BEAVER & CACHE CREEK STREAM SYSTEMS

Technical Report 2011-01

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OKLAHOMA WATER RESOURCES BOARD

Planning and Management Division

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Beaver & Cache Creek Stream Systems

TECHNICAL REPORT

INTRODUCTION

The Oklahoma Water Resources Board (OWRB) conducts technical studies on the stream systems of Oklahoma to determine the water availability of those systems and better manage the water resources of the State. In 2009, the Board implemented a modeling application called Central Resource Allocation Model (CRAM model) with the aim of assessing the availability of water resources and evaluating the potential for interference of water rights. The CRAM model allows simulating allocation practices in a river system using time series of historical naturalized monthly streamflows, reported surface-water uses and allocated amounts.

This report is a hydrological characterization of the Beaver and Cache Creek basins. Its purpose is to provide a compilation of information for use by the OWRB in determining the water availability to facilitate the adjudication of water rights. The first section of this document contains generalized information on soils, rainfall patterns, and stream hydrology, to help understanding their influence on the hydrology of the basin. In the second section, the surface water allocation model is explained in detail and the results from simulations are interpreted to determine the amount of water that can be dependably appropriated, as determined by inflow at each sub-watershed, reported water use, consumptive patterns, evaporation, and related factors.

1. STUDY AREA

1.1 Basin Characteristics

Cache Creek

The Cache Creek basin lies in the Oklahoma counties of Comanche, Caddo, Kiowa, Jefferson, Cotton and Tillman. East Cache Creek originates in the Wichita Mountains in the southwest part of Caddo County and flows to its confluence with West Cache Creek. Cache Creek originates at the junction of those two streams and flows into the Red River at river mile 912 (USACE, 1987).

The Cache Creek basin has been divided by the OWRB into two systems. Sub-stream system 1-13-1 has a drainage area of 906 mi^2, and includes Cache Creek and East Cache Creek. Sub-stream system 1-13-2 has a drainage area of 1,122 mi^2 and includes Deep Red Run and West Cache Creek to its confluence with Cache Creek. The mean annual flow for

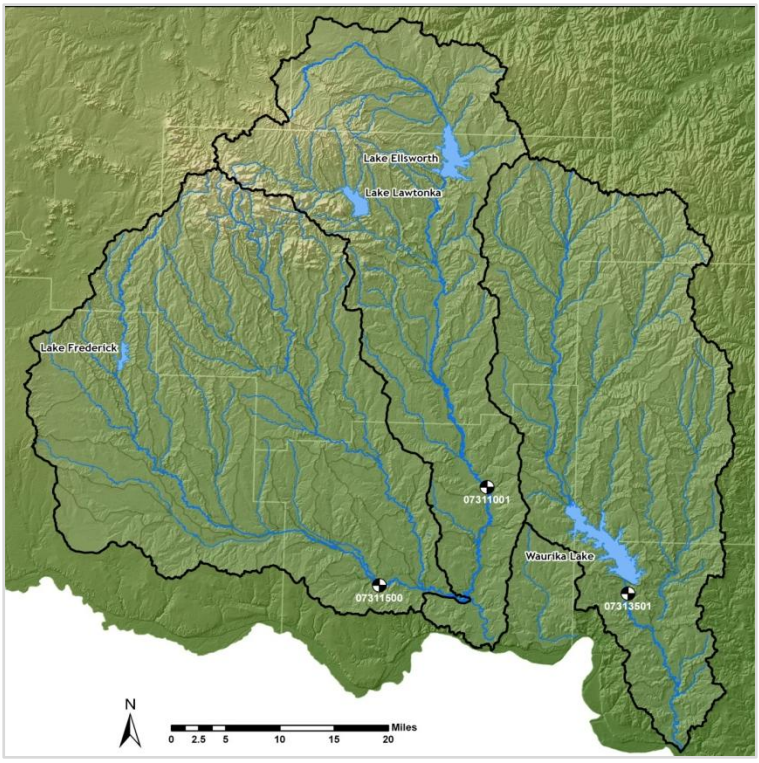

FIGURE 1 DEEP RED, CACHE CREEK AND BEAVER CREEK BASINS

West Cache Creek is 166.8 cfs for the period 1950-2010, as measured at the gauge Deep Red Creek near Randlett (USGS 07311500). The mean annual flow for East Cache Creek is 227.4 cfs for the same period, as recorded at the gauge East Cache Creek near Walters (USGS 07311000).

Beaver Creek

The Beaver Creek basin originates in Comanche county and flows into the Red River at river mile 883. The basin has a drainage area of 857 mi^2, and its main tributaries are Little Beaver Creek and Cow Creek. The mean annual flow at the gauge Beaver Creek near Waurika (USGS 073135000) is 142.7 cfs, representative for the period 1954 - 1993.

- ### Land Cover/Use

Soils in the Cache and Beaver basins consist of deep loamy soils. A land cover map based on the National Land Cover Dataset (USDA, 2009) is shown in Figure 2. Water supply is the prevalent water use in the area, followed by irrigation and industrial uses. The main crops are pasture and hay, whereas most of the land is covered by grass and herbaceous vegetation.

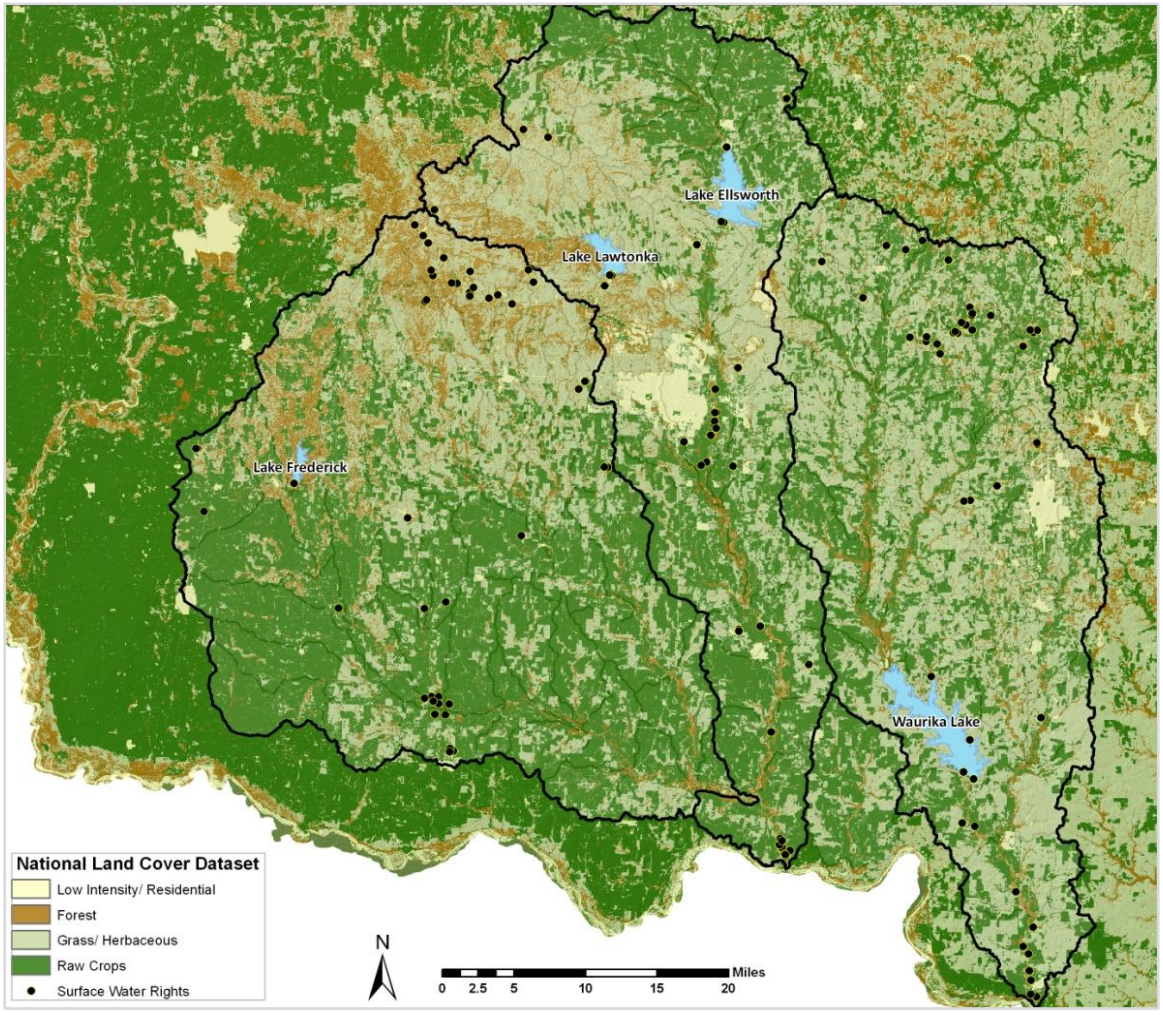

FIGURE 2 LAND USE AND COVER IN CACHE CREEK AND BEAVER CREEK BASINS

Groundwater

The geological features of the area include the uplifted Wichita Mountains, from the Cambrian-Precambrian age, and a portion of the Anadarko basin in the northeast. Most of the exposed rocks are Permian age, and include the Whitehorse, Post Oak, Conglomerate, Hennessey, Garber Sandstone and Wellington formations. Other formations from the Ordovician age are exposed, including the Arbuckle and the Cambrian Timbered Hills groups on the north side of the Wichita Mountains.

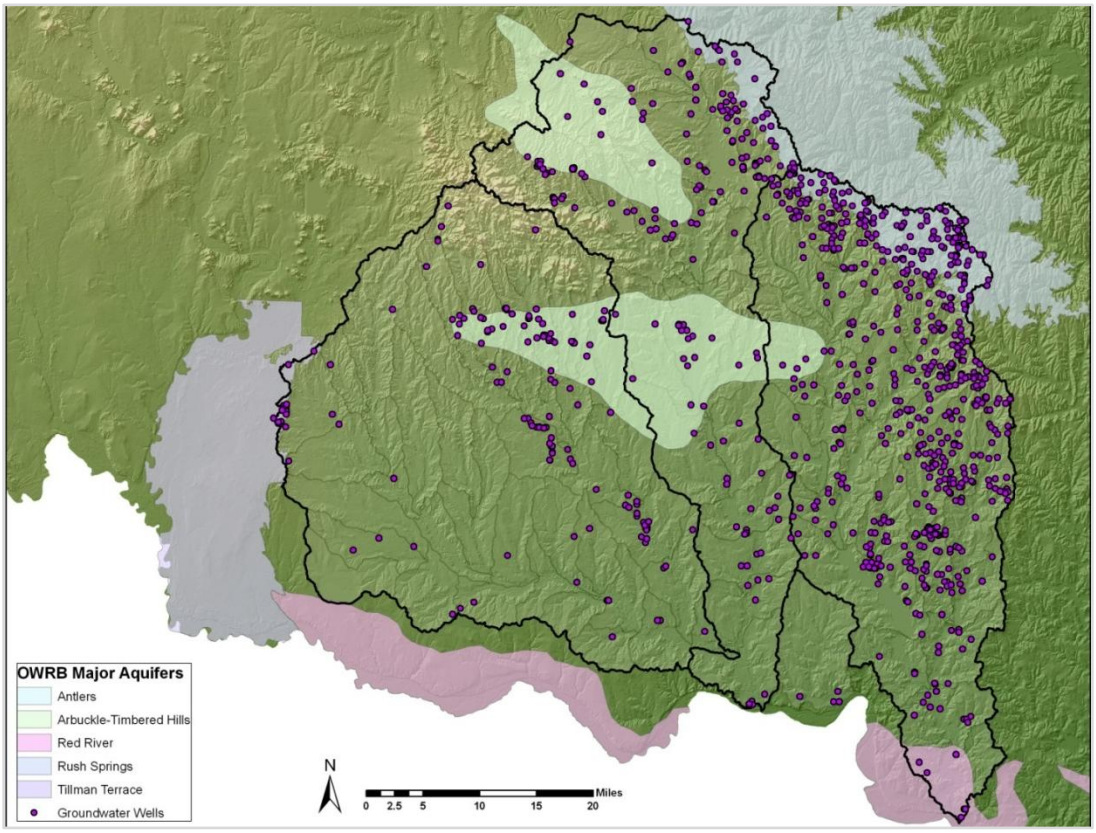

FIGURE 3 MAJOR GROUNDWATER BASINS IN THE AREA

1.2 Hydrologic Characteristics

- ### Water Balance

A water balance was constructed for Deep Red River, Cache Creek, and Beaver Creek basins for the period 2000-2010 using hydro-meteorological data as available. Precipitation data is gathered from the Mesonet station at Walters, streamflow is retrieved from the USGS gauges Deep Red near Randlett (USGS 07311500), East Cache Creek near Walters (USGS 07311000), and Beaver Creek near Waurika (USGS 07313500) and used as input of the PART program to obtain baseflow and runoff, and actual evapotranspiration is computed as a residual of the water budget. The seasonal variation of the components in the water budget for each basin is presented in Tables 1, 2 and 3 for Deep Red River, Cache Creek and Beaver Creek basins, respectively. The budget shows that precipitation (P) in the area averages 30 inches per year for the period 1999-2010, baseflow (BF) ranges from 1 to 5% of precipitation, runoff (R) ranges from 8 to 13 % of the precipitation, and actual evapotranspiration (aET) is the main output of the hydrologic system depleting more than 86% of the

available water. Figure 5 shows the monthly distribution of precipitation as measured at the Mesonet station near Waurika for the period 1999 to 2009.

