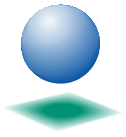
Interbasin Transfer Petition for the Cities of Concord and Kannapolis

Prepared for

North Carolina Environmental Management Commission

November 2004



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Executive Summary

The Cities of Concord and Kannapolis are requesting an interbasin transfer (IBT) certificate from the North Carolina Environmental Management Commission (EMC) for 24 million gallons per day (MGD) on an average day basis from a combination of the Catawba River basin and the Yadkin-Pee Dee River basin to the Rocky River subbasin. The associated maximum day IBT would be up to 38 MGD from the Catawba River Basin and up to 10 MGD from the Yadkin-Pee Dee River Basin. The proposed IBT is the preferred alternative that was identified through the development and analysis of many alternatives that also included several options from the Yadkin River as a potential source basin as well as non-IBT alternatives. The preferred alternative provides the best solution to a regional water supply problem in an area of limited water resources.

Combined, Concord and Kannapolis water systems supply almost 100 percent of the public water supply in Cabarrus County. Cabarrus County is located in the upper reaches of the Rocky River Subbasin, which has a limited watershed for water supply development. Recent master planning for Cabarrus County indicates its available water supply is 31 MGD (50-year safe yield). Based on a 30-year planning period, a 24 MGD available supply shortfall is anticipated by 2035. Section 6 of the *State Water Supply Plan* requires the submittal of a plan by 2007 to eliminate the projected supply shortfall. Therefore, the Concord and Kannapolis water systems must look to alternative sources, primarily the Catawba River or Yadkin River basins, and receive approval of an IBT to obtain additional water supply. Approval of the proposed IBT would be the first step in meeting North Carolina Department of Environment and Natural Resources (NCDENR) water supply planning criteria.

The IBT request is reasonable for the following reasons:

- Concord and Kannapolis have completed extensive master planning to document their water supply shortage.
- The existing water supplies within the Rocky River Subbasin available to Concord and Kannapolis have been fully developed and will be utilized to their capacity by 2015.
- The proposed IBT promotes a balanced solution to a regional problem by utilizing available water resources from both the Catawba and Yadkin – Pee Dee River Basins

The Environmental Impact Statement (EIS) contains an alternative analysis of all the alternatives considered in the development of the document. The EIS concludes that the direct impacts of the IBT on both the source and receiving basins would be insignificant. The project will not significantly change lake elevations, minimum dam releases, surface water hydrology, or water quality in the source or receiving basins. Secondary and cumulative environmental impacts may be potentially significant (due to the possibility that the IBT will facilitate growth and development in Cabarrus County through the eventual provision of water services to the region); however, the implementation of the various mitigation measures reduces these impacts to a level of insignificance.

Acronyms

ADD	average daily demand
cfs	cubic feet per second
CMU	Charlotte-Mecklenburg Utilities
DENR	North Carolina Department of Environment and Natural Resources
DWQ	North Carolina Division of Water Quality
DWR	North Carolina Division of Water Resources
EIS	environmental impact statement
EMC	North Carolina Environmental Management Commission
FERC	Federal Energy Regulatory Commission
gpcd	gallons per capita day
HQW	high quality water
IBT	interbasin transfer
MDD	maximum daily demand
MGD	million gallons per day
NCEPA	North Carolina Environmental Policy Act
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
RRR	Rocky River Regional
SNHA	Significant Natural Heritage Area
USGS	U.S. Geological Survey
WSACC	Water and Sewer Authority of Cabarrus County
WWTP	wastewater treatment plant

Section 1 Requested Action

1.1 Requested Action

The Cities of Concord and Kannapolis are requesting an interbasin transfer (IBT) certificate from the North Carolina Environmental Management Commission (EMC) for 24 million gallons per day (MGD) on an average day basis from a combination of the Catawba River basin and the Yadkin-Pee Dee River basin to the Rocky River subbasin. The associated maximum day IBT would be up to 38 MGD from the Catawba River Basin and up to 10 MGD from the Yadkin-Pee Dee River Basin; however, the total IBT from both sources will not exceed a maximum daily demand (MDD) of 38 MGD or an average daily demand (ADD) of 24 MGD. The proposed IBT is the preferred alternative that was identified through the development and analysis of many alternatives that also included the Yadkin River as a potential source basin as well as non-IBT alternatives. The preferred alternative provides the best solution to a regional water supply problem in an area of limited water resources. The proposed IBT is based on a transfer of raw water from Lake Norman, a transfer of treated water through existing and proposed interconnections with Charlotte-Mecklenburg Utilities (CMU) and the City of Salisbury, and through a transfer of treated water from a proposed interconnection with the City of Albemarle.

Combined, Concord and Kannapolis water systems supply almost 100 percent of the public water supply in Cabarrus County. Cabarrus County is located in the upper reaches of the Rocky River subbasin, which has a limited watershed for water supply development. Recent master planning for Cabarrus County indicates its available water supply is 31 MGD (50 year safe yield). The proposed IBT certificate(s) is based on a 30-year planning period. Projections show that by 2035, an available supply of 55.4 MGD is needed. Based on the safe yield of existing supplies, there is a 24 MGD ADD shortfall in available supply for the year 2035.

The IBT petition provides supporting documentation as required by North Carolina General Statute 143-215.22I; more detailed documentation of the environmental impacts of the requested action are contained in the Draft Environmental Impact Statement (CH2M HILL, 2004) which will be submitted to the State Clearinghouse when the EMC accepts consideration of this petition.

1.2 Background

The City of Concord is located in Cabarrus County adjacent to Mecklenburg County where the City of Charlotte is located. The Concord water system supplies the Concord City limits and adjacent county areas. The City of Kannapolis is located in northern Cabarrus County and southern Rowan County. The Kannapolis water system supplies the Kannapolis city limits in both Cabarrus County and Rowan County, and adjacent Cabarrus county areas. Combined, Concord and Kannapolis water systems supply almost 100 percent of the public water supply in Cabarrus County.

Concord's current raw water supplies include withdrawals from Lake Howell (Coddle Creek Reservoir) operated by the Water and Sewer Authority of Cabarrus County

(WSACC), as well as Lake Concord Reservoir and the Lake Fisher Reservoir. All are located in the Rocky River Subbasin, see Figure 1.

Kannapolis' raw water supply, Kannapolis Lake (Rocky River Subbasin), has a limited watershed of approximately 10 square miles. Kannapolis Lake is classified as a Class I reservoir. However, Kannapolis Lake is supplemented with raw water transfers from Lake Howell (Rocky River Subbasin) and Second Creek (South Yadkin River Subbasin). The transfer from Second Creek is a grandfathered IBT of 6 MGD, but only increases the safe yield of Kannapolis Lake by approximately 2.5 MGD.

Reservoirs are classified by the Division of Environmental Health, Public Water Supply Section (PWSS) as well as by the Division of Water Quality (DWQ). These water supply classifications are shown in Table 1.

TABLE 1
Water Supply Classifications
Concord/Kannapolis IBT Petition

Water Supply	Division of Water Quality	Division of Environmental Health Public Water Supply Section
Kannapolis Lake	WS-III	Class I
Lake Fisher	WS-IV	Class I
Lake Concord	WS-IV	Class I
Lake Howell (Coddle Creek Reservoir)	WS-II; HQW; CA	Class I

Table 2 presents the 50-year and 100-year safe yield amounts available from current water supply sources in Cabarrus County. The combined 50-year safe yield of the local governments is approximately 31 MGD. Table 2 also indicates the available supply can drop by nearly 50 percent to 16.5 MGD during severe droughts like the one experienced in 2002.

TABLE 2
Safe Yield Analysis for Existing Water Supply Reservoirs in Cabarrus County
Concord/Kannapolis IBT Petition

Water Source	Drainage Area (mi^2)	50-Year Safe Yield (MGD)	100-Year Safe Yield (MGD)
Lake Howell	47.0	16.20	7.05
Lake Fisher	18.7	5.15	3.00
Lake Concord	4.7	1.20	0.70
Kannapolis Lake[1]	10.6	8.50	5.70
Total Combined Safe Yield		31.05	16.45

1. Includes transfer of 2.5 MGD 50-year safe yield from Second Creek.

Source: Cabarrus County Water and Wastewater System Master Plan – Safe Yield Update July 2003.

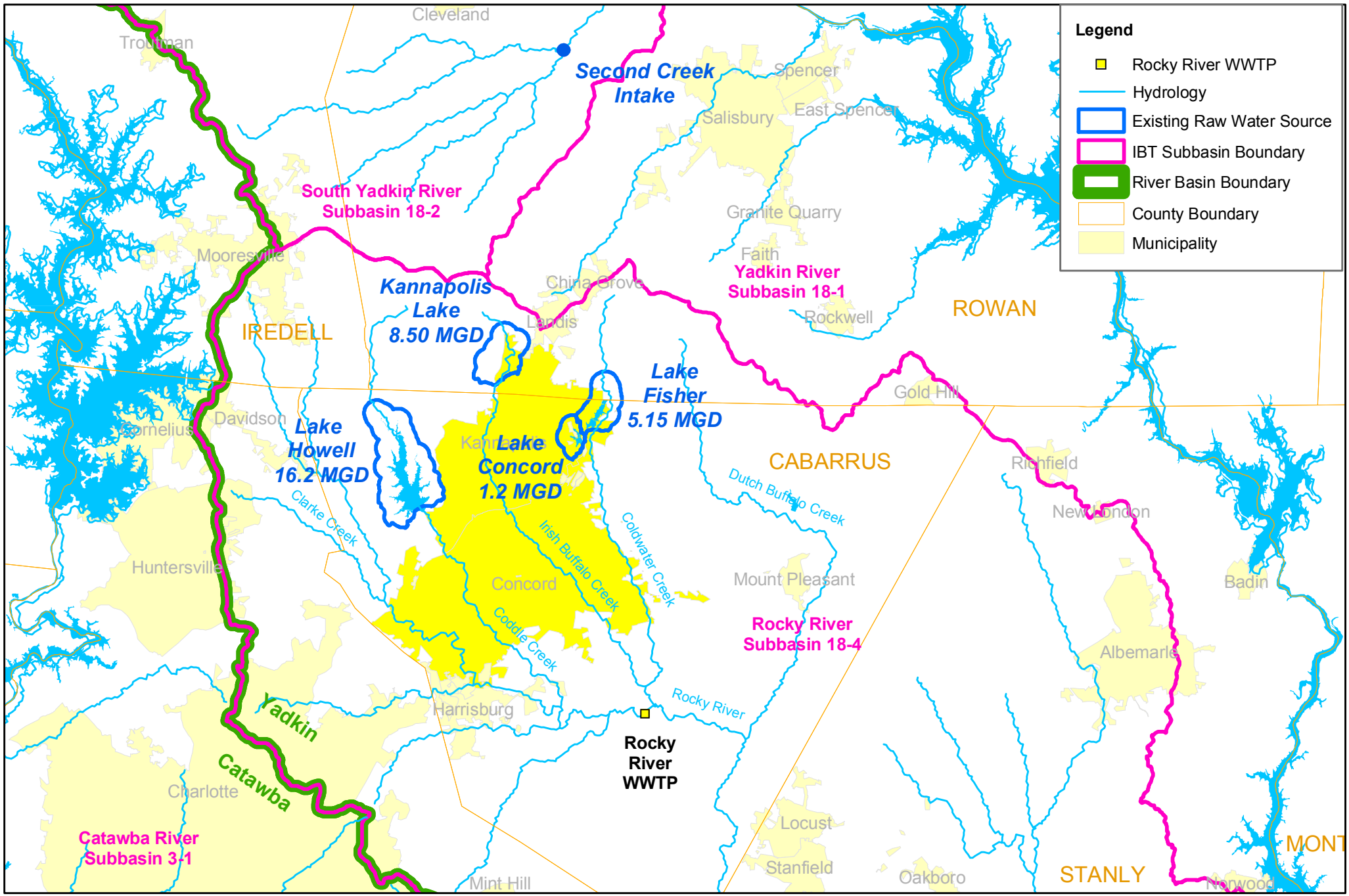

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Figure 1
Existing Raw Water Sources & 50-Year Safe Yields
Concord / Kannapolis IBT Petition

The most recent drought that ended during the fall/winter of 2002 and 2003 has caused the Cities of Concord and Kannapolis to pursue water distribution system improvements with the Cities of Charlotte (< 5 MGD), Albemarle (< 2 MGD) and Salisbury (< 2 MGD) to increase available supply during emergency conditions. IBT that occurs from the CMU interconnections utilize unused permitted IBT capacity. The Salisbury and Albemarle interconnections are limited to < 2 MGD to be in compliance with IBT statutes. The long-range plan for Concord and Kannapolis is to maintain these interconnections as emergency water sources.

1.3 Project Description

The Cities of Concord and Kannapolis are requesting an IBT certificate of 24 MGD on an average day basis and 38 MGD on a maximum day basis, from the EMC. The proposed IBT involves transfer of water from the Catawba River and Yadkin-Pee Dee River Basins to the Rocky River subbasin as shown in Figure 2 and described below:

- Catawba River Subbasin (source basin): Lake Norman, Mountain Island Lake, Lake Wylie, and the Catawba River from Lake Norman to the Wylie Dam.
- Yadkin-Pee Dee River Subbasin (source basin): High Rock Lake, Tuckertown Reservoir, Badin Lake, Lake Tillery, Blewett Falls Lake and the Pee-Dee River between Lake Tillery Blewett Falls Lake.
- Rocky River Subbasin (receiving basin): Cabarrus County, a small portion of Rowan County and the Main stream of the Rocky River to Norwood. The study area is almost entirely located in the Rocky River subbasin of the Yadkin River and includes Coddle, Irish Buffalo and Coldwater Creeks.

All of the water received from the source basins, less consumptive use through irrigation and on-site wastewater disposal, will be directly discharged to the Rocky River Subbasin as treated wastewater from the Rocky River Regional (RRR) WWTP. The RRR WWTP primarily serves Cabarrus County, but also receives some Mecklenburg County flows under a contractual agreement with WSACC.

The Concord and Kannapolis area has enjoyed a healthy economy, resulting in steady population growth and economic development. It is predicted that similar growth patterns will continue, increasing the demand for water and wastewater services. Population and water demand projections are presented in Section 3. The IBT required by the increased withdrawal from the Catawba River and Yadkin-Pee Dee River Subbasins and the increased flows to the Rocky River Subbasin is expected to be 38 MGD maximum day in 2035.

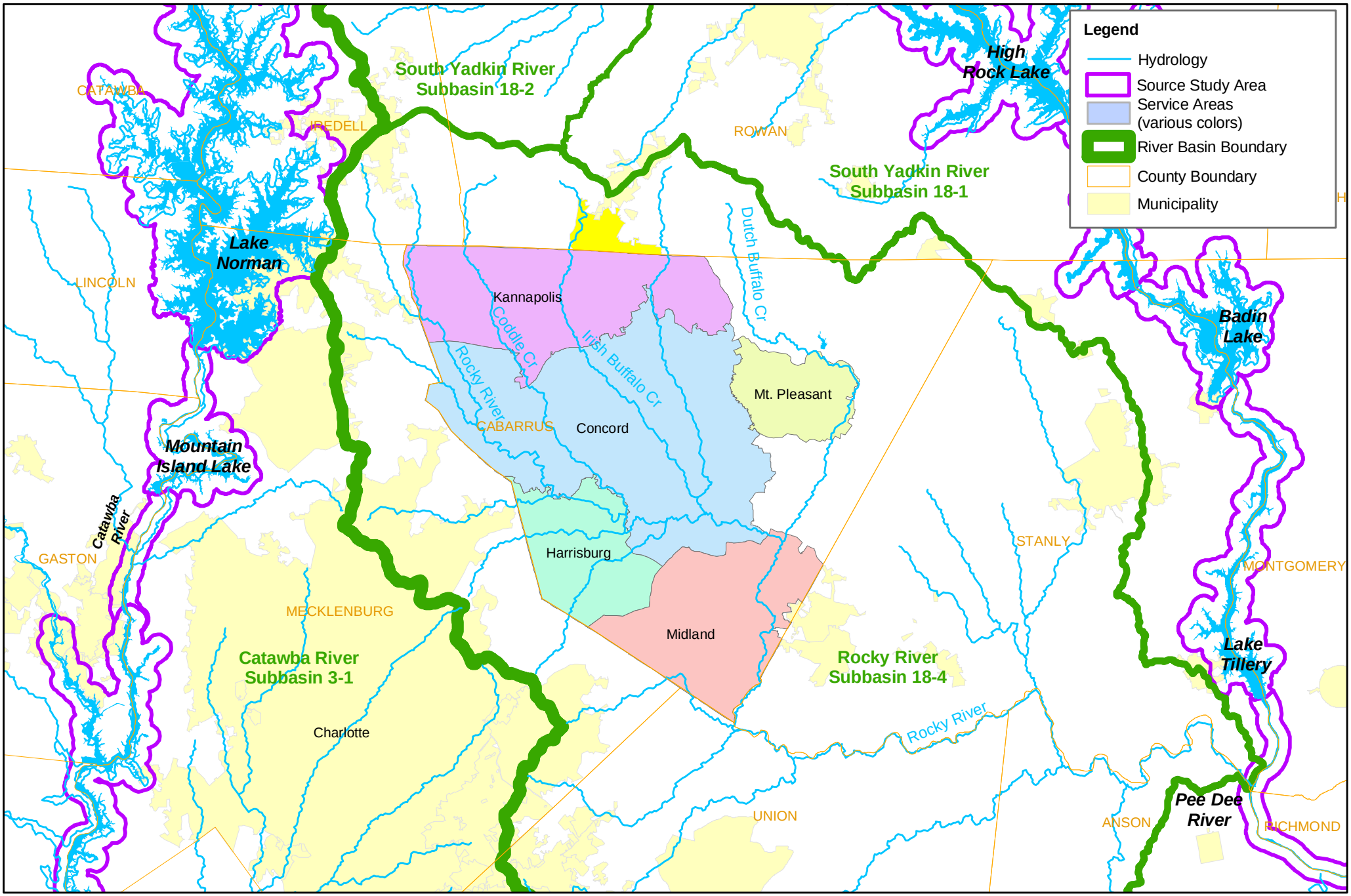

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Figure 2
Current Service Area
Concord / Kannapolis IBT Petition

Section 2 Summary of IBT Certification Process

In 2002, the Cities of Concord and Kannapolis initiated the IBT Certification process in consultation with the DENR and the Department of Administration, State Clearinghouse, by developing a scoping document related to the contents of the IBT Petition. The scoping request was submitted in May 2002. Based on July 2002 comments from the State Clearinghouse, an Environmental Impact Statement (EIS) was developed in compliance with NC General statute 143.215.22I, to examine the impacts of the proposed IBT and for use in the certification process. The EIS process has included involvement, input and comment from federal and state agencies, local municipalities, other stakeholders, and the public. The Draft EIS was submitted for agency review in December 2003. Agency comments were received in January 2004 and incorporated into the EIS.

Section 3 Evaluation Considerations

For ease of review, this section is organized according to the items the EMC is required to evaluate according to North Carolina General Statute 143-215.22I.

3.1 Need for Proposed IBT

3.1.1 Population Growth

Concord and Kannapolis continue to experience a growing demand for drinking water as part of the rapidly growing Charlotte metropolitan area. The primary cause of the area's growth is a bustling economy despite the recent decline in manufacturing and textile industries in the region. As a result of higher wages and low unemployment brought on by this economic growth, the metropolitan area has experienced a steady influx of new workers and residents. Many of these workers and residents are locating in Cabarrus County and the Cities' water service areas, as demonstrated by the recent 2001 Census. Cabarrus County, in which the Cities are primarily located, grew 32 percent between 1990 and 2000. During this same time period Concord grew 105 percent while Kannapolis grew approximately 24 percent. In addition, the incorporated area of Concord has grown from 23 square miles in 1990 to 51 square miles in 2000, a 125 percent increase in size.

An extensive population and land use analysis done by WSACC for its 2002 Water and Wastewater System Master Plan (2002 Master Plan) based future population projections for Cabarrus County on historical and regional growth trends. Table 3 illustrates these projections.

TABLE 3
Population Projections for Cabarrus County Water Service Areas
Concord/Kannapolis IBT Petition

Service Area	2000	2010	2020	2050
Concord/Harrisburg/Mt. Pleasant	72,816	111,311	156,122	281,700
Kannapolis	40,032	63,722	86,207	136,587
Cabarrus County Total	112,848	175,033	242,329	418,287

Source: Cabarrus County Water and Wastewater System Master Plan. December 2002

3.1.2 Water Demand Projections

Continued population growth has resulted in substantial increases in water demand since the 1997 Local Water Supply Plan was submitted to North Carolina Department of Environment and Natural Resources' (DENR) Division of Water Resources (DWR) in 1998. Current water demand projections, Table 4, predict the combined demand will be about 35 MGD ADD by 2020, and 54 MGD in the year 2050.

TABLE 4
Current and Projected Water System Demands for the Cabarrus County Water Service Areas
Concord/Kannapolis IBT Petition

	2000		2010		2020		2050	
Service Area	**ADD**	**MDD**	**ADD**	**MDD**	**ADD**	**MDD**	**ADD**	**MDD**
Concord/Harrisburg/Mt. Pleasant	10.96	17.55	16.61	28.23	21.91	36.64	36.22	59.66
Kannapolis	8.6	11.75	10.83	15.54	12.94	18.92	17.58	26.39
Combined Total	19.6	29.3	27.4	43.8	34.9	55.6	53.8	86.1

Source: Cabarrus County Water and Wastewater System Master Plan, December 2002

3.1.3 Need for Additional Water Supply

Adequate water supply can be determined by comparing the total existing 50-year safe yield (available supply) of the current sources to the predicted ADD. Section 6 of *State Water Supply Plan* requires the submittal of a plan to alleviate the available supply shortfall when the ADD is greater than 80 percent of available supply (80 percent criteria). The ADD should be less than 80 percent of the system's 50-year safe yield to allow for contingencies in the safe yield analysis. Also, this supply buffer can ensure adequate water supply during the planning period needed for securing additional supply if water demands are expected to continue growing in the future. Water demand projections listed in Table 4 indicate the ADD will reach 80 percent of the available supply (31 MGD) in about 2007.

Future water demand projections predict the combined ADD will increase to 53.8 MGD in 2050 (including Mt. Pleasant) requiring a minimum available supply of 67.3 MGD to meet the 80 percent criteria, creating a projected shortfall of 36 MGD.

The proposed IBT certificate(s) will be based on a 30-year planning period. Therefore, the IBT evaluation will be prorated to year 2035, when the ADD is projected to be 44.4 MGD. In order to meet the 80 percent criteria mentioned above, an available supply of 55.4 MGD would be needed. Based on the safe yield of existing supplies, there is a 24 MGD ADD shortfall in available supply for the year 2035.

3.1.4 Reasonableness of IBT Request

The cities of Concord and Kannapolis are requesting an IBT certificate based on the development and analysis of many alternatives identified in the EIS. The EIS is the result of in-depth master planning efforts for all of Cabarrus County completed in 2000 that indicates a future water supply shortage. The proposed request of 24 MGD on an average day basis from a combination of the Catawba River Basin and the Yadkin – Pee Dee River Basin is the result of these planning efforts. The IBT request is reasonable for the following reasons:

- Concord and Kannapolis have completed extensive master planning to document their water supply shortage.
- The existing water supplies within the Rocky River Subbasin available to Concord and Kannapolis have been fully developed and will be maximized by 2015.
- The proposed IBT promotes a balanced solution to a regional problem by utilizing available water resources from both the Catawba and Yadkin – Pee Dee River Basins

3.2 Alternatives to the Proposed IBT

The Concord and Kannapolis water and sanitary sewer services areas are located entirely in the Rocky River Subbasin of the Yadkin River Basin. This location is almost equidistant to the two major rivers that serve this region of North Carolina--the Catawba River and the Yadkin River. The Rocky River flows eastward into the Yadkin River between Lake Tillery and Blewett Falls Lake.

Both of these river basins are a potential source for eliminating the water supply deficit. Both raw water and finished water alternatives have been identified to address the projected 24 MGD (based on ADD) shortfall. Alternatives for additional raw water would replenish the existing reservoirs in Cabarrus County and result in increasing the available supply of the combined systems. Therefore, the IBT certificate for raw water alternatives would be for 24 MGD.

Finished water alternatives will require meeting daily fluctuations of peak demands of the distribution systems. Table 3-6 of the 2002 Master Plan indicates historical maximum day factors between 1995 and 1999 range from as low as 1.21 to a high of 2.2. For master planning purposes, a maximum day factor of 1.6 was used in the 2002 Master Plan. To be consistent with the 2002 Master Plan, a maximum day peak factor of 1.6 is used for finished water alternatives. Therefore, the amount of IBT required for finished water alternatives is 38 MGD on a maximum day basis (24 MGD times 1.6). Alternatives with a combination of finished and raw water sources are adjusted accordingly to the amount of finished water and raw water transferred.

Listed below is a description of the potential sources that can meet the entire supply shortfall by source basin:

Alternative 1 - Catawba River Basin

Alternative 1 is a combination of obtaining finished water from CMU and raw water from Lake Norman for a total IBT of 28 MGD. Eighteen MGD of raw water would be transferred from Lake Norman that would pump through a new raw water main and discharge into Lake Howell in Cabarrus County and Kannapolis Lake in Rowan County. The remaining 10 MGD (6 MGD ADD times 1.6) of finished water would be obtained by utilizing existing and proposed interconnections between the CMU water system and the Concord water system. Currently, Concord uses these interconnections for emergency supply. Alternative 1 would require the development of a water supply contract for 10 MGD with CMU to fund capacity upgrades to the CMU water system.

