Safe Drinking Water for Remote and Disadvantaged Communities

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Permanent Solutions to Providing Safe Potable/ Drinking Water to Remote and Disadvantaged Communities

Requirements for a permanent solution:

- Affordable capital cost
- Operation and maintenance (O&M) burden must be kept at a minimum
- Assurance of quality of drinking water
- Robust water supply
- Affordable water cost to residents
- Capacity for meeting future community growth
- Centralized monitoring, control and supervision of networked systems
- Community governance

* Significant time to plan, permit and deploy
* Small communities having smaller water systems are short on technical and managerial expertise

Cost Elements of Permanent Solutions to Providing Safe Potable Drinking Water to Remote and Disadvantaged Communities

Capital costs

- Planning
- Engineering
- Legal
- Permitting
- Community liaison/engagement
- System capital cost
- Construction
- Deployment/commissioning

Operation & maintenance (OPEX)

- Operation
  - Supervision (system operator)
  - Monitoring
  - Emergency response
  - Compliance (monitoring and reporting)
- Maintenance
  - Water system operator
  - Repairs (labor & components); routine and emergency maintenance/repairs

Admin Costs

- Community governance
- Information dissemination/transparency

Water Pricing

New Water Well

Search and locate a clean (uncontaminated) water source for a new community well

- No a priori assurance that the new well water will be of the desired quality over the short or long-long term
- Drilling a new well is costly (variable cost depending on well depth)
- May need to identify and secure rights to offsite well
  - Water line easement
  - Cost of installation of conveyance piping
  - Water pricing imposed by well owner and/or water system operator

Physical Consolidation/ Annexation of Water Systems

Physical consolidation and annexation of the community water system with a neighboring community water system that has a suitable source of drinking water or onsite treatment

- Physical consolidation may involve a high capital cost (~$1M or higher per 1 mile of pipe according to current estimates) in addition to any additional capital investment required for community water system infrastructure upgrade.
- Infeasible option if the affected community is far from a willing neighboring community with sufficient safe drinking water resource capacity.
- Agreements/negotiations may be complex and lengthy
- Uncertainty regarding operational & maintenance costs and prospects of increased water rate after consolidation
- Water pricing is not under the control of the small community.

Water Treatment at the Point-of-Use (POU)

(e.g., under the sink)

POU Issues:

- POU devices typically treat only a portion of the entering water stream for drinking
- No assurance that residents will be vigilant about only using POU treated water for drinking
- Grab sampling monitoring frequency is insufficient to ensure continuous supply of safe drinking water
- Current online monitors for contaminants of concern are costly
- Cost prohibitive for online sensors at every residential POU treatment system
- Lack of infrastructure for monitoring and maintenance of distributed treatment systems

A reliable and affordable Wellhead/POE water treatment for supplying safe drinking water to disadvantaged communities (DACs) where consolidation or alternate local well(s) are infeasible/impractical.

Issues:

- The operation of water treatment systems must be affordable
- Number of "customers" may be insufficient to absorb the cost of water treatment
- DACs do not have the expertise to operate water treatment facilities

Approach: "Virtual Consolidation"

- Multiple water treatment systems in multiple communities that are geographically separate but virtually networked (autonomous but remotely monitored/operated)
- Multiple wellhead water treatment systems that are operated remotely (but centrally) to provide economies of scale leading to affordable operating costs.
- Local operator for required onsite emergency/routine maintenance

Distributed Wellhead/Point-of-Entry (POE) Water Treatment Systems

DACs are Likely to be Suitable Candidates for Wellead/ POE Water Treatment If:

Physical consolidation is infeasible at the present time and for the near or foreseeable future

State Board, Regional Board and County are proactive in supporting solutions for DACs

DACs are willing communities

Residual water discharge to septic tank is allowed via permit or permit waiver to DACs were the potential for environmental impact is de minimis

DACs can contribute to ancillary onsite infrastructure upgrade or obtain State capital grants for this purpose

