Clackamas River Hydroelectric Project
Faraday Diversion Whitewater Boating Study

FINAL

Prepared for
Portland General Electric

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Executive Summary

The Faraday Diversion segment on the Clackamas River is a 1.8-mile bypass reach between the Faraday Diversion Dam and the Faraday Powerhouse. The boatable segment is a short but relatively steep pool-drop river, with seven to eight Class III-IV rapids. Access is limited to trails extending down from PGE roads that are generally high above the river. This reach currently has a minimum instream flow (120 cfs); higher flows only occur when inflows exceed the 5,200 cfs capacity of the Faraday Powerhouse. These "spill" events occur about 34 days per year, tend to be relatively short, and feature very high flows compared to base flows (often exceeding 3,000 cfs).

A controlled flow study was conducted in June 2002 to develop relationships between flow and whitewater boating opportunities. Two different flows were evaluated during a pre-study reconnaissance (1,300 cfs and 2,000 cfs) and four during the study itself (between 665 cfs and 1,220 cfs). Ten boating participants were surveyed after each flow and after they had run the full series of flows. The video/photographic documentation which accompanies this report was prepared by Portland General Electric's Multimedia Department.

Study results identified three types of boating opportunities available on the reach. **Technical/playboating** opportunities focus on technical routes through the rapids and the availability of surf waves, eddy lines, and other hydraulics used by boaters to execute rodeo or freestyle maneuvers. **Standard whitewater** opportunities are less focused on playboating, and feature straightforward runs through Class IV rapids. **"Big water" whitewater** opportunities focus on the powerful hydraulics and larger waves available at higher flows. **"Locational playboating"** is a possible fourth opportunity that could feature one or more playboating features available at relatively low flows. This opportunity is not currently available, but study participants discussed how minor channel modifications could create it.

Results help characterize boating at each of the four study flows. **665 cfs** offered steep technical routes, providing a boatable but very technical opportunity. **800 cfs** offered more route options and cleaner runs than 665 cfs, but generally appeared to be similar to 940 cfs for playboating opportunities. At **940 cfs,** "cleaner" route options were available than the two lower flows, and playboating opportunities improved. The highest flow in the study was **1,220 cfs,** which featured stronger hydraulics with very few boatability problems and more route options.

After completing all runs, boaters were asked to rate a series of 11 flows from 250 to 10,000 cfs on the seven-point acceptability scale. The curve suggests that flows below about 750 cfs are unacceptable, but ratings improve around 1,200 cfs, and they become optimal from 1,800 to 3,500 cfs before gradually declining.

A series of questions also asked boaters to identify flow ranges that provide technical, standard, and big water trips. Boaters identified 550 cfs as a minimum to use the river for transportation, but quality "technical trips" are not provided until about 700 cfs, and optimal technical flows are from about 800 to 1,100 cfs. The transition between technical and standard trips is between 1,000 and 1,200 cfs, and standard trips are optimal from 1,200 to 2,500 cfs. The transition between standard and big water trips is between 2,500 and 3,000 cfs, and big water trips are optimal from 3,250 to 10,000 cfs.

Boaters with rafting experience suggest that rafting would become acceptable about 1,000 to 1,200 cfs (similar to the standard opportunity for kayaking). There was less agreement about the optimal range for rafting, which may start as low as 1,200 cfs and continue through 10,000 cfs. Focus group discussion indicated that commercial rafting opportunities were limited on the reach given its short length and difficult access.

Whitewater boating flows between 800 and 2,000 cfs may have effects on biophysical resources or other recreation. Swimming and angling occurred on the Faraday Diversion reach during the study, suggesting that flows from 665 cfs to 1,220 cfs do not preclude those activities, but the study did not focus on flow needs for those opportunities.

When asked to assess the quality of the run, boaters noted that it was short and lacked high quality playboating compared to Bob's Hole, a "world class" playboating feature on the Three Lynx Reach. Most did not think it would attract high levels of use unless channel modifications created more playboating features that could be used at lower flows. Similarly, few boaters thought the reach had much potential for commercial or private rafting, although data suggests it becomes raftable about 1,000 cfs and would improve at higher flows. Difficult access and the short length of the reach were primary constraints.

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1.0 Introduction

More than 940 square miles of the Lower Willamette River watershed flows into the Clackamas River before it joins the Willamette near Portland, Oregon. The Clackamas River Project includes two hydroelectric developments in the basin, one on the Oak Grove Fork and one on the main stem Clackamas just east of Estacada (about 25 miles southeast of Portland). The developments are operated by Portland General Electric (PGE), which is applying to the Federal Energy Regulatory Commission (FERC) for a new license to continue to operate these facilities.

Recreation users, particularly whitewater boaters, are interested in the potential effects of power operation regimes on flow-dependent recreation in the basin, including the bypass reach immediately downstream of the Faraday Diversion Dam. This report analyses flows and whitewater boating to assist in relicensing discussions.

1.1 Study Objectives

This study assessed whitewater boating on the Faraday bypass reach, describing the range of opportunities and developing relationships between flow levels and experience quality. Specific study objectives included:

- Identify potential boating opportunities, which may vary by craft, skill level, or preferences for different types of whitewater conditions.
- Identify flow-related attributes for each of those opportunities, including a description and classification of key rapids.
- Develop relationships between flow levels and experience quality for each boating opportunity. Resulting “flow evaluation curves” identify minimum flows and optimum ranges for each opportunity.
- Identify other river recreation opportunities that may be affected by whitewater flows (such as angling and swimming), and discuss potential impacts of providing boating flows.

Study information can be integrated with information about biophysical resources to help determine if boating flows can or should be provided. It is beyond the scope of this study to assess specific impacts of boating flows on fish or other biophysical resources.

1.2 Report Organization

Following a description of the study area (including the hydrology of the segment), the report describes methods used to conduct the study. Results follow, including notes from the pre-study reconnaissance and analysis of data from the controlled flow study. A final section reviews likely Project effects and potential impacts from providing recreation flows on other types of recreation.

2.0 Study Area

The Faraday Segment refers to the 1.8 mile bypass reach between the Faraday Diversion Dam and the Faraday Powerhouse, immediately upstream of Estacada Lake. It is one of five segments on the Clackamas with boating opportunities. These are identified in Figure 1, with the study reach identified as Segment 4.

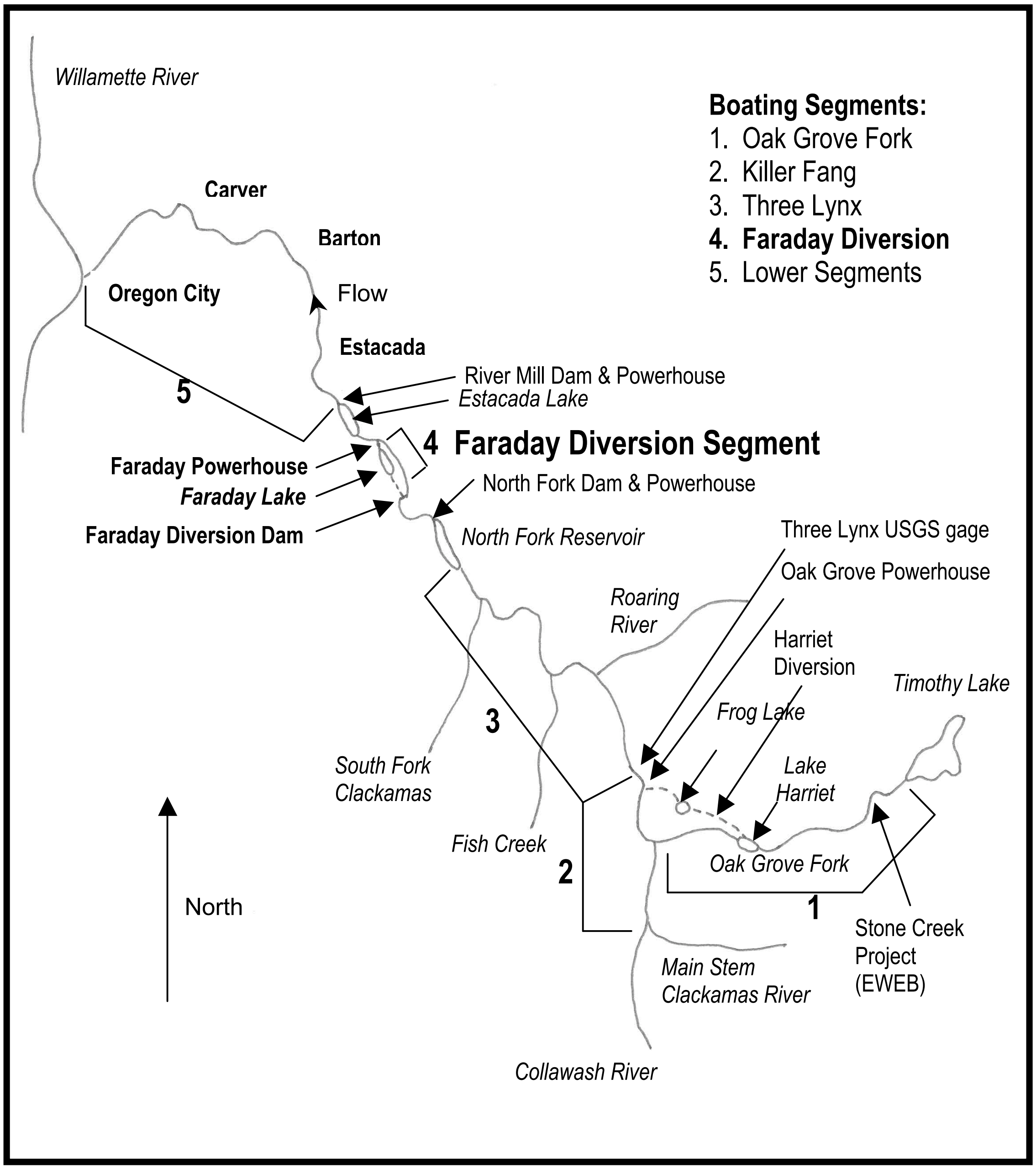

Figure 1. Schematic of the Clackamas Hydroelectric Project and boating reaches.

