Oxbow System Assessment and Protocol Development – Phase II

FINAL REPORT

FY 10 104(B)(3)

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ABSTRACT

Oxbow systems are unique systems in Oklahoma and have properties of both lakes and wetlands. A partnership between the Oklahoma Water Resources Board (OWRB), Oklahoma Conservation Commission (OCC), and Oklahoma State University (OSU) focused on assessing these systems through a three phase study. Phase I of the study completed an inventory of oxbow systems in Oklahoma and Level 1 assessments for selected oxbows.

Phase II focused on the collection of necessary data for oxbow assessments. Physical, chemical, and biological parameters were collected that would allow for Hydrogeomorphic (HGM) functional models, Index of Biological Integrity (IBI), California Rapid Assessment Method (CRAM) and Use Support Assessment Protocols (USAP) assessments. The USAP assessments found in Oklahoma Administrative Code (OAC) 785:46-15 are designed to determine attainment of beneficial uses designated for Fish and Wildlife Propagation, Agriculture, Industrial and Municipal Process and Cooling Water, Primary Body Contact Recreation, Secondary Body Contact Recreation, and Aesthetics.

Twelve oxbows were selected for USAP assessment. A prolonged drought throughout the state made sampling and achieving minimum data requirements difficult. Oxbows most often met the Agriculture beneficial uses. While some oxbows did meet individual parameters, no oxbow was found to be fully supporting of all assessed standards. While some oxbows did meet certain beneficial uses for Fish and Wildlife Propagation, this category was most often found to be not supporting. It was also determined that oxbows found to be impaired according to the USAP, may be functioning properly as wetlands. This suggests that a different assessment method may be needed for oxbow wetlands. Other assessment and data collections (CRAM and IBI) from Phase II will be used in Phase III.

Assessments of the oxbow systems will continue during Phase III of the project. Phase III will develop an Oklahoma specific Rapid Assessment Method (RAM) for wetland assessment. In addition, Level 1 assessments from Phase I will be calibrated using data from Phase II. Assessment methods developed in Phase III will also be used on other wetland systems.

BACKGROUND

The OWRB, OCC, and OSU entered into a three phase study in 2008 to assess the condition of oxbows across Oklahoma. Although lake and wetland assessments have been conducted for years in Oklahoma, none had specifically focused on oxbow systems. Oxbow systems share traits of both lakes and wetlands and are unique in that they are the only naturally formed lakes found in Oklahoma. These systems vary greatly in their attributes such as age, hydroperiod, depth, location, and source water. Some systems have well developed plant communities while others are sparsely vegetated. Oxbow systems provide several key ecosystem services such as floodwater retention, nutrient and sediment retention, nursery grounds for fish, and habitat for local and migratory waterbirds, amphibians and macroinvertebrates. Such attributes and variation often makes it difficult to characterize these systems as a lake or wetland. One goal of the overall project is to determine if these systems are more lake-like or wetland-like.

Phase I was completed in 2011 and concluded that there were approximately 940 oxbow systems in Oklahoma. Of the over 900 oxbows in the state, more than half of those are in good to excellent condition based on Level 1 assessments. These data were used in Phase II of the project to identify oxbows for the more intensive Level 3 assessments. Goals of the Phase II portion of the study include collecting the necessary data for Phase III assessment and further refinement and development of assessment methodologies.

PHASE II OVERVIEW

The objectives of Phase II were to identify oxbows and collect necessary data for the development of oxbow system assessments, and to share the data with the partnering agencies and the Oklahoma Wetland Technical Workgroup (OWTW). This project comprised the following tasks:

- **Planning and Implementation** – A Quality Assurance Project Plan (QAPP) was developed and completed before work began. OWRB, OSU, and OCC were involved in the planning.
- **Selection of Level III Assessment Oxbows** – A list of oxbows were generated from Phase I and verified through GIS analysis and ground-truthing.
- **Assessment** – Necessary data were collected to make assessments. Physical, chemical, and biological data were collected for inclusion into IBI, HGM, and USAP assessments.
- **Phase II Completion** – Consisted of a summary of sampling and assessment activities, a consolidated database of collected data, and the sharing of data with the involved agencies (OWRB, OCC, and OSU) and the OWTW.

DATA COLLECTION AND ASSESSMENT

Data collection for Phase II began in June of 2010 and was completed in May of 2012. Data collected included physical, chemical, and biological data on 25 oxbows in Oklahoma. All available data collected can be found in the Appendices of this document.

Data and sample collection activities followed the methods and procedures outlined in the approved QAPP. All staff involved in the project received training identified in the OWRB Quality Management Plan (QMP) (QTRAK No. 13-020). This included training in all relevant Lakes and Special Studies (Clean Lakes) program Standard Operating Procedures (SOPs). The SOPs are on file with EPA Region 6 as part of the OWRB QMP.

Site Selection: Using the oxbow wetland list generated by Phase I, GIS analysis, and ground-truthing, 25 oxbows were selected for assessment. Half of the oxbows selected were characterized by a temporary/seasonal hydroperiod (i.e., wetland-like oxbows) and half of the oxbows were characterized by a semi-permanent/permanent hydroperiod (i.e., lake-like oxbows). Within each hydroperiod, we selected oxbows that encompass a range of conditions.

Twelve of the 25 selected oxbows were assessed following the Use Support Assessment Protocols (USAP), which are housed in the Oklahoma Water Quality Standards. Two sites were selected within each oxbow for water quality sample collection (Site A and Site B). A two sample t-test and mood median statistical test was used to determine if Site A differed from Site B. Results showed that statistically, data collected from both sites were similar for all 12 oxbows and therefore, Site A and B data were used for assessments. All 25 oxbows were assessed following Hydrogeomorphic (HGM) functional models, Index of Biotic Integrity (IBI), and California Rapid Assessment (CRAM).

The selected oxbows were located on 5 major river systems within Oklahoma: the Caney River, the Little River, the Washita River, the Deep Fork River, and the South Canadian River. The systems ranged from far northern Oklahoma to southern Oklahoma. All 25 oxbows were located in the Cross Timbers ecoregion to reduce between site variability.

Problems Encountered: The summer of 2011 and 2012 were marked by statewide drought conditions which hampered collection of water quality data from several oxbow sites. Data collection activities were extended into the spring of 2012 to allow for additional sample collection trips. In some instances, minimum data requirements could not be met for certain oxbows/parameters because water was unavailable to sample. For *E. coli* assessments, Oklahoma Water Quality Standards (OWQS) state that all samples should be collected within 30 days of each other. This requirement was not met in the project due to widespread geographic locations among oxbows, limited field staff, and drought conditions during sampling season.

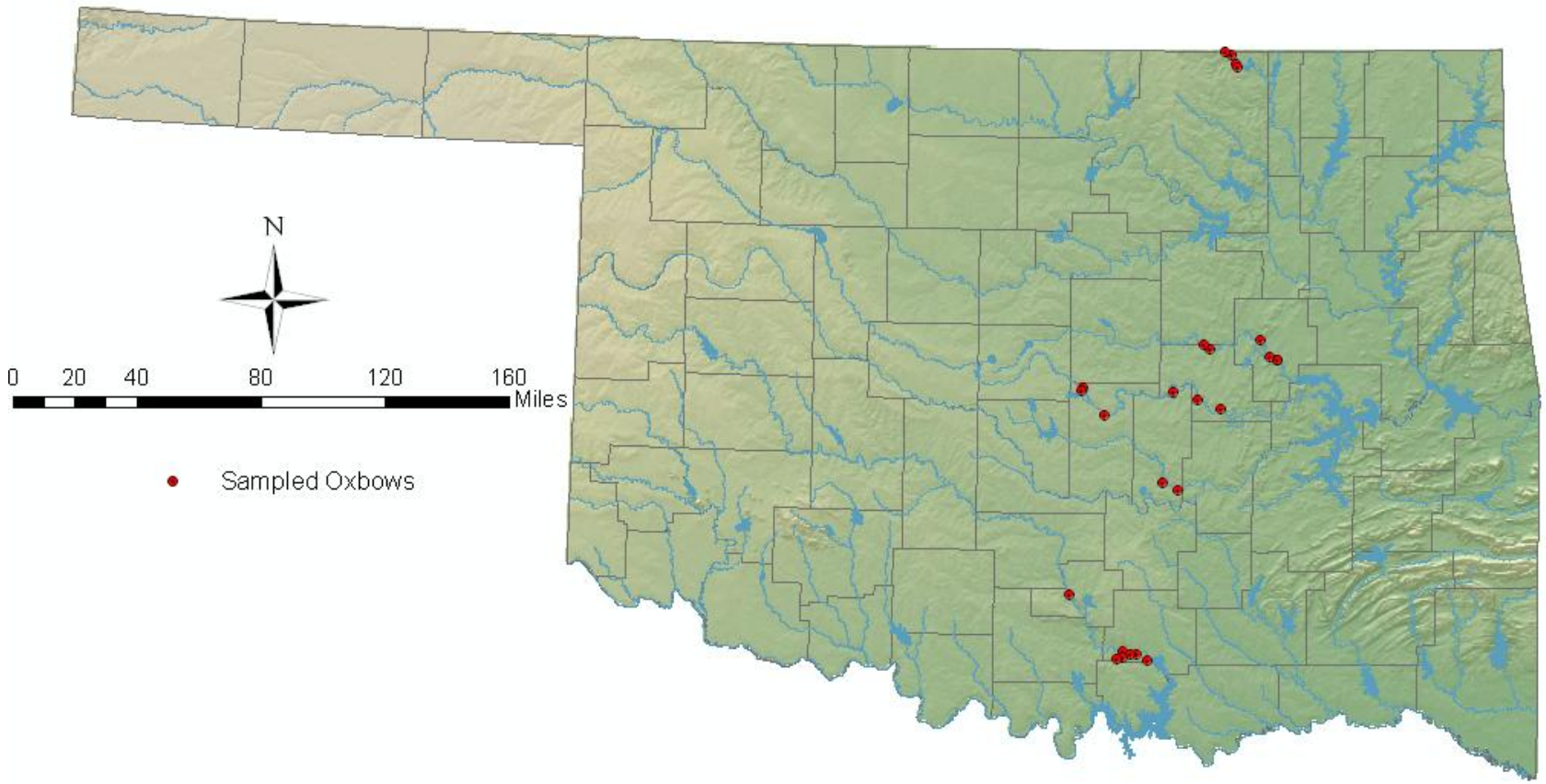

Figure 1. Location of sampled oxbows.

The project was established on a probabilistic design which makes assessment using USAP more difficult. Oklahoma USAP was designed for a fixed-station monitoring network that allows waterbodies and sites to be sampled year after year and long term data sets to be established. The probabilistic design may become temporally limited if conditions do not allow for data collection events. In addition, there are no long term data sets for each waterbody that allows historical averages to be used in assessments.

Assessments: Use Support Assessment Protocols (USAP) for lakes were used for the assessment of the 12 selected oxbows (Table 1). Lake-wide averages from the entire study are shown in Table 2. The lake-wide averages are shown merely as comparison between oxbows and their respective river systems.

The oxbows were found most often to meet the Agricultural beneficial uses. Although 2 oxbows could not be assessed due to lack of data, the remaining 10 oxbows met for sulfates, chlorides, and total dissolved solids. The exception for this is Oxbow 341 located along the Deep Fork River in Okmulgee County; it did not meet the standard for chlorides. Although there are no obvious sources of chloride contamination, there are oil wells and a four-lane highway directly adjacent to the oxbow. These could prove to be sources of excessive chlorides. It is unlikely that high chloride concentrations are naturally occurring. Oxbow 342, which is located along the same river system as Oxbow 341 and is only 0.5 miles directly east of Oxbow 341, met chloride standards. Further study of the system would be needed to accurately determine the source.

Primary Body Contact Recreation (PBCR) could only be assessed for 4 oxbows as not enough data were collected from the other oxbows. Minimum data requirements could not be met due to a lack of water in many of the oxbows from drought conditions. Three oxbows met the standard, while one oxbow, Oxbow 1167, did not support the PBCR standard.

For the Fish and Wildlife Propagation, only Oxbow 665 was found to be fully supporting for turbidity. Not enough information was collected to assess Oxbow 249 for turbidity. Most oxbows met the standard for pH with the exception of Oxbows 235, 654, and 1157. When oxbows did not meet the standard for pH, they were found to have a pH below the standard of 6.5 (the lowest recorded pH was 4.7 at Oxbow 1157). The dissolved oxygen standard was only supported for 4 of the sampled oxbows. Many of the oxbows were assessed for dissolved oxygen (DO) based on surface readings due to the shallow nature of the oxbows and the ongoing drought conditions in Oklahoma. Water Quality Standards only assess water column DO during periods of thermal stratification. If thermal stratification is not present, surface values for DO are to be used. Oxbow 1167 had a depth of 1.59 meters and thermal stratification was present during sampling and therefore assessed for DO based on the water column. The DO assessment for Oxbow 1167 was undetermined since 60% of the water column was found to be anoxic.

Table 1. Results of the USAP assessment for 12 selected Oklahoma oxbows

	Fish & Wildlife Propagation			Agriculture			Primary Body Contact
Oxbow	Turbidity	pH	Dissolved Oxygen	Sulfates	Chlorides	Total Dissolved Solids	E. coli
235	NS	NS	NS	S	S	S	S
249	NEI	S	NS	NEI	NEI	NEI	NEI
273	NS	S	S	S	S	S	NEI
341	NS	S	NS	S	NS	S	S
342	NS	S	NS	S	S	S	S
413	NS	S	S	S	S	S	NEI
654	NS	NS	NS	S	S	S	NEI
658	NS	S	S	S	S	S	NEI
665	S	S	NS	S	S	S	NEI
669	NEI	S	S	NEI	NEI	NEI	NEI
1157	NS	NS	NS	S	S	S	NEI
1167	NS	S	UD	S	S	S	NS

S - Fully Supporting
NS - Not Supporting
UD - Unable to Determine
NEI - Not Enough Information

Table 2. Lake-wide averages of selected parameters from the 12 USAP assessed oxbows.

River System	Oxbow	Turbidity NTU	pH	Dissolved Oxygen mg/L	Chloro-a mg/L	TSI	Secchi cm	Sulfates mg/L	Chlorides mg/L	TP mg/L	Ortho-P mg/L	N/N mg/L	Ammonia mg/L	*E. coli* Geometric Mean
Caney	249	555.5	7.38	4.71	676.7	65.9	14.7	43.4	6	0.41	0.20	2.96	3.69	-
Caney	413	136.4	7.47	6.73	90.5	68.4	24.1	12.6	11.1	0.39	0.19		0.05	6.5
Deep Fork	235	73.3	6.70	7.40	36.2	64.2	17.2	7.5	7.5	0.16	0.06		0.02	4.3
Deep Fork	341	64.6	7.04	6.43	54.3	68.5	17.6	22.5	212.9	0.15	0.06		84.40	26.3
Deep Fork	342	59.3	7.17	6.58	50.7	67.9	26.0	10.7	19.8	0.20	0.08		64.69	5.5
Deep Fork	1157	83.4	6.12	1.67	72.7	63.8	25.6	28.9	12.6	0.60	0.32	3.21	1.43	37.9
North Canadian	273	69.9	7.78	7.67	50.5	67.7	18.6	30.1	39.9	0.23	0.21		0.03	10.0
North Canadian	1167	38.6	7.52	6.00	174.3	77.4	27.8	216.9	58.2	2.34	2.08	1.95	1.22	564.7
Washita	654	25.4	7.09	4.83	47.2	64.1	42.4	9.5	10.6	0.22	0.05		0.07	57.6
Washita	658	192.1	7.79	7.41	52.9	63.7	21.8	43.8	5.1	0.47	0.15	0.30	0.04	6.1
Washita	665	7.8	7.61	6.90	14.3	45.2	49.8	27.3	11.4	0.54	0.46		0.03	2.0
Washita	669	136.9	7.78	6.12	35.1	58.9	57.4	17.7	4.32	0.21	0.10		0.04	222.1

The assessed oxbows are very shallow systems. The deepest sampled oxbow was Oxbow 413 at 2.54 meters of depth. This maximum depth occurred in April of 2012, compared to the average depth during the study which was 0.67 meters. Such shallow water can exacerbate some water quality problems. Shallow systems that do stratify are often polymictic as wind and rain events tend to regularly mix the waters. Rain events that bring inflow or create access to the original river channel can bring in sediment and nutrients that become trapped in the shallow basin. These increased sediment and nutrients can lead to USAP impairments.

