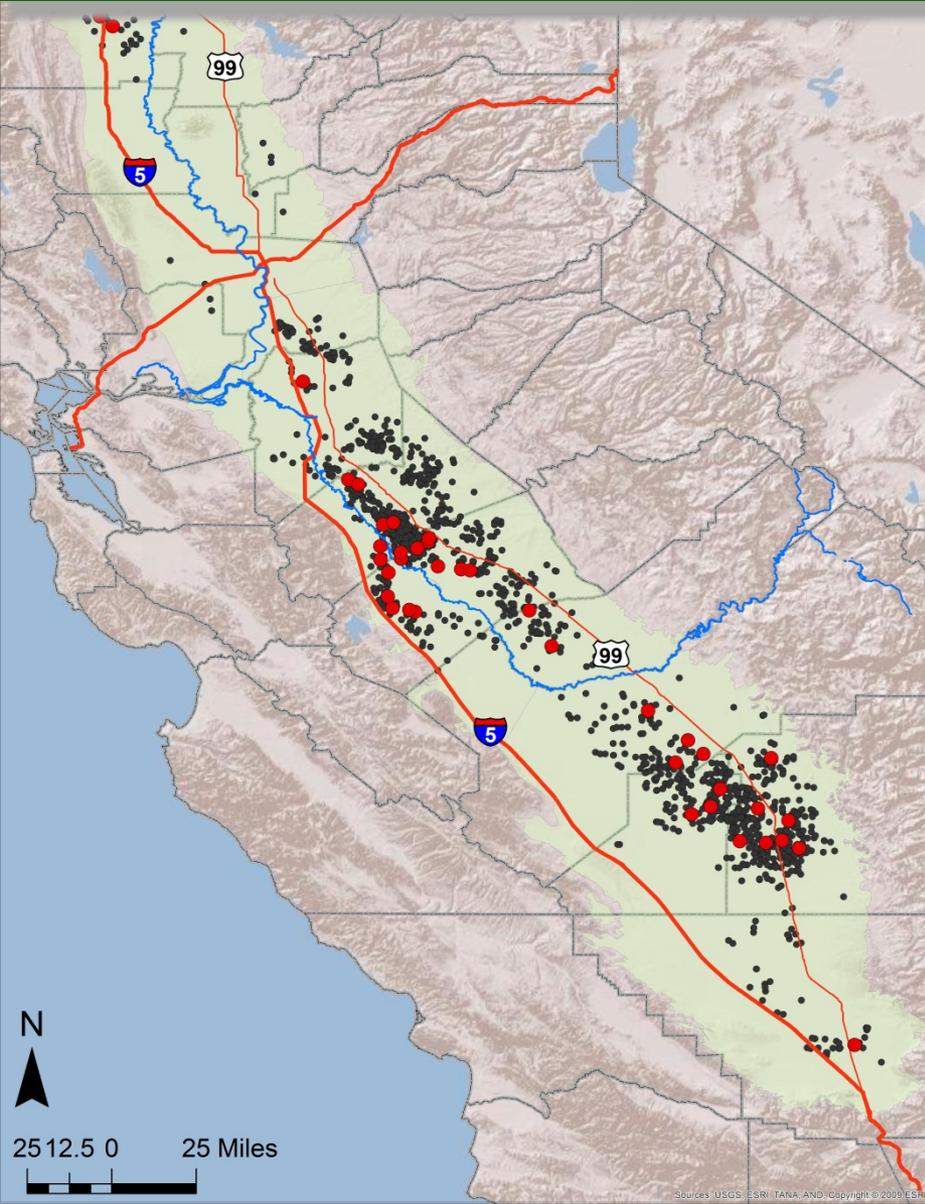


Central Valley Dairy Representative Monitoring Program – Status Update



Semi-Annual Stakeholder Meeting

Central Valley Regional Water
Quality Control Board

11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670

October 9, 2018



**Luhdorff &
Scalmanini**
Consulting Engineers

Presentation Overview

- 1) Draft Corral Subsurface Hydrogeologic Investigation Report – Results
- 2) Proportional Subsurface Nitrogen Loading (corrals, lagoons, manured fields)



