Design Conference 2008
PEOPLE MOVING PEOPLE

Stormwater Reuse: Water Quality & Infrastructure Issues

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Stormwater Management Academy
"Managed stormwater is good water."

UCF

Outline

- What and Why?
- Examples
- Water Quality Considerations
- Infrastructure Issues
- Benefits
- Conclusions

What?

Stormwater from surface or groundwater sources used for non-potable purposes, like irrigation

Picture credit to Dan Dobson of Florida Technology Transfer Center, 2008

Why?

The top 5 reasons….

1. Used when roadway green areas need to be irrigated.
2. Can have a utility or LOS (be a profit center), thus some else takes on the maintenance.
3. To reduce mass discharges from regional areas, or meet TMDL standards.
4. Can not get a permit to draft more water from an existing source (groundwater or surface water).
5. Want to save valuable potable groundwater or increase the level of the aquifer.

Some examples follow:

An Urban Example

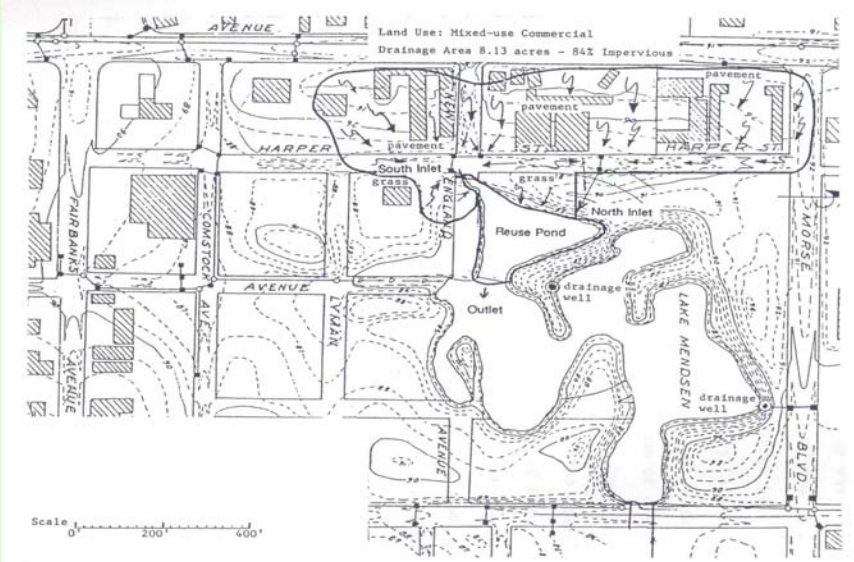


Figure 4-3. Watershed Detail

PRE-CONDITION NEGLECT

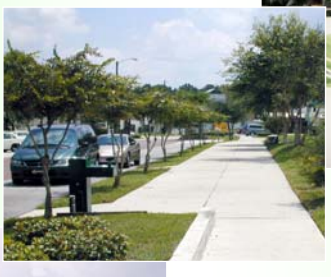
RESTORATION-IN-PROGRESS
WATERSHED AREA AND POND

SHORELINE BEFORE
REVEGETATION

SHORELINE AFTER
REVEGETATION

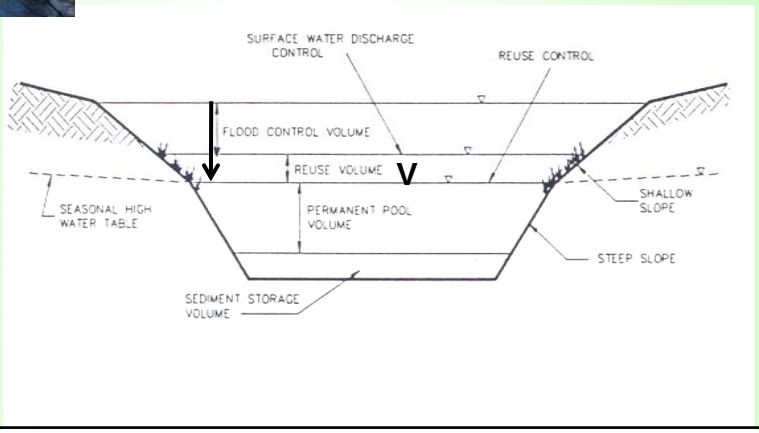
South Bay Utilities Inc.

