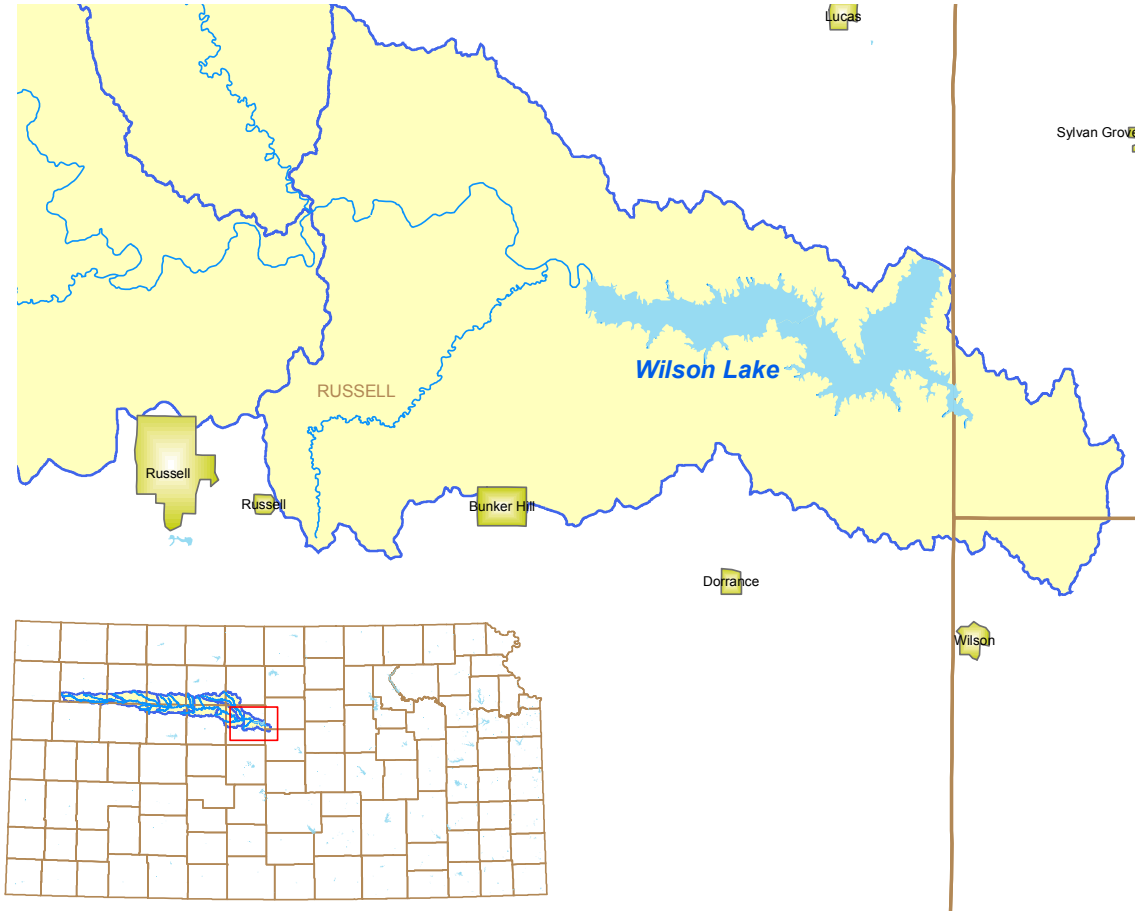


# Wilson Lake Yield Analysis Report



Kansas Water Office  
November 2004

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## Summary and Base Case Results

Wilson Lake was originally authorized for construction by the Bureau of Reclamation for the purposes of irrigation, navigation enhancement, flood control, recreation, fish and wildlife habitat, and water quality assurance. Due to the high salinity of the impoundment water, irrigation from the lake was determined impracticable and the construction and operation of the lake were transferred to the Corps of Engineers. In addition, based upon Wilson Lake’s distance from the Missouri River, navigation, while an authorized purpose of the reservoir, is no longer a specific consideration for the daily operations of the lake. Much interest exists in the storage capacity which had previously been planned for irrigation and navigation purposes. The lake lies in the vicinity of Russell and Hays and the possibility exists for reallocation of its storage to supply water for these cities. This water could prove crucial to assuring the long-term economic viability of the area. In order to project the amount of water available for reallocation, this yield study considered streamflow depletions, existing water usage and projected capacity of the reservoir.

According to statutory obligation, this yield was calculated forty years into the future using hydrologic and climatic conditions from 1952-1957. By regulation, this time period (1952-1957) includes the drought which has a 2% chance occurrence in any one year. It is the conclusion of this yield analysis that the safe yield for Wilson Lake is 29.0 million gallons per day (29.0 MGD). Table 1 summarizes the yield results for the base case for the projected years.

**Table 1: Wilson Lake Yield – Base Case**

Proj. year	Capacity (AF)	Yield (AF/day)	Yield (KAF/yr)	Yield (cfs)	Yield (MGD)
2000	231031	98.4	35.911	49.6	32.1
2020	226354	96.4	35.169	48.6	31.4
2030	216998	92.1	33.634	46.5	30.0
2044	210448	89.0	32.492	44.9	29.0

Wilson Lake is on the Saline River and drains an area of 1,917 sq mi, and contains 7 HUC11 subbasins sequentially numbered 10260009010 through 10260009070. This is the upstream component of the Saline River Basin, and is 56 percent of the Saline River Basin’s total drainage area of 3,419 sq mi. Figure 1 depicts the Smoky Hill-Saline Basin (shaded brown) with the Wilson Lake drainage area shaded yellow and the Saline River Basin outlined in red. Wilson Lake is located in the eastern-most HUC11 of the lake’s drainage area.

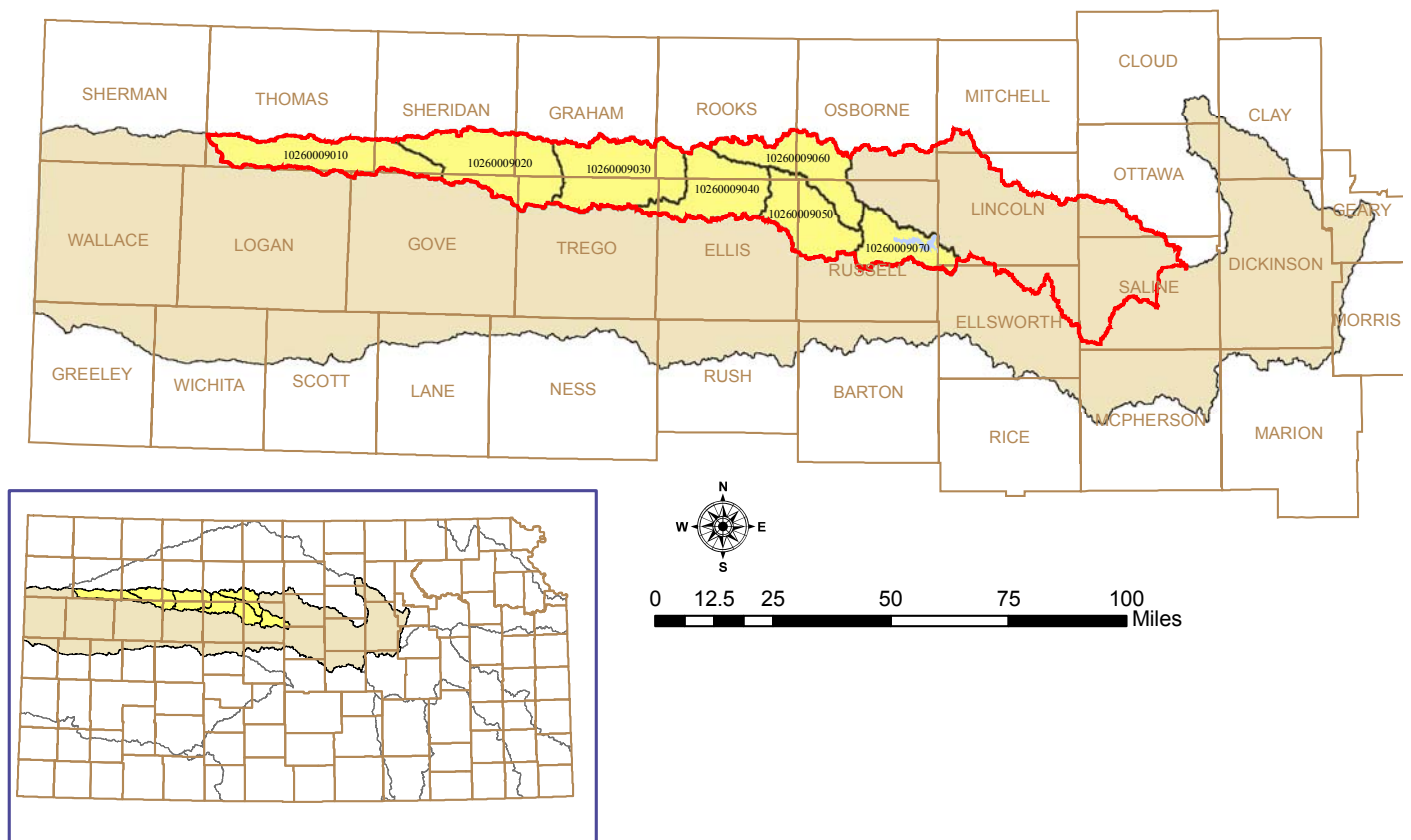


Figure 1. Smoky Hill-Saline Basin and Wilson Lake drainage area.

## Yield Methodology

The water supply yield from Wilson Lake was calculated according to KWO Administrative Regulation 98-5-8 as adopted by the Kansas Water Authority October 24, 1966 (Appendix A). This Regulation requires that the water supply yield be calculated on the basis of a one year drought with a two-percent chance of occurrence. This drought is assumed to be contained within the historical period of 1952-1957. In order to project the future yield, hydrologic conditions of the historical drought period are modified to account for the depletions to the inflows to Wilson Lake that have historically occurred.

The main factors affecting projected reservoir yield are storage capacity changes due to sedimentation, evaporation, inflow depletions, bypassed inflow for downstream senior water rights, and water quality releases. Yield calculations are made using a Microsoft Excel spreadsheet that routes water through the reservoir on a monthly time step for the six-year period (1952-1957) as required by regulation. For each time step, a volumetric balance is calculated to determine lake storage. This volumetric balance states that the change in storage equals the net sum of inflow, precipitation, evaporation, and discharge.

## Projected Storage Capacity

The Lake Yield for future years is based upon a projected capacity and area of Wilson Lake. The Corps of Engineers provided Elevation-Area-Capacity (EAC) tables for full surveys of the lake performed in 1963 and 1984 and a partial sediment survey performed in 1995. The dam gates were closed on December 29, 1964, but the multipurpose pool elevation (1516 ft.) was not reached until March 12, 1973.

Table 2 compares the capacities for the multipurpose and flood control pools at the different surveys. The average sedimentation rate in the multipurpose pool for the first 20.5 years was 258 acre-feet per year, while the average sedimentation rate in the multipurpose pool for the 11 years between the 1984 and 1995 surveys was 811 AF/year. This more than triples the sedimentation rate of the first period. During the lake design, the USGS estimated that the sedimentation rate would average 400 AF/year.

**Table 2: Capacities from Sediment Surveys**

Survey Date	Multipurpose Capacity (AF)	Average MP Sedimentation (AF/year)	Flood Pool Capacity (AF)	Average FC Sedimentation (AF/year)
Dec-64	247835		778545	
Jun-84	242528	258	772732	299
Jun-95	233605	811	763451	844
Average for 31 year period		452		496

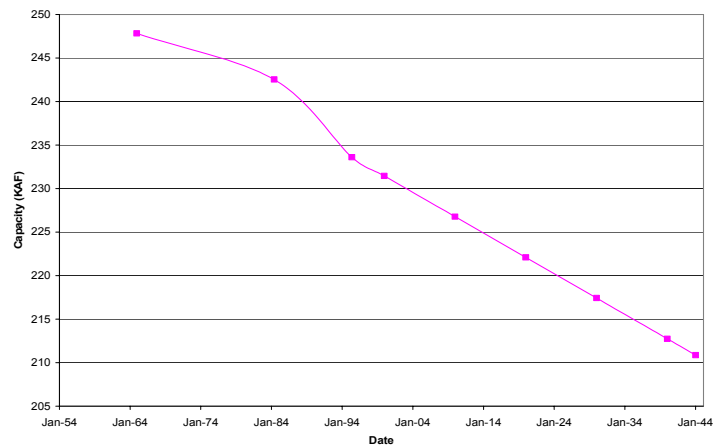
This dramatic rise in the sedimentation rate is not completely surprising when inflow rates are examined for the two periods between surveys. For the first period, the average monthly inflow was 6,400 AF while the average inflow for the second period was 13,100 AF. This increased average flow accounts for over half of the increase in sedimentation. The other portion of the increased sedimentation is likely due to the unusually large flood events that occurred between 1984 and 1995. These floods, including a one hundred-year event in July of 1993 and another large flood in May of 1995, would have deposited uncharacteristically large amounts of sediment into the reservoir. Rather than assume that sedimentation is accelerating or reflects the more recent rate, it seems best to assume that the fluctuations in sedimentation over the last 31.5 years will represent an average of the two periods for the next forty years. The average multipurpose sedimentation rate for the entire period was 452 AF/year, nominally greater than the original 400 AF/year prediction established by the USGS.

Linearly projecting the change in capacity at each elevation using the 31.5 year average, new projected EAC tables were generated. Figure 2 displays this projected capacity at the Multipurpose Pool (MP) using the linear projection. Table 3 provides the historic surveyed capacity and projected capacities.

