

Saline and Sodic Soils in Wisconsin: The Sad Story of an Infiltration Pond

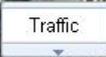
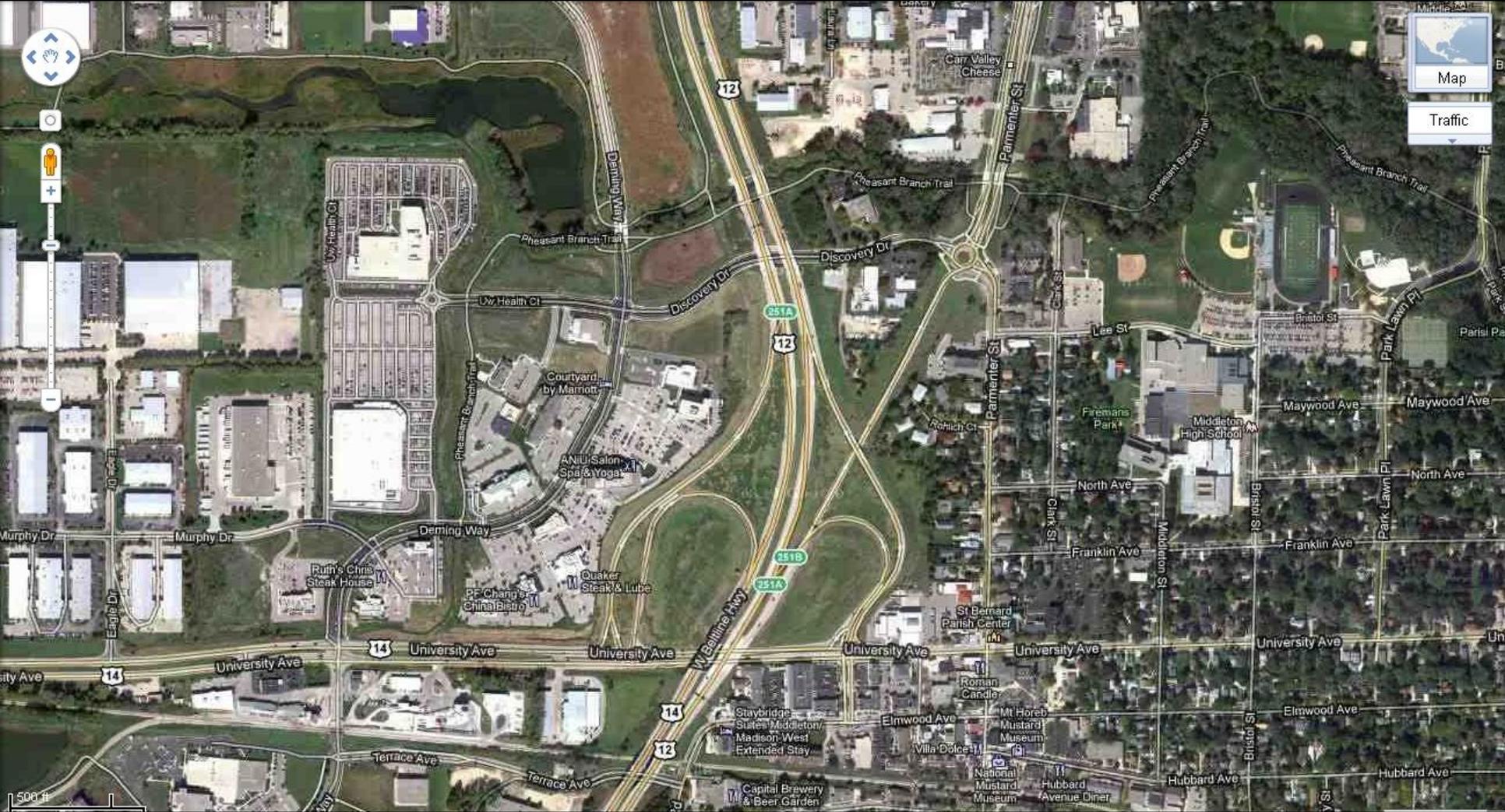
for Waukesha County Storm Water Workshop
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and with the sponsorship of The City of Middleton and the site owner



