Yadkin Hydroelectric Project (FERC No. 2197)
Operations Model IAG Meeting
November 6, 2003

Alcoa Conference Center
Badin, North Carolina

Final Meeting Summary

Meeting Agenda

See Attachment 1.

Meeting Attendees

See Attachment 2.

Welcome and Introductions

Jane Peeples, Meeting Director, opened the meeting with a welcome and introductions. Paul Shiers, PB Power, reviewed the meeting agenda. Gene Ellis, APGI Yadkin Division, asked to add a discussion of water storage and allocation to the agenda. Hearing no objections, Jane suggested adding the discussion at the end of the agenda.

Review of General Yadkin Project Data

Paul Shiers reviewed reservoir, inflow, and drainage area information for the Yadkin and Progress Energy developments (see presentation slides in Attachment 3). Paul explained that the information on the Progress Energy developments is limited to publicly available information. Don Seitz, Concerned Property Owners of High Rock Lake, asked if in the "Simplified Yadkin System" (slide 6) the storage of Narrows is represented as 50 rather than 100 because the surface area of Narrow Reservoir is approximately half of the surface area of High Rock Reservoir. Paul answered the usable reservoir volume of Narrows is approximately half that of High Rock. Reservoir volume is based both on surface area and depth. The surface area of Narrows, which is a deeper reservoir, is approximately one third the surface area of High Rock.

Larry Jones, High Rock Lake Association, asked if the estimate of storage available at High Rock Reservoir was based on the original reservoir volume calculations from the 1930s. Paul answered yes.

Continuing, Paul presented information on the long-term average inflow into each of the six developments (based on PB Power's analysis of the U.S. Geological Survey inflow data set – slide 9). Chris Ey, Devine Tarbell and Associates, asked if the inflows were net or adjusted inflows. Steven Nebiker, Hydro Logics, explained that the flows are the unregulated inflows into High Rock plus the tributary flows. Chris asked if water withdrawals and/or evaporation were accounted for in the average inflow numbers. Steve answered no and explained that withdrawals and evaporation would be accounted for in the OASIS model.

When asked about the specific USGS gages that were used to calculate the long-term average inflow into each development, Steve Nebiker explained that inflows to High Rock Reservoir were developed using the USGS fill-in program and the USGS Yadkin College, South Yadkin at Mocksville, South Yadkin at Cooleemee, and Wilkesboro gages. Inflows to Tuckertown, Narrows, and Falls were developed using drainage area ratios and the USGS Abbott's Creek and Rocky River gages. The inflows to the Progress Energy developments were developed using drainage area ratios and the USGS Rocky River, Eldorado, Little River, and Brown Creek gages. Steve explained that there are very few gages between the High Rock and Falls developments.

Continuing, Paul discussed the sources of inflow and the 20-year minimum, maximum, and average inflows to the Yadkin Project (slides 10-11). Paul noted that Yadkin's High Rock development is more than 250 miles upstream of Winyah Bay (slide 12). He also noted that Yadkin's developments account for approximately 40% of the drainage area above the USGS Pee Dee gage, whereas they only account for 20 to 30% of the drainage area above Winyah Bay.

OASIS Modeling Effort

Mary Tibbetts, PB Power, briefly reviewed information on the OASIS model (what it is and how it works), Yadkin's approach to modeling the Yadkin and Progress Energy developments, and the Yadkin Project and USGS based inflow data sets (all of this information was discussed thoroughly at the September 4, 2003 IAG meeting). She reaffirmed Yadkin's decision to use the USGS based inflow data set rather than the Yadkin calculated data set.

Mary Tibbetts explained that the purpose of calibrating and verifying the model is to show that for a range of inflow and headwater conditions, the model can accurately reproduce historic operations. She said that PB Power performed the calibration and verification of the OASIS model using the revised Yadkin measured data. PB Power used data from 1995 and 1998 to perform the calibration and data from 1990 (wet year), 1997 (average year), and 2000 (dry year) to perform the verification (slide 44). When asked how PB Power selected the years to use for the calibration and verification, Mary showed the average annual inflow for the years 1980 through 2002 and the quarterly inflow for 1995 and 1998 (the calibration years). The results of the calibration for 1995 showed that the historical and simulated generation matched very closely – a total deviation between the two of only 2.0% (slide 56). Mary showed plots of the historical and simulated headwater elevations and generation at each of the four developments, which also matched very closely. The results of the calibration for 1998 showed that the historical and simulated generation matched very closely – a total deviation between the two of only 1.5% (slide 61). Mary showed plots of the historical and simulated generation at each of the four developments.

Chris Ey asked if PB Power input the daily reservoir elevation target based on the average daily reading. Paul answered no; the reservoir elevation target was based on an end of the day reading.

Don Seitz asked if the generation during these years (1995 and 1998) was the actual generation or the maximum possible generation. Mary answered actual. Don asked Mary what would have happened if generation were at maximum capacity (around 8,000 cfs rather than the average 4,000 cfs). Mary said that Don's request represents an alternative operating scenario, which can be modeled using OASIS once it has been calibrated and verified.

Jim Mead, North Carolina Division of Water Resources, asked PB Power to speculate why the Tuckertown development, in 1995, had the least deviation in the simulated and historical runs (0.1%), but in 1998, had the greatest deviation in the simulated and historical runs (6.6%). Steve Nebiker said that it could be a result of how the flows were adjusted. Randy Benn, Yadkin counsel, said that the percent deviation for the 1995 and 1998 runs is very small.

Chris Ey asked if evaporation and precipitation were accounted for in the calibration runs. Mary Tibbetts said that evaporation and precipitation were accounted for because PB Power used the Yadkin data set (headwater elevations) to calibrate the model. Chris understood PB Power to be using the USGS data set for the operations modeling. Mary explained again that PB Power is using the Yadkin data set for the calibration and verification.

Next, Mary discussed the selection of verification years and the verification results. She reviewed the average quarterly inflow for the verification years: 1990 (wet), 1997 (average), and 2000 (dry). Again, the percent deviation between the simulated and historical runs for each of the three years was less than 2%. In summary, Randy Benn asked for and received general agreement that there should be a high level of confidence in the calibrated and verified OASIS model. Bud Badr asked that the model also be calibrated and verified using the USGS data for the same years. He said that if this additional step were taken, he would have very good confidence in the model. Bud reiterated that the calibration and verification of the OASIS model using the USGS data is very important.

Greg Walmsley, U.S. Fish and Wildlife Service (USFWS), asked if there was any seasonal trend in the deviation (i.e. are there certain seasons of the year that have more deviation). Mary said that when she was comparing the inflow data sets, the third quarter seemed to have more deviation.

Larry Jones asked why 2001 was not used as the dry year. Paul Shiers explained that 2001 and 2002 were so dry; the operation of the Yadkin Project was abnormal. Paul said that Project operations under drought conditions are an exception and should be considered separately. Larry stated that he assumed that PB Power had tested 2001 and was not comfortable with the results. Mary Tibbetts said that PB Power had not run the calibration/verification with the 2001 data because they would have had to adjust the historical data to such a large extent to get a mass balance of the water that they did not feel the results of the run would be as meaningful. Larry said that the worst-case scenarios have to be dealt with. Paul said that Yadkin would use the model to evaluate extreme cases, such as drought.

Randy Benn stated that the model should be built around the rules and not the exception to the rule (i.e. a drought). He understood that using the 2001 or 2002 data in OASIS would require so much adjustment of the data that there would be little confidence in the results. He said that droughts do not happen often and suggested that the OASIS not be built around this extreme. Don Seitz supposed that if the 2001 data were used, the model would have showed that Yadkin could not generate.

Bud Badr said that it is important to first be sure that the OASIS model can accurately represent the operation of the Yadkin Project reservoirs. He said that model could then be used to model what happens during the extreme case. Larry asked that PB Power run the model using the 2001 data. Gene Ellis agreed to run the model using the 2001 data and to report back to the IAG. Bud asked if PB Power could use the 2002 data for the calibration. Mary explained that 2002 had an exceptionally wet fourth quarter. Paul added that during 2002, Yadkin had to move off of the High Rock Reservoir operating guide. Larry Jones said that APGI maintained that they operated on the guide during the drought. Gene explained that Yadkin did operate based on the operating guide until it was able to get a license variance from FERC to further reduce releases from High Rock.

Review of APGI/Progress Energy Data Exchange Effort

Continuing, Paul said that Yadkin and Progress Energy plan to share technical data; however, a confidentiality agreement will be needed for full sharing of data and full model development (slide 69). He said that Progress Energy drafted a confidentiality agreement, which APGI is currently reviewing. Once both APGI and Progress Energy sign this agreement, full data sharing can occur.

Tom Fransen asked when APGI anticipates having a signed agreement. Gene speculated that there would be a signed agreement by the end of the year (2003). Bud Badr said that once the agreement is signed, the two companies should use the same inflow data set. Paul said that the APGI model would include the Kerr Scott development upstream, the four Yadkin Project developments, the two Progress Energy developments, and continue downstream to the USGS Pee Dee gage, and some not yet determined South Carolina nodes. The Progress Energy model will include the Yadkin Project developments, the Progress Energy developments, and nodes in South Carolina beyond the Pee Dee gage. Paul explained that Yadkin plans to use daily flow data while Progress Energy plans to use hourly flow data (slide 70). Bud said again that it is important that the two companies use the same inflow data set. Chris Ey said that the two companies were still discussing the data sets. Paul said he understood Progress was using USGS data from the Rockingham gage and working back upstream. Chris said that Progress Energy was using the Falls inflow data set, not USGS data which could cause a disconnect in the model results.

Continuing, Paul explained that the "low flow case" is a special case that Yadkin will consider using OASIS (slide 72). He said that Yadkin will look at on-peak and off-peak generation, while Progress Energy will look at on-peak, off-peak, and shoulder periods. Paul explained that the value of generation would need further consideration by APGI, Progress Energy, and Duke. Tom Fransen asked why APGI and Progress Energy were discussing the value of generation with Duke. Paul replied that Duke is currently relicensing their Catawba Project and have offered to share what they are doing. APGI wanted to understand how other current Licensees were handling this matter as part of its decision. Bud Badr liked that the models would differentiate between on-peak and off-peak because a dollar figure, rather than just generation, could be a product of the model.

Paul said that APGI and Progress Energy will continue to meet to try to resolve the model input data differences. He said that the that the OASIS and CHEOPs models will never agree exactly. He suggested that if the model results are within 10% of each other, then the companies should consider the results in agreement. However, if the results are off 30-40%, some investigation would be required (slide 74). Tom Fransen asked what was proposed if the model results were off between 10-30%. Paul said that the two companies would have to give this situation further consideration.

Paul said that APGI will consider reasonable assemblages of water withdrawals, but will not conduct future water supply planning (slide 75). Darlene Kucken, North Carolina Division of Water Quality, asked if information could be added to the model as it becomes available in the future. Gene Ellis clarified that assemblages of data would be incorporated into the model, not discrete data points. Wilson Laney, USFWS, asked Gene to define discrete data points. Gene said that for example, if Winston Salem withdrawals more than 10 million gallons per day, the withdrawal would be represented in the model, but it would not be city specific; it would be a withdrawal above High Rock. Tom Fransen said that the NCDENR had asked for nodes for withdrawals of 100,000 gallons or more. Tom said that the NCDENR wants to understand the individual withdrawals.

Wilson Laney said that the USFWS is interested in certain points downstream of the Progress Energy developments for water delivery and management at the Pee Dee Wildlife Refuge. Gene said that presently, APGI does not have a firm accounting of the downstream nodes to be included in the model. Wilson asked that the model have the capability to model water delivery to identified downstream nodes and Winyah Bay itself. Wilson offered to provide the specific locations of interest. Randy Benn said he was concerned about where the agencies are trying to drive the use of the model. He suggested that the IAG focus on developing the tool(s) first and then discuss how to use them.