**Table 3: Historical and Projected Lake Capacities**

Survey Date	MP Capacity (AF)	% of Original MP Capacity	Flood Pool Capacity (AF)	% of Original FC Capacity
Dec-64	247835	100.0%	778545	100.0%
Jun-84	242528	97.9%	772732	99.3%
Jun-95	233605	94.3%	763451	98.1%
Jan-00	231460	93.4%	761176	97.8%
Jan-10	226781	91.5%	756213	97.1%
Jan-30	217426	87.7%	746289	95.9%
Jan-44	210876	85.1%	739342	95.0%

**Figure 2: Projection of Multipurpose Capacity**



## **Inflow Depletions**

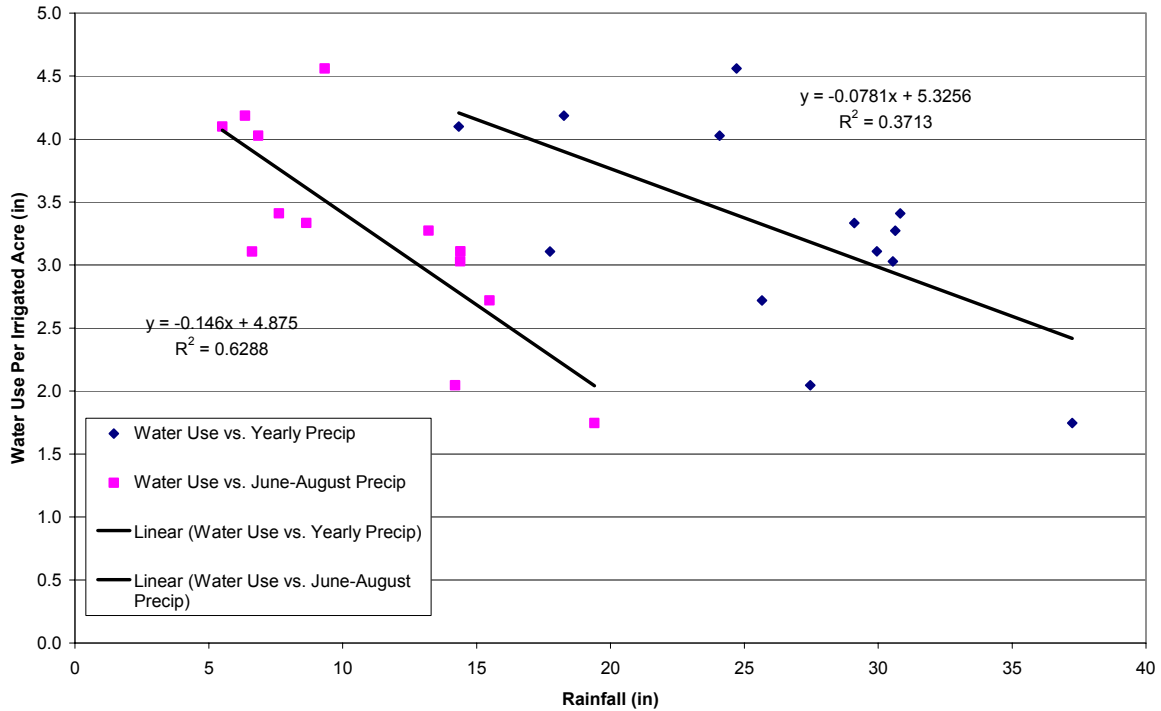
In order to route historical climatological data through current conditions it is necessary to determine the extent that increased water use and changes in land practices in the basin have depleted the streamflow into Wilson Lake from historical levels.

## **Projected Water Use**

Information was obtained from the Kansas Division of Water Resources (DWR) regarding the current points of diversion along the Saline River. According to Scott Ross from the DWR, upstream of the Wakeeney stream gage the Saline alluvium should be considered to be well connected to the High Plains Aquifer, below this point the aquifer connection deteriorates. He also said that there is another aquifer connection just north of Hays, however the extent and contribution to streamflow at this point is difficult to decipher. Due to a relatively small increase in the number of diversions in this area since 1952, no further depletions of this connection's contribution will be considered. For this yield analysis, all points of diversion upstream from the Wakeeney stream gage and all alluvial points of diversion downstream of the stream gage in the Wilson Lake drainage area will be considered to deplete inflows. Since the Kansas Water Office has not yet obtained a Water Reservation Right, all alluvial points of diversion below the dam were considered to have senior rights to the water and subtracted from the potential yield of the lake.

Reported groundwater and surface water usage for 1990 to 2003 were obtained from the DWR. On average, 97.5% of all water use in the basin is attributable to irrigation. Accordingly, as displayed in Figure 3, a correlation exists between precipitation and reported use. Thus, in order to more accurately predict water use by upstream and downstream senior water rights, current usage statistics must be extrapolated to historical precipitation data. When water use is plotted versus precipitation as a ratio, a linear trend can be ascertained (Figure 3). Because the water use in the basin is dominated by irrigation, precipitation for June through August is a better predictor of overall water use than is annual precipitation. While the projection is clearly linear, the correlations contain quite a bit of scatter attributable to differences in the precipitation distribution within the irrigation period. If all of the precipitation comes in a small number of large events while the rest of the period of interest is dry, more water use would occur than this model predicts. Table 4 displays the results of the applied relationship between June through August precipitation and recent water use to the precipitation (June through August) in 1952-57 (assumed to contain the 2% drought). Although these numbers predict a significant increase in water use from current levels, these predictions may still be underestimating the actual use during the 2% drought. The points of diversion are operating at water use levels substantially lower than their authorized quantity, and rainfall during drought periods is likely to occur in the form of a small number of intense events, requiring greater irrigation use than predicted.

**Figure 3: Water Use Vs. Precipitation**



**Table 4: Predicted Water Use Above Wilson**

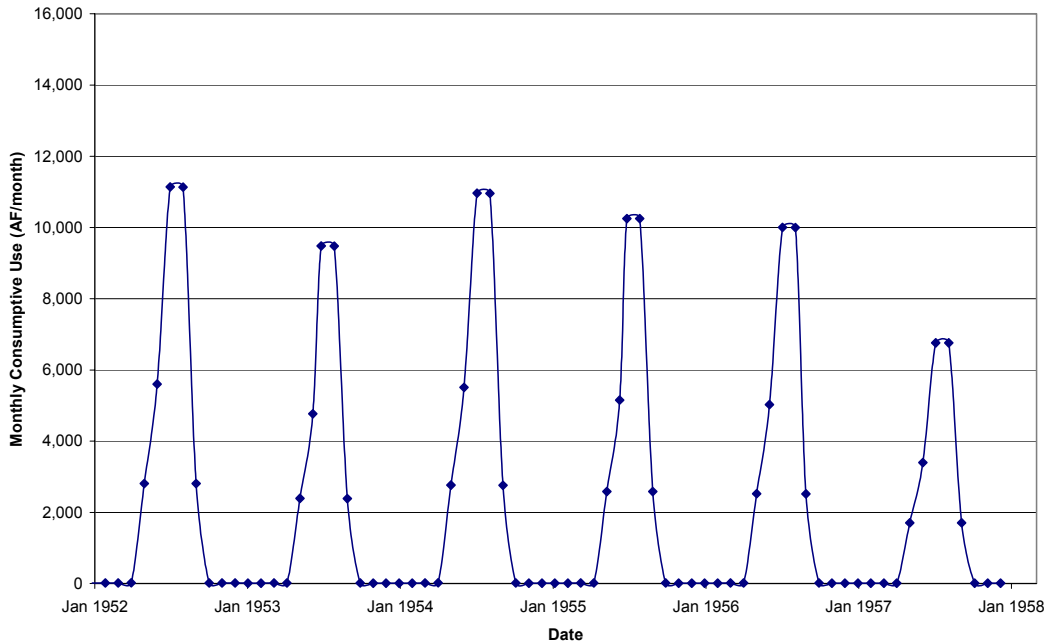
Model Year	Precipitation for Jun-Aug	Estimated Use (in)	Estimated Use (AF)	Authorized Use (AF)	Percent of Authorized
1952	3.7	4.33	37539	89683	42%
1953	8.14	3.69	31947	89683	36%
1954	4.19	4.26	36944	89683	41%
1955	6.08	3.99	34553	89683	39%
1956	6.75	3.89	33705	89683	38%
1957	15.38	2.63	22787	89683	25%

Assumptions for the distribution of consumptive use per month for this yield analysis were based upon the following consumptive use factors and monthly use distribution (Table 5). Figure 4 exhibits the predicted water use for the assumed 2% drought period based upon current points of diversion.

**Table 5: Consumptive Water Use by Month and Reported Use**

month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	c.u. factor
DOM	0.06	0.06	0.07	0.09	0.1	0.12	0.12	0.1	0.09	0.07	0.06	0.06	0.5
IND	0.06	0.06	0.07	0.09	0.1	0.12	0.12	0.1	0.09	0.07	0.06	0.06	0.3
IRR	0	0	0	0	0.084	0.167	0.333	0.333	0.08	0	0	0	0.9
MUN	0.06	0.06	0.07	0.09	0.1	0.12	0.12	0.1	0.09	0.07	0.06	0.06	0.5
STK	0.06	0.06	0.07	0.09	0.1	0.12	0.12	0.1	0.09	0.07	0.06	0.06	0.6
REC	0	0	0.167	0	0	0	0	0.167	0.33	0.333	0	0	0.2

Fig. 4: Monthly Consumptive Use For Period of Interest



### Inflow Depletions Due to Land Management

Calculations for this yield analysis are based upon streamflow conditions from 1952 to 1957. However, in the interim fifty years, soil conservation and land management practices appear to have altered that portion of precipitation becoming runoff to streams. To maximize accuracy, this landscape alteration needs to be considered. Due to chunks of missing streamflow data and the skewing of large periods of both low and high rainfall, simply plotting cumulative rainfall for the periods of record (Figure 5) does little to help estimate this type of inflow depletion.

For the data collected at the Tescott and Wilson locations, the gages report a decrease of 30% in average streamflow in the second 25 years as compared to the first 25 years (Table 6). However, this number is not very useful. Both of these gages lie downstream of Wilson Dam and thus the data is skewed for the period when the dam was first completed and the reservoir was being filled. In Figure 5, the period from 1964 to 1972 reflects this low flow phenomenon. Unfortunately, the streamgage which would be most useful in analyzing decreases in flows (Russell) only has a period of record going back to 1960. When examined, the second half of the period actually shows an increase in average streamflow, but these data are misleading because they include the high rainfall years of the 1990's while omitting a few years of very high rainfall and high streamflow in the late 1950's.

Figure 5: Cumulative Streamflow (KAF)

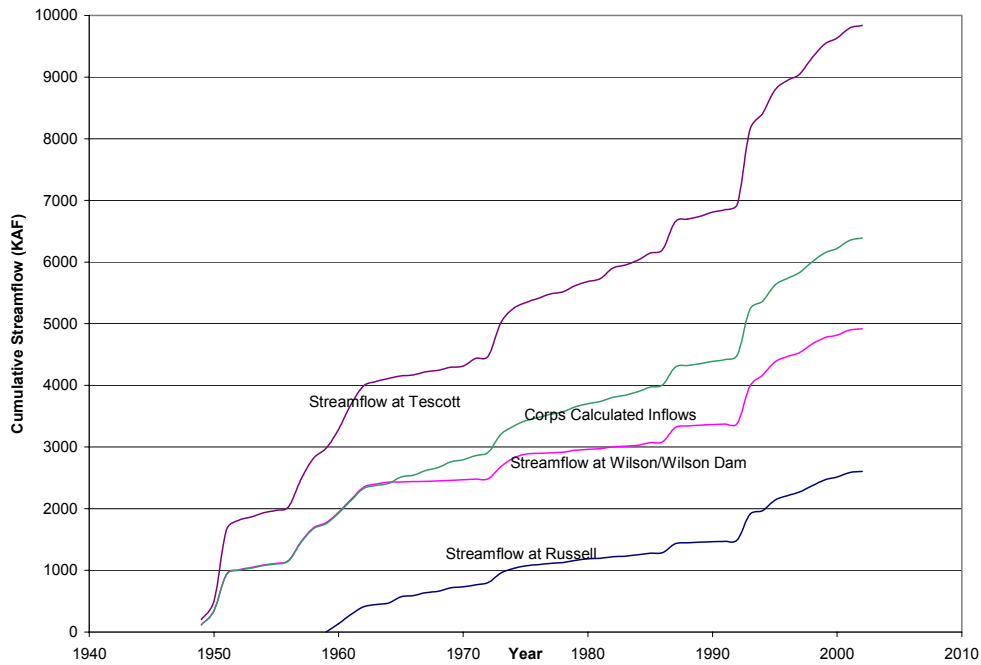
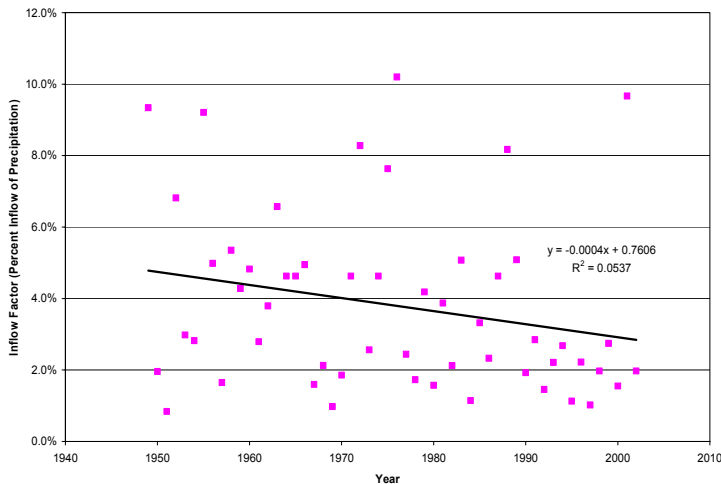


Table 6: Average Streamflow for Different Time Periods

	Average Streamflow (KAF/yr)			Precip (in.)
	Russell	Wilson Dam	Tescott	
1949-1975	NA	106.8	197.9	23.41
1976-2002	NA	75.3	166.4	23.42
1960-1980	54.3	54.6	125.1	22.83
1981-2002	67.1	92.5	195.5	24.15

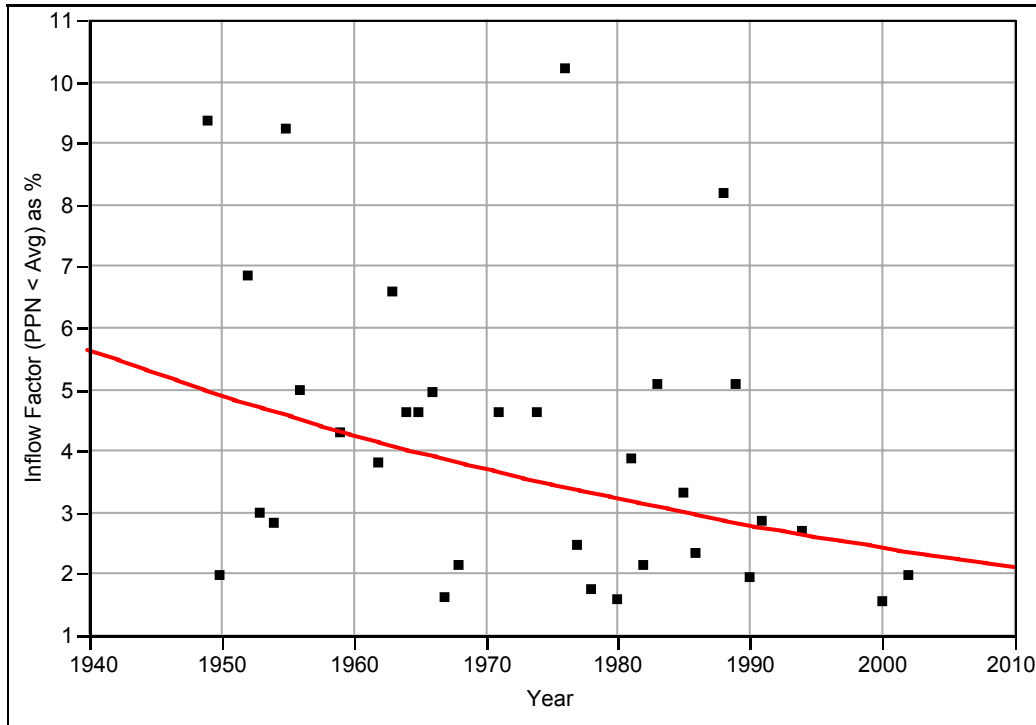
Figure 6: Percentage of Precipitation which Becomes Corps Inflow



A different approach, however, yielded more useable results. For the purposes of this analysis the percentage of precipitation, computed as the volume of annual precipitation in a drainage area divided by the annual streamflow, which reaches the streambed to become stream flow will be referred to as the “inflow factor”. When this inflow factor is charted chronologically for the stream gage at Russell (Figure 6), a definite downward trend can be seen, however quite a bit of scatter exists. The scatter here can be attributed to years where the precipitation primarily fell in more intense events, creating more runoff per inch of precipitation. Not coincidentally,

these years were primarily years where the overall rainfall was above average. As the period of interest for this yield analysis is one of extremely low precipitation, the years of high rainfall do little to help predict the actual changes in the inflow factor for our 2% event. When the years of above average rainfall were removed and the inflow factor for below average years at the Russell stream gage were charted, a cleaner, more useful trend appeared. Figure 7 shows a negative slope in the percentage of precipitation reaching the streambed through time.

