TENKILLER WHOLESALE WATER TREATMENT AND CONVEYANCE SYSTEM STUDY PHASE III – ADDITIONAL PRELIMINARY DESIGNS AND COST ESTIMATES

PLANNING ASSISTANCE TO STATES PROGRAM

Prepared For
Tenkiller Utilities Authority
Tahlequah, Oklahoma

Through
The Oklahoma Water Resources Board

By

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES

LIST OF FIGURES

APPENDIX

TENKILLER WHOLESALE WATER TREATMENT AND CONVEYANCE SYSTEM STUDY PHASE III – ADDITIONAL PRELIMINARY DESIGNS AND COST ESTIMATES

INTRODUCTION

This Phase III report presents conceptual designs and cost estimates for a regional wholesale water treatment and conveyance system serving Lake Tenkiller area. Phase III extends the system designed in Phase II to the eastern reaches of Sequoyah County. Three alternatives were developed in sufficient detail to arrive at a wholesale treated water cost per thousand gallons. Treatment plant capacities, conveyance line sizes, pumping station capacities, water tower sizes, and estimated construction costs were developed for each alternative. Gross appraisals of necessary real estate to be obtained were also determined for each alternative. In addition, possible environmental concerns that could impact construction of the alternatives were addressed.

STUDY AUTHORITY

The U.S. Army Corps of Engineers (COE), Tulsa District conducted the study for the Cherokee Hills Resource Conservation and Development (RC&D) Project, Incorporated, acting through the Oklahoma Water Resources Board (OWRB) under authority of Section 22 of the Water Resources Development Act of 1974 (Public Law 93-251), also known as the Planning Assistance to States Program. This authority establishes cooperative assistance to states for preparation of comprehensive water plans.

Section 319 of the Water Resource Development Act of 1990 (Public Law 101-640) provides authority for cost sharing of the Planning Assistance to States Program. The cost-sharing ratio for this study is 50% Federal and 50% non-Federal. A Letter Agreement between the COE, Tulsa District and the OWRB for this study was signed on April 20, 1999. The Letter Agreement is shown in Appendix 1.

PURPOSE

The purpose of this study was to develop, through a conceptual-level design, at least three alternative plans providing a regional wholesale water treatment and conveyance system serving the Lake Tenkiller area and to ultimately present a wholesale cost of treated water per thousand gallons. Representatives of the 27 water systems participating in the study will use this information to decide the feasibility of a wholesale water treatment and conveyance system serving the Lake Tenkiller area.

PROJECT LOCATION AND DESCRIPTION

Figure 1 shows the geographic limits of the study area, which spans Cherokee, Muskogee, and Sequoyah counties in northeast Oklahoma. The boundaries of the 27 participating water districts (listed in Table 1) run from north of Tahlequah to Gore and Vian in the south and extend from the eastern edge of Sequoyah County to Fort Gibson Lake in the west.

Table 1. Water Systems/Districts Within Study Area

Burnt Cabin	Muskogee County RWD #7
Cherokee County Rural Water District (RWD) #1	Paradise Hills, Inc.
Cherokee County RWD #2 (Keys)	Sequoyah County Water Association
Cherokee County RWD #3	Sequoyah County RWSG & SWMD #7
Cherokee County RWD #7	Stick Ross Mountain Water Company
Cherokee County RWD #8	Summit Water
Cherokee County RWD #13 (Cookson)	Tahlequah Public Works
City of Sallisaw	Lake Region Electric Development
East Central Oklahoma Water Authority	Tenkiller Aqua Park
Fin and Feather Water Association	Tenkiller State Park
Lake Tenkiller Harbor	Town of Gore
Lost City RWD	Town of Muldrow
Muskogee County RWD #4	Town of Roland
	Town of Vian

Note: Tenkiller Water Company was purchased by Lake Region Electric Coop and is now known as Lake Region Electric Development (LRED).

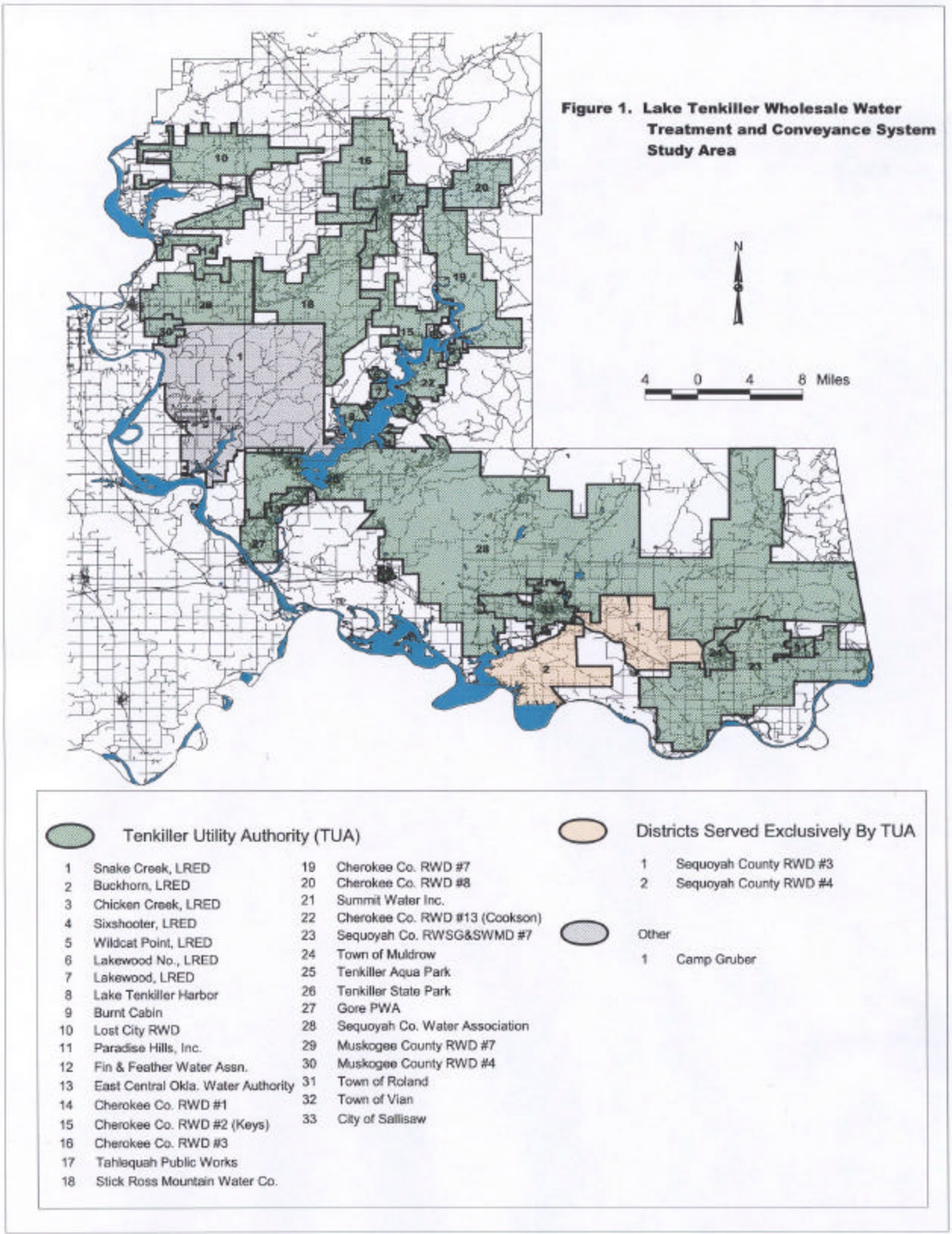


Figure 1. Lake Tenkiller Wholesale Water Treatment and Conveyance System Study Area
N
4 0 4 8 Miles
Tenkiller Utility Authority (TUA)
1 Snake Creek, LRED
2 Buckhorn, LRED
3 Chicken Creek, LRED
4 Sixshooter, LRED
5 Wildcat Point, LRED
6 Lakewood No., LRED
7 Lakewood, LRED
8 Lake Tenkiller Harbor
9 Burnt Cabin
10 Lost City RWD
11 Paradise Hills, Inc.
12 Fin & Feather Water Assn.
13 East Central Okla. Water Authority
14 Cherokee Co. RWD #1
15 Cherokee Co. RWD #2 (Keys)
16 Cherokee Co. RWD #3
17 Tahlequah Public Works
18 Stick Ross Mountain Water Co.
19 Cherokee Co. RWD #7
20 Cherokee Co. RWD #8
21 Summit Water Inc.
22 Cherokee Co. RWD #13 (Cookson)
23 Sequoyah Co. RWSG&SWMD #7
24 Town of Muldrow
25 Tenkiller Aqua Park
26 Tenkiller State Park
27 Gore PWA
28 Sequoyah Co. Water Association
29 Muskogee County RWD #7
30 Muskogee County RWD #4
31 Town of Roland
32 Town of Vian
33 City of Sallisaw
Districts Served Exclusively By TUA
1 Sequoyah County RWD #3
2 Sequoyah County RWD #4
Other
1 Camp Gruber

