Managing Peak Water Usage

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Introduction

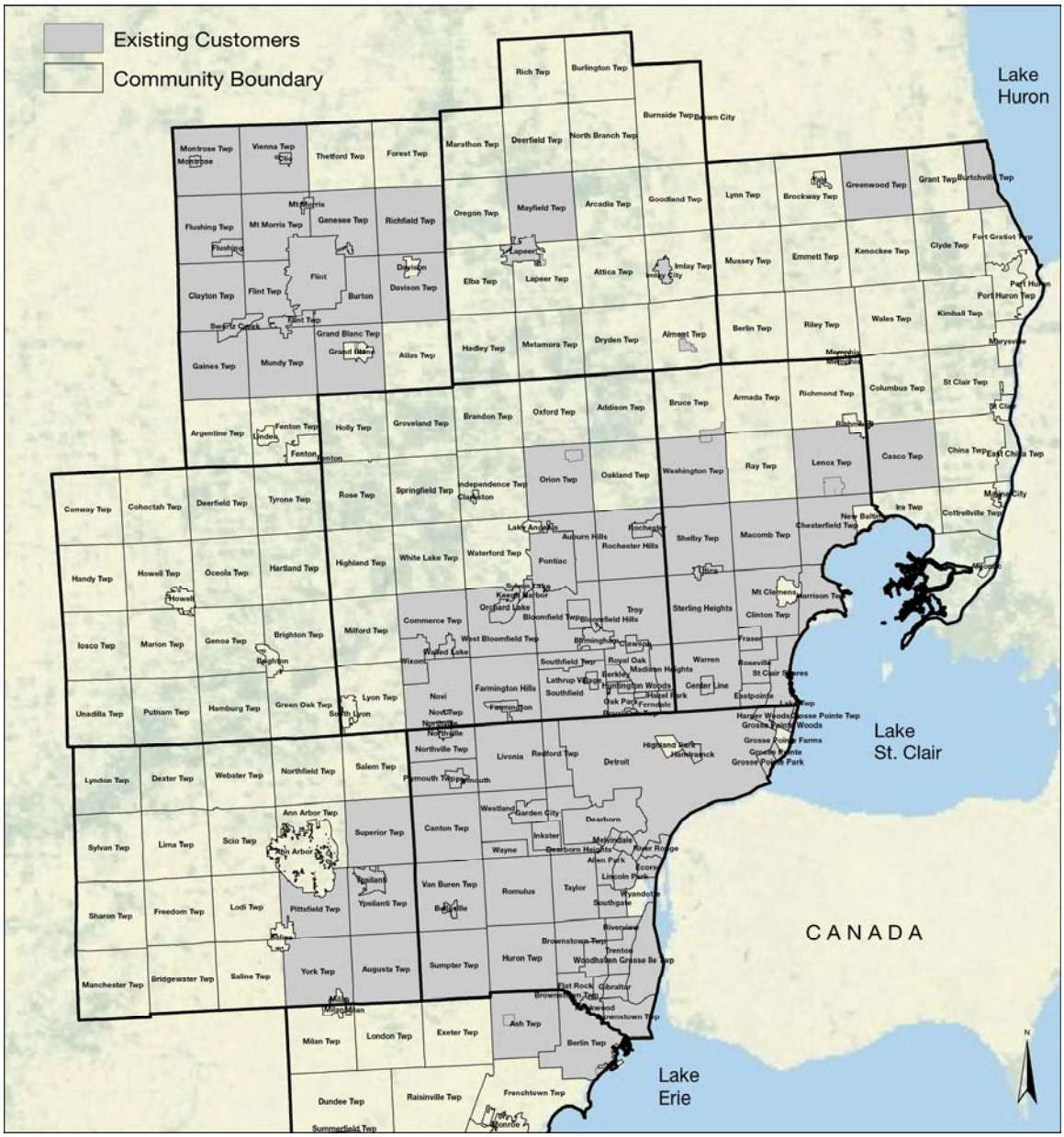
The water system in the Detroit Metropolitan area, similar to other regional systems with an adequate supply of water, have traditionally been designed based on historical high usage with conservative safety factors. As use of automatic irrigation systems have increased, so has peak usage. Therefore, water systems were regularly upgraded to meet increasing demands. The Detroit Water and Sewerage Department (DWSD) provides wholesale water service to 86 communities /water authorities. In developing new water contracts, DWSD in concert with its customers, decided to provide an opportunity for customers to decide on the level of service they desired, by specifying annual volumes, maximum day, and peak hour rates. Considering that the wholesale water rate is highly sensitive to the desired flow rates, this provided significant incentive for customers to consider a new concept – managing peak water usage. The purpose of this paper is to document the different strategies utilized by customers and their success to date.

There are several potential solutions available to DWSD customers in order to reduce their peak water usage. Several communities implemented public education plans focused on conservation. For some communities with existing storage, minor changes in their water system operations were able to greatly impact their peak water usage and therefore their water rates. Still more communities found that their peak usage was so high that the feasibility of constructing new storage was determined to be cost effective. Some communities with high peaking factors and without storage or communities with storage built for growth and a shrinking population looked into teaming with neighbors in further efforts to improve their water rates.