**Figure 7: Percentage of Precipitation which becomes Inflow for Below Average Precipitation Years**



**Transformed Fit LN**

LN(Inflow Factor (PPN < Avg)) = 29.426103 - 0.0142698 Year

**Summary of Fit**

RSquare	0.134541
RSquare Adj	0.106623
Root Mean Square Error	0.557623
Mean of Response	1.271413
Observations (or Sum Wgts)	33

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	1.498480	1.49848	4.8191
Error	31	9.639229	0.31094	Prob > F
C. Total	32	11.137710		0.0358

**Parameter Estimates**

Term	Estimate	Std Error	t Ratio	Prob> t
Intercept	29.426103	12.82561	2.29	0.0287
Year	-0.01427	0.0065	-2.20	0.0358

Although the R-square is relatively low, the coefficient associated with the slope of the fitted line is statistically significant at alpha = 0.05 (Prob>[t] = 0.0358). Therefore, statistical evidence supports the decline in the inflow factor through time.

By using the prediction equation derived from this model an estimate can be made of the change in the percentage of inflow from precipitation for 1952 to the present. Only a portion of this reduction in inflow is attributable to terracing and other land use practices. The majority of this reduction can be explained by increases in upstream water use by groundwater and surface water diversions. Table 7 illustrates the summary of this reduction in inflows and what portion of it cannot be accounted for by increases in reported water use. By using the mean precipitation for below average years, an average flow for 1952 conditions can be established. Then, the theoretical decrease in flow by the estimated reduction to the inflow factor can be compared to increases in reported consumptive use. By this almost 17 KAF of lost streamflow cannot be accounted for by increases in reported water usage. Thus, in order to account for changes in land practices, the streamflow for 1952-1957 must be decreased by 17.7% to adjust the flow to current conditions in the watershed.

**Table 7: Inflow Depletion Summary**

Estimated Percent of Precipitation Becoming Inflow (1952)	4.78%
Estimated Percent of Precipitation Becoming Inflow (2002)	2.37%
Percent Decrease in Inflow Percentage	50.4%
Average Wakeeney Precipitation (for below avg years) (in)	19.64
Average 1952 Flow during below avg. precip (KAF/Year)	96.04
Theoretical Decrease in Flow due to Inflow Factor Decrease KAF	48.39
Reported Consumptive Use in 2002 (KAF)	31.84
Estimated Consumptive Use in 1952 (KAF)	0.44
Increased Consumptive Use from 1952-2002 (KAF)	31.40
Unaccounted Decrease in Flow (KAF)	16.99
Estimated Percent of Flow Lost to Land Conservation etc:	17.7%

**Historical Water Use**

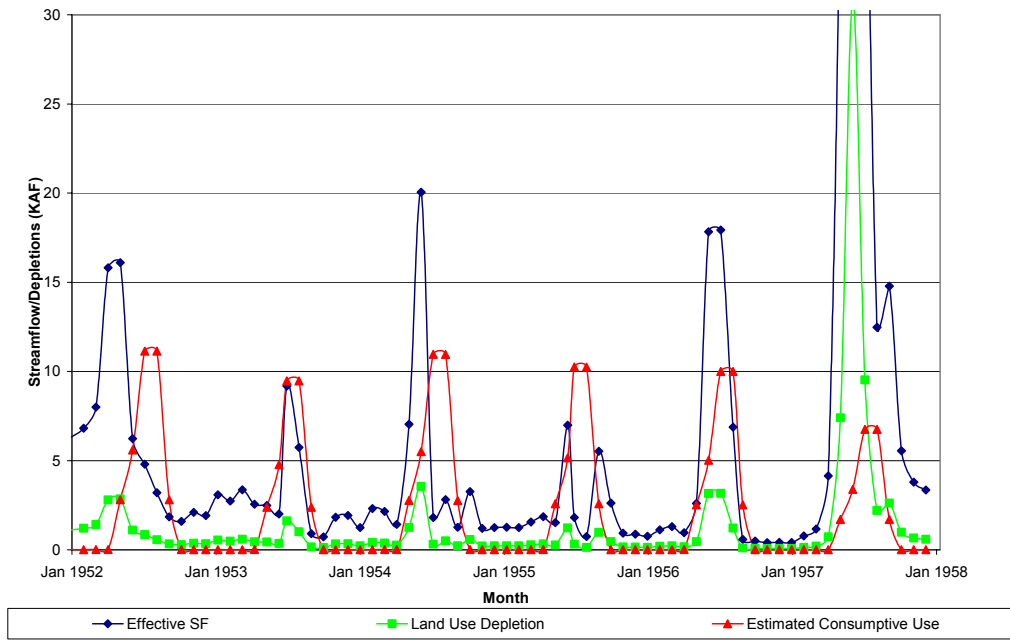
Water in the drainage area above Wilson Lake was just beginning to be appropriated in 1950. In response to the period of drought, a sharp rise in the number water rights and reported irrigated acres occurred during the period of interest (1952-1957). While there are no reported water use data available for that period, an estimate of water use can be made based upon current use practices. Using the 1990-2002 model for water use per irrigated acre versus precipitation for June through August and the reported irrigated acres and precipitation, estimated historical consumptive use for each year was derived. Due to increased efficiency in irrigation techniques in more recent times (center pivot systems, etc.) these water use estimates are considered conservative values. This historical consumptive usage would have depleted streamflow slightly and must be added to the period’s streamflow data prior to subtracting current consumptive use to determine effective streamflow.

**Predicted Streamflow**

Streamflow for the 2% drought conditions was obtained by using the historical streamflow data at the Saline River near Wilson USGS streamgage site 6868000. To this monthly average streamflow the

estimated historical consumptive use was added to establish the effective streamflow for the period. Finally, net inflows are calculated by reducing the effective flow by 17.7% to account for the reduction in flow from current land use practices and subtracting out projected use by upstream rights at current levels. Figure 8 compares the monthly effective streamflow to the projected consumptive use and land use depletions.

Figure 8: Streamflow And Depletions For Projected Period

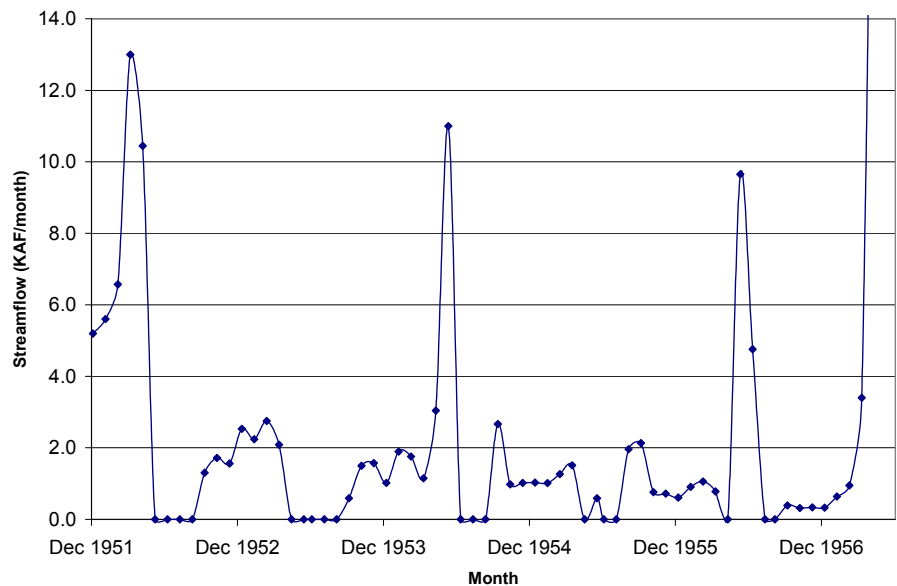


During the projected period there are a total of 18 months where use exceeds the effective streamflow. Table 8 illustrates the breakdown of those dry months by year. Figure 9 illustrates the adjusted monthly net inflow.

Table 8: Months Where Projected Use Exceeds Inflow

Year	Dry Months
1952	4
1953	5
1954	3
1955	3
1956	3
1957	0

Figure 9: Projected Net Monthly Streamflow

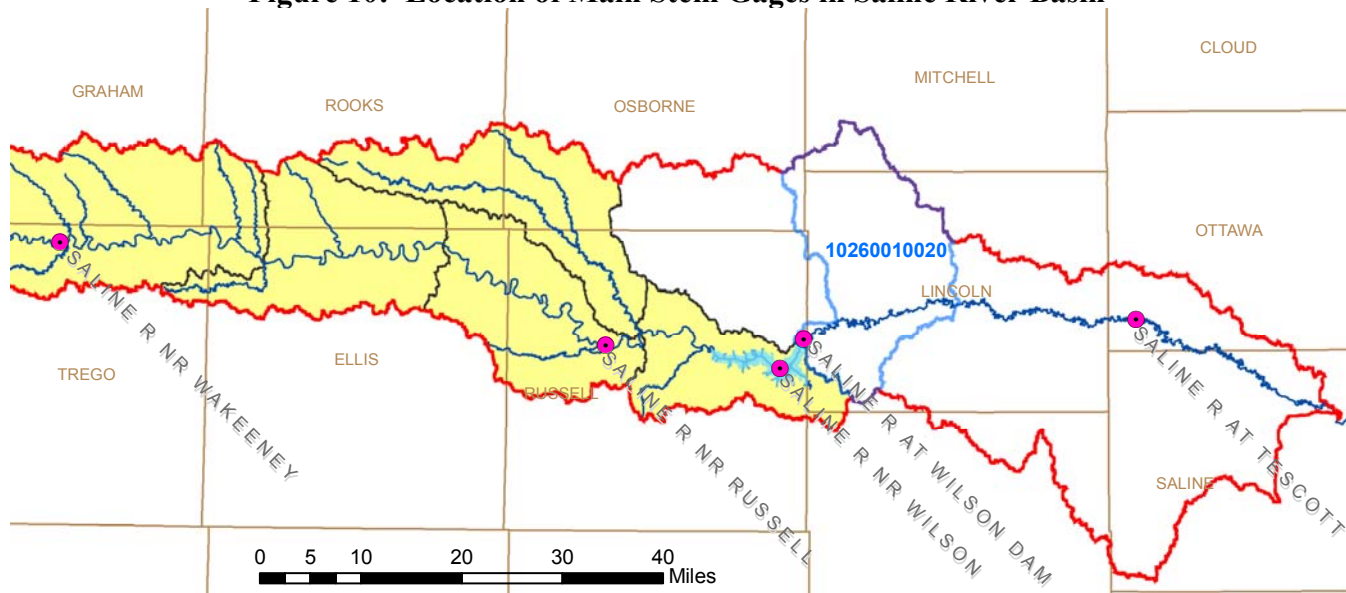


## Downstream Water Rights Bypasses

There is no reservation right for water storage in Wilson Lake, therefore, all downstream water rights are considered senior and should not be impaired by any new allocation. Whenever inflow to the lake is available, enough of that inflow should be bypassed to meet the downstream demands exerted by these senior rights.

In order to estimate how many of those rights must be assured bypasses from the reservoir, the historic streamflow between the Wilson gage and the streamflow gage at Tescott for the 1952-1957 period were compared (gage locations shown in Fig. 10). The gain in streamflow between these gages is more than sufficient to supply all of the downstream alluvial rights for the period. Thus, inflow bypasses are only responsible for meeting the downstream rights directly below the dam. Alluvial consumptive use in the HUC11 just below the dam (10260010020 as labeled in Fig. 10) was estimated by using the same ratio of projected use to current use obtained from the inflow depletion analysis of upstream water use. This estimated consumptive use for the immediate downstream HUC11 was used as the necessary inflow bypass for downstream rights.

**Figure 10: Location of Main Stem Gages in Saline River Basin**



## Water Quality Releases

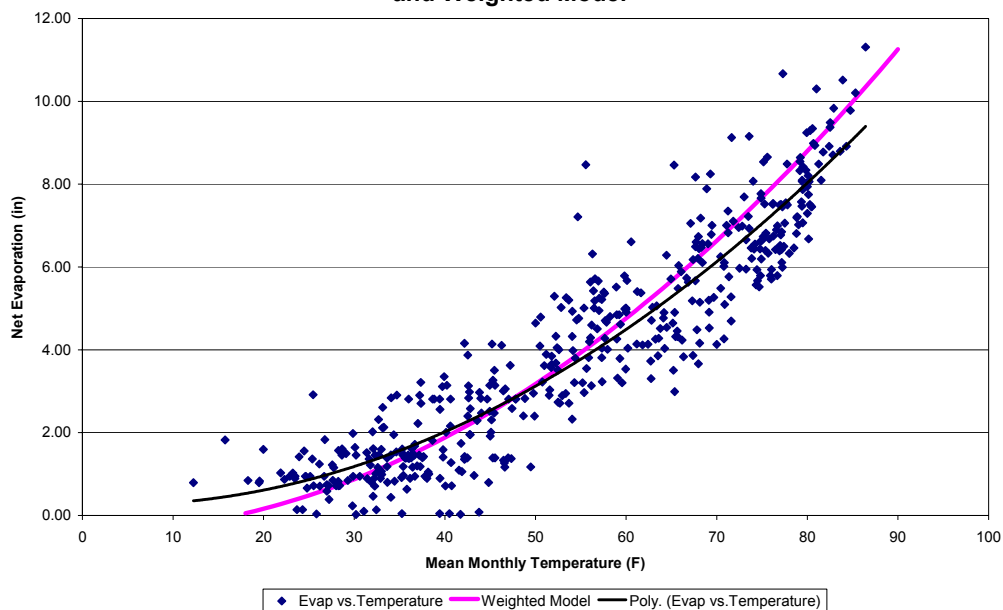
As the State of Kansas and the Corps of Engineers negotiate the reallocation of some of Wilson Lake's multipurpose pool to water supply storage, water quality releases should be maintained. The details regarding the percentage of reallocation and assurances for minimum releases will not be known until after contract finalization. These details impact the amount of water available for allocation to water supply. For this analysis, the reallocation of water will be assumed to be the highest percentage of the multipurpose pool which still maintains the current minimum release requirements in the Wilson Lake Regulation Manual for the forty year yield projection. This forty year yield projection period is set by KWO Administrative Regulation 98-5-8 (a)(4)(see Appendix A). The Wilson Lake Regulation Manual states that the minimum water quality release is 15 cfs for April through September and 5 cfs for October

through March. For this yield analysis, the largest percentage of MP capacity that can be reallocated while maintaining the full minimum releases under the 2044 conditions is 80.6%.