PROJECT HISTORY

Phase I studies were completed in October 1997. The first phase assessed the need for the 22 participating water systems to join a regional wholesale water treatment and conveyance system. A water industry profile was established that included information on each of the participating water districts, such as present and future water supply demands, water treatment facilities, water supply distribution systems, storage capacity, and cost of water to consumers. The water industry profile was then analyzed with respect to demand, treatment facilities, storage capacity, and cost. The relative need of each water system was assessed based on these criteria. Alternative solutions were developed, and institutional considerations were discussed. Three institutional arrangements were covered: trusts, master conservancy districts, and private entities.

Phase II studies were completed in August 1998. The second phase of study added Tahlequah Public Works as a participant and presented four alternatives, through a conceptual design level, for a regional wholesale water treatment and conveyance system serving the Lake Tenkiller area.

Prior to completion of the final report for the second phase of study, additional water districts showed an interest in participating in the study. A third phase of the study was proposed that would include Sallisaw, Sequoyah County RWSG & SWMD #7, Muldrow, and Roland. This Phase III study would provide conceptual level designs and cost estimates for the newly expanded wholesale water treatment and conveyance system.

EXISTING CONDITIONS AND WATER USE PROJECTIONS

Water district information, including water use projections and needs assessment, was updated to include Sallisaw, Sequoyah County RWSG & SWMD #7, Muldrow, and Roland. The complete needs assessment is included in Appendix 2. Tables 2 and 3 summarize current usage and water use projections, respectively, for the 27 participating water districts. Total average daily use varies from 5.962 million gallons per day (mgd) in 1995 to 8.397 mgd in 2050. Both the City of Tahlequah and the City of Sallisaw indicated that they would only need to meet 25% of their demand from the regional system.

Table 2. Present Demand

Name of District/Water System	Average Daily Usage (1,000 gallons/day)	Peak Daily Usage (1,000 gallons/day)
Burnt Cabin	30	50
Cherokee County RWD #1	70	85
Cherokee County RWD #2	80	140
Cherokee County RWD #3	175	250
Cherokee County RWD #7	100	150
Cherokee County RWD #8	100	NA
Cherokee County RWD #13	70	40
City of Sallisaw	575	1,075
East Central Oklahoma Water Authority	190	250
Fin and Feather Water Association	35	45
Lake Tenkiller Harbor	30	100
Lost City RWD	200	350
Muskogee County RWD #4	69	69
Muskogee County RWD #7	134	200
Paradise Hills, Inc.	22	105
Sequoyah County Water Association	1,385	1,600
Sequoyah County RWSG & SWMD #7	480	725
Stick Ross Mountain Water Company	200	275
Summit Water	67	NA
Tahlequah Public Works	641	1,115
LRED (total)	55*	250*
Tenkiller Aqua Park	10	37
Tenkiller State Park	18*	120
Town of Gore	271	332
Town of Muldrow	500	640
Town of Roland	275	300
Town of Vian	180	180
TOTAL	**5,962**	**8,483**

* Figures are from the Lake Tenkiller Development Coalition's 1995 report, entitled "Analysis of Water Systems Surrounding Lake Tenkiller."

Table 3. Actual and Projected Water Demand By Water System/District (1,000 gallons/day)

Water System/District	Year						
	1995	2000	2010	2020	2030	2040	2050
Burnt Cabin	30	32	36	37	38	40	42
Cherokee County RWD #1	70	75	84	87	89	94	99
Cherokee County RWD #2	80	86	95	99	102	107	113
Cherokee County RWD #3	175	189	209	217	223	235	247
Cherokee County RWD #7	100	108	119	124	128	134	141
Cherokee County RWD #8	100	108	119	124	128	134	141
Cherokee County RWD #13	70	75	84	87	89	94	99
City of Sallisaw	575	619	686	712	735	772	810
East Central Oklahoma Water	190	205	227	235	242	255	268
Fin and Feather Water Association	35	38	42	43	45	47	49
Lake Tenkiller Harbor	30	32	36	37	38	40	42
Lost City RWD	200	215	239	248	255	269	282
Muskogee County RWD #4	69	74	82	85	88	93	97
Muskogee County RWD #7	134	144	160	166	171	180	189
Paradise Hills, Inc.	22	24	26	27	28	30	31
Sequoyah County Water Assoc.	1,385	1,492	1,653	1,714	1,768	1,859	1,951
Sequoyah County #7	480	517	573	594	613	644	676
Stick Ross Mountain Water Co.	200	215	239	248	255	269	282
Summit Water	67	72	80	83	86	90	94
Tahlequah Public Works	641	653	722	760	792	841	900
LRED	55	59	66	68	70	74	77
Tenkiller Aqua Park	10	11	12	12	13	13	14
Tenkiller State Park	18	19	21	22	23	24	25
Gore Public Water	271	292	323	335	346	364	382
Muldrow	500	539	597	619	639	672	705
Roland Utility Authority	275	296	328	340	351	369	387
Vian Public Water	180	194	215	223	230	242	254
TOTAL	**5,962**	**6,383**	**7,073**	**7,346**	**7,585**	**7,985**	**8,397**

Note: The 1995 figures are from the Lake Tenkiller Development Coalition's 1995 report, entitled "Analysis of Water Systems Surrounding Lake Tenkiller." The projected figures are based on 1995 average annual use times the rate of growth projected by the OWRB's "State Water Issues and Updated Water Use Projections, 1995; Cherokee and Sequoyah Counties."

The entries for Tahlequah Public Works in Table 3 are noticeably different from those reported in Phase II. During preparation of the Phase III report, it was determined that the numbers in the Phase II report were total demands for Tahlequah, not the 25% they had requested. In both Phase II and Phase III, the engineering analysis and design used the correct 25% numbers, so the sizing of treatment facilities and conveyance lines was unaffected. The Phase II report discussion of necessary water rights and water storage was affected by the mistake and has been corrected in this report.

Water district operators in Sequoyah County felt that the projections in Table 3 did not adequately represent growth in their districts. Projected water use in each of these districts, determined by the district operators, is shown in Appendix 7. Accurate information on current water use for LRED was not available until after Phase III engineering was completed. LRED usage and projected usage are also shown in Appendix 7. Projections used as the basis for design in Phase III were consistent with those used in Phase II. Growth rates for Cherokee and Sequoyah counties, as detailed in the OWRB's "State Water Issues and Updated Water Use Projections" were used for all projections.

The projected average use in the year 2050 of 8.4 mgd would require 9,408 acre-feet of water rights at Lake Tenkiller. **Currently, the participating water systems have a total of 9,096 acre-feet of water rights on Lake Tenkiller, which is insufficient to meet the year 2050 demand**. Total water rights on Lake Tenkiller are 29,792 acre-feet. At this time, 14,739 acre-feet are allocated, and applications for 173,714 acre-feet of water are pending (all but 110 acre-feet of this total were filled in 1979). **A total of 15,053 acre-feet of water rights remain on Lake Tenkiller as of August 2000.** However, having sufficient water rights does not guarantee that the proposed regional wholesale water treatment and conveyance system would have enough water to meet projected demands. Water storage must also be considered.