2.1 Segment Description

The boatable segment between the Faraday Diversion Dam and the powerhouse is a short but relatively steep pool-drop reach. It is characterized by seven to ten major rapids, depending upon how one delineates them (Figure 2). The reach offers a technical boating run at lower flows, featuring boulder-dodging and a few ledge drops. At higher flows, the rapids have stronger hydraulics and less technical routes. One guidebook (Keller, 1998) rates lower flows as Class II-III. However, interviews and reconnaissance suggest the reach was Class III/IV at study flows, and may have Class V rapids at very high flows. Results from the study provide additional information about whitewater characteristics and difficulty ratings at different flows.

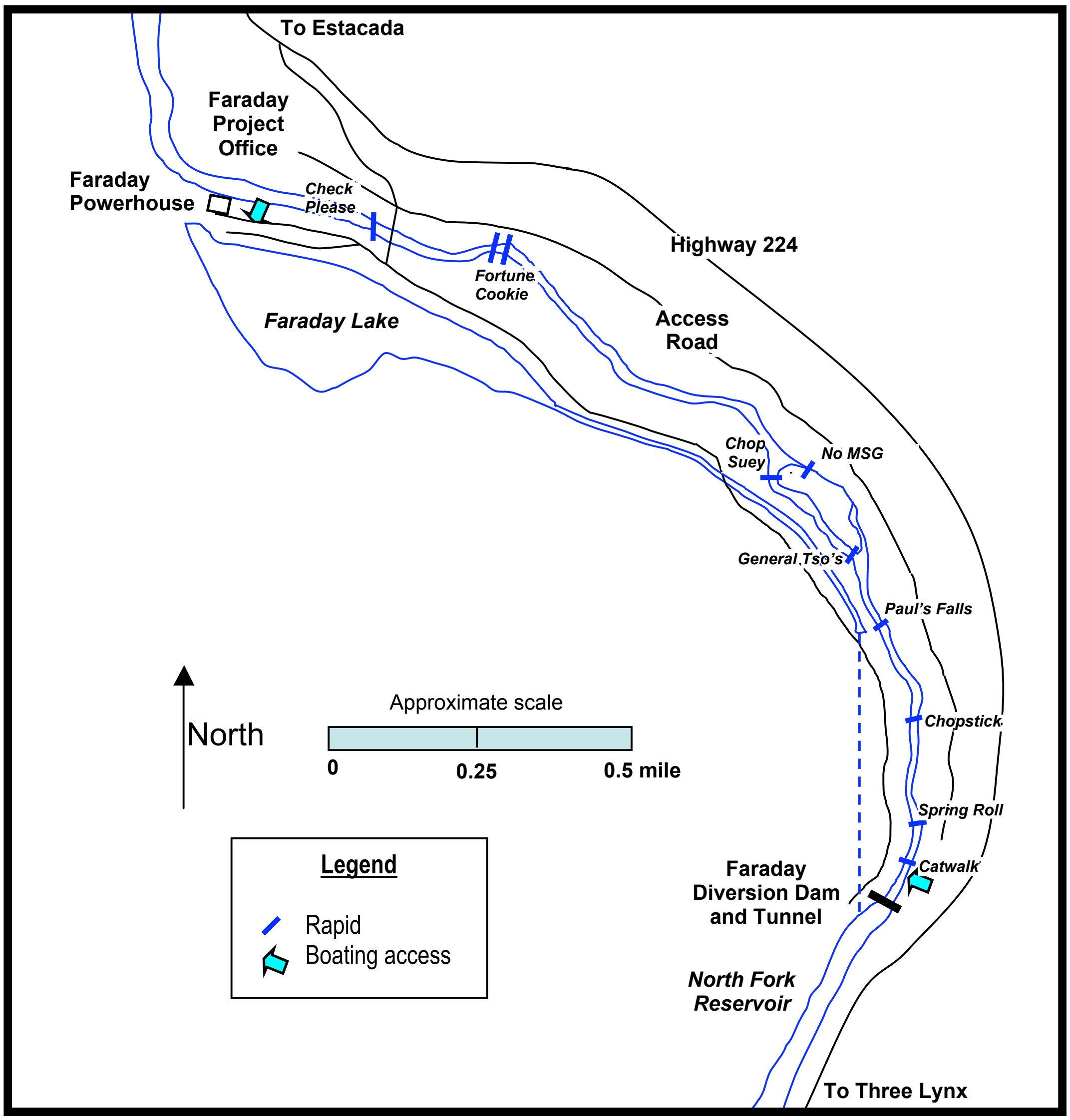

Figure 2. Schematic of the Faraday Diversion Reach and major rapids.

2.2 Access and Recreation Use

The steeply incised canyon walls of the Faraday Diversion reach limit access from PGE-maintained service roads that are generally high above the river. There is no public vehicle access to these roads, and recreation access is generally limited to pedestrians and cyclists. Angling use is common, particularly when salmon or steelhead are present. Anglers reach the river via several trails from the access roads on both sides of the river. Swimmers and picnickers may also use some of these trails.

2.3 Hydrology

A minimum of 120 cfs is released in the reach for fish throughout the year. Spill occurs only when outflows from North Fork Dam exceed the 5,200 cfs capacity of the Faraday Powerhouse. Table 1 summarizes spill events from 1984 through 1998, providing the number of days with spill, the average volume, and the highest spill occurrence each year and over the entire 15 year period. Spill events occurred an average of 34 days a year. They typically occurred for 3 to 7 days at a time during winter and spring months, and featured very high flows compared to "base levels" (often exceeding 3,000 cfs and occasionally reaching into the 10,000 to 20,000 cfs range). The highest flows during this period were in excess of 30,000 cfs in 1986.

Table 1. Summary of Faraday Diversion Reach spill flows by year.

Year	Number of days of spill	Average spill flow	Highest spill flow
1984	17	2,871	13,505
1985	18	1,309	5,695
1986	38	4,222	31,575
1987	14	3,642	17,100
1988	26	2,503	8,300
1989	23	1,510	9,700
1990	17	4,304	13,300
1991	37	2,295	8,400
1992	16	2,379	6,000
1993	30	2,415	10,000
1994	30	2,588	8,800
1995	59	4,670	21,900
1996	88	4,890	16,400
1997	61	3,253	23,100
1998	32	2,741	9,600
Average 1984-1998	33.7	3,039	13,558

3.0 Methods

A controlled flow study was conducted to characterize the Faraday Diversion Segment and develop relationships between flow and whitewater. Six different flows were released and evaluated during a pre-study reconnaissance and the study itself, focusing on boating opportunities using kayaks and rafts. Preliminary reconnaissance and study methods are given below.

3.1 Preliminary Reconnaissance · June 4, 2002

A preliminary reconnaissance of the segment was conducted to prepare for the controlled flow study. Goals of this step were to:

- Identify put-in and take-out locations.
- Identify potential video and still photography locations.
- Assess other logistical issues for conducting the actual study (e.g., run lengths, number of flows per day, focus group locations, accommodation options).
- Identify potential opportunities available on the reach and ensure they were adequately examined during the study.
- Determine the starting flow and subsequent increments for the study.

The preliminary assessment was conducted on June 4. Four boaters (listed below) participated in the preliminary reconnaissance; each paddled a hard shell kayak. Deb Schallert, from PGE hydroelectric relicensing, also participated in meetings and road-based scouting.

