

## Recreation Flow Study Report

### I. Executive Summary

This document reports the findings of the Recreation Flow Study that was done as part of the hydropower relicensing of the Catawba-Wateree Project – FERC # 2232. The scope included all or part of the river sections that had over two miles of flowing water and included the sections downstream of the Bridgewater Development (Angling and Paddling), Oxford Development (Paddling and Motorized Jon-boat), Wylie Development (Paddling), the Wateree Development (Paddling), and the Great Falls Bypass sections (Paddling). The field studies were performed from May through October of 2004 with the objective of determining the flow, range and timing of flows that result in a high quality recreation experience for anglers and boaters of various skill levels.

The study methodology utilized the flow assessment methodology of Whittaker, et. al., (1993) and included Professional Judgment and Controlled Flow techniques. Both techniques utilized participant experience of various known flow levels as a means of determining the flows for a quality recreation experience. Study participants were recruited from national and regional paddling and angling organizations, state, and federal natural resource agencies, outfitters, and unaffiliated recreationists. Recreational flows were obtained from turbine discharges into the river sections of interest.

Table 1 summarizes the flow levels that recreationists experienced during the study of each river section and recreationist suggestions for optimal flows after experiencing all (or most) study flows. The recreationist suggested flow levels are the median values from the Comparative Surveys that were completed after all flows were completed for a given river section..

**TABLE 1. Recreationist Experience of Study Flow Levels and Suggested Flows for Optimal Experiences**

<b>River Section and Study Flows Experienced (cfs) (From Upstream Hydro Developments)</b>	<b>Study Flows Producing Totally Acceptable or Acceptable Recreation Experiences (cfs)</b>	<b>Recreationist Suggested Optimum and Minimum Flow Levels (Median cfs)</b>
Bridgewater Angling 350, 900, 1300, 1800	Boat Fishing – 350 and 900 Wade Fishing – 350	Boat – 600 Wade – 350
Bridgewater Paddling 350, 900, 1300, 1800	900, 1300, and 1800	Optimum – 1000 Minimum – 400
Oxford Paddling 500, 2600, 5200	2600 and 5200	Optimum – 2600 Minimum - 1000
Oxford Motorized Boat 2600, 5200	2600 and 5200	Optimum – 5200 Minimum - 2600

Great Falls Bypass Long Channel Paddling 1420, 2950	1420 and 2950 cfs	Optimum – 3000 Minimum - 1400
Great Falls Bypass Short Channel Paddling 1700, 2100, 2900	2100 and 2900 cfs	Optimum – 2800 Minimum – 1900
Wylie – Fort Mill Paddling - 3000, 6000, 9000, 12000	3000, 6000, 9000, 12000	Optimum – 5250 Minimum – 3000
Wylie – Sugar Creek – Paddling 3000, 6000, 9000, 12000	3000, 6000, 9000, 12000	Optimum – 6000 Minimum – 3000
Wateree - Paddling 3000, 6000, 9000, 12000, 15000	3000, 6000, 9000, 12000, 15000	Optimum – 8500 Minimum – 3500

## II. Introduction

### A. Background

Duke Energy is in the process of relicensing its hydropower facilities on the Catawba and Wateree Rivers in North and South Carolina (Catawba-Wateree Project – FERC # 2232) with the Federal Energy Regulatory Commission (FERC). Duke Energy is utilizing a modification of the traditional FERC relicensing process involving the use of Study Teams, Resource Committees, Regional Advisory Groups, and State Relicensing Teams. The Recreation Flow Study Team (Recreation 02) is responsible for the scope of this study and the review of the study findings (Recreation Flow Study Plan Scope Document; available via the internet at [www.catawbahydrolicensing.com](http://www.catawbahydrolicensing.com)). The Recreation 02 Study Team (REC02) also provided expertise and time during the development of the field study methodology as well as participating in some of the field studies. Several Advisory Group and State Relicensing Team members participated in studies on various river sections. The Recreation and Shoreline Management Resource Committee (Rec/SMP RC) has provided broad oversight over all recreation and shoreline management studies and has received periodic updates on this study.

This study was requested and / or supported by stakeholders from American Whitewater, Carolina Canoe Club, Davidson College, Trout Unlimited, South Carolina Coastal Conservation League, American Rivers, Catawba-Wateree Relicensing Coalition, North Carolina Wildlife Resources Commission (NCWRC), NC Division of Water Resources (NCDWR), NC Division of Parks and Recreation (NCDPR), South Carolina Department of Parks, Recreation and Tourism (SCPRT), South Carolina Department of Natural Resources (SCDNR), U S Fish & Wildlife Service (USFWS) and Duke Energy.

The study identified the need for recreation flow studies on specific regulated river sections and one bypass that included two separate sections. Controlled flow studies were done on the river sections downstream from the Bridgewater, Oxford, Wylie, and Wateree Hydro Developments as well as in the Great Falls Bypass sections downstream from the Fishing Creek Hydro Development. The objective on all river sections was to determine the flow range and timing of flows that results in high quality recreation experiences for anglers and paddlers of various experience levels.

## B. Study Area

The source of the Catawba River is in the Blue Ridge Mountains in the area north and west of Morganton, NC. The river runs easterly towards Hickory, NC where it turns south and flows past Charlotte, NC into South Carolina. At the mouth of Big Wateree Creek, the river is known as the Wateree River. The Wateree joins the Congaree River to become the Santee River, which flows into the Atlantic Ocean near Georgetown, South Carolina. A map of the study areas is provided in the First Stage Consultation Document, Catawba-Wateree Project 2232 (accessible via the internet at [www.catawbahydrolicensing.com](http://www.catawbahydrolicensing.com)).

Table 2 lists the river sections evaluated in this study. The miles evaluated in each section and the total miles in the regulated river reach are also provided. All the river regulated sections with at least two miles of free flowing water were studied for part or all of their length.

**TABLE 2. River Section Description and Study Dates**

Section Name	Study Dates	Brief Description of the Section Evaluzted	Study Miles	Total Miles
Bridgewater	July 14-15, 2004	Bridgewater Access Area – River Mile (RM) 279.3 to Watermill Road Access –RM 271.8	7.5	15.3
Oxford	May 6, 7, 12, 28, July 22, 2004	Highway 16 Bridge at Oxford Dam – RM 229.9 to Head of Lookout Shoals Lake – RM 227.0	2.9	2.9
Wylie	July 20, August 3, 9, and October 2, 2004	Fort Mill Access – RM 143.4 to Sugar Creek – RM 132.2	11.2	30.4
Wylie	July 21, August 4, 10, and October 3, 2004	Sugar Creek – RM 132.2 to Landsford Canal State Park – RM118.4	13.8	
Great Falls Bypass: Long Channel	October 23-24, 3004	Great Falls Reservoir to Rocky Creek Reservoir	2.2	2.2
Great Falls Bypass: Short Channel	October 23-24, 2004	Great Falls Reservoir to Rocky Creek Reservoir	0.8	0.8

Wateree	July 23, 29, August 5, 13, 2004	Lugoff Access Area – RM 76.6 to Highway 1 Access – RM 69.4	7.2	76.6
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### III. Study Methodology

Two flow assessment techniques (Whittaker, et.al., 1993) were used to evaluate opportunities for angling and / or paddling at a range of flow conditions. A controlled flow assessment technique was used for the angling and paddling studies at Bridgewater and the paddling study at the Great Falls Bypass sections. A professional judgment technique utilizing known flow levels was used at Oxford, Wylie, and Wateree. In both techniques a specified group of study participants fished and / or paddled the river section(s) under two to five different flow conditions. In the “controlled flow” assessment, the timing of flows was constricted (i.e. four different flows planned over two consecutive days) and a larger number of recreationists (e.g. 20 – 30) were utilized, that had a variety of skill levels and knowledge of the river sections. In the “professional judgment” technique only a few recreationists (e.g. 2 – 7) participated in all the flows. These recreationists had extensive experience on a specific river section(s) and / or extensive recreational experience on a wide variety of rivers. In addition, the different flow levels were experienced by these recreationists over a longer time frame (i.e. one to three months). The “professional judgment” technique was modified to include self selected paddlers who learned about the study through the news media and other sources, and joined the core group for one or two flows. Regardless of the study technique used, all study participants (except for the Oxford Section) completed survey forms as a means of documenting the quality of the angling or paddling experience. The questions within the surveys varied slightly depending upon whether the survey documented angling or paddling recreational experiences and on the whitewater / moving water difficulty of the river section.

Upon completion of each test release, each recreationist filled out a Single Flow Survey (Appendix A) to describe the quality of the paddling / angling experience specific to that flow level. Specifically, recreationists were asked to rate the flow with regard to: 1) angling / paddling experience characteristics; 2) how well suited it was for different skill levels; 3) their overall experience; 4) whether they would prefer a higher or lower flow level; 5) whether they would return to the section at that flow level; and 6) the top three advantages and disadvantages of the flow level. They were also asked to describe safety hazards and provide any other general comments regarding the experience.

All recreationists on a given river section who fished / paddled all (or most) of the test flows also filled out a Comparative (Overall) Survey (Appendix B) to comparatively evaluate all the flow levels. Specifically, participants were asked to: 1) rank the importance of the angling / paddling experience characteristics; 2)

rank the flow levels in order of preference as regards each experience characteristic; and 3) make an overall evaluation about the quality of the recreational experience at the different flow levels.

Survey responses were compiled in spreadsheets (Appendix C) and compared across the different flow conditions to determine how the flows affected the quality of the paddling / angling experience and the acceptable flow levels. All written comments on the survey were compiled (Appendix D).

Anglers and paddlers were recruited utilizing the state and local Trout Unlimited organizations, the regional and national paddling organizations (e.g. American Whitewater, Carolina Canoe Club, and Western Carolina Paddlers), newspaper articles about the study, state and federal employees of the natural resource agencies, regional angling and paddling outfitters, and non-affiliated anglers and paddlers. All recreationists signed a waiver (Appendix E) and participated in a short study orientation that included an explanation of the survey instruments, safety briefing, and a description of major river features and test flow durations.

Flow releases were obtained from turbine discharges into the regulated river sections, generally at best efficiency flow. Releases lower than best efficiency flow were used at Bridgewater and Oxford for study purposes but cannot be maintained for long periods of time due to damage to the turbines. Flows into the Great Falls Bypass reaches (i.e. Short Channel and Long Channel sections) were obtained by controlling turbine discharge at Fishing Creek, Dearborn, and Great Falls Developments so that different amounts of water flowed over the weirs at the upstream end of both bypass channels. Flow levels in cubic feet per second (cfs) were obtained by either direct measurement or turbine discharge curves. All flow levels were documented with still and / or video photography.

#### **IV. Results and Discussion**

##### **A. Bridgewater Angling and Paddling Study - General**

The Bridgewater Angling and Paddling Flow Study was conducted on July 14-15, 2004, utilizing an 7.5-mile section of river near Glen Alpine, North Carolina between the Bridgewater Access Area (RM 279.3) and the Watermill Road Access Area (RM 271.8). The river channel at the put-in initially is narrow and braided with several islands and swift current. Muddy Creek (and the Old Catawba River Bypass Channel) join the Catawba River at RM 278.7 about 0.6 miles downstream from the Bridgewater Access Area. Water clarity generally changes from clear to turbid with the entrance of the Muddy Creek tributary. About RM 278.3 (about 1 mile downstream from the Bridgewater Access Area) the river channel becomes much wider with fairly deep runs (depending on water levels) mixed with shoal areas. The river retains this character downstream to the take-out that was used for this study at Watermill Road Access Area. About 3.2 miles downstream from the Watermill Road Access Area is a weir (RM 268.6) that is generally portaged by boaters, About 0.8 miles further downstream from

the weir is a boat access site. This site is located at the upstream end of the Morganton Greenway (RM 267.8). The river continues from this point about 3.8 miles further downstream and becomes the head of Lake Rhodhiss at RM 264.0. The entire river reach to this point is Class I to I+ whitewater shoals interspersed with moving flatwater stretches. The gradient from the Bridgewater Access Area to the Watermill Road Access Area is slightly higher than that from Watermill Road to the head of Lake Rhodhiss (5 and 2 feet per mile respectively). The flows during the study are shown below in Table 3 and were utilized by both the anglers and the paddlers. Actual flow in cfs is presented in the data tables in this report but discussion of flow results is referenced based on the flow number (e.g. Flow 1, 2, etc.), synonymous with the flow levels listed.

