Department of Public Utilities

Annual Report of Operations

2011-2012 Update

Energy Management Initiative

April 29, 2013

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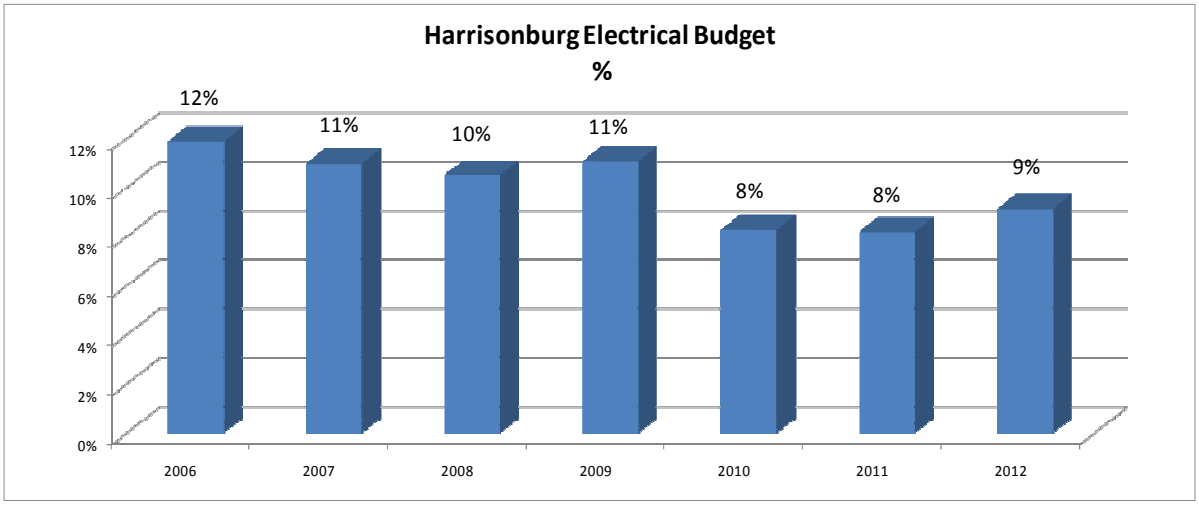
I. Introduction:

The City of Harrisonburg Department of Public Utilities has recognized that its stakeholders place value upon both cost efficient and environmentally sensitive performances. In that purpose and working under the framework of an Operation Performance Team, several functional division managers of the Public Utilities Department have given significant attention to minimizing energy consumption in all aspects of operations. This document provides insight into achievements that have been made as well as those that will be targeted in this area of resource management.

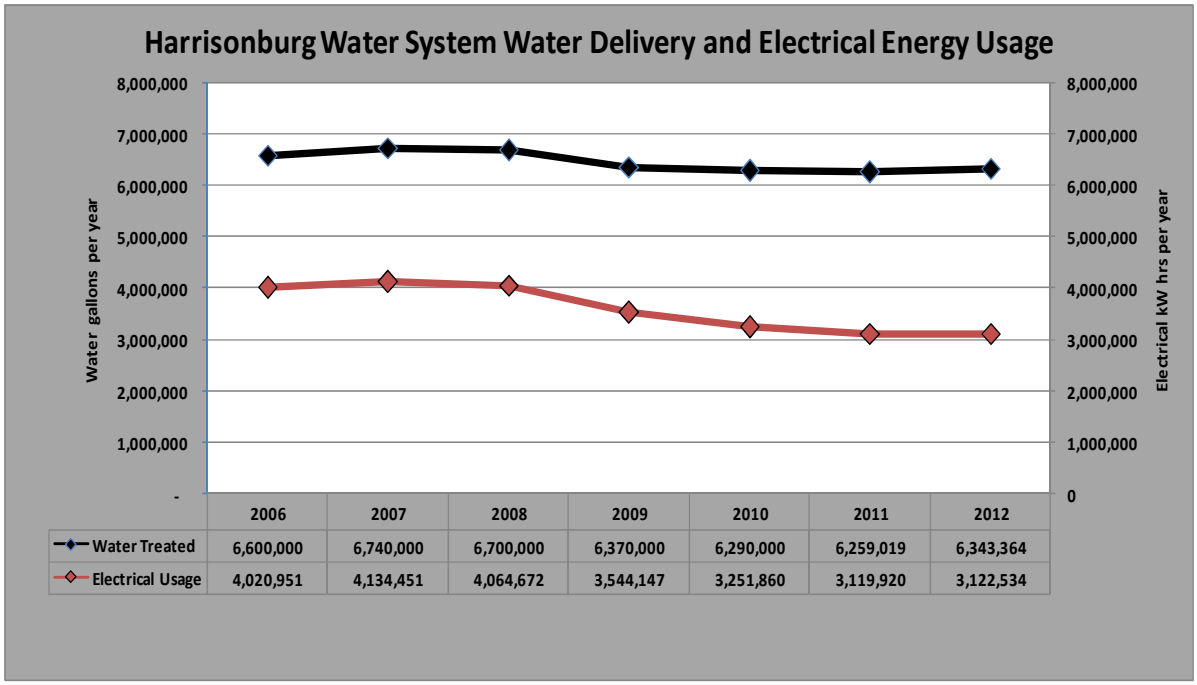
II. Harrisonburg Water System:

a) *Background:*

According to the American Water Works Association (AWWA), energy used to deliver water has ranged from 5 to 35 percent (11 percent average) of the water operating budget, which can significantly affect the bottom line. Therefore, the cost of purchasing power and energy is a major financial issue to the efficiency and effectiveness of delivering water service. To develop a perspective for the City of Harrisonburg, the same similarity is shown in the graph and data as follow. From 2006 through 2009, electrical costs were around 10% to 12% of the total operation and maintenance budget; the utility department was able to reduce these percentages to 8% to 9% in the years that followed through 2012.



b) ***Harrisonburg Water System Trending:***

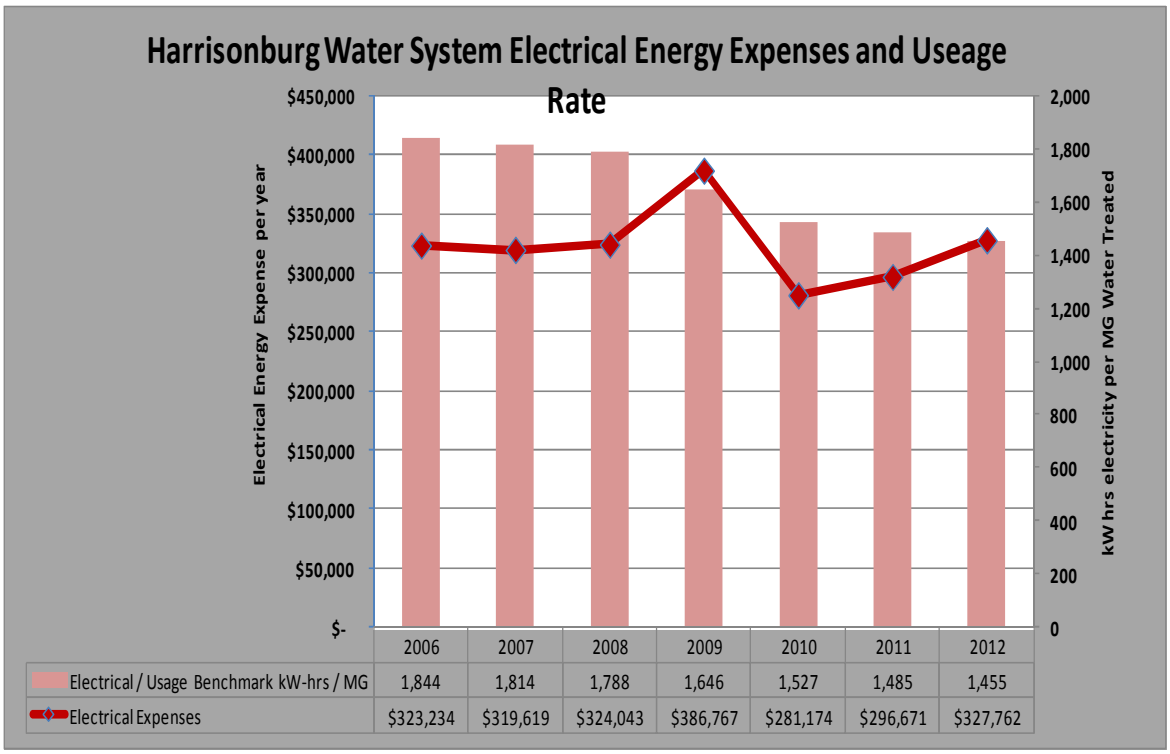


Water Treated: During the period from 2006 through 2012, the daily volume of water treated for delivery has averaged 6,472,000 gallons per day, plus or minus about 4%. During the initial two years the water consumption increased, but thereafter that treatment volume had decreased. Overall, water usage had decreased about 4% over the total duration. This trend is shown in the graph and data table above.