## Evaporation

Evaporation predictions are important to the accuracy of the yield calculations due to large fluctuations in yield which coincide with changes in evaporation models. Monthly lake evaporation losses in units of Acre-Feet (AF) and lake elevation data were obtained from the Corps of Engineers for years 1964 to the present. The monthly lake surface area was interpolated from elevation-capacity tables based on the rate of change in lake capacity per unit of elevation. The evaporation data obtained from the Corps was converted into monthly volumes per unit area, based on the average of the surface area at the beginning and end of the month. Figure 11 shows this monthly lake evaporation per unit area (inches) plotted against mean air temperature measured at the lake for the corresponding months. It shows a lightly scattered relationship between evaporation and temperature; a fitted, least-squares quadratic has an r-squared value of 0.866. Models which analyzed plotted evaporation by the *previous* month’s temperature showed less correlation.

**Figure 11: Evaporation vs. Temperature With Least Squares Trendline and Weighted Model**



When the Corps data for evaporation was plotted alongside the predicted estimations derived from the least-squares trendline, the charts showed that the fitted quadratic is good for predicting evaporation under average conditions, but tends to systematically underestimate actual evaporation during the hottest months. This underestimation becomes even more severe during drier years such as 1974, 1978, 1980 and 1982. Conditions in these years are the most similar to the hot and dry conditions experienced during the drought period this analysis is meant to replicate. Whereas these hottest months have a larger impact on total lake evaporation than the cooler months, it seems that this underestimation could cause yield calculations to be overly optimistic. Manipulating the coefficients in order to weight the model more heavily to the hotter and drier months produced a relationship given by:

$$e_i = c_0 + c_1 T_i + c_2 T_i^2, \tag{1}$$

Where  $c_0 = -0.4$ ,  $c_1 = 0.001$ , and  $c_2 = -0.00145$ . This equation is represented in Figure 10 by the thicker trendline. When predictions from equation (1) were plotted versus historical evaporation data the predictions were less accurate than the least squares model in gauging the net evaporation for average conditions, but more closely replicated net evaporation during hotter, drier months similar to the period of drought. Due to these reasons, Equation (1) using the weighted coefficients will be used to estimate evaporation for this yield analysis.

## Reservoir Yield Simulation

An iterative solution is applied to determine reservoir yield for specified years, including 2000, 2010, 2030 and 2044. The ending year for the simulation, 2044, was established to meet the requirement by regulation that the yield be projected 40 years into the future (see Appendix A for this regulation and further information on simulating reservoir yield). Simulations are implemented in an Excel workbook; calculations for each projected year are set up in a corresponding spreadsheet. The workbook was adapted from one developed for application to Clinton Lake (KWO, 2004).

The calculation of reservoir yield, defined as the maximum rate of release for water supply that can be maintained without completely exhausting water supply storage, is based on a volumetric balance. A simulation of the volumetric balance with monthly time steps for the period 1952-1957 is based on inflows taken from the USGS streamgauge near Wilson, precipitation at Wilson, evaporation as a function of temperature measured at Russell, bypassed inflow for downstream senior rights and minimum water quality release requirements. Inflows are routed through Wilson Lake using a volumetric balance that is calculated on a monthly time step,  $i$ , according to the equation:

$$V_i = V_{i-1} + I_i - E_i - O_i. \quad (2)$$

$V_i$  represents lake storage at the end of the current time step,  $i$ , and equals ending storage for the previous time step,  $V_{i-1}$ , plus inflows ( $I_i$ ), and minus evaporation ( $E_i$ ), and discharge ( $O_i$ ) for the current time step. The projected area-capacity tables are interpolated to calculate lake elevation given ending lake volume, and lake surface area given elevation.

## Precipitation Routing

Direct precipitation over the lake is represented by precipitation measured at Wilson during the drought period 1952-1957, and can be included in the reservoir routing simulation as either a component of evaporation (net evaporation) or a component of inflow. The distinction between these two approaches affects lake storage through the inflow that is considered available for bypassing to meet downstream senior water rights and minimum flow requirements. The first approach (direct precipitation expressed as net evaporation) is used for the base case simulation, however the second approach (direct precipitation as a component of inflow) will be simulated as a variation on the base case as part of sensitivity analysis.

## Sensitivity Analysis

The base case arrived at a 2% yield for 2044 of 29.0 MGD. The results for this case are presented in the summary section in Table 1. Simulation cases were run with rates of inflow, evaporation and sedimentation individually increased or decreased by ten percent in order to determine the sensitivity of water supply yield to these factors. Additional sensitivity cases 7-11 are the following:

- (7) Direct precipitation is included as a component of inflow instead of subtracted from evaporation (see discussion of precipitation routing, above).

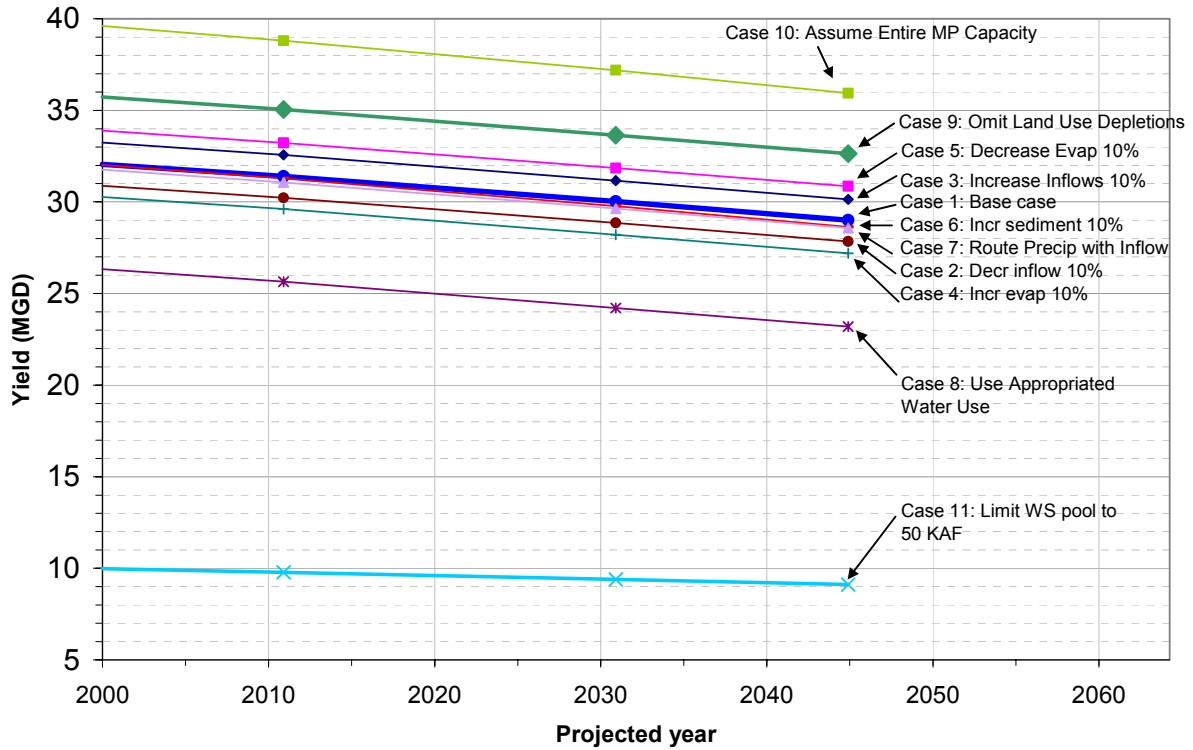
- (8) Inflow depletions for water use are based upon full authorized water right amounts rather than predicted use.
- (9) Inflow depletions exclude the 17.7% reduction accounting for changes in land use (terraces etc.).
- (10) Calculates the yield of the reservoir if minimum water quality releases were not guaranteed (water supply storage equals 100% of MP capacity).
- (11) Calculates the yield of the reservoir if the water supply pool is limited to 50 KAF in 2044

The comparison of sensitivity cases with respect to inflow, evaporation and sedimentation in Table 9 indicates that the calculated yield sensitivity to a change in sedimentation rate is relatively low, decreasing by 0.4 MGD due to a 10 percent increase in sedimentation (see case 6). Table 9 shows the yield sensitivity to be 3 times greater for the same percent change of inflow than to sedimentation (1.2 MGD vs. .4 MGD), and almost five times greater to a change of evaporation than to sedimentation (1.90 MGD vs. 0.4 MGD). Routing precipitation with inflow instead of including it with evaporation (as net evaporation) increased the amount of available inflow yet resulted in a 0.4 MGD (1.5%) reduction in yield. The inflow depletion factor for land use changes resulted in a 3.6 MGD (12.5%) reduction in yield. If the upstream points of diversion use their full allotments according to their water rights, the base case yield would be 5.8 MGD (20%) too high. Allotting the entire MP capacity for water supply (case 10) creates a 6.9 MGD (24%) increase in yield from the base case, which has 19.4 % of the MP capacity allotted for water quality releases. Restricting the water supply storage to 50 KAF in 2044 reduces the yield by 19.9 MGD from the base case (68.57 % reduction). Fig. 12 is a graphical comparison of projected yield for the base and sensitivity cases. `

**Table 9. Sensitivity of 2044 Yield to Inflow, Evaporation, Sedimentation and Accounting.**

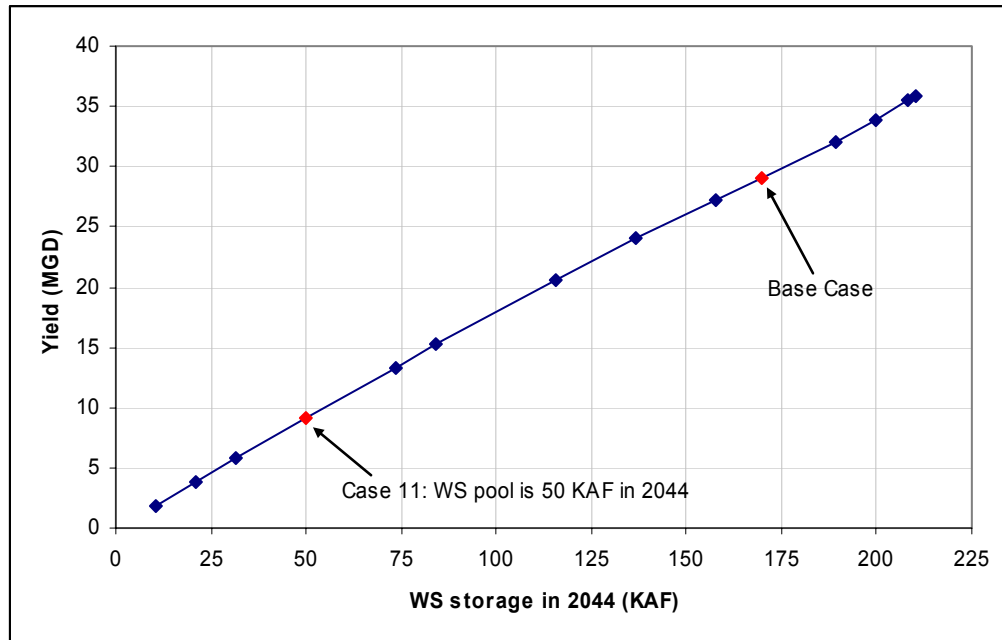
Case	Description	Min Elev (ft abv MSL)	Yield (MGD)	Change from Base Case					Percent Change
				(AF/day)	(KAF/yr)	(cfs)	(MGD)	(MGY)	
1	Base case	1463.63	29.0	0.0	0.0	0.0	0.0	0	0.00%
2	Decrease inflows 10 percent	1461.53	27.8	-3.6	-1.3	-1.8	-1.2	-423	-3.99%
3	Increase inflows 10 percent	1465.21	30.1	3.5	1.3	1.7	1.1	412	3.89%
4	Increase evaporation 10 percent	1460.91	27.2	-5.6	-2.0	-2.8	-1.8	-660	-6.24%
5	Decrease evaporation 10 percent	1466.43	30.9	5.7	2.1	2.9	1.9	679	6.41%
6	Increase sedimentation 10 percent	1463.85	28.6	-1.1	-0.4	-0.6	-0.4	-135	-1.27%
7	Route precip with inflow instead of evap	1462.63	28.6	-1.3	-0.5	-0.7	-0.4	-156	-1.48%
8	Use Appropriated Water Use	1457.11	23.2	-17.8	-6.5	-9.0	-5.8	-2122	-20.04%
9	Omit Depletion Estimate for Land Use	1471.32	32.6	11.2	4.1	5.6	3.6	1327	12.54%
10	Assume Entire MP Capacity Available	1456.05	35.9	21.3	7.8	10.7	6.9	2529	23.88%
11	Limit WS Pool to 50 KAF in 2044	1498.05	9.1	-61	-22.3	30.8	-19.9	-7260	-68.57

**Figure 12: Yield Sensitivity Comparison**



Finally, the effect of varying the water supply storage in 2044 on lake yield was studied by changing the percent of storage allocated to water supply in the base case scenario. The results are plotted in Figure 13.

**Figure 13: Effect of Varying Water Supply Storage on Yield**



## **Conclusions and Recommendations**

The base case in this yield analysis (see Appendix B for printed summary of this case) seems to represent the best assumptions for projecting yield. This uses the actual streamflow data for the drought period of interest and routes precipitation with evaporation. For the base case, the yield was found to be 29.0 MGD (10,588 MGY, 32.5 KAF). The present analysis is based on some uncertainties regarding future climatic and hydrologic conditions and the rate of sedimentation of the lake. The yield sensitivity analysis shows relatively low sensitivity to the sedimentation rate and relatively greater sensitivity to uncertainty in both inflows and evaporation. Each of these factors introduces significant uncertainty into estimates of expected water supply yield. Additionally, long-term climate changes are possible that could adversely affect water supply yield. Notwithstanding the uncertainty inherent in such calculations, it is the conclusion of this analysis that the yield from Wilson Lake for 2044 be taken as 29.0 MGD.

## References

- Kansas Department of Agriculture-Division of Water Resources. Water rights appropriations and reported use data.
- United States Geological Survey. Historical Streamflow Data.
- NCDC and NOAA. Historical climatological data.
- Corps of Engineers-Kansas City District. Area-elevation-capacity tables based on lake surveys performed in 1964, 1984, and 1995 and historical lake budgets. Provided by Stephen Spaulding.
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- Kansas Water Office, 2004. Clinton Reservoir Yield Analysis Report.
- Kansas Water Office, 2004. Kansas River Reservoir Storage Accounting Procedure. See Word file KSR\_pool\_Acctg\_procedure.doc and Excel workbook KLR\_Pool\_Acctg2004.xls in [\\Rain\Pool\Library\Lakes\\_Reservoirs\Accounting\KLR\2004](\\Rain\Pool\Library\Lakes_Reservoirs\Accounting\KLR\2004) .