DWSD Water Rates

DWSD provides water to 86 Tier 1 customers (see Figure 1). Increasing water rates led communities to request greater transparency in the DWSD water rate model. DWSD responded with customer outreach programs and technical advisory committees. Discussions within these areas led DWSD to provide a new model contract with modifications to the determination of flows that allowed for customer input.

Figure 1: DWSD Customers



DWSD's rate model is based on the AWWA approved base-extra capacity. This model recognizes that water systems are engineered to meet the required capacity during peak usage periods. DWSD allocates charges based on total volume of usage and peak demand. DWSD bases its current rate system on five main factors: base, maximum day, peak hour, distance and elevation, as defined below.

1. base – average amount of water used by a customer per day
2. maximum day – volume above the average day usage used on the day DWSD distributes the maximum volume of water

3. Peak hour – the amount of water used by a customer over and above maximum day usage as measured on the hour of the maximum day that DWSD distributes the largest amount of water.
4. Distance – average distance in miles from the customer's connection (s) and the five DWSD water plants
5. Elevation – measured elevation difference between the customer connection (s) and the average elevation of each of the five water plants

Generally, a community cannot modify its distance and elevation factor. Some communities were able to eliminate a metered connection to DWSD that may have had a high elevation or distance factor and effectively lower their rates. Additionally, some communities surveyed their meter locations and requested that their elevation factors be adjusted accordingly. Those modifications that were made to elevation and distance had some effect in lowering the water rates but the rate changes for these modifications were minor. The largest factors in a Tier 1 customer's rates are the maximum day and peak hour factors. These factors are also highly variable.

In the past, DWSD used historical data to calculate a community's maximum day and peak hour factors. In late 2007 DWSD rolled out a new model contract for its water customers. In the new DWSD model contract, DWSD is allowing communities to set their own maximum day and peak hour usage. Several communities saw this as an opportunity to reduce their water rates. This was especially effective due to the recent economic downturn in Southeast Michigan.

Part of the new model contract allows for an exclusionary period from midnight until six in the morning. During this period customers cannot be penalized for peak usage. One reason for this change in policy is an attempt to lower DWSD's electrical rates. Electrical rates for various DWSD facilities are set by Detroit Edison and are based on the maximum half hour of usage. By encouraging customers to use water outside of peak periods, DWSD can reduce peak electrical usage and effectively reduce system costs.

For many years DWSD discouraged communities from building their own storage. DWSD preferred large regional storage alternatives. DWSD's new model contract appears to promote storage by providing an exclusionary period that allows communities to fill their storage during early morning hours without incurring peak usage penalties. This "exclusionary period" provides incentive for communities to build their own storage or modify existing storage to take advantage of the early morning fill periods. These contract modifications provide communities with financial incentive to operate their systems in a way that is beneficial to the entire DWSD system.

Outside Factors

There are several factors outside the control of DWSD that effect system water usage, weather and the economy. In the late nineties the Detroit Metropolitan areas experienced a period of growth. Water systems had trouble keeping up with the demand during hot and dry summers including 2002. Based on past usage the DWSD Water System Master Plan predicted large peak usage and therefore, DWSD predicted the need for several major system improvements.

In 2007, during the roll out of the new model contract, the Detroit Metropolitan area experienced another hot and dry summer. A large number of communities utilized flow data from 2007 for setting their desired level of service. However in 2008 the economic conditions in southeast Michigan changed dramatically and usage in the DWSD water system decreased. Some communities have seen their average water sales reduce by over 30% since 2008. DWSD as a whole has seen a five (5) percent drop in annual water volume per year for the past ten years. In addition, the summers of 2008 and 2009 were rather mild. Higher than average rainfall coupled with the mild temperatures decreased peak usage. It is difficult to quantify the reduction in water usage associated with changes in the weather or with economic factors. Each community entering into a new model contract and setting their water rates is faced with the decision of their desired level of service. Over predicting peak water usage could lead to a community paying higher water rates but under predicting could lead to peak flow penalties.

Peak Shifting

For the past several years DWSD water rates have seen double digit increases for many Tier 1 customers. These rate increases, changing economic times and increased environmental awareness led many communities to produce public education plans focused on conservation. During the DWSD contract negotiations, DWSD offered community specific reductions in peak rates (generally around 10%) if the communities agreed to implement a public education plan and ordinances that promoted odd/even grass watering and watering during DWSD's off peak hours of midnight to 6am.

