

**Alum and gypsum amendments decrease phosphorus release from soil monoliths under
simulated snowmelt flooding**

Supplemental Material

This section contains nine pages with eight tables

Supplemental Table S1. Input parameters used for the Visual MINTEQ model for unamended, alum-amended and gypsum-amended Dencross 2 and Lakeland soils for 0, 14, 28, 42 and 56 days after flooding (DAF)

Parameter	Unamended					Alum- amended					Gypsum-amended				
	0 DAF	14 DAF	28 DAF	42 DAF	56 DAF	0 DAF	14 DAF	28 DAF	42 DAF	56 DAF	0 DAF	14 DAF	28 DAF	42 DAF	56 DAF
Dencross 2 soil															
Eh (mV)	397.3	257.1	211.6	194.9	103.5	358.2	181.0	123.8	35.6	33.7	389.1	270.1	246.9	226.6	187.0
pH	8.0	8.1	7.6	7.6	7.4	5.5	7.5	7.1	7.3	7.3	7.5	7.7	7.4	7.4	7.2
Ionic strength (mol/L)	0.02	0.25	0.07	0.07	0.08	0.29	0.30	0.25	0.20	0.17	0.19	0.28	0.30	0.28	0.29
Al (mg L ⁻¹)	0.03	0.23	0.50	0.09	0.05	0.61	0.88	1.28	0.43	0.08	0.03	0.22	0.50	0.14	0.09
Ca (mg L ⁻¹)	32.3	56.7	112.8	85.7	73.6	570.1	565.7	440.5	290.6	237.7	586.9	589.2	567.3	519.5	460.9
Cl (mg L ⁻¹)	5.5	5.7	7.3	5.4	4.3	7.8	9.5	10.9	5.9	5.6	9.7	8.7	11.7	7.2	6.6
DOC (mg L ⁻¹) ^a	14.5	23.9	27.2	29.7	32.7	0.2	15.6	22.9	11.0	21.5	2.4	16.6	22.6	13.4	25.9
F (mg L ⁻¹)	0.5	0.7	0.3	0.5	0.2	0.4	0.5	0.4	0.3	0.5	0.4	0.4	0.6	0.3	0.3
Fe (mg L ⁻¹)	0.026	0.026	0.8	0.8	1.2	0.026	0.026	0.8	0.9	1.1	0.026	0.026	0.4	0.5	1.5
Mg (mg L ⁻¹)	7.8	32.9	44.5	44.7	48.0	303.8	287.6	213.7	148.0	131.9	263.1	242.4	226.4	207.3	199.2
Mn (mg L ⁻¹)	0.011	0.011	0.2	0.4	0.5	0.2	0.2	0.6	0.7	1.0	0.011	0.1	0.3	0.8	1.1
NO ₃ (mg L ⁻¹)	26.6	0.001	0.001	0.001	0.001	19.3	0.001	0.001	0.001	0.001	35.6	0.2	0.001	0.001	0.001
P (mg L ⁻¹)	2.6	2.9	2.2	2.4	2.1	0.1	0.2	0.2	0.3	0.3	1.9	1.8	1.7	1.9	2.1
SO ₄ (mg L ⁻¹)	22.7	30.3	18.9	24.1	13.0	1798	2000	2379	1275	721	1177	1775	2321	1724	1418
Lakeland soil															
Eh (mV)	335.6	304.7	225.4	208.0	199.2	454.0	252.7	259.0	242.0	231.2	409.4	280.8	256.5	244.1	236.2
pH	8.2	8.2	8.0	8.1	7.9	7.8	8.0	8.0	7.8	7.8	8.0	8.1	7.8	7.8	7.9
Ionic strength (mol/L)	0.10	0.09	0.12	0.09	0.12	0.25	0.26	0.25	0.25	0.22	0.14	0.29	0.28	0.26	0.27
Al (mg L ⁻¹)	0.04	0.28	0.38	0.46	0.29	0.90	1.34	2.29	1.06	0.93	0.05	0.36	0.69	0.28	0.18
Ca (mg L ⁻¹)	134.1	143.2	182.8	134.5	151.0	476.5	536.1	461.1	416.7	298.6	781.3	702.6	615.9	563.1	652.9
Cl (mg L ⁻¹)	4.7	5.4	7.4	12.7	9.1	6.2	4.6	4.2	2.9	2.8	3.4	2.9	1.4	1.0	1.0
DOC (mg L ⁻¹) ^a	10.0	29.7	37.1	39.1	47.5	0.8	21.4	29.4	16.9	31.0	0.3	16.4	18.5	13.0	22.0
F (mg L ⁻¹)	0.3	0.3	0.4	0.3	0.5	0.3	0.6	0.3	0.6	0.3	0.3	0.3	0.3	0.5	0.3
Fe (mg L ⁻¹)	0.026	0.026	0.6	0.7	0.8	0.026	0.026	0.7	0.8	1.2	0.026	0.026	0.7	0.8	1.3
Mg (mg L ⁻¹)	9.9	70.5	87.3	60.6	82.6	177.9	230.4	197.3	193.2	160.7	394.9	252.0	201.6	173.4	172.9
Mn (mg L ⁻¹)	0.011	0.2	0.7	0.011	1.9	0.011	0.3	0.8	1.9	1.7	0.011	0.3	0.8	1.6	1.7
NO ₃ (mg L ⁻¹)	16.8	10.9	9.9	14.4	0.001	39.2	3.5	0.2	0.001	0.1	23.2	0.8	0.001	0.1	0.001
P (mg L ⁻¹)	0.2	0.4	0.4	0.5	0.5	0.1	0.3	0.3	0.4	0.3	0.2	0.2	0.3	0.3	0.2
SO ₄ (mg L ⁻¹)	31.5	34.6	58.0	77.3	22.0	1368	1439	1883	1322	868	1672	2075	2230	1880	1442

