Desalination and ASR as Alternative Water Supply Options in Florida

Robert G. Maliva

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History of desalination in Florida

What	Where	When
Seawater evaporation distillation still 7,000 gpd Founded buried in rubble, partially restored in the 1990's	Fort Zachary Taylor, Key West	1862
Three-effect seawater distillation plant, 60,000 gpd. Replaced earlier plant.	Dry Tortugas	1880
Invention of seawater RO (cellulose acetate).	University of Florida	1960
Municipal desalter	City of Key West	1940s
Rotunda brackish-water RO	Rotunda (Charlotte Co.)	1966
IWA ED plant	Sanibel Island	1973
Large RO (brackish-water)	Cape Coral	1976

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Desalination in Florida

- Mostly reverse-osmosis desalination of brackish groundwater.
- Membrane softening – nanofiltration (NF)
- Seawater desalination is much less common due to higher costs.

FDEP Regulatory District	*RO Plants*	*Population Served*	*Design Capacity (MGD)*
Northwest	2	< 1000	< 1 MGD
Northeast	15	~ 240,000	~ 23 MGD
Central	21	~730,000	~ 42 MGD
Southeast	42	~1,985,000	~ 280 MGD
South	31	~ 864,000	~ 81 MGD
Southwest	29	~ 459,000	~ 89 MGD
Totals	**140**	**~ 4,279,000**	**~ 515 MGD**

Table 3-6. Characterization of Desalination Plants in Florida (FDEP, 2009)

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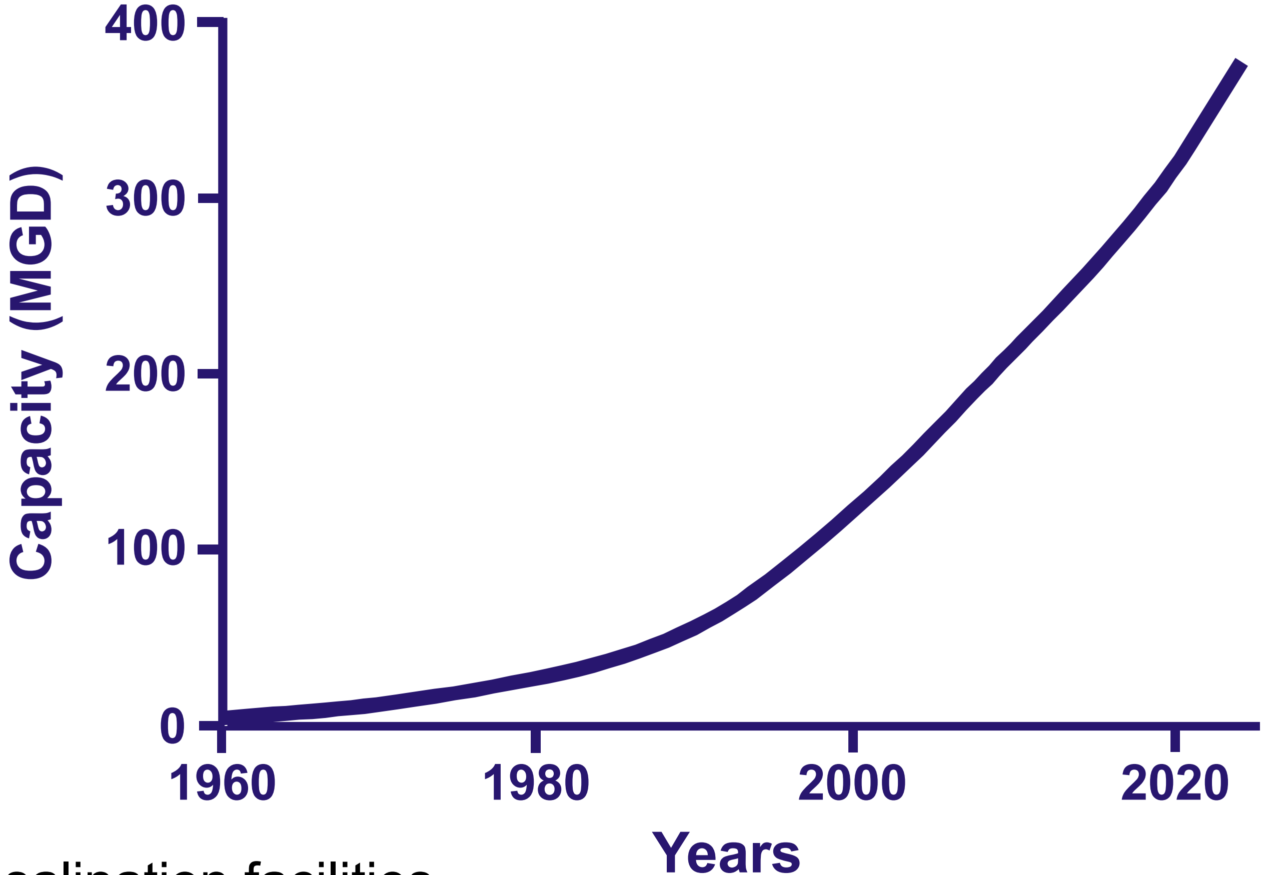
Brackish Water Desalination
Florida Capacities



