Prepared For

Reclaimed Water Policy Workgroup

Stormwater Harvesting – Its Enhanced Importance in Forthcoming Statewide Stormwater Rule, Practical Considerations, and Interplay With Reuse Water Supply

Location: Reedy Creek Improvement District

Date & time: November 19, 2010 at 11 a.m.

Prepared by Devo Seereeram, Ph.D., P.E.

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Reclaimed Water Policy Workgroup

Reuse Water "End User" Perspective & Comments to the Utilities and the Regulators

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PART 1

Stormwater Harvesting – Its Enhanced Importance in Forthcoming Statewide Stormwater Rule, Practical Considerations, and Interplay With Reuse Water Supply

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What Is Stormwater Harvesting ?

A stormwater harvesting pond is a retention pond which is also used as a source for irrigation water (or other non-potable use).

The reuse efficiency of a stormwater harvesting pond is a function of the volume of water which is consumed for irrigation which would otherwise have been discharged offsite. (There is an additional nutrient removal efficiency from wet retention.)

Design curves for estimating the efficiency of a stormwater harvesting pond are available in the FDEP handbook.

The maximum allowable application rate for irrigation is 0.7 in/wk.

Statewide FDEP Stormwater Rule

- The new statewide stormwater regulations (FDEP) mandate nutrient removal efficiencies in stormwater runoff.
- On some sites dry retention ponds are not practical, and wet detention ponds will not provide an adequate level of treatment.
- Additional BMPs will be necessary in order to achieve the required stormwater treatment efficiencies

Statewide FDEP Stormwater Rule

- Stormwater harvesting may be the only practical means to meet the mandated nutrient reduction efficiencies on some sites.
- Therefore, stormwater harvesting may need to take precedence over reclaimed wastewater, regardless of availability of reclaimed wastewater.

New FDEP Stormwater Rule for Stormwater Treatment

New stormwater regulations will mandate:

- An 85% reduction of post-development nutrient loading, or
- No net increase in post-development nutrient loading compared to predevelopment (natural vegetative community), i.e., Post <= Pre

Calculations based on average annual nutrient loading (N & P), in kilograms per year.

Predevelopment is not the same as existing conditions.

Visualize current site with a natural land cover condition, as if no clearing or earthwork had been done.

Stormwater Treatment Performance Standards

	REDEVELOPMENT SITES ≤ 2 ACRES	ALL OTHER ACTIVITIES
NON-OFWs	85% or Post = Pre, whichever is less, Unless feasibility analysis demonstrates lower level is appropriate	85% or Post = Pre, whichever is less
OFW	Post = Pre, Unless feasibility analysis demonstrates lower level is appropriate	Post = Pre
IMPAIRED WATERS	85% or Post = Pre, whichever is less, Unless feasibility analysis demonstrates lower level is appropriate AND Net Improvement for pollutant not meeting water quality standards	85% or Post = Pre, whichever is less, OR, if the water body is an OFW Post = Pre AND In either case net improvement for the pollutant not meeting water quality standards
IMPAIRED WATERS WITH ADOPTED TMDL OR BMAP	85% or Post = Pre, whichever is less, Unless feasibility analysis demonstrates lower level is appropriate AND Net improvement or TMDL/BMAP % reduction, whichever is greater, pollutant not meeting water quality standards	85% or Post = Pre, whichever is less, Or, if the water body is an OFW Post=Pre AND In either case net improvement or TMDL/ BMAP % reduction, whichever is greater, for the pollutant not meeting water quality standards

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Dry Pond Example, Required Retention Depth

Development Type	Curve Number	DCIA	Existing SJRWMD Rule, Retention Depth (in)	85% Reduction FDEP Rule, Retention Depth (in)	Post = Pre FDEP Rule, Retention Depth (in)
Low Density Residential	43.8	7.5	1	0.3	1.3
Single Family	48.4	22.8	1	0.5	3.1
Multi-Family	68.1	66.4	1.5	1.2	4+
High Intensity Commercial	66.9	81	1.6	1.4	4+

Notes:

1. Existing SJRWMD calculated for online treatment.
2. Post = Pre calculated using predevelopment Event Mean Concentration, for generic Undeveloped/ Rangeland/Forrest.

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Dry Pond Example, Required Retention Depth

For Type D soils in Central Florida

Development Type	Curve Number	DCIA	Existing SJRWMD Rule, Retention Depth (in)	85% Reduction FDEP Rule, Retention Depth (in)	Post = Pre FDEP Rule, Retention Depth (in)
Low Density Residential	81.5	7.5	1	1.2	1.0
Single Family	82.9	22.8	1	1.2	1.9
Multi-Family	88.9	66.4	1.5	1.5	3.6
High Intensity Commercial	88.5	81	1.6	1.6	3.4

Notes:

1. Existing SJRWMD calculated for online treatment.
2. Post = Pre calculated using predevelopment Event Mean Concentration, for generic Undeveloped/ Rangeland/Forrest.

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A Look At Best Management Practices (BMPs) For Achieving Nutrient Reduction in Stormwater Runoff

Primary "Bread and Butter" BMPs

- Dry Retention
- Wet Detention
- Wet Detention, wet detention with MAP/littoral credit
- Underdrains (provisional, pending further research)
- Stormwater Harvesting

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A Look At Best Management Practices (BMPs) For Achieving Nutrient Reduction in Stormwater Runoff

Moderately Used, Passive BMPs

- Swales (with & without blocks)
- Vegetative Natural Buffers
- Exfiltration Trenches
- Underground Storage and Retention Systems
- Underground Retention Vault/Chamber
- Pervious Pavement
- Low Impact Development

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A Look At Best Management Practices (BMPs) For Achieving Nutrient Reduction in Stormwater Runoff

Limited Use BMPs

- Green Roofs
- Chemical Treatment
- Wetland Stormwater Treatment

Dead BMPS (no longer allowed)