^a DOC- Dissolved organic carbon

Supplemental Table S2. Initial soil properties^a of the soils used in the experiment

Soil	Sand (g kg ⁻¹)	Clay (g kg ⁻¹)	OM ^b (g kg ⁻¹)	CCE ^c (g kg ⁻¹)	pH	M3- P ^d (mg kg ⁻¹)	M3-cations ^e (mg kg ⁻¹)				
							Ca	Mg	Fe	Mn	Al
Dencross 1	147	481	92.8	120.6	8.2	40.0	3872	1592	98	52	228
Dencross 2	55	694	106.8	167.0	7.9	68.0	3730	1161	74	56	176
Lakeland	168	499	86.6	106.6	8.3	13.9	2244	1370	146	21	22
Osborne1	115	640	110.3	146.2	8.1	64.6	2481	2008	102	28	87
Osborne2	76	625	94.1	116.8	8.0	72.0	1378	1173	147	38	421
Osborne3	108	647	111.0	89.2	7.9	85.2	3236	1084	71	45	588
Scanterbury 1	46	750	112.6	130.1	6.9	27.4	3155	1141	61	80	648
Scanterbury 2	48	768	110.0	97.7	7.2	57.0	3511	956	68	71	236

^aMean of three replicates.

^bOrganic matter

^cCalcium carbonate equivalent

^dMehlich 3-extractable phosphorus

^eMehlich 3- extractable cations

Supplemental Table S3. Mean porewater dissolved reactive P concentration (mg L⁻¹) with days after flooding in unamended, alum-amended and gypsum-amended soils (n=3). Standard error of mean is given in parentheses