Paul said that both APGI and Progress Energy would help fund the USGS salinity study. Tom Fransen asked if APGI considers salinity a relicensing issue. Gene answered that APGI does not think salinity is a relicensing issue, but because Alcoa does business in both states and APGI was asked to help, APGI agreed to partially fund the salinity study. Wilson Laney said that for the Roanoke Rapids relicensing, the agencies looked at hydrographs to determine how far downstream project operations had an effect. He assumed that something similar would be done for the Yadkin and Progress Energy relicensings and that the IAG would be able to determine quantitatively if Project operations are influencing salinity downstream. Gene said that it is not Yadkin's intent to study salt-water intrusion in South Carolina. Rather, Yadkin has committed to partially fund a salinity study to be conducted by the USGS. Wilson said that Gene's response did not answer his question, which was if it would be possible to determine the extent and effect of Project operations downstream (i.e. whether Project operations are influencing salinity downstream). Wilson commented that during extreme low flow conditions, the impact of Yadkin Project operations is greater on salinity downstream than under normal conditions. Gene noted that the operation of the Yadkin Project is also a net benefit to downstream flows during extreme low flow conditions and therefore helps to prevent or delay salt-water intrusion.

Larry Jones asked if Blewett Falls is the only source of inflow for the lower Pee Dee River or if there are also tributaries to the river. Bud Badr said that there are tributaries, such as the Waccamaw River that provide minimum inflows. Larry asked if these tributaries dried up during the drought. Wilson responded yes, because the coastal watersheds are smaller, the impact of the drought was greater.

Tom Fransen asked if either Yadkin or Progress Energy had considered integrating their operations model with the salinity model to determine the impact of increased flows on salinity. Gene said that Yadkin's decision to fund a portion of the salinity study was recent and that Yadkin plans to talk with the USGS. Randy Benn thought the suggestion premature, as the USGS has not even begun to build the salinity model.

In conclusion, Paul Shiers said that the OASIS model has been calibrated and verified and it will be used to evaluate operational alternatives.

Schedule and Status of Model Development

Paul Shiers said that the OASIS model is scheduled to be released in the first quarter of 2004. He clarified that the Progress Energy developments will be included in the model prior to its release.

Water Storage and Allocation

After lunch, Gene explained that in the March 2003 Operations Model IAG meeting, the IAG asked Yadkin to discuss water storage and allocation issues in the context of the Yadkin Project relicensing. At the time, Yadkin responded that water storage and allocation issues are bigger than the relicensing and are beyond the realm of what a FERC-licensee is asked to do, but committed to conducting some additional research and meeting with North and South Carolina and Progress Energy to discuss the issue. Gene said that Yadkin completed its research and met with the two states and Progress Energy and was prepared to make a suggestion as to how to deal with water storage and allocation.

Gene said that Yadkin's research confirmed that there are certain issues that must be discussed in a FERC license application, but water storage and allocation issues are broader issues and beyond what is required to be studied in a FERC relicensing. He said that rather than resting on its legal rights to not study and discuss these issues, Yadkin met with the states and Progress Energy to discuss a proposal to address the issues. Gene explained that Yadkin is amenable to discussing the issues in the IAG forum, but that during these discussions the states would take the lead and be in charge of the meeting agenda, directing the meeting, and preparing separate meeting minutes. He agreed that the IAG forum is a convenient place for these discussions because all of the interested parties are already present. Gene invited the states to share their response to Yadkin's proposal.

Danny Johnson, South Carolina Department of Natural Resources, said that Yadkin informed South Carolina of their proposal on Tuesday and while the SCDNR is considering the proposal, it is not ready to commit to it yet. Danny admitted that the SCDNR is not convinced that water storage and allocation are outside the scope of the FERC relicensing. He noted that Yadkin had suggested an interstate compact, which the SCDNR feels might be desirable at some point, but not at this early stage given the difficulty of achieving an interstate compact.

Tom Fransen stated that NCDENR's position is similar to that of South Carolina. He said that the NCDENR is interested in a good, open process, which Yadkin has been conducting to date. Rather than getting to far ahead, Tom suggested that Yadkin first complete the studies to better understand the issues.

Gene said that Yadkin is conducting the studies needed to support a license application and while the states do not think the timing is right to entertain Yadkin's proposal, Yadkin's proposal will stand until if and when the states are agreeable.

Wilson Laney asked for a copy of the USGS proposal for the salinity study. Bud agreed to send Wilson a copy.

Jane Peeples asked if there were any other comments or questions. Tom Fransen said that he thought the process was slipping a bit and that the salinity study was a good example. He said that the NCDENR feels that salinity is a relicensing issue that until such a time that a study is completed that says the Yadkin Project has or has no effect on salinity; the issue needs to remain in the relicensing forum. Similarly, he said that he does not understand why the two companies need to execute a confidentiality agreement before they can host a joint modeling meeting to discuss operations modeling. He thought the companies could begin discussing the locations of nodes, inflow data sets, etc. Tom also commented that the drought is slipping through the cracks. He thought a joint group should be discussing a low flow protocol.

Gene committed to responding to these issues at a future meeting.

With regard to a drought management protocol, Larry Jones said he believed that the license application must deal with drought as a normal condition, not as an exception to the norm. He said that the problem with the current license is that it does not deal with drought conditions. Larry said that he does not want another drought management emergency protocol.

Gene Ellis said that he hopes the IAG understands that from a modeling standpoint, 2001 is only being treated differently because of the complexities associated with bringing this year into the model (a technical issue). As a matter of policy though, he said that Yadkin is willing to discuss and include drought management in its license application. Danny Johnson said that drought management needs to be discussed jointly with Progress Energy.

Schedule and Agenda for Next Meeting

Don Seitz asked when all of the unresolved issues and study results being discussed in the other IAGs would be discussed collectively. Gene acknowledged that there are many studies that are interconnected that would need to be discussed in an overall meeting. Don asked when such a meeting would occur. Gene anticipated such a meeting in about one year.

Paul Shiers tentatively scheduled the next meeting of the Operations Model IAG for February 5, 2004. He said that the meeting would be contingent upon the availability of the model.

The meeting adjourned at about 12:30 p.m.

Attachment 1 – Meeting Agenda

Yadkin Project
FERC No. 2197
Communications Enhanced Three-Stage Relicensing Process

Operations Model Issue Advisory Group Meeting

Thursday, November 6, 2003
Alcoa Conference Center
Badin, North Carolina

10:00 AM

Preliminary Agenda

1. Introductions, Review Agenda
2. Review of General Yadkin Project Data
3. OASIS Modeling Effort
4. Review of APGI / Progress Energy Data Exchange Effort
5. Schedule and Status of Model Development
6. Schedule and Agenda for Next Meeting

Attachment 2 – Meeting Attendees

Name	Organization
Bud Badr	SC Department of Natural Resources
Chris Ey	Devine Tarbell and Associates
Coralyn Benhart	Alcoa
Danny Johnson	SC Department of Natural Resources
Darlene Kucken	NC Division of Water Quality
Don Cordell	Hazen and Sawyer
Don Seitz	Concerned Property Owners of High Rock Lake
Donna Davis	Stanly County Utilities
Gene Ellis	APGI, Yadkin Division
Greg Ott	APGI
Greg Walmsley	US Fish and Wildlife Service
Jim Mead	NC Division of Water Resources
Jody Cason	Long View Associates
Larry Jones	High Rock Lake Association
Mary Tibbetts	PB Power
Matt Brinkley	Town of Badin
Paul Shiers	PB Power
Randy Benn	Yadkin Counsel
Raymond Allen	City of Albemarle
Robert Petree	SaveHighRockLake.org
Roy Rowe	Piedmont Boat Club
Sonya Elam	Alcoa
Steven Nebiker	Hydro Logics
Tom Fransen	NC Division of Water Resources
Wendy Bley*	Long View Associates
Wilson Laney	US Fish and Wildlife Service

*On phone

Attachment 3 – Meeting Presentation

Operations Model IAG Meeting November 6, 2003

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Agenda

- Introductions
- Review of General Yadkin Project Data
- OASIS Modeling Effort
- Review of APGI / Progress Energy Data Exchange Effort
- Schedule and Status of Model Development
- Schedule and Agenda for Next Meeting

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General Yadkin Project Data

- Visually present physical descriptions of the Yadkin and Progress Energy Developments using publicly available data
  - Reservoir information
  - Inflow information
  - Drainage area information

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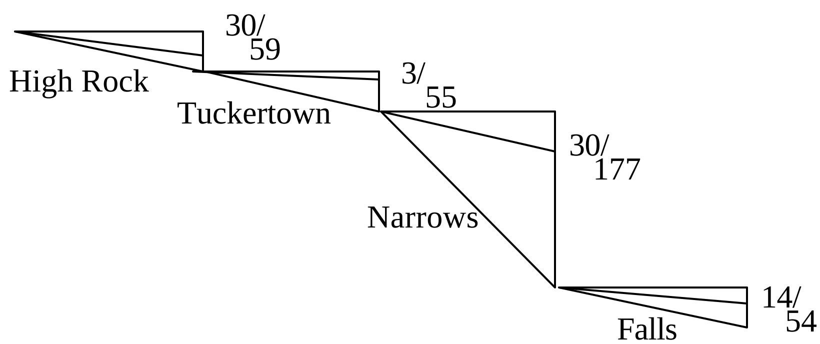
The Simplified Yadkin System