- Dry Detention
- Filtration

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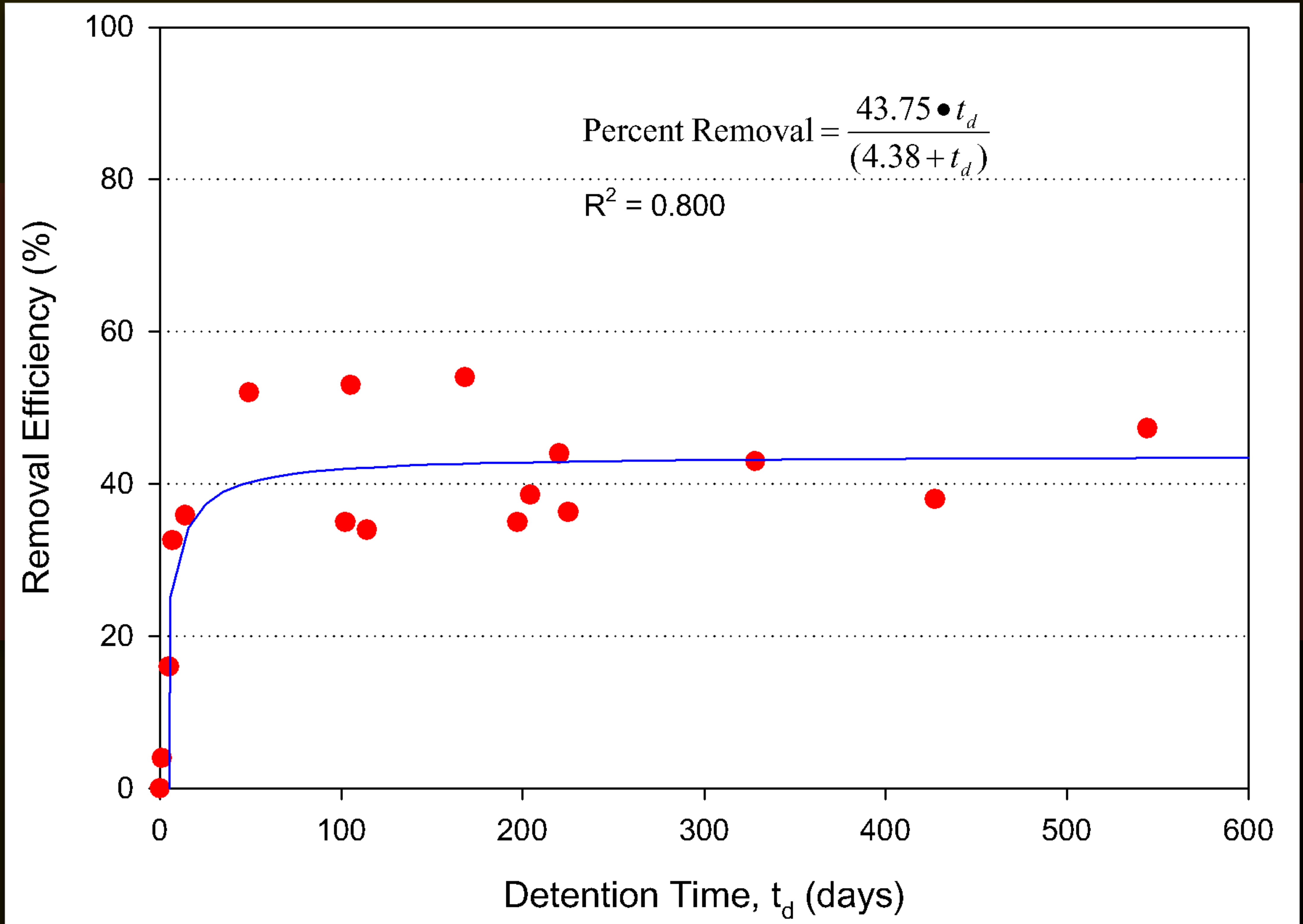
Wet Pond Limitations

- Wet ponds alone will generally not achieve the required stormwater treatment efficiencies.
- Nitrogen removal efficiency for a wet pond quickly reaches a point of diminishing returns. Nitrogen removal efficiency is limited to about 43%.
- Additional stormwater treatment is usually required in conjunction with wet ponds. This is often achieved by placing a dry pond ahead of the wet pond in a “treatment train”.
- Alternately, the wet pond may be designed as a stormwater harvesting pond, providing enhanced stormwater treatment (by reducing the offsite discharges) while providing a portion of a projects irrigation needs.