500 ft



\$10.5 million
Opened Aug 2008

~153,000 sq. ft. bldg

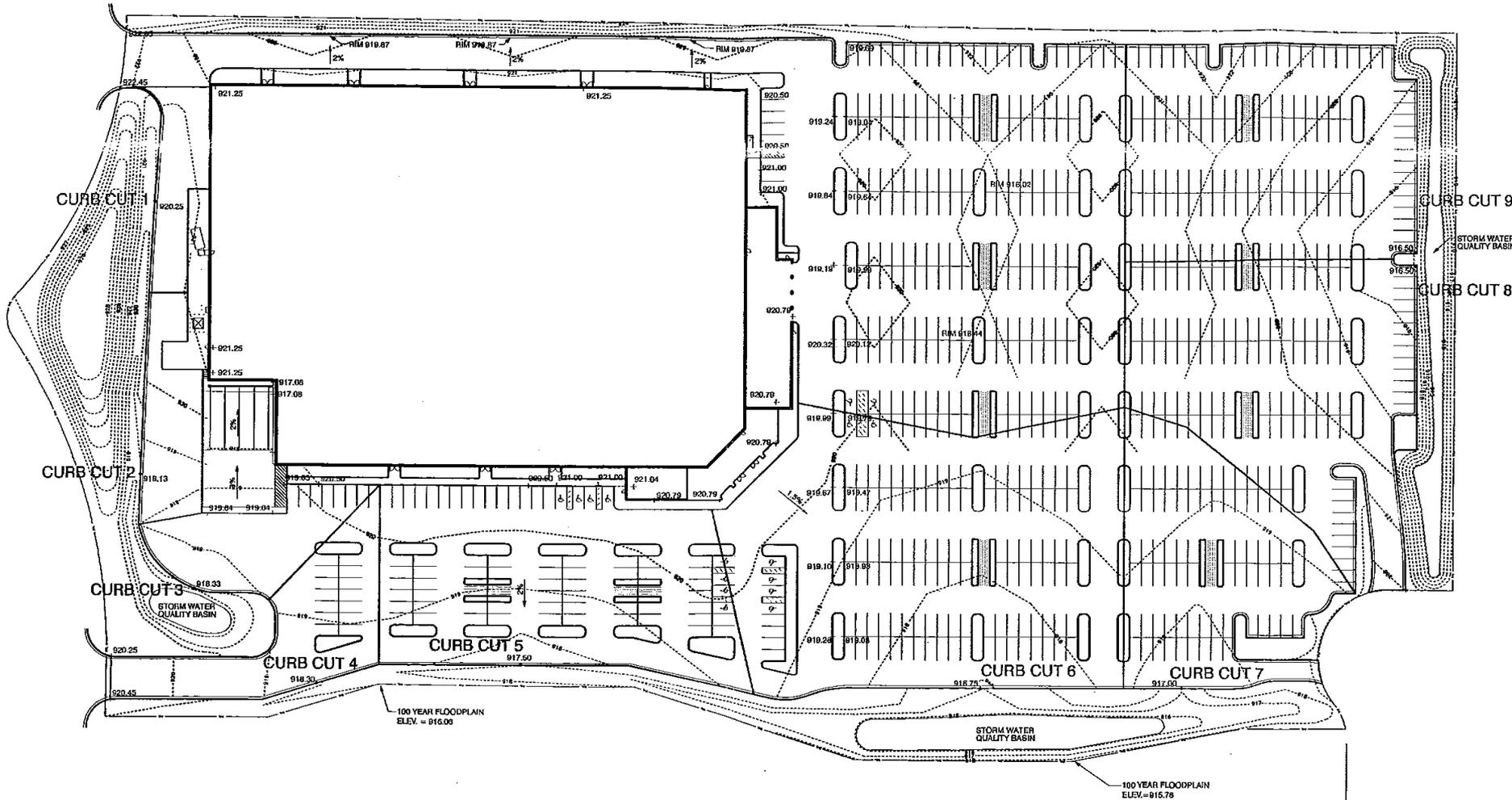
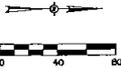
~440,000 sq. ft. parking lot

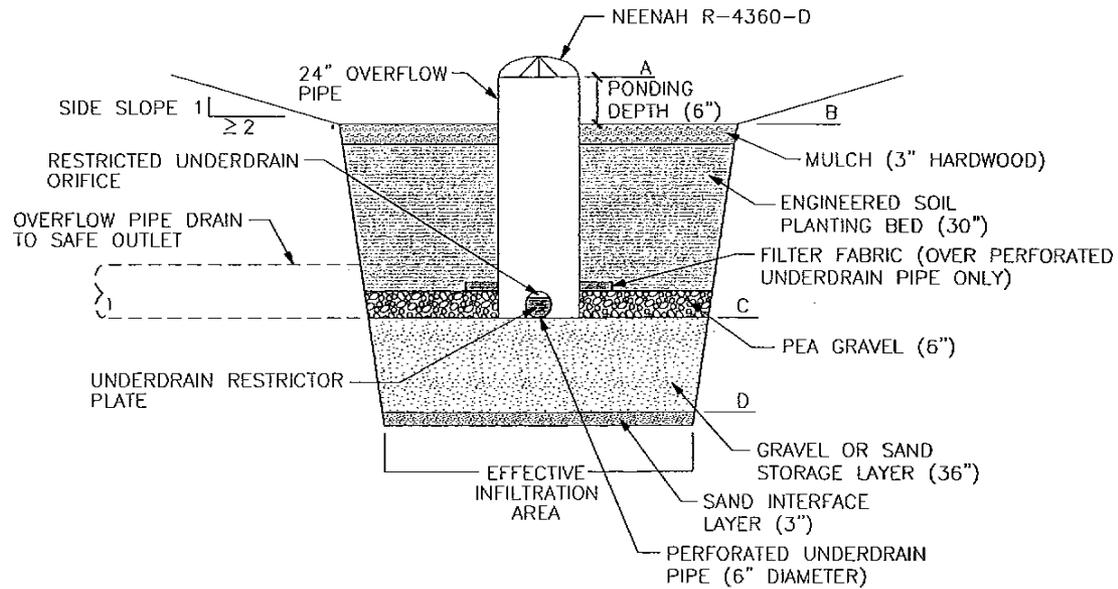
3 Stormwater quality basins:

2300, 8000 & 8700 sq. ft.