These systems are small, shallow, and often remotely located. These conditions make it unlikely that the oxbows would be used for public or private water supply or in many instances primary body contact. It is also unlikely that the oxbows would be used for irrigation (due to the low quantity of water and the oftentimes seasonality of available water), but they could potentially be used as a watering source for livestock. The systems have the potential to provide some flood storage during high flooding events. The most likely use for many of the oxbows is for fish and wildlife use or recreation by fishermen.

Beneficial uses for Fish and Wildlife Propagation were the most likely standards to be found not supporting and that is mainly due to turbidity. Several of the oxbows experience periods of dryness making it difficult for them to support fish and other large aquatic species. In this way, they function more like wetland ecosystems as periods of drying are part of the natural cycle of wetlands. Most of the oxbows did meet the standard for Agricultural beneficial use. The Agricultural beneficial use focuses on water quality as it pertains to irrigation, but not as a livestock watering source. In this instance, it may be more appropriate to examine nutrient and chlorophyll. Increased nutrients and chlorophyll values could potentially lead to harmful algal blooms which could produce toxins making the water unusable for livestock.

PHASE II COMPLETION AND CONCLUSION

This project is the first in the state to systematically focus on oxbow systems and collect data necessary for condition assessment of these important systems. The completion of the Phase II project collected critical data necessary for the assessment of oxbow systems. Data and knowledge gained in Phase II will be made available to other water quality and wetland scientists to further build capacity and understanding of these natural systems. The Oxbow Phase III project will incorporate the findings of this project, along with the results of the Phase I study. These data will allow for an accurate comparison of oxbow assessment methodologies and also lead to the development of an Oklahoma specific Rapid Assessment Method (RAM).

Beneficial uses for Fish and Wildlife Propagation were most often not met by the sampled oxbows. This is not to suggest that these systems are impaired, but that it may not be appropriate to assess these systems using protocols developed for lakes and reservoirs. This demonstrates the need for further study of these systems to ensure they are being assessed based on appropriate methodology that is specifically designed to evaluate the unique characteristics of oxbows. Data collection activities were hampered by the prolonged drought that occurred throughout Oklahoma during the past 2 years. It is recommended that data collection activities for future oxbow projects be extended over multiple seasons and years (minimum of a 2 year study, preferably 3 years) to take into account the possibility of some systems becoming dry. It also may be necessary to increase the number of sampled oxbows to take into account the potential for extended dry periods as well as the natural variation among oxbow systems.

APPENDIX A

Water Quality Data

	Oxbow ID	Date	Ammonia mg/L (NH3)	Alkalinity mg/L (CaCO3)	Hardness mg/L (CaCO3)	Chloride mg/L	N/N mg/L	Sulfate mg/L	TSS mg/L	Kjeldahl N mg/L	TP mg/L	Ortho-P mg/L	Secchi	Turbidity (NTU)	Chlorophyll-a	Pheophytin-a
Round 1	249-A	9/23/2010	2.3	100	126	7.34	BPQL	37.7	1130	15	0.655	0.478	3	>1000	1880	174
	249-B	9/23/2010	5.07	120	140	10.7	BPQL	36	6150	17.9	0.199	0.0654	3	>1000	2150	201
Round 3	249-A	4/25/2011	BPQL	102	235	5.01	3.4	153	414	3.42	0.33	0.1	3	314	2.64	9.39
	249-B	4/25/2011	BPQL	40	80	1.16	2.52	19.4	622	4.37	1	0.14	4	>1000	1.28	20.7
Round 7	249-A	5/22/2012	BPQL	202	210	5.89	BPQL	7.48	7	2.81	0.11	BPQL	40	9	13.8	4.7
	249-B	5/22/2012	BPQL	204	212	5.86	BPQL	6.92	28	BPQL	0.16	BPQL	35	10	12.4	4.64
Round 1	413-A	9/23/2010	0.062	100	122	7.46	BPQL	7.14	58	4.75	0.14	0.0532	10	83	53.9	13.2
	413-B	9/23/2010	0.043	96	118	7.44	BPQL	7.37	46	BPQL	0.153	0.0926	16	206	60.6	18.8
Round 2	413-A	3/15/2011	BPQL	140	158	10.5	BPQL	28.7	34	BPQL	BPQL	BPQL	<11	105	39.7	13.6
	413-B	3/15/2011	BPQL	138	162	10.4	BPQL	25.8	56	BPQL	0.19	BPQL	<13	44	54.8	17.4
Round 3	413-A	5/16/2011	BPQL	146	168	14.2	BPQL	16.3	68	BPQL	0.16	BPQL	20	90	44.1	7.56
	413-B	5/16/2011	BPQL	158	170	14.3	BPQL	15.9	38.8	BPQL	0.15	BPQL	18	58	39.7	5.43
Round 4	413-A	6/15/2011	BPQL	123	119	24.9	BPQL	7.43	268	7.14	1.95	0.29	5	561	447	85.3
	413-B	6/15/2011	BPQL	124	128	22.9	BPQL	6.54	200	5.39	0.88	0.34	5	375	280	58.5
Round 6	413-A	4/3/2012	BPQL	82	92	7.62	BPQL	11.8	10	BPQL	0.14	BPQL	65	20	16.4	6.54
	413-B	4/3/2012	BPQL	84	92	7.49	BPQL	11.7	8	BPQL	0.12	BPQL	55	18	13.3	10.9
Round 7	413-A	5/22/2012	BPQL	135	154	3.15	BPQL	6.16	20	BPQL	0.18	BPQL	23	35	18.5	3.7
	413-B	5/22/2012	BPQL	133	140	2.93	BPQL	5.97	22	BPQL	0.2	BPQL	24	42	18.5	4.19
Round 1	341-A	9/21/2010	166	0.0145	78	175	BPQL	14.3	60	2.19	0.02	0.0299	11	86	41.0	11.0
	341-B	9/21/2010	184	0.017	72	183	BPQL	11.9	36	2.12	0.0267	0.0278	22	68	66.5	11.2
Round 2	341-A	3/1/2011	49	BPQL	244	293	BPQL	31.2	44	BPQL	BPQL	BPQL	16	57	33.6	11.1
	341-B	3/1/2011	47.4	BPQL	266	301	BPQL	31.3	53	BPQL	0.11	BPQL	17	70	26.9	7.82
Round 3	341-A	4/18/2011	57.4	BPQL	250	371	BPQL	35.5	30.7	BPQL	BPQL	BPQL	14	44	25.6	5.63
	341-B	4/18/2011	54.2	BPQL	260	384	BPQL	36.2	42	BPQL	BPQL	BPQL	16	49	33.4	7.74
Round 4	341-A	6/14/2011	84.4	BPQL	154	99.6	BPQL	10.3	60	BPQL	0.19	0.08	14	89	109	41
	341-B	6/14/2011	88.4	BPQL	162	113	BPQL	11.2	76	2.09	0.36	0.12	12	103	133	23.6
Round 5	341-A	11/1/2011	73	BPQL	248	353	BPQL	30.6	34	BPQL	0.12	BPQL	26	40		
	341-B	11/1/2011	68	BPQL	246	353	BPQL	30.6	42.3	BPQL	0.11	BPQL	21	35		
Round 6	341-A	4/3/2012	69	BPQL	94	47.1	BPQL	13.8	39	BPQL	0.18	BPQL	15	80	48.5	28.1
	341-B	4/3/2012	71	BPQL	114	54.2	BPQL	14.7	41	BPQL	0.18	BPQL	15	78	46.4	36.8
Round 7	341-A	5/21/2012	85	BPQL	142	121	BPQL	27.8	22	BPQL	0.16	BPQL	25	43	45.2	11
	341-B	5/21/2012	85	BPQL	142	133	BPQL	16	34	BPQL	0.17	BPQL	23	63	42.9	18.6

	Oxbow ID	Date	Ammonia mg/L (NH3)	Alkalinity mg/L (CaCO3)	Hardness mg/L (CaCO3)	Chloride mg/L	N/N mg/L	Sulfate mg/L	TSS mg/L	Kjeldahl N mg/L	TP mg/L	Ortho-P mg/)	Secchi	Turbidity (NTU)	Chlorophyll-a	Pheophytin-a
Round 1	342-A	9/21/2010	84	0.0154	70	16.1	BPQL	6.13	32	2.01	0.0151	0.0184	23	42	28.0	13.2
	342-B	9/21/2010	84	0.0155	70	16.2	BPQL	6.21	30	2.12	0.0508	0.022	28	42	48.1	12.6
Round 2	342-A	3/1/2011	54.6	BPQL	84	15.1	BPQL	10.4	51	BPQL	0.14	0.15	14	54	60.7	24.4
	342-B	3/1/2011	53.4	BPQL	62	15.3	BPQL	10.3	50	BPQL	0.16	BPQL	15	53	47.9	19.3
Round 3	342-A	4/18/2011	64.6	BPQL	76	19	BPQL	11.5	80.3	2.45	0.33	BPQL	15	119	101	28.9
	342-B	4/18/2011	64.2	BPQL	78	19.4	BPQL	11.6	74	3.18	0.46	BPQL	12	140	92	31.9
Round 4	342-A	6/14/2011	66.2	BPQL	72	12.4	BPQL	4.86	18	BPQL	0.22	0.11	31	35	69.5	11.7
	342-B	6/14/2011	65.6	BPQL	72	12.3	BPQL	4.78	20	BPQL	0.19	0.1	30	38	55.7	18.9
Round 5	342-A	11/1/2011	65	BPQL	78	21.5	BPQL	16.2	83.1	BPQL	0.22	BPQL	17	67		
	342-B	11/1/2011	66	BPQL	84	21	BPQL	15.8	235	2.35	0.36	BPQL	12	148		
Round 6	342-A	4/3/2012	54	BPQL	66	23.5	BPQL	11.8	8	BPQL	BPQL	BPQL	52	14	22	8.17
	342-B	4/3/2012	53	BPQL	66	23.5	BPQL	11.9	16	BPQL	0.11	BPQL	47	21	21.8	10.6
Round 7	342-A	5/21/2012	66	BPQL	70	37.5	BPQL	20.9	12	BPQL	0.16	BPQL	40	23	30	9.42
	342-B	5/21/2012	65	BPQL	74	23.7	BPQL	7.28	21	BPQL	0.17	BPQL	28	34	31.7	13.9
Round 1	235-A	10/4/2010	0.0213	40	74	6.42	BPQL	5.29	50	2.55	0.103	0.037	18	91	28.8	12.6
	235-B	10/4/2010	0.0197	44	56	6.67	BPQL	5.31	28	BPQL	0.0887	0.0755	18	90	20.4	15.5
Round 2	235-A	3/7/2011	BPQL	21	28	8.95	BPQL	11.5	30	BPQL	0.16	BPQL	17	103	30.7	9.92
	235-B	3/7/2011	BPQL	22	10	9.78	BPQL	12.1	49.4	BPQL	0.19	BPQL	18	105	40.8	18
Round 3	235-A	4/18/2011	BPQL	30.8	20	8.67	BPQL	8.08	28.6	2.03	0.11	BPQL	21	69	38.1	8.66
	235-B	4/18/2011	BPQL	31	44	9.21	BPQL	8.02	38	BPQL	0.22	BPQL	21	70	33.7	8.97
Round 4	235-A	6/13/2011	BPQL	62.8	88	6.87	BPQL	2.36	55	BPQL	0.27	BPQL	15	107	81.7	15
	235-B	6/13/2011	BPQL	65.2	88	7.18	BPQL	2.33	34.4	BPQL	0.25	BPQL	14	83	86.5	15.2
Round 5	235-A	10/31/2011	BPQL	32	36	5.51	BPQL	11	21.5	BPQL	0.14	BPQL	13	47		
	235-B	10/31/2011	BPQL	34	38	5.49	BPQL	13.1	35	BPQL	BPQL	BPQL	10	60		
Round 6	235-A	4/3/2012	BPQL	61	70	8.96	BPQL	7.4	21	BPQL	0.14	BPQL	17	45	19.4	7.69
	235-B	4/3/2012	BPQL	65	74	9.62	BPQL	7.88	18	BPQL	0.12	BPQL	21	43	12	5.47
Round 7	235-A	5/21/2012	BPQL	57	54	6.04	BPQL	5.39	23	4.14	0.17	BPQL	20	53	20.4	5.38
	235-B	5/21/2012	BPQL	58	56	5.17	BPQL	4.57	23	BPQL	0.18	BPQL	18	60	22.3	6.1
Round 1	669-A	9/29/2010	0.031	124	120	3.48	BPQL	15.9	182	BPQL	0.0736	0.127	5	285	45.6	25.1
	669-B	9/29/2010	0.056	120	118	3.53	BPQL	15.9	182	BPQL	0.118	0.0657	5	379	33.6	32.6
Round 2	669-A	3/21/2011	BPQL	102	138	4.88	BPQL	31.6	238	3.6	0.65	BPQL	7	356	146	50.9
Round 4	669-A	6/6/2011	BPQL	167	190	7.27	BPQL	28.5	74	3.7	0.19	BPQL	10	87	33.5	5.45
	669-B	6/6/2011	BPQL	167	182	4.59	BPQL	29.1	46	3.02	0.1	BPQL	9	106	35.3	4.55
Round 6	669-A	4/2/2012	BPQL	198	208	2.83	BPQL	10.8	BPQL	BPQL	BPQL	BPQL	200	2	3.16	1.38
	669-B	4/2/2012	BPQL	197	202	2.8	BPQL	10.7	BPQL	BPQL	0.13	BPQL	170	1	5.53	0.8
Round 7	669-A	5/23/2012	BPQL	228	232	4.78	BPQL	8.32	BPQL	BPQL	0.26	BPQL	63	8	7.55	1.74
	669-B	5/23/2012	BPQL	221	232	4.73	BPQL	8.69	BPQL	BPQL	0.15	0.1	48	8	5.49	1.65