Water rights and water storage are not the same thing. Water rights refer to a right granted by the State of Oklahoma. Water storage is a contractual access to water in a reservoir. Both water rights and water storage are required before water can be drawn from a COE reservoir. The State of Oklahoma, through the OWRB, appropriates all State water rights at COE projects. The COE determines the yield and how much storage is available at each reservoir and enters into water supply contracts with the water users (i.e., municipalities or rural water districts).

Water rights and water storage under contract at Lake Tenkiller for potential members of the proposed Tenkiller Wholesale Water Treatment and Conveyance System are listed in Table 4. It appears that those members currently do not have enough Lake Tenkiller water storage under agreement in 2000 to fulfill the 1995 demands of 6.0 mgd listed in Table 3. Potential members hold water rights to 9,096 acre-feet of water per year, but it takes approximately 7,800 acre-feet of storage at Lake Tenkiller to yield 9,096 acre-feet of water. **Members currently have 3,898 acre-feet of storage at Lake Tenkiller, which will yield approximately 4.0 mgd under agreement. They need an additional 1,780 acre-feet of storage just to fulfill the 1995 demand or an additional 4100 acre-feet of storage to fulfill the ultimate demand of 8.4 mgd in the year 2050**.

Currently, 5,016 acre-feet of storage, which will yield approximately 5.3 mgd, are available for contracting at Lake Tenkiller. With multipurpose demands upon the storage identified as being available for reallocation for water supply, it could be prudent for members of the regional water supply system to secure the remaining storage that will be needed by the water supply customers.

Table 4. Water Rights and Water Storage Under Contract

Water System/District	Water Rights (acre-feet/year)	Water Storage Under Contract (acre-feet/year)	Water Storage Under Contract (mgd)
Burnt Cabin	90	12	0.013
Cherokee County RWD #1	0	--	--
Cherokee County RWD #2	129	100	0.105
Cherokee County RWD #3	0	--	--
Cherokee County RWD #7	0	--	--
Cherokee County RWD #8	0	--	--
Cherokee County RWD #13	272	100	0.105
City of Sallisaw	0	--	--
East Central Oklahoma Water	1,422	300	0.314
Fin and Feather Water Assoc.	11	12	0.013
Lake Tenkiller Harbor	140	200	0.210
Lost City RWD	0	--	--
Muskogee County RWD #4	0	--	--
Muskogee County RWD #7	0	--	--
Paradise Hills, Inc.	31	220	0.231
Sequoyah County Water Assoc.	3,000	2,200	2.306
Sequoyah County #7	0	--	--
Stick Ross Mountain Water Co.	3,000	--	--
Summit Water	21	140	0.147
Tahlequah Public Works	0	--	--
LRED	399	117	0.123
Tenkiller Aqua Park	21	17	0.018
Tenkiller State Park	0	--	--
Gore Public Water	560	480	0.503
Muldrow	0	--	--
Roland Utility Authority	0	--	--
Vian Public Water	0	--	--
Total	**9,096**	**3,898**	**4.088**

Water storage costs are determined by apportioning total project and operation and maintenance (O&M) costs for Lake Tenkiller to the various authorized project purposes. Since water supply was not an original project purpose at Lake Tenkiller, the water supply storage was taken away or "reallocated" from flood control storage, an authorized project purpose. The cost of the reallocated storage is based upon the current cost of storage, which is derived by updating the cost of the project to 1998 price levels. The cost is then prorated to each user with a water supply contract based upon the storage (acre-feet under contract) reallocated for their use.

The repayment period of costs assigned to the storage will be 30 years from the date of availability of the storage space. This is normally considered to be the date the repayment agreement is signed by the Assistant Secretary of the Army (Civil Works) (ASA [CW]) or his duly authorized representative. The interest rate used for repayment was established in the Water Resources Development Act of 1986 (WRDA '86). The rates are adjusted at 5-year intervals over the repayment period.

The water supply user is also responsible for a pro-rata share of additional costs required to operate and maintain the project. These costs consist of:

a. Annual Operation and Maintenance (O&M) Expense. Non-Federal sponsors are responsible for all O&M expenses allocated to their portion of the water supply storage space. This portion is determined by the amount of water supply storage placed under contract. These costs are to be paid yearly and are paid in advance, based on estimated O&M costs.

b. Repair, Replacement, Rehabilitation, and Reconstruction Costs. Costs allocated to water supply which are associated with these four items are to be paid by the non-Federal sponsor either during construction of each item or in a lump sum upon completion of construction, with interest at the rate prescribed in the WRDA '86 (Public Law 99-662). The non-Federal sponsor is encouraged to establish a sinking fund to cover these costs.

c. Dam Safety Assurance Costs. Modifications to a dam project and related facilities deemed necessary for dam safety assurances fall under the category of rehabilitation, except for cost sharing. Costs of project modification for dam safety are allocated in accordance with the provisions of Section 1203 of WRDA '86, which specifies that 15% of the cost is allocated among project purposes and assigned to appropriate project sponsors.

A new trust authority has been created for the Tenkiller Wholesale Water Treatment and Conveyance System – The Tenkiller Utility Authority (TUA). The TUA should be responsible for all water supply storage, including contracts already in existence. All existing water storage contracts should be transferred and assigned to the TUA. The TUA would then become responsible for obtaining any additional water rights from the State that will be needed and entering into a water storage contract with the Federal Government. The responsibilities of the TUA will include defending the water rights and paying water storage investment costs; annual O&M; repair, rehabilitation, and replacement costs; and, if necessary, dam safety assurance costs.

In the event the TUA decides to enter into an agreement for additional water supply storage in Lake Tenkiller, under current Corps policy there are two repayment options available: a) The TUA may elect to pay the indebtedness over a 30-year period from the date the storage agreement is signed by the ASA (CW) (applicable interest rates for repayment are those authorized by the WRDA '86, and the rate will be adjusted at 5-year intervals over the repayment period); or b) The TUA may elect to pay the indebtedness in a lump sum.

For either option, the TUA will be required to pay their pro rata share of joint-use O&M expenses on an annual basis. Costs allocated to water supply that are associated with repair, rehabilitation, or replacement costs are to be paid by the non-Federal sponsor either during construction of such item or in a lump sum, with interest at the rate prescribed in the WRDA '86, upon completion of construction.

Several coalition members currently have water storage contracts. These contracts contain different repayment scenarios depending upon when they were entered into and Corps policy at that time. The two options listed above are the only options available at this time. The

water supply contracting process can take 12 to 36 months or longer to complete (depending upon complexity).

Adequate storage has been identified as being available for water supply purposes at Lake Tenkiller; however, if none is available at a later date, but still needed, additional storage could be reallocated to water supply from other project purposes. Prior to the ASA (CW) making a decision to reallocate storage to water supply, a reallocation report will be required. Completion of the reallocation process can take 12 to 36 months or longer (depending upon complexity).

ALTERNATIVES

Phase I of this study presented three alternatives for consideration in Phase II. Early in the second phase of the study, the alternatives were revised to provide participants with a realistic yet broad range of choices. The no action or "without project" plan included in Phase I has been dropped due to the time-consuming process of gathering additional information on the participating water systems and the limited funds available for the study. In a typical study, the "without action" plan is included to provide a baseline to compare with other alternatives.

Phase II considered four alternatives that were developed through consultation with the study sponsors to show a range of possibilities from a minimalist system to one that is all inclusive, with two others in between. Conceptual level designs were based on these four alternatives, ultimately providing a wholesale cost of treated water per thousand gallons.

Phase III alternatives are based on the alternatives chosen by the study sponsors from those developed as a part of Phase II. The purpose of Phase III was to extend the system designed in Phase II to include Sallisaw, Sequoyah County RWSG & SWMD #7, Muldrow, and Roland. Three alternatives were identified for Phase III.

Alternative 1 includes all 27 water districts. This alternative assumes that the cities of Tahlequah and Sallisaw will supplement their water supply by purchasing 25% of their needs from the new system. This alternative would require two treatment plants, one located at the northern end of the lake and the other located at the southern end of the lake.