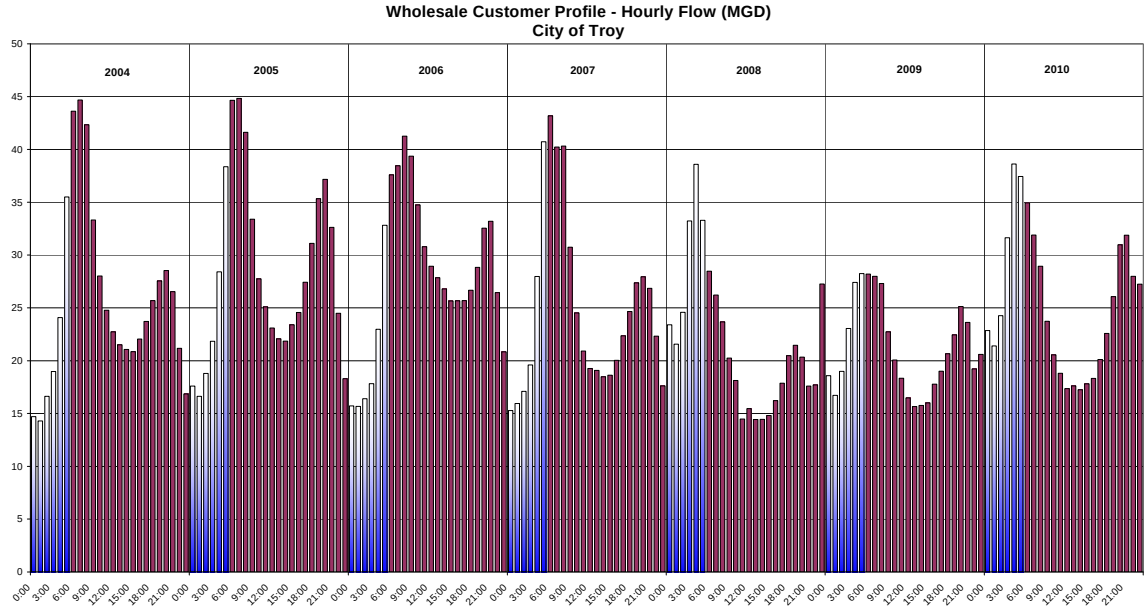
Several communities took advantage of these rate reductions. Two communities in particular took implementing public education plans and ordinances a step further. The City of Troy and the City of Novi implemented plans and were able to reduce their peak usage and, therefore, the communities' water rates.

City of Troy

The City of Troy decided to implement a mandatory grass-watering ordinance that required odd/even grass watering and prevented irrigation between 6 a.m. and 10 a.m.. The City is mostly residential with the majority on irrigation systems. The implementation of this ordinance was heavily publicized throughout the local news. Many residents were not in favor of a mandatory ordinance. Heated discussions occurred at several council meetings resulting in a large controversy surrounding the council's decision to move forward with a mandatory ordinance. The publicity associated with the implementation of the irrigation ordinance led to an increased public awareness of the new rules.

In the three years since the implementation of the ordinance, the City of Troy has seen a 30% reduction in peak water usage. The reduction is evident in both a decreased maximum day, and shift in morning usage into the DWSD exclusionary period. These results can be seen in Figure 2.

Figure 2: City of Troy Hourly Flow Profile



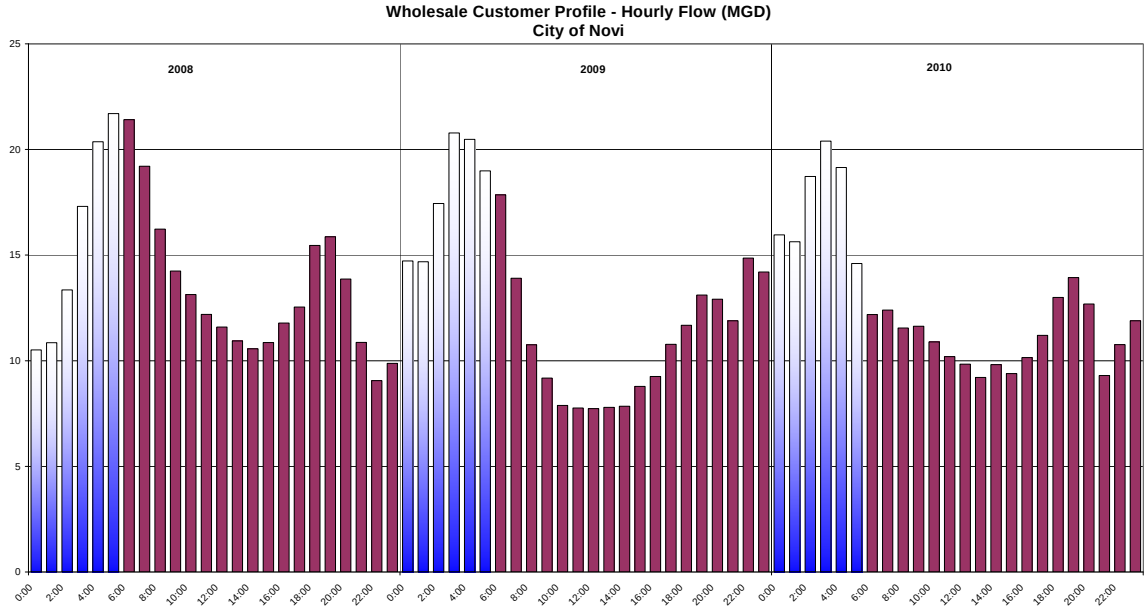
The City of Troy is a good example of how working with news agencies and publicizing information on water rates helps to reeducate the public. The City utilized this opportunity to change the behavior of its water customers.