CORRAL SUBSURFACE HYDROGEOLOGIC INVESTIGATION

Including Literature Review

Central Valley Dairy Representative
Monitoring Program



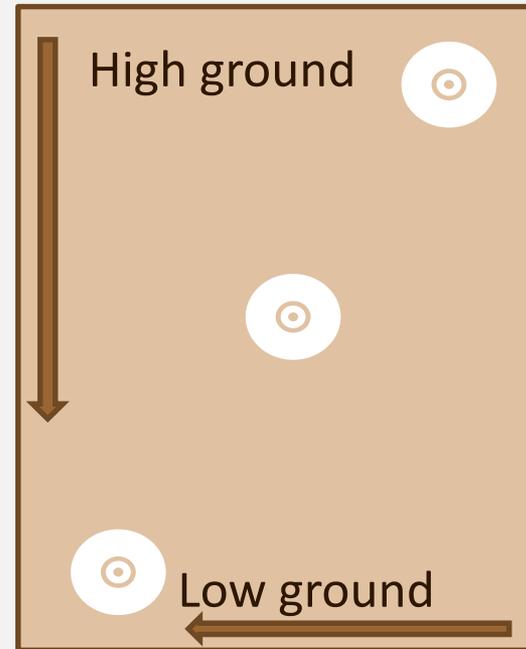
**Luhdorff &
Scalmanini**
Consulting Engineers

October 2018

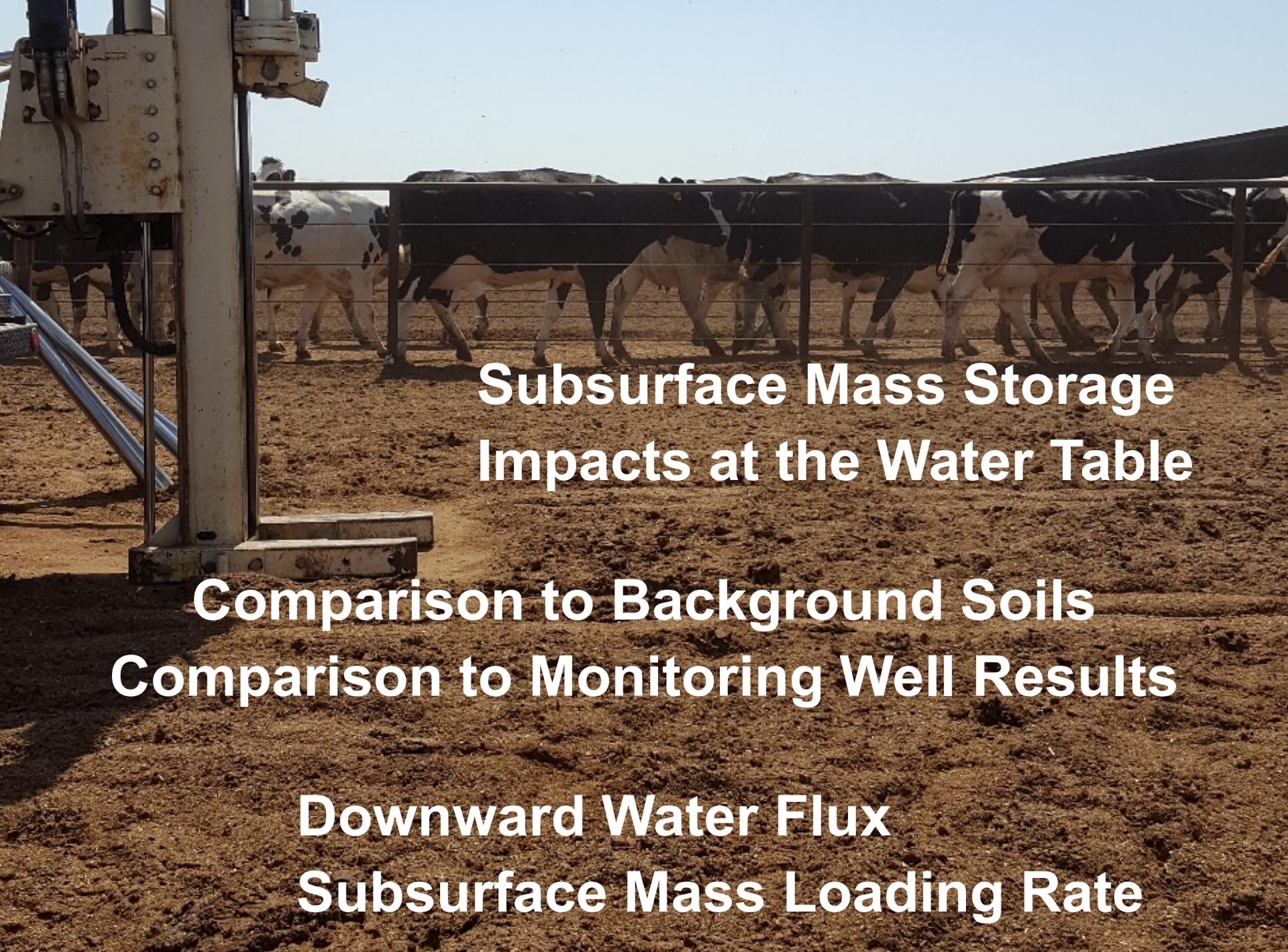
- 13 dairies
- Soil texture range: sand, loamy sand, sandy loam, loam, clay loam, clay
- Continuous soil cores in corrals and one on-site background location at each dairy
- Soil exploration depth to water table but no more than 20 ft
- Groundwater retrieval to 30 ft from uppermost few inches of the water table