## Appendix A. Yield Methodology

### Regulation 98-5-8

The yield for Wilson Lake was calculated according to the methodology outlined in Kansas Water Office Administrative Regulation 98-5-8, which was adopted by the Director of the Kansas Water Office and approved by the Kansas Water Authority on October 24, 1996 as follows.

K.A.R. 98-5-8. Determination of reservoir yields through droughts with a two percent chance of occurrence in any one year (Authorized by and implementing K.S.A. 82a-1309, effective November 22, 1996).

(a) In determining the yield of a reservoir through a drought with a two percent chance of occurrence in any one year, the following shall be used by the director:

- (1) The drought which has a two percent chance of occurrence in any one year lies within the continuous drought of record during the years 1952 through 1957;
- (2) The reservoir yield which can be reasonably expected to be maintained during a drought with a two percent chance of occurrence in any one year is the water which would be available from the conservation storage water supply capacity with no shortage through a period equivalent to the hydrologic and climatic record during the years of 1952 through 1957;
- (3) The historical monthly inflows during the years of 1952 through 1957, as adjusted for depletions after 1957, will be routed through the reservoir;
- (4) The conservation storage water supply capacity providing the reservoir yield will be that capacity which is anticipated to be available after 40 years of sedimentation from the time of determining the reservoir yield;
- (5) All conservation storage water supply capacity in a reservoir will be assumed to be fully utilized during the time period of 1952 through 1957, accounting for evaporation from the surface area of the reservoir; and
- (6) Reservoir yields of 100 million gallons per day (100 MGD) or less will be computed to a precision of 100,000 gallons per day (0.1 MGD). Reservoir yields greater than 100 million gallons per day (100 MGD) will be computed to a precision of one million gallons per day (1 MGD).

(b) The reservoir yield may be recalculated after receipt of updated information regarding inflow depths, reservoir sedimentation, or revisions to reservoir operating criteria.

## Definitions

The following definitions paraphrase or clarify the regulation’s specifications for the yield analysis.

**Two-percent drought:** a drought with a two percent chance of occurrence in any one year and assumed to have occurred within the continuous drought of record during the years 1952 - 1957.

**Reservoir inflows:** historic inflows for the period 1952-1957, adjusted for depletions after 1957.

**Downstream water rights:** for the purpose of this analysis, those water rights in the alluvium and located in the HUC-11 downstream from the Wilson Lake dam (Figure 9).

**Reservoir yield:** the maximum rate of constant outflow from the reservoir that can be maintained in addition to that required by downstream senior water rights and minimum releases, and which can be maintained with no shortage through the hydrologic conditions of the period 1952-1957. Reservoir yield is to be determined to the following precision (mgd = millions of gallons per day):

Reservoir yield	Precision
Yield <= 100 mgd	0.1 mgd
Yield > 100 mgd	1 mgd

**Conservation Storage Water Supply Capacity:** The capacity projected to be available 40 years from the time of determining the reservoir yield, requiring that capacity loss due to sedimentation be projected to that time.

## Wilson Lake Yield Spreadsheet Calculations

Spreadsheet calculations for Wilson Lake yield are explained in three parts, illustrated by the first year of the six-year drought period 1952-1957, modified for conditions projected to the year 2044. The first part explains how an overall lake volumetric balance is applied, taking into account bypasses for downstream senior rights and water quality (Table A1). The second part accounts for evacuation of the flood pool and allocation of inflows and evaporation to water quality and water supply pools (Table A2). The third part explains some error checks and the calculation of unmet downstream demand by senior water rights and minimum releases (Table A3).

### Lake volumetric balance (Table A1).

Inflows are routed through Wilson using a volumetric balance that is calculated on a monthly time step,  $i$ , in column H according to the equation

$$V_i = V_{i-1} + I_i - E_i - O_i. \quad (1)$$

$V_i$  represents lake storage at the end of the current time step,  $i$ , which equals ending storage for the previous time step,  $V_{i-1}$ , plus inflows ( $I_i$ ), evaporation ( $E_i$ ), and discharge ( $O_i$ ) for the current time step. Given the ending volume, the ending lake elevation is calculated in col. E in Table A1 by interpolating a table of storage capacity, established at 1 ft. increments and projected to year 2044 in the spreadsheet ‘Capacity’, and using a corresponding spreadsheet ‘Area’ to represent the slope  $dV/dz$  for each interval of

elevation. Col. F in Table A1 shows lake elevation with respect to the top of the multipurpose (MP) pool. Given the elevation, ending lake surface area is calculated in col. G by interpolating the table of lake surface area in the spreadsheet ‘Area’, and using a corresponding spreadsheet ‘dAdz’ to represent the slope  $dA/dz$  for each interval of elevation.

**Table A1. Spreadsheet Columns for Overall Lake Volumetric Balance.**

<b>A</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>O</b>
	<b>end</b>	<b>end</b>	<b>end</b>	<b>end</b>	<b>Dir</b>		<b>Senior</b>	<b>1516</b>	<b>Non-</b>		
	<b>Elev ft</b>	<b>elev ft</b>	<b>Area</b>	<b>Tot vol</b>	<b>prcp</b>	<b>Total</b>	<b>Rights</b>	<b>WQ</b>	<b>Bypass</b>	<b>Net</b>	<b>Lake</b>
<b>I</b>	<b>msl</b>	<b>bl MP</b>	<b>acres</b>	<b>AF</b>	<b>AF</b>	<b>Inflow</b>	<b>bypass</b>	<b>bypass</b>	<b>Inflow</b>	<b>Evap</b>	<b>Dischg</b>
0	1516.00	0.00	9264.5		210,448						
1	1516.00	0.00	9264.4	210,448	210,440	154	6,310	8.7	0	6,302	866
2	1516.00	0.00	9264.4	210,448	210,440	162	6,807	8.7	0	6,798	1,305
3	1516.00	0.00	9264.3	210,448	210,438	1,390	7,982	10.1	0	7,972	-75
4	1516.00	0.00	9264.3	210,448	210,435	2,501	15,793	13.0	0	15,780	218
5	1515.99	-0.01	9263.2	210,448	210,338	950	12,543	110.4	0	12,432	3,330
6	1514.88	-1.12	9123.7	210,448	200,195	888	0	0.0	0	0	6,439
7	1513.81	-2.19	8850.2	200,195	190,716	1,574	0	0.0	0	0	5,539
8	1513.01	-2.99	8731.8	190,716	183,783	3,739	0	0.0	0	0	2,991
9	1511.96	-4.04	8248.0	183,783	175,066	458	0	0.0	0	0	4,903
10	1511.37	-4.63	8072.6	175,066	170,385	0	1,580	10.1	0	1,570	2,914
11	1511.27	-4.73	8042.2	170,395	169,574	1,722	2,086	8.7	0	2,077	-329
12	1511.09	-4.91	7988.2	169,583	168,135	590	1,899	8.7	0	1,891	4

Direct precipitation (col. I) is approximated by the product of precipitation per unit area measured at Wilson Lake for the current time step and the lake surface area at the end of the previous time step.

Projected inflows (col. J, which references spreadsheet ‘Inflow Summary’) are based on the 1952-1957 simulation period, provided by the USGS streamgauge at Wilson, and reduced by depletions from the watershed above the lake. Monthly depletions are based on water rights in 2002, depletions associated with the change in land use, annual reported water use for years 1990-2002, and estimates of the temporal monthly demand patterns for each type of use made of water.

Inflows are bypassed to meet downstream senior water rights requirements (col. K), as limited by available inflows. The remaining non-bypassed inflow,  $[M] = [J] - ([K] + [L])$ , is available for storage in the water supply and quality pools, except for water in the flood pool, which is evacuated in the same time step that it accumulates, and is accounted for below (Table A2).

Lake net evaporation (col. N) as a volume is given by the product of lake surface area at the end of the previous time step,  $A_{i-1}$ , and monthly gross evaporation for the current time step expressed as a function of mean temperature for the current time step minus direct precipitation (col. I) on the lake surface,

$$E_i = A_{i-1}e_i(T_i) - P_i \tag{2}$$

A somewhat more accurate approach than Equation 2 might be to use an average of areas at the beginning and end of each time step. However, this approach makes for a more difficult solution, since the

evaporation becomes dependent on the ending volume through its relationship to area. This problem is avoided by using the area at the end of the previous time step.

Lake discharge (col. O) in Table A1 includes bypassed inflows for downstream senior water rights and water quality plus releases from flood, water quality and water supply storage pools.

**Pool accounting for flood, water supply and water quality pool storage (Table A2)**

Water in the flood pool (col. W) is evacuated in each time step, and is used to meet water supply and water quality requirements (col. X, Y). When the lake is below MP elevation and storage space is available, nonbypassed inflows are stored in the WS and WQ pools according to their relative capacity fractions (80.8 percent for WS and 19.2 percent for WQ; columns R and S). On the other hand, lake evaporation is charged against the WQ and WS pools according to their relative remaining lake storage fractions (col. U and V).

**Table A2. Pool Accounting for Flood, Water Quality and Water Supply Storage.**

A	Q	R	S	T	U	V	W	X	Y	Z	AA
	end	End	Water	Water	Water	Water	Flood				
	WQ	WS	Quality	Supply	Quality	Supply	Pool	FP for	FP for	WS	WQ
I	Vol AF	Vol AF	Inflow	Inflow	Evap	Evap	release	WS	WQ	Rel.	Rel.
0	40,827	169,621								from storage	from storage
1	40,827	169,621	168	698	168	698	5,436	3019	307	0	0
2	40,827	169,621	253	1,052	253	1,052	5,493	2824	278	0	0
3	40,827	169,621	0	0	-14	-60	8,047	3019	307	0	0
4	40,827	169,621	42	176	42	176	15,562	2921	893	0	0
5	40,827	169,621	646	2,684	646	2,684	9,102	3019	922.3	0	0
6	38,685	161,510	0	0	1,249	5,190	0	0	0	2,921	893
7	36,693	154,023	0	0	1,070	4,468	0	0	0	3,019	922
8	35,195	148,588	0	0	576	2,416	0	0	0	3,019	922
9	33,363	141,703	0	0	939	3,964	0	0	0	2,921	893
10	32,805	137,590	305	1,265	555	2,359	0	0	0	3,019	307
11	32,974	136,609	403	1,674	-63	-266	0	0	0	2,921	298
12	33,032	135,111	367	1,524	1	3	0	0	0	3,019	307

**Error checks and downstream deficits (Table A3)**

Error checks include comparison of non-bypassed inflow to the sum of allocated pool inflows (col. AF), and lake storage to sum of pool storage volumes (col. AG). Deficits of unmet demands by downstream senior rights (col. AK) and minimum flow requirements (col. AL) are also calculated.

**Table A3. Error Checks and Unmet Demands for Downstream Senior Rights and Minimum Flow.**

A	AB	AC	AD	AE	AF	AI	AK	AL
I	WQ avail Space for inflow	WS avail Space for inflow	WQ Excess	WS Excess	compare n.b. inflow to sum Infl(wq+ws)	compare vol in CP to sum V(wq+ws)	Senior rights dischg deficit	WQ min dischg deficit
0								
1	168	698	1,055	4,381	5,436	0	40,659	168,924
2	253	1,052	1,066	4,428	5,493	-9	40,574	168,570
3	0	0	1,547	6,426	7,972	-9	40,827	169,621
4	42	176	3,019	12,543	15,562	-10	40,785	169,446
5	646	2,684	1,766	7,336	9,102	-13	40,181	166,938

**Wilson Lake Yield Simulation Cases**

All simulation cases are run using a single Excel workbook named Wilson\_yield\_model\_100704\_jj\_cbg.xls. The case to be simulated is specified in the spreadsheet ‘Cases’, as reproduced below in Table A4, by entering the case number 1-10 into cell A19 (shaded in green in Table A4). The corresponding case name and parameters are referenced by index functions in cells B19:F19, which are in turn referenced by the simulation spreadsheets.

**Table A4. Specifying a Simulation Case to Run: Spreadsheet ‘Cases’**

Case	Description	Inflow	Water Use	Ratio of WS to total MP	Evap rate	Sed rate	Precip as inflow	Land Use Inflow Depletion
1	Base case	1	1	80.6%	1	1	0	17.7%
2	Decrease inflows 10 percent	0.9	1	80.6%	1	1	0	17.7%
3	Increase inflows 10 percent	1.1	1	80.6%	1	1	0	17.7%
4	Increase evaporation 10 percent	1	1	80.6%	1.1	1	0	17.7%
5	Decrease evaporation 10 percent	1	1	80.6%	0.9	1	0	17.7%
6	Increase Sedimentation 10 percent	1	1	80.6%	1	1.1	0	17.7%
7	Route Precip with Inflow Instead of evap	1	1	80.6%	1	1	1	17.7%
8	Use Appropriated Water Use	1	0	80.6%	1	1	0	17.7%
9	Don't Use Depletion Estimate for Land Use	1	1	80.6%	1	1	0	0.0%
10	Assume Entire MP Capacity Available for Yield	1	1	100.0%	1	1	0	17.7%
<b>9</b>	<b>Don't Use Depletion Estimate for Land Use</b>	<b>1</b>	<b>1</b>	<b>80.6%</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>

The iterative solution for reservoir yield can be done by trial and error as follows. For each iteration, a value for reservoir yield is estimated, and reservoir water supply storage is simulated for a six-year period based on drought years 1952-1957 with monthly time steps. The minimum value of reservoir storage

reached during the simulated time period is taken to be the solution of the simulation. The simulation objective is to find the inverse of this solution, which is done by adjusting reservoir yield so that the minimum value of reservoir storage reached during the simulation lies just above zero. Table A5 (below) is used to solve for yield in each projected year. For each projected year, begin with yield (AF/day, column B) set to zero; columns H and I show the corresponding minimum storage volumes in the water supply and water quality pools over the period of simulation. Successively increase yield (constant water supply release rate, column B) until the minimum water supply storage (column H) is reduced nearly to zero.

Simulations for projected years 2000, 2010, 2030 and 2044 are summarized from spreadsheets 'Yld\_2000', 'Yld\_2010', 'Yld\_2030' and 'Yld\_2044' and in the spreadsheet 'YldSum' for a given case.