Nitrogen Removal Efficiency for Wet Pond

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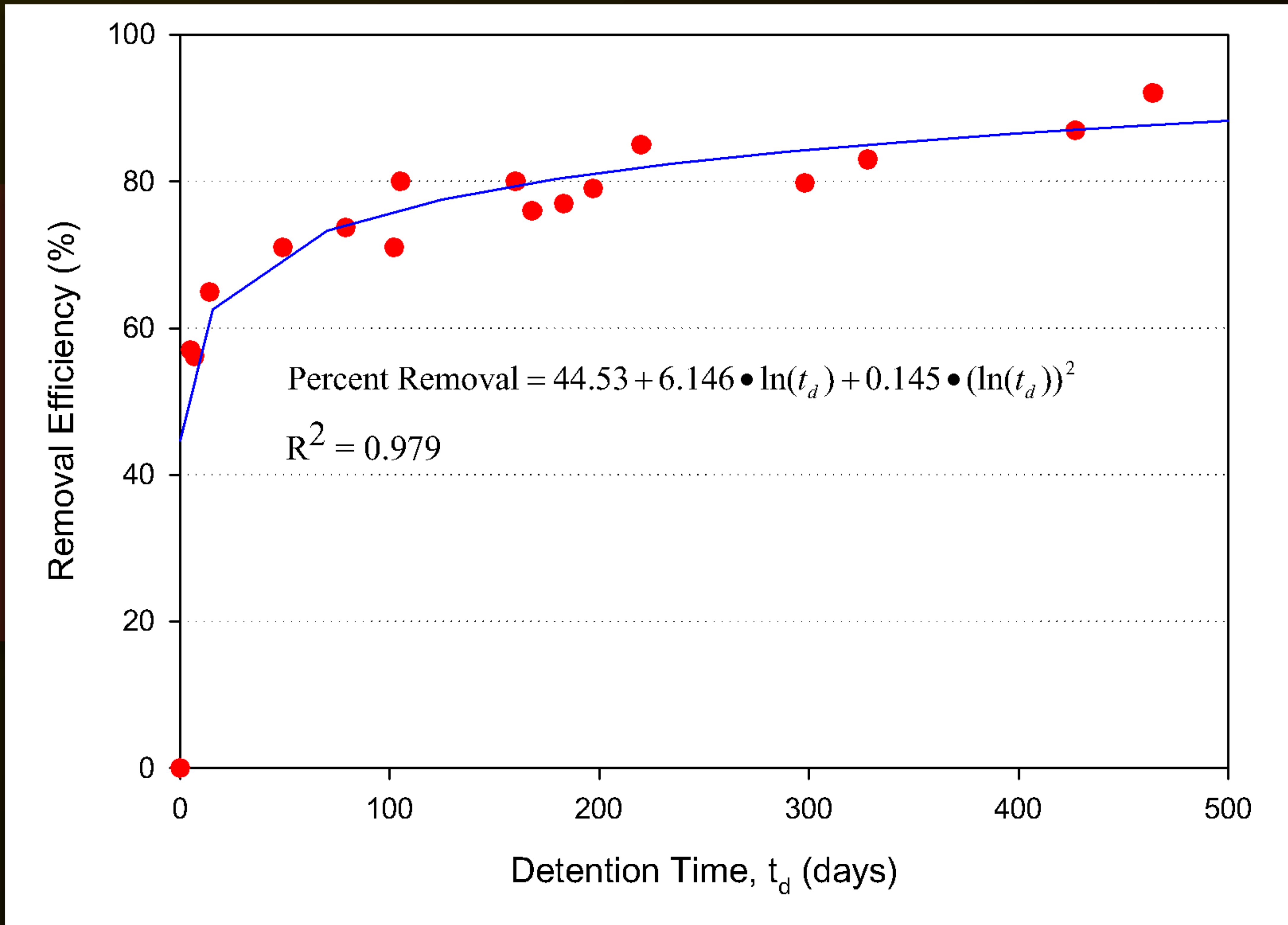
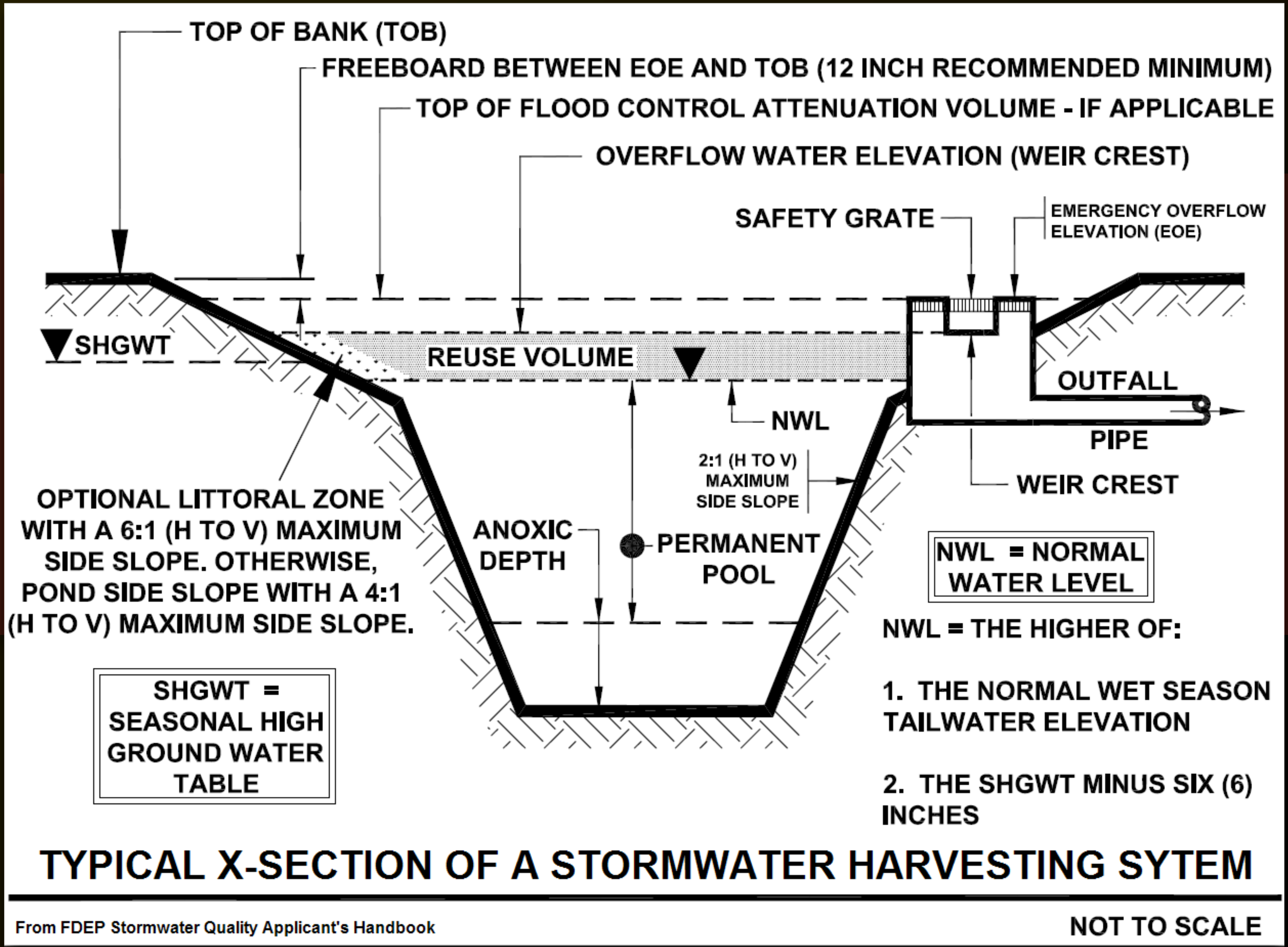


Phosphorous Removal Efficiency for Wet Pond



Typical Stormwater Harvesting Pond

Operational and Design Water Levels

- The pump-off elevation is usually the lower elevation of the reuse volume or no more than 1 foot below that elevation. If the reuse volume is set to begin at the seasonal high water table level then, pumping to 1 foot below the lower elevation of the reuse volume is allowed. If the reuse volume is set below the seasonal high water table level then the pump off is usually the bottom of the reuse volume.
- There are currently no design guidelines for the maximum depth of the reuse volume, but if the pond has a planted littoral shelf the plant tolerances for water fluctuation need to be considered. (Mounding impact should be considered).
- For the storm event routing calculations, the beginning water level in the pond for routing purposes should be the weir elevation or top of the reuse volume (currently).