Availability of permanent satellite water treatment operator

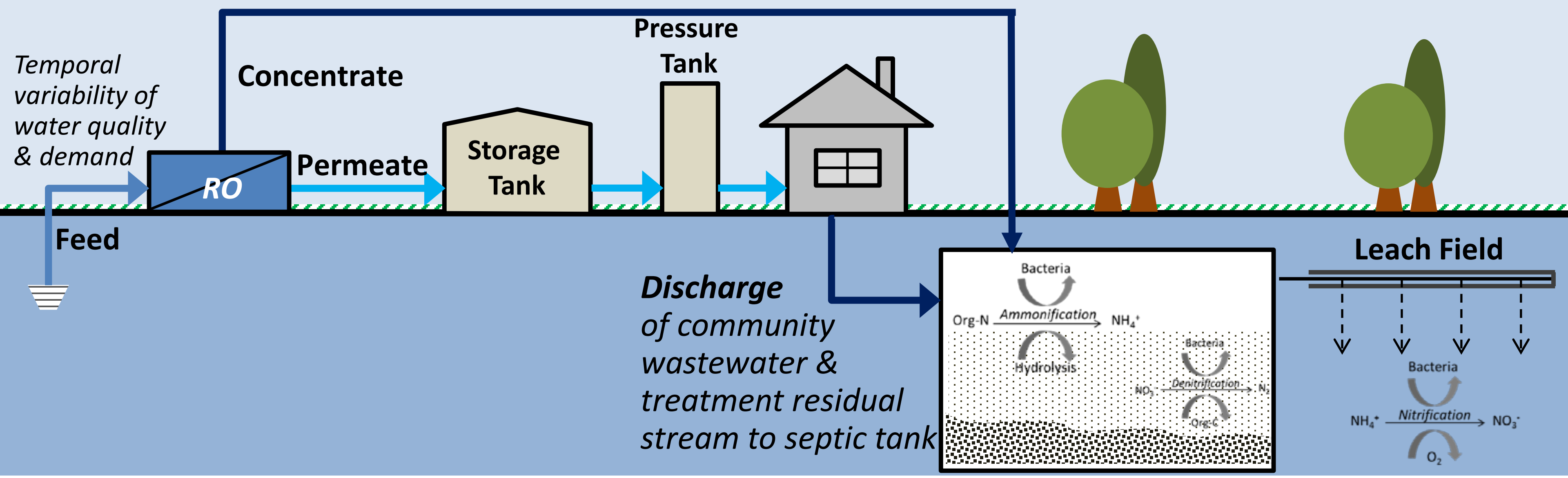
Nitrate Removal from Impaired Groundwater via Membrane Treatment

Treatment system design and operational attributes:

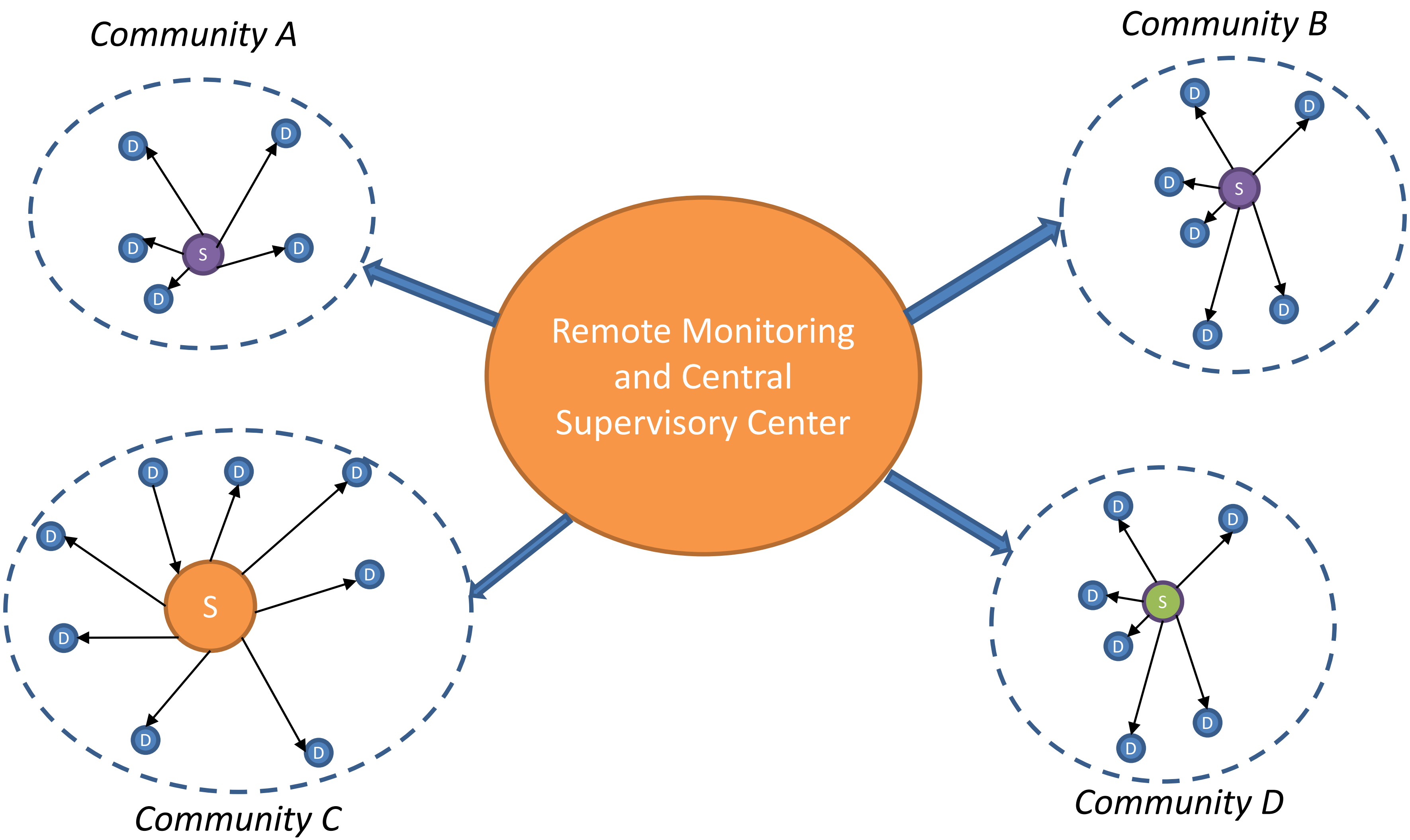
- ❑ Satisfy water quality requirements
- ❑ High recovery operation
- ❑ Self-adaptive operation
- ❑ Remotely monitored/controlled