**Table A5. Solving for Yield and Summarizing Results: Spreadsheet 'YldSum'**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>
<b>3</b>		<b>Case 1:</b>	<b>Base case</b>						
<b>4</b>	<b>Proj.</b>	<b>Yield</b>	<b>Yield</b>	<b>Yield</b>	<b>Yield</b>	<b>Yield</b>	<b>Proj.</b>	<b>WS min</b>	<b>WQ min</b>
<b>5</b>	<b>year</b>	<b>(AF/day)</b>	<b>(KAF/yr)</b>	<b>(cfs)</b>	<b>(MGD)</b>	<b>(MGY)</b>	<b>date</b>	<b>AF</b>	<b>AF</b>
<b>6</b>									
<b>7</b>	2000	98.39694	35.914881	49.61	32.063	11702.9	1/1/2000	1.8	4816.6
<b>8</b>	2010	96.36518	35.173291	48.58	31.401	11461.25	12/1/2010	0.9	4234.5
<b>9</b>	2030	92.15045	33.634913	46.46	30.027	10959.97	12/1/2030	1.4	3066.8
<b>10</b>	2044	89.02101	32.492668	44.88	29.008	10587.77	12/1/2044	1.4	2261.5

# Appendix B: Wilson Lake Spreadsheet Model – Monthly Operations

## Wilson Lake Reservoir Yield (Year 2000)

Yield =	98.387	Af/day=	32.1 MGD	49.6 cfs	35911 AF/yr
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Top of Multi Purpose Pool Elevation = 1,516.0 ft msl  
 Top of Multi Purpose Pool Area = 9208.1 Acres  
 Lowest Water Supply Volume = 4.8 AF  
 Lowest Water Quality Volume = 4,814.0 AF

	Capacity	Fract MP
Total MP Pool Storage =	231,031 AF	100.00%
Water Supply Storage =	186,211 AF	80.60%
Water Quality Storage =	44,820 AF	19.40%

Period	Mo.	Elev (ft)		Water	Water	Total	Non	Water	Water	Net	Water	Water	Lake	Water	Water	WQ	Senior
		MSL	Tot vol	Quality	Supply		Bypass	Quality	Supply	Lake	Quality	Supply		Evap	Evap		
1	Jan	1516.00	231024	44820	186211	5195	5188	167	694	861	167	694	4334	0	0	0	6.8
2	Feb	1516.00	231024	44820	186211	5603	5596	252	1,045	1297	252	1,045	4306	0	0	0	6.8
3	Mar	1516.00	231023	44820	186211	6571	6563	0	0	-74	-14	-60	6645	0	0	0	8.0
4	Apr	1516.00	231021	44820	186211	13000	12990	42	175	217	42	175	12784	0	0	0	10.3
5	May	1515.99	230944	44820	186211	10446	10360	642	2,668	3310	642	2,668	7137	0	0	0	86.8
6	Jun	1514.86	220788	42687	178099	0	0	0	0	6400	1,242	5,160	3843	2,952	891	0	0.0
7	Jul	1513.79	211349	40709	170639	0	0	0	0	5467	1,057	4,410	3971	3,050	921	0	0.0
8	Aug	1512.98	204417	39218	165199	0	0	0	0	2961	570	2,391	3971	3,050	921	0	0.0
9	Sep	1511.93	195736	37399	158337	0	0	0	0	4838	928	3,910	3843	2,952	891	0	0.0
10	Oct	1511.32	190734	36783	153959	1301	1293	251	1,042	2931	560	2,371	3365	3,050	307	0	8.0
11	Nov	1511.17	189530	36882	152654	1717	1710	332	1,379	-333	-64	-268	3255	2,952	297	0	6.8
12	Dec	1510.94	187726	36877	150856	1564	1557	302	1,255	4	1	3	3364	3,050	307	0	6.8
13	Jan	1510.71	185919	36868	149057	2531	2525	490	2,035	977	192	785	3363	3,050	307	0	5.8
14	Feb	1510.47	184066	36815	147257	2240	2234	433	1,801	1055	209	846	3038	2,755	277	0	5.8
15	Mar	1510.22	182070	36764	145313	2754	2747	533	2,214	1386	277	1,109	3364	3,050	307	0	6.8
16	Apr	1509.82	178972	36007	142974	2086	2077	403	1,674	1330	269	1,062	3851	2,952	891	0	8.7
17	May	1509.01	172862	34654	138208	0	0	0	0	2148	432	1,716	3971	3,050	921	0	0.0
18	Jun	1508.17	166750	33308	133442	0	0	0	0	2269	455	1,814	3843	2,952	891	0	0.0
19	Jul	1507.18	159611	31755	127856	0	0	0	0	3169	633	2,536	3971	3,050	921	0	0.0
20	Aug	1506.13	152331	30176	122155	0	0	0	0	3309	658	2,651	3971	3,050	921	0	0.0
21	Sep	1505.03	144774	28549	116225	0	0	0	0	3714	736	2,979	3843	2,952	891	0	0.0
22	Oct	1504.18	139072	27779	111300	589	582	113	469	2921	576	2,345	3364	3,050	307	0	6.8
23	Nov	1504.02	138035	27915	110126	1495	1489	289	1,200	-722	-144	-578	3254	2,952	297	0	5.8
24	Dec	1503.74	136202	27903	108305	1571	1565	304	1,262	41	8	33	3363	3,050	307	0	5.8
25	Jan	1503.30	133382	27696	105693	1018	1011	196	815	474	97	377	3364	3,050	307	0	6.7
26	Feb	1502.94	131033	27534	103505	1896	1889	367	1,523	1207	251	956	3039	2,755	277	0	6.7
27	Mar	1502.52	128401	27352	101057	1756	1748	339	1,409	1022	215	807	3365	3,050	307	0	7.9
28	Apr	1501.84	124077	26337	97750	1149	1139	221	918	1618	345	1,273	3853	2,952	891	0	10.1
29	May	1501.65	122946	25981	97050	3038	2953	573	2,380	37	8	29	4056	3,050	921	0	85.5
30	Jun	1502.37	127423	26677	100907	10997	10835	2,102	8,733	2439	515	1,925	4005	2,952	891	0	162.0
31	Jul	1500.87	118161	24615	93539	0	0	0	0	5452	1,141	4,318	3971	3,050	921	0	0.0
32	Aug	1499.46	109818	22785	87034	0	0	0	0	4365	909	3,455	3971	3,050	921	0	0.0
33	Sep	1498.26	102980	21272	81708	0	0	0	0	2996	622	2,374	3843	2,952	891	0	0.0
34	Oct	1498.07	101931	21410	80528	2665	2657	515	2,142	341	70	271	3365	3,050	307	0	7.9
35	Nov	1497.39	98220	21000	77226	977	970	188	782	1434	301	1,133	3255	2,952	297	0	6.7
36	Dec	1496.85	95314	20770	74551	1018	1011	196	815	560	120	440	3364	3,050	307	0	6.7

# Wilson Lake Reservoir Yield (Year 2000)-Continued

Yield = 98.387 Af/day= 32.1 MGD 49.6 cfs 35911 AF/yr

Top of Multi Purpose Pool Elevation = 1,516.0 ft msl  
 Top of Multi Purpose Pool Area = 9208.1 Acres  
 Lowest Water Supply Volume = 4.8 AF  
 Lowest Water Quality Volume = 4,814.0 AF

Capacity  
 Total MP Pool Storage = 231,031 AF 100.00%  
 Water Supply Storage = 186,211 AF 80.60%  
 Water Quality Storage = 44,820 AF 19.40%

Period	Mo.	Elev (ft) MSL	Tot vol	Water	Water	Total	Non	Water	Water	Net	Water	Water	Lake	Lake	Water	Water	Senior
				Quality	Supply		Bypass	Quality	Supply	Lake	Quality	Supply			Evap	Evap	
					Inflow	Inflow	Inflow	Inflow	Inflow	Evap	Evap	Evap	Disch.	(From Storage)		bypass	bypass
37	Jan	1496.40	92922	20649	72280	1029	1023	198	824	58	13	45	3363	3,050	307	0	6.3
38	Feb	1496.02	90912	20570	70348	1014	1007	195	812	-15	-3	-11	3038	2,755	277	0	6.3
39	Mar	1495.42	87875	20295	67587	1267	1259	244	1,015	938	212	726	3364	3,050	307	0	7.3
40	Apr	1494.68	84280	19406	64883	1513	1503	292	1,212	1254	290	964	3852	2,952	891	0	9.4
41	May	1493.49	78740	18122	60617	0	0	0	0	1579	364	1,216	3971	3,050	921	0	0.0
42	Jun	1492.32	73376	16900	56628	591	440	85	354	1809	416	1,393	3994	2,952	891	0	151.5
43	Jul	1490.71	66415	15256	51153	0	0	0	0	3142	724	2,425	3971	3,050	921	0	0.0
44	Aug	1489.03	59444	13647	45797	0	0	0	0	2994	688	2,306	3971	3,050	921	0	0.0
45	Sep	1488.50	57371	13114	44336	1964	1885	366	1,519	37	8	28	3921	2,952	891	0	78.9
46	Oct	1487.82	54667	12866	41806	2135	2128	413	1,715	1547	354	1,195	3364	3,050	307	0	7.3
47	Nov	1487.01	51550	12569	38987	758	752	146	606	618	146	473	3255	2,952	297	0	6.3
48	Dec	1486.24	48655	12340	36322	717	711	138	573	249	61	188	3363	3,050	307	0	6.3
49	Jan	1485.46	45839	12134	33712	611	604	117	487	64	16	48	3363	3,050	307	0	6.1
50	Feb	1484.82	43561	11992	31575	907	901	175	726	147	39	108	3038	2,755	277	0	6.1
51	Mar	1483.97	40701	11683	29025	1058	1051	204	847	750	206	543	3167	2,853	307	0	7.2
52	Apr	1482.85	37156	10807	26359	778	769	149	620	468	134	334	3852	2,952	891	0	9.2
53	May	1481.05	31939	9521	22418	0	0	0	0	1256	365	891	3971	3,050	921	0	0.0
54	Jun	1482.37	35729	9960	25917	9653	9506	1,844	7,661	1724	514	1,210	3990	2,952	891	0	147.8
55	Jul	1481.81	34060	9339	24995	4756	4474	868	3,606	2038	568	1,478	4253	3,050	921	0	282.4
56	Aug	1479.94	28947	8030	20906	0	0	0	0	1416	388	1,039	3971	3,050	921	0	0.0
57	Sep	1477.62	23367	6660	16708	0	0	0	0	1726	479	1,246	3843	2,952	891	0	0.0
58	Oct	1475.88	19720	6238	13490	387	380	74	306	663	189	474	3364	3,050	307	0	7.2
59	Nov	1474.17	16425	5888	10544	317	311	60	251	359	113	245	3255	2,952	297	0	6.1
60	Dec	1472.27	13148	5555	7599	337	331	64	267	251	90	161	3363	3,050	307	0	6.1
61	Jan	1469.99	10102	5305	4801	327	323	63	260	14	6	8	3361	3,050	307	0	4.2
62	Feb	1466.44	7558	5075	2487	635	631	122	508	142	75	68	3036	2,755	277	0	4.2
63	Mar	1463.12	5209	4994	220	950	945	183	762	-63	-43	-21	3362	3,050	307	0	4.8
64	Apr	1462.43	4812	4814	5	3398	3392	658	2,734	-55	-53	-2	3849	2,952	891	0	6.2
65	May	1481.62	33531	10293	23290	32727	32674	6,339	26,335	-61	-61	0	4023	3,050	921	0	52.7
66	Jun	1508.65	170234	36707	133627	140425	140325	27,223	113,102	-268	-82	-186	3942	2,952	891	0	99.9
67	Jul	1512.44	199925	42256	157858	37572	37381	7,252	30,129	3629	782	2,848	4162	3,050	921	0	190.9
68	Aug	1511.78	194453	40961	153678	3517	3327	645	2,682	4828	1,020	3,812	4160	3,050	921	0	189.5
69	Sep	1512.40	199572	41756	157866	10465	10413	2,020	8,393	1585	334	1,253	3895	2,952	891	0	52.0
70	Oct	1512.40	199589	42076	157517	4560	4555	884	3,672	1227	257	971	3362	3,050	307	0	4.8
71	Nov	1512.29	198678	42220	156463	3112	3107	603	2,505	769	162	607	3253	2,952	297	0	4.2
72	Dec	1512.09	197032	42225	154811	2749	2745	532	2,212	1034	220	814	3361	3,050	307	0	4.2

# Wilson Lake Reservoir Yield (Year 2010)

Yield =	96.353	AF/day=	31.4 MGD	48.6 cfs	35169 AF/yr
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Top of Multi Purpose Pool Elevation = 1,516.0 ft msl  
 Top of Multi Purpose Pool Area = 9220.9 Acres  
 Lowest Water Supply Volume = 5.9 AF  
 Lowest Water Quality Volume = 4,232.1 AF

Capacity  
 Total MP Pool Storage = 226,354 AF 100.00%  
 Water Supply Storage = 182,441 AF 80.60%  
 Water Quality Storage = 43,913 AF 19.40%

Period	Mo.	Elev (ft)		Water	Water	Total	Non	Water	Water	Net	Water	Water	Lake	Water	Water	WQ	Senior
		MSL	Tot vol	Quality	Supply		Bypass	Quality	Supply	Lake	Quality	Supply		Evap	Evap		
1	Jan	1516.00	226347	43913	182441	5195	5188	167	695	862	167	695	4333	0	0	0	6.8
2	Feb	1516.00	226347	43913	182441	5603	5596	252	1,047	1299	252	1,047	4305	0	0	0	6.8
3	Mar	1516.00	226346	43913	182441	6571	6563	0	0	-74	-14	-60	6645	0	0	0	8.0
4	Apr	1516.00	226343	43913	182441	13000	12990	42	175	217	42	175	12783	0	0	0	10.3
5	May	1515.99	226267	43913	182441	10446	10360	643	2,671	3314	643	2,671	7132	0	0	0	86.8
6	Jun	1514.87	216163	41778	174383	0	0	0	0	6409	1,244	5,167	3782	2,891	891	0	0.0
7	Jul	1513.80	206769	39797	166972	0	0	0	0	5484	1,060	4,424	3908	2,987	921	0	0.0
8	Aug	1513.01	199893	38305	161588	0	0	0	0	2969	571	2,397	3908	2,987	921	0	0.0
9	Sep	1511.97	191256	36484	154772	0	0	0	0	4856	930	3,925	3782	2,891	891	0	0.0
10	Oct	1511.35	186318	35869	150457	1301	1293	251	1,042	2929	559	2,370	3302	2,987	307	0	8.0
11	Nov	1511.21	185174	35968	149213	1717	1710	332	1,379	-332	-64	-268	3194	2,891	297	0	6.8
12	Dec	1510.99	183433	35962	147478	1564	1557	302	1,255	4	1	3	3301	2,987	307	0	6.8
13	Jan	1510.77	181691	35954	145742	2531	2525	490	2,035	975	191	784	3300	2,987	307	0	5.8
14	Feb	1510.54	179897	35902	144001	2240	2234	433	1,801	1052	208	844	2981	2,698	277	0	5.8
15	Mar	1510.29	177967	35852	142122	2754	2747	533	2,214	1382	276	1,106	3301	2,987	307	0	6.8
16	Apr	1509.90	174935	35097	139847	2086	2077	403	1,674	1326	267	1,059	3790	2,891	891	0	8.7
17	May	1509.09	168897	33747	135149	0	0	0	0	2139	429	1,710	3908	2,987	921	0	0.0
18	Jun	1508.26	162861	32406	130455	0	0	0	0	2254	450	1,804	3782	2,891	891	0	0.0
19	Jul	1507.27	155811	30860	124951	0	0	0	0	3142	625	2,517	3908	2,987	921	0	0.0
20	Aug	1506.23	148625	29290	119335	0	0	0	0	3278	649	2,629	3908	2,987	921	0	0.0
21	Sep	1505.13	141162	27673	113489	0	0	0	0	3681	725	2,956	3782	2,891	891	0	0.0
22	Oct	1504.28	135542	26910	108639	589	582	113	469	2901	569	2,332	3301	2,987	307	0	6.8
23	Nov	1504.13	134563	27045	107524	1495	1489	289	1,200	-718	-143	-576	3193	2,891	297	0	5.8
24	Dec	1503.86	132793	27033	105766	1571	1565	304	1,262	41	8	33	3300	2,987	307	0	5.8
25	Jan	1503.43	130039	26827	103219	1018	1011	196	815	470	96	375	3301	2,987	307	0	6.7
26	Feb	1503.08	127755	26669	101092	1896	1889	367	1,523	1199	247	952	2982	2,698	277	0	6.7
27	Mar	1502.67	125192	26489	98711	1756	1748	339	1,409	1016	212	804	3302	2,987	307	0	7.9
28	Apr	1502.00	120938	25479	95469	1149	1139	221	918	1609	340	1,269	3792	2,891	891	0	10.1
29	May	1501.82	119870	25123	94833	3038	2953	573	2,380	37	8	29	3993	2,987	921	0	85.5
30	Jun	1502.55	124417	25825	98753	10997	10835	2,102	8,733	2430	509	1,922	3944	2,891	891	0	162.0
31	Jul	1501.06	115242	23777	91458	0	0	0	0	5427	1,127	4,308	3908	2,987	921	0	0.0
32	Aug	1499.66	106983	21960	85023	0	0	0	0	4345	896	3,448	3908	2,987	921	0	0.0
33	Sep	1498.46	100221	20457	79764	0	0	0	0	2981	612	2,369	3782	2,891	891	0	0.0
34	Oct	1498.28	99237	20597	78648	2665	2657	515	2,142	340	69	270	3302	2,987	307	0	7.9
35	Nov	1497.61	95593	20192	75408	977	970	188	782	1428	296	1,132	3194	2,891	297	0	6.7
36	Dec	1497.08	92755	19964	72798	1018	1011	196	815	555	117	438	3301	2,987	307	0	6.7