- >140 desalination facilities
- >100 Brackish water facilities
- +/-515 MGD capacity

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Why brackish water RO in Florida

- Regulatory driven – additional fresh groundwater withdrawals are not permittable.
- Abundant brackish RO resources in southern part of state and along coasts.
- Deep injection is a viable disposal option in South Florida and west-central Florida.
- Reliable technology.
- Least expensive of large-scale AWS options.

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Desalination costs

Type	Cost (1970) (Per 1000 gal.)	Cost (Per 1000 gal.)*
Seawater (RO)	$8 - $12	$3.50 - $8.00 ($1/m^3 - $3.78)
Brackish Water	$2 - $4	$0.98 - $2.04

*Ghaffour et al. (2013)

Costs function of:
- System size (economies of scale)
- Raw water source
- Energy costs
- System specific issues (location, design, construction costs)
- Existing infrastructure

Energy requirements
BWRO: 1.5 to 2.5 KWh/1000 gallons
SWRO: 10 to 15 KWh/1000 gallons

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BWRO hydrogeology and regulatory constraints

Very competitive market. BWRO is entering realm of commodity engineering – cost rather than technology driven.

Feedwater

- Brackish groundwater resources are not unlimited.
  - Change in long-term water quality.
  - Competing uses of brackish aquifers (ASR).

Concentrate Disposal

- Economic concentrate disposal can be the key economic feasibility issue.
- Large plants – south and southwest part of state – deep well injection. Expensive, but economy of scale.
- Surface water discharges – likely not permittable.
- Small systems – wastewater blending, land application, zero-liquid discharge.
- Concentrate disposal a constraint for large-scale desalination in the central and northern part of the state.
- Deeper injection zone?

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Concentrate disposal in Florida