- 3 soil borings in each corral



- Soil cores were divided in 9 depth intervals
- Soil from the three borings was composited for each depth interval
- 187 soil samples total

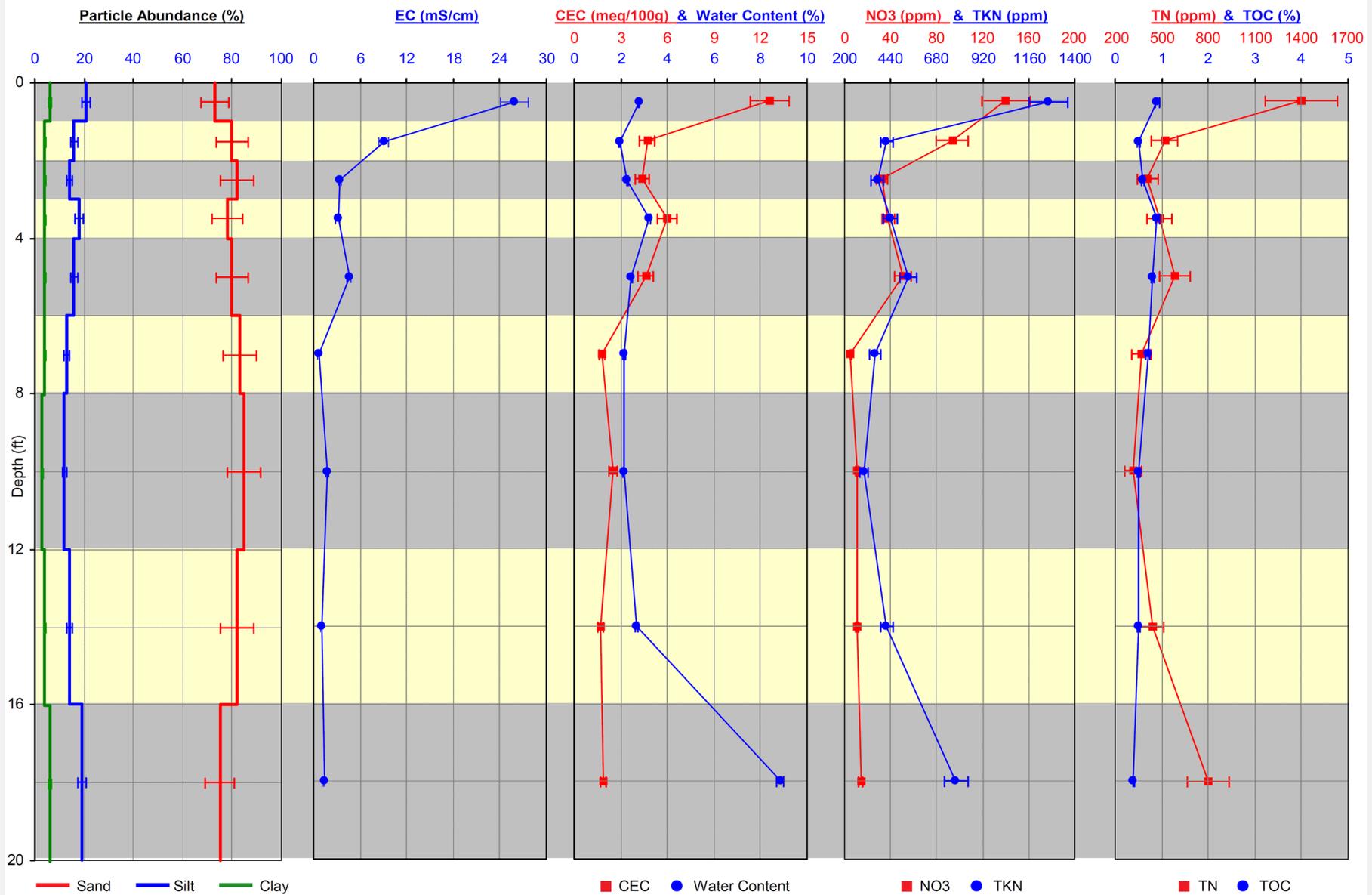


**Subsurface Mass Storage
Impacts at the Water Table**

**Comparison to Background Soils
Comparison to Monitoring Well Results**

**Downward Water Flux
Subsurface Mass Loading Rate**

Example Data for one Site



Dairy	Depth (ft)*	Total N			Phosphorous			Potassium		
		Corral	Bck ¶	Q‡	Corral	Bck ¶	Q‡	Corral	Bck ¶	Q‡
A	16,12	46,000	28,000	1.2	1,400	630	2.1	12,000	3,100	3.9
B	8, 8	16,000	18,000	0.9	2,300	920	2.5	30,000	2,300	13

