SB X 2-1

Nitrate in Groundwater in the Salinas Valley

Preparation for a Report to the Legislature

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- **Proposition 84 / SB X 2-1 => CDPH => SWRCB**

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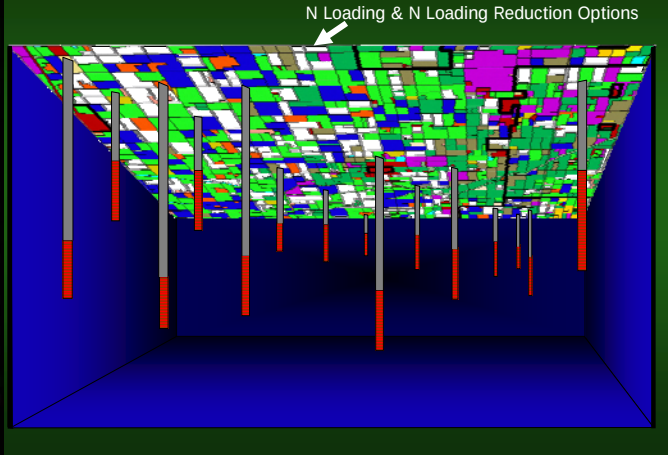
- ...many undergraduate students....

Motivation

- Nitrate most common groundwater pollutant
- Tulare Lake Basin and Salinas Valley among most affected groundwater basins in CA
- Domestic well water typically untreated / unknown quality
- High nitrate costly to treat for small / disadvantaged communities

How can this be best fixed?

Key Study Outcomes



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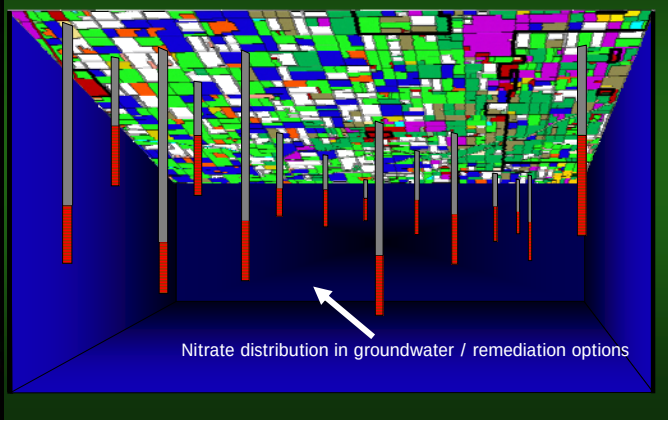

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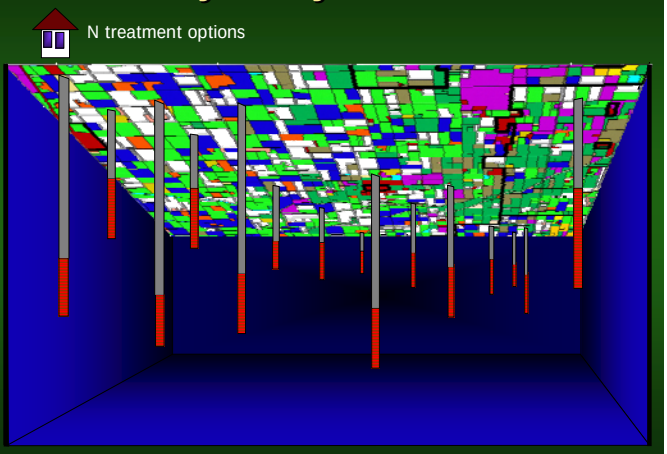

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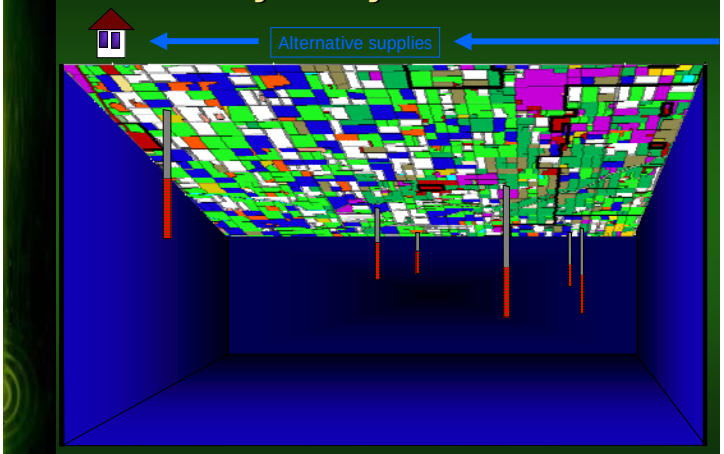