Water treatment system includes:

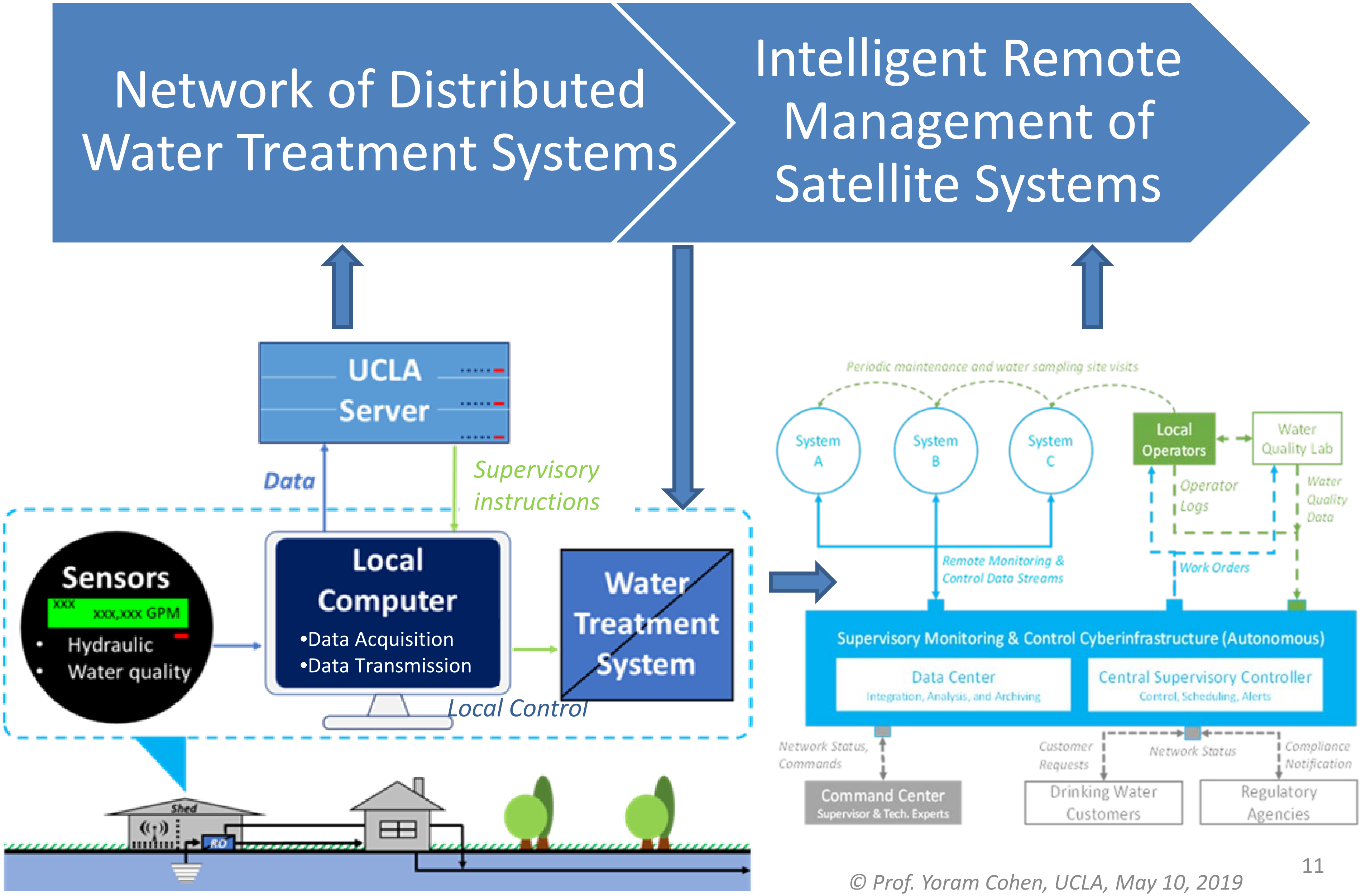
- Membrane unit
- Pre-/Post-treatment
- Product water and feedwater storage tanks
- Residuals storage tank & beneficial reuse
- Local and remote monitoring/control/management
- Emergency plan
- Web-accessible information/data