(~30:1 impermeable:basins)

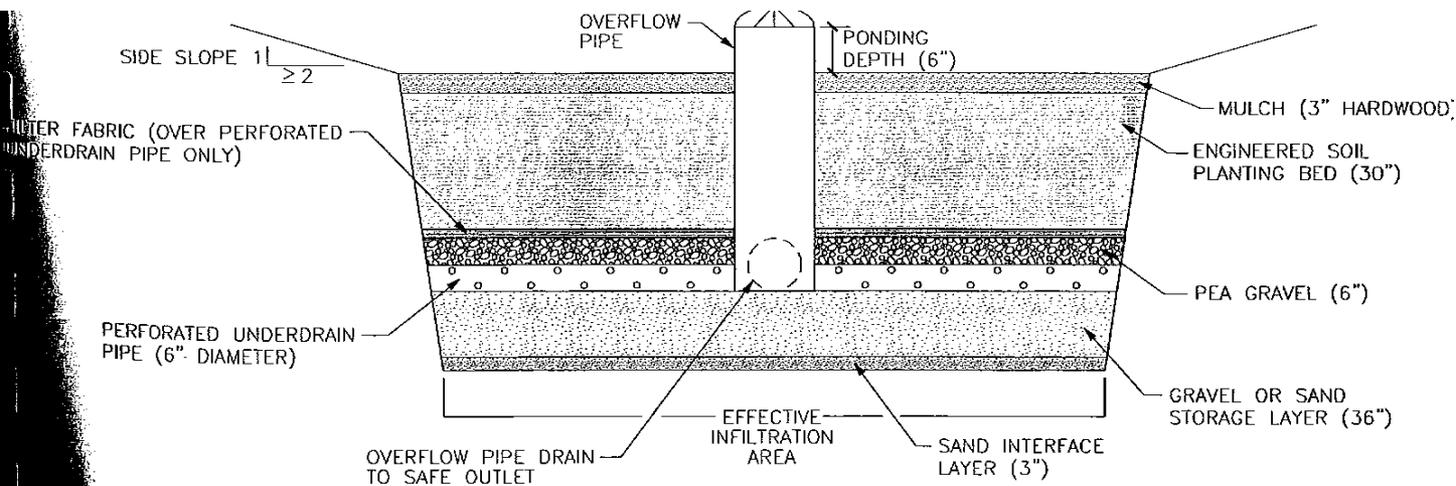
- LEGEND
- PROPOSED PROPERTY LINE
 - - - EXISTING CONTOUR MAJOR
 - - - EXISTING CONTOUR MINOR
 - - - 91:8 PROPOSED CONTOUR MAJOR
 - - - 92:0 PROPOSED CONTOUR MAJOR
 - PROPOSED SANITARY MANHOLE
 - PROPOSED STORM INLET
 - PROPOSED CURB OPENING





DEVICE	ELEV. A	ELEV. B	ELEV. C	ELEV. D
2	916.00	915.50	912.00	909.00
3	918.25	917.75	914.50	911.00

BIORETENTION DEVICE - CROSS SECTION ACROSS WIDTH OF DEVICE



BIORETENTION DEVICE - CROSS SECTION ACROSS LENGTH OF DEVICE



Annual Madison salt application:
10 – 25 tons/mile
(Goal: 6 tons/mile)

Tons of salt applied or purchased by municipality, winter of 2008/9:

27,000	Dane Co.
9,000	City of Madison
1,150	Town of Burke
1,350	City of Middleton
2,700	Others

Madison & Dane Co. Public Health

ROAD SALT REPORT – 2008/09

<http://www.publichealthmdc.com/publications/documents/RoadSalt2009.pdf>



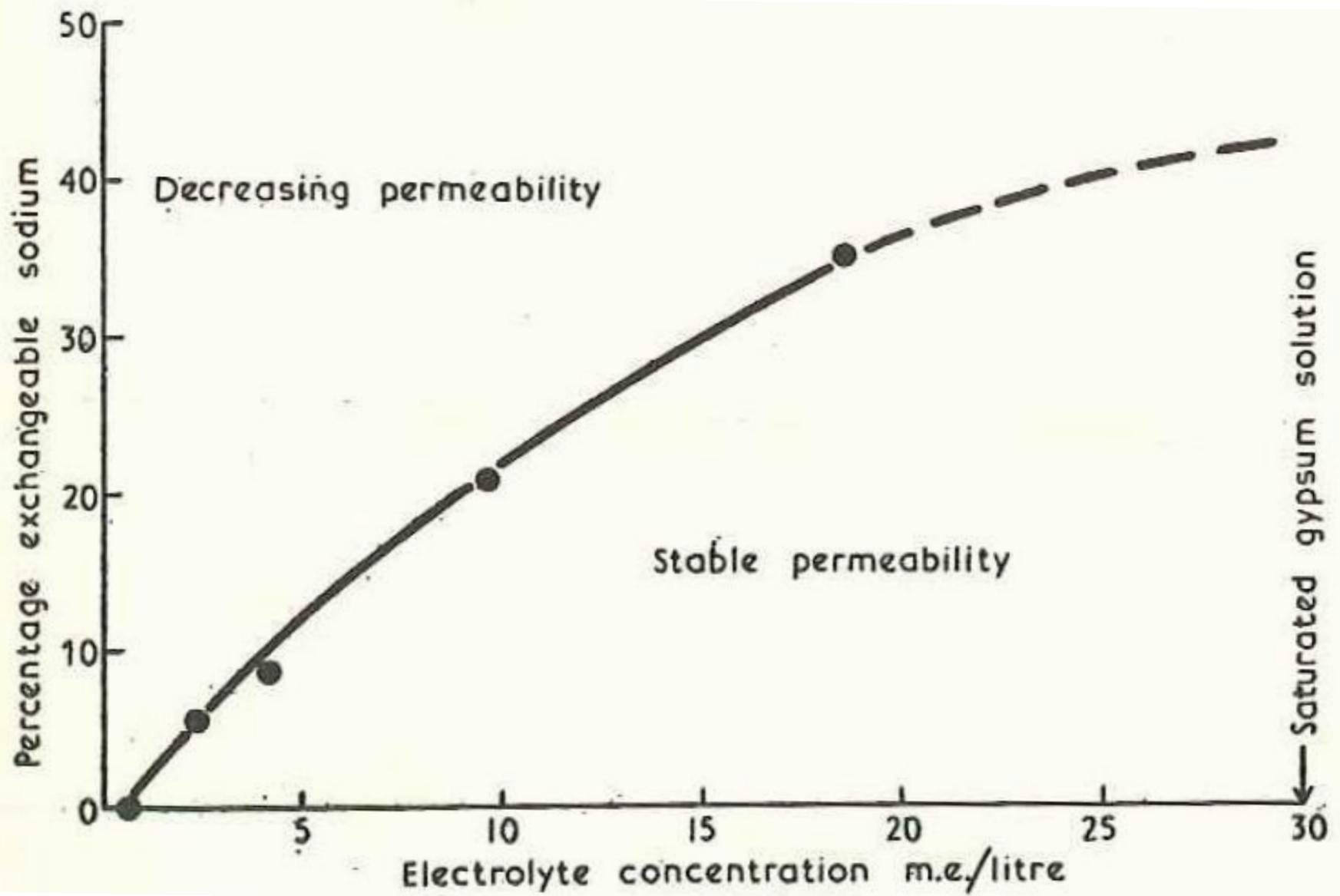
Diagnostic techniques:

Salinity—

- Electrical conductivity (EC) of soil water or saturated soil extract (lab; dS/m or mmho/cm)
- portable electromagnetic (EM) soil conductivity sensor mounted on vehicle (field)

Sodicity—

- Measurement of Exchangeable Sodium Percentage (ESP) by cation displacement
- Measurement of Sodium Adsorption Ratio (SAR) in soil solution, saturated soil extract or irrigation water



Quirk and Schofield. 1957. J. Soil Science



Sampling at retention ponds, Aug 2010



Collection of cores from retention ponds (in background).





BUSINESS

Red scales back 2011 forecast

NEW YORK (AP) — The U.S. economy is still in a fragile state, but the outlook is brighter than it was a year ago, according to a new forecast from the U.S. Commerce Dept. The forecast, released Tuesday, says the economy will grow 2.5 percent in 2011, down from 3.5 percent in 2010. It also says the unemployment rate will fall to 4.5 percent, down from 4.6 percent in 2010.

Existing home sales

Tight credit, jobless rate blamed for last month's nationwide decrease

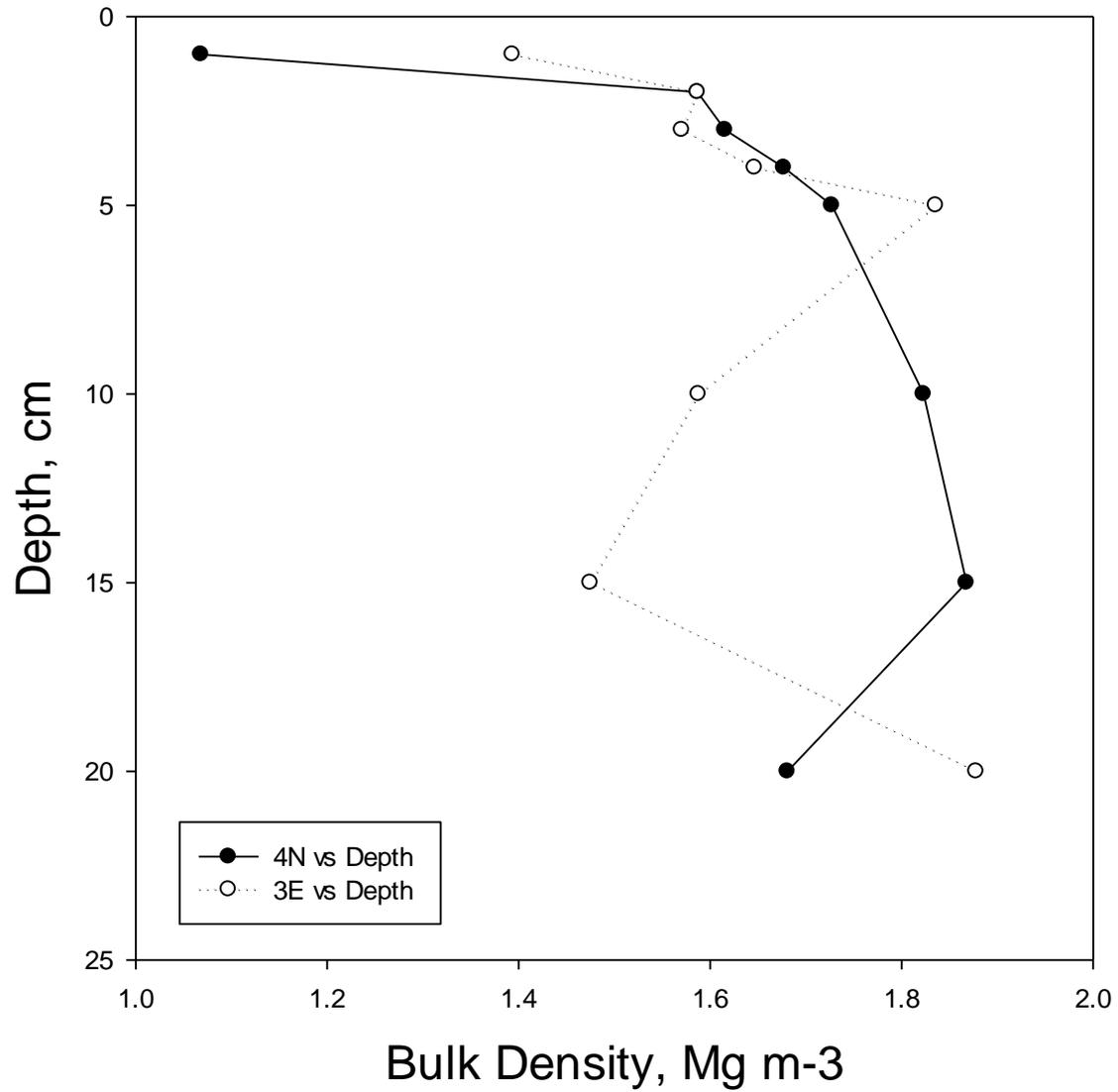
WASHINGTON — Sales of existing homes slipped 0.5 percent in October as the pace of sales slowed in the face of tight credit, joblessness and high unemployment, the National Association of Realtors said Tuesday. Sales of existing homes fell 0.5 percent to 3.5 million units, down from 3.52 million in September. The median price for a home sold in October was \$170,500, a 0.9 percent increase from \$168,900 in September. The pace of sales was weaker than had been expected, analysts said. The median price for a home sold in October was \$170,500, a 0.9 percent increase from \$168,900 in September. The pace of sales was weaker than had been expected, analysts said.