	Oxbow ID	Date	Ammonia mg/L (NH3)	Alkalinity mg/L (CaCO3)	Hardness mg/L (CaCO3)	Chloride mg/)	N/N mg/L	Sulfate mg/L	TSS mg/L	Kjeldahl N mg/L	TP mg/L	Ortho-P mg/L	Secchi	Turbidity (NTU)	Chlorophyll-a	Pheophytin-a
Round 1	1157-A	10/4/2001	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	1157-B	10/4/2010	0.0274	84	96	12.9	BPQL	15.8	76	BPQL	0.158	0.194	16	95	139	18
Round 2	1157-A	3/2/2011	BPQL	41.4	94	16	BPQL	23.7	27	BPQL	0.14	BPQL	>10	39	36.5	7.28
	1157-B	3/2/2011	2.25	34.4	44	6.03	BPQL	6.23	436	7.15	0.85	BPQL	30	448	364	189
Round 3	1157-B	4/18/2011	BPQL	107	108	13.4	BPQL	4.73	BPQL	2.05	0.17	BPQL	40	28	5.91	1.29
Round 4	1157-B	6/13/2011	BPQL	99.6	108	11.4	BPQL	0.74	86.7	BPQL	0.68	0.1	18	59	34.7	8.16
Round 5	1157-B	10/31/2011	2.01	BPQL	192	16.4	3.21	205	35	2.52	BPQL	BPQL	32	12		
Round 6	1157-A	4/3/2012	BPQL	45	49.6	5.01	BPQL	8.7	48	4.02	1.15	0.78	17	51	7.12	26.6
	1157-B	4/3/2012	BPQL	81	88.9	19.7	BPQL	18.6	26	2.89	0.64	0.15	26	39	9.7	9.44
Round 7	1157-A	5/21/2012	BPQL	35	34.7	5.05	BPQL	2.2	24	2.94	0.92	0.46	28	19	42.3	12.4
	1157-B	5/21/2012	BPQL	118	114	19.8	BPQL	3.1	25	3.14	0.73	0.22	23	44	14.8	3.79
Round 1	273-A	9/22/2010	0.0321	310	300	37.9	BPQL	20.7	42	BPQL	0.118	0.196	23	48	36	12.8
	273-B	9/22/2010	0.0327	296	270	40.5	BPQL	21.6	88	BPQL	0.0583	0.281	13	121	50.1	19.5
Round 2	273-A	3/7/2011	BPQL	343	348	38.5	BPQL	28.6	32.7	BPQL	0.11	BPQL	31	31	16.9	8.38
	273-B	3/7/2011	BPQL	345	364	38.4	BPQL	27.9	35.6	BPQL	0.17	BPQL	31	33	20.8	12.6
Round 3	273-A	4/20/2011	BPQL	316	310	44	BPQL	29.8	43.1	BPQL	0.21	BPQL	16	81	37.3	7.75
	273-B	4/20/2011	BPQL	324	316	43.9	BPQL	29.4	72	BPQL	0.24	BPQL	12	51	35.9	12.5
Round 4	273-A	6/7/2011	BPQL	205	212	32.5	BPQL	24.8	48	2.94	0.25	0.22	12	100	133	14.3
	273-B	6/7/2011	BPQL	212	224	33.9	BPQL	25.5	91	BPQL	0.36	0.26	20	50	55.7	10.4
Round 5	273-A	11/1/2011	BPQL	170	204	57.5	BPQL	67.1	37	BPQL	0.19	BPQL	12	48		
	273-B	11/1/2011	BPQL	177	210	58	BPQL	67.8	82	BPQL	0.29	BPQL	18	119		
Round 6	273-A	4/9/2012	BPQL	148	154	29.2	BPQL	24.4	65	BPQL	0.33	0.1	18	93	46.4	33.3
	273-B	4/9/2012	BPQL	153	155	29.5	BPQL	24.6	62	BPQL	0.29	BPQL	17	89	62.5	26.5
Round 7	273-A	5/22/2012	BPQL	191	200	37	BPQL	7.35	36	2.92	0.29	BPQL	20	45	35	8.29
	273-B	5/22/2012	BPQL	186	194	38	BPQL	21.2	48	BPQL	0.31	BPQL	18	70	76.8	11
Round 1	1167-A	9/22/2010	0.121	156	240	30.6	1.83	26.7	96	2.06	1.51	1.54	15	95	61.4	22.1
	1167-B	9/22/2010	0.126	164	240	57.4	2.14	2720	80	4.48	1.75	1.54	18	45	168	42.9
Round 2	1167-A	3/7/2011	0.75	230	156	61.7	0.92	24.5	28.4	2.24	1.55	1.41	30	28	33.5	33.5
	1167-B	3/7/2011	BPQL	232	168	61.1	1.03	24.5	18.4	BPQL	1.45	1.34	41	19	24.7	30.3
Round 3	1167-A	4/20/2011	BPQL	5	140	66.2	0.54	23.9	62.4	3.99	2.1	1.52	15	49	364	61
	1167-B	4/20/2011	BPQL	241	140	66	0.93	24.2	57.8	5.47	2.25	1.57	15	48	502	82.5
Round 4	1167-A	6/7/2011	1.75	220	156	55.5	0.98	22.8	62	4.5	1.65	1.6	14	71	111	30.8
	1167-B	6/7/2011	2.73	224	150	58.6	1.17	22.3	25.5	5.86	2.2	2.1	24	28	123	11
Round 5	1167-A	11/1/2011	BPQL	208	128	60.9	3.75	27.5	25	2.64	2	1.92	28	24		
	1167-B	11/1/2011	BPQL	205	130	60.3	4.19	26.7	16	2.83	2.4	2.12	50	21		
Round 6	1167-A	4/9/2012	0.98	219	151	60.9	2.5	24	37	5.28	4.25	4.1	30	40	160	102
	1167-B	4/9/2012	1.86	217	150	59.5	2.49	25.1	39	2.65	5.1	4.4	32	28	156	113
Round 7	1167-A	5/22/2012	1.3	212	142	58.3	1.83	22	24	2.66	2.5	2.1	32	26	348	18.3
	1167-B	5/22/2012	1.33	211	142	58.2	3.03	22.4	16	2.62	2	1.8	45	19	40.5	18.1

	Oxbow ID	Date	Ammonia mg/L (NH3)	Alkalinity mg/L (CaCO3)	Hardness mg/L (CaCO3)	Chloride mg/L	N/N mg/L	Sulfate mg/L	TSS mg/L	Kjeldahl N mg/L	TP mg/L	Ortho-P mg/L	Secchi	Turbidity (NTU)	Chlorophyll-a	Pheophytin-a
Round 1	654-A	9/29/2010	0.107	84	80	2.8	BPQL	2.6	9	2	0.147	0.0522	60	9	43.8	15.8
	654-B	9/29/2010	0.039	90	80	2.74	BPQL	2.49	48	BPQL	0.135	BDL	59	10	32.9	5.01
Round 2	654-A	3/16/2011	BPQL	170	174	4.82	BPQL	0.5	120	BPQL	0.37	BPQL	15	154	102	34.2
	654-B	3/17/2011	BPQL	312	298	23.2	BPQL	12.6	10	BPQL	BPQL	BPQL	>25	10	31.1	5.42
Round 3	654-A	4/25/2011	BPQL	339	340	25.4	BPQL	25.6	33.3	BPQL	0.12	BPQL	18	27	58.8	14.1
	654-B	4/25/2011	BPQL	276	248	22.6	BPQL	20.4	111	3.19	0.47	BPQL	15	43	155	30
Round 4	654-A	6/6/2011	BPQL	122	124	7.38	BPQL	6.21	16	BPQL	0.21	BPQL	53	5	73.9	14.1
	654-B	6/6/2011	BPQL	122	120	7.74	BPQL	2	13	BPQL	BPQL	BPQL	79	11	10.3	1.57
Round 5	654-A	10/26/2011	BPQL	143	136	11.3	BPQL	11.8	BPQL	2.06	BPQL	BPQL		4		
	654-B	10/27/2011	BPQL	138	134	11.5	BPQL	14.2	BPQL	BPQL	BPQL	BPQL		2		
Round 6	654-A	4/2/2012	BPQL	99	120	5.19	BPQL	8.55	BPQL	2.47	0.23	BPQL	>47	22	8.7	5.93
	654-B	4/2/2012	BPQL	100	108	5.56	BPQL	12.9	BPQL	BPQL	0.12	BPQL	48	12	4.63	3.58
Round 7	654-A	5/23/2012	BPQL	154	160	8.87	BPQL	5.89	10	BPQL	0.16	BPQL	45	11	23.4	3.59
	654-B	5/23/2012	BPQL	153	156	9.46	BPQL	7.86	42	BPQL	0.23	BPQL	32	36	21.3	11.2
Round 1	658-A	9/29/2010	0.033	110	96	3.66	BPQL	25.5	94	BPQL	0.0936	0.124	11	156	49.9	21.2
	658-B	9/29/2010	0.037	134	98	3.65	BPQL	24.9	77	BPQL	0.0816	0.0288	12	149	41.1	13.3
Round 2	658-A	3/16/2011	BPQL	161	214	5.83	BPQL	64	38	BPQL	0.24	0.1	23	88	35.2	9.33
	658-B	3/17/2011	BPQL	166	226	5.7	BPQL	65.1	232	BPQL	0.42	0.13	11	204	42.5	19.3
Round 3	658-A	4/25/2011	BPQL	159	220	8.03	BPQL	72.3	143	4.48	1.2	BPQL	4	497	140	47.1
	658-B	4/25/2011	BPQL	152	213	7.84	BPQL	71.8	282	3.42	0.89	BPQL	7	486	169	38.3
Round 4	658-A	6/6/2011	BPQL	183	214	6.52	BPQL	39.1	56	2.56	0.52	0.22	12	116	63.8	18.7
	658-B	6/6/2001	BPQL	147	192	7.29	0.3	50.5	3.78	3.13	0.68	0.12	8	516	68.9	36.8
Round 6	658-A	4/2/2012	BPQL	74	98	1.89	BPQL	17.5	BPQL	BPQL	0.45	0.27	66	24	3.59	2.12
	658-B	4/2/2012	BPQL	85	114	2.1	BPQL	30.2	BPQL	BPQL	0.41	0.32	50	25	4.88	2.35
Round 7	658-A	5/23/2012	BPQL	165	200	4.42	BPQL	32	23	BPQL	0.34	0.11	28	22	7.68	0.71
	658-B	5/23/2012	BPQL	161	194	4.32	BPQL	33.2	24	BPQL	0.26	0.12	30	22	8.82	1.87
Round 1	665-A	9/29/2010	0.031	168	166	6.88	BPQL	20.6	10	2.24	0.874	0.654	41	8	40.5	10
	665-B	9/29/2010	0.031	188	196	6.87	BPQL	21	15	2.19	0.8	0.625	49	11	64.6	16
Round 2	665-A	3/21/2011	BPQL	152	218	16.9	BPQL	85	BPQL	BPQL	0.1	BPQL	>42	3	1.49	1.99
	665-B	3/21/2011	BPQL	158	230	17.2	BPQL	86.7	BPQL	BPQL	BPQL	BPQL	>46	3	0.94	1.1
Round 3	665-A	4/25/2011	BPQL	191	195	18.6	BPQL	32.5	BPQL	3.25	0.47	0.43	41	4	0.3	1.38
	665-B	4/25/2011	BPQL	189	188	18.7	BPQL	34	BPQL	3.19	0.41	0.41	60	4	1.02	0.46
Round 4	665-A	6/6/2011	BPQL	222	202	15.9	BPQL	4.26	BPQL	BPQL	0.46	0.48	59	10	4.64	1.53
	665-B	6/6/2011	BPQL	220	196	16.3	BPQL	4.28	BPQL	BPQL	0.51	0.47	63	8	4.6	1
Round 6	665-A	4/2/2012	BPQL	123	126	3.92	BPQL	16.1	BPQL	BQPL	0.51	0.4	50	5	2.48	2.1
	665-B	4/2/2012	BPQL	121	126	3.88	BPQL	15.9	BPQL	BPQL	0.54	0.39	60	2	1.61	2.62
Round 7	665-A	5/23/2012	BPQL	217	208	5.74	BPQL	3.34	13	BPQL	0.66	0.39	40	13	21.7	10.4
	665-B	5/23/2012	BPQL	218	208	5.75	BPQL	3.58	15	BPQL	0.64	0.4	35	22	27.4	11.3

Site	Date Collected	Alkalinity (mg/L as CaCo3)†	Hardness (mg/L) ††	Specific Conductance (mS/cm) □	pH □	Total Phosphorus (µg/L)†‡	Orthophosphate (mg/L PO4-3)††	Ammonia (mg/L NH3 -N)††	Nitrate (mg/L NO3- -N)††	Nitrite (mg/L NO2- -N)††	Chlorophyll a (µg/L)†
173	6/9/2011	61	85.1	0.215	7.76	459.7	0.62	0.08	0.00	0.00	48.67
203	6/16/2011	72	290.7	0.856	7.64	151.0	0.09	0.09	0.00	0.00	40.56
210	6/16/2011	47	68.4	0.521	7.19	306.2	0.23	0.32	0.00	0.00	76.04
235	7/4/2011	76	119.7	0.171	7.23	386.6	0.46	0.14	0.00	0.00	107.71
249	6/1/2011	139	376.2	0.703	7.94	770.5	0.15	0.31	0.05	0.04	104.62
273	6/13/2011	229	256.5	0.565	8.38	314.5	0.18	0.13	0.00	0.00	68.19
286*											
300	7/5/2011	82	153.9	0.259	7.27	793.3	2.54**	0.6**	0.00	0.00	61.56
314	7/5/2011	206	222.3	0.402	8.31	302.0	1.13	0.13	0.00	0.00	112.54
324	6/14/2011	233	290.7	0.521	7.19	1123.4	0.86	0.45	0.00	0.00	235.85
341	6/8/2011	102	171.0	0.548	9.54	477.3	1.29	0.13	0.00	0.00	152.47
342	6/21/2011	74	119.7	0.190	7.24	189.3	1.09	0.06	0.00	0.00	49.44
413	6/3/2011	138	188.1	0.369	8.06	297.1	0.92	0.12	0.00	0.00	111.79
614	7/8/2011	163	171.0	0.894	8.67	1125.0	1.96	0.57**	0.03	0.00	257.26
654	7/7/2011	161	188.2	0.337	7.12	165.4	1.06	0.02	0.00	0.00	66.34
658	7/1/2011	186	222.3	0.369	8.99	1202.0	1.31	0.47	0.00	0.01	185.98
665	6/30/2011	264	239.4	0.511	9.06	1012.8	1.49	0.14	0.07	0.06	72.51
669	6/30/2011	119	205.2	0.330	7.93	628.2	0.63	0.09	0.08	0.05	208.09
1157	6/10/2011	33	68.1	0.105	7.19	892.2	1.36	0.23	0.00	0.00	42.45
1159*											
1163	6/2/2011	60	119.7	0.135	6.83	992.5	8.9**	0.08	0.01	0.00	18.55
1164*											
1167	6/15/2011	243	187.2	0.676	8.21	1524.8	8.5**	1.4**	0.36	0.30	45.22
2000	6/7/2011	51	102.6	0.148	6.72	290.3	0.47	0.12	0.00	0.00	40.07
3000	7/9/2011	181	427.5	0.957	9.02	1724.0	0.73	0.76**	0.00	0.00	68.25

† Received and analyzed by the OSU Ecotoxicology and Water Research Laboratory past EPA recommended holding time

†† Analyzed using HACH ® field kits

□ Determined using a Quanta ® Hydrolab Water Quality Monitoring System

‡ Received and analyzed by ODAFF Laboratory Services Division past EPA recommended holding time

* No water present at time of sampling

** Above detection limit (0-2.5 mg/L for Orthophosphate and 0-0.5 for Ammonia, Nitrate and Nitrite)

Site	Date Collected	Alkalinity (mg/L as CaCo3)†	Hardness (mg/L) ††	Conductivity (mS/cm) □	pH □	Total Phosphorus (µg/L)†+	Orthophosphate (mg/L PO4-3)††	Ammonia (mg/L NH3 -N)‡	Kjeldahl Nitrogen, Total (mg/L)‡	Chlorophyll a (µg/L)†
173	9/10/2011	42	85.5	0.280	7.03	96.43	1.40	0.012	1.42	104.93
203*										
210	9/4/2011	47	68.4	0.242	7.36	625.97	1.02	0.6	7.57	835.95
235	9/11/2011	51	85.5	0.140	7.22	98.97	0.12	<0.11	0.90	17.80
249*										
273	9/7/2011	246	256.5	0.694	7.34	137.47	0.38	<0.11	1.16	70.39
286*										
300*										
314	9/7/2011	194	171.0	0.468	9.09	447.28	0.14	<0.11	10.13	633.17
324*										
341	9/10/2011	80	307.8	1.398	7.71	222.09	1.05	<0.11	3.07	217.30
342	9/12/2011	70	85.5	0.235	7.25	76.45	0.18	<0.11	1.41	39.44
413*										
614	9/4/2011	144	136.8	1.300	8.19	412.77	0.00	0.18	1.54	425.28
654	9/3/2011	137	188.1	0.644	6.68	71.00	0.25	<0.11	1.31	159.32
658*										
665*										
669*										
1157*										
1159*										
1163	9/5/2011	85	119.7	0.186	7.26	1228.87	3.1**	0.59	10.40	82.00
1164*										*
1167	9/7/2011	230	136.8	0.734	7.17	1033.11	3.00	<0.11	2.15	219.71
2000	9/10/2011	89	102.6	0.231	9.33	142.19	0.24	<0.11	1.81	43.84
3000*										

