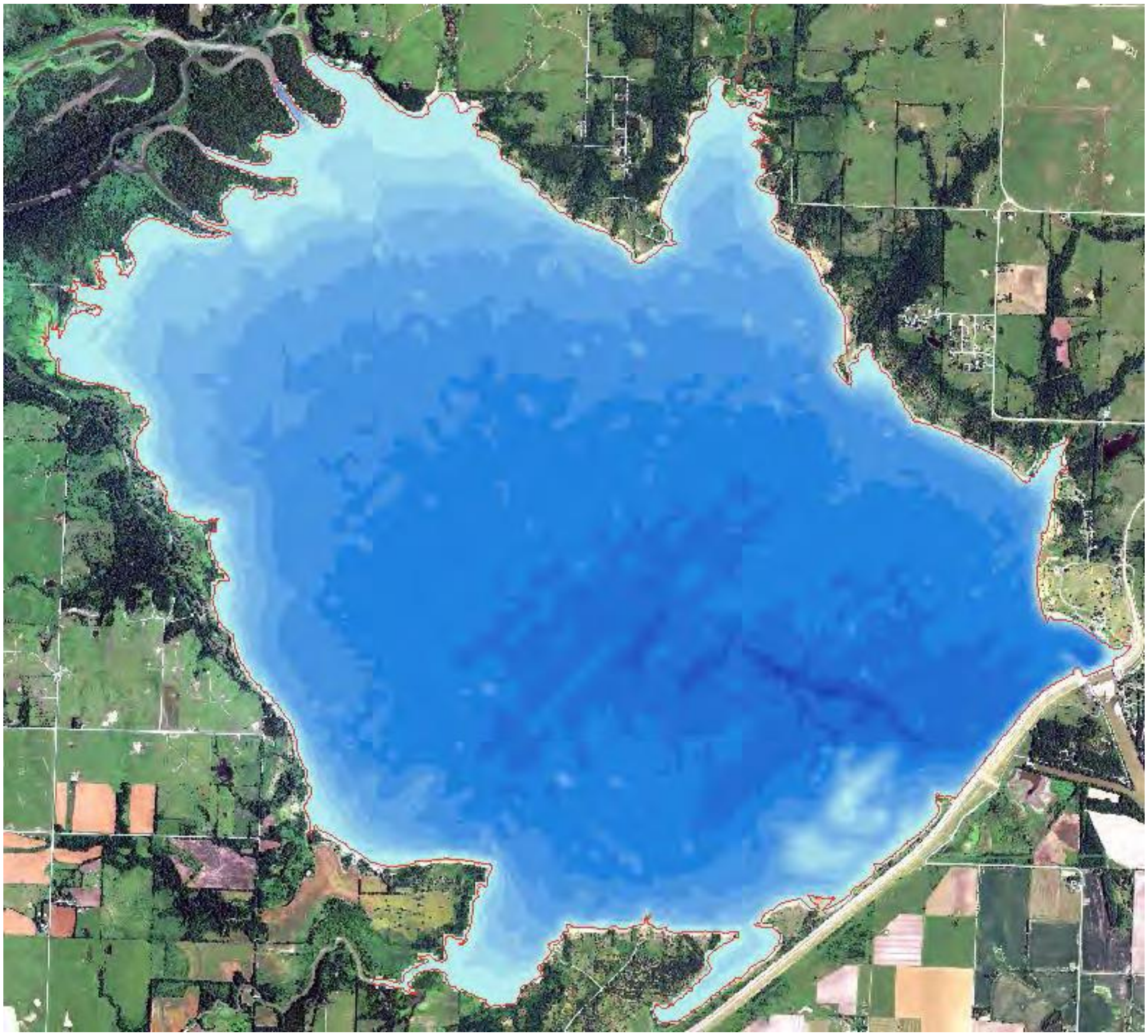
Characterization and Mapping of Sediment Thickness and Pattern in John Redmond Reservoir, Coffey County, Kansas



Kansas Biological Survey

Applied Science and Technology

Reservoir Assessment (ASTRA) Program

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Characterization and Mapping of Sediment Thickness and Pattern in John Redmond Reservoir

SUMMARY

In July 2014, the Kansas Biological Survey (KBS) conducted extensive sediment sampling in John Redmond Reservoir in Coffee County, Kansas. A two-phase sampling approach was employed. A set of 105 predetermined sampling sites were identified along a 500-meter grid pattern across the reservoir. One phase consisted of sampling 75 sites for surface sediments to characterize spatial patterns of texture and nutrients and, in the second phase, 30 sites were sampled using vibra-core sampling equipment to determine sediment thickness, nutrient history, and textural history. Of the 105 sites sampled, ten either had no sediment or not enough sediment for analysis.

INTRODUCTION

The nature and rate of sediment deposition and nutrient enrichment of reservoirs is relatively complex. To characterize the spatial patterns of sediment deposition, texture and nutrients in the sediment requires a large number of samples. John Redmond Reservoir, which has accumulated a large quantity of sediment over time, was selected for extensive sediment sampling and analysis to determine if the information obtained would aid in this characterization. The inflow of material into the reservoir is generally related to runoff events with deposition of large quantities following sizable events. Depending on the size and density of the particulate material, discernable layers are formed that can often be determined in the analysis of sediment cores. Layers may be visible along a core, detected by texture analysis, or revealed by chemical analysis of nutrient (nitrogen and phosphorous) concentrations.

Deposition of material is not necessarily uniform throughout the reservoir with heavier material being deposited near the reservoir inlet and lighter material being carried further into the reservoir. The pattern of flow through the reservoir also effects where the material is deposited as well as wind and wave action that creates internal currents that redistributes material. Material generated by shoreline erosion can be deposited as well, adding to the potential for additional heterogeneity in the pattern and composition of the material deposited. This variability can be evaluated by analysis of the texture and nutrient composition of the upper layer of sediment.

The sampling design to characterize the sediment composition was to collect a combination of core samples and surface sediment samples along a grid consisting of 105 sampling sites spaced 500 meters apart (Figure 1). Core samples were taken at 30 sites and surface sediment samples were taken at 75 sites. The sampling sites were predetermined by using ESRI's Arc GIS software and 2012 georeferenced National Agricultural Imagery Project (NAIP) photography of Coffee County. A digitized polygon shapefile of the lake boundary of John Redmond Reservoir was created from the photography and the 500 meter grid pattern generated within the boundary. A GPS receiver attached to a laptop computer that had the photography and grid displayed was used to navigate to each sampling site.

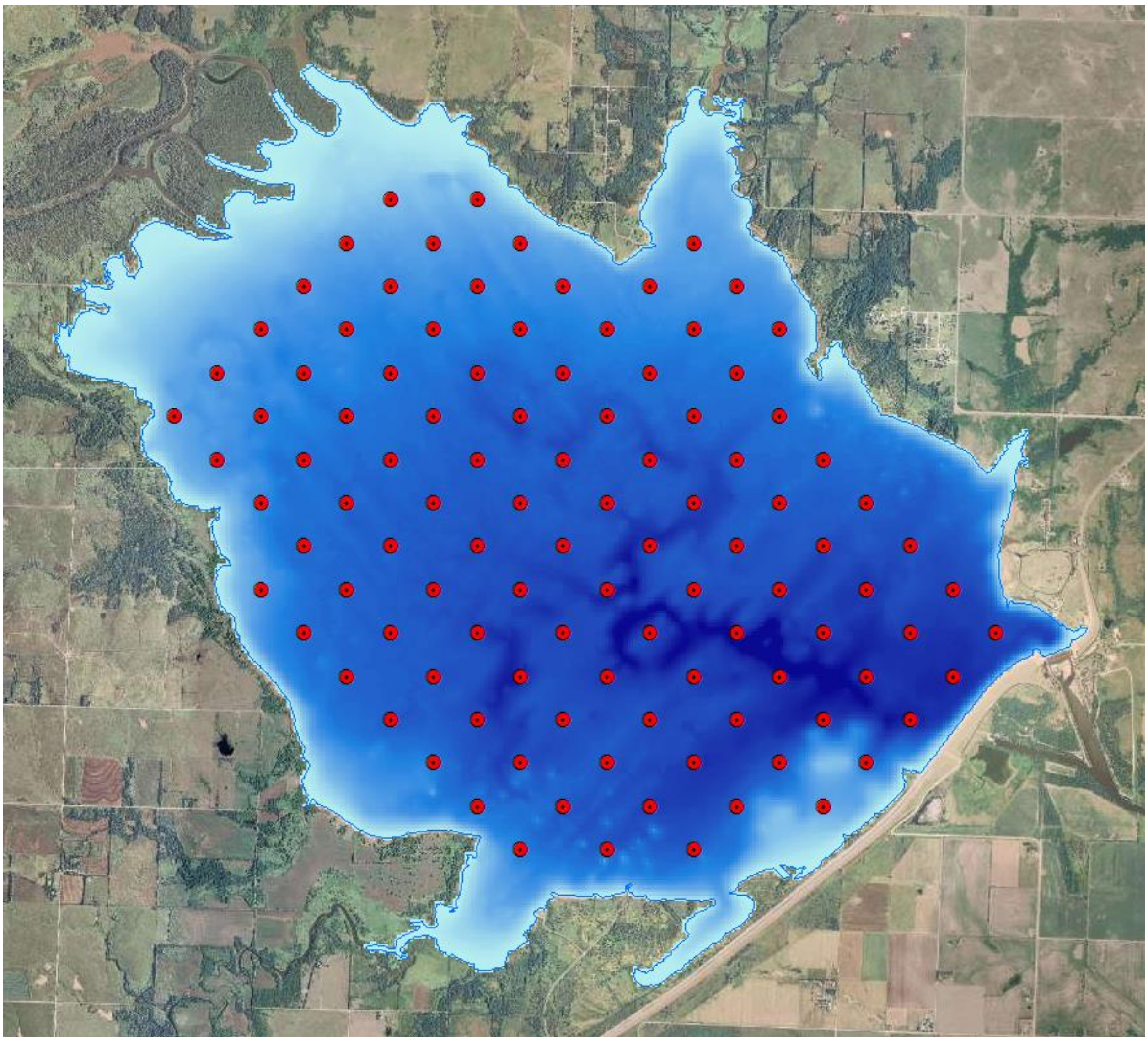


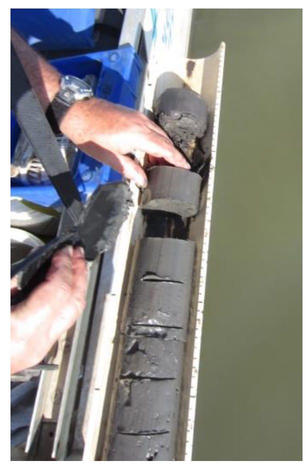
Figure 1. Sediment sampling sites on 500-meter grid for John Redmond Reservoir.

SEDIMENT CORING PROCEDURES

KBS operates a Specialty Devices Inc. sediment vibracorer mounted on a dedicated 24' pontoon boat. The vibracorer uses 3" diameter aluminum thinwall pipe in user specified lengths. The system uses a 24-v electric motor with counter-rotating weights in the vibracorer head unit to create a high-frequency vibration in the pipe, allowing the pipe to penetrate sediments and substrate as it is lowered into the lake using a winch. Once the open end of the core pipe has penetrated to the substrate, the unit is turned off and the unit is raised to the surface using the winch. At the surface, the pipe containing the sediment core is disconnected from the vibracore head and the sediment extruded from the pipe and measured.

KBS vibe-core system

At each site the core boat was anchored and the vibracore system used to extract a sediment core down to and including the upper several inches of pre-impoundment soil (substrate). The cores were then carefully extruded from the core pipe, and the interface between sediment and substrate identified. Typically, this identification is relatively easy, with the interface being identifiable by changes in material density and color, and the presence of roots or sticks in the substrate. For cores to be used to determine nutrient history the entire extruded core sample was sectioned into sequential 5 centimeter subsamples and each subsample sealed in a sampling container for analysis. Each subsample was labeled with the site location and corresponding location of the subsample along the core.


Core being sectioned

A total of 30 sites were sampled (Figure 2) but no sediment was found at three sites near the northwest end of reservoir. Length measurements were recorded for all 27 cores that were taken, however, no discrete interface between the original bottom and the deposited sediment was found for six cores that were measured. Of the 27, 10 cores were entirely sectioned into subsamples for nutrient and texture analysis, a subsample of the top 10-15 cm of sediment of 13 cores was collected for nutrient and texture analysis, and no samples were collected for analysis from 4 cores taken and measured.

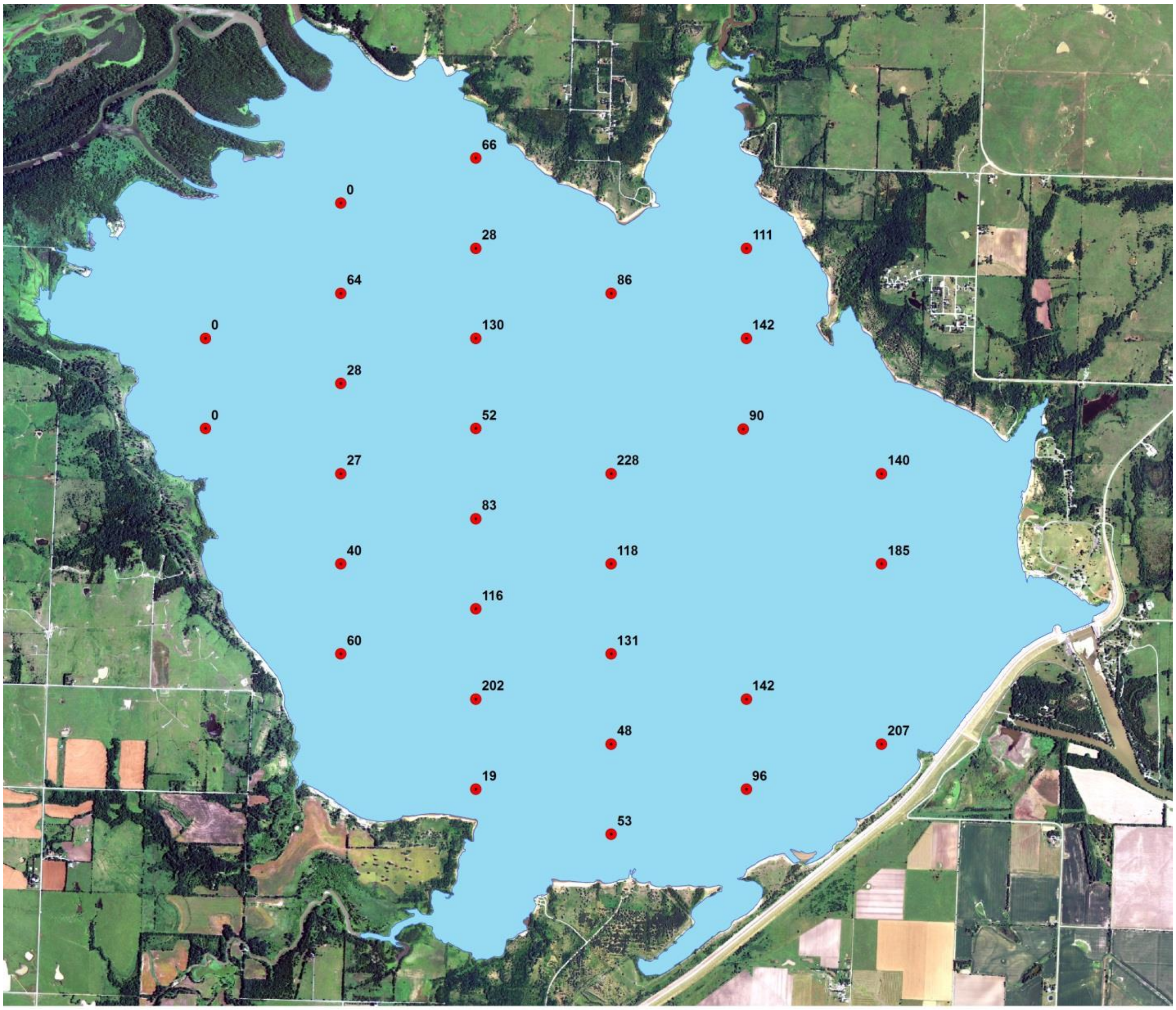


Figure 2. Core sampling site locations with length (cm) of core sample.

<u>SEDIMENT CORE ANALYSIS</u>

Ten of the 27 core samples were sequentially sectioned (chronosequence) and the sections sent to the Kansas State University Soil Testing Lab for texture (particle size), total phosphorous (TP), and total nitrogen (TN) analysis. Complete results of the analysis can be found in the Appendix (spreadsheet tables and bar graphs). However, averages were calculated from the detailed data for total nitrogen and phosphorous (Figure 3) and texture (Figure 4) for each of the 10 sectioned core sample.

Average total nitrogen and phosphorous did not very greatly between core samples. The exception was the core sample taken near the dam (JRVC-6) that had lowest concentrations of both TN and TP. This sample also had the highest average amounts of sand and silt and the lowest amount of clay than the other core samples (Figure 4).

Due to adsorption of phosphorous to clay particles and the lower percentage of clay at the site, the lower TP at the JRVC-6 site is not unexpected.