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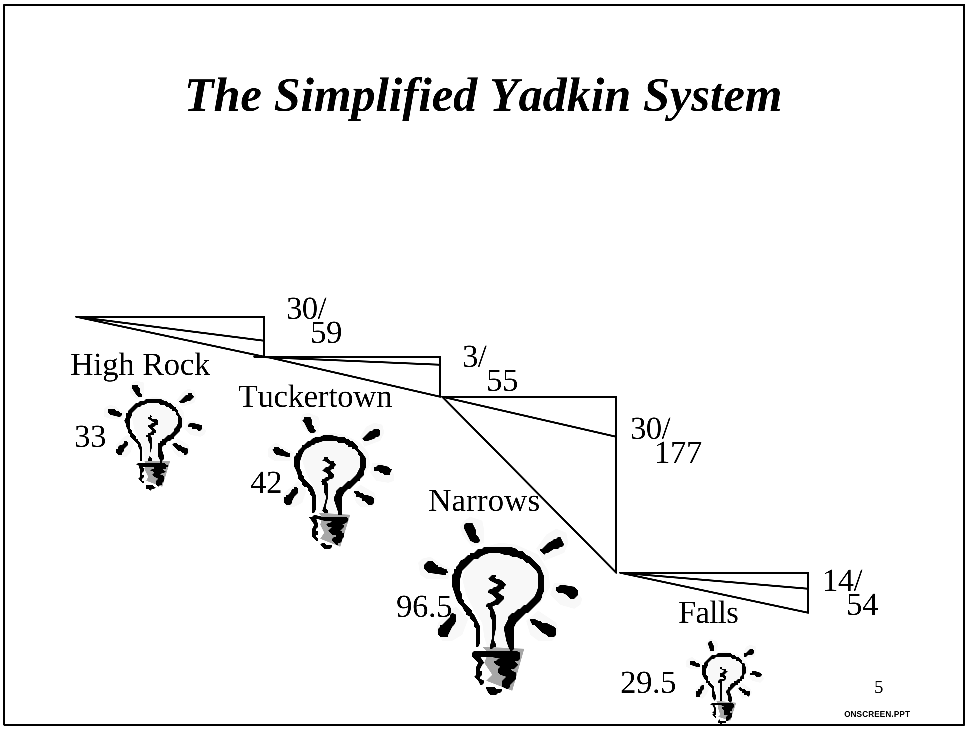
The Simplified Yadkin System
30/
59
High Rock
33
3/
55
Tuckertown
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Narrows
96.5
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54
Falls
29.5
5
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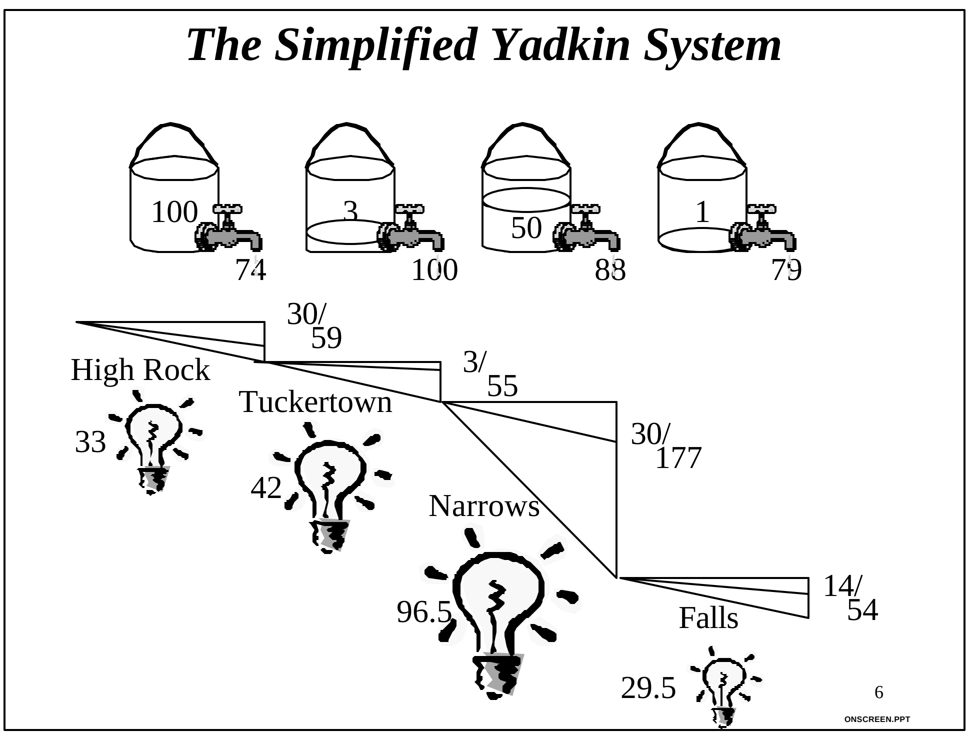
The Simplified Yadkin System
100
74
3
100
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88
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30/
59
High Rock
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Narrows
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Falls
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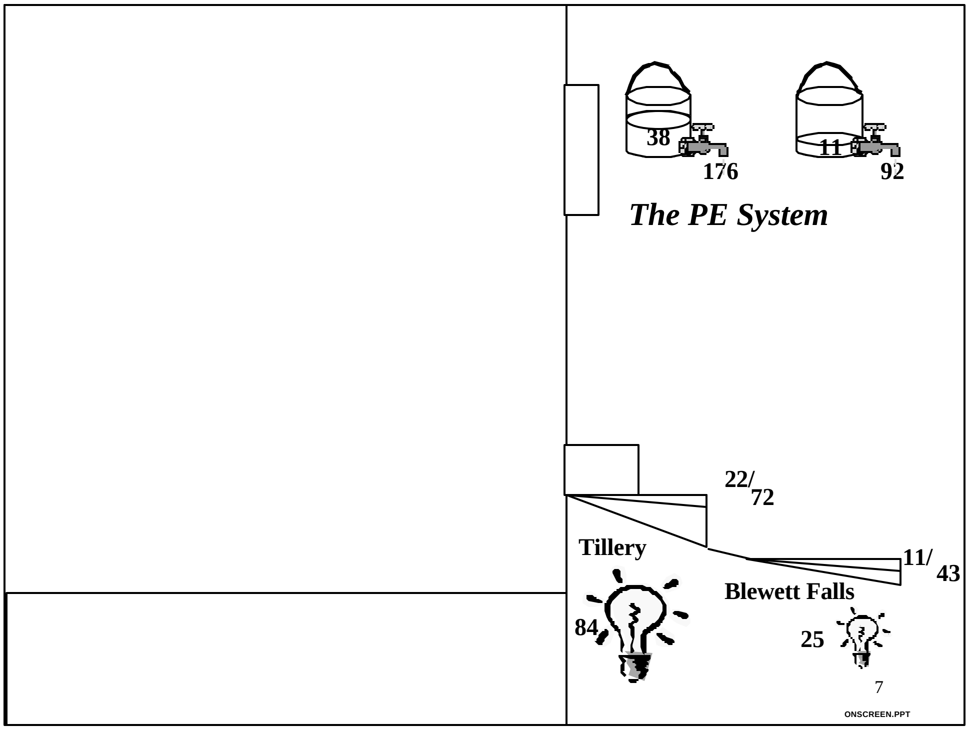
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176
11
92
The PE System
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72
Tillery
11/
43
Blewett Falls
84
25
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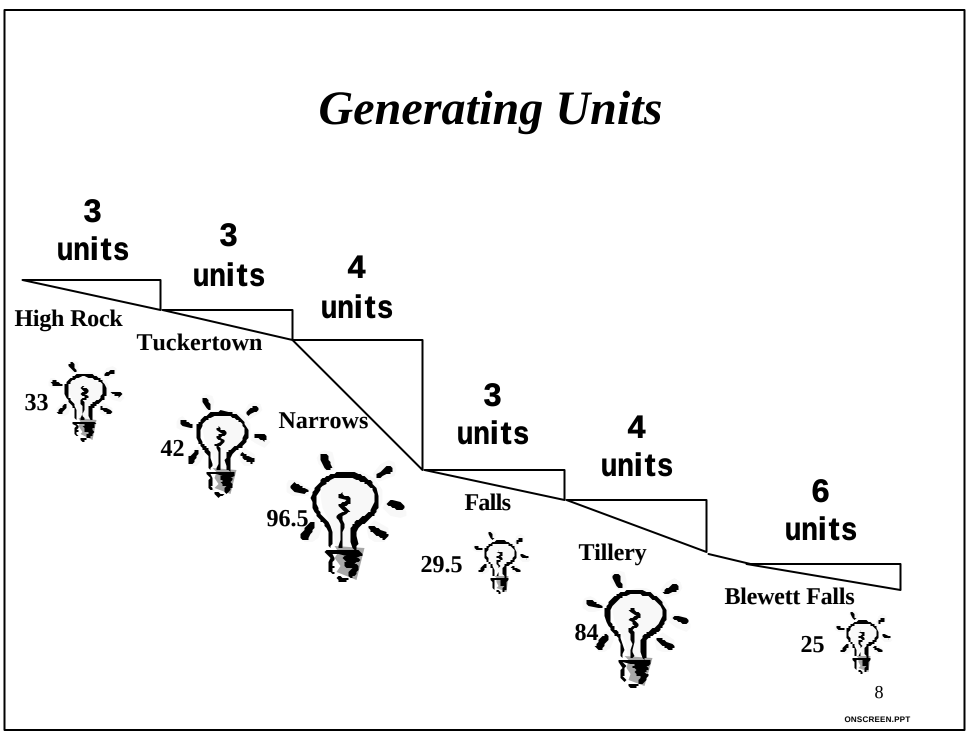
Generating Units
3
units
3
units
4
units
3
units
4
units
6
units
High Rock
Tuckertown
Narrows
Falls
Tillery
Blewett Falls
33
42
96.5
29.5
84
25
8
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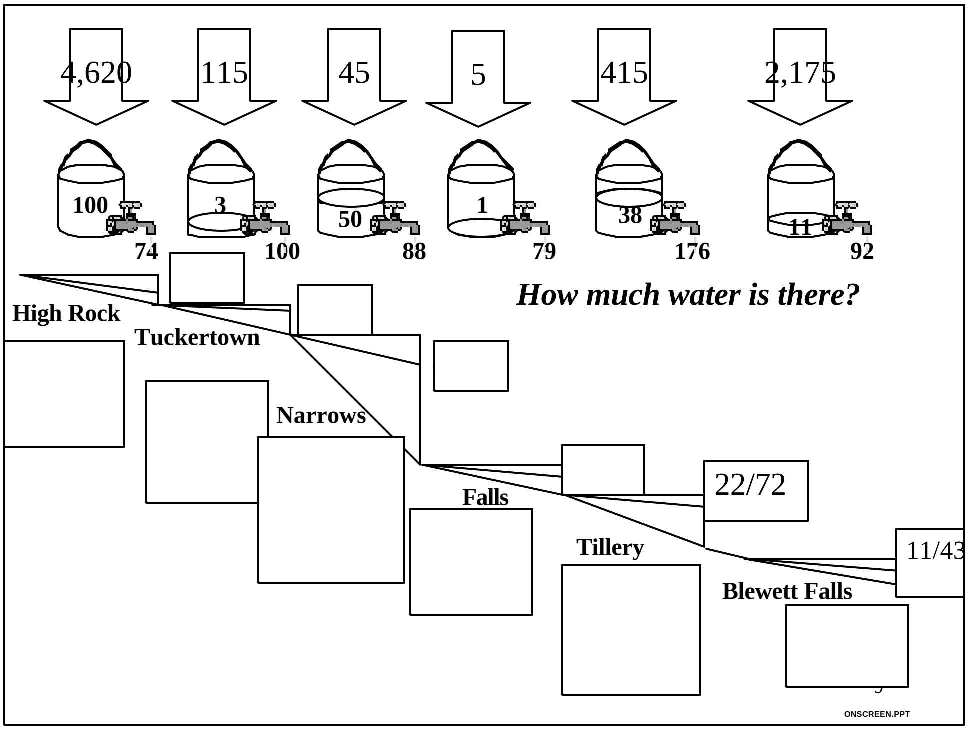

Sources of inflow

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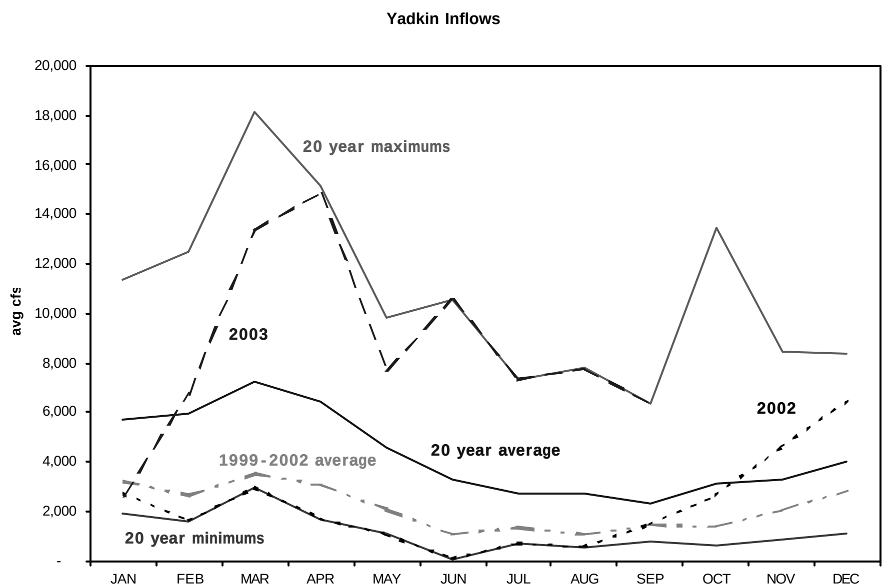

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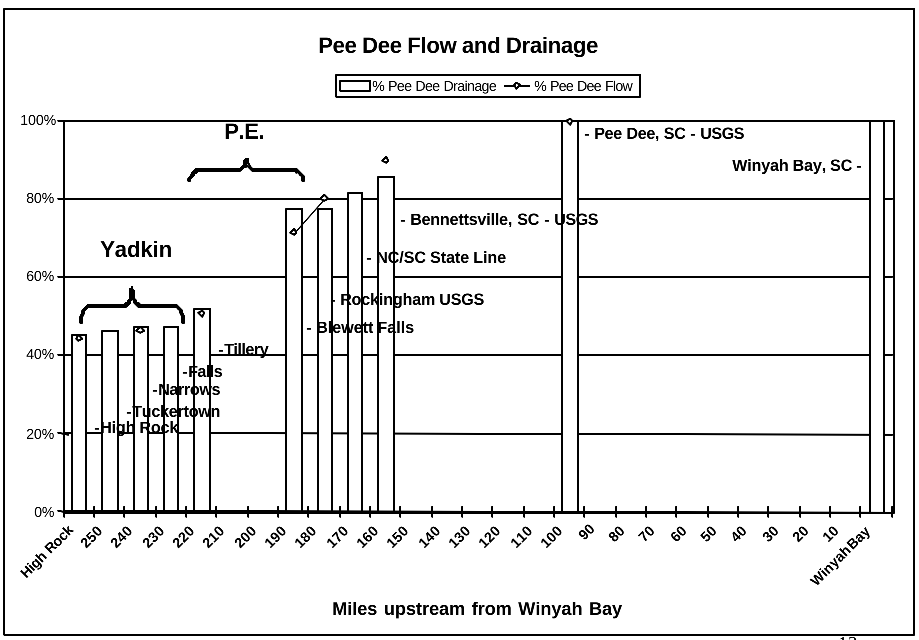

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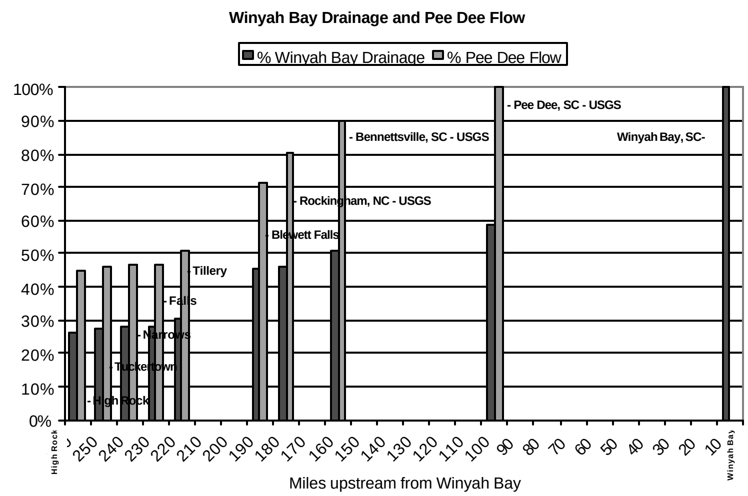

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Operations Model

- OASIS is the tool we will use to evaluate operational alternatives and their potential impacts on:
  - Reservoir water levels
  - Stream flows
  - Energy generation

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What is OASIS and How Does it Work?