Alternative 2 - Yadkin-Pee Dee River Basin

Alternative 2 would obtain an IBT of up to 38 MGD (24 MGD ADD) of finished water from Tuckertown Reservoir or Badin Lake. 38 MGD of finished water would be supplied from the Albemarle water system by expanding its system capacity, or expand the existing Albemarle intake(s) and transfer 38 MGD of raw water to a future water treatment plant in northeastern Cabarrus County.

Alternative 3 - Yadkin-Pee Dee River Basin

Alternative 3 would obtain an IBT of 24 MGD of raw water from High Rock Lake. The 24 MGD would be transferred from High Rock Lake and pumped through a new raw water main that would discharge into Lake Howell in Cabarrus County and Kannapolis Lake in Rowan County.

Preferred Alternative

The Preferred Alternative is a combination of Alternatives 1 and 2 where an IBT from both the Yadkin-Pee Dee River and the Catawba River to the Rocky River subbasin will occur. This alternative would continue the utilization of the interconnections with the Cities of Charlotte, Salisbury, and Albemarle to meet short-term increases in demands, and allow Concord and Kannapolis the opportunity to expand the amount of finished water obtained from Charlotte and Albemarle or obtain raw water from Lake Norman. The Preferred Alternative IBT certificate would be for up to 38 MGD (MDD) from the Catawba River Basin and up to 10 MGD (MDD) from the Yadkin-Pee Dee River Basin; however, the total IBT from both sources will not exceed a MDD of 38 MGD or an ADD of 24 MGD. The Preferred Alternative represents a regional solution to meeting water supply needs through cooperation with neighboring communities.

Non-IBT Alternatives

Alternative 4A - Rocky River Supply (Indirect Reuse)

Alternative 4A would withdraw 24 MGD from Rocky River near Midland approximately 10 miles downstream of the Rocky River WWTP and pump raw water up to Lake Howell. This alternative would take advantage of increased river flows due existing grandfathered and previously approved IBTs from upstream waste water treatment plants in the Town of Mooresville, Mecklenburg County, and the Rocky River Regional WWTP in Cabarrus County.

Alternative 4B - Reverse IBT

Alternative 4B would transfer 24 MGD of raw water from Lake Norman to Lake Howell, and simultaneously withdraw 24 MGD from Rocky River near Midland and pump it over to McAlpine Creek near Mint Hill in the Catawba River Basin to mitigate the IBT.

No Action Alternative

Individual systems or community systems would serve future growth areas. These systems would be reliant on groundwater for water supply. An IBT does not occur with this alternative. A summary of the alternatives is listed in Table 5 below.

TABLE 5
Summary of Interbasin Transfer Alternatives (MGD)
Concord/Kannapolis IBT Petition

Alternative	Alt#1		Alt#2		Alt#3		Preferred Alt		Alt#4A, 4B & No Action	
	ADD	MDD	ADD	MDD	ADD	MDD	ADD	MDD	ADD	MDD
Source Basin										
Yadkin-Pee Dee River	0	0	24	38	24	24	<6	<10	0	0
Catawba River	24	28	0	0		0	<24	<38	0	0
Total IBT		28		38		24	24	38		0
Receiving Basin	Rocky River		Rocky River		Rocky River		Rocky River		N/A	

3.3 Present and Future Impacts on Source Basins

The section summarizes the findings of the EIS regarding the present and future impacts within the source basins on the following:

- Water Supply
- Wastewater Assimilation
- Water Quality
- Fish & Wildlife
- Navigation
- Recreation
- Hydroelectric Power Generation

3.3.1 Water Supply

Catawba River Basin

In a previous study for a proposed 163 MGD ADD withdrawal by CMU, Duke Power has stated that they expect to operate the reservoirs of the Catawba-Wateree Project within the same elevation ranges that they have been historically operated. Duke Power currently operates its system to meet a minimum daily average flow of 411 cubic feet per second (cfs).

In 2001, a Computer Hydro-electric Operations and Planning Software (CHEOPS) model was developed to evaluate CMU's increased annual withdrawal to 163 MGD and the associated increase in consumptive use for reservoirs in the Catawba River system. The approach used to analyze the impacts of the proposed IBT of 24 MGD on the Catawba River

– Wateree Project was to perform a "desk top" analysis of the impacts by using the results of the CHEOPS model run for the CMU impact analysis. Duke Power is in the process of conducting several studies related to FERC relicensing including the development of a water supply plan and updating the CHEOPS model. The completion of this effort was not available at the time this document was produced, so the results of this analysis are based on the existing model.

The results of the CHEOPS modeling were modified to include the proposed 24 MGD IBT as a consumptive use as if it had been included in the original modeling effort. The focus of this analysis is utilizing the modeling results for the cumulative scenario for the year 2030 used in the CHEOPS model. This scenario is based on a projected 96 MGD increase in consumptive use in the Catawba River basin in Lake Wylie, Mountain Island Lake, Lake Norman and upstream (from an estimated 243 MGD in 2000 to 339 MGD in 2030). This of course does not include CMU's return of water to the basin downstream of Lake Wylie. The minimal effect of the increasing the projected increase in consumptive use from 96 to 120 MGD, by including the proposed 24 MGD IBT, results in little or no changes to the conclusions regarding lake levels, downstream flows, water supply withdrawals, and hydroelectric power generation that were presented in the original study.

During a drought situation, CMU, Concord, and Kannapolis would be following their Water Shortage Response Plans, which include either voluntary or mandatory conservation measures depending on the severity of the drought. The results of the CHEOPS modeling previously discussed do not consider conservation measures customarily implemented in a drought period which tend to reduce water use rates. Therefore, the expected impacts on lake surface elevations and cumulative reservoir outflows during a drought would be less severe than those presented.

In conclusion, potential impacts to water supply withdrawals due to the proposed additional 24 MGD withdrawal are almost negligible since lake levels are maintained for project operation purposes as discussed previously.

Indirect impacts associated with expanding pumping facilities, existing wastewater treatment plants, raw water transmission lines, water treatment plants, and the finished distribution system will be permitted separately under appropriate state and federal programs. Their environmental impacts will therefore be evaluated under a parallel NCEPA process.

The interbasin transfer will not affect the provision of water or sewer services in the Catawba source basin. The project will therefore not change the existing pattern or rate of growth expected in the source basin. There are no secondary or cumulative impacts in the source basin directly related to the transfer of water.

Yadkin River Basin

ALCOA Power Generating Inc. responded to a request to evaluate the potential impacts on lake levels, stream flows, and power generation on High Rock Lake, Tuckertown Reservoir, and Badin Lake/Narrows Reservoir of the Yadkin Hydroelectric Project. Based on the information provided, a straight line projection of lake level impacts was performed. The analysis showed a monthly reduction in lake levels ranging from 0.19 to 1.03 feet for the three lakes, depending on lake levels. This conservative analysis is based on the assumption that inflow into the lake is zero. ALCOA reports that water withdrawals from the Yadkin reservoirs will have only a minor impact on lake levels, unless withdrawals approach 14

MGD at Tuckertown Reservoir. However, maximum day withdrawal from the Yadkin River basin will not exceed 10 MGD and will be from both Badin Lake and Tuckertown Reservoir.

The proposed transfer does not require the construction of additional water intake structures. Indirect impacts associated with expanding pumping facilities, existing wastewater treatment plants, raw water transmission lines, water treatment plants, and the finished distribution system will be permitted separately under appropriate state and federal programs. Their environmental impacts will therefore be evaluated under a parallel NCEPA process.

The proposed transfer will not result in significant adverse impacts related with water availability for other existing and future users of water in the source basin.

There are no secondary impacts on water supply related to growth due to the transfer of water from the source basin. There are no significant cumulative impacts in the source basin directly related to the transfer of water.

3.3.2 Wastewater Assimilation

Catawba River Basin

There are no expected significant direct impacts in the wastewater assimilation capacity in the source basin as the result of the 24 MGD transfer of water from Lake Norman. The hydrology of the system will not be affected in any major manner due to the proposed transfer. Therefore, the assimilative capacity of the surface waters in the source basin is not expected to change due to the proposed transfer of water. In addition, DWQ discourages lake dischargers.

There are no secondary impacts on water quality related to growth due to the transfer of water from the source basin. There are no significant cumulative impacts in the source basin directly related to the transfer of water.

Yadkin River Basin

There are no expected significant direct impacts in the wastewater assimilation capacity in the source basin as the result of the 10 MGD transfer of water from the Yadkin River Basin. Removing 10 MGD of water from the Yadkin system is less than 2 percent of the low flow estimated by Yadkin, Inc between 1980 and 2000 coming into High Rock Lake. By the time the water reaches Blewett Falls Lake, a large portion of the water will be returned to the Pee Dee River through the Cabarrus County discharge into the Rocky River. In addition, the hydrology of the system will not be affected in any major manner due to the proposed transfer. Therefore, the assimilative capacity of the surface waters in the source basin is not expected to change due to the proposed transfer of water. In addition, DWQ discourages lake dischargers.

There are no secondary impacts on water quality related to growth due to the transfer of water from the source basin. There are no significant cumulative impacts in the source basin directly related to the transfer of water.

3.3.3 Water Quality

Catawba River Basin

Direct impacts in the water quality of surface waters in the source basin are not expected because there will not be any major changes in the hydrology of the system due to the increased withdrawal. Since the hydrology of the system will not be affected in any major manner due to the proposed transfer, water quality should not be affected in Lake Norman, Lake Wylie, Mountain Island Lake or in the other surface waters of the study area in the source basin.

As previously mentioned, there are no secondary impacts on water quality related to growth due to the transfer of water from the source basin. There are no significant cumulative impacts in the source basin directly related to the transfer of water.

Yadkin River Basin

There are no expected significant direct impacts in water quality in the source basin as the result of the transfer of water from the Yadkin lakes. Direct impacts in the water quality of surface waters in the source basin are not expected because there will not be any major changes in the hydrology of the system due to the increased withdrawal.

The proposed transfer does not require the construction of additional water intake structures. Indirect impacts associated with expanding pumping facilities, existing wastewater treatment plants, raw water transmission lines, water treatment plants, and the finished distribution system will be permitted separately under appropriate state and federal programs. Their environmental impacts will therefore be evaluated under a parallel NCEPA process.

There are no secondary impacts on water quality related to growth due to the transfer of water from the source basin. There are no significant cumulative impacts in the source basin directly related to the transfer of water.

3.3.4 Fish and Wildlife Resources

Catawba River Basin

In total, there are 3 rare natural communities, one special animal habitat, 2 rare and one special concern vertebrate animal species, and one sensitive vascular plant species potentially existing in the source basin. There is also a substantial number of recreational fishery species that exist in the lake that compose the source basin. No construction is associated with this project; thus there are no direct impacts on rare communities. Construction activities will need to be permitted separately.

Both aquatic and terrestrial resources that inhabit lake or stream-side habitat, including aquatic and wetland plants, freshwater mussels, and fisheries in the source basin, could be directly affected by water quality and quantity changes from transfers of water out of the basin, if lake elevations or the volume or rate of flow between reservoirs change dramatically. Such changes could lead to either flooding or draining of sensitive species or habitat areas, or shifts in water quality, depending on how the hydrology in the system changes. With no significant changes to lake elevation, lake and basin hydrology, or water quality in the source basin, the interbasin transfer project will not have any significant direct impact on fish, aquatic, wildlife, or sensitive resources within the study area.

The interbasin transfer will not affect the provision of water or sewer services or other infrastructure in the source basin around Lake Norman. The project will not change the existing pattern or rate of growth expected in the study area. The interbasin transfer will not, when considered with other water withdrawal projected from the reservoir system, cause significant cumulative lake elevation changes or water quality impacts. Therefore, the project will not have any secondary or cumulative impacts to fish, aquatic or terrestrial wildlife resources, or sensitive species in the Lake Norman study area.

Yadkin River Basin – Tuckertown Reservoir

In total, there are 3 SNHAs, three natural communities, 2 threatened vertebrate animal species, and 5 significantly rare sensitive vascular plant species and one state endangered vascular plant potentially existing in the study area. n addition, there is a substantial number of recreational fishery species that exist in Tuckertown Reservoir.

Both aquatic and terrestrial resources that inhabit lake or stream-side habitat, including aquatic and wetland plants, freshwater mussels, and fisheries in the source basin, could be directly affected by water quality and quantity changes from transfers of water out of the basin, if lake elevations or the volume or rate of flow between reservoirs change dramatically. Such changes could lead to either flooding or draining of sensitive species or habitat areas, or shifts in water quality, depending on how the hydrology in the system changes.

However, with no significant changes to lake elevation, lake and basin hydrology, or water quality in the source basin due to the IBT, the project will not have any significant direct impact on fish, aquatic, wildlife, or sensitive resources. The proposed IBT does not require the construction of additional water intake structures in the Reservoir. Any proposed pumping stations and conveyance lines associated with implementing the transfer will be permitted separately under appropriate state and federal programs and their fish, wildlife, and sensitive species impacts evaluated under a separate NCEPA or NEPA process.

The IBT will not affect the provision of water or sewer services or other infrastructure in the source basin around Tuckertown Reservoir nor will it change the existing pattern or rate of growth. The interbasin transfer will not, when considered with other water withdrawal projected from the reservoir system, cause significant cumulative lake elevation changes or water quality impacts. The project will therefore not have any secondary or cumulative impacts to fish, aquatic or terrestrial wildlife resources, or sensitive species in the source basin.

Yadkin River Basin – Badin Lake

In total, there are 5 SNHAs, 7 natural communities, one endangered and one special concern vertebrate animal species, and one threatened and one significantly rare vascular plant species potentially existing in the Badin Lake study area. n addition, there is a substantial number of recreational fishery species that exist in the study area.

Both aquatic and terrestrial resources that inhabit lake or stream-side habitat, including aquatic and wetland plants, freshwater mussels, and fisheries in the source basin, could be directly affected by water quality and quantity changes from transfers of water out of the basin, if lake elevations or the volume or rate of flow between reservoirs change dramatically. Such changes could lead to either flooding or draining of sensitive species or

habitat areas, or shifts in water quality, depending on how the hydrology in the system changes.

However, with no significant changes to lake elevation, lake and basin hydrology, or water quality in the source basin due to the IBT, the project will not have any significant direct impact on fish, aquatic, wildlife, or sensitive resources. The proposed IBT does not require the construction of additional water intake structures in the lake. Any proposed pumping stations and conveyance lines associated with implementing the transfer will be permitted separately under appropriate state and federal programs and their fish, wildlife, and sensitive species impacts evaluated under a separate NCEPA or NEPA process.

The IBT will not affect the provision of water or sewer services or other infrastructure in the source basin around Badin Lake nor will it change the existing pattern or rate of growth. The IBT will not, when considered with other water withdrawals projected from the reservoir system, cause significant cumulative lake elevation changes or water quality impacts. The project will therefore not have any secondary or cumulative impacts.

3.3.5 Navigation

Catawba River Basin & Yadkin River Basin

No direct or indirect impacts of the proposed IBT on navigation in the source basin are expected.

3.3.6 Recreation

Catawba River Basin & Yadkin River Basin

The IBT will not significantly alter the availability of water to the source basin to serve existing and projected land uses in the source basin. The IBT will not, when considered with other water withdrawal projected from the reservoir system, cause significant cumulative elevation changes in any of the study area lakes, nor will water quality in any of the water bodies change substantially. Minimum releases of water from the various reservoirs in the chain will not change, even under severe drought conditions. No land uses, public areas, or recreational sites will be flooded or drained with the transfer. The project will therefore not change the existing recreational use in the source basin.

3.3.7 Hydroelectric Power Generation

Catawba River Basin

Direct impacts of the proposed IBT on hydroelectric power generation in the Catawba River subbasin are not expected to be significant. The addition of 24 MGD of withdrawal to the cumulative 2030 analysis with the CHEOPS model for an average and dry year modeling scenarios, has little or no additional impact on the downstream releases from Lake Wylie. Duke Power has also has stated that, as withdrawals and interbasin transfers increase, they expect to operate the reservoirs of the Catawba-Wateree Project within the same elevation ranges that they have been historically operated within. This limits the potential impacts of the proposed increase in withdrawal to the cumulative reservoir outflows and power generation. The IBT contribution to these potential impacts is minor.

Yadkin River Basin

ALCOA Power Generating Inc. responded to a request to evaluate the potential impacts on lake levels, stream flows, and power generation on High Rock Lake, Tuckertown Reservoir, and Badin Lake/Narrows Reservoir of the Yadkin Hydroelectric Project. Based on the information provided, a straight line projection of lake level impacts was performed. The analysis showed a monthly reduction in lake levels ranging from 0.19 to 1.03 feet for the three lakes, depending on lake levels. This conservative analysis is based on the assumption that inflow into the lake is zero. ALCOA reports that water withdrawals from the Yadkin reservoirs will have only a minor impact on lake levels, unless withdrawals approach 14 MGD at Tuckertown Reservoir. However, maximum day withdrawal from the Yadkin River basin will not exceed 10 MGD and will be from both Badin Lake and Tuckertown Reservoir.

ALCOA reports that, it has the potential to loose 1,300 to 1,500 mega-watt hours per year for a 5 MGD IBT and 5,000 to 7,000 mega-watt hours per year of power generation for a 23 MGD IBT.

3.4 Present and Future Impacts on Rocky River Subbasin (Receiving Basin)

This section summarizes the findings of the EIS regarding the present and future impacts within the Rocky River Subbasin on the following:

- Water Quality
- Wastewater Assimilation
- Fish & Wildlife
- Navigation
- Recreation
- Flooding

3.4.1 Water Quality

The transfer of water will result in additional wastewater being discharged into the receiving basin through the Rocky River Regional WWTP (existing). It is estimated that in addition to the proposed IBT, previously approved IBTs and grandfathered amounts will be added cumulatively to the Rocky River from this point source. No increase in the permitted flow at the treatment plant will be needed to accommodate the increased flows from the IBT.

Primary impacts to water quality from the IBT originate from the operation of existing wastewater treatment facilities. These NPDES permits were issued to protect instream water quality. The permitting process for each of these facilities has complied with the NCEPA requirements. DWQ's anti-degradation policy requires that only the alternative that causes the least amount of environmental damage can be permitted under the NPDES program.

Direct impacts related to flooding and streambank erosion due to an increase in stream flow are not expected to be significant. Again, the permitted NPDES flows will handle the proposed IBT flow amounts. Average annual stream flow in the Rocky River, downstream from Crooked Creek, is expected to increase from 663 cfs to approximately 690 cfs at permitted flows, or about 4 percent. The expected increase is minor and well within the

historical stream flow variability based on a flow duration analysis conducted in conjunction with the Raleigh Office of USGS.

Finally, the ratio of the additional wastewater (26 cfs) to the drainage area of the Rocky River (683 mi^2), below Crooked Creek, is less than 0.40. DWR has asserted, based on studies conducted in Piedmont streams (DWR, 1987), that floodwater carrying capacity, streambank erosion, and fish habitat need not be considered in detail for NCEPA documentation or for NPDES permit decisions when the aforementioned ratio is less than 0.40. In light of the above and the fact that current NPDES permitted flows will accommodate the IBT, the proposed IBT is not expected to result in significant flooding and/or additional streambank erosion from current levels. Therefore, further analyses, such as stream flow modeling or estimates of streambank erosion, were not deemed necessary.

Dense urban development from full build-out of the receiving basin may continue this downward trend for water quality in the receiving basin. Potentially significant indirect or secondary impacts on water quality and aquatic habitat in areas adjacent to and downstream of the receiving basin area may occur with full urbanization.

Short-term declines in water quality from installation of sewer and water lines, public facility construction projects, and long-term declines in water quality from land use changes may have significant impacts on water quality and subsequent impacts on aquatic habitat, wetlands, and sensitive aquatic and amphibian species in the receiving basin.

Changes in land use have a major effect on both the quantity and quality of stormwater runoff. Urbanization and land use development, if not properly planned and managed, can dramatically alter the natural hydrology and riparian buffers of an area. Impervious surfaces increase the volume and rate of stormwater runoff. These changes lead to more frequent and severe flooding and also lead to degradation of water quality from the various stormwater pollutants that wash off impervious areas during rain events (e.g. sediments, nutrients, pathogen-indicators). As imperviousness increases, the more impacted surface waters become from pollution and flooding. The cumulative effects of stormwater runoff are evident in the frequent correlation between the location of a stream and its water quality, where urban streams overall have poorer water quality than rural streams. Mitigation measures to address these issues related to growth are summarized in Appendix A.

A major positive secondary impact of the IBT and the construction of regional public water and wastewater collection systems in the receiving basin will be the eventual elimination of privately owned package treatment plants. Potential reductions of discharges into low flow streams from existing public WWTPs, adequate maintenance of sewer lines to prevent overflows, and public enforcement actions on failing septic systems will protect surface waters from discharges of wastewater in the project area.

3.4.2 Wastewater Assimilation

Primary impacts to water quality from the IBT originate from the operation of wastewater treatment facilities. However, these facilities have been already permitted and the IBT will not result in additional permitted capacities. Existing NPDES permits were issued to protect instream water quality. The permitting process for each of these facilities has complied with the NCEPA requirements. DWQ's antidegradation policy requires that only the alternative that causes the least amount of environmental damage can be permitted under the NPDES program. Additional growth and development in the receiving basin may impact water quality, stormwater runoff, frequency and intensity of flooding and land use. Mitigation

measures for secondary impacts related to growth and development are presented in Appendix A.

3.4.3 Fish and Wildlife

The IBT itself will not have any direct impacts on natural communities, SNHAs, fisheries, or sensitive species and their habitats in the study area since no construction is planned with the IBT.

However, there may be secondary impacts on fish and wildlife resources through increased growth and development, which may be facilitated by the proposed IBT. Additional growth and development in the receiving basin may impact water quality, stormwater runoff, frequency and intensity of flooding and land use. Mitigation measures for secondary impacts related to growth and development are presented in Appendix A.

3.4.4 Navigation

No direct or indirect impacts of the proposed IBT on navigation in the Rocky River Subbasin are expected since stream flows in the Rock River Subbasin are not expected to change significantly. No expansion of existing WWTPs or construction on new WWTPs is planned within the receiving basin.

3.4.5 Recreation

The proposed IBT will not have any direct or indirect impacts on recreation in the Rocky River Subbasin. Increased wastewater as a result of the proposed IBT will be within existing permit limits and will not significantly affect recreational resources along the receiving stream corridors. No recreational lands will be subject to additional threats of flooding as a direct result of the proposed IBT.

3.4.6 Flooding

Direct impacts related to flooding due to an increase in stream flow are not expected to be significant. Again, the permitted NPDES flows will handle the proposed IBT flow amounts. Average annual stream flow in the Rocky River, downstream from Crooked Creek, is expected to increase from 663 cfs to approximately 690 cfs at permitted flows, or about 4 percent. The expected increase is minor and well within the historical stream flow variability based on a flow duration analysis conducted in conjunction with the Raleigh Office of USGS.

Finally, the ratio of the additional wastewater (26 cfs) to the drainage area of the Rocky River (683 mi^2), below Crooked Creek, is less than 0.40. DWR has asserted, based on studies conducted in Piedmont streams (DWR, 1987), that floodwater carrying capacity, streambank erosion, and fish habitat need not be considered in detail for NCEPA documentation or for NPDES permit decisions when the aforementioned ratio is less than 0.40. In light of the above and the fact that current NPDES permitted flows will accommodate the IBT, the proposed IBT is not expected to result in significant flooding.

However, there may be secondary impacts within the receiving basin related to growth and development which may potentially increase both stormwater runoff from construction activities and impervious surface area and result in a higher risk of flooding. A summary of measures to mitigate adverse impacts is included in Appendix A.

3.5 Other Considerations

3.5.1 Regional Water Supplier

Concord and Kannapolis' water systems supply almost 100 percent of the public water supply in Cabarrus County. Therefore, these two cities are regional water suppliers.

3.5.2 Water Conservation and Reuse

The WSACC does not have a reclaimed water system at this time. The 2002 "Water and Wastewater System Master Plan" for WSACC provides the results of a conceptual investigation of developing a start-up reclaimed water system by identifying current state compliance regulations, potential customers, infrastructure improvements, and capital cost estimates for a pilot project and a 2 MGD system.

A comparison of the per capita water use history for Concord and Kannapolis water systems to other similar sized water systems in the Charlotte region has been performed to demonstrate their commitment to water conservation especially in drought situations. To account for fluctuations in industrial and commercial water demands that can occur due to changes in the regional economy, the comparison is made on residential water demands only since they are the most consistent demands in the system. Information on residential water use was extracted from 1997 Local Water Supply Plans available on the DENR website (2002 LWSP updates were not available at the time of this writing). As shown in Table 6 below, the Concord and Kannapolis water systems have very similar per capita water use of other similar sized systems in the Charlotte region.

TABLE 6
1997 Local Water Supply Plan – Residential Water Use
Concord/Kannapolis IBT Petition

Water System	Population Served	ADD (Res)	GPCD
Concord/Harrisburg	53,985	3.301[1]	61.313
Kannapolis	35,288	1.526[2]	43.24
Similar sized systems in Charlotte area			
Monroe	23,051	1.640	71.15
Albemarle	24,105	0.920	38.17
Salisbury	28,077	2.450	87.26
Union County	41,810	3.162	75.63
Gastonia	65,343	4.746	72.63

1. Concord noted ~ 3 MGD of Commercial demand reported as Residential.
2. A portion of Kannapolis' Residential demand was likely reported in Industrial demand due to Pillotex.