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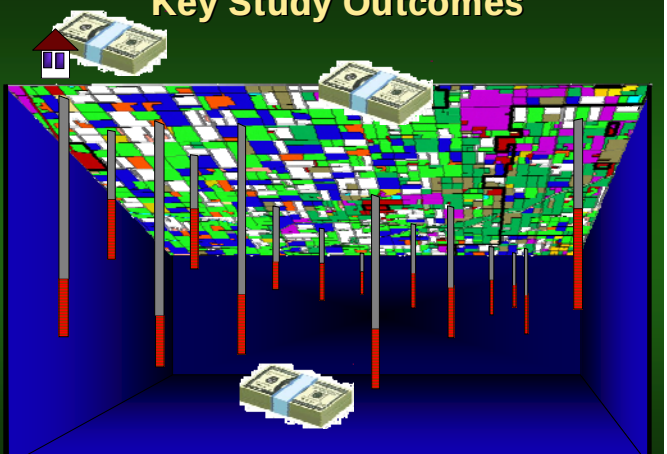

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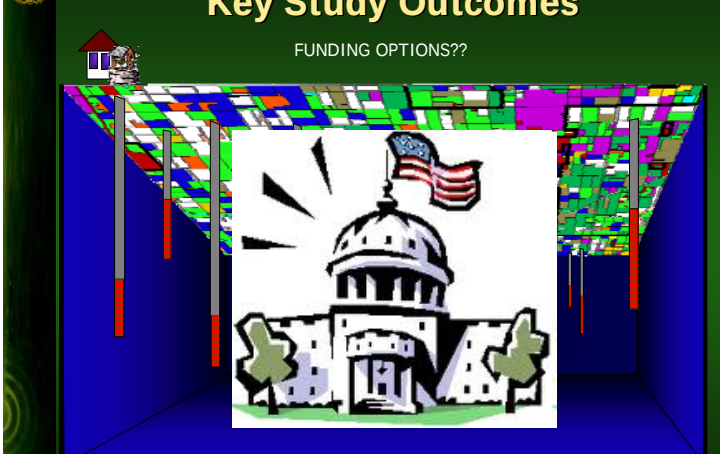
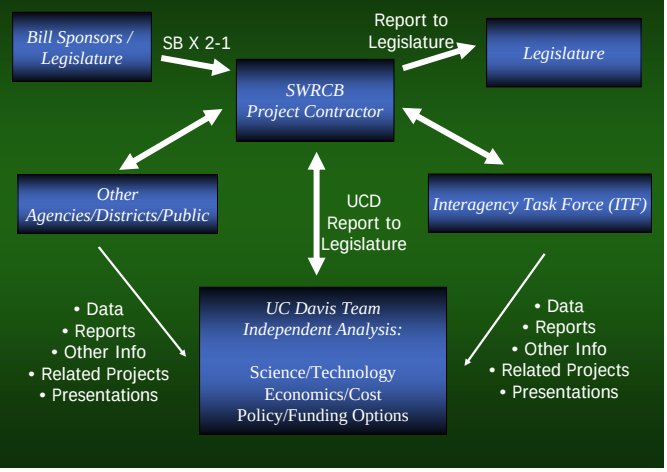


UC Davis Role



Timeline

- Data collection and analysis – 1st Quarter 2011
- Economic and policy analysis – 2nd Quarter 2011
  - **2nd ITF Meeting – May 2011**
- Draft report – September 2011
  - **3rd ITF Meeting – October 2011**
- Final report – December 2011
- SWRCB Report to Legislature – April 2012
- Directed follow-up studies – April 2013

Project Area

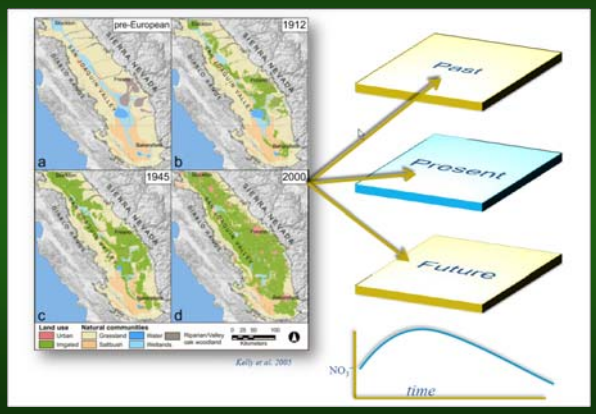
- nearly 4 million acres of cropland and pasture (1.5 million ha)