City of Novi

The City of Novi is a newer community with a large amount of residential irrigation. A significant portion of the City is also commercial. In an effort to reduce their peak water usage the City of Novi created a marketing plan. As part of this marketing plan, the City implemented an aggressive public education plan. The City provided flyers and information to all its water customers. Clerks at the water billing department were provided educational information on the DWSD rate system and on better practices for watering yards. Anyone who called or visited the water billing department regarding high bills or other billing questions were provided information on the benefits of odd/even grass watering and watering during the exclusionary period and peak hours.

This aggressive education plan along with the economic downturn resulted in drastically reduced peak water rates. The City of Novi implemented their program two years ago. Figure 3 shows the reduction in water usage on the City's maximum day over the past few years. Peak hour peaking factors were reduced from 4.5 to 3.2 during this period.

Figure 3: City of Novi Hourly Flow Profile



These two communities used different approaches to reduce their water rates. The results are that both communities saw a drastic reduction in morning peak water usage. Some of this reduction may be due to weather conditions or the economic downturn, however, part of the change is the timing of automatic sprinkler systems. Typically set at 6 a.m or 7 a.m. previously, now being asked to set them at 4 a.m. The shifting of the peak from 6-10 a.m. to earlier in the morning is evidence that the communities' actions are making a difference in water usage. These two communities are good examples of how one can effectively manage peak water usage without large capital outlays.

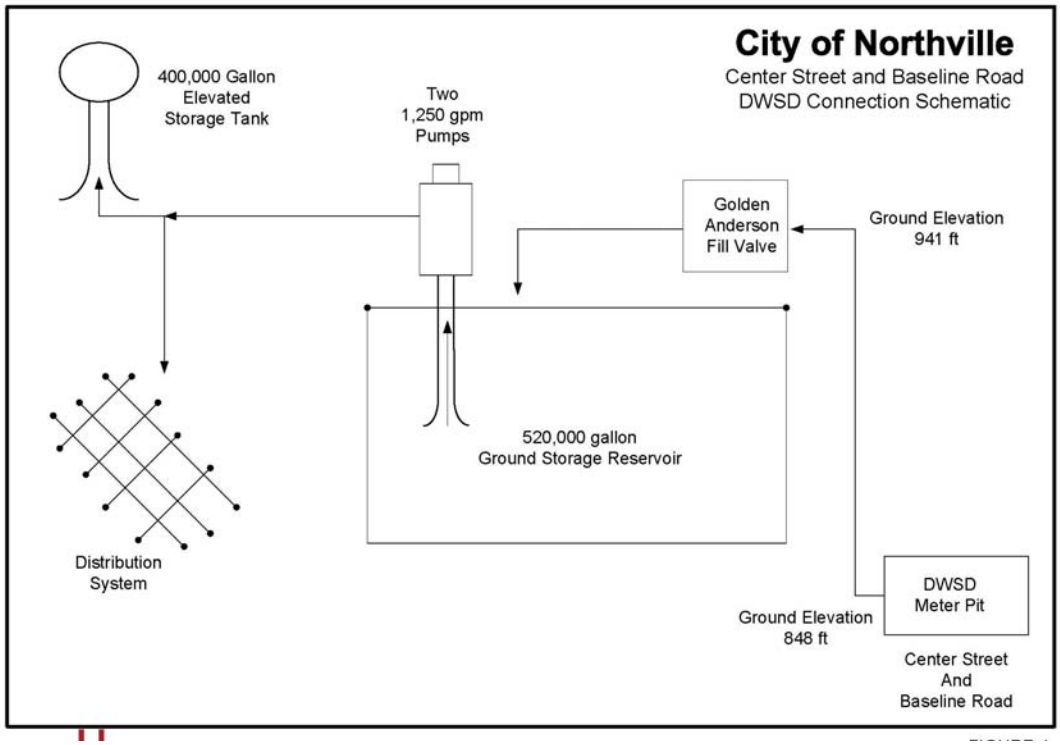
Water System Operations

A number of communities experiencing large rate increases had existing storage facilities; many in place for over 40 years. Operations for these facilities had often never been modified or only slightly modified over the years as the communities grew and changed. Upon review of system operations it became clear that minor operational changes or moderate capital improvements could help communities reduce their peak flow from DWSD, and therefore their water rates.

City of Northville

The City of Northville had a well system and treatment plant prior to tying into the DWSD system. Their water system consisted of a 540,000 gallon ground storage tank with pump station and a 400,000 gallon elevated storage tank (see Figure 4). Originally the ground storage tank filled from wells. When the City connected to the DWSD water system in the early 1960s they did little to change their system operations. The DWSD water main and control valve replaced the existing well pumps. When the tank was low, controls opened the fill valve and filled the tank. When the tank was full, the valve was closed. Their water system continued to operate in this manner until 2005.