† Received and analyzed by the OSU Ecotoxicology and Water Research Laboratory past EPA recommended holding time

†† Analyzed using HACH ® field kits

□ Determined using a Quanta ® Hydrolab Water Quality Monitoring System

‡ Received and analyzed by ODAFF Laboratory Services Division past EPA recommended holding time

* No water present at time of sampling

** Above detection limit (0-2.5 mg/L for Orthophosphate and 0-0.5 for Ammonia, Nitrate and Nitrite)

APPENDIX B

E. coli results reported as #/100ml

		235	249	273	341	342	413	654	658	665	669	1157	1167
Round 1	6/6/2011							12.6	6.1	2.0	2.0		
	6/7/2011			8.3									1732.9
	6/13/2011	17.0										4.0	
	6/14/2011				4.1	6.3							
	6/15/2011						<1.0						
Round 2	7/11/2011							64.4			10.9		
	7/13/2011												
	7/18/2011	<1.0			27.5	5.2						10.9	1046.2
Round 3	8/8/2011			18.7				727.0			4611.1		>2419.6
	8/9/2011	12.1			25.6	6.3						370.0	
	8/15/2011						42.6						
Round 4	9/7/2011	1.0		3.0	148.3	2.0					>24196		45.9
Round 5	9/27/2011			21.3				18.7					285.1
	9/28/2011	7.4			29.2	12.1						127.4	

APPENDIX C

Vertical Profile Data

Site	Date MMDDYY	Time HHMMSS	Temp °C	pH Units	ORP mV	SpCond µ/cm	Sal ppt	TDS g/l	LDO% Sat	LDO mg/l	Dep100 meters	Res kê-cm
235A	10/4/2010	14:10:22	17.92	6.74	397	131.1	0.05	0.0833	76.7	6.99	0.13	
235A	10/4/2010	14:11:46	16.17	6.61	395	132.7	0.06	0.0849	63.4	6	0.49	
235A	10/4/2010	14:12:51	15.95	6.56	380	132	0.06	0.0845	58.7	5.58	0.51	
235A	3/7/2011	10:37:00	10.4	6	355	98.8	0.04	0.0632	91.8	9.77	0.1	10.12
235A	3/7/2011	10:37:48	10.3	6.03	357	100.3	0.04	0.0642	91.1	9.73	0.5	9.969
235A	3/7/2011	10:37:59	10.3	6.06	357	100.2	0.04	0.0641	90.4	9.66	0.6	9.98
235A	3/7/2011	10:38:57	10.3	6.09	362	100	0.04	0.064	86.8	9.26	0.6	9.996
235A	4/18/2011	13:02:00	19.3	6.77	291	109.2	0.04	0.0699	132.5	11.72	0	9.155
235A	4/18/2011	13:02:00	18.1	6.68	293	109.3	0.04	0.0706	120.7	10.95	0.5	9.146
235A	4/18/2011	13:02:00	17.4	6.54	289	110.7	0.04	0.0709	105.6	9.8	0	9.031
235A	6/13/2011	10:43:13	27.64	7.02	336	160.1	0.07	0.1028	47.9	3.59	0.1	
235A	6/13/2011	10:44:18	27.24	6.91	338	160.4	0.07	0.1027	36	2.72	0.5	
235A	6/13/2011	10:45:42	27.03	6.91	327	160.8	0.07	0.1029	26.2	1.98	0.3	
235A	10/31/2011	13:34:58	12.59	6.47	365	108.6	0.04	0.0695	80.5	8.25	0.14	
235A	10/31/2011	13:35:31	12.55	6.5	366	108.9	0.04	0.0695	80	8.21	0.54	
235A	10/31/2011	13:35:38	12.51	6.51	366	108.8	0.04	0.0696	79.9	8.2	0.57	
235A	4/4/2012	16:30:10	22.23	6.48	324	176	0.08	0.1127	54.7	4.69	0.16	
235A	4/4/2012	16:30:48	21.32	6.55	316	175.9	0.08	0.1126	50.1	4.37	0.47	
235A	5/21/2012	15:57:59	29.09	7.5	297	145.1	0.06	0.0929	126.2	9.23	0.21	
235A	5/21/2012	15:58:42	27.2	7.04	292	142.4	0.06	0.0912	90.9	6.88	0.58	
235A	5/21/2012	15:59:19	28	7.19	286	142.1	0.06	0.0909	110.5	8.24	0.59	
235B	10/4/2010	14:17:17	19.95	6.83	385	133.1	0.06	0.0852	83.9	7.34	0.05	
235B	10/4/2010	14:18:40	18.27	6.7	384	131.4	0.05	0.0841	67.8	6.14	0.54	
235B	10/4/2010	14:19:52	14.87	6.53	370	133.4	0.06	0.0853	50.4	4.9	0.85	

235B	3/7/2011	10:44:33	10.7	6.29	382	105.3	0.04	0.0674	93.7	9.92	0.1	9.498
235B	3/7/2011	10:45:41	10.6	6.21	385	105.3	0.04	0.0674	87.9	9.34	0.5	9.493
235B	3/7/2011	10:47:14	10.3	6.16	386	105	0.04	0.0672	85	9.07	0.8	9.521
235B	4/18/2011	13:09:00	21.4	7.03	297	116.2	0.05	0.0742	145.2	12.32	0.1	8.624
235B	4/18/2011	13:09:00	19.7	6.98	299	116.7	0.05	0.0748	138.6	12.15	0.7	8.57
235B	4/18/2011	13:09:00	17.4	6.62	306	119.7	0.05	0.0728	99.7	9.16	0.4	8.353
235B	6/13/2011	10:36:23	28.04	7.09	329	162.7	0.07	0.1041	65.3	4.85	0.1	
235B	6/13/2011	10:37:36	27.67	7	332	162.3	0.07	0.1039	51.8	3.87	0.5	
235B	6/13/2011	10:38:13	27.03	6.93	324	164.1	0.07	0.105	20.5	1.55	0	
235B	10/31/2011	13:46:09	14.63	6.86	362	116.1	0.05	0.0743	86.3	8.46	0.1	
235B	10/31/2011	13:46:35	13.5	6.83	365	116.3	0.05	0.0744	84.4	8.47	0.49	
235B	4/4/2012	17:00:29	22.42	6.52	329	183.3	0.08	0.1173	72.9	6.22	0.17	
235B	4/4/2012	17:01:01	22.4	6.71	322	182.6	0.08	0.1169	72.4	6.19	0.45	
235B	5/21/2012	16:05:35	29.68	7.56	285	147	0.06	0.0941	123.9	8.97	0.28	
235B	5/21/2012	16:06:17	25.25	7.23	293	141.9	0.06	0.0908	96.1	7.53	0.53	
235B	5/21/2012	16:07:04	22.93	6.89	297	144	0.06	0.0922	47.7	3.91	0.85	
249A	9/23/2010	11:48:03	26.11	6.71	36	840.4	0.44	0.5378	5.2	0.4	0.18	
249A	9/23/2010	11:50:38	27.03	7.89	63	237.5	0.11	0.152	177.2	13.62	0.21	
249A	4/25/2011	10:49:05	13.46	7.52	358	646.5	0.33	0.4137	82.4	8.13	0.18	
249A	4/25/2011	10:49:20	13.33	7.51	356	590.2	0.3	0.3777	80.3	7.95	0.26	
249A	5/22/2012	12:19:21	25.18	7.32	214	442.7	0.22	0.2833	28.8	2.25	0.09	
249A	5/22/2012	12:19:43	24.29	7.31	215	430.3	0.22	0.2754	20.6	1.64	0.46	
249A	5/22/2012	12:20:08	23.47	7.28	216	432.1	0.22	0.2765	17	1.38	0.66	
249B	9/23/2010	11:39:45	26.27	7.13	170	333.1	0.16	0.2132	28.1	2.17	0.25	
249B	4/25/2011	10:44:39	13.43	7.63	344	150.7	0.07	0.0965	95.7	9.47	0.12	
249B	4/25/2011	10:44:54	13.26	7.65	344	138.1	0.06	0.0884	95.5	9.48	0.26	
249B	5/22/2012	12:30:43	25.13	7.35	227	437.6	0.22	0.2801	24.5	1.93	0.12	
249B	5/22/2012	12:31:35	23.76	7.34	227	432.4	0.22	0.2768	18.8	1.52	0.47	
249B	5/22/2012	12:32:11	23.62	7.31	226	433.6	0.22	0.2775	16	1.29	0.65	
273A	9/22/2010	9:20:02	25.82	7.38	335	656.1	0.34	0.4199	45.6	3.55	0.09	

273A	9/22/2010	9:21:09	25.81	7.39	330	656.1	0.34	0.4199	43.3	3.38	0.48	
273A	9/22/2010	9:22:42	25.65	7.42	326	654.8	0.34	0.4191	41.4	3.24	0.97	
273A	9/22/2010	9:23:48	25.26	7.45	257	655.1	0.34	0.4191	45.9	3.62	1.51	
273A	9/22/2010	9:25:05	25.29	7.26	163	663.6	0.34	0.4247	31	2.44	1.78	
273A	3/7/2011	13:21:56	10.9	7.73	313	783.7	0.41	0.5016	109.2	11.46	0.1	1.276
273A	3/7/2011	13:22:27	10.7	7.72	313	783.9	0.41	0.5017	109	11.52	0.5	1.276
273A	3/7/2011	13:23:00	10.7	7.71	313	783.2	0.41	0.5013	109.2	11.53	1	1.277
273A	4/20/2011	9:00:00	18.9	7.71	351	758.2	0.39	0.4853	107.2	9.55	0.1	1.319
273A	4/20/2011	9:00:00	18.9	7.72	349	758	0.39	0.485	106.4	9.48	0.7	1.319
273A	4/20/2011	9:00:00	18.7	7.72	348	757.6	0.39	0.4849	102.8	9.19	1.2	1.32
273A	4/20/2011	9:00:00	18.4	7.72	343	762.7	0.39	0.4881	100.7	9.11	0	1.311
273A	6/7/2011	11:41:33	28.83	8.05	389	538.4	0.27	0.3446	101.3	7.5	0.1	
273A	6/7/2011	11:42:25	28.64	7.97	392	538.7	0.27	0.3448	94.1	6.99	1.1	
273A	6/7/2011	11:43:34	27.88	7.69	394	540.5	0.27	0.3459	54.4	4.1	1	
273A	6/7/2011	11:44:38	27.03	7.61	396	542.5	0.28	0.3472	42.7	3.27	1.2	
273A	11/1/2011	14:43:12	16.8	8.08	365	624.2	0.32	0.3995	99.4	9.28	0.13	
273A	11/1/2011	14:44:00	15.45	8.01	367	621.6	0.32	0.3978	90.7	8.71	0.5	
273A	11/1/2011	14:44:23	15.3	8.01	367	622.6	0.32	0.3984	89	8.58	0.53	
273A	4/9/2012	11:57:03	18.4	7.55	272	432.7	0.22	0.2769	62.9	5.81	0.21	
273A	4/9/2012	11:58:28	18.2	7.48	273	433	0.22	0.2771	48.9	4.53	0.53	
273A	4/9/2012	11:59:17	17.95	7.42	274	433.8	0.22	0.2776	37	3.45	1.02	
273A	4/9/2012	11:59:58	17.9	7.4	274	433.6	0.22	0.2775	35.5	3.31	1.51	
273A	4/9/2012	12:01:14	17.87	7.37	263	434.3	0.22	0.2779	34.1	3.18	1.74	
273A	5/22/2012	17:07:40	26.1	8.41	311	537.8	0.27	0.3442	188.4	14.52	0.1	
273A	5/22/2012	17:08:22	24.71	8	313	537	0.27	0.3437	122	9.64	0.49	
273A	5/22/2012	17:11:37	22.44	7.64	313	545	0.28	0.3488	60.5	4.99	1	
273B	9/22/2010	9:33:49	25.88	7.52	297	661.6	0.34	0.4234	55.9	4.35	0.1	
273B	9/22/2010	9:34:29	25.85	7.52	296	661.3	0.34	0.4232	53.5	4.17	0.8	
273B	9/22/2010	9:35:36	25.61	7.44	184	662.1	0.34	0.4237	45.6	3.57	0.97	
273B	9/22/2010	10:37:16	26.6	7.92	297	680.3	0.35	0.4354	83.6	6.43	0.14	

273B	3/7/2011	13:30:53	11.1	7.71	342	787.3	0.41	0.5039	112.5	11.77	0	1.27
273B	3/7/2011	13:31:34	11.1	7.72	341	785.9	0.41	0.503	113.3	11.86	0.5	1.272
273B	3/7/2011	13:32:26	11.1	7.72	337	787.3	0.41	0.5039	112.1	11.75	0.8	1.27
273B	4/20/2011	8:47:00	18.2	7.66	363	764.7	0.4	0.4894	101.6	9.16	0.1	1.308
273B	4/20/2011	8:47:00	18.2	7.65	350	764.9	0.4	0.4895	101.2	9.14	0.5	1.307
273B	4/20/2011	8:47:00	18.2	7.69	347	765.6	0.4	0.49	99.9	9.02	0.5	1.306
273B	6/7/2011	11:29:05	28.8	7.94	393	551.1	0.28	0.3527	83.1	6.16	0.1	
273B	6/7/2011	11:29:17	28.82	7.93	393	551.6	0.28	0.353	82.7	6.13	0.1	
273B	6/7/2011	11:29:52	28.74	7.92	394	551.2	0.28	0.3527	81.6	6.05	0.5	
273B	6/7/2011	11:30:33	28.68	7.88	395	550.8	0.28	0.3525	80.1	5.95	0.8	
273B	11/1/2011	14:26:15	17.11	8.19	368	625.9	0.32	0.4006	109	10.11	0.1	
273B	11/1/2011	14:26:47	16.88	8.19	367	628.6	0.32	0.4023	108.4	10.1	0.45	
273B	4/9/2012	12:09:51	20.48	8.15	270	433.5	0.22	0.2775	114.1	10.11	0.2	
273B	4/9/2012	12:10:47	19.5	7.96	273	433.5	0.22	0.2775	98.4	8.89	0.52	
273B	4/9/2012	12:11:30	17.69	7.57	275	434.9	0.22	0.2783	51.2	4.8	1.01	
273B	5/22/2012	17:19:51	28.87	8.57	302	529.2	0.27	0.3387	197.9	14.51	0.19	
273B	5/22/2012	17:20:28	28.63	8.54	303	529.9	0.27	0.3391	196.2	14.45	0.53	
273B	5/22/2012	17:21:34	27.53	8.26	305	534.9	0.27	0.3423	151.8	11.4	0.79	
341A	9/21/2010	10:41:39	26.39	7.03	385	757.8	0.39	0.485	58.3	4.49	0.1	
341A	9/21/2010	10:42:18	26.26	7.01	367	755.5	0.39	0.4835	52	4.02	0.48	
341A	9/21/2010	10:42:48	26.22	6.93	178	754.7	0.39	0.4828	45.7	3.53	0.39	
341A	9/21/2010	10:56:55	26.85	7.18	352	781.7	0.41	0.5003	67.2	5.14	0.09	
341A	3/3/2011	10:35:00	11.3	6.62	348	1128	0.59	0.7218	82.3	8.66	0.1	0.887
341A	3/3/2011	10:35:00	11.3	6.49	349	1128	0.59	0.7217	81.9	8.63	0.3	0.887
341A	3/3/2011	10:35:00	11.3	6.58	350	1126	0.59	0.7209	81.8	8.63	0.3	0.888
341A	3/3/2011	10:35:00	11.2	6.53	350	1129	0.59	0.7223	79.6	8.42	0.5	0.886
341A	3/3/2011	10:35:00	11.2	6.57	337	1128	0.59	0.7217	78.9	8.35	0.6	0.887
341A	4/18/2011	17:00:00	21.5	7.23	361	1380	0.73	0.8829	138.2	11.65	0.1	0.725
341A	4/18/2011	17:00:00	19.3	6.91	361	1396	0.74	0.8933	109.4	9.62	0.5	0.716
341A	4/18/2011	17:00:00	19	6.9	359	1382	0.73	0.8842	109.8	9.73	0.6	0.724