Benefits of Stormwater Harvesting

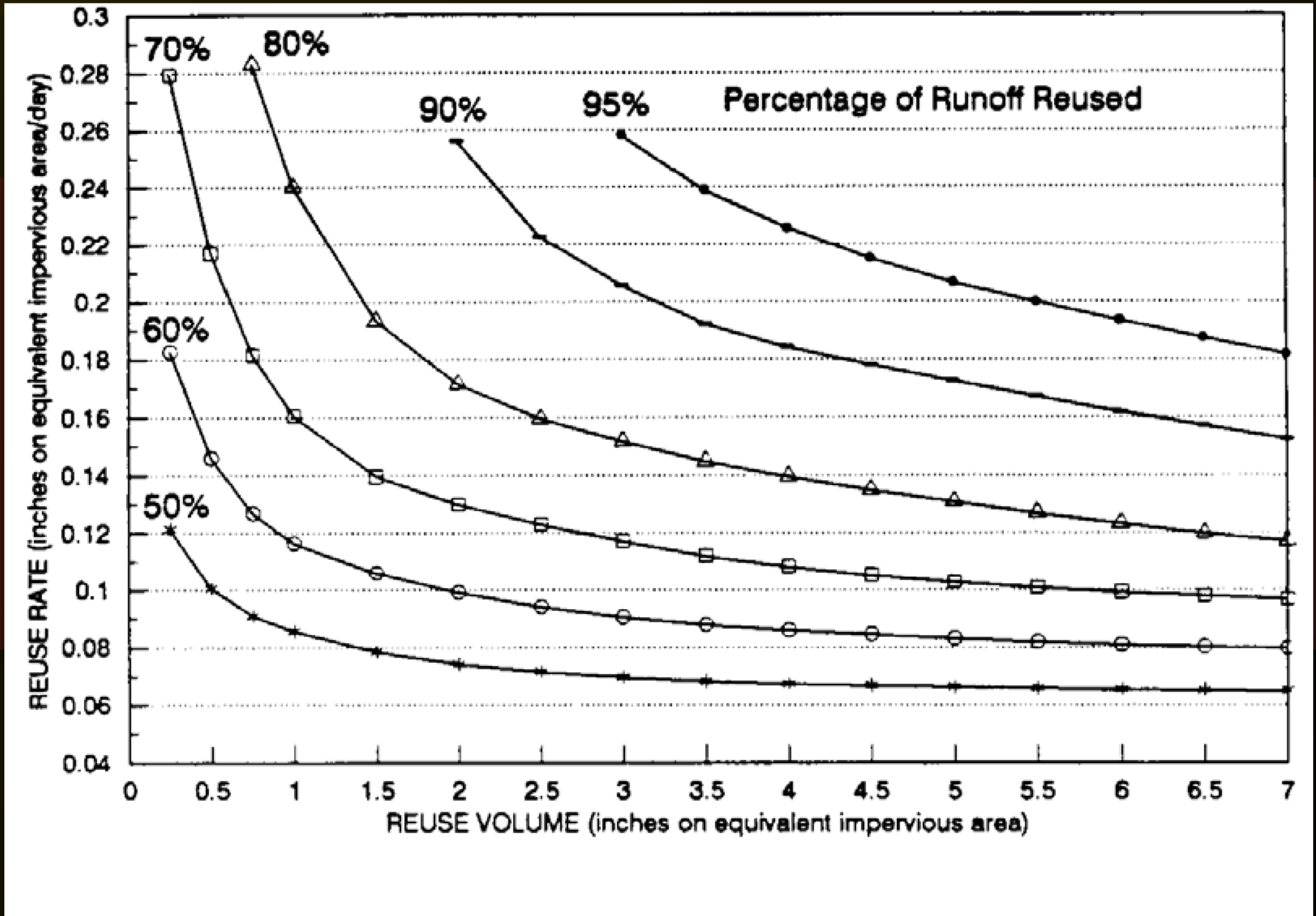
- Reduction of runoff volume discharged to the receiving waters;
- Reduction of pollutants discharged to the receiving waters;
- Substitution of stormwater use instead of potable ground water withdrawals; and
- Potential economic savings from not having to pay user fees for potable water.

Design Methodology For Stormwater Harvesting Ponds

The current design methodology for calculating the treatment efficiency of stormwater harvesting ponds has been simplified as a series of design curves in the following variables:

- Reuse rate (R)
- Treatment efficiency (E)
- Reuse volume in pond (V)

- The design curves are based on continuous simulation modeling, in order to calculate the expected treatment efficiency for an "average" rainfall year.
- However, the design curves do not guarantee the availability and timing of stormwater. Stormwater may not be available during dry periods.
- Therefore, a secondary source of irrigation water may be needed in addition to stormwater harvesting.



ORLANDO RAINFALL STATION

Example of R-E-V Design Curves for Stormwater Harvesting

Filtration and Disinfection

- Harvested stormwater that is used for irrigation must be withdrawn from a structure that allows for seepage of the harvested stormwater volume through a minimum of 4 feet of native soils or clean sands. This is best accomplished by withdrawing water through a horizontal well configuration located directly adjacent or under the reuse pond.
- Withdrawal of irrigation water from the stormwater harvesting pond in this manner effectively removes algae, turbidity, and other materials that might be considered adverse to human health when converted to an aerosol condition.
- Acceptable alternatives include in-pipe treatment filtration that is used to remove detained water from ponds. Options other than horizontal wells must demonstrate removal of turbidity and algae toxins.

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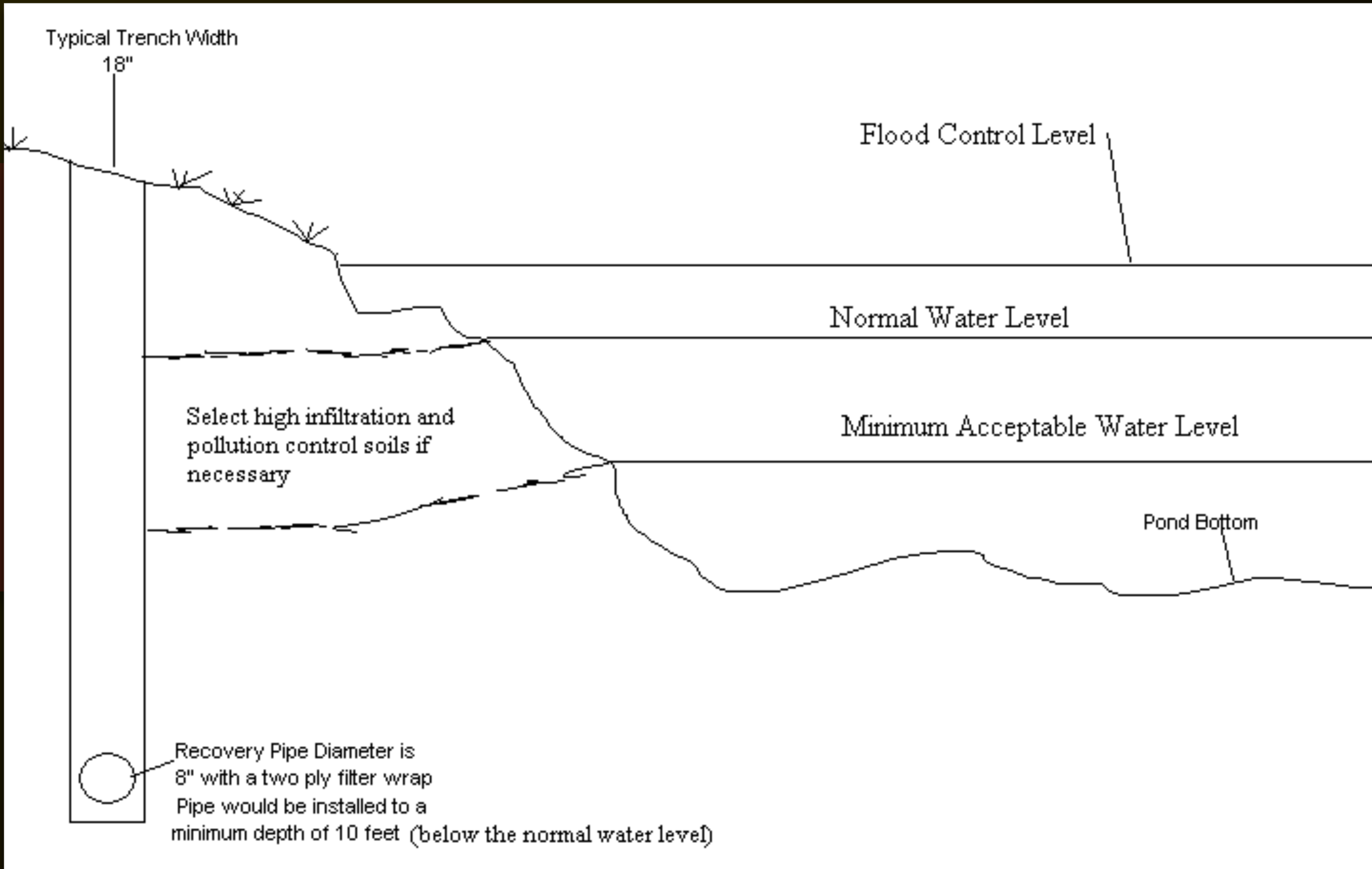