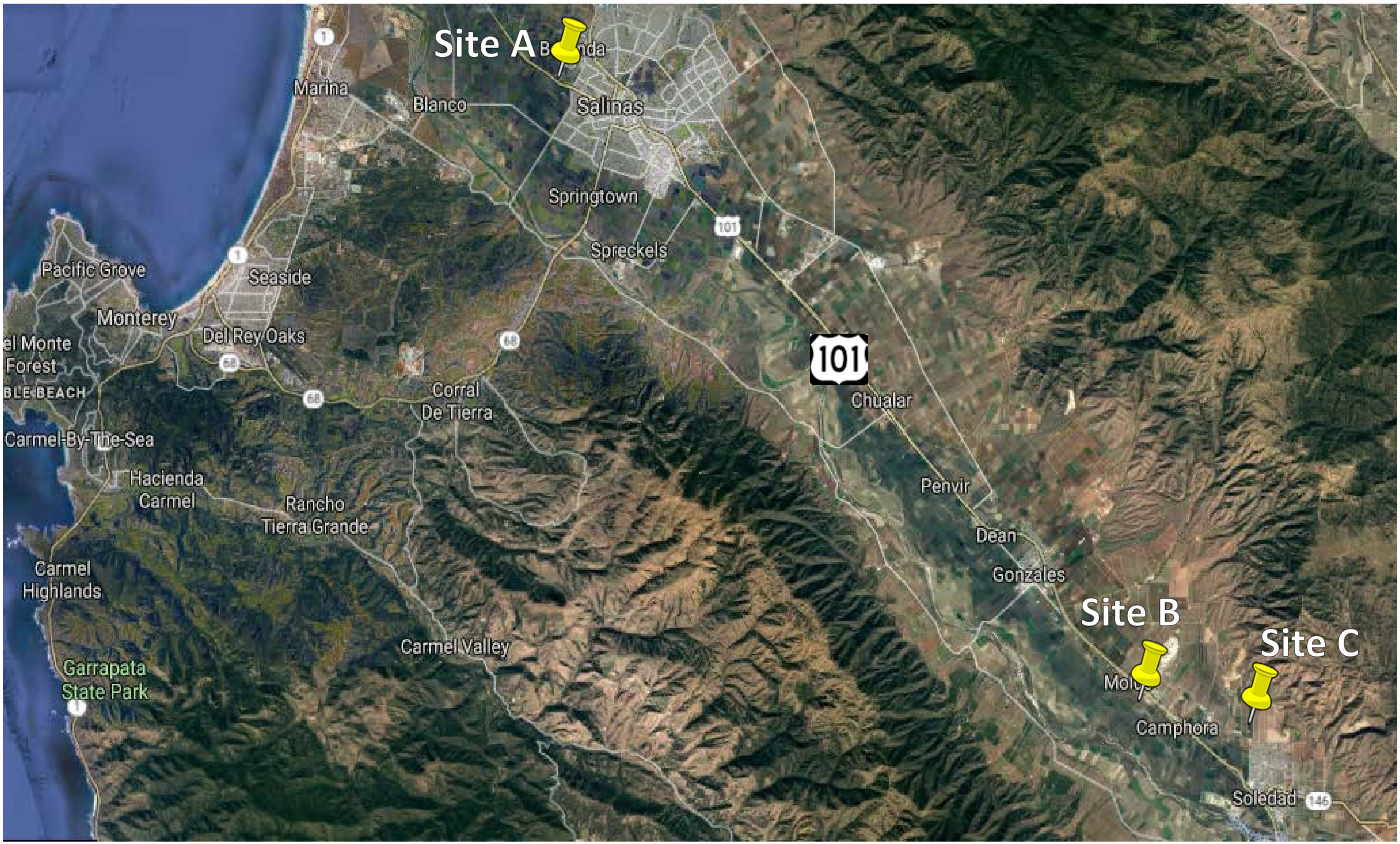
Network of Distributed Water Treatment Systems