- Bo Shelby — Confluence Research and Consulting
- Tim Shibahara — Portland General Electric
- Keith Jensen — Alder Creek Kayak and American Whitewater
- Bob Patterson — Local paddler

Boaters met at PGE's Faraday Project office east of Estacada, examined large format aerial photos of the reach, received first-hand information from a skilled local boater experienced with this run (Patterson), and began scouting the reach by vehicle. They drove both sides of the river on Project roads to identify put-in and take-out locations as well as the major rapids. Based on the assessment, they decided it would be safe and useful to boat the reach at the existing spill flow, which was approximately 1,321cfs. Following this run, boaters requested higher flows. For this second run, a release of approximately 2,000 cfs was provided.

3.2 Controlled Flow Study · June 24-25, 2002

The controlled flow study was conducted on June 24-25. Ten boaters evaluated the river at four different flows over a two-day period. Study methods are summarized below.

Participants. Keith Jensen of Alder Creek and John Gangemi of American Whitewater (AW) organized the participants. To increase safety, minimize logistical complexity, and ensure a sufficient sample for the study, 10 boaters participated; 9 used hard shell kayaks and one used an inflatable kayak. A list of participants is provided in Appendix A. Although a small cataraft was available for the study, access concerns and initial runs suggested rafts would not be appropriate craft because of difficult access and boatability issues at General Tso's Rapid.

All participants were highly skilled (Class IV/V) boaters with a diversity of interests in whitewater boating. A pre-study survey asked boaters to describe their experience and skill, as well as preferences for different types of trips. Results are summarized below and in Figure 3.

- *Kayaking experience.* All nine of the hard shell kayakers reported they kayak frequently, and five reported having over 10 years of kayaking experience. The mean number of years of experience was 15. Seven of the nine classified themselves as Class V boaters; the other two were Class IV boaters. The kayakers reported boating from 25 to 200 days a year; the median number was 80 days per year.
- *Inflatable kayaking experience.* Four boaters reported some experience with inflatable kayaks (IKs), although only one boater used this craft in the study. Of the four, two reported using IKs occasionally and two reported using them rarely. Of the four, three reported they were Class III IK boaters and one was a Class IV boater.
- *Rafting experience.* Four boaters also reported some experience with rafts. Of the four, two use rafts occasionally, one rafts frequently, and one rafts rarely. Three of the four reported Class IV rafting skills. The median number of years rafting was 10.
- *Participants' age and gender.* Three boaters were under age 25, three were between 26 and 45, and four were between 46 and 55. One boater was female.
- *River-running preferences.* Boaters were asked to agree or disagree (on a seven point scale with a "no opinion" mid-point) with ten statements about river-running preferences that have been used in similar studies. Responses helped characterize participants' boating interests and offered potential explanations for variations in other responses during the study. A summary of responses to each of the following statements is given in Figure 3.
  - I prefer running rivers with difficult rapids (Class IV and V).
  - Running challenging whitewater is the most important part of my boating trips.
  - I often boat short river segments (under 4 miles) to take advantage of whitewater play areas.
  - I often boat short river segments to experience a unique and interesting place.
  - I often boat short river segments to run challenging rapids.
  - Good whitewater play areas are more important than challenging rapids.
  - I am willing to tolerate difficult put-ins and portages in order to run interesting reaches of whitewater.
  - I prefer boating rivers that feature large waves and powerful hydraulics.
  - I prefer boating steep, technical rivers.
  - I enjoy boating both technical and big water rivers.

  Results suggest several conclusions about the panel as a group:

  - Nine out of ten boaters were interested in boating short river segments if they offer whitewater playboating or opportunities to explore a unique or interesting place. However, only 60% reported interest in short segments for their challenging rapids.
  - All 10 boaters reported a willingness to tolerate difficult access or portages to run interesting whitewater.

- The majority were more interested in challenging rapids than whitewater play areas (places to execute rodeo or freestyle maneuvers), although about a third of the panel was more interested in whitewater play.
- Most of the panel appeared interested in both “creek boating” (smaller, technical streams) and “big water” boating (stronger hydraulics and larger waves), although more preferred stronger hydraulics than technical runs.
- The panel as a whole was very interested in challenging rapids, with about 90% agreeing that they prefer to run Class IV and V rivers and 60% agreeing that challenge is the most important part of their trips.

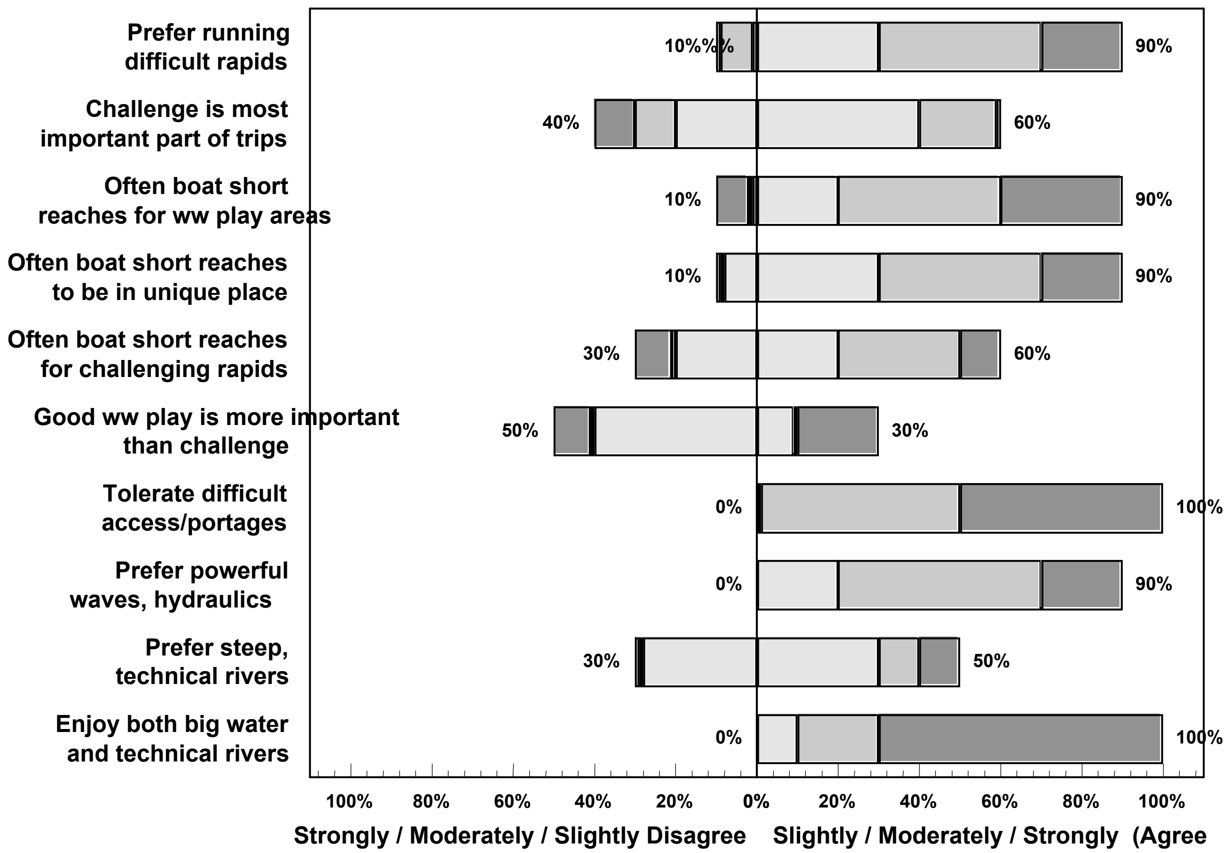

Figure 3. Summary of responses (in %) to pre-study survey of ten boaters about their river-running preferences

Target and Actual Flows. Preliminary reconnaissance suggested that 500 to 600 cfs would be a good starting point for the study, allowing boaters to learn the lines in rapids with minimal safety issues. Three additional flows were planned at about 200 to 300 cfs increments. The study goal was to evaluate flows from 500 to 1,500 cfs. This range is less than the boatable range identified in the preliminary assessment report (Whittaker and Shelby, 2000), but it was selected because it is similar to available summer flows. In addition, hydrology data (Section 2.3) indicate that spills already provide higher flow opportunities about 34 days each year, so it was less likely that whitewater advocates would request those flows.

The initial target flow was 550 cfs; an actual flow of 665 cfs was provided (the missed target related to a communication problem between operators and researchers about whether fish ladder flows of 120 cfs were included in the target flow). For subsequent flows, participants collaborated on the flow choices and operators provided them with good precision. Boaters tried to choose flows that were substantially different from previous flows, but which would help define acceptable and optimal conditions for "technical" and "standard" trips (see results below for definitions of these terms). Table 2 provides the target and actual flows evaluated on the two days.

Table 2. Target and actual flows evaluated during the study.