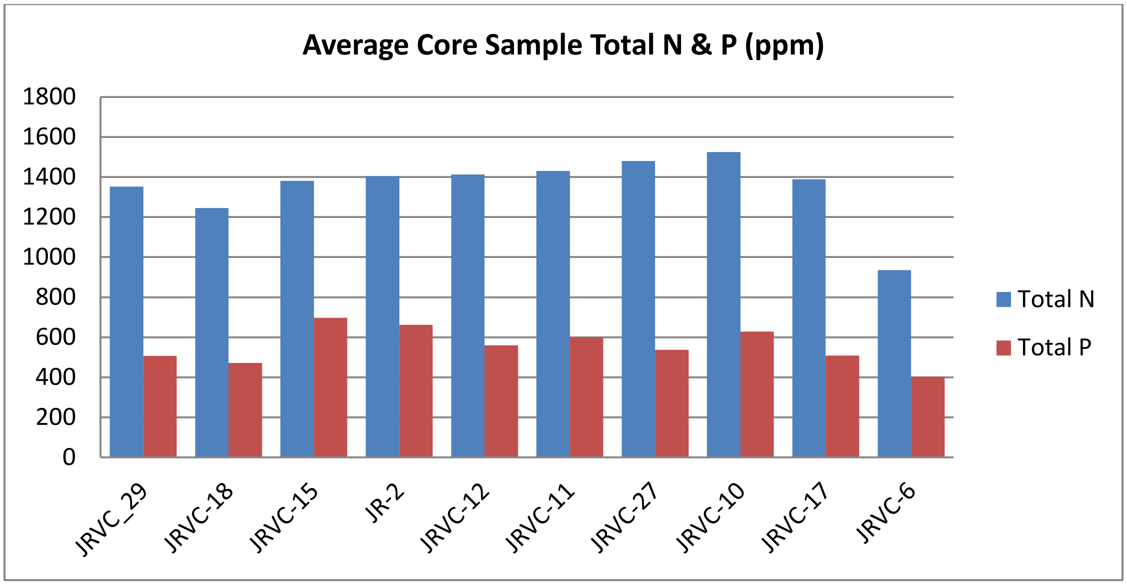


Figure 3. Average core sample total nitrogen and phosphorous.

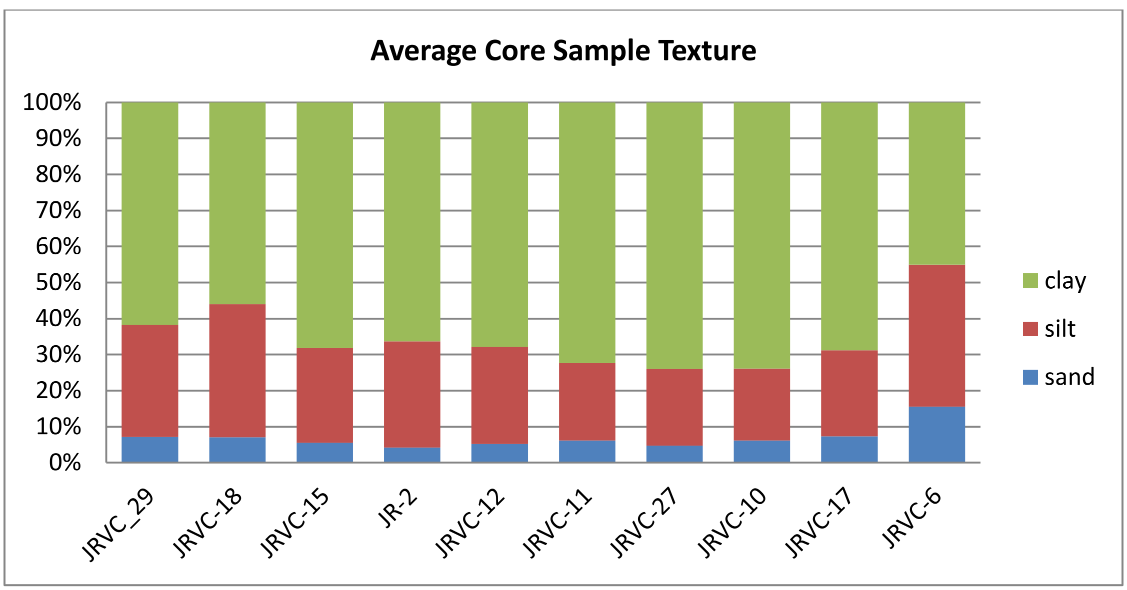


Figure 4. Average particle size content of core samples.

TOP SAMPLING PROCEDURES

A Wildco drop-corer (Wildlife Supply Company, Buffalo, NY) was used to sample the top portion of the sediment. The same method was used for the GPS location of each sample site as was used for the core samples. Only the upper 10 – 15 cm of sediment was collected and sealed in a sampling container for analysis. Of the 75 sampling site locations, sediment was found at 67 sites and no sediment was found at eight sites. Sampling site locations can be found in Figure 5. Not enough sediment for analysis was found at eight sites and, while only a small amount found was at two additional sites, there was enough sediment for analysis. The two sites with sparse sediment were also generally located in the same area near the northwest end of lake where no sediment was found during core sampling.

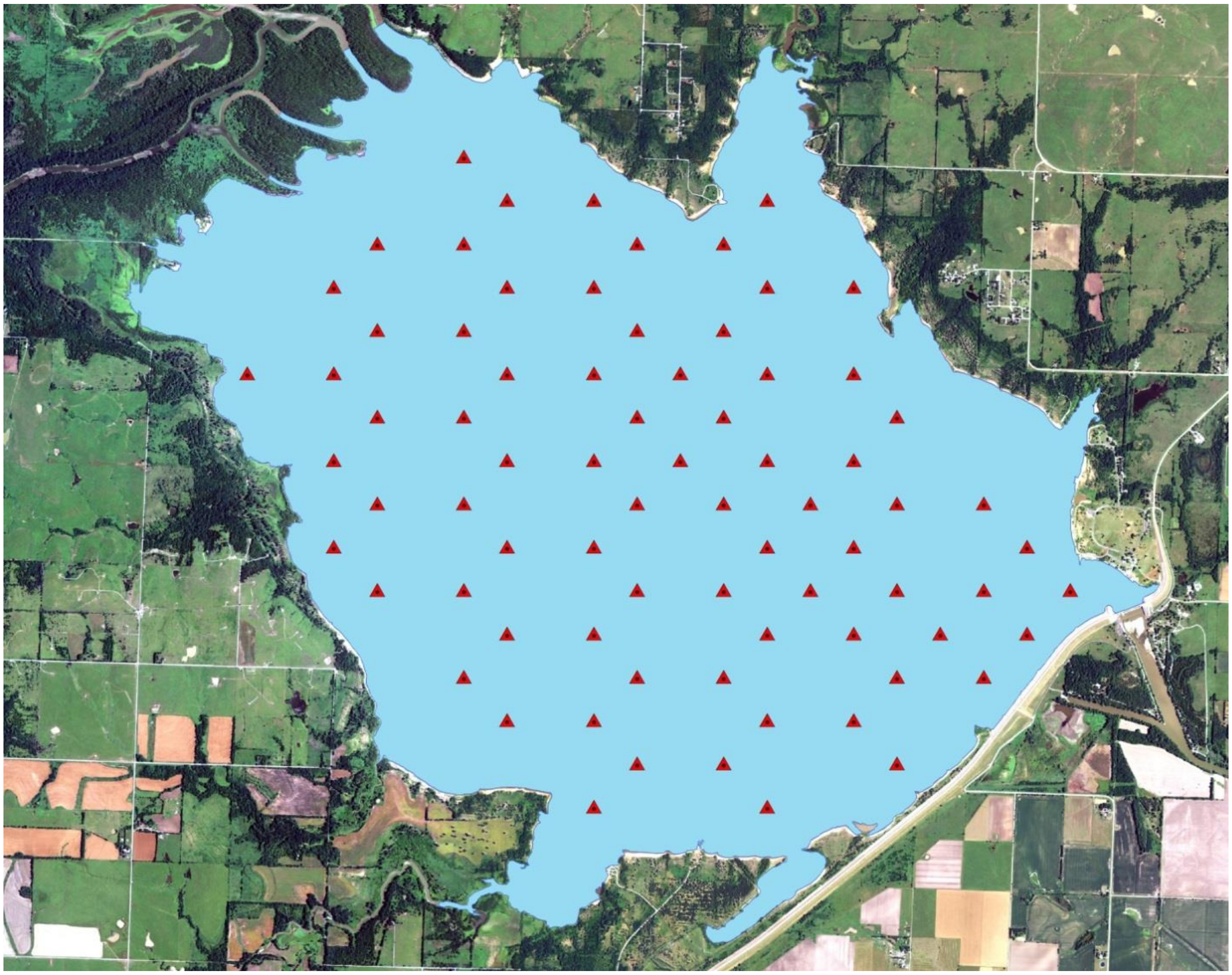


Figure 5. Wildco top sediment sampling locations.

Surface sediment samples were also analyzed by the Kansas State University Soil Testing Lab for texture (particle size), total phosphorous (TP), and total nitrogen (TN). The surface sample data combined with the data for only the top portion of each of the core samples allows for the comparison of similar data from all 94 sites across the reservoir where sediment was found. The quantity of TP found in surface sediment ranged from 302ppm to 721ppm. In general, lower concentrations were found in samples taken in peripheral region of the reservoir and the higher concentrations in main basin (Figure 6). The quantity of TN ranged from 513ppm to 1722ppm. The low to high pattern of TN concentrations across the reservoir is similar but not exactly the same to that of TP (Figure 7).

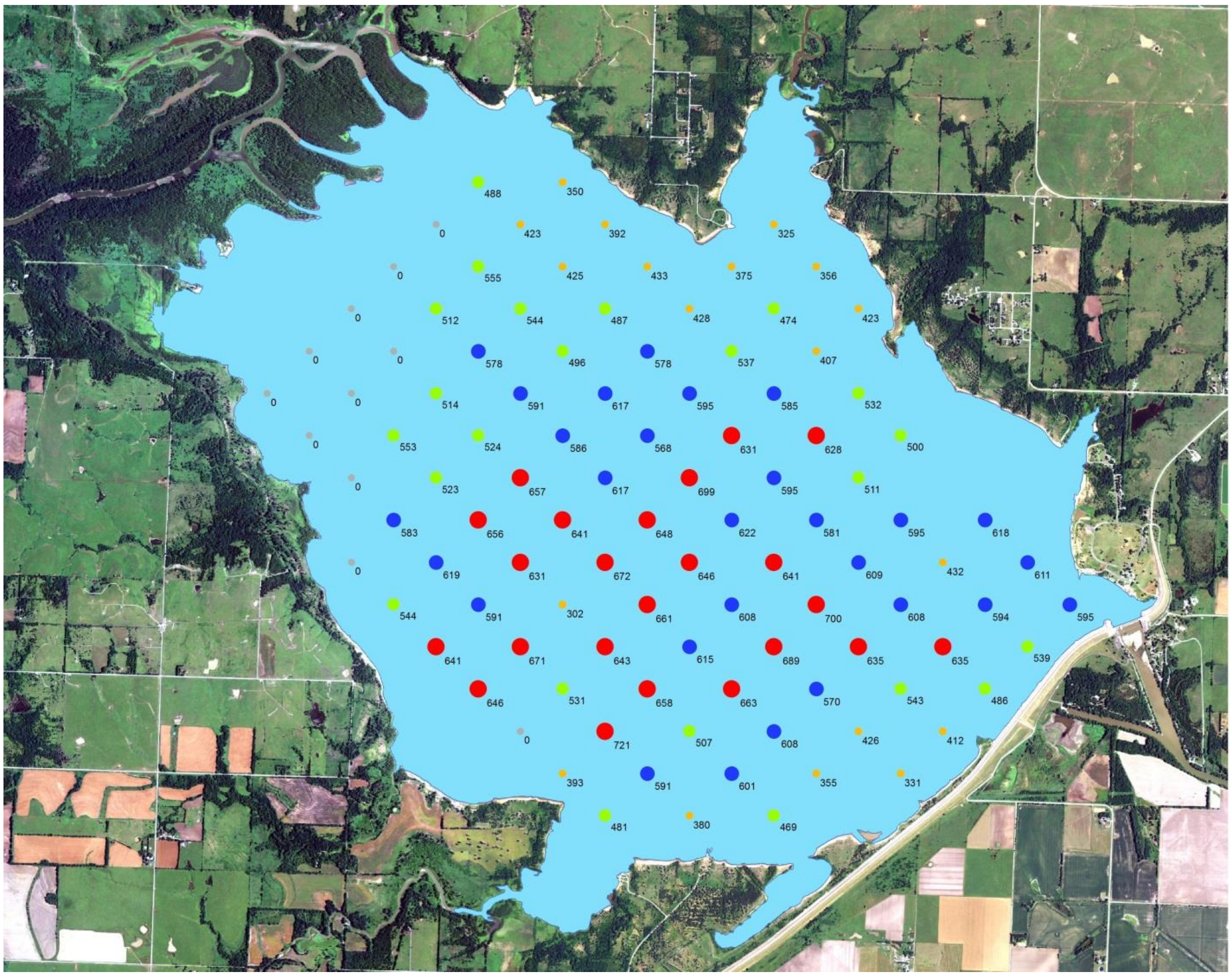


Figure 6. Quantity of Total Phosphorus (ppm) found in surface sediment samples. Dot size and color is used to illustrate 5 classes of TP concentration (0, 1-433, 434-555, 556-622, 623-721).

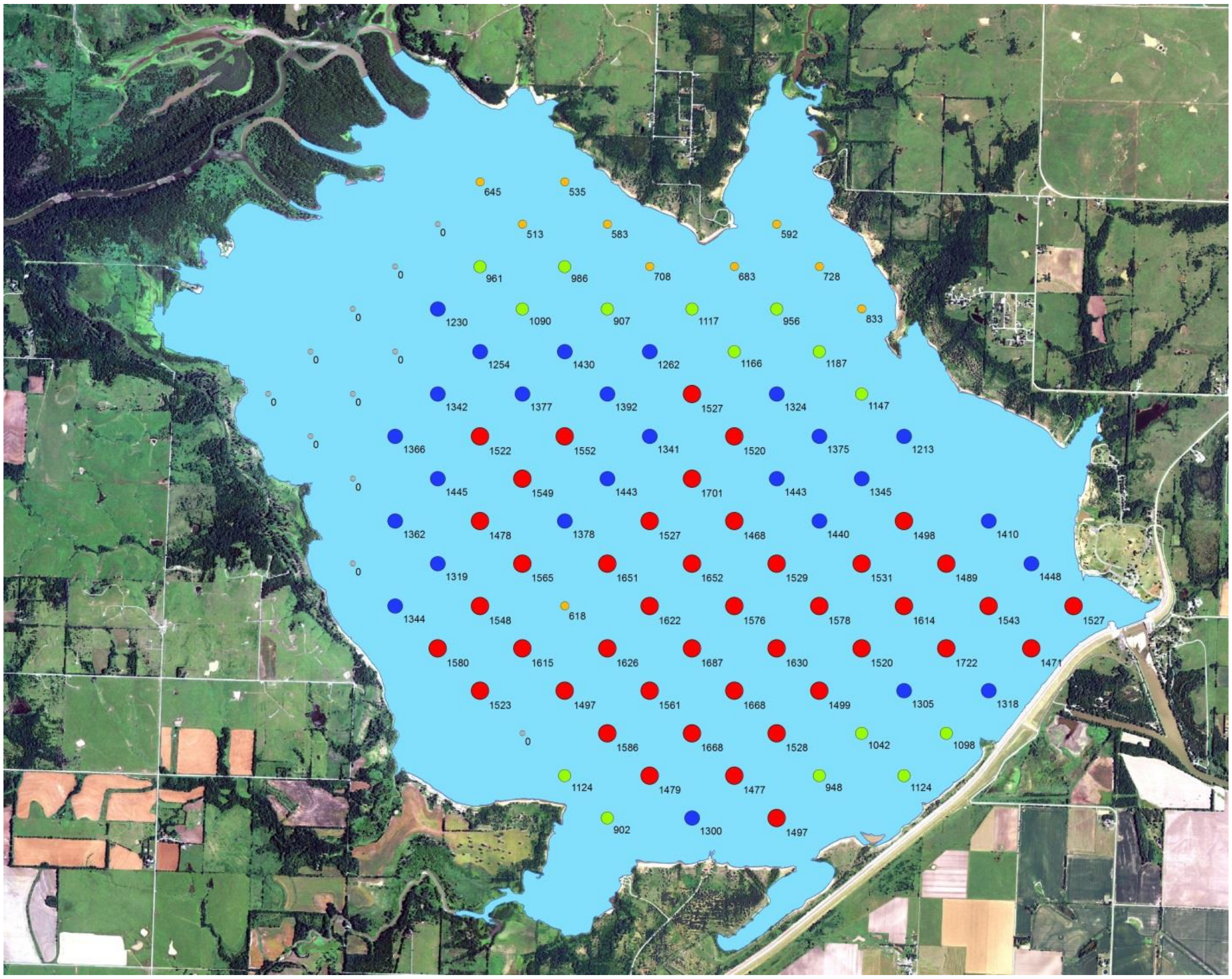


Figure 7. Quantity of Total Nitrogen (ppm) found in surface sediment samples. Dot size and color is used to illustrate 5 classes of TN concentration (0, 1-833, 834-1187, 1188-1448, 1449-1722).

Results of the texture analysis (percent sand, silt and clay) of the surface sediment samples were reasonably consistent with the distribution of the amounts of TP and TN that were found (see Appendix –Spreadsheet Data and Graphs). Often, samples with a higher percent composition of silt and clay also had the higher concentrations of TP and TN. While phosphorous and nitrogen both adsorb to smaller size particles (silt and clay), only the ammonia (NH_3) component of TN tends to bind to clay and organic particles (Morris and Fan, 1998). (Separate constituents were not included in sediment analysis for TP and TN, or the organic fraction). The percent composition of clay found in the 94 samples is shown in Figure 8 to illustrate the relationship TN and TP depicted in the previous figures.

The higher percent composition of clay is found in the main basin region of the reservoir with lesser amounts of all three constituents in the vicinity of the inlet and northeastern portion of the reservoir. It should be noted the highest percentage of sand was also found in these same areas of the reservoir. In addition to the nutrients and clay distribution pattern, the lack of measurable sediment in the northwestern region of the reservoir adds support to the findings of the bathymetric survey also conducted this past summer (KBS Report 2014-01, October 2014) that additional sediment deposition since 2007 is primarily occurring in lower elevations within the reservoir.