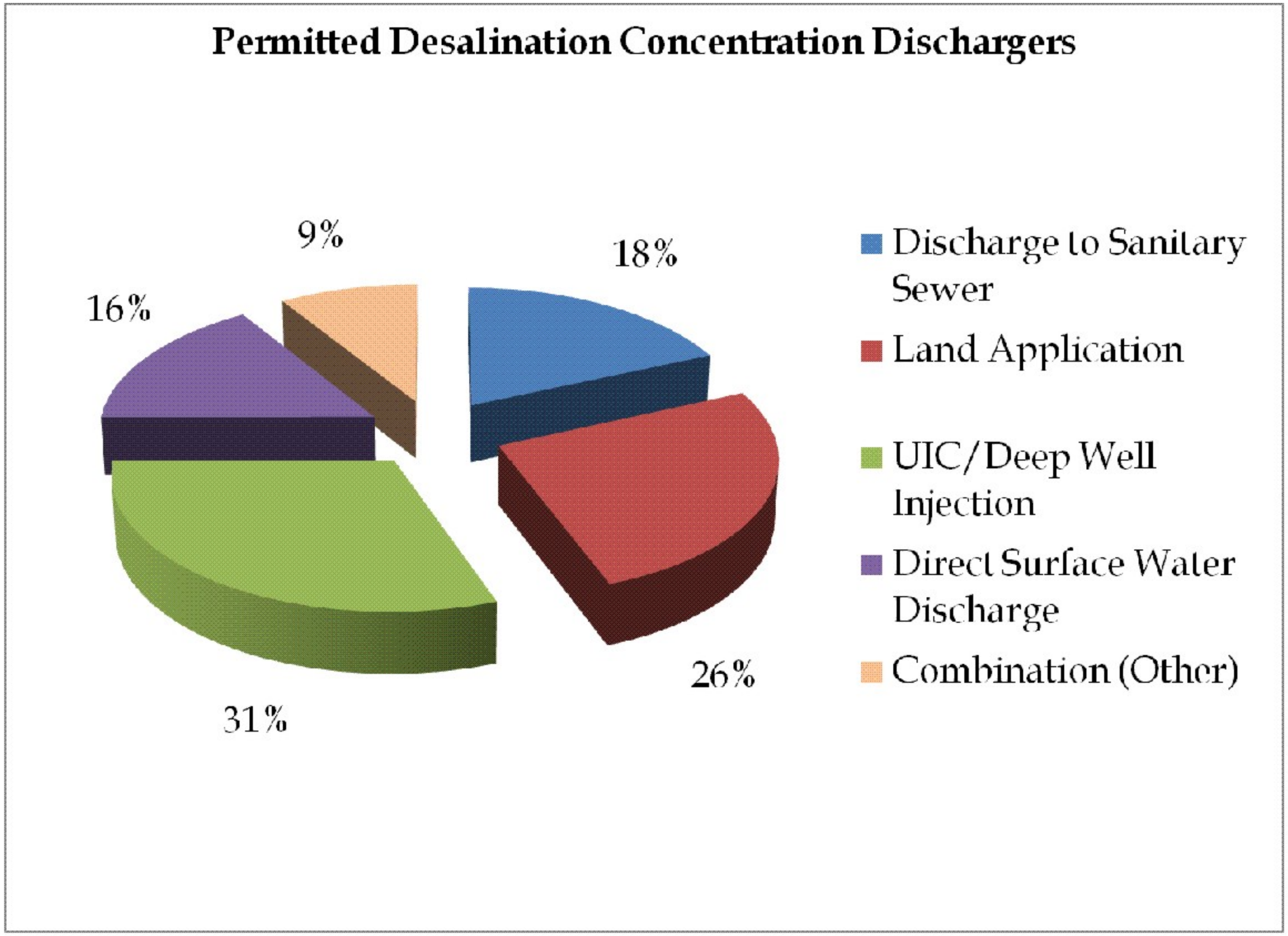

Figure 4-4. Desalination Concentrate Management Methods in Florida (FDEP, 2008a)

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Seawater desalination in Florida

- **One large facility (Tampa Bay); some small systems.**
- Technically viable and can provide unlimited supply of freshwater.
- Limitation: **Cost**. Energy intensive (50% of costs); carbon footprint.
- Environmental – open intakes cause impingement and entrainment of marine organisms – can be avoided with subsurface intakes.
- Will be option of last resort.

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Florida seawater desalination
Tampa Bay SW Desalination Facility

- Location: Apollo Beach, Hillsborough County
- Co-located at Tampa Bay Electric Big Bend Power Plant

- Design capacity: 25 Mgd
- Fully operational: 2008

- Total cost: $158 million ($85 from SWFWD)

- Water cost: $3.00 to $3.50/1,000 gal.