**TABLE 3. Study Flow Levels**

<b>Flow Level</b>	<b>Flow 1</b>	<b>Flow 2</b>	<b>Flow 3</b>	<b>Flow 4</b>
<b>cfs</b>	<b>350</b>	<b>1300</b>	<b>900</b>	<b>1800</b>

**1. Bridgewater Angling Flow Study**

Anglers often access this study section using drift boats of various types, canoes and jon boats. Wade anglers use the first mile or so (generally upstream of Muddy Creek) during periods of no generation and generally access the channel from the Bridgewater Access Area. Bank anglers fish at the access area, the bank across the river from the access area, and the bridge over the channel (Powerhouse Road). The North Carolina Wildlife Resources Commission stocks catchable trout in the river section above Muddy Creek and fingerlings in the section from Muddy Creek downstream to the Morganton Weir. Public access to the river channel along this study section is limited to the Bridgewater Access Area and the Watermill Road Access Area. All other land along the study section is privately owned property. Boat fishing downstream from the Watermill Road Access Area is limited to boats that can be carried across the portage trail around the weir at the Morganton Water Treatment Plant.

In this study twenty-three anglers participated in at least two different flow levels. All participants used boats to access the river and most stopped to wade-fish the shoals at wadeable water levels. Table 3.1 provides general information about the participants. Fourteen participants experienced all four flow levels. Four participants experienced Flows 3 and 4 and filled out the Comparative Survey. The participants who fished only Flows 1 and 2 only filled out the Single flow Survey.

**Table 3.1. Bridgewater Section Angling Study. Participant Information**

Participant Gear	Spin/Lure - 17; Fly - 2; Combinations including Bait - 3
Skill Level	Novice – 1; Intermediate – 13; Advanced - 8
River Access	Drift Boat (wood, pontoon, or cataraft) – 8; Canoe – 12; Touring Kayak - 2
Times Fished at	Average of 7 days / year with range of 0 to 30.

Bridgewater	
Times Fished Any River	Average of 39 days/year with range of 0 to 150

Participant ratings from the Single Flow Survey for angling experience characteristics during the four flow levels are shown in Table 3.2.

**Table 3.2. Bridgewater Section Angling Study. Median Rating of the Four Flows for Angling Characteristics**

5-point scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Characteristic	Flow 1 350 cfs	Flow 2 1300 cfs	Flow 3 900 cfs	Flow 4 1800 cfs
Ease of Walking Shoreline	1	-1	0	-2
# Quality Fishing Spots	1.5	0.5	1.5	-1
Walking Channel	1.5	-1	1	-2
Ease of Casting	2	1	1.5	0
Aesthetic Quality	2	1.5	1.5	1
Visibility of Fish	1	0	0	-1
Ease of Landing fish	1	1	1	0
Interesting areas to Fish	2	0.5	1	-1
Ease of Moving Boat to Desired Area	1	1	1	-1
Ease of Moving Boat Through Shoals	1	2	1	1
Overall Velocity or Current Speed	1	0	1	-1
Ease of Access at Put-in	2	1.5	1	1
Ease of Access at Take-out	1	2	1	1

Overall, Flow 1 and Flow 3 provided more acceptable angling opportunities for these anglers than Flow 2 and Flow 4. Aesthetic Quality, Ease of Moving Boat through Shoals, and Ease of Access at Put-in and Take-out were rated Acceptable or Totally Acceptable at all flow levels. However, written comments from some recreationists indicated that it was difficult, and perhaps unsafe, to launch boats at the Bridgewater Access Area at the higher flow levels.

Participants were asked in the Comparative Survey to rate the importance of the above angling characteristics plus Fishing Success, Driving Distance to the River, and Crowding. Table 3.3 lists the top nine characteristics along with a ranking of the four flows for each characteristic (where a rating was done).

**Table 3.3. Bridgewater Section Angling Study. Mean Rating of Flows for the Most Important Angling Characteristics**

Importance Scale: 1 = Irrelevant; 2 = Not Important; 3 = Somewhat Important; 4 = Important; 5 = Very Important. Flow Ranking Scale: 4-Point Preference Scale from 1 (Best) to 4 (Worst).

Characteristic	Importance of Characteristic Mean Score	Flow 1 350 cfs	Flow 2 1300 cfs	Flow 3 900 cfs	Flow 4 1800 cfs
No. Quality Fishing Spots	4.4	1	3	2	4
Overall Current Speed	4.3	1	3	2	4
Move Boat to Desired Area	3.9	1	3	2	4
Move Boat Through Shoals	3.8	4	2	3	1
Access at Put-in & Take-out	3.8				
Aesthetic Quality	3.7	4	3	1	4
Interesting Areas to Fish	3.6	1	3	2	4
Crowding	3.6				
Walking in Channel	3.5	1	3	2	4

Flow 1 and Flow 3 are the preferred flows for more of the important characteristics that these recreationists said comprise a quality angling experience. Other flow levels were preferred for Ease of Moving Boat through Shoals where the top preference was for Flow 4 and then Flow 2 (the higher flows) and Aesthetic Quality where Flow 3 was the top preference.

Recreationists were asked to rate the suitability of each flow level for anglers of different skill levels (Table 3.4).

**Table 3.4. Bridgewater Section Angling Study. Median Ratings for Flows for Different Skill Levels**

5-Point Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Unacceptable

Skill Level	Flow 1 350 cfs	Flow 2 1300 cfs	Flow 3 900 cfs	Flow 4 1800 cfs
Novice	2	-1	1	-2
Intermediate	2	0	2	-1
Advanced	1.5	1	2	1

There was an Acceptable or Totally Acceptable rating for all skill levels for Flow 1 and Flow 3 while Flow 2 and Flow 4 were rated Acceptable only for advanced skill level anglers.

The ratings of overall experience from the Single Flow Survey and the Comparative Survey show similar trends, particularly for boat fishing (Table 3.5).

**Table 3.5. Bridgewater Section Angling Study. Median Ratings for Overall Experience and Flow Preference.**

Overall Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Preference Scale; 1 – Much Lower; 2 = Lower; 3 = No Change; 4 = Higher; 5 = Much Higher

Questions	Flow 1 350 cfs	Flow 2 1300 cfs	Flow 3 900 cfs	Flow 4 1800 cfs
Single Flow Overall Rating – Wade	2	-1	0	-2
Single Flow Overall Rating – Boat	1	0	2	-1
Flow Level Preference – Wade	3	1	2	1
Flow Level Preference - Boat	4	2	3	1
Wade-Fish at this Level Again (Yes/No)?	Y = 10 N = 3	Y = 2 N = 12	Y = 3 N = 8	Y = 0 N = 11
Boat-Fish at this Level Again (Yes/No)?	Y = 16 N = 0	Y = 12 N = 4	Y = 18 N = 1	Y = 8 N = 9
Comparative Overall Rating	1.5	0	2	-2

Participants had a definite preference for Flow 1 for wade fishing and rated the other flows no higher than Neutral. For boat fishing Flow 1 and Flow 3 were rated as Acceptable and Totally Acceptable, respectively. Preferences for higher or lower water levels are consistent with the overall ratings. Participants would return to wade-fish only at Flow 1 but would return to boat-fish at Flow 1, Flow 2, and Flow 3. Even at Flow 4, half the participants would return, though a number of those who would return said they would do so simply to enjoy being on the river rather than for the fishing.

On the Comparative Evaluation participants suggested 350 cfs (median) as optimal for wade angling and 600 cfs (median) as optimal for boat angling.

Anglers were also asked to designate the three primary advantages and disadvantages of each flow level. The advantages were clustered in several categories. Those noted for Flow 1 and Flow 3 included: 1) Lots of Quality Fishing Spots; 2) Easy to Move Boat to Desired Spots; and 3) Current Speed Good for Fishing. Advantages noted for Flow 2 and Flow 4 were A Positive Challenge and Easy to Move Boat through Shoals. High Aesthetic Quality was an advantage at Flow 2, Flow 3, and Flow 4, and Easy to Cast at Flow 2 and Flow 3. There were generally fewer Disadvantages noted than Advantages. Disadvantages clustered at Flow 2 and Flow 3 for Hard to Walk Shoreline / Bank and Difficult to Walk in River Channel and Flow 2 and Flow 4 for Few Quality Fishing Spots.

The participants noted very few safety issues in general. A few comments concerning hard to spot rocks were noted at Flow 1. The dangers of strainers (objects, such as trees, where water can move through relatively freely but large objects like boats and people cannot) and sweepers ((tree branches hanging close to or in the water, which can cause boats to overturn) combined with current speed, particularly in the upper 2 miles, were increasingly mentioned at Flow 2, Flow 3, and Flow 4. In addition, several recreationists noted that it was difficult to launch boats at the put-in except at the lowest flow level. At Flow 4 many

participants said the current was too fast and the waves in the rapids too high to be safe for a canoe loaded with fishing gear.

Other comments included the need for additional access areas to break the reach into shorter fishing sections and concerns for the increased turbidity after the confluence with Muddy Creek.

### **Conclusions for the Bridgewater Angling Flow Study**

This section of the Catawba River is characterized by a fairly continuous gradient of about 5 feet per mile (Benner and Benner, 2002). The river channel is generally vegetated which provides a sense of isolation to the river recreation experience. The upper mile is more challenging, particularly at the two highest flows, due to the narrowness of the channel that includes several sharp twists and turns that can capsize novice boaters / anglers. Public access is available at the Bridgewater Access Area at the put-in and at the Watermill Road Access Area at the take-out. The remainder of the river corridor is private property. One or two additional access areas would be ideal for this stretch. This would support use for shorter morning and evening trips, disperse usage, and improve usability for boat angling at higher flow levels by avoiding the upper mile of river where there is faster water and narrow channels.

The results of the controlled flow study indicate Acceptable and Totally Acceptable flows for boat angling occur at Flow 1 (350 cfs) and Flow 3 (900 cfs), respectively, with a median optimal flow recommendation of 600 cfs. The acceptable flow for wade-fishing is Flow 1 (350 cfs) or lower with 350 cfs being the median optimal flow recommendation. At these two flow levels the angling elements that are considered important for a high quality fishing experience for wade and boat anglers, respectively, are present.

Recreationists on this river section should be familiar with the safety issues regarding wading and paddling in streams with swift current and rapids of Class 1 to easy Class 2 difficulty. Flow 2 and Flow 4, the two highest flows, provide increased safety challenges due to the greater current speed, the larger waves at several shoal areas, and the strainers and sweepers, which are more prevalent and more dangerous at these flow levels. Heavily loaded boats in particular could swamp under these conditions and novice paddlers in particular should boat with more experienced paddlers.

## **2. Bridgewater Paddling Flow Study**

Paddlers often use this section of the Catawba River and it is described in two regional guide books (Benner and Benner, 2002; and Mayer, 2000). A retail outfitting store in Morganton, CBS Sports, rents canoes and recreational kayaks, and runs shuttles for the section. .

Twenty-seven paddlers participated in the study (Table 4.1).

**Table 4.1. Bridgewater Section Paddling Study. Participant Information**

OC1 = Solo Open Canoe; OC2 = Tandem Open Canoe; KWW = Whitewater kayak;  
 RecK! = Solo Recreation Kayak; TourK1 = Solo Touring Kayak

<b>Participants</b>	OC1=8; OC2= 7; KWW= 4; RecK1= 6; TourK1 =2
<b>Skill Level</b>	Novice = 2; Intermediate = 22; Advanced =3
<b>Years Paddled</b>	Mean and Median = 22; Range = 4-50
<b>Times Boated Bridgewater / Year</b>	Mean = 1.5; Range = 0-10
<b>Times Boated / Year</b>	Mean = 35; Median = 25; Range = 5-200
<b>No. Rivers Boated / Year</b>	Mean and Median = 9; Range = 2-20

One recreationist paddled in only the first two flows and three others paddled in only the last two flows (two of the three also filled out Comparative Evaluations). Most (81%) of the recreationists were self designated intermediate level paddlers. They had paddled the study section an average of 1.5 times per year, boated other rivers an average of 35 (median of 25) times per year, and paddled an average of nine different rivers per year.

The participant ratings from the Single Flow Survey for paddling characteristics during the four flow levels are shown in Table 4.2.

**Table 4.2. Bridgewater Section Paddling Study. Rating of the Four Flows for Paddling Characteristics**

5-point scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Level in cfs	Flow 1 350		Flow 2 1300		Flow 3 900		Flow 4 1800	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Paddling Characteristics								
Navigability	1.2	1	1.9	2	1.5	2	1.7	2
Current Speed	0.7	1	1.5	2	1.4	1.5	1.4	2
Aesthetic Quality	1.3	1	1.6	2	1.4	2	1.3	1.5
Safety	1.6	2	1.6	2	1.5	2	1.0	1
Interesting Surroundings	1.4	1	1.5	2	1.3	1	1.4	1
Time for Run	1.1	1	1.5	2	1.4	1.5	0.4	2
Play Area Quality	0.4	0	1.2	1	1.3	1	1.1	1
Access – Put-In	1.6	2	1.6	2	1.5	2	1.5	2
Access – Take-Out	1.7	2	1.7	2	1.4	2	1.5	2

All characteristics at all four flows were rated (median) as Acceptable or Totally Acceptable except for a Neutral rating for Play Area Quality at Flow 1.