Home housing starts down from '09

WASHINGTON — New housing starts in the U.S. were down 17 percent in October from a year earlier, according to the Commerce Dept. The number of new housing starts in October was 1.4 million, down from 1.6 million in October 2009. The number of new housing starts in October was 1.4 million, down from 1.6 million in October 2009.



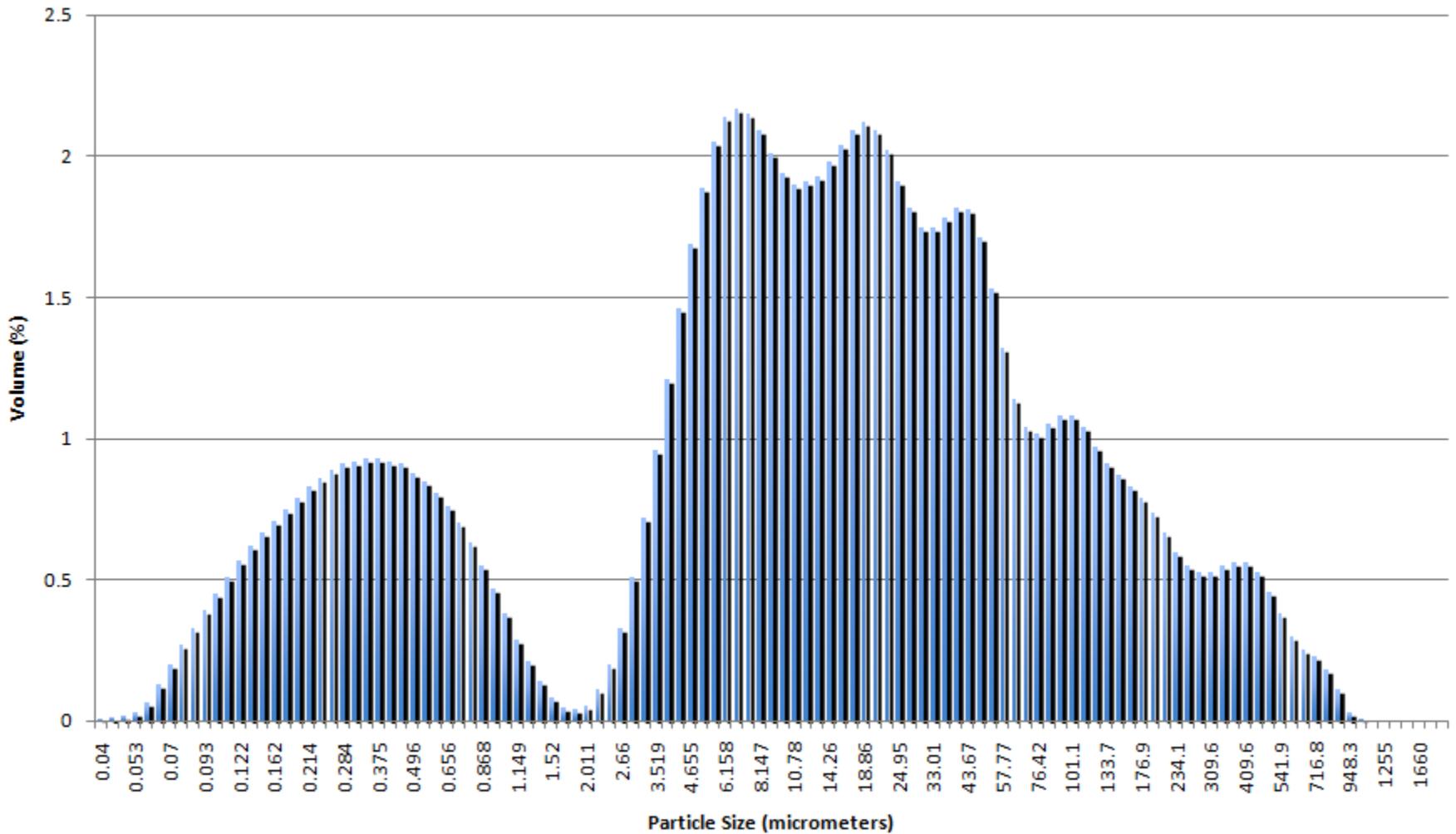