Date and time	Target flow	Actual flow
June 24 morning	550	665
June 24 afternoon	950	940
June 25 morning	1,200	1,220
June 25 afternoon	800	800

Boating Access. The best boating put-in was on river right at the end of the PGE access road near the fish ladder. Although parking near the site was limited, it accommodated the number of boaters and vehicles used in the study. There is a short, steep user-developed trail from the fish ladder facility to the river (at Spring Roll rapid). Boaters could also walk farther upstream along the fish ladder structure (the Catwalk) toward the pool below the dam, providing access to the upper part of Catwalk Rapid. Rafter use of either trail would be difficult; the short trail to the river is steep and the Catwalk is narrow. Both trails were used during the study by kayakers without difficulty.

The best take-out was on river left (south side) near the powerhouse. This site has parking associated with powerhouse maintenance buildings. There is also a trail from the river to the parking lot; it is steep and somewhat brushy and would be marginal for raft use, but was easily usable by kayakers.

Both access points required keys to gates on the roads, which were provided by PGE.

Survey Instruments and Focus Groups. Primary information from the boating study was developed from surveys of participants, who answered questions before the study, after each flow, and after they completed the full series of flows. Item format and content (see surveys in Appendix B) were similar to several previous studies to allow comparisons. Focus group meetings were also conducted to capture qualitative information about flows and their effects on recreation opportunities, as well as to develop consensus opinions about the best flows for different types of opportunities. Focus group meetings took place in PGE's Faraday office. Focus group notes are in Appendix C.

Video and Still Camera Documentation. Video/photographic documentation was conducted by PGE Multimedia to show how major rapids or other key river features changed at different flows. Preliminary reconnaissance identified four photo/video stations with views of most of the major whitewater features, including (see Figure 2):

- On the river right bank above Spring Roll, the hole at the end of Catwalk Rapid.
- On river right at Paul's Falls.
- On river left at the bottom of General Tso's Rapid.
- On the bridge near the take out with views of the two surf waves at Fortune Cookie.

A photo gallery with illustrative pictures and captions is provided in Appendix E. A video (now on DVD) was also prepared to complement this report; it summarizes study methods and findings.

Safety, Insurance, and Liability. Portland General Electric, Confluence Research and Consulting, and American Whitewater worked cooperatively to provide a safe and informative whitewater boating study. A safety plan was developed prior to the study, and all participants signed liability waivers and took appropriate safety measures before getting on the river. Participants were strong Class IV-V boaters with commensurate self-rescue skills. American Whitewater provided PGE with a Certificate of Insurance to cover the participants. Local law enforcement and rescue personnel were notified of the study and the potential for safety issues, but they were not needed on-site during the study.

4.0 Results and Discussion

4.1 Boating Opportunities and Preliminary Evaluations

Preliminary reconnaissance identified three general types of boating opportunities on the Faraday Diversion Segment, as discussed below.

- **Technical/playboating.** This opportunity focuses on technical routes through the rapids and the availability of surf waves, sharp eddy lines, and other hydraulics used for rodeo or freestyle maneuvers. It appears to be available at lower flows; the 1,321 cfs flow seen during reconnaissance was probably near the high end of the acceptable range for this opportunity.
- **Standard whitewater boating.** This opportunity is less focused on the availability of playboating features and has more straightforward runs through the rapids. The 1,321cfs reconnaissance run probably represents the low end of the optimal range for this opportunity, while the 2,000 cfs reconnaissance flow was near the high end of this range.
- **"Big water" whitewater boating.** This opportunity focuses on the powerful hydraulics and larger waves available at higher flows. Neither reconnaissance flow provided a big water opportunity; this opportunity is more likely to occur with flows well above 2,000 cfs.

At 1,321 cfs, the reach offers a Class IV boating opportunity most suitable for hard shell and inflatable kayaks. The most difficult rapid, General Tso's, was probably not runnable in rafts or catarafts and has some pinning hazards at this flow, although it could easily be portaged or lined on river left. Other rapids are probably Class III/IV and have less difficult route options. The two significant play features, a pair of waves near the take-out, were lower energy but better formed at this flow, suggesting that play options may be better at lower flows.

The 2,000 cfs reconnaissance flow also provided a Class IV opportunity, but with less well-defined eddies and "pushier" hydraulics. General Tso's rapid offered a "cleaner" line at this level, with less of a pinning hazard, but some other rapids became more powerful. Rafts and catarafts might still have to portage or line General Tso's at this flow. The two play waves (Fortune Cookie) at the end of the run were faster at this flow, but also slightly flatter and not as easy to use for surfing or rodeo maneuvers.

"Locational playboating" is a possible fourth opportunity on the segment that would offer one or more playboating features available at relatively low flows (e.g., 200 to 500 cfs). Some of the main rapids may be unrunnable at these flows, but playboating could occur at the specific features and most likely would not involve running the entire reach. This opportunity does not currently appear available, but study participants discussed how minor channel modifications could create it.

4.2 General Description of Study Flows

The following describes runs in the Faraday Diversion Segment at the four controlled flows based on general comments made at focus group meetings. Appendix C includes paraphrased comments from boaters at those meetings.

665 cfs. This was the initial flow in the study and offered an opportunity to scout and run the river at lower flows. Preliminary reconnaissance trips suggested that General Tso's Rapid would offer the most significant boatability issues, but all nine hard shell boaters safely negotiated this rapid; the IK boater portaged this rapid at all flows. All boaters were able to run the other rapids without significant problems. Most offered short, steep, technical routes, with relatively weak hydraulics. This lower flow provided “bony” conditions in the rapids, with most boaters having multiple hits (the average was about 11 hits per person). There were few excellent play areas, but the waves at the end of the run provided some good surfing, and there was some retention in the wave/hole at Spring Roll. Pools between rapids had relatively slower current velocities. In general, this flow provided a boatable but very technical opportunity.

940 cfs. This was the second flow evaluated in the study, and it offered more and “cleaner” route options (less contact with the rocks in the channel). Hydraulics in the rapids were also more “filled in” and aerated. General Tso’s Rapid was still rocky, but all the hard shell kayakers ran this rapid without incident. There were better play areas at this flow, although the wave/hole at Spring Roll was less retentive. The waves at Fortune Cookie were probably at their best of any of the four flows evaluated. Current velocities between rapids increased slightly over the 665 cfs flow. In general, this flow helped identify the start of more “standard” opportunities, and probably could have been boated by small rafts or catarafts (with a portage at General Tso’s Rapid).

1,220 cfs. The highest flow in the study had relatively more power compared to the other three. This flow had stronger hydraulics in the main rapids, with very few boatability problems (with the exception of a few hits in General Tso’s Rapid). Route options in rapids were more plentiful, and hydraulics were more filled in and aerated. While there were some play features available, particularly those associated with powerful eddylines and the two surf waves at Fortune Cookie, the major rapids had few retentive play features and poor “eddy service” (eddies that allow boaters to return to a hole or wave). Current velocities between rapids were noticeably faster, shortening the length of the trip on an already short segment. In general, this flow helped define the start of more optimal standard opportunities, with less technical routes. There was a consensus among boaters that this flow provided a good standard trip, which would improve only marginally at higher flows until a “big water” trip became available. Small rafts and catarafts would be able to run the reach at this flow with a possible portage at General Tso’s Rapid, although access for rafts is poor and the segment is short.

800 cfs. This intermediate flow between 665 and 940 cfs was requested to help provide greater precision about the low end of the optimal range for technical/playboating trips. It offered more route options and cleaner runs than the 665 cfs level, and generally appeared to be more similar to the 940 cfs flow in terms of play opportunities (the waves at Fortune Cookie and a few other small wave-holes were used by kayakers for extended freestyle sessions). However, this flow did not provide a standard opportunity like the two higher flows, and several boaters had some hits in rapids. In general, this flow probably defines the low end of a good quality technical run (although slightly higher flows are probably better). Small rafts and catarafts are probably not appropriate at this flow.

4.3 Rating Whitewater Difficulty

Boaters were asked to rate the Class of whitewater on the six class International Scale. Boaters generally thought the Faraday Bypass Reach was a Class III+ or IV- run, with some increased difficulty as flows increased. Difficulty ratings are presented for the reach in Table 3.

Table 3. Whitewater difficulty (on the six class International Scale) of the overall reach.

Flow in cfs	Median rating	Lowest individual rating	Highest individual rating
665	III/IV	III+	IV
800	IV-	III+	IV
940	IV-	III+	IV
1,220	IV-	III/IV	IV

4.4 Flow Comparison Information

Following each run, boaters were asked to report the number boatability problems they had, and evaluate nine attributes of whitewater boating trips (including providing an overall evaluation). While boatability reports and attribute evaluations help boaters focus on key attributes and the ways flows affect them, post-run results are generally less useful than evaluations made after boaters have observed all of the study flows (see below). Accordingly, post-run results have been summarized in Appendix D.

At the end of the study, boaters were asked to complete a "close-out" survey with questions that compared study flows with the full range of flows that might be available in the reach. Results help develop "flow evaluation curves" that relate flows and overall recreation quality, defining acceptable and optimal ranges for specific opportunities.