Participants were asked in the Comparative Survey to rate the importance of the above paddling characteristics. Table 4.3 lists the mean and median ratings for the eight characteristics that recreationists said were Important or Very Important and a ranking of the four flows for each characteristic.

**Table 4.3. Bridgewater Section Paddling Study. Mean Rating of Flows for the Most Important Paddling Characteristics**

Importance Scale: 1 = Irrelevant; 1 = Not Important; 3 = Somewhat Important; 4 = Important; 5 = Very Important. Flow Rating Scale: 4-Point Preference Scale from 1 (Best) to 4 (Worst).

Characteristic	Importance of Characteristic		Flow 1 350 cfs	Flow 2 1300 cfs	Flow 3 900 cfs	Flow 4 1800 cfs
	Mean	Median				
Navigability	4.4	5	4	2	3	1
Safety	4.3	5	1	3	2	4
Aesthetic Quality	4.2	4	4	2	3	1
Size of Shoals	4.0	4	4	2	3	1
Current Speed	3.8	4	4	2	3	1
Interesting Surroundings	3.8	4	3	3	3	2
No. Shoals / Rapids	3.7	4	4	2	1	3
Ease of Access	3.6	4				

The Time for the Run and Play Area Quality were only somewhat important to the study team and were not included in the list of characteristics. It appears that Flow 2 and Flow 4 generally satisfy participants better than Flow 1 and Flow 3. Flow 1 was ranked first for Safety and Flow 3 was first for Number of Shoals / Rapids.

Recreationists were asked to rate the suitability of each flow level for paddlers of different skill levels (Table 4.4).

**Table 4.4. Bridgewater Section Paddling Study. Median Ratings for Flows for Different Skill Levels**

5-Point Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Skill Level	Flow 1 350 cfs	Flow 2 1300 cfs	Flow 3 900 cfs	Flow 4 1800 cfs
Novice	1	1	2	0
Intermediate	1	2	1	2
Advanced	-1	2	1	2

The participants rated the four flows as Acceptable or Totally Acceptable for all skill levels except Advanced at Flow 1, which was rated as Unacceptable and

Novice at Flow 4, which was rated Neutral, Even though all flow levels except Flow 4 were rated Acceptable for Novices, the written comments did emphasize that novice level paddlers should paddle with more experienced paddlers, particularly on the first mile from the put-in.

The ratings of overall experience from the Single Flow Survey and the Comparative Survey, the preference for more or less water, and whether the recreationists would return to paddle at a given level are shown in Table 4.5.

**Table 4.5. Bridgewater Section Paddling Study. Median Ratings for Overall Experience and Flow Preference.**

Overall Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Preference Scale; 1 = Much Lower; 2 = Lower; 3 = No Change; 4 = Higher; 5 = Much Higher

Return to Paddle Scale: 1 – Definitely Paddle Again; 2 = Probably Paddle Again; 3 = Toss Up Between This and Similar Options; 4 = Return if No Other Options Available; 5 = Not Return

Questions	Flow 1 350 cfs	Flow 2 1300 cfs	Flow 3 900 cfs	Flow 4 1800 cfs
Single Flow Overall Rating	1	2	2	2
Flow Level Preference	4	3	3	2
Return to Paddle at this Flow level	3	2	2	2
Comparative Overall Rating	0	2	2	2

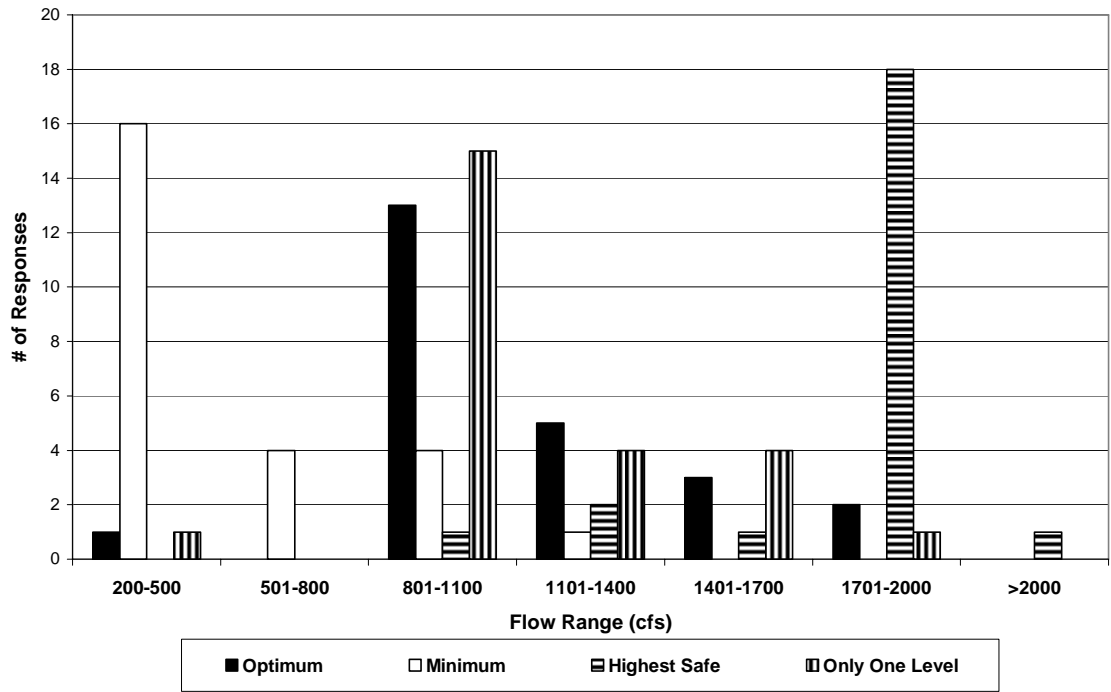
The overall rating of the flows on both the Single Flow and Comparative Surveys is Totally Acceptable for Flows 2, 3, and 4 while the rating for Flow 1 changed from Acceptable on the Single Flow Survey to Neutral on the Comparative Survey. The flow preferences at each flow level are generally consistent with the overall ratings for that flow. However, even though the Overall Rating for Flow 4 was Totally Acceptable the recreationists still wanted less flow. These paddlers would Probably Return to paddle this section at Flow 2, Flow 3, and Flow 4 but it would be a Toss up between This and Similar Options at Flow 1.

Table 4.6 and Figure 4.1 show the flow levels that participants would choose for various experiences or conditions.

**Table 4.6. Bridgewater Paddling Study. Median, Mean, and Mode Flow Levels for Specified River Experiences**

Specify Flow for Experience of:	Median cfs	Mean cfs	Mode cfs
Optimal Flow Level	1000	1127	900
Minimum Acceptable Flow Level	400	550	350
Highest Safe Flow Level	1800	1774	1800
If Only One Flow Level Provided	1000	1100	900

Figure 4.1. Bridgewater Paddling Study. Flow Levels for Specific River Experiences



The Optimal and the If Only One Flow Level Provided are almost identical (both in the 1000 cfs range). Participants were asked on the Comparative Survey whether they would recommend their Optimal and Minimum Acceptable flows to various skill levels. Forty two percent of the recreationists would recommend their Optimum flow level to beginners, 88% to novices, 100% to intermediates, and 71% to advanced level paddlers. The percentage recommending their Minimum Acceptable level was 83% to beginners, 96% to novices, 75% to intermediates, and 33% to advanced. Most recreationists (75 – 100%) would recommend their Optimum or Minimum Acceptable levels to novices and intermediates but would tend to recommend only the Minimum Acceptable flow to beginners and only the Optimum flow to advanced level paddlers. The Highest Safe flow recommendation was the same as Flow 4 at 1800 cfs.

Paddlers were also asked to designate the three primary advantages and disadvantages of each flow level (Table 4.7).

**Table 4.7. Bridgewater Paddling Study. Advantages and Disadvantages of the Flow Levels**

A = Advantage; D - Disadvantage

Characteristic	Flow 1 350 cfs	Flow 2 1300 cfs	Flow 3 900 cfs	Flow 4 1800 cfs
Easy to Move Boat through Shoals	A	A	A	A
Shoals had Too Many Rocks	D			
Current Speed Just Right		A	A	

Current Speed Too Slow	D			
High Aesthetic Quality	A			A
Interesting Surroundings	A			
Time for Run Just Right			A	
Some Places to Play in Current		A	A	A
Few Places to Play in Current	D			
Positive Challenge				A
Easy to Move Boat to Desired Spots	A		A	

Participants generally noted many more advantages than disadvantages. While the significant advantages were distributed among all four flows, the significant disadvantages were all noted for Flow 1.

On a five-point scale with 1 being Worse than Average and 5 being Among the Very Best, this section was rated at 3 or Better than Average when recreationists compared it to local rivers within a one hour drive. They rated it as 2 or Average when compared to regional and national rivers.

The primary safety issue noted was the presence of strainers along the banks and in the river channel. This issue was deemed more serious at higher flows, particularly for novice boaters paddling without more skilled companions. Also, waves (one about 300 yards downstream of the put-in) develop at the two higher flows that can cause novice paddlers to capsize.

Other comments included: 1) the water quality deterioration that comes from Muddy Creek; 2) the need for an additional take-out, possibly under the transmission lines near the Powerhouse Road bridge about two miles downstream from the put-in; 3) the need for a flow release communication system; 4) the desire to extend the Morganton Greenway to Lake James; 5) the desire to limit development along the river corridor, and 6) the undesirability of settling on only a single amount of flow as THE recreational flow since providing a variety of flows would allow for a range of skill levels and type of river experience – from placid family floats or angling to large waves and potential play spots.

### **Conclusions for the Bridgewater Recreational Paddling Flow Study**

This section of the Catawba River is characterized by a fairly continuous gradient of about 5 feet per mile (Benner and Benner, 2002). The river is mostly moving flat water with Class I – I+ shoals with two or three Class II rapids depending on the water level. The riverbanks are generally vegetated which provides a sense of isolation to the river recreation experience. The upper mile is more challenging due to the narrowness of the channel that includes several sharp twists and turns that can capsize novice boaters. Public access is available at the Bridgewater Access Area at the put-in and at the Watermill Road Access Area at the take-out. The remainder of the river corridor is private property. An additional access area would be ideal for this stretch.

The results of the controlled flow study indicate Flow 2 (1300 cfs), Flow 3 (900 cfs), and Flow 4 (1800 cfs) are Totally Acceptable for recreational paddling. Even so, the recreationists indicated an Optimal flow level of 1000 cfs. They also suggested a Minimal Acceptable level of 400 cfs, a Highest Safe level of 1800 cfs and 1000 cfs If Only One Flow Level could be provided. The Bridgewater Section compares favorably (Better than Average) with other local rivers and was rated as average when compared to other regional and national rivers.

Recreationists should be familiar with the safety issues regarding paddling in streams with swift current and rapids of Class I to II difficulty. Flow 2 and Flow 4, the two highest flows, provide increased safety challenges due to the greater current speed, the larger waves at several shoal areas, and the strainers and sweepers, which are more prevalent and more dangerous at these flow levels. Novice paddlers should boat with more experienced paddlers.

## **B. Oxford Section – Paddling and Motorized Jon Boat**

The evaluation of this section was informal. Flows were documented pictorially but participants filled out no surveys. The evaluations were conducted on May 6 (about 500 cfs), May 7 (about 1400 cfs), May 12 (2 Units of turbine discharge - about 5200 cfs) and May 28, 2004 (1 Unit - about 2600 cfs). Observations were also made with representatives from the North Carolina Wildlife Resources Commission, North Carolina Division of Water Resources, and Carolina Canoe Club in December of 2003. An upriver and downriver jon-boat run at 1 and 2 units was done on July 22, 2004 with the North Carolina Wildlife Resources Commission.

This 2.9-mile segment of the Catawba River begins downstream from the Oxford Development (RM 229.9) and ends at the head of Lookout Shoals Lake (227.0). Riverbend Park (Catawba County Recreation Area) property begins about 200 yards downstream from the Oxford Dam and has almost a mile of river frontage. The river channel contains large rocks and a small rock and sand bottom. At no generation the rocks are evident and would require dragging boats over many rocks to paddle the section. At about 500 cfs the rocks are still mainly above water but there are distinct channels that can be found if paddlers have some river reading ability and reasonable control of their craft. Two shoal areas develop around the islands toward the end of the run that are shallow but can be paddled without getting out of a kayak or canoe. There are deep pools between the rocky sections. A flow of about 1400 cfs covers most of the shoals though they remain shallow and some hits and scrapes are unavoidable. The 1400 cfs level is probably close to being minimally acceptable. At about 2600 cfs most of the rocks are covered and the two shoal areas are easily paddled. This is a totally acceptable and probably an optimal flow level for paddling. At about 5600 cfs almost all the rocks are completely covered and the two shoals are still easy to paddle. This level is also totally acceptable but the features have started to wash out and the additional water does not improve the paddling experience except for

those who want to get down the river faster. A visual comparison is provided in Figures E.1, E.2, E.3 and E.4.

