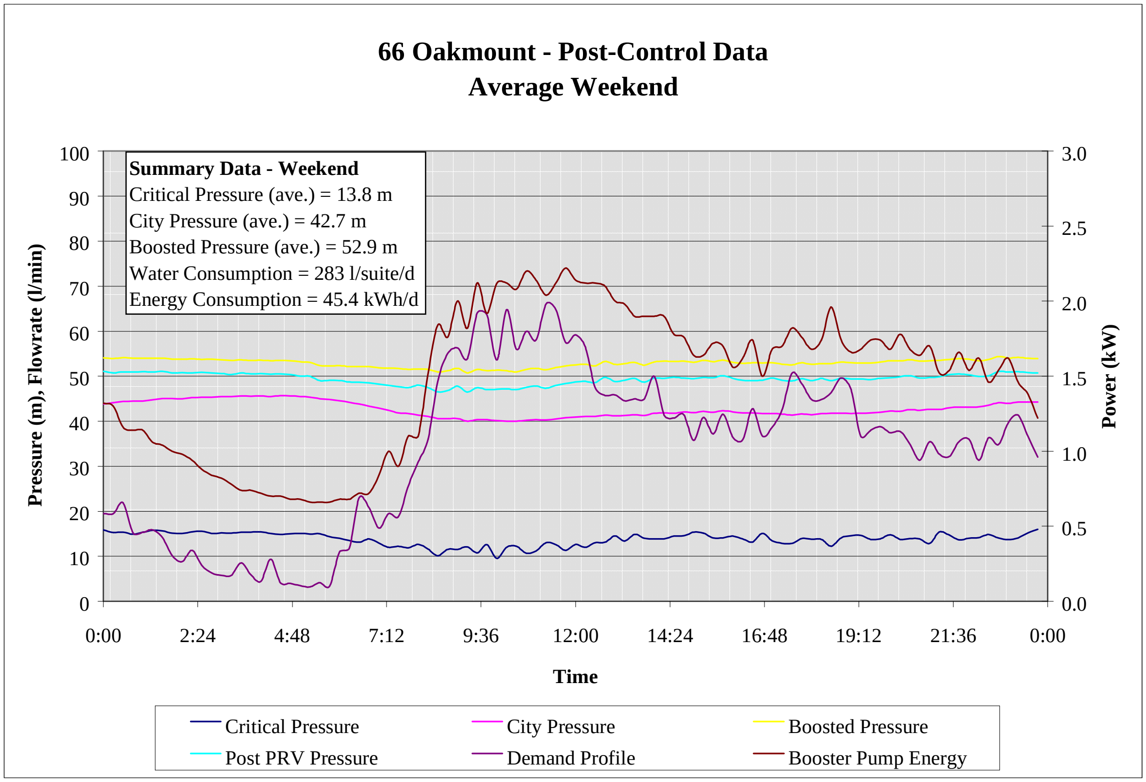
Simply Payback Calculation: 17.3 years

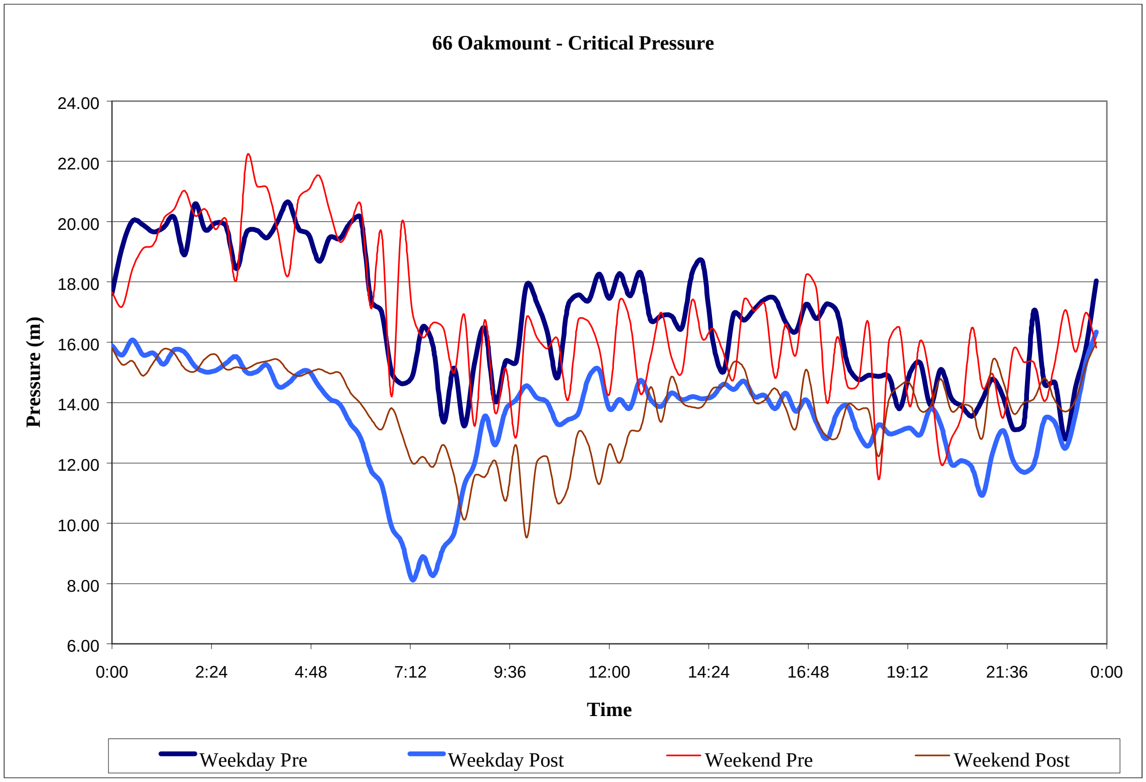

Schematic Overview - Water Distribution System
66 Oakmount Road, Toronto, Ontario
Critical Pressure
Floors 1 - 12
Hot Water Recirculating Pumps
#1
Hot Water Storage Tank
Reduced Pressure
Pressure Reducing Valve (PRV)
Boosted Pressure
Booster Pumps (x 2)
City Pressure
M
Minto Water Meter (Profiling)
M
City Water Meter (Billing)