341A	6/14/2011	11:01	28.37	7.25	325	532.8	0.27	0.3413	55.4	4.09	0.1	
341A	6/14/2011	11:01	28.29	7.24	326	536.8	0.27	0.3435	54.6	4.04	0.5	
341A	6/14/2011	11:01	28.29	7.22	327	537.2	0.27	0.3438	53.4	3.95	0.7	
341A	11/1/2011	10:45:53	13.07	7.46	415	1320	0.7	0.8451	91.1	9.2	0.11	
341A	11/1/2011	10:46:34	12.98	7.53	412	1321	0.7	0.8453	91.8	9.29	0.51	
341A	11/1/2011	10:46:50	13	7.54	411	1321	0.7	0.8454	91.7	9.27	0.54	
341A	4/4/2012	10:19:55	19.96	6.91	285	334.4	0.16	0.214	41.9	3.76	0.23	
341A	4/4/2012	10:20:28	20	6.93	285	334.3	0.16	0.214	41.9	3.75	0.54	
341A	4/4/2012	10:20:59	19.98	6.86	281	335.3	0.16	0.2146	39.6	3.54	0.92	
341A	5/21/2012	11:04:01	25.14	7.41	310	644.9	0.33	0.4127	81.3	6.38	0.31	
341A	5/21/2012	11:04:33	23.44	7.35	311	638.9	0.33	0.4089	69.3	5.61	0.65	
341A	5/21/2012	11:05:33	23.14	7.2	306	638.1	0.33	0.4084	48	3.91	0.92	
341B	9/21/2010	10:57:45	27.41	7.27	344	783.9	0.41	0.5017	74.9	5.67	0.11	
341B	9/21/2010	10:58:01	26.52	7.14	345	781	0.4	0.4998	62	4.77	0.5	
341B	9/21/2010	11:00:49	26.3	7.05	149	781.1	0.4	0.4999	24.5	1.89	0.59	
341B	3/3/2011	10:51:00	11.1	6.77	399	1149	0.6	0.7351	82.6	8.75	0.1	0.871
341B	3/3/2011	10:51:00	10.4	6.66	398	1156	0.61	0.7398	79.4	8.56	0.2	0.865
341B	3/3/2011	10:51:00	10.4	6.61	393	1142	0.6	0.7306	75.5	8.12	0.3	0.876
341B	4/18/2011	17:25:00	21.2	7.18	381	1404	0.74	0.8985	139	11.79	0.1	0.712
341B	4/18/2011	17:25:00	20.1	6.98	367	1404	0.74	0.8985	120.4	10.44	0.5	0.712
341B	4/18/2011	17:25:00	20	6.93	337	1402	0.74	0.897	114	9.91	0.6	0.713
341B	6/14/2011	11:16	29.03	7.23	328	591.3	0.3	0.3785	50.1	3.66	0.1	
341B	6/14/2011	11:16	28.95	7.2	329	591	0.3	0.3782	47.7	3.48	0.5	
341B	6/14/2011	11:16	28.95	7.19	330	591.2	0.3	0.3783	47.8	3.49	0.5	
341B	11/1/2011	10:37:54	13.17	7.01	477	1332	0.7	0.8527	95	9.57	0.09	
341B	11/1/2011	10:38:27	12.88	7.09	473	1336	0.71	0.8554	94.4	9.59	0.5	
341B	11/1/2011	10:38:53	12.89	7.13	471	1337	0.71	0.855	95.2	9.65	0.58	
341B	4/4/2012	10:33:28	20.36	7.05	290	370.2	0.18	0.2369	37.8	3.36	0.26	
341B	4/4/2012	10:34:17	20.38	6.99	289	370.2	0.18	0.2369	37	3.28	0.57	
341B	4/4/2012	10:34:45	20.39	6.94	284	369.8	0.18	0.2367	36.2	3.21	0.9	

341B	5/21/2012	11:14:56	25.45	7.29	314	663.3	0.34	0.4245	71	5.53	0.34	
341B	5/21/2012	11:15:52	23.88	7.17	316	659.1	0.34	0.4218	55.4	4.45	0.58	
341B	5/21/2012	11:17:02	23.12	7.03	309	657.1	0.34	0.4206	29.3	2.38	0.94	
342A	9/21/2010	11:47:55	28.45	7.22	274	220.2	0.1	0.1409	68.9	5.13	0.16	
342A	9/21/2010	11:48:30	27.89	7.15	276	219.7	0.1	0.1398	59.8	4.49	0.73	
342A	9/21/2010	11:49:20	27.41	7.03	254	220	0.1	0.1408	41.1	3.12	1.02	
342A	9/21/2010	11:50:10	27.4	6.98	181	220	0.1	0.1408	35	2.65	1.11	
342A	3/3/2011	11:43:00	12.1	7.18	408	174	0.08	0.1113	99.8	10.36	0.1	5.748
342A	3/3/2011	11:43:00	12.4	7.15	410	172.1	0.08	0.1102	96.2	9.91	0.2	5.81
342A	3/3/2011	11:43:00	11.6	7.11	411	173.1	0.08	0.1108	95.8	10.07	0.3	5.779
342A	3/3/2011	11:43:00	11	7.1	410	173.5	0.08	0.111	97.3	10.36	0.4	5.764
342A	4/18/2011	16:01:00	22.3	7.57	340	213.9	0.1	0.1368	157.4	13.12	0.1	4.679
342A	4/18/2011	16:01:00	22	7.47	332	213.6	0.1	0.1367	153.6	12.87	0.4	4.683
342A	6/14/2011	12:32	29.64	7.15	339	190.2	0.09	0.1217	52.7	3.81	0.1	
342A	6/14/2011	12:32	29.45	7.06	343	190.3	0.09	0.1218	40.3	2.92	0.5	
342A	6/14/2011	12:32	29.17	6.97	347	191.2	0.09	0.1224	30.4	2.21	1	
342A	6/14/2011	12:32	29.15	6.95	347	190.8	0.09	0.1221	31	2.26	1.1	
342A	11/1/2011	12:01:20	14.55	7.5	383	228.4	0.11	0.1462	96.1	9.43	0.11	
342A	11/1/2011	12:01:40	14.51	7.44	386	228.4	0.11	0.1462	95.6	9.38	0.31	
342A	4/4/2012	11:41:01	21.28	6.94	297	221.3	0.1	0.1416	36.7	3.21	0.26	
342A	4/4/2012	11:41:51	21.32	6.89	299	221.5	0.1	0.1417	36.8	3.21	0.46	
342A	4/4/2012	11:42:38	21.33	6.87	301	221.1	0.1	0.1415	36	3.14	0.97	
342A	4/4/2012	11:43:26	21.32	6.83	290	221.9	0.1	0.142	35	3.05	1.38	
342A	5/21/2012	12:19:10	26.1	7.39	324	238.9	0.11	0.1332	93.8	7.24	0.25	
342A	5/21/2012	12:19:47	24.81	7.33	326	237.3	0.11	0.1516	86.9	6.86	0.6	
342A	5/21/2012	12:20:26	23.73	7.03	319	238.4	0.11	0.1525	52	4.19	1.06	
342B	9/21/2010	12:03:58	27.57	7.4	320	216.3	0.1	0.1384	84.5	6.39	0.1	
342B	9/21/2010	12:04:57	27.44	7.33	315	216.3	0.1	0.1382	80	6.07	0.77	
342B	9/21/2010	12:06:17	26.77	7.1	249	217.9	0.1	0.1394	50.5	3.87	0.55	
342B	3/3/2011	11:56:00	11.5	7.25	432	174.4	0.08	0.1116	100.5	10.57	0	5.735

342B	3/3/2011	11:56:00	11.4	7.25	431	174.3	0.08	0.1115	100.7	10.62	0.2	5.738
342B	3/3/2011	11:56:00	11.3	7.23	427	174.2	0.08	0.1115	100.1	10.58	0.4	5.74
342B	3/3/2011	11:56:00	11.2	7.23	426	173.9	0.08	0.1113	99.6	10.58	0.3	5.75
342B	4/18/2011	15:51:00	22.2	7.23	373	214	0.1	0.137	153.2	12.81	0.1	4.673
342B	4/18/2011	15:51:00	22.2	7.59	346	0	-0.02	0	155.7	13.08	0	0
342B	6/14/2011	12:56	28.55	7.2	350	190.5	0.09	0.1214	65.4	4.82	0.1	
342B	6/14/2011	12:56	28.25	7.04	356	190	0.09	0.1216	52.4	3.88	0.6	
342B	6/14/2011	12:56	28.35	7.07	355	190.1	0.09	0.1217	54.2	4.01	0.5	
342B	6/14/2011	12:56	28.21	6.94	357	190.5	0.09	0.1222	44.1	3.27	1	
342B	6/14/2011	12:56	28.23	6.97	352	190.4	0.09	0.1218	44.6	3.3	1	
342B	11/1/2011	12:16:18	14.98	7.81	390	229.7	0.11	0.147	101.4	9.85	0.11	
342B	11/1/2011	12:16:31	15.07	7.75	387	165.9	0.07	0.1062	103.9	10.08	0.06	
342B	11/1/2011	12:16:57	14.71	7.51	345	229.2	0.11	0.1467	97.1	9.49	0.04	
342B	4/4/2012	11:55:29	21.04	6.87	296	220.6	0.1	0.1412	38.9	3.41	0.29	
342B	4/4/2012	11:56:41	21.01	6.83	297	220.3	0.1	0.141	38.8	3.41	0.51	
342B	4/4/2012	11:57:57	21.05	6.81	298	220.1	0.1	0.1409	39	3.42	1.06	
342B	4/4/2012	11:58:46	21.03	6.77	290	220.5	0.1	0.1411	38.1	3.34	1.29	
342B	5/21/2012	12:07:57	24.75	7.25	325	237.6	0.11	0.1521	84.9	6.72	0.33	
342B	5/21/2012	12:09:16	24.85	7.24	328	236.9	0.11	0.1516	85.4	6.74	0.61	
342B	5/21/2012	12:10:11	23.83	7.1	324	237.4	0.11	0.1519	71.5	5.76	0.97	
413A	9/23/2010	12:40:42	26.95	7.79	183	234.1	0.11	0.1498	113.3	8.66	0.17	
413A	3/15/2011	13:00	10.2	7.65	296	343.3	0.17	0.2197	116.7	12.57	0.3	2.913
413A	3/15/2011	13:00:00	10.3	7.64	296	343	0.17	0.2198	116.8	12.57	0.3	2.916
413A	5/16/2011	11:19:41	20.09	8.03	358	391.2	0.19	0.2503	111.6	9.59	0.1	
413A	5/16/2011	11:20:13	20.11	8.02	358	390.9	0.19	0.2502	113	9.7	0.21	
413A	6/15/2011	12:35	33.8	9.09	324	309.2	0.15	0.1979	270.3	18.19	0.1	
413A	4/3/2012	13:38:19	24.04	7.02	313	221.1	0.1	0.1415	68.6	5.68	0.1	
413A	4/3/2012	13:38:55	23.9	7.01	313	221.3	0.1	0.1415	60.2	5	0.55	
413A	4/3/2012	13:40:35	23.24	6.9	313	228.1	0.11	0.146	28.9	2.43	1.01	
413A	4/3/2012	13:41:30	22.14	6.79	281	219.5	0.1	0.1405	17	1.46	1.54	

413A	4/3/2012	13:42:35	18.08	6.65	196	224.4	0.1	0.1436	2.1	0.19	1.99	
413A	4/3/2012	13:43:10	14.89	6.74	189	254.5	0.12	0.1629	2	0.2	2.5	
413A	5/22/2012	13:18:34	25.65	7.4	260	310	0.15	0.1984	71.6	5.57	0.1	
413A	5/22/2012	13:19:17	21.24	7.2	254	303.2	0.15	0.1941	39.8	3.36	0.49	
413B	9/23/2010	12:31:20	26.68	7.93	270	227.5	0.11	0.1456	102.7	7.89	0.18	
413B	3/15/2011	13:15:00	10.9	7.7	356	335.3	0.16	0.2146	119.7	12.67	0.4	2.983
413B	5/16/2011	11:34:48	20.36	8.23	357	387.9	0.19	0.2482	122.5	10.46	0.1	
413B	5/16/2011	11:35:54	19.27	8.27	360	386	0.19	0.247	129.7	11.31	0.08	
413B	6/15/2011	12:45	32.28	8.84	314	321.4	0.16	0.2057	233.7	16.13	0.1	
413B	4/3/2012	13:49:46	24.09	7.21	261	220.2	0.1	0.1409	65.5	5.42	0.19	
413B	4/3/2012	13:50:51	23.99	7.19	263	220.8	0.1	0.1413	62.6	5.19	0.52	
413B	4/3/2012	13:51:51	23.03	7.06	267	220.9	0.1	0.1414	40.6	3.42	1.04	
413B	4/3/2012	13:53:18	22.32	6.95	269	218.5	0.1	0.1398	26.5	2.26	1.46	
413B	4/3/2012	13:55:04	17.18	6.73	178	223.2	0.1	0.1429	1.9	0.18	2.05	
413B	4/3/2012	13:55:51	14.64	6.82	173	244.5	0.12	0.1565	2	0.2	2.54	
413B	5/22/2012	13:22:17	25	7.47	249	303	0.15	0.1939	76.7	6.03	0.07	
413B	5/22/2012	13:23:11	22.54	7.38	254	298.4	0.14	0.1909	63.8	5.25	0.43	
654A	9/29/2010	11:03:40	21.15	6.37	178	157.5	0.07	0.1008	5.4	0.46	0.09	
654A	9/29/2010	11:04:22	20.46	6.34	162	157.8	0.07	0.101	3	0.26	0.49	
654A	9/29/2010	11:04:41	20.35	6.33	152	159.6	0.07	0.1021	2.6	0.23	1	
654A	3/16/2011	11:00:00	13.6	7.41	310	341.9	0.17	0.2188	81.5	8.13	0.1	2.925
654A	3/16/2011	11:00:00	13.6	7.42	309	340.3	0.17	0.2178	83.9	8.36	0.3	2.939
654A	3/16/2011	11:00:00	13.7	7.43	307	340.6	0.17	0.218	86	8.55	0.3	2.936
654A	4/25/2011	12:00:00	23.39	8.21	357	749.3	0.39	0.4795	331.5	26.68	0.1	
654A	4/25/2011	12:00:00	23.24	8.16	355	733.5	0.38	0.4715	303.9	24.53	0.2	
654A	6/6/2011	11:35	29.02	7.27	358	277.3	0.13	0.1775	55.2	4.08	0.1	
654A	6/6/2011	11:35	27.59	7.1	358	276.8	0.13	0.1772	28.4	2.15	0.5	
654A	6/6/2011	11:35	27.13	7.07	358	276.1	0.13	0.1767	24.9	1.9	0.7	
654A	10/26/2011	11:40:42	19.03	7.31	310	320.3	0.16	0.205	57.7	5.13	0.11	
654A	10/26/2011	11:42:15	18.58	7.17	306	321	0.16	0.2054	29.1	2.62	0.56	