Energy Usage: During the same 2006 through 2012 period, the total electrical energy consumption in the Harrisonburg water system was 4,442,071 kW hrs in 2006 and then progressively decreased to 3,368,134 kW-hrs in 2012. Total electrical energy consumption has reduced by 1,073,937 kW-hrs or 24**%.** This trend is also shown in the graph and data table above.

c) ***Harrisonburg Water System Benchmarking:***

To better understand the relevance of the observed water and energy trends to the City of Harrisonburg water system, the total cost for electricity is a benchmark pertaining to the bottom line budget. In addition, "energy consumed per unit water treated" is a second benchmark pertaining to energy use efficiency. Both benchmarks are shown together in the graph and data table below.



	2006	2007	2008	2009	2010	2011	2012
Electrical / Usage Benchmark kW-hrs / MG	1,844	1,814	1,788	1,646	1,527	1,485	1,455
Electrical Expenses	$323,234	$319,619	$324,043	$386,767	$281,174	$296,671	$327,762

Electrical Cost: Observed from the trend graph above is the electrical energy cost for the period between 2006 and 2012. The 2006 and 2012 costs compare relatively equally at $323,000 and $328,000, respectively; however, observing a maximum of $387,000 in 2009. The total electrical cost incurred by the Department of Public Utilities has been influenced by several factors that include water demand (showing about a 4% decrease as noted previously), the cost of electricity (average cost per kW-hr increasing 43% from $0.07 to $0.10 during the span), and improvements in energy efficiency that were incurred from efforts made by the Public Utilities Department under this initiative. The previously referenced reductions in total energy consumption have nearly offset the incurred increases in the unit cost of energy.

Energy Efficiency: Observed from the trend graph above is the electrical energy efficiency benchmark for "energy used per million gallons water treated" for the period between 2006 and 2012. The 2006 and 2012 benchmarks have consistently decreased from 1,844 to 1,455. The efficiency of energy consumption has reduced by 389 kW-hrs per MG water treated which indicates a 21% increase in efficiency. This trend was in response to activities engaged by the Department of Public Utilities.

d) ***Harrisonburg Water System Demand Centers***

Provided in the following table is a summary Harrisonburg water system assets that have been identified as significant electrical energy users.

Energy Demand Center	ID	GPM	Efficiency
North River Pump Station	NRPS	2,350	1,998
Garber's Church Pump Station	GCPS	2,160	1,127
Tower Street Pump Station kw-hrs	TSPS	2,200	226
Stonespring Pump Station kw-hrs	SSPS	1,620	419
Park View Pump Station	PVPS	210	720
Ridgeville Pump Station kw-hrs	RVPS	475	693
Valley Mall Pump Station kw-hrs	VMPS	340	1,038
Dale Enterprise Pump Station	DEPS	335	TBD
Cooper's Mountain	CMPS	TBD	TBD
Forest Hills	FHPS	TBD	TBD
Bluestone Hills	BHPS	225	TBD
Copper Beech	CBPS	TBD	TBD

Efficiency expressed in kW hrs / MG using 2012 observed data

e) ***Methodology for Energy Management:***

To combat the significant electrical expenses to our own system, we have actively engaged this initiative to reduce and mitigate both existing and future electrical consumption and expenses. The initial focus of this initiative was to examine and develop understandings of the department's facilities and assets in terms of the characteristics that influence the amount of electricity that each consumes. The second focus was to select and engage selected principles to reduce and mitigate electrical usage. As a result, energy savings have been realized in many ways, from field testing and proper maintenance of equipment to using computers to optimize operation control schemes. The principles used in this initiative effort were as follows:

1. Decrease the volume of water pumped; adjusting the boundaries of the water system zones with purpose to maximize the number of customers that can be provided adequate service in the lowest energy use zone.

2. Lower the head against which the water must be pumped with focus to keep supply pressures to an acceptable minimum level.

3. Increase the wire to water efficiency of pumps; use operating and capital funds to ensure that the pumps operate at the best efficiency point.

4. Select the assets best suited to minimize power consumption.

5. Ensure the application and the proper use of variable speed pumps.

6. Recognize energy tariff incentives such as avoiding peak period pumping and making effective use of stored water by filling during off periods and draining during peak periods.

7. Use SCADA to engage computer aided optimized pumping configuration and reservoir control.

8. Engage close attention to "Best Management Practices" (BMPs).

The City of Harrisonburg has been able to implement and benefit from many of the above referenced approaches. Achievements are summarized in Section f that follows in this document and details regarding progress within subsystems of the water system are provided in the Appendix.

f) Achievements in Water System Efficiency

Using the techniques listed in Section e) above; the following achievements have been realized; detailed descriptions of how these achievements have occurred are provided in the Appendices of this document:

• Western Raw Water System	445,000 kilowatt hours per year
• First Low Zone	80,000 kilowatt hours per year
• First High Zone	240,000 kilowatt hours per year
• Dale Enterprise Zone	140,000 kilowatt hours per year
• Recirculation Zones	50,000 kilowatt hours per year
• Water Treatment Plant	50,000 kilowatt hours per year
• **Total**	**1,005,000 kilowatt hours per year**

g) 2013 Water System Efficiency Improvement Targets

As we move forward into the 2013 fiscal year, the following areas have been selected as immediate targets for the next energy improvements:

- Western Raw Water System: This effort includes master planning for the continued long range advancement of the 30" raw water line that will increase use of water from the Dry River source. This effort will include more immediate scheduling of upgrades to the North River Pump Station with VFD technology and rate structure management.

- Park View Water Zone: This effort includes reduction in zone size, replacement of the existing Park View Pump Station, and considerations to use Garber's Church Pump Station as a feed to the Park View Zone.

- First High Water Zone: This effort includes reduction in zone size for the First High Water Zone.

- Recirculation Zones: This effort will include enhanced capture of water transfer data.

- BMP – This effort will consider building energy losses during colder climate.

h) Progress and Target Matrix

The matrix as follows correlates the energy consuming components of the water system to their electrical demand, their determined electrical savings incurred through 2012 with this initiative and the individualized savings associated with the techniques that were used to reduce actual energy consumption.

HARRISONBURG WATER SYSTEM ELECTRICAL DEMAND AND DEMAND REDUCTION SUMMARY

Water System Zone	Annual Useage kW hrs/yr	Incurred Savings kW hrs/yr	Savings by Volume	Savings by Head	Savings by Asset	Savings by W to W	Savings by VS	Savings by Tariff	Savings by SCADA	Savings by BMP
Raw Water System	**2,256,000**	445,000			445,000	2013 target	2013 target	2013 target	2013 target	2013 target
First Low Water Zone	**17,000**	80,000			80,000					2013 target
Second Low Water Zone	**4,000**									2013 target
First High Water Zone	**266,000**	240,000	230,000			10,000				2013 target
Park View Water Zone	**83,000**		2013 target		2013 target	2013 target	2013 target	2013 target	2013 target	2013 target
Dale Enterprise Water Zone	**62,000**	140,000	140,000							2013 target
Second High Water Zone	**288,000**									2013 target
Recirculation Systems	**146,000**	50,000			50,000					2013 target
Water Treatment Plant	**246,000**	50,000								50,000
Total	**3,368,000**	**1,005,000**	**370,000**		**575,000**	**10,000**				**50,000**

III. Harrisonburg Sewer System:

The Harrisonburg Sewer system energy usage is composed of six sewer pumping stations that used a total of 89,000 kW-hrs of electricity in 2012. The decomposition is as follows:

Greens pump Station	22,000 kW hrs
Shands Hill Pump Station	12,000 kW hrs
Fairview Pump Station	< 1,000 kW hrs
Harmony Heights Pump Station	14,000 kW hrs
Smithland Road Pump Station	22,000 kW hrs
Old Furnace Pump Station	19,000 kW hrs
TOTAL	89,000

Through the 2012 fiscal year, limited attention has been directed toward the Harrisonburg Sewer System under this initiative.

IV. Water Operation Center

In fiscal year 2012, the Harrisonburg Water Operation Center at 2155 Berry Road used 169,200 kW hrs of electricity at a cost of $ 16,620. Through the 2012 fiscal year, limited attention has been directed toward the Water Operation Center energy demand under this initiative. Going forward, the Department of Public Utilities will gather historical data for this demand area and will then move forward in the context of considering a Best Management Plan for the facility.

V. Conclusion

The Department of Public Utilities has undertaken the challenge of an "Energy Management Initiative". The three categories of demand have been identified as the Water System, the Sewer System, and the Water Operation Center. Most of the attention has been directed to the water system.

The electrical costs for the water system approached about $325,000 in 2001 and remain at this level today. The Public Utilities has made argument that the electrical consumption would now surpass 4,000,000 kW hrs per year had it not engaged upon this effort. With reference to current conditions, the water system uses slightly higher than 3,000,000 kW hrs per year and suggests that this effort has contributed to the 1,000,000 kW hrs reduction in electrical consumption.

Little effort has yet been generated toward managing the sewer system and the Water Operations Center energy demand.