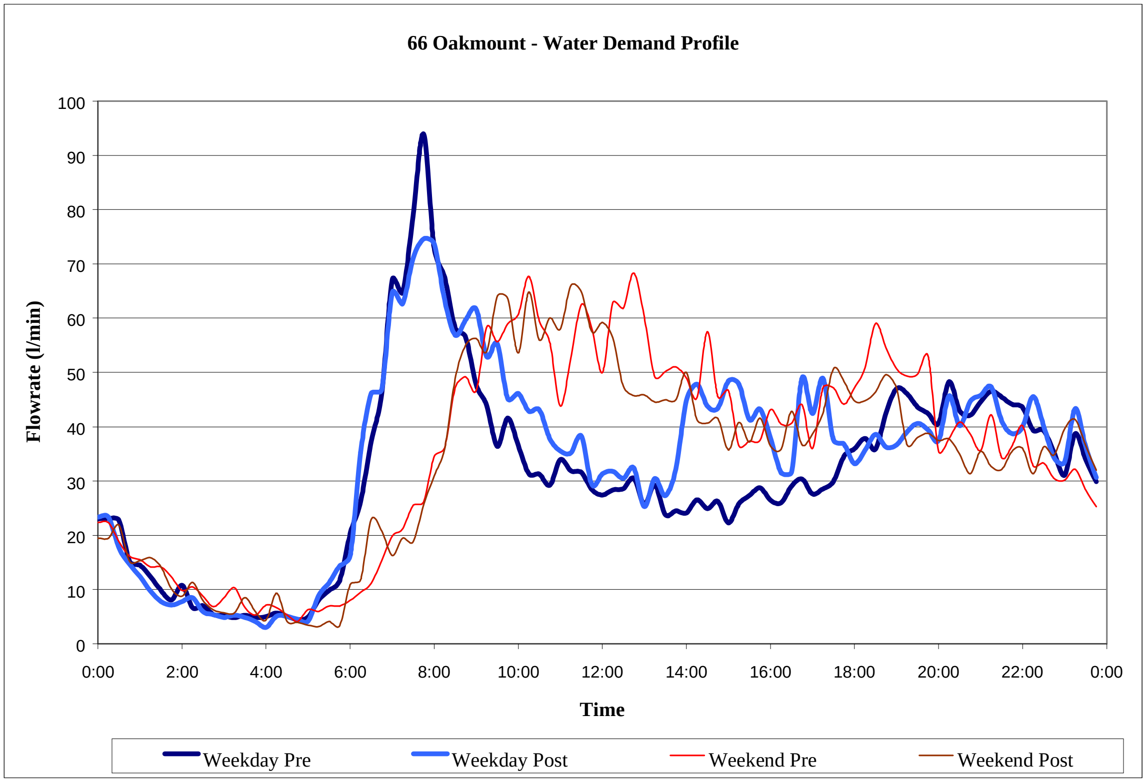

66 Oakmount - Pre-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 16.8 m
City Pressure (ave.) = 43.3 m
Boosted Pressure (ave.) = 57.0 m
Water Consumption = 262 l/suite/d
Energy Consumption = 47.9 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy

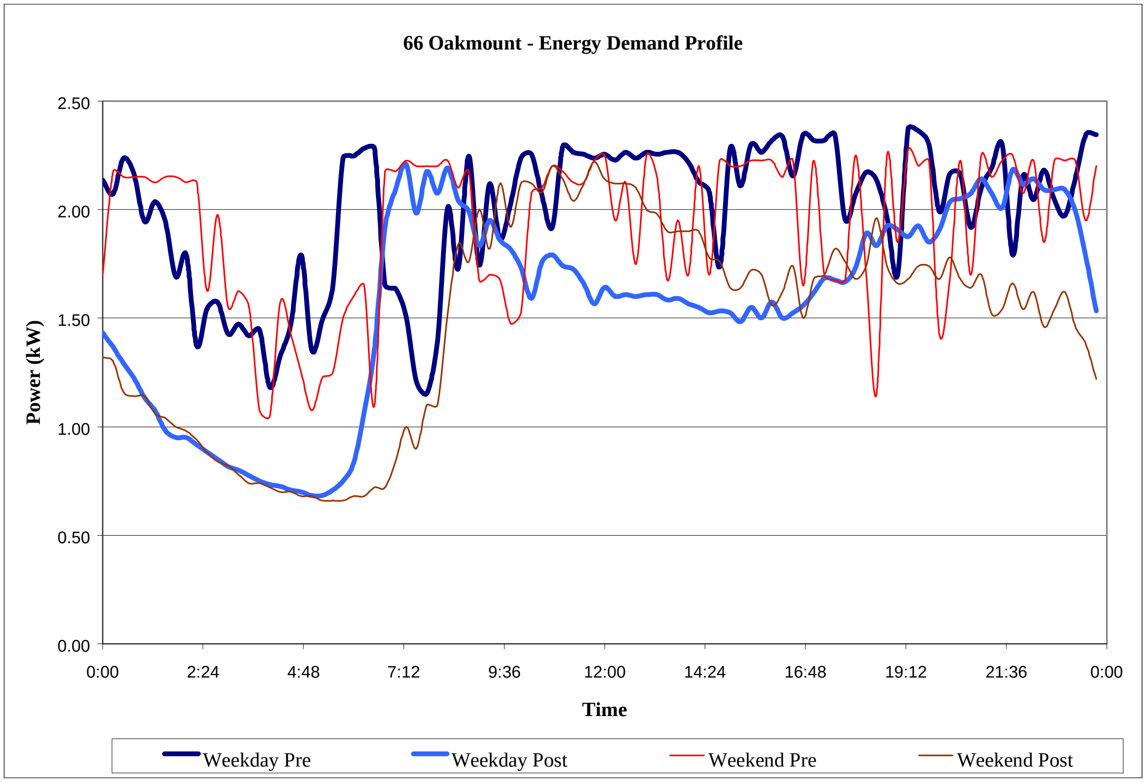

66 Oakmount - Post-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 13.5 m
City Pressure (ave.) = 42.3 m
Boosted Pressure (ave.) = 52.9 m
Water Consumption = 287 l/suite/d
Energy Consumption = 37.5 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