An upriver run was also made with the North Carolina Wildlife Resources Commission to assess whether Commission staff could safely access the river channel for Commission business. A small jon-boat with a jet intake was used. The trip from Lookout Shoals Lake to the Oxford Dam and back to the lake was relatively easy at 2 Units of flow with an experienced river driver piloting the boat (no rock hits). The second shoals (traveling upriver) and the shoals under the Highway 16 Bridge required the most attention and skill. The round trip was also accomplished at 1 Unit (with the same now more experienced driver) but the water level had dropped enough that extreme attention and skill was required to make the round trip and 6 rocks were tapped either on the way up or down. In addition, it was not possible without damage to the motor to go completely up the rapid under the Highway 16 Bridge. It appears feasible for skilled drivers with the right boat and motor to access the river channel either starting at Lookout Shoals Lake or at the dirt ramp at Riverbend Park.

**Figure E.1. Oxford Section at Highway 18 Bridge (River Mile 229.9) with no generation.**



**Figure E.2. Oxford Section at the Highway 18 Bridge (River Mile 229.9). with generation at 500 cfs.**



**Figure E.3. Oxford Section at the Highway 18 Bridge (River Mile 229.9). with generation at 1400 cfs.**



**Figure E.4. Oxford Section at the Highway 18 Bridge (River Mile 229.9) with generation at 2600 cfs.**



**C. Great Falls Bypass Paddling Study for the Short Channel and Long Channel Sections**

The Great Falls Bypass Paddling Flow Study was conducted on October 23-24, 2004. The Great Falls Bypass Channels are located in Chester and Lancaster Counties of South Carolina near the town of Great Falls, South Carolina. The Long Channel Bypass is formed about 500 yards downstream from the Fishing Creek Development by a Diversion Weir between the east side of Mountain Island and the east bank of the river channel. The Diversion Weir directs water to the powerhouses of the Great Falls – Dearborn Development and acts as a spillway. The Long Channel varies from about 150 to 450 yards in width, is about 2.2 miles long and ends at Rocky Creek Reservoir in the vicinity of Hill Island. This river channel is heavily congested with small trees and shrubs, particularly in the middle quarter of the section. Even so, there are a few good channels through the trees that are reasonably navigable by intermediate level paddlers. The Short Channel Bypass is formed about 1.6 miles downstream from the Fishing Creek Development by the Headworks Weir, which extends from the west side of Mountain Island to the west bank of the river channel which is the east side of Dearborn Island. The Headworks Weir structures act as both a

spillway and a canal that leads to the Great Falls – Dearborn Development. The Short Channel is about 100 to 200 yards in width, is about 0.8 miles long and ends at Rocky Creek Reservoir a little east of Hill Island. The Short Channel also contains some trees and small shrubs, particularly towards the downstream end of the section but the routes are more evident than in the Long Channel.

The flows during the study were obtained by balancing the turbine discharge from Fishing Creek Development with that from the Great Falls – Dearborn Development. Flows were measured near the end of each channel in the vicinity of Hill Island and these measured flows are used to define the flow levels in this study. Four flows were planned for this study. Difficulties balancing the turbine discharges from Fishing Creek with those from Great Falls – Dearborn and the failure of the flashboards at the Headworks Weir on the Short Channel decreased the number of flows possible to two different flows in the Long Channel and three in the Short Channel. These flow levels still provided the study teams with enough information to characterize the two channels and to recommend Optimum and Minimal Acceptable flow levels. The original study plan provided time for the Short Channel Team to also paddle the Long Channel. Due to the above difficulties that only happened for the first flow. The measured flows for the Short Channel and Long Channel are provided in Table 5.0.

**Table 5.0. Measured Flow Levels in the Long Channel and Short Channel during the Flow Study**

	<b>Flow 1</b> <b>cfs</b>	<b>Flow 2</b> <b>cfs</b>	<b>Flow 3</b> <b>cfs</b>	<b>Flow 4</b> <b>cfs</b>
<b>Long Channel</b>	<b>1420</b>	<b>2950</b>		
<b>Short Channel</b>	<b>2100</b>	<b>2900</b>	<b>1700</b>	

The flow levels were planned to increase steadily from Flow 1 to Flow 4 in each Channel. Flow 1 and Flow 2 ended up being higher than projected, particularly in the Short Channel. Since the Short Channel recreationists predicted that Flow 1 was higher than Minimum Acceptable and Flow 2 was probably close to Optimum and the Long Channel recreationists predicted that Flow 1 was Minimum Acceptable and Flow 2 might be close to Optimum, Flow 3 was lowered in an attempt to get closer to the Short Channel Minimum Acceptable flow level. Since the Long Channel recreationists had already determined Minimum Acceptable, they did not paddle Flow 3 but waited for Flow 4. Flow 4 was to be a much higher flow in order to bracket the Optimum Flow in the Long Channel. The flashboards on the Short Channel failed at the higher flow prior to recreationists getting into the channels. Once the flashboards failed, the flow study was stopped due to safety considerations and the inability to control the flow levels in either channel sufficiently for study purposes.

While the river channels in both the Long Channel and the Short Channel are heavily congested with small trees and shrubs in places, there are channels through the trees that are reasonably navigable for Advanced and experienced

Intermediate level paddlers. Neither channel has been paddled very often due to the remote location and the necessity for high water events to put sufficient flows into the river channel. However, local paddlers have accessed the Long Channel several times, particularly over the last several years during high flow events.

**1. Great Falls Bypass – Long Channel**

To access the Long Channel participants paddled across Great Falls Reservoir from an informal access area under the west end of the Highway 200 Bridge to the tip of Mountain Island (about 300 yards), where they portaged the diversion weir. The Long Channel is about 2.2 miles long and joins Rocky Creek Reservoir at the tip of Hill Island. The take-out at Stumpy Pond Landing requires a 20 to 30 minute paddle across the lake or a 10-minute boat ride. This section is rated as Class II to II+ in difficulty and has many playable water features depending on the water level.

There were thirteen participants on the study team of mainly experienced intermediate skill level (Table 5.1).

**Table 5.1. Great Falls Long Channel Paddling Study. Participant Information**

OC1 = Solo Canoe; OC2 = Tandem Canoe; K1 = Kayak designed for Creek Running, General Whitewater Recreation, or Whitewater Playboating

Participants	OC1 =1; OC2 = 4; Creek K1 = 3; Rec K1 = 3; Play K1 = 2
Skill Level	Novice = 1; Intermediate = 9; Advanced = 2; Expert = 1
Years Paddled	Median = 13; Range = 3 - 32
Age	Median – 45; Range = 23 - 73
Boat Class II /III	Median = 25; Range = 10 – 130 days / year
Boat Class III / IV	Median – 6; Range – 0 -100

One participant paddled only the first flow and only filled out a Single Flow Survey for that flow. Most of the recreationists were of intermediate skill level with about 13 (median) years of whitewater paddling experience and 25 (median) days of paddling Class II – III whitewater each year.

The ratings from the Single Flow Survey for the paddling characteristics (the elements of a quality whitewater paddling experience) for each of the two flow levels is provided in Table 5.2

**Table 5.2. Great Falls Long Channel Paddling Study. Rating of Flows for Paddling Characteristics**

Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Levels in cfs	Flow 1 1420		Flow 2 2950	
Paddling Characteristics	Mean	Median	Mean	Median

Navigability	1.3	1	1.9	2
Technical Boating Opportunities	0.8	1	1.7	2
Size of Waves / Hydraulics	0.7	1	1.5	2
Whitewater Play Areas	0.9	1	1.1	1
Size / Difficulty of Rapids	0.7	1	1.4	1
Overall Whitewater Challenge	0.6	1	1.6	2
Safety	0.9	1	1.2	1
Aesthetics	1.0	1	1.3	1
Length of Run	0.9	1	1.0	1
Overall Rating	0.9	1	1.6	2

The recreationists rated Flow 1 as Acceptable for all characteristics and Flow 2 as Totally Acceptable for half the characteristics (including Overall Whitewater Challenge) and Acceptable for the other half.

A rating of the importance of the Paddling Characteristics and a ranking of the two flows as to which flow was better for each characteristic is provided in Table 5.3.

**Table 5.3. Great Falls Long Channel Paddling Study. Rating of Flows for the Most Important Paddling Characteristics**

Importance Scale: 1 = Irrelevant; 2 = Not Important; 3 = Somewhat Important; 4 = Important; 5 = Very Important.

Flow Ranking Scale: 2-Point Preference Scale from 1 (Best) to 2 (Worst).

Characteristic	Importance of Characteristic Mean Score	Flow 1 1420 cfs	Flow 2 2950 cfs
Safety	4.5	2	1
Navigability	4.2	1	2
Overall Challenge	4.1	1	2
Size / Difficulty of Rapids	4.0	1	2
Whitewater Play Areas	3.9	1	2
Size of Hydraulics / Waves	3.8	1	2
Technical Boating Opportunities	3.7	1	2
Number of Portages	3.7		
Water Quality	3.7	1	2
Aesthetic Quality	3.6	1	2
Crowding	3.6		

Recreationists rated Flow 2 as the best for all characteristics except Safety. They also placed more importance on the technical whitewater characteristics (e.g. Navigability, Overall Challenge, etc) than on the non-technical characteristics (e.g. Number of Portages, Water Quality, etc.).

Table 5.4 defines the skills needed to paddle the Long Channel and the whitewater difficulty of this section.

**Table 5.4. Great Falls Long Channel Paddling Study. Whitewater Skills Needed to Paddle the Two Flows and The Whitewater Difficulty**

Skill Level Needed: B = Beginner; N = Novice; I = Intermediate; A = Advanced; E = Expert  
Whitewater Classification Scale: Class I to Class VI

Skill Level	Flow 1 1420 cfs	Flow 2 2950 cfs
Skills Needed	I	I
Whitewater Difficulty	Class II	Class II+

The recreationists defined the Long Channel as Class II whitewater at Flow 1 and Class II+ at Flow 2. Intermediate level skills were deemed necessary to paddle the section at both flow levels.

The ratings of overall experience from the Single Flow Survey and the Comparative Survey, the preference for more or less water, and whether the recreationists would return to paddle at a given flow level are shown in Table 5.5.

**Table 5.5 Great Falls Long Channel Paddling Study. Median Ratings for Overall Experience and Flow Preference**

Overall Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Preference Scale; 1 – Much Lower; 2 = Lower; 3 = No Change; 4 = Higher; 5 = Much Higher

Return to Paddle Scale: 1 – Definitely Paddle Again; 2 = Probably Paddle Again; 3 = Toss Up Between This and Similar Options; 4 = Return if No Other Options Available; 5 = Not Return

Questions	Flow 1 1420 cfs	Flow 2 2950 cfs
Single Flow Overall Rating	1	2
Flow Level Preference – Minimum Acceptable	3	2
Flow Level Preference - Optimal	4	3
Return to Paddle at this Flow level	2	1
Comparative Overall Rating	1	2

The overall ratings from the Single Flow and Comparative Surveys are the same with an Acceptable rating for Flow 1 and a Totally Acceptable rating for Flow 2. The flow level preference scores are consistent with the overall ratings for Minimum Acceptable and Optimal flows. These paddlers would Probably Return to paddle Flow 1 and would Definitely Return to paddle Flow 2.

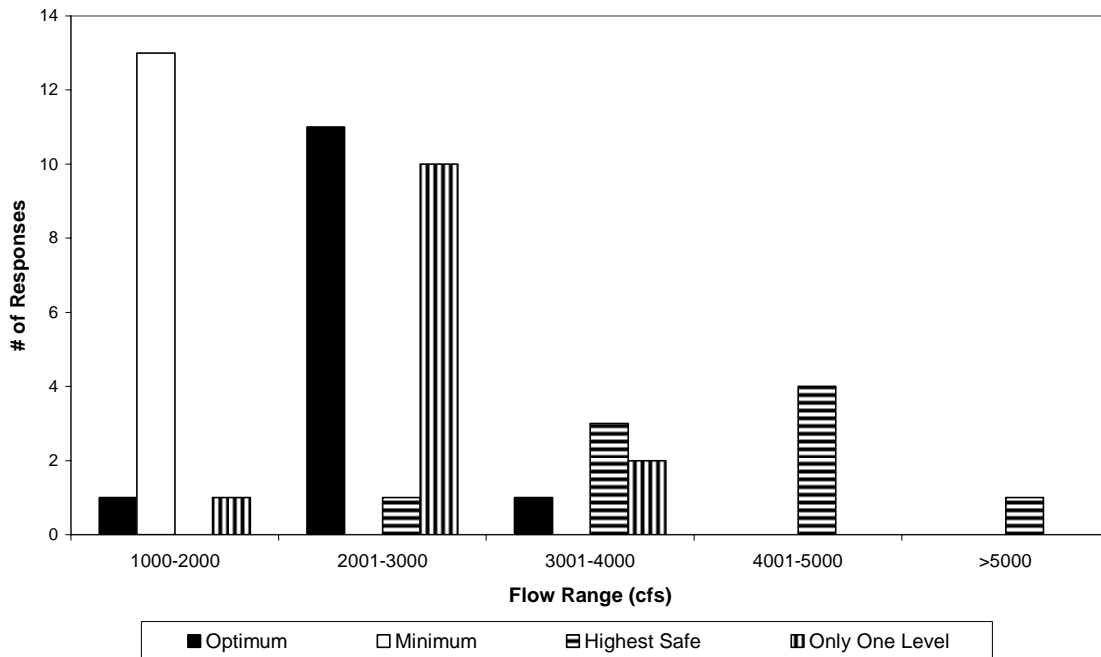
Table 5.6 and Figure 5.1 provide information about the flow levels participants would choose for various experiences or conditions.