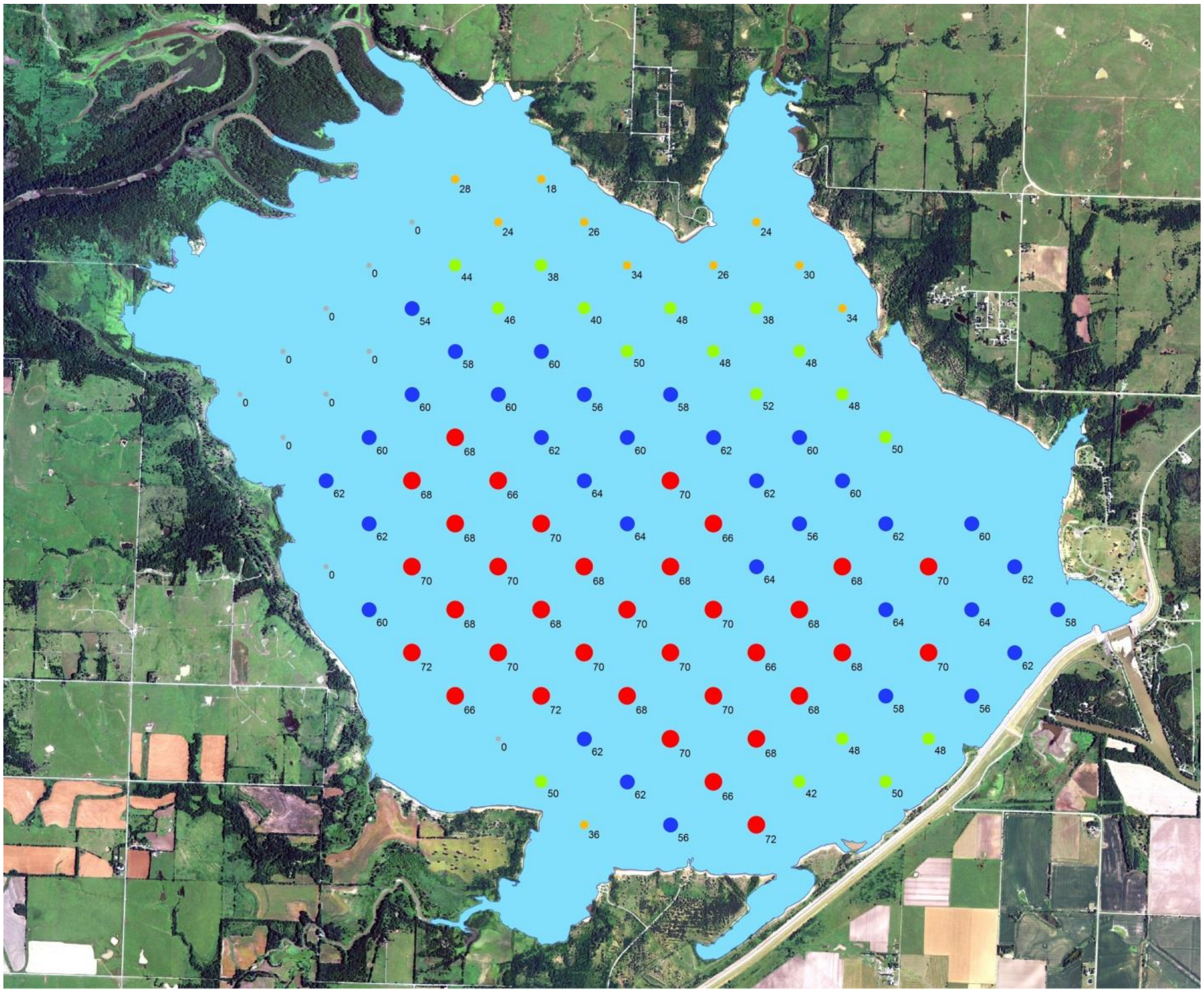


Figure 8. Percent composition of clay found in surface sediment samples. Dot size and color is used to illustrate 5 percentage classes (0, 1-36, 37-52, 53-64, 65-72).

Although there is a close relationship between TP and the percent clay component of reservoir sediment, other constituents are readily found with clay, silt and other small sized particles found in sediment. Because of the variety of particles sizes contained in source material coming into a reservoir and the differential deposition of different particle sizes within a reservoir, a normalization of the surface area of particles is needed to more accurately compare constituent composition from site to site or sample to sample (Collins, Walling and Leeks, 1997). The normalization procedure for TP with clay for these comparisons is simply achieved by dividing TP by the percent clay. A map of the 94 surface sediment sites (Figure 9) shows the results of normalization of TP.

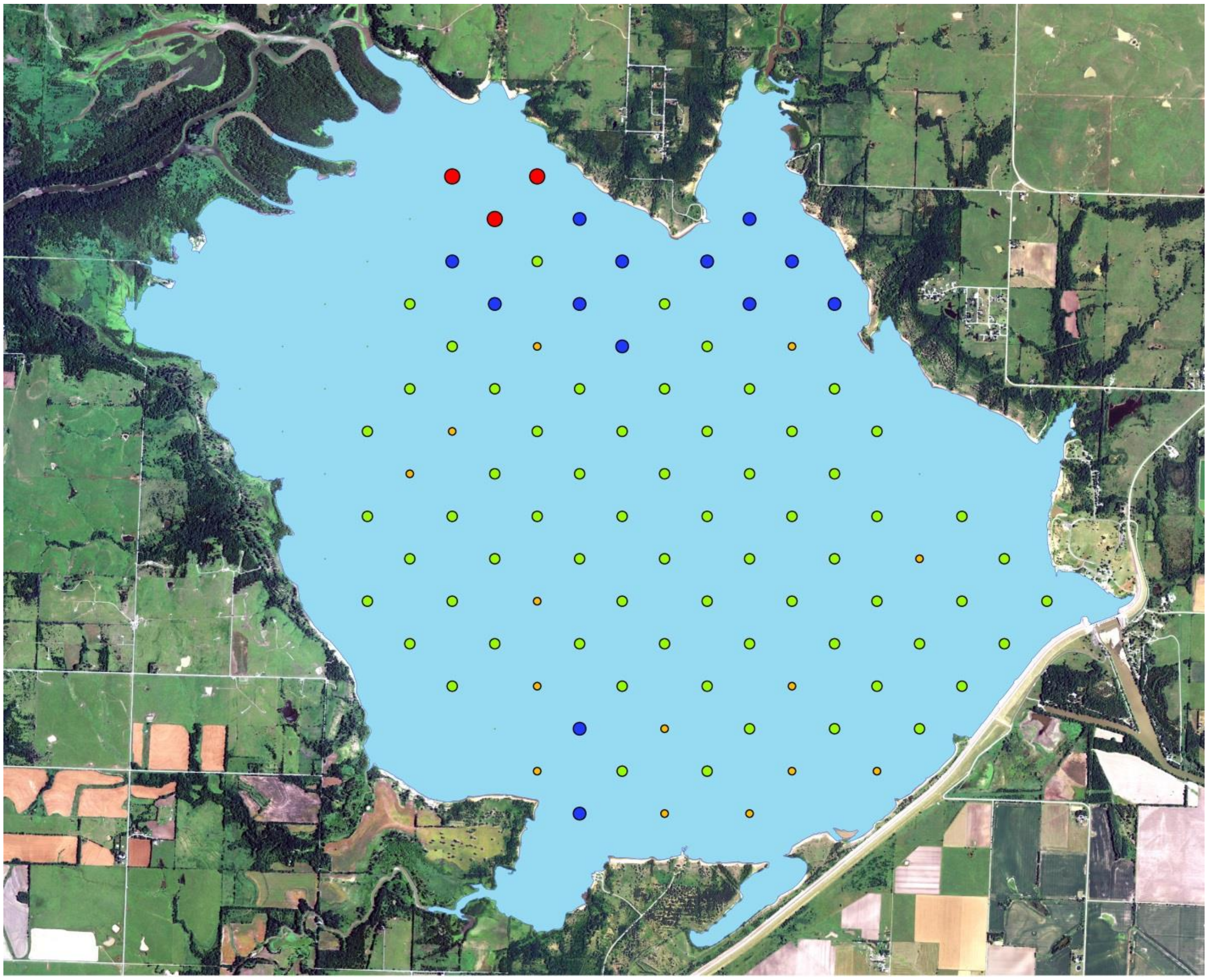


Figure 9. Normalized total phosphorous (TP/% clay) found in surface sediment samples. Dot size and color is used to illustrate 4 normalized class levels of TP.

STUDY DATA

A total of 324 sediment samples were analyzed for nutrient content (TN and TP) and texture (percent sand, silt and clay). Data from analysis of all sediment samples (n=324) and graphical depictions of some data is presented in the Appendix.

Literature Cited

Collins, A.L., Walling, D.E., and Leeks, G.J.L., 1997. Source type ascription for fluvial suspended sediment based on a quantitative composite fingerprinting technique: Catena, v. 29, pgs. 1-27.

Morris, L.M., and Fan, J., 1998. Reservoir sedimentation handbook: New York, McGraw-Hill, p. 4.17.

APPENDIX

Sample Analysis Data and Graphs

Surface Sediment Data Followed by Graphs of Data

(Includes surface sediment data from sectioned core samples, n=94 samples)

Data: pages 12-14

Graphs: page 14

Sectioned Core Sample Data Followed by Graphs of Data

(10 cores samples sectioned)

Data: pages 16-24

Graphs: pages 25 -34

Site Location Coordinates

page 35

Spreadsheet of Surface Sediment Data

Name	%Sand	%Silt	%Clay	Total_N (ppm)	Total_P (ppm)
JR_10	6	28	66	1477	601
JR_11	6	26	68	1528	608
JR_12	4	26	70	1668	663
JR_13	4	30	66	1630	689
JR_14	6	26	68	1520	635
JR_15	4	32	64	1614	608
JR_16	6	30	64	1543	594
JR_17	6	32	62	1448	611
JR_18	6	34	60	1410	618
JR_19	4	34	62	1498	595
JR_2	6	34	60	1375	628
JR_20	4	28	68	1531	609
JR_21	4	32	64	1529	641
JR_22	6	24	70	1576	608
JR_23	6	24	70	1622	661
JR_24	6	24	70	1626	643
JR_25	6	26	68	1561	658
JR_26	8	30	62	1586	721
JR_27	8	30	62	1479	591
JR_28	22	42	36	902	481
JR_30	8	26	66	1523	646
JR_31	6	24	70	1615	671
JR_32	6	26	68	1548	591
JR_33	6	24	70	1565	631
JR_34	6	26	68	1651	672
JR_35	2	34	64	1527	648
JR_36	4	30	66	1468	622
JR_37	2	36	62	1443	595
JR_38	2	38	60	1345	511
JR_39	2	48	50	1213	500
JR_4	6	32	62	1471	539
JR_40	4	48	48	1147	532
JR_41	8	58	34	833	423
JR_42	6	56	38	956	474
JR_43	8	66	26	683	375
JR_44	10	66	24	592	325
JR_45	4	48	48	1166	537

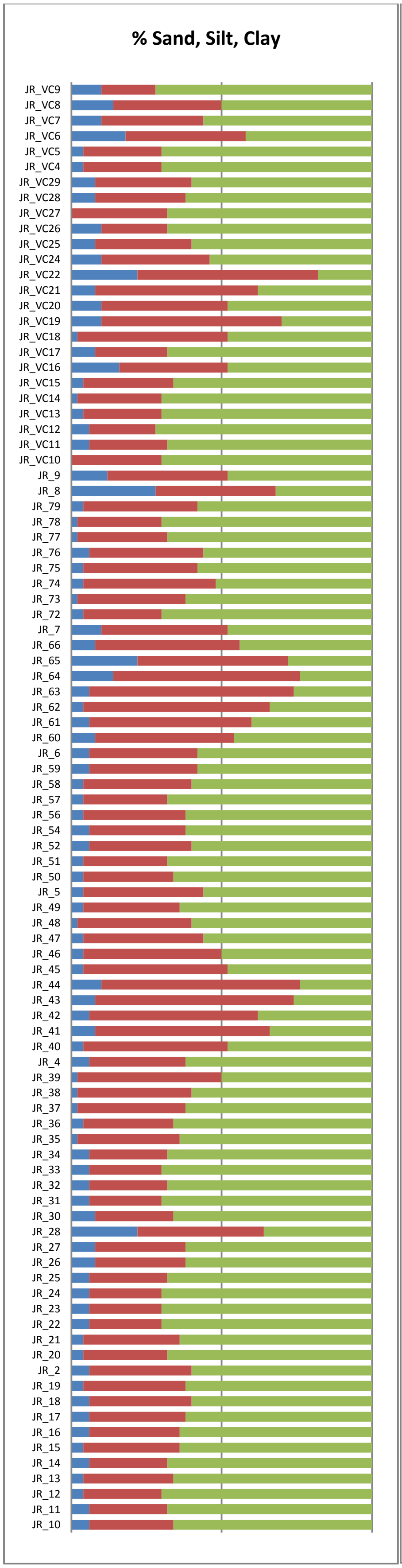
Spreadsheet of Surface Sediment Data (continued)

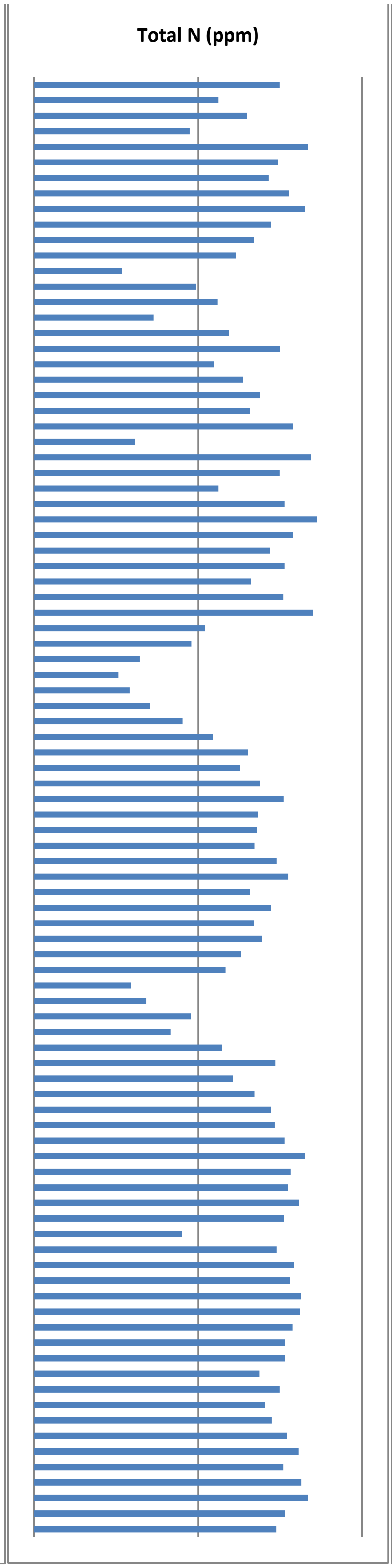
Name	%Sand	%Silt	%Clay	Total_N (ppm)	Total_P (ppm)
JR_46	4	46	50	1262	578
JR_47	4	40	56	1392	617
JR_48	2	38	60	1341	568
JR_49	4	32	64	1443	617
JR_5	4	40	56	1318	486
JR_50	4	30	66	1549	657
JR_51	4	28	68	1478	656
JR_52	6	34	60	1344	544
JR_54	6	32	62	1362	583
JR_56	4	34	62	1366	553
JR_57	4	28	68	1522	524
JR_58	4	36	60	1377	591
JR_59	6	36	58	1254	578
JR_6	6	36	58	1305	543
JR_60	8	46	46	1090	544
JR_61	6	54	40	907	487
JR_62	4	62	34	708	433
JR_63	6	68	26	583	392
JR_64	14	62	24	513	423
JR_65	22	50	28	645	488
JR_66	8	48	44	961	555
JR_7	10	42	48	1042	426
JR_72	4	26	70	1701	699
JR_73	2	36	62	1520	631
JR_74	4	44	52	1324	585
JR_75	4	38	58	1527	595
JR_76	6	38	56	1440	581
JR_77	2	30	68	1578	700
JR_78	2	28	70	1722	635
JR_79	4	38	58	1527	595
JR_8	28	40	32	1124	331
JR_9	12	40	48	1497	469
JR_VC10	0	30	70	1687	615
JR_VC11	6	26	68	618	302
JR_VC12	6	22	72	1580	641
JR_VC13	4	26	70	1319	619
JR_VC14	2	28	70	1378	641