Figure 4: City of Northville Water System Schematic

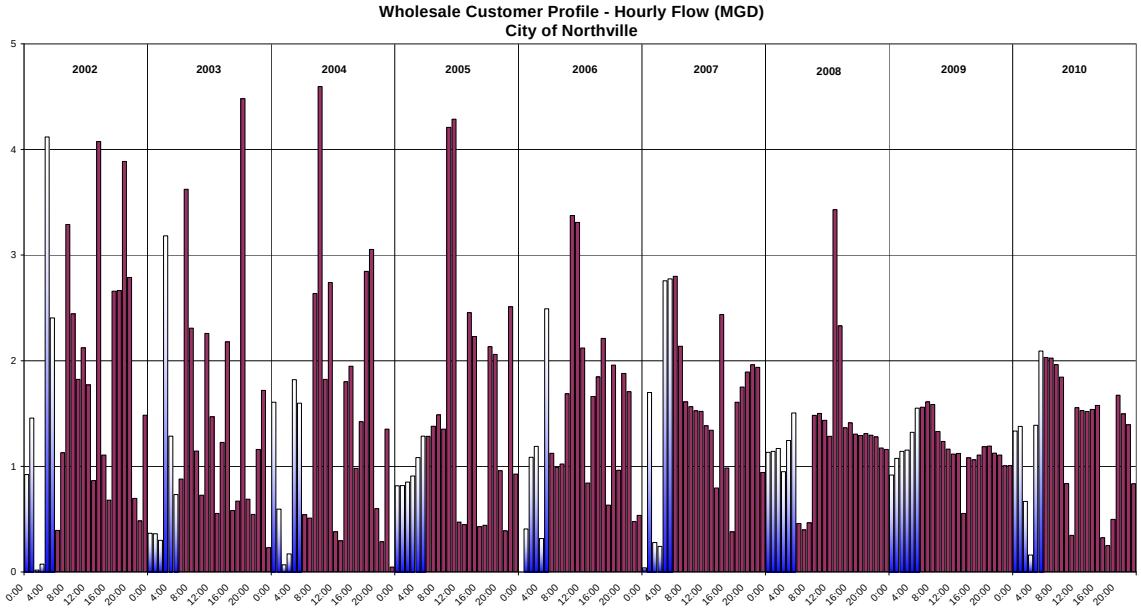


This operation caused flow fluctuations in the DWSD system. The rate of filling in the tank was highly dependant on the pressure provided by DWSD. In some cases the rapid filling of the ground storage tank caused pressures to fluctuate in the City of Northville's water system. It was determined that through a minor change in operational strategy the City could reduce the pressure fluctuations and reduce water rates.

The new operations required modest changes. The City changed the pilot on the City's fill valve and added a supervisory control and data acquisition (SCADA) system. The original system was a quick fix to get the City through the summer of 2005. This involved opening the valve a predetermined number of seconds and maintaining a throttling position until the tank filled. This operational change limited the peak flows entering the tank but had large variability as the percent the valve would open was highly dependant on the DWSD system pressures.

Once the City realized the huge impact to pressures and water rates they decided to move forward with the second phase of the operational changes. Phase II involved tying into the DWSD water meter signal and sending this signal back to the control valve. The valve then throttles to maintain a set flow rate based on the City's maximum day usage. This system allowed the City to drastically reduce their peak flows from over 4,000 gpm to under 1,000 gpm. This led to a 43% decrease in the City's water rates. Figure 5 shows how effective the system has been over the past few years.