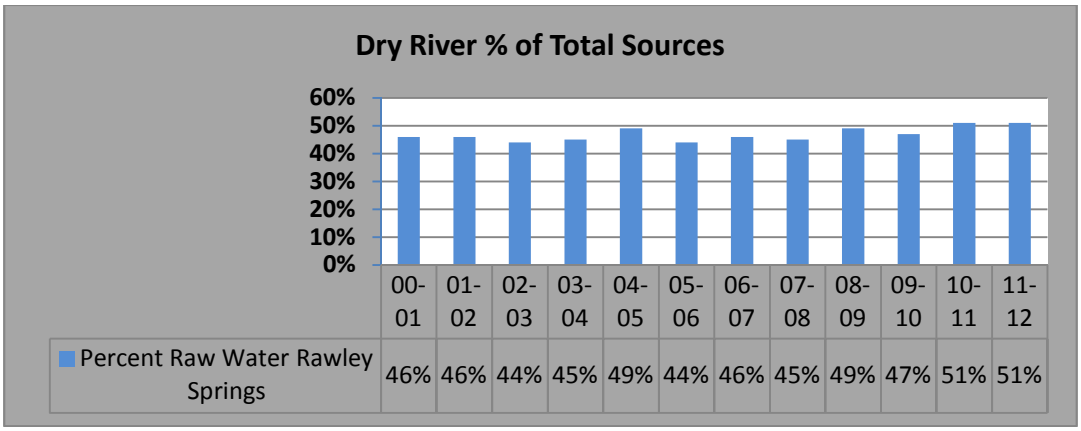
Appendix

Raw Water Sub-system

Harrisonburg's Raw Water System has included two active sources (Dry River and North River) and one inactive source (Silver Lake). A future source is planned from the South Fork Shenandoah River.

- **Dry River Source**: The Dry River source has been a complete gravity supply with zero electrical consumption; this source has provided Harrisonburg with a high quality and cost effective asset in the effort to supply raw water. The Dry River is the City's preferred source of raw water; policies and practices of operation target a maximum use of this source. The City's ability to use this source has two limitations.
  1. During infrequent times of drought, this source has potential to decrease to less than 1.0 MGD.
  2. During times of available water in the drainage shed, the City's delivery system has been limited to 3.4 MGD maximum since the 1960s. However, in the early 2000s the City had begun to upgrade assets in small progressive projects, installing sections of larger 30" pipe. At current status, the City has installed 24,900 feet of 30" pipe (45% of 55,000 feet needed to complete the project) and thereby has increased the maximum delivery to 4.0 MGD. When completed, the capacity will increase to 13.8 MGD.

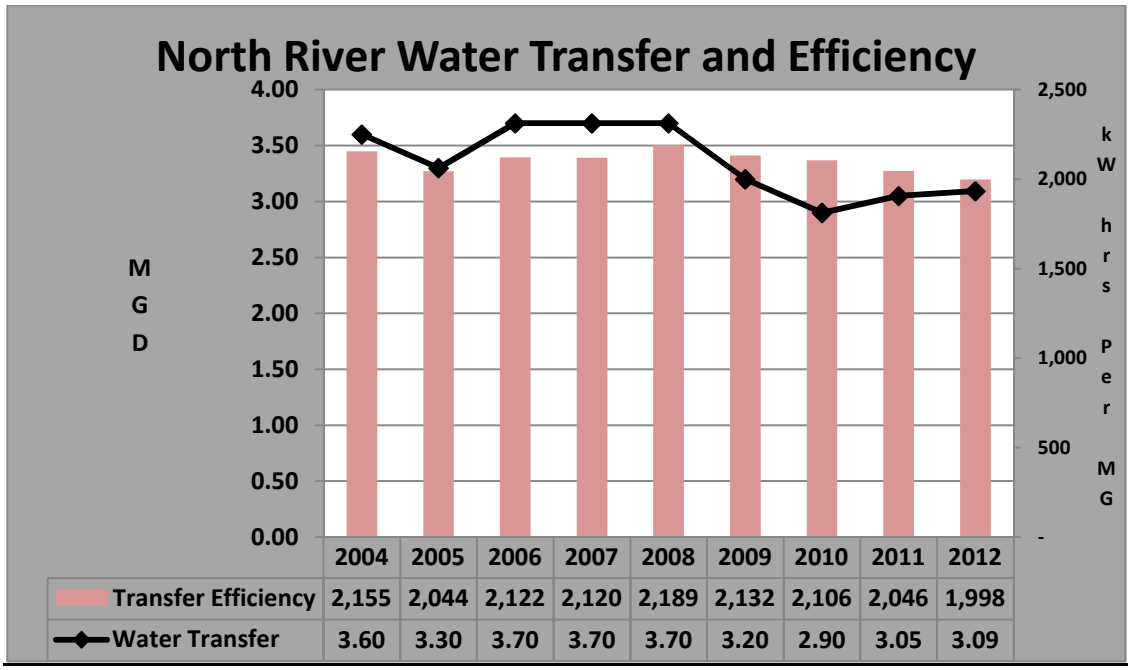
The level to which the City has been able to maximize the use of Dry River is shown in the graph as follows, ranging from 44% to 51% of the annual volume of raw water used between 2001 and 2012.



The City has made significant advancements in electrical cost savings with the installation of the 30" pipe project. The 30" pipe project began in 2000; prior to this the maximum pipe delivery capacity of 3.4 MGD from Dry River allowed the City to capture an annual average of 2.53 MGD for the final five years. Since the 30" project began; the average raw water usage has averaged 3.12 MGD. Understanding that without the pipe project, this water would have been provided from North River (see below) at 2,070 kW hrs / MG in comparison to zero electrical usage from Dry River. The electrical savings from the 30" pipe project has averaged:

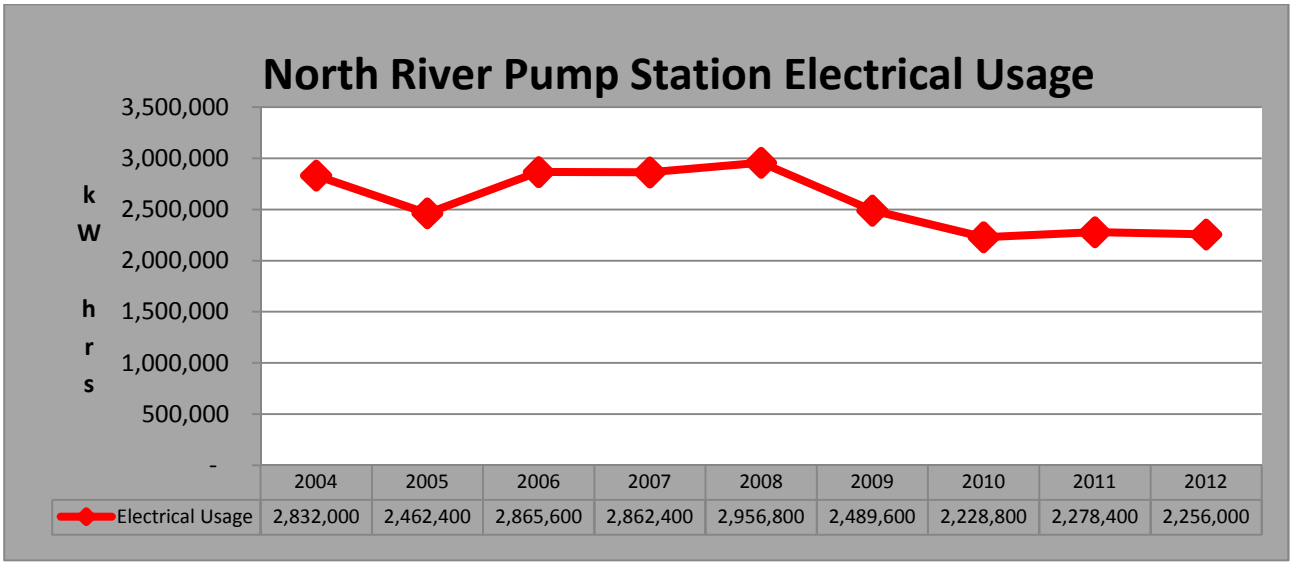
(3.12 – 2.53) x 365 x 2070 = 445,775 kW hrs per year.

- **<u>The North River</u>**: In contrast to the Dry River, this source required electrical driven pumping to deliver the water to the water treatment plant. This cost, in addition to being a lesser quality of raw water due to acute precipitation runoff, makes the North River source a secondary target source. However, the North River has provided the City operations with the flexibility to supplement the Dry River source to meet fluctuating demands.



<u>Water Transfer:</u> The annual volume of water transferred from the North River Pump Station has varied from 2.90 MGD to 3.70 MGD from 2004 to 2012. The higher total demand generally correlates with higher use of the North River Pump Station

<u>Transfer Efficiency</u>: The figure and table above shows that the efficiency of pumping has ranged from 1,998 kW-hrs / MG to 2,189 kW-hrs / MG. The variation was mostly due to the frequency of single pump and dual pump operations. The efficiency of the pumping is inherent to the rate of pumping, the pump efficiency, and the efficiencies of the drive system components. The latter three factors have remained relatively constant.



Electrical Energy Usage: The figure above shows the electrical consumption to supply raw water from North River Pump Station from 2004 through 2012. Annual usage has ranged from 2,832,000 to 2,256,000 KW hrs with the lowest and most recent occurring simultaneously. The volume of water pumped has been the most contributing factor to the variation in the trend as all other variables have remained virtually consistent.