**Table 5.6. Great Falls Long Channel Paddling Study. Median, Mean and Mode Flow Levels for Specified River Experiences and Percentage of Participants Who Would Recommend that Flow Level to Various Skill Level Paddlers**

% Who Would Recommend to Various Skill Levels Beg = Beginner; Nov = Novice; Int = Intermediate; Adv = Advanced

Specify Flow for Experience of:	Median cfs	Mean cfs	Mode cfs	Recommend To: % Yes			
				Beg	Nov	Int	Adv
Optimal Flow Level	3000	2790	3000	0	31	100	100
Minimum Acceptable Flow Level	1400	1392	1400	18	67	85	77
Highest Safe Flow for My Skills	4250	4438	5000	Did Not Rate			
If Only One Flow Level Provided	3000	2835	3000	0	23	92	100
High Challenge Flow Level	3500	3773	3000	0	8	77	100
Moderate Trip Flow Level	2000	2050	1400	0	38	100	92

**Figure 5.1. Great Falls Bypass Long Channel Paddling Study. Flow Levels for Specific River Experiences**



The flow levels recommended for Optimum and If Only One Flow Level Provided are both in the 3000 cfs range. This level is also close to Flow 2 in the study, which was rated as Totally Acceptable. The Minimum Acceptable level is 1400 cfs, which is also close to Flow 1 in the study that was rated as Acceptable.

On a five-point scale with 1 being Worse than Average and 5 being Among the Very Best, the Long Channel was rated as 4 or Excellent when the recreationists compared it to local rivers within a one hour drive. They rated it as 2 or Average when compared to regional and national rivers.

On a five-point scale with 1 being Not Important and 5 being Extremely Important, the Recreationists indicated (median of 4) that it was Very Important to provide more than one flow into the Long Channel in order to provide for different boating experiences and to accommodate different skill level paddlers.

The study team compared the Long Channel to other regional rivers. It was rated more desirable than the Saluda, the Catawba at Landsford Canal and the Lower Green. It was similarly desirable to the Haw, Tuckasegee, Nantahala, French Broad, and Chattooga (Section III) Rivers. They also compared the Long Channel to other regional rivers with regard to paddling experience characteristics and found it More Desirable for Driving Distance and Lack of Crowding, Less Desirable for Ease of Access and Length of Run and Similarly Desirable for Navigability, Technical Boating, Powerful Waves and Hydraulics, Whitewater Play Areas, Size and Difficulty of Rapids, Overall Whitewater Challenge, Safety, Aesthetics, Number of Rapids, Easy Shuttles, and Water Quality.

The written comments indicated that there were a couple of swims but nothing out of the ordinary for a whitewater trip and the study team adequately handled these incidents. The main safety hazard is the trees and shrubs in the river channel, particularly in the upper and middle sections of the river. This vegetation does affect the navigability and play-ability of the section as well as safety. Several recreationists mentioned that this would be a good teaching river at either flow level if some of the trees were removed. When asked about access, the comments included (1) better access to Great Falls Reservoir, either from the east (would require tree removal) or west end of the Highway 200 Bridge, (2) a better portage trail around the diversion weir and a constructed chute or sluice over the weir and (3) a trail along the river so paddlers could walk back to play areas or even to the top of the river.

### **Conclusions for the Long Channel of the Great Falls Bypass**

This 2.2-mile section is characterized by a gradient of about 50 feet per mile and is Class II to II+ in difficulty depending on the water level. The river channel is bedrock with a vegetated shoreline that provides a remote setting for the river recreation experience. There are many small trees and shrubs in the river channel, particularly in the middle part of the section. There are passages through the trees but some tree removal will be necessary for a quality paddling experience for varied skill level paddlers. Public access is currently limited to the informal access area on either end of the Highway 200 Bridge over the Great Falls Reservoir. Developed public access is needed for this section.

The overall ratings from the controlled flow study indicate that Flow 1 (1420 cfs) is Acceptable and Flow 2 (2950 cfs) is Totally Acceptable for recreational paddling. In addition, all the elements or characteristics that help define a quality paddling experience were rated as Acceptable or Totally Acceptable at both flow levels. The recreationists recommended an Optimal flow level of 3000 cfs, a Minimal Acceptable level of 1400 cfs, a Highest Safe Level of 4250 cfs and a flow of 3000 cfs If Only One Flow Provided. The Long Channel is rated Excellent in comparison to other local rivers within an hour’s drive and Average in comparison with regional and national rivers.

The hazards of paddling close to the Diversion Weir at the portage and the amount of vegetation in the river channel increase the risk for novice and inexperienced intermediate level paddlers in the Long Channel. The recreationists in the flow study were selected because their experience and skill level would be sufficient to make sound judgments on the water and to negotiate the trees in the channel. If flows are provided into the channel, recreationists with lesser skills and experience may find the Channel more difficult and perhaps more dangerous than the study team did.

**2. Great Falls Bypass – Short Channel**

To access the Short Channel participants paddled across Great Falls Reservoir to a point on Mountain Island near the Headworks Weir. They portaged the Headworks Weir and accessed the river channel close to the bottom of the structure. The Short Channel joins Rocky Creek Reservoir after about 0.8 miles. The take-out at Stumpy Pond Landing requires a 20 to 30 minute paddle across the lake or a 10-minute boat ride. This section is rated Class III in difficulty and has many excellent playable features depending on the water level. Table 6.1 provides general information about the recreationists.

**Table 6.1. Great Falls Short Channel Paddling Study. Participant Information**

OC1 = Solo Open Canoe

Participants	OC1=2; Rodeo Kayak= 11; Creek kayak = 1
Skill Level	Advanced = 11; Expert = 3
Years Paddled Whitewater	Median = 9; Range = 3-28
Age	Median = 32; Range = 22-52
Boat Class II / III	Median = 25; Range = 5 - 100 Days /Year
Boat Class III / IV	Median = 40; Range = Range = 20-200 Days /Year

There were fourteen paddlers on the study team with advanced / expert skills and the time on the water to have honed those skills. Thirteen paddled all three flows and filled out the Single Flow and Comparative Evaluations. One recreationist paddled the first two flow levels and only filled out the Single Flow Survey.

Table 6.2 provides the recreationist ratings of the three flows for the paddling and associated characteristics that are the elements of a quality whitewater paddling experience.

**Table 6.2. Great Falls Short Channel Paddling Study. Mean and Median Rating of Flows for Paddling Characteristics.** Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Levels in cfs	Flow 1 2100		Flow 2 2900		Flow 3 1700	
	Mean	Median	Mean	Median	Mean	Median
Navigability	1.5	2	2.0	2	1.3	1
Technical Boating	1.4	1	1.7	2	0.7	1
Size of Waves / Hydraulics	1.1	1	1.9	2	0.6	1
Whitewater Play Areas	1.0	1	1.9	2	0.6	1
Size / Difficulty of Rapids	1.4	1	1.6	2	1.1	1
Overall Whitewater Challenge	1.0	1	1.6	2	1.3	1
Safety	1.8	2	1.6	2	1.5	2
Aesthetics	1.5	1.5	1.0	1	2.0	2
Length of Run	0.2	0	0.8	1	0.3	0
Overall Rating	1.1	1	1.9	2	0.8	1

Recreationists rated all flows Totally Acceptable or Acceptable for all characteristics except the Length of Run, which was rated Neutral at Flows 1 and 3. The general pattern was for a Flow 2 rating of Totally Acceptable with Flow 1 and Flow 3 ratings of Acceptable. This pattern varied for Navigability, Safety, Aesthetics and Length of Run.

Participants rated the importance of the Paddling Characteristics and ranked the flows from best to worst for each characteristic where they thought the quality of the characteristic changed with flow level (Table 6.3).

**Table 6.3. Great Falls Short Channel Paddling Study. Rating of Flows for the Most Important Paddling Characteristics**

Importance Scale: 1 = Irrelevant; 1 = Not Important; 3 = Somewhat Important; 4 = Important; 5 = Very Important.

Flow Rating Scale: 4-Point Preference Scale from 1 (Best) to 3 (Worst).

Characteristic	Importance of Characteristic Mean Score	Flow 1 2100 cfs	Flow 2 2900 cfs	Flow 3 1700 cfs
Technical Boating Opportunities	4.5	2	1	3
Navigability	4.4	2	1	3
Size of Hydraulics / Waves	4.4	2	1	3

Overall Whitewater Challenge	4.4	2	1	3
Safety	4.2	1	2	3
Size / Difficulty of Rapids	4.1	2	1	3
Whitewater Play Areas	4.0	2	1	3
Water Quality	3.9			
Crowding	3.8			
Driving Distance	3.6			

Flow 2 was generally ranked best, followed by Flow 1 and then Flow 3. For Safety the ranking varied with Flow 1 best, Flow 2 next, and Flow 3 third. Similar to the Long Channel recreationists, the Short Channel recreationists placed more importance on the technical whitewater characteristics rather than the non-technical characteristics.

Table 6.4 defines the skills needed to paddle the Short Channel and the whitewater difficulty of this section at the three different flow levels.

**Table 6.4. Great Falls Short Channel Paddling Study. Whitewater Skills Needed to Paddle the Three Flows and The Whitewater Difficulty**

Skill Level Needed: I = Intermediate; A = Advanced  
Whitewater Classification Scale: Class I to Class VI

Skill Level	Flow 1 2100 cfs	Flow 2 2900 cfs	Flow 3 1700 cfs
Skills Needed	I+	A	I
Whitewater Difficulty	Class III	Class III	Class III

The participants defined the short Channel as Class III whitewater at all three levels but the whitewater skills needed to paddle the flows changed from Intermediate at Flow 3 to Intermediate Plus at Flow 1 and Advanced at Flow 2.

The ratings of overall experience from the Single Flow and Comparative Surveys, the preference for more or less water, and whether the recreationists would return to paddle again at a given flow level are shown in Table 6.5.

**Table 6.5. Great Falls Short Channel Paddling Study. Median Ratings for Overall Experience and Flow Preference.**

Overall Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Preference Scale; 1 – Much Lower; 2 = Lower; 3 = No Change; 4 = Higher; 5 = Much Higher

Return to Paddle Scale: 1 – Definitely Paddle Again; 2 = Probably Paddle Again; 3 = Toss Up Between This and Similar Options; 4 = Return if No Other Options Available; 5 = Not Return

Questions	Flow 1 2100 cfs	Flow 2 2900 cfs	Flow 3 1700 cfs
Single Flow Overall Rating	1	2	1

Flow Level Preference – Minimum Acceptable	2.5	2	3
Flow Level Preference - Optimal	4	3	4
Return to Paddle at this Flow level	2	1	4
Comparative Overall Rating	1	2	0

The Overall Rating of the flows on both the Single Flow and Comparative Surveys is Totally Acceptable for Flow 2 and Acceptable for Flow 1, however the Single Flow rating of Acceptable for Flow 3 changed to Neutral on the Comparative Survey. The flow level preferences for higher or lower flows are consistent with the overall ratings. These paddlers would Definitely and Probably return to paddle at Flows 2 and 1, respectively but would Not Return to paddle Flow 3 unless other options were not available and they really wanted to paddle.