- Generalized water resources simulation/optimization model
- Uses the principle of mass balance to ensure that all the water in the system is accounted for
- Solves a set of linear equations for each time step to optimize benefits subject to user-defined constraints and targets

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Yadkin OASIS Model

- Approach
  - Assemble data and construct model
  - Calibrate and verify model
    - Match historical stage and compare computed energy and discharges to historical
  - Utilize model to investigate operational alternatives

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Yadkin OASIS Model (cont.)

- Model will include:
  - W. Kerr Scott Dam and Reservoir
  - All Yadkin Developments
  - All Progress Energy Developments
- Daily time step
- Period of record: 1929 to 2002

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Yadkin Project, Historic Inflow Data

- Historic operating data recorded by Yadkin
- Daily data available electronically
  - High Rock: 1980 to 2003
  - Tuckertown, Narrows & Falls: 1986 to 2003
- Hourly data available electronically, all developments from 1997 to 2003

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Issues Related to Using Yadkin Calculated Inflow Data

- Data available electronically for relatively short period of record
- Each development's data is recorded independently of other developments
- Turbine efficiency changes affect calculated turbine discharges and inflows
- Storage – elevation relationship changes affect calculated change in storage volumes and inflows

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Yadkin Project, USGS Based Inflow Data

- Yadkin has opted to develop a USGS-based inflow dataset
- Use available gage data at High Rock Dam
- Use Fill-in to complete missing record for inflows to High Rock Reservoir
- Add tributary inflows downstream of High Rock based on representative USGS gages

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Fill-in Program

- Fill-in is a USGS program used to estimate monthly flows at gages with missing records based on correlations with other gages
- Limits to Fill-in accuracy:
  - Gages are only accurate to within +/- 5%, at best
  - Fill-in uses a monthly average correlation

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Comparison of USGS "Measured" Inflows & USGS Based Inflows at High Rock

- Known flows at High Rock from 1919 to 1927 and 1941 to 1962
  - Known flows at High Rock from 1919 to 1927 and 1941 to 1951 time period were used for Fill-in input. Used Fill-in to estimate flows for 1952 to 1962 time period and compared with known flows.
  - Known flows at High Rock from 1919 to 1927 and 1952 to 1962 time period were used for Fill-in input. Used Fill-in to estimate flows for 1941 to 1951 time period and compared with known flows.

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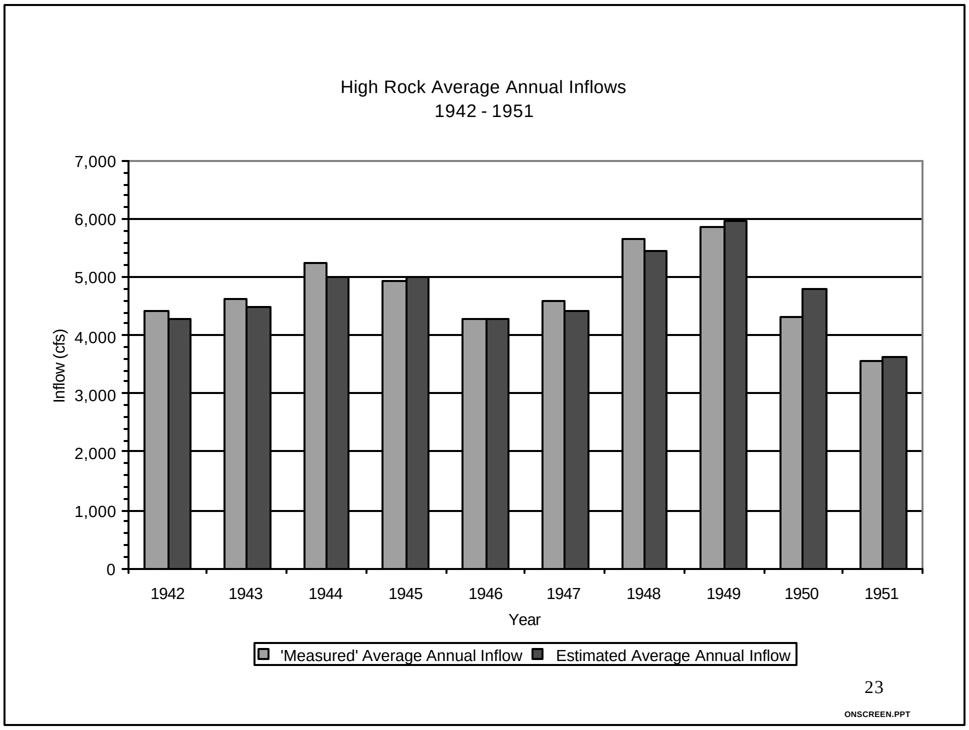

High Rock Average Annual Inflows
1942 - 1951
Inflow (cfs)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
Year
'Measured' Average Annual Inflow
Estimated Average Annual Inflow
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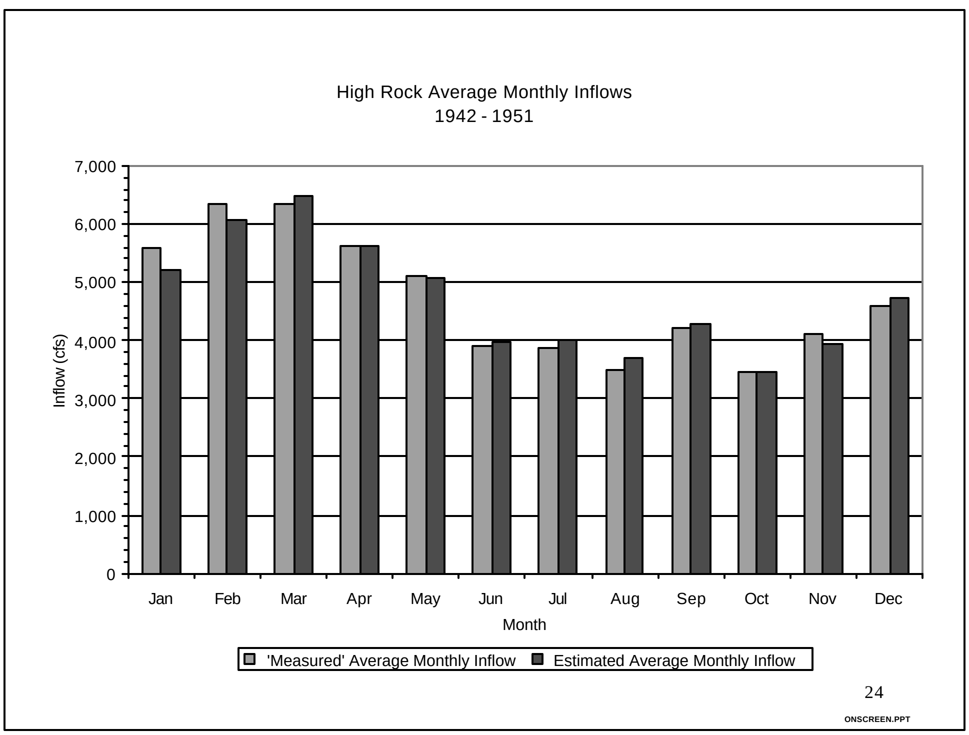

High Rock Average Monthly Inflows
1942 - 1951
Inflow (cfs)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
'Measured' Average Monthly Inflow
Estimated Average Monthly Inflow
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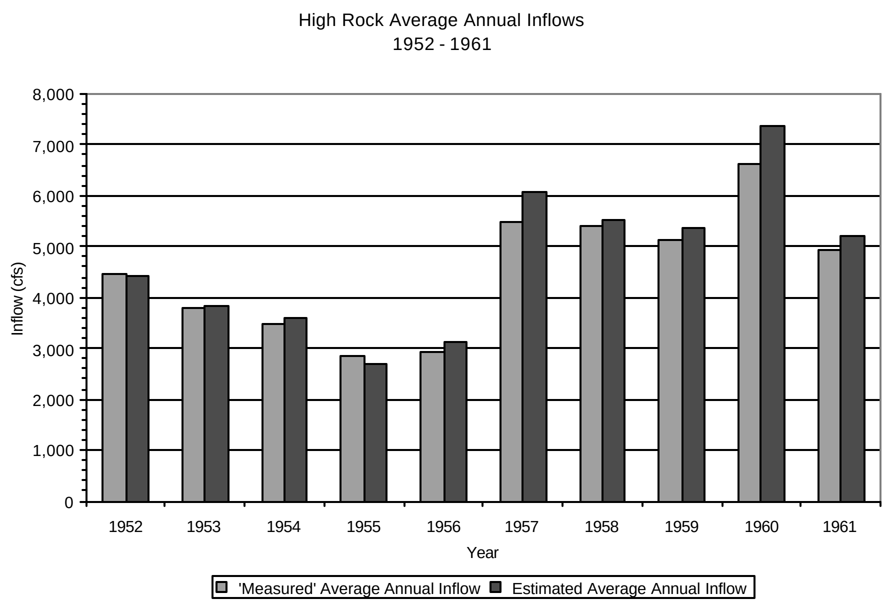

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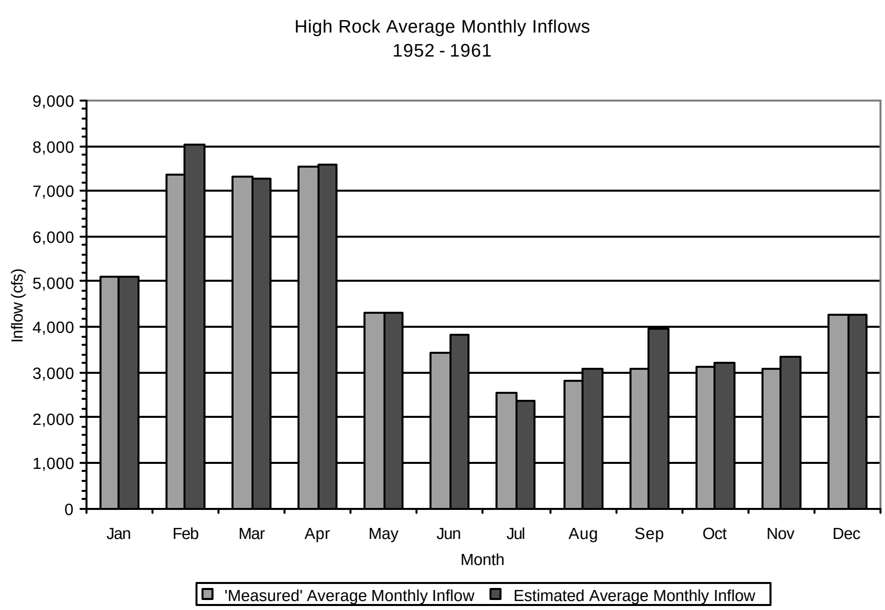

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Comparison Conclusions

- Calculated and measured flows compared well
  - On an average annual basis, the calculated inflows are less than 1% lower than the measured inflows (1942 to 1951)
  - On an average annual basis, the calculated inflows are 4% higher than the measured inflows (1952 to 1961)

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Comparison of USGS Based Inflows & Yadkin Calculated Inflows at High Rock Reservoir