TABLE 1 SEASONAL WATER BALANCE FOR DEEP RED (2000-2009) IN AC-FT

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	%P
P	42,928	44,125	81,309	90,104	138,926	106,767	66,531	120,738	58,933	133,212	62,463	48,612	994,649	-
BF	4,443	3,401	4,505	7,626	11,932	17,025	7,713	4,314	690	10,877	7,754	1,292	81,573	1
R	658	927	868	568	897	838	2,722	209	120	179	1,197	449	9,633	8
aET	37,843	39,817	76,014	81,938	126,033	88,848	55,941	116,161	58,245	122,084	53,638	46,727	903,288	91

TABLE 2 SEASONAL WATER BALANCE FOR CACHE CREEK (2000-2009) IN AC-FT

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	%P
P	46,964	48,273	88,953	98,575	151,985	116,804	72,785	132,087	64,473	145,735	68,335	53,182	1,088,149	
BF	3,895	4,713	5,564	4,549	6,644	6,349	6,055	2,847	1,996	2,455	4,255	3,371	3,895	5
R	3,358	5,096	5,413	10,284	15,534	27,413	9,404	7,957	1,078	10,244	7,881	2,014	3,358	10
aET	39,600	38,520	78,120	83,880	129,960	83,160	57,240	121,320	61,560	133,200	56,160	47,880	39,600	86

TABLE 3 SEASONAL WATER BALANCE FOR BEAVER CREEK (2000-2009) IN AC-FT

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	%P
P	39,171	40,263	74,193	82,218	126,767	97,423	60,708	110,171	53,775	121,553	56,996	44,358	39,171	
BF	1,451	1,351	1,301	1,501	3,128	2,802	676	225	175	375	976	1,251	1,451	2
R	4,598	6,830	7,854	10,870	15,370	25,358	12,218	8,787	2,389	10,216	9,146	3,240	4,598	13
aET	33,029	32,129	65,158	69,962	108,396	69,362	47,742	101,190	51,346	111,099	46,842	39,935	776,189	86

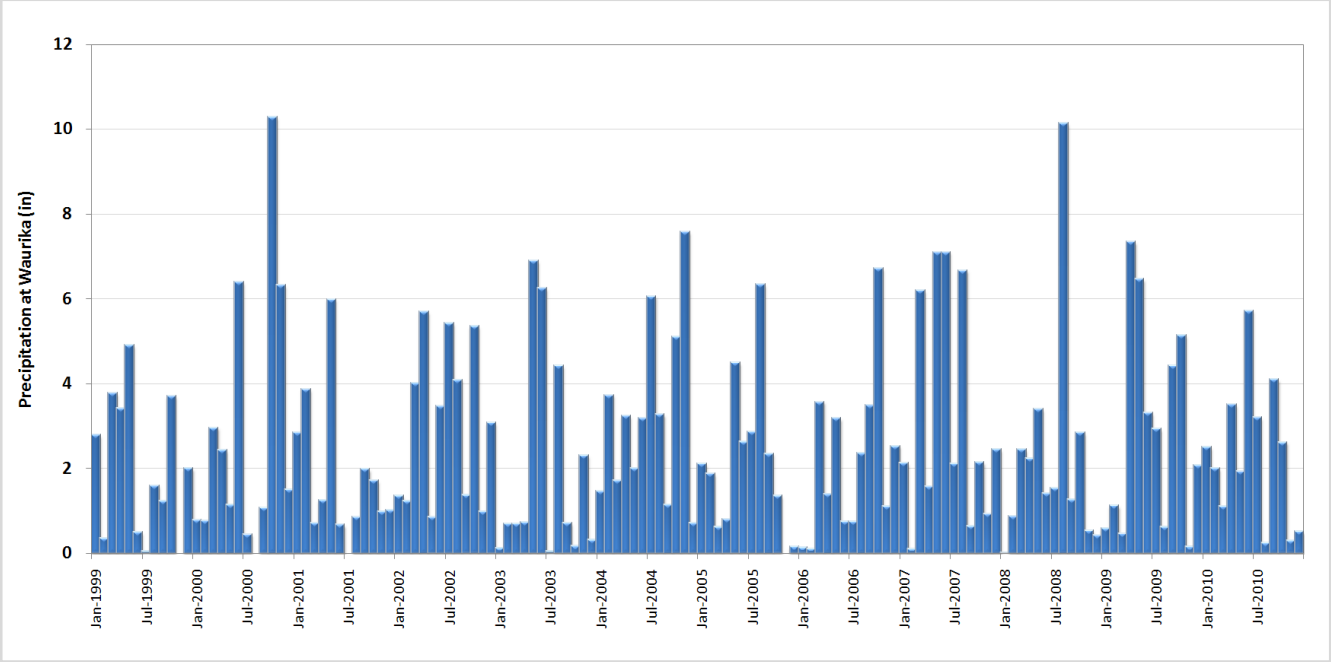

FIGURE 5 MONTHLY PRECIPITATION AT THE MESONET STATION # 101 NEAR WAURIKA, OK

Baseflow

About 30 percent of the streams in the area are perennial, while 70 percent of the streams is intermittent and carry water only during wet periods of the year when runoff is abundant and water tables rises above the base of the stream channels. The significant amount of intermittent streams indicates that baseflow is a minor component of streamflow in the area, as verified by hydrograph separation of the streamflow measured at the gauges, which shows that on a mean monthly basis a 10% of baseflow passed the gauge near Randlett (1950-2009), 34% of baseflow was estimated at gauge near Walters (1970-2009), and 26% passed the gauge near Waurika (1954-1992). The higher component of baseflow at the gauges near Walters and Waurika should be interpreted with caution, as the hydrograph separation technique used by the PART program interprets most regulated releases as baseflow.

Reservoirs and lakes

Cache Creek is composed of 64 sub-watersheds, or 12-digit hydrologic unit codes (HUCs) boundaries, while Beaver Creek has only 28 sub-watersheds. Table 4 shows the largest reservoirs in the basins, where eleven have a storage capacity greater than 800 acre-feet, and more than 35 of capacity between 100 and 800 acre-feet are registered in the OWRB Dam Safety database, as of 2011.

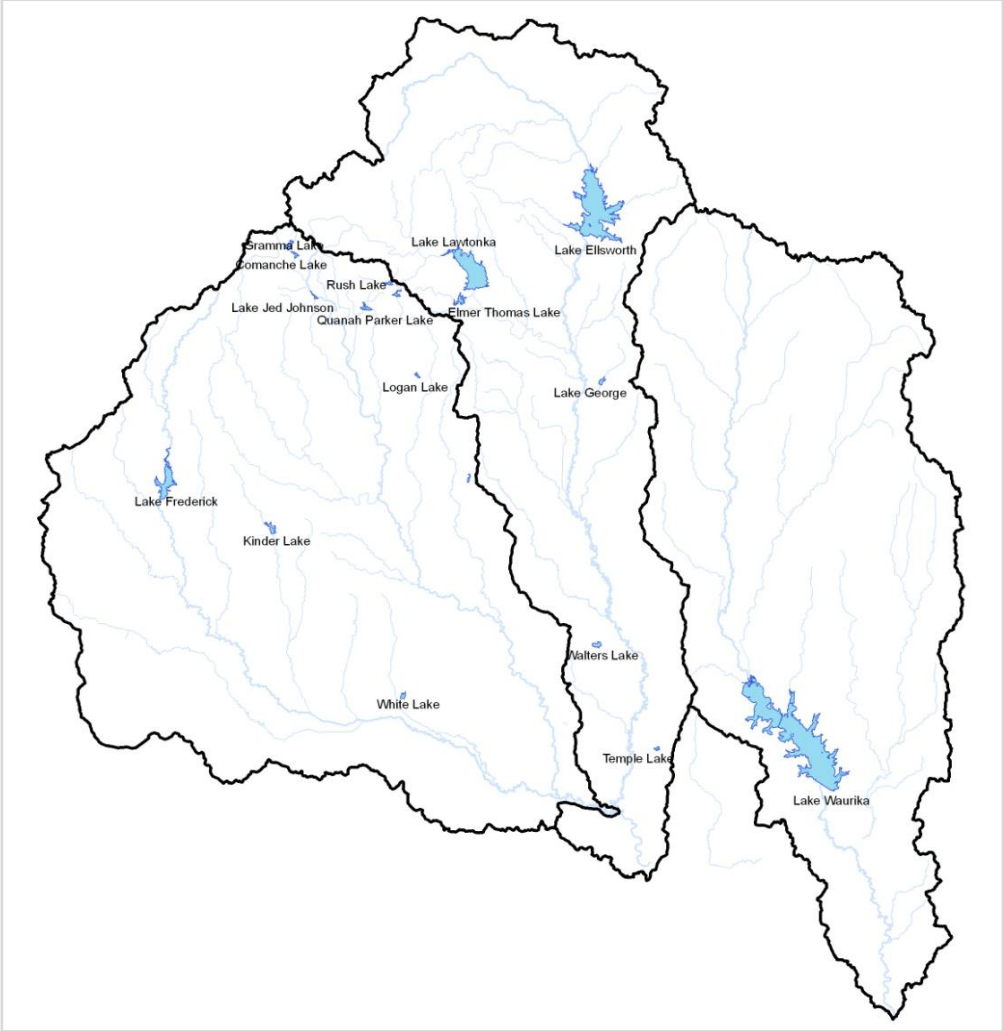

FIGURE 6 RESERVOIRS AND LAKES IN BEAVER AND CACHE CREEK, OK

TABLE 4 RESERVOIRS AND LAKE STORAGE IN THE DEEP RED, CACHE CREEK AND BEAVER CREEK BASINS

Storage	Number of Structures	Name	Storage (Ac-ft)	
			Average	Total
> 800 ac-ft	11	Waurika Lake	203,100	385,600
		Lake Ellsworth	95,200	
		Lake Lawtonka	56,574	
		Elmer Thomas	14,000	
		Lake Frederick	9,526	
		Walters City Lake	2,300	
		Jed Johnston Lake	1,100	
		Lake Rush	1,080	
		Grama Lake	960	
		Quanah Parker Lake	905	
		Boyer Lake	861	
100 - 800 ac-ft	+35	N/A		~ 13,000

Annual Flows and Peaks

The USGS gauges Deep Red near Randlett, East Cache Creek near Walters (USGS 07311000), and Beaver Creek near Waurika (USGS 073135000) are used to retrieve streamflow data as available for the period 1950-2010. The annual flows at the gauges are presented in Figure 7, where the mean annual discharge shows an upper trend.