Residential water use data from 2000, 2001, and 2002 were obtained from Concord and Kannapolis water systems to analyze their per capita water use during the severe drought. This information has been presented in Table 7, and indicates that even though these two water systems were experiencing growth in population served year over year, their water conservation plans were effective in maintaining consistent ADDs by reducing per capita

consumption. Copies of the Concord and Kannapolis water conservation plans have been provided in Appendix B.

TABLE 7
Concord and Kannapolis Recent Water Use History
Concord/Kannapolis IBT Petition

Water System		Population Served	ADD (Res)	GPCD
Concord/Harrisburg	2000	57,714	4.138	71.70
	2001	60,325	3.711	61.52
	2002	63,136	3.791	60.04
Kannapolis	2000	45,387	2.74	60.37
	2001	46,633	2.62	56.18
	2002	47,557	2.61	54.88

Section 4 Compliance and Monitoring Plan

The proposed compliance and monitoring plan for the requested interbasin transfer certificate includes the following four elements, which are described in the sections below:

1. Monthly Reports
2. Annual Reports
3. Status Reports
4. Drought Management Reporting and Coordination

The details of monitoring and compliance will be specified in a Compliance and Monitoring Plan approved by DWR.

4.1 Monthly Reports

At the end of each month, Concord and Kannapolis will calculate the daily IBT amounts for that month and provide this information to DWR in monthly reports. The reports will be submitted to DWR on the same schedule that Daily Monitoring Reports for water reclamation facilities are provided to the Division of Water Quality - within 30 days of the end of the month.

Table 8 provides an example of the calculations that will be submitted. The calculation methodology was developed in conjunction with DWR staff, and is based on the guidance developed by DWR for estimating IBT amounts as part of the Local Water Supply Planning process.

Consumptive use for each day is assumed to be the difference between total water use and total wastewater discharged, or zero if discharge is greater than potable water use. This may

underestimate consumptive use in the winter months (when water use is typically lower than wastewater discharge), but the effect will be to slightly overestimate the resulting IBT amount. When discharge is greater than water use, the portion of raw water withdrawal that is discharged as wastewater in each basin is assumed to be proportional to the actual wastewater discharges in that basin. In effect, this is assuming that the same degree of inflow and infiltration occurs in the sewer system in each basin. These assumptions will not impact evaluation of compliance with the requested IBT certificate, since the maximum IBT is expected to occur in the summer.

The portion of consumptive use that occurs in the source basin will be estimated as the portion of the water service area in the source basin, and will be updated annually to reflect changes to the service area.

4.2 Annual Reports

At the end of each calendar year, the monthly IBT reports will be summarized in an annual report to DWR. The annual report will also document compliance with conditions, if any, that the EMC includes in the certificate.

4.3 Status Reports

At the end of each calendar year, if requested by DWR, Concord and Kannapolis will provide status reports on specific measures or other activities discussed in the EIS or IBT petition. DWR will identify the specific measures/activities to be addressed. One example of an activity to be included would be the applicants' progress toward returning water to the Catawba River Basin.

TABLE 8
Sample Daily Calculations for Interbasin Transfer

DATE	Water Withdrawal from Catawba Basin (MGD)	Water Withdrawal from Yadkin–Pee Dee River Basin (MGD)	Consumptive Use (MGD)	Portion of Water Use Discharged as Wastewater (MGD)	Total Return to Rocky River Sub-Basin (MGD)	Interbasin Transfer (MGD)	IBT as % of Withdrawal
			Rocky River Subbasin	Rocky River Subbasin			
05/01/00	5.6	6.3	0.2	0.1	0.2	5.4	96%
05/02/00	6.3	7.2	0.8	0.1	0.9	5.4	86%
05/03/00	6.2	7.0	0.6	0.1	0.7	5.5	89%
05/04/00	6.7	7.1	0.9	0.1	1.0	5.7	85%
05/05/00	8.7	7.0	2.0	0.1	2.1	6.6	76%
05/06/00	9.6	7.0	1.9	0.1	2.0	7.5	79%
05/07/00	11.5	7.0	2.8	0.1	2.9	8.7	75%
05/08/00	8.4	7.5	1.8	0.1	1.9	6.5	77%
05/09/00	10.0	8.4	3.2	0.1	3.3	6.8	67%
05/10/00	11.6	8.5	3.3	0.1	3.4	8.2	71%
05/11/00	10.2	8.4	2.5	0.1	2.6	7.6	75%
05/12/00	12.1	8.3	3.6	0.1	3.7	8.4	69%
05/13/00	12.7	8.4	4.0	0.1	4.1	8.6	68%
05/14/00	14.1	8.3	4.9	0.1	5.0	9.1	65%
05/15/00	9.1	8.3	3.2	0.1	3.2	5.9	64%
05/16/00	11.1	8.7	3.5	0.1	3.6	7.5	68%
05/17/00	11.1	8.7	3.7	0.1	3.8	7.3	66%
05/18/00	11.7	7.8	3.3	0.1	3.4	8.3	71%
05/19/00	14.2	8.6	4.6	0.1	4.7	9.5	67%
05/20/00	13.4	8.9	4.6	0.1	4.6	8.7	65%
05/21/00	10.2	9.0	3.4	0.1	3.5	6.7	65%
05/22/00	5.2	9.1	1.1	0.1	1.2	4.0	78%
05/23/00	7.4	9.0	2.0	0.1	2.1	5.3	71%
05/24/00	9.8	9.0	3.0	0.1	3.1	6.7	69%
05/25/00	10.1	9.1	3.1	0.1	3.2	6.9	68%
05/26/00	12.0	9.0	4.4	0.1	4.5	7.5	63%
05/27/00	10.9	9.1	4.3	0.1	4.4	6.5	59%
05/28/00	8.7	9.1	3.1	0.1	3.2	5.5	63%
05/29/00	5.7	9.1	1.9	0.1	2.0	3.7	64%
05/30/00	6.9	9.2	1.7	0.1	1.8	5.2	74%
05/31/00	9.6	9.0	2.8	0.1	2.9	6.7	70%
Minimum						3.7	
Maximum						9.5	
Average	9.7	8.3	2.8	0.1	2.9	6.8	70%

Section 5 Drought Management Plan

As a follow up to the completion of the WSACC Master Plan in 2002, a regional drought management plan was prepared. This report re-evaluated the safe yield of existing water sources available to Cabarrus County, and established a drought operations plan for the county (*Safe Yield Update and Regional Drought Operations*, Black and Veatch, 2003).

This plan is based on the implementation of drought operating curves for Lake Howell that indicate drought severity. Five conditions, normal and stages 1 through 4, were identified that are based on the useable volume available in the reservoir and the current reservoir inflow. The current reservoir inflow is compared to the historical mean monthly inflow for the current month and a historical percentage is identified. The ultimate goal of the five conditions is to preserve usable volume in the reservoir, and increase restrictions on the withdrawals as a drought increases in severity from "normal " conditions up to Stage 4.

A copy of the "Safe Yield Update and Regional Drought Operations" report is included in Appendix B.

The Cities of Concord and Kannapolis have been proactive in the development of city ordinances to protect and preserve its water supply. Concord amended its Water Management Plan Ordinance in March 2003 to address future connections and extensions of its water system. The city of Kannapolis has been following its amended ordinance since March 2001.

Appendix A

Summary of Mitigation Measures

Mitigation of Adverse Impacts

The proposed IBT of raw water to the Rocky River Subbasin will not have the potential to cause significant direct impacts to the environment. The IBT, however, may have the potential to significantly impact the environment through secondary and cumulative impacts as a result of facilitating growth in the receiving basin.

CH2M HILL has reviewed existing regulations and programs at the federal, state and local levels to determine if these existing programs may mitigate the anticipated impacts of urbanization of the project area. A summary of federal, state, and local programs is provided. Also included is a summary of planned updates to local ordinances.

With the existing regulatory and non-regulatory environmental protection programs in effect at the local, state and federal levels, the impacts from the proposed IBT will be minimal.

Summary of Federal and State Regulations and Programs

The following is a brief description of existing regulations and programs at the federal and state levels in the receiving basin (Table 1). The discussion emphasizes the extent to which existing programs may adequately mitigate the anticipated impacts of urbanization of the project area.

TABLE 1
Summary of Existing State and Federal Programs and the Environmental Resources They Protect

Program or Regulation	Local Govt. Program Required	Wetlands	Land Use	Fish and Wildlife	Sensitive Species	Water Quality	Air Quality	Ground-water	Noise	Toxics
Endangered Species Act		X	X	X	X	X				
CWA Section 404		X	X	X	X	X				
CWA Section 401		X	X	X	X	X				
National Flood Insurance Program		X	X	X	X	X				X
NPDES Stormwater	X	X		X	X	X				X
NC Ecosystem Enhancement Program		X		X	X	X				
Archaeological Protection			X							
Sediment & Erosion Control	X	X	X	X	X	X				
Sanitary Sewer Overflow Regulations.		X	X	X	X	X		X		X
Clean Water Management Trust Fund		(X)	(X)	(X)	(X)	(X)				
Groundwater			X					X		X
Water Supply Watershed	X	X	X	X	X	X				
Land Conservation Incentives		(X)	(X)	(X)	(X)	(X)				

X = Demonstrates clear environmental benefits
(X) = Shows potential for environmental benefits (policy only, program not mandatory, or regulation not yet adopted)

Local Regulations and Programs

The following is a brief description of existing and proposed regulations and programs at the local government level in the project receiving basin, with specific effort given to determining if these existing programs may, when combined with existing federal and state regulations, adequately mitigate the anticipated impacts of urbanization of the receiving basin.

The following analysis addresses relevant regulations and programs from an environmental management and land use policy analysis perspective. These local initiatives to prevent impacts to natural resources will offset future impacts resulting from growth.

Phase II Stormwater Programs

The cities have prepared Phase II permits and have submitted them to the state. The community working group involved representatives from Concord, Kannapolis, Harrisburg, Cabarrus County, developers, and area residents. Development of a Draft Stormwater Ordinance, with input from the community working group, was a result of this process. The goal of the development of this ordinance was that each City could then modify and adopt the ordinance as needed. Development of the Unified Development Ordinance (UDO) was a start to their programs.

Water Supply Watershed Protection

The County has adopted a water supply watershed protection program, which has been approved by the State, to ensure sustainability of its current water supply reservoirs and their watersheds. Within the County Zoning Ordinance, a Watershed Overlay Zone is designated for the Coddle Creek and Dutch Buffalo Creek watersheds.

All lots within each watershed's critical area, defined as land within ½ mile of the high water mark of the reservoir, shall have a minimum size of two acres. In the case of cluster development, overall density of the site shall be the same, one dwelling per two acres of development. This clustering encourages the preservation of undisturbed open space. Within this critical area, no commercial or industrial development is permitted. A 150-foot buffer shall be maintained around each reservoir.

In the remainder of the watershed, one dwelling unit per acre or the requirements of the Cabarrus County Zoning Ordinance must be met, whichever is more stringent.

Unified Development Ordinance

The Cities of Concord, Kannapolis, Harrisburg, and Mount Pleasant have adopted a UDO. Cooperative efforts between all municipalities within the County contributed to the UDO's development. Updates to the UDO are planned to address, and go beyond, Phase II Stormwater Rule requirements and protect natural resources.

Draft Stormwater Quality Management and Discharge Control Ordinance

Each City is developing a version of the Stormwater Quality Management and Discharge Control Ordinance (Stormwater Ordinance), to be adopted into each UDO. The City of Concord is also in the process of developing and approving the use of a Stormwater Technical Standards Manual (Manual). These collaborative efforts will limit the impacts of development in the Service Areas of the Cities. Discussion in this document pertains to

aspects of the UDO, including the additional stormwater provisions, that address SCI that may result from the Project. Further details of the UDO include:

- Post-construction stormwater requirements that:
  - Require on-site stormwater management to attenuate runoff to predevelopment levels at the 1-year 24-hour storm level
  - Require 85 percent total suspended solids removal must be achieved by stormwater protection measures
  - Encourage the use of low impact development techniques
- No net loss in floodplain storage within the 100-year floodplain
  - Fill in the floodplain must be balanced by an equal cut
- Increase in stream buffer widths

As part of the UDO, developments that disturb above one acre or more than an additional 20,000 square feet at an existing facility will require preparation of a Stormwater Management Plan, which must be approved by the Stormwater Administrator. This process gives the local government the ability to ensure proper preparations for stormwater treatment are being made in accordance with the UDO. Provisions are included to ensure continued protection of water quality over the long term. Maintenance of BMP structures, to be conducted by the owners, is required.

The City of Concord's manual also identifies stormwater drainage requirements that shall control and treat any increase in the volume of stormwater runoff from pre-development conditions, peak discharge, total suspended solids, fecal coliform, and other pollutants to levels identified in their Manual.

These efforts will help to prevent changes in stream hydrology and morphology, preserve floodplain storage, and limit sediment loading.

Buffer Requirements

Within the UDO, current stream buffer regulations set forth in the UDO will be enhanced by the Stormwater Ordinance addition to increase water quality and aquatic habitat benefits. Current County-wide buffers of USGS blue line streams will be improved in the City of Concord to include buffers along both perennial and intermittent streams. The City of Kannapolis's plan will be similar to that of the City of Concord's, and is still in development. The City of Concord's draft definitions are:

- A perennial stream buffer shall be an undisturbed area measured, at minimum, 50 feet from the top of stream bank plus 20 feet of vegetated setback, totaling 70 feet.
  - Concord's ordinance also includes an additional vegetated width based on slope.
  - The vegetated setback zone may be maintained by property owners.
  - No new structures are permitted.
- An intermittent stream buffer shall be an undisturbed area measured from the top of stream bank perpendicularly for a distance of 20 feet with an additional 10 feet of vegetated setback, totaling 30 feet.

In general, buffers along perennial streams within the City of Concord are wider than the minimum 70 total feet. Slope is factored into the equation to determine buffer width. The greater the slope, the wider the stream buffer is. Floodplain storage and riparian wetlands

will be protected with this measure, further protected by a rule excluding buildings within the buffer.

The proposed stream buffer regulation includes:

- No new on-site sewage systems, which utilize ground adsorption, within the buffer
- No new structures
- Maintenance of stream buffer to maintain sheet flow and provide for diffusion and infiltration of runoff and filtering pollutants to the maximum extent practicable

In addition, the Cities of Concord and Kannapolis have agreed to require that intermittent and perennial streams be delineated by a qualified consultant or staff member as part of the development plan review process. Intermittent streams will be determined based on guidance developed by the Division of Water Quality. This provides a more accurate determination of stream type and location than the current method of using USGS topographic quadrangles.

Implementation of these more stringent buffer rules, as well as BMPs described in the UDO to control and minimize the quantitative and qualitative impacts of stormwater on receiving streams are proposed as mitigation for the SCI addressed in this EIS. Including intermittent streams in this rule will help protect critical headwater habitat areas. Concord plans to adopt updates to the UDO in the first quarter of 2005. Kannapolis is planning to adopt changes to the UDO in 2005. This is before any of the IBT would occur, ensuring that measure to protect the service area's natural resources are in place well before the IBT, and subsequent impacts, occur.

Parks and Open Space Program

Cabarrus County's "Livable Community Blueprint" was initiated with the goal of developing a parks and recreation master plan in 2001. This completed plan now includes provisions for parks, greenways, leisure and recreational facilities, open space, and bicycle and pedestrian transportation routes. This multi-jurisdictional project was completed in response to rapid population growth and accompanying development that has been occurring in Cabarrus County over the past decade.

Impacts to terrestrial natural resources such as forests and wildlife habitats will be limited by the open space requirements set forth in each City's UDO. Based on development densities, subdivisions must set aside anywhere from eight percent where densities are less than two dwellings per acre to thirty percent of their total sizes within cluster developments. These values are above and beyond the setbacks required for floodway areas, wetlands, and open water. Clustering developments, in process setting aside larger tracts of open space, will limit habitat fragmentation, provide wildlife corridors, and present recreational opportunities. In addition, Concord does encourage the use of Low Impact Development (LID) planning as part of its Phase II Stormwater Permit, but is not requiring the use of LID.

Land Use Planning

Cabarrus County is in the process of completing long range land use plans, referred to as the Envision Cabarrus plan. These plans are being prepared by area, with some approved by the County and some still in draft form. Public involvement has been a large factor in

development of these plans. The goal of this planning process is to improve quality of life for those currently living in the community and for future residents.

The Concord Planning and Community Development Program adopted a land use plan in 2004. Goals of the plan include maintaining a balance of compatible land uses, providing vehicular and pedestrian connectivity, achieving a sustainable community, preservation of unique character, providing adequate infrastructure, promoting farmland, natural resource and open space preservation, and linking plans and strategies with neighboring towns and the County. Concord's plan focuses around mixed use districts and village centers, therefore not supporting sprawl. The use of LID practices is encouraged. It also preserves the historic nature of downtown with its Center City Plan.

Kannapolis has developed its Draft 2015 Comprehensive Land Use Plan, which was adopted on July 26, 2004. The purpose the land use plan is to establish policies to define the future city, such as quality of life indicators, rate of growth, and location of growth.

Overall, these plans provide the cities and county with decision making tools to guide appropriate development and growth. The development of a UDO is just one component of the efforts the area is undertaking to promote sustainable growth and protect natural resources as growth occurs.

Other Ordinances

The County has several ordinances that help protect environmental resources. These include:

- Allowance for cluster development – clusters of home sites on smaller lots, resulting in the remaining "saved" space being retained as open space.
- Subdivisions which contain 30 or more houses must include a mini-park.
- Decreased traffic in residential areas – part of a customized development standard to protect residential areas from high traffic volume, traffic speed, noise, and fumes.
- Flood Damage Prevention Ordinance: If a subdivision is planned within 150 feet of any water course, the prospective subdivider shall provide evidence to the Planning and Zoning Commission (by referencing maps prepared by FEMA [dated 1994]) that the lots within the subdivision will not be flooded. The prospective subdivider shall make a determination of the crest elevation of a flood of 100-year probable frequency in accordance with generally accepted engineering practice. During the construction, preparation, arrangement, and installation of subdivision improvements, and facilities in subdivisions located at or along stream bed, the developer shall maintain the stream bed of each stream, creek, or backwash channel contiguous to the subdivision in an unobstructed state.
- River Stream Buffer: All subdivisions containing or located adjacent to all rivers or streams shown on USGS Quadrangle Maps as a solid blue line shall be subject to all of the regulations set forth in Chapter 4, Part II (River/Stream Overlay Zone) in the Cabarrus County Zoning Ordinance. These current regulations include:
  - retaining natural vegetation to avoid erosion and reduce the velocity of overland flow
  - trapping sediment and other pollutants and keeping them from entering the waterway

  - using BMPs in farming
  - installing and maintaining 50-foot (minimum) to 120-foot (maximum) stream buffer, depending on development
  - submitting a progress report by those disturbing the land to the Planning and Zoning Department

- Cabarrus County Sediment and Erosion Control Ordinance
- Stormwater Drainage: Must provide adequate drainage of all surface water. Modifications of streams and other natural water courses are prohibited.
- Water and Sewer Systems: Private wells and septic tanks must be approved by the Cabarrus County Health Department.
- Connection to public water and sewer systems shall be in accordance with the policies and regulations of WSACC.

Summary

Table 5 presents a correlation between existing and proposed regulations and ordinances and the potential environmental impacts that may occur as a result of the IBT and associated infrastructure improvements. In many cases, local ordinances exceed State requirements and offset any potential impacts that may result from this project.

TABLE 5
Areas of Potential Secondary and Cumulative Impacts to be Addressed by Permitting and Mitigation in the Receiving Basin

Environmental Resource	Potential for SCI	Mitigation Programs
Wetlands	LI	Riparian Buffers (all) County Zoning Ordinance, 150-foot buffer required around reservoirs Section 404 and Section 401 regulations
Urban / Developed Land	PI	UDOs (Concord and Kannapolis) and Zoning ordinances (all) - buffers required between adjacent land uses Encouragement of use of Low Impact Development (Concord) Water Supply Watershed Regulations limit development densities Land Use Planning recently updated by County, Concord, and Kannapolis
Public Land / Recreation Uses	LI	Land Use Planning recently updated by County, Concord, and Kannapolis – plans include greenway and park plans and open space considerations Subdivision Ordinance – Recreational Areas requirements (all) County Zoning Ordinance – Recreational District Overlay Zone; Watershed Overlay Zone provides for 150 foot buffer surrounding reservoirs.
Prime Agricultural Land	PI	Land Use Planning recently updated by County, Concord, and Kannapolis
Forestry Land	PI	Riparian buffers (all) UDO open space requirements for new development (Concord and Kannapolis) County Zoning Ordinance, 150-foot buffer required around reservoirs
Archaeological / Historical Areas	LI	Land Use Planning recently updated by County, Concord, and Kannapolis Concord-Center City Plan for historic area
Wildlife Habitat	PI	Riparian buffers provide habitat and corridors (all) County Zoning Ordinance, 150-foot buffer required around reservoirs UDO open space requirements (Concord and Kannapolis)
Fisheries and Aquatic Resources	LI	Riparian buffers (all) State SSO regulations NPDES permitting including Phase II stormwater regulations UDO (Concord and Kannapolis)
Sensitive and Threatened Species & Habitat	LI	Endangered Species Act NEPA and NCEPA regulations Cabarrus County Natural Heritage Inventory

TABLE 5
Areas of Potential Secondary and Cumulative Impacts to be Addressed by Permitting and Mitigation in the Receiving Basin

Environmental Resource	Potential for SCI	Mitigation Programs
Water Resources & Water Quality	PI	Riparian buffers (all) Stormwater Ordinances (all) & UDO (Concord and Kannapolis) County Sediment and Erosion Control Ordinance Clean Water Management Trust Fund projects Cabarrus County and Rowan County Zoning Ordinances -Water Supply Watershed Overlay Zones
Air Quality	LI	Public transportation available Land Use Plans encourage connectivity for pedestrians proper thoroughfare planning (all) Encourage use of Low Impact Development (Concord)
Groundwater	LI	Failing septic systems taken offline as infrastructure developed Availability of infrastructure reduces future increase in septic tanks.
Noise	LI	Land use planning (all) encourages transportation planning Landscape buffers between adjacent land use types to reduce noise levels (County Zoning Ordinance; Concord and Kannapolis UDOs)
Toxic & Hazardous Substances	LI	Land use planning and zoning encourage growth in appropriate areas. NPDES Phase II stormwater education programs Brownfield Assessment Demonstration Pilot Project (Concord)

Notes:
PI = Areas of Potential Impact (major relevance in NCEPA documents and permitting applications)
LI = Areas of Limited Impact (minor relevance in NCEPA documents and permitting applications)

This table is meant to show the relevance of each of the environmental issues in terms of potential for secondary and cumulative impacts. **"PI" indicates areas where there is a potential for secondary and cumulative impacts to occur without adequate mitigation programs in place.** The listed mitigation programs will reduce these impacts to below a level of significance. Coordination with public agencies contributed to the mitigation plans outlined in this document.

Appendix B

Water Conservation & Drought Operations Plans

HEADLINES

Water Management Plan Ordinance
Submitted: 3/27/2003

ORD. #03-25

AN ORDINANCE TO AMEND SECTION 62-36 OF THE CONCORD CITY CODE TO PROTECT AND PRESERVE THE WATER SUPPLY NECESSARY TO MEET THE PRESENT AND FUTURE DEMANDS FOR WATER AND SERVICES WITHIN THE CITY OF CONCORD AND THE SERVICE AREAS OF THE CONCORD REGIONAL WATER SYSTEM.

WHEREAS, NCGS 160A-312 authorizes the City of Concord to: (a) "...acquire, construct, establish, enlarge, improve, maintain, own, operate, and contract for the operation of any or all of the public enterprises as defined in this Article (including but not limited to water supply and distribution systems) to furnish services to the city and its citizens....and may acquire, construct, establish, enlarge, improve, maintain, own, and operate any public enterprise outside its corporate limits, within reasonable limitations, but in no case shall a city be held liable for damages to those outside the corporate limits for failure to furnish any public enterprise service. (b) ...to protect and regulate any public enterprise system belonging to or operated by it by adequate and reasonable rules. The rules shall be adopted by ordinance, shall apply to the public enterprise system both within and outside the corporate limits of the city, and may be enforced with the remedies available under any provision of law...";
and

WHEREAS, NCGS 160A-174 authorizes the City of Concord to "...define, prohibit, regulate, or abate acts, omissions, or conditions, detrimental to the health, safety, or welfare of its citizens...";and

WHEREAS, the City of Concord may furnish utility service outside the City "but in no case shall the City be held liable for damages to those outside the corporate limits" for failure to furnish utility service under NCGS 160A-312; and

WHEREAS, a long line of cases establish the right of the City of Concord to impose conditions upon furnishing utility service outside the city limits, including but not limited to Atlantic Construction Company v. City of Raleigh 230 NC 365, 53 SE2d 165(1959) and George v. City of Asheville 80 F2d 50 (4th Cir., 1935); and

WHEREAS, the City of Concord has long operated a water supply and distribution system under the statutes referenced above and their predecessors; and

WHEREAS, the City of Concord water supply and distribution system is located between two major rivers, the Catawba and the Yadkin, but does not currently have a direct connection to either system; and

WHEREAS, the City of Concord is currently seeking additional water supply and distribution connections to one or more of the two major river systems during a time of fiscal austerity; and

WHEREAS, recent studies of the cost of such additional water supply and distribution infrastructure demonstrate that the current water rates and impact fees for residential connections do not recover the proportional cost of the infrastructure; and

WHEREAS, funding of streets, sewers, sidewalks, and other infrastructure leaves less funding available to address water needs: and

WHEREAS, the City of Concord has operated under mandatory water restrictions since February, 2001; and

a city meeting the fi

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WHEREAS, the City of Concord expects that some form of mandatory water restrictions will continue until connection between one or more of said river systems and the City of Concord water supply and distribution system is established; and

WHEREAS, despite recent wet weather, the City of Concord only received 82% of normal precipitation during the year 2002. Out of the 82% total, 42% of the precipitation fell between the months of October-December 2002; and

WHEREAS, there is no regular United States Geological Survey well monitoring in Cabarrus County but readings from the wells in the Rowan County area show evidence that water supply from those wells was declining through September, 2002;

NOW, THEREFORE, BE IT ORDAINED by the Concord City Council does hereby amend Section 62-36 of the City Code as follows:

Section 1. Subsection 62-36(d)(1) is hereby amended by adding the words "or regulated" between the word "suspended" and the word "for" in the next to the last line of the subsection.