Flow Evaluation Curves

Boaters were asked to rate a series of 11 flows from 250 to 10,000 cfs using a seven-point acceptability scale (1=unacceptable, 4= marginal, and 7=acceptable). Results are given in Figures 4 and 5, with overall post-run evaluations for the four study flows also shown for comparison purposes. The figures show flow along the horizontal axis and acceptability evaluations along the vertical axis; curves describe the relationship between flows and overall boating quality.

Comparisons between the post-run and close-out results through the **study flow range** are highlighted in Figure 4; they reveal noticeable differences. Post-run ratings were higher than close-out ratings at 665 and 800 cfs, similar at 940 cfs, and slightly lower at 1,220 cfs.

These post-run/close-out differences are similar to those from other controlled flow studies, and suggest two possible explanations. First, the lowest flow was experienced on the initial run and was boaters' first exposure to a new river segment. On subsequent trips, the novelty may have waned, leading to lower close-out ratings for that first run. The initial trip also involved more route-finding challenges, which may heighten experiences. Second, it may have been more difficult to evaluate the initial run because there were no comparisons with other flows yet; 665 cfs may have appeared acceptable as a stand-alone run because it was at least boatable. However, once boaters had seen the stronger hydraulics and improved boatability at higher flows, 665 cfs received lower ratings during the close-out. We tend to place more weight on the close-out results, which let boaters rate the full set of flows after they have seen several flows for comparison purposes.

The overall evaluation curve shown through a **larger range of flows** (Figure 5) provides additional information about boating flows outside the study range. Results show the characteristic bell shape found in many previous studies (Whittaker & Shelby, 2002), and indicate that boating could probably occur on the reach at a fairly wide range of flows. The curve suggests that while flows below about 750 cfs are rated unacceptable, ratings improve around 1,200 cfs, and are projected to become optimal from about 1,800 to 3,500 cfs before gradually declining (although they remain in the acceptable range through 10,000 cfs). Based on these data, the optimum flow would be about 2,500 cfs, but any flow above 750 cfs is acceptable.

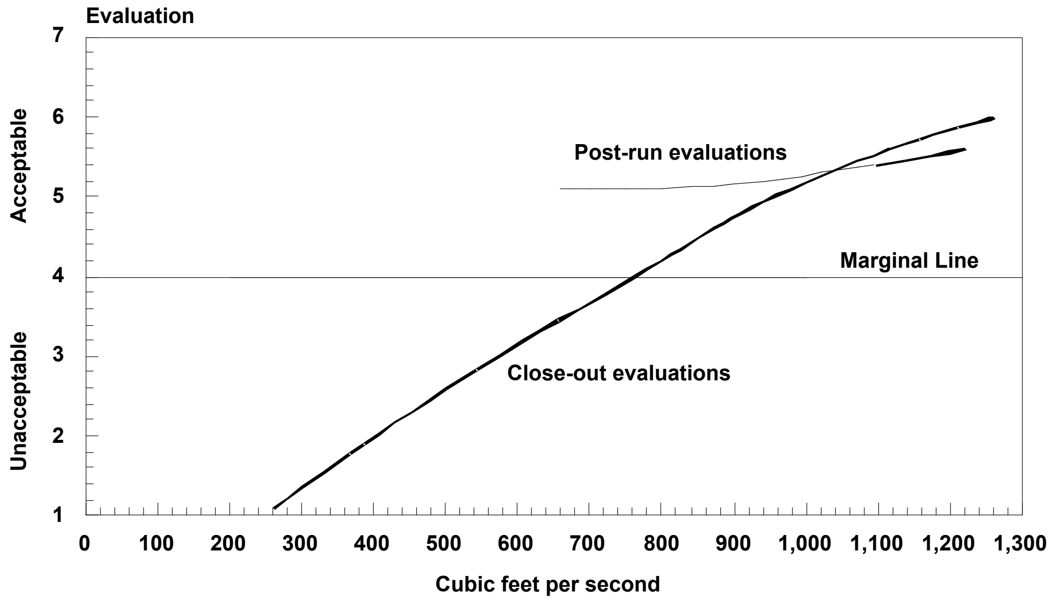

Figure 4. Post-run and close-out overall evaluation curves through the range of study flows (0 to 1,200 cfs).

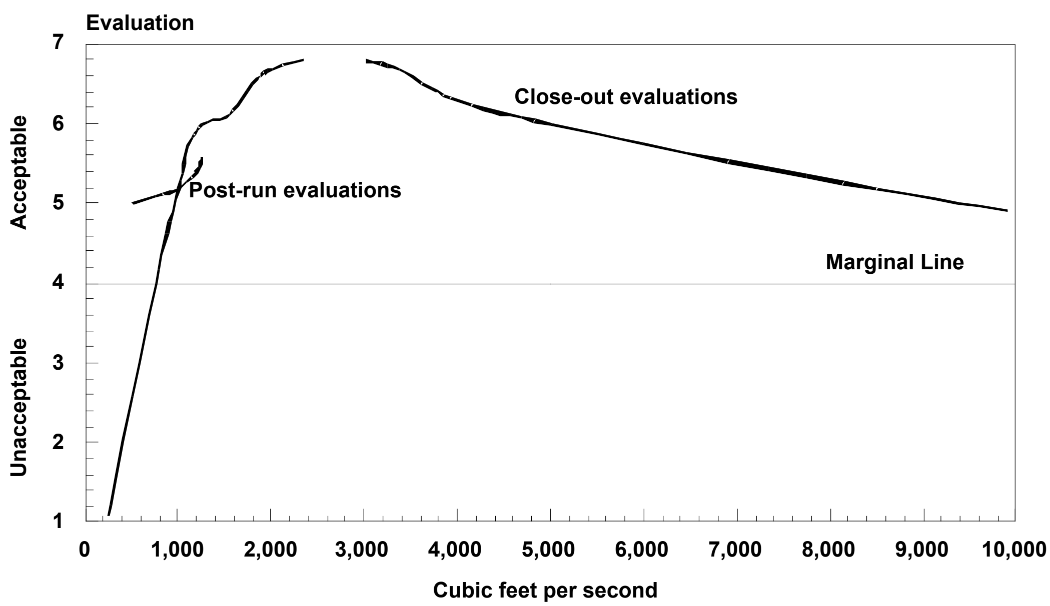

Figure 5. Post-run and close-out overall evaluation curves from 0 to 10,000 cfs.

Specified Flow Ranges for Different Opportunities

A series of "specified flow" questions asked boaters to identify flows or ranges that provide a variety of different opportunities. The specific questions are given below. Table 4 shows the mean and median responses, the "inter-quartile range" (the 25 and 75 percentile responses), and the lowest and highest responses. Results suggest several important findings, as discussed below. Medians are used to summarize central tendencies and inter-quartile ranges to discuss variation.

Specified flow questions:

> Think of the river as a waterway used for transportation. What is the lowest flow you need to simply get down the reach in your craft?
>
> Some people are interested in a "technical/playboating" whitewater trip at low to medium flows. Think of this **"technical/playboating trip"** in your craft.
> What is the lowest flow that provides an acceptable experience for this type of trip?
> What is the best or optimal range of flows for this type of trip?
>
> Some people are interested in taking trips at somewhat higher flows that feature stronger hydraulics but may offer less playboating areas and less technical routes through rapids. Think of this **"standard trip"** in your craft.
> What is the lowest flow that provides an acceptable experience for this type of trip?
> What is the best or optimal range of flows for this type of trip?
>
> Some people are interested in taking trips at much higher flows that feature more powerful hydraulics and large waves. Think of this **"big water trip"** in your craft.
> What is the lowest flow that provides an acceptable experience for this type of trip?
> What is the best or optimal range of flows for this type of trip?
>
> For those willing and able to evaluate **rafting** on the reach…
> What is the lowest flow that would provide an acceptable rafting experience?
> What is the best or optimal range of flows for a "standard" rafting trip?
> Does this reach appear to have potential as a commercial rafting run?
>
> What is the highest safe flow for your craft and skill level?
>
> If PGE released only one flow for boating, what flow would you prefer?
>
> If PGE released two flow levels that offer different types of boating experiences, what two flows would you prefer?

Table 4. Descriptive statistics for "specified flow" questions (in cfs).

