

## CONSERVATION OF REUSE WATER

James Hawley, Rev. 2 March 2007

Rapid growth in Central Florida is draining the Florida Aquifer System at an alarming rate. Saving the drinking water is an urgent necessity.

The City of Apopka supplies non-potable reuse water used principally for irrigation to many residential and commercial customers. The reuse consists of about 61% treated waste effluent and 39% well water. To reduce the growing need for supplement well water the City has requested a permit to withdraw water from the North Shore Restoration Area (NSRA) and Lake Apopka.

Conservation of reuse water is a better solution.

A conservation plan is herein developed and described which does not use well water to supplement the effluent. It uses the results of two tests described in reports made for the St Johns River Water Management District (District ) by the University of Florida. The first is xeriscape landscaping and the second is soil moisture sensors. Both minimize the amount of irrigation needed by the City's residential and the large commercial reuse customers.

### SUMMARY

The City of Apopka's consumptive use permit application (CUP 102497) was studied. It gives estimates for the supply and demand of irrigation water for the years 2004 through 2035. For 2006 a list of their reuse customers and their consumption is provided for the month of May.

The two conservation methods listed above are applicable to Central Florida. They were used to estimate the reduction in the Cities' reuse water demand for residential and commercial customers. .

The reuse demands are then compared to the available treated waste water effluent.

The results show that, to meet reuse demand by end of 2008 the City will need more than the sum of its treated waste water and the 5 million gallons a day (MGD) they have requested from Lake Apopka/NSRA .By 2035 the city plan requires supplement increases to more than 16 MGD.

Using conservation the Cities' treated waste water could supply all new reuse for household and commercial customers expected after 2007 .Large amounts of storm water collection, storage ,and distribution can replace the current use of well water in the City's

reuse. An example is discussed in the section Storage Ponds/Reservoirs.

Pros and cons for this proposed withdrawal plan and conservation plan are then discussed.

Steps needed to accomplish the conservation plan are described.

## CITY OF APOPKA PLAN

City of Apopka- The City passed an ordinance in 2002 which adopts as its own ,those water restrictions imposed by the St. John's River Water Management District (SJRWMD). They are working on a draft ordinance which would limit landscape irrigation to 2 days a week and prohibit it between 10AM and 4PM. The provisions would apply to all sources of water including the City utility, private wells, or connections to surface water bodies. And because the City's reclaimed water contains well water it would also apply to its' reuse water. After the first violation fines will be imposed. Xeriscape is not required.

Residential reuse customers (current and planned) are almost all developments of single family homes. The pre 2006 lot sizes averaged was about 0.37 acres, units planned after 2006 are expected to average 0.21 acres. The estimated reuse water consumption for each home varies from 750 gallons per day in 2005 to 497 gallons per day in 2035. The potable water use is estimated at 201 gallons per day. Hence, initially the city expects to use 79% of the total water outside the households and 71% in 2035. This outside use exceeds the 58% reported by the American Works Association and the 67% reported by the City of Winter Garden in 2006 (Bart Patria).

The City of Apopka also supplied their estimated demand for Commercial reuse for the years 2004 to 2035; as well as, the reuse by their Commercial customers for the month of May 2006.

The effluent expected to be available for reuse included an initial 10% reduction for losses ( leaks and unauthorized customers) and a 3% loss in the waste water plant.

## HIGH LEVEL CONSERVATION PLAN

### Residential

The conservation plan used the City of Apopka estimates of growth in the number of reuse homes and their potable water needs.

The plan reduced the estimated amount of residential reuse by using the results from a University of Florida study of several new homes in Central Florida. It showed that average irrigation consumption could be cut to 46% of the total household water usage for those yards having on average 35% turf grass and 65% in plantings beds ,when the

initial landscape establishment period was excluded (Brum). The conservation plan used this configuration to estimate the residential reuse. Tests were made on 27 households located on the Central Florida Ridge (Dukes, Miller, Haley) . The households were divided into 3 treatment groups having different size yards and turf areas. The irrigation usage was computed as a percentage of the total household water supply. The test was conducted for 26 months and the turf was St. Augustine grass.