Virtual Consolidation



The Salinas Valley Pilot Communities



Site Investigation: Community Groundwater Quality

	Well Source Water		
	Site A	**Site B**	**Site C**
Turbidity (NTU)	0.15	0.15	3.2
Total dissolved solids (mg/L)	1126 - 1500	1091- 2020	554 - 594
Nitrate (mg/L as N^-)	26.4 – 39.6	20.2 – 21.3	10.1 – 10.8
pH	7.3	7.6	7.4
	Tap Water [a]		
	Site A	**Site B**	**Site C**
Lead (µg/L)	ND	ND	ND
Copper (µg/L)	75.1	624	21.8

[a] kitchen tap water was collected based on the "Lead and Copper Rule"

Pilot Project: Distributed membrane-based water treatment in disadvantaged communities

Community	No. Single Family Units	Population	Ave/Max Water Consumption (gal/day)	Proximity to nearest centralized water delivery and sewer infrastructure (km)	Septic Tank Capacity, Gallons (Retention time, days
Site A	11	16	1013/1996	2.2 km[a]	4,500 (2.3 - 4.44)
Site B	8	36	2520/3597	4.4 km[b]	5,000 (1.4 – 2)
Site C	10	34	1246/2826	4.1 km[b]	5,000 (1.8 -4)

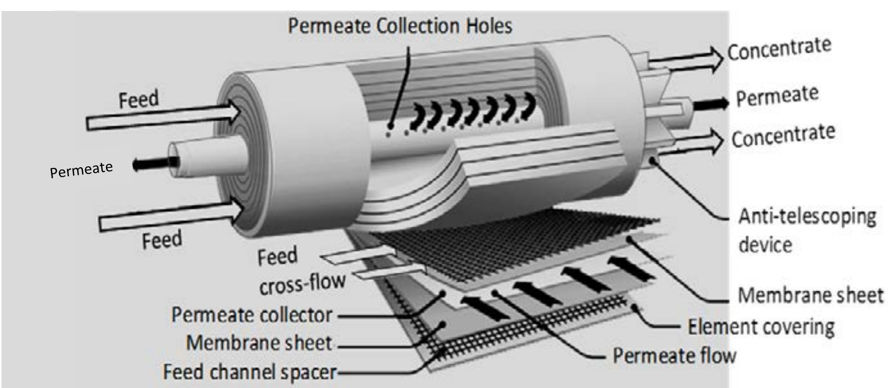
[a] distance from nearest Water treatment plant, and [b] distance from Soledad sewage treatment plant.