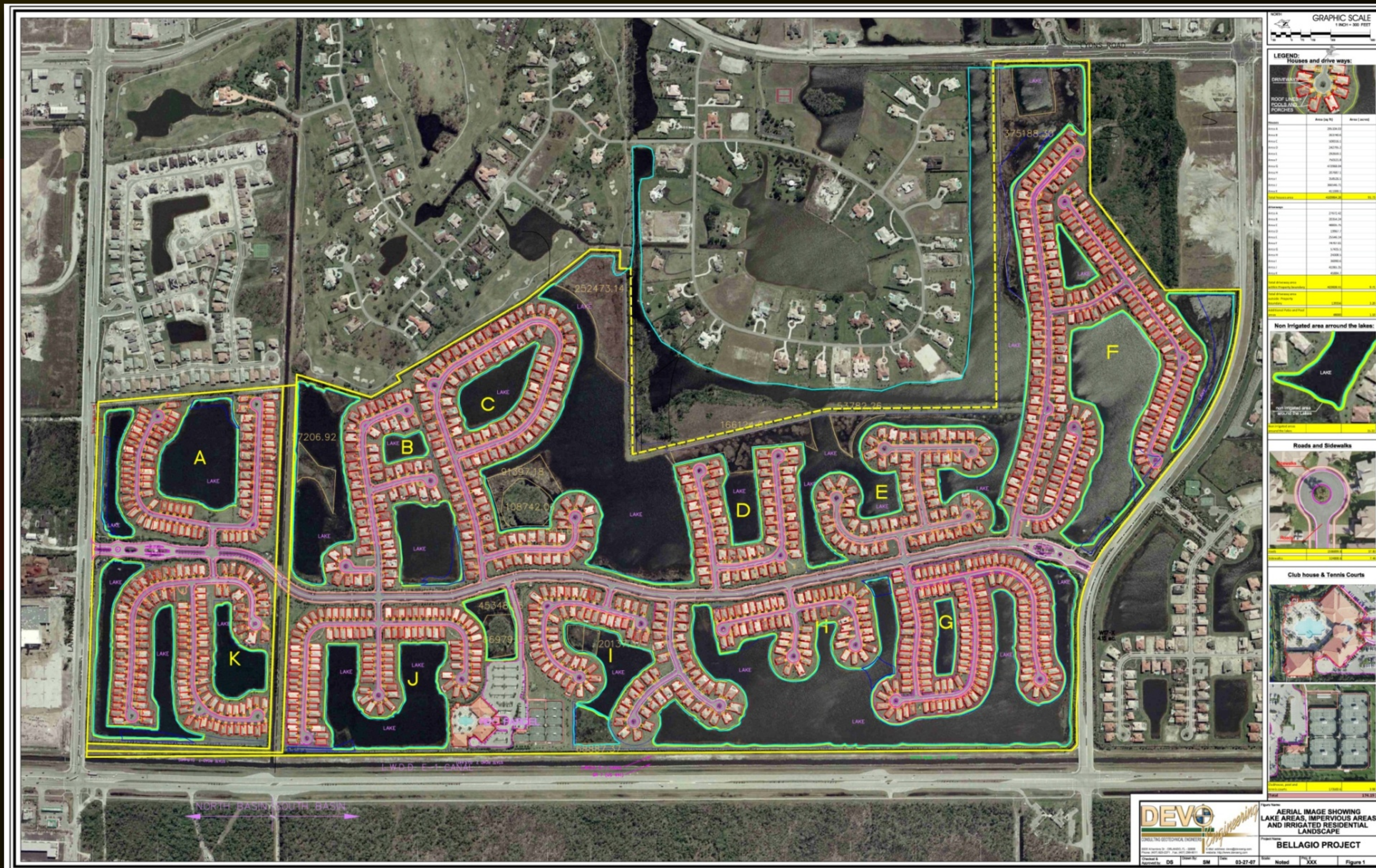
Filtration and Disinfection

Types of Filtration Systems

There are generally four-types of filters used for filtration of surface waters for irrigation purposes. The type of filtration system that is selected will depend on the water quality.

- Screen
- Centrifugal
- Disk
- Sand Media

Screen and centrifugal filters are best suited for removing sand and large inorganic particles. If there are organic solids, then disk filters will work for light concentrations, but heavy concentrations require sand media filters. Thus, if the water quality is poor (high organic solids), then sand media filters will probably be the best choice. Screen filters are typically installed downstream of the sand media filter to capture sand that may escape the media filters during backwashing.