66 Oakmount - Pre-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 16.8 m
City Pressure (ave.) = 43.2 m
Boosted Pressure (ave.) = 55.9 m
Water Consumption = 294 l/suite/d
Energy Consumption = 46.2 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


66 Oakmount - Post-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 13.8 m
City Pressure (ave.) = 42.7 m
Boosted Pressure (ave.) = 52.9 m
Water Consumption = 283 l/suite/d
Energy Consumption = 45.4 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


66 Oakmount - Critical Pressure
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
Pressure (m)
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


66 Oakmount - Water Demand Profile
100
90
80
70
60
50
40
30
20
10
0
Flowrate (l/min)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


66 Oakmount - Energy Demand Profile
Power (kW)
2.50
2.00
1.50
1.00
0.50
0.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post

3.8 255 Glenlake Ave.

3.8.1 Building Description

255 Glenlake Ave. is the largest multi-residential high-rise at High Park Village with 23 floors and a total of 336 suites. The building is hot water heated. Both the domestic hot water and heating hot water is heated from gas-fired boilers located in 111 Pacific Ave.

3.8.2 Building Plumbing System

The plumbing system at 255 Glenlake Ave. prior to the completion of the monitoring program was as follows (please refer to the plumbing system schematic at the end of this section):

Domestic Cold Water
Domestic cold water is provided from the City of Toronto through a service line that enters the sprinkler room at 255 Glenlake Ave. The service line tees into the fire protection or sprinkler system and the domestic cold water system where it passes through the City billing meter. Immediately downstream from the City billing meter is the Minto control meter which was used to collect the demand information for this building.

Prior to the booster pump assembly, there is a feed to the buildings lawn irrigation system. The domestic cold water booster pump assembly is comprised of the following:

Primary Pump:	15HP motor with base mount suction pump.
Secondary Pump:	15HP motor with base mount suction pump.

Following the booster pump assembly, the domestic cold water is divided into a high pressure and low pressure zone. The high pressure zone is fed directly from the booster pump discharge pressure (120 psi) and services floors 14 to 24. The low pressure zone is fed from the booster pump and the pressure is reduced through a pressure reducing valve (105 psi) and services floors 1 to 12. Both zones are top fed meaning that the water is pumped to the top floor of each zone and distributed along a central main at that floor and then fed downwards through individual risers.

Domestic Hot Water
The domestic hot water system is also divided into the same two zones as the domestic cold water system. The hot water system is however constantly re-circulated to ensure a constant temperature. There is a hot water make up feed for each zone from the associated domestic cold water system.

3.8.3 Water Demand & Water Management History

Prior to any water management, the average daily consumption recorded at 255 Glenlake Ave. between March 1998 and February 1999 was 203 m^3/day or 604 l/suite/day. Following the replacement of water closets and showerheads in March 1999, the water consumption was reduced 20%. Following the replacement of the faulty ballcocks in late 1999, consumption was 129 m^3/day or 383 l/suite/day in February 2000. This represented a savings of 36%.

3.8.4 Pre Booster Pump Control Monitoring

In order to establish the baseline pre-control water and energy demand, a detailed monitoring program was completed at 255 Glenlake Ave. from March 1 to March 28, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	12	37	79	71	10	5
Maximum	21	45	88	88	189	7
Average	17	42	84	80	71	6
Units	m	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	14	39	80	72	12	5
Maximum	21	45	88	88	207	7
Average	17	42	84	80	92	6
Units	m	m	m	m	l/min	kWh/h

The average daily consumption recorded at 255 Glenlake Ave. during the pre control monitoring was as follows:

Parameter	Water Demand	Booster Pump Energy
Weekday	305	137
Weekend	393	139
Units	l/unit/day	kWh/day

3.8.5 Post Booster Pump Control Monitoring

The control system implemented at 255 Glenlake Ave. was a variable speed drive assembly on the primary booster pump. Based on the pre monitoring results and location of the pressure transducer, it was determined that the set point for the critical pressure would be 14 m or 20 psi.

The post control monitoring program was completed at 255 Glenlake Ave. from April 18 to May 15, 2000. The following locations were recorded at 15 minute intervals:

- City Pressure
- Boosted Pressure
- Post PRV Pressure
- Critical Pressure (Penthouse)
- Total Water Demand
- Booster Pump Energy

A graphical representation of the average daily profile for each component listed above for both weekdays and weekends can be found at the end of this section. A summary of recorded data follows:

Average Weekday

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	12	37	77	69	11	4
Maximum	15	45	80	79	180	7
Average	14	41	79	75	67	5
Units	m	m	m	m	l/min	kWh/h

Average Weekend

Parameter	Critical Pressure	City Pressure	Boosted Pressure	Post PRV Pressure	Water Demand	Energy Demand
Minimum	13	38	77	70	13	4
Maximum	15	45	80	79	162	6
Average	14	42	79	74	80	5
Units	m	m	m	m	l/min	kWh/h

The average daily consumption recorded at 255 Glenlake Ave. during the post control monitoring was as follows:

Parameter	**Water Demand**	**Booster Pump Energy**
Weekday	289	117
Weekend	343	120
Units	l/unit/day	kWh/day

3.8.6 Water & Energy Savings Calculations

Based on the results obtained from the pre & post control monitoring the following savings were obtained.