- Uses existing power plant intake and outfall
- Largest operational SW desalination plant in the United States.
- Current status: standby

Florida sweater desalination
Coquina Coast, Northeast Florida

- Initial plans
  - 10-15 MGD by 2020
  - 25-50 MGD by 2050

- Estimated water costs: $6.27 to $7.74 per 1,000 gallons (10-15 Mgd)
- Future water costs: $4.27 per 1,000 gallons

- Partners pulled out of project
- Demand growth has not occurred
- Project “on the shelf”

Public-Private Partnerships

- SB/HB-84: New (2013) law signed by Gov. Scott facilitates public-private partnerships for utility projects including:

  - Design-build
  - Design-build-operate
  - Design-build-finance-operate

  Could attract more interest in Florida desalination market by international private firms.

- Clarification of state support for these types of projects and removes some obstacles.
- South Miami Heights (DBO/DBOF)

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Desalination – current status

- Brackish water desalination will continued to be implemented as a cost effective alternative water supply.
  - plants need to be designed to accommodate changes in water quality over time.
- Seawater desalination – expensive option of last resort.
- Concentrate disposal still a constraint outside of south and west-central Florida
- Lull in activity – drop of rate of population growth reduced current needs. Many utilities have considered excess in WTP capacity.
- Regulatory “green light”
- Future – more PPP

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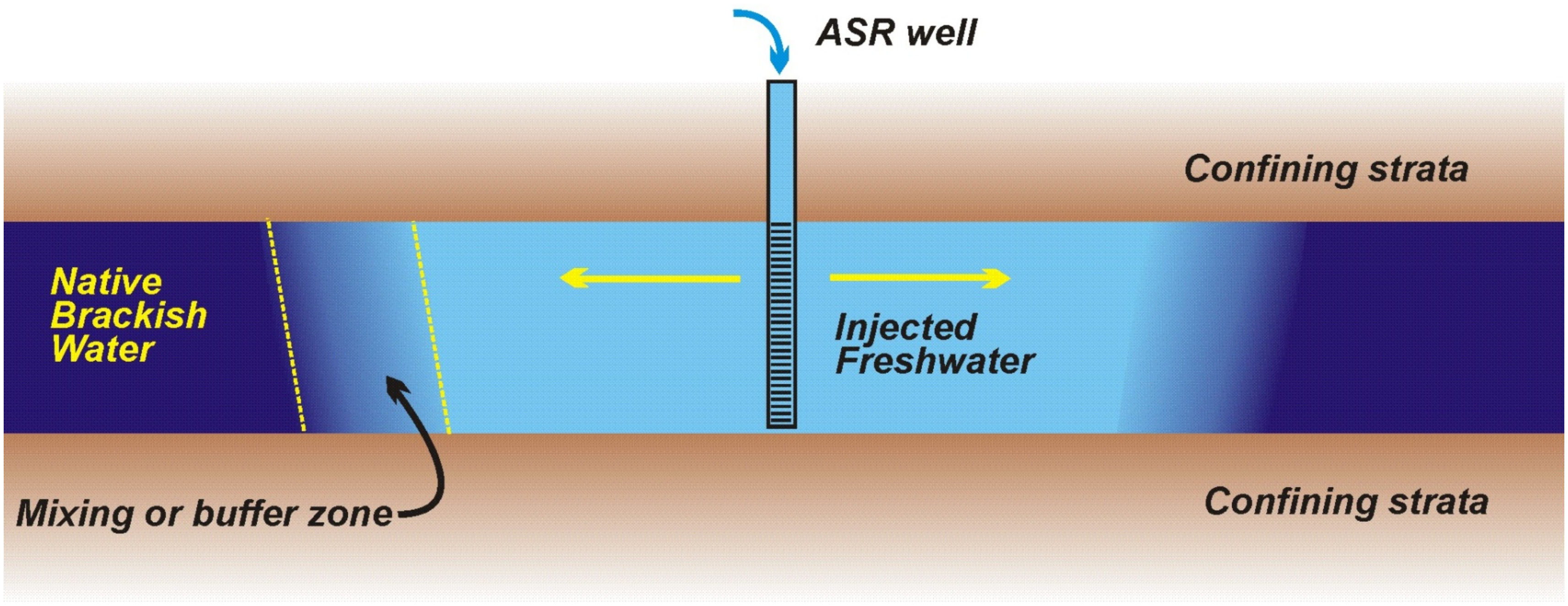
Aquifer storage and recovery (ASR)