Example - Bellagio

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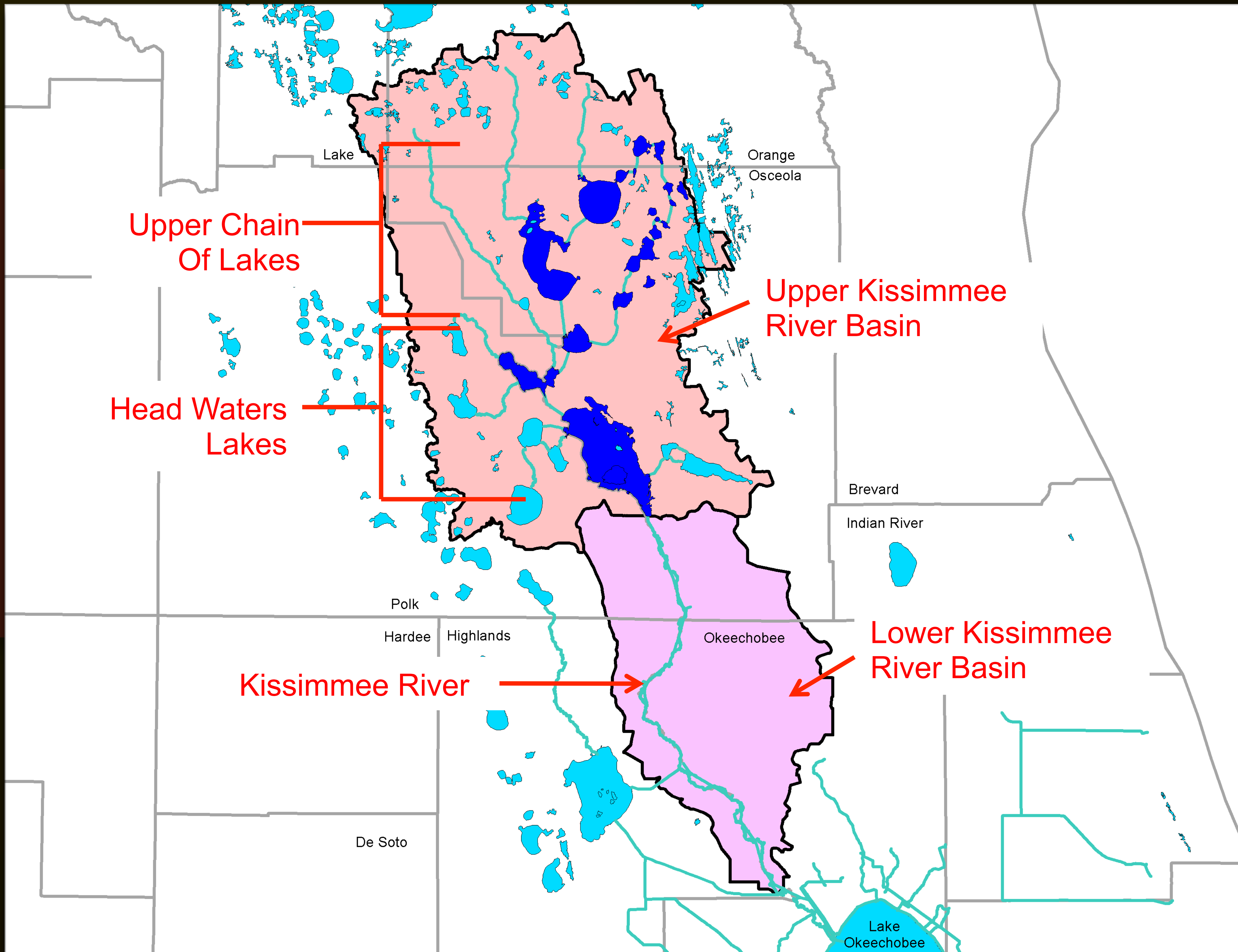
Stormwater Harvesting Ponds - Utility Perspective

- Taking stormwater into reclaimed lines (FDEP regulations).
- Treatment through horizontal wells (or filtration).
- Pond size thresholds - economics tied to harvesting yields.
- Capital costs.
- Maintenance costs.
- Who does the water belong to? Fees to be charged.



Kissimmee River Reservation

Monday, November 29, 2010

Issues Within the Kissimmee River Reservation

- In order to further the goals of the Kissimmee River restoration project, SFWMD is proposing rule changes within the Kissimmee River Reservation to preserve the volume of water which recharges the Kissimmee River system. This means that development can not result in a decrease in runoff discharge volume, compared to predevelopment conditions.

- This goal is somewhat at odds with the FDEP rules for nutrient reduction in stormwater runoff which generally require a reduction in annual runoff volume to achieve required treatment levels (i.e., dry ponds and stormwater harvesting ponds), since wet ponds alone will not generally provide the desired treatment levels.

Potential Issues With Horizontal Wells

Potential Issues With Horizontal Wells

- They are high maintenance and can result in pump burnout during droughty periods when the water table is low.
- Horizontal wells are not easy to maintain systems and their startup requires a lot of tuning as their production is not known ahead of time and there is a tendency to burn out pumps and cavitate/crush the well bores during this start up process.
- The wells will draw some groundwater in addition to surface water which could result in high iron levels.

Potential Issues With Horizontal Wells (cont'd.)

- To minimize mixing of groundwater, the collection system should be installed at the bottom of the pond, sized as typical for underdrains. Create a sand blanket to accommodate the effective aquifer required for the underdrain system, since wet ponds are typically located in low permeable soils. The underdrain system would then be manifolded into an appropriate wet well structure with pump(s).

- It is be best to make the vertical header pipe (wet well) 12" in diameter instead of 8". This will allow for more storage and minimizes drawdown somewhat, and that becomes critical during low water table conditions typical of dry season and especially during droughts.

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Potential Issues With Horizontal Wells (cont'd.)

- It is a good idea to install a drawdown seal above the pump - this forces more of the pump withdrawal volume to come from the horizontal well rather than the vertical header pipe. At Reunion, the horizontal wells were creating a vortex (even with a 15 ft water column above the pump) which caused air to be entrained. The air in the line rendered the flow meter inaccurate and caused it to read artificially high.

- Pumping for stormwater reuse directly from a pond has been practiced for many years. The rule should allow this without the need for the horizontal wells, unless there is definite indication of toxic algae. Also, it will be difficult to install horizontal wells in some formations. Does this need a water use permit?

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Potential Implementation Issues

Potential Implementation Issues

- Iron staining. Surface waters may contain high levels of dissolved iron, which can precipitate when oxidized, resulting in iron staining when used in an irrigation system.
- Phased development where greenspace is not in place when the stormwater management system is constructed
- Is this not a "pumped" discharge that is frowned upon by the regulatory agencies for homeowner association (HOA) controlled facilities? Are the agencies going to change their policy on allowing pumped systems to be maintained by HOAs? Typically some treatment is required if iron content is too high - major staining?

Potential Implementation Issues

- Most water management districts currently do not allow HOAs to control these systems since many HOA's tend to be derelict in their duty and financial obligations. If a system is permitted as a stormwater reuse system and then not pumped due to system malfunction or lack of funds, how is the responsible entity asked to comply?
- Where possible should the bleed down discharge not be sent to reclaimed facility through sanitary sewer (for example, APRICOT)? This should be considered when tie-in to irrigation system not feasible.

Potential Implementation Issues

- If the stormwater is introduced into a reclaimed water line with treated wastewater, it falls under the jurisdiction of the FDEP with their own requirements. If the mixed stormwater and reclaimed water is sold to residents, it must be treated by filtration and disinfection prior to introduction into the reclaimed line, unless it is a pure end user under one ownership such as a golf course or commercial facility.
- Is the system going to be regulated by the water use/consumptive use permit review staff or the ERP staff at each district?
- SFWMD currently restricts pumping from stormwater ponds to 55% of permitted allocation during droughts when the destination for the irrigation water is a golf course. This constraint needs to be lifted where stormwater treatment is part of the process.

Potential Implementation Issues

- There will need to be a criteria for analysis of safe yield from stormwater ponds. The critical time for these systems is during the dry season when there is little or no stormwater runoff and high demand. This is the period when the demand is highest and the supply is lowest. SFWMD has recognized this and requires a 90 day, no rainfall analysis to check the drawdown for this critical scenario.
- If a minimum lake level is set for a cutoff, there must be a backup supply as this is the time when demand is greatest. Drawdown impact needs to be assessed carefully as a permanent drawdown in the water table to adjacent property can cause house settlement (if there are buried layers of muck), kill mature trees, etc.