Critical Pressure

Average Pre Pressure: 17 m
Average Post Pressure: 14 m
Reduction Percentage: 18 %

Water Demand

Average Pre Demand: 330 l/suite/day
Average Post Demand: 304 l/suite/day
Reduction in Water Demand: 8%

Booster Pump Energy

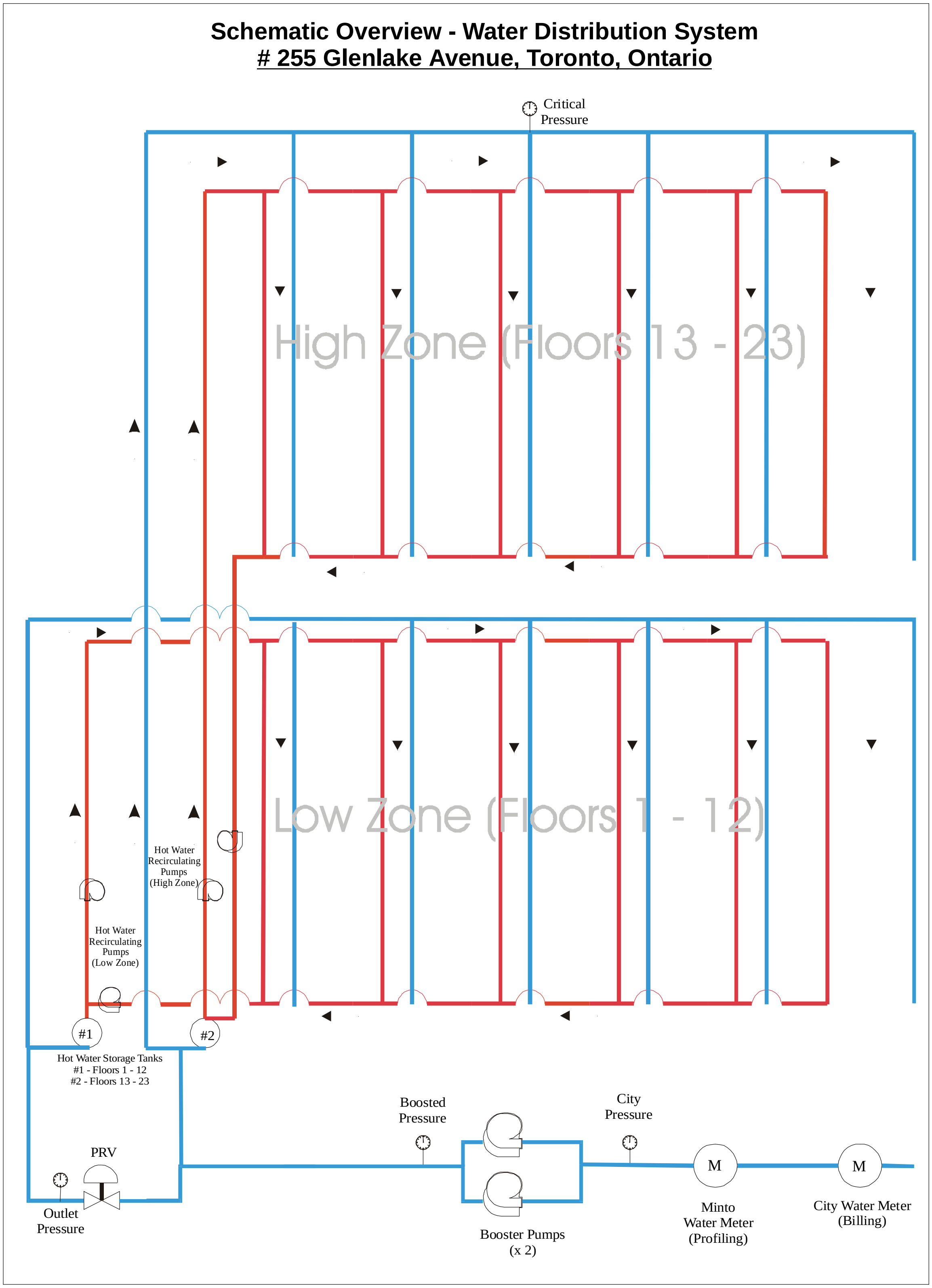
Average Pre Demand: 138 kWh/day
Average Post Demand: 118 kWh/day
Reduction in Energy: 14%

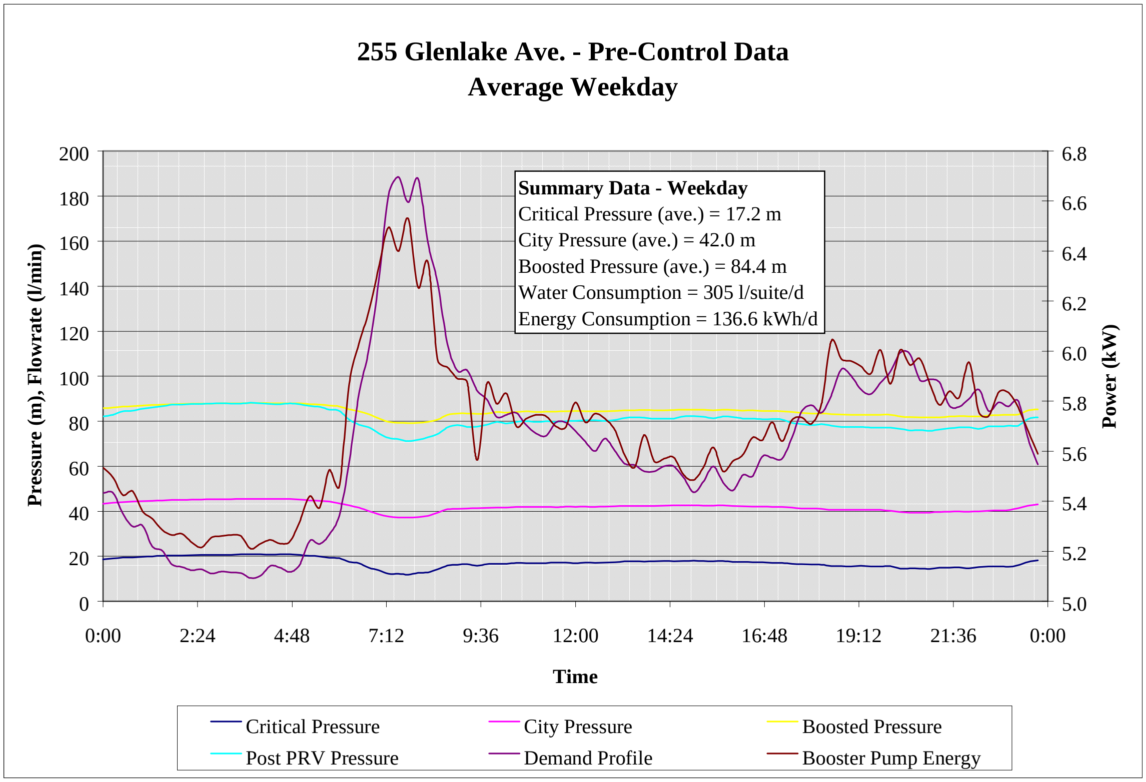
In order to complete a simple payback calculation the following rates were used:

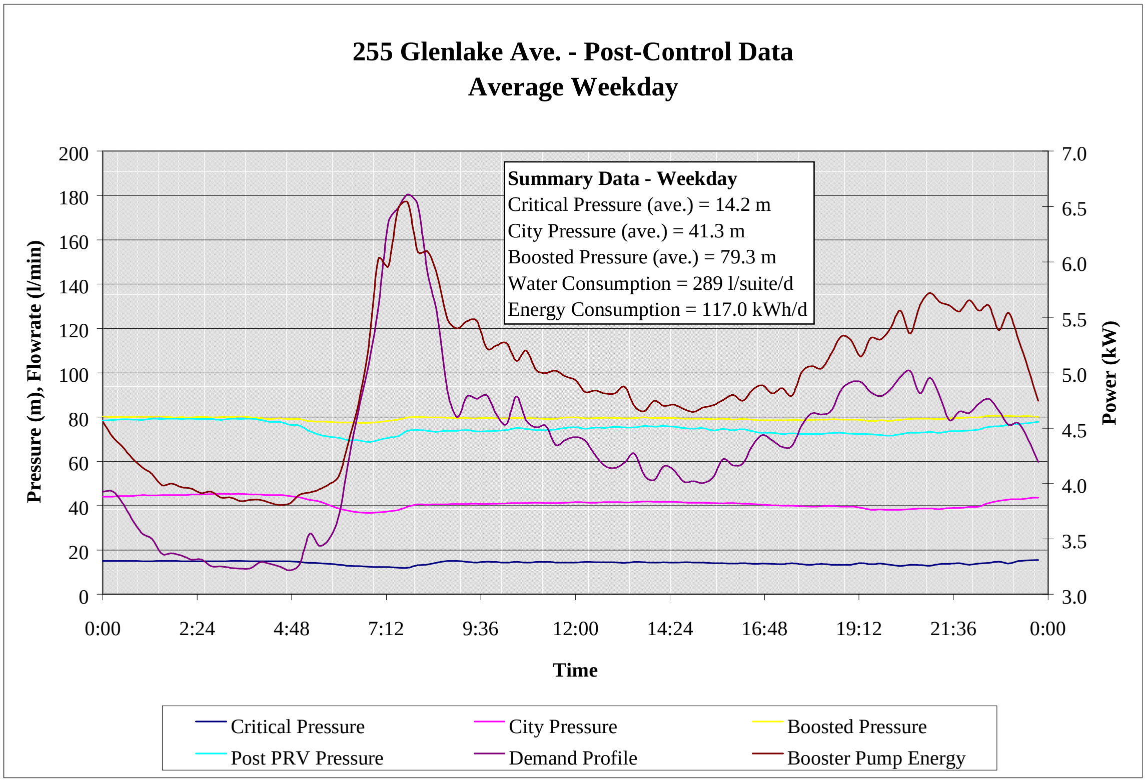
Cost of Water: \$0.96 per m^3
Cost of Energy: \$0.072 per kWh
Cost of VSD: \$5,000

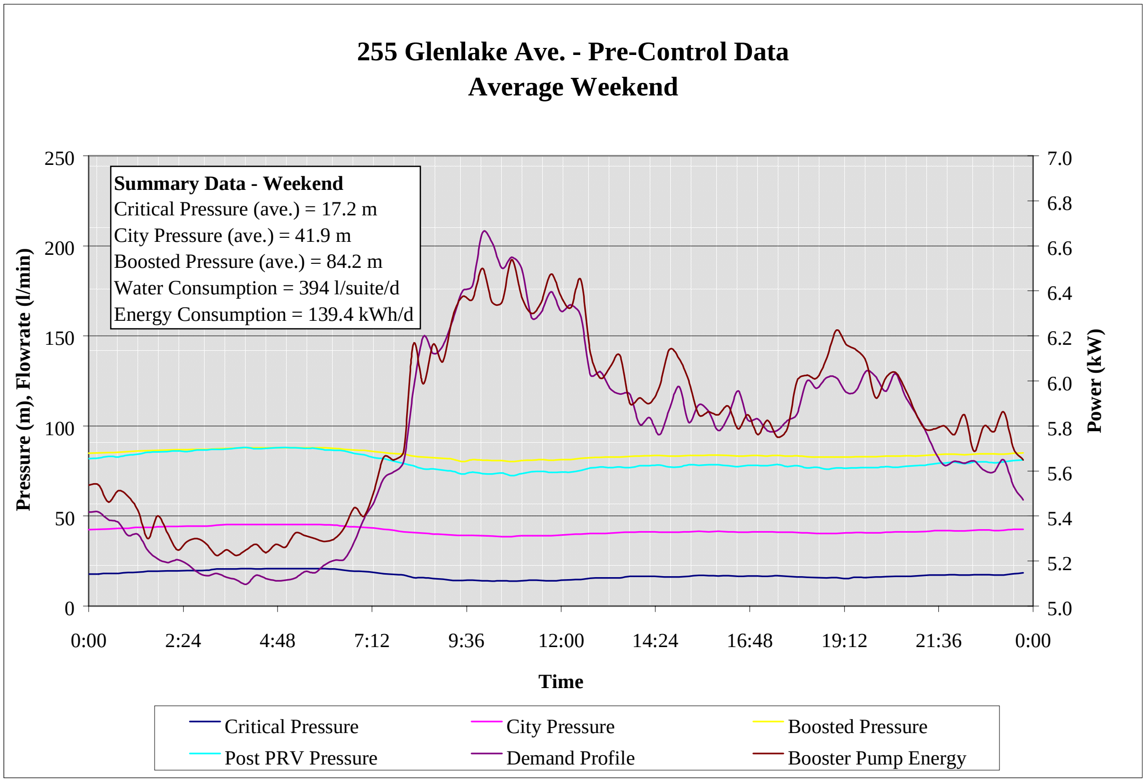
Estimated yearly water savings: \$3,061.00
Estimated yearly energy savings: \$ 525.00
Total Savings **\$3,586.00**