# Wilson Lake Reservoir Yield (Year 2030)

Yield = 92.149 Af/day= 30.0 MGD 46.5 cfs 33634 AF/yr

Top of Multi Purpose Pool Elevation = 1,516.0 ft msl  
 Top of Multi Purpose Pool Area = 9308.0 Acres  
 Lowest Water Supply Volume = 3.5 AF  
 Lowest Water Quality Volume = 3,066.8 AF

Capacity  
 Total MP Pool Storage = 216,998 AF 100.00%  
 Water Supply Storage = 174,900 AF 80.60%  
 Water Quality Storage = 42,098 AF 19.40%

Period	Mo.	Elev (ft)		Water	Water	Total	Non	Water	Water	Net	Water	Water	Lake	Disch.	Water	Water	WQ	Senior
		MSL	Tot vol	Quality	Supply		Inflow	Bypass	Quality	Supply	Lake	Quality			Supply	Evap		
1	Jan	1516.00	216998	42098	174900	5195	5188	169	701	870	169	701	4325	0	0	0	6.8	
2	Feb	1516.00	216998	42098	174900	5603	5596	253	1,050	1302	253	1,050	4301	0	0	0	6.8	
3	Mar	1516.00	216998	42098	174900	6571	6563	0	0	-75	-14	-60	6646	0	0	0	8.0	
4	Apr	1516.00	216998	42098	174900	13000	12990	42	175	218	42	175	12783	0	0	0	10.3	
5	May	1516.00	216998	42098	174900	10446	10360	645	2,679	3323	645	2,679	7123	0	0	0	86.8	
6	Jun	1514.89	206915	39960	166955	0	0	0	0	6428	1,247	5,181	3655	2,764	891	0	0.0	
7	Jul	1513.84	197619	37973	159646	0	0	0	0	5519	1,066	4,453	3777	2,857	921	0	0.0	
8	Aug	1513.06	190858	36479	154379	0	0	0	0	2984	573	2,411	3777	2,857	921	0	0.0	
9	Sep	1512.03	182314	34654	147660	0	0	0	0	4888	934	3,954	3655	2,764	891	0	0.0	
10	Oct	1511.43	177515	34041	143474	1301	1293	251	1,042	2929	557	2,372	3171	2,857	307	0	8.0	
11	Nov	1511.31	176495	34139	142356	1717	1710	332	1,379	-331	-64	-268	3068	2,764	297	0	6.8	
12	Dec	1511.10	174885	34134	140751	1564	1557	302	1,255	4	1	3	3170	2,857	307	0	6.8	
13	Jan	1510.90	173274	34127	139147	2531	2525	490	2,035	972	190	783	3169	2,857	307	0	5.8	
14	Feb	1510.68	171602	34077	137525	2240	2234	433	1,801	1049	207	843	2863	2,580	277	0	5.8	
15	Mar	1510.45	169808	34029	135779	2754	2747	533	2,214	1377	273	1,104	3170	2,857	307	0	6.8	
16	Apr	1510.07	166910	33277	133633	2086	2077	403	1,674	1320	265	1,056	3664	2,764	891	0	8.7	
17	May	1509.27	161006	31932	129074	0	0	0	0	2126	424	1,702	3777	2,857	921	0	0.0	
18	Jun	1508.45	155122	30599	124523	0	0	0	0	2229	442	1,787	3655	2,764	891	0	0.0	
19	Jul	1507.46	148252	29068	119184	0	0	0	0	3093	610	2,483	3777	2,857	921	0	0.0	
20	Aug	1506.43	141257	27517	113741	0	0	0	0	3217	631	2,586	3777	2,857	921	0	0.0	
21	Sep	1505.35	133988	25922	108066	0	0	0	0	3614	704	2,910	3655	2,764	891	0	0.0	
22	Oct	1504.52	128551	25175	103375	589	582	113	469	2856	552	2,303	3170	2,857	307	0	6.8	
23	Nov	1504.38	127690	25306	102383	1495	1489	289	1,200	-712	-139	-572	3067	2,764	297	0	5.8	
24	Dec	1504.13	126051	25295	100756	1571	1565	304	1,262	41	8	33	3169	2,857	307	0	5.8	
25	Jan	1503.71	123434	25091	98343	1018	1011	196	815	465	93	371	3170	2,857	307	0	6.7	
26	Feb	1503.37	121283	24940	96343	1896	1889	367	1,523	1183	240	942	2864	2,580	277	0	6.7	
27	Mar	1502.99	118865	24766	94099	1756	1748	339	1,409	1003	206	797	3171	2,857	307	0	7.9	
28	Apr	1502.33	114757	23764	90992	1149	1139	221	918	1591	332	1,260	3666	2,764	891	0	10.1	
29	May	1502.19	113896	23409	90487	3038	2953	573	2,380	37	8	29	3863	2,857	921	0	85.5	
30	Jun	1502.96	118662	24124	94538	10997	10835	2,102	8,733	2412	496	1,917	3817	2,764	891	0	162.0	
31	Jul	1501.46	109507	22110	87397	0	0	0	0	5378	1,093	4,285	3777	2,857	921	0	0.0	
32	Aug	1500.07	101410	20317	81093	0	0	0	0	4320	872	3,448	3777	2,857	921	0	0.0	
33	Sep	1498.90	94802	18835	75968	0	0	0	0	2952	591	2,361	3655	2,764	891	0	0.0	
34	Oct	1498.74	93957	18976	74981	2665	2657	515	2,142	339	67	271	3171	2,857	307	0	7.9	
35	Nov	1498.08	90443	18580	71863	977	970	188	782	1423	287	1,136	3068	2,764	297	0	6.7	
36	Dec	1497.57	87743	18357	69387	1018	1011	196	815	547	112	435	3170	2,857	307	0	6.7	

# Wilson Lake Reservoir Yield (Year 2030) - Continued

Yield =	92.149	Af/day=	30.0 MGD	46.5 cfs	33634 AF/yr
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Top of Multi Purpose Pool Elevation = 1,516.0 ft msl  
 Top of Multi Purpose Pool Area = 9308.0 Acres  
 Lowest Water Supply Volume = 3.5 AF  
 Lowest Water Quality Volume = 3,066.8 AF

Capacity  
 Total MP Pool Storage = 216,998 AF 100.00%  
 Water Supply Storage = 174,900 AF 80.60%  
 Water Quality Storage = 42,098 AF 19.40%

Period	Mo.	Elev (ft)	Water		Total	Non Bypass	Water Quality Inflow	Water Supply Inflow	Net Lake Evap	Water Quality Evap	Water Supply Evap	Lake Disch.	Water	Water	WQ bypass	Senior Rights bypass	
			Quality Vol	Supply Vol									Supply (From Storage)	Quality Release			
37	Jan	1497.14912	85545.451	18236	67309	1028.96	1022.7	198	824	56.852	12	44.95798	3169.808	2857	307	0	6.3
38	Feb	1496.79432	83709.85	18158	65552	1013.64	1007.3	195	812	-14.424	-3	-11.34891	2863.662	2580	277	0	6.3
39	Mar	1496.24446	80886.397	17896	62991	1266.83	1259.5	244	1015	919.42	199	719.992	3170.857	2857	307	0	7.3
40	Apr	1495.53808	77471.903	17017	60455	1512.80	1503.3	292	1212	1262.4	279	983.0881	3664.908	2764	891	0	9.4
41	May	1494.33796	72107.077	15747	56360	0.00	0.0	0	0	1587.5	349	1238.815	3777.31	2857	921	0	0.0
42	Jun	1493.18588	67173.336	14567	52607	591.16	439.7	85	354	1718	375	1342.78	3806.932	2764	891	0	151.5
43	Jul	1491.58368	60454.061	13008	47446	0.00	0.0	0	0	2942	638	2303.997	3777.31	2857	921	0	0.0
44	Aug	1489.85343	53768.237	11461	42307	0.00	0.0	0	0	2908.5	626	2282.687	3777.31	2857	921	0	0.0
45	Sep	1489.38549	51964.098	10929	41035	1964.07	1885.2	366	1519	33.864	7	26.64536	3734.346	2764	891	0	78.9
46	Oct	1488.72725	49460.568	10726	38734	2134.89	2127.5	413	1715	1467.6	309	1158.912	3170.857	2857	307	0	7.3
47	Nov	1487.94655	46552.566	10445	36107	758.32	752.0	146	606	598.57	130	468.7605	3067.759	2764	297	0	6.3
48	Dec	1487.21091	43859.543	10222	33637	717.47	711.2	138	573	240.69	54	186.6844	3169.808	2857	307	0	6.3
49	Jan	1486.48482	41238.256	10018	31220	610.55	604.4	117	487	62.188	14	47.69395	3169.653	2857	307	0	6.1
50	Feb	1485.89543	39136.257	9880	29256	906.72	900.6	175	726	145.21	35	109.9331	2863.507	2580	277	0	6.1
51	Mar	1485.12057	36455.67	9587	26868	1057.84	1050.7	204	847	752.04	190	562.1831	2986.38	2672	307	0	7.2
52	Apr	1484.07003	33086.609	8719	24368	777.96	768.7	149	620	482.35	127	355.4955	3664.676	2764	891	0	9.2
53	May	1482.30441	28037.215	7463	20574	0.00	0.0	0	0	1272.1	335	936.8753	3777.31	2857	921	0	0.0
54	Jun	1483.769	32186.51	7963	24223	9653.26	9505.5	1844	7661	1700.7	453	1248.05	3803.216	2764	891	0	147.8
55	Jul	1483.2998	30809.776	7397	23412	4756.02	4473.6	868	3606	2073	513	1560.152	4059.723	2857	921	0	282.4
56	Aug	1481.35627	25595.201	6132	19464	0.00	0.0	0	0	1437.3	345	1092.176	3777.31	2857	921	0	0.0
57	Sep	1479.10362	20284.412	4844	15440	0.00	0.0	0	0	1655.3	397	1258.771	3655.462	2764	891	0	0.0
58	Oct	1477.38484	16851.413	4456	12396	386.88	379.7	74	306	649.2	155	494.1622	3170.677	2857	307	0	7.2
59	Nov	1475.61055	13755.985	4128	9628	317.46	311.3	60	251	345.28	91	253.9802	3067.605	2764	297	0	6.1
60	Dec	1473.77873	10686.5	3814	6872	337.37	331.2	64	267	237.2	71	166.0219	3169.653	2857	307	0	6.1
61	Jan	1471.80223	7831.261	3565	4267	327.09	322.9	63	260	14.667	5	9.432441	3167.663	2857	307	0	4.2
62	Feb	1467.08562	5439.1224	3334	2105	635.00	630.8	122	508	165.62	75	90.23335	2861.517	2580	277	0	4.2
63	Mar	1463.51574	3281.0923	3248	33	950.19	945.3	183	762	-60.137	-37	-23.27013	3168.355	2857	307	0	4.8
64	Apr	1463.1539	3070.2078	3067	3	3398.39	3392.2	658	2734	-52.413	-52	-0.531883	3661.691	2764	891	0	6.2
65	May	1483.71493	32027.871	8546	23482	32726.95	32674.2	6339	26335	-60.735	-61	-0.068275	3830.024	2857	921	0	52.7
66	Jun	1510.3397	168981.59	34953	134028	140424.89	140325.0	27223	113102	-284.18	-76	-208.3596	3755.352	2764	891	0	99.9
67	Jul	1513.97465	198804.36	40503	158302	37572.43	37381.5	7252	30129	3781.4	782	2999.243	3968.237	2857	921	0	190.9
68	Aug	1513.3412	193296.16	39197	154099	3516.51	3327.0	645	2682	5057.9	1030	4027.415	3966.853	2857	921	0	189.5
69	Sep	1513.92521	198374.45	39985	158389	10465.09	10413.1	2020	8393	1679.3	341	1338.779	3707.483	2764	891	0	52.0
70	Oct	1513.9373	198479.56	40303	158177	4560.31	4555.5	884	3672	1286.9	259	1027.468	3168.355	2857	307	0	4.8
71	Nov	1513.84982	197718.85	40445	157274	3111.53	3107.4	603	2505	806.62	164	642.8324	3065.615	2764	297	0	4.2
72	Dec	1513.67666	196213.19	40448	155765	2748.99	2744.8	532	2212	1087	222	864.6328	3167.663	2857	307	0	4.2

# Wilson Lake Reservoir Yield (Year 2044)

Yield = 89.019 Af/day = 29.0 MGD 44.9 cfs 32492 AF/yr

Top of Multi Purpose Pool Elevation = 1,516.0 ft msl  
 Top of Multi Purpose Pool Area = 9264.5 Acres  
 Lowest Water Supply Volume = 3.5 AF  
 Lowest Water Quality Volume = 2,261.6 AF

Capacity Fract MP  
 Total MP Pool Storage = 210,448 AF 100.00%  
 Water Supply Storage = 169,621 AF 80.60%  
 Water Quality Storage = 40,827 AF 19.40%