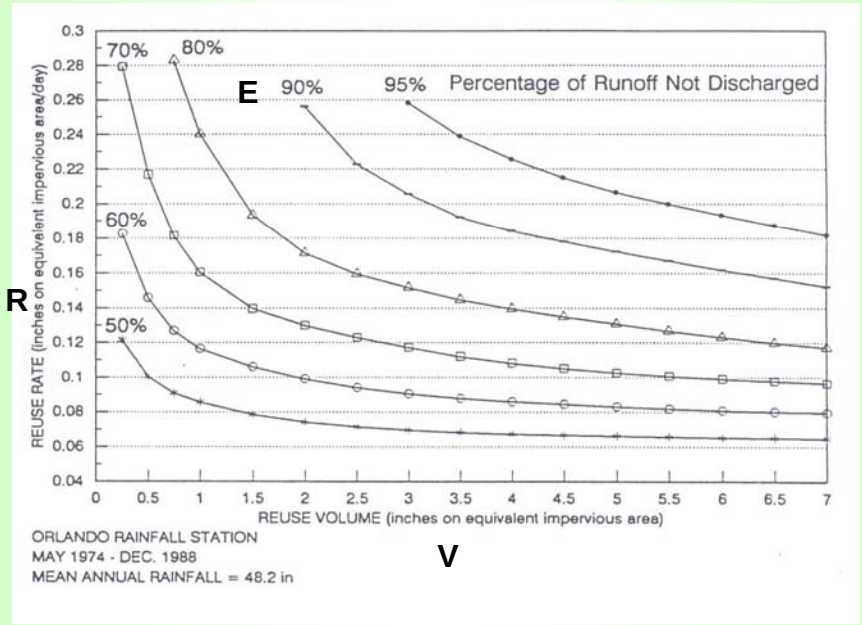
- Upscale residential irrigation demand
- No CUP
- No FPSC
- No FDEP



- 50¢/1,000 gallons not certified
- Shallow wells
- Customer agreements
  900 homes - HOA
- Coastal / fragile resource

Pond Design Nomenclature





Found in the State Wide Stormwater Draft Rule

Water Quality Considerations

- Irrigation water must be clear of disease causing organisms that people may drink.
- Removal of pollutants that would be otherwise discharged.
- Aid in meeting TMDL limitations.
- Become part of a stormwater plan

Research Objectives

Determine the counts of Cyanobacteria

- Document if Cyanobacteria exists in stormwater ponds in the Central Florida area.

Determine the concentration of toxins

- Document if toxins associated with Cyanobacteria exist in the stormwater ponds and at what levels.

Research Objectives (continued)

Determine if filtration through a natural soil media affects the counts and concentration

- Document the counts and concentration after filtration through poorly-graded A-3 sandy soil.

Determine if stormwater ponds can be a safe source for irrigation

- Document if the counts and concentration of Toxins in stormwater ponds are a public health risk.

14 Roadway Ponds

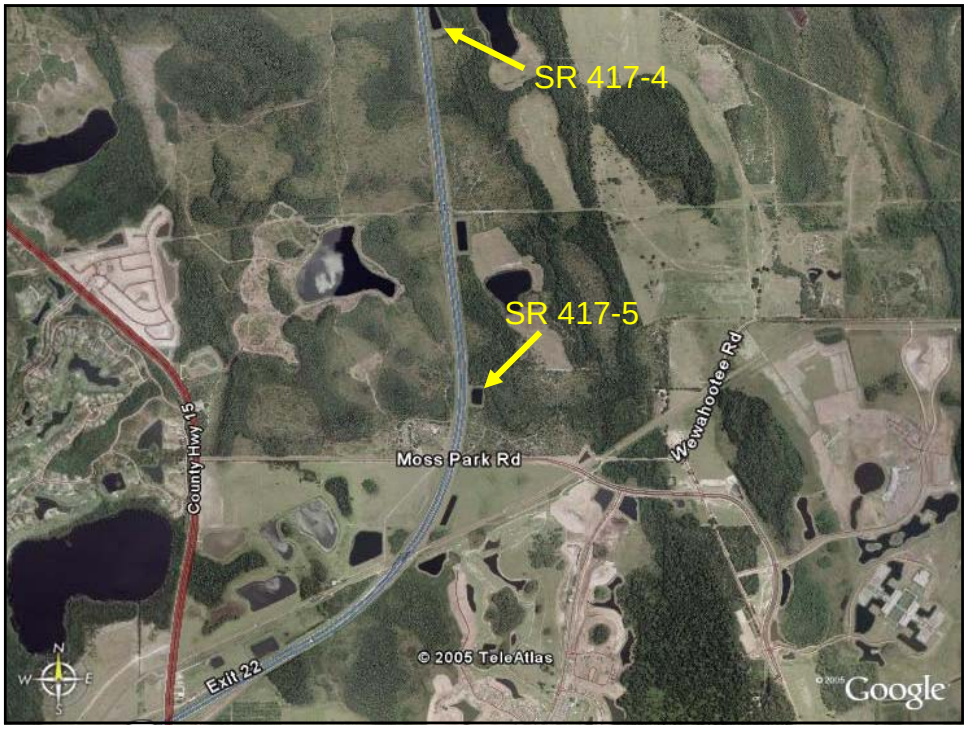
- Geographic area (Central Florida)
- Stormwater ponds
  - Drainage from a roadway
  - 12 were FDOT design.
  - 14 ponds sampled, one had access problems
  - 10-470 acre watershed
  - Pond 0.2 – 9.4 acres and 3-14 feet depth