The yard size which was used in the conservation plan had an average size of 9,146 square feet (0.21 acres) All homes studied used St. Augustine turf grass and were watered twice weekly unless prevented by their rain sensor.

The conservation was achieved by reducing grass turf areas and increasing plant beds to 66% of the total yard They used native vegetation with micro irrigation. Also, the electrical timers were varied so that the irrigation fit a seasonal schedule which simulated the areas evapotranspiration (ET) requirements. Soil monitors were not used to control the irrigation.

The cost of some of this landscaping ranged from \$ 2,000 to \$ 10,000 or more for paved paths, rock walls, etc. (Dukes, Miller, Haley)

The University test evaluators were not in control of the irrigation schedule .In all treatment groups most homeowners over irrigated even though the University evaluators would reset the timers when monitoring the households.

### Commercial

During the month of May 2006 the city delivered the following amounts of reuse water. Reuse consumption is listed in millions of gallons per month (MGM).

Golf Courses (61.2 %)	
Errol Estate Country Club	37.35
Rock Springs Golf Course	20.54
Nurseries (7.5%)	
Bronson's	5.706
Englemanns	1.363
Landscaping (31.3%)	
Northwest Recreational Phase 1	11.548
Other (HOA's, Roads, etc.)	18.095
	Total
	94.01

Converting the monthly data of 94.01 to daily yields 3.05 MGD

The city estimated growth rate for commercial reuse as 24% in 2006 to 16% in 2010. This is similar to their estimated residential growth rate where the numbers of homes increased by about the same amount. The reuse demand in May 2006 showed that 2

large golf courses and nurseries took 69% of the total commercial reuse.

However, the existing large golf courses and nursery customers do not provide a growing demand for reuse. Therefore, the city estimate of commercial reuse may be too large for this period. (Future golf courses are expected to be smaller than Errol Estates (928 acres) or Rock Springs (225 acres) and use only about 125 acres for 18 holes ).

May was the only month in which commercial reuse data was supplied for 2006 .The District may obtain the reuse measured for all of 2006. Lacking that information an estimate of the average daily reuse demand was made . Irrigation required during the month of May has been estimated to be 1.61 times higher than the average of all monthly irrigation needed for a 36 hole golf course in Fort Myers Fl. (Maliva, Martin, Missimer). Since the month of May required about 61% more irrigation than the average daily use, the annual reuse value for 2006 demand was estimated at 1.89 MGD (3.05/1.614) This is lower than the City estimate of 2.28 MGD.

Using the City reuse of 1.46 MGD supplied in 2004 a total growth in commercial demand of about 14% yields 1.89 MGD for 2006. This 14% growth was used in the conservation plan through 2010, thereafter the Cities' lower rates were used.

#### Retrofit Golf Course Reuse

Conservation of golf course irrigation falls into 3 general categories which are listed below with their percentage water saving (Bibliography Golf Courses).

1. Weather station with computer control over the irrigation system ( 25% to 50%);
2. Reuse of on-site water from ponds and streams (55%);
3. Reduction of turf in non play and rough areas (30% to 32%).

According to District staff, weather stations with computer controls have already been included in these Apopka courses. Reuse of on-site water may be possible at Errol Estates, as is a reduction in non play areas at both courses . The reuse supplied by the city to Errol Estates, could be reduced if water from their golf course ponds were used for irrigation. The District has helped fund a 140 million gallon pond with liner which the City will build .District might also help fund similar irrigation ponds on Errol Estates' 3 golf courses. On site irrigation from the golf course ponds will not require the high level of treatment needed for the city reuse water. The on site pond irrigation might reduce the demand for city reuse by as much as 50% (Golf Course Bibliography, Cases 2) However, no changes in the golf courses or nursery reuse were included in this conservation plan.

#### Soil Moisture Sensors

The remaining 31% of the commercial reuse are for sport fields, road grass areas, home

owners associations, etc. Conservation of this reuse in these sites were estimated using soil moisture sensors (SMS) .