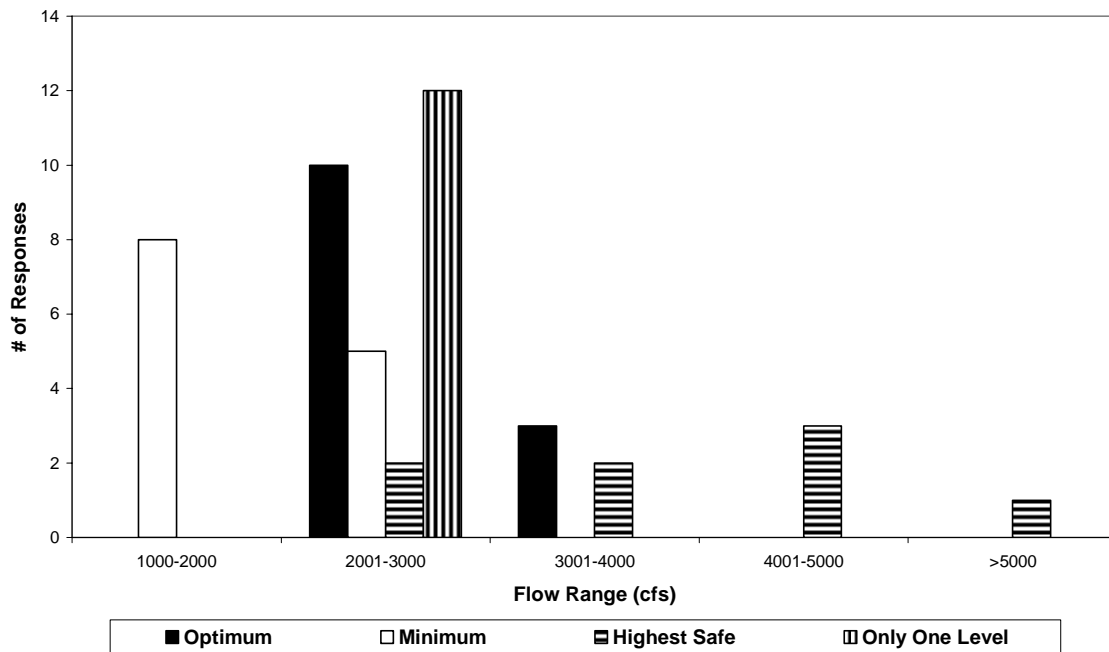
Table 6.6 and Figure 6.1 show the flow levels recreationists would choose for various experiences or conditions.

**Table 6.6. Great Falls Short Channel Paddling Study. Median, Mean and Mode Flow Levels for Specified River Experiences and Percentage of Participants Who Would Recommend that Flow Level to Various Skill Level Paddlers**

% Who Would Recommend to Various Skill Levels Beg = Beginner; Nov = Novice; Int = Intermediate; Adv = Advanced

Specify Flow for Experience of:	Median cfs	Mean cfs	Mode cfs	Recommend To: % Yes			
				Beg	Nov	Int	Adv
Optimal Flow Level	2800	3235	2800	0	23	92	85
Minimum Acceptable Flow Level	1900	1838	2100	8	75	100	42
Highest Safe Flow	4500	4850	5000	Did Not Rate			
If Only One Flow Level Provided	2800	2871	2800	0	25	92	92
High Challenge Flow Level	2950	2983	2800	0	9	82	82
Moderate Trip Flow Level	2100	2080	2100	8	42	100	67

**Figure 6.1. Great Falls Bypass Short Channel Paddling Study. Flow Levels for Specific River Experiences**



The flow levels recommended for Optimum, High Challenge, and If Only One Flow Provided conditions are all in the 2800 to 2900 cfs level. This level is also close to Flow Level 2 in the study, which was generally rated as Totally Acceptable. The mean of 3235 for the Optimal Level experience is due to an outlier number of 8000 cfs. The recreationists would generally recommend all the flow experiences in Table 6 to Intermediate Paddlers, none to Beginners, only the Minimal Acceptable to Novices, and all but the Minimum Acceptable to Advanced paddlers.

On a five-point scale with 1 being Worse than Average and 5 being Among the Very Best, this section was rated at 4 or Excellent when recreationists compared it to local rivers within a one hour drive. They rated it as 2 or Average when compared to regional and national rivers.

On a five-point scale with 1 being Not Important and 5 being Extremely Important, the participants indicated (median of 4) that it was Very Important to provide more than one flow into the Short Channel in order to provide for different boating experiences and to accommodate different skill level paddlers.

The study team compared the Short Section to other regional rivers. It was rated more desirable than the Saluda, the Nantahala, the Tuckasegee, and the Landsford Canal rapids on the Catawba River and was rated as similar to the French Broad (Section IX) and Chattooga (Section III) Rivers. They also compared the Short Channel to other regional rivers with regard to paddling experience characteristics

and found it similarly desirable for navigability, technical boating opportunities, powerful hydraulics, play areas, difficulty of rapids, overall challenge, safety, and aesthetics. It was more desirable for lack of crowding, easy shuttles and driving distance and less desirable for water quality, ease of access and length of run.

The written comments indicated that at Flow 1 there was a stopper hole at the first rapid that flipped about 6 paddlers who subsequently rolled back up, At Flow 3 one boat encountered a strainer and flipped, but there was no problem given the skill level and rescue abilities of the individual and the paddling group. Other comments described the play boating at each level, which corresponded to the ratings of the study team. When asked about access, the suggestions included a public access with parking at the Duke owned property just upstream from the Headworks Weir, a better portage trail and / or steps around the Headworks Weir on Mountain Island, and a trail so that paddlers could carry back up to the best play spots and also walk back to the Headworks Weir so that no shuttle would be required.

### **Conclusions for the Short Channel of the Great Falls Bypass**

This 0.8-mile section is characterized by a gradient of about 50 feet per mile and is Class III in difficulty. The river channel is bedrock with a vegetated shoreline that provides a remote setting for the river recreation experience. Public access is currently limited to the informal access area on either end of the Highway 200 Bridge over the Great Falls Reservoir. Developed public access is needed for this section.

Results of the controlled flow study indicate that Flow 1 (2100 cfs) is Acceptable and Flow 2 (2700 cfs) is Totally Acceptable for recreational paddling. Both flows are Totally Acceptable or Acceptable with regard to the characteristics or elements that make up a quality paddling experience. The participants recommended an Optimal flow level of 2800 cfs, a Minimal Acceptable level of 1900 cfs, a Highest Safe Level of 4500 cfs and a flow of 2800 cfs if only one flow could be provided. This section is rated Excellent in comparison to other local rivers within an hour's drive and Average in comparison with regional and national rivers.

The hazards of paddling close to the Headworks Weir at the portage and the amount of vegetation in the river channel increases the risk for novice and inexperienced intermediate level paddlers in the Short Channel. The recreationists in the flow study were selected because their experience and skill level would be sufficient to make sound judgments on the water and to negotiate the trees in the channel. If flows are provided into the channel, recreationists with lesser skills and experience may find the Short Channel more difficult and perhaps more dangerous than the study team did.

## **D. Wylie Paddling and Angling Study**

The Wylie Paddling Study was conducted on July 20 – 21, August 3 – 4, August 9 – 10 and October 3 – 4, 2004. On the first day of each two-day block the study team paddled the Fort Mill to Sugar Creek Section (Fort Mill – RM 143.4 to RM132.2) and the second day, the Sugar Creek to Landsford Canal Section (Sugar Creek – RM 132.2 to RM 118.4). The core team for the Fort Mill Section comprised six paddlers who participated in all or most of the flows and two anglers who participated in the first two flows. The core team for the Sugar Creek Section comprised five paddlers and no anglers. Core team members either were very experienced paddlers and / or very experienced on the river section downstream from the Wylie Development. Paddlers who had heard about the study on an ad hoc basis joined the core team on a day convenient for their schedule. The ad hoc members filled out a Single Flow Survey but not a Comparative Evaluation. Most of these paddlers joined for only one flow on one section.

The flow levels for both sections were obtained from best efficiency turbine discharge (Table 7).

**Table 7. Study Flow Levels for Wylie - Fort Mill Access Area to Landsford Canal State Park**

Flow Level	Flow 1 1 Unit	Flow 2 2 Units	Flow 3 3 Units	Flow 4 4 Units
cfs	3000	6000	9000	12000

Flow 1 was one turbine and a turbine was added for each flow until there was a four-turbine discharge at Flow 4. The approximate flow in cfs is noted in the table.

**1. Fort Mill to Sugar Creek Section**

The Fort Mill to Sugar Creek Section is about 11.2 miles long with the put-in at the Duke Energy owned Fort Mill Access Area and the take-out on private property that was made available for study purposes. The river channel is wide and straightforward with a number of shoals between the Fort Mill Access Area and the River Park Access Area in Rock Hill, South Carolina (RM 130.0 - about 6.4 miles). Below River Park the river maintains the same character but without as many shoals. While the shoals are Class I to I+ in whitewater difficulty, this section is best described as a moving water river. The riverbanks are vegetated, which provides a feeling of isolation to the river recreation experience while on the river and ducks, eagles, osprey and other bird life was viewed during each trip.

Anglers in jon boats and small motor boats were observed fishing in the vicinity (within a mile) of the Fort Mill Access Area. There is no access for trailered boats in the river section except at Fort Mill. Paddlers using a variety of paddle or

oar boats were also seen on this section including a large group in recreation kayaks associated with the Rock Hill Recreation Department.

The core group of six was augmented by two paddlers on Flow 1, two paddlers on Flow 2, four paddlers on Flow 3, and three paddlers on Flow 4 for a total of 16 paddling participants during the course of the study.

Median and Mean ratings from the Single Flow Survey for paddling experience characteristics during the four flow levels are shown in Table 7.1.

**Table 7.1. Wylie - Fort Mill to Sugar Creek Paddling Study. Rating of Flows for Paddling Characteristics**

Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Levels in cfs	1 Unit 3000		2 Units 6000		3 Units 9000		4 Units 12000	
	Median	Mean	Median	Mean	Median	Mean	Median	Mean
Navigability	2	1.4	2	1.8	2	1.8	2	1.8
Overall Current Speed	1	0.9	2	1.7	2	1.8	1	1.0
Aesthetic Quality	1	1.4	2	1.7	2	1.5	1.5	1.0
Safety	1.5	1.5	1.5	1.4	1.5	1.5	1	1.2
Interesting Surroundings	2	1.6	1	1.3	1.5	1.4	1	0.7
Time for Run	2	1.6	2	1.6	1.5	1.5	1.5	1.5
River Play Areas	0.5	0.4	0	0.3	0	0.4	-1	-1
Access at Put-In	1	1.3	2	1.7	2	1.7	1	1.2

All characteristics were rated as Acceptable or Totally Acceptable at all four flow levels except for River Play Areas that were rated between Neutral and Acceptable for Flow 1, Neutral at Flows 2 and 3 and Unacceptable at Flow 4. This is not surprising since this section has much more moving water than it does river features and shoals, where river play areas develop.

Recreationists rated the importance of the above characteristics on the Comparative Survey and ranked the flows as to how well the flow met their expectations for each characteristic (Table 2).

**Table 7.2. Wylie - Fort Mill to Sugar Creek Paddling Study. Mean Rating of Flows for the Most Important Paddling Characteristics**

Importance Scale: 1 = Irrelevant; 2 = Not Important; 3 = Somewhat Important; 4 = Important; 5 = Very Important. Flow Rating Scale: 4-Point Preference Scale from 1 (Best) to 4 (Worst).

Characteristic	Importance of Characteristic Mean Score	Flow 1 3000 cfs	Flow 2 6000 cfs	Flow 3 9000 cfs	Flow 4 12000 cfs
Safety	4.3	1	2	3	4
Wildlife Viewing	4.3	Did Not Rate			
Aesthetic Quality	4.2	1	2	3	4
Interesting Surroundings	4.2	Did Not Rate			
River "Play Areas"	4.2	1	2	3	4
Navigability	4.0	3	1	2	4
No. of Shoals / Rapids	4.0	1	2	3	4
Difficulty of Shoals / Rapids	3.8	1	2	3	4
Overall Current Speed	3.7	4	3	2	1

Table 7.2 lists the top eight characteristics that recreationists considered to be Important or Very Important and provides a ranking of the flows for each characteristic. All characteristics, except Navigability and Overall Current Speed were ranked best at Flow 1, then Flows 2, 3 and 4. Navigability was considered first at Flow 2, then Flows 3, 1 and 4 while Overall Current Speed was ranked first at Flow 4, and then Flows 3, 2, and 1

Table 7.3 provides the median ratings for the flows for different skill levels.

**Table 7.3. Wylie – Fort Mill to Sugar Creek Paddling Study. Median Ratings for Flows for Different Skill Levels**

5-Point Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Skill Level	Flow 1 3000cfs	Flow 2 6000 cfs	Flow 3 9009 cfs	Flow 4 12000 cfs
Novice	1	1	1	1
Intermediate	2	2	2	2
Advanced	1.5	2	1	2

Recreationists rated all flow levels as Acceptable or Totally Acceptable for all skill levels. Even so, there were concerns that novices should paddle with more experienced paddlers particularly at the higher flows where the water level is often in the trees along the bank. The two anglers rated Flow 1 as Neutral to Acceptable for Novices, Acceptable for Intermediates and Totally Acceptable for Advanced anglers. Flow 2 was rated as Totally Unacceptable or Unacceptable for all skill levels.

The Single Flow Overall Rating for all Flows was Acceptable (Table 7.4).