S.R. 417 Stormwater Ponds – Greenway in Orange County

- S.R. 417-1
  - NB at Lee Vista Boulevard Exit
  - Approximately 1.7 acres
  - Average Depth 8 feet
  - Approximate Volume 14 acre-ft
  - Estimated watershed area of 85 acres

S.R. 417 Stormwater Ponds – Greenway in Orange County

- S.R. 417-2
  - SB 0.5 miles south of Lee Vista Boulevard
  - Approximately 1.8 acres
  - Average Depth 8 feet
  - Approximate Volume 14 acre-ft
  - Estimated watershed area of 90 acres



S.R. 417-4

- Northwest corner

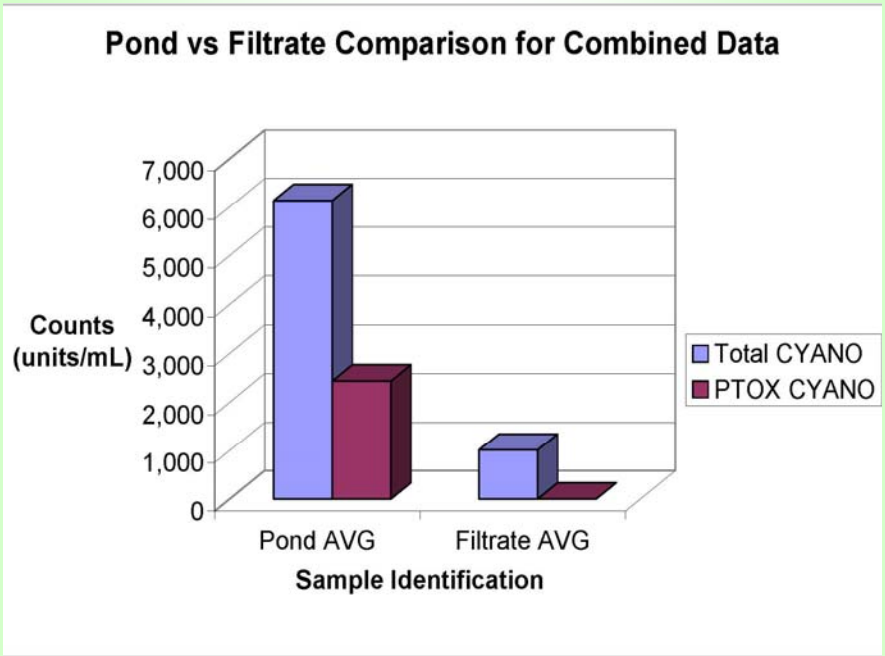
- View of north shoreline

Urban Roadway Stormwater Ponds

- Horatio Avenue and Via Tuscany No. 1
  - NW of intersection
  - Approximately 1.1 acres
  - Average Depth 4 feet
  - Approximate Volume 4.4 acre-ft
  - Estimated watershed area of 55 acres

Sampling Results

- 2 Sampling periods: Late Spring (April) and late Summer (August)
- Documented count and toxin concentrations.
- Comparisons…
  - Pond and lake water counts
  - Pond and filtrate water counts and toxins
  - Count to pond volumes.