This University of Florida's study showed that SMSs used 56 percent less water on average than systems with rain sensors when timers were set to water twice a week. Although irrigation was set for twice per week the SMSs adjusted for weather automatically and provided the correct water flow to the turf grass roots ( Cardina - Laihacar, Dukes, Miller ). Soil moisture sensors studied are priced from \$75 to \$ 350 (UF News).

The SMS tests were made on Bermuda grass. Four models of different sensors were tested. Model C performed poorly and was not be used in my calculations. Rather the water used by sensors A,B, and D over the test duration were combined and the averaged. A 55% reduction in reuse was estimated in this conservation plan.

## RESULTS

The City of Apopka's estimate of demand and supply of reuse is shown in Figure 1. The supply includes the 5 MGD of additional reuse that they have requested. Even with this additional supply they expect the reuse demand to exceed their supply by the end of 2008. The City will need evermore supplemental supply each year in the future. The deficiency gets larger with each passing year, reaching 16.9 MGD in 2035.

For the conservation plan the estimated demand and supply of reuse is shown in figure 2. The conservation plan does not use the additional 5MGD which the City requested. Initially the demand exceeds the supply by 2.7 MGD and stays more or less constant between 2.7 to 3.8 MGD in subsequent years. In 2035 the deficiency is estimated as 2.14 MGD. The City could address these small deficiencies with other options.

Conservation of reuse water can provide a better long term solution than drawing water from Lake Apopka/North Shore Restoration Area.