654A	4/2/2012	10:37:11	22.62	6.85	263	238.5	0.11	0.1527	37.6	3.2	0.09	
654A	4/2/2012	10:37:56	22.31	6.84	260	238.1	0.11	0.1524	37.1	3.17	0.33	
654A	4/2/2012	10:38:26	22.28	6.86	259	236.6	0.11	0.1514	38.1	3.26	0.43	
654A	5/23/2012	12:00:27	26.56	7.59	273	346.3	0.17	0.2217	73.2	5.6	0.4	
654A	5/23/2012	12:01:18	25.77	7.47	273	346.5	0.17	0.2218	56.4	4.37	1.6	
654A	5/23/2012	12:01:48	25.45	7.44	272	346.7	0.17	0.2219	51	3.98	2.5	
654B	9/29/2010	10:18:02	20.28	6.42	380	182.8	0.08	0.117	11.9	1.03	0.08	
654B	9/29/2010	10:21:51	20.28	6.52	344	182.9	0.08	0.117	14.4	1.25	0.54	
654B	9/29/2010	10:22:30	20.26	6.49	291	183.1	0.08	0.1176	11.3	0.98	1.11	
654B	9/29/2010	10:22:55	20.26	6.47	246	183.5	0.08	0.1174	10.2	0.88	1.12	
654B	3/16/2011	12:07:00	13.8	7.46	315	662.1	0.34	0.4237	114.5	11.33	0.1	1.51
654B	3/16/2011	12:07:00	13.9	7.43	314	661.9	0.34	0.4236	114.2	11.29	0.3	1.511
654B	4/25/2011	12:40:00	23.57	7.56	341	618.2	0.32	0.3957	103.4	8.3	0.1	
654B	6/6/2011	11:05	29.65	7.05	365	274.1	0.13	0.1754	32.8	2.39	0.1	
654B	6/6/2011	11:05	27.04	7.06	364	277.4	0.13	0.1775	25.9	1.98	0.8	
654B	6/6/2011	11:05	26.32	6.9	353	300.2	0.15	0.1921	11.8	0.91	1	
654B	10/26/2011	11:18:06	18.9	6.72	286	314.7	0.15	0.2014	5.1	0.46	0.09	
654B	10/26/2011	11:18:34	18.69	6.75	273	315.9	0.15	0.2022	4.8	0.43	0.39	
654B	4/2/2012	11:03:56	21.97	7.08	285	240	0.11	0.1536	42.8	3.69	0.06	
654B	4/2/2012	11:05:40	21.97	7.1	285	240.3	0.11	0.1538	43.7	3.76	0.3	
654B	4/2/2012	11:07:26	21.87	7.04	283	240.7	0.11	0.154	37.1	3.2	0.58	
654B	5/23/2012	11:35:58	27	7.27	263	357.6	0.18	0.2278	59.3	4.5	0.6	
654B	5/23/2012	11:36:41	24.88	7.22	262	353.9	0.17	0.2265	38.7	3.05	1.7	
654B	5/23/2012	11:37:29	24.64	7.17	261	357	0.18	0.2285	33.5	2.65	2.4	
658A	9/29/2010	12:01:35	23.44	7.84	290	261.5	0.12	0.1673	91.8	7.47	0.12	
658A	9/29/2010	12:02:27	21.75	7.53	283	261.6	0.12	0.1674	69.1	5.8	0.51	
658A	9/29/2010	12:03:22	21.43	7.51	269	261.8	0.12	0.1676	66.2	5.59	0.7	
658A	3/16/2011	17:16:00	19.1	8.17	273	438.4	0.22	0.2806	146.8	13.03	0.1	2.281
658A	3/16/2011	17:16:00	18.7	8.15	279	440.2	0.22	0.2817	144.1	12.9	0.2	2.272
658A	4/25/2011	13:31:00	24.6	8.22	353	466	0.23	0.2982	128.3	10.11	0.1	

658A	6/6/2011	12:17	33.02	8.55	357	424.8	0.21	0.2718	122.7	8.46	0.1	
658A	4/2/2012	12:29:17	25.78	7.26	333	198.4	0.09	0.127	63.4	5.09	0.06	
658A	4/2/2012	12:29:45	25.24	7.24	334	198.9	0.09	0.1273	62.2	5.03	0.18	
658A	4/2/2012	12:30:10	24.73	7.21	335	200.7	0.09	0.1284	57.9	4.74	0.34	
658A	4/2/2012	12:30:27	23.9	7.17	336	206.8	0.1	0.1323	45.9	3.81	0.48	
658A	4/2/2012	13:28:06	25.32	7.54	324	410.1	0.2	0.2625	62.3	5.03	0.06	
658A	5/23/2012	13:19:48	29.38	8.42	288	402.5	0.2	0.2576	121.8	8.86	0.4	
658A	5/23/2012	13:20:16	29.42	8.43	287	402.1	0.2	0.2572	121.1	8.8	0.8	
658B	9/29/2010	12:15:42	24.52	7.92	326	269.3	0.13	0.1723	96.8	7.72	0.11	
658B	9/29/2010	12:16:39	21.53	7.59	335	270.8	0.13	0.1733	71.6	6.04	0.56	
658B	9/29/2010	12:17:52	21.37	7.48	280	273.1	0.13	0.1748	62.5	5.29	0.87	
658B	3/16/2011	18:04:00	18.3	8.09	319	446.7	0.22	0.2859	120.1	10.82	0.1	2.239
658B	3/16/2011	18:04:00	18.3	8.08	320	446.4	0.22	0.2857	120.4	10.84	0.3	2.24
658B	3/16/2011	18:04:00	18.3	8.07	319	446.8	0.22	0.2859	120	10.82	0.4	2.238
658B	4/25/2011	14:00:00	23.7	7.91	391	464.7	0.23	0.2974	105	8.42	0.1	
658B	4/25/2011	14:00:00	23.7	7.9	391	464.6	0.23	0.2974	104.4	8.37	0.2	
658B	6/6/2011	12:50	31.98	8.08	356	394.6	0.2	0.2526	98.4	6.91	0.1	
658B	6/6/2011	12:50	31.37	7.93	357	396.1	0.2	0.2535	86.7	6.15	0.4	
658B	4/2/2012	12:07:24	24.65	7.36	320	250.7	0.12	0.1605	68.7	5.63	0.12	
658B	4/2/2012	12:08:08	24.68	7.35	320	251.3	0.12	0.1609	68.9	5.64	0.12	
658B	4/2/2012	12:08:39	24.64	7.36	320	250.6	0.12	0.1604	69.1	5.66	0.35	
658B	4/2/2012	12:09:00	24.57	7.36	320	250.6	0.12	0.1604	69.7	5.71	0.46	
658B	4/2/2012	12:09:22	24.47	7.36	321	250.2	0.12	0.1601	70	5.75	0.61	
658B	4/2/2012	12:09:48	24.54	7.36	321	250.4	0.12	0.1603	70.1	5.76	0.76	
658B	5/23/2012	12:50:07	28.32	8.35	287	390.5	0.19	0.2499	113.3	8.41	0.4	
658B	5/23/2012	12:50:22	28.29	8.36	286	390.6	0.19	0.25	113	8.37	0.8	
665A	9/29/2010	13:44:04	26.26	7.84	308	411.2	0.21	0.2632	109.7	8.46	0.12	
665A	9/29/2010	13:44:51	23.05	7.46	315	420.6	0.21	0.2692	63.7	5.22	0.37	
665A	3/21/2011	10:55:00	21.2	7.37	279	517	0.26	0.3309	101.9	8.67	0.1	1.934
665A	3/21/2011	10:55:00	21.2	7.37	279	517.1	0.26	0.3309	99.3	8.45	0.1	1.934

665A	3/21/2011	10:55:00	21	7.41	278	520	0.26	0.3328	98.9	8.45	0.1	1.923
665A	4/25/2011	15:00:00	22.58	7.51	436	499.1	0.25	0.3194	79.8	6.52	0.1	
665A	4/25/2011	15:00:00	22.47	7.5	435	501.1	0.25	0.3207	78.6	6.45	0	
665A	6/6/2011	13:51	33.84	8.12	353	472.2	0.24	0.3022	109.1	7.42	0.1	
665A	6/6/2011	13:51	32.97	8.26	354	467	0.24	0.2986	146	10.07	0.4	
665A	4/2/2012	14:11:26	26.81	7.05	335	293.4	0.14	0.1878	14.7	1.16	0.18	
665A	4/2/2012	14:11:57	24.29	6.9	215	295.8	0.14	0.1893	3.6	0.3	0.7	
665A	5/23/2012	15:12:45	30.53	7.63	316	460	0.23	0.2944	88.4	6.34	0.08	
665A	5/23/2012	15:13:21	28.88	7.51	319	458.2	0.23	0.2931	77.4	5.68	0.45	
665A	5/23/2012	15:13:53	28.41	7.5	319	456.6	0.23	0.2922	78.7	5.82	0.63	
665B	9/29/2010	13:51:51	25.57	7.85	339	407.2	0.2	0.2606	107.6	8.41	0.09	
665B	9/29/2010	13:52:33	23.48	7.88	336	407.4	0.2	0.2607	113.5	9.22	0.34	
665B	3/21/2011	11:05:00	21.2	7.93	281	524.6	0.27	0.3357	136.4	11.6	0.1	1.907
665B	3/21/2011	11:05:00	21.2	7.92	281	524.6	0.27	0.3358	138	11.74	0.4	1.906
665B	4/25/2011	15:15:00	22.41	7.59	423	498.8	0.25	0.3192	85.3	7	0.1	
665B	4/25/2011	15:15:00	22.43	7.59	422	498.8	0.25	0.3192	84.2	6.91	0	
665B	6/6/2011	13:56	33.24	8.04	358	475.2	0.24	0.3041	103.5	7.11	0.1	
665B	6/6/2011	13:56	32.69	8.05	359	2.6	-0.01	0.0017	106.4	7.39	0	
665B	4/2/2012	14:29:53	26.32	7.06	306	292.5	0.14	0.1872	14.9	1.19	0.12	
665B	4/2/2012	14:30:37	23.53	6.67	120	318.1	0.16	0.2036	3.1	0.26	0.75	
665B	5/23/2012	15:27:23	29.93	7.93	316	448.6	0.23	0.2871	127.3	9.16	0.1	
665B	5/23/2012	15:27:55	29.19	7.84	318	448	0.23	0.2868	118.8	8.67	0.53	
665B	5/23/2012	15:28:23	28.97	7.81	318	448.1	0.23	0.2868	117.3	8.59	0.61	
669A	9/29/2010	15:06:36	25.21	8.13	322	273.7	0.13	0.1752	114.3	8.99	0.11	
669A	9/29/2010	15:08:13	24.23	8	277	275.3	0.13	0.1762	96.7	7.75	0.42	
669A	9/29/2010	15:09:36	22.25	7.61	255	276.9	0.13	0.1772	67.9	5.65	0.97	
669A	3/21/2011	12:05:00	20.3	8.7	257	273.9	0.13	0.1753	111.9	9.69	0.2	3.651
669A	6/6/2011	14:34	33.99	8.12	342	383.9	0.19	0.2457	143.7	9.75	0	
669A	6/6/2011	14:34	30.99	7.69	347	391.3	0.19	0.2504	86.2	6.15	0	
669A	4/2/2012	13:28:15	25.42	7.53	325	409.4	0.2	0.262	62.3	5.03	0.09	

669A	4/2/2012	13:28:53	25.45	7.54	324	409.4	0.2	0.262	62.4	5.03	0.30	
669A	4/2/2012	13:29:33	25.46	7.54	325	409	0.2	0.2618	63.5	5.12	0.61	
669A	4/2/2012	13:30:03	25.37	7.52	326	408.5	0.2	0.2614	61.1	4.93	0.91	
669A	4/2/2012	13:31:22	25.52	7.51	326	409.6	0.2	0.2621	58.8	4.74	0.24	
669A	4/2/2012	13:31:55	25.47	7.54	324	409.4	0.2	0.262	62	5	0.98	
669A	4/2/2012	13:32:29	17.99	7.17	331	320.8	0.16	0.2053	8.5	0.79	1.92	
669A	5/23/2012	14:34:03	28.79	7.9	286	458.5	0.23	0.2935	85.3	6.27	0.12	
669A	5/23/2012	14:34:53	28.66	7.9	286	458	0.23	0.2931	85.4	6.29	0.43	
669A	5/23/2012	14:35:53	27.45	7.83	288	457.8	0.23	0.293	75.8	5.7	1.07	
669A	5/23/2012	14:36:23	27.25	7.76	289	459.3	0.23	0.294	70	5.29	1.49	
669B	9/29/2010	15:00:08	25.8	8.12	288	272.2	0.13	0.1742	109.9	8.55	0.14	
669B	9/29/2010	15:01:46	23.04	7.68	300	272.1	0.13	0.1741	71.8	5.86	0.46	
669B	6/6/2011	14:45	36.19	8.3	340	383.9	0.19	0.2457	165.8	10.85	0	
669B	6/6/2011	14:45	34.83	8.18	344	384.6	0.19	0.2461	148	9.97	0.2	
669B	4/2/2012	13:36:15	24.95	7.54	324	403.7	0.2	0.2584	63.3	5.15	0.09	
669B	4/2/2012	13:36:41	24.94	7.53	324	403.5	0.2	0.2582	61	4.96	0.49	
669B	4/2/2012	13:37:09	24.54	7.45	325	399.9	0.2	0.2559	49.7	4.08	0.91	
669B	4/2/2012	13:37:30	20.21	7.25	333	312.2	0.15	0.1998	12	1.07	1.49	
669B	5/23/2012	14:25:00	28.4	7.95	282	457.8	0.23	0.293	89.4	6.61	0.06	
669B	5/23/2012	14:26:01	28.44	7.95	282	458	0.23	0.2931	88.8	6.56	0.46	
669B	5/23/2012	14:27:26	28.26	7.91	283	458.6	0.23	0.2935	85.2	6.32	1.04	
669B	5/23/2012	14:28:09	27.37	7.77	285	458.9	0.23	0.2937	70.6	5.32	1.40	
1157A	3/2/2011	11:00:00	7.3	5.98	173	190.4	0.09	0.1218	19.6	2.28	0.2	5.253
1157A	4/18/2011	11:20:00	16.7	6.22	97	230.5	0.11	0.1475	6	0.56	0	4.338
1157A	4/4/2012	14:40:13	19.86	6.09	164	159.6	0.07	0.1021	4.4	0.39	0.23	
1157A	4/4/2012	14:41:57	17.94	5.89	143	236.8	0.11	0.1516	1.8	0.17	0.4	
1157B	10/4/2010	11:12:10	12.5	6.25	316	239.9	0.11	0.1544	41.1	4.22	0.07	
1157B	10/4/2010	11:13:33	12.23	6.18	219	240.8	0.11	0.1541	25	2.58	0.5	
1157B	3/2/2011	10:15:00	7.7	5.74	272	191.3	0.09	0.1224	33.4	3.86	0.8	5.228
1157B	3/2/2011	10:15:00	7.6	5.89	244	197.9	0.09	0.1267	27.6	3.19	1.5	5.053