Alternative 2 presents a two-phased approach that will ultimately serve all 27 water districts. This alternative is similar to Alternative 3 of the Phase II study. The first phase would consist of a single treatment plant on the south end of the lake and would provide water to the districts with water rights on Lake Tenkiller, plus Vian and Tenkiller State Park. Those districts with water rights on Lake Tenkiller are Burnt Cabin, Cherokee County RWD #2, Cherokee County RWD #13, East Central, Fin and Feather, Lake Tenkiller Harbor, Paradise Hills, Sequoyah County, Summit, LRED, Tenkiller Aqua Park, and Gore. The second phase would include an additional treatment plant on the north end of the lake that would provide supplemental water (at 25% of their 2050 projected need) to Tahlequah and the districts it currently serves (Cherokee County RWD #3, #7, and #8), plus all the water needs of Stick Ross Mountain, Muskogee County RWD #4, Muskogee County RWD #7, Cherokee County RWD #1, and Lost City. Additional conveyance lines, pump stations, and storage would be included to serve Sallisaw (at 25% of their 2050 projected need), Sequoyah County RWSG & SWMD #7, Muldrow, and Roland. The second phase is scheduled to be operational in 2010.

Alternative 3 is included at the request of the sponsor and is the same as Alternative 1, except an additional demand of 7,000 gpm (capacity of a 24-inch pipe flowing at about 5 feet per second) has been added at Roland. **This additional demand is not based on water use projections, but on the assumption that 100% of the additional water would be sold.**

PRELIMINARY DESIGNS

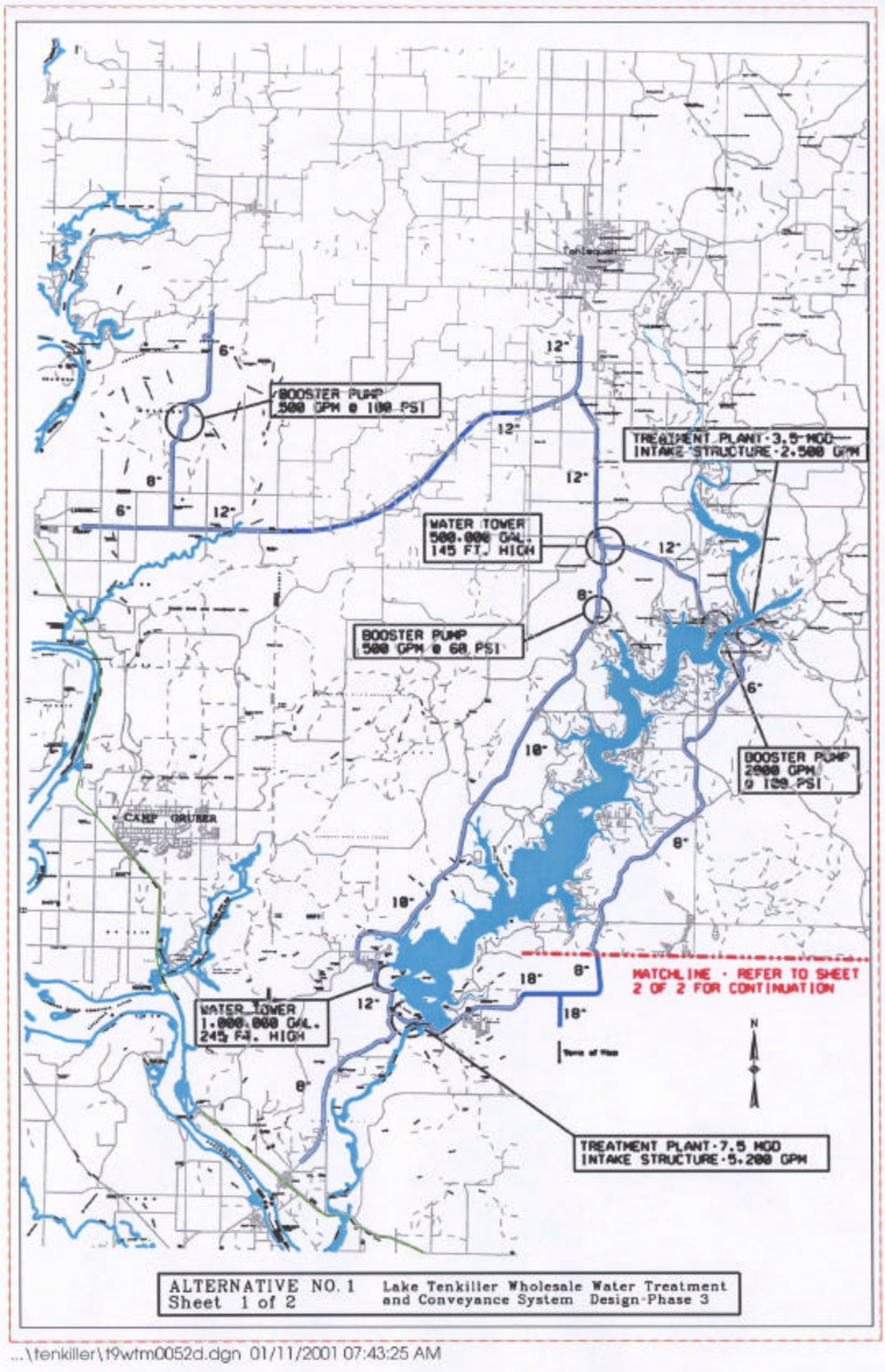
Conceptual level designs were developed for each of the three alternatives. These designs included sizing and locating the treatment plant(s), water towers, booster pump stations, and conveyance lines. A detailed description of the conceptual designs is included at Appendix 3. A summary of treatment plant capacities and finished water storage is provided in Table 5.

Table 5. Treatment Plant Capacity and Finished Water Storage

Alternative	Treatment Plant Capacity (mgd)	Water Storage (million gallons)
1	7.5 (south plant) 3.5 (north plant)	2.00
2	7.5 (south plant) 3.5 (north plant)	2.00
3	19.5 (south plant) 3.5 (north plant)	2.00

System requirements for **Alternative 1** include one treatment plant with 7.5-mgd capacity and an intake of 5,200 gpm at the south end of the lake, and another treatment plant with a 3.5-mgd capacity and an intake of 2,500 gpm at the north end of the lake; three water towers totaling 2,000,000 gallons of treated water storage; and four booster pump stations: one 500 gpm at 100 psi, one 500 gpm at 60 psi, one 2,000 gpm at 100 psi, and one 2,500 gpm at 160 psi. Approximately 133 miles of conveyance lines are needed, with the largest lines having an 18-inch diameter. Alternative 1 is shown in Figures 2 and 3.

Alternative 2 would require two phases of construction. The first phase would cover the Lake Tenkiller area, similar to Alternative 3 of the Phase II study, as shown in Figure 4. One treatment plant would be constructed on the south end of the lake. The second phase would complete the lines in the northern and western portions of the study area and extend through Sequoyah County. The southern treatment plant would be expanded to handle the increased demand, and a new treatment plant would be constructed on the northern end of the lake to serve the increased demand in the northern and western reaches of the study area. The second phase would be completed in 2010. When completed, this alternative would be identical to Alternative 1 in layout, with the same conveyance line configuration (see Figures 2 and 3). Final treatment plant capacities would remain the same as Alternative 1. Finished water storage would also remain the same with 2,000,000-gallon capacity. The booster pump stations would also be identical to Alternative 1. The second phase of construction will include the replacement of