Soil	Treatment	Days after flooding (DAF)								
		0	7	14	21	28	35	42	49	56
Dencross 1	Control	0.84 (0.093)	0.86 (0.073)	0.91 (0.032)	0.93 (0.041)	0.84 (0.039)	0.98 (0.023)	0.96 (0.049)	0.93 (0.034)	0.96 (0.051)
	Alum	0.12 (0.030)	0.38 (0.019)	0.45 (0.032)	0.44 (0.059)	0.57 (0.037)	0.56 (0.045)	0.56 (0.045)	0.65 (0.042)	0.72 (0.039)
	Gypsum	0.39 (0.045)	0.59 (0.046)	0.63 (0.031)	0.64 (0.037)	0.73 (0.040)	0.85 (0.045)	0.85 (0.038)	1.15 (0.020)	1.15 (0.084)
Dencross 2	Control	2.62 (0.258)	3.06 (0.402)	2.89 (0.225)	1.99 (0.206)	2.18 (0.135)	2.17 (0.079)	2.38 (0.138)	2.54 (0.236)	2.08 (0.180)
	Alum	0.04 (0.009)	0.12 (0.009)	0.24 (0.036)	0.16 (0.011)	0.22 (0.019)	0.26 (0.017)	0.26 (0.011)	0.22 (0.005)	0.27 (0.052)
	Gypsum	1.91 (0.128)	2.21 (0.138)	1.80 (0.080)	1.44 (0.128)	1.68 (0.076)	1.92 (0.137)	1.94 (0.138)	2.10 (0.244)	2.13 (0.194)
Lakeland	Control	0.23 (0.047)	0.32 (0.023)	0.40 (0.071)	0.34 (0.023)	0.40 (0.047)	0.49 (0.095)	0.50 (0.013)	0.49 (0.040)	0.49 (0.012)
	Alum	0.13 (0.009)	0.20 (0.007)	0.27 (0.030)	0.22 (0.033)	0.31 (0.032)	0.36 (0.030)	0.37 (0.030)	0.30 (0.003)	0.34 (0.008)
	Gypsum	0.21 (0.033)	0.20 (0.044)	0.25 (0.047)	0.28 (0.020)	0.32 (0.036)	0.32 (0.037)	0.34 (0.008)	0.38 (0.042)	0.18 (0.042)
Osborne 1	Control	1.14 (0.317)	1.80 (0.347)	1.76 (0.293)	1.79 (0.311)	1.77 (0.237)	1.78 (0.211)	1.79 (0.213)	1.98 (0.273)	1.57 (0.454)
	Alum	0.06 (0.019)	0.54 (0.047)	0.68 (0.051)	0.56 (0.045)	0.58 (0.186)	0.79 (0.062)	0.79 (0.065)	0.85 (0.025)	0.53 (0.070)
	Gypsum	0.48 (0.016)	0.68 (0.030)	0.72 (0.033)	0.70 (0.032)	0.74 (0.019)	0.80 (0.052)	0.81 (0.053)	0.77 (0.063)	1.05 (0.038)
Osborne 2	Control	2.29 (0.183)	2.57 (0.192)	2.61 (0.181)	2.41 (0.110)	2.64 (0.146)	2.78 (0.092)	2.80 (0.092)	2.51 (0.089)	2.15 (0.045)
	Alum	0.92 (0.103)	1.37 (0.105)	1.45 (0.049)	1.45 (0.032)	1.52 (0.082)	1.72 (0.082)	1.80 (0.132)	1.70 (0.077)	1.72 (0.078)
	Gypsum	1.27 (0.116)	1.37 (0.023)	1.37 (0.033)	1.39 (0.064)	1.15 (0.092)	1.25 (0.164)	1.09 (0.109)	1.53 (0.100)	1.79 (0.253)
Osborne 3	Control	2.31 (0.164)	2.42 (0.020)	2.50 (0.188)	2.39 (0.120)	2.60 (0.125)	2.63 (0.104)	2.66 (0.105)	2.54 (0.161)	2.19 (0.079)
	Alum	0.43 (0.061)	1.44 (0.137)	1.60 (0.044)	1.56 (0.086)	1.84 (0.093)	1.92 (0.181)	1.94 (0.183)	1.84 (0.065)	1.88 (0.132)
	Gypsum	1.23 (0.115)	1.72 (0.097)	1.61 (0.066)	1.64 (0.077)	1.85 (0.083)	1.89 (0.059)	1.91 (0.320)	1.83 (0.088)	1.69 (0.134)
Scanterbury 1	Control	0.27 (0.028)	0.30 (0.045)	0.34 (0.015)	0.29 (0.058)	0.33 (0.042)	0.36 (0.050)	0.37 (0.051)	0.39 (0.055)	0.89 (0.084)
	Alum	0.03 (0.005)	0.02 (0.011)	0.08 (0.019)	0.28 (0.053)	0.23 (0.057)	0.16 (0.035)	0.16 (0.035)	0.45 (0.114)	0.05 (0.024)
	Gypsum	0.17 (0.021)	0.20 (0.026)	0.24 (0.064)	0.25 (0.075)	0.25 (0.054)	0.27 (0.049)	0.27 (0.049)	0.32 (0.110)	0.30 (0.016)
Scanterbury 2	Control	1.29 (0.068)	1.15 (0.111)	1.15 (0.060)	1.11 (0.094)	1.23 (0.116)	1.27 (0.163)	1.28 (0.166)	0.96 (0.180)	1.34 (0.039)
	Alum	0.21 (0.094)	0.43 (0.033)	0.57 (0.129)	0.35 (0.072)	0.47 (0.066)	0.62 (0.133)	0.63 (0.134)	0.63 (0.135)	1.00 (0.325)
	Gypsum	0.24 (0.013)	0.31 (0.085)	0.40 (0.093)	0.53 (0.120)	0.47 (0.071)	0.42 (0.111)	0.42 (0.112)	0.46 (0.116)	0.40 (0.126)

Supplemental Table S4. Main effects ($P < F$) of amended treatment, days after flooding (DAF), and their interactions on Eh, pore water dissolved reactive P (DRP) concentration and pore water pH (at 5-cm depth), and floodwater DRP concentration and floodwater pH