To minimize and mitigate electrical consumption in the use of the North River source, ***the Public Utilities Department has completed a study with Wiley & Wilson Engineering and is moving forward:***

The city plans to install VFD drives in the North River Pump Station. The addition of this technology will allow the City to operate the pump station at its most energy efficient output.

The City plans to evaluate the potential to save costs with the alternative Schedule 120 rate tariff from Dominion Virginia Power.

- **Silver Lake:** The Silver Lake source is currently inactive but this source is currently in holding as a potential future energy advantage at 137 kW hrs / MG water pumped.

- **Raw Water Summary:**

In summary to the raw water subsystem and in reference to the techniques listed previously for energy management, the City has made the following advancements within its raw water system:

1. Volume adjustment: City demand is generally unregulated with exception that the City currently has a drought management plan that engages conservation measures when specific conditions occur.

2. Dynamic Head Adjustment: The 30" pipe project reduces the dynamic headloss in the water conveyance piping from Dry River to the Water Treatment Plant and therefore allows for greater use of the zero electrical gravity system.

3. Asset selection**:** The City's operating strategy targets maximum use of the Dry River source.

4. Wire to Water efficiency: The forthcoming 2013 North River Pump Station project will target an increase in wire to water efficiency.

5. Variable speed application. The forthcoming 2013 project will target the use of variable speed application at the North River Pump Station.

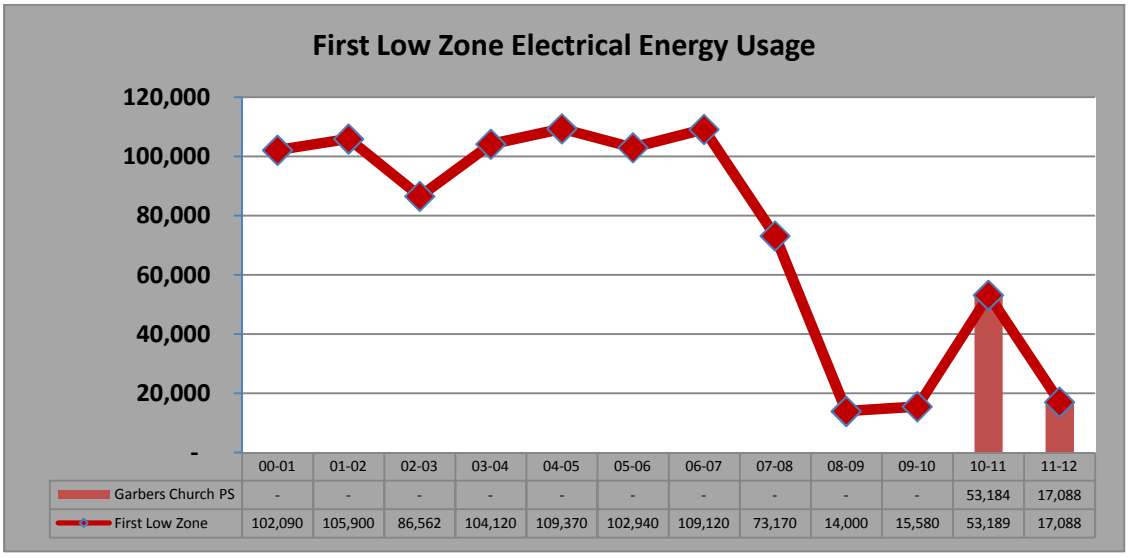
6. Electric tariff schedule: The forthcoming 2013 project will target the Dominion Virginia Power tariff schedules 120 and 130 for the North River Pump Station.

7. SCADA: Follow up to the forthcoming 2013 project will engage efforts to mature the City SCADA to efficiently operate the provisions that are provided in the energy project.

First Low Zone:

The City's "First Low Zone" is one of the most cost effective operations within the water system as the means of water delivery is primarily by gravity. The only use of electricity is the selective use of Garber's Pump Station (see bullet two below) during infrequent periods of needed water transfer conditions. The City's efforts to be effective and efficient with energy are applicable to this zone from three separate approaches as defined below:

- The City has recently undertaken efforts to place as many customers as possible into the "First Low Zone". This objective is tempered by the criteria to assure that all customers have adequate domestic pressure and available fire flow; yet pursued in the effort to optimize by avoiding the "gold plating" of services. Progress in this area is discussed later in this document under the heading of the zone from which the customers have been removed.
- Prior to 2008, an aerator mixer was required in two open top reservoirs for the purpose of adding chlorine to the finished water that was exposed to sunlight without direct cover. The open top reservoirs have been replaced with several covered top concrete tanks (Grand View Tank, Ramble Wood Tank and Tower Street Tank), thereby eliminating the chlorine addition and the mixing devices. In 2011, the Garber's Church Pump Station configuration was altered to deliver water to the new Tower Street Tank; this removed the energy usage from the "First High Zone" and to the "First Low Zone". The new application is for limited use purposes.



	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12
Garbers Church PS	-	-	-	-	-	-	-	-	-	-	53,184	17,088
First Low Zone	102,090	105,900	86,562	104,120	109,370	102,940	109,120	73,170	14,000	15,580	53,189	17,088

Electrical Energy Usage: The figure as shown above graphically displays the trends as referenced above. Annual consumption had approached 100,000 KW-hrs per year until 2007; however, this demand has thereafter decreased to an insignificant miscellaneous demand.

Low Zone annual savings are estimated at 80,000 kW hrs per year

First High Zone:

Harrisonburg's First High Water Zone has included two pumping stations. They included Tower Street Pump Station (TSPS) and Stone Spring Road Pump Station (SRPS).

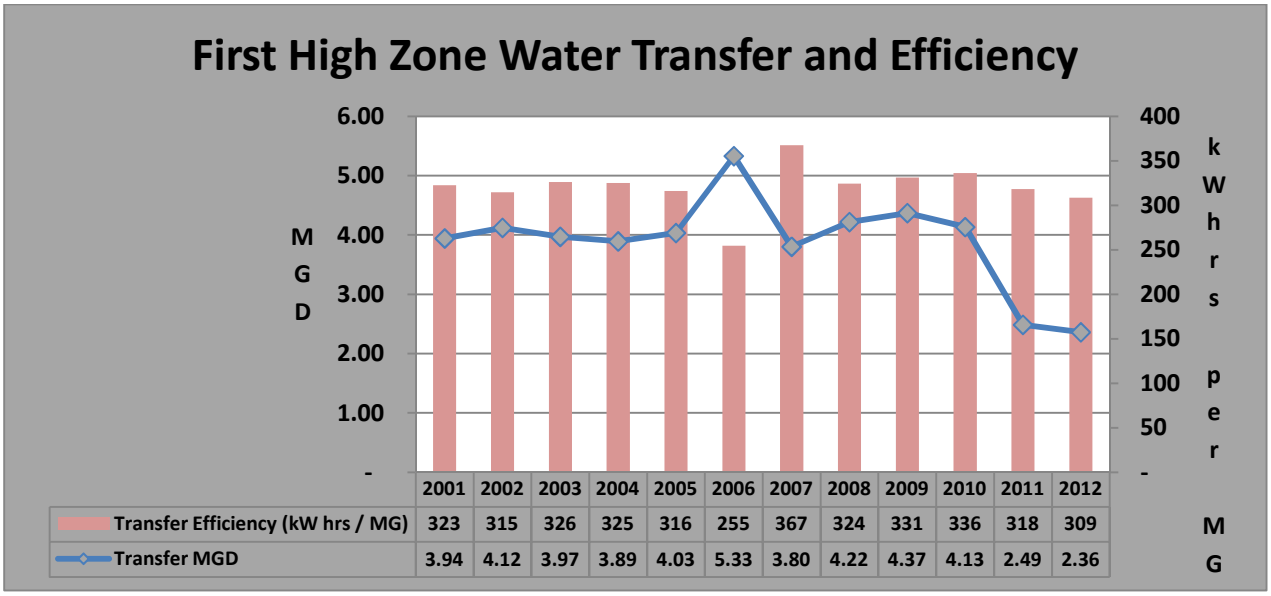
- **TSPS**: TSPS is the predominate unit of the two as pertains to delivery and efficiency. During the most recent 2012 fiscal year, the City used the TSPS to deliver 59% of the water into this zone at about 2,200 gallons per minute output. The efficiency of the TSPS requires about 226 kW-hrs / MG to pump water from the Tower Street Tank in the First Low Zone; the latter zone includes the Washington Street Tank in the First High Zone.

- **SSPS**: The City used the SSPS to deliver 41% of the water into this zone in comparison to using TSPS for 59% of the effort. This pump station is 193 kW-hrs / MG less efficient in comparison to TSPS. It pumps water at about 1,620 gallons per minute from the Second Low Zone to the JMU Tank in the First High Zone.