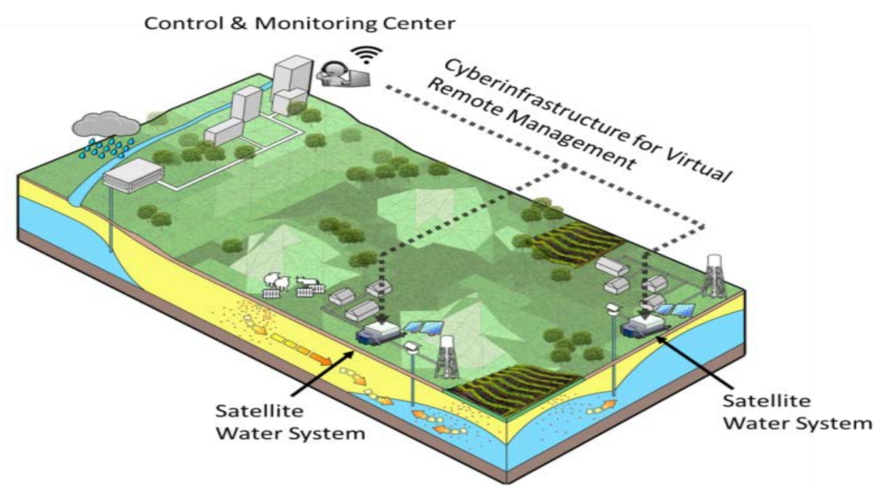
New Paradigm: Distributed Membrane-Based Water Treatment Systems

RO Membrane Treatment technology is suitable for upgrading well water serving remote communities:

- Operational Simplicity
- Small foot print
- Removal of multiple contaminants (e.g., Nitrate, Cr(VI), etc.)
- Salinity reduction
- Compliance with water quality requirements (< MCL) at high recovery operation
- Suitable for self-adaptive/autonomous operation

Spiral-wound Reverse Osmosis Membrane



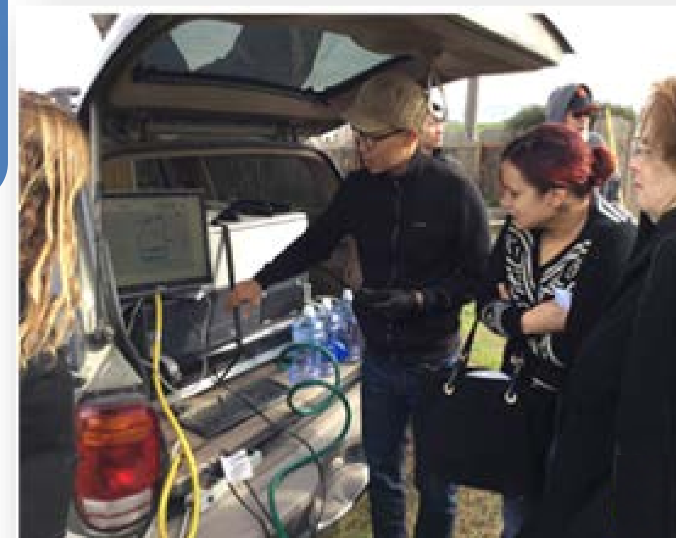


Distributed Water Treatment Systems

Onsite Testing of Nitrate Removal for Design and for other pollutants

Significant community outreach activities have been ongoing since the beginning of the project with the objectives of:

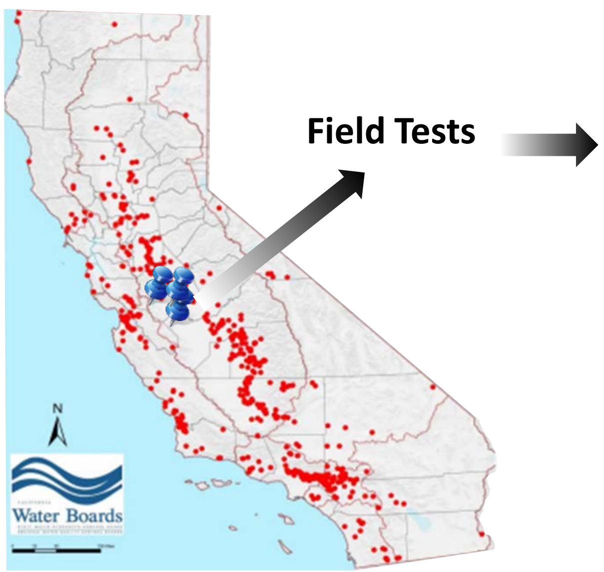
- Informing the residents of the basic treatment technology
- Demonstrating the water treatment technology
- Respond to questions by the residents
- Coordinate scheduling of site visits to carry out various elements of the project work
- Informing the residents and owners regarding the project status project along its various stages