Potential Implementation Issues

- Will horizontal wells be allowed under dry retention ponds? This will be a good option for getting some dry pretreatment credit. It will be akin to a pumped “biofiltration” pond. Dehydration impacts will have to be assessed, of course

- The demand of 0.74 inches per week (as stated) is not applicable to all golf courses. It is based on the soil type, depth to water table, and use of soil amendments. There should be no onerous restriction on allocation if the stormwater water is available for reuse/treatment. The landscape vegetation and grasses soil/root zone should be considered an organic biofiltration system. This is the zone where nitrogen uptake is a maximum. Additional sprinkling over the predicted demand can be allowed in these applications.

Potential Implementation Issues

- There are times when the pump system will not work, either due to downtime for repairs and maintenance or lack of power during storms. In such cases, there will not be an opportunity to bring the water level in the pond back to its control level by mechanical pumping. This elevated water level in the pond can lead to flooding since there will be no attenuation volume in case of another storm. It is recommended that emergency bleed-down devices be installed so they can be opened during such events, usually for a maximum period of 30 days operation.
- In light of the above, a 30 day backup supply should also be permitted to keep the vegetation alive during such a potential downtime. The source water for backup is usually Floridan aquifer water or other deep aquifer well.

Potential Implementation Issues

- There are some areas where horizontal wells are going to be problematic from an installation and operation standpoint – take for example the Miccosukee clays in Tallahassee which have low permeability but support wet detention ponds. In addition, in the shallow limerock area of Broward County – horizontal wells may not be practical. Dense coquina zones on the west side of St. Lucie County will also be problematic and the FDEP may have to waive the filtration requirement and allow direct pumpage to end users as is practiced now.

Potential Implementation Issues

- Interconnected, equalized wet detention ponds are more desirable for stormwater reuse since they tend to distribute the withdrawal load across the ponds, taking advantage of the hydro-geotechnical localities which may be more productive within a site. In other words, one pond may safely produce 15,000 gpd while another similarly sized pond may produce 30,000 gpd, so it is best to equalize and interconnect them to get the weighted average withdrawal and minimize impacts.

- For flood routing in such systems, what initial stage can be used in computer modeling? Must it be the top of the reuse volume which is very conservative? Or can it be the control level similar to a wet detention pond?

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PART 2

Development Engineer's Perspective on Mandatory Reuse Zones

Potential Users of Reclaimed Water

- Residential developments
- Golf courses
- Commercial
- Industrial
- Other

Why Golf Courses Like Reclaimed Water

- Little or no pH adjustment required
- Nutrients (less fertilizer)
- Less spray outside green area
- Not subject to water shortage limitations (compared to ground water)

Why Golf Courses Don't Like Reclaimed Water

- Cost. Bulk rate is onerous to large golf operators
- Difficult to obtain a guaranteed supply. Can't get water when they want it, during drought. What happens if utility can't deliver?
- The commitment of reclaimed water is deducted from their permitted groundwater. Can result in inadequate permitted backup allocation.
- Locks the land use in long-term, which is not always desirable for a land owner. Makes future conversion of land use more difficult.
- Onsite storage in lined storage ponds: unsightly when water level fluctuates and requires algae control and can generate offensive odor.
- Potential costly groundwater monitoring.

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Financial Burden

The financial burden of switching to reclaimed wastewater will not have the same burden for all users.

- Individual residential users are less likely to feel an impact as a result of lower consumption in general, and the smaller differential between reclaimed wastewater cost compared to utility supplied potable water cost.

- Large consumers, such as golf courses, will feel a greater impact due to the relatively high cost of reclaimed wastewater, compared to less expensive sources, such as private wells and/or surface water from onsite ponds (including stormwater harvesting ponds).

Golf Course Cost Comparison Example - Project X

Three golf courses and some irrigated common areas, with a combined irrigation demand of 1,430 MGY. Water is currently supplied from Upper Foridan aquifer and surficial aquifer wells.

Current Cost of Irrigation:

Assuming the cost to pump is $0.10 / 1000 gallons,
1,430 MGY @ $0.10 / kgal = $143,000 / yr

Cost Comparison Example - Project X

Cost of Reclaimed Water:

Description	Formula	Cost
Reclaimed Bulk Rate	$0.89 /kgal x 1,430 MGY	+ $1,272,700 / yr
Meter Charge	$2,500/mo x 12 mo x 2	+ $60,000 /yr
Savings on Fertilizer	$3,000/mo x 12 mo	- $36,000 /yr
Total		**$1,296,700 /yr**

Switching from groundwater to reclaimed wastewater will result in a net increase in operating cost of approximately $1,153,700 /yr.

At a cost of $50 per round of golf, this equates to approximately 23,000 rounds of golf per year.

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Average Public Golf Course Statistics

- The median cost of a weekend round of golf at an 18-hole municipal golf course in the U.S. is $36 including cart and green fee. At a daily fee course it`s $40.

- The average 18-hole daily fee golf course records 30,000 rounds per year, employs a total of 13 full-time people and brings in about $992,000 in total revenues. Nine-hole courses average 17,000 rounds and have four employees.

Source: http://www.golfchannelsolutions.com/markets/usa

Balancing The Interests Of All Parties

State of Florida

↓

Permitting Agency

↓

Permit Holders & Utilities

↓

Customers of Utilities:
Residential, commercial, industrial, developers, golf courses, etc.

Balancing The Interests Of All Parties

State/Permitting Agencies:

- Reduce the discharge of nutrient laden wastewater effluent into surface water bodies.

- Reduce the dependency on ground water withdrawals for irrigation purposes, to the extent practicable.

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Balancing The Interests Of All Parties

The Utility:

- Should reclaimed wastewater be seen as a potential revenue stream, or

- Should reclaimed wastewater delivery be seen as an operational cost, and should that cost be incurred at the source (as a sewer disposal fee) or at the end use.

- Should the utility share in environmental credits, etc., which are achieved at the point of delivery as a result of less reliance on groundwater pumping by the end user (reduced wetland drawdowns, etc.)?

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Balancing The Interests Of All Parties

The End User:

- The cost to large water users can be onerous.

- If mandates are imposed for the use of reclaimed wastewater, then the bulk rate for the reclaimed water should be in line with what it would cost to pump water from existing sources, such as groundwater and/or surface water.

- At the same time, the cost to small (residential) users should not be so low as to encourage overwatering.

Stakeholders

Invite more stakeholders to participate in the Reclaimed Water Policy Workgroup.

- Florida Golf Course Association
- Florida Home Builders Association
- Chamber Of Commerce
- League of Cities
- Florida Engineering Society
- Florida Stormwater Association
- Land use litigators and planning departments
- FDOT

Some Concerns and Pitfalls

- Excessive use of reclaimed wastewater in subdivisions can result in raising the groundwater table. Example, Country Club in Sanford. Low cost to homeowners can encourage excessive watering.