- **First High System Operation**

Asset Option	GPM Output	kW-hrs / MG	Delivery (MG)	% Use
TSPS	2,200	226	1.39	59%
SSPS	1,620	419	0.97	41%

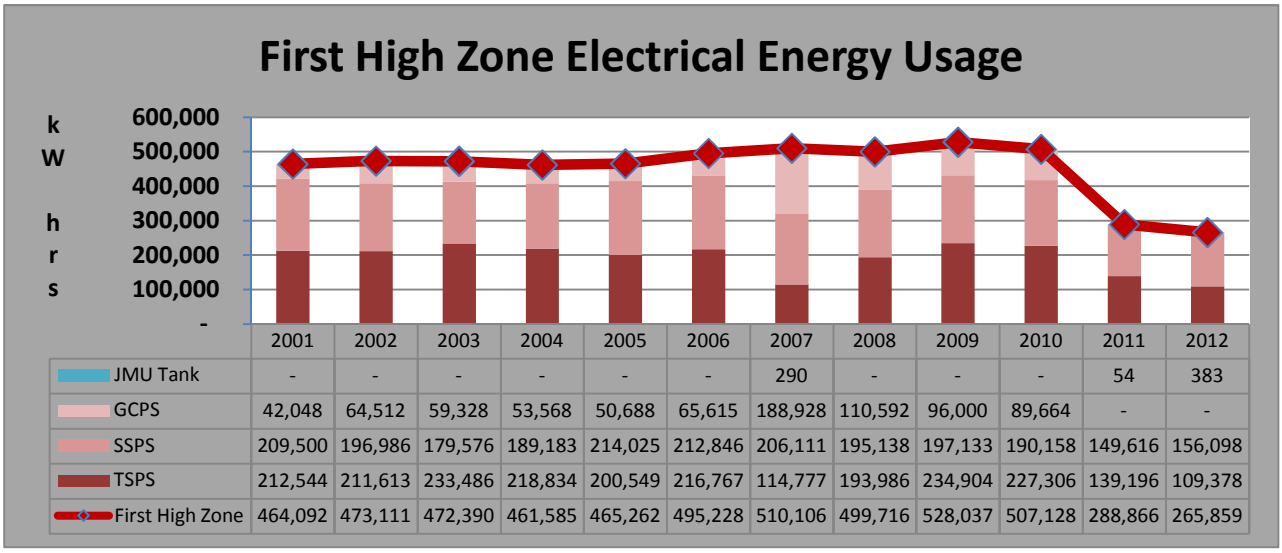
The pumps in the First High Zone are controlled automatically through a SCADA system that has reached a maturity that reacts to demand needs but has not matured to include electrical cost considerations. The work performed by pumping devices into the First High Zone between 2001 and 2012 are shown in the following graph and data table. Also shown is the efficiency in which the work was performed. The cumulative effects from activities that were undertaken since 2010 are shown in trend.



Water Transfer: The trend shows that the volume of water transferred into the First High Zone had ranged from 3.80 to 5.33 MGD prior to 2010; this transfer volume has decreased to 2.49 and 2.36 MGD in the most recent two years, respectively.

Transfer Efficiency: The trend also shows that the efficiency with which the volume of water was transferred into the First High Zone had averaged 322 kW hrs per MG prior to 2010; thereafter it had decreased to an average of 313 kW hrs per MG in the most recent two years.

Prior to 2011, Harrisonburg's "First High Zone" subsystem included three pump stations: Tower Street Pump Station, Stone Springs Pump Station and Garber's Church Pump Station. The subsystem system has been reduced to two pump stations with the removal of Garber's Church Pump Station to now serve the First Low Zone in 2010. Total electrical and component usage is shown below.



- **First High System Summary**

1. Volume adjustment: The volume of water pumped into the First High Zone has been reduced significantly after in Fiscal Year 2010. In the scheme to construct the Tower Street Tank (project 404) as a replacement for the open Tower Street Reservoirs, the Public Utilities staff has moved a considerable group of customers from the "First High Zone" to the "First Low Zone". This area is located in the north of the City along the 16" distribution pipe that extends from Garber's Church Pump Station to the Tower Street and Washington Street storage tanks. This area was originally placed into the City system as the "Flop Zone" ("First Low Zone" when WTP operating and "First High Zone" when WTP closed) beginning in the 1970's and then converted to permanent "First High Zone" in the 1990's. The area is now permanent "First Low Zone".

2. Reconfiguration of Dynamic Head: The construction and installation of the Tower Street Tank into the First Low Zone has altered the hydraulic characteristics of the Tower Street Pump Station. This change has been realized in the static head component of the total dynamic head. Prior to the installation of the new tank, the Tower Street Pump Station pumped against an approximate total dynamic head of 53 feet; under the new conditions this total dynamic head has decreased to 32 feet. A higher water elevation is obtained in the new tank by gravity flow and therefore requires less elevation to be overcome by pumping to the Washington Street Tank (First High).

3. Improve Wire to Water Efficiency:

   - Tower Street Pump Station; 2 pumps (TSPS):

   In contrast to the benefit recognized with the reduction of dynamic head in previous item 2, the reduction also created a misfit with the existing pumps in the TSPS. The pumps were much larger than would be chosen for this revised application and therefore they operated with significant loss of hydraulic efficiency under the new head conditions. To fully adapt to these new conditions, the most effective remedy was to select another set of pumps at significant cost and long term commitment to the pump station asset. At the time, however, the Public Utilities Department had chosen to mitigate, but not fully eliminate, the impact by installing smaller impellers in the existing pumps and replacing the old motors with new high efficiency motors. The funding of the impellers and the motors were made using $7,769 from an EECBG block grant.

   Project Benefits: The table as follows was taken from the design conclusion and suggested that the City would incur a saving of 19 KW-hrs per MG (202 versus 221) with its efforts for an annual savings of 11,196 kW-hrs.

Tower Street Pump Station Upgrade Comparison				
parameter		2010		2011
run hrs per year		8,192		4,270
pump gpm		2,000		2,300
volume pumped per year (MG)		983		589
Theoretical TE (KW-MG)		221		202
theoretical pumping demand (kwhrs / year)		217,239		119,036
actual kwhrs demand per year		234,904		139,196
ancillary kwhr demand per year		17,665		20,160
cost ($)	$	22,096	$	12,863
Upgraded TSPS shown as 2011 data and pre-existing conditions shown as 2010 data.				
calculated kw-hrs at 2010 volume / 202 TE		198,562		
calculated kw-hrs at 2011 volume / 202 TE		119,036		
annual Kwhrs Savings from Volume reduction		79,526		
calculated 2011 kw-hrs usage at 221 TE =		130,233		
calculated 2011 kw-hrs usage at 202 TE =		119,036		
Annual Savings from TE increase =		11,196		

Actual Benefits: Observed operations data suggested that the pump station transferred water at an average of 242 kW hrs / MG from 2001 through 2010 but had improved efficiencies to 226 kW/ hrs / MG in 2011 and 2012, respectively. The concluded savings was 16 kW hrs / MG. With the reduced pumping volume in 2011 and 2012, this savings provided an average 10,400 savings in annual kW-hrs.

- Stone Spring Pump Station (2 pumps)
  - ❖ No changes
- Garber's Church Pump Station (2 pumps)
  - ❖ Eliminated as a transfer asset from this zone in 2010.

4. <u>Asset selection:</u>

As the staff better understands the efficiencies of all its pumping assets, they may have future opportunity to engage strategy to optimize a matrix of selection opportunities among the pumping station assets. Opportunity resides with the maturity of the City SCADA system to include optimization through real time application of computerized control for energy management.

For background purposes, the performance evaluations below have been provided from the study by Wiley & Wilson that was funded in part with $12,000 EECBG grant funds. The following were based on calculated conditions and show some discrepancy with actual observed results from the field operations. Ranking of assets for efficiency appears accurate but calibration is suggested for actual performance values.

Tower Street Pump Station 1 pumps	TE = 202 KW hrs / MG
Tower Street Pump Station 2 pumps	TE = TBD KW hrs / MG
Garber's Church Pump Station 1 pumps	TE = 472 KW hrs / MG
Garber's Church Pump Station 2 pumps	TE = 527 KW hrs / MG
Stone Spring Pump Station 1 pumps	TE = 515 KW hrs / MG
Stone Spring Pump Station 2 pumps	TE = 647 KW hrs / MG

5. Variable speed application: In the "First High Pumping Optimization Study", variable speed applications have not become prominent considerations due to limited expectations of return through electrical savings.

6. Electric tariff schedule: There are limited opportunities as HEC rate structure does not have peak incentives.

7. SCADA: See Asset Selection

First High Zone annual savings are estimated at 240,000 kW hrs per year

Transfer savings: 2.01 MGD @ 309 kW hrs 230,000 kW hrs

Wire to Wire saving: 10,000 kW hrs

Second High Zone:

Harrisonburg's Second High Water Zone has included two pumping stations. They included Ridgeville Pump Station (RVPS) and Valley Mall Pump Station (VMPS).