- Yadkin measures headwater elevation, generation, and flood gate openings at High Rock
- Yadkin measured data is used to calculate inflow to High Rock
- Compared USGS based inflows and Yadkin calculated inflows at High Rock (1980 to 2002)

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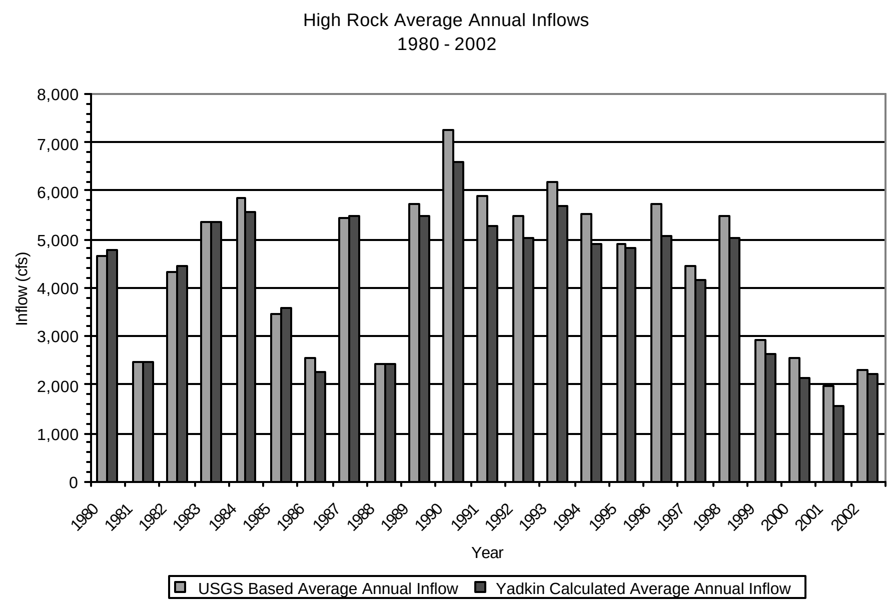

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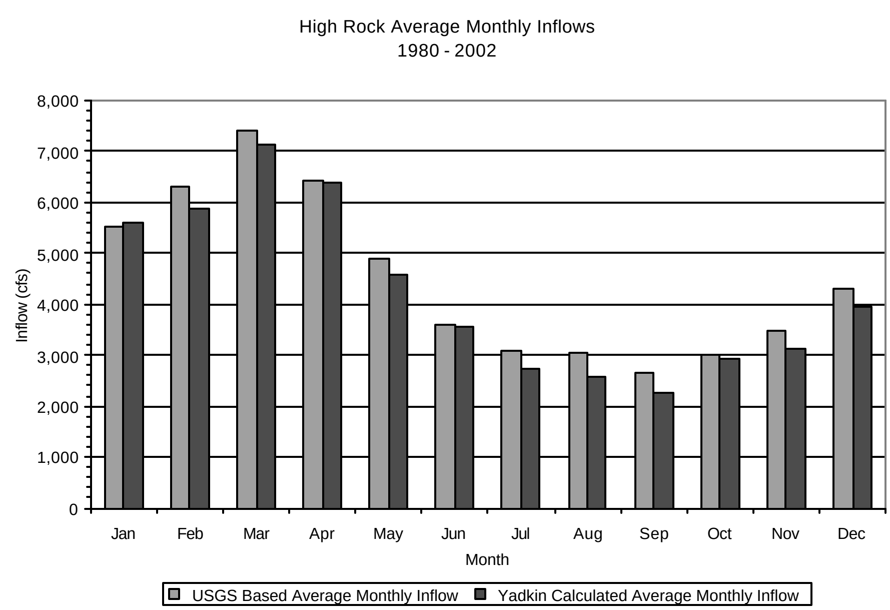

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Comparison Conclusions

- On an average annual basis, the USGS based inflows are approximately 6% higher than the Yadkin calculated inflows (1980 to 2002)
- Possible reasons include:
  - Accuracy of USGS gage data
  - Accuracy of Yadkin data
- Neither data set is “correct”

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Model Construction

- High Rock Reservoir operating guide
- High Rock - Narrows drawdown schedule
- Storage – elevation relationships
- Turbine performance relationships

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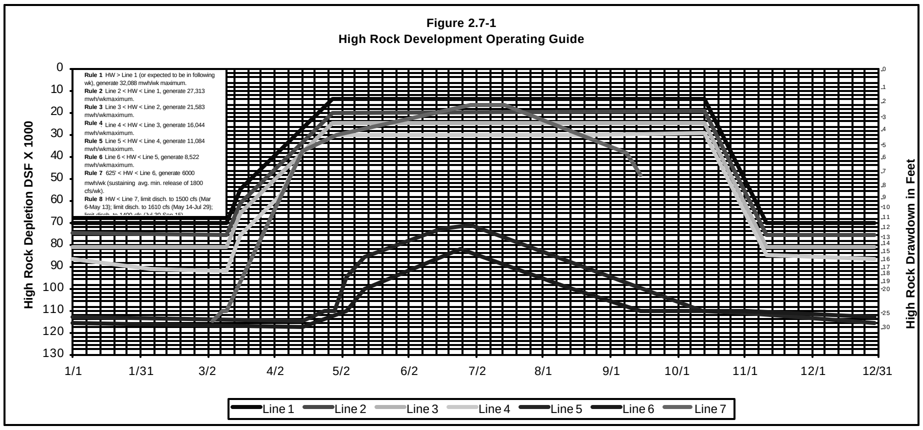
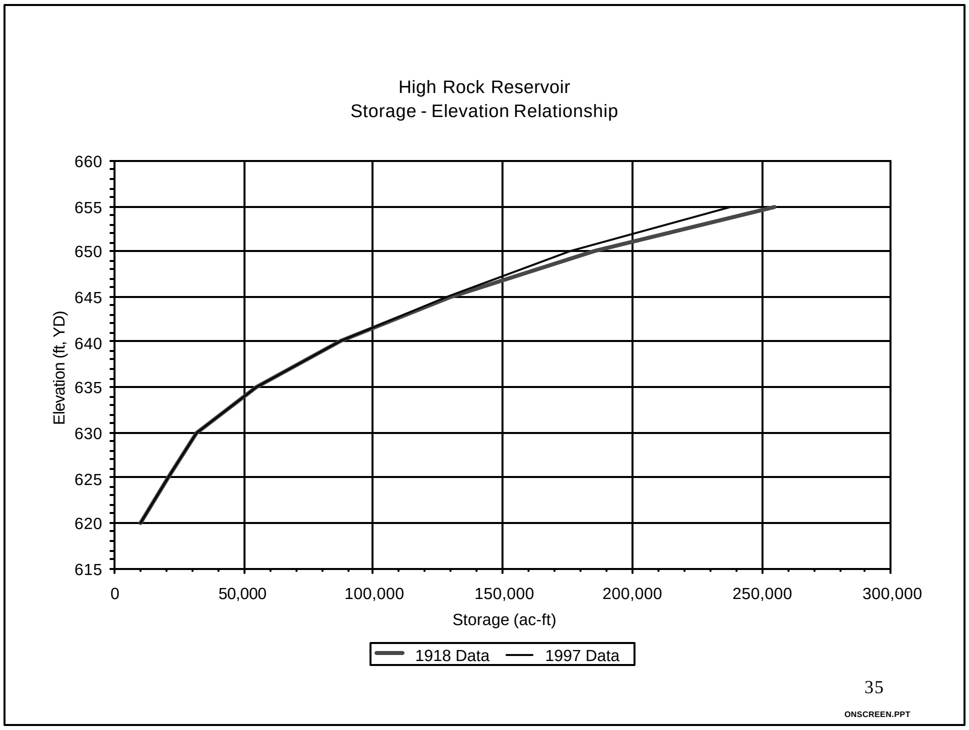
High Rock Reservoir Guide Curve



High Rock – Narrows Drawdown Schedule

High Rock Reservoir Elevation (ft, YD)	High Rock Reservoir Drawdown (ft)	Narrows Reservoir Elevation (ft, YD)	Narrows Reservoir Drawdown (ft)
655.0	0.0	541.1 - 539.0	0.0 - 2.1
654.0	1.0	539.5 - 534.5	1.6 - 6.6
631.0	24.0	539.5 - 534.5	1.6 - 6.6
631.0	24.0	534.0	7.1
629.0	26.0	525.0	16.1
625.0	30.0	510.0	31.1


High Rock Reservoir
Storage - Elevation Relationship
Elevation (ft, YD)
660
655
650
645
640
635
630
625
620
615
0
50,000
100,000
150,000
200,000
250,000
300,000
Storage (ac-ft)
1918 Data
1997 Data
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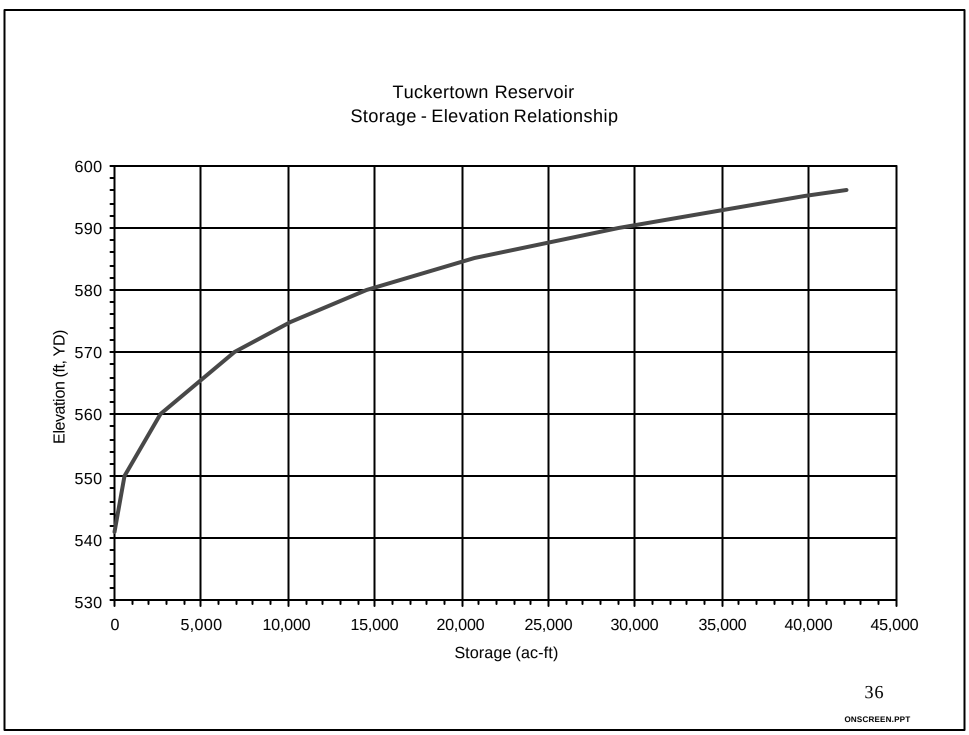
Tuckertown Reservoir
Storage - Elevation Relationship
Elevation (ft, YD)
600
590
580
570
560
550
540
530
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
Storage (ac-ft)
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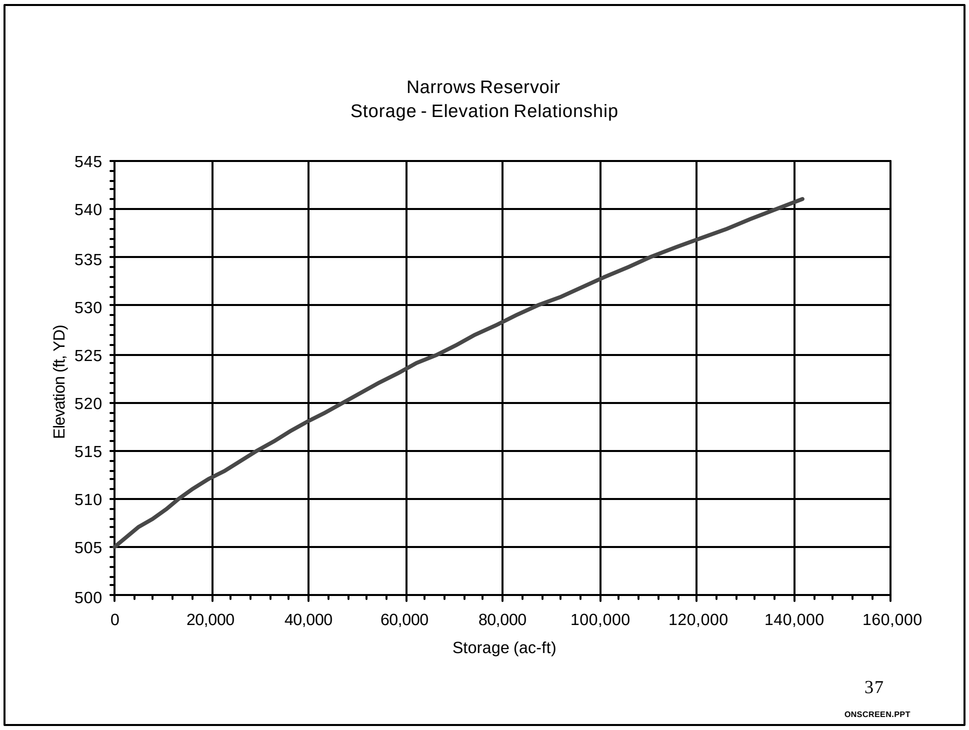
Narrows Reservoir
Storage - Elevation Relationship
545
540
535
530
525
520
515
510
505
500
Elevation (ft, YD)
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
160,000
Storage (ac-ft)
37
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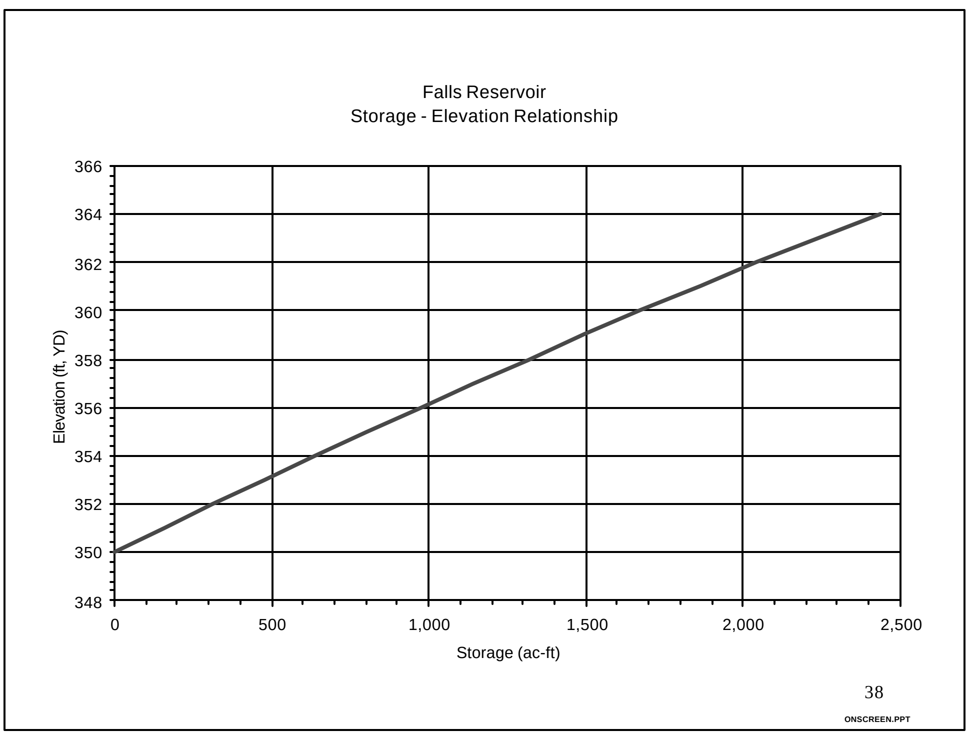
Falls Reservoir
Storage - Elevation Relationship
366
364
362
360
358
356
354
352
350
348
Elevation (ft, YD)
0
500
1,000
1,500
2,000
2,500
Storage (ac-ft)
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Turbine Performance Curves