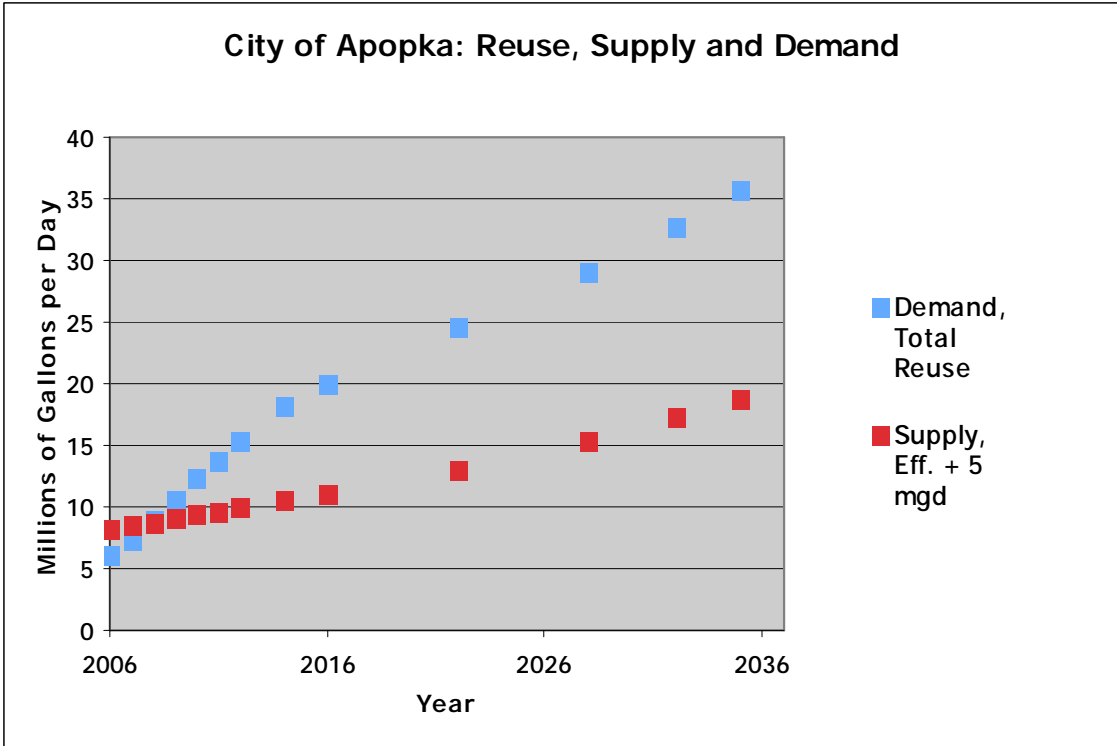


Figure 1

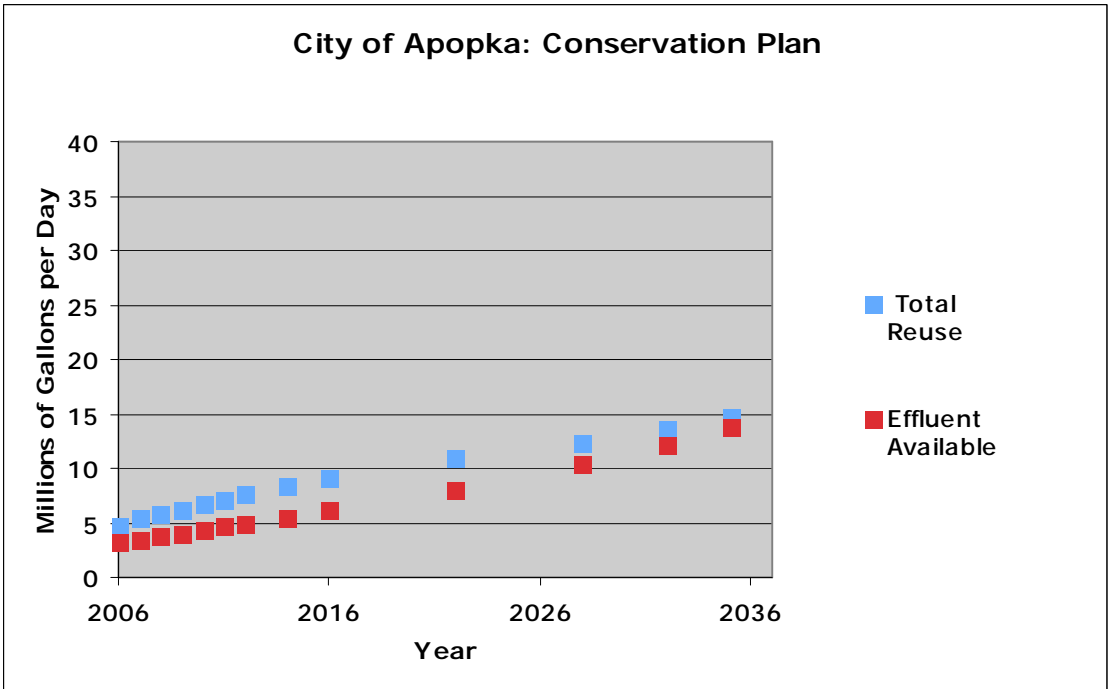


Figure 2

COMPARISON of REUSE SYSTEMS

The City has stated the following advantages:

1. The Lake Apopka /NSRA water will directly reduce the amount of supplemental well water which the City plans for reuse.
2. Water the City pumps from the NSRA represents water that the SJRWMD does not have to treat and pump into Lake Apopka.
3. NSRA water pumped by the City is water that has high levels of total phosphorous (P) and hence will reduce P loadings into Lake Apopka .

The City's Plan has the following disadvantages:

1. The city states that their supplemental use of well water for reuse will be directly reduced by the Lake Apopka/NSRA schedule of withdrawal. They do not say it will replace all well water supplements, nor how much well water will still be required.
2. The City's average daily demand is 5 MGD. Their analysis shows that no surface water is available from Unit 2 of the NSRA during April and May. However, they claim a need of only 1 MGD during these months. This, they say, will be taken from either (a) the canals in Unit 2 or (b) the City's 140 MG storage areas or (c) from Lake Apopka which will be allowed to flow by gravity into the canals by opening an inlet.

The stated plan to withdraw only 1 MGD during April and May means that the City will be short of their average by 4 MGD. Since this is the dry season they will probably be short by substantially more than 4 MGD.