Conceptual Approaches and Expected Outcomes

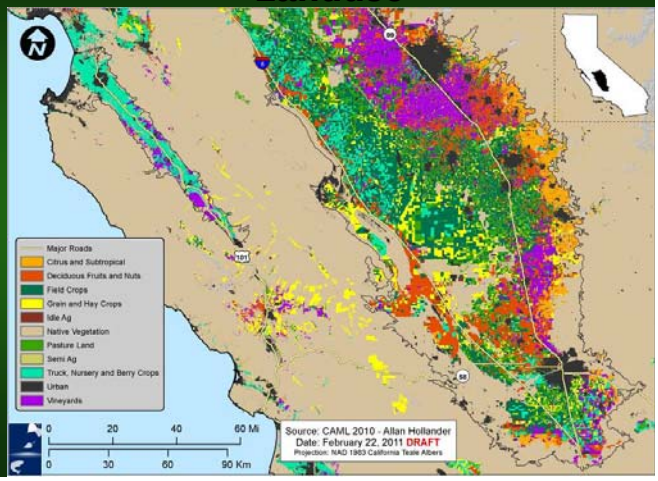
Nitrate Loading: Significant Sources of Nitrate

- Irrigated cropland
- Livestock manure (ponds, corrals, fields)
- Food and milk processing waste discharges
- Municipal wastewater discharges
- Golf courses and other fertilized urban landscapes
- Septic tanks
- Nursery operations
- Geologic nitrogen

Historic, Current, and Future Landuse => Inform Current and Future GW NO3



Landuse



Nitrogen Losses to Groundwater Basic Example: Lettuce

- Total irrigation: 14 inches
- Crop ET: 8 inches
  - => **leaching loss: 6 inches water**
- Soil test: 20 ppm of NO3-N ~ 80 mg/L
  - => 80 mg/L in 6 inches leaching water: **110 lbs N**
- Drinking water limit: 10 mg/L

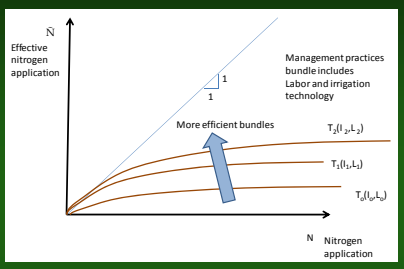
DOES IT MATTER?

- 2.5 crops/year = 12-18 inches of recharge
  - => **approximately half of all groundwater recharge in the Salinas Valley**
  - => **at >5-10x drinking water limit**

Ag N Source Reduction Strategies

System		Strategy	How well documented	Expert consensus	Extent of current usage	Barriers to further adoption
1	Vegetables, strawberries	e.g., "increase irrigation efficiency"	Review of technical lit	Convene panels – (grower, industry, extension,researcher) – to debate feasibility	Expert panel and published survey data	•Costs (capital, labor, opportunity) • Regulatory • Technology • Information • Risk perception
2	Trees and vines					
3	Field crops – non-manured					
4	Field crops-manured					
5	Rice					
6	Confined livestock and poultry					
7	Livestock on pasture					
8	Urban landscaping					

Cost of Effective Crop N Management



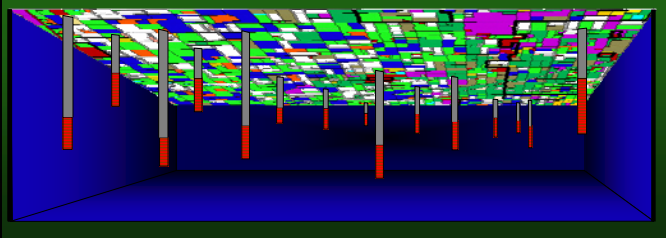
- Nitrogen source reductions involve management practices
- Improved irrigation technology may lead to reduced nitrogen leaching
- Capital and other investments in nitrogen application practices may increase effective nitrogen application