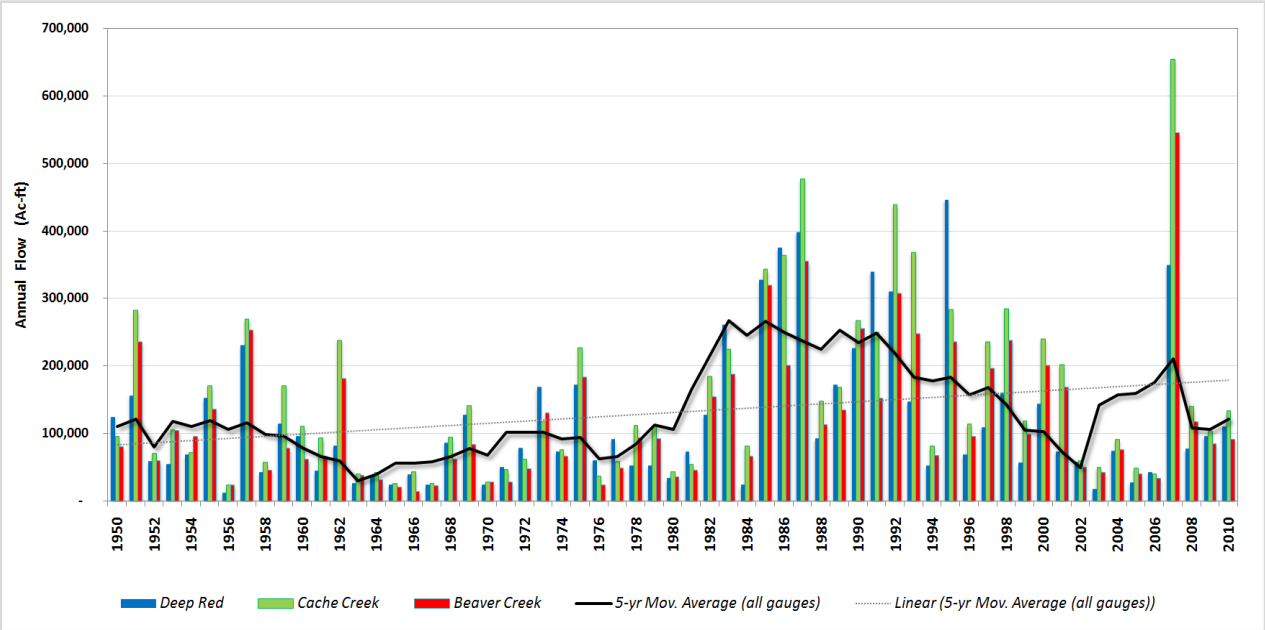

FIGURE 7 ANNUAL FLOWS IN CACHE CREEK AND BEAVER CREEK BASINS

Figure 8 shows the annual peak flows in the Cache Creek and Beaver Creek basins. The largest discharge produced by the stream is 46,300 cfs in Deep Red in 1983. From the continuous daily streamflow data recorded at the gauges, the gauge near Randlett has recorded zero flows 11% of the time, while the gauge near Waurika reports zero flows 19% of the time, and the gauge near Walters has no days of zero flows. Peak flows for the three basins show a slight trend upwards for West and East Cache Creek, while the flow measured near

Waurika shows a downward trend that evidences the impoundment of water during the time of construction of Lake Waurika in 1977, and the effect of its releases in regulating the streamflow.

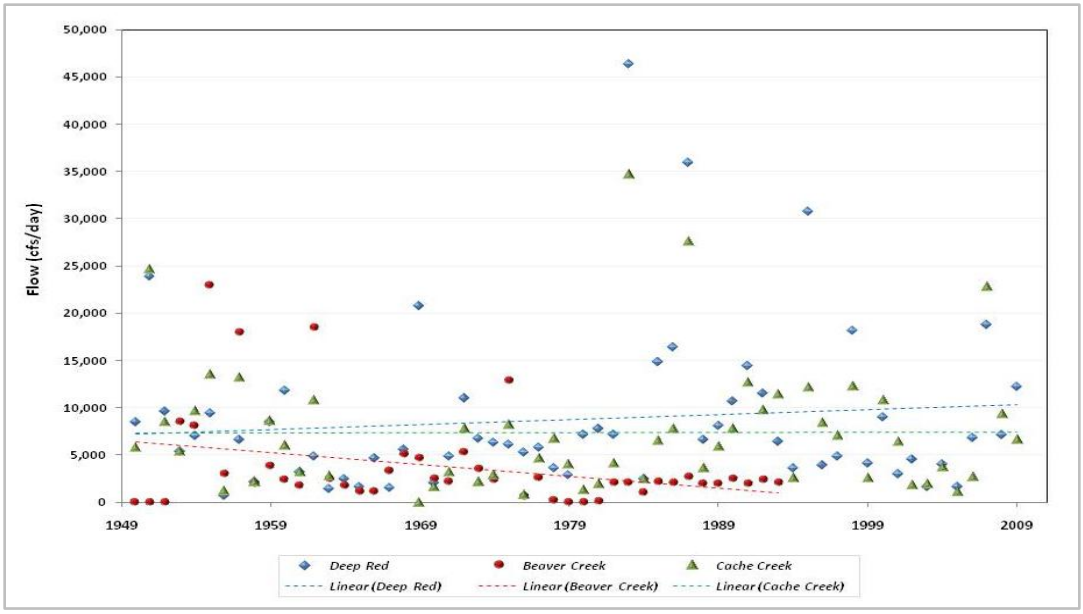

FIGURE 8 ANNUAL PEAK FLOWS IN CACHE CREEK AND BEAVER CREEK BASINS

▪ Flow Duration Curves

The Cache Creek and Beaver Creek show perennial flows more than 90% of the time, as shown in Figure 9 where the percentage of time that the measured daily flow at the gauges is likely to be equaled or exceeded. Because runoff is the primary component of streamflow, the curves show a brief period of low flows in the low flow portion of the curve. Table 5 shows the monthly flow duration curves for the gauges in the area, also depicted in Figure 10.

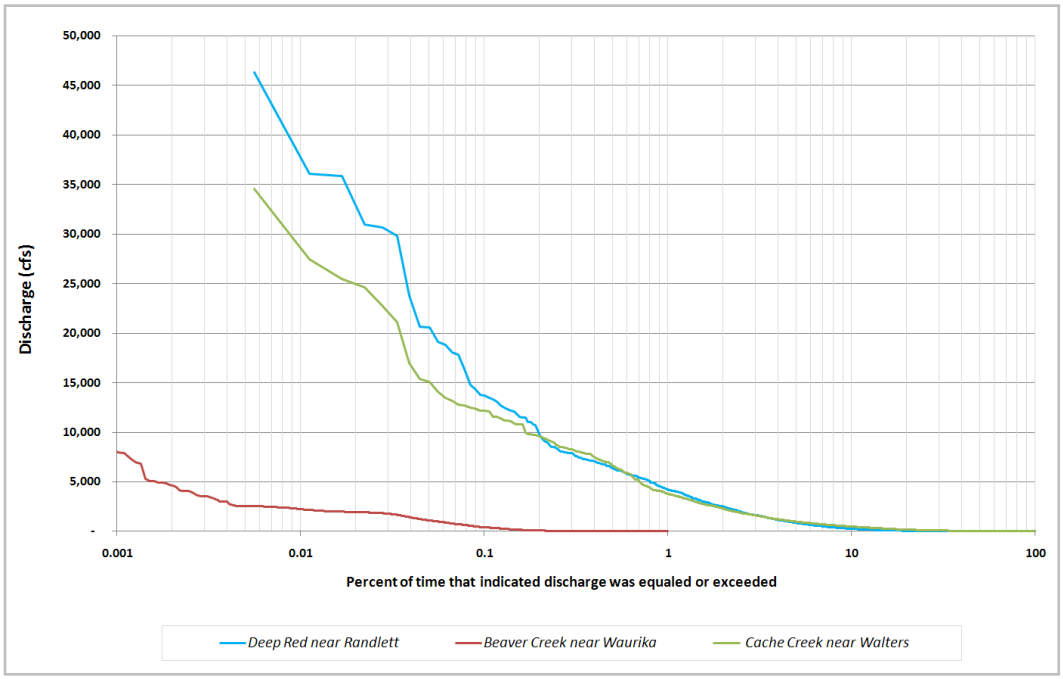

FIGURE 9 FLOW DURATION CURVES AT GAUGES IN THE DEEP RED, CACHE CREEK AND BEAVER CREEK BASINS (1950-2009)

Table 5 MONTHLY PERCENT EXCEEDANCES (AC-FT) AS MEASURED AT GAUGES IN THE AREA (1950-2009)

Flow in Ac-ft		Mean	Exceedance			
			90%	80%	50%	20%
January	Deep Red	3,829	45	75	398	4,404
	Cache Creek	894	21	33	58	1,015
	Beaver Creek	2,117	6	520	1262	2914
February	Deep Red	4,881	67	149	876	6,942
	Cache Creek	1,243	24	39	88	1,094
	Beaver Creek	2,660	306	639	1,067	2,595
March	Deep Red	7,904	68	246	1,721	10,341
	Cache Creek	1,285	28	51	270	682
	Beaver Creek	4,219	194	404	2,639	7,305
April	Deep Red	8,380	269	505	2,831	13,612
	Cache Creek	1,956	36	56	245	1,243
	Beaver Creek	6,643	281	713	3,749	8,553
May	Deep Red	25,813	730	1,482	14,829	53,657
	Cache Creek	11,238	53	79	428	6,515
	Beaver Creek	25,901	1,111	2,910	7,432	43,593
June	Deep Red	25,813	539	1,354	8,154	30,510
	Cache Creek	7,912	25	52	286	4,593
	Beaver Creek	13,607	295	761	3,132	25,373
July	Deep Red	5,028	29	127	1,054	4,202
	Cache Creek	1,866	13	28	76	2,101
	Beaver Creek	3,058	310	482	1,917	9,127
August	Deep Red	4,271	25	75	555	6,651
	Cache Creek	656	16	25	58	680
	Beaver Creek	3,058	44	286	912	6,129
September	Deep Red	9,232	4	63	2,083	16,743
	Cache Creek	1,303	18	23	94	1,004
	Beaver Creek	3,579	129	383	2,996	8,660
October	Deep Red	14,616	6	137	1,344	10,307
	Cache Creek	3,834	16	25	106	1,854
	Beaver Creek	3,256	173	466	1,706	5,915
November	Deep Red	5,957	20	116	640	3,846
	Cache Creek	1,239	16	25	106	1,854
	Beaver Creek	5,215	5	221	1,211	9,141
December	Deep Red	3,861	18	59	350	3,322
	Cache Creek	1,377	27	32	71	1,023
	Beaver Creek	2,315	8	355	1,092	4,115
YEAR	Deep Red	119,585	1,820	4,388	34,835	164,537
	Cache Creek	34,803	293	468	1,886	23,658
	Beaver Creek	75,628	2,862	8,140	29,115	133,420

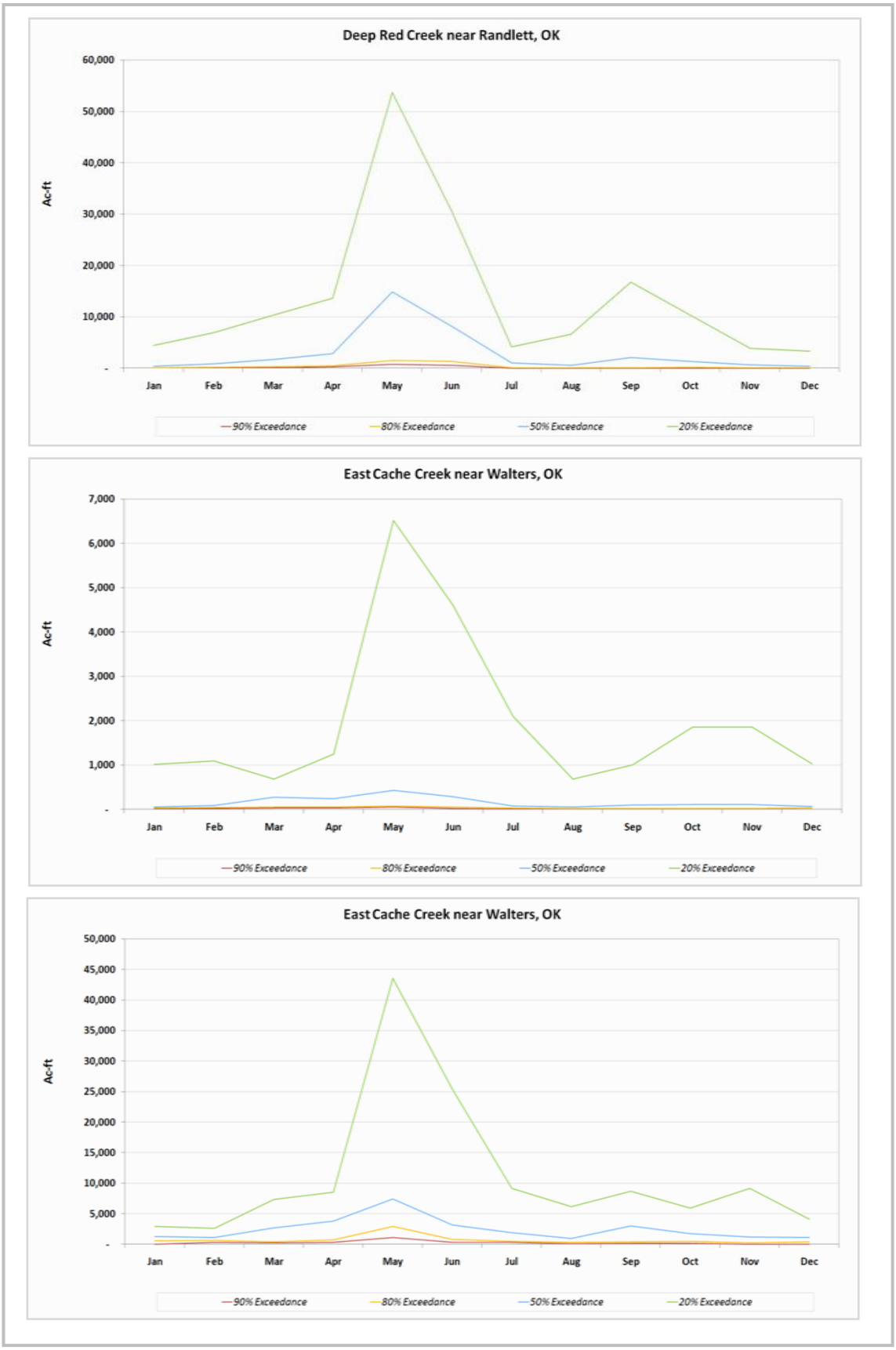

FIGURE 10 MONTHLY FLOW DURATION CURVES AS MEASURED AT THE GAUGES (1950-2009)

Water Use

As of 2009, there are 27 surface water permits in the Deep Red River basin that total 9,898 ac-ft allocated, 32 permits in the Cache Creek basin that add up to 47,926 ac-ft allocated, and 34 permits in the Beaver Creek that equal 51,278 ac-ft. Figure 11 depicts the reported use (bars) and the permitted amounts for each basin in the area.