Figure 5: City of Northville Hourly Flow Profile

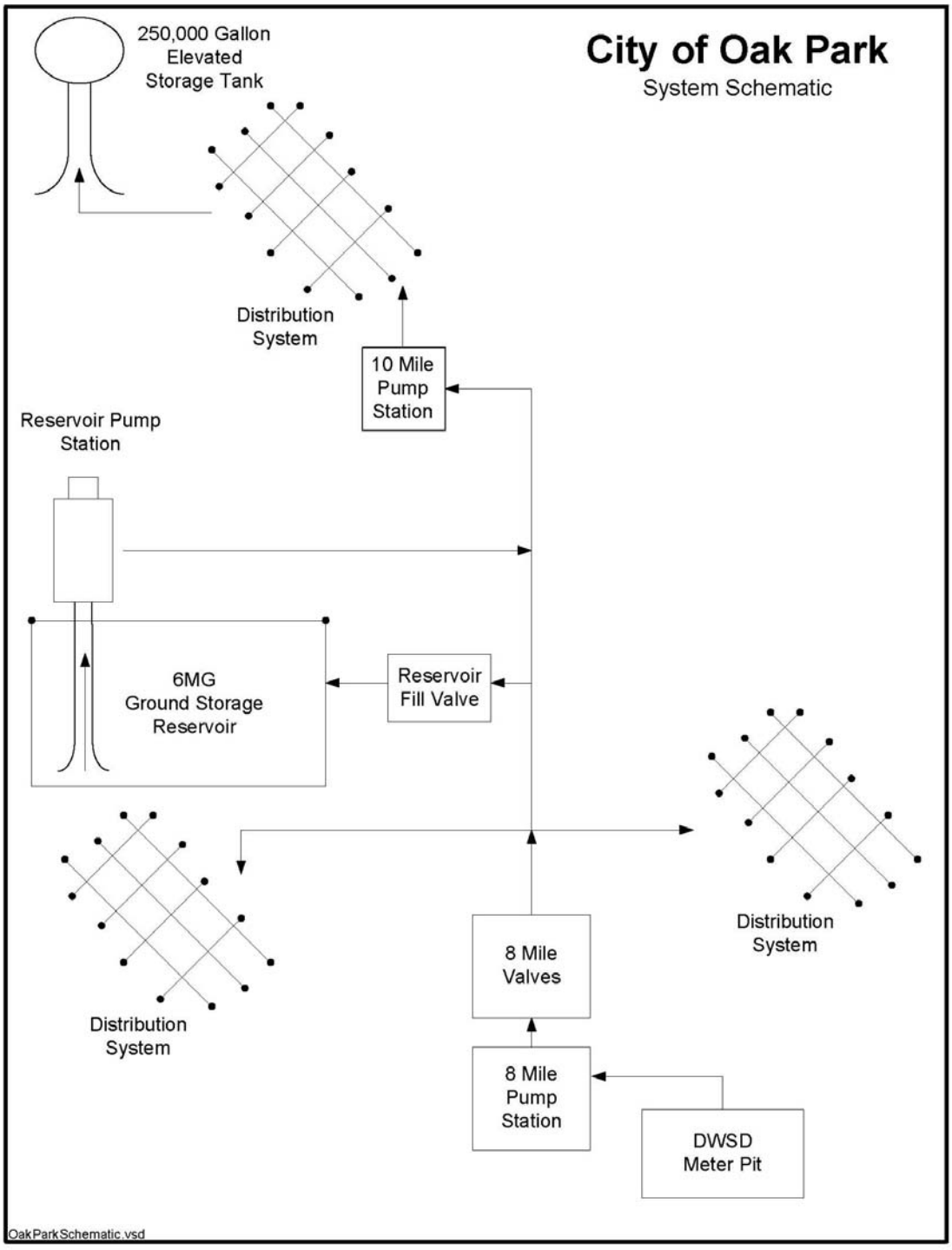


Note that the 2010 data does not appear to perform as well as in previous years. Two days before the maximum day water usage the City's ground storage tank was hit by lightening. This took out the SCADA system and one of the City's pumps. The City operated the system manually for a few days until the required parts could be repaired or replaced.

City of Oak Park

The City of Oak Park is an aging community with a decreasing population. They have over 6 million gallons in ground storage filled through a pump station (see Figure 6). This is a large amount of storage for the City's existing population and water usage. Under the City's original operations the storage tank had a ball valve that opened when the tank was empty and closed once the tank was full. This operation meant that the City had little control over when the pump station started drawing water from DWSD and they incurred some high peak rate charges as a result.

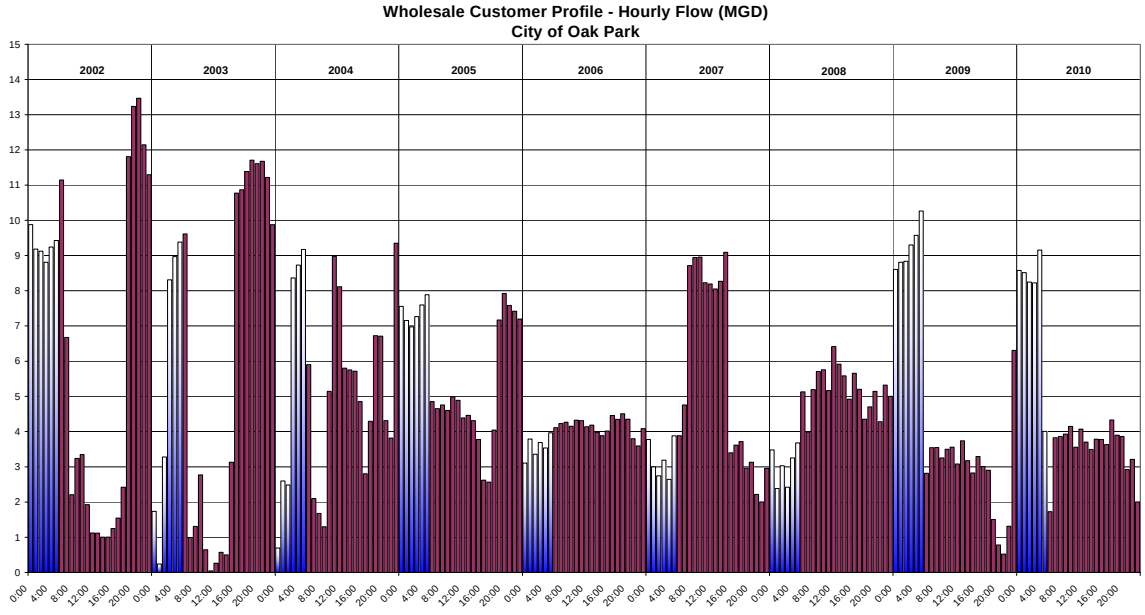
Figure 6: City of Oak Park Schematic



A modification to the City's existing telemetry system and the addition of a flow meter at the pump station has allowed the City to reduce their peak water usage. The new system operations call for the tank to fill between midnight and 6 a.m. and to maintain level within one (1) foot of high water level until 6 a.m. if the tank reaches high water level prior to 6 a.m.. The City then is

able to draw from DWSD as needed throughout the day. The City was able to reduce their peak water usage from 4,900 gpm to 3,350 gpm (see Figure 7).