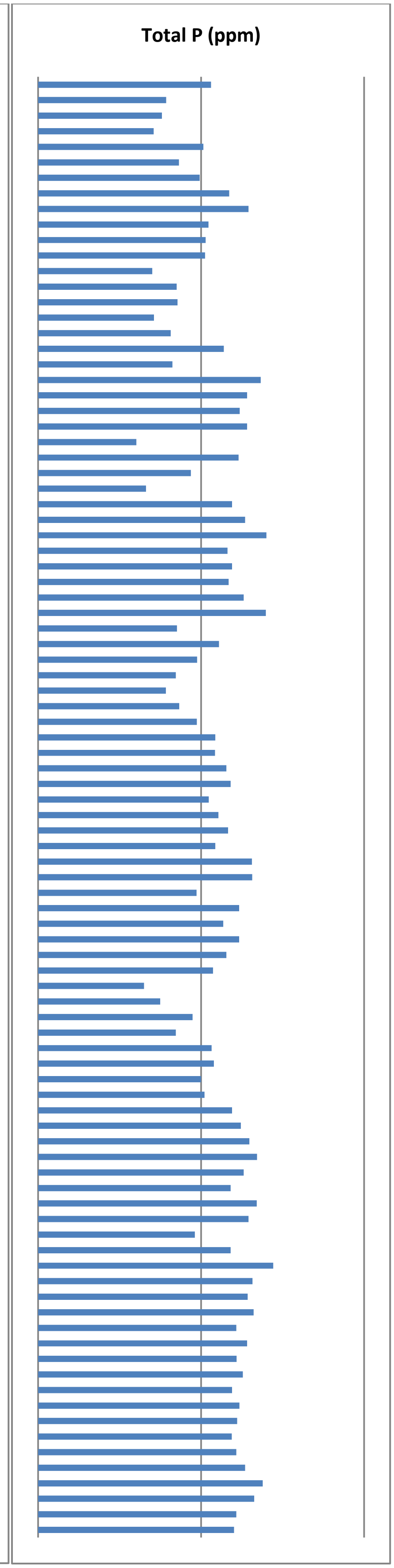
Spreadsheet of Surface Sediment Data (continued)

Name	%Sand	%Silt	%Clay	Total_N (ppm)	Total_P (ppm)
JR_VC15	4	30	66	1275	683
JR_VC16	16	36	48	1098	412
JR_VC17	8	24	68	1499	570
JR_VC18	2	50	48	1187	407
JR_VC19	10	60	30	728	356
JR_VC20	10	42	48	1117	428
JR_VC21	8	54	38	986	425
JR_VC22	22	60	18	535	350
JR_VC24	10	36	54	1230	512
JR_VC25	8	32	60	1342	514
JR_VC26	10	22	68	1445	523
JR_VC27	0	32	68	1652	646
JR_VC28	8	30	62	1552	586
JR_VC29	8	32	60	1430	496
JR_VC4	4	26	70	1489	432
JR_VC5	4	26	70	1668	507
JR_VC6	18	40	42	948	355
JR_VC7	10	34	56	1300	380
JR_VC8	14	36	50	1124	393
JR_VC9	10	18	72	1497	531

Graphs of Surface Sediment Data







Sediment Core Sample Data

JRVC_29 (core length = 130 cm)

Sample ID	Lab #	Total N	Total P	sand	silt	clay
		ppm	ppm	%	%	%
JRVC_29 5cm	24	1383	508	10	42	48
JRVC_29 10cm	25	1369	507	10	32	58
JRVC_29 15cm	26	1335	494	8	28	64
JRVC_29 20cm	27	1367	518	8	26	66
JRVC_29 25cm	28	1402	558	6	26	68
JRVC_29 30cm	29	1390	497	8	30	62
JRVC_29 35cm	30	1350	472	8	34	58
JRVC_29 40cm	31	1099	482	8	36	56
JRVC_29 45cm	32	1227	459	8	40	52
JRVC_29 50cm	33	1285	495	0	28	72
JRVC_29 55cm	34	1354	581	6	24	70
JRVC_29 60 cm	35	1394	525	6	30	64
JRVC_29 65cm	36	1330	478	6	38	56
JRVC_29 70cm	37	1298	475	8	32	60
JRVC_29 75cm	38	1391	492	4	28	68
JRVC_29 80cm	39	1378	486	6	30	64
JRVC_29 85cm	40	1414	546	6	28	66
JRVC_29 90cm	41	1404	545	6	24	70
JRVC_29 95cm	42	1416	516	6	30	64
JRVC_29 100cm	43	1385	506	8	28	64
JRVC_29 105cm	44	1364	486	6	28	66
JRVC_29 110cm	45	1322	512	8	34	58
JRVC_29 115cm	46	1323	527	10	36	54
JRVC_29 120cm	47	1300	499	10	34	56
JRVC_29 125cm	48	1439	517	8	32	60
JRVC_29 130cm	49	1430	496	8	32	60

JRVC_18 (core length = 142 cm)

Sample ID	Total N	Total P	sand	silt	clay
	ppm	ppm	%	%	%
JRVC-18 5cm	1276	546	12	40	48
JRVC-18 10cm	1434	476	8	28	64
JRVC-18 15cm	1293	476	6	32	62
JRVC-18 20cm	1358	516	6	32	62
JRVC-18 25cm	1313	489	6	30	64
JRVC-18 30cm	1282	494	6	36	58
JRVC-18 35cm	1301	521	8	34	58
JRVC-18 40cm	1213	465	6	40	54
JRVC-18 45cm	1075	431	8	46	46
JRVC-18 50cm	1247	511	8	34	58
JRVC-18 55cm	1189	482	8	34	58
JRVC-18 60cm	1241	478	6	34	60
JRVC-18 65cm	1265	441	8	32	60
JRVC-18 70cm	1226	489	8	32	60
JRVC-18 75cm	1279	486	6	36	58
JRVC-18 80cm	1198	481	6	38	56
JRVC-18 85cm	1286	533	8	30	62
JRVC-18 90cm	1288	500	8	34	58
JRVC-18 95cm	1239	504	6	36	58
JRVC-18 100cm	1226	489	6	40	54
JRVC-18 105cm	1245	445	8	30	62
JRVC-18 110cm	1240	458	8	38	54
JRVC-18 115cm	1289	449	8	36	56
JRVC-18 120cm	1255	428	6	36	58
JRVC-18 125cm	1197	377	8	44	48
JRVC-18 130cm	1014	379	6	52	42
JRVC-18 135cm	1183	447	6	50	44
JRVC-18 142cm	1187	407	2	50	48

JRVC_15 (core sample length = 225 cm)

Sample ID	Total N ppm	Total P ppm	Sand %	Silt %	Clay %
JRVC-15 5cm	1631	782	8	40	52
JRVC-15 10cm	1469	722	6	42	52
JRVC-15 15cm	1538	750	8	32	60
JRVC-15 20cm	1436	665	10	34	56
JRVC-15 25cm	1302	607	10	44	46
JRVC-15 30cm	1462	748	10	26	64
JRVC-15 35cm	1528	679	8	26	66
JRVC-15 40cm	1507	757	6	12	82
JRVC-15 45cm	1517	713	6	16	78
JRVC-15 50cm	1446	774	6	28	66
JRVC-15 55cm	1499	709	4	24	72
JRVC-15 60cm	1529	746	4	20	76
JRVC-15 65cm	1462	696	6	20	74
JRVC-15 70cm	1564	747	4	20	76
JRVC-15 75cm	1538	751	4	18	78
JRVC-15 80cm	1460	684	4	24	72
JRVC-15 85cm	1293	663	6	24	70
JRVC-15 90cm	1462	665	4	26	70
JRVC-15 95cm	1540	723	8	26	66
JRVC-15 100cm	1486	684	4	30	66
JRVC-15 105cm	1466	723	6	24	70
JRVC-15 110cm	1451	789	4	30	66
JRVC-15 115cm	1405	608	6	34	60
JRVC-15 120cm	1439	718	8	24	68
JRVC-15 125cm	1509	726	8	22	70
JRVC-15 130cm	1205	608	6	32	62
JRVC-15 135cm	1234	669	6	24	70
JRVC-15 140cm	1235	639	6	24	70
JRVC-15 145cm	1246	674	6	24	70
JRVC-15 150cm	1296	631	4	26	70
JRVC-15 155cm	1271	641	6	24	70
JRVC-15 160cm	1172	682	4	28	68
JRVC-15 165cm	1250	663	4	26	70
JRVC-15 170cm	1314	675	4	22	74
JRVC-15 175cm	1279	719	4	26	70
JRVC-15 180cm	1317	664	4	26	70
JRVC-15 185cm	1279	702	4	28	68
JRVC-15 190cm	1293	715	4	30	66
JRVC-15 195cm	1272	696	2	20	78
JRVC-15 200cm	1244	688	4	30	66
JRVC-15 205cm	1287	705	4	28	68
JRVC-15 210cm	1258	672	4	22	74
JRVC-15 215cm	1216	682	4	24	72
JRVC-15 220cm	1280	722	6	24	70
JRVC-15 225cm	1275	683	4	30	66

JR_2 (core sample length = 90 cm)

Sample ID	Total N	Total P	sand	silt	clay
	ppm	ppm	%	%	%
JR-2 (-5-0)	1313	574	6	52	42
JR-2 5cm	1406	632	4	32	64
JR-2 10cm	1547	689	6	20	74
JR-2 15cm	1525	689	4	22	74
JR-2 20cm	1326	590	6	32	62
JR-2 25cm	1349	626	4	30	66
JR-2 30cm	1448	687	4	32	64
JR-2 35cm	1315	616	4	30	66
JR-2 40cm	1325	697	2	32	66
JR-2 45cm	1332	661	4	32	64
JR-2 50cm	1496	688	2	26	72
JR-2 55cm	1430	691	4	28	68
JR-2 60cm	1575	731	4	24	72
JR-2 65cm	1396	663	4	28	68
JR-2 70cm	1473	731	4	26	70
JR-2 75cm	1397	653	4	32	64
JR-2 80cm	1227	582	6	36	58
JR-2 85cm	1346	660	4	34	62
JR-2 90cm	1375	628	6	34	60

JRVC_12 (core sample length = 60 cm)

Sample ID	Total N	Total P	sand	silt	clay
	ppm	ppm	%	%	%
JRVC-12 5cm	1349	533	4	24	72
JRVC-12 10cm	1371	557	6	28	66
JRVC-12 15cm	1380	540	6	30	64
JRVC-12 20cm	1318	505	6	34	60
JRVC-12 25cm	1380	538	6	26	68
JRVC-12 30cm	1313	538	4	28	68
JRVC-12 35cm	1510	559	4	28	68
JRVC-12 40cm	1381	522	6	24	70
JRVC-12 45cm	1404	588	6	28	66
JRVC-12 50cm	1452	584	4	26	70
JRVC-12 55cm	1512	602	4	26	70
JRVC-12 60cm	1580	641	6	22	72

JRVC_11 (core sample length = 120 cm)

Sample ID	Lab #	Total N	Total P	sand	silt	clay
		ppm	ppm	%	%	%
JRVC-11 5cm	156	1401	503	8	28	64
JRVC-11 10cm	157	1470	554	6	22	72
JRVC-11 15cm	158	1452	535	8	22	70
JRVC-11 20cm	159	1498	582	6	22	72
JRVC-11 25cm	160	1345	582	6	26	68
JRVC-11 30cm	161	1387	609	4	22	74
JRVC-11 35cm	162	1450	593	8	20	72
JRVC-11 40cm	163	1452	585	8	16	76
JRVC-11 45cm	164	1442	589	6	18	76
JRVC-11 50cm	165	1466	624	4	22	74
JRVC-11 55cm	166	1442	654	6	22	72
JRVC-11 60cm	167	1454	634	6	18	76
JRVC-11 65cm	168	1426	615	6	18	76
JRVC-11 70cm	169	1444	595	6	18	76
JRVC-11 75cm	170	1414	621	6	20	74
JRVC-11 80cm	171	1494	624	6	22	72
JRVC-11 85cm	172	1469	668	6	20	74
JRVC-11 90cm	173	1513	662	6	24	70
JRVC-11 95cm	174	1547	650	8	20	72
JRVC-11 100cm	175	1577	648	8	18	74
JRVC-11 105cm	176	1521	662	4	24	72
JRVC-11 110cm	177	1598	707	4	26	70
JRVC-11 120cm	178	618	302	6	26	68

JRVC_27 (core sample length = 118 cm)

Sample ID	Total N	Total P	sand	silt	clay
	ppm	ppm	%	%	%
JRVC-27 5cm	1449	471	6	28	66
JRVC-27 10cm	1407	477	6	16	78
JRVC-27 15cm	1408	455	4	18	78
JRVC-27 20cm	1350	502	6	18	76
JRVC-27 25cm	1456	495	6	22	72
JRVC-27 30cm	1426	547	4	24	72
JRVC-27 35cm	1454	551	6	20	74
JRVC-27 40cm	1460	594	6	20	74
JRVC-27 45cm	1455	565	4	18	78
JRVC-27 50cm	1490	571	4	20	76
JRVC-27 55cm	1622	514	6	18	76
JRVC-27 60cm	1539	539	4	24	72
JRVC-27 65cm	1479	616	6	22	72
JRVC-27 70cm	1498	534	4	16	80
JRVC-27 75cm	1465	507	4	18	78
JRVC-27 80cm	1468	514	4	22	74
JRVC-27 85cm	1417	477	4	20	76
JRVC-27 90cm	1466	523	6	22	72
JRVC-27 95cm	1426	482	4	24	72
JRVC-27 100cm	1464	572	4	22	74
JRVC-27 105cm	1614	624	4	24	72
JRVC-27 110cm	1564	576	6	22	72
JRVC-27 118cm	1652	646	0	32	68

JRVC_10 (core sample length = 130 cm)

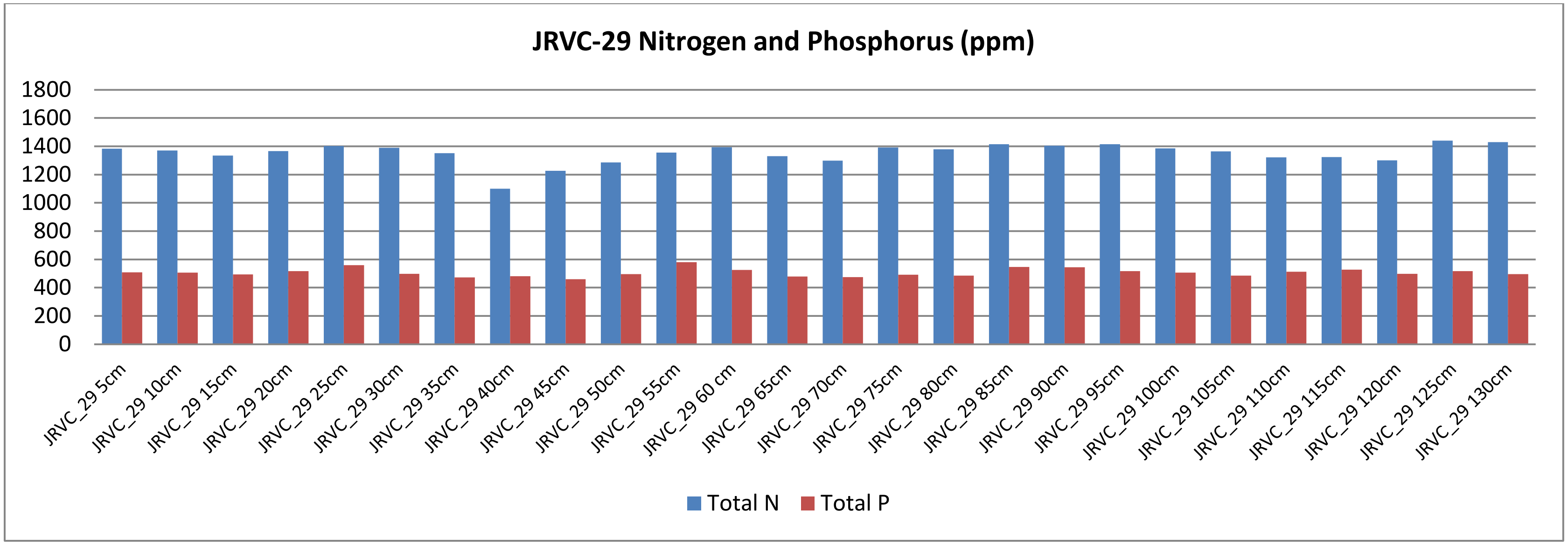
Sample ID	Total N	Total P	sand	silt	clay
	ppm	ppm	%	%	%
JRVC-10 5cm	1527	592	12	16	72
JRVC-10 10cm	1459	617	6	16	78
JRVC-10 15cm	1412	587	8	14	78
JRVC-10 20cm	1457	581	6	14	80
JRVC-10 25cm	1579	596	4	18	78
JRVC-10 30cm	1358	556	6	18	76
JRVC-10 35cm	1420	560	4	22	74
JRVC-10 40cm	1509	605	6	22	72
JRVC-10 45cm	1427	635	6	24	70
JRVC-10 50cm	1501	672	8	20	72
JRVC-10 55cm	1525	670	6	18	76
JRVC-10 60cm	1526	657	6	16	78
JRVC-10 65cm	1589	637	6	18	76
JRVC-10 70cm	1585	664	8	20	72
JRVC-10 75cm	1565	692	6	20	74
JRVC-10 80cm	1482	613	6	16	78
JRVC-10 85cm	1505	612	6	24	70
JRVC-10 90cm	1481	650	8	20	72
JRVC-10 95cm	1483	593	6	20	74
JRVC-10 100cm	1545	602	6	22	72
JRVC-10 105cm	1531	616	6	26	68
JRVC-10 110cm	1527	649	6	20	74
JRVC-10 115cm	1672	721	6	20	74
JRVC-10 120cm	1672	685	6	22	72
JRVC-10 125cm	1620	642	6	22	72
JRVC-10 130cm	1687	615	0	30	70

