WATERSHED BASED PLAN

FOR THE

FORT COBB WATERSHED

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Table of Contents

PREFACE

The Fort Cobb Watershed covers 314 square miles in southwestern Oklahoma in Caddo, Washita, and Custer Counties. Ft. Cobb Reservoir's designated beneficial uses include public and private water supply, warm water aquatic community, agriculture, municipal and industrial uses, primary body contact recreation, and aesthetics. The reservoir is the primary drinking water source for the Cities of Anadarko and Chickasha. The watershed is located in the Central Great Plains Ecoregion in southwestern Oklahoma. Landuse in the watershed includes agricultural fields, cattle operations, rural communities, and one hog operation. Most soils in the watershed are highly erodible, sandy clays and loams. The water quality of the reservoir and its tributaries has been of concern for more than a decade with water quality problems identified beginning in 1981.

Oklahoma Water Quality Standards list Fort Cobb Reservoir as a Nutrient Limited Watershed (due to high primary productivity) and a sensitive public and private water supply. 1998 Oklahoma Water Resources Board (OWRB) data showed the lake was hypereutrophic and in 1999, eutrophic (OWRB 2002). Studies indicated biological, chemical, and habitat degradation within the Ft Cobb Reservoir Watershed. DDT was detected in fish flesh tissue in 1981. Ft. Cobb Reservoir and six waterbody segments in its watershed were listed on the 1998 303(d) list as being impaired by nutrients, pesticides, siltation, suspended solids, and unknown toxicity (Table 1). The Reservoir and three streams, Cobb, Willow, and Fivemile Creek, are currently listed on the 2008 303(d) list as being impaired (see Table 1; ODEQ 2008). In addition, concerns have been expressed by the Master Conservancy District reservoir managers regarding the nutrient and sediment loads.

Table 1. 303(d) Listed Causes of Impairment in Fort Cobb Watershed.

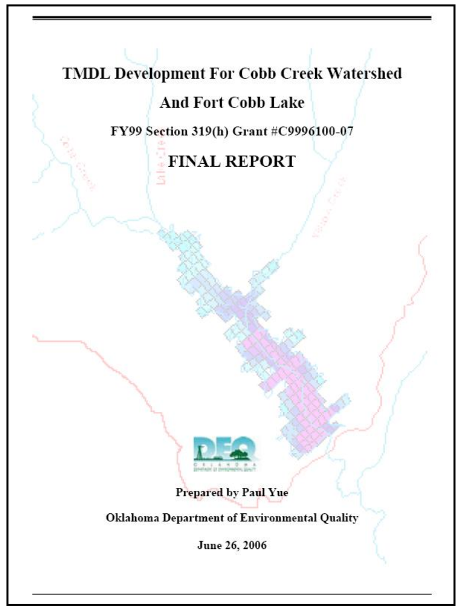
303(d) list year	OK Waterbody ID	Name	Cause of Impairment
1998	OK 310830050020	Fort Cobb Reservoir	pesticides, suspended solids, turbidity
1998	OK 310830060030	Willow Creek	nutrients, siltation, suspended solids
1998	OK 310830060040	Lake Creek	unknown toxicity, pesticides, nutrients, siltation, other habitat alterations, suspended solids
1998	OK 310830060050	Cobb Creek	pesticides, nutrients, siltation, suspended solids
1998	OK 31080060080	Fivemile Creek	nutrients, siltation, suspended solids
1998	OK 31080060130	Crowder Lake	nutrients, organic enrichment/D.O., suspended solids
2002	OK310830050020	Fort Cobb Reservoir	phosphorus
2002	OK 310830060030	Willow Creek	pathogens
2002	OK 310830060040	Lake Creek	low dissolved oxygen[1], turbidity
2004	OK310830050020	Fort Cobb Reservoir	phosphorus
2004	OK 310830060030	Willow Creek	Fecal coliform, Enterococcus, E. coli
2004	OK 310830060040	Lake Creek	selenium
2006	OK310830050020	Fort Cobb Reservoir	phosphorus, turbidity
2006	OK 310830060030	Willow Creek	Fecal coliform, Enterococcus, E. coli
2006	OK 310830060040	Lake Creek	selenium
2006	OK 31080060130	Crowder Lake	turbidity, dissolved oxygen
2008	OK310830050020	Fort Cobb Reservoir	turbidity
2008	OK 310830060030	Willow Creek	Fecal coliform, Enterococcus, E. coli
2008	OK 310830060050	Cobb Creek	ammonia, Enterococcus, E. coli
2008	OK 31080060080	Fivemile Creek	Enterococcus, E. coli
2008	OK 31080060130	Crowder Lake	turbidity, chlorophyll-a, dissolved oxygen

Considerable efforts have been made to identify the causes, sources, and extent of water quality threats and impairments in the basin, and extensive remedial efforts have occurred in the past several years. Previous studies of the reservoir and watershed were conducted by the U.S. Fish and Wildlife Service (USFWS), the Bureau of Reclamation (BOR), and the U.S. Geological Survey (USGS). These studies identified the causes, extent, and some of the sources of water quality impairment in the watershed.

In 2006, the Oklahoma Department of Environmental Quality (ODEQ) released the final draft of a TMDL for phosphorus loading to Fort Cobb Reservoir (Appendix A). This TMDL recommended a 78% phosphorus load reduction to restore beneficial use support to the reservoir. Because there are no point source dischargers in the watershed, this reduction must come entirely from nonpoint sources in the watershed.

1 Listing for D.O. later determined to be in error during TMDL development.

The TMDL was based on watershed data collected between 1990 and 2001; therefore, loading reduction recommendations are based upon loading during that period. Since that period, many changes have taken place in the watershed which suggests that Oklahoma is making significant progress towards the TMDL goal. These efforts include, but are not limited to, a decrease in peanut production in the watershed following the loss of government subsidies of peanut production, a 2001 §319 Project focused on education and demonstration of practices to reduce sediment and nutrient pollution in the watershed, a 2005 §319 Project focused on no-till, and continued effects of previous NPS education programs in the watershed which have resulted in the voluntary implementation of best management practices such as riparian zones, nutrient management, and conservation tillage.



Additional work in the watershed includes education programs developed by the Oklahoma Cooperative Extension Service (OCES), the Deer Creek, West Caddo, North Caddo, and Mountain View Conservation Districts, the Natural Resources Conservation Service (NRCS), and the Oklahoma Conservation Commission (OCC), and various programs to reduce nonpoint source loading in the watershed. As a result of these efforts, Lake Creek was delisted for pesticides and unknown toxicity in 2002.

A Conservation Reserve Enhancement Program (CREP) is planned for the Fort Cobb watershed, which will further address sediment and nutrient loading. This watershed based plan (WBP) discusses the efforts which have already occurred as well as those necessary to expand the programs ongoing in the watershed to reach the load reduction goals established by the TMDL and to restore beneficial use support to Fort Cobb Reservoir and the waterbodies in its watershed.

INTRODUCTION

In 1997, on the 25th anniversary of the 1972 Federal Clean Water Act, Vice President Al Gore initiated development of a nationwide strategy to protect water quality. This initiative resulted in the development of the *Clean Water Action Plan* (CWAP), which established goals and implementation schedules for numerous strategies dealing with point and nonpoint sources. Oklahoma's Office of Secretary of Environment (OSE) was designated as the state lead agency to implement the provisions of the CWAP in Oklahoma.

Under OSE's leadership, Oklahoma has successfully met the CWAP requirement to establish a *Unified Watershed Assessment* (UWA) strategy. Oklahoma's UWA is a written document whose development and implementation relied upon input from the state's UWA Work Group. Through the UWA process, the Work Group identified "Category I" watersheds in Oklahoma that were recognized as significantly impaired and in need of immediate federal and state funding to target restoration activities. Fort Cobb Watershed was one of these high priority watersheds (Figure 1).

EPA's Nonpoint Source Program and Grants Guidelines for States and Territories for FY 2004 and Beyond requires a Watershed-Based Plan (WBP) to be completed prior to implementation using incremental funds. The guidance defines the 9 key components to be addressed in a watershed-based plan, much of which builds from the strategies outlined in a Watershed Restoration Action Strategy (WRAS). These components are: 1) identification of causes and sources that will need to be controlled to achieve load reductions, 2) estimate of load reductions expected from the management measures described, 3) a description of the management measures that will need to be implemented to achieve load reductions, 4) an estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources or authorities who will bear responsibility, 5) an information/education component that will be used to enhance public understanding of the project and encourage early participation in the overall program, 6) a schedule for implementing the Non-Point Source (NPS) management measures identified in this plan that is reasonably expeditious, 7) a description of interim, measurable milestones for determining whether control actions are being implemented, 8) a set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made or whether the Watershed Plan or Total Maximum Daily Load (TMDL) needs to be revised, and 9) a monitoring component to evaluate the effectiveness of the implementation efforts over time.

The WBP for the Fort Cobb Watershed has been developed as a dynamic document that will be revised, when necessary, to incorporate the latest information, address new strategies, and define new partnerships between watershed shareholders following this initial documentation. Also, it is understood that the water quality goals set forth in this WBP, as well as the technical approach to address the goals, may not be comprehensive and it may be necessary to revise or expand them in the future.