1157B	4/18/2011	10:50:00	17.6	6.4	340	267.4	0.13	0.1711	26.5	2.43	0.1	3.74
1157B	4/18/2011	10:50:00	15.6	6.36	224	268	0.13	0.1715	22	2.1	0.5	3.732
1157B	4/18/2011	10:50:00	14.8	6.34	160	268.9	0.13	0.1721	8.2	0.79	0.7	3.719
1157B	6/13/2011	12:53:35	28.5	6.63	323	253.8	0.12	0.1624	26.6	1.96	0.1	
1157B	6/13/2011	12:54:05	23.09	6.6	245	330.9	0.16	0.2118	2.7	0.22	0.5	
1157B	6/13/2011	12:54:23	21.09	6.59	196	436.5	0.22	0.2793	2	0.17	0.7	
1157B	10/31/2011	11:15:04	10.43	4.76	378	528	0.27	0.3379	66.4	7.12	0.1	
1157B	10/31/2011	11:15:27	9.3	4.7	377	530.8	0.27	0.3397	65.7	7.26	0.28	
1157B	4/4/2012	14:10:53	19.72	6.3	177	286.4	0.14	0.1829	2.1	0.19	0.27	
1157B	4/4/2012	14:11:26	19.2	6.33	159	291.1	0.14	0.1863	1.9	0.17	0.27	
1157B	4/4/2012	14:11:33	19.42	6.34	156	290.5	0.14	0.1859	1.8	0.16	0.27	
1157B	4/4/2012	14:12:35	18.22	6.24	126	295.7	0.14	0.1893	1.8	0.17	0.5	
1157B	4/4/2012	14:14:03	15.49	6.14	85	531.9	0.27	0.3404	1.9	0.19	1.01	
1157B	4/4/2012	14:15:09	15.69	6.17	69	517.1	0.26	0.331	1.9	0.19	1.09	
1157B	5/21/2012	14:05:59	25.09	6.46	237	336.7	0.17	0.2155	13.8	1.08	0.26	
1157B	5/21/2012	14:06:35	19.91	6.21	205	547.6	0.28	0.3505	2.6	0.23	0.59	
1157B	5/21/2012	14:07:20	17.92	6.26	123	956.8	0.5	0.6124	2	0.18	1	
1167A	9/22/2010	10:37:54	26.58	7.91	297	680.4	0.35	0.4355	81.2	6.24	0.17	
1167A	9/22/2010	10:39:07	26.56	7.9	297	681.1	0.35	0.4359	75.5	5.81	0.49	
1167A	9/22/2010	10:39:50	26.46	7.8	299	682.3	0.35	0.4366	62.6	4.83	1.03	
1167A	9/22/2010	10:41:37	26.4	6.88	31	689.2	0.36	0.4411	9.3	0.68	1.27	
1167A	3/7/2011	14:18:28	11.8	7.79	333	710.9	0.37	0.455	74.8	7.69	0.1	1.407
1167A	3/7/2011	14:19:15	11.8	7.8	334	711	0.37	0.455	73.6	7.58	0.5	1.407
1167A	3/7/2011	14:20:12	11.7	7.76	335	711.3	0.37	0.4552	71.5	7.37	1	1.406
1167A	3/7/2011	14:21:40	11.4	7.64	329	711.9	0.37	0.4556	62.1	6.45	1.5	1.405
1167A	4/20/2011	9:55:00	19.1	8.59	316	711.9	0.37	0.4556	158.5	14.07	0	1.405
1167A	4/20/2011	9:55:00	19.1	8.59	315	711.7	0.37	0.4555	153.1	13.59	0.5	1.405
1167A	4/20/2011	9:55:00	18.8	8.47	316	716.3	0.37	0.4584	113	10.06	1.3	1.396
1167A	4/20/2011	9:55:00	18.6	7.98	252	725.6	0.37	0.4644	52.8	4.73	1.5	1.378
1167A	6/7/2011	10:35	29.4	7.54	424	664.7	0.34	0.4254	79.4	5.82	0.1	

1167A	6/7/2011	10:35	29.18	7.47	424	663.5	0.34	0.4246	55.9	4.11	0.5	
1167A	6/7/2011	10:35	28.49	7.26	425	669.3	0.34	0.4284	13	0.97	1	
1167A	11/1/2011	15:34:19	15.23	7.76	377	671.2	0.35	0.4296	107.3	10.36	0.11	
1167A	11/1/2011	15:34:56	15	7.76	377	672.2	0.35	0.4302	107.5	10.42	0.51	
1167A	11/1/2011	15:35:52	14.3	7.63	377	671.1	0.35	0.4295	84.7	8.34	0.99	
1167A	11/1/2011	15:37:58	13.39	7.42	368	672.8	0.35	0.4306	66.8	6.71	1.41	
1167A	4/9/2012	10:41:09	18.37	7.6	361	692	0.36	0.4429	91.4	8.44	0.24	
1167A	4/9/2012	10:42:11	18.09	7.51	359	692.2	0.36	0.443	72.3	6.71	0.53	
1167A	4/9/2012	10:43:29	17.87	7.44	357	695.2	0.36	0.4449	57	5.32	0.99	
1167A	4/9/2012	10:44:39	17.83	7.44	356	697.3	0.36	0.4462	52.7	4.92	1.51	
1167A	4/9/2012	10:45:53	17.82	7.36	344	697.5	0.36	0.4464	46.7	4.37	1.66	
1167A	5/22/2012	18:05:54	25.02	7.78	321	689.8	0.36	0.4415	100.8	7.92	0.1	
1167A	5/22/2012	18:06:31	24.2	7.64	321	689.9	0.36	0.4415	73.6	5.87	0.47	
1167A	5/22/2012	18:09:18	21.53	7.37	322	688.8	0.35	0.4408	15.9	1.34	1.12	
1167B	9/22/2010	10:46:41	26.74	7.67	255	674	0.35	0.4314	78.2	5.99	0.13	
1167B	9/22/2010	10:47:42	26.08	7.59	259	674.3	0.35	0.4315	62.2	4.82	0.74	
1167B	9/22/2010	10:48:18	25.79	7.57	253	675.7	0.35	0.4325	50.2	3.91	1	
1167B	9/22/2010	10:48:42	25.77	7.32	164	676.7	0.35	0.4331	44.9	3.5	0.87	
1167B	3/7/2011	14:27:11	11.6	7.52	349	711.3	0.37	0.4552	69.2	7.16	0.1	1.406
1167B	3/7/2011	14:28:32	11.7	7.5	349	710.8	0.37	0.4549	66.7	6.89	0.6	1.407
1167B	3/7/2011	14:29:45	11.2	7.65	344	710	0.37	0.4544	71.5	7.46	1.5	1.408
1167B	3/7/2011	14:31:23	10.4	7.16	149	798.7	0.41	0.5112	57.6	6.13	1.2	1.252
1167B	4/20/2011	10:05:00	18.7	8.66	255	706	0.36	0.4518	203.3	18.17	0.1	1.416
1167B	4/20/2011	10:05:00	18.7	8.67	257	706.7	0.36	0.4523	204.3	18.26	0.5	1.415
1167B	4/20/2011	10:05:00	18.6	8.54	264	710.7	0.37	0.4549	130.3	11.78	1.3	1.407
1167B	4/20/2011	10:05:00	17.6	6.42	79	1195	0.63	0.765	12.7	1.15	1.3	0.837
1167B	6/7/2011	10:45	30.18	7.46	418	688.6	0.35	0.4407	129	9.33	0.2	
1167B	6/7/2011	10:45	28.34	7.15	422	690.9	0.36	0.4422	38.1	2.84	0.5	
1167B	6/7/2011	10:45	27.6	6.97	415	692	0.36	0.4429	2.3	0.17	1.1	
1167B	6/7/2011	10:45	27.24	6.71	399	751.5	0.39	0.481	1.8	0.13	1.3	

1167B	11/1/2011	15:43:53	15.5	7.58	369	673.6	0.35	0.4311	75.4	7.23	0.06
1167B	11/1/2011	15:45:32	13.33	7.32	372	672.6	0.35	0.4304	32	3.22	0.51
1167B	11/1/2011	15:47:00	12.69	7.23	373	672.8	0.35	0.4306	14.2	1.45	1.01
1167B	11/1/2011	15:48:57	13.71	6.67	304	928.4	0.48	0.5942	2.1	0.21	1.5
1167B	11/1/2011	15:50:25	14.51	6.66	129	963.5	0.5	0.6167	2	0.19	1.59
1167B	4/9/2012	10:53:57	18.37	7.52	342	704.6	0.36	0.4513	95.2	8.79	0.23
1167B	4/9/2012	10:55:02	17.86	7.49	342	704.3	0.36	0.4507	77.4	7.22	0.51
1167B	4/9/2012	10:55:52	17.81	6.33	287	795.9	0.41	0.5094	41.3	3.85	1
1167B	5/22/2012	18:15:55	23.45	7.54	319	684.7	0.35	0.4382	59.9	4.84	0.2
1167B	5/22/2012	18:16:30	22.17	7.41	320	685.2	0.35	0.4385	39.3	3.26	0.51
1167B	5/22/2012	18:17:20	21.15	6.69	120	1120	0.59	0.7166	12.1	1.02	1.02
1167B	5/22/2012	18:17:53	20.96	6.62	107	1758	0.94	1.123	3.2	0.27	1.14

APPENDIX D

California Rapid Assessment Method (CRAM) results. Scores for each attribute ranged from 100 (best condition) to 25 (worst condition).

Site	Buffer and Landscape Context	Hydrology	Physical Structure	Biotic Structure	Overall Score
173	88	92	50	97	82
203	68	75	63	78	71
210	75	100	63	53	73
235	88	92	75	89	86
249	48	92	25	56	55
273	68	75	63	75	70
286	75	100	25	72	68
300	45	67	25	53	47
314	75	92	50	53	67
324	63	67	50	83	66
341	75	92	25	56	62
342	93	92	25	67	69
413	70	83	25	58	59
614	75	83	38	83	70
654	63	92	63	78	74
658	88	92	25	86	73
665	88	92	38	72	72
669	88	92	25	75	70
1157	75	83	38	81	69
1159	100	100	50	86	84
1163	56	92	50	100	74
1164	65	92	38	67	65
1167	68	58	25	56	52
2000	56	92	75	81	76
3000	88	75	50	78	73

APPENDIX E

Invertebrate Data: Abundance of invertebrate taxa from 22 oxbows collected in June and July of 2011. Four timed sweepnet samples were collected from each site except for sites 173, 1163 and 2000 where six samples were collected and site 3000 where two samples were collected. At 173, 1163 and 2000, six samples were collected due to the diversity of habitats at the site, while at 3000, only two samples were collected because a small pool of water remained and four samples could not be collected without overlapping the sample area. Three study oxbows did not have water at the time of sampling, so no invertebrate samples were collected from them. Specimens were identified to genus except for the following taxa: Chironomidae identified to family, Prostigmata identified to sub-order, Cladocera and Copepoda identified to order, Collembola identified to sub-class, and Ostracoda, Annelida, Porifera and Bryozoa identified to class. Damaged samples were identified to the highest possible taxonomic resolution.

Site	Taxa	Total
273	Baetidae	2
	Berosus	9
	Caenis	12
	Callibaetis	5
	Ceratopogon	20
	Chironomidae	185
	Corixidae	7195
	Culicoides	3
	Cyclopidae	1
	Hyalella	2
	Hydra	1
	Ischnura	1
	Oligochaeta	104
	Ostracoda	2705
	Palmacorixa	32
	Physa	55
	Probezzia	5
	Prostigmata	168
	Ranatra	1
	Stagnicola	4
	Trichocorixa	83
273 Total		10593
300	Arigomphus	2
	Belostomatidae	8

	Caenis	14
	Calanoida	24
	Ceratopogon	1
	Chironomidae	17
	Cladocera	1979
	Coenagrionidae	31
	Coptotomus	2
	Corixidae	100
	Curculionidae	1
	Cyclopidae	3
	Dytiscidae	3
	Gerridae	1
	Helisoma	2
	Hyalella	3
	Hydrocanthus	8
	Hydrovatus	7
	Ischnura	2
	Laccophilus	8
	Lepidoptera	1
	Neoporus	5
	Notonectidae	1
	Oligochaeta	45
	Ostracoda	2
	Palmacorixa	89
	Physa	56
	Prostigmata	2
	Ptilodactylidae	1
	Ramphocorixa	9
	Saldidae	7
	Trichocorixa	115
	Tropisternus	5
300 Total		2554
314	Arigomphus	2
	Belostomatidae	2
	Berosus	21
	Caenis	70
	Callibaetis	1
	Ceratopogon	1
	Chironomidae	453
	Cladocera	1
	Copelatus	1
	Corixidae	392

	Culicoides	23
	Dineutus	3
	Erythemis	7
	Helochares	1
	Hyalella	6
	Neoporus	1
	Oecetis	1
	Oligochaeta	48
	Ostracoda	18315
	Palmacorixa	229
	Peltodytes	2
	Physa	18
	Prostigmata	5
	Trichocorixa	364
	Tropisternus	1
314 Total		19968
324	Arigomphus	3
	Berosus	1
	Buenoa	1
	Cambaridae	2
	Chironomidae	57
	Cladocera	3
	Collembola	1
	Corixidae	24
	Helisoma	2
	Oligochaeta	52
	Ostracoda	15
	Palmacorixa	233
	Physa	28
	Ramphocorixa	1
	Sigara	14
	Trichocorixa	116
	Tropisternus	1
324 Total		554
341	Berosus	13
	Ceratopogon	27
	Ceratopogonidae	5
	Chironomidae	223
	Collembola	1
	Coptotomus	1
	Corixidae	95

	Culicoides	56
	Glossiphoniidae	2
	Monohelea	2
	Oligochaeta	78
	Palmacorixa	13
	Physa	2
	Probezzia	3
	Sigara	1
	Sphaeromias	18
	Trichocorixa	29
	Tropisternus	18
341 Total		587
342	Anisoptera	2
	Argia	7
	Argulus	1
	Belostoma	1
	Belostomatidae	8
	Berosus	4
	Caenis	108
	Celina	2
	Ceratopogonidae	4
	Chironomidae	135
	Cladocera	2
	Coenagrionidae	30
	Collembola	1
	Corixidae	3
	Cyclopidae	23
	Dineutus	3
	Dugesiidae	1
	Erythemis	2
	Gerridae	4
	Glossiphoniidae	4
	Hyalella	76
	Hydrochus	1
	Ischnura	28
	Menetus	4
	Naucoridae	1
	Oecetis	3
	Oligochaeta	6
	Orthoptera	1
	Orthotrichia	1
	Palaemonetes	36

	Palmacorixa	29
	Paraplea	29
	Physa	9
	Prostigmata	1
	Ranatra	6
	Scirtes	71
	Stagnicola	38
	Tabanus/Whitneyomyia	3
	Tropisternus	4
	Unionicola	1
	Veliidae	4
342 Total		697
413	Berosus	17
	Bezzia/Palpomyia	1
	Ceratopogon	3
	Chironomidae	224
	Coleoptera	1
	Coptotomus	3
	Corixidae	536
	Desmopachria	1
	Dineutus	1
	Glossiphoniidae	1
	Hirudinidae	1
	Hydrochus	2
	Laccophilus	6
	Oligochaeta	53
	Palmacorixa	34
	Physa	121
	Pisidium	1
	Prostigmata	1
	Sigara	5
	Trichocorixa	18
	Tropisternus	8
413 Total		1038
614	Berosus	1
	Ceratopogon	11
	Chironomidae	93
	Cladocera	2
	Corixidae	83
	Culicoides	1
	Cyclopidae	1

	Oecetis	1
	Oligochaeta	28
	Palmacorixa	47
	Physa	4
	Probezzia	3
	Sphaeromias	1
	Trichocorixa	211
614 Total		487
654	Belostoma	2
	Belostomatidae	41
	Berosus	3
	Caenis	6
	Chaoborus	3
	Chironomidae	84
	Coenagrionidae	7
	Coleoptera	2
	Corixidae	1
	Crambidae	5
	Culex	4
	Culicidae	2
	Culicoides	74
	Cybister	1
	Dasyhelea	3
	Derallus	22
	Enochrus	3
	Ephemerellidae	2
	Erythemis	10
	Gerridae	1
	Haliplus	1
	Helophorus	1
	Hyalella	1
	Hydrocanthus	30
	Ischnura	4
	Macrovelia	5
	Macroveliidae	1
	Mesoveliidae	2
	Neoporus	2
	Nepidae	1
	Noctuidae	1
	Notonectidae	2
	Odontomyia/Hedriodiscus	59
	Oligochaeta	12