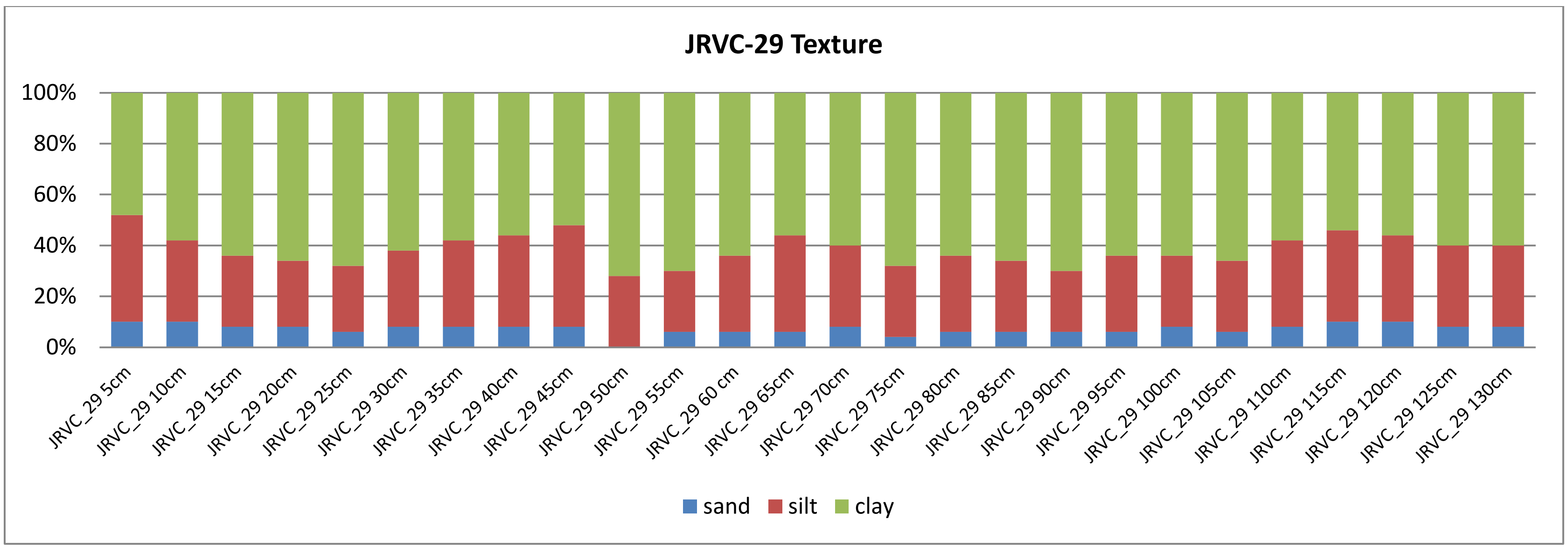
JRVC_17 (core sample length = 142 cm)

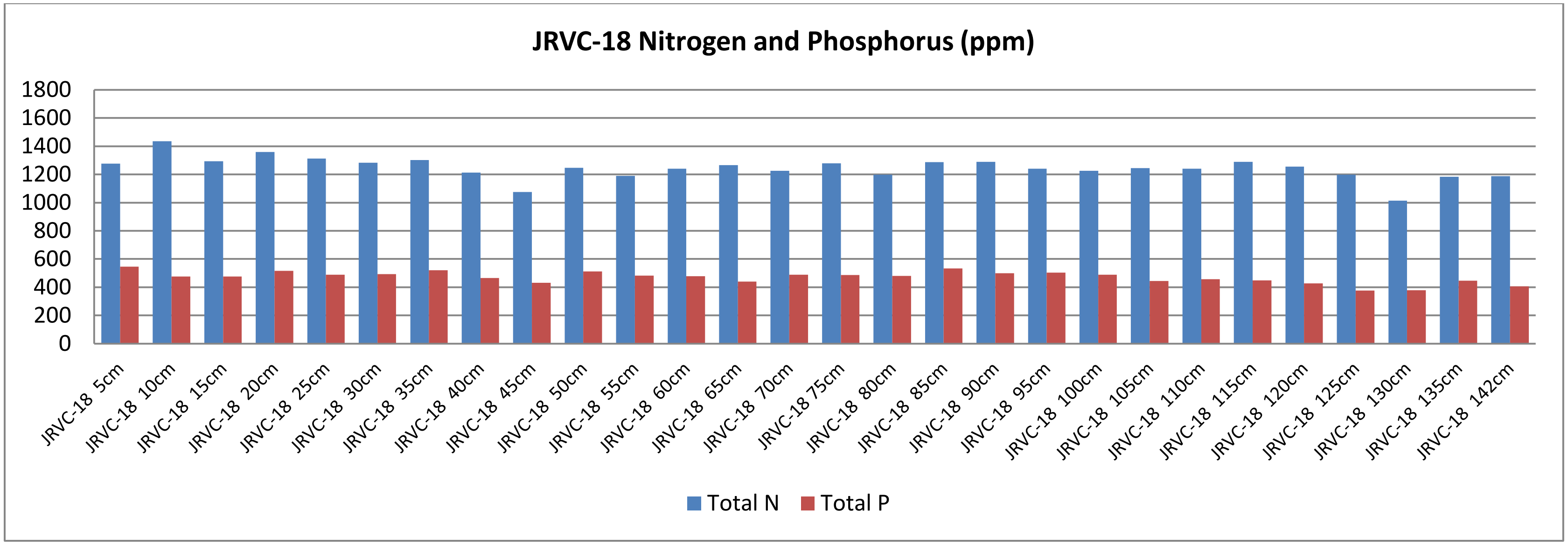
Sample ID	Total N	Total P	sand	silt	clay
	ppm	ppm	%	%	%
JRVC-17 5cm	1434	516	10	32	58
JRVC-17 10cm	1365	573	8	18	74
JRVC-17 15cm	1372	511	6	18	76
JRVC-17 20cm	1390	496	6	16	78
JRVC-17 25cm	1304	526	6	20	74
JRVC-17 30cm	1303	526	8	20	72
JRVC-17 35cm	1340	496	8	22	70
JRVC-17 40cm	1364	486	8	24	68
JRVC-17 45cm	1278	478	6	26	68
JRVC-17 50cm	1325	498	8	24	68
JRVC-17 55cm	1418	475	8	20	72
JRVC-17 60cm	1363	504	8	18	74
JRVC-17 65cm	1472	505	8	24	68
JRVC-17 70cm	1465	502	8	24	68
JRVC-17 75cm	1437	521	8	24	68
JRVC-17 80cm	1300	488	8	24	68
JRVC-17 85cm	1396	523	8	20	72
JRVC-17 90cm	1301	486	8	34	58
JRVC-17 95cm	1341	510	6	28	66
JRVC-17 100cm	1333	519	8	20	72
JRVC-17 105cm	1341	496	8	24	68
JRVC-17 110cm	1370	491	8	28	64
JRVC-17 115cm	1419	488	6	32	62
JRVC-17 120cm	1526	507	6	26	68
JRVC-17 125cm	1470	502	6	24	70
JRVC-17 130cm	1489	498	4	28	68
JRVC-17 135cm	1493	526	6	26	68
JRVC-17 142cm	1499	570	8	24	68

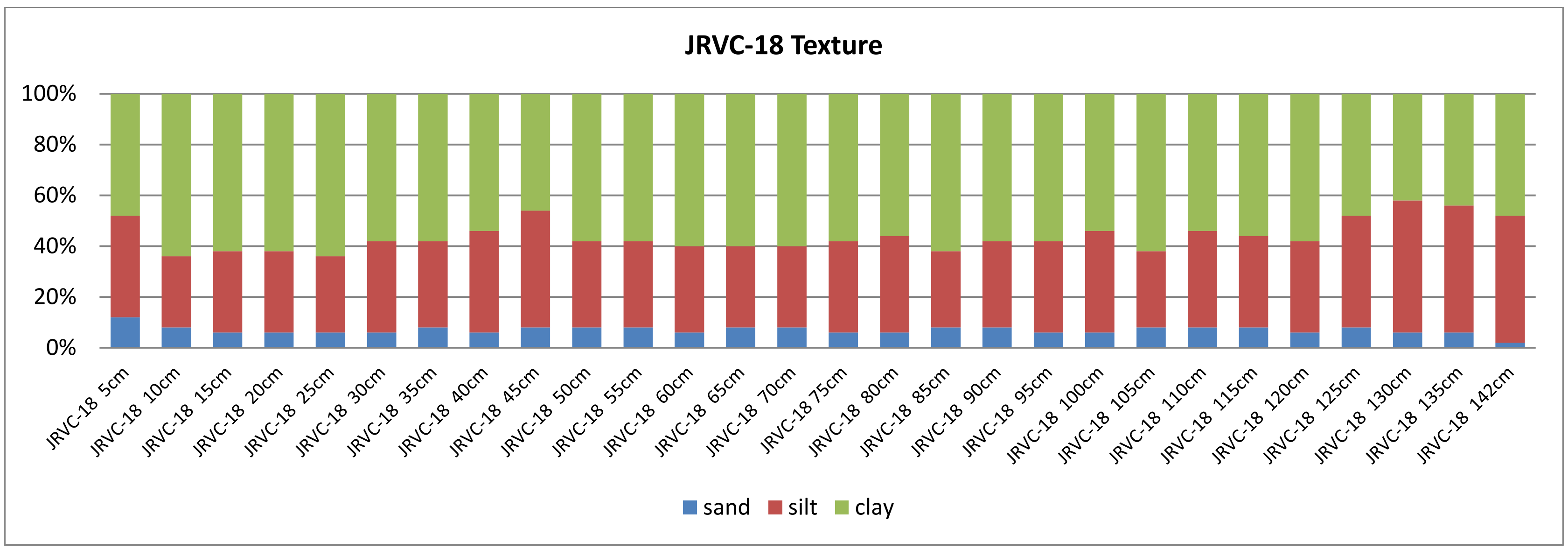
JRVC_6 (core sample length = 96 cm)

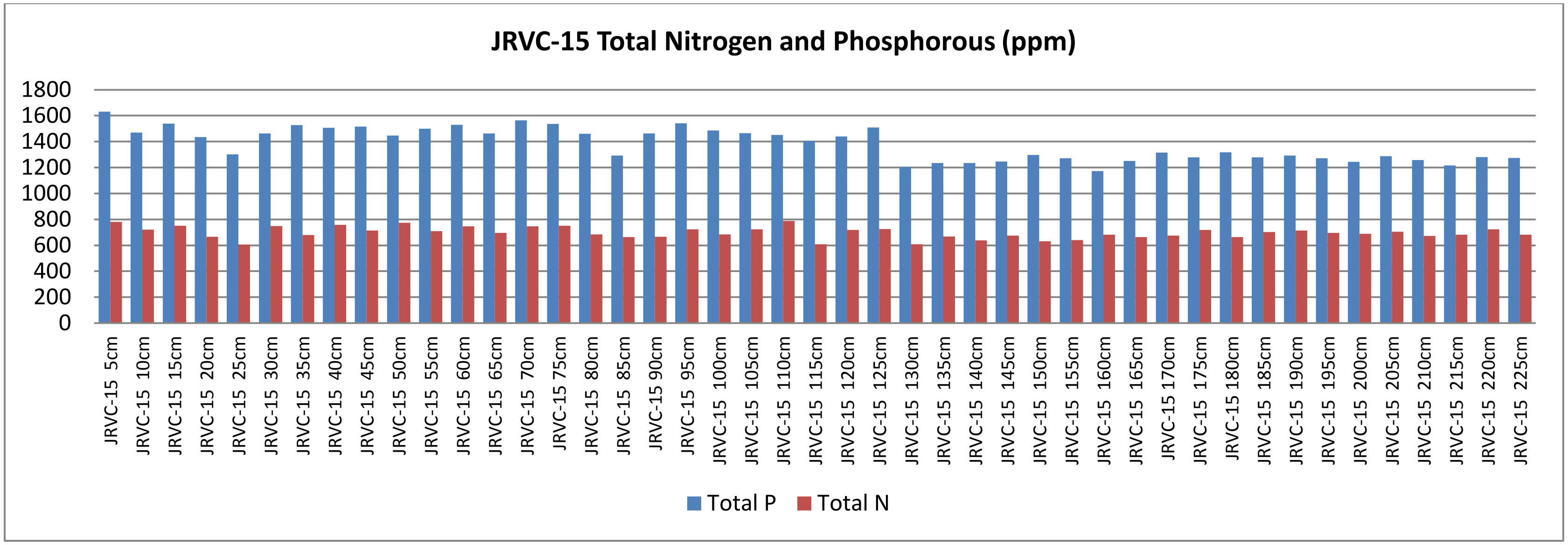
Sample ID	Total N	Total P	sand	silt	clay
	ppm	ppm	%	%	%
JRVC-6 10cm	948	355	18	40	42
JRVC-6 20cm	1037	366	14	36	50
JRVC-6 30cm	1003	375	14	42	44
JRVC-6 40cm	860	327	18	42	40
JRVC-6 50cm	1058	483	14	30	56
JRVC-6 60cm	869	414	16	38	46
JRVC-6 70cm	802	383	16	44	40
JRVC-6 80cm	907	419	14	40	46
JRVC-6 88cm	921	437	14	42	44
JRVC-6 96cm	940	463	18	40	42

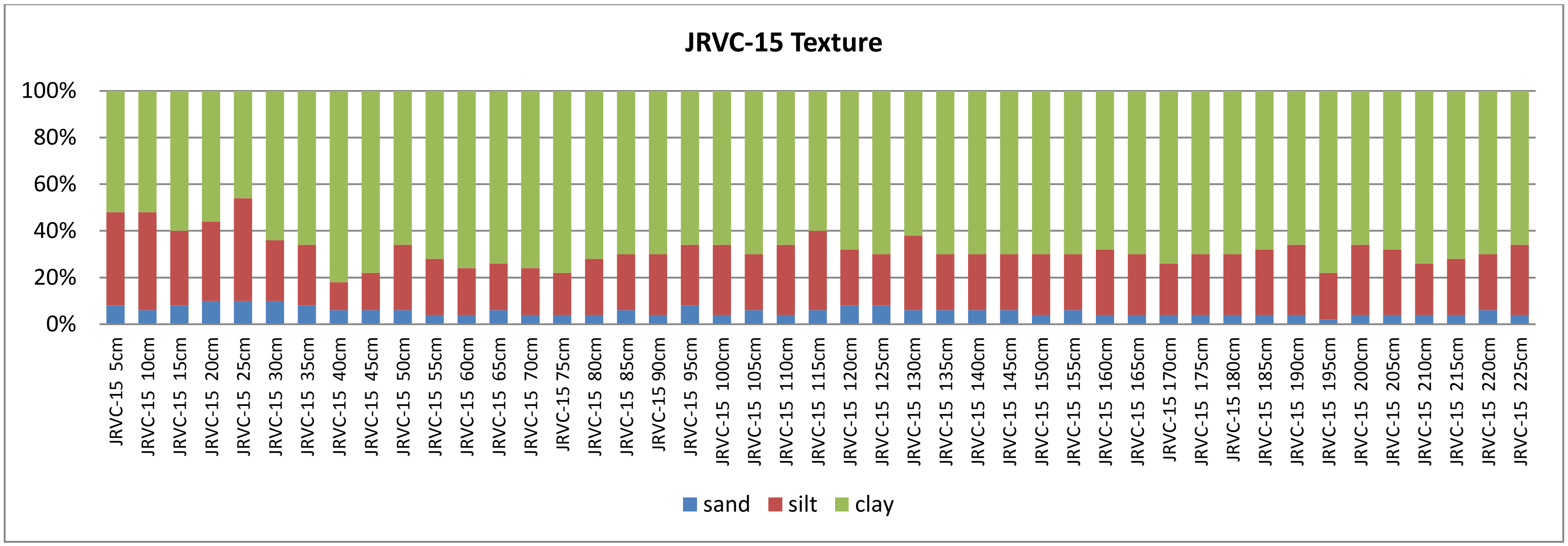

JRVC-29 Nitrogen and Phosphorus (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JRVC_29 5cm
JRVC_29 10cm
JRVC_29 15cm
JRVC_29 20cm
JRVC_29 25cm
JRVC_29 30cm
JRVC_29 35cm
JRVC_29 40cm
JRVC_29 45cm
JRVC_29 50cm
JRVC_29 55cm
JRVC_29 60 cm
JRVC_29 65cm
JRVC_29 70cm
JRVC_29 75cm
JRVC_29 80cm
JRVC_29 85cm
JRVC_29 90cm
JRVC_29 95cm
JRVC_29 100cm
JRVC_29 105cm
JRVC_29 110cm
JRVC_29 115cm
JRVC_29 120cm
JRVC_29 125cm
JRVC_29 130cm
Total N
Total P

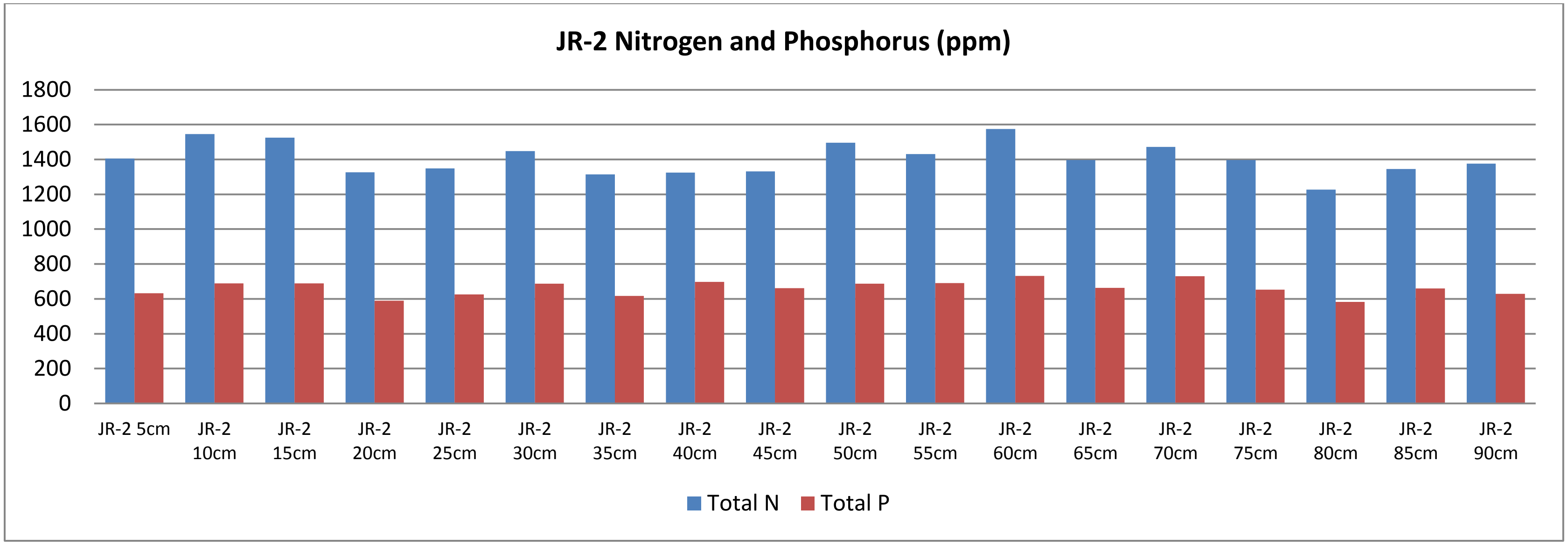

JRVC-29 Texture
100%
80%
60%
40%
20%
0%
JRVC_29 5cm
JRVC_29 10cm
JRVC_29 15cm
JRVC_29 20cm
JRVC_29 25cm
JRVC_29 30cm
JRVC_29 35cm
JRVC_29 40cm
JRVC_29 45cm
JRVC_29 50cm
JRVC_29 55cm
JRVC_29 60 cm
JRVC_29 65cm
JRVC_29 70cm
JRVC_29 75cm
JRVC_29 80cm
JRVC_29 85cm
JRVC_29 90cm
JRVC_29 95cm
JRVC_29 100cm
JRVC_29 105cm
JRVC_29 110cm
JRVC_29 115cm
JRVC_29 120cm
JRVC_29 125cm
JRVC_29 130cm
sand
silt
clay