Section 2. In addition the above subsection, is further amended by the addition of the following sentence "The manager or his designee may use the following point system to regulate issuance of zoning clearance permits and/or the divisions of land that involve waterline connections or extensions, or any upgrade in capacity for water usage:

Water Management Program

Program Goal

The City of Concord initiated mandatory water restrictions in February 2001. Although recent rainfall events have helped fill the City's water supply reservoirs, the streams that feed the reservoirs are conveying only 50% of their average flow. Until the City is able to secure additional water supply sources, the City will use the following program to prioritize water supply allocations to new development. The goal of the program is to prioritize proposed developments that will maximize existing infrastructure so City funds may be focused toward the capital needed to connect the City's water system to new water supply sources.

Annual Water Allocations

Utility master planning efforts have predicted that the City's existing water supply sources will be able to support the current growth rate until 2009. The available capacity of the City's existing water system has been evenly divided over the next six years. The City will only approve up to a total of 1,000,000 gallons per day in new water allocations per state fiscal year, beginning state fiscal year 2003-2004. Due to state standards of 400 gallons per day per household, approved residential dwelling units may not exceed 1,200 per fiscal year. Water may not be allocated to more than 150 residential dwelling units for any developer or combination of entities including the same developer within any one state fiscal year. Increases to the current volume of treated water dedicated to local governmental bodies through interlocal agreements will also be limited by the annual water allocation. Any phase of any subdivision that has not received final plat approval for that phase within two years of the approval of a preliminary plat shall be regarded as having forfeited the unused portion of their water allocation. The allocation for unsubdivided development shall expire at the same time that plan approval expires under the Unified Development Ordinance. The water allocation for projects with preliminary plats and site plans approved prior to March 28, 2003 have been accounted for in the capacity of the City's existing water system and will not be subject to this program. No final connection of waterlines for domestic use will be allowed using water under this program until after November 1, 2003.

Proposed Development Prioritization

Within the Municipal Limits
Developments within the existing municipal limits of the City of Concord will be reviewed upon receipt throughout the year in accordance with the Unified Development Ordinance and the Code of the City of Concord. If the proposed developments within the municipal limits require more than the annual water supply allocation, developments will be prioritized based on the following points system. Developments that have not received final engineering plan approval from the City will be re-prioritized every three months (July 1, October 1, January 1, and April 1).

Outside the Municipal Limits
If the proposed developments within the existing municipal limits do not utilize the entire annual water allocation after six months, developments outside the existing municipal limits will be considered for one-half of the remainder of the annual water allocation for the fiscal year. Developments earning the greater point values in excess of 120 points shall proceed for review immediately to the limits of the allocation available at the mid year level. Developments outside of the existing municipal limits will be prioritized at the conclusion of each state fiscal year based on the following points system.

Water Resources (40 point maximum)
20 Located adjacent to existing water main
12 Located within 2,000 feet along existing public right-of-way of an existing main
4 Located within 1 mile along existing public right-of-way of an existing main
0 Located more than 1 mile along existing public right-of-way from an existing main
20 Located within Concord municipal limits or a water and sewer district of Cabarrus County
10 Located within Concord's service area
0 Located outside of the Concord municipal limits, water and sewer districts, and service area

Wastewater Resources (20 point maximum)
10 Located adjacent to existing sanitary sewer
6 Located within 2,000 feet of existing sanitary sewer
2 Located within 1 mile of existing sanitary sewer
0 Located more than 1 mile from existing sanitary sewer
10 No pump station required within or between the development and the wastewater
treatment plant
5 No pump station required to connect to the existing sewer system, downstream pump station exists
0 Pump station required to connect to the existing sewer system

Transportation (15 point maximum)
10 Located within 0.5 miles of a transit stop
0 Located more than 0.5 miles from a transit stop
5 Located adjacent to property with an existing roadside sidewalk
0 Not located adjacent to property with an existing roadside sidewalk

Fire Protection (15 point maximum)
10 Located 3 road miles or less from an existing Concord fire station
6 Located between 3 and 5 road miles from an existing Concord fire station
2 Located between 5 and 10 road miles from an existing Concord fire station
0 Located more than 10 road miles from an existing Concord fire station
5 0-1 signaled intersection between existing Concord fire station and development
3 2-3 signaled intersection between existing Concord fire station and development
1 4-5 signaled intersection between existing Concord fire station and development
0 More than 5 signaled intersection between existing Concord fire station and

development

Police Protection (15 point maximum)
15 Located within or adjacent to existing municipal limits of Concord
5 Located within 1 mile of existing municipal limits of Concord
0 Located 1 mile of existing municipal limits of Concord

Zoning (15 point maximum)
15 Located in the appropriate zoning district or conforms to an approved City of
Concord land use master plan
0 Re-zoning required that does not conform to a City-approved land use plan

Schools (10 point maximum; 10 points if schools will not be impacted, e.g., industry, retirement home, etc.; otherwise, use the points below)
3 Located 0.5 road mile or less from an existing elementary school
2 Located between 0.5 and 5 road miles from an existing elementary school
1 Located between 5 and 10 road miles from an existing elementary school
0 Located more than 10 road miles from an existing elementary school
3 Located 1 road mile or less from an existing middle school
2 Located between 1 and 5 road miles from an existing middle school
1 Located between 5 and 10 road miles from an existing middle school
0 Located more than 10 road miles from an existing middle school
4 Located 1 road mile or less from an existing high school
2 Located between 1 and 5 road miles from an existing high school
1 Located between 5 and 10 road miles from an existing high school
0 Located more than 10 road miles from an existing high school

Total (130 point maximum)

Extra Credit Design-Related Points (65 point maximum)
10 points Water conservation measures (as approved by the Director of Water Resources or his designee)
10 points Donation of buildable, road-front land* to the City exceeding 5% of the total development acreage (distance from the center point of the donated land to the furthest property line shall not exceed 1.5 times the distance from the center point of the donated land to the nearest property line) Example-park or playground space that is not impervious.
*Donated land does not count as required open space.
10 points Development to be served by City electric system
5 points Impervious surface area 25% less than the maximum allowed
5 points Existing mature woody vegetation meets buffer requirements and will not be removed
5 points Conservation easements along all perennial streams on property proposed for development
5 points Open space 25% more than the required minimum
5 points All buildings to contain sprinkler systems

Plan Review Prioritization and Sequencing
120-140+ point developments Approved for immediate review
<120 <120 point developments Hold and reevaluate points every 3 months to prioritize unused capacity

Section 3. If any provision, standard, or requirement of this ordinance is found to be in conflict with any provision of any ordinance or code of the City, the provision that establishes the higher standard or more stringent requirement shall prevail.

Section 4. This ordinance shall become effective immediately upon adoption.

Adopted this 27th day of March, 2003.
CITY COUNCIL
CITY OF CONCORD
NORTH CAROLINA

/s/ J. Scott Padgett, Mayor

ATTEST: /s/ Vickie C. Weant, City Clerk

Contact: Annette Privette-Darnell
Phone: 704-920-5215
Email: privettea@ci.concord.nc.us

Outdoor Water Use Tips

- The standard recommendation for irrigating/watering a lawn is 1 inch of water per week. This can be measured by placing a rain gauge or a small tuna can near your irrigation or sprinkler system.
- Set your mower for the highest setting recommended for your turf. Never cut off more than 1/3 of the leaf blade at one time, to minimize unnecessary stress to the turf.
- Choose a calm day with little wind and irrigate between 6 p.m. - 6 a.m. By watering during these hours you will eliminate up to 50 percent of evaporation loss from the heat of the day.
- Use drip irrigation in flower beds and shrubs, this slowly directs water to where it is needed most.
- Adjust irrigation heads to prevent water from landing on impervious surface areas, to the extent that no running water leaves the property.
- Plant drought-resistant trees, shrubs and flowers. Once established, they don't need to be watered as frequently and they usually will tolerate a 2 - 3 week dry spell without problems.
- Spread a layer of mulch around trees and plants to slow the evaporation of moisture and discourage weed growth.

Did You Know?

- Lawn watering accounts for more than 60 percent of residential water use. The quickest and easiest way to reduce a water bill is to eliminate over watering and runoff.
- To reduce evaporation and to maximize watering efficiency, use sprinklers that throw large drops of water close to the ground as opposed to a fine mists in the air.
- Over watering causes more than 75 percent of turf problems.
- Over watering causes leaves or grass to turn a lighter shade of green or yellow.
- Over watering may cause leaves to turn green but yet become brittle. Algae, moss and mushrooms are signs of excess amounts of water.
- Watering too lightly and frequently causes a shallow root system. Watering deeply and infrequently produces a healthier and deeper root system that is better equipped to withstand heat and drought.
- If you leave footprints behind when you walk on your lawn it's a sign that the grass needs watering.

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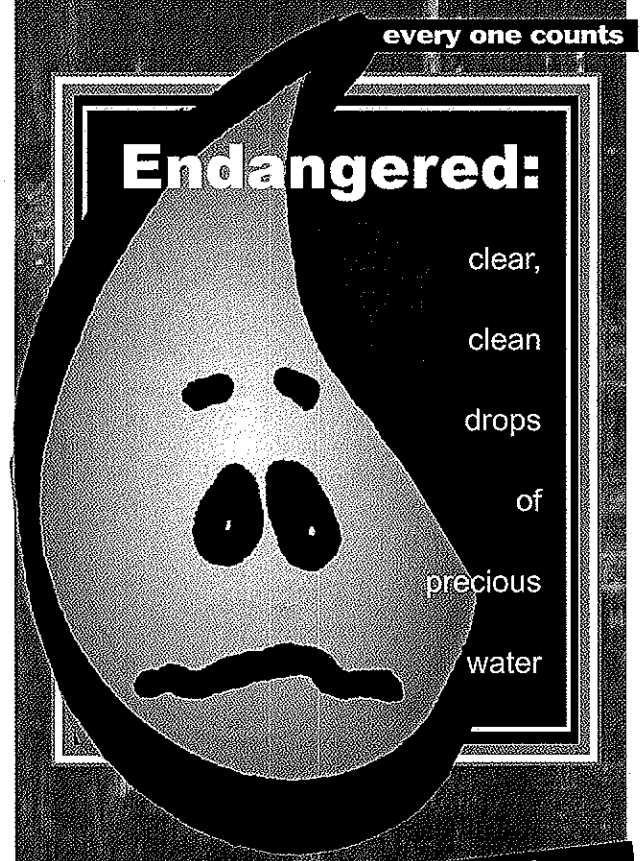

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City of Concord's Water Conservation Program

The City's Water Conservation Program includes a combination of educational and regulatory measures to encourage wise water use. With recent rainfall Concord's water sources have stabilized and refilled.

The City has three natural sources of water: Lake Howell, Lake Concord and Lake Fisher.

While we do have water now we must remember that our region is still feeling the effects of the recent five-year drought and early predictions are that we will have a hot dry summer.

We continue to pursue a long-term solution to our water needs by applying for an interbasin certificate which will allow us to access water from the Catawba and Yadkin Rivers. We anticipate receiving the state's approval for this certificate next year.

The city has also adopted a water allocation program to make sure growth does not outpace our water resources.

Water Restrictions Relaxed

The City of Concord has relaxed irrigation restrictions. The current restrictions for public water customers are:

- All residents may now irrigate any day of the week between the hours of 6 p.m. and 6 a.m.
- No irrigation or sprinklers are allowed in use when it is raining.
- The use of handheld hoses with spring-loaded nozzles is still required for out door use and these hoses may be used any day of the week and at any time of the day.
- Swimming pools may be topped off any day of the week and at any time using handheld hoses with spring-loaded nozzles.
- All irrigation systems must have a rain sensor device to eliminate irrigation when it is raining.

The city will continue to enforce the water restrictions with no warnings being issued. Penalties for violating the restrictions range from $100 - $500 for residents and $500 - $1,000 for businesses.

The City of Concord Water Resources Department will continue to monitor our water sources daily and restrictions will be modified if we see water levels dropping. We commend you on your continual efforts to conserve water.

Rain Sensor Devices Required

To assure that irrigation systems do not operate during periods of rainfall, irrigation users are required to install rain sensors. This sensor is a small inexpensive device mounted on the irrigation system.

The rain sensor is designed to interrupt the cycle and shut down the irrigation system when adequate rainfall has been received. The sensors should be set to shut off the irrigation system when 1/4 inch of rainfall has fallen.

Sensors and water gauges may be purchased at any local plumbing supply or hardware businesses. The average price is between $20-30 for the sensors.

If irrigation misuse occurs a citation will be issued and a penalty fee applied to your utility bill. Continued abuse of water restrictions may result in disconnection of water service.

More information about the water conservation program can be found on the City's web site: www.ci.concord.nc.us

Please remember: the cost of using large amounts of water, especially for irrigation, has increased to pay for long term solutions to our water needs.

AN ORDINANCE AMENDING THE CODE OF THE CITY OF KANNAPOLIS TO AMEND ARTICLE II, SECTION 17-38 WATER EMERGENCY MANAGEMENT

WHEREAS, due to a serve drought and decreasing water supplies; and

WHEREAS, the City Council of the City of Kannapolis finds that it is necessary to establish measures enacting water emergency management procedures;

NOW, THEREFORE, BE IT ORDAINED, that the City Code is hereby amended by adding the following section:

ARTICLE II

SECTION 17-38 Water Emergency Management

A. Definition:

"Water Emergency" shall be defined as any condition or situation which threatens the safety or supply of either treated or potable water within the water supply, treatment and distribution systems of the City of Kannapolis or within the systems of the municipal, commercial and industrial customers. Determination of whether specific situations are considered to be water emergencies shall be made by the City Manager or his designee after consultation with the appropriate City Staff, and City Council, Water Emergency situations shall include, but not limited to: drought, or periods of insufficient raw water supply and fires of a magnitude, such that system integrity is threatened.

B. Declaration of Water Emergency:

The City Manager or his designee after consultation with the City Council, is authorized to declare that a water emergency exists. Depending on the severity of the emergency; Voluntary (Level I), Mandatory (Level II, III), or Mandatory (Level IV) staged water use restrictions as described in the following section (s) shall be imposed upon water customers.

C. Staged Water Use Restrictions:

During a Declared Level I Water Emergency, the following voluntary water conservation practices shall be encouraged for the public water system served by the City of Kannapolis:

1. Watering of lawns, ornamental plants and gardens shall be limited to the hours of 9:00 PM and 7:00 AM.

2. Household water should be re-utilized to the greatest possible extent for watering.

3. Use of water for wash down of outside areas such as driveways or parking lots should be curtailed.

4. Faucets should not be left running while shaving, brushing teeth, or washing dishes.

5. The use of clothes and dishwashers should be limited if possible and these units should be operated with

full loads when used.

6. Washing of cars or other vehicles should be curtailed to Saturdays or Sundays. Hoses should not be left running while washing vehicles.

7. The use of flow restrictions and other water saving devices is encouraged.

8. Showers should be used for bathing and showers should be limited to four (4) minutes or less.

9. Filling of pools shall be deferred or limited to hours between 9:00 P.M. and 7:00 AM.

10. Any practice listed above may be modified or additional practices added at the discretion of the Water and Sewer Utilities Director.

D. During a Declared Level II Water Emergency, the following mandatory water use restrictions shall be in effect for the public water system served by the City of Kannapolis:

1. The water use and time restrictions described in Level I shall be mandatory during a Level II Water Emergency.

2. Watering of ornamental plants, gardens, and lawns shall not be done except by handheld container (bucket, jug, etc.).

3. Use of water for wash down of outside areas is prohibited.

4. Residential washing of cars and other vehicles is prohibited. Automobile retail establishments and commercial automobile washing facilities including those providing hand held washing nozzles may continue normal operation. However, the facility owner/operator shall ensure that water wastage does not occur.

5. Restaurants and other food serving establishments shall serve water to patrons only at the request of the patron (s).

6. Commercial, industrial and construction operations shall eliminate all possible waste of water. Large scale commercial and industrial water /customers and construction activities utilizing 150,000 or more gallons water per month shall submit water reduction compliance plans to achieve 25, 50 or 75 percent (%) water reductions as specified under the Level III Water Emergency within (14) fourteen days after the effective date of the Level II Water Emergency Declaration.

7. Above-ground pools, Jacuzzis and hot tubs having a capacity of 500 gallons or more and all newly constructed or drained in ground pools shall be filled by permit only. Fill permits shall be issued by the Water and Sewer Utilities Director and issuance of the permits may be curtailed depending on the severity of the situation.

8. Any practice listed above may be modified or additional practices added at the discretion of the Water and Sewer Utilities Director.

E. During a Declared Level III Water Emergency, the following mandatory use restrictions shall be in effect for the public water system served by the City of Kannapolis:

1. Watering and irrigation of lawns, gardens, and other plants are prohibited.

2. Washing of cars, vehicles and equipment is prohibited.

3. Restaurants and other food serving establishments shall utilize single serving utensils and plates, and serve water at the patron's request.

4. Recreational use of potable water including filling of pools is prohibited.

5. Large scale commercial and industrial water customers and construction activities utilizing 5000 or more gallons of water per day, shall achieve mandatory reductions in daily water usage of 25, 50 or 75 percent (%) through whatever means is available. The target reduction percentage shall be determined the severity of the Water Emergency, and shall be publicly announced as part of the emergency declaration. The Water and Sewer Utilities Director shall determine compliance with the daily usage reduction targets. Variances to this restriction may be granted to designated public health facilities including but not limited to hospitals and nursing homes.

6. Drinking water taps or hydrant permits shall be issued or revoked at the discretion of the City Staff.

7. Any practice listed above may be modified or additional practices added at the discretion of the Water and Sewer Utilities Director.

F. During a Declared Level IV Water Emergency, the following mandatory water use restrictions shall be in effect for the public water system served by the City of Kannapolis.

1. All use of water for purposes other than maintenance of public safety is prohibited.

2. Where the Kannapolis system is not functional daily per day residential water use shall not exceed three-hundred (300) gallons at each metered location.

3. Where the Kannapolis system is not functional, National Guard and Emergency Service vehicles shall be utilized to distribute water for household use at prearranged locations within the affected area. Usage by individuals shall be limited to those amounts necessary to sustain life through drinking, food preparation and personal hygiene.

4. Compliance Plan for Industries During Level IV remains the same as Level III or as directed by the State of North Carolina Public Health Officials. Such plans shall be submitted to the City of Kannapolis Water and Sewer Utilities Department within 14 days from the adoption of this ordinance. Plans shall be updated at least every five-(5) years.

5. Any practice listed above may be modified or additional practices added at the discretion of the Water and Sewer Utilities Director.

G. Non-Compliance of Water Emergency Management Ordinance

1. Penalties

Any person, firm or corporation violating the Mandatory Provisions of this ordinance shall be issued a civil citation Pursuant to Section 1-14 of the Kannapolis City Code and a fine not to exceed one-hundred ($100.00) for residential customers and five-hundred ($500.00) for commercial or industrial users. Each occurrence of a violation of this ordinance shall be considered a separate violation. The provisions of this ordinance may also be enforced by actions for abatement or injunction.

2. Discontinuance of Service

Pursuant to the provisions of General Statute Section 162A-88 and the City Waterworks Ordinance,

water service may be temporarily discontinued for willful disregard of this ordinance. All applicable penalty fees may be applied in the event of service suspensions. In the event of continued gross non-compliance with this ordinance, removal of the meter and service will be deemed proper and service will be discontinued. Tap fees and deposits will be forfeited.

3. Municipal Customers, Water Corporations or Company Compliance

Municipalities, water corporations or companies purchasing water from the City of Kannapolis shall adopt and enforce this entire ordinance as a condition of continuing existing water sales agreements, upon declaration of a Water Emergency, said municipalities and companies shall enforce the appropriate water use restrictions for the level of declared emergency. Water service to said municipalities and companies shall be terminated for not enforcing the provisions of this ordinance.

This ordinance is to be in full force and effective from and after the 19th day of March, 2001.

WATER SUPPLY

Water Supply

Drought and Water Restriction Timeline

Water Supply Projects

Kannapolis Lake Level and Rainfall Statistics

Conservation Tips

Available from the City of Kannapolis

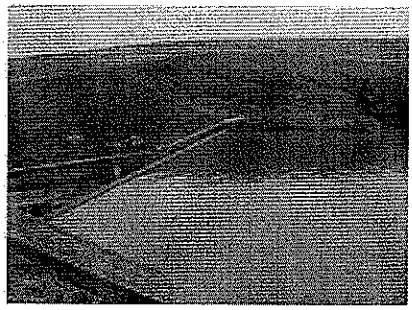
Water Emergency Ordinance

Download a Water Packet for Kids

Links to more water conservation information

key word search
GO!

Qu
If y ...out the status of the city's water su ...c Works Department at 704-920-4200 or the City Offices at 704-920-4300. Click here to see a chart of the water levels comparing 2001, 2002 and 2003.



Water Supply
Since March 2003, Kannapolis Lake has been at or near full pond. Rainfall most months has been at or above average levels. Secondary water sources, Lake Don T. Howell and Second Creek, have not been utilized in several months. The citywide water consumption rate remains about 5 million gallons a day. Here are some other drought and water supply facts:

- 2003 started with Kannapolis Lake 31 inches below full pond compared to 67 inches below full pond at the beginning of 2002. This is a 36 inch improvement.
- Above average rainfall in Oct., Nov. and Dec. 2002 plus pumping from supplemental sources increased the lake level by 82 inches. Six months of below average rainfall preceded the three months of above average rainfall.
- In 2002, the water treatment plant distributed 2,568,000 gallons of water, which is an average consumption rate of 5.85 mgd.
- Water consumption declined by 9.9 percent in 2002 and 24.4 percent in 2001resulting in a 34.3 percent reduction

over the last two years.

- Rainfall in 2002 totaled 43.45 inches, which is a deficit of 5.59 inches for the year.
- Second Creek in Rowan County is one of the City's supplemental sources of water. For most of the year up to 5.5 mgd is pumped to Kannapolis Lake. During the summer, the totaled pumped per day may drop to two to four mgd. In July and Aug. of 2002, the City could not pump any water due to an historically low stream flow.
- The maximum amount that can be pumped from Lake Don T. Howell is 2 mgd. Pumping has continued throughout the drought.
- Kannapolis Lake annually reaches its lowest levels between August and October. Through the winter enough precipitation is needed to recharge the lake for the dry spring and summer months.
- The current drought is in its fifth year.
- The longevity of the drought has impacted groundwater levels which lowers the base stream flow into Kannapolis
- Lake and supplementary water sources.

Drought and Water Restriction Timeline

1997

- Water levels in Kannapolis Lake and rainfall are at average to above average levels for the year.
- Recognizing that dependence on surface waters for the City's water supply may not support anticipated growth, City Officials take the first steps to identify new water supply options. Without a major river adjacent to the city, leaders know that the process of securing additional water resources will be long and challenging.

1998

- Before much progress is made to identify new water supply options, drought, now referred to as a 100-year drought, begins in mid-1998.

1999

- As water levels in Kannapolis Lake fall, City officials work with representatives of the North Carolina Department of the Environment and Natural Resources (NCDENR) to develop an ordinance outlining the city's policy on water restrictions.
- Voluntary restrictions are instituted Sept. 3 and lifted Oct. 11.
- Finkbeiner, Pettis and Strout, a civil engineering firm, is hired to begin water supply and water distribution and master plans that includes work to secure additional water supply alternatives.

2000

- The worst year of the drought- water levels averaged 30 inches below normal, rainfall totals 34.67 inches, a 13.88-inch deficit for the year.
- July 24 voluntary restrictions are implemented.
- Sept. 11 mandatory restrictions begin limiting water use to

weekends for watering lawns and plants and washing cars.

- Water conservation education begins.