Comparisons to Lakes

- 2-3 order of magnitude less in ponds versus lakes.
  - Lake Apopka 1,363,860 units/ml
  - Lake Beauclair 650,370 units/ml
  - Lake Harris 235,570 units/ml
    - Ref. Chapman et al, June 2005 15th Annual conference of the Florida Lake Management Society
- Ponds averaged about 6,000 units/ml
- Filtrate less than 1,000 units/ml.

Water Quality Summary

- Sampled fourteen (14) stormwater ponds that had detectable Cyanobacteria
  - Total, PTOX and Microcystin Toxins encountered
  - Variety of locations, sizes and watersheds
    - Residential, UCF campus, industrial site, major expressway and urban roads
- Geographically restricted to Central Florida
  - Orange and Seminole counties

Water Quality Conclusions

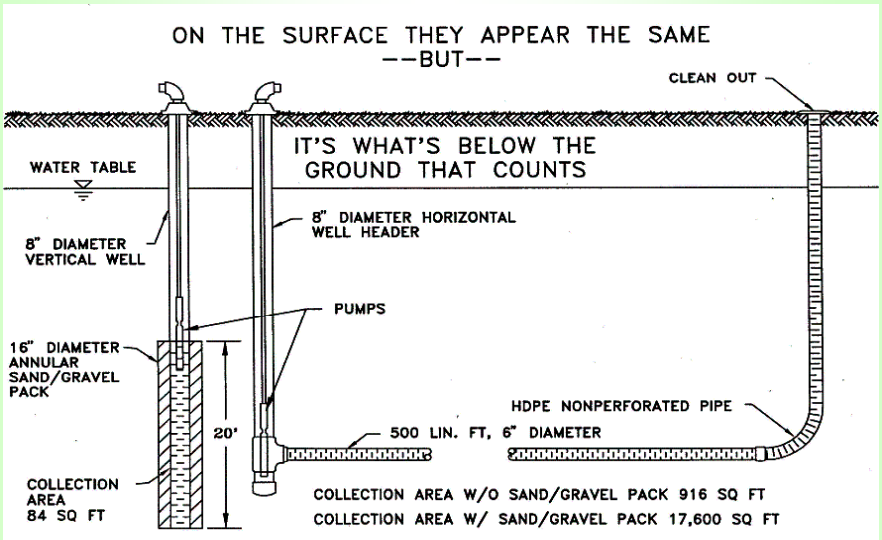
- Cyanobacteria does exist in stormwater ponds evaluated in this study.
- Counts in the stormwater ponds are much lower than those encountered in large lakes and rivers.

Water Quality Conclusions Continued

- Filtration through the poorly-graded A-3 sandy soil does reduce the counts of TOTAL and PTOX.
- No correlation between pond volume and Cyanobacteria counts or toxin concentrations.
- Filtrate waters - Microcystin concentration less than the WHO 1 ug/L standard for drinking water, and the pond water exceeded the standard 7 % of the time, or in 2 of 28 stormwater ponds sampled.

Recommend Horizontal Wells
Horizontal versus Vertical Well

(less cone of depression and more water per investment)



How Do We Design & What Are The Infrastructure Issues

- Example using I-4 widening through Winter Park/Orlando.
- Limited right of way and storage options.
- Defined the watershed, not always easy.
- Definite benefits to the community from reusing stormwater for irrigation.
  - Less potable water used.
  - Pollution control
  - Most economical solution

Dubstread Golf Course and I-4 Stormwater Management Plan

- Need – Provide water on a golf course to improve the play and image of the course.
- FDOT – Can provide the water.
- WIN -WIN FDOT and a high school gets stormwater plans, citizens get a “real” golf course.
- All get stormwater treatment and saving of potable water that would otherwise be used for irrigation.
- And oh yes, Wekiva is protected.

District Signature Project

Reuse Infrastructure Design

- **Problem**: To design a wet detention pond for reuse of stormwater and to estimate its pollution removal on a yearly basis, such that for TN and TP, the post loading is equal to pre loading.
- **Approach**: Use a treatment train approach and the statewide data (State Wide applicant's handbook, 3-5-08 draft). Incorporate the latest understanding of the performance of wet detention facilities and reuse.