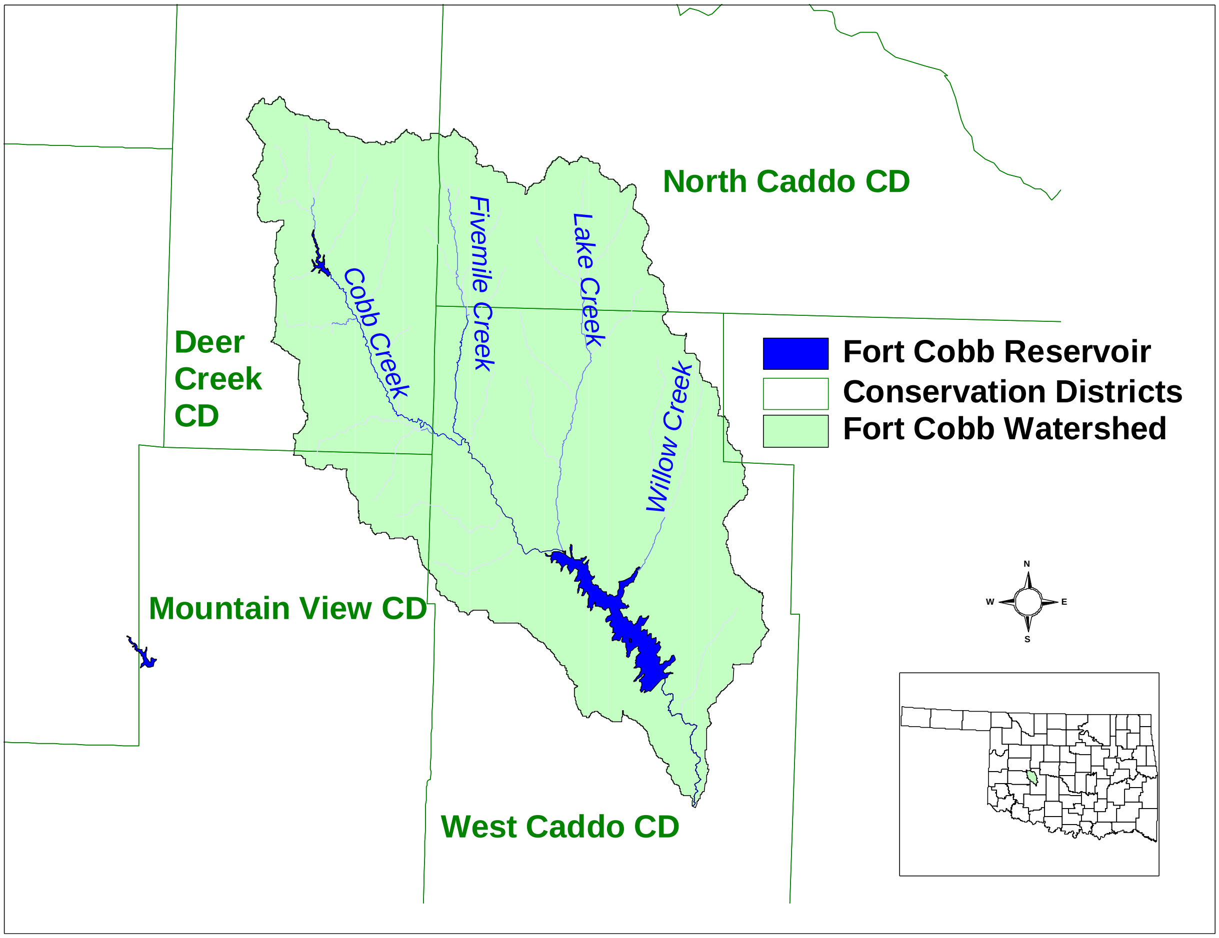


Figure 1. Fort Cobb Watershed.

Federal and state funding allocations for future water quality projects designed to address the Fort Cobb Watershed problems should not be based solely upon their inclusion in this WBP, rather the WBP should be considered a focal point for initial planning and strategy development. In order for this WBP to become an integral part of the entire watershed restoration program, it must be amenable to revision and update. It is anticipated that at least biannual revisions may be necessary, and that the responsibility for such revisions will rest primarily with the OCC with support from the Office of the Secretary of the Environment (OSE) and the NPS Working Group.

CAUSES AND SOURCES

Causes

Currently, Fort Cobb Reservoir, Willow Creek, Cobb Creek, and Fivemile Creek are impaired by turbidity (reservoir), bacteria (all creeks), and ammonia (Cobb Creek) (Table 1). The Fort Cobb TMDL (ODEQ 2006) focuses on phosphorus as the primary cause of impairment in Fort Cobb Reservoir and suggests that the dissolved oxygen listing for Lake Creek was in error. In addition, it confirms that pesticide impairments cited by the 1998 303(d) list are no longer present, as indicated by current water quality and biological data (Appendix A).

Sources

Point Sources

The TMDL verified that there were no permitted point source dischargers in the Fort Cobb Watershed. However, there are two Concentrated Animal Feeding Operation (CAFO) farms in the watershed, both with total retention NPDES permits. Permits on these farms, one a cattle farm with 2700 animal units, and the other a swine farm with 800 animal units allow overflows only under 25 year, 24 hour storm events. According to the TMDL, these provisions are determined sufficient to protect the waters in the Cobb Creek watershed. The TMDL recommends no additional measures for these CAFO farms. In order to rule out effects of these facilities on nearby stream health, the relative load contribution attributable to these facilities should be considered by the State to verify that these facilities are not significant contributors to local or watershed-wide water quality problems. Based on these findings, the TMDL may need to be revised.

Nonpoint Sources

In rural settings, the primary sources of nutrients may include runoff of applied fertilizer and manure to agricultural land, runoff of animal wastes associated with the erosion of sediments in grazing fields, runoff from concentrated animal operations, failing septic tanks, and contributions from wildlife. The TMDL used the Soil and Water Assessment Tool (SWAT) model to estimate NPS loadings from landuse in the watershed (Appendix B). This is the same model and model runs that were used to target NPS implementation with an FY 2001 §319 project in the Fort Cobb Watershed. The model subdivided the basin into 90 subbasins, based on 10-meter USGS Digital Elevation Model data for the basin (Figure 3). Loading estimates for these 90 subbasins as predicted by SWAT are seen in Table 2. Loading estimates from Fort Cobb landuses as predicted by SWAT are seen in Table 3. Figure 4 displays the SWAT predictions related to phosphorus loading from subbasins in the Fort Cobb watershed. The darkest red basins produce the highest phosphorus in runoff. The SWAT model estimated a total sediment load to the lake (excluding roads) of 276,000 metric tons per year and a total phosphorus load of approximately 70,000 kg P/year.

Typical landuse in the Fort Cobb Watershed (photo courtesy of Storm et al. 2003).

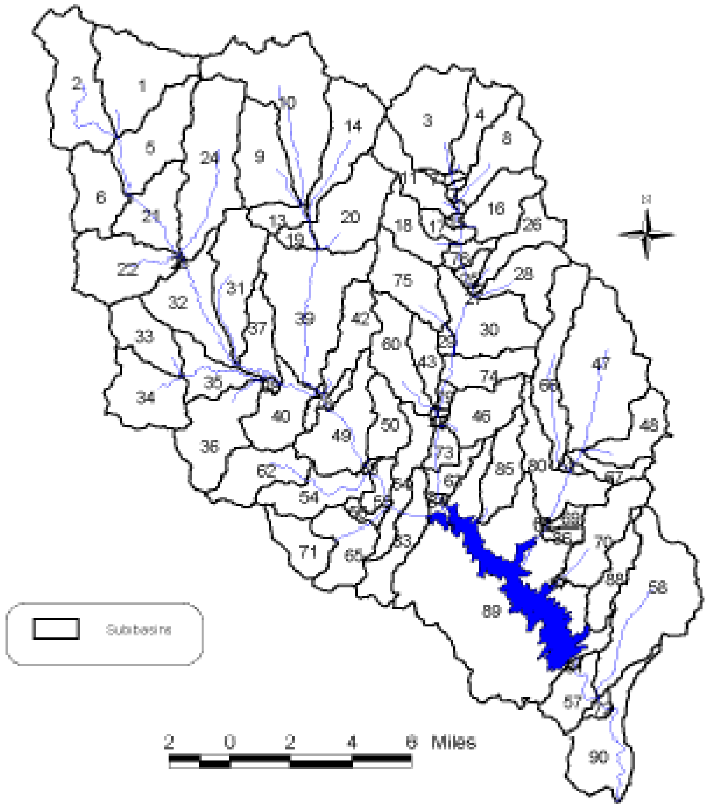


Figure 1. Sub-basin layout used in the Cobb Creek SWAT model (Storm et al. 2003).

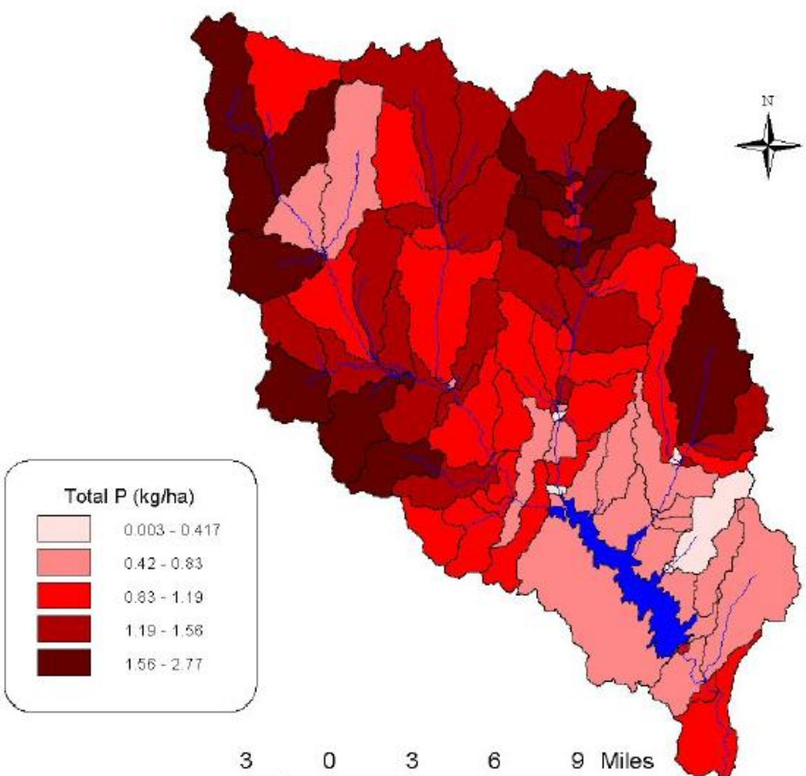


Figure 3. Total phosphorus loading by sub-basin as predicted by SWAT (Storm et al. 2003).

Table 2. SWAT Estimated Sub-basin Loading.