**Table 7.4. Wylie – Fort Mill to Sugar Creek Paddling Study. Median Ratings for Overall Experience and Flow Preference.**

Overall Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Preference Scale; 1 = Much Lower; 2 = Lower; 3 = No Change; 4 = Higher; 5 = Much Higher

Return to Paddle Scale: 1 – Definitely Paddle Again; 2 = Probably Paddle Again; 3 = Toss Up Between This and Similar Options; 4 = Return if No Other Options Available; 5 = Not Return

Questions	Flow 1 3000 cfs	Flow 2 6000 cfs	Flow 3 9000 cfs	Flow 4 12000 cfs
Single Flow Overall Rating	1	1	1	1
Flow Level Preference	4	3	2	2
Return to Paddle at this Flow level	1.5	2	2	3
Comparative Overall Rating	1	2	1	1

The Comparative Overall Rating was Totally Acceptable for Flow 2 and Acceptable for the other flows. The preference for more or less water at each flow is generally consistent with the overall ratings. These paddlers would Probably Return to Paddle Again at all four levels. One angler rated Flow 1 as Acceptable and liked the water level and the other rated the flow as Neutral and wanted more water. Both would return to fish at Flow 1. They rated Flow 2 as Unacceptable but would return for angling in the future because they know the river and it is close to home.

Table 7.5 shows the flow levels participants would choose for specific experiences or conditions.

**Table 7.5. Wylie – Fort Mill to Sugar Creek Paddling Study. Median Flow Levels for Specified River Experiences**

Specify Flow for Experience of:	Median cfs
Optimal Flow Level	5250
Minimum Acceptable Flow Level	3000
Highest Safe Flow Level	20000
If Only One Flow Level Provided	3150

The Minimal Acceptable and If Only One Flow Level Provided suggested levels are similar and are equivalent to discharge from one turbine unit while the optimum is close to the discharge from two turbine units. The core group would generally recommend their Optimal and Minimal Acceptable flows to all skill levels and their Highest Safe Flow only to Intermediate and Advanced paddlers.

Paddlers were also asked to designate the three primary advantages and disadvantages of each flow level. In general there were more advantages noted than disadvantages. The most prominent advantages were Easy to Maneuver through Shoals and Time for Run Just right and these were applied to all four flow levels. The only prominent disadvantage was that there were Few Places to Play in the Current and these were applied to all four flows.

On a five-point scale with 1 being Worse than Average and 5 being Among the Very Best, the Fort Mill to Sugar Creek section was rated at 3 (Better than Average) when compared to local rivers within a one hour drive. It was rated at 2 (Average) when compared to regional and national rivers.

The safety issues were straight forward. At Flow 1 beginners might have problems in the shoals and should paddle this section with more experienced paddlers. At Flows 2, 3 and 4 the water is increasingly faster and in the trees, which makes strainers a real problem. Also, if a boater takes a swim in mid current it may be difficult to get to shore and once at shore to find a place to get out of the channel due to the often steep vegetated banks with overhanging trees.

Additional comments provided after specific flows included (1) Flow 1 gives channels and play spots, (2) Flow 2 was 1 – 1.5 feet higher than considered optimum, (3) Flow 2 was too flat and monotonous, (4) Flow 3 is good for long trips and some of the features that were washed out at Flow 2 have been recreated, (5) Flow 3 washed out most features, (6) Abundant wildlife, few houses in sight because of extensive forested buffers, General comments included (1) the river would be acceptable in the fall, spring, and winter but is too hot to paddle in the summer and (2) It's the pristine banks – large undeveloped tracts that harbor the bird life that makes this special.

### **Conclusions for Fort Mill Section**

This 11.2-mile section is characterized by a gradient of about 2.5 feet per mile (Able and Horan, 2001) and is mainly moving flat water with occasional Class I to I+ shoals depending on the water level. The river channel is bedrock with a vegetated shoreline that provides a secluded setting for the river experience. Public access is available at the Duke Energy Fort Mill Access Area and at River Park in Rock Hill, SC. Additional access in this section would be ideal since the next public access is about 20 miles downstream at Landsford Canal State Park.

The Overall Ratings from the paddling flow study indicate that all four flows are Acceptable and Flow 2 was rated Totally Acceptable on the Comparative Survey. In addition, all the elements or characteristics that help define a quality paddling experience were rated as Acceptable or Totally Acceptable at all four flows. The participants recommended an Optimal flow level of 5250 cfs (about 2 Units), a Minimal Acceptable level of 3000 cfs, (about 1 Unit) and a flow of 3150 cfs (about 1 Unit) if Only One Flow Could be Provided. The South Carolina Water Resources Commission (Report Number 163. 1988) determined minimum instream flows for navigation for one site in the vicinity of the highway 21 Bridge of 1100 cfs. The Fort Mill section was rated as Better than Average when compared to rivers within a one hour drive and Average in comparison with regional and national rivers.

Even though this is mainly a moving water river experience, there are shoals with whitewater rated at Class I+. At the higher flows the water level is often high on the often steep banks that makes it difficult to recover from a capsized. Paddlers should have a basic knowledge of moving water and self rescue skills and inexperienced novices should paddle with more experienced paddlers.

**2. Sugar Creek to Landsford Canal State Park**

The Sugar Creek Section is about 13.8 miles long with the put-in (RM 132.2) on the same private property used as the take-out for the Fort Mill to Sugar Creek Section. The take-out is at the second Landsford Canal State Park access Area (RM 118.4). Paddlers can take out at the first Landsford Canal State Park informal access site and miss the next 1.6 miles of Class II whitewater shoals,

The river channel for the entire section is wide and straightforward with fewer shoals (except at Landsford Canal State Park) than on the Fort Mill Section. This section does have a Class I+ to II rapid at RM131.6 on the river left (east) side of the river about a half-mile downstream from Sugar Creek. The west side of the river channel remains a Class I shoal with fast moving water. There is also about 1.6 miles of Class I+ to II rapids at Landsford Canal State Park. Even with these rapids this section is best described as a moving water river, particularly since the 1.6 miles at Landsford can be accessed from the Park. The riverbanks are vegetated, which provides a feeling of isolation while on the river and ducks, eagles, and osprey were viewed during each trip.

The core group of 6 was joined by two paddlers on Flow 1, five paddlers on flow 2, five paddlers on Flow 3, and two paddlers on Flow 4 for a total of 20 paddling participants during the course of the study.

Participant ratings from the Single Flow Survey for paddling experience characteristics during the four flow levels are shown in Table 8.1.

**Table 8.1. Wylie - Sugar Creek to Landsford Canal Paddling Study. Rating of Flows for Paddling Characteristics**

Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Levels in cfs	1 Unit 3000		2 Units 6000		3 Units 9000		4 Units 12000	
	Median	Mean	Median	Mean	Median	Mean	Median	Mean
Navigability	2	1.6	2	1.6	2	2	2	1.6
Overall Current Speed	0	0.6	2	1.6	2	1.9	1	1.4
Aesthetic Quality	2	1.7	2	1.8	1	1.1	1	1.1

Safety	2	1.6	1	1.2	2	1.2	1	1.3
Interesting Surroundings	1	1.3	1	1.0	1	1.4	1	1.1
Time for Run	1	1.0	1	1.4	2	1.9	2	1.6
River “Play Areas”	1	0.6	1	0.8	1	0.7	0	0.1
Access at Take-out	2	1.4	1	0.6	2	1.7	1	1.3

All characteristics were rated as Acceptable or Totally Acceptable at all four flow levels except for Overall Current Speed that was rated Neutral at Flow 1 and River Play Areas that was rated Neutral at Flow 4

Recreationists rated the importance of the above characteristics on the Comparative Survey (Table 8.2).

**Table 8.2. Wylie - Sugar Creek to Landsford Canal Paddling Study. Mean Rating of Flows for the Most Important Paddling Characteristics**

Importance Scale: 1 = Irrelevant; 2 = Not Important; 3 = Somewhat Important; 4 = Important; 5 = Very Important. Flow Rating Scale: 4-Point Preference Scale from 1 (Best) to 4 (Worst).

Characteristic	Importance of Characteristic Mean Score
Safety	4.4
River Play Areas	4.2
No. of Shoals / Rapids	4.0
Difficulty of Shoals / Rapids	4.0
Aesthetic Quality	4.0
Navigability	3.8
Overall Current Speed	3.8
Interesting Surroundings	3.6

Table 8.2 lists the top eight characteristics that participants considered to be Important or Very Important. A ranking of the flows is not provided due to the small number of responses to this question.

Table 8.3 provides the median ratings for the flows for different skill levels.

**Table 8.3. Wylie – Sugar Creek to Landsford Canal Paddling Study. Median Ratings for Flows for Different Skill Levels**

5-Point Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Skill Level	Flow 1 3000 cfs	Flow 2 6000 cfs	Flow 3 9000 cfs	Flow 4 12000 cfs
Novice	1	1	1	1
Intermediate	2	2	2	2
Advanced	1.5	2	1	2

Participants rated all flow levels as Acceptable or Totally Acceptable for all skill levels. However, there were concerns that novices should paddle with more experienced paddlers particularly at the higher flows and specifically at Sugar Creek Rapid and the rapids at Landsford Canal State Park.

The Single Flow Overall Rating for Flow 1, Flow 2, and Flow 4 was rated Acceptable while Flow 3 was Totally Acceptable (Table 8.4).

**Table 8.4. Wylie – Sugar Creek to Landsford Canal Paddling Study. Median Ratings for Overall Experience and Flow Preference.**

Overall Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Flow Preference Scale; 1 = Much Lower; 2 = Lower; 3 = No Change; 4 = Higher; 5 = Much Higher

Return to Paddle Scale: 1 – Definitely Paddle Again; 2 = Probably Paddle Again; 3 = Toss Up Between This and Similar Options; 4 = Return if No Other Options Available; 5 = Not Return

Questions	Flow 1 3000 cfs	Flow 2 6000 cfs	Flow 3 9000 cfs	Flow 4 12000 cfs
Single Flow Overall Rating	1	1	2	1
Flow Level Preference	4	3	3	2
Return to Paddle at this Flow level	2	1.5	1	2
Comparative Overall Rating	1	2	1	1

The Comparative Overall Rating was Totally Acceptable for Flow 2 and Acceptable for the other flows. The preference for more or less water at each flow is consistent with the overall ratings. These paddlers would Probably Return to Paddle Again at Flow 1 and 3 and definitely return For Flow 2 and 4. Written comments indicated that some paddlers would definitely return for the Landsford Canal part of the section only,

Table 8.5 shows the flow levels participants would choose for specific experiences or conditions.

**Table 8.5. Wylie – Sugar Creek to Landsford Canal Paddling Study. Median Flow Levels for Specified River Experiences**

Specify Flow for Experience of:	Median cfs
Optimal Flow Level	6000
Minimum Acceptable Flow Level	3000
Highest Safe Flow Level	14000
If Only One Flow Level Provided	6000

The Optimal and If Only One Flow Level Provided suggested levels are similar and are equivalent to discharge from two turbines while the Minimum Acceptable is close to the discharge from one turbine. The core group would generally

recommend their Optimal and Minimal Acceptable flows to all skill levels and their Highest Safe Flow only to Intermediate and Advanced paddlers.

Paddlers were also asked to designate the three primary advantages and disadvantages of each flow level. The most prominent advantages were Easy to Maneuver through Shoals, Easy to Move Boat to Desired Spots, Aesthetic Quality, and Time for Run Just Right. The advantages were not concentrated in any one Flow level but were spread through all four levels. The two prominent disadvantages were Few Places to Play in Current and Current Speed too slow or fast and these disadvantages were also applied to all four flows.

On a five-point scale with 1 being Worse than Average and 5 being Among the Very Best, the Sugar Creek to Landsford Canal section was rated at 2 (Average) when compared to local rivers within a one hour drive as well as regional and national rivers.

The safety issues were similar to those in the Fort Mill section. Beginners and novices might have problems in the shoals at Sugar Creek and Landsford Canal and should at least paddle these sections with more experienced paddlers. At Flows 2, 3 and 4 the current speed is increasingly faster and the flow level is sometimes in the trees, which makes strainers a problem. Also, if a boater takes a swim in mid current it may be difficult to get to shore and once at shore to find a place to get out of the channel due to the often-steep vegetated banks with overhanging trees.

Additional comments indicated: 1) the length of the run is too long; 2) the 1.6 mile section at Landsford Canal State Park should be rated separately from the rest of the section; 3) a flow communication system is needed to inform the public of when river recreationists can access the channel and what flow levels can be expected.