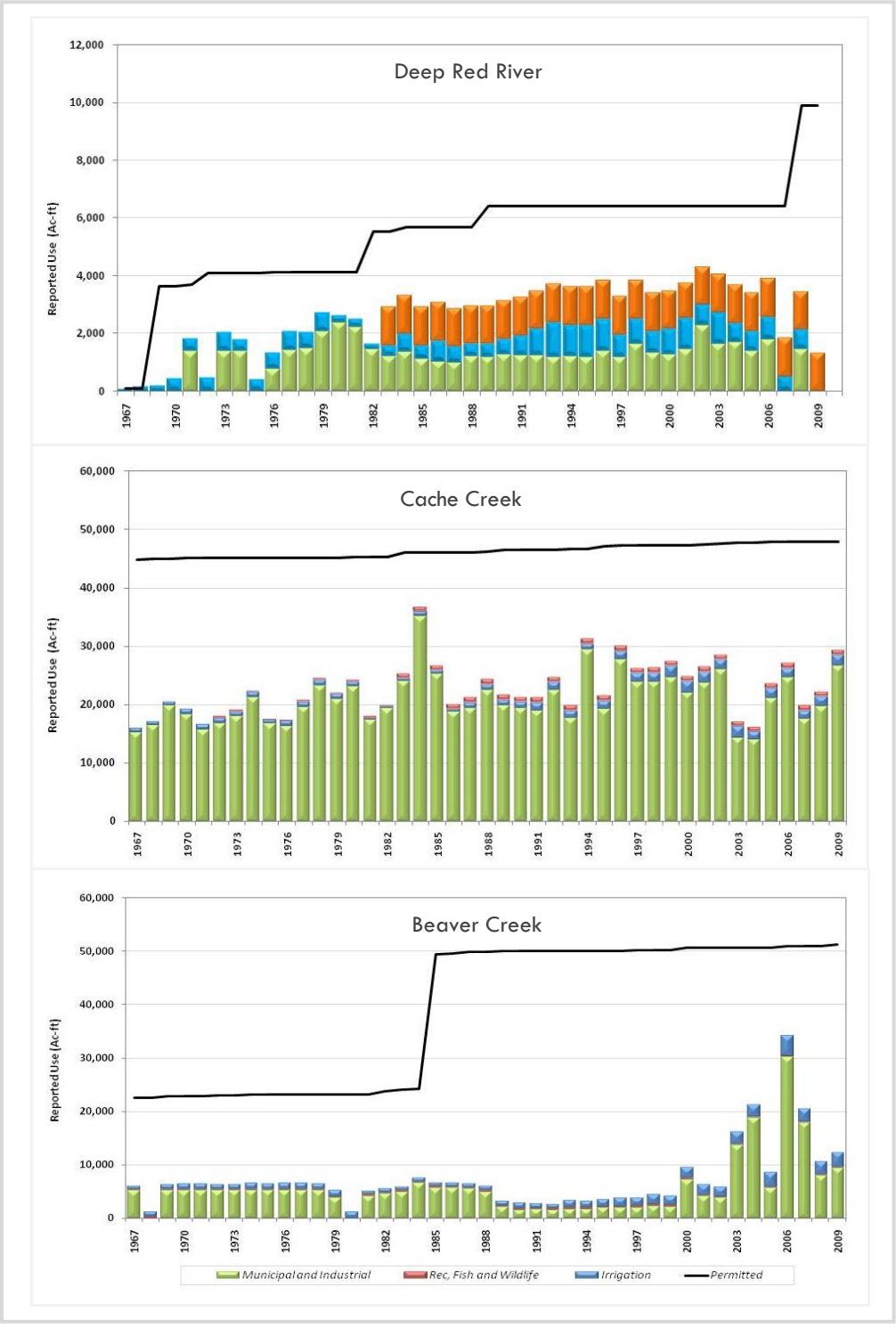

FIGURE 11 REPORTED WATER USE AND ALLOCATED WATER AT DEEP RED, CACHE CREEK AND BEAVER BASINS

1.3 Stream Water Allocation Modeling

The OWRB Stream Allocation Program is a comprehensive water administrative tool for the evaluation and effective management of stream water rights in the state. In Oklahoma, stream water is considered to be publicly owned and subject to appropriation by the OWRB. Current Oklahoma water law and OWRB regulations require that a permit application be filed prior to the diversion of water. The permit would be senior to permits issued on the stream at a later time, which is referred to as the Doctrine of Prior Appropriation (first in time, first in right) that is used by many states in the west to allocate and administer water rights.

Approval of a permit application by the Water Board must satisfy three conditions: 1) A present or future need for the water must exist and the intended use must be beneficial; 2) the applied for amount of unappropriated water must be available; 3) the use of water must not interfere with domestic or existing appropriative uses, and must not interfere with existing or proposed beneficial uses within the stream system and the needs of the area's water users if the application is for the transportation of water for use outside the area where the water originates.

This program aims to address the need for a more accurate determination of the latter three conditions mentioned above. Previous methods to assess water availability at ungauged locations were approximate, and interference of water rights was complex and difficult to estimate. The OWRB surface water allocation program uses data from 1950 to present, providing estimates of water availability after appropriation at any location of a basin, showing areas of potential interference and shortages, and taking into consideration inter-and intra-basin transfers.

The models are constructed using a network-flow algorithm in Microsoft Excel® called Central Resource Allocation Model (CRAM) that simulates management of the water resources under a priority-based water allocation system. Historic water use reports and streamflow at selected USGS gauging stations are used to assemble and calibrate the models on a monthly time-step. Simulations consist of naturalized flows that are distributed throughout the basin with water being allocated to each water right. The results include water available after appropriation at ungauged locations, flow and content at reservoirs, amount and frequency of shortages at permitted locations due to overuse by other permits or low streamflow conditions. At the present the OWRB has completed eight stream water allocation models for 12 basins in Oklahoma, and plans to continue developing models for the rest of the state.

▪ ExcelCRAM Model

The OWRB compiles data on the water use reported by water right holders on an annual basis in the Water Rights Administration database. Data on the reported usage is important to construct the water budget of a stream system and thus determine how much water is available for appropriation. A matrix of reported water use values is constructed for each year and permit in the basin. Demand patterns are applied to annual values in order to obtain monthly estimates for the basins, accounting for return flows.

Naturalization of the flows consists of removing the effects of the permitted water uses to compute the flow that would have occurred at the gage under natural conditions. For this purpose, consumptive water usage within the stream system is added back to the direct runoff data on a monthly basis and then combined with monthly time series of baseflow. Naturalization serves the OWRB to calibrate the models to the actual gauge flows, as it compensates for the impacts caused by stream water withdrawals and others caused by human activity. The resulting naturalized flows are included in the model as inflows, each one containing monthly time series of naturalized streamflow. Monthly values of naturalized streamflow are divided by the drainage area of the basin to obtain the amount of acre-feet of water per square mile available in the basin.

An Excel CRAM model is composed of two types of objects that are connected to form the network: Nodes, which are points at which water meets, and Arcs or links that carry water from one node to another. Construction of the model includes drawing objects in the model interface and linking them to data from 1950 to 2009 for the hydrologic features as well as for the water rights. Hydrologic features include monthly inflows at each sub-watershed, reservoir/lake operations, instream flows, inter/intra-basin transfers, etc, whereas data on the water rights includes the monthly consumptive use reported by the permit holders. Figure 12 shows the network built for the Cache Creek and Beaver Creek basins. The model includes 115 inflows which represent the water entering the sub-basins, 93 demands that represent the existing water rights, and 38 reservoirs or lakes

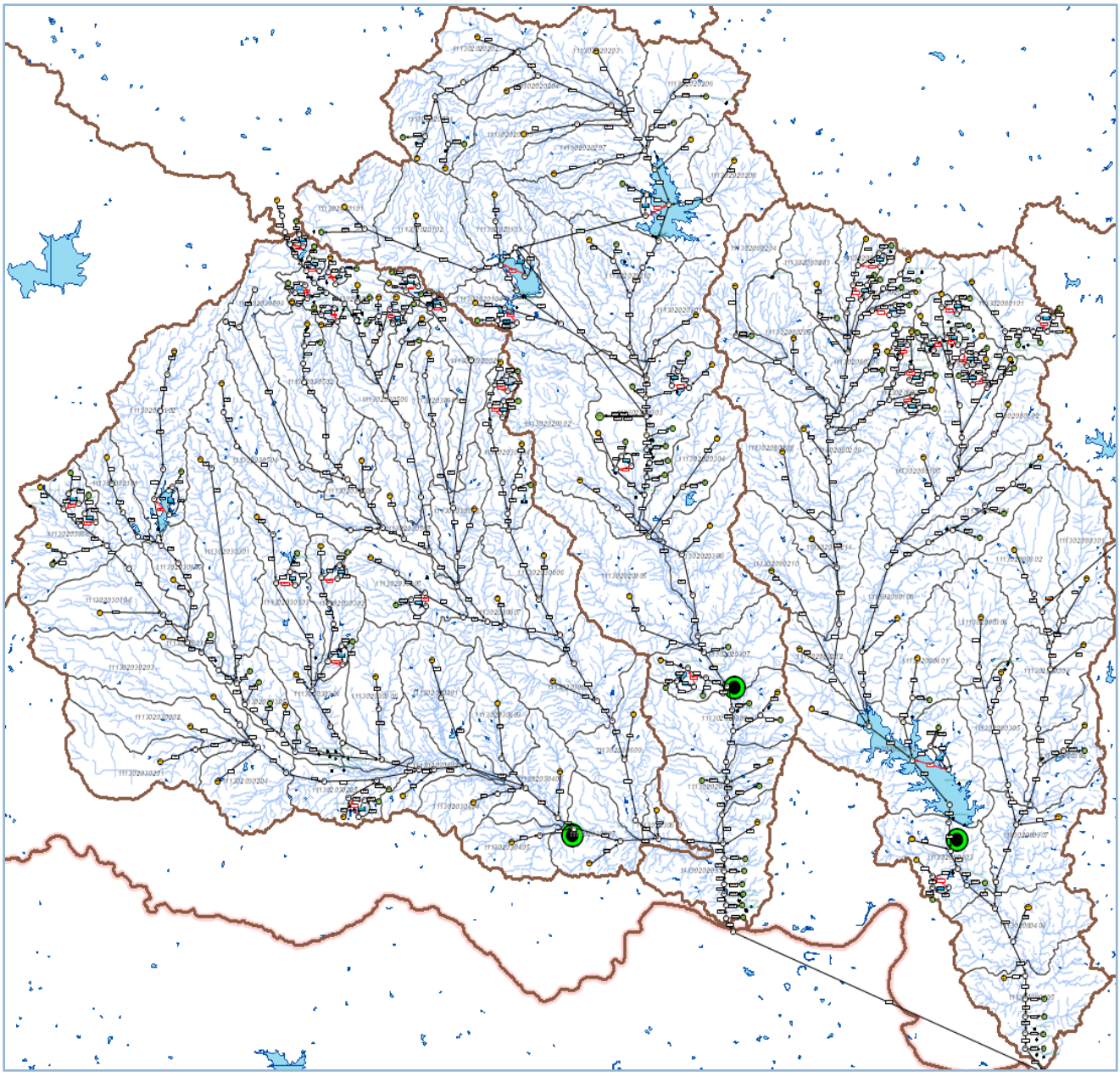

FIGURE 12 NETWORK SCHEMATIC REPRESENTING THE DEEP RED, CACHE CREEK AND BEAVER CREEK BASINS

Water is distributed in the system on a monthly basis and demands are supplied based upon the selected scenario:

- **Scenario 1: Historic Use**
  Simulation under this scenario consists on delivering water to currently active demands using the average reported values. Average water use is assigned for unreported annual values, while demands remain closed for years prior to date of permit issue. This scenario is mainly used for calibration of the model, in which the simulated monthly flows are compared to the flow recorded at USGS gauges.