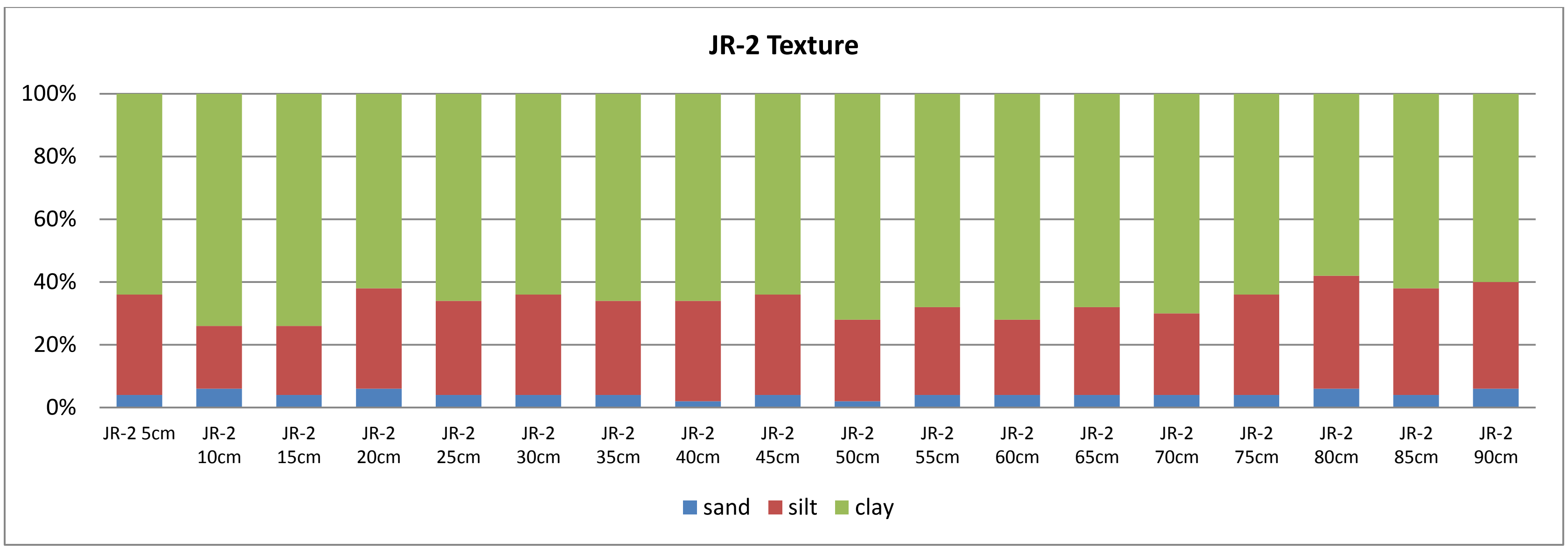

JRVC-18 Nitrogen and Phosphorus (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JRVC-18 5cm
JRVC-18 10cm
JRVC-18 15cm
JRVC-18 20cm
JRVC-18 25cm
JRVC-18 30cm
JRVC-18 35cm
JRVC-18 40cm
JRVC-18 45cm
JRVC-18 50cm
JRVC-18 55cm
JRVC-18 60cm
JRVC-18 65cm
JRVC-18 70cm
JRVC-18 75cm
JRVC-18 80cm
JRVC-18 85cm
JRVC-18 90cm
JRVC-18 95cm
JRVC-18 100cm
JRVC-18 105cm
JRVC-18 110cm
JRVC-18 115cm
JRVC-18 120cm
JRVC-18 125cm
JRVC-18 130cm
JRVC-18 135cm
JRVC-18 142cm
Total N
Total P

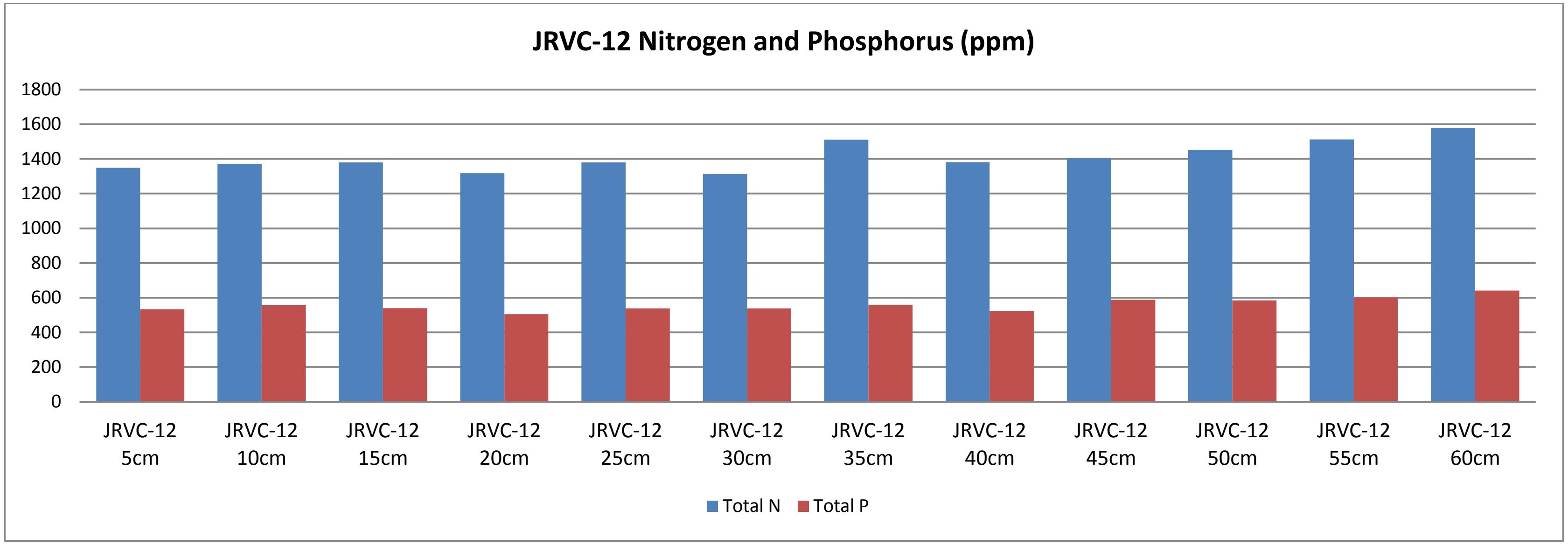

JRVC-18 Texture
100%
80%
60%
40%
20%
0%
JRVC-18 5cm
JRVC-18 10cm
JRVC-18 15cm
JRVC-18 20cm
JRVC-18 25cm
JRVC-18 30cm
JRVC-18 35cm
JRVC-18 40cm
JRVC-18 45cm
JRVC-18 50cm
JRVC-18 55cm
JRVC-18 60cm
JRVC-18 65cm
JRVC-18 70cm
JRVC-18 75cm
JRVC-18 80cm
JRVC-18 85cm
JRVC-18 90cm
JRVC-18 95cm
JRVC-18 100cm
JRVC-18 105cm
JRVC-18 110cm
JRVC-18 115cm
JRVC-18 120cm
JRVC-18 125cm
JRVC-18 130cm
JRVC-18 135cm
JRVC-18 142cm
sand
silt
clay

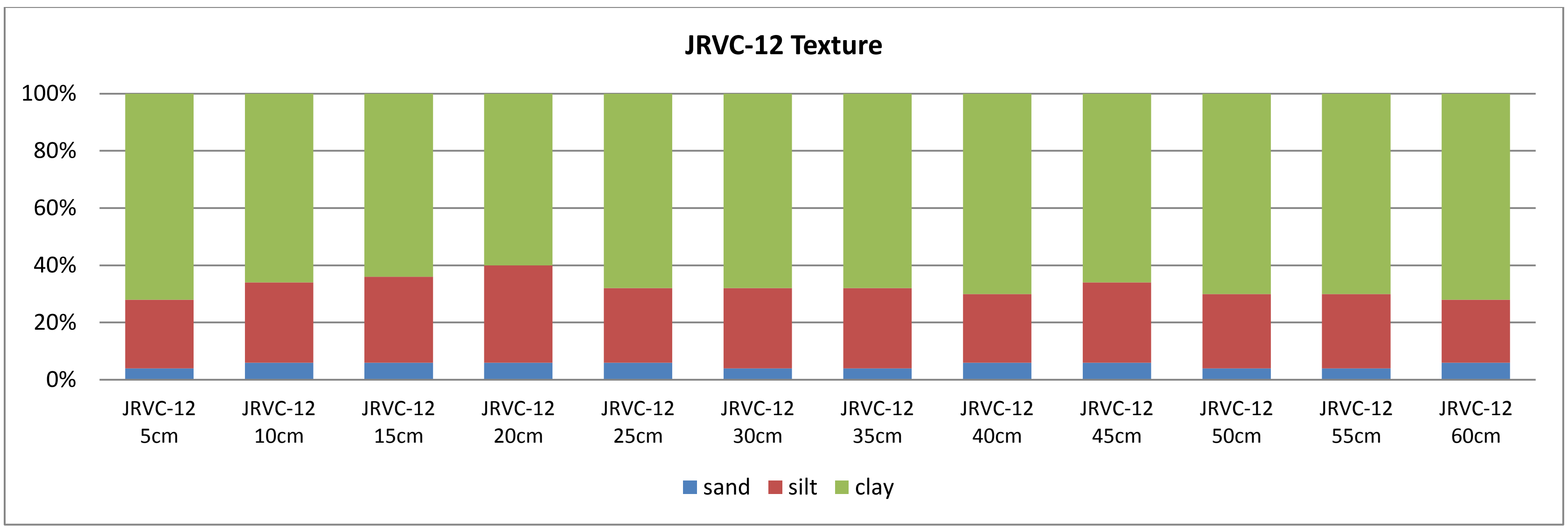

JRVC-15 Total Nitrogen and Phosphorous (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JRVC-15 5cm
JRVC-15 10cm
JRVC-15 15cm
JRVC-15 20cm
JRVC-15 25cm
JRVC-15 30cm
JRVC-15 35cm
JRVC-15 40cm
JRVC-15 45cm
JRVC-15 50cm
JRVC-15 55cm
JRVC-15 60cm
JRVC-15 65cm
JRVC-15 70cm
JRVC-15 75cm
JRVC-15 80cm
JRVC-15 85cm
JRVC-15 90cm
JRVC-15 95cm
JRVC-15 100cm
JRVC-15 105cm
JRVC-15 110cm
JRVC-15 115cm
JRVC-15 120cm
JRVC-15 125cm
JRVC-15 130cm
JRVC-15 135cm
JRVC-15 140cm
JRVC-15 145cm
JRVC-15 150cm
JRVC-15 155cm
JRVC-15 160cm
JRVC-15 165cm
JRVC-15 170cm
JRVC-15 175cm
JRVC-15 180cm
JRVC-15 185cm
JRVC-15 190cm
JRVC-15 195cm
JRVC-15 200cm
JRVC-15 205cm
JRVC-15 210cm
JRVC-15 215cm
JRVC-15 220cm
JRVC-15 225cm
Total P
Total N

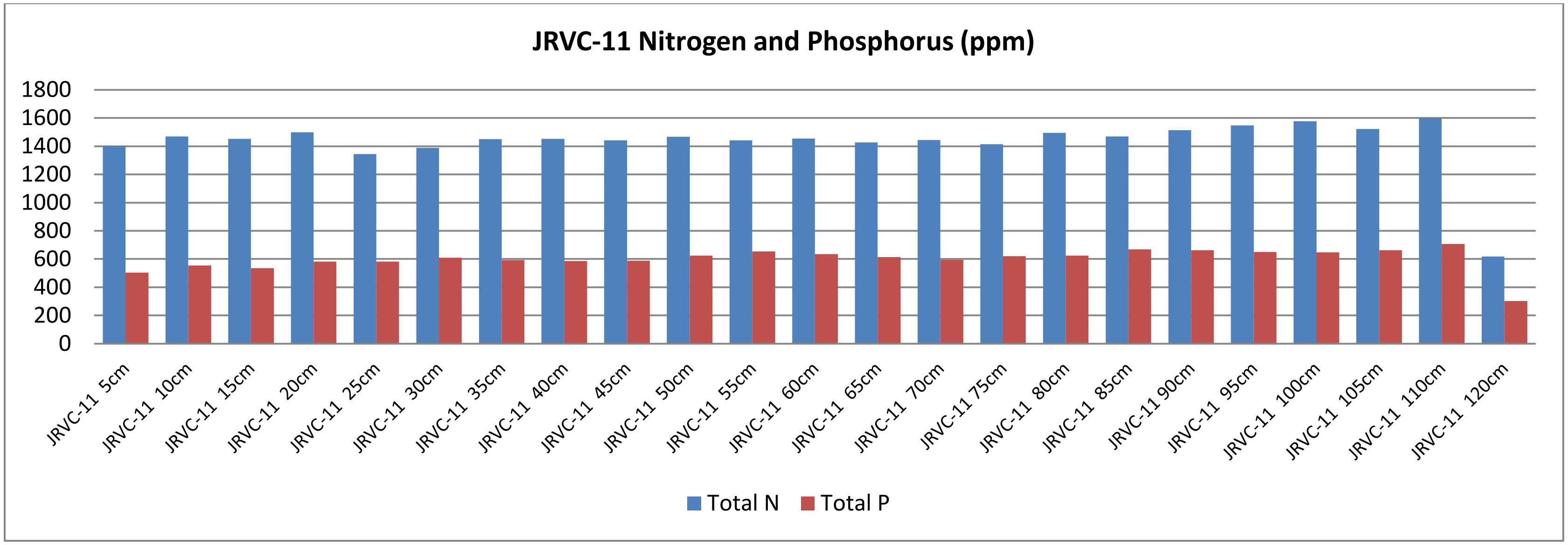

JRVC-15 Texture
100%
80%
60%
40%
20%
0%
JRVC-15 5cm
JRVC-15 10cm
JRVC-15 15cm
JRVC-15 20cm
JRVC-15 25cm
JRVC-15 30cm
JRVC-15 35cm
JRVC-15 40cm
JRVC-15 45cm
JRVC-15 50cm
JRVC-15 55cm
JRVC-15 60cm
JRVC-15 65cm
JRVC-15 70cm
JRVC-15 75cm
JRVC-15 80cm
JRVC-15 85cm
JRVC-15 90cm
JRVC-15 95cm
JRVC-15 100cm
JRVC-15 105cm
JRVC-15 110cm
JRVC-15 115cm
JRVC-15 120cm
JRVC-15 125cm
JRVC-15 130cm
JRVC-15 135cm
JRVC-15 140cm
JRVC-15 145cm
JRVC-15 150cm
JRVC-15 155cm
JRVC-15 160cm
JRVC-15 165cm
JRVC-15 170cm
JRVC-15 175cm
JRVC-15 180cm
JRVC-15 185cm
JRVC-15 190cm
JRVC-15 195cm
JRVC-15 200cm
JRVC-15 205cm
JRVC-15 210cm
JRVC-15 215cm
JRVC-15 220cm
JRVC-15 225cm
sand
silt
clay