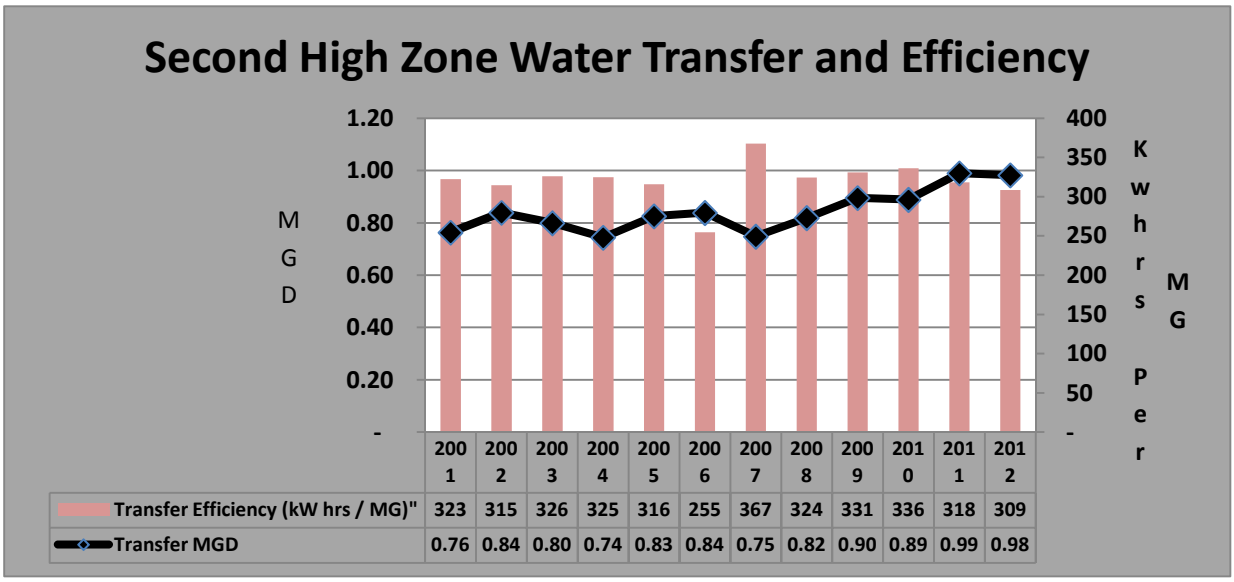
- **RVPS**: RVPS is the predominate unit of the two as pertains to delivery and efficiency. During the most recent 2012 fiscal year, the City used the RVPS to deliver 68% of the water into this zone at 475 gpm at 0.67 MGD. Water is pumped from the First High Zone into this zone that includes Ridgeville Tank.

- **VMPS**: The City used the VMPS to deliver 32% of the water into this zone in comparison to using TSPS for 68% of the effort. This pump station, at 340 gpm, is 135 kW-hrs / MG less efficient in comparison to RVPS. It pumps water at about 340 per minute from the First High Zone into this zone that includes Ridgeville Tank.

- **First High System Operation**

Asset Option	GPM Output	kW-hrs / MG	Delivery (MG)	% Use
RVPS	475	693	0.67	68%
VMPS	340	1,038	0.31	32%

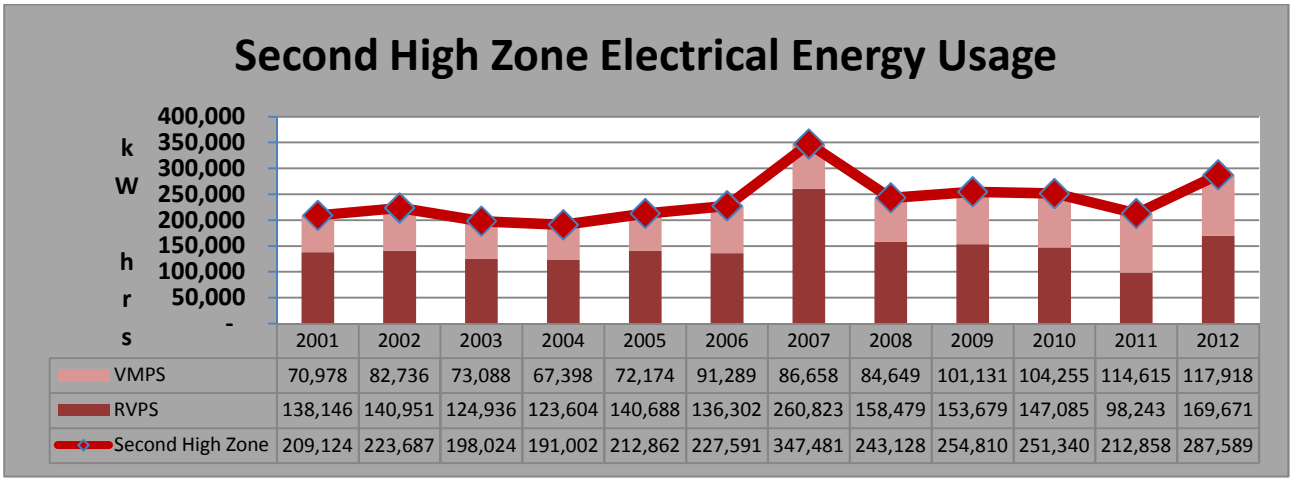
The pumps in the Second High Zone are controlled automatically through a SCADA system that has reached a maturity that reacts to demand needs but has not matured to include electrical cost considerations. The work performed by pumping devices into the Second High Zone between 2001 and 2012 are shown in the following graph and data table. Also shown is the efficiency in which the work was performed.



Water Transfer: The trend shows that the volume of water transferred into the Second High Zone had averaged about 0.80 MGD from 2001 through 2008, increasing to an average of 0.94 MGD over the last four years.

Transfer Efficiency: The trend also shows that the efficiency with which the volume of water was transferred into the Second High Zone had ranged fairly consistently from 309 to 367 kW hrs per MG prior with one outlier year at 255.

The graph that follows shows the total electrical consumption for the Second High Zone and the individual consumption for each pump station component of the Second High Zone from 2001 through 2012. Annual consumption had approached an average of 210,000 KW hrs per year during the initial six years but has exhibited a trend of 255,000 KW hrs per year in the latter years. This creep has occurred due to an increase of 0.14 MGD in the volume of water pumped. Also adding to the electrical increase is the higher dependency upon the lesser efficient components to meet the increased water volume. The 2006-2007 outlier data has not been explained as pump run time did not increase with the reported increase in electrical demand.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
VMPS	70,978	82,736	73,088	67,398	72,174	91,289	86,658	84,649	101,131	104,255	114,615	117,918
RVPS	138,146	140,951	124,936	123,604	140,688	136,302	260,823	158,479	153,679	147,085	98,243	169,671
Second High Zone	209,124	223,687	198,024	191,002	212,862	227,591	347,481	243,128	254,810	251,340	212,858	287,589

- **Second High System Summary**

1. Volume adjustment: Expansion of the zone boundaries, such as the inclusion of the abandoned Forest Hills Zone in 2008 (discussed later in this document), was the one noted increase to the volume of water pumped into the "Second High Zone". To be consistent with system wide effort to optimized energy usage, future consideration will be given to reducing the boundaries of the zone for the purpose of energy optimization.

2. Dynamic Head Adjustment: See Footnote

3. Wire to Water efficiency: See Footnote

4. Asset selection: See Footnote

5. Variable speed application: See Footnote

6. Electric tariff schedule: See Footnote

7. SCADA: all may be considered for energy management in the future pending priority target within the scope of this initiative.

Footnote: The potential energy reduction targets in the Second High Zone have yet to receive attention under this initiative. The Department of Public Utilities foresees to add a pump station and storage tank to this zone in the near future. All opportunities for energy management as listed above will be holistically considered at the time of the proposed pump station and tank addition.

Park View Zone:

Harrisonburg's Park View Water Zone has included one sole pumping station (PVPS).

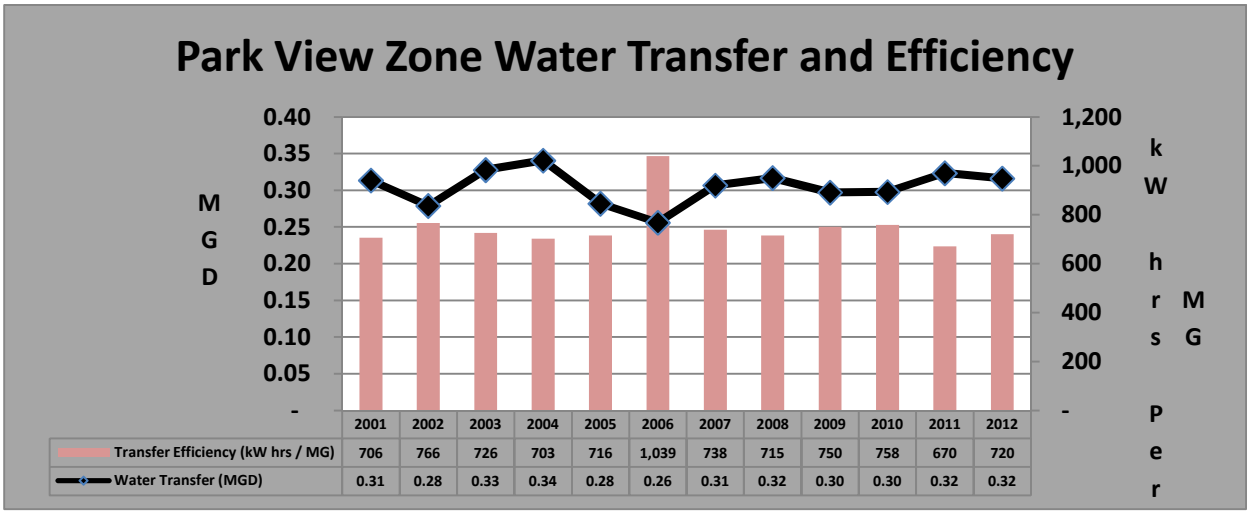
- **PVPS**: During the most recent 2012 fiscal year, the City used the PVPS to deliver 100% of the water into this zone at 210 gpm at 0.32 MGD. Water is pumped from the First Low Zone into the Park View Zone; the latter zone includes the Park View Tank (PVT).