Sub-basin	AREA (km^2)	Surface Runoff (mm)	Baseflow (mm)	Total Water Yield (mm)	Sediment (mg/ha)	Organic Nitrogen (kg/ha)	Organic P (kg/ha)	Nitrate in surface runoff (kg/ha)	Soluble Mineral P (kg/ha)	Sediment bound mineral P (kg/ha)	Total P (kg/ha)
1	1.92E+01	27.198	21.307	51.494	3.02	4.895	0.603	0.106	0.009	0.452	1.064
2	2.12E+01	44.085	35.825	84.136	6.228	6.636	0.803	0.308	0.005	0.828	1.636
3	1.86E+01	45.708	41.17	91.644	4.087	7.324	0.917	0.139	0.015	0.589	1.521
4	8.41E+00	59.531	54.213	121.906	3.919	6.681	0.814	0.173	0.01	0.589	1.413
5	1.51E+01	59.522	35.941	105.415	1.371	9.323	1.123	0.21	0.119	0.951	2.193
6	1.15E+01	54.575	44.673	104.907	1.299	10.146	1.179	0.153	0.092	0.869	2.14
7	7.76E-01	64.588	93.128	175.716	4.213	3.414	0.427	0.221	0.006	0.538	0.971
8	1.18E+01	83.927	68.263	158.491	5.242	7.35	0.92	0.285	0.03	0.837	1.787
9	1.48E+01	50.333	41.2	94.889	2.573	4.644	0.576	0.149	0.012	0.465	1.053
10	2.92E+01	31.725	28.935	64.179	3.398	6.12	0.763	0.081	0.007	0.482	1.252
11	8.49E+00	49.722	43.356	100.008	4.762	7.552	0.933	0.143	0.014	0.688	1.635
12	3.92E-01	81.615	63.218	150.528	4.692	4.613	0.591	0.288	0.008	0.637	1.236
13	4.08E+00	57.373	45.845	109.125	4.154	5.687	0.689	0.172	0.012	0.647	1.348
14	1.49E+01	51.162	45.908	101.745	3.902	6.746	0.844	0.145	0.016	0.619	1.479
15	6.40E-01	67.495	56.309	133.605	4.144	3.42	0.445	0.244	0.006	0.555	1.006
16	1.04E+01	66.203	48.74	118.653	5.349	7.315	0.898	0.219	0.007	0.786	1.691
17	3.25E+00	65.768	53.966	125.363	3.876	5.338	0.673	0.233	0.007	0.628	1.308
18	8.27E+00	61.75	65.052	135.163	4.894	6.626	0.815	0.238	0.009	0.844	1.668
19	2.34E+00	63.825	41.101	109.131	3.083	4.99	0.623	0.227	0.007	0.557	1.187
20	1.56E+01	52.451	43.091	98.176	4.097	6.665	0.816	0.174	0.006	0.643	1.465
21	1.17E+01	62.091	37.157	119.144	2.322	3.437	0.384	0.103	0.026	0.413	0.823
22	1.58E+01	54.363	47.485	112.845	5.096	7.144	0.845	0.14	0.03	0.761	1.636
23	1.54E-01	57.438	54.933	119.686	5.707	6.978	0.85	0.235	0.006	0.7	1.556
24	2.58E+01	63.747	38.638	116.515	1.651	3.385	0.38	0.135	0.035	0.413	0.828
26	8.30E+00	55.895	41.336	102.702	3.631	6.642	0.812	0.148	0.013	0.595	1.42
27	3.16E-01	70.184	82.381	159.887	3.497	3.602	0.441	0.251	0.006	0.47	0.917
28	1.11E+01	58.754	90.282	162.144	3.27	4.629	0.573	0.157	0.01	0.497	1.08
29	1.33E+00	60.497	53.606	127.77	3.833	4.113	0.503	0.207	0.005	0.525	1.033
30	1.63E+01	56.704	79.111	143.377	4.087	5.737	0.709	0.168	0.006	0.602	1.317
31	1.56E+01	59.96	35.11	96.799	3.669	5.706	0.705	0.214	0.008	0.694	1.407
32	1.60E+01	44.063	49.617	102.287	4.17	3.912	0.497	0.155	0.004	0.559	1.06
33	9.64E+00	45.049	45.392	95.578	4.119	5.626	0.685	0.162	0.004	0.61	1.299

Sub-basin	AREA (km^2)	Surface Runoff (mm)	Baseflow (mm)	Total Water Yield (mm)	Sediment (mg/ha)	Organic Nitrogen (kg/ha)	Organic P (kg/ha)	Nitrate in surface runoff (kg/ha)	Soluble Mineral P (kg/ha)	Sediment bound mineral P (kg/ha)	Total P (kg/ha)
34	1.38E+01	42.272	36.619	82.554	4.841	7.858	0.943	0.14	0.018	0.752	1.713
35	8.03E+00	45.779	47.536	103.311	4.865	5.756	0.713	0.147	0.015	0.648	1.376
36	1.63E+01	41.155	36.611	81.13	5.508	8.637	1.034	0.123	0.016	0.808	1.858
37	7.86E+00	71.821	93.901	178.555	3.963	4.737	0.582	0.301	0.009	0.714	1.305
38	6.23E-01	60.379	52.918	117.398	10.491	8.53	1.027	0.221	0.005	1.078	2.11
39	2.97E+01	51.589	100.085	167.169	3.579	4.675	0.575	0.184	0.018	0.599	1.192
40	1.10E+01	32.863	32.221	66.38	3.782	6.5	0.791	0.094	0.003	0.554	1.348
41	2.39E-01	37.573	89.244	141.895	1.859	2.549	0.322	0.117	0.003	0.256	0.581
42	9.76E+00	35.479	57.285	99.696	2.994	5.537	0.682	0.104	0.014	0.562	1.258
43	5.64E+00	50.394	37.238	90.2	2.031	3.753	0.47	0.159	0.007	0.432	0.909
44	2.39E-01	68.272	51.862	126.06	1.636	2.306	0.328	0.197	0.005	0.257	0.59
45	3.41E-01	54.859	69.637	137.479	0.968	1.207	0.175	0.151	0.003	0.149	0.327
46	1.08E+01	44.676	82.178	133.882	2.73	3.618	0.436	0.141	0.005	0.472	0.913
47	3.17E+01	67.633	71.945	148.966	5.84	6.645	0.821	0.233	0.007	0.844	1.672
48	9.09E+00	72.984	51.113	128.756	4.478	6.09	0.747	0.267	0.008	0.694	1.449
49	1.56E+01	48.316	64.608	122.413	2.924	4.499	0.556	0.148	0.018	0.534	1.108
50	7.69E+00	59.272	119.231	185.652	2.76	3.342	0.397	0.198	0.007	0.509	0.913
51	4.69E-01	52.32	99.866	172.358	0.875	0.793	0.11	0.14	0.003	0.14	0.253
52	4.18E-01	72.596	53.314	139.115	4.258	4.933	0.624	0.248	0.006	0.58	1.21
53	4.18E-01	51.149	59.582	117.475	5.527	3.89	0.455	0.164	0.005	0.634	1.094
54	1.02E+01	51.24	42.769	97.537	4.672	5.997	0.734	0.157	0.005	0.678	1.417
55	3.56E+00	55.822	69.517	133.307	3.071	3.307	0.396	0.186	0.006	0.494	0.896
56	1.80E+00	56.706	56.26	120.711	2.619	3.573	0.456	0.177	0.005	0.413	0.874
57	8.04E+00	50.824	75.133	131.671	2.129	3.164	0.4	0.172	0.006	0.418	0.824
58	2.83E+01	37.324	73.863	116.036	1.448	3.002	0.372	0.105	0.01	0.297	0.679
59	2.56E-04	29.149	122.047	151.789	5.553	8.264	0.982	0.258	0.009	0.686	1.677
60	1.20E+01	43.583	55.189	103.275	2.564	4.431	0.551	0.138	0.006	0.494	1.051
61	5.99E-02	92.043	48.162	145.011	1.77	2.39	0.302	0.375	0.009	0.366	0.677
62	1.11E+01	34.114	31.551	67.489	5.613	7.922	0.949	0.099	0.003	0.739	1.691
63	3.92E+00	61.29	95.521	171.36	3.253	3.11	0.386	0.206	0.007	0.551	0.944
64	9.31E+00	45.097	120.841	184.917	3.077	2.532	0.3	0.148	0.005	0.492	0.797
65	1.03E+01	45.126	41.258	88.964	2.588	5.11	0.63	0.123	0.016	0.505	1.151
66	1.57E+01	53.374	106.726	177.098	2.706	3.754	0.457	0.168	0.014	0.48	0.951

Sub-basin	AREA (km^2)	Surface Runoff (mm)	Baseflow (mm)	Total Water Yield (mm)	Sediment (mg/ha)	Organic Nitrogen (kg/ha)	Organic P (kg/ha)	Nitrate in surface runoff (kg/ha)	Soluble Mineral P (kg/ha)	Sediment bound mineral P (kg/ha)	Total P (kg/ha)
67	3.85E+00	59.375	71.051	137.048	2.903	4.243	0.522	0.191	0.005	0.466	0.993
68	8.70E-03	43.584	63.164	112.436	0.007	0.009	0.001	0.094	0.001	0.001	0.003
69	1.80E+00	44.714	46.247	95.734	2.079	3.344	0.417	0.135	0.004	0.344	0.765
70	1.30E+01	26.598	126.714	163.971	1.14	1.639	0.199	0.077	0.003	0.215	0.417
71	7.55E+00	37.126	32.073	71.802	2.793	4.819	0.579	0.094	0.007	0.482	1.068
72	1.40E+00	53.081	82.98	143.678	3.572	5.059	0.614	0.176	0.005	0.548	1.167
73	3.34E+00	45.478	55.954	107.349	1.931	3.024	0.382	0.129	0.004	0.336	0.722
74	8.29E+00	59.304	81.656	151.916	3.641	4.695	0.59	0.187	0.005	0.512	1.107
75	1.24E+01	55.807	87.467	155.92	4.042	5.144	0.618	0.183	0.014	0.651	1.283
76	2.75E+00	96.8	81.318	192.216	12.309	9.954	1.204	0.411	0.012	1.557	2.773
77	1.13E+00	70.043	55.222	132.27	6.565	7.172	0.872	0.246	0.006	0.836	1.714
78	2.70E+00	68.549	64.252	144.007	4.496	5.311	0.699	0.259	0.008	0.717	1.424
79	1.25E+00	68.765	58.196	139.176	4.478	4.673	0.581	0.235	0.006	0.63	1.217
80	1.36E+01	40.901	125.391	186.441	2.599	3.061	0.369	0.132	0.004	0.408	0.781
81	3.33E-01	47.632	90.536	159.356	4.14	4.9	0.674	0.138	0.003	0.388	1.065
82	1.71E-02	35.8	84.674	120.944	1.205	2.99	0.397	0.09	0.004	0.207	0.608
83	9.91E+00	40.605	55.685	99.948	2.405	4.03	0.499	0.123	0.005	0.432	0.936
84	5.80E-01	49.712	86.352	148.054	1.111	1.33	0.175	0.132	0.003	0.17	0.348
85	9.08E+00	53.278	124.399	194.81	2.157	2.228	0.262	0.185	0.021	0.465	0.748
86	1.68E+00	33.15	34.701	69.55	1.149	2.413	0.299	0.092	0.004	0.242	0.545
87	1.96E-01	53.203	84.646	154.727	0.935	1.425	0.2	0.137	0.002	0.121	0.323
88	7.79E+00	39.372	118.206	168.503	1.84	2.465	0.3	0.125	0.005	0.342	0.647
89	8.69E+01	26.772	81.711	113.273	1.679	2.725	0.336	0.076	0.003	0.292	0.631
90	1.62E+01	53.325	61.977	120.823	2.375	4	0.494	0.197	0.006	0.423	0.923

The SWAT model predictions are subject to the following limitations:

- Loads are subject to all the same limitations as those presented in the report: Fort Cobb Basin – Modeling and Land Cover Classification 2003;
- The loads are from upland sources only and do not consider bank or stream bed erosion, instream nutrient processes, or deposition of sediment in reservoirs or flood control structures on main channels;
- These data contain significantly more uncertainty than absolute load predicted to the lake or basin outlet. With limited calibration data, these data would be best utilized to relatively rank subbasins in terms of their nutrient contributions.

Although these predictions are subject to limitations, the estimates provide valuable information about areas contributing most significantly to watershed loading and suggest areas where incentives and other implementation programs should be targeted to have the greatest impact on water resources. These high priority subwatersheds (highest contributing watersheds as depicted in Figure 3) account for approximately 66.17 or 20% of the 329.35 square miles in the watershed and about 30% of the load. Including the next highest contributing set of subwatersheds increases the area to 210.83 square miles or 47% of the watershed and approximately 61% of the load.