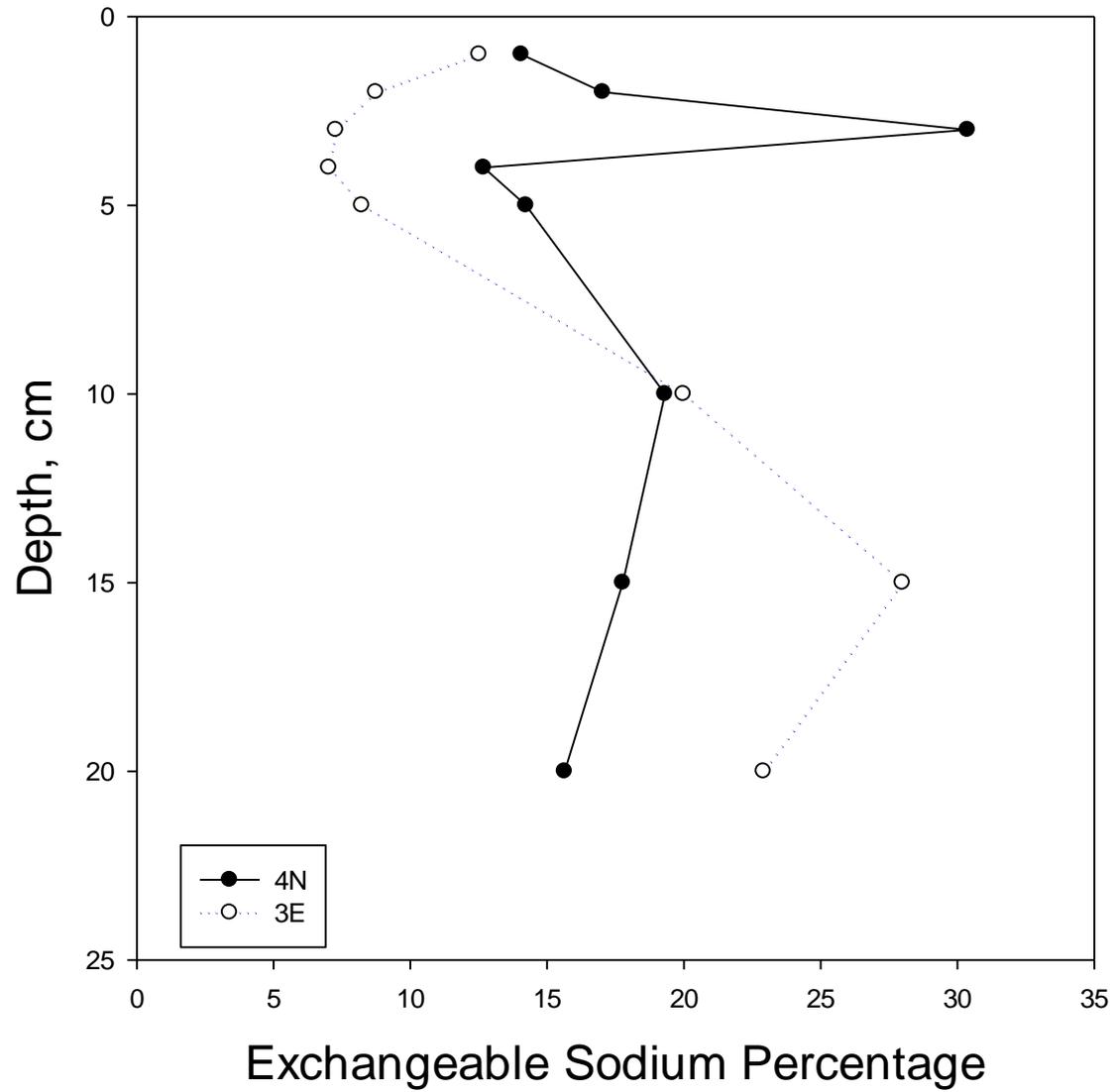




Dispersion of 1-cm core segments in 1% sodium polymetaphosphate and mechanical agitation, here allowed to settle showing bands of sand, silt and suspended clay, for particle size determination by laser scattering—after removal of pea gravel by sieving.

Particle Size Distribution by Laser Scattering, gravel removed. Gravel was 10-15% of core segment, by wt.





Typical remediation techniques:

Saline soils—

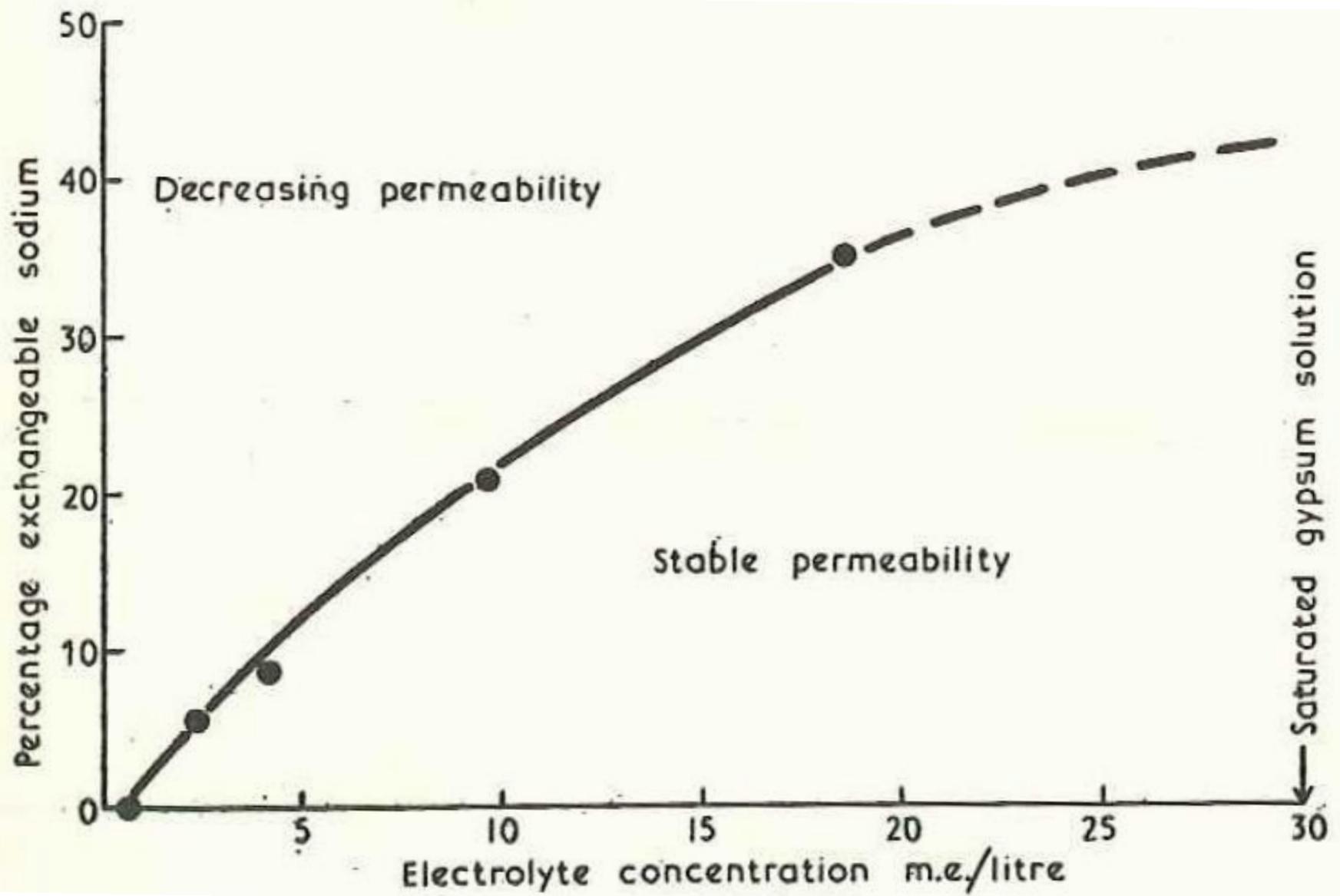
Add high quality water and drain

Sodic and saline-sodic soils—

Add gypsum, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, and then drain

(Gypsum dissolves to provide a relatively high ionic concentration and provides Ca^{2+} to displace exchangeable Na^+)

Contraindicated—adding high quality water and draining; likely to cause impermeability



Quirk and Schofield. 1957. J. Soil Science

Findings for a different West Madison retention pond, for which change in SAR and EC upon gypsum addition were calculated.
 (Note persistence of high SAR and EC until May.)

Gypsum Added	Pond Water Characteristics:						Gypsum Added
	9/1/200x		1/27/200x		5/12/200x		
--mM--	SAR	EC*	SAR	EC	SAR	EC	--g/L--
0	0.9	0.1	11.7	1.2	11.6	1.0	0
5	0.2	1.3	4.8	2.4	4.3	2.2	0.9
10	0.2	2.3	3.5	3.4	3.2	3.2	1.7
Sat'd	0.1	3.1	2.9	4.4	2.6	4.2	2.6

* dS/m or mmho/cm



Falling head permeameter
to measure K_{sat} on intact cores, using
sequence of:

- tap water,
- gypsum-saturated water, and
- 25 mM calcium chloride

K_{sat} measured with Falling Head Permeameters

	cm d ⁻¹	cm h ⁻¹	cm s ⁻¹
Sand	504	21.0	5.83E-03
Sandy loam	62.6	2.59	7.19E-04
Loam	31.7	1.32	3.67E-04
Silt loam	16.3	0.68	1.89E-04
Clay	1.44	0.06	1.67E-05
Core 2E:			
tapwater	0.33	0.01	3.86E-06
gypsum-sat'd	2.32	0.09	2.69E-05
25 mM CaCl ₂	2.35	0.10	2.72E-05
250 mM CaCl ₂	2.53	0.10	2.93E-05
Core 2N:			
tapwater	0.52	0.02	6.06E-06
gypsum-sat'd	0.72	0.03	8.30E-06

Conclusions:

- This is an autopsy, not a resuscitation or remediation
- Engineered soil has puddled and structure has been lost
- Most of runoff water exits directly thru overflow pipes to sewers
- Retention ponds will never be able to remediate salts but will only pass it on, sooner or later, to groundwater or overflow drains

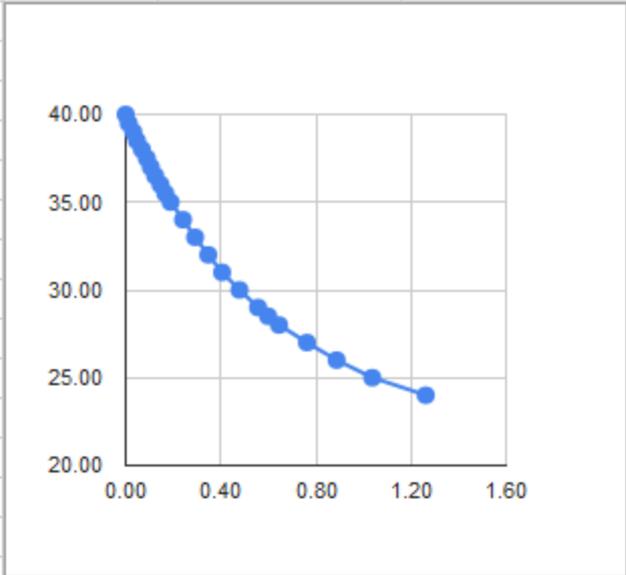
Replacing the soil of the 'storm water quality basins', which failed in two winters, should be accompanied by:

- Diversion of sodium chloride used for deicing parking lot, creating a '3-season basin'
- Routine addition of gypsum to ponds to raise SAR and reduce tendency to form sodic soil (~2 g/L)
- Substitution of calcium chloride, calcium acetate, or potassium chloride for sodium chloride in parking lots draining into retention ponds will prevent occurrence of clogging due to sodicity
- Rating of engineered soils for sensitivity to sodicity if no change from sodium chloride is feasible.