- **Scenario2: Full Permit**
  Water is delivered to all currently active permits using the full permitted amounts for all years. Distribution of water to demands is based on their priority in time. This scenario is used to identify potential shortages, based on interference and priority of water rights.

- **Scenario 3: Current use**
  This scenario delivers water to currently active demands using the average of the reported use, for all years, based on their priority in time. The resulting information is useful to determine shortages and interference based on average use.

- **Scenario 4: Full permit –No priority**
  This scenario allocates water from upstream to downstream in the basin, using the permitted amounts for active demands, for all years. This scenario is used to more accurately determine potential interference and shortages that may occur in the basins.

Water Availability

The model is calibrated to match the monthly flows at the gauges using Scenario 1. Then, simulations are run to analyze various management scenarios with the aim of estimating water availability and reliability at each sub-basin after water has been appropriated, and also to anticipate potential interference between water rights. Table 6 presents the estimates water availability for each HUC-12 (see map in appendix 1) from the simulation of the calibrated model under the assumptions of scenario 1. Missing data on the annual reported uses is filled in with the averaged reported use under this particular scenario, and therefore the results on water availability might contain small errors. The spatial distribution of shortages of water in the basins under all the simulation scenarios are depicted Figures 13 through 17.

TABLE 6 ESTIMATED AVAILABLE WATER AT EACH SUB-BASIN IN THE CACHE CREEK AND BEAVER CREEK AREA (AC-FT)

HUC-12	Area (mi^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
111302020102	37.7	780	1,020	1,536	1,415	3,163	2,936	1,114	905	1,176	1,483	883	1,350
111302020103	28.6	431	576	993	813	1,479	911	193	262	140	418	297	699
111302020104	42.6	920	1,217	1,944	1,661	3,383	2,709	797	728	839	1,357	842	1,557
111302020201	24.9	302	395	594	548	1,225	1,137	431	350	455	574	342	522
111302020202	23.3	584	764	1,150	1,059	2,368	2,198	834	678	880	1,110	661	1,010
111302020203	24.1	292	382	575	530	1,184	1,099	417	339	440	555	331	505
111302020204	24.3	878	1,148	1,729	1,593	3,562	3,306	1,254	1,019	1,324	1,669	995	1,520
111302020205	20.1	243	318	480	442	988	917	348	283	367	463	276	422
111302020206	30.7	372	486	732	675	1,507	1,395	522	424	557	707	421	644
111302020207	24.6	298	390	587	541	1,210	1,123	426	346	450	567	338	516
111302020208	24.5	296	387	583	538	1,202	1,115	423	344	447	563	335	513

HUC-12	Area (mi^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
111302020209	38.5	1,602	2,466	3,665	3,288	8,799	7,558	2,277	1,181	2,231	3,584	1,616	3,220
111302020210	38.5	2,064	3,071	4,579	4,129	10,685	9,308	2,935	1,714	2,928	4,465	2,139	4,023
111302020301	18.4	222	291	437	403	901	836	317	258	335	422	252	384
111302020303	55.3	4,260	5,757	8,504	8,253	18,782	16,959	6,348	6,399	5,508	8,107	4,754	7,408
111302020304	26.0	314	411	620	571	1,276	1,173	431	350	467	598	356	544
111302020305	52.2	631	826	1,244	1,146	2,562	2,378	902	733	952	1,201	715	1,093
111302020306	39.3	5,632	7,553	11,209	10,745	24,352	22,118	8,291	7,977	7,572	10,718	6,309	9,785
111302020307	31.8	364	480	721	651	1,508	1,385	481	374	536	703	410	649
111302020308	37.3	7,078	9,449	14,062	13,361	30,251	27,566	10,296	9,590	9,732	13,480	7,946	12,307
111302020309	30.5	7,447	9,932	14,788	14,030	31,746	28,944	10,804	10,002	10,280	14,181	8,364	12,946
111302020310	38.4	14,265	18,929	29,818	29,749	79,831	75,999	19,604	18,233	27,456	41,336	19,601	20,731
111302030101	16.6	98	129	216	229	705	690	129	123	255	401	164	107
111302030103	35.9	208	277	462	490	1,519	1,474	253	239	533	862	353	230
111302030104	34.5	412	546	914	968	2,990	2,915	521	495	1,065	1,699	695	453
111302030105	14.8	439	588	1,004	1,032	3,378	3,421	583	493	1,152	1,921	758	485
111302030201	30.1	177	234	393	416	1,280	1,253	233	223	463	728	298	194
111302030202	26.6	334	442	741	784	2,415	2,365	441	421	874	1,373	562	366
111302030203	37.2	219	289	486	514	1,583	1,550	289	276	573	900	369	240
111302030204	27.6	716	946	1,588	1,681	5,174	5,067	944	902	1,872	2,942	1,205	785
111302030205	22.2	847	1,117	1,877	1,986	6,117	5,982	1,098	1,050	2,206	3,478	1,424	928
111302030301	44.8	264	349	586	620	1,909	1,869	348	333	690	1,085	444	290
111302030302	20.3	118	156	263	279	863	835	143	136	304	487	200	130
111302030303	30.2	165	217	361	388	1,245	1,212	199	184	409	703	280	186
111302030304	20.8	405	535	896	955	2,994	2,916	504	475	1,034	1,694	687	451
111302030305	18.8	1,288	1,710	2,885	3,023	9,519	9,421	1,678	1,537	3,357	5,410	2,187	1,416
111302030306	31.4	1,878	2,490	4,191	4,412	13,849	13,645	2,426	2,244	4,874	7,864	3,185	2,070
111302030401	29.8	2,996	3,964	6,669	7,033	21,921	21,542	3,880	3,635	7,787	12,453	5,064	3,295
111302030402	16.1	2,820	3,732	6,279	6,621	20,652	20,299	3,649	3,414	7,328	11,732	4,769	3,102
111302030403	21.5	127	167	281	298	916	897	167	160	331	521	213	139
111302030404	15.8	93	123	206	218	672	658	123	117	243	382	157	102
111302030405	17.0	100	132	222	235	723	708	132	126	262	411	168	110
111302030406	22.0	3,345	4,426	7,444	7,853	24,447	24,015	4,341	4,075	8,701	13,889	5,652	3,678
111302030501	36.3	193	252	430	431	1,406	1,420	234	205	481	805	322	214
111302030502	36.0	212	280	470	497	1,531	1,499	279	266	553	870	356	232
111302030503	38.9	229	303	508	538	1,656	1,622	302	289	599	941	386	251
111302030504	43.4	256	338	567	600	1,848	1,810	337	322	668	1,050	430	280
111302030505	11.8	510	674	1,132	1,198	3,688	3,611	672	642	1,334	2,096	858	559
111302030506	36.6	408	537	908	937	2,964	2,946	519	476	1,045	1,691	685	451
111302030507	18.8	1,285	1,695	2,852	2,994	9,298	9,149	1,673	1,579	3,336	5,292	2,159	1,412
111302030601	15.0	88	116	195	207	637	624	116	111	230	362	148	97
111302030602	31.3	177	226	391	406	1,278	1,271	211	201	456	743	299	196
111302030603	17.6	369	479	816	855	2,663	2,627	464	443	956	1,530	622	406
111302030604	25.8	149	199	334	351	1,095	1,053	174	166	376	614	253	165
111302030605	28.3	165	219	366	385	1,200	1,168	203	195	426	682	278	182
111302030606	32.2	2,314	3,048	5,134	5,396	16,750	16,440	2,970	2,817	5,996	9,536	3,893	2,543
111302030607	26.4	1,975	2,599	4,379	4,600	14,287	14,046	2,546	2,413	5,125	8,143	3,321	2,170
111302030608	36.5	2,530	3,333	5,611	5,901	18,305	17,963	3,253	3,088	6,558	10,420	4,255	2,779
111302030609	31.5	2,715	3,578	6,023	6,336	19,646	19,276	3,498	3,322	7,043	11,182	4,567	2,982
111302080101	35.3	419	475	772	739	1,703	1,596	497	334	373	610	460	342
111302080102	22.2	265	300	486	466	1,073	1,012	323	219	239	385	290	217
111302080103	32.4	725	834	1,363	1,327	3,189	2,991	854	593	747	1,228	834	610
111302080104	27.2	324	367	595	570	1,312	1,230	383	257	288	472	355	265
111302080105	37.4	1,434	1,639	2,667	2,577	6,066	5,704	1,721	1,181	1,389	2,261	1,613	1,191

HUC-12	Area (mi^2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
111302080106	39.2	2,225	2,536	4,120	3,969	9,272	8,720	2,675	1,825	2,100	3,413	2,481	1,839
111302080201	19.3	226	257	414	396	920	853	255	168	189	327	247	185
111302080202	14.6	172	195	318	305	703	656	200	133	151	249	189	140
111302080203	21.9	261	296	480	460	1,057	996	316	213	235	380	286	214
111302080204	28.8	342	388	629	603	1,388	1,309	419	284	310	499	376	280
111302080206	17.4	867	984	1,593	1,526	3,521	3,296	1,022	684	761	1,258	949	709
111302080208	35.8	427	484	784	751	1,729	1,630	521	353	386	621	468	349
111302080209	20.2	2,056	2,331	3,784	3,629	8,369	7,850	2,459	1,649	1,826	2,981	2,256	1,680
111302080210	30.6	365	414	670	642	1,478	1,394	446	302	330	531	400	299
111302080211	22.3	2,747	3,116	5,055	4,846	11,172	10,494	3,304	2,222	2,452	3,988	3,014	2,247
111302080212	14.6	3,286	3,727	6,045	5,795	13,356	12,553	3,962	2,668	2,940	4,772	3,605	2,688
111302080301	29.9	356	403	654	626	1,442	1,360	435	295	322	518	390	291
111302080302	30.5	482	530	804	788	1,640	1,559	675	534	516	696	526	436
111302080303	30.2	1,198	1,341	2,118	2,047	4,538	4,293	1,548	1,126	1,163	1,737	1,311	1,021
111302080304	23.8	141	185	311	329	1,012	992	185	177	366	576	236	154
111302080305	24.9	438	522	856	852	2,216	2,127	547	422	635	1,008	561	397
111302080306	23.1	1,473	1,653	2,625	2,532	5,655	5,346	1,885	1,354	1,412	2,138	1,613	1,247
111302080401	27.2	321	364	592	567	1,309	1,234	391	263	289	468	352	262
111302080402	67.3	5,860	6,787	10,850	10,160	24,505	22,345	5,982	3,387	4,554	8,755	6,245	4,691
111302080403	31.4	6,229	7,206	11,522	10,803	26,006	23,742	6,405	3,662	4,873	9,291	6,649	4,994
111302080404	37.3	8,967	10,318	16,522	15,641	37,226	34,374	9,848	6,123	7,668	13,641	9,730	7,314
111302030102	57.5	255	344	595	599	2,045	2,116	340	260	670	1,163	448	283
111302030106	10.4	913	1,215	2,054	2,144	6,811	6,769	1,184	1,065	2,377	3,871	1,557	1,005
111302030610	8.0	6,353	8,389	14,114	14,875	46,202	45,358	8,224	7,765	16,508	26,271	10,710	6,980
111302080205	27.0	664	753	1,220	1,169	2,691	2,538	811	550	601	967	728	544
111302080207	25.0	284	322	528	511	1,180	1,094	331	216	247	405	314	231
111302080307	32.1	2,293	2,608	4,182	4,055	9,418	8,932	2,899	2,093	2,393	3,702	2,593	1,956
111302080405	37.5	9,414	10,825	17,343	16,428	39,037	36,058	10,352	6,458	8,057	14,292	10,221	7,680
MEAN		**1,540**	**1,943**	**3,101**	**3,049**	**7,982**	**7,553**	**1,961**	**1,614**	**2,412**	**3,789**	**1,977**	**1,834**