2001

- Businesses and citizens reduce water consumption by 25 percent.
- February 12 restrictions are tightened prohibiting car washing, except at a commercial facility, or watering of plants or lawns, except by hand held container.
- April 24 restrictions are relaxed to allow water use for outdoor activities on Wed. and Sat. with a hand-held spring-loaded nozzle.
- June 12 restrictions are relaxed to allow water use for outdoor activities on Wed. and Sat. from 7 am to 7 pm the following mornings.
- March 26 a suspension of plan approvals and water line extensions is in effect creating a building moratorium.
- Beginning in March, rainfall returns to normal levels in Kannapolis.
- In August, City Council approves the issuance of $35 million in revenue bonds, $20 million of which are for water and sewer projects. The bonds fund a $14 million renovation of the water treatment plant to bring it into compliance with federal and state guidelines and increase the treatment capacity from 12 million gallons per day (MGD) to 15 MGD. The remaining funds are used for replacing aging lift stations, installing new water mains in the Coddle Creek annexation area and replacing water and sewer lines.
- Also in August, City Council approved the negotiation of a contract with the City of Salisbury to obtain up to 3.1 mgd of treated water through a $2.4 million water main extension along Hwy. 29 to the northern city limits. One million dollars of the cost will go to complete infrastructure improvements in northern Kannapolis where the water from Salisbury will enter the city's system. The remaining cost is Kannapolis' share of a larger project involving Rowan County, China Grove and Landis. Up to 2 mgd might be available by summer 2002 without an interbasin transfer (IBT) permit from the state. The remaining 1.1 mgd will be available after an IBT is obtained.
- Sept. 11, Kannapolis Lake is 27.5 inches above normal; rainfall totals 27.68 inches for the year (only a 5.98-inch deficit) and mandatory restrictions are reduced to voluntary.
- The suspension of plan approvals and water line extensions continues while City staff complete a number of water related plans and policies including the water supply and water distribution master plans; a water allocation plan that will keep a running total of the water available for new development; a new water line extension policy; a backflow policy; and a wastewater collections master plan.
- Due to National Drought Monitoring Council predictions of below average winter rainfall, mandatory restrictions were reinstated November 20 as a precautionary measure. Kannapolis Lake was at 70 inches below full pond, one inch below average for the time of year and 27 inches higher than 2000.

2002

- At their January 28 meeting, City Council approved a

contract between the City of Kannapolis, the City of Concord and an outside consultant to conduct the environmental assessments necessary to begin the process of applying to the State for an interbasin transfer. The environmental assessment will study the feasibility of pursuing such long-term options as a raw water intake on the Yadkin or Catawba Rivers.

- February a Community Well and Water Extension Policy is approved by City Council.
- April 26, the moratorium on plan reviews and water line extensions, first implemented March 26, 2001, is lifted when the lake level improves to four inches below full pond, .25 inches below average.
- By July 3, Kannapolis Lake is 30 inches below full pond, 8.5 inches below normal and dropping. The prolonged effect of the drought has impacted the groundwater at Second Creek reducing the stream flow by 85 percent. For the first time in the City's history water cannot be pumped meaning that 5.5 mgd of water is not supplementing Kannapolis Lake.
- July 27 City Council amended water restrictions to discontinue irrigation with automated systems or household sprinklers previously allowed on Wednesdays and Saturdays from 7 pm to 7 am the following morning.
- Mayor Ray Moss asks citizens to pray for rain.
- In August, emergency water flows from Charlotte through Concord to Kannapolis and on to Landis. Kannapolis accepts 700,000 gallons a day, 300,000 of which goes to Landis.
- On August 26, City Council discontinued warnings for water restriction violations and approved police officers, code enforcement officers and other city staff to issue immediate fines of $100 per residential water violation and $300 per business violation.
- At the same meeting City Council, reinstated the moratorium on plan reviews and water line extensions and amended the water emergency management ordinance to prohibit car wash fundraisers, to eliminate tanker fill-ups and to limit automobile dealerships to washing cars only when they arrive on their lot and when they are sold.
- Sept. 23 City Council adopted the water system master plan and a backflow prevention policy.
- Two inches of rain during September allow pumping at Second Creek to increases to 2.2 mgd, half the usual amount of 5.5 mgd.
- October 10, Kannapolis reaches an historic low- 113 inches below full pond.
- Plans are underway to complete a new waterline and pump station along the Kannapolis Parkway in 2004 that will bring additional treated water from Charlotte through Concord.
- October rainfall equaled 7.57 inches, 2.7 inches above normal. This is the first above average rainfall for the year. The rainfall deficit is still 9 inches for the year and 48 inches, equivalent to a year of rainfall, since the drought started.
- The rain brings pumping at Second Creek back to full capacity at 5.5 mgd.
- Due to almost 11 inches of rain in a month, mid-November Kannapolis Lake is 85 inches below full pond up from 97.25 inches below full on Nov. 1. This is still 14 inches below average.
- Water consumption for customers of the Kannapolis water system drop to an all time low of 4.9 mgd from the previous low of 5.4 mgd.

- Mandatory water restrictions and the moratorium on plan reviews and waterline extensions remain in place.

2003

- On January 27 City Council voted to amend water restrictions to allow tanker truck fill ups, car wash fundraisers on Wed. and Sat., pool filling permits to be issued. They also lifted the moratorium on water lines and plan reviews in place since Aug. 2002.
- February 24, 2003 City Council voted to allow daily use of water for outdoor activities with a hose with a hand-held spring-loaded nozzle. Irrigation with an automated sprinkler system or household sprinkler remains prohibited.
- With Kannapolis Lake a half inch above full pond, water restrictions were amended to allow irrigation with an automated system or household sprinkler under an odd/even schedule. Homes with even house numbers could irrigate on Sundays, Wednesdays and Fridays from 10 pm to 6 am. Homes with odd numbers could irrigate on Tuesdays, Thursdays and Saturdays from 10 pm to 6 am. No irrigation was allowed on Mondays.

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Water Supply Projects

Collaborative Work with the City of Concord
During the height of the five-drought that plagued the region from 1998 to 2003, Concord, Charlotte, Kannapolis and Landis with the help of State officials reached an agreement so that 700,000 gallons of supplemental emergency water was available to pass from Charlotte to Kannapolis through Concord. City officials also continue working with the City of Concord to pursue new raw and treated water options from the Yadkin and Catawba Rivers as well as future connections with the City of Charlotte. Both cities have contracted with an outside consultant to conduct the environmental assessments necessary to begin the process of applying to the State for interbasin transfers (IBT). Receipt of an IBT is expected in 2004.

Western Cabarrus Waterline
The western Cabarrus waterline that will extend up the new Kannapolis Parkway is under construction. When completed, the line could bring up to one mgd of treated water from Charlotte through Concord.

Salisbury Water Line
Cooperative efforts between the City of Kannapolis, Rowan County, the City of Salisbury, the Town of Landis and the Town of China Grove have resulted in a new waterline from Salisbury to the northern city limits. The waterline from Salisbury makes a minimum of 300,000 gallons of treated water a day available to Kannapolis. When Salisbury finishes upgrades to their system, up to 2 mgd will be available. After an interbasin transfer is obtained, a minimum of 400,000 gallons a day will be purchased with a maximum of 3.1 mgd.

Water Treatment Plant Renovation
The $14 million, two-year renovation of the water treatment plant on Pump Station Road was substantially complete in December 2003. Remaining construction should be complete in January 2004. The renovations will bring the plant into compliance with state and federal regulations while increasing the water treatment capacity from 12 mgd to 15 mgd. To pay for the renovation and numerous other water and wastewater system improvements, City

Council budgeted for the issuance of $35 million in revenue bonds in fiscal year 2002.

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Available from the City of Kannapolis

Conservation Kits
The City of Kannapolis sells household water conservation kits for $7. The 10-piece water conservation kit includes a leak detecting kit, flow rate bag for toilets, a drip gauge, toilet displacement toilet tank bag, pressure enhanced showerhead, a kitchen faucet aerator, two bathroom faucet aerators, teflon tape and a toilet fill cycle diverter. The kits are available from the Water and Sewer Administration, 133 Floyd Street, or call 704-933-1133 for information.

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Water Conservation Tips
IN THE BATHROOM
*Fill a plastic bottle or bag with water or pebbles. Place it in your toilet tank. The water displaced per flush saves 5 to 10 gallons a day or up to 300 gallons a month.
*Replace your five-to-seven gallon per flush toilet with a one-and-a-half gallon, ultra-low flush model.
*Put dye tablets or food coloring into your toilet tank. If color appears in the bowl without flushing, a leak needs to be repaired. Saves 400 gallons a month.
*Turn off the water while brushing your teeth or shaving. Saves three to six gallons a
day.

IN THE KITCHEN AND LAUNDRY
*Wash dishes by hand when possible. Use two sinks, one for washing and one for rinsing, to avoid running water continuously. For single sinks, use a spray device or short blasts of water to rinse. Saves 200 to 500 gallons a month.
*Use a small amount of detergent when hand washing dishes to minimize rinsing. Saves 50 to 150 gallons a month.
*Keep a bottle of chilled water in the refrigerator instead of running water to cool it for drinking. Saves 200 to 300 gallons a month.
*Take frozen foods out in time to defrost or use the microwave. These methods, instead
of hot water, can
save 50 to 150 gallons a month.
*Clean vegetables or fruits in a filled sink or a pan instead of under running water. Saves 150 to 250 gallons a month.
*Use garbage disposals less and the garbage cans or compost pile more. Saves 50 to 150
gallons a month.
*Turn on clothes and dishwashers when there are full loads.

OUTSIDE
*Use recycled household water from cleaning, dishes or fish tanks to water
*Catch rainwater in large basins for watering
*Put a layer of mulch, bark, peat moss or gravel around trees and plants to slow evaporation. Saves 750 to 1,500 gallons a month.
*Keep a cover over outdoor pools to lessen evaporation. Saves 1,000 gallons a month.
*Set lawn mower blades a notch higher to slow evaporation. Saves 500 to 1,500 gallons a
month.
*Instruct your children not to play with garden hoses. Saves 10 gallons a minute.
*Drain evaporative air conditioners to a flowerbed, tree base or lawn.
*Use only commercial car washes that recycle wash water.

Additional Tips from the American Water Works Association
Clean greasy hands with a waterless hand cleaner.
Insulate hot water pipes.
Deactivate automatic sprinkler systems
Landscape using low-water plants and rock gardens to reduce the amount of lawn

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Water Conservation Links
Education and resource sites
Environmental Protection Agency www.epa.gov
North Carolina State Government www.ncgov.com
North Carolina Department of Environment and Natural Resources
www.ehnr.state.nc.us
The North Carolina Drought Monitoring Council
www.dwr.ehnr.state.nc.us/drought/detail.htm
The Federal Energy Management Program
http://www.eren.doe.gov/femp/techassist/waterconserve.html

The following links are not an endorsement of any product or company but a service to our communities. They list water conservation products for the home and garden:
http://www.conserving-water.com
http://www.greenculture.com
http://www.frostproof.com/catalog/ng06.html
(Soil Moist, a product that stores over 200 times its weight in tap water, is available through this site.)

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WSACC
WATER & SEWER AUTHORITY
OF CABARRUS COUNTY

Office: 232 Davidson Hwy.
Concord, NC 28027

Mail to: P.O. Box 428
Concord, NC 28026-0428

Phone: 704.786.1783
Fax: 704.795.1564

Letter of Transmittal

AUG 2 9 2003

To: City of Concord **Date:** 8/27/03

Attention: Mr. Jim Greene

Address: Post Office Box 308
Concord, North Carolina 28026-0308

Project / Re: Regional Drought Management Plan

We are sending you the following submittal items:

Copies	Date	Description	
1	8/25/03	Regional Drought Management Plan – Final Draft Revised per last meeting on August 20, 2003.	

Comments:

Final copy for your use. Revised per our discussions and comments given at the last Regional Drought Management Plan meeting of August 20, 2003. If you have any questions please give me a call at 704-786-1783 ext. 28.

Signed: Jeff Davis

Jeff Davis, P.E.
Engineering Director

Enclosure

cc: WSACC Board of Directors
Henry Waldroup, Concord
Wilmer Melton, Kannapolis
Mike Legg, Kannapolis
Carl Parmer, Harrisburg
Troy Barnhardt, Mt. Pleasant
Jonathan Marshall, Cabarrus County
John C. Murdock, III, WSACC
Ray Furr, WSACC
Jim Mead, NCDENR
Woody Yonts, NCDENR
Adugna Kebede, NCDENR
Ron Linville, Division of Wildlife Mgt.

Safe Yield Update and Regional Drought Operations

1.0 Safe Yield Update

The severity of the recent drought has resulted in record low stream flows, low reservoir levels, emergency water supplies from sources outside Cabarrus County, and extended mandatory water restrictions. Using the mass-balance model to simulate reservoir operations, it can be shown that the recent drought (1998-2002) was the most severe in the last 103 years of record with respect to reservoir yield and reliability. To quantify the effects of the recent drought, it was necessary to update the mass-balance models. The update includes the new drought of record for the four major water supply reservoirs serving Cabarrus County: Lake Howell, Kannapolis Lake, Lake Fisher, and Lake Concord. In addition, the collection of bathymetric information for these reservoirs coupled with a better representation of the inflows to the reservoirs needed to be incorporated into the safe yield calculations.

1.1 Mass-Balance Model Approach

The model used to analyze the reservoirs calculates the average annual yield for the reservoir based on constant demands imposed on simulated historical hydrologic data and current reservoir geometry. Yield is determined by solution of a water balance equation using an iterative approach. Solution of the water balance equation occurs when the difference in reservoir inflow and outflow equals the change in reservoir storage volume. Model inflows include precipitation and stream flow into the reservoir. Outflows include evaporation, user demands, spillway overflows, and downstream releases. The following water balance equation is used in the reservoir yield model:

$$VOL_1 = [VOL_0 + INFLOW + PRECIP] - [YIELD + EVAP + SPILL + MIF]$$

The variables in the equation are defined as:

VOL_1	= reservoir volume at the end of the month.
VOL_0	= reservoir volume at the beginning of the month.
INFLOW	= volume of inflow during the month.
PRECIP	= volume of precipitation on reservoir during the month.
YIELD	= average volume of yield during the month.
EVAP	= volume of lake evaporation during the month.
SPILL	= volume of spillway overflows during the month.
MIF	= minimum release downstream of the dam and intake

1.2 Reservoir Volume Update

Updated bathymetric data including elevation, storage and surface area of the four reservoirs--Howell, Kannapolis, Fisher and Concord--was provided by the City of Concord. The data provides current information on lake bottom contours and the storage capacity of each reservoir. Using this information, the effects of sedimentation over time can be observed.

The updated bathymetric data showed reduced storage volumes at full-pool elevations for Lake Howell and Kannapolis Lake. The recent survey of Lake Howell is compared to historical data, and a loss of 734 million gallons of storage is observed, as shown on Figure 1.

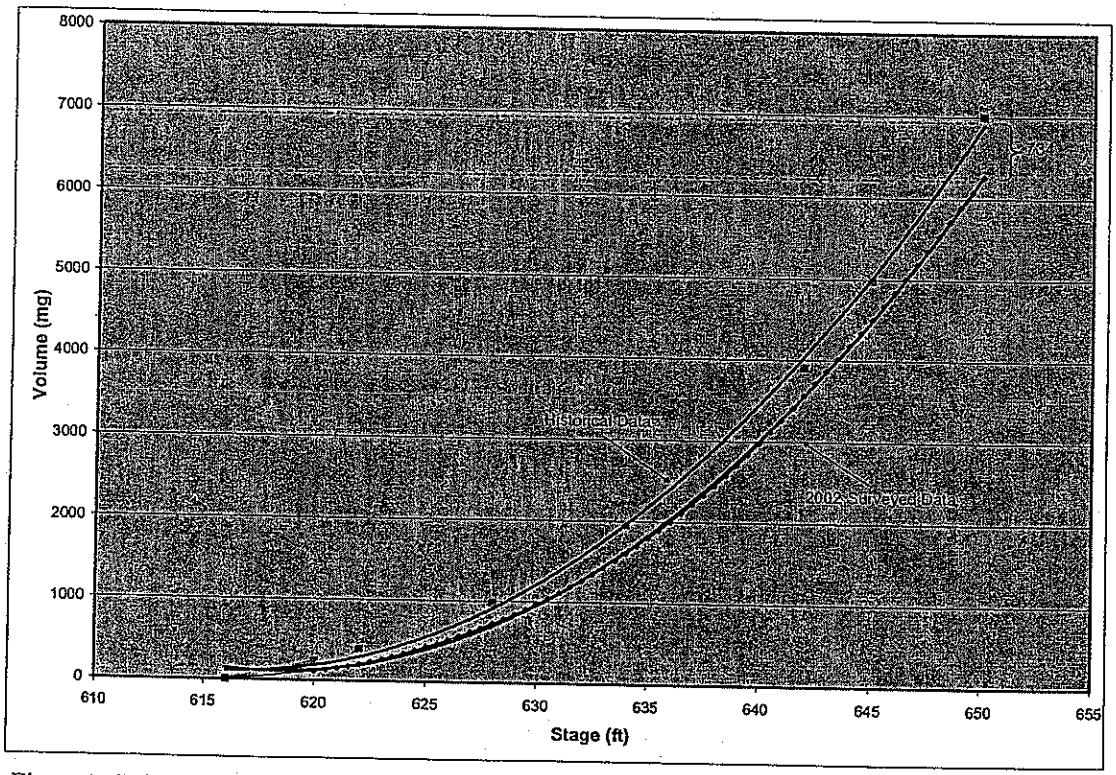

Figure 1. Lake Howell stage-storage volume update

Data obtained from the recent survey of Lake Kannapolis is compared to historical data, and a loss of 94 million gallons of total storage is observed, as shown in Figure 2. The surveys of Lake Fisher and Lake Concord provided information that was not previously available. The current relationship between water surface elevation (stage) and storage is shown for Lakes Fisher and Concord in Figures 3 and 4, respectively.

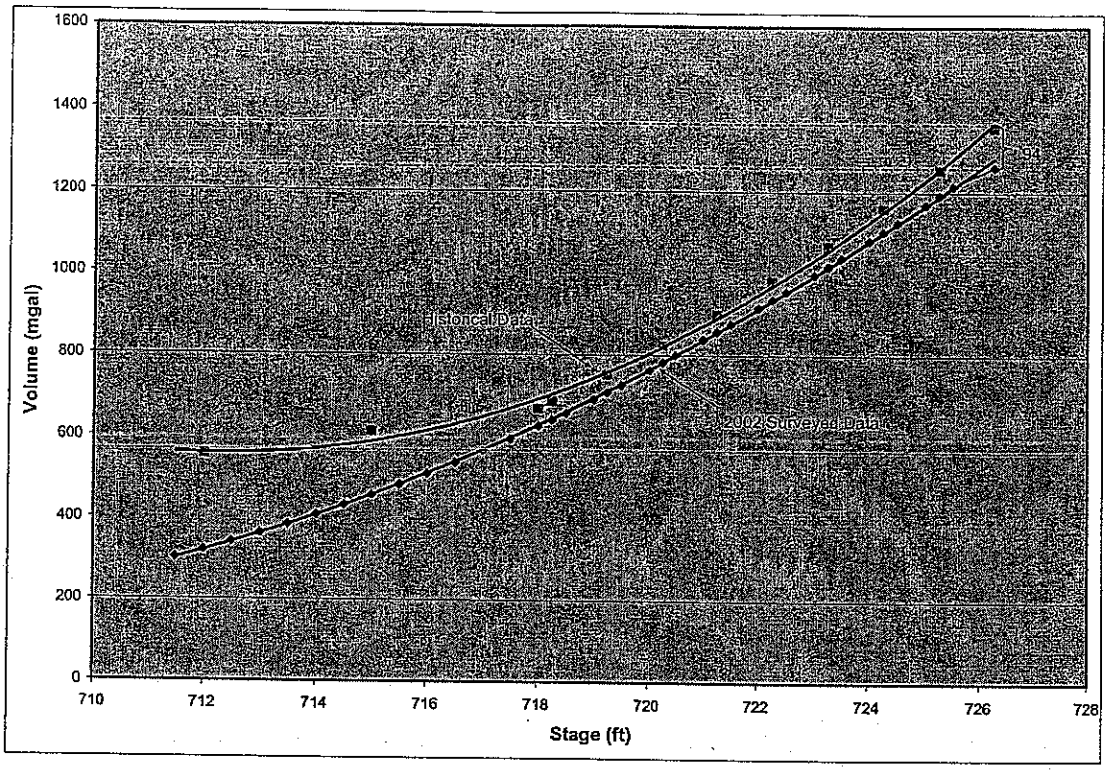

Figure 2. Kannapolis Lake stage-storage volume update

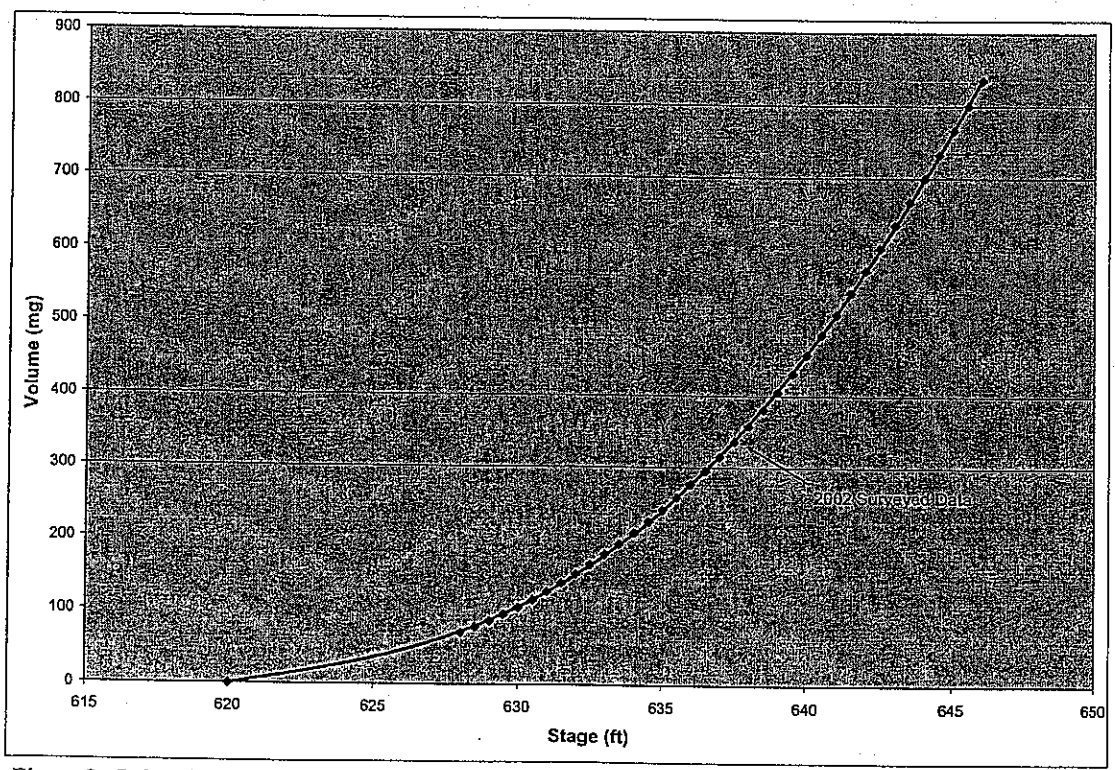

Figure 3. Lake Fisher stage-storage relationship

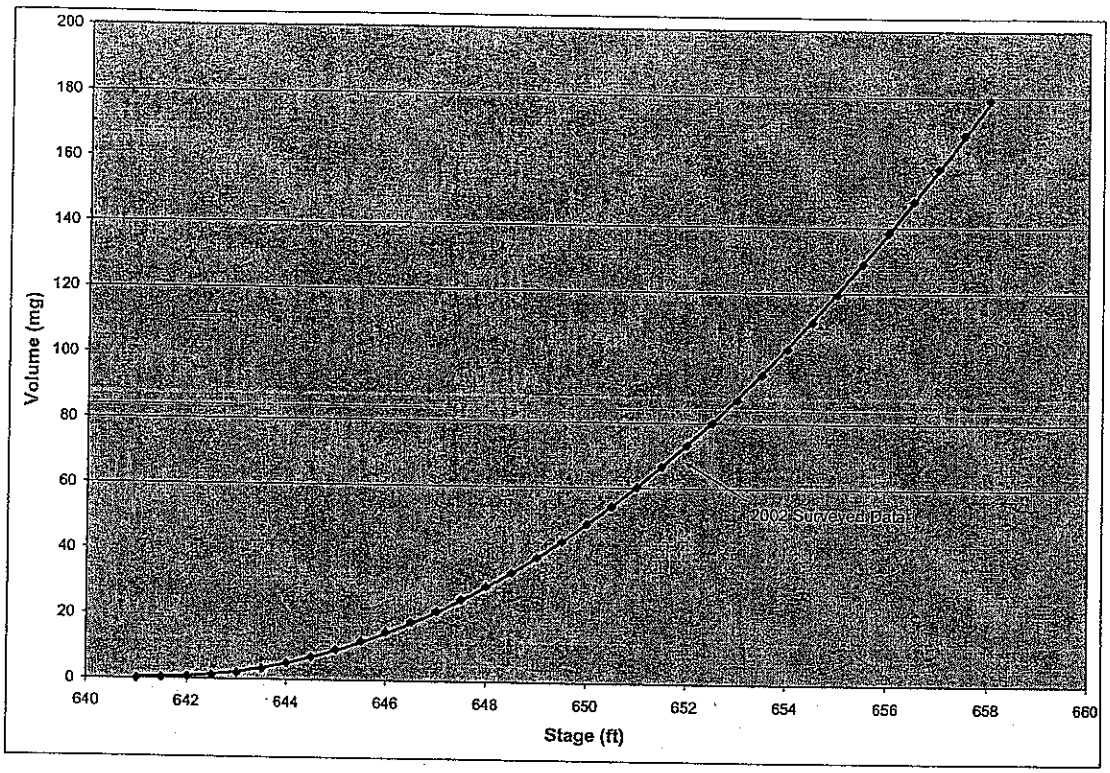

Figure 4. Lake Concord stage-storage relationship

1.3 Stream Flow Evaluation

The simulated stream flow record was extended to incorporate flow data through February 28, 2003. Some of the lowest stream flows of record were observed in August and September of 2002. Therefore, the gage weighting factors used to simulate the stream flow record were recalculated to account for the new data.