Sizing the Pond for Reuse

(note numbers from the actual situation are changed)

- Follow FDOT research and the SJRWMD Manual of Practice (soon to be State Wide Draft Stormwater Rule).
- Needs
  - Watershed area is 4.59 acres, and EIA (effective impervious area) must be calculated
  - Irrigation area and average irrigation rates (weekly at 2 times per week)
  - Area for pond and storage

Background Related Information

- Wet detention ponds…
  - Marginal effectiveness beyond a yearly average detention time of 20-30 days.
  - Maximum nitrogen removal is usually considered to be 40% and phosphorus at 70%.
- Precondition:
  - Range land undisturbed, so called natural pre condition.
  - Loadings for TN and TP are 1.15 mg/L and 0.055 mg/L respectively.

Pre Condition Loadings

- Annual runoff coefficient = 0.105 (Draft Rule), thus the annual volume is

  0.105(50/12)4.59= 2.0 Acre Feet

Loadings: TN=1.15 mg/L, thus annual load of TN=1.15(2.0)(.325828)(3.79)=2.84 kg/yr

TP=0.055mg/L, thus annual load of TP=0.055(2.0)(.325828)3.79=0.135 kg/yr

Post Development Loadings

- Post Development CN=79 and 80%DCIA:
- Annual runoff coefficient=0.669 (Draft Rule), thus the annual volume is .669(50/12)4.59= 12.8 Acre Feet

Loadings: TN=1.64 mg/L, thus annual load of
TN=1.64(12.8)(.325828)(3.79)=25.9 kg/yr

TP=0.22 mg/L, thus annual load of
TP=0.22(12.8)(.325828)(3.79)=3.48 kg/yr

Removal Needed

- Required Removal Effectiveness:
  TN=[(25.9-2.84)/25.9]100= 89%
  TP=[(3.48-.135)/3.48]100= 96%
- Which Water Quality Parameter Controls?
  TN: assume 80% reuse: thus Removal = {1-[(1-.80)(1-.40)]}100=88%~=89%
  TP: assume 90% reuse: thus Removal= {1-[(1-.90)(1-.70)]}100=97% > 96%
- Controlling removal: TP and 90% reuse must be designed

Pond and Irrigation Design

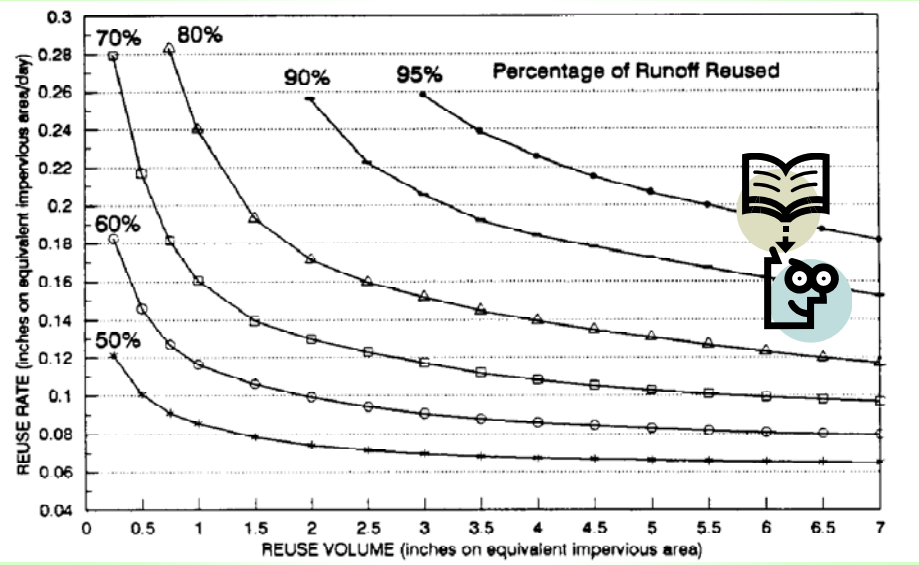
- Available irrigation area is at least 3.86 Acres
- Maximum irrigation rate is 1.5 in per week
- Provide for 3 inches of storage above the permanent pool (assumed, can be changed)
- Can 90% removal be obtained? Use the REV curve from the State wide rule (next slide):