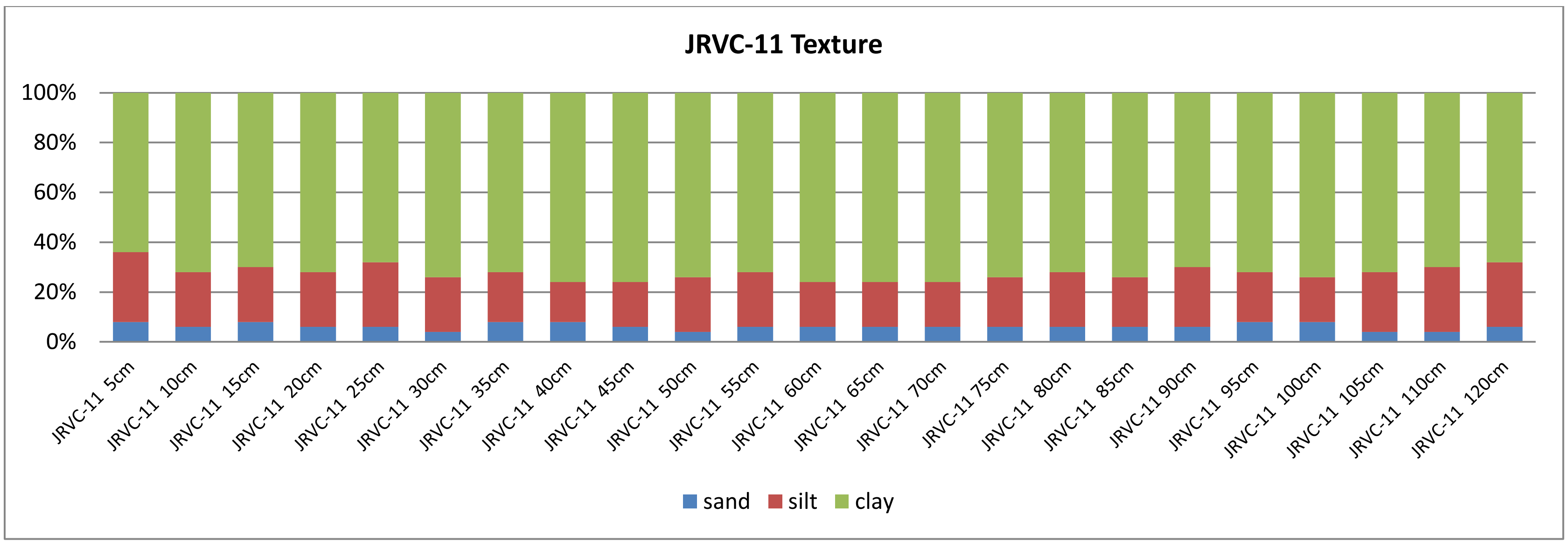

JR-2 Nitrogen and Phosphorus (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JR-2 5cm
JR-2 10cm
JR-2 15cm
JR-2 20cm
JR-2 25cm
JR-2 30cm
JR-2 35cm
JR-2 40cm
JR-2 45cm
JR-2 50cm
JR-2 55cm
JR-2 60cm
JR-2 65cm
JR-2 70cm
JR-2 75cm
JR-2 80cm
JR-2 85cm
JR-2 90cm
Total N
Total P

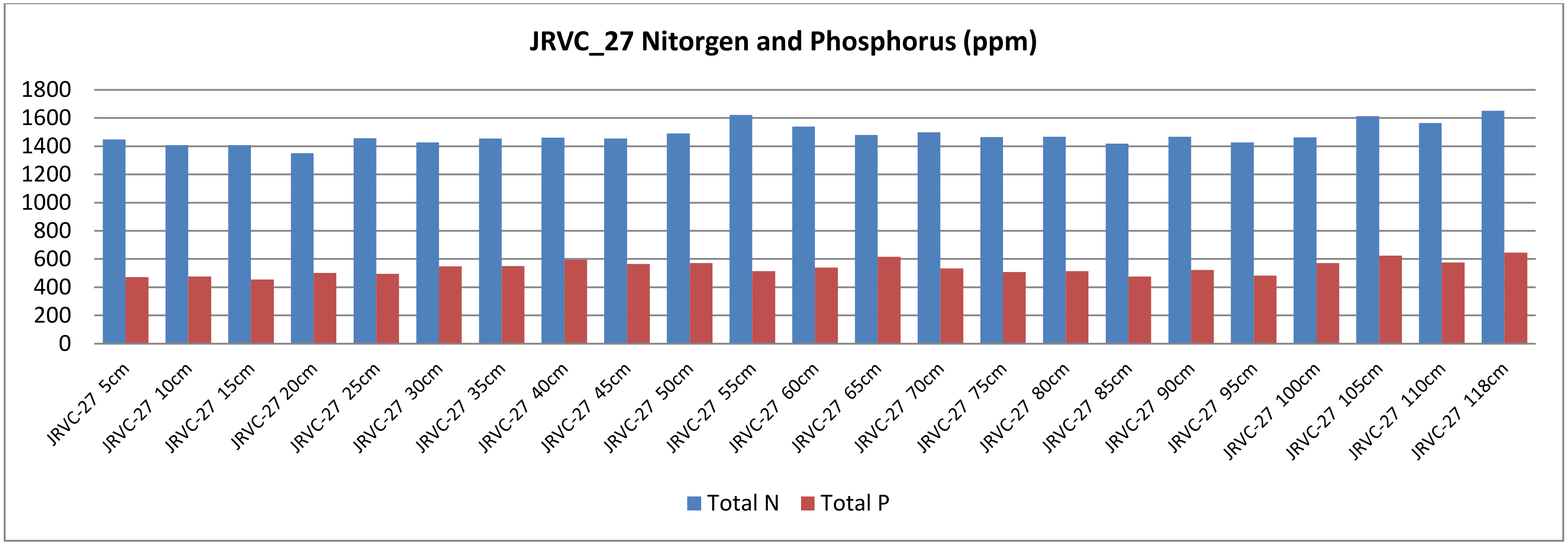

JR-2 Texture
100%
80%
60%
40%
20%
0%
JR-2 5cm
JR-2 10cm
JR-2 15cm
JR-2 20cm
JR-2 25cm
JR-2 30cm
JR-2 35cm
JR-2 40cm
JR-2 45cm
JR-2 50cm
JR-2 55cm
JR-2 60cm
JR-2 65cm
JR-2 70cm
JR-2 75cm
JR-2 80cm
JR-2 85cm
JR-2 90cm
sand
silt
clay

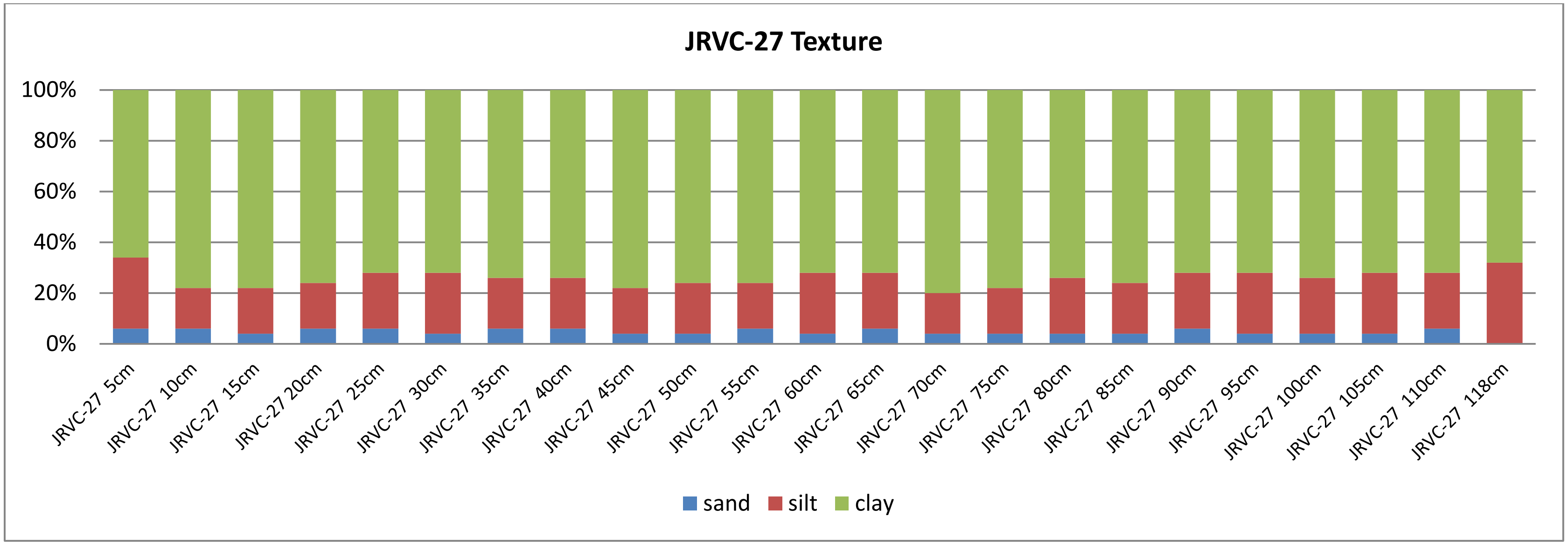

JRVC-12 Nitrogen and Phosphorus (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JRVC-12 5cm
JRVC-12 10cm
JRVC-12 15cm
JRVC-12 20cm
JRVC-12 25cm
JRVC-12 30cm
JRVC-12 35cm
JRVC-12 40cm
JRVC-12 45cm
JRVC-12 50cm
JRVC-12 55cm
JRVC-12 60cm
Total N
Total P

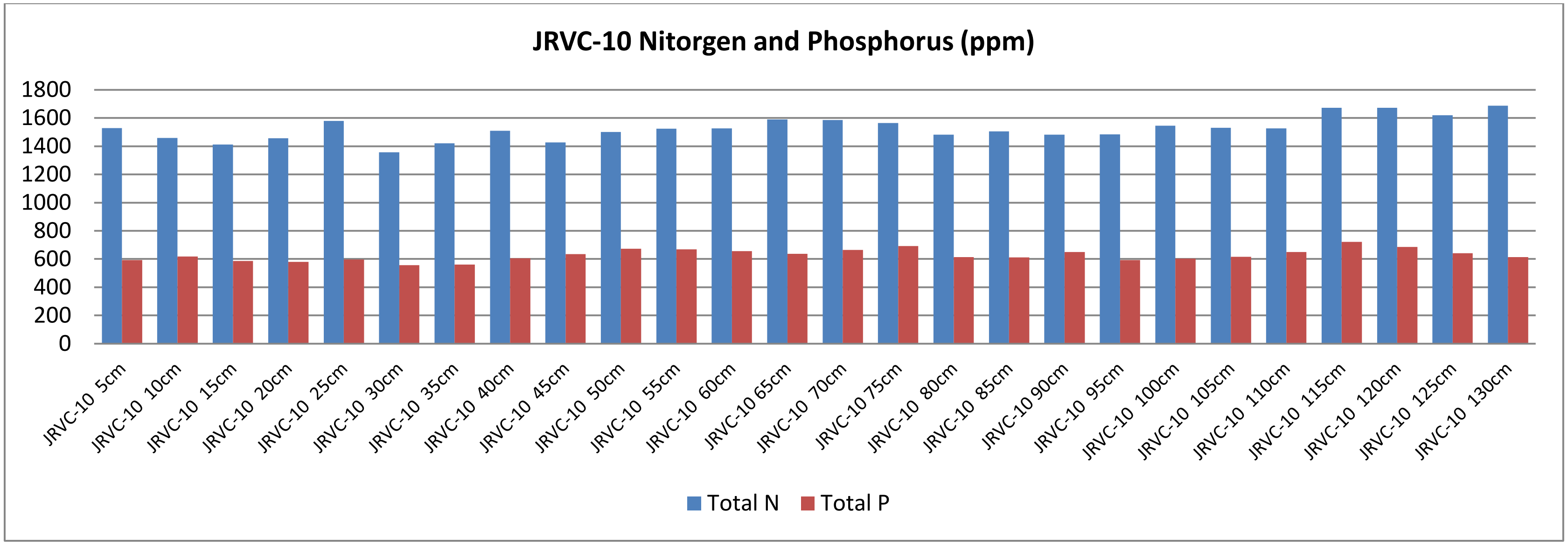

JRVC-12 Texture
100%
80%
60%
40%
20%
0%
JRVC-12 5cm
JRVC-12 10cm
JRVC-12 15cm
JRVC-12 20cm
JRVC-12 25cm
JRVC-12 30cm
JRVC-12 35cm
JRVC-12 40cm
JRVC-12 45cm
JRVC-12 50cm
JRVC-12 55cm
JRVC-12 60cm
sand
silt
clay

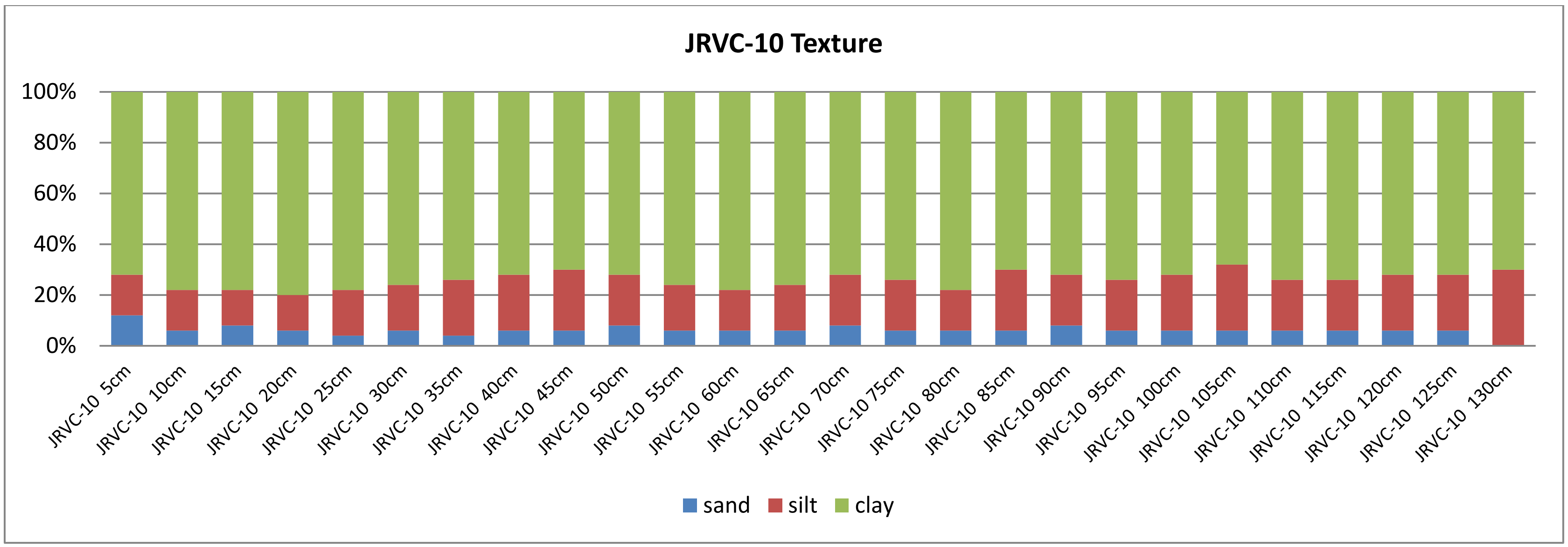

JRVC-11 Nitrogen and Phosphorus (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JRVC-11 5cm
JRVC-11 10cm
JRVC-11 15cm
JRVC-11 20cm
JRVC-11 25cm
JRVC-11 30cm
JRVC-11 35cm
JRVC-11 40cm
JRVC-11 45cm
JRVC-11 50cm
JRVC-11 55cm
JRVC-11 60cm
JRVC-11 65cm
JRVC-11 70cm
JRVC-11 75cm
JRVC-11 80cm
JRVC-11 85cm
JRVC-11 90cm
JRVC-11 95cm
JRVC-11 100cm
JRVC-11 105cm
JRVC-11 110cm
JRVC-11 120cm
Total N
Total P

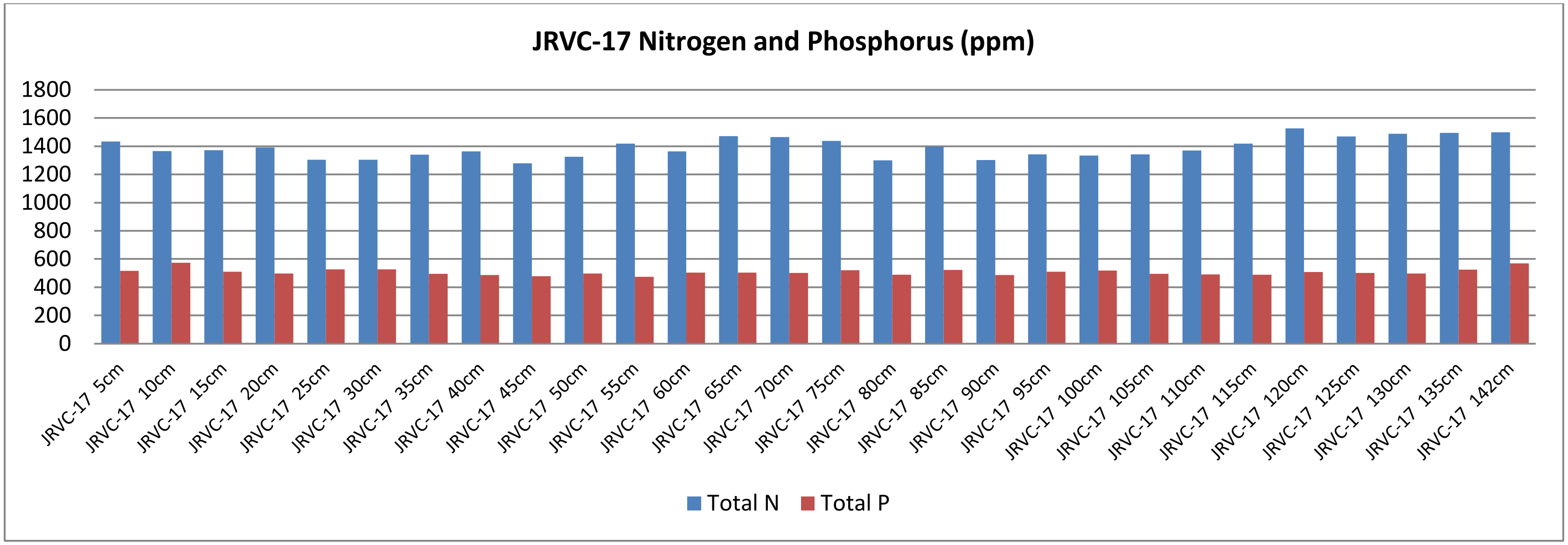

JRVC-11 Texture
100%
80%
60%
40%
20%
0%
JRVC-11 5cm
JRVC-11 10cm
JRVC-11 15cm
JRVC-11 20cm
JRVC-11 25cm
JRVC-11 30cm
JRVC-11 35cm
JRVC-11 40cm
JRVC-11 45cm
JRVC-11 50cm
JRVC-11 55cm
JRVC-11 60cm
JRVC-11 65cm
JRVC-11 70cm
JRVC-11 75cm
JRVC-11 80cm
JRVC-11 85cm
JRVC-11 90cm
JRVC-11 95cm
JRVC-11 100cm
JRVC-11 105cm
JRVC-11 110cm
JRVC-11 120cm
sand
silt
clay