Soil	Parameter				
	Eh	Pore water DRP	Pore water pH	Floodwater DRP	Floodwater pH
Amendment treatment					
Dencross 1	0.4386	<0.0001	0.0229	0.0002	0.1102
Dencross 2	0.0583	<0.0001	0.0659	<0.0001	0.0009
Lakeland	0.3928	<0.0001	0.1391	0.1683	0.8821
Osborne 1	0.2095	0.0080	0.0079	0.0004	0.1035
Osborne 2	0.0075	0.0001	0.0683	0.0047	0.3587
Osborne 3	0.0019	0.0004	0.0327	0.0054	0.3309
Scanterbury 1	0.0404	0.0005	0.0006	0.0255	0.0308
Scanterbury 2	0.0838	0.0002	0.0094	<0.0001	0.0961
Days after flooding (DAF)					
Dencross 1	<0.0001	<0.0001	0.0001	<0.0001	<0.0001
Dencross 2	<0.0001	0.0268	<0.0001	<0.0001	<0.0001
Lakeland	<0.0001	0.0006	0.0011	0.0002	0.0003
Osborne 1	<0.0001	0.0003	<0.0001	0.0088	<0.0001
Osborne 2	<0.0001	0.0011	<0.0001	<0.0001	0.0001
Osborne 3	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Scanterbury 1	<0.0001	0.0060	0.0002	<0.0001	0.0008
Scanterbury 2	<0.0001	0.0850	<0.0001	<0.0001	0.0005
Amendment treatment × DAF					
Dencross 1	<0.0001	< 0.0001	0.1474	<0.0001	0.0020
Dencross 2	0.2092	0.0038	<0.0001	<0.0001	0.0036
Lakeland	0.0186	0.0952	0.9032	0.0749	0.2038
Osborne 1	<0.0001	0.0021	0.0029	0.0057	0.0199
Osborne 2	<0.0001	<0.0001	0.3098	0.0002	0.2870
Osborne 3	<0.0001	0.0019	<0.0001	<0.0001	0.0220
Scanterbury 1	0.0333	<0.0001	0.0155	0.0078	0.3763
Scanterbury 2	0.0036	0.1737	<0.0001	<0.0001	0.2589

Supplemental Table S5. Mean floodwater dissolved reactive P concentration (mg L⁻¹) with days after flooding in unamended, alum-amended and gypsum-amended soils (n=3). Standard error of mean is given in parentheses