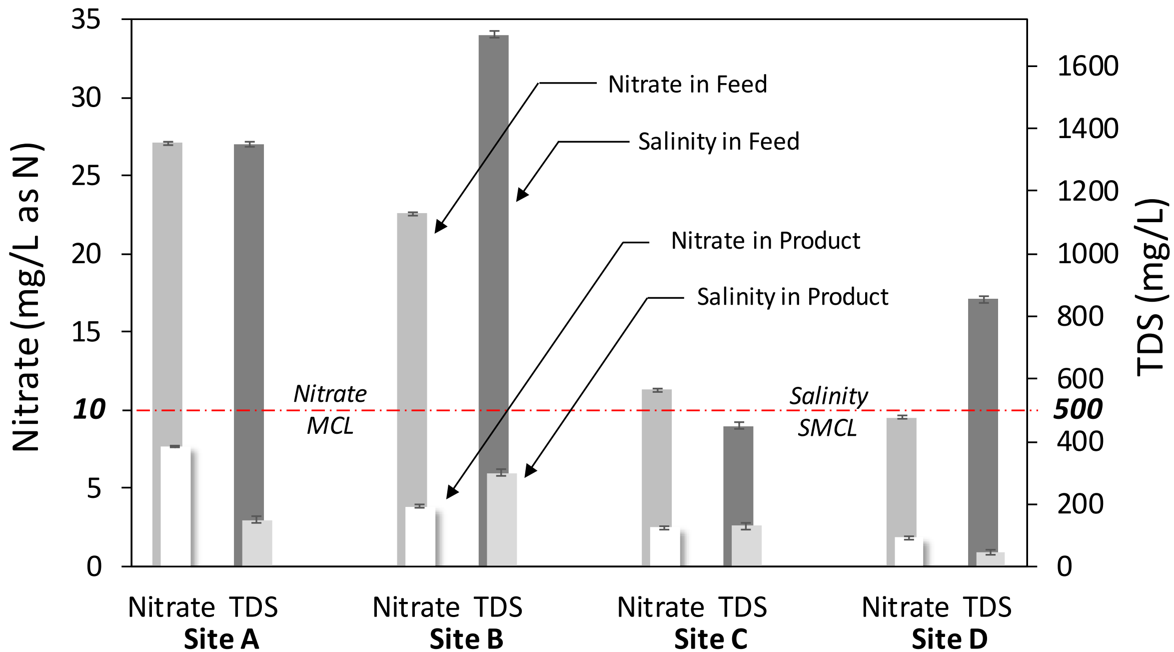


Smart Water Meter installed at Santa Teresa

Community Source Water Purification and Salinity reduction

- High Recovery (90%) RO Operation enabling nitrate removal and salinity reduction to significantly below the MCL and SMCL, respectively.





Parameter	Regulation
Nitrate (MCL)	*10 mg/L as N*
Salinity(guideline) [1]	*≤ 500 mg/L TDS*