- Large quantity of reclaimed water entering storm sewer due to spraying outside irrigation limits. Typically a problem with narrow median strips. Nitrogen and phosphorous directly enter lakes and ponds. Reclaimed wastewater can contain high levels of orthophosphorous, which is readily available for biological processes (as opposed to total phosphorous which is addressed by the new FDEP stormwater rules).

- Studies have shown that subdivisions with reclaimed application have higher N & P.

Photo date: 2005

Pavement Failure Due to Over Irrigation of Landscape Areas Central Florida Parkway

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Photo date: 2005

Pavement Failure Due to Over Irrigation of Landscape Areas Hiawassee Road

Leaching Over Curb

Infrastructure failure from reclaimed water overirrigation - Country Club

Limerock Pumping
From Base

Infrastructure failure from reclaimed water overirrigation - Country Club

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Pavement Distress

Infrastructure failure from reclaimed water overirrigation - Country Club

Additional Considerations

- Northeast Florida: use reclaimed water for paper plants. That should make a huge positive impact with one fell swoop. One major regional project can solve problem instead of several mini-projects.

- Ranking of alternative water supplies (non-brackish): surface water, stormwater, reclaimed water, St. Johns River.

- Reclaimed flows are usually not there on day one, so a secondary alternate source is needed.

- Focus on irrigation. Irrigation is the killer when it comes to demand. Inside/household requirements are small in comparison.

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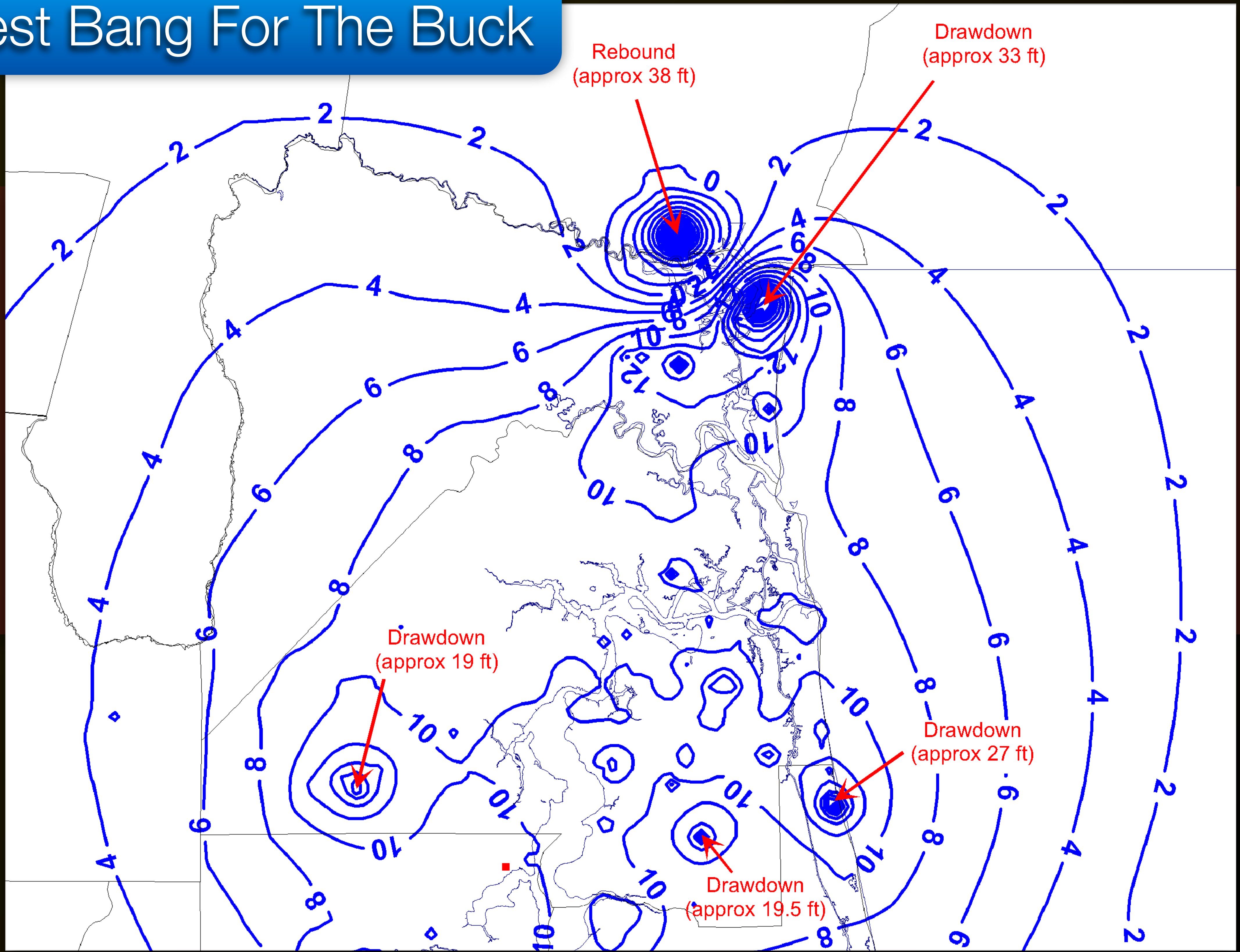
Best Bang For The Buck



Where possible, identify potential users which have significant regional impacts.

Additional Considerations

- Mandating switch to reclaimed water from an existing source should not result in an increased cost burden to an existing permittee who is being forced to switch. The utility has to adjust it's rate structure to PROMOTE & ENCOURAGE the use of reclaimed water, instead of viewing it as a revenue stream. Large irrigation users should be regarded as effluent disposal systems, with free capital infrastructure. Does it cost the utility more to discharge the reclaimed water to a river or a percolation pond as opposed to providing it to a golf course. The policy seems to be written from a one-sided perspective.

- Is this mandatory reclaimed zone intended to preclude owners with individual wells from using well water for irrigation. What about the sub-threshold permittees (4" wells).

Integrated Stormwater and Reclaimed Wastewater Systems

- Need to investigate integrated systems, such as combined stormwater harvesting and reclaimed wastewater.

- Possibility of mixing or augmenting reclaimed wastewater in stormwater harvesting ponds, providing that the stormwater ponds can accept back to back 100 year storms without discharging, for example.

- Augmenting of reclaimed water supplies during times of shortage (regional stormwater ponds, etc.). Mixing of stormwater and reclaimed water in same delivery system?

Summary

- Mandatory reclaimed water usage will result in mandatory cost to the end user, which are particularly onerous for large water uses such as golf courses.

- The bulk rate for reclaimed wastewater should be structured to encourage its usage, but not to encourage its over-usage. A "one size fits all" rate structure could be counterproductive.

- The cost of reclaimed wastewater should be addressed at the source, through sewer disposal fees, in addition to the cost to the end user.

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