To evaluate the level of accuracy of the simulated flow record for Lake Howell, it was compared to USGS flow measurements collected over the last two years in the three streams feeding Lake Howell. The gage weighting factors used to simulate the stream flow record are heavily weighted toward Second Creek values. Therefore, the stream flow record for Second Creek (adjusted to size) was compared to the USGS field-measured data to assess its accuracy of stream flow prediction.

The USGS field data was collected over the period from January 2001 to September 2002. The sum of the three stream flow values from the tributaries provided the value used to represent total inflow into Lake Howell.

A common flow basis is needed for determination of flow accuracy. Accordingly, Second Creek gauged values were adjusted, based on drainage area ratio, for direct comparison to Lake Howell inflows. For the days on which the USGS collected Lake Howell inflow data, the actual measurements were compared to adjusted Second Creek flows, and to the synthesized flow record previously used in the safe yield model (also called Weighted Average). The numerical data are presented in Table 1, and the data are shown graphically on Figure 5.

Table 1
Comparison of Inflows into Lake Howell (cfs)

Date	USGS at Howell	Second Creek Adj.	Weighted Average
1/24/2001	9.27	12.35	16.57
7/12/2001	3.43	2.79	7.56
9/18/2001	2.11	1.79	3.41
11/7/2001	3.40	4.38	6.09
1/8/2002	8.01	8.36	16.64
2/12/2002	15.40	16.33	24.42
3/29/2002	13.28	17.13	22.85
4/8/2002	10.89	14.34	16.15
5/25/2002	4.51	3.31	6.50
7/23/2002	1.08	1.23	2.46
8/20/2002	0.16	0.80	3.07
9/26/2002	3.47	1.67	7.03

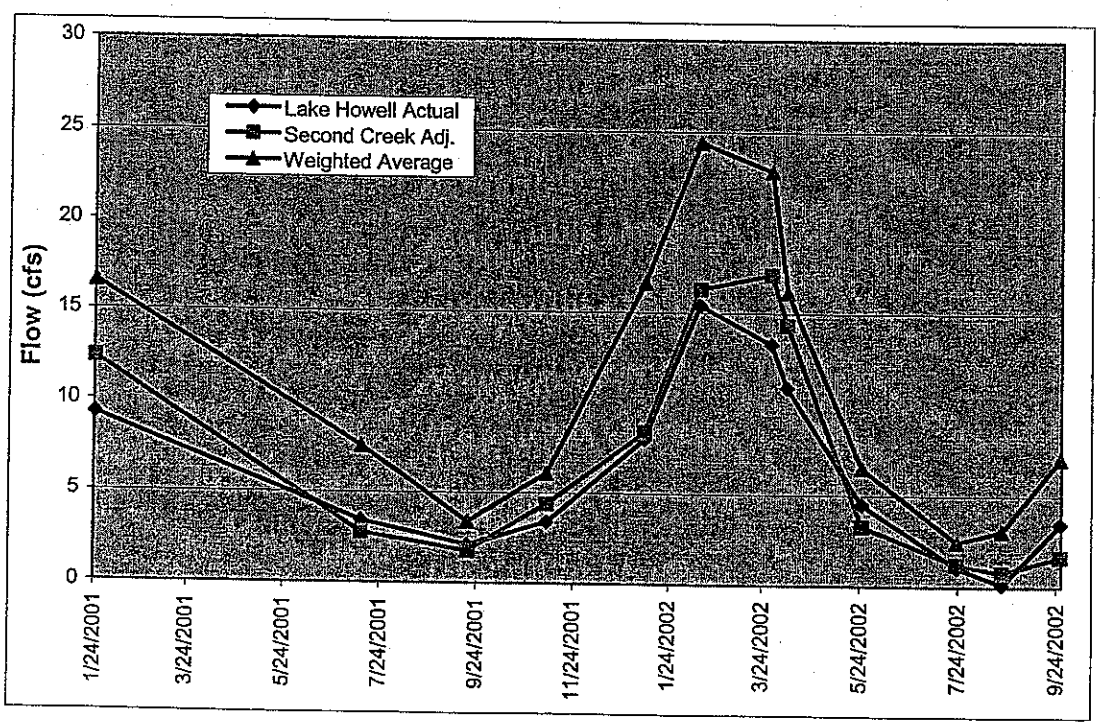

Figure 5. Comparison between simulated records and USGS stream flows at Lake Howell

The comparison of flows showed that the Weighted Average record overestimated the low flows observed at Lake Howell. The Second Creek values, adjusted to a comparable drainage area, are much closer to the actual Lake Howell inflows. Overall, they overestimated flows slightly over the period analyzed.

Additionally, a correlation analysis was performed on the three sources of data to provide a statistical determination of the accuracy of flow prediction. The correlation coefficient (R) is an index of the degree of association between two values. The correlation coefficient measures the degree to which the measured and predicted values agree, and is used as a measure of the accuracy of future predictions. A correlation coefficient greater than 0.7 indicates a significant degree of association between the measured and predicted values. The results of the correlation analysis show that both the weighted average-generated flows and Second Creek values associate extremely well to field-measured data for Lake Howell.

- Correlation between USGS measurements and Second Creek flows, R = 0.98
- Correlation between USGS measurements and weighted average flows, R = 0.98
- Correlation between Second Creek and weighted average flows, R = 0.96

Based on these results, a common (cfs/mi^2) simulated stream flow record (Jan. 1900 – Nov. 2002) based on USGS stream flow gages was generated for all reservoirs. When Second Creek gage data was available, this gage was used without other gage data. For all other periods, a weighted average approach was taken for the previously selected gages. Reservoir inflows were obtained by multiplying the common (cfs/mi^2) record by the corresponding reservoir's drainage area.

1.4 Reservoir Operating Assumptions

For the purpose of updating the mass-balance model and safe yield values for Lake Howell, Kannapolis Lake, Lake Fisher, and Lake Concord, operating constraints were re-evaluated in light of the extreme drought. Table 2 summarizes the operating assumptions used in the updated safe yield models for the four reservoirs.

Table 2
Reservoir Operating Constraints

Water Source	Total Volume (mg)	Usable Volume (mg)	Normal Elev. (ft)	Minimum Elev. (ft)	Basis	Minimum Release (cfs)
Lake Howell	6270.9	5296.3	650	630	Gravity flow to WTP	6.0
Kannapolis Lake	1262.2	941.1	726	712	Invert Intake Elev.	0.0
Lake Fisher	836.0	749.6	646	629	Elev. Sluice Gate #5	0.0
Lake Concord	179.2	179.2	658	641	Bottom of Reservoir	0.0

1.5 Safe Yield Conclusions

The safe yield of a water source is a measure of the capacity of the source and is defined as the allowable draft rate at which water can be continuously withdrawn during a low flow or drought event. It is a function of the stream flow, topographic conditions of the watershed, climatological conditions affecting evaporation from the reservoir, watershed development conditions affecting sedimentation of the stream, reservoir seepage, and usable storage capacity in the reservoir.

1.5.1 Significant Water Supply Droughts. The updated mass-balance models were used to simulate an approximately 100-year period of hypothetical operations for each reservoir (1900-2002). The most significant 8 to 10 periods of drought were identified for each reservoir, and a yield was computed for each separate drought. The droughts are ranked based on the safe yield results. The lowest safe yields correspond to the most severe droughts for each source. The recent drought ranks as the drought-of-record for all reservoirs.

For each lake, the month and year that resulted in the lowest lake elevation is also identified. The results are shown in Table 3.

Table 3
Significant Water Supply Droughts (1900-2002)

Lake Howell

Rank	Year	Month	Safe Yield (mgd)
1	2002	October	7.05
2	1956	November	16.20
3	1927	November	16.30
4	1970	July	18.00
5	1942	November	18.30
6	1986	December	18.50
7	1981	November	18.80
8	1932	September	19.05
9	1914	November	20.25
10	1994	December	21.00

Lake Concord

Rank	Year	Month	Safe Yield (mgd)
1	2002	October	0.70
2	1986	November	1.20
3	1956	January	1.55
4	1925	December	1.60
5	1981	December	1.65
6	1993	November	1.70
7	1967	November	1.70
8	1930	November	1.75

Kannapolis Lake

Rank	Year	Month	Safe Yield (mgd)
1	2002	September	5.70
2	1956	November	8.50
3	1927	November	8.60
4	1986	November	8.65
5	1981	November	8.95
6	1967	November	9.00
7	1942	January	9.00
8	1931	November	9.20

Lake Fisher

Rank	Year	Month	Safe Yield (mgd)
1	2002	October	3.00
2	1986	November	5.15
3	1956	January	6.35
4	1926	October	6.55
5	1981	November	6.65
6	1967	November	6.90
7	1993	December	7.00
8	1931	November	7.10
9	1983	November	7.35

1.5.2 Fifty-Year Safe Yield. The 50-year safe yield is computed for each reservoir to meet the North Carolina Department of Environment, Health, and Natural Resources guidelines. The guidelines base the safe yield of an impounded surface water source serving more than 50,000 people on a 50-year drought. Each of the four reservoirs was evaluated to determine its safe yield, using a 50-year drought recurrence interval.

Since approximately 100 years of reservoir operations are simulated, the most detrimental drought event of the period is determined to have a 100-year recurrence, and the second most significant drought is determined to have a 50-year recurrence. A summary and comparison of these safe yield values to previously published values is in Table 4.

Table 4
Reservoir Yield Estimates (mgd)

Water Source	1999 Report[1]	2002 Master Plan		2003 Update	
	20-yr	20-yr	50-yr	50-yr	100-yr
Lake Howell	23.80	21.60	17.60	16.20	7.05
Kannapolis Lake	-----	-----	8.60	8.50	5.70
Lake Fisher	7.10	6.30	6.30	5.15	3.00
Lake Concord	1.90	1.70	1.70	1.20	0.70

[1] *Water Supply Draft Rates*, Woolpert, for City of Concord, December 1999.

Reservoir safe yield numbers appropriate for operation and management of the water supplies, in accordance with North Carolina guidelines follow:

- Lake Howell = 16.2 mgd.
- Kannapolis Lake = 8.5 mgd.
- Lake Fisher = 5.15 mgd.
- Lake Concord = 1.2 mgd.

Results of the simulation of each reservoir, setting the fixed withdrawal rate equal to these 50-year safe yields, are shown in Figures 6, 7, 8, and 9.

It is significant to note that during the recent drought, withdrawals equal to the 50-year safe yield values could not have been sustained. The total safe yield from the four lakes equals 31.05 mgd, considering a 50-year recurrence, and reduces to 16.45 mgd, considering a 100-year recurrence. A drought management strategy is needed to manage the sources, in conjunction with water use reductions and purchase of additional supplies, to ensure safe and reliable operations. Drought management considerations and a recommended approach are discussed in the following sections.

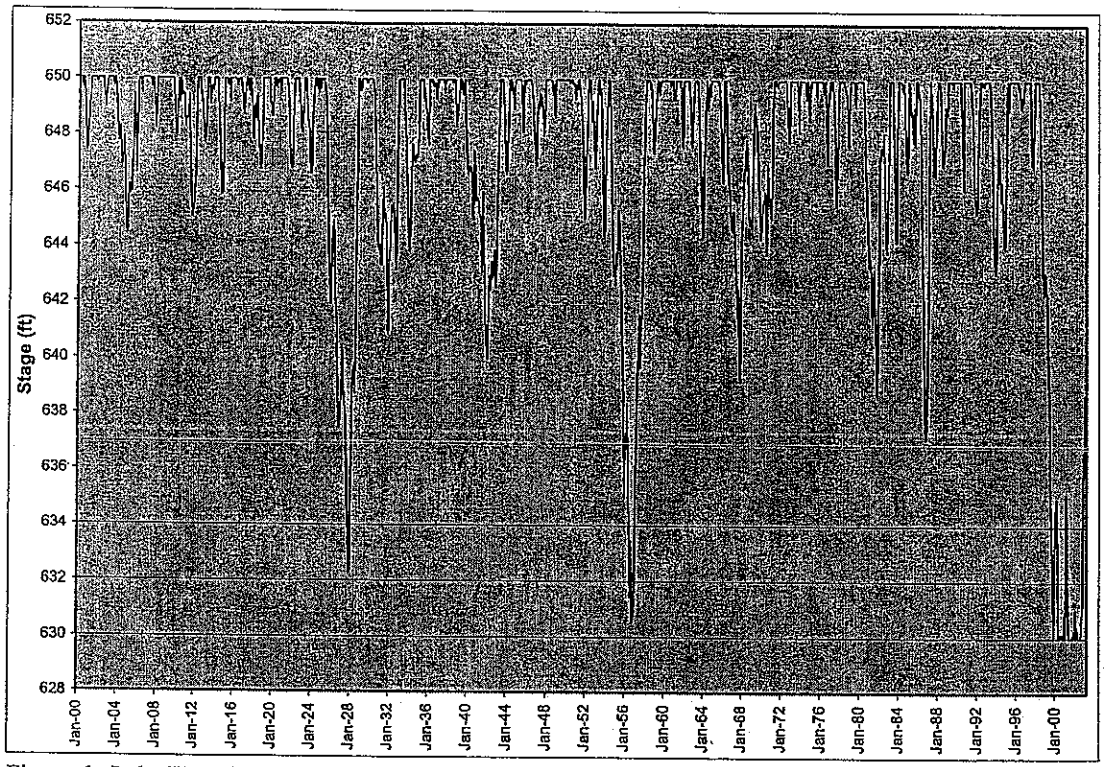

Figure 6. Lake Howell stage during the 103 years of simulated record at the 50-yr safe yield (16.2 mgd)

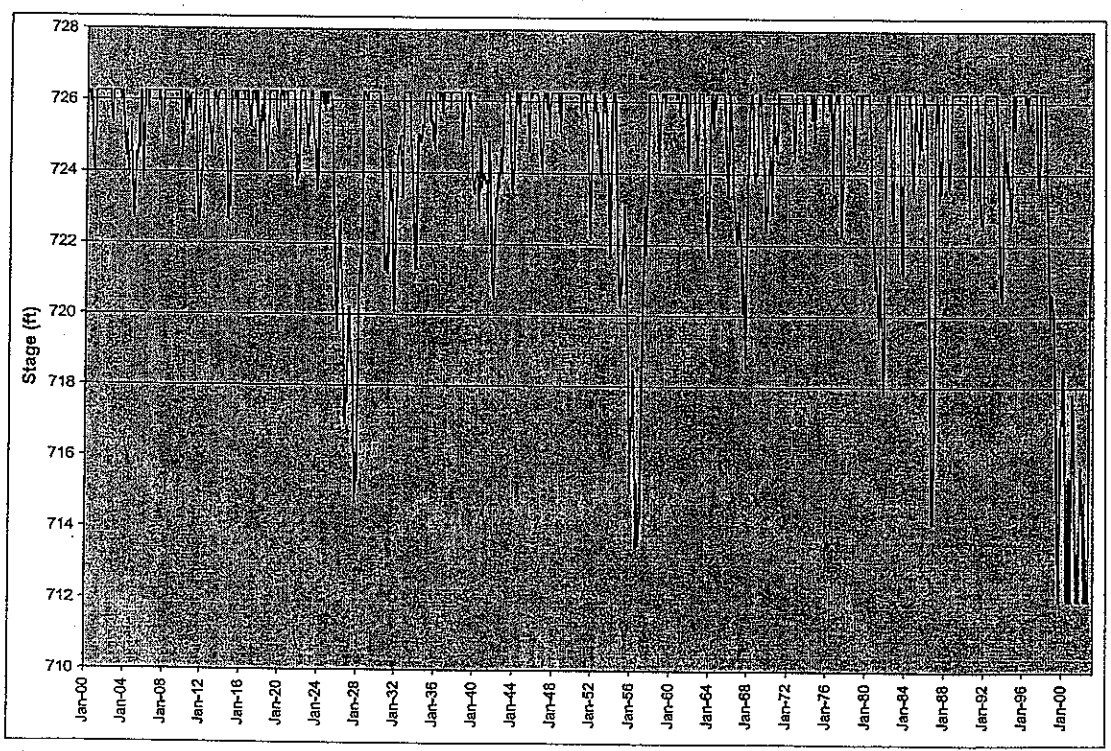

Figure 7. Kannapolis Lake stage during the 103 years of simulated record at the 50-yr safe yield (8.5 mgd)

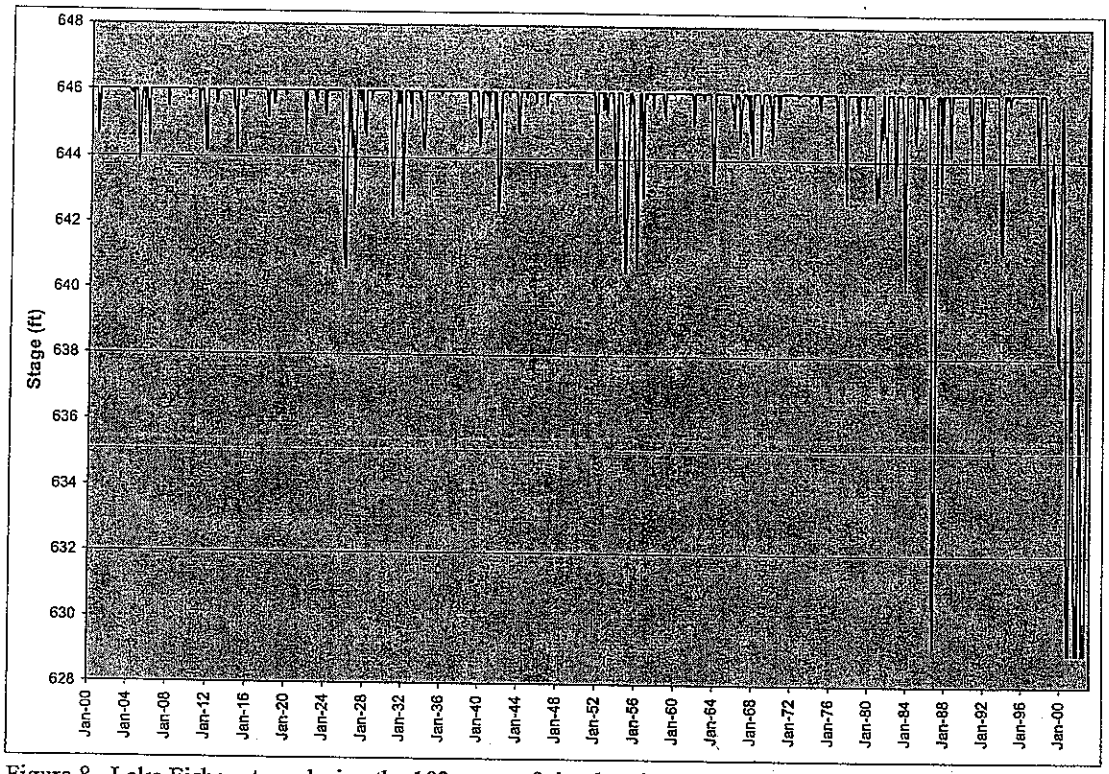

Figure 8. Lake Fisher stage during the 103 years of simulated record at the 50-yr safe yield (5.15 mgd)

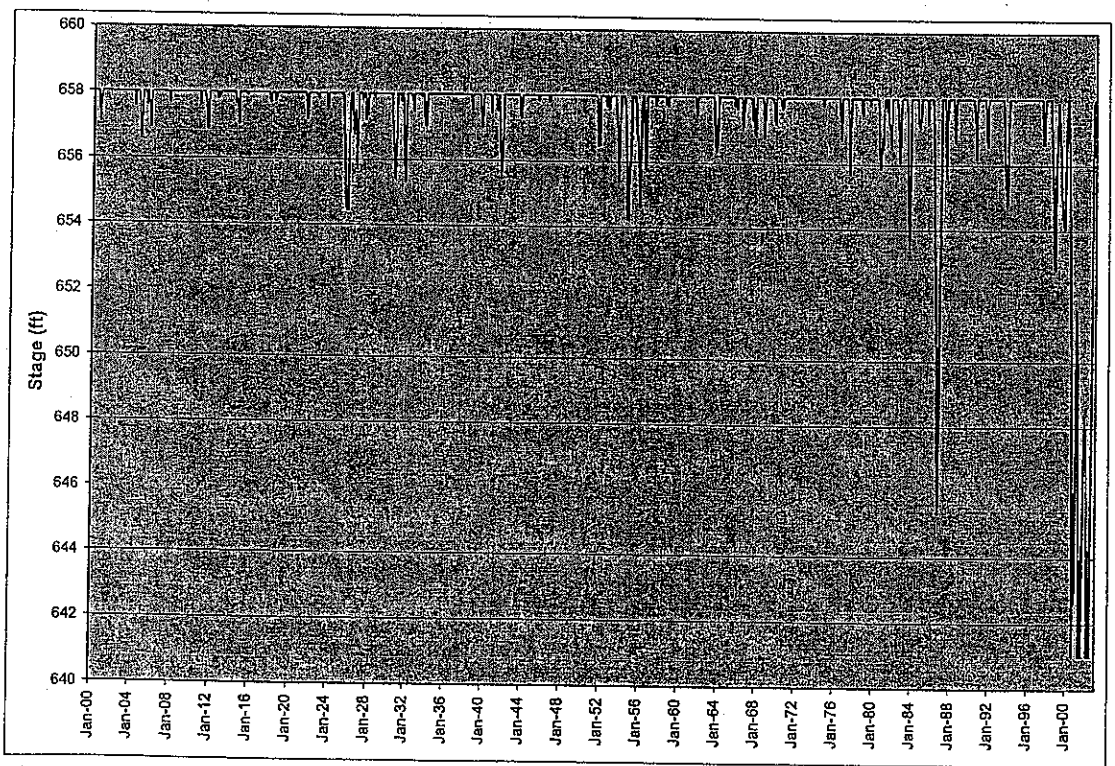

Figure 9. Lake Concord stage during the 103 years of simulated record at the 50-yr safe yield (1.2 mgd)

2.0 Regional Drought Operations

The occurrence of the recent, exceptional drought and the resulting record low levels in the water supply lakes provides great incentive to examine the benefits of managing and operating the water supplies of Cabarrus County in a coordinated manner. The objective of the evaluation of coordinated regional operations is to determine a sequence of operations that best extends the availability of the region's water supply storage in times of drought. A number of local, state, and river-based drought programs were investigated to provide information on similar programs implemented by others. Summaries of these programs are included in Appendix A.

2.1 Staged Water Use Restrictions

Water use restrictions are an integral component of any drought contingency plan, and these restrictions should become progressively more stringent as drought conditions increase in severity. Determining the onset and severity of drought conditions requires specific criterion that "trigger" the implementation of the appropriate drought mitigation techniques. These indicators must provide sufficient warning for adequate drought response, but not trigger these activities so prematurely or frequently that the public becomes complacent and non-responsive.

A four-staged approach to water use restrictions is preferred by WSACC and the member governments, for development of the operational plan. Voluntary Restrictions would occur in Stage 1; Mandatory Restrictions in Stages 2 and 3; and Emergency Restrictions in Stage 4. The mass-balance safe yield models developed for the four water supply reservoirs (Lake Howell, Kannapolis Lake, Lake Fisher, Lake Concord) provide the basis for developing the drought operating approach. The mass-balance model simulates hypothetical reservoir operations, including interactions with the other reservoirs in the system, using regional hydrologic information to develop a historical reservoir stage record.

A number of climatic indicators are available for monitoring drought conditions and triggering stages of drought response. Possible indicators include precipitation, stream flow, groundwater levels, and reservoir storage levels. A discussion of the most meaningful indicators of the water supplies of Cabarrus County follows.

2.2 Indicators of Drought

Drought indicators are used to identify the onset of deteriorating water supply conditions and provide a warning for appropriate stages of drought response. Initial triggers prompt

early response actions such as voluntary conservation. Subsequent triggers indicate an imminent water shortage, and eventually the need for strict water rationing. These triggers must provide sufficient warning for drought response by the region's water customers. Similarly, indicators are useful for determining the appropriate timing for lessening or discontinuing staged water use restrictions

Since the bulk of the raw water supplies in Cabarrus County are surface water storage reservoirs, the parameters evaluated are precipitation, stream flow, and reservoir volume. These parameters directly influence surface water sources, and they are easy to monitor.

The mass-balance models, developed for computation of safe yield, provided the tool to evaluate the effectiveness of drought indicators. The safe yield model simulates hypothetical reservoir operations, considering stream flow, precipitation, releases, and withdrawal rates to develop historical reservoir stage records.

2.2.1 Precipitation. Precipitation is the parameter used to determine meteorological drought, considering seasonal rainfall patterns, degree of dryness, and duration of the dry period. In agricultural applications, differences between actual and expected evapo-transpiration and topsoil moisture can define a drought. Sustained periods of departures from expected precipitation will eventually affect the groundwater and surface water base flows. Although the concept of accumulated precipitation deficit is a simple concept to grasp, it is not as effective as an indicator or predictor of water supply drought.

2.2.2 Stream Flow. The annual cycle of reservoir inflow generally peaks in the spring, and then slowly declines through the summer months with minimum flows typically observed in the fall. Conversely, the annual pattern for water demand peaks during the summer months with more modest demands in the spring and fall, and the lowest demands (reflecting minimum outdoor water use) in the winter. Winter and spring are typically the "refill" periods where inflow exceeds the moderate demand.

Hydrological drought occurs when a precipitation deficiency affects the surface or subsurface water supplies. It takes varying periods of time for precipitation deficiencies to affect the different parts of the hydrologic system, such as soil moisture, stream flow, groundwater, and reservoir levels. A few months of below-normal rainfall are not likely to affect the volume of water stored in the reservoirs; however, each reservoir will behave differently, based on its unique combination of drainage area, storage volume, and inflow factors.