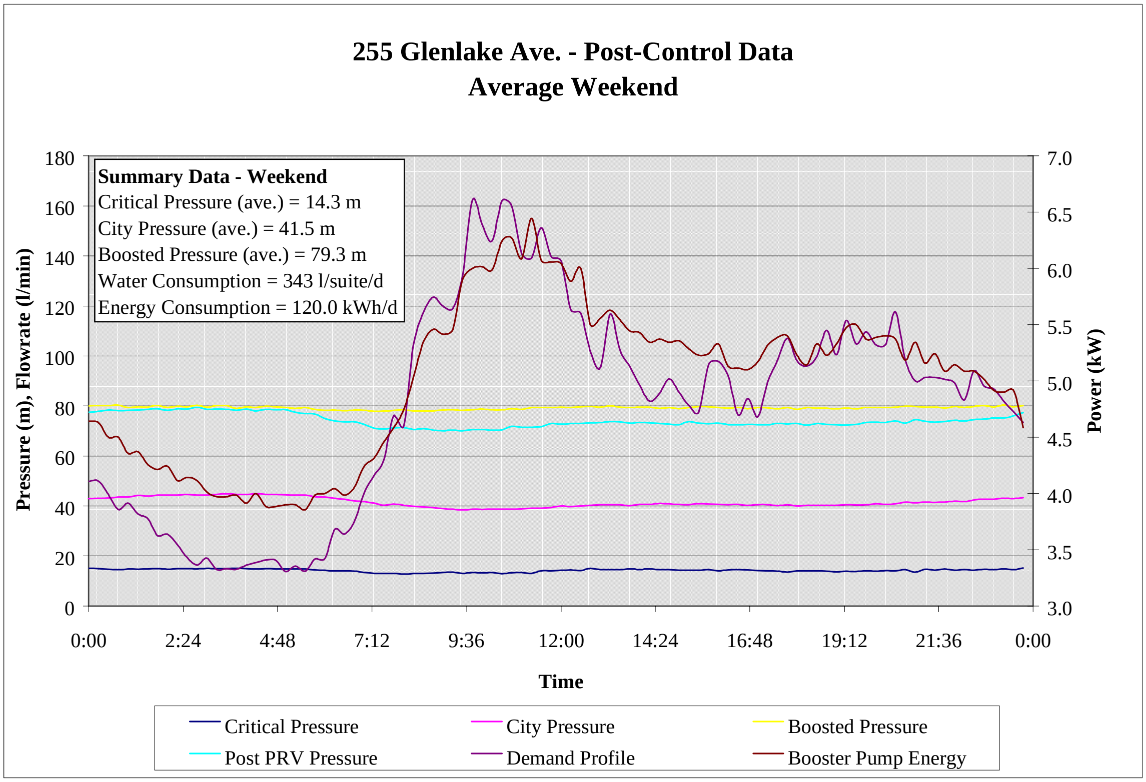
Simply Payback Calculation: 1.4 years

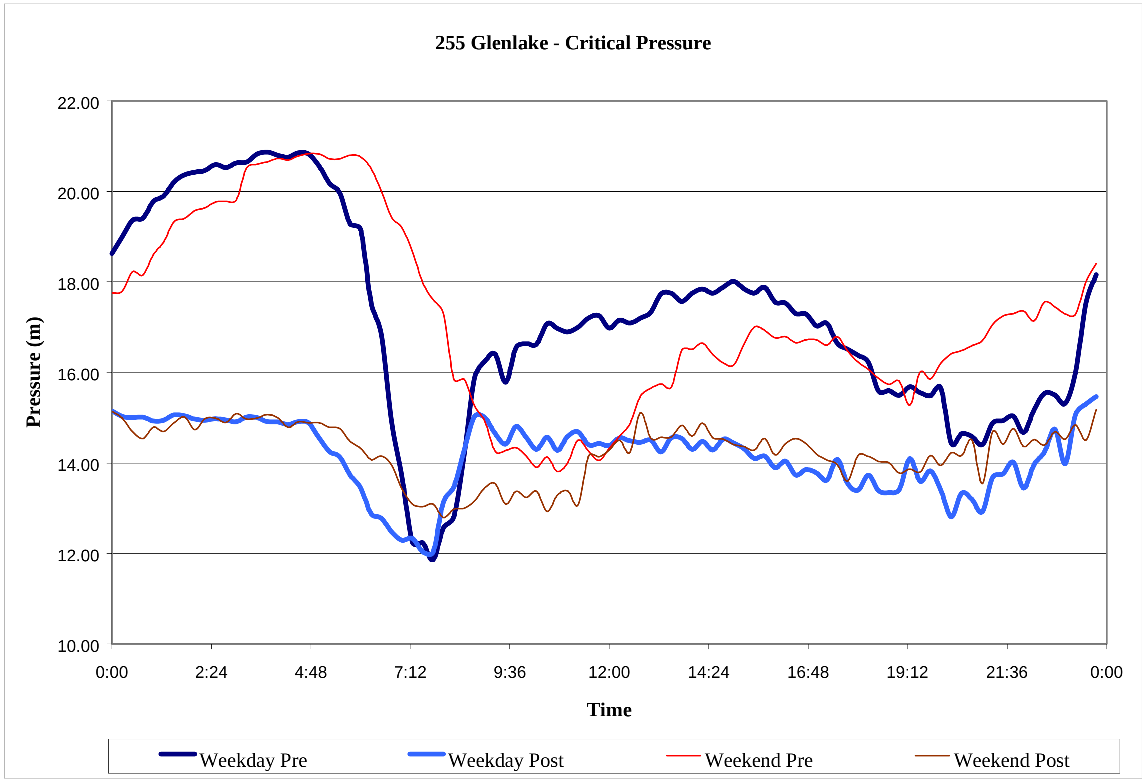

Schematic Overview - Water Distribution System
255 Glenlake Avenue, Toronto, Ontario
Critical Pressure
High Zone (Floors 13 - 23)
Low Zone (Floors 1 - 12)
Hot Water Recirculating Pumps (High Zone)
Hot Water Recirculating Pumps (Low Zone)
#1
#2
Hot Water Storage Tanks
#1 - Floors 1 - 12
#2 - Floors 13 - 23
Boosted Pressure
City Pressure
PRV
M
M
Outlet Pressure