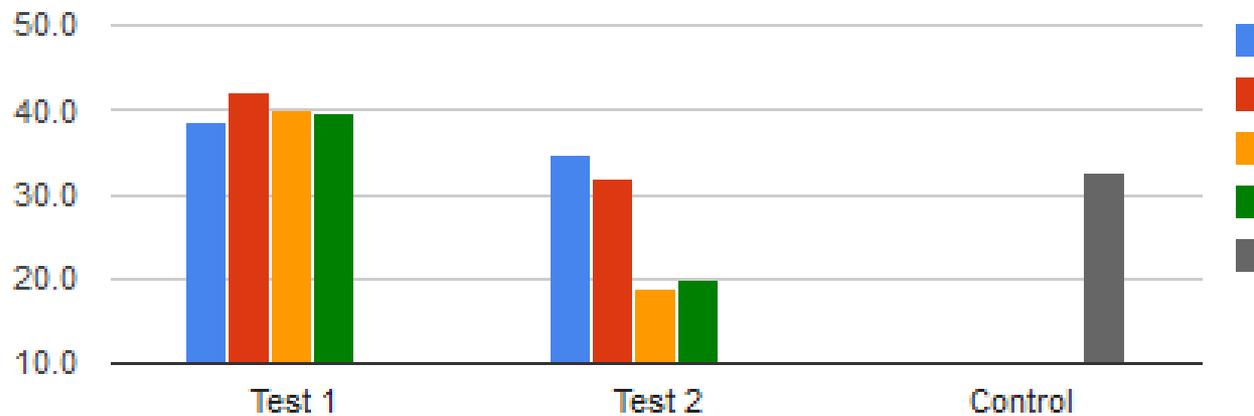
Engineered soil, sand, <5% clay

	A	B	C	D	E	F	G	H	I	J	K
7	Chris Long										
8	Permeameter 2										
9	Water: 0.1 M N				21.1	h_out cm					
10					20.8	Δx , cm:					
11	DATA			CALCS							
12	time hr:min:sec	height (cm)		head (cm)	elapsed, hrs	height (cm)	dh/dt	Ksat cm/hr			
13	10:14:15	40.00		19.20	0.00	39.88	-29.07	32.20			
14	10:15:00	39.50		18.70	0.01	39.52	-28.57	32.26			
15	10:16:10	39.00		18.20	0.03	38.97	-27.80	32.35			
16	10:17:05	38.50		17.70	0.05	38.55	-27.21	32.42			
17	10:18:21	38.00		17.20	0.07	37.99	-26.39	32.51			
18	10:19:35	37.50		16.70	0.09	37.45	-25.62	32.59			
19	10:20:35	37.00		16.20	0.11	37.03	-25.00	32.65			
20	10:21:42	36.50		15.70	0.12	36.57	-24.32	32.70			
21	10:23:03	36.00		15.20	0.15	36.03	-23.52	32.76			
22	10:24:15	35.50		14.70	0.17	35.57	-22.82	32.80			
23	10:25:36	35.00		14.20	0.19	35.07	-22.05	32.84			
24	10:28:44	34.00		13.20	0.24	33.96	-20.32	32.87			
25	10:31:47	33.00		12.20	0.29	32.97	-18.73	32.83			
26	10:35:06	32.00		11.20	0.35	31.98	-17.10	32.70			
27	10:38:36	31.00		10.20	0.41	31.03	-15.49	32.46			
28	10:42:59	30.00		9.20	0.48	29.96	-13.64	32.01			
29	10:47:40	29.00		8.20	0.56	28.97	-11.86	31.36			
30	10:50:13	28.50		7.70	0.60	28.48	-10.98	30.94			
31	10:52:58	28.00		7.20	0.65	28.00	-10.10	30.45			
32	11:00:00	27.00		6.20	0.76	26.93	-8.17	29.13			
33	11:07:30	26.00		5.20	0.89	26.02	-6.63	28.05			
34	11:16:30	25.00		4.20	1.04	25.12	-5.48	28.36			
35	11:30:00	24.00		3.20	1.26	23.95	-5.18	37.80			
36											
37						0.0527	RMS	32.05	mean		
38								1.91	std		



Sandy engineered soil:

Ksat Value:	low SAR, EC	high SAR, EC	low SAR, EC	low SAR, EC	tap water
Test 1	38.7	42.1	39.9	39.6	
Test 2	34.9	32.0	19.0	20.0	
Control					32.5





201
50 mL
±5%
40
30
20

202
50 mL
±5%
40
30
20

203
50 mL
±5%
40
30
20

204
50 mL
±5%
40
30
20

205
12/5/11

206
12/5/11

207
12/5/11

208
12/5/11

209
25

210
25

211
25

212
25

213
25

Preliminary Conclusions/Questions re: sandy engineered soil:

- Hydraulic conductivity can be cut in half by sodicity; more to come later?
- More resilient to salt than engineered soil currently used in these ponds
- Sandy soil still bleeds clay when sodic; will this lead to impermeability over time if a clay lamellae forms?
- Would not something other than sodium chloride be desirable?
- How about something other than a swelling clay, such as attapulgite or biochar, to form a moisture retentive upper horizon for plant growth?