Stream flow can serve as a reasonable predictor of water supply drought; particularly if it is compared to expected monthly values. For Lake Howell, a table of expected inflow by month was prepared for use in monitoring actual inflows (Table 5).

Table 5
Mean Monthly Inflow to Lake Howell (cfs)

Month	Mean Flow	75% Mean	50% Mean	25% Mean	10% Mean
January	51.8	38.9	25.9	13.0	5.2
February	58.5	43.9	29.3	14.6	5.9
March	63.5	47.6	31.7	15.9	6.3
April	51.9	38.9	25.9	13.0	5.2
May	38.3	28.7	19.2	9.6	3.8
June	35.0	26.3	17.5	8.8	3.5
July	29.9	22.4	15.0	7.5	3.0
August	31.0	23.3	15.5	7.7	3.1
September	26.6	20.0	13.3	6.7	2.7
October	31.8	23.9	15.9	7.9	3.2
November	30.3	22.7	15.1	7.6	3.0
December	39.7	29.8	19.9	9.9	4.0
Annual Average	40.7	30.5	20.3	10.2	4.1

For example, the twelve USGS field measurements of inflow to Lake Howell (refer to Table 1) show that flows in 2001 and 2002 were only 10 to 25 percent of the flow expected in those months. Over the period from May 1998 to November 2002, average inflow was between 25 and 50 percent of the expected annual average flow. Mean inflow to each of the four reservoirs during three severe droughts is shown in Table 6

Table 6
Mean Inflow (cfs) during Severe Droughts

Water Source	Drought Period			Drainage Area (mi^2)
	4/54 – 6/58	3/86 – 2/87	5/98 – 11/02	
Lake Howell	35.2	21.3	15.3	47.0
Kannapolis Lake[1]	14.6	11.3	9.5	66.2
Lake Fisher	14.0	8.5	6.1	18.7
Lake Concord	3.5	2.1	1.5	4.7

[1] Includes drainage area (55.6 sq.mi.) and inflows from Second Creek Pumping Station.

Stream flow can be most effective as a supplementary drought indicator, when it is used with monitoring reservoir storage.

2.2.3 Reservoir Volume. Each reservoir was analyzed independently and then in the context of the whole system to assess the reservoir's value as an indicator of the total available volume of the system. Plots of usable volume versus percentage of volume remaining for each reservoir and the combined system storage are shown on Figure 10. Lake Howell contains approximately 74% of the usable volume of the system; Kannapolis Lake and Lake Fisher contain approximately 13% and 11%, respectively; and Lake Concord contains about 2% of the usable volume of the system.

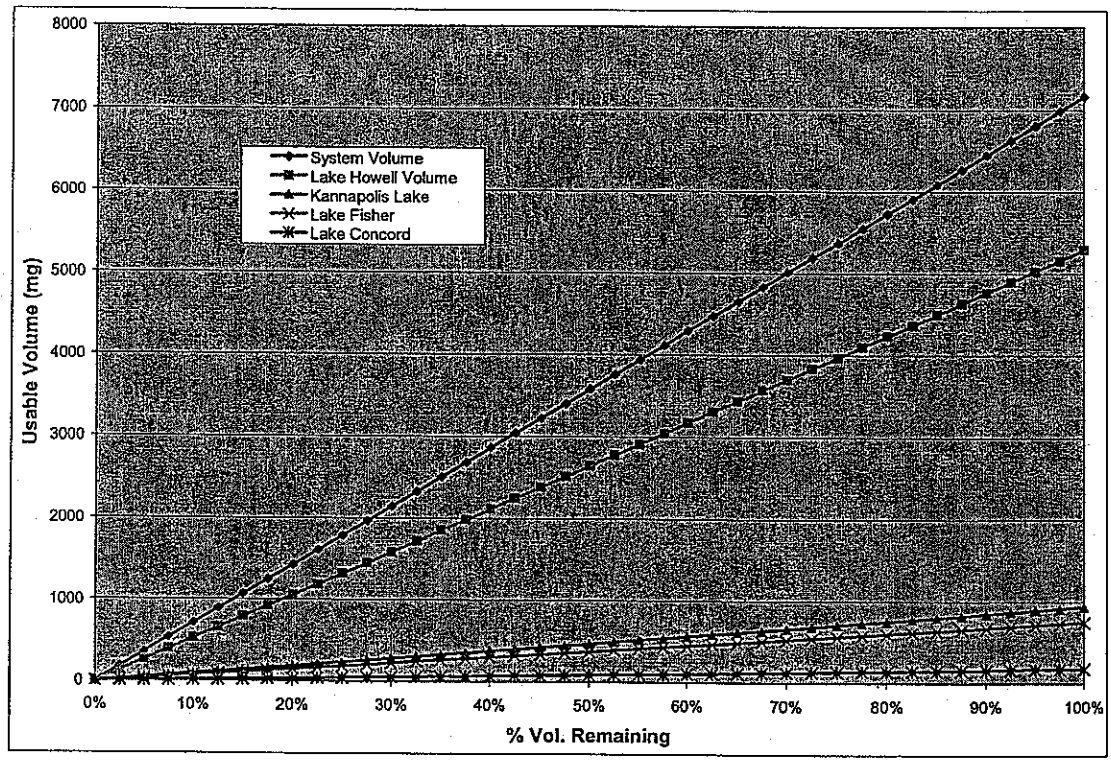

Figure 10. Distribution of storage of usable volume for the system

Because of its dominating share of the total system storage, only Lake Howell can reasonably represent the condition of the total system storage. Drought operating curves that correspond to usable volume will use the storage contained in Lake Howell as the primary drought stage indicator.

2.3 Evaluation of Reservoirs during Drought Conditions

The purpose of simulating and evaluating the operations of each of the four reservoirs is to determine the preferred manner of managing the raw water sources of Cabarrus County during periods of drought. In the analysis, each reservoir is analyzed independently and as part of the system. Three specific drought periods were considered (1950s, 1980s, and 1998-2002) to evaluate reservoir response to droughts with different characteristics.

Operation of the reservoirs was analyzed over the recent, record drought. Each reservoir was simulated to operate at a flow equal to the safe yield values computed for the drought-of record (Table 4). Remaining volume in each reservoir and total system volume is plotted over time in Figure 11. The figure shows the strong relationship between Lake Howell volume and total remaining volume available to the system

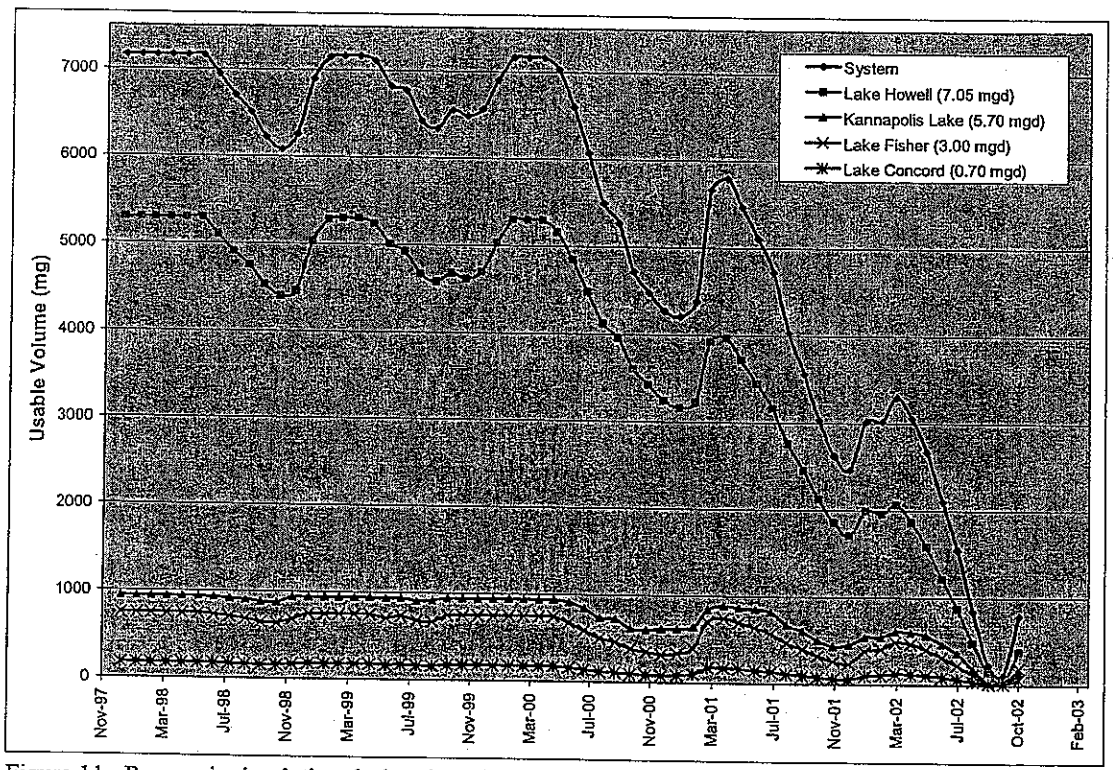

Figure 11. Reservoir simulation during drought of record, withdrawals at 100-yr safe yield

It is useful to refer back to Figures 6, 7, 8, and 9 to analyze reservoir behavior with withdrawals equal to the 50-year safe yield. Although the recent drought is the drought-of-record for all four reservoirs, the next most severe drought, the basis of the 50-year safe yield, is not the same for all reservoirs. The 50-year safe yield of Lake Howell and Kannapolis is determined by the 1950's drought. For Lakes Fisher and Concord, the

drought of the late 1980's defines the 50-year safe yield. Generally, Lake Howell and Kannapolis Lake are affected by similar droughts and Lakes Fisher and Concord are affected by similar droughts, as shown in Table 3.

The similarities are attributable to the ability to refill the lake based on drainage area or the lack of significant storage volume to capture the available inflow. These observations are described for each reservoir, and they provide information for development of the drought operations strategy.

2.3.1 Lake Howell. Lake Howell is affected by droughts of long duration and low to moderate inflow, similar to characteristics of the droughts of the 1920s and 1950s. Droughts of extremely low inflow, but shorter duration, like the 1980's drought, do not affect Lake Howell greatly because of the large volume stored. The most recent drought exhibited long duration, from 1998 through 2002, and very low inflows. The ratio of Lake Howell's usable volume to its drainage area ratio is 112.7 million gallons/square mile.

2.3.2 Lake Fisher and Lake Concord. Lake Fisher and Lake Concord hold much less storage, and they do not respond well to very low inflows, even of short duration. The drought of the 1980's exhibited these characteristics. Over a longer duration, small storms may occur that refill the smaller storage volume. They both respond well to longer duration droughts of low to moderate inflow, like the 1920's and 1950's droughts. Their refill capabilities are due to larger drainage areas, relative to their usable volumes. Their usable volume to drainage area ratios are similar. Lake Fisher holds 40.1 million gallons for each square mile of drainage area, and Lake Concord holds 38.1 million gallons for each square mile of drainage area.

2.3.3 Kannapolis Lake. Kannapolis Lake exhibits characteristics of both types of reservoir, due to its smaller volume, but greater refill capacity from Second Creek. Considering only the lake's watershed, Lake Kannapolis contains nearly 89 million gallons of usable volume per square mile of drainage area. If the Second Creek drainage area (55.6 mi^2) was considered, then the refill capability increases dramatically.

2.4 Drought Operating Curves

2.4.1 Seasonal Considerations. For reliable and safe reservoir operation, it is desirable for the reservoir to be nearly full in the Spring, prior to the onset of low flow,

high evaporation, and high water demand months. Likewise, it is expected that the reservoir will drop to its lowest acceptable levels in the early Fall, following the same high water use months. These two empirical objectives are used to define the upper and lower bounds of usable volume, for each stage of drought, when seasonal effects are considered. The proposed drought operating curves reflect these complementary annual cycles.

2.4.2 Minimum Release from Lake Howell

In addition to stipulating water use reductions, each stage of drought restriction is proposed to coincide with a reduction in the minimum release from Lake Howell. The NCDENR Administrative Code provides consideration of reductions in specified minimum release from a dam. The language can be found in Title 15A, Subchapter 2K - Dam Safety, Section 0500, (http://www.dlr.enr.state.nc.us/Title15A_SubCh2K.html).

Preliminary conversations were held with representatives of the Instream Flow Unit of the Division of Water Resources and others with expertise in the water supply program and biological resources to discuss the development of a tiered release approach for the dam at Lake Howell. The protection of base flows in Coddle Creek downstream of the dam was identified as a principal objective to sustain biological habitat. Preliminary guidance was to devise a release schedule that would provide water supply relief earlier in the drought, to reduce the frequency of calling for severe stages of drought restrictions and dam release reductions later in the drought.

A number of options were modeled, and the following tiered release system was selected because Stage 4 drought restrictions would have occurred only once during the period of time simulated. Only during the severe drought experienced from 1998 to 2002 would the implementation of Stage 3 and 4 drought restrictions have been required.

For purposes of evaluating the proposed drought curves, the required minimum release from Lake Howell is reduced from 6 cfs in normal conditions to 3 cfs during Stage 1 drought restrictions; to 2 cfs during Stages 2, 3 and 4 restrictions. Water withdrawal reductions from Lake Howell of 10, 10, 20, and 25 percent are planned to coincide with Drought Stages 1, 2, 3 and 4, respectively. Mean monthly inflow values are reported in Table 5.

2.4.3 Proposed Drought Operating Curves.

Percentage of usable volume, reservoir pool elevation, and frequency of drought restrictions were factors in the derivation of the drought curves. An evaluation of several combinations resulted in the following criteria used for the Stage 1, Stage 2, Stage 3 and Stage 4 drought curves, as presented on Figures 12 and 13. The curves are based on the percentage of usable volume in Lake Howell and consider seasonal variations in storage in Stages 3 and 4. The basis of and actions planned for each stage of drought follow:

- Normal: over 70 percent of the usable volume remaining in Lake Howell and reservoir inflow is above 75 percent of the historical mean monthly flow for the corresponding month (see Table 5); minimum release = 6 cfs; water withdrawal reduction from Lake Howell = 0 percent.
- Stage 1: over 70 percent of the usable volume remaining in Lake Howell, but reservoir inflow is below 75 percent of the historical mean monthly flow for the corresponding month (see Table 5); minimum release = 3 cfs; water withdrawal reduction from Lake Howell = 10 percent.
- Stage 2: 70 percent of the usable volume remaining in Lake Howell; minimum release = 2 cfs; water withdrawal reduction from Lake Howell = 10 percent.
- Stage 3: 60 percent to 40 percent of the usable volume remaining, depending on month; minimum release = 2 cfs; water withdrawal reduction from Lake Howell = 20 percent.
- Stage 4: 50 percent to 30 percent of the usable volume remaining, depending on month; minimum release = 2 cfs; water withdrawal reduction from Lake Howell = 25 percent.

A summary of storage volume and reservoir pool elevation data used to develop the operating curves is in Table 7. As shown, the operating curve arrangement triggers the four drought stages, depending on the month of the year, as follows.

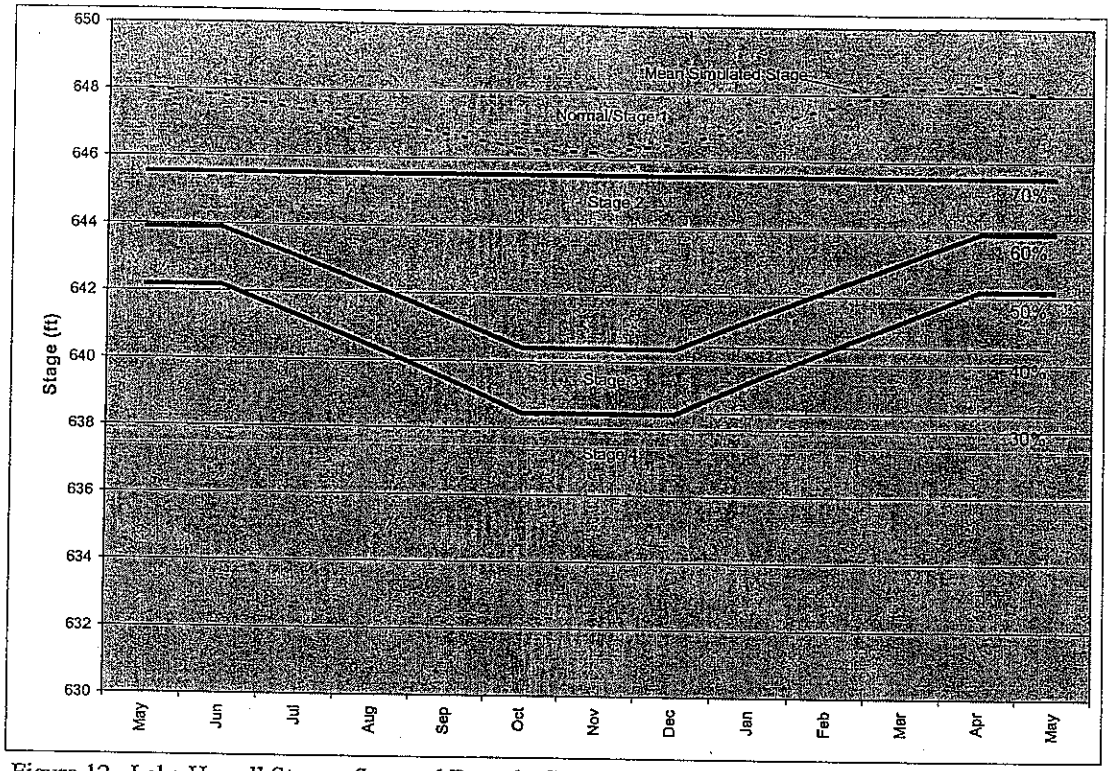

Figure 12. Lake Howell Stage – Seasonal Drought Curves

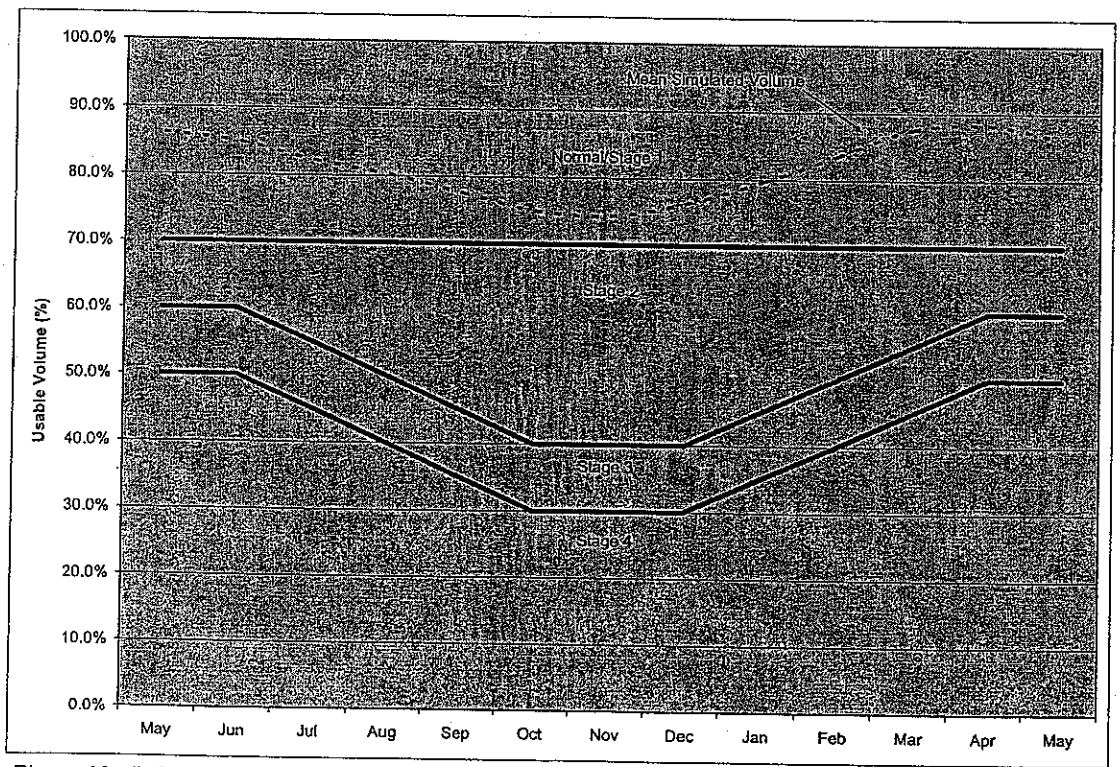

Figure 13. Lake Howell Percentage of Usable Volume – Seasonal Drought Curves

Table 7
Lake Howell, Seasonal Drought Operating Curve Data

Month	Crest Elevation = 650 feet with a usable volume of 5.3 billion gallons									Simulated Data		
	Percent of Usable Volume			Usable Volume [10^6 gal]			Reservoir Stage [ft]			Mean	Mean	Mean
	Stage 2	Stage 3	Stage 4	Stage 2	Stage 3	Stage 4	Stage 2	Stage 3	Stage 4	Stage	Volume	% Vol
May	70.0%	60.0%	50.0%	3707	3178	2648	645.5	643.9	642.2	647.7	4458	84.2%
Jun	70.0%	60.0%	50.0%	3707	3178	2648	645.5	643.9	642.2	647.5	4372	82.6%
Jul	70.0%	55.0%	45.0%	3707	2913	2383	645.5	643.1	641.3	647.0	4212	79.5%
Aug	70.0%	50.0%	40.0%	3707	2648	2119	645.5	642.2	640.4	646.7	4118	77.8%
Sep	70.0%	45.0%	35.0%	3707	2383	1854	645.5	641.3	639.5	646.3	3983	75.2%
Oct	70.0%	40.0%	30.0%	3707	2119	1589	645.5	640.4	638.4	645.9	3844	72.6%
Nov	70.0%	40.0%	30.0%	3707	2119	1589	645.5	640.4	638.4	645.7	3782	71.4%
Dec	70.0%	40.0%	30.0%	3707	2119	1589	645.5	640.4	638.4	646.3	3972	75.0%
Jan	70.0%	45.0%	35.0%	3707	2383	1854	645.5	641.3	639.5	646.7	4125	77.9%
Feb	70.0%	50.0%	40.0%	3707	2648	2119	645.5	642.2	640.4	647.4	4347	82.1%
Mar	70.0%	55.0%	45.0%	3707	2913	2383	645.5	643.1	641.3	647.9	4532	85.6%
Apr	70.0%	60.0%	50.0%	3707	3178	2648	645.5	643.9	642.2	648.0	4553	86.0%
May	70.0%	60.0%	50.0%	3707	3178	2648	645.5	643.9	642.2	647.7	4458	84.2%

2.4.4 Frequency Analysis.

As mentioned previously, an effective drought monitoring program must not trigger the need for water restrictions so prematurely or frequently that the overall drought contingency plan becomes ineffective. With this in mind, this evaluation examined the frequency of drought stage triggering over the entire simulated record. Conservation measures resulting in reduced demand, and reduced downstream releases are simulated, corresponding to drought stage. The resulting simulation of Lake Howell pool elevation is shown on Figure 14. Under these conditions, a Stage 2 drought condition would be called in 3 droughts over the 103 year record, or a frequency of once every 33 years (Table 8). Stage 3 and 4 restrictions would be implemented in only one drought over the 103-year record. That drought event is the 1998-2002 occurrence.

Table 8
Frequency of Entering Drought Stage By Events (103-yr)

Normal	Stage 1	Stage 2	Stage 3	Stage 4
-----	-----	3	0	1

Another consideration is the cumulative amount of time that the water customers would experience the various stages of drought restrictions. These are expressed in two different ways in Table 9. First, the percentage of months of the entire period (103 years) of simulation is shown. Then the number of months that each Stage would be expected to occur in a 10-year period is expressed. For example, based on the previous criteria,

Lake Howell is considered to be in a "normal" condition in 57.8 percent of the record. Expressed differently, this is 69 months in a 10-year period. Stage 1 drought conditions occur 38.0 percent of the simulated time. This is equivalent to 46 months in a 10-year period. Drought events resulting in Drought Stage 2, 3, or 4 conditions occur only 4.2 percent of the simulated time, or for a total of 5 months in a 10-year period.

Table 9
Duration of Time in Drought Stage

Drought Stage	Frequency (%)	Months in 10-years
Normal	57.8	69
Stage 1	38.0	46
Stage 2	1.7	2
Stage 3	0.6	1
Stage 4	1.9	2

During periods of severe extended drought, conservation measures alone may not be adequate to provide reliable water supply to the communities. Additional water supplies may need to be imported to achieve the desired level of supply reliability.

2.5 Summary

The proposed drought curves use Lake Howell reservoir stage as the primary drought indicator. The analysis of safe yield shows that Lake Howell is limited in its ability to recharge, once its volume and elevation have dropped. Therefore, preserving the volume of water in Lake Howell becomes a priority, once Stage 1 restrictions are implemented. Water use restrictions in concert with reductions in reservoir release are recommended to ensure reliability of the water supply during drought.