- **Park View System Operation**

Asset Option	GPM Output	kW-hrs / MG	Delivery (MG)	% Use
PVPS	210	720	0.32	100%

The pumps in the Park View Zone are controlled automatically through a SCADA system that has reached a maturity that reacts to demand needs but has not matured to include electrical cost considerations.

The work performed by the pumping devices into the Park View Zone between 2001 and 2012 are shown in the following graph and data table. Also shown is the efficiency in which the work was performed.

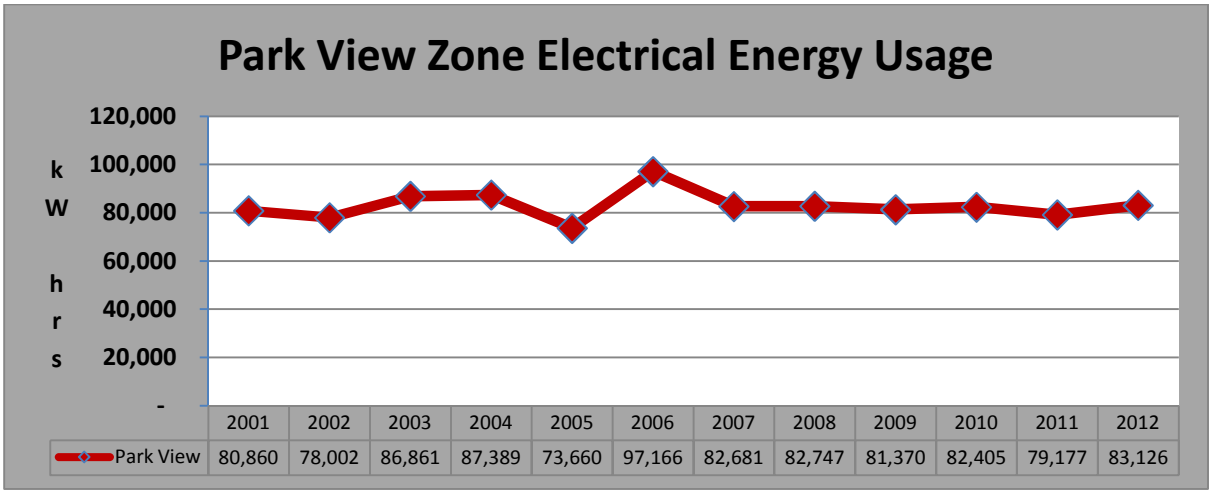


	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Transfer Efficiency (kW hrs / MG)	706	766	726	703	716	1,039	738	715	750	758	670	720
Water Transfer (MGD)	0.31	0.28	0.33	0.34	0.28	0.26	0.31	0.32	0.30	0.30	0.32	0.32

Water Transfer: The trend shows that the volume of water transferred into the Park View Zone has been consistent over the total period from 2001 through 2012; transfer volume has been between 0.26 MGD to 0.34 MGD.

Transfer Efficiency: The trend also shows that the efficiency with which the volume of water was transferred into the Park View Zone had ranged fairly consistently from 670 to 766 kW hrs per MG except for one unexplained outlier year at 1,039 in 2006.

The graph that follows shows the total electrical consumption for the Park View Zone from 2001 through 2012. Much like the water transfer volume, the annual electrical consumption had approached been relatively consistent with an average of 82,000 KW hrs per year.



- **<u>Park View System Summary</u>**

1. <u>Volume adjustment:</u> Priorities for fiscal year 2013 will give emphasis to reducing the boundaries of the Park View Zone for the purpose of energy optimization.

2. <u>Dynamic Head Adjustment:</u> See Footnote

3. <u>Wire to Water efficiency:</u> See Footnote

4. <u>Asset selection:</u> See Footnote

5. <u>Variable speed application:</u> See Footnote

6. <u>Electric tariff schedule:</u> See Footnote

7. <u>SCADA:</u> See Footnote

Footnote: In 2013 the Department of Public Utilities expects to begin the planning phase to add a pump station and storage tank to this zone. All opportunities for energy management as listed above will be holistically considered at the time of the proposed pump station and tank addition.

Dale Enterprise Zone:

Dale Enterprise Water Zone has included one sole pumping station (DEPS).

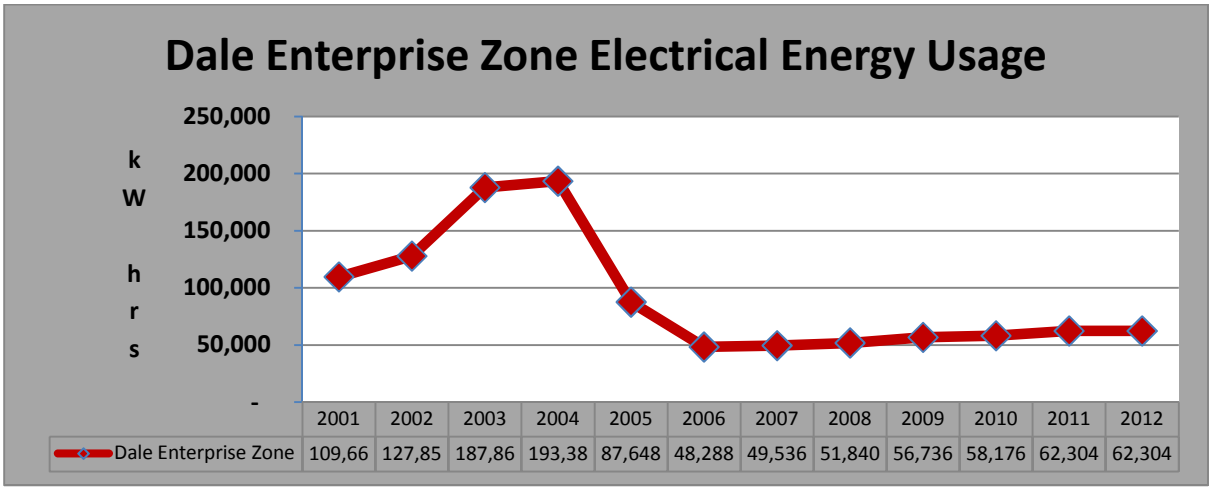
- **DEPS**: During the most recent 2012 fiscal year, the City used the DEPS to deliver 100% of the water into this zone at unknown amount. Water is pumped from the First Low Zone into the Dale Enterprise; the latter zone includes the Cooper's Mountain Tank (CMT).

- **Dale Enterprise System Operation**

Asset Option	GPM Output	kW-hrs / MG	Delivery (MG)	% Use
DEPS	335	TBD	TBD	100%

The pumps in the Dale Enterprise Zone are variable speed with local control and uses SCADA as a monitoring system; the control systems have reached a maturity that reacts to demand needs but has not matured to include electrical cost considerations.

The graph that follows shows the total electrical consumption for the Dale Enterprise Zone from 2001 through 2012. With usage from 110,000 to 193,000 kW hrs per year in the 2001 to 2004 years, the consumption now ranges from 48,000 to 63,000 KW hrs per year.



- **Dale Enterprise System Summary**

1. Volume adjustment: The Public Utilities Department has undertaken and completed the effort that has significantly reduced the volume of water pumped into this zone and the corresponding electrical usage. The effort was a capital project in 2005 that converted a raw water 12" pipeline to potable status; thus allowing total gravity flow of potable water to the Hinton Poultry Plant. Whereas annual electrical usage had reached 190,000 kW hrs per year prior to 2006, the referenced activities created a savings of approximately 150,000,000 gallons of water pumped annually and a reduction of 140,000 kW hrs annually.

2. Dynamic Head Adjustment: As the City plans forward long term to the upgrade of both the Western Raw Water System and the Western Potable Water System, consideration shall be given to the best use of existing pipe assets from DEPS to Cooper's Mountain Pump Station.

3. Wire to Water efficiency: Potential future target

4. Asset selection: Considerations in items 2 above will also consider the possibility of reconfiguration to achieve gravity flow from the Water Treatment Plant to the Cooper's Mountain Tank.