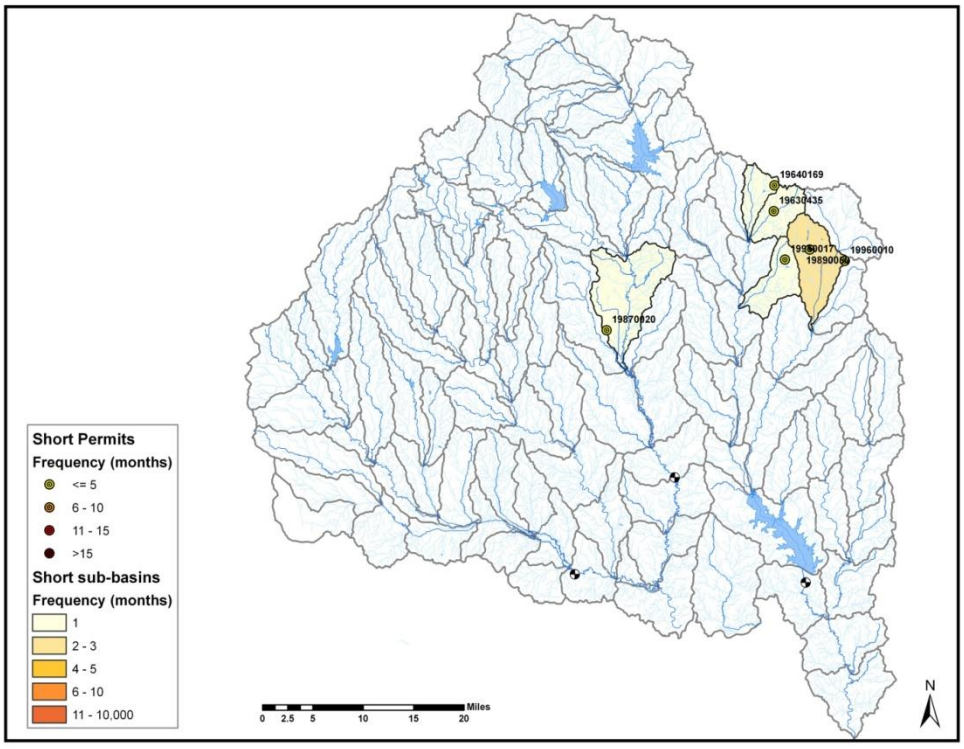

FIGURE 13 SIMULATION RESULTS FROM SCENARIO 1 (1950-2010)

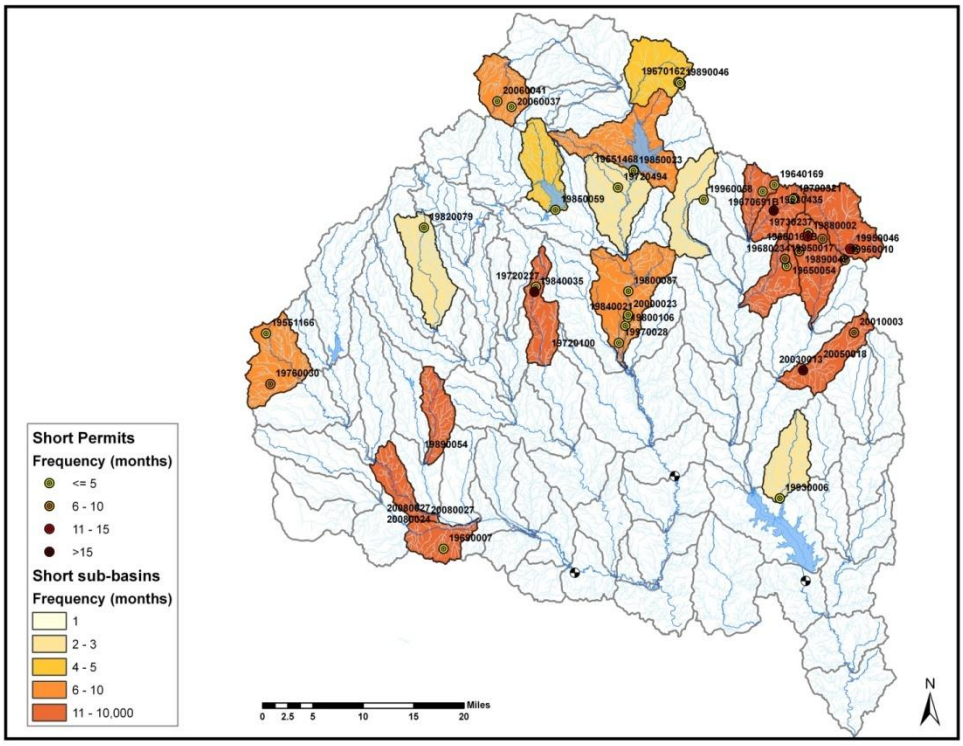

FIGURE 15 RESULTS FROM SCENARIO 3 (1950-2010)

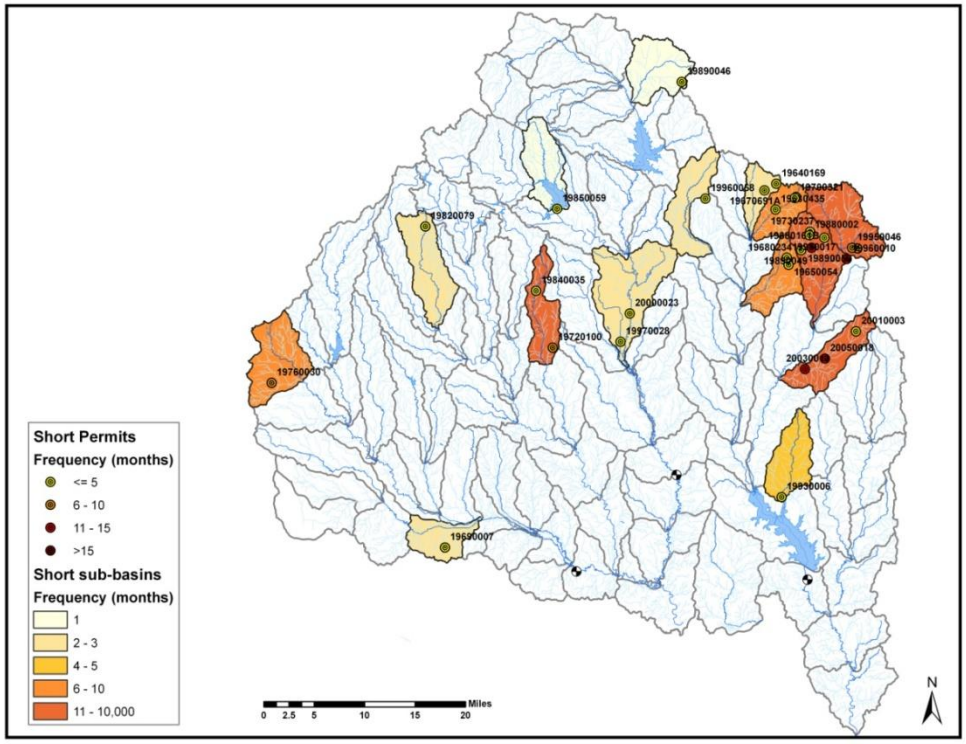

FIGURE 14 RESULTS FROM SCENARIO 2 (1950-2010)

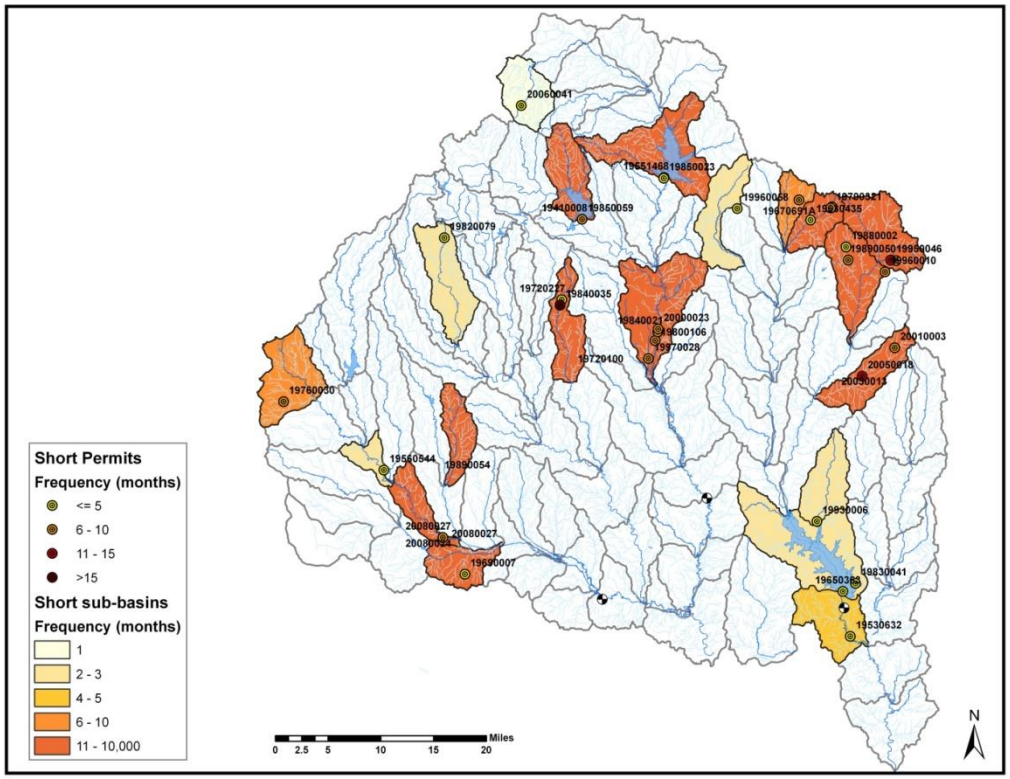

FIGURE 16 RESULTS FROM SCENARIO 4

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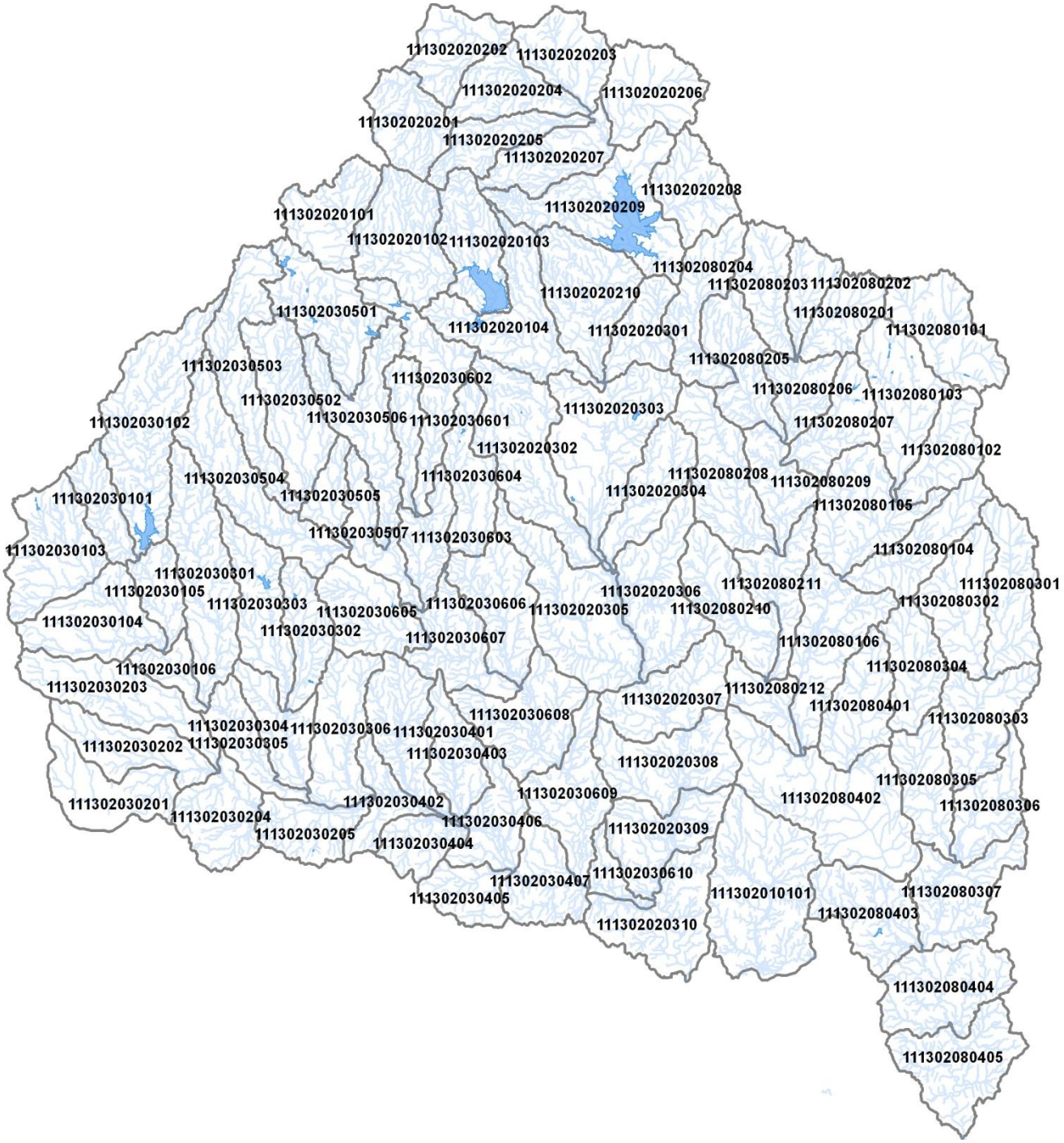
Appendix 1
Hydrologic Unit Codes (HUC) for Cache and Beaver Creek Basins