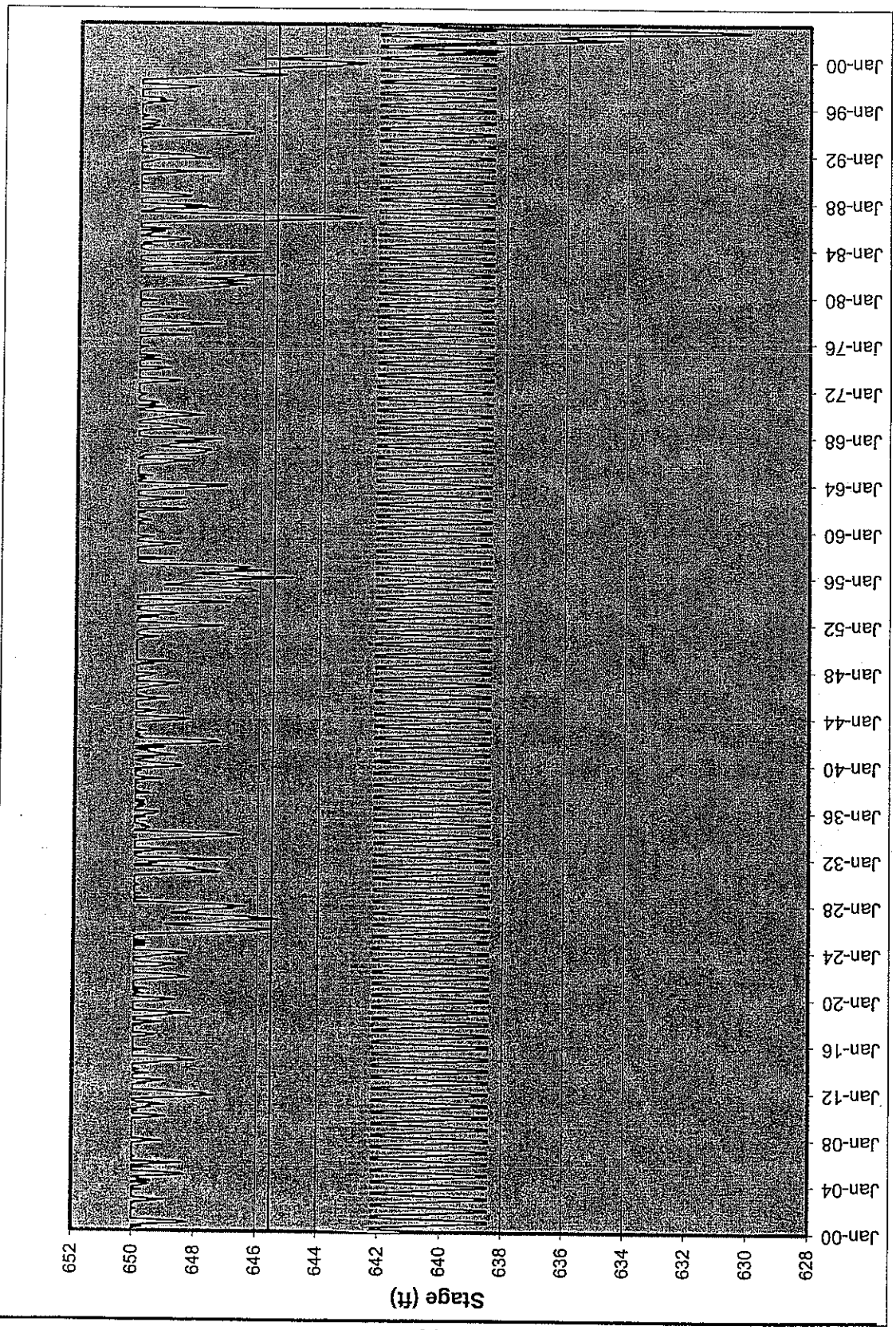
Stage (ft)
652
650
648
646
644
642
640
638
636
634
632
630
628
Jan-00
Jan-04
Jan-08
Jan-12
Jan-16
Jan-20
Jan-24
Jan-28
Jan-32
Jan-36
Jan-40
Jan-44
Jan-48
Jan-52
Jan-56
Jan-60
Jan-64
Jan-68
Jan-72
Jan-76
Jan-80
Jan-84
Jan-88
Jan-92
Jan-96
Jan-00

Figure 14

Appendix A

Drought Program Summaries:

Charlotte-Mecklenburg, NC
Delaware River Basin
Durham, NC
Greensboro, NC
Newport News, VA
Orange County Water and Sewer Authority, NC
Potomac River Basin
State of Maryland
State of Pennsylvania

Location: Charlotte-Mecklenburg, North Carolina

Management Agency: Charlotte-Mecklenburg Utilities

Drought Indicator(s):
- ☒ Reservoir Water Levels
- ☐ Stream Flows
- ☒ Water Production and Distribution Capabilities
- ☐ Drawdown Rates
- ☐ Precipitation Outlook
- ☐ Daily Water Use Patterns
- ☐ Seasonal and Long-Term Weather Patterns
- ☐ Availability of Water from Other Sources
- ☐ Other:

Additional Information:
Water Watch Index www.charmeck.org/apps/cmuforms/waterwatch.cfm
Water Smart Program - (704)399-2221

Program Summary

The program was completely rewritten and will be available to the public in Spring 2003.

Location: Delaware River Basin

Management Agency: Delaware River Basin Commission (DRBC)

Drought Indicator(s):
- ☒ Reservoir Water Levels
- ☐ Stream Flows
- ☐ Water Production and Distribution Capabilities
- ☐ Drawdown Rates
- ☐ Precipitation Outlook
- ☐ Daily Water Use Patterns
- ☐ Seasonal and Long-Term Weather Patterns
- ☐ Availability of Water from Other Sources
- ☐ Other:

Additional Information:
"Delaware River Basin Commission's Homepage"
http://www.state.nj.us/drbc/drbc.htm/
Delaware River Basin Commission (2003)

Program Summary

The Delaware River Basin drains portions of four states: Pennsylvania, New Jersey, New York, and Delaware. In 1961, the governors of these states and the federal government created the Delaware River Basin Commission (DRBC) to manage water resources throughout the basin without regard to political boundaries.

The DRBC monitors regional drought conditions using storage-based reservoir operating curves for the New York City – Delaware River Basin Reservoirs (Cannonsville, Pepacton, and Neversink), which are located in the river's headwaters in the Catskill Mountains. The drought operating (rule) curves are based on the combined storage of the three reservoirs (271 billion gallons). These curves establish minimum storage levels that reflect annual reservoir inflow variations and seasonal demand patterns. During drought periods, the DRBC uses the operating curves to allocate water diversions to New York City and New Jersey while providing minimum flow targets at selected river locations for salinity control in the Delaware Estuary. The DRBC also monitors storage in the Blue Marsh and Beltzville Reservoirs, which are located in the Lower Delaware River Basin, in an effort to address varying hydrologic conditions within the watershed.

The drought operating curves define three drought operating status "zones" that outline a phased water diversion reduction schedule and accompanying releases for salinity control. When the combined reservoir storage drops below the drought watch curve for five consecutive days, allocations and flow targets are reduced according to the phased reduction schedule. Additional reductions are implemented on the first day that the combined reservoir storage drops into the drought warning zone. If the combined reservoir storage enters the drought zone and remains there for five consecutive days, the DRBC further reduces allocations and flow targets and may declare a drought emergency for the region. Note that a drought declaration requires a unanimous vote among the Commission's members.

Location: Durham, North Carolina

Management Agency: City Manager and the Conservation Program

Drought Indicator(s):
- ☒ Reservoir Water Levels
- ☒ Stream Flows
- ☒ Water Production and Distribution Capabilities
- ☒ Drawdown Rates
- ☒ Precipitation Outlook
- ☒ Daily Water Use Patterns
- ☒ Seasonal and Long-Term Weather Patterns
- ☐ Availability of Water from Other Sources
- ☐ Other:

Additional Information:
The Water Conservation Ordinance of Durham:
www.ci.durham.nc.us/departments/environ/ordinance.asp

Program Summary

The city of Durham uses a Risk-Based Simulation Model for drought management. It is based on historical data. The model was developed in 1999, before the most recent drought, so a few minor changes to the plan were made to account for the severity of the drought in 2001-2002. The changes simply consist of stricter water use requirements during different stages of drought.

Stage I - Continuing Voluntary Conservation Practices
No changes made as a result of the 2001-2002 drought.

Stage II – Voluntary Conservation
No changes made as a result of the 2001-2002 drought.

Stage III – Moderate Mandatory Conservation
2002 changes include the mandatory 30% reduction in industrial, manufacturing, and commercial water use. Car washing is limited to private wells or where 50% or more of the water is recycled or where it can be demonstrated that 30 gallons of water or less are used to wash the vehicle.

Stage IV – Severe Mandatory Conservation
2002 changes include the mandatory 50% reduction in industrial, manufacturing, and commercial water use

Stage V – Stringent Mandatory Conservation

Stage VI - Rationing

Location: Greensboro, North Carolina

Management Agency: Department of Water Resources, Director of Water Resources, City Manager, Mayer, and City Council

Drought Indicator(s):
- ☒ Reservoir Water Levels
- ☒ Stream Flows
- ☒ Water Production and Distribution Capabilities
- ☒ Drawdown Rates
- ☒ Precipitation Outlook
- ☒ Daily Water Use Patterns
- ☒ Seasonal and Long-Term Weather Patterns
- ☒ Availability of Water from Other Sources
- ☐ Other:

Additional Information:
Emergency Water Conservation and Restriction Plan
http://www.ci.greensboro.nc.us/wateres/Conservation/CHAPTER%2029.pdf

Program Summary

All of Greensboro's water comes form surface water sources: Lake Higgins, Lake Brandt, and Lake Townsend Reservoirs. The criteria used to determine a water shortage are listed above. However, the severity of the shortage is determined primarily by the levels of Lakes Brandt and Lake Townsend.

a) **Stage I** – Water Restrictions Alert
These *voluntary* restrictions are enacted when the levels of the lakes do not conform to seasonal expectations or the daily water demand is approaching ninety five percent of the system capacity.

b) **Stage IIA*** – Water Shortage Level I Warning
These mandatory restrictions are imposed when it is determined that there are no more than 150 days' of supply water available.

c) **Stage IIB** * – Water Shortage Level II Warning
This stage occurs upon the determination that no more than 125 days' of supply water is available.

d) **Stage III** * – Water Shortage Danger
These restrictions are enacted when the supply of water is determined to be less than 100 days of supply available.

e) **Stage IV** *– Water Shortage Emergency
The restrictions of Stage IV are imposed upon the determination of less than 75 days of water supply available.

f) **Stage V*** – Water Shortage Crisis
Stage V is in effect when it is determined that the available water supply is less than 50 days.

Location: Newport News, Virginia

Management Agency: Newport News Department of Public Utilities

Drought Indicator(s):
- ☒ Reservoir Water Levels
- ☒ Stream Flows
- ☒ Water Production and Distribution Capabilities
- ☒ Drawdown Rates
- ☒ Precipitation Outlook
- ☒ Daily Water Use Patterns
- ☒ Seasonal and Long-Term Weather Patterns
- ☐ Availability of Water from Other Sources
- ☒ Other:Estimates of Min. Essential Supplies to Preserve Public Health and Safety

Additional Information:
The King William Reservoir Project- Additional Future Water Supply
http://www.kwreservoir.com/

Newport News Waterworks
http://www.newport-news.va.us/wwdept/index.shtml

Program Summary

The primary sources of raw water are the Chickahominy River and the Diascund Reservoir with lesser contributions from Skiffes Creek, Lee Hall and Harwood's Mill reservoirs. Little Creek Reservoir is an insignificant source of water because of its small watershed area, however, its large volume helps to supply water during dry periods when there is relatively little natural flow. In addition, a project is underway (The King William Reservoir Project) to help ensure reliable future water supply.

Should any one tier fail to conserve sufficient amounts of water supply, the next tier may be implemented.

The drought plan does not define specific triggering criteria. However, consideration of these various climatic parameters and the other considerations listed above provide a basis for initiating drought response efforts.

a) Tier 1, Voluntary Conservation, economic incentives
b) Tier 2, Mandatory Restrictions, fees used to encourage compliance
c) Tier 3, Water Rationing, violators incur charges of a Class 4 misdemeanor and a fine

Location: Orange County, North Carolina

Management Agency: Orange Water and Sewer Authority

Drought Indicator(s):
- ☒ Reservoir Water Levels
- ☒ Stream Flows
- ☐ Water Production and Distribution Capabilities
- ☒ Drawdown Rates
- ☐ Precipitation Outlook
- ☒ Daily Water Use Patterns
- ☐ Seasonal and Long-Term Weather Patterns
- ☒ Availability of Water from Other Sources
- ☐ Other:

Additional Information:
www.owasa.org/pages/2003consord.asp

Program Summary

The determination of drought shortage conditions shall be guided by periodic extimates of the risk (i.e., probability) that water stored in OWASA's reservoir system will decline to unacceptably low levels within the foreseeable future. Until improved or alternative criteria are developed, such guidance shall be based on a five percent or greater risk that total reservoir storage will decline to 20 percent or less of total storage capacity within an 18 month period. In the event of a water supply shortage, OWASA shall, using its best professional judgment, determine which of the following stages is the most appropriate response to the estimated level of risk.

A. Water Supply Advisory

B. Stage One (1) Water Shortage
Actions shall be taken with the goal of reducing the overall water demand by 10%.

C. Stage Two (2) Water Shortage
Actions shall be taken with the goal of reducing the overall water demand by 15%.

D. Stage Three (3) Water Shortage
Actions shall be taken with the goal of reducing the overall water demand by 20%.

E. Water Supply Emergency
In addition to the previous measures the following actions shall be taken.

1. No OWASA-supplied potable water may be used for any outdoor purposes other than emergency fire or other safety issues.
2. Water used for heating or cooling shall be reduced to all but essential facilities.
3. Water may be discontinued in portions of the service area to preserve the availability of water for essential public health.

Location: Potomac River Basin

Management Agency: Section for Cooperative Water Supply Operations of the Interstate Commission on the Potomac River Basin (CO-OP)

Drought Indicator(s):
- ☒ Reservoir Water Levels
- ☐ Stream Flows
- ☐ Water Production and Distribution Capabilities
- ☐ Drawdown Rates
- ☐ Precipitation Outlook
- ☐ Daily Water Use Patterns
- ☐ Seasonal and Long-Term Weather Patterns
- ☐ Availability of Water from Other Sources
- ☒ Other:National Weather Service Drought Monitoring

Additional Information:
"Interstate Commission on the Potomac River Basin"
http://www.potomacriver.org/
Interstate Commission on the Potomac River Basin (2003)

Program Summary

The Potomac River Basin drains portions of four states (Virginia, Maryland, Pennsylvania, and West Virginia) and the District of Columbia. In 1940, these states, the District of Columbia, and the United States Congress created the Interstate Commission on the Potomac River Basin (ICPRB) to protect the basin's water resources.

Cooperative agreements among the ICPRB and the three major Washington metropolitan area water utilities – Fairfax County Water Authority (FCWA), Washington Suburban Sanitary Commission (WSSC), and the Washington Aqueduct Division (WAD) of the Corps of Engineers – govern water resource management in the Potomac River Basin. Under the 1978 Low Flow Allocation Agreement (LFAA) and the 1982 Water Supply Coordination Agreement (WSCA), deteriorating drought conditions defined by low river flows initiate coordinated water supply management operations, which include releases from regional reservoirs to meet municipal demands and minimum flow requirements. Additionally, the LFAA established a formula based on the utility's average daily "winter" use for determining water allocation during times of drought. The CO-OP suppliers share the cost of operating and maintaining the Potomac storage reservoirs along with the funding for cooperative committee operations and supporting studies, such as regular water supply-demand projection analysis updates.

In addition to the CO-OP agreements, the Metropolitan Washington Council of Governments (MWCOG) monitors regional drought conditions and maintains a drought awareness and response plan. This plan addresses the need for regional drought management for water sources outside of those governed by the LFAA and WSCA. For example, WSSC and FCWA each independently own and operate water supply reservoirs located on Potomac River tributaries. The plan outlines coordinated public drought response actions as follows: call for voluntary conservation under a drought watch, require voluntary water restrictions under a drought warning, and implement mandatory water restrictions under a drought emergency.

Location: State of Maryland

Management Agency: Maryland Department of the Environment

Drought Indicator(s):
- ☒ Reservoir Water Levels
- ☒ Stream Flows
- ☐ Water Production and Distribution Capabilities
- ☐ Drawdown Rates
- ☒ Precipitation Outlook
- ☐ Daily Water Use Patterns
- ☒ Seasonal and Long-Term Weather Patterns
- ☐ Availability of Water from Other Sources
- ☒ Other:Groundwater Levels

Additional Information:
"Maryland Drought Information"
www.mde.state.md.us/Water/Drought/home/index.asp
Maryland Department of the Environment (2002)

"Drought Monitoring and Response Plan"
www.mde.state.md.us/assets/document/drought/droughtreport.pdf
Maryland Department of the Environment (2000)

Program Summary

Nearly 90 percent of Maryland's population relies on public water supplies. However, the primary water source varies according to a region's geologic setting, topographic features, and weather patterns. Larger water suppliers, such as the Washington Suburban Sanitary Commission, operate large reservoirs, while rural systems rely on groundwater wells. Moreover, the state is divided into four specific regions based on climatological similarities and water sources. With this in mind, the Maryland Drought Monitoring and Response Plan includes a state-wide climate monitoring program and a staged drought response plan tailored to meet the state's diverse water management needs.

The drought monitoring program employs four regional drought indicators: precipitation deficits, stream flow, groundwater levels, and reservoir storage. Current precipitation amounts, expressed as a percentage of normal (30-year running average), are monitored to identify regional precipitation anomalies. Select streamgages and groundwater wells represent different regions and their primary water supply sources. Remaining available storage in ten reservoirs across the state provide an indication of impending water shortages, particularly in the summer months.

The drought response plan presents a staged approach to defining drought status. Stage 1 represents normal conditions. Stage 2 and Stage 3 represent a drought watch and drought warning, respectively, where voluntary water use reductions are encouraged through public outreach and education. Stage 4 represents a drought emergency where mandatory water use restrictions are enforced in an attempt to achieve a 15-20 percent reduction in water use. Prohibited activities include lawn watering, operation of ornamental fountains, and automobile washing among other non-essential uses.

Location: State of Pennsylvania

Management Agency: Pennsylvania Emergency Management Agency
Pennsylvania Department of Environmental Protection

Drought Indicator(s):
- ☒ Reservoir Water Levels
- ☒ Stream Flows
- ☐ Water Production and Distribution Capabilities
- ☐ Drawdown Rates
- ☒ Precipitation Outlook
- ☐ Daily Water Use Patterns
- ☒ Seasonal and Long-Term Weather Patterns
- ☐ Availability of Water from Other Sources
- ☒ Other:Groundwater Levels, Palmer Drought Severity Index

Additional Information:

"Drought Information Center (Pennsylvania)"
www.dep.state.pa.us/dep/subject/hotopics/drought/
Pennsylvania Department of Environmental Protection (2002)

Program Summary

The Pennsylvania Department of Environmental Protection (DEP) monitors state-wide drought conditions and provides recommendations for drought response to the Pennsylvania Emergency Management Agency (PEMA). The Pennsylvania Drought Management Plan includes a drought monitoring program, which is based on regional drought indicators, and a comprehensive drought response program that outlines conservation measures and water use restrictions to be implemented as appropriate.

The drought monitoring program employs five climatic parameters as drought indicators as shown above. Precipitation deficits, expressed as a percentage of normal (30-year running average), provide an early indication of impending drought conditions. DEP calculates 30-day average stream flows for 73 streamgages throughout the state and compares these values to exceedance probabilities. Similarly, groundwater wells (including at least one well in each county) are monitored to provide 30-day average depths to water and compared to representative exceedances. Remaining available storage in several reservoirs across the state provide an indication of impending water shortages. The PDSI represents long-term, abnormal climatic variations.

The drought response plan presents a staged approach to defining drought status. A drought watch status requires voluntary conservation targeting a five percent water use reduction. A drought warning requires additional voluntary conservation to achieve a 10-15 percent reduction. A drought emergency initiates increased coordination among the various agencies to ensure effective implementation of drought response measures, which may include mandatory non-essential water use restrictions or water rationing if needed.

In addition to the state-wide drought management plan, Pennsylvania requires all public water suppliers to submit individual drought contingency plans. These plans must identify a drought watch, warning, and emergency for each specific water system.

Appendix B: Black Run Reservoir Safe Yield

The Water and Sewer Authority of Cabarrus County owns and operates the Mount Pleasant water supply and treatment system. The system consists of a water treatment plant with an intake structure on the Dutch Buffalo Creek and an offline reservoir that impounds water from Black Run. The reservoir supplements the creek's stream flow during periods of low-flow conditions, as Black Run is a tributary of Dutch Buffalo Creek and is located upstream of the water treatment plant's intake structure. The figure below shows the stage-storage relationship at Black Run Reservoir, created from the recent bathymetric survey. A total storage volume of 177.4 million gallons is estimated, and because of the reservoir outlet configuration, all of that volume is assumed usable. A minimum of 0.2 cfs is required to be released from the reservoir on Black Run through an outlet pipe.

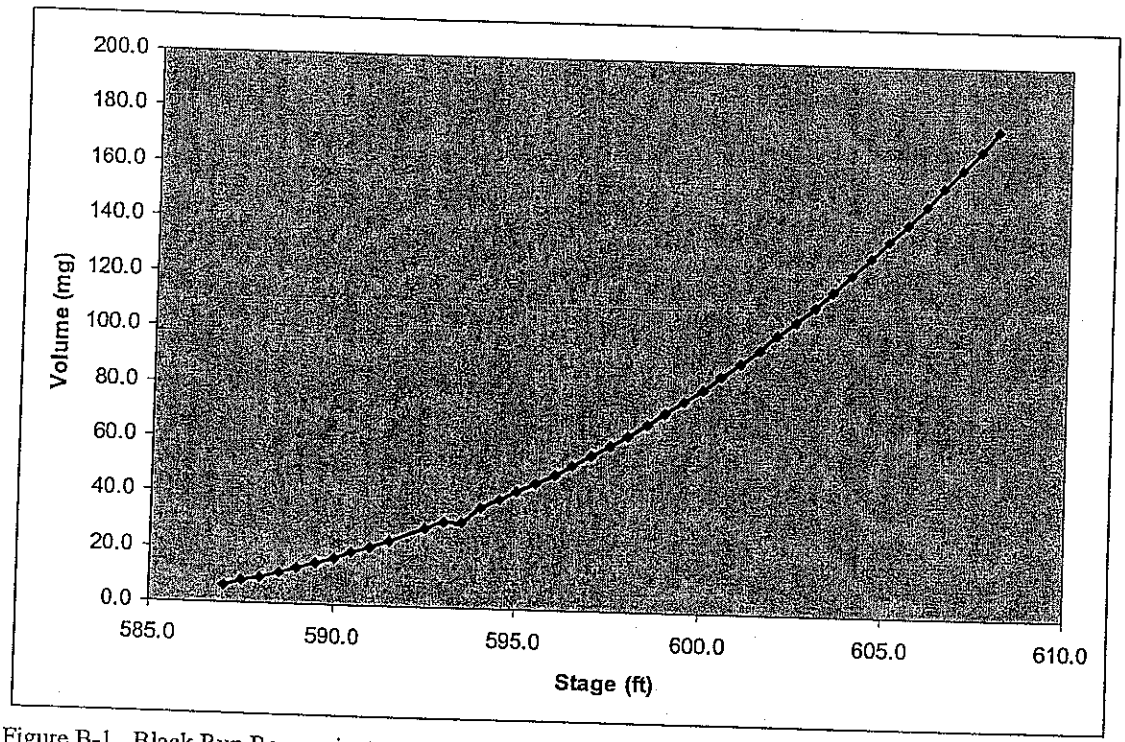

Figure B-1. Black Run Reservoir stage-storage relationship

The safe yield of Black Run is estimated based on a comparison with other reservoirs for which mass-balance models were developed. The following assumptions are used:

- The inflow characteristics of Black Run are similar to those of the tributaries to Lake Concord and Lake Fisher.

- The reservoir behaves similarly to Lakes Fisher and Concord during drought events, and the 50-yr safe yield is defined by the 1986-1987 drought event.
- Duration of the critical drought is related to storage volume.
- Stream flow, precipitation, and evaporation are not considered.

Table B-1
Comparison of Reservoir Parameters

	Black Run Res.	Lake Concord	Lake Fisher
Drainage Area	6.7 sq. mi.	4.7 sq. mi.	18.7 sq.mi
Volume	177.4 mgal	179.2 mgal	749.6 mgal
Duration of 50-yr Drought, days	Assume 365 days	365 days	396 days
Zero Inflow Yield (=Volume/Duration)	0.49 mgd	0.49 mgd	1.89 mgd
Mass-Balance Yield	--	1.2 mgd	5.15 mgd

Based on these assumptions, a "zero inflow" yield value was calculated by dividing the usable reservoir volume by the duration of the 50-year drought event, assuming that no inflow occurs. The duration of the event is defined from the time that the reservoir was full until it reaches its minimum elevation and then refills. At Lake Fisher the event lasted 396 days, and at Lake Concord, that event lasted 365 days.

The "zero inflow" value can be compared to the safe yield computed using the mass balance model. The mass balance models consider the effect of precipitation, evaporation and stream flow. It is apparent that not considering these effects results in underestimating the reservoir's yield. Following the methodology described above to compute the zero inflow yield at Lake Fisher resulted in a value of 1.89 mgd, while the use of a detailed mass-balance model yielded 5.15 mgd. For Lake Concord a "zero inflow" yield of 0.49 mgd was calculated, while a mass balance model yields 1.2 mgd.

Taking these relationships into consideration it is assumed that the Black Run Reservoir, similar to Lake Concord based on drainage are and storage volume, will respond to drought in a similar manner. Considering the 1.2 mgd safe yield computed using the mass balance model and subtracting the 0.2 cfs (0.13 mgd) minimum release requirement, it is reasonable to assume a safe yield of 1.0 mgd for the Black Run Reservoir, not considering additional flows from Dutch Buffalo Creek.