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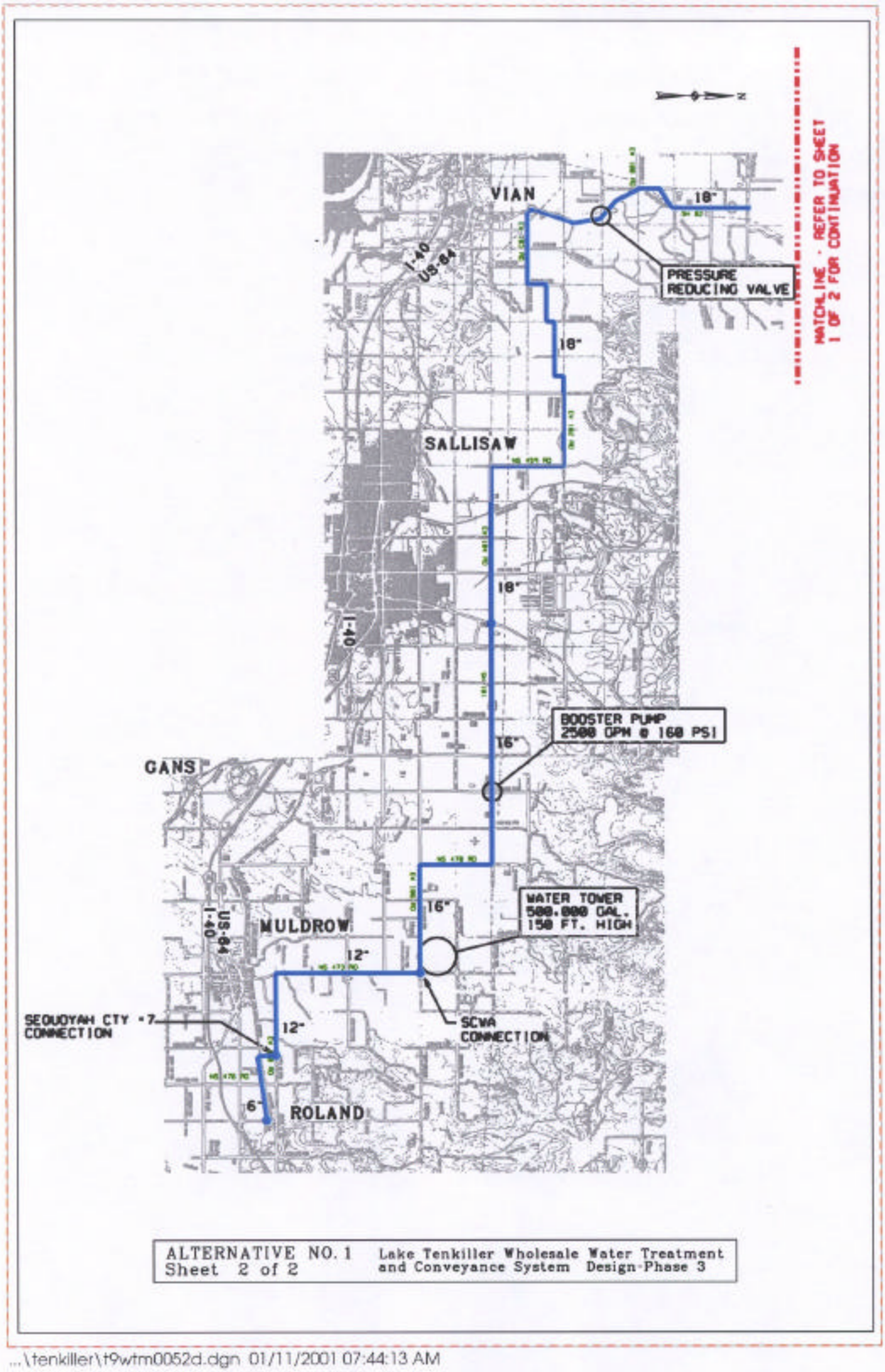
VIAN
18"
I-40
US-64
PRESSURE REDUCING VALVE
18"
SALLISAW
18"
I-40
MATCHLINE - REFER TO SHEET 1 OF 2 FOR CONTINUATION
BOOSTER PUMP 2500 GPM @ 160 PSI
16"
GANS
WATER TOWER 500,000 GAL. 150 FT. HIGH
16"
US-64
I-40
MULDROW
12"
SEQUOYAH CTY #7 CONNECTION
12"
SCWA CONNECTION
6"
ROLAND
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Sheet 2 of 2
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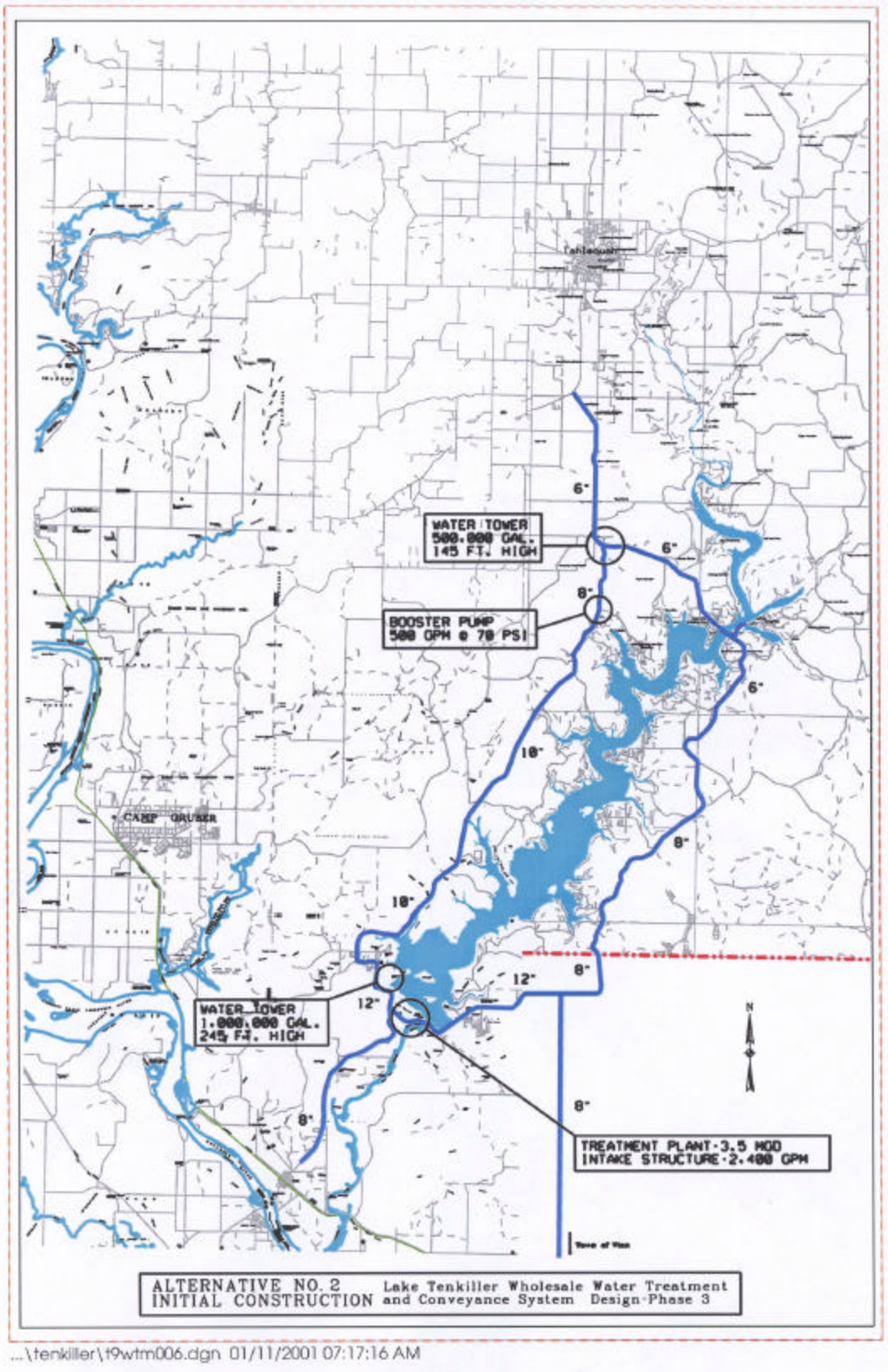
WATER TOWER
500,000 GAL.
145 FT. HIGH
BOOSTER PUMP
500 GPM @ 70 PSI
CAMP GRUBER
WATER TOWER
1,000,000 GAL.
245 FT. HIGH
TREATMENT PLANT-3.5 MGD
INTAKE STRUCTURE-2,400 GPM
6"
8"
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ALTERNATIVE NO. 2
INITIAL CONSTRUCTION
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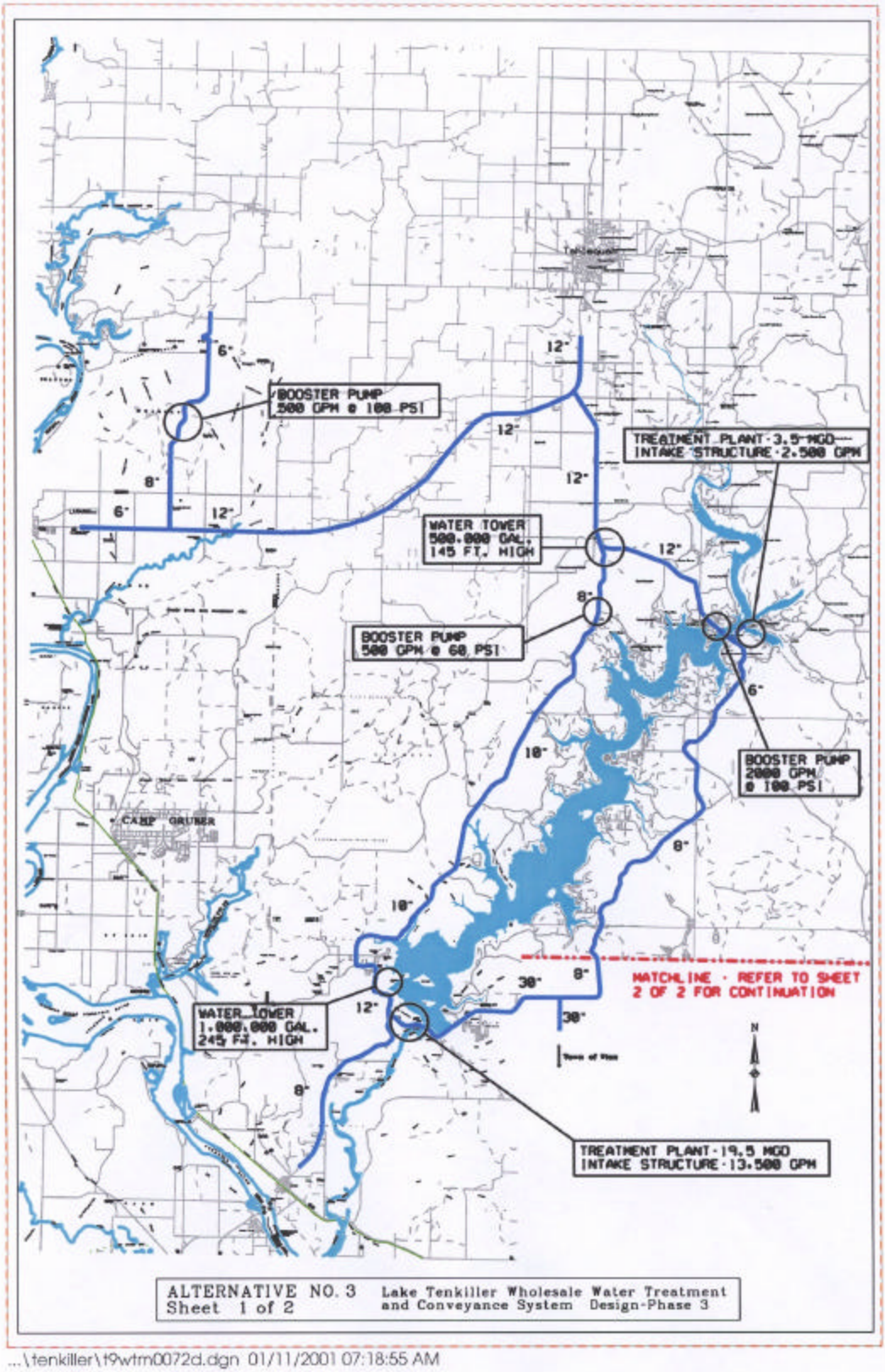
5 miles of 6-inch line with 12-inch line at the north end of the lake and 5 miles of 12-inch line with 18-inch line at the south end of the lake.