The TMDL estimated phosphorus loading from septic tanks to be 3,608 kg/year, assuming all watershed residents used septic systems and using a worst case scenario where:

- All septic tanks were failing,
- Every household was assumed to have one septic tank, equaling 1,124 septic tanks in the watershed,
- Effluent from the tanks (11.6 mg P/L) drained directly to streams and lakes,
- Persons in the watershed produced 75 gallons of wastewater per day.

This loading would be approximately five percent of the total phosphorus loading to the watershed. Given that this is an over estimate of the loading from the current systems, the TMDL determined that loading from septic tanks was insignificant.

The primary crops grown in the watershed are wheat (80% of cropland), peanuts, sorghum, and cotton (Storm et. al 2003). Wheat, peanuts, and sorghum are the landuses that provided the highest nutrient and sediment loading in the watershed (Table 3); croplands, which are about 50.4% of the total land in the watershed, account for 90.4% of total P load. With the loss of peanut subsidies, peanut production has declined in the watershed, and many formerly peanut fields have been converted to cotton fields. The SWAT model estimated that the conversion of peanuts to cotton without BMPs to address cotton could result in increased phosphorus and sediment loading to the lake (Table 4).

Cotton is one of the row crops produced in the Fort Cobb Watershed (photo courtesy of Storm et al. 2003).

Table 3. SWAT simulated loads by land cover for the Fort Cobb Basin for the period 1/1990 - 10/2001 (from Storm et al. 2003).

Land Cover	Fraction of Basin (%)	Surface Runoff (mm)	Total Stream Flow (mm)	Sediment (Mg/ha)	Total N (kg/ha)	Total P (kg/ha)
Forest	6.0%	23.98	178.98	0.01	2.20	0.01
Pasture-Range	41.4%	40.34	105.36	1.61	3.60	0.62
Peanut	7.1%	61.76	147.15	4.06	7.74	1.87
Sorghum	2.8%	96.02	161.33	3.16	6.95	1.20
Urban	0.1%	87.60	100.95	0.05	1.20	0.09
Water	2.1%	0.00	0.00	0.00	0.00	0.00
Wheat for Grain	30.8%	57.58	121.60	5.88	9.90	1.91
Grazeout Wheat	9.7%	56.10	118.77	5.16	8.69	1.81
Basin Average	---	48.47	118.46	3.36	6.26	1.19

Table 4. Load summary for Fort Cobb Basin as predicted by the SWAT model (from Storm et. al 2003).

Crop Scenario	Runoff (CMS)	Total Water Yield (CMS)	Sediment (Mg/yr)	Total P (kg/yr)	Total N (kg/yr)
Current	1.37	3.05	301,277	108,031	543,615
Peanuts converted to cotton	1.28	2.95	307,131	110,103	543,461

Further details about the estimation of causes and sources in the Fort Cobb Watershed can be found in the TMDL (ODEQ 2006) and SWAT model reports (Storm et. al. 2003).

LOAD REDUCTIONS

The draft TMDL estimated that a **78% phosphorus load reduction**[2] would be necessary to restore beneficial use support to Fort Cobb reservoir. This sets a goal of reducing phosphorus loading from 70,000 kg/yr to 15,400 kg/yr. The TMDL addresses both phosphorus and turbidity impairment to the reservoir because most phosphorus is found attached to sediment, one of the primary causes of turbidity. The TMDL reasons that if phosphorus is reduced to meet water quality standards, then turbidity levels in contributing streams will also be reduced to a level that will meet the turbidity standard. Fortunately, BMPs recommended by the TMDL will also work to address the other sources of impairment in watershed streams including pathogens. The TMDL also estimates that every 1.0% reduction in phosphorus will correspond to a 1.33% reduction in total nitrogen and a 1.5% reduction in sediment delivery to the lake. Further explanation of the methodology for arriving at the 78% load reduction can be found in the TMDL and SWAT model reports (ODEQ 2006; Storm et. al 2003).

2 This includes the load reduction to allow for a margin of safety and potential growth in the watershed.

CRITERIA

Fort Cobb Reservoir's designated beneficial uses include public and private water supply, warm water aquatic community, agriculture, municipal and industrial uses, primary body contact recreation, and aesthetics. The reservoir is the primary drinking water source for the Cities of Anadarko and Chickasha.

The goal of the TMDL is to reduce the 1998 – 2001 loading to the lake of approximately 70,000 kg P/year to 15,400 kg P/year. That load reduction is based on the following endpoints, based on Oklahoma's Water Quality Standards (OWRB 2004a, b):

- Trophic State Index (chlorophyll-*a* based) for Fort Cobb Reservoir less than 62
- Dissolved Oxygen (surface water)
    - Summer (June 16 – October 15): 4.0 mg/L
    - Seasonal (October 16 – June 15): 5.0 mg/L
- Anoxic volume in Fort Cobb Reservoir less than 50% of water column.

Additional criteria that apply to causes of impairment in the watershed are (OWRB 2004):

- Turbidity (only applicable during baseflow)
  25 NTU for lakes
  50 NTU for streams
- Coliform bacteria
  Monthly geometric mean <5000 colonies/100 ml at point of intake
- <5% of total samples in any 30 day period will total coliform exceed 20,000 colonies/100 ml
- Enterococci bacteria
  Geometric mean of 33 colonies/100 ml
- *Escherichia coli* (*E. coli*)
  Geometric mean of 126 colonies/100 ml
- Warm Water Aquatic Community
  IBI = 22

These criteria stem from Oklahoma's Water Quality Standards (OWRB 2004a). The procedures by which the data must be collected and analyzed to verify whether or not these criteria have been met are identified in Oklahoma's Use Support Assessment Protocols (OWRB 2004b). Both of these documents fall under the jurisdiction of the Oklahoma Water Resources Board.

NPS MANAGEMENT MEASURES

According to the TMDL, croplands account for about 90% of the phosphorus loading in the watershed; therefore, load reduction efforts should focus on cropland (Table 3). The TMDL SWAT modeling applied various scenarios relative to landuse and BMPs used in the watershed to estimate the possible solutions to achieve the recommended 78% phosphorus load reduction. As shown in Table 5, below, the TMDL evaluated the effectiveness of various BMPs to achieve a phosphorus load reduction. No single BMP type will fully address the required load reduction; a combination of BMPs will be necessary.

Table 5. Load reductions for different BMPs (from ODEQ 2006).

Practice	% Reduction In Total Basin Load		
	Sediment	Total N	Total P
No-till wheat and row crops	-51.10%	-42.80%	-34.40%
No winter cover on row crops	9.20%	11.10%	6.80%
Worst 1% of cultivated land to pasture	-6.00%	-3.20%	-4.40%
Worst 2.5% of cultivated land to pasture	-11.50%	-8.10%	-8.00%
Worst 5% of cultivated land to pasture	-18.00%	-13.90%	-12.30%
Worst 7.5% of cultivated land to pasture	-23.00%	-18.30%	-15.50%
Worst 10% of cultivated land to pasture	-26.50%	-21.40%	-17.90%
Worst 15% of cultivated land to pasture	-33.00%	-27.10%	-22.10%
Worst 20% of cultivated land to pasture	-37.50%	-31.10%	-25.10%
Worst 25% of cultivated land to pasture	-41.50%	-34.70%	-27.70%
Worst 35% of cultivated land to pasture	-48.00%	-40.40%	-32.00%
Riparian Buffer	-75% to -90%	-35% to -55%	-40% to -60%
Nutrient Management		-15%	-35%

In addition to the BMPs mentioned above, grade stabilization structures are necessary in this watershed due to the highly erodible soils; damage is already evident in the watershed with extensive gullying and rill erosion being relatively common. The SWAT model could not predict areas where grade stabilization structures would be necessary, nor could it predict the loading reduction that would result from installation of these structures. Such a prediction would require extensive reconnaissance in the watershed and ultimately, a conservation plan for every producer. However, an estimate of the need can be roughly extrapolated from the need demonstrated with the FY 2001 §319 project, where approximately 25% of the cooperators required grade stabilization structures to reduce erosion.

The FY 2001 §319 project funded a targeting exercise based on the SWAT model that was later expanded into the TMDL. Results of that exercise were used to focus implementation into areas of origin for the bulk of the sediment and phosphorus loading. Subsequently, the OCC used these results in conjunction with the recommendations of the TMDL as part of a FY 2005 §319 project. Figure 6 displays results of the 2003 targeting effort. Implementation of BMPs in the red areas was expected to reduce nutrient loading to the watershed by approximately 50%. Implementation of BMPs in the yellow areas could reduce nutrient loading by an additional 30%.