Soil	Treatment	Days after flooding (DAF)								
		0	7	14	21	28	35	42	49	56
Dencross 1	Control	0.08 (0.075)	0.11 (0.076)	0.25 (0.132)	0.32 (0.202)	0.43 (0.318)	0.52 (0.426)	0.62 (0.460)	0.71 (0.463)	0.78 (0.488)
	Alum	0.02 (0.015)	0.00 (0.000)	0.06 (0.006)	0.06 (0.025)	0.08 (0.019)	0.08 (0.015)	0.06 (0.007)	0.04 (0.012)	0.02 (0.016)
	Gypsum	0.02 (0.013)	0.01 (0.011)	0.08 (0.021)	0.10 (0.031)	0.10 (0.024)	0.11 (0.018)	0.15 (0.017)	0.19 (0.022)	0.28 (0.117)
Dencross 2	Control	0.06 (0.040)	0.09 (0.043)	0.25 (0.022)	0.32 (0.051)	0.44 (0.085)	0.49 (0.107)	0.59 (0.134)	0.75 (0.192)	0.89 (0.156)
	Alum	0.00 (0.003)	0.18 (0.176)	0.11 (0.018)	0.05 (0.003)	0.07 (0.007)	0.08 (0.010)	0.08 (0.012)	0.06 (0.018)	0.04 (0.022)
	Gypsum	0.04 (0.034)	0.07 (0.039)	0.15 (0.008)	0.24 (0.003)	0.32 (0.050)	0.36 (0.052)	0.35 (0.034)	0.31 (0.042)	0.29 (0.033)
Lakeland	Control	0.04 (0.043)	0.04 (0.035)	0.13 (0.041)	0.11 (0.045)	0.10 (0.040)	0.10 (0.040)	0.09 (0.034)	0.09 (0.030)	0.04 (0.015)
	Alum	0.02 (0.017)	0.02 (0.011)	0.06 (0.013)	0.03 (0.014)	0.04 (0.005)	0.05 (0.010)	0.05 (0.009)	0.05 (0.011)	0.02 (0.012)
	Gypsum	0.03 (0.014)	0.00 (0.000)	0.06 (0.006)	0.07 (0.012)	0.07 (0.007)	0.08 (0.003)	0.08 (0.010)	0.07 (0.021)	0.01 (0.010)
Osborne 1	Control	0.12 (0.093)	0.04 (0.036)	0.14 (0.051)	0.12 (0.058)	0.16 (0.054)	0.19 (0.056)	0.36 (0.096)	0.40 (0.096)	0.33 (0.038)
	Alum	0.20 (0.188)	0.01 (0.008)	0.06 (0.005)	0.05 (0.000)	0.05 (0.012)	0.06 (0.017)	0.07 (0.026)	0.08 (0.026)	0.00 (0.005)
	Gypsum	0.01 (0.003)	0.03 (0.026)	0.08 (0.030)	0.09 (0.015)	0.09 (0.019)	0.08 (0.025)	0.11 (0.016)	0.15 (0.053)	0.02 (0.005)
Osborne 2	Control	0.07 (0.043)	0.17 (0.076)	0.31 (0.061)	0.32 (0.052)	0.37 (0.055)	0.44 (0.051)	0.45 (0.058)	0.46 (0.084)	0.47 (0.071)
	Alum	0.00 (0.000)	0.00 (0.000)	0.06 (0.003)	0.07 (0.019)	0.06 (0.010)	0.05 (0.006)	0.05 (0.004)	0.04 (0.011)	0.02 (0.022)
	Gypsum	0.00 (0.003)	0.14 (0.047)	0.16 (0.045)	0.26 (0.052)	0.27 (0.042)	0.25 (0.052)	0.29 (0.066)	0.35 (0.068)	0.34 (0.061)
Osborne 3	Control	0.05 (0.046)	0.14 (0.016)	0.21 (0.042)	0.31 (0.035)	0.34 (0.053)	0.39 (0.085)	0.66 (0.064)	0.83 (0.163)	0.98 (0.155)
	Alum	0.00 (0.003)	0.00 (0.005)	0.08 (0.019)	0.18 (0.095)	0.16 (0.052)	0.11 (0.050)	0.10 (0.052)	0.08 (0.048)	0.09 (0.076)
	Gypsum	0.07 (0.052)	0.16 (0.081)	0.23 (0.104)	0.16 (0.075)	0.26 (0.045)	0.33 (0.073)	0.34 (0.056)	0.34 (0.061)	0.34 (0.060)
Scanterbury 1	Control	0.02 (0.022)	0.02 (0.019)	0.08 (0.021)	0.05 (0.015)	0.09 (0.015)	0.11 (0.016)	0.14 (0.044)	0.14 (0.058)	0.05 (0.027)
	Alum	0.00 (0.000)	0.00 (0.002)	0.09 (0.003)	0.05 (0.012)	0.06 (0.004)	0.06 (0.005)	0.04 (0.010)	0.02 (0.009)	0.00 (0.000)
	Gypsum	0.03 (0.026)	0.10 (0.104)	0.11 (0.092)	0.14 (0.079)	0.11 (0.044)	0.11 (0.026)	0.08 (0.029)	0.07 (0.026)	0.00 (0.005)
Scanterbury 2	Control	0.05 (0.029)	0.14 (0.003)	0.24 (0.003)	0.29 (0.020)	0.32 (0.018)	0.32 (0.029)	0.32 (0.020)	0.33 (0.035)	0.30 (0.013)
	Alum	0.02 (0.018)	0.01 (0.008)	0.08 (0.016)	0.05 (0.008)	0.07 (0.015)	0.08 (0.029)	0.06 (0.011)	0.05 (0.024)	0.00 (0.002)
	Gypsum	0.01 (0.012)	0.06 (0.022)	0.07 (0.014)	0.08 (0.023)	0.09 (0.025)	0.11 (0.035)	0.06 (0.022)	0.04 (0.021)	0.02 (0.008)

Supplemental Table S6. Mean redox potential (Eh, mV) values with days after flooding in unamended, alum-amended and gypsum-amended soils (n=3). Standard error of mean is given in parentheses