- Underground storage of freshwater in aquifer using wells
- In Florida- freshwater is stored in an aquifer containing poorer-quality water



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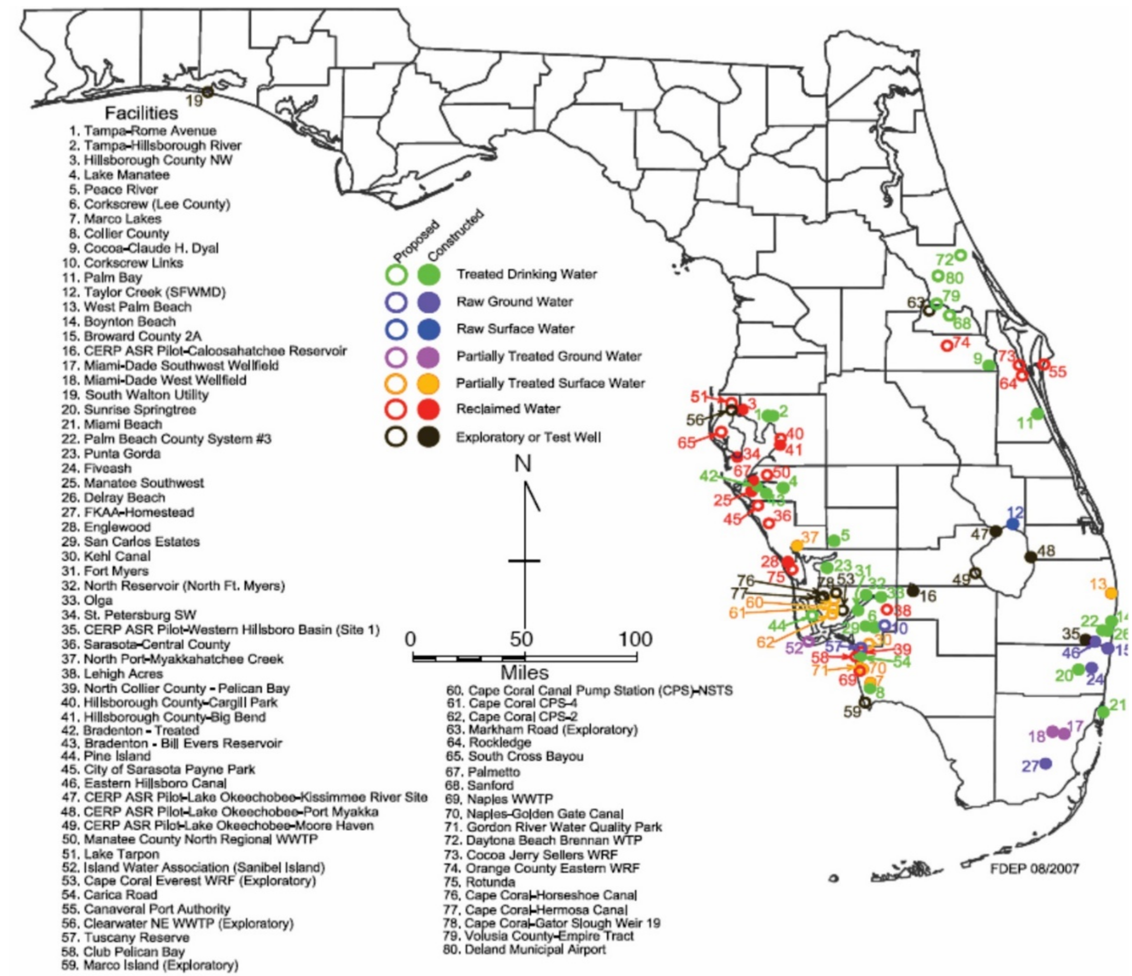
Numerous ASR systems are in various stages of development in Florida