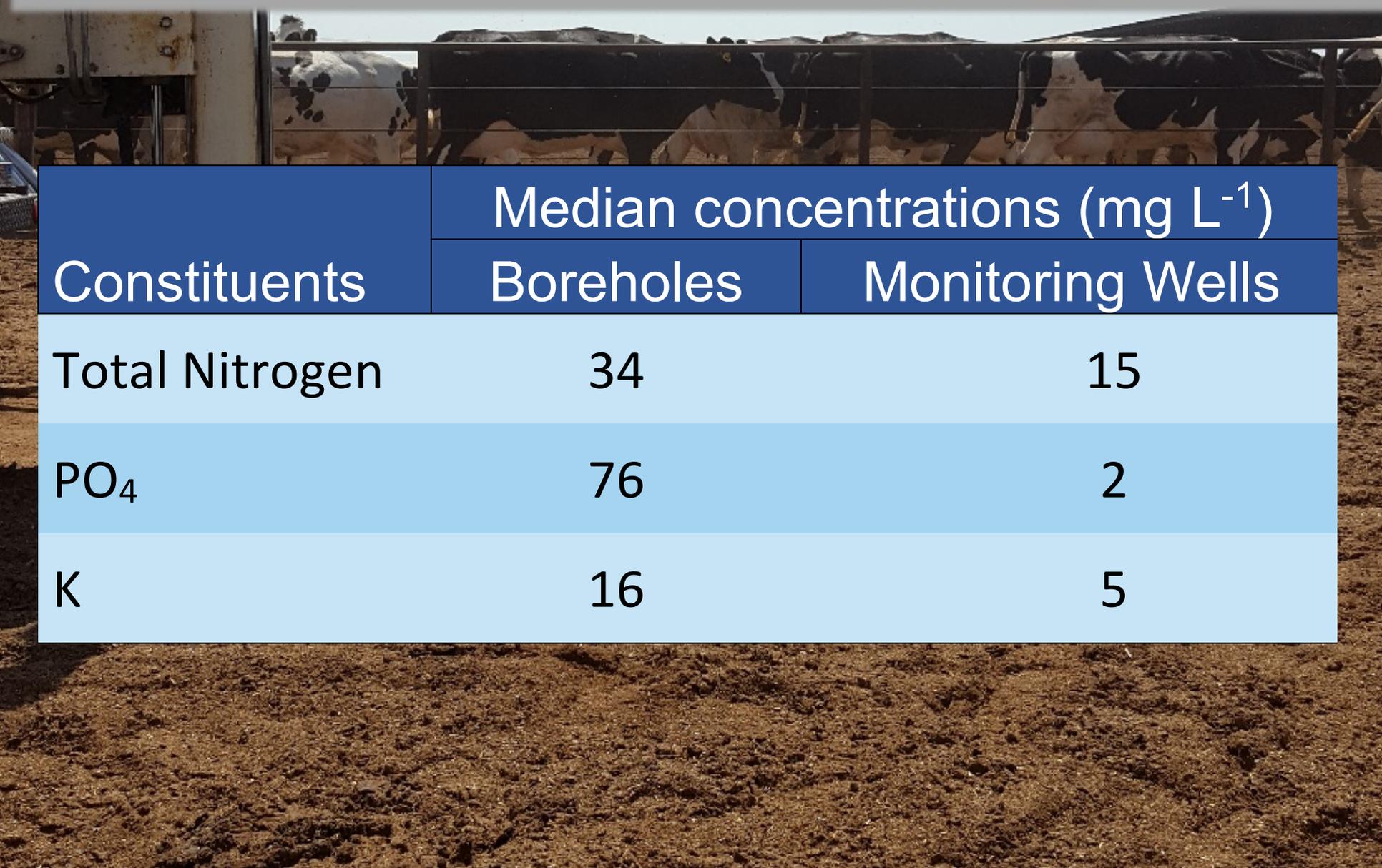
Quotients of constituent mass in corral soils and background soils (min, max, median)

TN: 0.6, 2.1, 1.0
P: 1.0, 2.8, 1.7
K: 1.2, 13, 2.2

J	16, 20	67,000	85,000	1.0	4,300	1,700	2.8	44,000	23,000	2.1
K	20, 20	33,000	37,000	0.9	2,200	1,800	1.2	37,000	17,000	2.2
L	20, 20	51,000	52,000	1.0	860	870	1.0	9,800	8,500	1.2
M	20, 20	72,000	49,000	1.5	1,600	1,500	1.0	48,000	7,600	6.4
N	20, 20	44,000	69,000	0.6	1,100	480	2.3	20,000	2,900	6.9

‡ Zeros do not indicate significant figures; * corral, background; ¶ background location; ‡ The quotient was calculated after aggregating the depth compartments where data from both corral and background were available; † G and H share a background location

Groundwater concentrations were substantially greater in boreholes than in monitoring wells



Constituents	Median concentrations (mg L ⁻¹)	
	Boreholes	Monitoring Wells
Total Nitrogen	34	15
PO ₄	76	2
K	16	5

400 mm y^{-1} recharge and TN concentration of 34 mg L^{-1} yield a mass flux of 121 lbs $ac^{-1} y^{-1}$

Annual precipitation across investigated dairies 8-14 in (200-360 mm), one site at 22 in (560 mm)

96% of Central Valley dairy herd in areas with <16 in; 1.5% in areas >22 in

Daily liquid excretion by adult Holstein cow is 0.085 L kg^{-1} animal weight. For a 1,400 lbs cow = 4.9 mm y^{-1}