### **Conclusions for the Sugar Creek Section**

This 13.8-mile section is characterized by a gradient of about 2.5 feet per mile (Able and Horan, 2001) and is mainly moving flat water with occasional Class I to I+ shoals depending on the water level. This section does have a Class I+ to II rapid at River Mile 121.6 on the river left (east) side of the river about a half-mile downstream from the confluence with Sugar Creek. The west side of the river remains a Class I shoal with fast moving current. There is also the 1.6-mile stretch of Class I-II rapids at Landsford Canal State Park. The river channel is bedrock with a vegetated shoreline that provides a secluded setting for river recreation experiences. Public access in this section is available only at Landsford Canal State Park. Additional access in this section would be ideal, possibly in the area of Highway 5.

The overall ratings from the Single flow Survey indicate that Flows 1, 2, and 4 are Acceptable and Flow 3 is Totally Acceptable. The overall ratings from the

Comparative survey show that Flows 1, 3, and 4 are Acceptable and Flow 2 is Totally Acceptable. In addition, all the elements or characteristics that help define a quality paddling experience were rated as Acceptable or Totally Acceptable at all four flows with the exception of Overall Current Speed that was rated neutral at Flow 1 and River Play Areas, which was rated Neutral at Flow 4. The participants recommended an Optimal flow level of 6000 cfs (about 2 Units), a Minimal Acceptable level of 3000 cfs, (about 1 Unit) and a flow of 3150 cfs (about 1 Unit) if Only One Flow Could be Provided. The South Carolina Water Resources Commission (Report Number 163. 1988) determined minimum instream flows for navigation for two sites in the vicinity of Landsford Canal State Park of 3300 and 1300 cfs. The Sugar Creek section was rated as Average when compared to rivers within a one-hour drive and Average in comparison with regional and national rivers.

Even though this is mainly a moving water river experience, there are shoals with whitewater rated at Class I+ to Class II. At the higher water levels the water level is often high on the sometimes-steep banks, which can make it difficult to recover from a boat capsize. Paddlers should have a basic knowledge of moving water paddling skills and self rescue skills and inexperienced novices should paddle with more experienced paddlers, particularly through the rapid downstream of sugar Creek and in the area at Landsford Canal State Park.

#### **E. Wateree Paddling Study**

The Wateree Paddling Study was conducted on July 23, 29 and August 5, 13, 2004. The core team for this section comprised four paddlers who participated in all or most of the flows. Core team members were very experienced paddlers but did not have experience on this river section. Paddlers who had heard about the study on an ad hoc basis joined the core team on a day convenient for their schedule. One person joined for Flow 1, two for Flow 3, four for Flow 4 and one for Flow 5. The ad hoc members filled out a Single Flow Survey but not a Comparative Evaluation. Most of these paddlers joined for only one flow level.

The Wateree River begins at the junction of Big Wateree Creek and the Catawba River. The study section starts immediately below the Wateree Dam (Lugoff Access Area – RM 76.6) and ends about 7.2 miles downstream at the Highway 1 Access Area (RM 69.4). The Lugoff Access Area has a fishing platform, a small boat ramp, informal parking and open areas along the bank where anglers bank fish. Bank fishing and platform fishing was noted during all the flow study days. There are small continuous shoals from about 0.25 miles downstream of the Lugoff boat ramp that continue for about 2 miles. At that point there is an island with a Class II rapid to the left of the island and a Class I+ rapid to the right.

Generally, the most river features are found at Flow 1 but the most well defined features are present at Flow 2. At Flow 3 the Class II rapid about 2 miles downstream from the put-in is probably the most well defined (largest wave /

hydraulic features) but the shoals upstream of it begin to wash out and are less defined. At Flow 4 the rapid starts to wash out and at Flow 5 it is almost completely washed out (most rocks covered and few wave / hydraulic features). Downstream from the island the river becomes moving flat water to the take-out, which makes the greatest part of this section moving flat water. The study team also observed motorized fishing boats in the area below the island. Informal conversation with one boat angler indicated that he liked the higher water levels like the one that day, which was a 3 Unit flow. This core group consisted of people who had also participated in the Bridgewater and Wylie studies and all agreed that this section had the best bird life of all the sections.

The flow levels were obtained from best efficiency turbine discharge (Table 9.0).

**Table 9.0 Approximate Flow Levels during the Wateree Flow Study**

Flow Level	Flow 1 1 Unit	Flow 2 2 Units	Flow 3 3 Units	Flow 4 4 Units	Flow 5 5 Units
cfs	3000	6000	9000	12000	15000

Flow 1 was one turbine (1 Unit) and a turbine was added for each flow until there was a five-turbine discharge at Flow 5. The approximate flow in cfs is noted in Table 9.1.

Median ratings from the Single Flow Survey for paddling experience characteristics during the five flow levels are shown in Table 9.1.

**Table 9.1. Wateree – Lugoff to Highway 1 Access Paddling Study. Median Rating of Flows for Paddling Characteristics**

Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable

Approximate Flow in cfs	Flow 1 1 Unit 3000	Flow 2 2 Units 6000	Flow 3 3 Units 9000	Flow 4 4 Units 12000	Flow 5 5 Units 15000
Navigability	2	2	2	2	2
Overall Current Speed	1	2	2	2	2
Aesthetic Quality	2	2	2	2	2
Safety	2	2	1	1	1
Interesting Surroundings	2	2	2	2	1
Time for Run	2	2	1	2	1
River “Play Areas”	0	1	0	1	0
Access at Put-in	2	2	2	2	2
Access at Take-out	2	2	2	2	2

All characteristics were rated as Acceptable or Totally Acceptable at all five flow levels except for River Play Areas that was rated Neutral at Flows 1, 3 and 5.

Participants rated the importance of the above characteristics on the Comparative Survey and Table 9.2 lists the top eight characteristics that participants considered to be Important or Very Important.

**Table 9.2. Wateree – Lugoff Access to Highway 1 Access Paddling Study. Mean Rating of Flows for the Most Important Angling Characteristics**

Importance Scale: 1 = Irrelevant; 2 = Not Important; 3 = Somewhat Important; 4 = Important; 5 = Very Important.

Characteristic	Importance of Characteristic Median Score
Safety	4.5
Navigability	4.5
1No. of Shoals / Rapids	4.5
Difficulty of Shoals / Rapids	4.0
Aesthetic Quality	4.0
Overall Current Speed	4.0
River Play Areas	4.0
Interesting Surroundings	4.0
Easy Access	4.0
Wildlife Viewing	4.0

The one remaining characteristic on the survey (Time for Run) was only rated Somewhat Important. A ranking of the flows is not provided due to the small number of responses to this question.

The section was rated Acceptable or Totally Acceptable for all skill levels at all flows except Flow 5 was rated Neutral for Novices (Table 9.3).

**Table 9.3. Wateree – Lugoff Access to Highway 1 Access Paddling Study. Median Ratings for Flows for Different Skill Levels**

5-Point Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Unacceptable

Skill Level	Flow 1 3000 cfs	Flow 2 6000 cfs	Flow 3 9000 cfs	Flow 4 12000 cfs	Flow 4 15000
Novice	1	1	1	1	0
Intermediate	2	2	2	2	2
Advanced	2	2	2	2	2

In general novice paddlers should be with a group which includes more experienced paddlers at all flow levels due to the difficulty of rescue in a wide swift river, particularly at the higher water levels where the water is often in the trees along the bank.

The Single Flow and Comparative Overall ratings are practically identical and all five flows were rated Acceptable or Totally Acceptable (Table 9.4).

**Table 9.4. Wateree – Lugoff Access to Highway 1 Access Padding Study. Median Ratings for Overall Experience and Flow Preference.**

Overall Rating Scale: -2 = Totally Unacceptable; -1 = Unacceptable; 0 = Neutral; 1 = Acceptable; 2 = Totally Acceptable  
 Flow Preference Scale; 1 = Much Lower; 2 = Lower; 3 = No Change; 4 = Higher; 5 = Much Higher  
 Return to Paddle Scale: 1 – Definitely Paddle Again; 2 = Probably Paddle Again; 3 = Toss Up Between This and Similar Options; 4 = Return if No Other Options Available; 5 = Not Return

Questions	Approximate cfs	Flow 1 3000	Flow 2 6000	Flow 3 9000	Flow 4 12000	Flow 5 15000
Single Flow Overall Rating		2	2	2	1	1
Flow Level Preference		4	3	3	3	2
Return to Paddle at this Flow level		3	2	2	2	4
Comparative Overall Rating		1.5	2	2	1	1

The flow level preferences show a desire for more water at Flow 1, less water at Flows 4 and 5 and about the same levels at Flows 2 and 3 and are consistent with the overall ratings. These recreationists would probably paddle here again at Flow 2, Flow 3 and Flow 4.

The suggested flow levels for different experiences or conditions are provided in Table 9.5.

**Table 5. Wateree – Lugoff Access to Highway 1 Access Paddling Study. Median Flow Levels for Specified River Experiences**

Specify Flow for Experience of:	Median cfs
Optimal Flow Level	8500
Minimum Acceptable Flow Level	3500
Highest Safe Flow Level	15000
If Only One Flow Level Provided	6000

The recreationists suggested a Minimum Acceptable level of 3500 cfs (a little more than 1 Unit), an Optimal Flow of 8500 (almost 3 Units), and 6000 cfs (about 2 Units) if Only One Flow Could be Provided.

Recreationists were also asked to designate the three primary advantages and disadvantages of each flow level. The most prominent advantages were Easy to Maneuver through Shoals, Aesthetic Quality, Time for Run Just Right and these were generally found among all five flow levels. The one prominent disadvantage was Few Places to Play in Current and this was applied to all five flows.

On a five-point scale with 1 being Worse than Average and 5 being Among the Very Best, this section of the Wateree River was rated at 3 (Better than Average)

when compared to local rivers within a one hour drive and 2 (Average) for regional and national rivers.

The safety issues relate mostly to the shoals and the Class II rapid at the island. Beginners and novices should paddle this section with more experienced paddlers. At Flows 3, 4 and 5 the current speed is increasingly faster and the water level is in the trees, which makes strainers a problem. Also, if a boater takes a swim in mid current it may be difficult to get to shore and once at shore to find a place to get out of the channel due to the often-steep vegetated banks with overhanging trees.

Additional comments indicated that 1) the lower flows provided more water features, 2) lower flows provided more wildlife viewing opportunities and 3) the need for a flow communication system,

### **Conclusions for Wateree River Paddling Study**

This 7.2-mile section is characterized by a gradient of about 1 foot per mile (Able and Horan, 2001) and is mainly moving flat water with occasional Class I to I+ shoals in the first 2.8 miles depending on the water level. There is one Class II rapid about 2 miles downstream from the Lugoff Access Area put-in. The river channel is bedrock with a vegetated shoreline that provides a secluded setting for river recreationists.

The overall ratings from the Single Flow Survey and the Comparative Survey indicate that Flow 1, Flow 2, and Flow 3 are Totally Acceptable and Flow 4 and Flow 5 are Acceptable. In addition, all the elements or characteristics that help define a quality paddling experience were rated as Acceptable or Totally Acceptable at all five flows with the exception of River Play Areas, which was rated Neutral at Flows 1, 3, and 5. The participants recommended an Optimal flow level of 8500 cfs (almost 3 Units), a Minimal Acceptable level of 3500 cfs, (about 1 Unit) and a flow of 6000 cfs (about 2 Units) if Only One Flow Could be Provided. The South Carolina Water Resources Commission (Report Number 163. 1988) determined minimum instream flows for navigation for three sites within 5 miles of the Wateree Dam of 800 – 1100 cfs. The Wateree River was rated as Better than Average when compared to rivers within a one hour drive and Average in comparison with regional and national rivers.

Even though this is mainly a moving water river experience, there are shoals with whitewater rated at Class I+. At the higher water flows the water level is often high on the sometimes-steep banks, which can make it difficult to recover from a boat capsize. Paddlers should have a basic knowledge of moving water paddling skills and self rescue skills and inexperienced novices should paddle with more experienced paddlers, particularly through the first 3 miles of the section..

## **V. References Cited**

Recreation Flow Study Plan Scope Document for Catawba-Wateree Project 2232. 2003. Duke Energy Hydropower Relicensing Website: [www.catawbahydrolicensing.com](http://www.catawbahydrolicensing.com)

First Stage Consultation Document for Catawba-Wateree Project 2232. 2003. Duke Energy Hydropower Relicensing Website: [www.catawbahydrolicensing.com](http://www.catawbahydrolicensing.com)

Able, G. and J Horan. 2001. Paddling South Carolina. Sandlapper Publishing Company.

Benner and Benner. 2002. A Canoeing & Kayaking Guide to the Carolinas. Menasha Ridge Press

Mayers, B. 2000. Paddling Asheville.

Whittaker, et. al. 1993. Instream Flows for Recreation: A Handbook on Concepts and Research Methods. National Park Service Publication, Alaska Region.

Instream Flow Study Phase II: Determination of Minimum Flow Standards to Protect Instream Uses n Priority Stream Segments, A Report to the South Carolina General Assembly. Report Number 163, May, 1988.