Specified Flow	Mean	Median	Interquartile Range	Min-Max Range
Minimum boatable flow	549	550	400 to 665	400 to 700
Lowest acceptable technical flow	683	700	541 to 800	500 to 800
Low end of optimal technical flow	783	800	648 to 975	200 to 1,200
High end of optimal technical flow	1,178	1,100	1,000 to 1,430	1,000 to 1,500
Lowest acceptable standard flow	1,043	1,020	825 to 1,175	800 to 1,500
Low end of optimal standard flow	1,322	1,200	1,100 to 1,500	800 to 2,000
High end of optimal standard flow	2,500	2,500	2,000 to 3,000	1,500 to 3,500
Lowest acceptable big water flow	2,714	3,000	1,500 to 3,500	1,000 to 5,000
Low end of optimal big water flow	3,200	3,250	2,375 to 3,875	1,000 to 5,000
High end of optimal big water flow	9,429	10,000	6,000 to 10,000	5,000 to 15,000
Lowest acceptable rafting flow	1,100	1,150	950 to 1,200	900 to 1,200
Low end of optimal rafting flow	1,840	2,000	1,350 to 2,250	1,200 to 2,500
High end of optimal rafting flow	7,100	4,000	3,250 to 12,500	3,000 to 15,000
Highest safe flow	6,187	5,500	3,875 to 9,375	2,500 to 10,000
Preferred single flow	1,322	1,200	800 to 1,350	800 to 3,500
Lowest of two best flows	1,178	900	800 to 1,050	800 to 3,500
Highest of two best flows	2,194	1,500	1,275 to 3,000	1,200 to 5,000

- Boaters identified flows lower than the lowest in the study (550 cfs) as a minimum to use the river for transportation, but recognized that quality "technical/playboating trips" are not provided until flows are above about 700 cfs. An optimal range for "technical trips" is from about 800 to 1,100 cfs.
- Boaters recognize differences between "technical," and "standard" trips, with flows around 1,000 to 1,200 cfs defining the transition between these two opportunities.
- Standard opportunities appear acceptable at about 1,000 cfs, and they are optimal from 1,200 to 2,500 cfs.
- Boaters also recognize differences between "standard" and "big water" trips, with flows about 2,500 to 3,000 cfs defining the transition between these two opportunities.
- Big water opportunities appear acceptable by 3,000 cfs and optimal from 3,250 to 10,000 cfs.
- The high end of the big water range is considerably higher than the flow boaters identified as the "highest safe flow" (5,500 cfs) for their craft and skill level. The study did not include flows higher than 1,200 cfs, although four study participants were present during the preliminary reconnaissance when 2,000 cfs was provided, and one boater had been down the reach on several occasions at much higher flows (estimated 5,000 to 10,000 cfs).
    - There is greater variation in responses for the high end of the standard range and all the big water specified flows (compared to flows for technical and the other standard parameters). Probable explanations focus on 1) the lack of experience with higher flows, and 2) differences in skill levels among respondents.
    - Only four boaters answered specified flow questions about rafting. These boaters think rafting would become acceptable at about 1,000 to 1,200 cfs (similar to the standard opportunity for kayaking). There was less agreement about the optimal range for rafting, which may start as low as 1,200 cfs and continue through 10,000 cfs or more. Focus group discussion clearly suggested that commercial rafting opportunities were limited on the reach given its short length and difficult access.
    - When asked to specify a single flow that should be provided for whitewater, boaters appeared to respond in one of two ways: the low end of a technical opportunity (800 to 900 cfs) or the low end of a standard opportunity (1,200 cfs).
- When asked to specify two flows that should be provided for whitewater, they tended to list one that was at the low end of the technical range (900 cfs) and a second that was a little higher than the low end of the standard range (1,500 cfs).

Integrating Overall Flow Evaluation Curves and Specified Flows

Figure 6 shows the overall flow evaluation curve and specified flow ranges for different opportunities. The figure highlights how different parts of the hydrograph provide different boating opportunities. It shows how the "technical range" corresponds with the point where the flow evaluation curve crosses the marginal line, while standard and big water opportunities receive higher overall ratings. Most boaters prefer these higher flow trips to technical ones, but they recognize that hydroelectric operations may constrain those opportunities. Accordingly, their preferences for whitewater releases focus on the low end of the technical and standard ranges (if just one or two flows could be released).

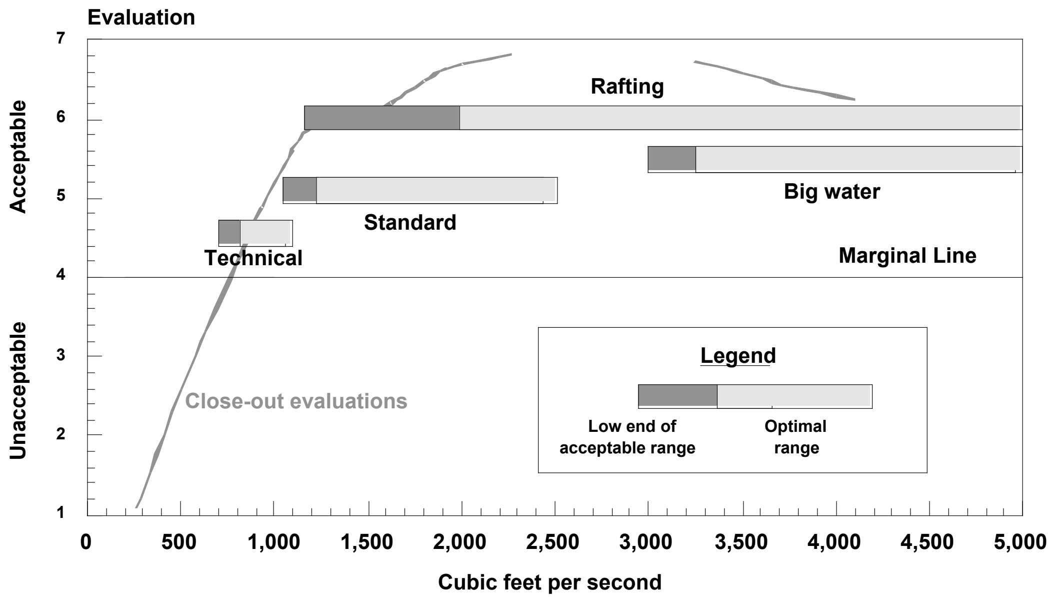

Figure 6. Close-out flow evaluation curve and "range bars" for various opportunities.

4.5 Flows for Other Recreation Opportunities

If boating flows in the 800 to 2,000 cfs range are released, they may have effects on biophysical resources or other types of recreation. While this study did not focus on flow needs for other opportunities, observations of other recreation activities during the study may help suggest preliminary flow options or the potential effects of flow releases on these other resources and opportunities.

Angling for steelhead and Chinook salmon occurred on the Faraday Diversion reach throughout the study. However, it is unknown how anglers evaluated those flows (in the 665 cfs to 1,220 cfs range) compared to base flows they usually experience. Fishability studies on other hydroelectric diversion reaches (e.g., California's Upper North Fork Feather and Pit rivers) suggest that fly anglers prefer low flows that have greater wadeability and concentrate fish in deeper holes or "pocket water." Spin and bait anglers on these same rivers generally prefer slightly higher flows.

Most anglers observed during the Faraday Diversion study were fishing with spinners or bait, and most were fishing from the bank rather than wading in the river. It appears that this type of fishing occurs at the top or bottom of pools, most of which would be difficult to wade at any flow. With wadeability a smaller issue, fishing may be acceptable through a range of flows from 120 cfs through about 1,500 to 2,000 cfs, when many pools would change into runs. From an angler's perspective, however, flows less than about 1,000 cfs are probably preferable because fish are likely to be more concentrated, and lower current velocities would allow anglers to use less weight with their tackle.

Swimming was also observed during the study and does not appear to be constrained by flow levels up to 1,200 cfs. There are several pools that remained deep and had relatively slow velocities at all the study flows. The pool downstream of Chop Suey Rapid was used by local residents on the second day. During the afternoon 800 cfs flow, they were jumping off 20 to 30 foot cliffs and the pool apparently had plenty of depth. As flows exceed about 1,500 cfs, a few pools are likely to become more like runs, which could present hazards to less skilled swimmers. Accordingly, acceptable swimming probably exists from 120 to 1,500 cfs, but optimal swimming is probably from base flows through 1,000 cfs.

Many **general riverside recreation** activities are enhanced by the river's aesthetics, which are in turn related to flows in the channel (Moore et al., 1990). While flows may be one of several important factors in people's evaluations of scenic quality in a riverscape (topographic relief, vegetation, color, and weather conditions also play important roles), research also shows that recreationists can evaluate the aesthetics of flow levels directly. In general, aesthetic evaluations of rivers are high except when flows do not cover the bottom of the channel (Whittaker and Shelby, 2002). On the Faraday Diversion segment, even flows at the base level (120 cfs) provide a relatively aesthetic riverscape, and higher whitewater flows are unlikely to have negative effects on general river recreation.

4.6 Assessment of Faraday Boating Opportunities

Boaters were asked to rate the Faraday Diversion Reach in comparison to other reaches on the Clackamas, in the Portland area (within a 3 hour drive), in the Pacific Northwest, and in the country. Responses were on a five point scale from "worse than average," to "average," "better than average," "excellent," and "among the very best." Results show that no boater considered the Faraday Diversion reach excellent or among the very best, and only 1 of the 10 reported it was better than average compared to other Clackamas reaches. Seven out of ten felt the reach was worse than average compared to other Clackamas reaches or other Portland-area rivers.