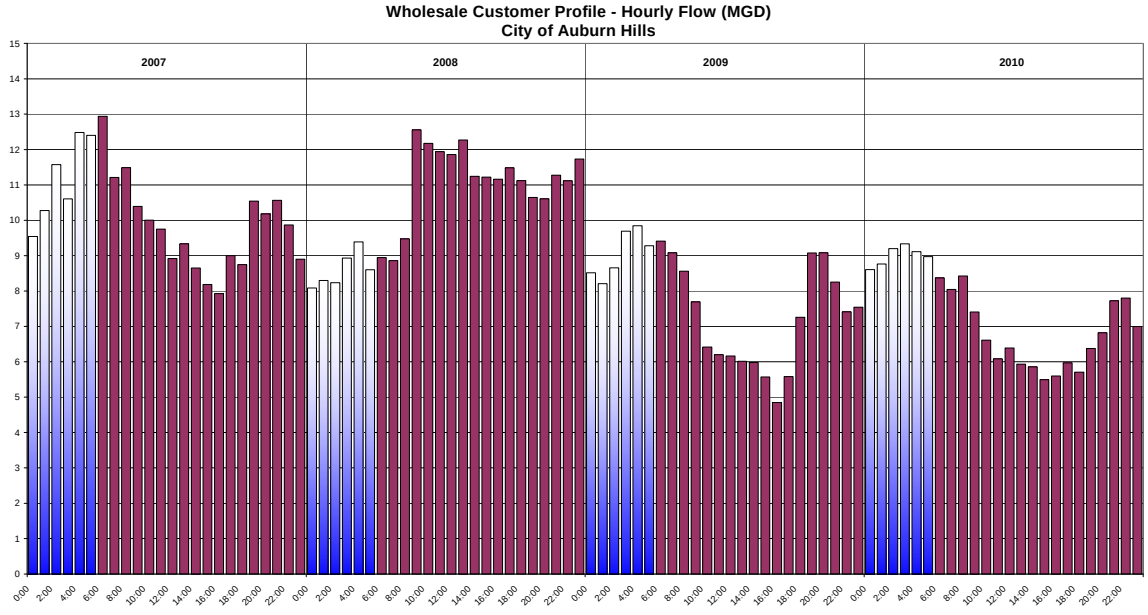
Figure 7: City of Oak Park Hourly Flow Profile



City of Auburn Hills

The City of Auburn Hills added a pump station and elevated storage tank to their water system in 2004. These system improvements were designed to prevent low pressures when DWSD supply pressure is low. The pump station succeeded in maintaining pressures but system operations did not prevent the filling of the storage tank during the morning peaks. Minor operational changes to the City's existing telemetry system allowed the City to maximize their million gallons of storage and reduce peak flows. This change, along with industrial and commercial users adopting an odd/even grass water ordinance, allowed the City to reduce their peak flow in this district from 3,600 gpm to 1,800 gpm (see Figure 8)

Figure 8: City of Auburn Hills Hourly Flow Profile



Several additional communities made similar modifications. The overall effect is lower water rates for customers and reduced peak water usage for DWSD.