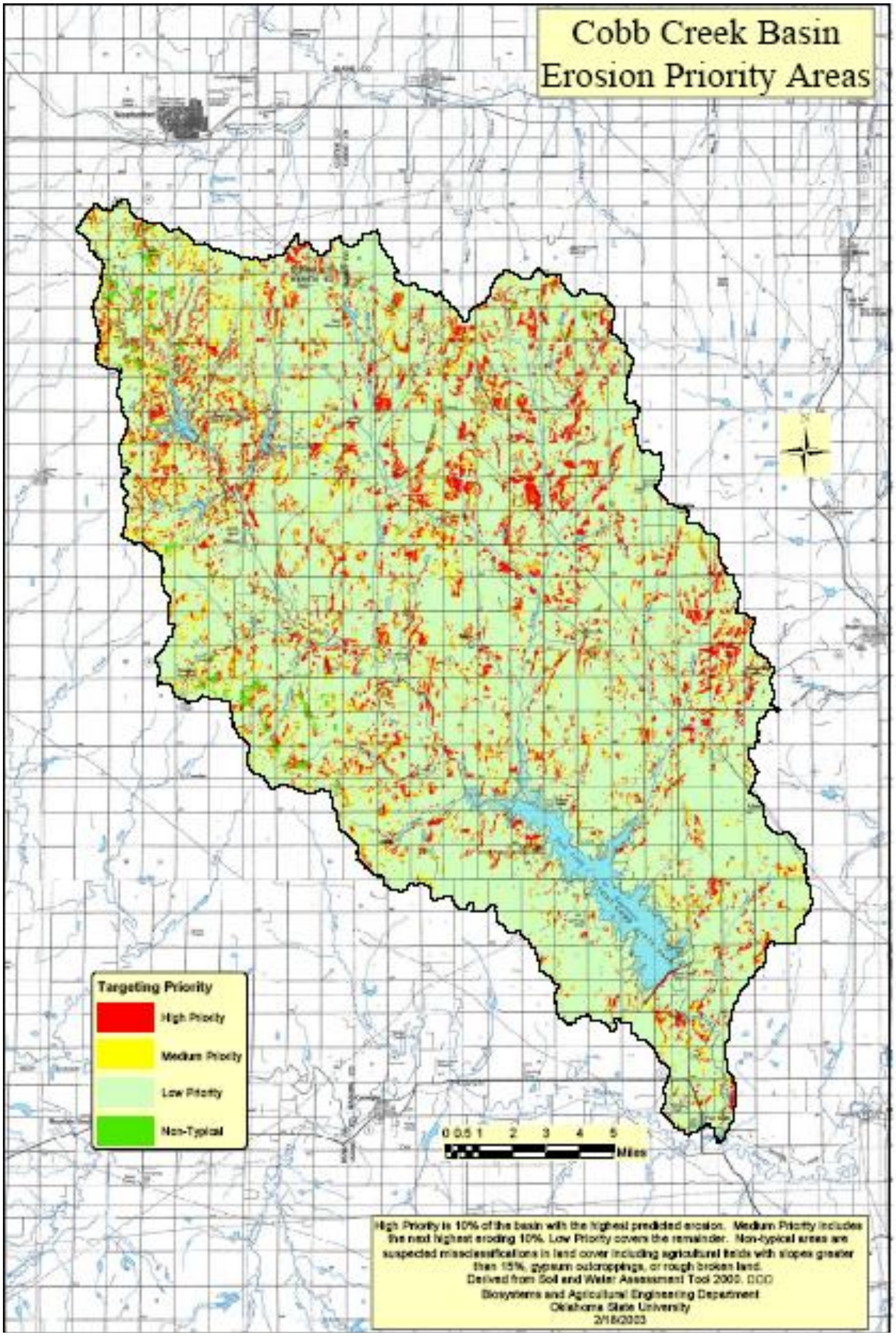


Figure 6. Location of areas in Fort Cobb Watershed most likely contributing the greatest portions of total sediment, and therefore phosphorus loading.

TECHNICAL AND FINANCIAL ASSISTANCE NEEDED

The amounts of technical and financial assistance needed are closely tied to one another. All programs to implement NPS BMPs outlined in the above section require technical assistance in the form of a plan writer, certified by the NRCS. Such a position typically costs a total of $42,000 - $61,000 per year, including benefits. NRCS funds this technical support for their own programs (mainly EQIP in this watershed), but programs like a Conservation Reserve Enhancement Program or §319 must fund technical support through some other means. In addition, part-time help may be required to address the needs of the tri-county area. Any staff that provides technical support would be best served to work through the local conservation district and NRCS offices, as these are the places local landowners are most comfortable in going to for technical support. Therefore, it is beneficial to provide assistance to these districts to help support the program.

Funding necessary to implement the BMPs recommended by the TMDL is estimated using a combination of best professional judgment, based on experience in the watershed, and use of the PRedICT model. These values are seen in Table 6. An initial value of approximately $16 million has been estimated as necessary to implement the TMDL recommended practices. However, this value will likely change as the programs evolve and the Watershed Based Plan is updated. The actual amount of funding for BMP implementation in each of the OCC's projects is given below:

2001 Fort Cobb project (2001-2005):
128 cooperators
$1,386,611 of practices installed,
total:
$365,650 from State funds
$498,054 from Federal 319 funds
$522,907 from landowners (38%)

2005 Fort Cobb project (2005-2008):
60 cooperators
$865,403 of practices implemented,
total:
$502,556 from State funds
$290,250 from Federal 319 funds
$72,597 from landowners (8%)

Table 7 provides some estimates of funding planned or already implemented for technical support in the watershed. Some of these are multi-year efforts, and some are single-year efforts. At a minimum, around $160,000 is required for technical support each year to provide support to the conservation districts and personnel to meet with landowners and draft conservation plans.

Table 8 estimates funding necessary to support monitoring needs in the watershed. Not all information is available at this time regarding monitoring costs for USGS or Bureau of Reclamation; however, available information suggests that at least $230,000 is needed every five years.

Table 6. Funding Needs for Technical Support for Implementation of BMPs.

Project/Funding Source	Task	Federal	State Cost Share Funds	Total
FY 2001 §319 Fort Cobb Project- five year period	On-Site Coordinator	$225,000		$225,000
	Plan Writer	$80,000		$80,000
	District Support	$75,000		
FY 2005 §319 Fort Cobb TMDL Implementation Project- salaries and support for 2 years beyond 2001 project	On-Site Coordinator	$121,000		$121,000
	District Support	$15,000		$15,000
Conservation Reserve Enhancement Program (CREP)- funding for 2-3 years of technical support	Plan Writer		$94,000 - $312,000	$94,000 - $312,000
NRCS District Conservationists (3)		$52,000 - $85,000[3]		$52,000 - $85,000
	Total	**$609,800 - $642,800**	**$94,000 - $312,000**	**$703,000 - $954,800**

3 Estimated from GS 9/11 salary range + benefits.

Table 7. Funding Necessary to Implement TMDL Recommended Practices to Restore Beneficial Use Support to Fort Cobb Reservoir.

Load Reduction: TMDL target	Load Reduction: Anticipated from this project	TMDL Recommended BMP	Project/Funding Source	Federal	State/Local	Total
17%	7%	No-till in 50% of wheat and other row crop	FY 2005 §319 Fort Cobb TMDL Implementation	$672,380	$586,754	$1,259,134[4]
	10%		CSP, EQIP			$930,000
25%		Convert 20% of worst cultivated land to pasture	FY 2001 §319 Fort Cobb Project			
			EQIP, CSP			$2,050,000[5]
30%	1%	Riparian Areas in 60% of watershed	FY 2001 §319 Fort Cobb Project	$38,802	$25,867	$64,669
	15%		2010 CREP	$4,726,790	$945,358	$5,672,148
	14%		EQIP, CRP, CSP	$4,235,204	$1,058,801	$5,294,005
31.5%	31.5%	Nutrient Management Plans for 90% of producers	FY 2001 and 2005 §319 Programs, EQIP, CRP, CSP			$375,000[6]
???	???	Grade Stabilization Structures	FY 2001 §319 Fort Cobb Project	$92,804	$61,870	$154,674
	???		EQIP,???			
Total						$15,799,630

4 Represents an estimated start-up costs for no-till on 39% of cropland based on purchase of no-till drills for the 4 conservation districts, 30% cost-share on purchase of 10 drills for landowners, and $10/acre incentive payment (rate recommended by Fort Cobb WAG) for a three year period. Does not include technical support costs seen in Table 3.
5 Assumes a cost of $51 per acre (based on pasture costs in 20% of cultivated land (40,192 acres)
6 $5.00/acre/year for 90% of all crop and pastureland in the watershed, based on annual incentives offered through other State 319 programs, plus annual cost of soil testing. Most likely would only need to apply to all cropland, as few producers fertilize pasture, which would reduce costs to $250,000 annually.

Table 8. Monitoring Funding Needs Associated with Fort Cobb Watershed.

Monitoring Program	Parameters assessed	State	Federal	Total
OCC Rotating Basin	Stream water quality, biological community, habitat, hydraulic budget, riparian condition, landuse / landcover,		$10,000 - $30,000 every 5 years	$10,000 - $30,000 every 5 years
OWRB BUMP Program	Lake Water Quality	$10,000 annually		$10,000 annually
Watershed modeling (OSU, ODEQ, ARS)	Landuse / Land Cover, BMP implementation, Load reduction			$150,000 every 5 years
USGS	Groundwater/Surface Water Quality, Load reduction		???	???
Bureau of Reclamation	???		???	???

IMPLEMENTATION SCHEDULE

The TMDL recommends a 78% load reduction from loading seen between 1998 and 2001. Implementation towards this load reduction has progressed with formal programs such as the FY 2001 and 2005 §319 Projects and passive changes resulting from the loss of peanut subsidies. Measures of water quality changes as a result of those efforts are not fully available at this time; however, information is available on the implementation completed through the FY 2001 and 2005 programs such that an estimate of potential load reductions attributed to the project activities thus far has been estimated. These reductions are seen in Table 7 under the “Load Reduction” column under “Anticipated from this project”.

These efforts are initial steps towards full implementation of the TMDL recommendations. Table 9 presents a schedule towards implementation of the remaining TMDL recommendations. Included in table 9 is a column that schedules the evaluation of each program. Failure of the programs to meet planned implementation level or load reduction goals will result in adaptations, as possible during the program period or, as necessary, with follow-up, supplemental programs until the load reduction goals have been met.

The ARS CEAP program provides an excellent opportunity to evaluate the progress of these programs towards the TMDL-established goals. The Watershed Based Plan will be updated following the completion of the ARS effort in 2010 to summarize its findings and to make necessary adaptations to reach the TMDL load reduction goals.

Table 5. Schedule for Implementation of TMDL-Recommended Practices.

TMDL-recommended practice	Program proposed to implement	Begin Date	Completion Date	Date to evaluate	Agency(ies) / Group(s) involved
No-till 50% of row crops and wheat pasture	FY 2005 §319 Project	October 2005	January 2009	Annually during project, and following completion of the CEAP program.	OCC, conservation districts, USDA
	EQIP, CSP, ???	Immediate	Ongoing		
Convert 20% worst cultivated land to pasture	FY 2001 §319 Project[7]	October 2001	September 2006	Annually during the project, and following completion of the CEAP program.	OCC, conservation districts, USDA
	USDA Programs such as EQIP, CRP, etc.	ongoing	ongoing	following completion of the CEAP program	NRCS, FSA, ARS, Conservation Districts
Riparian Buffers in 60% of Watershed	FY 2001 §319 Fort Cobb Project	October 2001	September 2006	Annually during the project, and following completion of the CEAP program.	OCC, conservation districts, USDA
	2010 CREP	2010	2025	Annually during the project period	FSA, NRCS, OCC, Conservation Districts
	EQIP, CRP, CSP, and ???	ongoing	ongoing	following completion of the CEAP program	NRCS, FSA, ARS, Conservation Districts
Nutrient Management Plans for 90% of Producers	FY 2001 and 2005 §319 Programs, EQIP, CRP, CSP, and ???	ongoing	ongoing	Annually during the projects, & following completion of the CEAP program	NRCS, FSA, ARS, Conservation Districts, OCC
Grade Stabilization Structures	FY 2001 §319, EQIP, CSP, and ???	ongoing	ongoing	Annually during the project & following completion of the CEAP program	NRCS, FSA, ARS, Conservation Districts, OCC

7 The project did not implement much of this conversion; however, based on recommendations of the TMDL, the Project Coordinator attempted to contact landowners of the worst-cultivated lands to encourage them towards pasture conversion using either the 319 program or USDA programs.