Groundwater Nitrate: Conceptual Overview

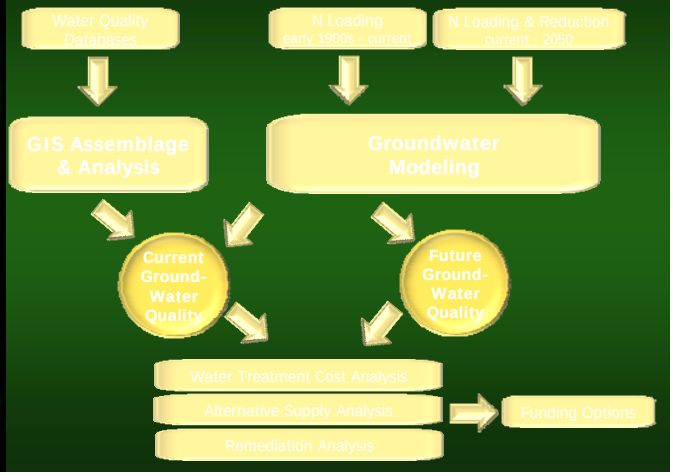
"Who currently has a nitrate problem?"

"Where else do we currently have nitrate problems, but don't know about it?"

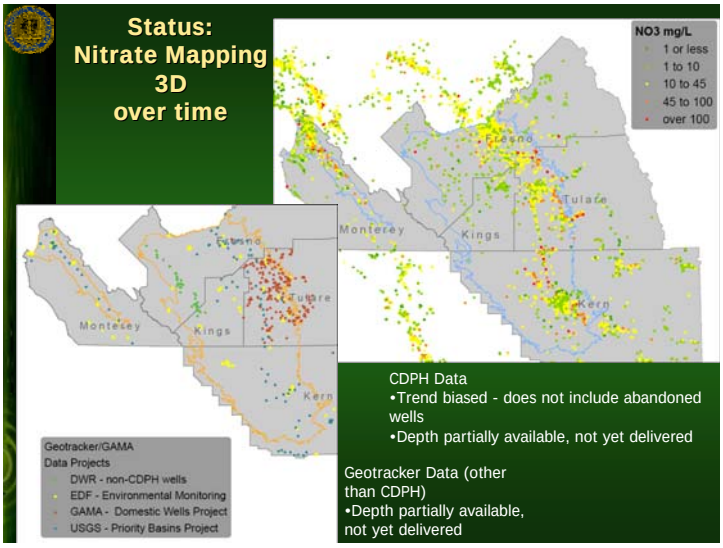
"What will the nitrate problem be in the future (2050)?"



Approach



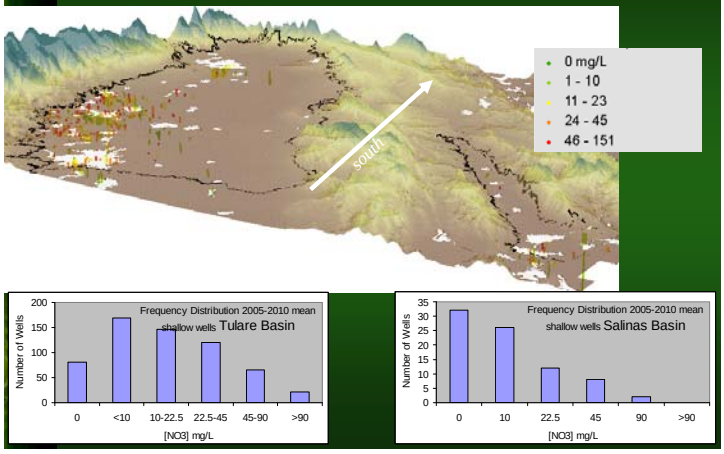
Status: Nitrate Mapping 3D over time



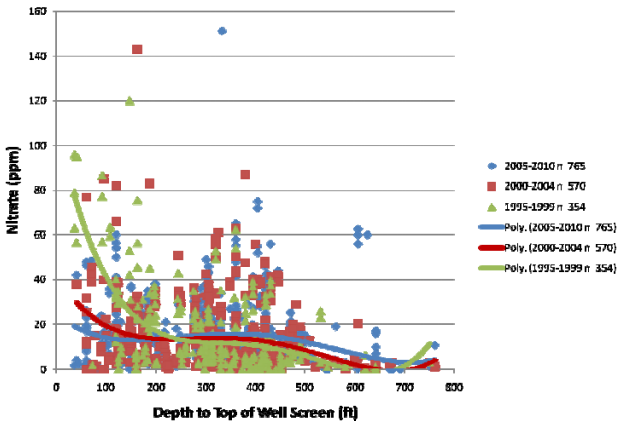
CDPH Data
- Trend biased - does not include abandoned wells
- Depth partially available, not yet delivered