Alternative 3 is the same as Alternative 1 except the treatment plant at the south end of the lake has been increased to 19.5 mgd, and the conveyance line sizes across Sequoyah County have been increased to carry the extra capacity required by this alternative. Figures 5 and 6 illustrate the layout of Alternative 3. Water storage is the same as Alternatives 1 and 2 -- 2,000,000 gallons. Four booster pump stations are needed: one 500 gpm at 100 psi, one 500 gpm at 60 psi, one 2,000 gpm at 100 psi, and one 10,000 gpm at 160 psi. At least 133 miles of conveyance lines are necessary to cover the service region, with approximately 20 miles having a 24-inch diameter and 26.6 miles having a 30-inch diameter.

As a means to reduce the initial cost of the system, the treatment facilities have been sized to adequately satisfy initial demand, but not sized to maximum projected capacity. It is assumed that expansion to full size will occur after the initial cost payback period. All conveyance lines are sized to handle maximum projected capacity.

The major construction cost for any of these alternatives is in the conveyance lines. To lessen the size of lines needed and provide a substantial cost savings, booster pump stations were added.

Conveyance lines chosen for the system are predominantly high-pressure PVC pipe. However, some areas will use cement-mortar lined, polyethylene-coated ductile iron pipe with a sacrificial anode cathodic protection system. PVC pipe can readily handle the high pressures required by the system and is cheaper than ductile iron pipe. The requirements for high pressure are due to the large variation in elevation of the system. A pressure-reducing valve and a flow control valve will be required at most connection points. Pipe sizes were determined by hydraulic analysis using the KYPIPE computer program developed by the University of Kentucky. Where possible, conveyance lines would be run in existing roadway easements.



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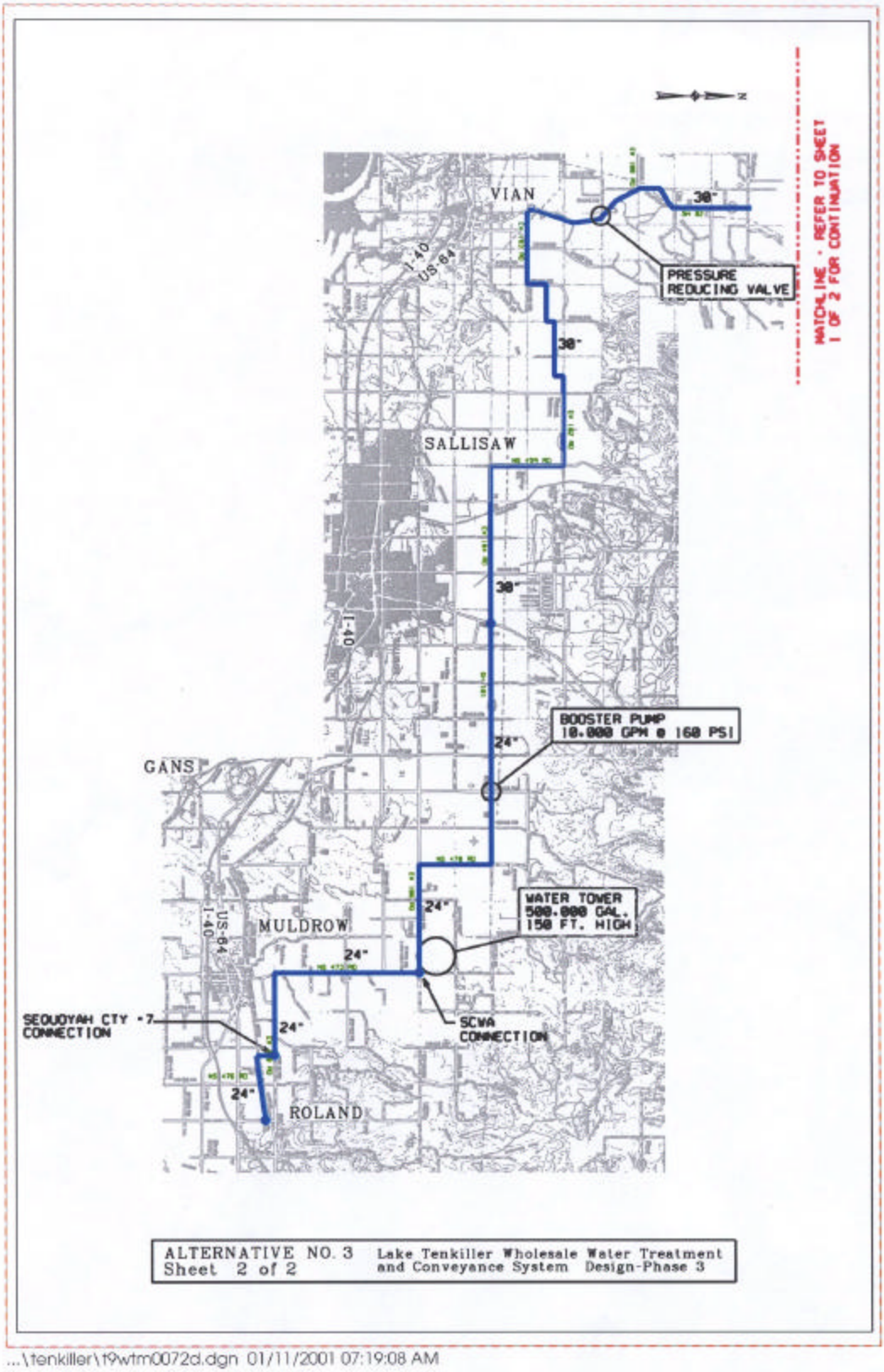
VIAN
30"
PRESSURE REDUCING VALVE
MATCHLINE - REFER TO SHEET 1 OF 2 FOR CONTINUATION
I-40
US-64
30"
SALLISAW
30"
I-40
BOOSTER PUMP 10,000 GPM @ 160 PSI
24"
GANS
WATER TOWER 500,000 GAL. 150 FT. HIGH
24"
MULDROW
I-40
US-64
24"
SEQUOYAH CTY #7 CONNECTION
24"
SCWA CONNECTION
24"
ROLAND
ALTERNATIVE NO. 3
Sheet 2 of 2
Lake Tenkiller Wholesale Water Treatment and Conveyance System Design-Phase 3
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REAL ESTATE