- Multiple turbine performance curves for varying heads
- Multiple turbine performance curves for air injection
- Turbine performance relationships at maximum capacity, best efficiency, and elsewhere on the curves

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Calibration

- Calibration:
  - Using the model to reproduce Project operations (water levels, stream flows, and generation) that were measured over a certain time interval
  - Model parameters are adjusted, or calibrated, until the model is able to reproduce historical conditions

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Verification

- Verification:
  - Applying the calibrated model to reproduce Project operations measured over a time interval different from the calibration interval

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Purpose of Calibration / Verification

- Purpose:
  - To show that for a range of inflow and headwater conditions, the model can accurately reproduce historic operations
  - Once the model can accurately predict historical operations, it can be used with confidence to analyze future operating scenarios

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Calibration / Verification

- Performed using revised Yadkin measured data
  - Data adjusted to balance flow between developments
  - Turbine performance curves adjusted
  - High Rock storage elevation relationship adjusted
- Match historical stage and compare computed energy and discharges to historical

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Calibration / Verification Years

- Calibration Years:
  - 1995
  - 1998
- Verification Years:
  - 1990 (Wet Year)
  - 1997 (Average Year)
  - 2000 (Dry Year)

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Selection of Calibration Years

AVERAGE ANNUAL INFLOW		
Rank	Flow (cfs)	Year
1	6,591	1990
2	5,692	1993
3	5,573	1984
4	5,467	1989
5	5,464	1987
6	5,349	1983
7	5,282	1991
8	5,075	1996
9	5,026	1998
10	5,022	1992
11	4,888	1994
12	4,827	1995
13	4,774	1980
14	4,431	1982
15	4,154	1997
16	3,554	1985
17	2,614	1999
18	2,466	1981
19	2,417	1988
20	2,250	1986
21	2,213	2002
22	2,150	2000
23	1,547	2001
Average	4,210	

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Selection of Calibration Year - 1995

AVERAGE QUARTERLY INFLOW							
Year	Average Inflow 1st QTR	Year	Average Inflow 2nd QTR	Year	Average Inflow 3rd QTR	Year	Average Inflow 4th QTR
1993	12,238	1987	7,737	1989	4,558	1990	7,751
1990	9,416	1983	7,638	1984	4,349	1989	6,673
1998	9,372	1991	7,569	1994	4,338	1992	5,841
1994	8,593	1984	7,522	1996	4,053	1995	5,013
1991	8,374	1998	7,281	1995	3,808	1996	4,683
1984	8,264	1980	7,133	1987	3,166	1983	4,658
1987	8,235	1992	6,836	1985	2,986	2002	4,586
1980	7,557	1990	6,607	1992	2,893	1985	4,061
1983	7,292	1993	6,158	1991	2,863	1982	3,711
1996	7,218	1997	5,903	1990	2,650	1987	2,804
1995	6,652	1982	5,433	1982	2,531	1994	2,768
1997	6,332	1989	5,053	1980	2,256	1986	2,758
1982	6,097	1996	4,363	1997	2,160	1991	2,413
1989	5,583	1994	3,922	1993	2,128	1993	2,392
1992	4,532	1995	3,862	1983	1,876	1997	2,289
1985	4,461	1981	3,071	1981	1,812	1988	2,210
1999	4,105	1999	2,915	1998	1,747	1984	2,209
1988	3,615	1985	2,720	1999	1,714	1980	2,208
2000	3,504	2000	2,684	1988	1,545	1981	2,086
1986	3,187	1988	2,312	2000	1,432	1999	1,919
1981	2,913	1986	1,702	1986	1,368	1998	1,824
2001	2,610	2001	1,687	2001	1,078	2000	1,001
2002	2,464	2002	945	2002	848	2001	837
Average	6,201		4,828		2,529		3,335

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Selection of Calibration Year - 1998

AVERAGE QUARTERLY INFLOW							
Year	Average Inflow 1st QTR	Year	Average Inflow 2nd QTR	Year	Average Inflow 3rd QTR	Year	Average Inflow 4th QTR
1993	12,238	1987	7,737	1989	4,558	1990	7,751
1990	9,416	1983	7,638	1984	4,349	1989	6,673
1998	9,372	1991	7,569	1994	4,338	1992	5,841
1994	8,593	1984	7,522	1996	4,053	1995	5,013
1991	8,374	1998	7,281	1995	3,808	1996	4,683
1984	8,264	1980	7,133	1987	3,166	1983	4,658
1987	8,235	1992	6,836	1985	2,986	2002	4,586
1980	7,557	1990	6,607	1992	2,893	1985	4,061
1983	7,292	1993	6,158	1991	2,863	1982	3,711
1996	7,218	1997	5,903	1990	2,650	1987	2,804
1995	6,652	1982	5,433	1982	2,531	1994	2,768
1997	6,332	1989	5,053	1980	2,256	1986	2,758
1982	6,097	1996	4,363	1997	2,160	1991	2,413
1989	5,583	1994	3,922	1993	2,128	1993	2,392
1992	4,532	1995	3,862	1983	1,876	1997	2,289
1985	4,461	1981	3,071	1981	1,812	1988	2,210
1999	4,105	1999	2,915	1998	1,747	1984	2,209
1988	3,615	1985	2,720	1999	1,714	1980	2,208
2000	3,504	2000	2,684	1988	1,545	1981	2,086
1986	3,187	1988	2,312	2000	1,432	1999	1,919
1981	2,913	1986	1,702	1986	1,368	1998	1,824
2001	2,610	2001	1,687	2001	1,078	2000	1,001
2002	2,464	2002	945	2002	848	2001	837
Average	6,201		4,828		2,529		3,335

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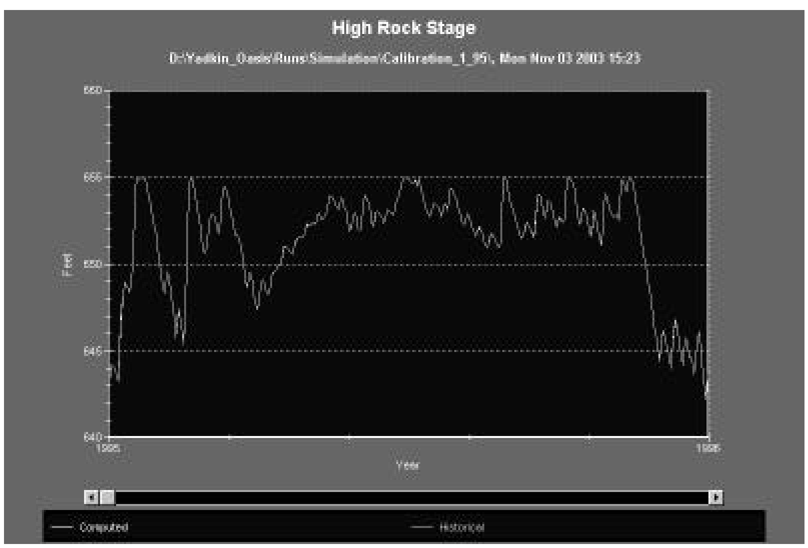
1995 – High Rock Headwater Elevations



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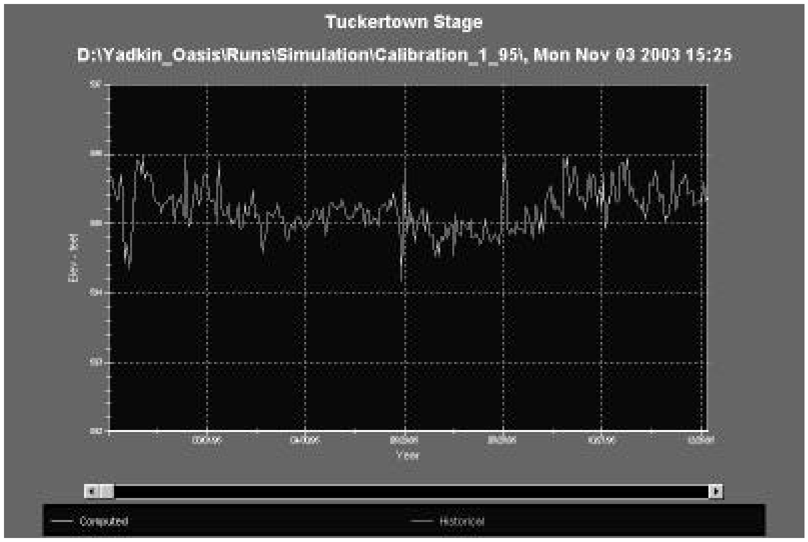
1995 – Tuckertown Headwater Elevations