Soil	Treatment	Days after flooding (DAF)								
		0	7	14	21	28	35	42	49	56
Dencross 1	Control	419 (17.6)	284 (37.1)	257 (18.3)	238 (17.3)	239 (19.2)	213 (30.7)	129 (23.5)	73 (24.5)	60 (7.3)
	Alum	507 (43.2)	348 (33.9)	301 (43.4)	188 (27.3)	160 (24.5)	156 (13.7)	157 (22.0)	143 (27.0)	149 (25.4)
	Gypsum	413 (24.3)	283 (32.5)	289 (34.9)	228 (22.1)	150 (22.1)	147 (17.8)	146 (21.6)	145 (24.1)	157 (35.8)
Dencross 2	Control	397 (34.9)	287 (41.1)	257 (54.3)	238 (19.4)	212 (45.2)	197 (46.9)	195 (47.5)	185 (48.8)	220 (45.5)
	Alum	358 (69.1)	166 (30.1)	181 (47.3)	130 (14.3)	124 (25.7)	109 (33.8)	36 (11.0)	60 (7.9)	104 (27.4)
	Gypsum	389 (69.2)	291 (62.3)	270 (53.2)	284 (17.9)	247 (42.0)	242 (39.1)	227 (30.2)	214 (25.2)	187 (25.1)
Lakeland	Control	336 (51.4)	210 (40.2)	305 (36.0)	218 (40.5)	225 (51.7)	212 (45.8)	198 (41.9)	194 (39.1)	199 (35.4)
	Alum	454 (33.7)	274 (19.1)	253 (18.8)	275 (16.0)	259 (15.7)	245 (13.2)	242 (19.9)	236 (17.2)	231 (18.8)
	Gypsum	409 (37.8)	302 (33.5)	281 (32.8)	262 (28.4)	257 (25.7)	249 (23.4)	244 (23.3)	240 (22.2)	236 (21.1)
Osborne 1	Control	323 (23.2)	238 (47.9)	245 (28.7)	234 (25.6)	217 (32.6)	209 (24.8)	200 (29.6)	175 (29.6)	199 (33.5)
	Alum	437 (28.2)	290 (21.1)	226 (20.1)	250 (19.2)	235 (13.7)	223 (16.9)	146 (9.6)	132 (9.6)	107 (7.6)
	Gypsum	402 (25.4)	266 (15.4)	254 (15.4)	240 (19.0)	271 (12.3)	228 (16.0)	203 (18.3)	211 (11.8)	199 (15.3)
Osborne 2	Control	419 (17.9)	255 (17.6)	239 (21.9)	233 (13.6)	212 (26.0)	227 (14.3)	224 (14.6)	218 (15.1)	211 (16.9)
	Alum	351 (14.2)	95 (12.4)	145 (20.7)	132 (17.6)	131 (15.4)	116 (16.2)	101 (12.6)	124 (15.1)	77 (10.0)
	Gypsum	390 (40.0)	269 (25.9)	241 (24.2)	239 (23.1)	229 (19.0)	225 (18.2)	225 (19.5)	219 (19.5)	209 (20.3)
Osborne 3	Control	370 (25.9)	259 (19.0)	234 (17.1)	221 (15.7)	214 (14.1)	199 (15.7)	227 (12.7)	182 (15.7)	185 (12.5)
	Alum	420 (31.9)	121 (8.8)	110 (10.8)	114 (7.4)	81 (7.7)	45 (6.6)	37 (4.5)	24 (3.6)	23 (4.6)
	Gypsum	374 (40.6)	257 (18.6)	194 (22.0)	172 (26.0)	140 (13.6)	126 (17.6)	121 (24.0)	121 (21.9)	114 (10.7)
Scanterbury 1	Control	477 (58.8)	356 (36.6)	331 (29.9)	315 (30.6)	293 (24.7)	288 (22.7)	238 (15.2)	232 (17.5)	234 (17.3)
	Alum	506 (49.6)	341 (28.1)	371 (23.9)	250 (23.7)	277 (34.6)	288 (45.5)	214 (18.0)	331 (47.4)	178 (13.7)
	Gypsum	434 (86.1)	267 (44.4)	254 (27.5)	222 (34.3)	177 (9.7)	153 (20.2)	156 (35.7)	143 (29.4)	135 (31.0)
Scanterbury 2	Control	351 (43.9)	243 (24.9)	202 (41.0)	245 (55.0)	198 (35.8)	149 (37.8)	141 (36.4)	125 (28.0)	130 (27.1)
	Alum	325 (44.1)	223 (33.7)	172 (33.1)	117 (19.5)	67 (20.0)	65 (17.8)	62 (20.9)	55 (19.9)	157 (28.5)
	Gypsum	404 (62.1)	91 (20.1)	210 (20.0)	173 (17.6)	156 (12.0)	142 (13.5)	128 (19.1)	103 (17.6)	91 (9.2)

Supplemental Table S7. Mean pore water pH values with days after flooding in unamended, alum-amended and gypsum-amended soils (n=3). Standard error of mean is given in parentheses