Geotracker Data (other than CDPH)
- Depth partially available, not yet delivered

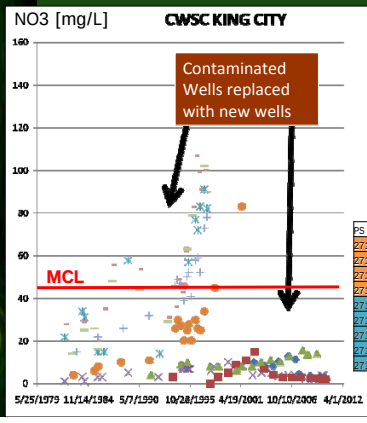
2005 - 2010 Shallow Wells



Salinas Valley - all wells, all areas.
Nitrate Concentration and Top of first Perforation



Bias Toward Clean Wells Due to Abandonment?

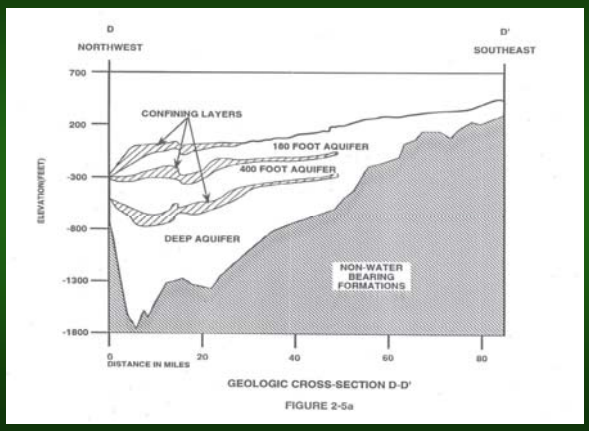


Newer wells in this figure are screened at similar intervals to the contaminated wells

PS CODE	ptop(m)	pbottom(m)	pbot-ptop (m)	Max Finding (ppm)
2710009-012	55.4736	70.7136	15.24	13
2710009-008	38.1	60.96	22.86	15
2710009-007	54.864	85.344	30.48	15.574
2710009-006	39.624	61.5696	21.9456	10
2710009-005	28.0416	63.0936	35.052	91
2710009-004	57.3024	68.2752	10.9728	83
2710009-003	49.6824	59.1312	9.4488	143
2710009-002	12.192	35.052	22.86	107
2710009-001	10.9728	33.8328	22.86	102

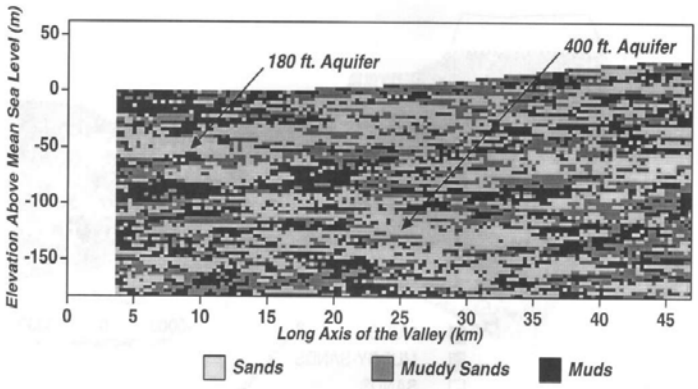
Simplified representation of Salinas Valley hydrogeology

Image from Montgomery Watson Final Report – Salinas Valley IGSM (1997)

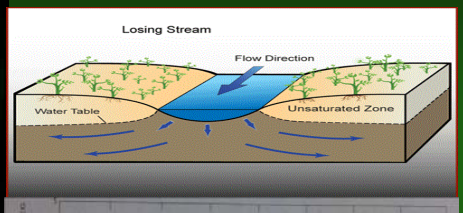


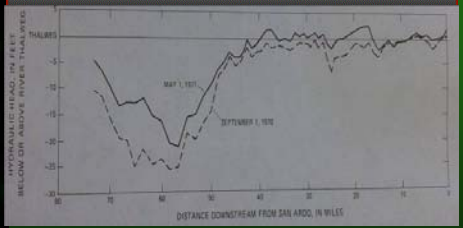
Realization of Subsurface Heterogeneity.