The following is a summary of the implementation achieved through the OCC's 2001 and 2005 §319 projects (2001-2008):

- 21,086 acres of no-till farming
- 32 grade stabilization structures
- 8 diversions, 7 grassed waterways, and 2 terraces
- 230 acres of riparian area exclusion fencing
- 1 stream crossing
- 10,767 acres of cropland converted to pasture
- 957 acres of grass planting for pasture improvement
- 35,030 linear ft of cross-fencing
- 4 wells
- 4 septic systems

Visible improvements from no-till implemented through the §319 program are obvious throughout the watershed. Often, large piles of sandy soil accumulate along fence lines and in fields when dry and windy conditions occur in this area. No-till helped to hold moisture in the soil and reduce the amount of soil lost by wind and rain erosion, as seen in the photos below (Figure 7). The first two photos are of a no-till field, while the next two photos are of an adjacent, conventional till field. Much of the wheat in the conventional till field has been covered by soil which blew or washed over the plants.

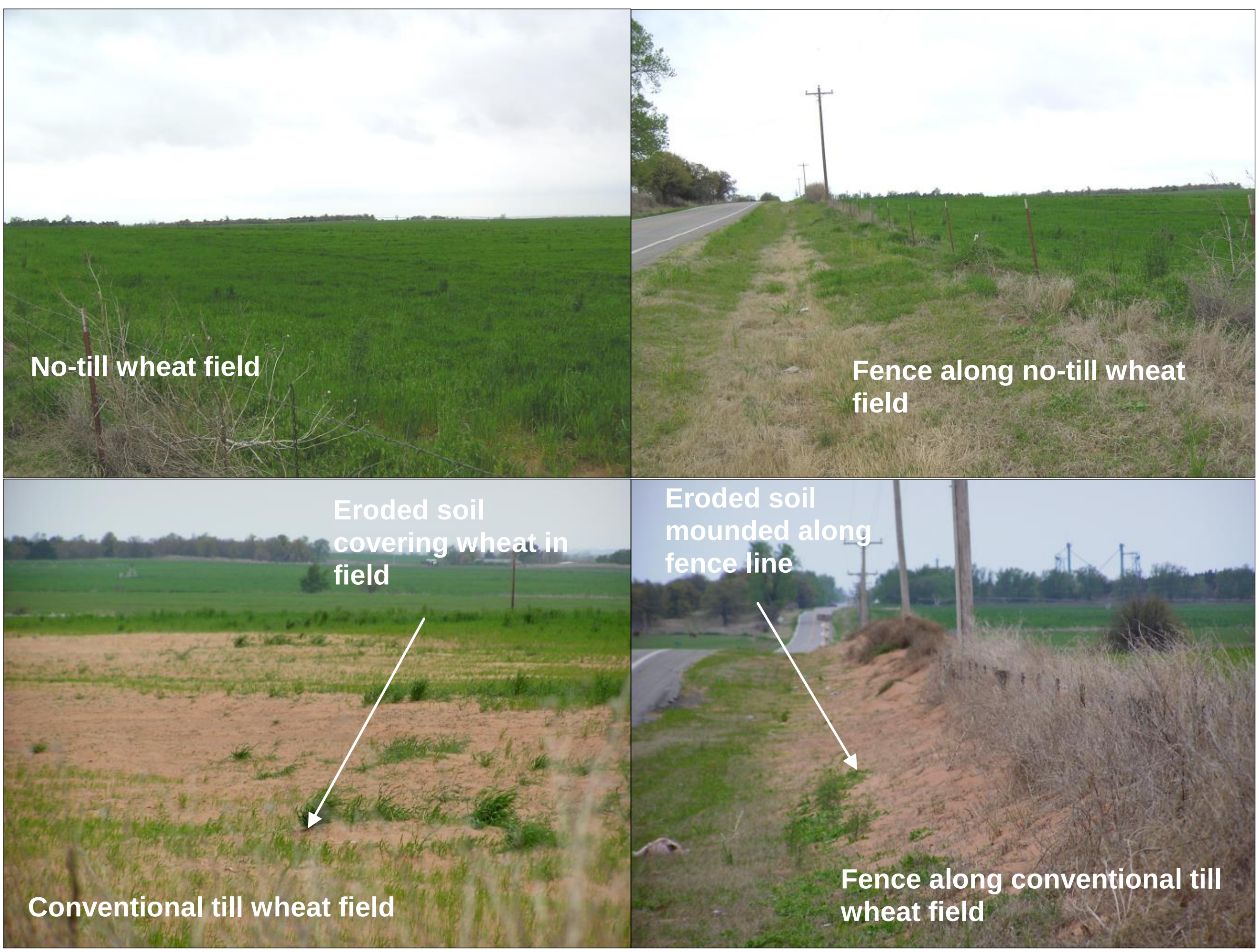


Figure 7. Two adjacent wheat fields, the top in no-till and the bottom in conventional till.

The OCC's no-till program has resulted in implementation of almost 30% of the TMDL goal for no-till. An additional 30% of row crops have been converted to conservation tillage, so at least 60% of the row crop acreage in the watershed is now in some form of conservation tillage (Table 10). In addition, approximately 63% of the TMDL goal for converting row crops to pasture has been achieved through the §319 program. NRCS EQIP has provided funding for both no-till and conservation tillage as well, so additional progress toward the overall TMDL goal has been made.

Table 10. OCC §319 progress toward TMDL goals, 2001-2008.

Total conventional row crop in basin at start of project: 98,289 acres			
BMP	**Total Amount Implemented (acres)**	**Goal for TMDL (acres)**	**% Towards TMDL Goal**
Row Crop Converted to No-Till	16,401	58,973	27.8
Row Crop Converted to Conservation Tillage	17,286	58,973	29.3
Convert Worst Row Crop to Pasture	12,462	19,658	63.4
Establish Riparian Buffers	169	8,547	2.0

A phosphorus load reduction of approximately **20%** has already been accomplished since 2001 due to a dramatic change in crop production in the watershed (ODEQ 2006). Specifically, many acres that were used for peanut production have now been converted to wheat production or pasture. According to the SWAT watershed model (Storm et al. 2006), if there was 100% conversion of row crops and wheat to no-till, total phosphorus loading would be expected to decrease by 34%. Based on the conversion of 16,000 acres to no-till, total phosphorus loading should be reduced by approximately **6%**. The maturation of other BMPs, installed as part of the 2001 and 2005 projects, will further reduce the phosphorus loading in the watershed.

Approximately one-third of the implementation from 2001-2008 occurred in areas that were expected to be contributing high levels of phosphorus, according to the SWAT model:

- Of the 9,188.6 acres that were in the top 10% of phosphorus load supplying areas, 32% now have BMPs on them;
- Of the 10,033.2 acres in the next 10% of high phosphorus areas, 27% have BMP implementation.

Figure 8, below, shows the overlay of implementation and targeting. Further details about the OCC implementation projects can be found in the final reports associated with the 2001 and 2005 projects.

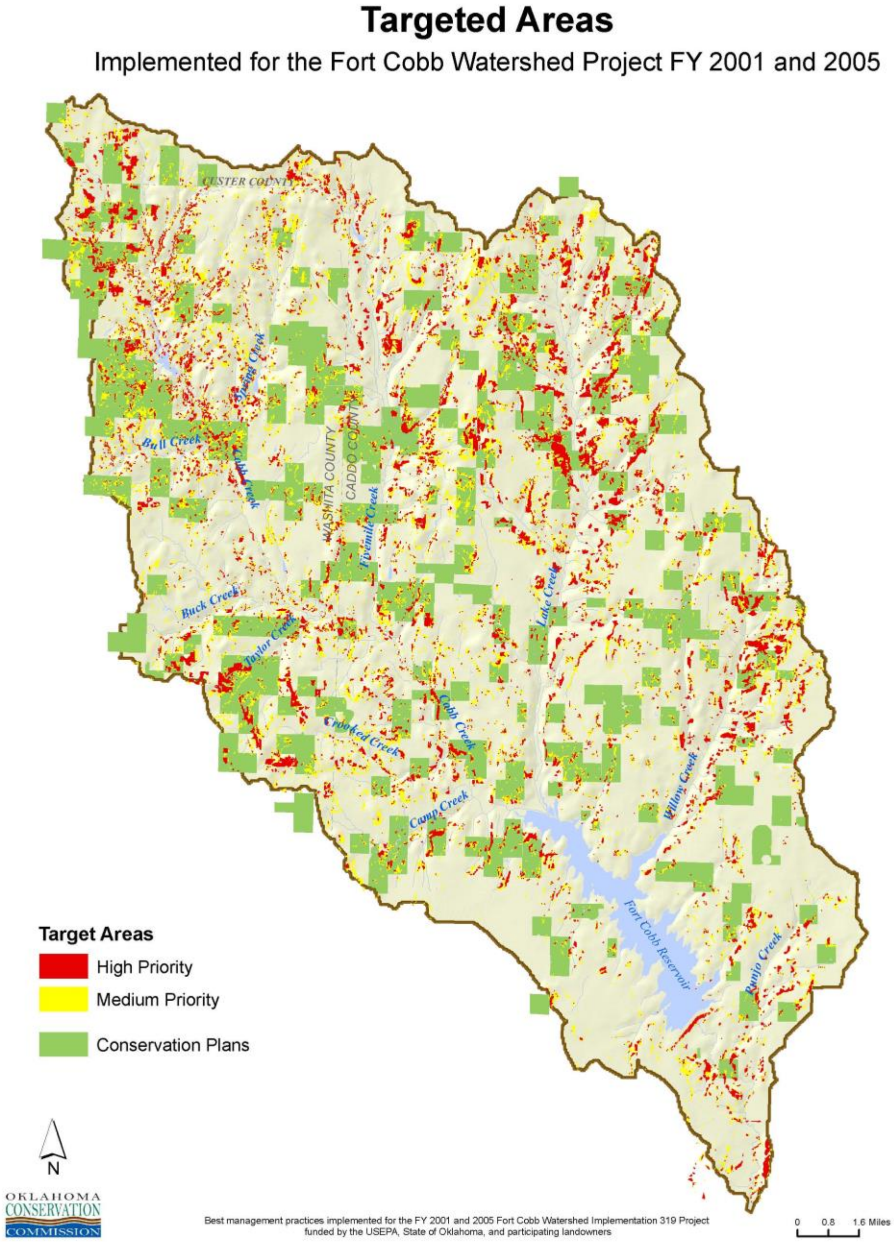


Figure 8. Overlay of regions of high phosphorus loading (targeted regions) onto areas of BMP implementation through the §319 program, 2001-2008.

A Conservation Reserve Enhancement Program (CREP) is planned for the Fort Cobb watershed beginning in 2010. This project aims to restore stable riparian vegetation and riparian buffers and to reduce livestock access to floodplains. This will result in reduced overland flow of pathogens and phosphorus to the streams and will lessen streambank erosion by stabilizing stream banks. Overall, this will lead to better water quality, lower maintenance requirements to the road and highway system, and will help to preserve existing floodplain cropland, pasture, and rangeland. The WBP will be updated at the conclusion of the CREP signup to estimate the load reductions expected from this implementation.

INTERIM MILESTONES

Interim milestones towards addressing the recommendations of the TMDL will continue to be developed as activities are implemented under the Watershed Based Plan. Some of these have already been completed through various project workplans, others are ongoing or planned.