Likewise the City's 140 MG storage pond will also be low in the dry season. Hence, it is likely that more inflows from Lake Apopka will be needed to make up the April and May withdrawals. Moreover, even with this 5 MGD plan the City shows their annual total reuse needs will increase dramatically in future years. Starting with an average daily reuse shortfall in 2008 of 0.1 MGD and to 16.9 MGD in 2035. Such high levels of withdrawal from Lake Apopka or the NSRA would not permit any recreational usage on a rapidly shrinking Lake.

According to the City more than the 5 MGD will be needed shortly. Hence, this withdrawal plan is not a long term solution for the reuse they have projected.

3. Question? Will a precedent be set by granting this CUP to the City of Apopka? The Town of Minneola has submitted an application for 20 MGD (average) from Lake Apopka via the Marsh Flow way. Other local governments may also then request Lake Apopka water to supplement their reuse programs.

4. The SJRWMD will not be in control of the City's withdrawal pumps or the 60 acre

withdrawal site in the NSRA. In the past when changes have been made on Lake Apopka or the NSRA conditions have sometimes turned out poorly. This lack of supervision and control can become a major problem, a few examples are given below:

(a) Seepage through the earthen farm dike which separates the Lake from the lower NSRA might raise water levels in Unit 2 canals and allow the City to withdraw more than the scheduled amount of 1 MGD in the dry season.

(b) Sludge will be generated on the 60 acre site due to filtering the canal water. How will it be stored and when and where will it be put?

(c) The U.S. Fish and Wildlife Agency has already stated their desire to have low water levels in the Unit 2 canals. Will they object to raising them for April and May withdrawals. Will they have other problems with this plan?

5. Regarding the Cities advantage (3) regarding the reduced need for the District to pump alum treated water which contains total phosphorous into Lake Apopka:

All water which the District is now pumping from Unit 2 is treated with alum. Although this process does not remove total phosphorous it does "bind-it-up" so that the active P is prevented from causing more nutrafication of the Lake. Some concern has been raised that active P will separate out if the pH in the lake changes. However, this condition can be avoided by passing the alum treated water from Unit 2 through a holding pond to allow the alum floc to settle out. The Duda ponds, located on the Lake front next to Unit 2 could be used for this purpose. If this is done the alum treated water flow into the lake would be of high quality and would greatly benefit Lake Apopka.

6. Long term restoration plans include further flooding of the NSRA to crate marsh areas. Loss of water will reduce this potential.

## II High Level Conservation of Reuse Plan

Advantages of the high level conservation are:

1. Provide a long term solution in which reuse effluent from each home can supply its own irrigation needs both now and in the future.

2. Since the early 1950's Lake Apopka has been chronically below its scheduled water levels by more than 1/2 foot. In 7 out of 10 years it has gone below the minimum desirable level. This was done to prevent over flow from the Lake onto the farms. High Lake levels could have destroyed the dike and flooded the farms .Conservation will allow restoration of NSRA Unit 2 to proceed without the need of providing long term withdrawals for reuse. Restoration of the soils would then permit shallow flooding of Unit 2 without endangering birds or wildlife. This would allow Lake Apopka's average water level to be increased since the danger of flooding from large storms would be reduced by temporarily putting excess flood water into Unit 2 of the NSRA. Higher average lake levels would increase boating , fishing and recreational use of the Lake Apopka.

3. In my opinion, the full environmental impact of removing billions of gallons of water each year from Central Florida lakes and rivers is not known. This conservation plan could be used to reduce water demand and avoid future problems.

#### Disadvantages of High Level Conservation Plan

The following are disadvantages to the reuse Conservation plan:

1. Initial costs for conservation are higher than the Cities' 5 MGD withdrawal plan. Operational costs will be lower, since less reuse will be needed in future years. Although saving reuse water will produce long term dollar savings for reuse customers, the Cities' approach is to supply as much irrigation water as desired by its new home owner associations and some of its residents.

This situation could be changed if the SJRWMD required high conservation techniques from all utilities for their new reuse customers. In order not to discourage the utilities from using as much effluent for reuse as possible, the District might best require high conservation methods be put into the potable water permits. It could be self defeating to raise the cost of reuse since individuals can install irrigation wells without permits.