Appendix 2. Reported Surface Water Use, Deep Red Creek, OK

	19551166	19560544	19660356	19690006	19690007	19690030	19710246	19720100	19720227	19760030	19820075	19820076	19820077	19820078	19820079	19820080	19820081	19820082	19820083	19820084	19820086	19820087	19840035	19890054_1	19890054_2	19890055	20080024_1	20080024_2	20080027_1	20080027_2
1967	0	0	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1968	0	0	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	0	0	58	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1970	94	0	62	0	124	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	140	12	56	70	124	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	250	12	90	70	124	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	94	-	38	70	124	0	66	0	232	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	94	0	12	0	0	0	66	0	220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	0	3	24	-	-	0	0	0	232	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	94	3	48	-	-	782	66	0	232	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	94	3	36	60	124	1428	66	0	232	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	94	-	36	60	-	1494	66	0	220	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	94	3	36	60	124	2079	66	0	220	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	71	5	6	-	-	2381	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	79	-	-	-	-	2208	27	0	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	16	5	3	35	62	1467	27	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-
1983	49	10	5	-	-	1138	63	0	159	0	272	202	32	32	18	50	323	163	146	119	16	26	-	-	-	-	-	-	-	-
1984	54	13	4	-	-	1302	67	0	-	-	272	202	32	32	18	50	323	163	146	119	16	26	0	-	-	-	-	-	-	-
1985	62	5	125	-	-	1066	35	0	122	16	272	202	32	32	18	50	323	163	146	119	16	26	0	-	-	-	-	-	-	-
1986	40	0	125	53	0	1002	97	0	282	7	272	202	32	32	2	16	323	163	146	119	16	26	-	-	-	-	-	-	-	-
1987	40	3	79	0	0	958	97	0	210	12	272	202	32	32	2	51	323	163	146	119	16	26	84	-	-	-	-	-	-	-
1988	40	3	5	33	12	1189	97	1	132	-	272	202	32	32	2	16	323	163	146	119	16	26	88	-	-	-	-	-	-	-
1989	-	0	5	53	62	1165	-	0	52	14	272	202	32	32	2	16	323	163	146	119	16	26	108	0	0	0	-	-	-	-
1990	-	0	5	27	16	1200	-	0	70	39	272	202	32	32	18	50	323	163	146	119	16	26	108	0	0	109	-	-	-	-
1991	-	4	5	46	36	1172	-	0	52	5	272	202	32	32	18	50	323	163	146	119	16	26	108	44	26	170	-	-	-	-
1992	-	0	5	51	53	1189	-	0	31	-	272	202	32	32	18	50	323	163	146	119	16	26	108	142	85	121	-	-	-	-
1993	155	0	-	55	64	1153	-	0	30	20	272	202	32	32	18	0	323	163	146	119	16	26	132	192	115	152	-	-	-	-
1994	92	1	5	53	50	1164	0	0	35	14	-	-	-	-	18	-	-	-	-	-	-	-	138	207	124	150	-	-	-	-
1995	46	0	-	31	17	1108	23	0	-	12	272	202	32	32	18	51	323	163	146	119	16	26	123	214	129	152	-	-	-	-
1996	-	5	5	26	7	1330	200	0	34	4	272	-	32	32	18	50	323	163	146	119	16	26	126	176	106	169	-	-	-	-
1997	67	3	8	9	13	1119	27	0	34	7	272	202	32	32	16	35	323	163	146	119	16	26	126	143	86	135	-	-	-	-
1998	92	0	-	40	-	1533	92	0	30	15	272	-	32	32	-	89	323	163	146	119	16	26	108	-	-	-	-	-	-	-
1999	34	0	73	8	18	1332	20	0	30	-	-	-	-	-	-	0	-	-	-	-	-	-	108	134	80	89	-	-	-	-
2000	0	0	80	6	32	1276	0	0	44	30	272	-	32	32	0	0	323	163	146	119	16	26	108	188	113	114	-	-	-	-
2001	67	0	131	109	12	1460	67	0	-	0	272	202	32	32	0	0	323	163	146	-	16	26	108	134	80	118	-	-	-	-
2002	39	0	131	30	45	2274	55	0	-	15	-	-	-	-	0	0	-	-	-	-	-	-	108	44	26	40	-	-	-	-
2003	-	0	175	17	18	1588	-	0	-	-	272	-	32	32	-	-	323	163	146	119	16	26	108	138	83	95	-	-	-	-
2004	-	0	0	25	9	1588	-	0	-	50	272	-	32	32	16	89	323	163	146	119	16	26	108	39	24	83	-	-	-	-
2005	-	0	30	33	7	1406	-	0	-	-	272	202	32	32	0	0	323	163	146	119	16	-	123	38	23	87	-	-	-	-
2006	-	0	41	0	3	1782	-	0	234	0	-	-	-	-	0	0	-	-	-	-	-	-	117	59	35	96	-	-	-	-
2007	0	0	0	12	19	0	0	0	177	0	-	202	-	-	18	51	-	163	146	119	-	-	111	27	16	63	-	-	-	-
2008	-	0	-	22	28	-	-	0	85	0	-	-	-	-	-	-	-	-	-	-	-	-	117	43	26	108	0	0	0	0
2009	0	0	3	8	10	-	-	0	22	0	272	202	32	32	18	51	323	163	146	119	16	26	117	52	31	63	0	0	0	0

Appendix 3. Reported Surface Water Use, Cache Creek, OK

	19530089	19530632	19551418A	19630435	19640169	19640218B	19650054	19650363	19670243	19670691A	19670691B	19680161B	19680234	19690352	19700321	19720209	19730234	19730237	19800143	19830041	19880002	19890049	19890050	19930006	19950017	19950018	19950046	19960010	19960058	20010003	20020019	20030013	20040008	20050018
1967	180	92	0	0	0	0	74	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1968	180	200	162	120	0	0	120	111	0	45	0	0	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	180	148	120	120	0	0	100	0	-	45	0	74	85	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1970	180	178	120	120	0	116	72	0	40	46	0	84	85	40	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	180	178	222	120	-	116	60	-	-	46	0	40	99	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	0	174	120	-	-	34	-	30	46	0	44	85	40	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	180	200	54	120	-	0	20	0	-	46	0	0	70	0	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	180	200	244	140	-	-	60	-	38	30	0	44	85	0	-	0	23	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	180	-	0	142	60	-	66	0	38	46	0	120	-	0	-	40	80	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	180	40	0	182	-	-	90	0	-	46	0	140	85	40	100	166	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	180	0	168	222	70	8	56	0	-	45	0	140	-	20	100	80	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	180	0	-	220	70	76	56	0	-	45	0	-	-	40	98	60	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	180	0	-	240	60	80	56	3898	-	45	0	120	85	40	60	-	21	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	180	150	26	119	49	40	43	13	-	18	0	0	130	20	-	44	5	27	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	180	0	0	36	-	18	56	4210	-	9	14	-	71	1	20	-	5	13	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	180	0	-	54	-	42	43	4653	-	15	24	-	93	0	36	-	5	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	180	0	75	74	21	37	53	4464	-	15	24	20	161	5	40	-	5	20	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	180	50	-	72	10	30	67	6062	9	12	19	-	90	5	37	44	6	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	180	100	-	77	10	30	50	5188	10	12	19	13	105	6	34	-	5	40	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	180	75	-	70	22	43	32	5124	-	15	24	15	100	34	46	-	7	20	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	180	34	-	140	14	34	60	4971	-	18	28	14	152	15	53	-	17	20	0	569	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	180	13	-	117	8	34	65	4411	-	15	24	15	113	0	70	-	26	20	38	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	180	5	-	105	37	34	53	1609	-	15	24	65	98	20	47	12	9	20	38	0	84	56	123	-	-	-	-	-	-	-	-	-	-	-
1990	180	0	-	-	15	45	40	1052	-	15	24	58	110	53	49	80	14	20	38	0	108	34	175	-	-	-	-	-	-	-	-	-	-	-
1991	180	15	-	105	10	45	28	1096	-	15	24	30	50	55	40	20	14	20	38	0	95	76	167	-	-	-	-	-	-	-	-	-	-	-
1992	180	36	-	90	6	21	30	1031	-	11	18	34	40	20	25	5	6	20	38	0	95	60	110	-	-	-	-	-	-	-	-	-	-	-
1993	180	37	-	238	-	44	25	918	-	18	30	54	120	38	50	1	8	20	38	0	135	127	240	0	-	-	-	-	-	-	-	-	-	-
1994	180	66	0	195	-	40	55	1183	10	18	28	40	53	23	50	0	8	20	38	0	140	112	180	41	-	-	-	-	-	-	-	-	-	-
1995	180	38	0	125	-	25	56	1156	-	22	35	98	53	20	48	15	10	25	38	0	108	-	135	-	181	62	0	-	-	-	-	-	-	-
1996	180	0	0	140	23	26	55	1349	-	21	35	-	96	35	58	54	6	27	38	0	79	-	200	60	275	135	34	20	0	-	-	-	-	-
1997	180	37	0	99	45	21	56	1248	-	25	41	30	93	20	42	65	5	25	-	0	70	130	240	-	222	170	30	22	1	-	-	-	-	-
1998	180	50	100	120	30	7	56	1463	10	18	30	69	80	20	60	0	9	25	38	0	180	135	240	354	400	140	63	38	1	-	-	-	-	-
1999	180	34	102	90	45	7	56	1420	-	30	48	70	90	20	40	20	14	25	-	0	150	135	248	221	280	167	50	40	1	-	-	-	-	-
2000	180	38	102	50	15	14	56	6488	-	26	42	-	80	20	73	30	14	-	38	0	150	136	240	0	282	162	230	179	0	-	-	-	-	-
2001	180	88	102	75	44	0	56	3390	-	-	-	140	84	20	47	20	16	-	38	0	178	139	240	220	270	162	45	23	0	81	-	-	-	-
2002	180	59	102	75	28	21	56	2276	-	18	28	80	85	20	41	31	9	18	38	0	180	140	240	1021	283	162	18	24	1	38	20	-	-	-
2003	180	75	102	48	34	8	72	13054	4	0	0	-	90	20	38	62	9	20	38	0	185	-	300	61	270	154	9	16	0	48	45	0	-	-
2004	180	70	102	0	70	0	63	17868	-	0	0	70	90	20	5	51	9	20	38	0	185	68	240	344	272	162	9	0	1	31	30	386	50	-
2005	180	53	102	63	55	0	112	4477	-	0	0	59	82	20	0	0	4	15	38	0	183	115	240	663	282	160	18	10	0	38	48	388	-	0
2006	180	75	102	0	171	0	56	29396	0	0	-	40	85	20	0	47	6	8	38	0	180	152	240	171	287	165	5	12	0	16	54	380	1440	12
2007	180	70	102	0	28	0	56	17106	0	0	0	52	85	80	0	151	6	14	38	0	165	135	240	139	282	140	7	9	0	78	14	366	60	20
2008	180	57	102	0	-	0	56	7175	-	0	0	72	85	20	-	60	5	10	38	0	180	139	240	-	282	162	9	14	0	-	48	380	75	0
2009	180	44	102	0	-	-	56	8768	0	0	0	70	90	20	-	40	-	0	38	0	180	90	240	91	288	142	9	-	0	63	48	380	49	0