Project	Description	Responsible Party	Target Date	Complete
TMDL	Compile watershed loading model and link to lake model	ODEQ, OSU	2003	X
	Calibrate model to water quality monitoring data	ODEQ	2003	X
	Develop draft TMDL	ODEQ	2004	X
	Solicit public input to draft TMDL	ODEQ	2005	X
	Submit to EPA	ODEQ	2005	X
2001 §319 Project	Hire Local staff- project and education coordinators and plan writer	OCC, Conservation Districts (CDs)	2002	X
	Establish agreements with CDs	OCC, CDs	2001	X
	Establish a WAG and EdWAG	CDs	2001	X
	Complete GIS-Based Targeting	OCC, WAG	2001	X
	WAG selection of BMPs and cost-share rates	WAG, OCC	2001	X
	Watershed Implementation Plan	OCC	2002	X
	BMP Demonstration	OCC, CDs	2002 – 2006	X
	Develop education program to educate producers and other watershed citizens about problems and solutions	EdWAG	2002	X
	Identify oil and gas related sources in the watershed	Corp. Comm	2001 - 2002	X
	Hire companies to plug abandoned wells	Corp. Comm.	As needed	Ongoing
	Educate current operators and when necessary take enforcement actions	Corp. Comm.	As needed	Ongoing
	Sample creeks, streams, and agricultural lands in watershed for pesticides and fertilizer-related parameters	ODAFF[8]	2002	X
	Conduct pesticide education programs	ODAFF	2001 - 2003	Ongoing
	Summary of Project Activities including estimation of load reduction due to practices implemented and comparison of implementation to TMDL recommendations	OCC, ODAFF, Corp. Comm.	2006	X

8 Oklahoma Department of Agriculture, Food, and Forestry

Project	Description	Responsible Party	Target Date	Complete
2005 §319 Project	Further delineate targeted areas based on TMDL recommendations	OCC	2006	**X**
	Implement no-till practices	OCC, CDs	2006 - 2008	**X**
	Update WBP	OCC	2008	**X**
	Follow-up GIS evaluation of implementation	OCC	2008 - 2009	**X**
	Instream Habitat Monitoring to Support ARS CEAP Project and evaluate success of BMPs	OCC	2006 - 2008	**X**
CEAP	Water Quality monitoring, watershed modeling, and compilation of BMPs implemented in watershed to evaluate impacts of BMPs	ARS, NRCS, OCC	2005 - 2010	**Ongoing**
CREP	Develop program plan with FSA and NRCS	OCC, FSA, NRCS	2003 – 2005	**X**
	Secure State match and Governor's approval	OCC, OSE	2007	**X**
	Submit plan to USDA	OCC, FSA, NRCS	2009	**Planned**
	Begin implementation	OCC, FSA, NRCS	2010 - 2013	**Planned**
EQIP	Explore possibility of declaring watershed a special emphasis area to secure higher funding level	FSA, NRCS, CDs	Annually	**Ongoing**
	Continue to implement EQIP practices annually in watershed			
CSP	Designate watershed as a CSP priority watershed	FSA, NRCS, CDs	???	**???**
WBP	Update Watershed Based Plan and evaluation of progress towards TMDL goals with watershed modeling at least every five years or more frequently upon completion of major tasks/projects	OCC, WAG	2012	**Ongoing**
Continue water quality monitoring to identify sources, causes, and progress towards TMDL goals		OWRB, Bureau of Recl., USGS, OCC, ARS	Annually	**Ongoing**

PUBLIC OUTREACH

Many local efforts, as well as efforts by state and federal agencies and other organizations, are collectively contributing to the Public Outreach efforts in the Fort Cobb Watershed. Public outreach will need to be continued in order to reach the water quality goals of restoring beneficial use support and attaining water quality standards in the watershed. This section identifies those agencies, organizations, and services that are active in the watershed (in no particular order). To varying degrees, these groups have been, and will continue to be, active in development and expansion of the Watershed Based Plan and other planning efforts in the watershed. The roles of these groups and programs are summarized below:

1. Deer Creek, West Caddo, North Caddo, and Mountain View Conservation Districts

These agencies are critical to ensuring participation of local landowners in water quality improvement programs. Local Conservation Districts are generally the most effective means to bring a large federal or state program to private citizens because the local agencies know the local people. Local agencies often have the most accurate knowledge concerning current land management practices and local needs. In addition, these agencies have existing programs and mechanisms directed towards the goals of the WBP.

The Conservation Districts, partnered with the OCC, NRCS, and Cooperative Extension, have been among the primary agencies responsible for public outreach in the watershed. The districts and NRCS work one-on-one with citizens of the watershed to reduce pollution and educate about the importance of protecting water resources. These groups also organize or participate in seminars, training sessions, and meetings to interact with local people and provide technical assistance and information. The Deer Creek Conservation District has a very active education program through its outdoor classroom. This program targets mainly elementary school children and teaches them about environmental issues. In addition, Deer Creek has housed the Education Coordinator for the FY 2001 and 2005 §319 Fort Cobb Projects and served as the hub for education activities of that project.

2. Watershed Advisory Group (WAG) and Education Watershed Advisory Group (EdWAG)

The success of water quality protection programs in the Fort Cobb Watershed depends on the approval and cooperation of the local landowners and various government agencies. The WAGs were made up of local shareholders in the watershed (including private citizens, representatives of local industries, and local government) who provided guidance in delivering the §319 programs based on information supplied to them by technical agencies in conjunction with their knowledge of the needs of the watershed residents. The WAGs were developed to help insure that the programs most effectively worked towards reducing water quality impacts, but, at the same time, met the needs of and were acceptable to the local producers and other landowners. The WAG recommended the practices and cost-share rates to reduce the NPS pollution problems in the watershed. The EdWAG considered the issues in the watershed and recommended an education program to help inform watershed citizens about those issues using a “show and tell” approach.

3. The Oklahoma Conservation Commission (OCC)

With the 2001 project, the OCC devoted almost $2.3 million towards a program to educate citizens and implement best management practices to reduce nonpoint source pollution in the watershed. A portion of these funds support the WAG, a portion is devoted to identifying the major sources in the watershed and monitoring the success of the program, another portion is devoted towards education, but the majority of the funds provides cost-share assistance to farmers to implement WAG-recommended and OCC-approved BMPs to protect the water resources of the watershed. This effort was extended through the FY 2005 program, which focused on recommendations of the TMDL, primarily no-till.

The OCC's main function is to provide oversight for successful completion of the program. To do this, they provide technical guidance and final approval to the WAG and local conservation districts for implementation of the BMPs. The OCC implemented an education program targeted towards citizens of the watershed whose change in behavior could have the most substantial impacts on water quality. The OCC is also responsible for monitoring the success and providing administrative support for the §319 projects, and working with NRCS and FSA to implement a CREP Program in the watershed.

In addition, Blue Thumb, OCC's education program, is active in the Fort Cobb watershed. Streams are monitored by volunteers and school groups are taught about water quality through this program.

4. Oklahoma Cooperative Extension Service (OCES)

The Oklahoma Cooperative Extension Service (OCES) is another leader in promoting water quality education efforts in the State, working closely with the conservation districts and the NRCS to promote water quality awareness. The OCES provides one-on-one meetings and education with landowners along with group presentations and other forms of technical assistance to improve awareness in the watershed. The OCES also develops and utilizes test plots and demonstration sites to educate producers about the effectiveness of certain best management practices. One such set of test plots, developed by the Oklahoma State University Cooperative Extension Service, was utilized to demonstrate methods of integrated pest management and effectiveness of more managed fertilizer application in wheat production. The OCES also holds public meetings and workshops to educate landowners on topics such as pesticide and fertilizer management, animal waste issues, and general BMPs.

5. NRCS Local Offices and FSA (USDA)

The United States Department of Agriculture Natural Resource Conservation Service (USDA/NRCS) and Farm Services Agency (FSA) in Oklahoma have several programs active in or that could be expanded in the Fort Cobb Watershed. These programs include the Environmental Quality Incentives Program (EQIP), Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP), Wildlife Habitat Incentives Program (WHIP), and the Wetlands Reserve Program (WRP). These programs are employed by the USDA to help landowners protect natural resources.

6. Oklahoma Corporation Commission (Corp. Comm.)

Corp. Comm., as the state agency with jurisdiction over oil and gas mining activities, has ongoing efforts in the watershed to identify and reduce impacts from oil and gas activities. These include efforts to identify location and severity of erosion related to well sites and pipelines, followed by cleanup by the operators and pipeline companies. Corp. Comm. will begin additional work in the watershed to further identify problem areas in the watershed and initiate educational and other actions for site operators. These efforts range in extent from informing landowners about who to contact in the case of pollution occurring at well sites or exploration sites to what best management practices can be utilized during exploration and operation of oil and gas sites. Another focus of additional planned Corp. Comm. activities includes efforts to reduce impacts from abandoned oil and gas activities.

7. Oklahoma Department of Agriculture, Food, and Forestry (ODAFF)

The ODAFF has an ongoing project aimed at reducing impacts of fertilizers and pesticides to surface and groundwater in the watershed. The program has attempted to locate sources or likely sources of contamination from these fertilizers or pesticides and conduct educational programs to reduce the impact of those sources.

8. Bureau of Reclamation

Fort Cobb Reservoir is owned by the Bureau of Reclamation, which has played an active role in the watershed with cooperative efforts towards water quality monitoring, land management, and education.

9. Agricultural Research Service (ARS)

The ARS is currently pursuing a project to evaluate the success of BMPs implemented in the watershed through the Conservation Effects Assessment Project (CEAP). This program will involve water quality monitoring, watershed modeling, and cooperation with local conservation districts, NRCS, OCC and similar agencies to obtain current information on management practices in the watershed. Information will be shared regarding the success of programs and can be used to improve efficiency with cost-share and other implementation programs, as well as to evaluate progress towards meeting the goals of the TMDL.

Youth education is a significant effort pursued by OCES, NRCS, and the conservation districts. Most youth education activities focus on general water quality maintenance and improvement and include activities such as 4-H group water quality monitoring and education, “Earth-Day-Every-Day” activities fair where hundreds elementary school children and some of their parents are exposed to environmental education, and various other training sessions.

Newspaper articles and other media are a method that can be used to inform citizens of the watershed about programs focused on water quality. The OCES, Conservation Districts, and NRCS often contribute articles that were released to local papers, covering a wide range of topics related to water quality, and more specifically, advertising education events and programs. Many articles serve as promotions for various upcoming trainings or other events. Other media related activities such as radio spots and logo contests can be used to further the efforts of the program. However, in using media and advertising in education programs, efforts must focus on measurable results. An information article about water quality is not enough; the article must be associated with some additional effort that is likely to change behaviors. Information alone doesn't often change people's behaviors; people must be persuaded to change their behavior. Persuasion is more likely to occur as part of a program of repeated contact and interaction than as the result of a well-written article in a newspaper.