Soil	Treatment	Days after flooding (DAF)								
		0	7	14	21	28	35	42	49	56
Dencross 1	Control	7.6 (0.06)	8.5 (0.17)	8.1 (0.05)	8.1 (0.07)	7.8 (0.12)	7.8 (0.06)	7.8 (0.12)	8.1 (0.08)	7.6 (0.01)
	Alum	7.3 (0.17)	8.1 (0.25)	7.8 (0.08)	7.9 (0.20)	7.5 (0.10)	7.5 (0.10)	7.5 (0.08)	7.8 (0.13)	7.4 (0.10)
	Gypsum	7.6 (0.09)	8.3 (0.16)	7.9 (0.04)	7.9 (0.20)	7.5 (0.11)	7.6 (0.05)	7.6 (0.14)	7.8 (0.19)	7.5 (0.04)
Dencross 2	Control	8.0 (0.19)	8.2 (0.13)	8.1 (0.14)	7.9 (0.19)	7.6 (0.20)	7.6 (0.20)	7.6 (0.20)	8.0 (0.33)	7.4 (0.17)
	Alum	5.5 (0.51)	7.6 (0.28)	7.5 (0.09)	7.5 (0.21)	7.1 (0.07)	7.3 (0.07)	7.3 (0.08)	7.6 (0.19)	7.3 (0.01)
	Gypsum	7.5 (0.12)	7.8 (0.00)	7.7 (0.07)	7.7 (0.05)	7.4 (0.03)	7.5 (0.02)	7.4 (0.02)	7.7 (0.16)	7.2 (0.03)
Lakeland	Control	8.2 (0.24)	8.5 (0.10)	8.2 (0.01)	8.3 (0.18)	8.0 (0.21)	8.0 (0.18)	7.9 (0.18)	8.4 (0.26)	7.9 (0.09)
	Alum	7.8 (0.13)	8.1 (0.03)	8.0 (0.08)	8.1 (0.05)	7.7 (0.01)	7.8 (0.05)	7.8 (0.01)	8.1 (0.10)	7.8 (0.03)
	Gypsum	8.0 (0.23)	8.2 (0.05)	8.1 (0.04)	8.1 (0.13)	7.8 (0.07)	7.9 (0.07)	7.8 (0.07)	8.1 (0.05)	7.9 (0.07)
Osborne 1	Control	7.8 (0.04)	8.6 (0.17)	8.2 (0.06)	8.2 (0.15)	7.8 (0.11)	7.8 (0.07)	7.8 (0.03)	8.0 (0.12)	7.7 (0.02)
	Alum	6.3 (0.49)	8.1 (0.17)	7.9 (0.16)	7.7 (0.00)	7.4 (0.09)	7.5 (0.15)	7.5 (0.09)	7.8 (0.17)	7.4 (0.14)
	Gypsum	7.6 (0.02)	8.3 (0.12)	8.1 (0.05)	8.1 (0.15)	7.7 (0.09)	7.8 (0.06)	7.8 (0.09)	8.0 (0.01)	7.7 (0.05)
Osborne 2	Control	7.9 (0.03)	8.6 (0.11)	8.3 (0.04)	8.4 (0.07)	7.9 (0.02)	8.0 (0.07)	7.9 (0.03)	8.0 (0.05)	7.8 (0.04)
	Alum	7.6 (0.34)	8.2 (0.16)	7.8 (0.08)	7.9 (0.03)	7.7 (0.14)	7.6 (0.09)	7.7 (0.08)	7.9 (0.18)	7.6 (0.13)
	Gypsum	7.9 (0.13)	8.3 (0.11)	8.0 (0.01)	8.1 (0.08)	7.8 (0.04)	7.9 (0.02)	7.8 (0.01)	8.0 (0.15)	7.7 (0.03)
Osborne 3	Control	7.9 (0.22)	8.4 (0.17)	8.1 (0.12)	8.2 (0.16)	7.8 (0.13)	7.8 (0.08)	7.8 (0.09)	8.0 (0.11)	7.7 (0.07)
	Alum	5.9 (0.48)	8.0 (0.23)	7.7 (0.04)	7.8 (0.15)	7.6 (0.15)	7.5 (0.07)	7.5 (0.06)	7.7 (0.03)	7.4 (0.08)
	Gypsum	7.9 (0.19)	8.3 (0.08)	8.0 (0.01)	8.0 (0.07)	7.6 (0.05)	7.7 (0.04)	7.7 (0.09)	7.9 (0.12)	7.6 (0.05)
Scanterbury 1	Control	6.8 (0.19)	8.0 (0.27)	7.4 (0.06)	7.4 (0.07)	7.2 (0.03)	7.2 (0.04)	7.2 (0.02)	7.3 (0.04)	7.0 (0.03)
	Alum	4.5 (0.17)	6.5 (0.59)	5.9 (0.30)	6.0 (0.24)	6.1 (0.25)	6.1 (0.16)	6.3 (0.17)	6.8 (0.38)	6.1 (0.13)
	Gypsum	6.7 (0.17)	7.5 (0.44)	7.0 (0.23)	6.8 (0.08)	6.7 (0.08)	6.7 (0.08)	6.7 (0.07)	6.8 (0.10)	6.6 (0.08)
Scanterbury 2	Control	7.1 (0.12)	8.0 (0.22)	7.6 (0.26)	7.5 (0.13)	7.2 (0.12)	7.2 (0.07)	7.2 (0.13)	7.3 (0.34)	7.1 (0.08)
	Alum	4.8 (0.19)	7.5 (0.22)	7.1 (0.16)	7.0 (0.11)	6.8 (0.02)	6.9 (0.03)	6.9 (0.04)	7.2 (0.09)	6.9 (0.02)
	Gypsum	6.9 (0.14)	7.8 (0.29)	7.2 (0.07)	7.2 (0.12)	7.0 (0.16)	7.0 (0.06)	7.0 (0.06)	7.3 (0.03)	6.9 (0.05)