#### Implementation of Reuse Conservation Plan

To put this conservation plan in place the following are needed:

1. Limit irrigation to a maximum of twice weekly; and limit its duration. For the sandy soil in Central Florida  $\frac{3}{4}$  inch of water is sufficient wet the roots and provide the correct amount irrigation. (Trenholm , Gilman, Knox, Black). Soil moisture sensors can be used in place of rain sensors to automatically terminate irrigation when enough soil moisture is present.
2. Have a separate metered reuse line at each household and customer;
3. Have a reuse line from the utility to all reuse customers;
4. Install soil moisture sensors with irrigation controls for commercial customers excluding golf courses and nurseries; and
5. Add specifications to xeriscape yards and limit the amount of turf grass to no more than 1/3 of the yard area. Since the SJRWMD issues permits for potable and reuse water it can request that such action be taken.

#### STORAGE PONDS/RESERVOIRS

Stormwater which is collected and stored can later be used to supplement the supply of reuse .This source of reuse was not included in the conservation plan but should be considered .Large amounts of storm water storage and distribution could replace well water the city is using to supplement its supply of reuse; also it could eliminate the need for draining lakes and rivers both now and in the future.

Long term storage ponds are subject to evaporation rates. Generally speaking a good

pond location would have the following (USGS Circular 1137):

1. A flow of run-in available to enter the pond to make up for the evaporation losses.
2. Seepage into the pond by having it in a discharge area where ground water normally flows in.
3. Clay soils which prevent leakage out of the pond.

Much of the City of Apopka is located in a recharge area. However, leakage can be prevented by adding impregnable liners inside the pond. Storm water inflows during the wet season can compensate for evaporation and provide additional reuse water during the dry season.

Most of the new developments will have large impervious areas which produce high runoff into lower areas. Such a low place would be a good site for a long term storage pond, particularly if it also was in a discharge area.

The Friends of Lake Apopka (FOA) position paper considered the NSRA as a location for a long term storage reservoir. This was a compromise to reduce draw down from the aquifer. In operation the reservoir was to be completely isolated from water flows in and out of Lake Apopka and the NSRA. It would receive rainfall and storm water runoff during the wet seasons from developed areas outside of the NSRA and supplement reuse water during the dry seasons. The NSRA has more than 12,000 acres and the reservoir would require only a small part of this area.

About 1000 acres on the west side of Unit 2 of the NSRA and all of the 3000 acres of the Duda farm have lower levels of pesticides and are being flooded for conversion into a marsh. In most of the remaining 8000 acres the District has measured high pesticides levels (Units 1 and 2 ). High levels of pesticides in the soil can transfer up through the food chain from fish to birds. A large kill-off of about 800 white pelicans resulted when Unit 2 of Zellwood was first flooded.

Therefore, if an uncontaminated site can not be found any reservoir in the NSRA Unit 1 or Unit 2 would need to be isolated from the farm soil, as well as from water leakage through the bottom of the reservoir. The reservoir would be encased with liners which are then covered with clean soil. Alternatively, the contaminated topsoil of about one foot could be removed and sent to a special dump site. However, a liner might still be required to prevent water seepage into the reservoir from adjacent contaminated sites. Also the dumping cost might be very high.

Storm water runoff from development areas which can be 40-50% of rainfall, would be collected and sent to the reservoir. Storm water from roadway ponds could also be collected for storage and released during the dry season. Use of storm water from detention ponds or from the overflow in retention ponds has the advantage of already being treated for release into ground water. Hence, if it is not used no further treatment is required when it is discharged.

For the conservation plan ,a reservoir which supplied an average of 3.8 MGD in supplemental reuse would fulfill all City's reuse needs thru 2035. A supply of 3.8 MGD (1390 million gallons per year) requires the reservoir system to collect about 4300 acre

feet for distribution each year. Most of NSRA Unit 1 and Unit 2 are at about 5 feet below the surrounding area and lake level. For example, for a reservoir depth of 6 feet a total area of about 800 acres would be sufficient. The reservoir system could consist of several interconnected ponds. If the entire 800 acres were put on the NSRA it would have a minimal effect on water discharges to Lake Apopka.

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