Appendix 4. Reported Surface Water Use, Beaver Creek, OK

	19360079	19410008	19490111	19540769	19540683	19540798	19551468	19670162	19680427	19690119	19690364	19710043	19720494	19740303	19800087	19800106	19820085	19820112	19830059_1	19830059_2	19840021	19850023	19850059	19860047	19870020	19870042	19890046	19970028	20000023	20030045	20060037	20060041	20090023
1967	270	4963	-	310	234	90	10098	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1968	414	9022	-	300	226	90	7100	26	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	398	2909	-	270	226	90	16571	28	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1970	398	5702	-	270	308	102	12195	44	0	102	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	300	13220	-	270	216	70	2220	48	50	78	-	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	384	8971	225	310	246	78	7464	48	50	70	86	46	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	390	10910	225	290	172	70	6482	60	-	78	80	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	0	14626	225	290	172	102	6464	60	50	78	80	40	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	243	14289	225	30	0	0	2047	-	50	0	80	40	215	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	245	5948	225	270	172	68	9866	80	44	78	80	40	221	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	265	9943	225	270	172	68	9117	100	44	78	80	40	221	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	265	15455	225	270	172	72	7347	44	-	78	80	40	221	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	268	12716	225	270	172	72	7743	44	50	80	40	40	215	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	268	8691	225	-	319	60	13958	17	-	20	40	20	218	94	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	232	16629	225	0	93	12	10434	10	-	13	86	40	62	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	234	19115	225	27	54	24	1857	-	0	13	0	0	62	-	9	8	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	302	23702	225	10	78	-	6687	5	0	24	86	34	62	40	13	14	14	594	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	341	25452	225	-	144	13	9091	-	-	24	79	40	154	62	11	25	14	594	36	6	125	-	-	-	-	-	-	-	-	-	-	-	-
1985	396	23271	-	25	96	14	1502	-	10	51	86	40	154	60	14	7	14	594	0	0	75	0	0	-	-	-	-	-	-	-	-	-	-
1986	332	12000	225	35	78	14	2223	-	0	14	40	20	221	45	18	36	14	594	-	-	75	0	3952	0	-	-	-	-	-	-	-	-	-
1987	349	12000	225	57	-	27	116	-	99	32	86	40	220	123	-	19	14	594	-	-	120	0	6531	250	0	0	-	-	-	-	-	-	-
1988	376	12000	225	135	-	34	5630	-	0	0	86	40	220	145	-	15	14	594	-	-	124	0	3975	250	3	142	-	-	-	-	-	-	-
1989	1	12000	225	72	-	40	161	-	0	27	86	40	-	83	22	-	14	594	-	-	0	0	7357	-	39	165	14	-	-	-	-	-	-
1990	371	12000	225	105	-	40	301	-	0	27	79	40	-	160	22	14	14	594	-	-	45	0	6286	250	39	159	15	-	-	-	-	-	-
1991	-	12000	225	-	-	37	290	-	0	-	0	0	218	138	22	-	14	594	-	-	300	0	5898	250	-	159	17	-	-	-	-	-	-
1992	-	12000	225	-	-	40	4272	-	0	-	79	40	219	153	-	-	14	594	47	7	85	0	0	250	-	-	6	-	-	-	-	-	-
1993	0	12000	225	-	-	37	327	-	0	-	95	40	218	115	-	10	14	594	-	-	75	0	4893	250	-	163	12	-	-	-	-	-	-
1994	-	10268	225	36	-	40	8384	5	0	-	0	0	218	139	43	14	-	-	-	-	118	0	0	177	39	165	5	-	-	-	-	-	-
1995	329	12000	-	10	169	58	684	0	0	-	0	0	218	120	43	10	14	594	-	-	600	0	5836	221	39	165	5	-	-	-	-	-	-
1996	342	11417	-	40	169	56	9866	-	0	-	86	40	218	101	43	12	14	594	28	5	298	260	0	221	-	175	15	-	-	-	-	-	-
1997	411	12000	-	27	150	61	1843	-	0	80	53	17	218	104	-	9	14	594	-	-	263	0	4607	213	-	230	14	0	-	-	-	-	-
1998	487	12000	-	0	208	58	7140	-	0	80	-	-	218	105	-	16	14	594	26	4	300	0	3881	177	39	276	20	240	-	-	-	-	-
1999	350	12000	225	17	228	57	5733	-	0	90	86	40	218	100	37	0	-	-	136	21	-	0	6099	177	385	276	8	335	-	-	-	-	-
2000	354	12000	-	42	169	60	4063	-	0	60	86	40	218	127	43	42	14	594	102	16	300	0	0	0	385	-	15	117	0	-	-	-	-
2001	433	9452	-	42	210	56	8035	-	0	-	43	30	218	100	43	-	14	594	-	-	300	0	5572	60	385	276	9	94	0	-	-	-	-
2002	433	9355	-	0	162	60	-	-	0	80	-	-	10	139	43	24	14	-	47	7	-	-	-	330	-	276	15	108	0	-	-	-	-
2003	384	6276	-	-	210	61	7710	-	0	20	-	-	7	139	130	11	14	594	15	2	-	0	0	0	385	276	14	90	55	0	-	-	-
2004	374	7099	-	20	90	61	1404	8	0	7	-	-	189	139	79	16	14	594	-	-	-	0	0	262	22	276	9	140	-	5	-	-	-
2005	372	9355	225	39	119	61	8749	8	0	-	-	-	227	139	116	25	14	594	-	-	-	2253	0	212	385	0	0	214	45	5	-	-	-
2006	402	9639	-	58	104	62	1659	-	0	-	-	-	209	139	45	33	-	-	-	-	-	0	7800	-	385	0	12	234	-	5	0	0	-
2007	33	9664	-	0	64	60	4306	-	0	-	-	-	199	139	0	-	-	-	-	-	-	0	3139	-	385	0	0	47	-	16	0	0	-
2008	343	4814	-	0	68	61	0	-	0	40	-	-	200	139	-	0	-	594	51	8	-	1419	0	-	385	-	0	122	100	16	0	0	-
2009	342	8649	-	0	77	-	-	3	0	-	65	25	201	139	-	14	14	594	-	-	122	1910	-	-	385	-	3	175	320	38	0	0	0

Appendix 5. Active Surface Water Permits in the Deep Red, Cache Creek and Beaver Creek basins

DEEP RED				
Demand #	**Permit Number**	**Allocated**	**Purpose**	**Permit Holder**
1	19820081	323	Recreation, F & Wildlife	U S Fish & Wildlife Service
2	19820084	119	Recreation, F & Wildlife	U S Fish & Wildlife Service
3	19820080	51	Industrial	U S Fish & Wildlife Service
4	19820076	202	Recreation, F & Wildlife	U S Fish & Wildlife Service
5	19820077	32	Recreation, F & Wildlife	U S Fish & Wildlife Service
6	19820078	32	Recreation, F & Wildlife	U S Fish & Wildlife Service
7	19820086	16	Recreation, F & Wildlife	U S Fish & Wildlife Service
8	19820083	146	Recreation, F & Wildlife	U S Fish & Wildlife Service
9	19820082	163	Recreation, F & Wildlife	U S Fish & Wildlife Service
10	19690030	3400	Municipal	Frederick, City of
11	19710246	66	Irrigation	Horton, Jow C
12	19551166	94	Irrigation	Horton, Joe C
13	19760030	16	Irrigation	McCord, Robert & Ramona
14	19560544	3	Irrigation	Treadwell, J W
99	19890054_1	178	Irrigation	Holloway, Kenneth
15	19890054_2	370	Irrigation	Holloway, Kenneth
16	19890055	170	Irrigation	Holloway, Kenneth
17	20080027_2	420	Irrigation	Hunt Farms L L C
18	19690006	53	Irrigation	Hunt, Kenneth C
19	19690007	62	Irrigation	Hunt, Kenneth C
20	19660356	5	Irrigation	Cash, Grover L and Bernardita
21	19720100	189	Municipal	Carr, Margaret
22	19720227	232	Irrigation	Wilson, Harold W
23	19840035	160	Irrigation	Pipes, John H
24	19820087	26	Recreation, F & Wildlife	U S Fish & Wildlife Service
25	19820075	272	Recreation, F & Wildlife	U S Fish & Wildlife Service
26	19820079	18	Industrial	U S Fish & Wildlife Service
27	20080024_1	840	Irrigation	Hunt Land & Cattle Co
97	20080027_1	280	Irrigation	Hunt Farms L L C
98	20080024_2	1960	Irrigation	Hunt Land & Cattle Co
CACHE CREEK				
Demand #	**Permit Number**	**Allocated**	**Purpose**	**Permit Holder**
28	20060041	210	Irrigation	Burk Royalty Co
29	20060037	68	Irrigation	Kimbell, David A
30	19670162	7.5	Irrigation	Patterson, James M
31	19890046	70	Irrigation	Patterson, James M
32	19850023	13634	Municipal	Lawton, City of
33	19551468	9866	Municipal	Lawton, City of
34	19720494	218	Industrial	Dolese Bros Co
35	19860047	250	Industrial	Wildlife Conservation, Dep of
36	19490111	225	Recreation, F & Wildlife	HQ WSAFACFS, ATZR-B (B2930)
37	20000023	450	Irrigation	Sullivan, Joe N and Sharon K
38	19840021	125	Irrigation	Sullivan, Joe N and Sharon K
39	19800106	14	Irrigation	John, Ramon L and G Russell
40	19970028	158	Irrigation	Goodin, Virgil Lee & Esther Jean
41	19870042	175	Irrigation	Bott, Clarence C
42	19360079	268	Municipal	Walters, City of
43	19870020	150	Irrigation	Lawton Metropolitan Airprt Auth
44	19680427	10	Irrigation	Moore, Marvin M
45	19740303	94	Irrigation	Jones, Kenneth L
46	19690119	104	Irrigation	Parkey, Gordon F
47	19540798	36	Irrigation	Parkley Land Trust
48	19830059_1	180	Irrigation	Parkey, Richard A
49	19540683	172	Irrigation	Parkey, David

50	19830059_2	180	Irrigation	Parkey, Richard A
51	19540769	35	Irrigation	Dupler, Lester R
52	19410008	12000	Municipal	Lawton, City of
53	19850059	11500	Municipal	Lawton, City of
54	19820112	594	Recreation, F & Wildlife	U S Fish & Wildlife Service
55	19690364	86	Irrigation	Graham, Billy R
56	19710043	40	Irrigation	Graham, Billy R
57	19800087	130	Irrigation	Pittman, George Tuck
58	19820085	14	Recreation, F & Wildlife	U S Fish & Wildlife Service
59	20030045	38	Municipal	Walters, City of
94	20090023	306	Municipal	Walters, City of
BEAVER CREEK				
Demand #	**Permit Number**	**Allocated**	**Purpose**	**Permit Holder**
60	19960058	0.5	Industrial	Ouachita Exploration Inc
61	19670243	9	Irrigation	Curry, Ronnie
62	19640169	22	Irrigation	Nunley, Jackie
63	19670691A	16.9	Irrigation	Leslie, Charlie E
64	19670691B	28.1	Irrigation	Leslie, James W & Charles W
65	19640218B	43	Irrigation	Coleman, Joe
66	19700321	102	Irrigation	Coleman, Larry
67	19630435	234	Irrigation	Brantley, Leva Joy
68	19730234	7	Irrigation	Pinchback, Linda J
69	19950017	282	Irrigation	Nunley, William E & Shirley J
70	19680234	85	Irrigation	Nunley, William E & Shirley J
71	19650054	56	Irrigation	Nunley, William E & Shirley J
72	19730237	20	Irrigation	Alexander, Kenneth and/or Betty
73	19880002	180	Irrigation	Nunley, William E & Shirley J
74	19890049	135	Irrigation	Nunley, Steven E
75	19890050	240	Irrigation	Nunley, William E & Shirley J
76	19680161B	70	Irrigation	Nunley, Steven E
77	19960010	28	Irrigation	Young, Fred D & Norma F
78	19950018	162	Irrigation	Nunley, William E & Shirley J
79	19690352	20	Irrigation	Nunley, William E & Shirley J
80	19950046	111	Irrigation	Young, Fred D & Norma F
81	20010003	262	Irrigation	Wllsworth, Donald L &/or Melodee A
82	20050018	109	Irrigation	Edwards Trust dba Stagestand Ranch
83	20030013	200	Irrigation	Oil City Associates L L C
84	19930006	60	Industrial	Wildlife Conservation, Dep of
85	19650363	44022	Municipal	Waurika Project Master Conservancy Dst
86	19830041	784	Municipal	Waurika Project Master Conservancy Dst
87	19530089	180	Recreation, F & Wildlife	Wildlife Conservation, Dep of
88	19530632	150	Irrigation	Bartling, Roy
89	19800143	38	Recreation, F & Wildlife	Brown, Bud
90	19720209	44	Irrigation	Hall, Gerald
91	20020019	48	Irrigation	Morrison, Larry & Tina
92	19551418A	101.6	Irrigation	Crawford, Timothy Jay & Birdena Mae
93	20040008	75	Irrigation	Hall, Keith