Current outreach programs in the watershed will need to expand and perhaps partially redirect their public outreach efforts to work towards more measurable results. Although current education efforts are valuable programs, efforts may need to be expanded to insure that the target audience is being reached. The target audience is the people whose change of behaviors could have the most substantial benefits to water quality. In other words, the target audience in the Fort Cobb Watershed should include people such as county commissioners and road maintenance crews, agricultural producers, and people in the oil and gas industry, among others. Existing and planned outreach programs will need to coordinate among themselves and with other ongoing efforts in the watershed in order to educate more watershed citizens and more importantly, change behaviors of land users in the watershed.

Public Outreach to assure support of this and future evolutions the Watershed Based Plan will come from:

- Conservation District Newsletter and/or website
- Continued support the WAG or a similar group
- Public meetings and listening sessions held throughout the local communities (and eventually, throughout the watershed)
- Regular media coverage of activities/issues (both at local and State levels)
- Education programs such as the ones developed in the 2001 and 2005 §319 projects that involve segments of the community ranging from school children to agricultural producers to homeowners and lakeside residents
- Programs that encourage local citizens to experience "ownership and understanding" of environmental issues such as volunteer monitoring, clean-up events, and other educational grassroots efforts to address the problem

MONITORING PLAN

Every Watershed Based Plan requires a monitoring plan to gage overall success of restoration and remediation efforts. The goal of the monitoring plan for this WBP will be to expand current monitoring efforts into a long-range monitoring program with clearly defined milestones that will oversee the progress towards the TMDL recommended load reductions, restoration of the beneficial use support in the watershed, and preservation of natural resources for future generations.

The monitoring plan for this WBP provides for development of individual monitoring plans and associated quality assurance plans and Standard Operating Procedures for each underlying project or effort working toward the ultimate goal of restoration of beneficial use support. These monitoring efforts must be based on Oklahoma's Water Quality Standards and Use Support Assessment Protocols, which define the process by which beneficial use support can be determined. Technical assistance in developing these plans can come from various sources including the Oklahoma State Agency peer review process, and the Oklahoma Water Quality Monitoring Council. In addition, local stakeholders need to be involved in developing these plans to ensure that the plans address monitoring needs identified by stakeholders and that stakeholders remain informed about watershed monitoring activities.

Monitoring methodologies specified in this WBP have been selected to provide: 1) a quantifiable measure of changes in parameters of concern, 2) success measures that can be easily understood by cooperators and stakeholders with a variety of technical backgrounds, and 3) consistent, compatible information throughout the watershed. As the WBP evolves, it is anticipated that this list will expand and contract.

Monitoring will focus on the primary causes of impairment, as listed in the 303(d) list, but will also consider related causes that may exacerbate the impacts of the primary causes or may ultimately reach impairment levels without improved management. The primary types of monitoring to be conducted in the Fort Cobb Watershed include:

- Surface water quality: nutrients, sediments, suspended solids, fecal bacteria, dissolved oxygen, temperature, pH, conductivity, alkalinity, hardness, turbidity, chlorophyll-a, pesticides, BOD
- Hydraulic budget: in-stream flows, infiltration rates, aquifer recovery, groundwater levels
- Groundwater quality: nutrients, metals, pesticides, pH
- Landuse/Land cover: acreage in different landuses, quality and type of land cover, timing and other variables of associated management practices
- Riparian Condition: extent and quality of riparian zones in the watershed, to include quality and type of vegetation, degree of impact or stability, condition of streambanks, and primary source of threat or impact
- Aquatic Biological Communities: assessment of the condition of fish and benthic macroinvertebrate communities related to reference streams and biocriteria
- BMP and other implementation effort coverages: type, extent, and when possible, specific location of practices to include an estimate of the potential load reduction effected by implementation
- Behavioral change: participation in Watershed Based Plan-related activities and behavioral changes of affected communities
- Sediment quality: nutrients, pesticides, other organics of concern

With each WBP-related program, as well as for the WBP as a whole, baseline conditions will be established and monitored prior to implementation. A monitoring schedule and Quality Assurance Project Plan (QAPP) will be developed based on the type of project and timing of its implementation. Monitoring results will be reported to appropriate local, state, and federal entities as defined in the QAPPs.

Baseline Data

The baseline data to evaluate progress in the Fort Cobb Watershed has been established by the draft TMDL. This includes watershed data from primarily the period between 1998 – 2001. Specifically, this data is listed below:

- 2000 census data to estimate watershed population and septic tank loading in the watershed
- SWAT model used:
  - Land use was determined using data retrieved from June 10, 2001 30 m resolution Landsat TM imagery, a crop type breakdown based on 1999-2001 Oklahoma Agricultural Statistics Service data, and center pivot irrigation locations tagged from aerial photos.
  - 1 meter resolution Digital Orthophoto Quarter Quads (DOQQ) from 1995 for the entire Fort Cobb Basin were used in ground-truthing the Landsat data.
  - Soil test phosphorus for common agricultural land covers was derived from OSU county level averages for the period 1995-1999.
  - The model was calibrated for flow for the period January 1990 through October 2001 and validated for flow in Cobb Creek for the period 1975 – 1989.
  - 10 m USGS DEM
  - 200 m NRCS MIADS Soils Data
  - EPA Reach3 Streams
  - National Inventory of Dams
  - County level National Agricultural Statistics Service (NASS) cattle estimates for the period 1996-2000 were combined with land cover data to estimate the number of cattle within the basin.
  - Approximate CAFO locations and animal numbers were taken from an Oklahoma Department of Agriculture coverage available at the ODEQ website. The metadata are listed at the following address: http://www.deq.state.ok.us/deqmap/help/CAFO.htm.
  - Few stream gage data were available to calibrate the SWAT Model for the period Jan 1990 - Oct 2001. The only suitable gage was Cobb Creek near Eakley (USGS 07325800). The hydrologic calibration was performed almost entirely with data from this gage. Another gage downstream of the Fort Cobb Reservoir was also utilized as a check of the calibration.
- OWRB and USFWS lake data collected in 1998-1999 was used to calibrate the model, and USGS and USFWS data collected in 2000–2001 was used to validate the model.
- Atmospheric deposition of nutrients was based on annual data for Oklahoma downloaded from National Atmospheric Deposition Program's web site. The average of the data from 1998 to 2001 was used in the model.
- Hourly weather data, daily flow data, and daily loadings (from the SWAT model) to the lake were also used in the model. Weather data was obtained from Oklahoma Mesonet for the Fort Cobb station. The data includes hourly atmosphere pressure,

air temperature, wind speed and direction, relative humidity, rainfall, and solar radiation. The hydraulic data was downloaded from Army Corps Of Engineer's web site (http://www.swtwc.usace.army.mil/FCOBcharts.html). The data includes daily inflow, release, pool elevation, and evaporation. Once again, 1998 – 1999 data was used in calibration, and 2000 – 2001 data was used in validation.

Data Collection Responsibilities for Current and Future Monitoring

Responsibility for the collection of additional data of the types described above will reside with project managers of the individual projects as spelled out their individual work plans. These project managers will be responsible for ensuring that the data is submitted to the ODEQ for inclusion in the Oklahoma State Water Quality Database, which will ultimately be uploaded to the National STORET database. Data reporting under individual workplans will also be the responsibility of the project managers. Monitoring results will be made public through the ODEQ's website, at a minimum. In addition, project and monitoring results should be presented locally with a public meeting or to the WAG or similar group.

In addition to those monitors to be identified in the workplans of the individual projects under this WBP, the following groups, at a minimum, will be involved in monitoring activities:

- Oklahoma Water Resources Board: Beneficial Use Monitoring Program and Oklahoma Water Watch Monitoring Program
- Oklahoma Conservation Commission: Rotating Basin Monitoring Program, Priority Watershed Project Monitoring, and Blue Thumb Project Monitoring
- U.S. Geological Survey: Surface and Groundwater quality and quantity monitoring and special studies
- Oklahoma Department of Agriculture, Food, and Forestry: soil sampling associated with CAFO regulations
- ARS: CEAP associated monitoring
- US Bureau of Reclamation

Currently, the OCC has two sites in the Fort Cobb watershed which are part of the Rotating Basin monitoring program. These sites were sampled every five weeks from 2004-2006 and will be sampled again from 2009-2011. The parameters measured include water temperature, dissolved oxygen, pH, specific conductance, alkalinity, turbidity, instantaneous discharge, nitrate, nitrite, orthophosphate, total phosphorous, total Kjeldahl nitrogen (TKN), ammonia, chloride, sulfate, total suspended solids, total dissolved solids, 5-day biochemical oxygen demand (BOD_5), and total hardness, as well as biological (fish and macroinvertebrates) and habitat data.

The OWRB has 6 sites in the reservoir from which physico-chemical data are collected quarterly. The parameters measured include turbidity, true color, dissolved oxygen, metals, chloride, sulfates, total dissolved solids, pH, nutrients, temperature, and chlorophyll-a.

The USGS has 5 “real time” gauging stations in streams in the Fort Cobb watershed, as well as one reservoir station and a meteorological station from which data may be accessed. The parameters collected include temperature, instantaneous discharge, conductivity, dissolved oxygen, pH, nutrients, suspended sediments, and alkalinity.

The ARS has been monitoring 15 sites in the Fort Cobb watershed since 2004 as part of a national CEAP Watershed Assessment Study. Fortunately, Fort Cobb is included within one of the 12 benchmark watersheds in the US, and as a result, ARS, working collaboratively with the Great Plains RC&D, will complete an extensive bi-weekly water quality monitoring program. This program includes monitoring of the following paramters: pH, dissolved oxygen, conductivity, salinity, total dissolved solids, temperature, turbidity, oxygen reduction potential, nitrate concentration, ammonia concentration, suspended sediment, and phosphorus. The Great Plains RC&D will work collaboratively with ARS to contact farmers to obtain conservation and production management information relevant to the assessments.

Benefits of the Monitoring Plan

Implementation of this monitoring plan will enable Fort Cobb partners to meet the goals of the WBP, which is ultimately to restore beneficial use support to waters of the Fort Cobb Watershed. Implementation of the monitoring plan will help further define areas of the watershed where restoration activities should be focused to realize the optimum benefit for the investment as well as evaluating the impacts (realized and potential) of implementation efforts. Collection of the data described under this monitoring plan will help define the relative contributions from various sources in the watershed and the processes contributing to water quality degradation in the watershed. And finally, continued collection of this data and evolution of the monitoring plan for the watershed will allow the program to adapt to meet the changing needs of watershed protection in the Fort Cobb Watershed.

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APPENDIX A:

TMDL Development For Cobb Creek Watershed And Fort Cobb Lake

FY99 Section §319(h) Grant #C9996100-07

FINAL REPORT
2006

APPENDIX B:

Fort Cobb Basin –

Modeling and Land Cover Classification

FINAL REPORT

(not attached to this version)