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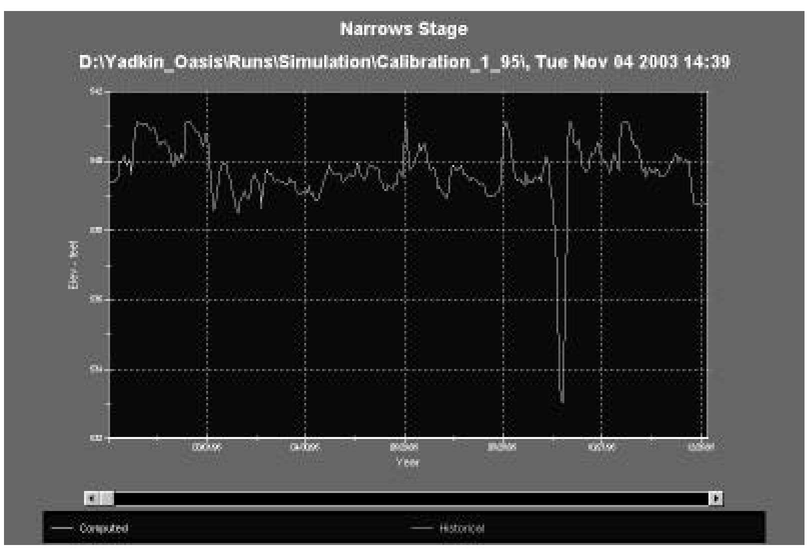
1995 – Narrows Headwater Elevations



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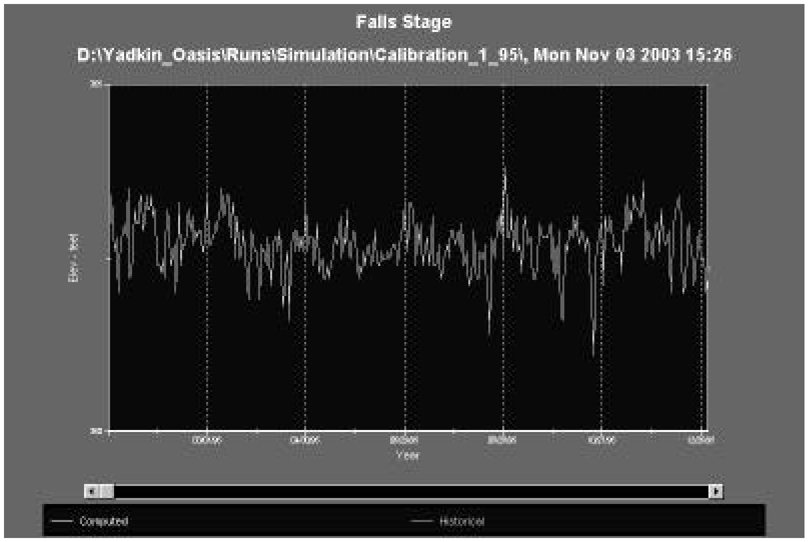
1995 – Falls Headwater Elevations



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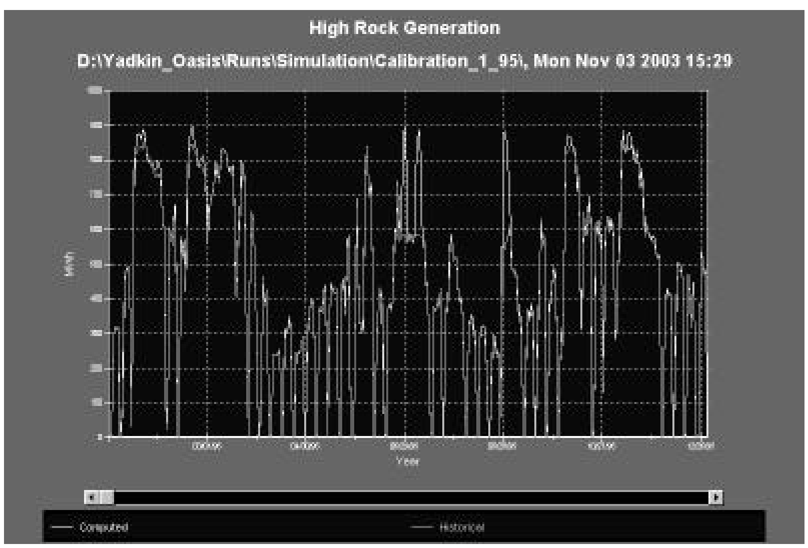
1995 – High Rock Generation



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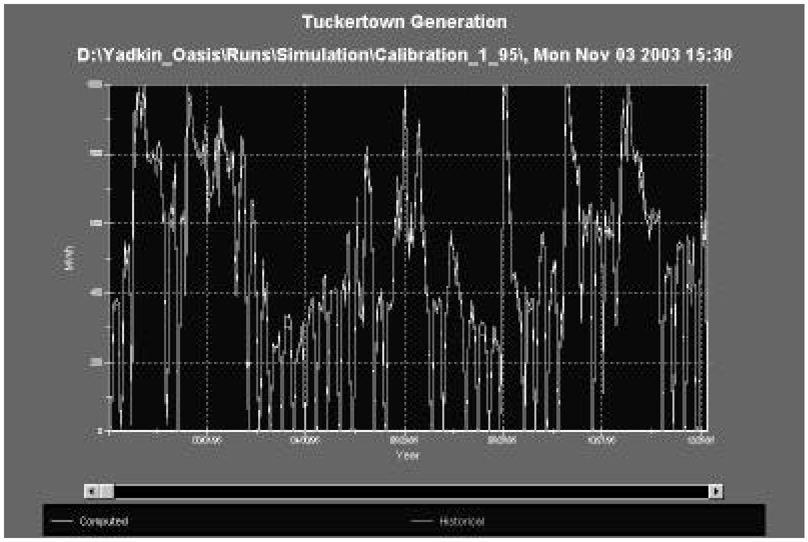
1995 – Tuckertown Generation



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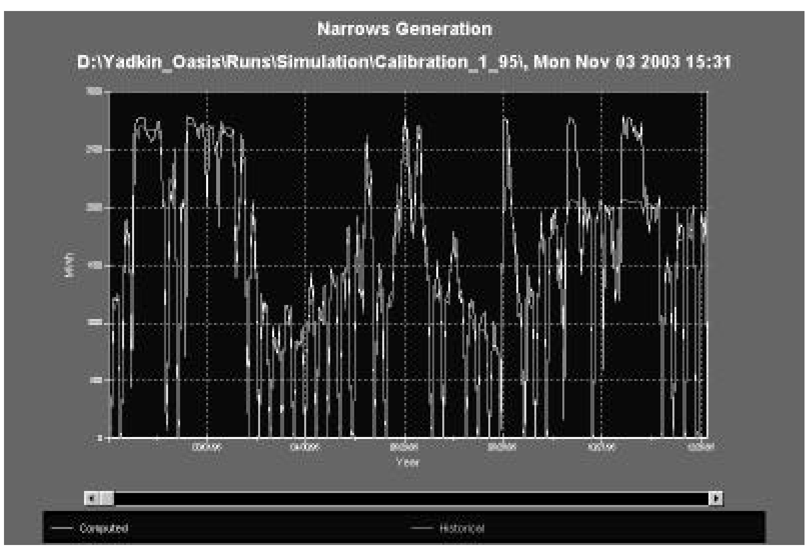
1995 – Narrows Generation



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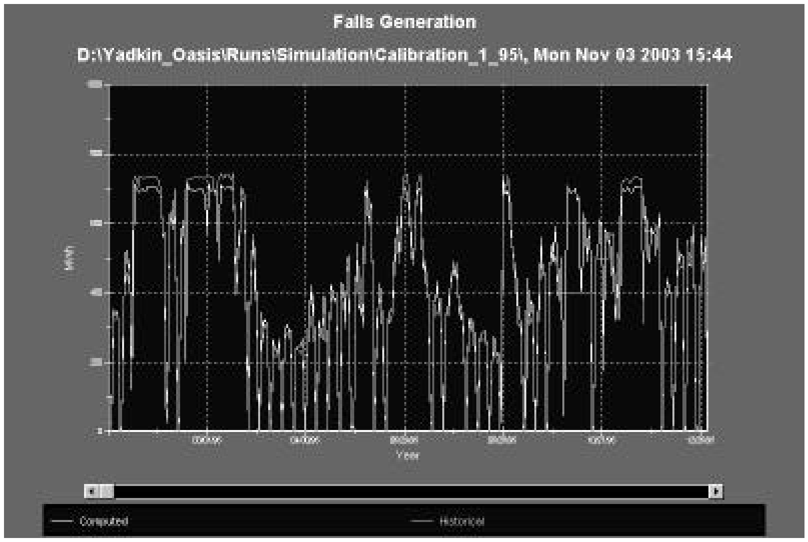
1995 – Falls Generation



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Calibration Results - 1995

1995	Simulated (MWh)	Historical (MWh)	Deviation (%)
High Rock	164,000	159,000	2.6%
Tuckertown	168,000	168,000	0.1%
Narrows	550,000	537,000	2.4%
Falls	151,000	149,000	1.7%
Total	1,033,000	1,013,000	2.0%

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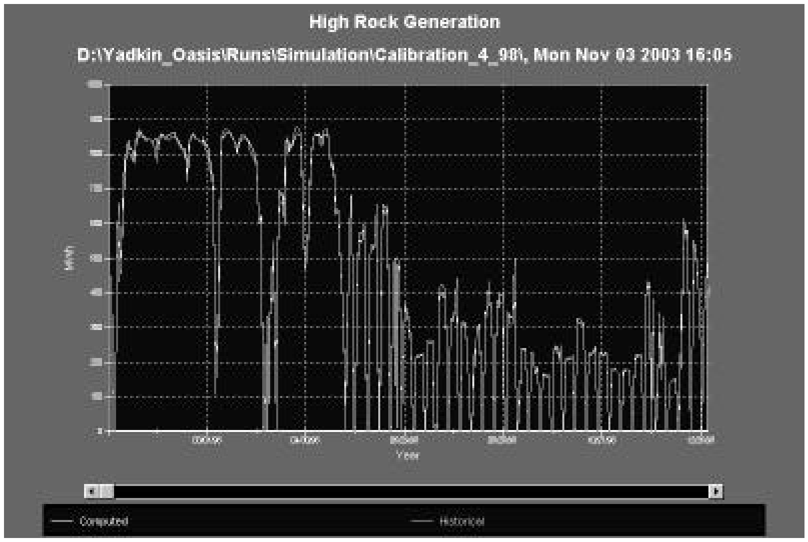
1998 – High Rock Generation



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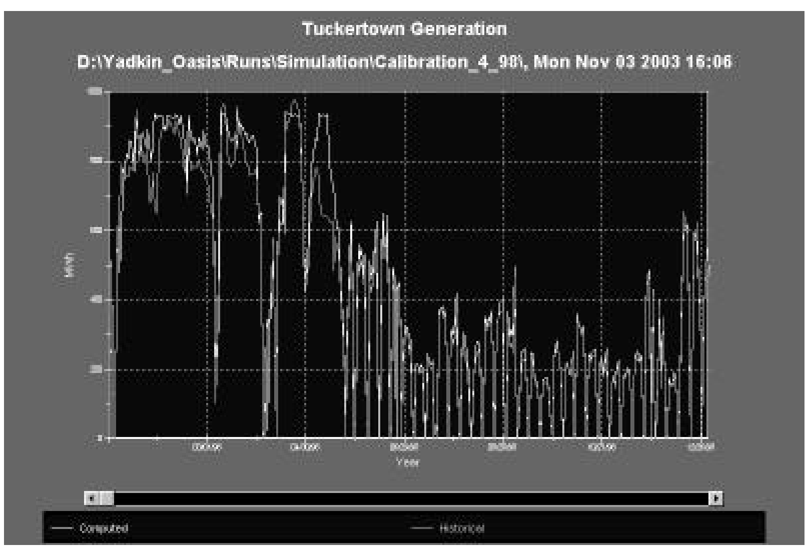
1998 – Tuckertown Generation