A gross appraisal of the real estate necessary for each alternative was conducted. Costs were estimated for acquiring the lands for the treatment plant(s), booster pump stations, and water towers. Existing roadway easements would be used to run the conveyance lines; however, easements would still be required for areas where the existing easements are not large enough to carry the additional pipe. Acreage for additional easements for each alternative was estimated. Associated with the purchase of any lands, including easements, is an administrative fee for preparing legal descriptions of the land, etc. For a typical COE project, administrative fees are estimated as $8,000 per ownership. For this study, however, a lower figure of $4,000 per ownership was agreed upon with the local sponsors as being reasonable. Also included in the real estate costs are damages and a contingency fee of 25%. Phase III of this study took alternatives developed in Phase II and added an extension across Sequoyah County. Real estate costs were developed for the new extension. Furthermore, each of the three alternatives considered as a part of Phase III are based on Alternative 3 of the Phase II study and will have the same real estate costs. A detailed description of real estate activities is included as Appendix 4. A summary of real estate costs is shown in Table 6.

Table 6. Summary of Real Estate Costs ($)

	Phase II Alternative 3	**Sequoyah Co. Extension**	**Phase III Alternatives**
Lands	128,300	90,000	218,300
Damages	38,500	27,000	65,500
Contingencies	41,700	46,800	88,500
Administrative Costs	500,000	11,700	511,700
Total	**708,500**	**175,500**	**884,000**

All three alternatives have identical real estate costs. Real estate costs for Alternative 3 of the Phase II study were used as a starting point for determining real estate costs in Phase III. Phase II's Alternative 3 would require 11 acres of land for the two treatment plants, two water towers, and three booster pump stations. Pipeline easements to be acquired total 70.41 acres, and 125 ownerships are affected. Extension of the system across Sequoyah County will require an

additional 78.37 acres of pipeline easement and 2 acres for the booster pump and water tower. Approximately 207 ownerships are affected by the Sequoyah County extension.

WHOLESALE WATER COST

To determine the wholesale cost of water, it is assumed that 100% of the project will be locally financed with revenue bonds (29 years at 5-1/2%). The reason for assuming 100% local financing is to determine an upper bound on the wholesale cost of water. If grants or other funds are available for construction of the project, the total locally-financed cost will decrease, resulting in a lower wholesale cost of water than shown below. The total initial cost of the system includes construction cost, engineering and construction management costs, and real estate costs. Constructions cost estimates, including contingencies and real estate, are included as Appendix 5. The fee for engineering and construction management is assumed to be 10% of the construction cost. The initial cost will be financed by the sale of revenue bonds, which includes a 3-1/2% charge for legal fees and commissions. Using a capital recovery factor of 0.06977, based on bond terms of 29 years at 5-1/2% interest, an annual capital cost is calculated. Annual cost for the wholesale water treatment and conveyance system will include the annual capital cost and costs for O&M. The O&M costs include energy costs, labor, sludge disposal, and chemicals for water treatment. To arrive at the wholesale cost of water, the total annual cost was divided by the annual water sales. These sales were based on current average daily consumption increased by a factor of 20% to account for higher summer usage. A summary table of the numbers used to arrive at the wholesale cost of water and the wholesale cost per 1,000 gallons, by alternative, is shown in Table 7.

Table 7. Project Costs, Including Wholesale Cost of Water

	Alternative		
	1	**2**	**3**
Construction Cost ($)	38,086,000	13,199,000 26,519,000	55,920,000
Engineering and Construction Management ($)	3,809,000	1,320,000 2,652,000	5,592,000
Real Estate ($)	884,000	510,000 374,000	884,000
Total Initial Cost ($)	42,779,000	15,029,000 29,545,000	62,396,000
Bond Legal Fees and Commissions ($)	1,497,000	526,000 1,034,000	2,184,000
Total Bond Amount ($)	44,276,000	15,555,000 30,579,000	64,580,000
Annual Capital Cost ($)	3,089,000	1,085,000 2,133,000	4,506,000
Annual Operations and Maintenance Cost ($)	685,000	262,000 423,000	1,438,000
Total Annual Cost ($)	3,774,000	1,347,000 2,556,000	5,944,000
Average Present Daily Use (gallons)	4,946,000	1,893,000 5,904,000	15,026,000
Initial Annual Water Sales (million gallons)	2,166	829 2,586	5,484
Initial Cost per 1,000 gallons ($)	**1.70**	**1.60** **1.50**	**1.10**

Note: For Alternative 2, the second number represents the costs associated with expansion in the year 2010. The wholesale cost of water in that year will be $1.50/1,000 gallons.

It is important to note that this is a wholesale cost of water, and the numbers presented in Phase I of this study were the cost to consumers compared at a usage of 10,000 gallons. Individual water districts will add their cost for distribution, O&M on their distribution systems, and overhead and/or profit to arrive at a final retail cost of treated water delivered to the consumer. This cost will vary from district to district as it currently does. However, one benefit of the wholesale water treatment and conveyance system is that each participating district no longer has to operate and maintain a treatment plant, which should enable them to lower their overhead costs.

ENVIRONMENTAL

Existing environmental conditions were determined from investigations to identify potential problem areas, such as endangered species, cultural resources, wetlands, and water quality. The scope of the investigations did not include a full environmental assessment or an environmental impact statement. Existing environmental conditions are as follows.

ENVIRONMENTAL SETTING

The proposed project is located in the Oak-hickory upland woodlands of the Boston Mountains ecoregion of northeast Oklahoma. Woodlands at the water treatment plant location are characterized by red and white oaks, elm, pecan, hickory, flowering and rough dogwood, redbud, and hackberry in the overstory. Poison ivy, greenbriar, eastern redcedar, and buckbrush are found in the understory. Surface soils are dominated by chert gravel, which covers shallow bedrock primarily composed of limestone and sandstone, forming Karst topography. Land use in the project area is primarily pastoral, residential, and recreational as influenced by activities associated with Lake Tenkiller and the McClellan-Kerr Navigation System.

ENDANGERED SPECIES

The U.S. Fish and Wildlife Service (USFWS) has identified the Interior least tern, American burying beetle, bald eagle, gray bat, Ozark big-eared bat, peregrine falcon, and piping plover as Federally-listed threatened and/or endangered species which could occur in the project area (see correspondence in Appendix 6).