Booster Pumps (x 2)
Minto Water Meter (Profiling)
City Water Meter (Billing)

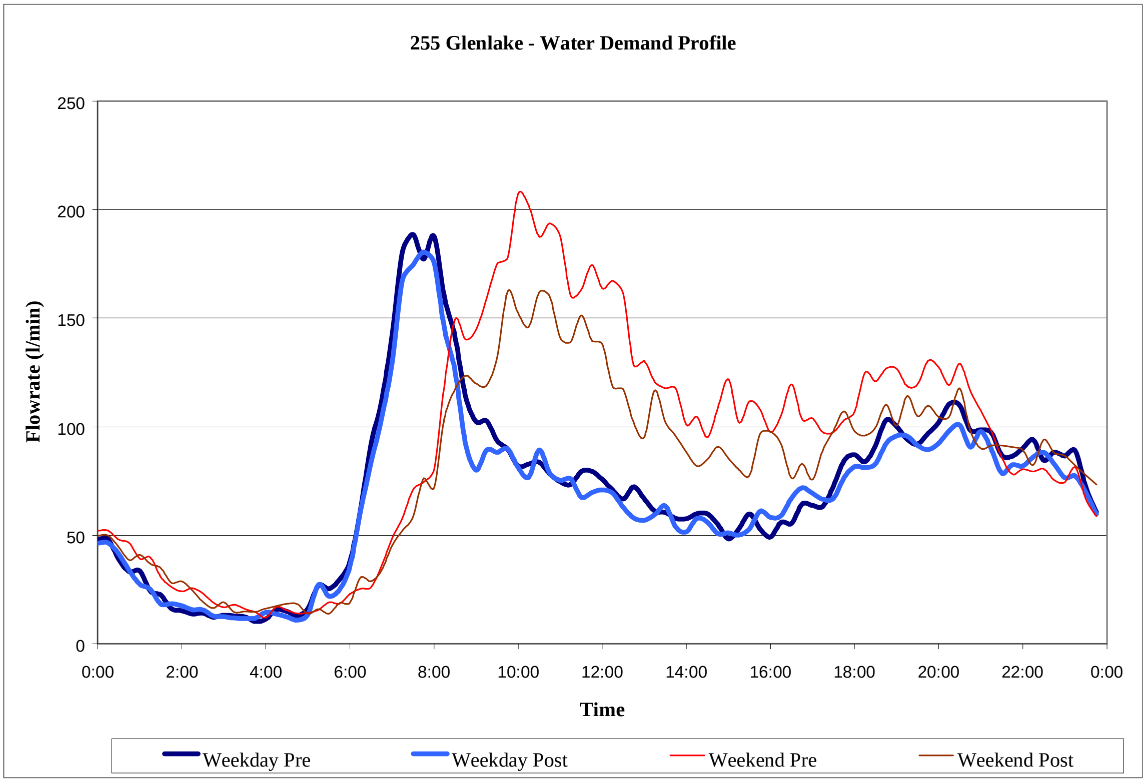

255 Glenlake Ave. - Pre-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 17.2 m
City Pressure (ave.) = 42.0 m
Boosted Pressure (ave.) = 84.4 m
Water Consumption = 305 l/suite/d
Energy Consumption = 136.6 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
200
180
160
140
120
100
80
60
40
20
0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy

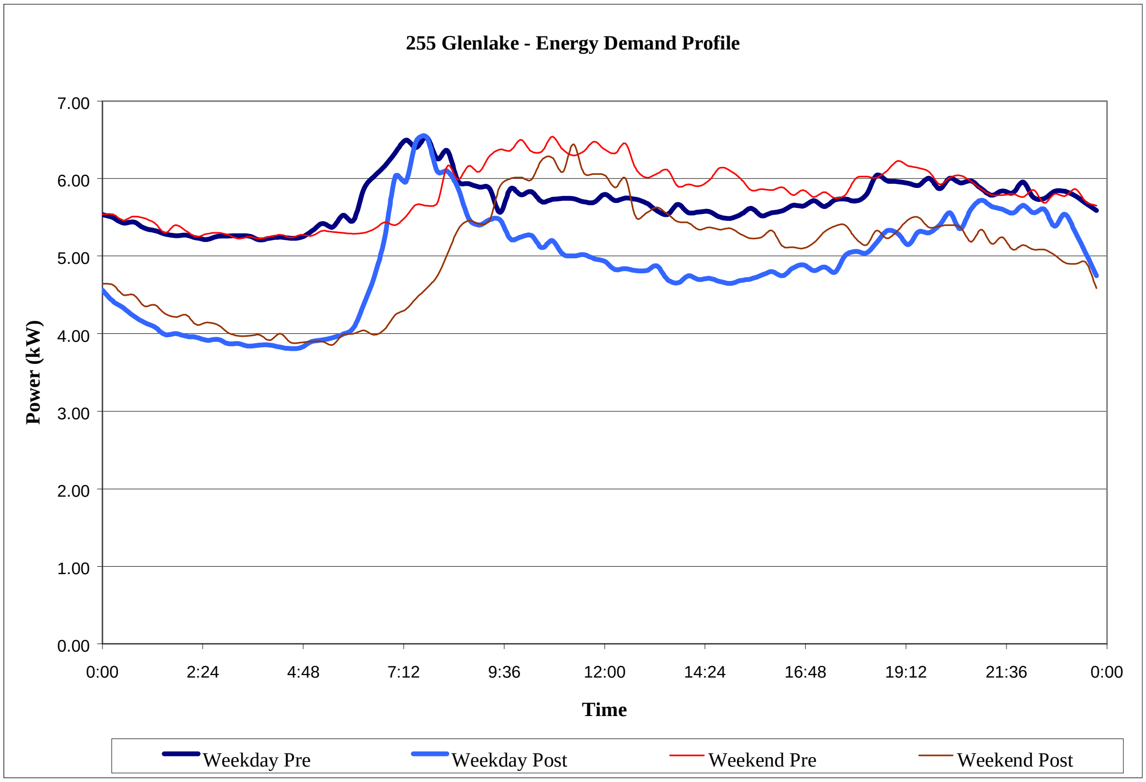

255 Glenlake Ave. - Post-Control Data
Average Weekday
Summary Data - Weekday
Critical Pressure (ave.) = 14.2 m
City Pressure (ave.) = 41.3 m
Boosted Pressure (ave.) = 79.3 m
Water Consumption = 289 l/suite/d
Energy Consumption = 117.0 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
200
180
160
140
120
100
80
60
40
20
0
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


255 Glenlake Ave. - Pre-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 17.2 m
City Pressure (ave.) = 41.9 m
Boosted Pressure (ave.) = 84.2 m
Water Consumption = 394 l/suite/d
Energy Consumption = 139.4 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
0
50
100
150
200
250
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


255 Glenlake Ave. - Post-Control Data
Average Weekend
Summary Data - Weekend
Critical Pressure (ave.) = 14.3 m
City Pressure (ave.) = 41.5 m
Boosted Pressure (ave.) = 79.3 m
Water Consumption = 343 l/suite/d
Energy Consumption = 120.0 kWh/d
Pressure (m), Flowrate (l/min)
Power (kW)
0
20
40
60
80
100
120
140
160
180
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Critical Pressure
City Pressure
Boosted Pressure
Post PRV Pressure
Demand Profile
Booster Pump Energy


255 Glenlake - Critical Pressure
Pressure (m)
22.00
20.00
18.00
16.00
14.00
12.00
10.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


255 Glenlake - Water Demand Profile
Flowrate (l/min)
250
200
150
100
50
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post


255 Glenlake - Energy Demand Profile
Power (kW)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
Time
Weekday Pre
Weekday Post
Weekend Pre
Weekend Post

4.0 Global Summary of Savings & Paybacks

The following table illustrates the global water consumption for the entire High Park Village for both pre and post monitoring:

Building	# Suites	Pre Water Consumption	Pre Daily Total	Post Water Consumption	Post Daily Total
35 High Park	201	444	89	428	86
65 High Park	321	429	138	437	140
95 High Park	218	374	82	445	97
66 Pacific Ave.	229	406	93	443	101
111 Pacific Ave.	242	357	86	359	87
66 Oakmount Ave.	171	270	46	286	49
255 Glenlake Ave.	336	330	111	304	102
Total	**1718**	**373**	**645**	**386**	**662**
Units		l/suite/day	m^3/day	l/suite/day	m^3/day

From a global perspective, it is clear to see that no water savings were achieved with the booster pump control system. In fact, the global High Park Village water usage showed an increase of 2.6% during the post monitoring. This value is insignificant as normal demand variations in multi-residential buildings can range up to 5%.

The following table illustrates the global booster pump energy consumption for the entire High Park Village for both pre and post monitoring:

Building	# Suites	Pre Energy Consumption	Post Energy Consumption
35 High Park	201	357	108
65 High Park	321	239	86
95 High Park	218	84	20
66 Pacific Ave.	229	168	122
111 Pacific Ave.	242	76	55
66 Oakmount Ave.	171	47	36
255 Glenlake Ave.	336	138	118
Total[2]	**1718**	**1109**	**545**
Units		kWh/day	kWh/day

The energy savings achieved are very apparent from the table above. The global booster pump energy consumption was 1109 kWh/day pre vs. 545 kWh/day post – a 51% global reduction in energy consumption in the seven buildings. This energy savings equates to a yearly savings of $14,822 in energy costs based on a rate of $0.072 per kWh. This gives a simple payback of 3.4 years based on a system installation cost of $5,000 for each of the seven buildings and including the pump replacement costs for 35 & 95 High Park.

5.0 Conclusions and Recommendations

In conclusion, this study has identified that water savings may not always be achieved through the use of VSD technology on domestic cold water booster pumps in multi-residential high rise buildings.

Based on these results, it is our opinion that the VSD technology on a domestic cold water booster pump high rise application should be evaluated based solely on the energy merits. While we believe that water savings may be achieved in buildings with extensive leaks, fixture replacement or retrofit programs should provide a more cost effective solution to high water consumption rather then lowering the pressure in leaky buildings.

For proper water efficiency we conclude that building owners should:

1. Trend water use in their buildings.
2. Implement cost effective water conversions.
3. Install VSD technology on the booster pumps.
4. Continuously track and monitor performance.
5. Evaluate cost effectiveness of proper pump sizing.

February 2001

Report Author:
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