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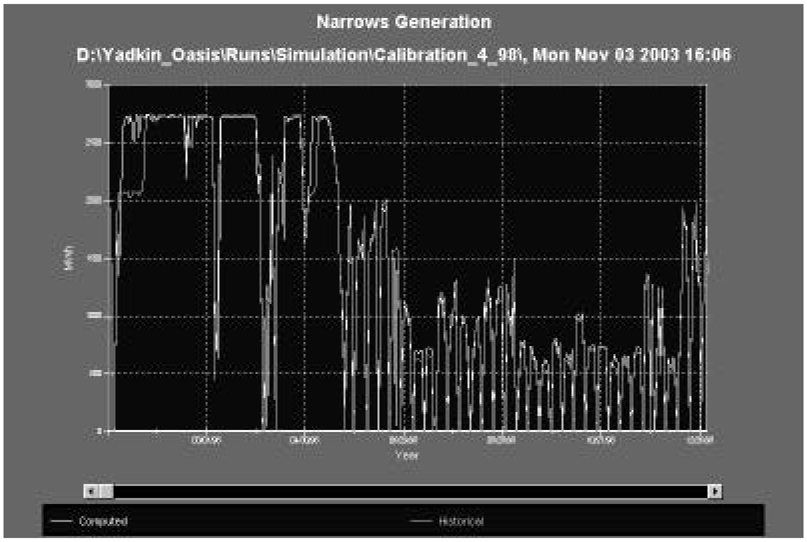
1998 – Narrows Generation



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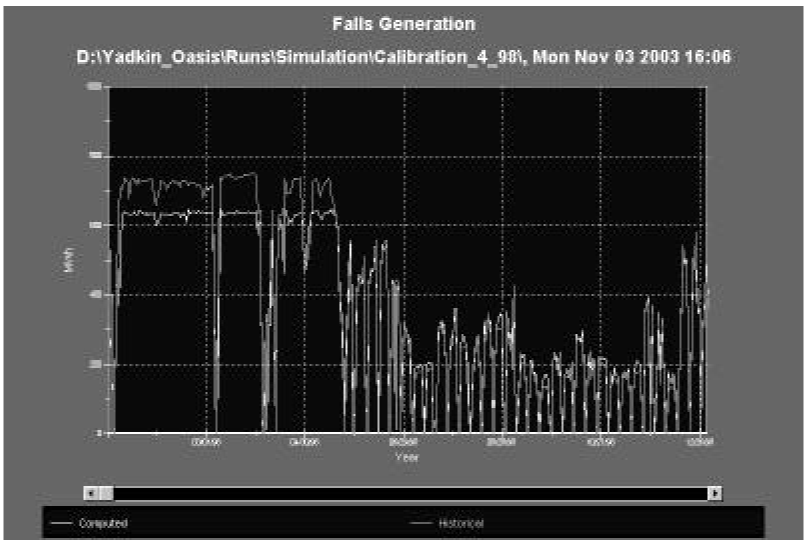
1998 – Falls Generation



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Calibration Results - 1998

1998	Simulated (MWh)	Historical (MWh)	Deviation (%)
High Rock	153,000	154,000	-0.7%
Tuckertown	159,000	149,000	6.6%
Narrows	500,000	488,000	2.4%
Falls	128,000	135,000	-5.2%
Total	940,000	926,000	1.5%

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Selection of Verification Years

AVERAGE ANNUAL INFLOW		
Rank	Flow (cfs)	Year
1	6,591	1990
2	5,692	1993
3	5,573	1984
4	5,467	1989
5	5,464	1987
6	5,349	1983
7	5,282	1991
8	5,075	1996
9	5,026	1998
10	5,022	1992
11	4,888	1994
12	4,827	1995
13	4,774	1980
14	4,431	1982
15	4,154	1997
16	3,554	1985
17	2,614	1999
18	2,466	1981
19	2,417	1988
20	2,250	1986
21	2,213	2002
22	2,150	2000
23	1,547	2001
Average	4,210	

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Selection of Verification Year - 1990

		AVERAGE QUARTERLY INFLOW					
Year	Average Inflow 1st QTR	Year	Average Inflow 2nd QTR	Year	Average Inflow 3rd QTR	Year	Average Inflow 4th QTR
1993	12,238	1987	7,737	1989	4,558	1990	7,751
1990	9,416	1983	7,638	1984	4,349	1989	6,673
1998	9,372	1991	7,569	1994	4,338	1992	5,841
1994	8,593	1984	7,522	1996	4,053	1995	5,013
1991	8,374	1998	7,281	1995	3,808	1996	4,683
1984	8,264	1980	7,133	1987	3,166	1983	4,658
1987	8,235	1992	6,836	1985	2,986	2002	4,586
1980	7,557	1990	6,607	1992	2,893	1985	4,061
1983	7,292	1993	6,158	1991	2,863	1982	3,711
1996	7,218	1997	5,903	1990	2,650	1987	2,804
1995	6,652	1982	5,433	1982	2,531	1994	2,768
1997	6,332	1989	5,053	1980	2,256	1986	2,758
1982	6,097	1996	4,363	1997	2,160	1991	2,413
1989	5,583	1994	3,922	1993	2,128	1993	2,392
1992	4,532	1995	3,862	1983	1,876	1997	2,289
1985	4,461	1981	3,071	1981	1,812	1988	2,210
1999	4,105	1999	2,915	1998	1,747	1984	2,209
1988	3,615	1985	2,720	1999	1,714	1980	2,208
2000	3,504	2000	2,684	1988	1,545	1981	2,086
1986	3,187	1988	2,312	2000	1,432	1999	1,919
1981	2,913	1986	1,702	1986	1,368	1998	1,824
2001	2,610	2001	1,687	2001	1,078	2000	1,001
2002	2,464	2002	945	2002	848	2001	837
Average	6,201		4,828		2,529		3,335

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Selection of Verification Year - 1997

		AVERAGE QUARTERLY INFLOW					
Year	Average Inflow 1st QTR	Year	Average Inflow 2nd QTR	Year	Average Inflow 3rd QTR	Year	Average Inflow 4th QTR
1993	12,238	1987	7,737	1989	4,558	1990	7,751
1990	9,416	1983	7,638	1984	4,349	1989	6,673
1998	9,372	1991	7,569	1994	4,338	1992	5,841
1994	8,593	1984	7,522	1996	4,053	1995	5,013
1991	8,374	1998	7,281	1995	3,808	1996	4,683
1984	8,264	1980	7,133	1987	3,166	1983	4,658
1987	8,235	1992	6,836	1985	2,986	2002	4,586
1980	7,557	1990	6,607	1992	2,893	1985	4,061
1983	7,292	1993	6,158	1991	2,863	1982	3,711
1996	7,218	1997	5,903	1990	2,650	1987	2,804
1995	6,652	1982	5,433	1982	2,531	1994	2,768
1997	6,332	1989	5,053	1980	2,256	1986	2,758
1982	6,097	1996	4,363	1997	2,160	1991	2,413
1989	5,583	1994	3,922	1993	2,128	1993	2,392
1992	4,532	1995	3,862	1983	1,876	1997	2,289
1985	4,461	1981	3,071	1981	1,812	1988	2,210
1999	4,105	1999	2,915	1998	1,747	1984	2,209
1988	3,615	1985	2,720	1999	1,714	1980	2,208
2000	3,504	2000	2,684	1988	1,545	1981	2,086
1986	3,187	1988	2,312	2000	1,432	1999	1,919
1981	2,913	1986	1,702	1986	1,368	1998	1,824
2001	2,610	2001	1,687	2001	1,078	2000	1,001
2002	2,464	2002	945	2002	848	2001	837
Average	6,201		4,828		2,529		3,335

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Selection of Verification Year - 2000

AVERAGE QUARTERLY INFLOW

Year	Average Inflow 1st QTR	Year	Average Inflow 2nd QTR	Year	Average Inflow 3rd QTR	Year	Average Inflow 4th QTR
1993	12,238	1987	7,737	1989	4,558	1990	7,751
1990	9,416	1983	7,638	1984	4,349	1989	6,673
1998	9,372	1991	7,569	1994	4,338	1992	5,841
1994	8,593	1984	7,522	1996	4,053	1995	5,013
1991	8,374	1998	7,281	1995	3,808	1996	4,683
1984	8,264	1980	7,133	1987	3,166	1983	4,658
1987	8,235	1992	6,836	1985	2,986	2002	4,586
1980	7,557	1990	6,607	1992	2,893	1985	4,061
1983	7,292	1993	6,158	1991	2,863	1982	3,711
1996	7,218	1997	5,903	1990	2,650	1987	2,804
1995	6,652	1982	5,433	1982	2,531	1994	2,768
1997	6,332	1989	5,053	1980	2,256	1986	2,758
1982	6,097	1996	4,363	1997	2,160	1991	2,413
1989	5,583	1994	3,922	1993	2,128	1993	2,392
1992	4,532	1995	3,862	1983	1,876	1997	2,289
1985	4,461	1981	3,071	1981	1,812	1988	2,210
1999	4,105	1999	2,915	1998	1,747	1984	2,209
1988	3,615	1985	2,720	1999	1,714	1980	2,208
2000	3,504	2000	2,684	1988	1,545	1981	2,086
1986	3,187	1988	2,312	2000	1,432	1999	1,919
1981	2,913	1986	1,702	1986	1,368	1998	1,824
2001	2,610	2001	1,687	2001	1,078	2000	1,001
2002	2,464	2002	945	2002	848	2001	837
Average	6,201		4,828		2,529		3,335

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Verification Results - 1990

1990	Simulated (MWh)	Historical (MWh)	Deviation (%)
High Rock	199,000	192,000	3.9%
Tuckertown	202,000	204,000	-1.2%
Narrows	652,000	651,000	0.2%
Falls	177,000	178,000	-0.8%
Total	1,230,000	1,225,000	0.4%

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Verification Results - 1997

1997	Simulated (MWh)	Historical (MWh)	Deviation (%)
High Rock	134,000	131,000	2.0%
Tuckertown	139,000	142,000	-1.8%
Narrows	445,000	427,000	4.2%
Falls	122,000	127,000	-3.8%
Total	840,000	827,000	1.6%

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Verification Results - 2000

2000	Simulated (MWh)	Historical (MWh)	Deviation (%)
High Rock	71,000	69,000	2.5%
Tuckertown	76,000	78,000	-2.9%
Narrows	246,000	252,000	-2.6%
Falls	68,000	65,000	4.8%
Total	461,000	464,000	-0.8%

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APGI / PE Data Exchange (cont.)

- Yadkin / PE plan to share technical data (ICD-type data, but with greater specificity than ICD) on modeling without need of confidentiality agreement
- Confidentiality agreement needed for full sharing of Yadkin / PE input data and full model development by Yadkin / PE

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Operations Models

- Yadkin model will extend from W. Kerr Scott to USGS Pee Dee Gage
- Progress model will extend from High Rock into SC beyond the USGS Pee Dee Gage
- Yadkin will use daily flow data; PE will use hourly flow data

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Inflow Datasets

- USGS data will be used by both Yadkin and PE
- Yadkin / PE to meet and review independent analysis of development of USGS flow datasets

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Low Flow Case

- Low flow will be a special case in Yadkin modeling effort; PE will consider
  - Project may be operated differently during periods of low inflow
  - Drought management protocol would be used for reservoir operation / flow releases during this period

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Generation and Value of Generation

- Yadkin will look at on-peak and off-peak generation; PE will look at on-peak, off-peak and shoulder periods
- Value of generation issue needs further consideration – Duke, Yadkin, PE

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Resolution of APGI / PE Modeling Differences

- Yadkin and PE will meet to attempt to resolve input data differences
- Results of models will never agree exactly
  - If results within 10%, consider agreement
  - If results off 30% to 40%, need investigation

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Water Withdrawals

- Reasonable assemblages of water withdrawal info from states will be considered
- No future water supply planning to be conducted by Yadkin / PE

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Salinity Model

- Yadkin and PE will participate in funding of USGS salinity model

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Status of Model Development

- Yadkin model is calibrated and verified to model historical operation of Yadkin Developments
- Yadkin operations model will be used to evaluate future operational alternatives

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Status of Model Development (cont.)

- Yadkin operations model will utilize:
  - USGS “fill-in” inflow dataset
  - Revised High Rock storage – elevation relationship
  - Upgraded turbine performance relationships at High Rock and Narrows
    - With air injection
    - Without air injection
    - Multiple curves for varying heads
  - Existing turbine performance relationships at Tuckertown and Falls

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Model Development Schedule

- Schedule for release
  - 1^{st} Quarter 2004
  - PE Developments to be included in model prior to release

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Schedule and Agenda for Next Meeting

- Next meeting tentatively scheduled for February 5, 2004
- Meeting contingent on availability of model for roll out

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