Only a small percentage have progressed to an operation permit

- Poor results
- Arsenic leaching
- Not needed – developed other AWS (BWRO)



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ASR in Florida – Good news

- Florida's water supply and demand regime is high favorable for ASR – excess water during summer wet season and excess demand during dry season.

- Successful systems:
  - Peace River
  - Boynton Beach
  - Manatee Road (Collier County)
  - Marco Shores (Collier County)
  - Lake Manatee
  - Destin Water Users

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ASR in Florida – Bad news

- Mixed track record – many abandoned systems
- Poor implementation
  - Lack of technical sophistication
  - Failure to appreciate hydrogeological complexity
  - Technical approach = bare minimum FDEP requirements
  - Construct, inject, and hope for the best.

- Unforeseen conditions – arsenic and metals leaching

- Weak economic case – BWRO is more reliable and often less expensive

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Arsenic leaching

- Fluid-rock interactions releases arsenic and metals

- Regulatory violation if As > 0.010 mg/L MCL

- Status

- FDEP is working at finding a solution as it is recognized that ASR is important to state.

- Pre-treatment (dissolved oxygen removal)
- Zone of discharge (ZOD) – compliance point at boundary of area of institutional control (property boundary)
- Non-USDW storage zone.

Economics of ASR

- Economic benefits should exceed costs (positive NPV).
- Costs
  - Design and permitting
  - Construction
  - Operations & maintenance
  - Marginal cost of stored water
- Benefits
  - Marginal value of recovered water
  - Disposal costs avoided (reclaimed water ASR systems)
- Cost-benefit analysis should considered risks of under-performing system. Florida – CBAs have been biased in that a positive outcome is assumed (e.g., 100% recovery efficiency)

- **Economic case is strongest where**
  - Stored water is cheap (requires minimal additional treatment)
  - High value of recovered water (potable use)
  - Other sources of additional water are much more expensive
  - Secondary benefits are large (excess reclaimed water disposal)

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ASR Economics - subsidization

- Big picture: ASR makes very good water management sense as a tool for optimization of water management.

- Problem: May not be economically viable (Positive CBA) from perspective of owner (e.g., water utility)
  - Owner incurs costs but may not capture all benefits
  - Externalities

- State/Water management district (SB444) support has been critical for many projects.

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Most appropriate types of ASR in Florida

- Surface water for potable use. Capture seasonally available excess surface water for use when surface water supplies are limited.
  - Peace River
  - Marco Lakes

- Seasonal storage of potable water (peak shaving): less expensive than to construct seldom needed BWRO capacity
  - Manatee Road (Collier County)
  - Boynton Beach

- Reclaimed water – less expensive than disposal plus secondary supply benefits
  - Destin Water Users

Other managed aquifer recharge options in Florida

- Infiltration – planned and unplanned. Already widely practiced.

- Indirect potable reuse (aquifer recharge) using highly treated wastewater (tertiary treatment plus RO and AOP)
  - City of Clearwater
  - Miami-Dade County

- Coastal salinity barrier – climate change driver

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ASR – Future in Florida

- Slow growth – lack of enthusiasm among potential system owners.
- Will be pursued where it is the least cost AWS, objectively considering risk and reliability.
- Subsidies (grants) may be necessary to make it economically attractive – societal benefits may be greater than water and wastewater utility benefits.

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