Supplemental Table S8. Saturation index[†] (SI = log IAP – log Ksp) of P-sorbing mineral species in equilibrium solution in unamended (control), alum-amended and gypsum amended soils at 0, 28 and 56 days after flooding (DAF) as predicted by Visual MINTEQ modeling

Mineral	SI at 0 DAF			SI at 28 DAF			SI at 56 DAF		
	Un-amended	Alum-amended	Gypsum-amended	Un-amended	Alum-amended	Gypsum-amended	Un-amended	Alum-amended	Gypsum-amended
Dencross 2 soil									
Amorphous Al(OH) ₃	-3.8	-2.5	-1.1	0.5	1.3	0.4	-1.6	-0.1	0.1
Al ₂ O ₃ (s)	-6.1	-3.6	-0.8	2.5	4.0	2.3	-1.7	1.3	1.6
Al ₄ (OH) ₁₀ SO ₄ (s)	-8.6	3.0	4.6	9.1	15.1	11.1	1.0	8.8	10.0
Boehmite	-1.6	-0.4	1.0	2.6	3.4	2.5	0.5	2.1	2.2
Diaspore	0.3	1.5	2.9	4.5	5.3	4.4	2.4	3.9	4.1
Fe(OH) ₂ .7Cl ₃ (s)	-15.8	2.3	-10.6	-4.7	-1.4	-6.8	-3.2	0.6	3.8
Gibbsite (C)	-0.63	0.6	2.0	3.6	4.4	3.5	1.6	3.1	3.2
Goethite	-16.6	0.8	-11.2	-5.6	-2.5	-7.8	-4.1	-0.4	2.8
Hematite	-30.9	3.9	-20.2	-8.9	-2.7	-13.3	-6.0	1.5	7.9
Hercynite	-27.0	-3.8	-15.6	-3.6	3.1	-6.4	-4.2	3.9	4.7
Lepidocrocite	-16.7	0.7	-11.3	-5.7	-2.6	-7.9	-4.2	-0.5	2.7
Maghemite	-37.0	-2.2	-26.3	-15.0	-8.7	-19.4	-12.1	-4.6	1.8
Magnetite	-53.7	1.7	-37.0	-16.9	-5.5	-23.9	-10.4	2.2	9.1
Lakeland soil									
Amorphous Al(OH) ₃	-2.8	0.7	-0.3	-0.7	0.9	0.6	-1.4	0.7	0.0
Al ₂ O ₃ (s)	-4.2	2.9	1.0	0.1	3.2	2.6	-1.4	3.0	1.4
Al ₄ (OH) ₁₀ SO ₄ (s)	-5.3	11.3	8.1	3.9	11.6	10.7	0.6	11.2	8.2
Boehmite	-0.7	2.9	1.9	1.5	3.0	2.7	0.7	2.9	2.1
Diaspore	1.2	4.8	3.8	3.4	4.9	4.6	2.6	4.8	4.0
Ferrihydrite	-19.2	-7.9	2.2	-13.4	-10.4	-6.7	-13.3	-5.3	1.6
Gibbsite (C)	0.3	3.9	2.9	2.5	4.0	3.7	1.7	3.9	3.1
Hematite	-29.7	-7.1	13.3	-18.1	-12.1	-4.6	-17.8	-1.8	12.1
Hercynite	-23.6	-6.9	2.5	-11.2	-5.7	-2.4	-12.1	-0.1	5.0
Lepidocrocite	-16.1	-4.8	5.4	-10.3	-7.3	-3.5	-10.1	-2.1	4.8
Maghemite	-35.8	-13.2	7.2	-24.2	-18.1	-10.7	-23.9	-7.9	6.0
Magnesianferrihydrite	-37.4	-14.5	5.7	-25.2	-19.0	-11.9	-25.1	-9.3	4.8
Magnetite	-51.0	-18.8	12.8	-31.3	-22.9	-11.6	-30.3	-6.8	13.8

[†]Positive SI values (in red text) indicate oversaturation. IAP ion activity product, KSP solubility product constant