Image from Fogg, et al (1999)



Stream Recharge





River thalweg 1970 water Year. USGS Salinas Model – Durbin, et al. (1978)

- Salinas River is losing most of the year, for most of its length.
- Salinas River contributes more than half of total annual recharge.

Water Budget

Montgomery Watson Final Report – Salinas Valley IGSM (1997)

Average Annual Water Budget (1970-1994)

(Values in 1000 Acre-feet)

Boundary Flow	+38
Salt Water Intrusion	-15
Deep Percolation (rain + applied water)	+189
Stream Recharge	+263
Groundwater Pumping	-519
Average Annual Loss of Fresh Groundwater	-44

Predicting Nitrate in Wells

Fraction of Young Water = Fraction of Contaminated Water

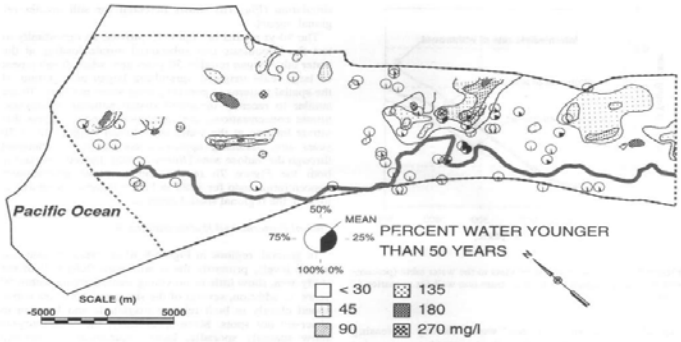
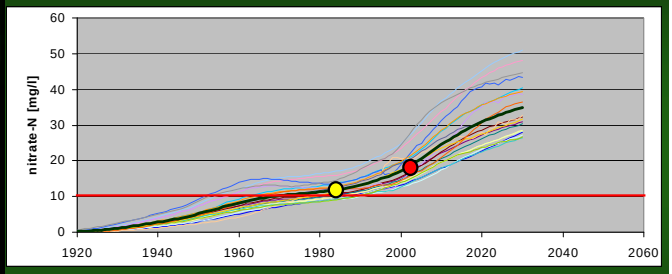


Figure 9. Transport simulation results (scenario 1) comparing average percent water younger than 50 years in withdrawals from approximately 55-m (180-ft) depth, corrected for induced infiltration from Salinas River, and observations of nitrate concentrations for 1988 from *Snow et al.* [1988].

Groundwater Modeling: Temporal Trends Across Groups of Wells



Input/Driver:
N Loading in individual well's source area over time

Treatment Options - Approach

Literature Review
Design and cost considerations
Case studies - Full scale systems
Pilot studies - Emerging technologies

Water Quality Data
Assess nitrate occurrence
Locate potable water systems
Characterize water quality
WQM and PICME databases

Survey
Survey of water systems
Applied treatment in project area
Cost information

GOAL

Nitrate treatment recommendations with consideration of water quality, system size, feasibility and cost