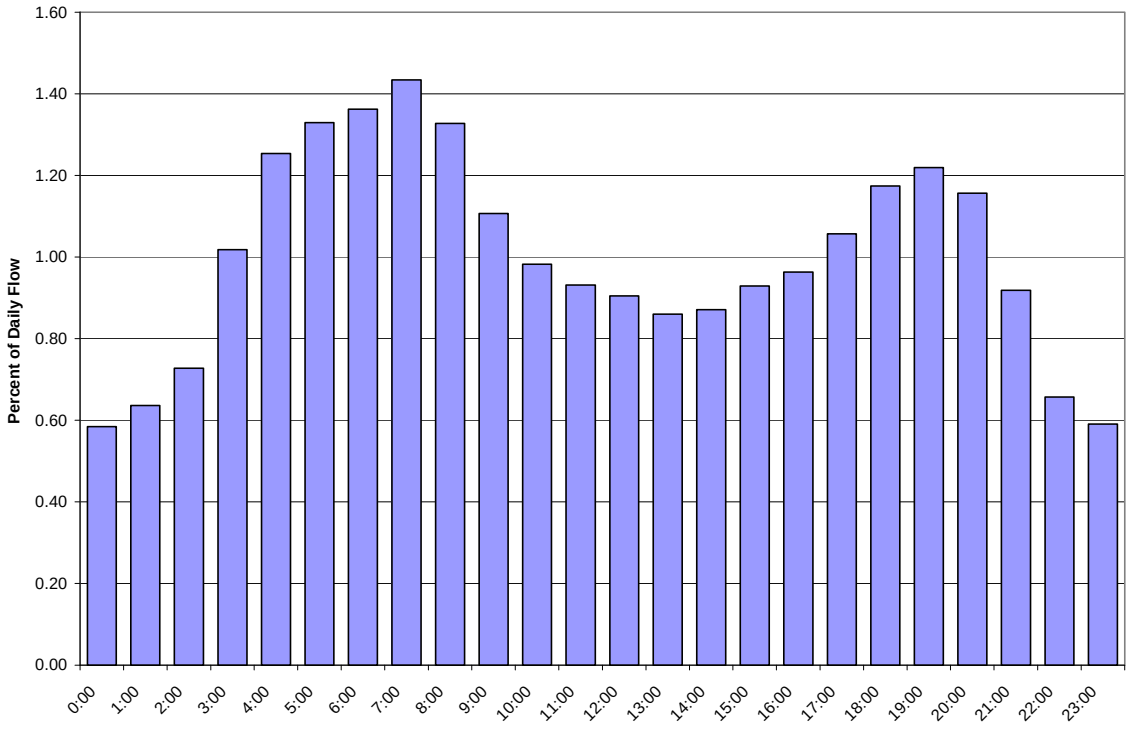
New Storage Construction

Bedroom communities with the majority of users on irrigation sprinklers found morning peaking factors over 3.0. Large peaking factors due to high morning water usage led to high water rates under the new rate system. Some of these communities found that the option off adding storage would greatly reduce their water rates such that they could pay for the construction within three (3) to ten (10) years. This created incentive for storage tank construction as the communities would also gain more reliable pressure, increase system reliability and increased fire protection along with the large reduction in water rates.

<u>Orion Township</u>

Orion Township is the last customer on a large dead end main from DWSD. The Township had experienced some pressure and fire flow concerns during peak usage periods. In addition, the Township's water usage pattern (see Figure 9) shows a large peak in the morning hours. Storage would add system reliability, consistent pressures and reduced DWSD water rates.

Figure 9: Orion Township Diurnal Curve



Based on the Township's current usage, the addition of sufficient storage to become a maximum day customer (peak hour usage is equal to or less than the maximum day usage) the Township could reduce their water rates by $900,000 annually, which is a 25% decrease in water rates. Therefore, the Township decided to move forward with the construction of a 2.5 million gallon elevated storage tank. The approximate project cost is anticipated to be $4.5 million with bids for the elevated storage tank coming in at $3.2 million. Therefore, it is estimated that the Township will have paid for the tank in rates alone within five (5) years.

Partnering

Currently the DWSD rate methodology does not provide increased incentives for reducing a community's peak flow below their maximum day flow rate. Communities and water authorities, such as the City of Oak Park, Southeaster Water Utility Authority (SOCWA) and the City of Pontiac, who have large storage facilities and have seen a decline in both manufacturing and population, have excess storage capacity. This excess capacity is not currently providing these utilities value. However, there are other communities in the area with high peak usage and therefore high water rates. The potential exists for these communities to enter into partnering agreements to further reduce water rates.

City of Oak Park

The City of Oak Park has six (6) million gallons in ground storage and additional elevated storage. After a year under new operational guidelines it became clear that the City could reduce its peak usage well below that of its maximum day. DWSD currently is not providing additional incentive to further reduce peak flow. However, several other Tier 1 customers have high peaking factors and no storage available. The City of Oak Park has opened discussion with other

communities to possibly become a utility authority and share their storage in an effort to provide additional peak usage savings to the area. This could also provide rate savings to a community without storage.

City of Pontiac

The City of Pontiac has 10 million gallons of ground storage. Over the years the population in the City has declined. The City has excess storage capacity and is in need of additional revenue. One alternative presented to the City was to utilize its existing storage to provide a neighboring community with water. This would reduce water rates for that community and bring in revenue to help manage operational costs for the City of Pontiac.

Pontiac has been working with its neighbor, the City of Auburn Hills, on the potential of providing water service to parts of the City not currently managed by their storage tank. This proposal would reduce the City of Auburn Hill's water rates and provide revenue to the City of Pontiac. In addition, the DWSD Water System Master Plan included several large improvements to solve the pressure problems experienced in this area. If the DWSD water rate reduction provides the City of Auburn Hills incentive to transfer to the City of Pontiac they would be taking water from a different DWSD feed. This could greatly reduce the peak flow on the DWSD Adams Road Pump Station. The communities are working with DWSD to determine whether this relocation of flow could solve the low pressure concerns and eliminate or delay the need for large system improvements in this area. In a trying economic period the limiting capital expenditures is a key concern for DWSD and its customers.

Conclusions

Over the past few years significant capital improvements, reduced water usage, and escalating costs led to significant rate increases for the Detroit Water and Sewerage (DWSD) Water System. In some communities the rate increases were substantial thus increasing awareness on peak water usage and how this usage was driving local water rates. By providing incentives through water rates, DWSD was able to entice their customers to make changes to their water usage practices. Highly publicized water rate increases tied to mandatory and/or voluntary odd/even grass watering ordinances were able to positively effect the end users water usage. In addition, minor changes to system operations to customers with existing water storage facilities also drastically reduced peak hour flow rates. Some communities were even enticed to build storage as the water rate savings would pay back the construction costs in less than 5 years. All of these system modifications occurred because DWSD provided their Tier 1 customers a financial incentive to change.

The financial incentive drove people to irrigate at different times, caused communities to update their system operations, and add storage or team with communities that have storage. The results are a better operated system that saves money on operations during peak distribution periods and limits large capital expenditures during slow economic times. DWSD did not need to regulate peak water usage; they could entice customers into making decisions to regulate their own usage or to pay for the privilege of not regulating their usage.