Period	Mo.	Elev (ft) MSL	Tot vol	Water Quality		Water Supply		Non Bypass		Water Quality		Water Supply		Net Lake		Water Quality		Water Supply		Lake		Water Supply Release (From Storage)		Water Quality Release		WQ bypass		Senior Rights	
				Vol	Vol	Inflow	Inflow	Inflow	Inflow	Evap	Evap	Evap	Evap	Disch.	Evap	Disch.	Evap	Disch.	Evap	Disch.	Evap	Disch.	Evap	Disch.	Evap	Disch.	Evap	Disch.	Evap
1	Jan	1516	210448.43	40827	169621	5194.56	5187.7	168	698	865.82	168	697.8516	4328.738	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.8	
2	Feb	1516	210448.43	40827	169621	5603.06	5596.2	253	1052	1304.7	253	1051.562	4298.392	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.8	
3	Mar	1516	210448.43	40827	169621	6570.94	6563.0	0	0	-74.728	-14	-60.23078	6645.672	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8.0	
4	Apr	1516	210448.43	40827	169621	13000.22	12990.0	42	176	218.03	42	175.7342	12782.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10.3	
5	May	1516	210448.43	40827	169621	10446.37	10359.5	646	2684	3329.9	646	2683.871	7116.501	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86.8	
6	Jun	1514.905	210448.43	38687	161760	0.00	0.0	0	0	6440	1249	5190.665	3561.578	2671	891	0	0	0	0	0	0	2671	891	0	0	0	0	0.0	
7	Jul	1513.8639	200446.82	36696	154527	0.00	0.0	0	0	5543.5	1070	4473.581	3680.297	2760	921	0	0	0	0	0	0	2760	921	0	0	0	0	0.0	
8	Aug	1513.09933	191223.04	35201	149348	0.00	0.0	0	0	2994.4	575	2419.775	3680.297	2760	921	0	0	0	0	0	0	2760	921	0	0	0	0	0.0	
9	Sep	1512.07947	184548.34	33373	142703	0.00	0.0	0	0	4910.4	937	3973.764	3561.578	2671	891	0	0	0	0	0	0	2671	891	0	0	0	0	0.0	
10	Oct	1511.49151	176076.39	32761	138610	1301.29	1293.3	251	1042	2932.3	556	2376.514	3074.479	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	8.0	
11	Nov	1511.37518	171370.91	32859	137585	1717.20	1710.4	332	1379	-330.85	-63	-267.6031	2974.42	2671	297	0	0	0	0	0	0	2671	297	0	0	0	0	6.8	
12	Dec	1511.18515	170444.54	32854	136078	1564.01	1557.2	302	1255	3.8644	1	3.119382	3073.339	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	6.8	
13	Jan	1510.995	168931.35	32848	134571	2531.15	2525.3	490	2035	971.2	189	782.32	3072.32	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	5.8	
14	Feb	1510.78685	167418.99	32798	133036	2240.10	2234.3	433	1801	1048.7	206	842.9118	2775.562	2493	277	0	0	0	0	0	0	2493	277	0	0	0	0	5.8	
15	Mar	1510.56418	165834.86	32752	131388	2753.87	2747.1	533	2214	1375.2	272	1103.236	3073.29	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	6.8	
16	Apr	1510.19603	164140.21	32002	129337	2086.13	2077.4	403	1674	1317.7	263	1054.776	3570.312	2671	891	0	0	0	0	0	0	2671	891	0	0	0	0	8.7	
17	May	1509.40402	161338.32	30660	124878	0.00	0.0	0	0	2119.9	420	1699.409	3680.297	2760	921	0	0	0	0	0	0	2760	921	0	0	0	0	0.0	
18	Jun	1508.58841	155538.14	29333	120428	0.00	0.0	0	0	2215.9	437	1779.118	3561.578	2671	891	0	0	0	0	0	0	2671	891	0	0	0	0	0.0	
19	Jul	1507.60705	149760.62	27812	115206	0.00	0.0	0	0	3061.7	600	2462.01	3680.297	2760	921	0	0	0	0	0	0	2760	921	0	0	0	0	0.0	
20	Aug	1506.58444	143018.65	26274	109889	0.00	0.0	0	0	3174.9	617	2557.487	3680.297	2760	921	0	0	0	0	0	0	2760	921	0	0	0	0	0.0	
21	Sep	1505.50676	136163.46	24693	104333	0.00	0.0	0	0	3575.1	690	2885.279	3561.578	2671	891	0	0	0	0	0	0	2671	891	0	0	0	0	0.0	
22	Oct	1504.69368	129026.74	23960	99764	588.82	582.0	113	469	2818.3	539	2278.948	3073.29	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	6.8	
23	Nov	1504.57221	123723.95	24089	98865	1494.58	1488.8	289	1200	-708.37	-137	-571.1873	2973.401	2671	297	0	0	0	0	0	0	2671	297	0	0	0	0	5.8	
24	Dec	1504.32915	122953.5	24078	97334	1571.18	1565.4	304	1262	40.449	8	32.52467	3072.32	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	5.8	
25	Jan	1503.93097	121411.9	23875	95019	1017.86	1011.1	196	815	462.34	92	370.653	3073.231	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	6.7	
26	Feb	1503.60173	118894.19	23730	93114	1896.14	1889.4	367	1523	1170.8	235	935.7048	2776.473	2493	277	0	0	0	0	0	0	2493	277	0	0	0	0	6.7	
27	Mar	1503.23065	116843.04	23560	90971	1756.00	1748.1	339	1409	993.47	202	791.7044	3074.353	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	7.9	
28	Apr	1502.58024	114531.22	22565	87966	1148.93	1138.8	221	918	1577.5	325	1253.013	3571.678	2671	891	0	0	0	0	0	0	2671	891	0	0	0	0	10.1	
29	May	1502.45512	110530.95	22210	87557	3038.23	2952.8	573	2380	36.528	7	29.0704	3765.763	2760	921	0	0	0	0	0	0	2760	921	0	0	0	0	85.5	
30	Jun	1503.24873	109766.9	22936	91708	10996.60	10834.7	2102	8733	2396.1	485	1911.269	3723.531	2671	891	0	0	0	0	0	0	2671	891	0	0	0	0	162.0	
31	Jul	1501.76849	114643.88	20948	84679	0.00	0.0	0	0	5337.2	1068	4269.408	3680.297	2760	921	0	0	0	0	0	0	2760	921	0	0	0	0	0.0	
32	Aug	1500.39177	105626.39	19172	78461	0.00	0.0	0	0	4313.1	855	3457.742	3680.297	2760	921	0	0	0	0	0	0	2760	921	0	0	0	0	0.0	
33	Sep	1499.23227	97632.974	17704	73432	0.00	0.0	0	0	2934.9	576	2358.615	3561.578	2671	891	0	0	0	0	0	0	2671	891	0	0	0	0	0.0	
34	Oct	1499.09763	91136.464	17847	72542	2664.92	2657.1	515	2142	337.39	66	271.844	3074.353	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	7.9	
35	Nov	1498.45071	90389.641	17458	69511	977.01	970.3	188	782	1423.7	281	1142.578	2974.311	2671	297	0	0	0	0	0	0	2671	297	0	0	0	0	6.7	
36	Dec	1497.95313	86968.659	17237	67129	1017.86	1011.1	196	815	547.61	110	437.6837	3073.231	2760	307	0	0	0	0	0	0	2760	307	0	0	0	0	6.7	



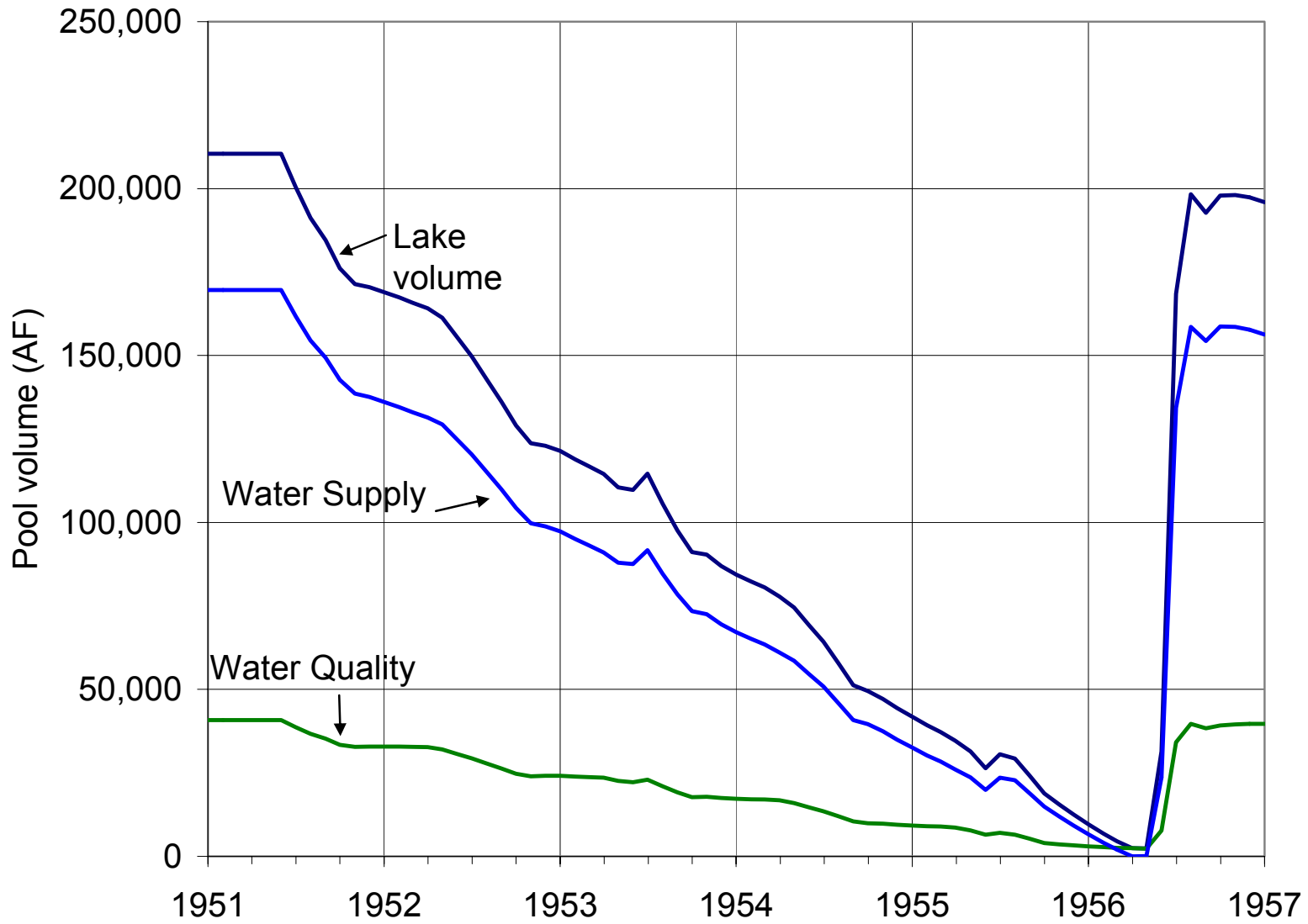


Figure B1: Storage volume for Wilson Lake (Lake Volume), Water Supply and Water Quality Pools for base case projected to 2044

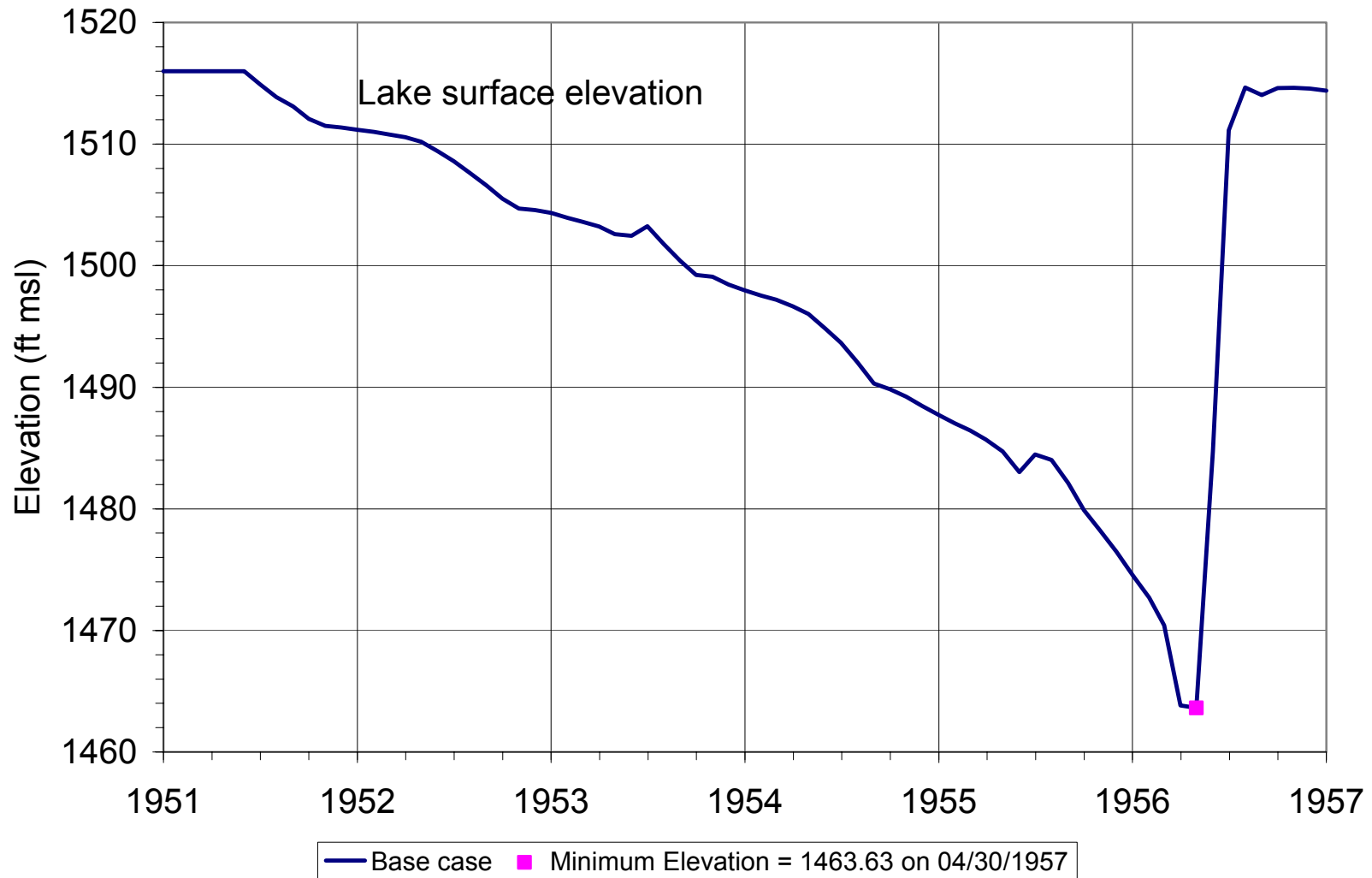


Figure B2: Simulated lake elevation for the base case projected to 2044