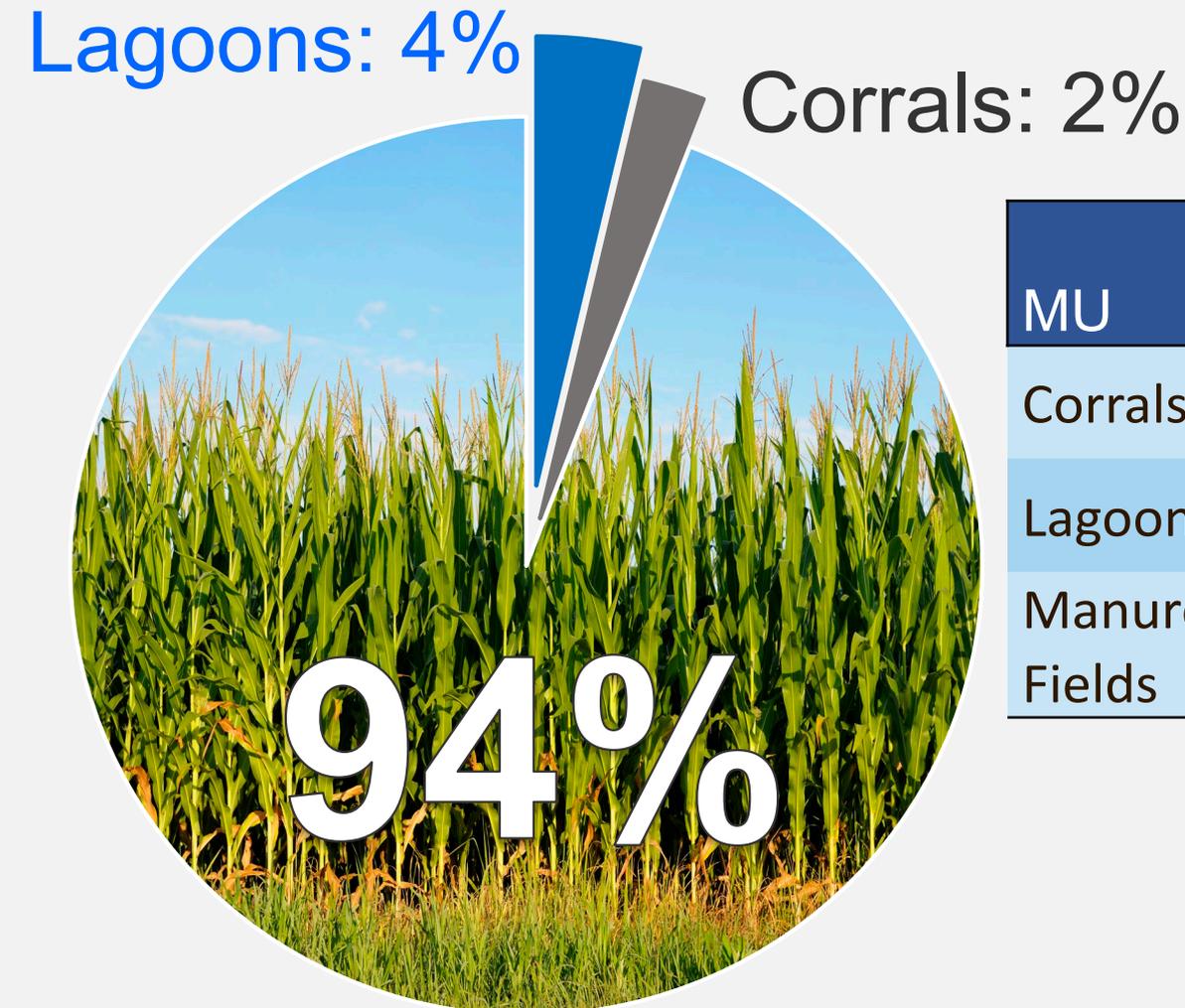
Rule of thumb: 1/3 of liquid excreted is milk, 1/3 is urine, 1/3 is in feces. For a cow that gives 10 gal of milk per day, we get 6.8 mm y^{-1}