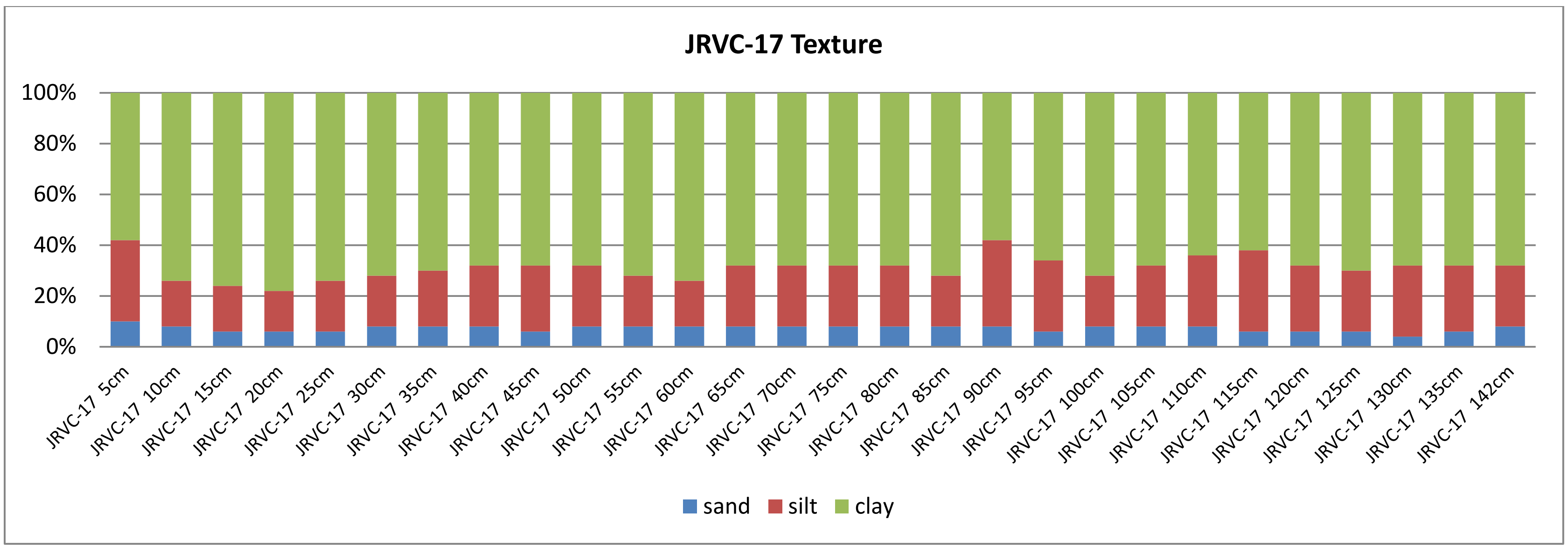

JRVC_27 Nitorgen and Phosphorus (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JRVC-27 5cm
JRVC-27 10cm
JRVC-27 15cm
JRVC-27 20cm
JRVC-27 25cm
JRVC-27 30cm
JRVC-27 35cm
JRVC-27 40cm
JRVC-27 45cm
JRVC-27 50cm
JRVC-27 55cm
JRVC-27 60cm
JRVC-27 65cm
JRVC-27 70cm
JRVC-27 75cm
JRVC-27 80cm
JRVC-27 85cm
JRVC-27 90cm
JRVC-27 95cm
JRVC-27 100cm
JRVC-27 105cm
JRVC-27 110cm
JRVC-27 118cm
Total N
Total P

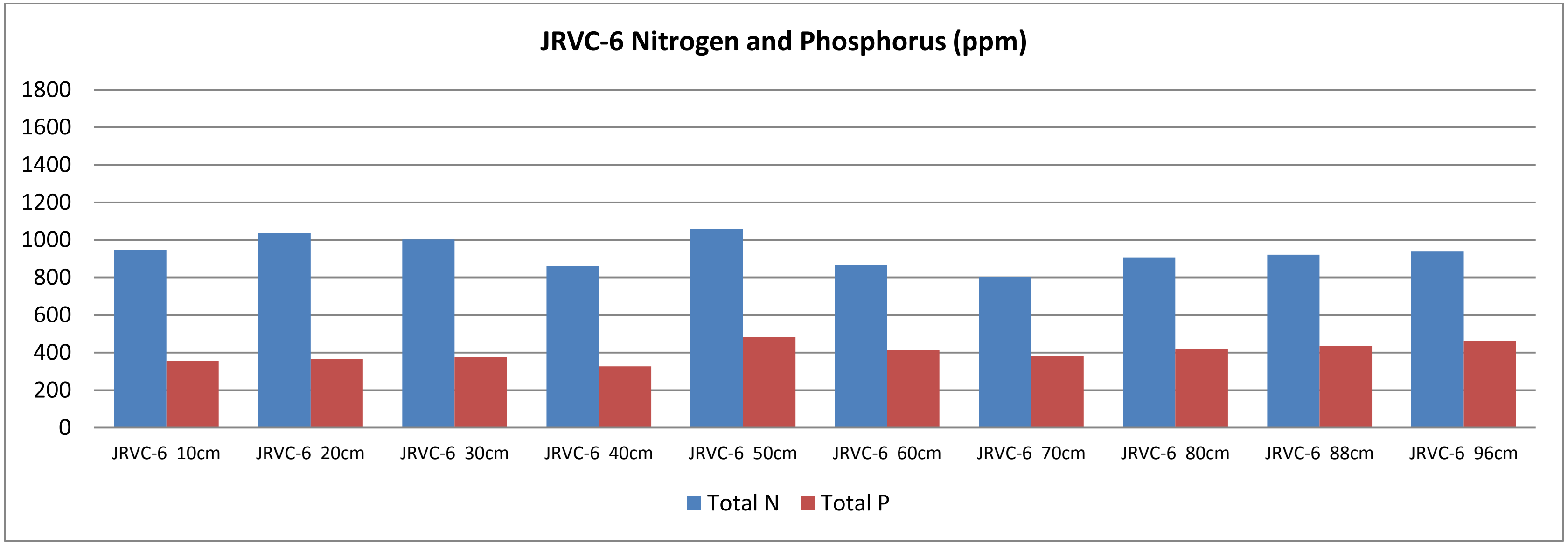

JRVC-27 Texture
100%
80%
60%
40%
20%
0%
JRVC-27 5cm
JRVC-27 10cm
JRVC-27 15cm
JRVC-27 20cm
JRVC-27 25cm
JRVC-27 30cm
JRVC-27 35cm
JRVC-27 40cm
JRVC-27 45cm
JRVC-27 50cm
JRVC-27 55cm
JRVC-27 60cm
JRVC-27 65cm
JRVC-27 70cm
JRVC-27 75cm
JRVC-27 80cm
JRVC-27 85cm
JRVC-27 90cm
JRVC-27 95cm
JRVC-27 100cm
JRVC-27 105cm
JRVC-27 110cm
JRVC-27 118cm
sand
silt
clay

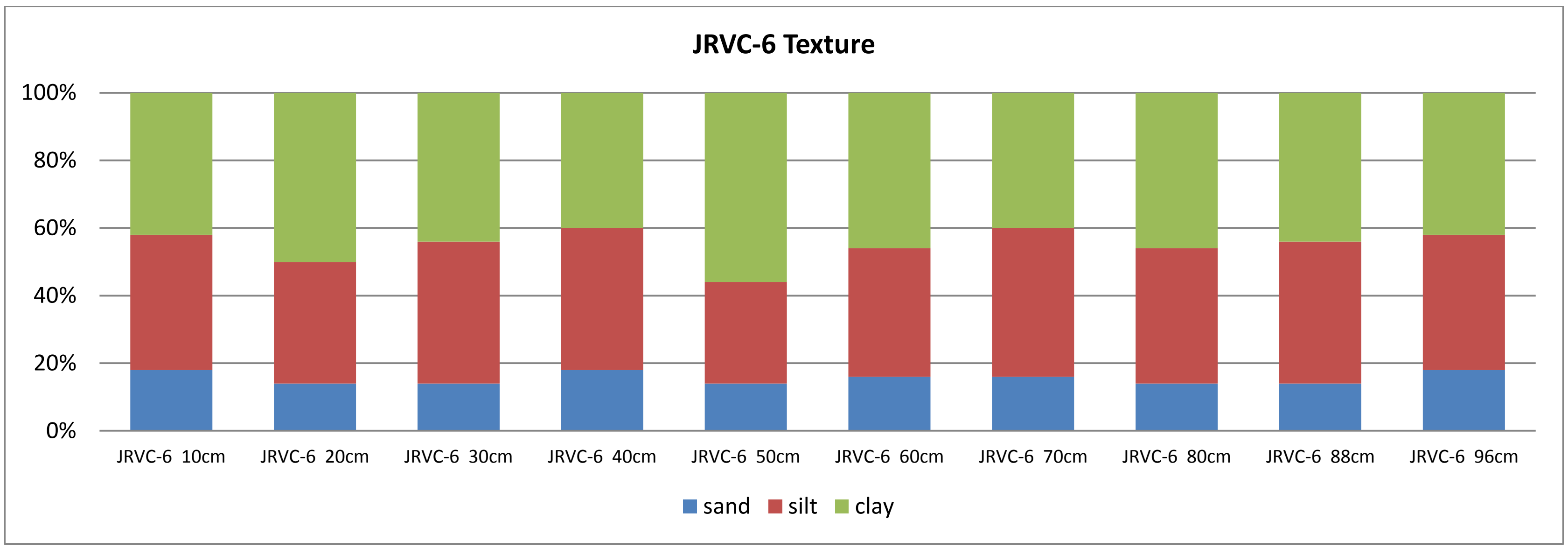

JRVC-10 Nitorgen and Phosphorus (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JRVC-10 5cm
JRVC-10 10cm
JRVC-10 15cm
JRVC-10 20cm
JRVC-10 25cm
JRVC-10 30cm
JRVC-10 35cm
JRVC-10 40cm
JRVC-10 45cm
JRVC-10 50cm
JRVC-10 55cm
JRVC-10 60cm
JRVC-10 65cm
JRVC-10 70cm
JRVC-10 75cm
JRVC-10 80cm
JRVC-10 85cm
JRVC-10 90cm
JRVC-10 95cm
JRVC-10 100cm
JRVC-10 105cm
JRVC-10 110cm
JRVC-10 115cm
JRVC-10 120cm
JRVC-10 125cm
JRVC-10 130cm
Total N
Total P


JRVC-10 Texture
100%
80%
60%
40%
20%
0%
JRVC-10 5cm
JRVC-10 10cm
JRVC-10 15cm
JRVC-10 20cm
JRVC-10 25cm
JRVC-10 30cm
JRVC-10 35cm
JRVC-10 40cm
JRVC-10 45cm
JRVC-10 50cm
JRVC-10 55cm
JRVC-10 60cm
JRVC-10 65cm
JRVC-10 70cm
JRVC-10 75cm
JRVC-10 80cm
JRVC-10 85cm
JRVC-10 90cm
JRVC-10 95cm
JRVC-10 100cm
JRVC-10 105cm
JRVC-10 110cm
JRVC-10 115cm
JRVC-10 120cm
JRVC-10 125cm
JRVC-10 130cm
sand
silt
clay


JRVC-17 Nitrogen and Phosphorus (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JRVC-17 5cm
JRVC-17 10cm
JRVC-17 15cm
JRVC-17 20cm
JRVC-17 25cm
JRVC-17 30cm
JRVC-17 35cm
JRVC-17 40cm
JRVC-17 45cm
JRVC-17 50cm
JRVC-17 55cm
JRVC-17 60cm
JRVC-17 65cm
JRVC-17 70cm
JRVC-17 75cm
JRVC-17 80cm
JRVC-17 85cm
JRVC-17 90cm
JRVC-17 95cm
JRVC-17 100cm
JRVC-17 105cm
JRVC-17 110cm
JRVC-17 115cm
JRVC-17 120cm
JRVC-17 125cm
JRVC-17 130cm
JRVC-17 135cm
JRVC-17 142cm
Total N
Total P


JRVC-17 Texture
100%
80%
60%
40%
20%
0%
JRVC-17 5cm
JRVC-17 10cm
JRVC-17 15cm
JRVC-17 20cm
JRVC-17 25cm
JRVC-17 30cm
JRVC-17 35cm
JRVC-17 40cm
JRVC-17 45cm
JRVC-17 50cm
JRVC-17 55cm
JRVC-17 60cm
JRVC-17 65cm
JRVC-17 70cm
JRVC-17 75cm
JRVC-17 80cm
JRVC-17 85cm
JRVC-17 90cm
JRVC-17 95cm
JRVC-17 100cm
JRVC-17 105cm
JRVC-17 110cm
JRVC-17 115cm
JRVC-17 120cm
JRVC-17 125cm
JRVC-17 130cm
JRVC-17 135cm
JRVC-17 142cm
sand
silt
clay


JRVC-6 Nitrogen and Phosphorus (ppm)
1800
1600
1400
1200
1000
800
600
400
200
0
JRVC-6 10cm
JRVC-6 20cm
JRVC-6 30cm
JRVC-6 40cm
JRVC-6 50cm
JRVC-6 60cm
JRVC-6 70cm
JRVC-6 80cm
JRVC-6 88cm
JRVC-6 96cm
Total N
Total P


JRVC-6 Texture
100%
80%
60%
40%
20%
0%
JRVC-6 10cm
JRVC-6 20cm
JRVC-6 30cm
JRVC-6 40cm
JRVC-6 50cm
JRVC-6 60cm
JRVC-6 70cm
JRVC-6 80cm
JRVC-6 88cm
JRVC-6 96cm
sand
silt
clay

Site Location Coordinates

Universal Transverse Mercator (UTM)

Name	UTMX	UTMY		Name	UTMX	UTMY		Name	UTMX	UTMY
JR_1	257287	4237488		JR_38	256580	4237488		JR_74	255873	4238195
JR_2	256227	4237842		JR_39	256934	4237842		JR_75	255166	4238195
JR_4	257994	4236074		JR_40	256580	4238195		JR_76	256227	4237135
JR_5	257641	4235720		JR_41	256580	4238902		JR_77	256227	4236427
JR_6	256934	4235720		JR_42	255873	4238902		JR_78	257287	4236074
JR_7	256580	4235367		JR_43	255520	4239256		JR_79	258348	4236427
JR_8	256934	4235013		JR_44	255873	4239609		JR_VC4	257287	4236781
JR_9	255873	4234660		JR_45	255520	4238549		JR_VC5	255166	4235367
JR_10	255520	4235013		JR_46	254813	4238549		JR_VC6	256227	4235013
JR_11	255873	4235367		JR_47	254459	4238195		JR_VC7	255166	4234660
JR_12	255520	4235720		JR_48	254813	4237842		JR_VC8	254105	4235013
JR_13	255873	4236074		JR_49	254459	4237488		JR_VC9	254105	4235720
JR_14	256580	4236074		JR_50	253752	4237488		JR_VC10	255166	4236074
JR_15	256934	4236427		JR_51	253398	4237135		JR_VC11	254105	4236427
JR_16	257641	4236427		JR_52	252691	4236427		JR_VC12	253045	4236074
JR_17	257994	4236781		JR_53	252338	4236781		JR_VC13	253045	4236781
JR_18	257641	4237135		JR_54	252691	4237135		JR_VC14	254105	4237135
JR_19	256934	4237135		JR_55	252338	4237488		JR_VC15	255166	4237488
JR_20	256580	4236781		JR_56	252691	4237842		JR_VC16	257287	4235367
JR_21	255873	4236781		JR_57	253398	4237842		JR_VC17	256227	4235720
JR_22	255520	4236427		JR_58	253752	4238195		JR_VC18	256227	4238549
JR_23	254813	4236427		JR_59	253398	4238549		JR_VC19	256227	4239256
JR_24	254459	4236074		JR_60	253752	4238902		JR_VC20	255166	4238902
JR_25	254813	4235720		JR_61	254459	4238902		JR_VC21	254105	4239256
JR_26	254459	4235367		JR_62	254813	4239256		JR_VC22	254105	4239963
JR_27	254813	4235013		JR_63	254459	4239609		JR_VC23	253045	4239609
JR_28	254459	4234660		JR_64	253752	4239609		JR_VC24	253045	4238902
JR_29	253752	4235367		JR_65	253398	4239963		JR_VC25	253045	4238195
JR_30	253398	4235720		JR_66	253398	4239256		JR_VC26	253045	4237488
JR_31	253752	4236074		JR_67	252691	4239256		JR_VC27	255166	4236781
JR_32	253398	4236427		JR_68	252338	4238902		JR_VC28	254105	4237842
JR_33	253752	4236781		JR_69	251631	4238195		JR_VC29	254105	4238549
JR_34	254459	4236781		JR_70	252338	4238195		JR_VC30	251984	4238549
JR_35	254813	4237135		JR_71	252691	4238549		JR_VC31	251984	4237842
JR_36	255520	4237135		JR_72	255166	4237488				
JR_37	255873	4237488		JR_73	255520	4237842				