  EIA =composite C times the area or

  C=3.67(1)+.92(.2)/4.59=0.84

  EIA = 0.84(4.59) = 3.86 Acres

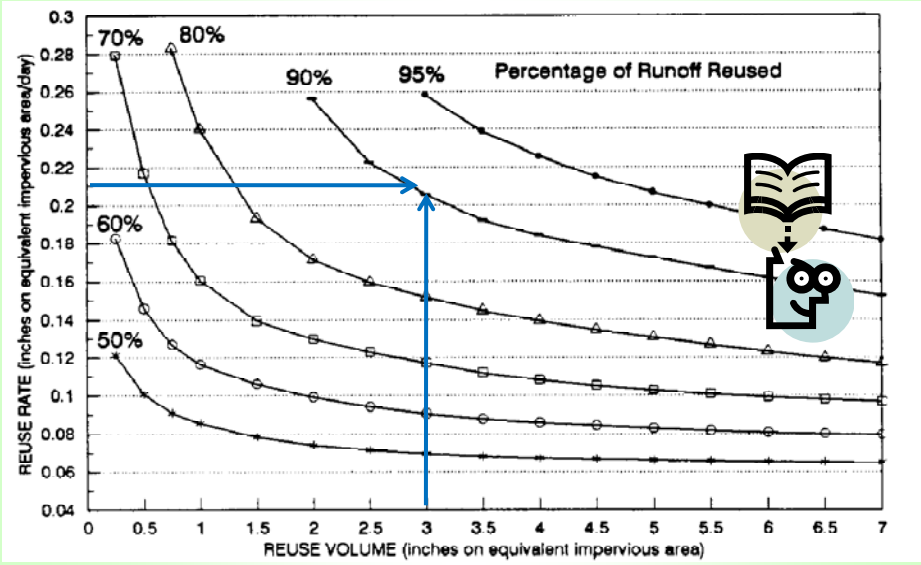
REV Curve for Orlando Area



Pond and Irrigation Design

- At average annual irrigation rate of 1.5 inches per week, the irrigation rate would be 0.21 inches per day, assuming 3.83 acres of irrigation land is available (actually more is available).
- From REV curve for Orlando at 3 inches of Reuse (above the pond control elevation), and 0.21 inches per day irrigation, an average annual removal effectiveness of 90% (runoff not discharged) is obtained and you have achieved post equal pre mass loadings for TN and TP.

REV Curve for Orlando Area



Other Infrastructure Issues

1. Users and use characteristics
   a) Is there a need? Wetland hydration, lawn irrigation, agricultural needs, etc
   b) Non metered vs. meter
   c) Pressure
   d) Volume and rate
   e) Additional treatment (at point of use)

Infrastructure Issues

2. Source

   a) Is there land available for a regional site, or a surficial aquifer?

   b) Collection system under-drain, horizontal drainage wells, shallow wells, deep wells, ponds, canals and reclaimed water (power plant, wastewater, etc.)

   c) Volume and rate as a safe yield.

   d) Water quality, chlorides, corrosive, calcium and magnesium hardness, pKs, metals (iron etc.) and odors (H_2S etc.), bacteria and virus content.

Infrastructure Issues

3. Regulatory Thresholds
   a) Water use permit > 4”
   b) 100,000 gallons/day (may be 50,000 in springshed areas).
   c) FDEP – if mixed with reclaimed H_20
   d) Right of way utilization easements

Infrastructure Issues

4. Size of Pond and Performance
   a) Mass Balance IN-OUT=Storage Change
   b) Consider all inputs and outputs
   c) Consider also the availability of alternative supplies to increase reliability.
   d) Simulations

Infrastructure Issues

5. Others
   a) Electrical Power Feeds
   b) Interconnection valves and meters, blow offs, grit removal
   c) Ground soil conditions to include porosity, type and others
   d) More, but site specific

Benefits

1. Very cost effective, home owners pay less, $.12-.50 versus $2-5, and a Utility can make money.
2. Reduces pollution (TMDLs)
3. Preserve potable water sources
4. Maintains hydrologic balance and Uses natural cleansing processes

More Benefits

5. Lowest energy requirement
6. Local sources first, Chapter 40 FAC
7. Use of lowest quality water for lowest quality need
8. Can be used for multiple reasons, like aesthetics

Conclusions

1. An alternative water source
2. Least economic burden on a community
3. Helps meet TMDL limitations
4. Proven Technology
5. Benefits

The best water resources option that you have not considered

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Thank you,
Questions and Discussion?

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