Focus group discussion examined this issue in greater depth. While boaters enjoyed the rapids as flows were increased, the short length of the run was a primary shortcoming. In addition, boaters were disappointed by the lack of play features that became available, noting that none of the play waves or holes approached the "world class" quality of Bob's Hole on the Three Lynx reach of the Clackamas. Considerable discussion focused on whether minor channel modifications could create some higher quality playboating rapids in the reach. Without such modifications, however, most boaters did not think the Faraday Diversion reach would attract much use if whitewater releases were provided.

During the close-out focus group, boaters suggested there were some similarities between the Faraday reach and the Sandy River Gorge, the Killer Fang segment on the Upper Clackamas, and the White Salmon below Husom Falls. In all three cases, however, those other reaches are longer and have better access.

5.0 Conclusions

Flows in the Faraday Diversion segment are affected by Clackamas hydroelectric Project operations. Under existing operating conditions, this reach features relatively static base flows with occasional pulses associated with facility maintenance or floods/spills.

To increase the diversity of boating opportunities, periods of higher flow releases would be necessary. If flow regime modifications are considered, additional issues include scheduling releases to maximize boating values while minimizing effects on other resource values, as discussed below.

- Boaters consistently indicated that this reach would be more attractive if it had more playboating features. Minor channel modifications could conceivably provide boating opportunities through a full range of flows, including base flows. Although its feasibility and the impact to other resources have not yet been analyzed, this could possibly be achieved by moving a few of the existing boulders in the rapids, creating a quality playboating area.
- If whitewater flows are provided, some access improvements are likely to be necessary (e.g., road access during spill periods and improved put-in and take-out trails). Vehicle access cannot currently be provided due to Project security limitations.

- Anglers use the river throughout the fishing season, but higher use likely occurs during the summer weekends, setting up potential conflicts with boaters.
- When integrating recreation information with ecological flow needs, considerable attention may focus on designing whitewater releases to mimic natural high flow events and thus serve various ecological purposes. Historically, of course, these types of higher flow events occurred in winter and spring, but the availability of other whitewater opportunities at those times would dilute the impact of providing them on the Faraday Diversion Reach.

In conclusion, providing a diversity of recreation opportunities on the Faraday Diversion Reach may be challenging. Providing flows for one opportunity may diminish the quality of another or affect biophysical resources. Finally, hydropower generation obviously would be affected by potential changes in the flow regime to create whitewater boating opportunities. The purpose of this report is to provide information to help evaluate these trade-offs.

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Appendix A: Study Participants

John Gangemi	American Whitewater
Keith Jensen	Alder Creek Kayak Supply and private boater
Bob Patterson	Private boater
Scott Collins	Private boater
Jacob Selander	Private boater
Cindy Pytel	Private boater
Steve Morgan	Private boater
Tim Shibahara	PGE fisheries biologist and private boater
Bo Shelby	Confluence Research and Consulting
Doug Whittaker	Confluence Research and Consulting

Appendix B: Survey Instruments

(on following pages)

FARADAY DIVERSION PRE-RUN INFORMATION FORM

Date: _____ / _____ / 2002 Your name: ____________________________________

1. For the following types of whitewater craft, please indicate 1) the frequency you use each compared to other craft, 2) the years of experience you have with each, and 3) your skill level with that craft (the highest class of whitewater you feel comfortable running).

Craft	Frequency of use (circle one for each craft)	Years of experience	Skill level (circle one class)
Hard shell kayak	Rare Occasional Frequent		II III IV V
Inflatable kayak	Rare Occasional Frequent		II III IV V
Raft/cataraft (length: ____)	Rare Occasional Frequent		II III IV V
Other: _______________	Rare Occasional Frequent		II III IV V

2. In general, how many days per year do you spend whitewater boating? _____ days per year

3. What is your age? _____ years

4. Are you ❒ male or ❒ female?

5. Please respond to each of the following statements about your river-running preferences.

	Strongly disagree	Moderately disagree	Slightly disagree	No Opinion	Slightly agree	Moderately agree	Strongly agree
I prefer running rivers with difficult rapids (Class IV and V).	1	2	3	4	5	6	7
Running challenging whitewater is the most important part of my boating trips.	1	2	3	4	5	6	7
I often boat short river segments (under 3 miles) to take advantage of whitewater play areas.	1	2	3	4	5	6	7
I often boat short river segments to experience a unique and interesting place.	1	2	3	4	5	6	7
I often boat short river segments to run challenging rapids.	1	2	3	4	5	6	7
Good whitewater play areas are more important than challenging rapids.	1	2	3	4	5	6	7
I am willing to tolerate difficult put-ins and portages in order to run interesting reaches of whitewater.	1	2	3	4	5	6	7
I prefer boating rivers that feature large waves and powerful hydraulics.	1	2	3	4	5	6	7
I prefer boating steep, technical rivers.	1	2	3	4	5	6	7
I enjoy boating both technical and big water rivers.	1	2	3	4	5	6	7

FARADAY DIVERSION POST-RUN EVALUATION FORM

Date of run: _____ / _____ / 2002 Flow: _____ cfs Your name: ___________________________

1. What type of craft did you use for this run? kayak inflatable kayak other __________

2. In general, what class (I to VI) was the whitewater difficulty at this flow? _____

3. Please estimate the number of **hits**, **stops**, **boat drags**, and **portages** you had on this run.
   I **hit** rocks or other obstacles (but did not stop) about… _____ times
   I was **stopped** after hitting rocks or other obstacles about… _____ times
   I had to get out to **drag or pull my boat** off rocks or other obstacles about… _____ times
   I had to **portage** around unrunnable rapids or sections… _____ times

4. Did you have any significant problems (e.g., became pinned, wrapped a boat, had to swim, etc.) during your run? Please provide a brief description and location of any incident (continue on back if needed).

5. Please evaluate the flow on this run for your craft and skill level for each of the following characteristics. *(Circle one number for each item).*

	Totally Unacceptable			Marginal			Totally Acceptable
Boatability	1	2	3	4	5	6	7
Availability of technical rapids	1	2	3	4	5	6	7
Availability of powerful hydraulics	1	2	3	4	5	6	7
Availability of play areas	1	2	3	4	5	6	7
Overall whitewater challenge	1	2	3	4	5	6	7
Safety	1	2	3	4	5	6	7
Aesthetics	1	2	3	4	5	6	7
Rate of travel	1	2	3	4	5	6	7
Number of portages	1	2	3	4	5	6	7
Length of the segment	1	2	3	4	5	6	7
Please make an overall evaluation considering all of the flow-related conditions that contribute to a high quality trip.							
Overall Rating	1	2	3	4	5	6	7

6. In general, would you prefer a flow that was higher, lower, or about the same as this flow? *(Circle one).*
   1. Much lower flow
   2. Slightly lower flow
   3. About the same; this was close to an optimum flow
   4. Slightly higher flow
   5. Much higher flow

7. If this flow were provided periodically, are you likely to return for future boating? *(Circle one).*
   1. Definitely no
   2. Possibly
   3. Probably
   4. Definitely yes

FARADAY DIVERSION "CLOSE-OUT" FORM

1. Given what you know about the quality of whitewater and other features on the Faraday Diversion Reach, please tell us maximum number of **hits**, **stops**, **boat drags**, and **portages** that are tolerable for a high quality trip in your craft? If you "don't care," place an X in the space provided.

   I will tolerate up to _____ **hits** per trip (contacts with rocks/other obstacles that do not stop you).
   I will tolerate up to _____ **stops** per trip (contacts with rocks or other obstacles that stop you, but you do not have to get out of your boat to continue downstream).
   I will tolerate up to _____ **boat drags** per trip (times where you have to get out of your boat to get it off of rocks or other obstacles).
   I will tolerate up to _____ **portages** around unrunnable rapids per trip.