5. Wire to Water efficiency**:** Potential future target

6. Variable speed application: Variable speed is currently in operations

7. Electric tariff schedule: Potential future target

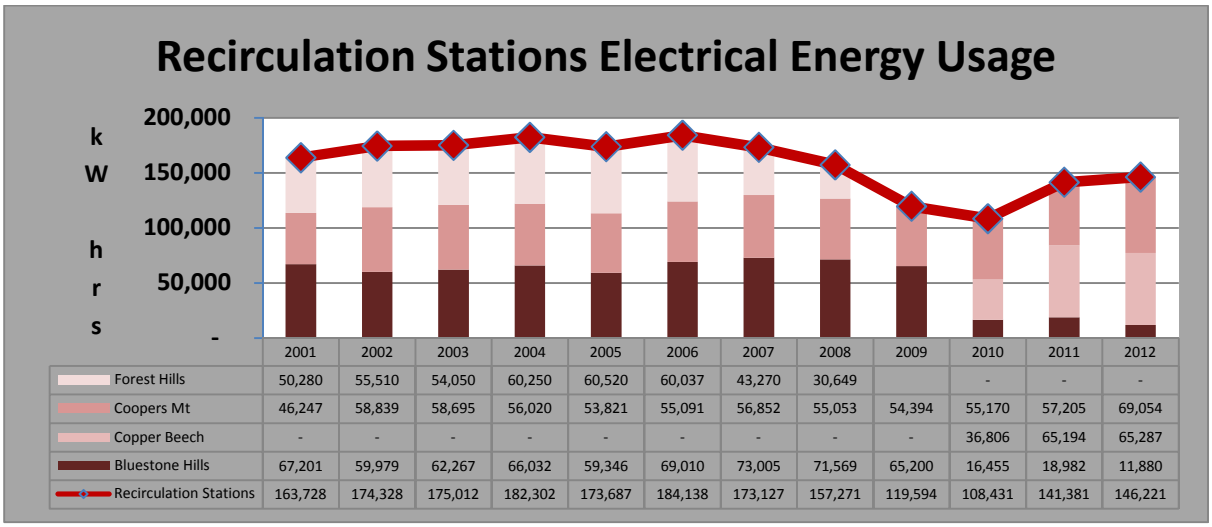
8. SCADA: Use of SCADA in a mature system may be simultaneously considered to facilitate energy optimization if and when items 5 & 7 are evaluated.

Dale Enterprise Zone annual savings are estimated at 140,000 kW hrs per year

Transfer savings: 0.41 MGD @ 935 kW hrs / MG = 140,000 kW hrs

Recirculation Zones:

"Grandview Drive", "Forest Hills", "Bluestone Hills/Copper Beech" and "Cooper's Mountain" are systems that have one pump station and no storage tank. Typically, these applications are a very inefficient uses of electricity. The trend graph shows that this group of pumps (Grandview not included as it is shown in the Water Treatment Plant usage) had once operated at about 160,000 to 190,000 KW Hrs usage of electricity per year; the most recent use has decreased to approximately 108,000 - 147,000 KW hrs per year.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Forest Hills	50,280	55,510	54,050	60,250	60,520	60,037	43,270	30,649		-	-	-
Coopers Mt	46,247	58,839	58,695	56,020	53,821	55,091	56,852	55,053	54,394	55,170	57,205	69,054
Copper Beech	-	-	-	-	-	-	-	-	-	36,806	65,194	65,287
Bluestone Hills	67,201	59,979	62,267	66,032	59,346	69,010	73,005	71,569	65,200	16,455	18,982	11,880
Recirculation Stations	163,728	174,328	175,012	182,302	173,687	184,138	173,127	157,271	119,594	108,431	141,381	146,221

Decomposing the "Recirculation Pump Station Group", the following have been determined:

- **Forest Hills Pump Station:** The Forest Hills Pump Station was deactivated in 2008. The customers in this zone were moved to receive service from the "Second High Zone". During the most recent years of active service, the Forest Hills Pump Station used approximately 50,000 to 60,000 KW hrs of electricity annually.

- **Copper Beech / Bluestone Hills Pumps Stations:** From 2001 through 2009, a period with only the Bluestone Hills Pump Station operating, the system demanded from 59,346 to 73,005 KW hrs per year. Copper Beech Pump Station was added as a compliment to Bluestone Pump Station in 2010 to accommodate an expansion of the zone for inclusion of a new development. The Copper Beech pump station was equipped with variable speed pumps that were designed to enhance fire flow to the area and to also make the daily operations of the system more optimized in terms of electrical consumption. During 2011 and 2012 the combined electrical energy usage of the two pump stations has averaged 80,500 kW hrs per year.

- **Cooper's Mountain Pump Station:** In Early 2011, the Public Utilities Department began a capital project to replace the pumps with new variable speed units. This project was funded under the Capital Improvement Program titled "Western Potable Water System. Further evaluation is needed to understand the increased electrical consumption that has occurred at this location.

- **Recirculation Systems Summary**

1. Volume adjustment: Decommissioning of Forest Hills Pump Station has decrease the volume pumped and resulted in a savings of 50,000 kW hrs per year

2. Dynamic Head Adjustment: Potential future target; see footnote

3. Wire to Water efficiency: Potential future target; see footnote

4. Asset selection: Potential future target; see footnote

5. Wire to Water efficiency**:** Potential future target; see footnote

6. Variable speed application: **:** Potential future target; see footnote

7. Electric tariff schedule: Potential future target; see footnote

8. SCADA: Use of SCADA in a mature system may be simultaneously considered to facilitate energy optimization if and when items 3 through 8 are evaluated.

Footnote: Fiscal year 2013 will target the installation and collection of pumping transfer data for these stations with purpose to obtain transfer volumes and efficiency information. Further investigation of the Coopers Mountain variable speed installation is needed.

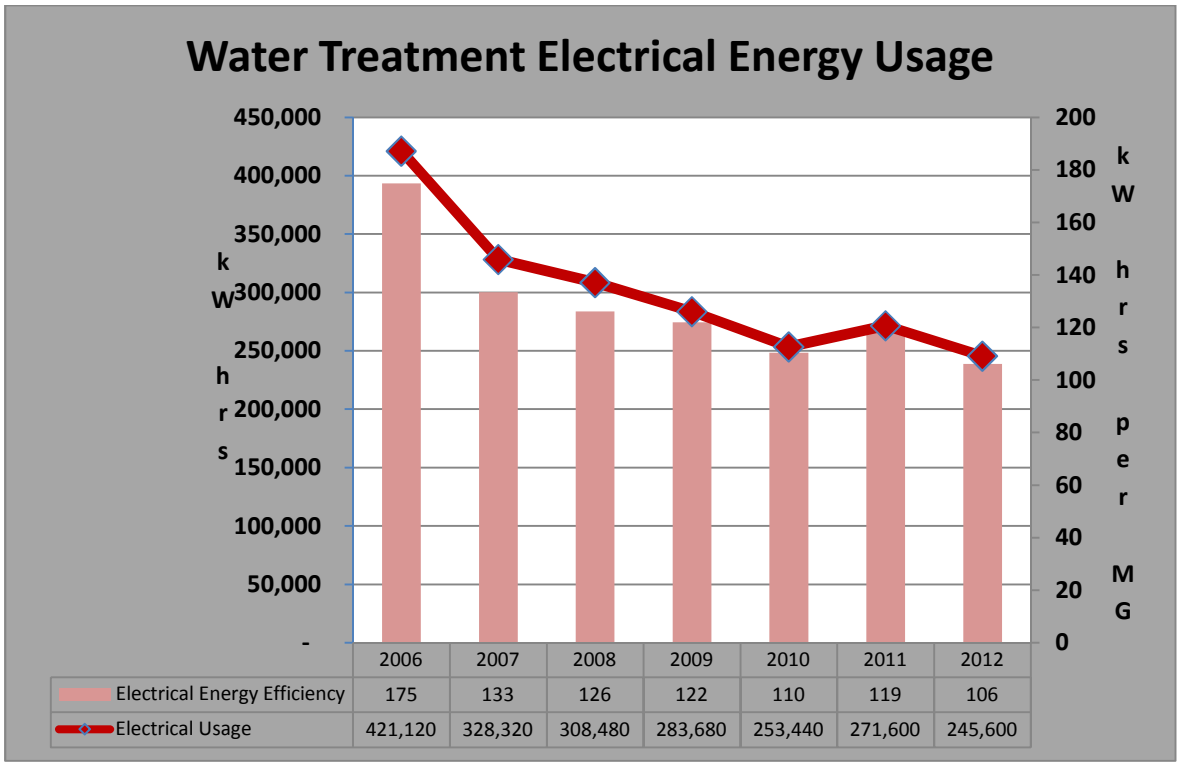
Recirculation Zones: annual savings are estimated at 50,000 kW hrs per year

Transfer savings: 50,000 kW hrs

Water Treatment Plant:

The trend graph shows the electrical consumption at the City Water Treatment Plant. The facility was upgraded in 2005-2006 with the highest consumption of 421,000 KW Hrs of electricity used in that year.

- The facility appeared to reach steady state in 2008 at about 309,000 kW hrs and 126 kW hrs per MG. Since then, the Chief Operator and staff have worked diligently in operations management to reduce electrical energy consumption at the facility. The usage has continuously decreased to a most recent 245,600 kW hrs in 2012 and an efficiency benchmark of 106 kW hrs per MG treated. This is a 21% reduction in total electrical usage and a 16% increase in electrical efficiency.



Water Treatment Plant annual savings are estimated at 50,000 kW hrs per year resulting from Best Management Practices (BMP).

To minimize and mitigate electrical consumption in the City's Water Treatment Plant; the Public Utilities Department may consider an energy audit that will make evaluation of the Water Treatment Plant electrical usage.