Examples of Treatment Options

Ion Exchange

Source: Siemens

Finding the best treatment option for nitrate removal from potable water

Chemical Denitrification

Source: Hepure Technologies

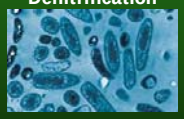
Reverse Osmosis

Source: Dow Chemical

Electrodialysis

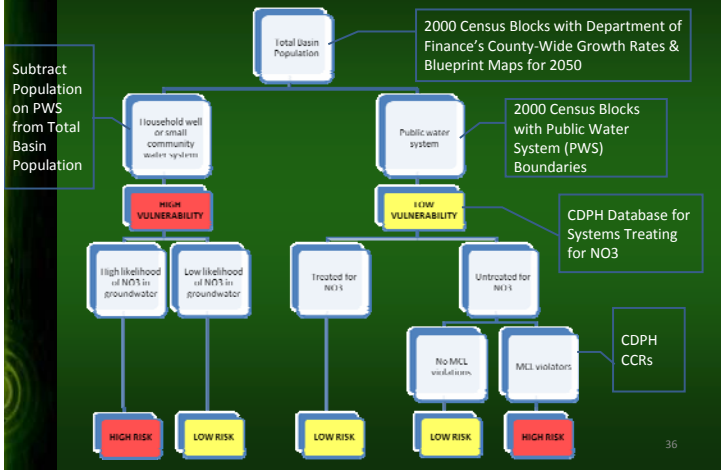
Source: PC Cell

Biological Denitrification

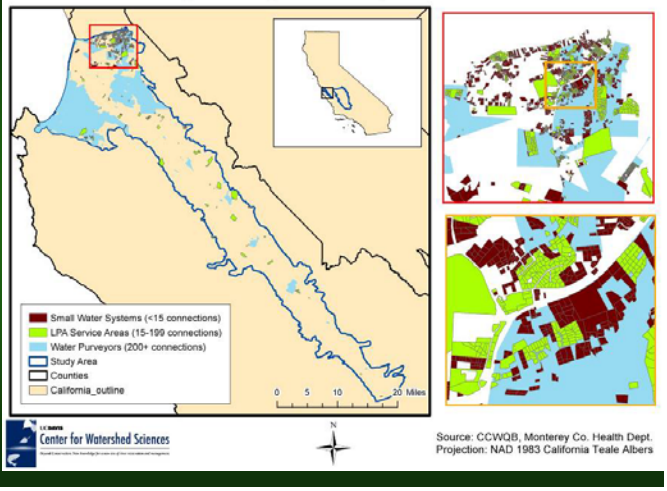


Source: AnoxKaldnes

Estimating the Susceptible Population

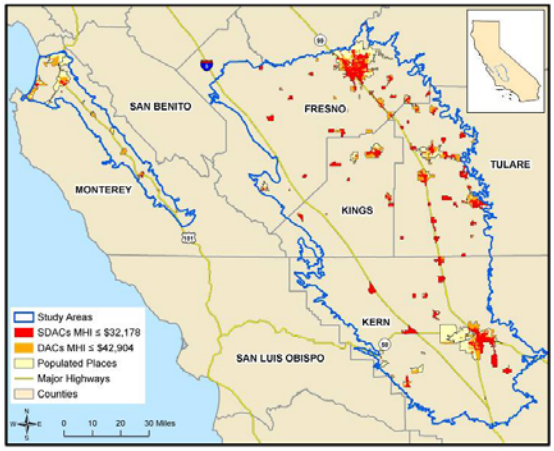


Monterey County Water System Boundaries



Source: CCWQB, Monterey Co. Health Dept.
Projection: NAD 1983 California Teale Albers

Severely Disadvantaged Communities (SDACs) within Urban and Unincorporated Areas (CDPs)



Alternative Water Supply Options

- **Improve Existing Source**
  - Blending [+ Well Water Quality Testing]
  - Drill Deeper Well [+ Well Water Quality Testing]
  - Community Treatment
  - Household Treatment [+ Dual System]
- **Alternative Supplies**
  - Piped Connection to a Better System
    - Existing system
    - New system
    - Regionalization and Consolidation
  - Trucked Water [+ Dual System]
  - Bottled Water
- **Relocate Households**
- **Ancillary Activities**
  - Well Water Quality Testing
  - Dual System

Related Prior / Ongoing Studies

- Nitrate Report to Legislature, 1988
  - Identify nitrate sensitive areas / priority areas for nitrate control programs
  - Establish nitrate management programs / develop best management practices
  - Establish research & demonstration projects on nitrate control (irrigation, fertilizer, manure)
- LLNL Nitrate Report to SWRCB, 2002
  - Current state of approaches to assess nitrate in groundwater
  - Recommendation for improved characterization & assessment (sources, gw age, gw quality)
- USGS National Nitrate Vulnerability Assessment, 2002
- Drinking Water Source Assessment Program, 2003
- Nitrate Hazard Index, 2005
- CV SALTS pilot projects, ongoing
- GAMA, ongoing
  - Statewide asssessment of public sources (USGS)
  - Tulare County domestic well survey (SWRCB)
  - Special projects (LLNL)
- UC Davis work on groundwater nitrate (Salinas Valley, CV dairies)
- UC Davis Ag Sustainability Institute: CA Nitrogen Assessment
- ITF and Other Agency Databases / Reports / Studies

integrate into SB X 2-1 report

Related Policy Activities

- Central Valley Dairy General Order
- Central Valley Irrigated Lands Regulatory Program (CV ILRP)
- Central Valley Salt & Nitrate Basin Plan Amendment (CV SALTS)
- Central Coast Agricultural Order Renewal

Guidance from SB X 2-1 report