Annual stocking rate 29-58 head ac^{-1} => 200-400 mm y^{-1}

Deep percolation 20-40% of liquid deposition

Therefore: 80 to 400 mm y^{-1} groundwater recharge

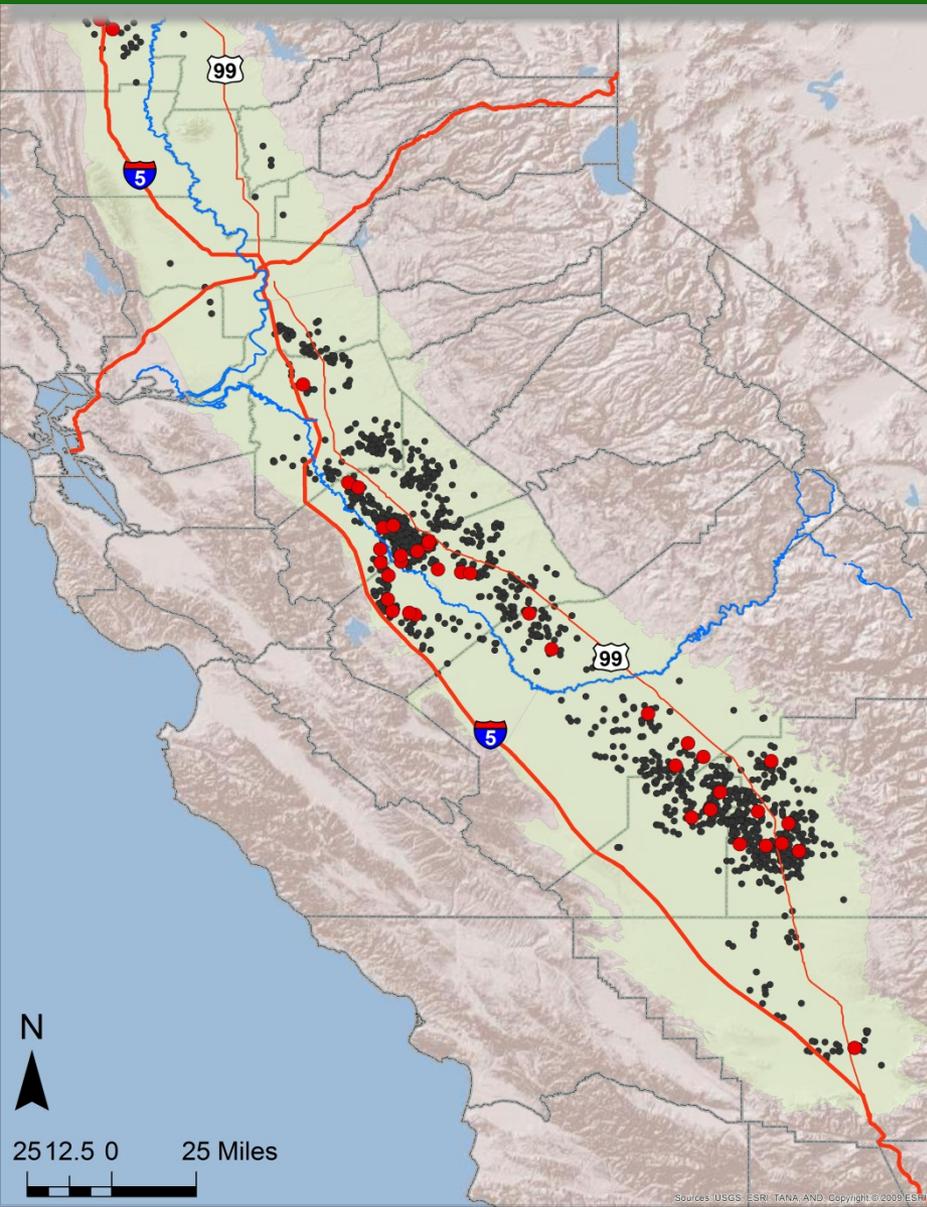
Manured crop fields contribute 94% of subsurface nitrogen emissions on dairies



MU	Loading Rate lbs ac ⁻¹ y ⁻¹	Acres*
Corrals	121**	30,254
Lagoons	1,045	5,877
Manured Fields	368*	429,424

*Harter, Dzurella et al. (2017) Nitrogen Fertilizer Loading to Groundwater in the Central Valley. Final Report. FREP projects 11-0301 & 15-0454; **SB X2 1 Nitrate Report (2012) used 163

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Thank you!

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