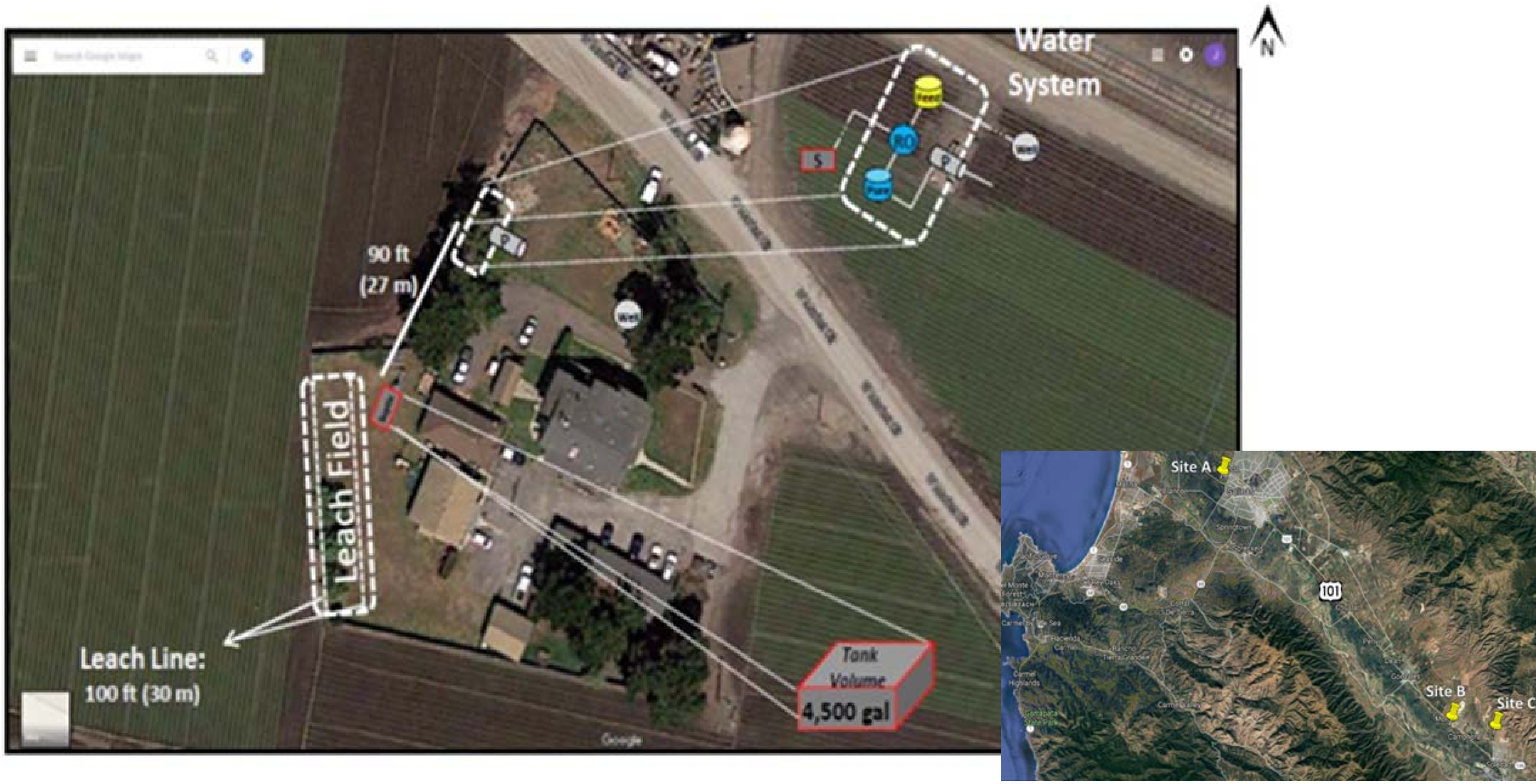
* USEPA: https://www.epa.gov/dwregdev/drinking-water-regulations-and-contaminants#SecondaryList

Site A

Existing Unit	Planned Unit
Well	RO
Pressure Tank	Feed Tank
Septic Tank	Product Water Tank

Straight Lines: Aerial distance between shown units

Dotted Lines: Water system site / Leach field



<u>Note:</u> Source water, treatment system product water & residual streams monitored as per established detailed regulatory monitoring plans regarding handling of residuals and water treatment operation.

Major stages/cost elements in the development & deployment of membrane-based water treatment of impaired groundwater:

- Obtain permit/authorization for handling of treatment residuals
- Obtain permit for treatment system design and operation
- Establish compliance mandated monitoring program
- Obtain permit for site infrastructure upgrade to accommodate treatment system
- Construct/procure treatment system
- Perform site infrastructure upgrade
- Treatment system commissioning
- Permitting of treatment system for delivery of drinking water
- Operation of water treatment system

Major Cost Elements:
Implementation of a membrane-based water treatment of impaired community well water

Cost Tracking:

- Planning
- Design
- Permitting
- Capital cost
  - Treatment unit(s)
  - Site infrastructure upgrade
- Operating costs
  - Remote monitoring/supervision
  - Local operator (as needed)
  - Regulatory compliance (water quality, residuals & system operation)
  - Communications
  - Community outreach
  - Emergency response
- Maintenance
  - Routine maintenance
  - Repairs (labor and replacement parts)

Distributed Water Treatment Systems: Economies of Scale

Economies of scale benefits are afforded by:

- Reduced capital cost due to standardization treatment system design and manufacture
- Virtual network of geographically separated water treatment systems:
  - Autonomous water system operation
  - Centralized remote monitoring and supervisory control of networked water treatment systems
  - Intelligent fault detection and scheduling of system maintenance
- All systems having the same level of expert supervision/operation

CLOSURE

The technology for treatment of impaired groundwater (nitrate removal and salinity reduction) has been demonstrated both in the lab and in the field

Treatment systems for deployment in multiple pilot communities are now under construction

Approval received for management of treatment residual stream, along with a mandated monitoring program

A major goal of the solution under evaluation is to demonstrate annual O&M costs per household that are at or below 1.5% of the median household income

Questions?