Impacts from construction and operation of a regional water treatment facility (or facilities) with a network of conveyance lines could be realized by some of these species should they be found to inhabit the project area. Possible exceptions would be Interior least terns, piping plovers, and peregrine falcons, which are primarily found as migrants throughout this general area. The most likely species to be impacted by this action would be the American burying beetle. Limiting construction disturbance to the proposed water treatment plant, water tower sites, and existing road easement right-of-ways should minimize and/or preclude severe adverse impacts. Specific surveys would be necessary to address impacts on listed species as

well as any candidate species that might become listed in the future. Surveys for the presence of Federally listed species and formal Section 7 consultation would require interagency coordination with the USFWS prior to initiation of construction activities. Detailed information with respect to impacts of this project on Federally listed threatened and endangered species is beyond the scope of this study.

CULTURAL RESOURCES

A record search was conducted using Tulsa District quadrangle maps modified to indicate the locations of cultural resource sites in the proposed project areas and consultation with the State Historic Preservation Office, the Oklahoma Archeological Survey, and the Caddo Tribe. **Review by the Oklahoma Archeological Survey indicated that 10 archaeological sites are listed in the project area: MS-268, MS-8, MS-3, MS-172, CK-274, CK-338, CK-269, SQ-269, SQ-364, and SQ-365. An archaeological field inspection is therefore considered necessary prior to project construction to identify significant archaeological resources that may exist in the project area.** No additional sites were noted by either the State Historic Preservation Office or the Caddo Tribe. Copies of the coordination letters can be found in Appendix 6.

WATER QUALITY

In general, Tenkiller Lake can be classified as eutrophic. High nutrient (nitrogen and phosphorus) concentrations, elevated levels of chlorophyll a, and the increasing incidence of nuisance algal blooms support this classification. Nolen et al. (1989) calculated Carlson Trophic State Index (TSI) values for 14 sample sites from the upper reaches (Horseshoe Bend) to the dam. The TSI values were derived from chlorophyll a, secchi disk transparency, and total phosphorus. Interpretation of these values ranged from hyper-eutrophic to eutrophic. Vertical thermal stratification develops in Tenkiller Lake during May and persists in the deeper waters throughout late September and early October. Hypolimnetic oxygen is significantly depleted throughout this period. Conductivity levels indicate moderate concentrations of ionized salts and surface pH levels are typically circumneutral (6.2 - 9.5), fluctuating seasonally with algal activity. Total alkalinity of Lake Tenkiller is indicative of a system well buffered against drastic

pH shifts. Tenkiller water is soft to moderately hard, chloride levels are low, and Biochemical Oxygen Demand (BOD) is low. Fecal coliform counts are generally below State of Oklahoma standards for maximum acceptance.

WETLANDS

A majority of the wetlands, identified on National Wetland Inventory (NWI) Maps (USFWS), which could be close to construction activities are small palustrine impoundments of unknown depth that are permanently flooded (POWHh). Other palustrine wetlands found in the area around Lake Tenkiller include temporarily and seasonally flooded deciduous forest (PFO1A & PFO1C), seasonally flooded persistent emergent wetlands (PEM1C), seasonally flooded scrub-shrub (broadleaf-deciduous) wetlands (PSS1C), and permanently flooded excavations (POWHx). Numerous intermittent and ephemeral streams feed the Illinois River, Lake Tenkiller, and McClellan-Kerr Navigation System from uplands of the Boston Mountains and Ozark Highlands. Riverine habitats other than the Illinois River are composed of intermittent, seasonally flooded streams (R4SBC). Wetlands located within the expanded study area in Sequoyah County include PFO1A, POWHx, POWHh, and R4SBC. This area also contains some stream crossings where riverine wetlands (R20WH) would be impacted. No lacustrine wetlands are indicated on NWI maps within the scope of this study.

The small permanently flooded impoundments and excavations are mostly farm ponds and cattle tanks. Details regarding the extent of hydrologic recharge areas associated with these streams are beyond the scope of this investigation.

SECTION 404, CLEAN WATER ACT

The proposed Tenkiller Wholesale Water Treatment and Conveyance System would be subject to Section 10 of the River and Harbors Act of 1899 as well as Section 404 of the Clean Water Act. Construction of an intake structure should fall within the scope of a Nationwide permit or a General permit. Construction of water processing facilities would require a determination of status regarding jurisdictional waters of the U.S. The placement of a waterline would fall within the scope of Nationwide Permit No. 12, Utility Line Discharges. The State of Oklahoma has classified several waterways in this area as Outstanding Resource Waters (ORS). A Nationwide permit can be issued for ORS waterway crossings; however, they are not valid until the applicant obtains a Section 401 Water Quality Certification from the Oklahoma Department of Environmental Quality. The entire length of the proposed waterline would require a determination regarding the necessity of a preconstruction notification. Prior to construction, a Section 404 (Clean Water Act) determination should be requested from the Tulsa District COE (Regulatory Branch) to assure compliance with Federal law.

NATIONAL FORESTS AND OTHER PUBLIC USE AREAS

The proposed project is not located within any National Forests, National Parks, Monuments, or Recreation Areas. However, numerous public use areas exist and operate (seasonally) on and around Lake Tenkiller and the system of lakes comprising the McClellan-Kerr Navigation System. State parks include Tenkiller State Park, immediately adjacent to the dam at the Pine Creek Cove; and Cherokee Landing, at the Highway 82 bridge crossing.

The Oklahoma Department of Wildlife Conservation (ODWC) manages the Cherokee Wildlife Management Area, north of Sawmill Hollow and west of Burnt Cabin Ridge, and the Cookson Hills Wildlife Management Area, 8 miles east of Cookson, Oklahoma. The ODWC also manages a put and take trout fishery on the Illinois River below Lake Tenkiller.

The U.S. Army Corps of Engineers manages and operates 15 parks on and adjacent to Lake Tenkiller as well as numerous parks and recreational facilities associated with Webbers Falls Lake and Robert S. Kerr Lake. The U.S. Fish and Wildlife Service operates the Sequoyah National Wildlife Refuge just south of the city of Vian on Robert S. Kerr Lake.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

Should Federal funds be expended for construction of any part of the proposed alternatives and/or proposed facilities be constructed on Federal property, NEPA coordination will be required. Public involvement would include disclosure of project purpose, design, and alternatives accomplished by means of a public scoping meeting or workshop held at a time of optimal availability, Monday through Friday, early in the planning phase of the project. At least 2-weeks notice of the public meeting or workshop should be issued to the local community by means of publishing an advertisement or public notice in the local newspaper(s). Since this project is regional in scope, several community newspapers may have to be used. Documentation required by the NEPA could be limited to a Record of Environmental Consideration, an Environmental Assessment with a Finding of No Significant Impact or may require an Environmental Impact Statement.

CONCLUSIONS

Conceptual designs and cost estimates were presented for a regional wholesale water treatment and conveyance system serving the Lake Tenkiller area. Three alternatives were considered. Treatment plant capacities, conveyance line sizes, pumping station capacities, water tower sizes, estimated construction costs, and necessary real estate costs were calculated for each alternative. Total initial costs (including construction, management, and real estate costs) ranged from $42.78 million to $62.40 million. Wholesale water costs were developed for the three alternatives considered in this study. **Costs ranged from $1.10 per thousand gallons to $1.70 per thousand gallons.** Additional water storage contracts and water rights are needed for implementation of the three alternatives considered in this report. **The participating water districts currently do not have enough water rights or contracted water storage in Lake Tenkiller to meet the year 2050 demand estimated for Alternatives 1 and 2; however, there**

are enough water rights and water storage available in Lake Tenkiller at this time to meet the demands of Alternatives 1 and 2. Obtaining adequate water storage contracts and water rights should be addressed as soon as possible. **Alternative 3 would require an additional 16,900 acre-feet of storage and an additional 15,380 acre-feet of water rights. Both water rights and storage on Lake Tenkiller are currently not available for a need this great. The possibility does exist that additional water could be picked up downstream to make up the difference.** A cursory examination of possible environmental concerns was performed. **Consultation with the USFWS will likely be required regarding the American burying beetle. Ten documented archaeological sites were found to lie within the project area. Field inspection surveys will be necessary prior to any construction.**

LITERATURE CITED

Nolen, S. L, J. H. Carroll, D. L. Combs, J. N. Veenstra, and J. C. Staves. 1989. Limnology of Tenkiller Ferry Lake, Oklahoma, 1985-1986. Proc. Okla. Acad. Sci. 69:45-55.