	Pachydiplax	35
	Paraplea	5
	Peltodytes	2
	Physa	2
	Prostigmata	1
	Pseudosuccinea	1
	Ranatra	2
	Scirtes	4
	Stagnicola	2
	Staphylinidae	1
	Tabanus/Whitneyomyia	19
	Tropisternus	8
	Veliidae	1
654 Total		481
658	Berosus	41
	Canacea	1
	Ceratopogon	24
	Chironomidae	219
	Cladocera	55
	Corixidae	145
	Culicoides	1
	Cyclopidae	2
	Hygrobates	1
	Neobidessus	3
	Oecetis	3
	Oligochaeta	7
	Palmacorixa	191
	Physa	3
	Prostigmata	1
	Saldidae	1
	Trichocorixa	174
658 Total		872
665	Amphipoda	2
	Belostomatidae	3
	Berosus	19
	Bezzia/Palpomyia	3
	Buenoa	100
	Caenis	1
	Ceratopogon	3
	Chironomidae	55
	Coptotomus	2

	Corixidae	11
	Erythemis	13
	Gastropoda	1
	Gerridae	861
	Helisoma	45
	Hirudinidae	1
	Hyalella	1
	Hydrophilidae	1
	Mesovelia	16
	Neoporus	9
	Nerthra	1
	Notonectidae	47
	Odontomyia/Hedriodiscus	2
	Pachydiplax	27
	Palmacorixa	7
	Paraplea	1
	Physa	12
	Prostigmata	8
	Ramphocorixa	1
	Saldidae	1
	Trichocorixa	9
	Tropisternus	9
665 Total		1272
669	Arigomphus	2
	Belostomatidae	3
	Berosus	107
	Ceratopogon	1
	Chironomidae	160
	Coenagrionidae	2
	Coptotomus	15
	Corixidae	1370
	Dineutus	2
	Gerridae	3
	Hirudinidae	1
	Hydrochus	1
	Laccophilus	7
	Neoporus	13
	Notonectidae	2
	Oecetis	1
	Oligochaeta	11
	Palaemonetes	2
	Palmacorixa	720

	Peltodytes	2
	Perithemis	1
	Physa	8
	Plathemis	1
	Prostigmata	1
	Trichocorixa	1290
669 Total		3726
1157	Anthicidae	1
	Baetidae	1
	Belostomatidae	4
	Caecidotea	38
	Ceratopogon	2
	Chaoborus	3
	Chironomidae	172
	Coenagrionidae	1
	Coleoptera	1
	Collembola	2
	Corixidae	14
	Crangonyx	9
	Curculionidae	2
	Desmopachria	11
	Dytiscidae	3
	Enochrus	2
	Hyalella	1
	Hydrocanthus	3
	Lestes	1
	Musculium	3
	Notonecta	2
	Odontomyia	7
	Oligochaeta	4
	Palmacorixa	1
	Physa	8
	Ranatra	1
	Sigara	5
	Sphaerium	1
	Staphylinidae	2
	Stratiomyidae	5
	Thermonectus	1
	Trichocorixa	2
	Tropisternus	9
1157 Total		322

1163	Amphizoa	1
	Anax	6
	Belostomatidae	9
	Berosus	8
	Bivalvia	111
	Cambaridae	4
	Chaoboridae	2
	Chaoborus	4
	Chironomidae	113
	Cladocera	137
	Coenagrionidae	5
	Corixidae	10
	Crambidae	2
	Crangonyctidae	1
	Culex	1
	Curculionidae	5
	Cyphon	6
	Desmopachria	7
	Dubiraphia	2
	Enochrus	4
	Ephydridae	1
	Gastropoda	37
	Glossiphoniidae	3
	Gyraulus	1
	Hebridae	1
	Helisoma	14
	Hydrocanthus	26
	Hydrophilus	1
	Hydrovatus	3
	Monohelea	3
	Musculium	30
	Neoporus	7
	Notonecta	5
	Notonectidae	7
	Odontomyia	4
	Oligochaeta	4
	Palmacorixa	1
	Paraplea	8
	Physa	10
	Prostigmata	1
	Sigara	2
	Sphaerium	1
	Stagnicola	1

	Staphylinidae	1
	Sympetrum	1
	Tabanus/Whitneyomyia	1
	Tropisternus	6
1163 Total		618
1167	Baetidae	2
	Berosus	2
	Bidessonotus	2
	Ceratopogonidae	2
	Chironomidae	142
	Cladocera	1429
	Coenagrion/Enallagma	3
	Coenagrionidae	13
	Collembola	1
	Corixidae	886
	Crambidae	1
	Culex	2
	Culicidae	1
	Curculionidae	3
	Cyclopidae	167
	Dytiscidae	1
	Enochrus	2
	Gerridae	2
	Helophorus	1
	Hyalella	48
	Hydrochus	1
	Hydrophilidae	1
	Hydrovatus	2
	Ischnura	5
	Laccophilus	12
	Libellulidae	1
	Limnoporus	1
	Monohelea	1
	Neoporus	1
	Odontomyia	5
	Odontomyia/Hedriodiscus	5
	Oligochaeta	30
	Ostracoda	846
	Palmacorixa	14
	Paracymus	4
	Peltodytes	2
	Physa	35

	Ranatra	2
	Stagnicola	6
	Staphylinidae	2
	Tabanidae	2
	Trichocorixa	4
	Tropisternus	27
	Veliidae	3
1167 Total		3722
173	Acrididae	1
	Anopheles	3
	Asellidae	1
	Baetidae	26
	Belostomatidae	40
	Berosus	2
	Caecidotea	112
	Caenis	1
	Callibaetis	17
	Cambaridae	1
	Ceratopogon	5
	Ceratopogonidae	1
	Chaoborus	3
	Chironomidae	103
	Cladocera	21
	Coenagrion/Enallagma	2
	Coenagrionidae	5
	Collembola	1
	Coptotomus	3
	Corixidae	191
	Culicidae	2
	Culicoides	3
	Curculionidae	3
	Cybister	4
	Cyclopidae	3
	Dineutus	1
	Diptera	1
	Disonycha	1
	Helochares	1
	Hydrobius	1
	Hydrocanthus	7
	Leucorrhinia	1
	Menetus	13
	Musculium	1

	Neoporus	1
	Notomicrus	2
	Oligochaeta	19
	Palmacorixa	59
	Peltodytes	4
	Physa	12
	Planorbidae	1
	Pleidae	2
	Probezzia	1
	Prostigmata	1
	Ranatra	1
	Saldidae	1
	Stagnicola	5
	Stratiomys	3
	Tabanidae	2
	Thermonectus	2
	Trichocorixa	34
	Tropisternus	86
173 Total		817
2000	Ancylidae	1
	Anopheles	2
	Anthicidae	1
	Baetidae	1
	Belostomatidae	3
	Berosus	1
	Bezzia/Palpomyia	3
	Caenis	17
	Celina	1
	Ceratopogonidae	2
	Chaoborus	1
	Chauliodes	7
	Chironomidae	249
	Cladocera	12
	Coenagrionidae	25
	Corixidae	1
	Crambidae	1
	Crangonyx	17
	Culex	2
	Culicidae	1
	Culicoides	1
	Curculionidae	1
	Cybister	1

	Cyclopidae	2
	Cyphon	2
	Derallus	5
	Dytiscidae	3
	Gastropoda	8
	Gerridae	2
	Glossiphoniidae	2
	Helisoma	4
	Hyalella	237
	Hydrobius	3
	Hydrocanthus	33
	Ischnura	13
	Menetus	17
	Musculium	1
	Naucoridae	8
	Notonecta	2
	Odontomyia	3
	Oligochaeta	8
	Ostracoda	2
	Pachydiplax	4
	Palaemonetes	6
	Palaemonidae	2
	Palmacorixa	2
	Peltodytes	1
	Physa	122
	Pleidae	3
	Saldidae	1
	Sepedon	1
	Sphaerium	1
	Stagnicola	7
	Tabanidae	1
	Tropisternus	14
2000 Total		871
249	Berosus	115
	Chironomidae	326
	Collembola	1
	Coptotomus	1
	Corixidae	2
	Culicidae	5
	Derovatellus	1
	Helophorus	2
	Hygrotus	8

	Laccophilus	34
	Monohelea	1
	Notonectidae	1
	Oligochaeta	3
	Palmacorixa	11
	Probezzia	101
	Sigara	2
	Thermonectus	4
	Trichocorixa	16
	Tropisternus	8
249 Total		642
3000	Arigomphus	2
	Berosus	5
	Chaoborus	1
	Chironomidae	1
	Coptotomus	9
	Helochares	1
	Laccophilus	2
	Monohelea	1
	Neoporus	116
	Oligochaeta	1
	Palmacorixa	6
	Stagnicola	3
	Stratiomys	2
	Trichocorixa	3
3000 Total		153

APPENDIX F

Plant Data

Scientific name	Common name	# of Sites
Acer negundo	boxelder	7
Acer saccharinum	silver maple	3
Agrostis stolinifera	creeping bentgrass	2
Alopecurus carolinianus	Carolina foxtail	1
Amaranthus tuberculatus	roughfruit amaranth	6
Ambrosia psilostachya	cuman ragweed	1
Ambrosia trifida	great ragweed	2
Ammannia coccinea	valley redstem	4
Amorpha fruticosa	false indigo bush	1
Andropogon virginicus	broomsedge bluestem	1
Apocynum cannabinum	indianhemp	1
Avena fatua	wild oat	1
Betula nigra	river birch	1
Bidens cernua	nodding beggartick	1
Bidens frondosa	devil's beggartick	1
Bromus japonicus	Japanese brome	2
Campsis radicans	trumpet creeper	4
Cardiospermum halicacabum	balloon vine	4
Carduus nutans	nodding plumeless thistle	1
Carex caroliniana	Carolina sedge	1
Carex crus-corvi	ravenfoot sedge	8
Carex hyalinolepis	shoreline sedge	2
Carex lupulina	hop sedge	6
Carex oklahomensis	Oklahoma sedge	1
Carex tribuloides	blunt broom sedge	2
Carex vulpinoidea	fox sedge	2
Carya illinoinensis	pecan	2
Celtis laevigata	sugarberry	6
Cephalanthus occidentalis	common buttonbush	16
Chamaesyce maculata	spotted sandmat	1
Chasmanthium latifolium	Indian woodoats	3
Chenopodium album	lambsquarters	2
Clematis pitcheri	purple clematis	1
Commelina virginica	Virginia dayflower	1
Conyza canadensis	Canadian horseweed	13
Cornus drummondii	roughleaf dogwood	1
Cuscuta polygonorum	smartweed dodder	1

Plant Data

Scientific name	Common name	# of Sites
Cyperus erythrorhizos	redroot flatsedge	3
Cyperus pseudovegetus	marsh flatsedge	3
Cyperus squarrosus	bearded flatsedge	3
Cyperus strigosus	strawcolored flatsedge	2
Daucus carota	Queen Anne's lace	6
Diodia teres	poorjoe	1
Diospyros virginiana	common persimmon	9
Echinochloa crus-galli	barnyardgrass	3
Echinochloa muricata	rough barnyardgrass	1
Eclipta prostrata	false daisy	7
Eleocharis macrostachya	pale spikerush	1
Eleocharis obtusa	blunt spikerush	4
Eleocharis palustris	common spikerush	1
Eleocharis rostellata	beaked spikerush	1
Eleocharis tenuis	slender spikerush	2
Elymus canadensis	Canada wildrye	2
Elymus virginicus	Virginia wildrye	7
Epilobium leptophyllum	bog willowherb	1
Equisetum hyemale	scouring horsetail	4
Eragrostis hypnoides	teal lovegrass	1
Fimbristylis vahlii	Vahl's fimbry	3
Forestiera acuminata	eastern swampprivet	5
Fraxinus pennsylvanica	green ash	9
Galium tinctorium	stiff marsh bedstraw	1
Gleditsia triacanthos	honeylocust	1
Heliotropium indicum	Indian heliotrope	3
Hibiscus laevis	halberdleaf rosemallow	4
Ilex decidua	possumhaw	2
Juncus diffusissimus	slimpod rush	2
Juncus effusus	common rush	7
Juncus tenuis	poverty rush	3
Juncus validus	roundhead rush	3
Justicia americana	American water-willow	5
Lemna minor	common duckweed	7
Lepidium viginicum	Virginia pepperweed	1
Leptochloa fusca	bearded sprangletop	1
Leptochloa panicea	mucronate sprangletop	1
Lespedeza cuneata	sericea lespedeza	5
Limnosciadium pinnatum	tansy dogshade	1
Lindernia dubia	yellowseed false pimpernel	7

Plant Data

Scientific name	Common name	# of Sites
Lonicera japonica	Japanese honeysuckle	1
Ludwigia alternifolia	seedbox	1
Ludwigia palustris	marsh seedbox	10
Lycopus americanus	American water horehound	1
Lythrum californicum	California loosestrife	1
Maclura pomifera	Osage orange	1
Marsilea vestita	hairy waterclover	1
Mikania scandens	climbing hempvine	3
Morus rubra	red mulberry	1
Muhlenbergia mexicana	Mexican muhly	1
Myriophyllum pinnatum	cutleaf watermilfoil	1
Neeragrostis reptans	creeping lovegrass	2
Nelumbo lutea	American lotus	1
Paspalum dilatatum	dallisgrass	1
Persicaria amphibia	water smartweed	1
Persicaria hydropiper	water pepper	10
Persicaria lapathifolia	nodding smartweed	10
Persicaria maculosa	spotted ladysthumb	1
Persicaria pensylvanica	Pennsylvania smartweed	8
Phyla lanceolata	lanceleaf frogfruit	16
Pilea pumila	Canadian clearweed	3
Platanus occidentalis	American sycamore	5
Pluchea odorata	sweetscent	10
Populus deltoides	eastern cottonwood	7
Potamogeton diversifolius	waterthread pondweed	1
Quercus palustris	pin oak	1
Ranunculus sceleratus	cursed buttercup	3
Rorippa palustris	bog yellowcress	3
Rorippa sinuata	spreading yellowcress	13
Rubus oklahomus	Oklahoma blackberry	6
Rudbeckia hirta	blackeyed Susan	2
Rumex altissimus	pale dock	6
Rumex crispus	curly dock	9
Rumex maritimus	golden dock	1
Sagittaria lancifolia	bulltongue arrowhead	1
Sagittaria latifolia	broadleaf arrowhead	3
Salix interior	sandbar willow	1
Salix nigra	black willow	16
Samolus valerandi	seaside brookweed	1
Schoenoplectus americanus	chairmaker's bullrush	1

Plant Data

Scientific name	Common name	# of Sites
Sesbania herbacea	bigpod sesbania	3
Setaria parviflora	marsh bristlegrass	1
Smilax bona-nox	saw greenbrier	5
Sorghum halepense	johnsongrass	4
Symphoricarpos orbiculatus	coralberry	1
Symphyotrichum divaricatum	southern annual saltmarsh aster	7
Tamarix ramosissima	saltcedar	2
Teucrium canadense	Canada germander	3
Toxicodendron radicans	eastern poison ivy	5
Trifolium vesiculosum	arrowleaf clover	1
Typha domingensis	southern cattail	1
Ulmus americana	American elm	9
Vitis palmata	catbird grape	1
Vitis rotundifolia	muscadine	1
Wolffia brasiliensis	Brazilian watermeal	1
Xanthium strumarium	rough cocklebur	8
Zizaniopsis miliacea	giant cutgrass	5