2. Compared to other rivers, how would you rate boating opportunities on the Faraday Diversion Reach. *(Circle one number for each; if you are unsure about a comparison, leave that item blank).*

Compared to…	the Faraday Diversion Reach is…				
	Worse than average	Average	Better than average	Excellent	Among the very best
…other reaches on the Clackamas	1	2	3	4	5
…other rivers in the Portland area (within 3 hours driving)	1	2	3	4	5
… other rivers in the Pacific Northwest	1	2	3	4	5
… other rivers in the country	1	2	3	4	5

3. Please provide overall evaluations for the Faraday Diversion Reach for following flows for your craft and skill level. Please consider all the flow-dependent characteristics that contribute to high quality trips (e.g., boatability, whitewater challenge, safety, availability of surfing or other play areas, aesthetics, and rate of travel). *(If you do not feel comfortable evaluating a flow you have not seen, don't answer for that flow).*

	Totally unacceptable			Marginal			Totally acceptable
250 cfs	1	2	3	4	5	6	7
500 cfs	1	2	3	4	5	6	7
750 cfs	1	2	3	4	5	6	7
1,000 cfs	1	2	3	4	5	6	7
1,250 cfs	1	2	3	4	5	6	7
1,500 cfs	1	2	3	4	5	6	7
2,000 cfs	1	2	3	4	5	6	7
3,000 cfs	1	2	3	4	5	6	7
4,000 cfs	1	2	3	4	5	6	7
5,000 cfs	1	2	3	4	5	6	7
10,000 cfs	1	2	3	4	5	6	7

Based on your boating trips on the Faraday Diversion Reach, please specify the flows that provide the following types of experiences. *(Note: you can specify flows that you have not seen, but which you think would provide the type of experience in question).*

Flow in cfs

Think of the river as a waterway used for transportation. What is the lowest flow you need to simply get down the reach in your craft? _____

Some people are interested in a "technical/playboating" whitewater trip at low to medium flows. Think of this **"technical/playboating trip"** in your craft.

What is the lowest flow that provides an acceptable experience for this type of trip? _____

What is the best or optimal range of flows for this type of trip? _____ to _____

Some people are interested in taking trips at somewhat higher flows that feature stronger hydraulics but may offer less playboating areas and less technical routes through rapids. Think of this **"standard trip"** in your craft.

What is the lowest flow that provides an acceptable experience for this type of trip? _____

What is the best or optimal range of flows for this type of trip? _____ to _____

Some people are interested in taking trips at much higher flows that feature more powerful hydraulics and large waves. Think of this **"high challenge trip"** in your craft.

What is the lowest flow that provides an acceptable experience for this type of trip? _____

What is the best or optimal range of flows for this type of trip? _____ to _____

For those willing and able to evaluate **rafting** on the reach…

What is the lowest flow that would provide an acceptable rafting experience? _____

What is the best or optimal range of flows for a "standard" rafting trip? _____ to _____

Does this reach appear to have potential as a commercial rafting run? (Circle one) No Yes

What is the highest safe flow for your craft and skill level? _____

If PGE released only one flow for boating, what flow would you prefer? _____

If PGE released two flow levels that offer different types of boating experiences, what two flows would you prefer? _____ & _____

How important is it to release a variety of flow levels on the Faraday Diversion Reach? Please rate the importance of providing several different flows for the two reasons below, or check the box if variety is not important.

Providing several different flows is necessary to…	Not at all important	Slightly important	Moderately important	Very important	Extremely important
…provide different types of boating experiences.	1	2	3	4	5
… provide opportunities for people with different skill levels and craft types.	1	2	3	4	5

Or… Check here ❒ if it isn't important to provide a variety of flow levels.

Appendix C: Focus Group Notes

Names for Rapids from Participants

Consensus name	Location or initial name	Discarded names
Catwalk	Fish Ladder	Boardwalk, Rebar
Spring Roll	Drop at end of fish ladder rapid	Fish Trap Hole
Chopstick	Slanting log	Tim's Folly, Log Drop
Paul's Fall	Ledge Drop	Bob's Boof, Jacob's Ladder
General Tso's	Upper Island Left	Picket Fence, Sweet & Sour, Elbow Banger
Chop Suey	Lower Island Left	Stir Fry
No MSG	Island Right	MSG, No MSG, Kung Pao
Fortune Cookie	Play waves	Junior Mint, Appetizer
Check Please	Class III right after waves	None

665 cfs flow (545 over dam + 120 through fish ladder)
June 24, 2002 morning run

Advantages
- Not pushy.
- Technical run.
- Possible to run all rapids.
- Hard to get to knocked over.

Disadvantages
- Bony.
- Shallow.
- Not for beginners (too technical).
- Limited craft options.
- Rocky in put-in rapid.

What would a lower flow be like?
- I wouldn't boat it.
- Rockier yet (especially at General Tso's).
- But Spring Roll might improve as a play spot.

What would a higher flow be like?
- Probably will clean-up.
- Maybe a bit pushier.
- Should be better for less skilled paddlers.
- More lines will open up.

Other Comments
- Overall the run is Class III to IV (no firm agreement)
- Most agree that General Tso's is Class IV (and portage there is easy).
- Probably not raftable at this flow.
- Run is too short for rafts, especially commercial trips.
- Put-in and take-out are tough for rafts.
- Need steps or trail at put-in.
- Potential for creating play waves at Spring Roll, Fortune Cookie, and Check Please.

940 cfs (820 cfs over dam + 120 through fish ladder)
June 24, 2002 afternoon run

Advantages
- Similar number of rapids as from Fish Creek to Bob's Hole on Three Lynx reach.
- Cleaner lines at this flow.
- Rapids filled in.
- More play spots.
- Deeper play spots.
- Good intermediate run as long as experienced boaters are on trip.

Disadvantages
- Less good play in Catwalk and Spring Roll.
- Still scratchy.
- Still lots of rocks and not a beginner run.
- Some places are deceptively hard.
- Shallow with lots of rocks.
- Still not a great run (too short, needs more play, not great rapids).
- None of the play spots are great, but some are ok.

What would a lower flow be like?
- Probably not anything that good between 940 and 665.
- Nothing lower is likely to be much of an improvement.

What would a higher flow be like?
- Still hoping it will clean-up, especially in General Tso's and Chop Suey.

Other Comments
- Still seems like a Class III/IV run (no consensus).
- Probably still not raftable (commercially, normal 14 foot rafts).
- Too short for rafts; still poor access.
- But maybe could get a small raft or cat down it.

1,220 cfs (1,100 cfs over dam + 120 through fish ladder)
June 25, 2002 morning run

Advantages
- Much cleaner.
- Safer.
- More playable.
- Went faster.

Disadvantages
- Run is short; this flow accentuates that.
- Needs a good play spot (or three).

What would a lower flow be like?
- Didn't miss anything between this flow and 940 cfs.

What would a higher flow be like?
- Hard to say.
- Main rapids would be more powerful and cleaner, but probably not pushy until 3,000.
- High challenge may not happen until 3,500 cfs (Patterson).
- High challenge is provided during occasional spill periods (8k or more at Three Lynx).
- "Standard" trip would just improve, but run would get shorter.
- Not likely to provide any more play.

Other Comments
- Class III+ or IV.
- This was definitely raftable, except maybe General Tso's.
- Still too short for commercial raft trips and bad access for rafts.
- Long discussion on need to see higher flows; consensus decision to examine 800 cfs to learn about low end of technical trips.

800 cfs (680 cfs over dam + 120 through fish ladder)
June 25, 2002 afternoon run

Advantages

- As good as 940 cfs to me.
- Better as a technical run than 1,220 cfs.
- Surf waves at end are better than at 665 cfs or 1,220 cfs; similar to 940 cfs.
- Boof at Paul's Falls is very good at this level.
- Glad we looked at this flow; some differences from 940 cfs.

Disadvantages

- Worse than 1,220 cfs.
- Other rapids are much more "junky" than at 1,200 cfs (especially General Tso's and Chop Suey).
- Felt similar to 940 cfs, but not quite as good.
- 800 cfs is much better than 665 cfs.
- Difference between 665 cfs and 900 cfs fells larger than between 800 cfs and 940 cfs.

What would a lower flow be like?

- We were at the edge of a decent technical run.
- Nothing lower would be much good without creating play waves.

What would a higher flow be like?

- We saw two higher flows; they were better but 940 cfs was not lots better.

Other Comments

- Still Class III/IV run (no consensus).
- Not a good rafting flow.

Close-out Comments
June 25, 2002

Similar River Reaches in Area

- Sandy Gorge is similar, but it has perhaps 12 rapids over about 5 to 6 miles; sarcastically: "trashy rapids with undercuts."
- Steeper and bonier rapids than Three Lynx.
- Some rapids are similar to Killer Fang segment rapids.
- A little like lower White Salmon (below Husom).

Other Comments

- Confrontation with angler was obnoxious.
- Fix rebar near catwalk.
- Watching water come up from base flows to 1,220 at Spring Roll: no great play spot at any flow (but better in that lower range).
- Study helps highlight what must be covered up by reservoirs.
- Needs a play hole, a play wave, and play wave-hole.
- Would be a good run if there were just a few more play features.
- If play features were built, you would also need to develop restrooms, access trails.
- I worry about too much modification for play features; may not have to do much (use existing boulders – just move some around).

Appendix D: Additional Post-Run Results

D.1 Boatability Issues

Boatability issues refer to the ability of boaters to negotiate the reach while minimizing inadvertent contact with rocks or obstacles in the channel or becoming grounded. Boaters were asked to report the number of boatability problems (hits, stops, and boat drags as defined below) during each of their runs.

- Hits: contact with an in-channel rock without loss of momentum.
- Stops: contact that causes the boat to stop, but you can continue without getting out of your boat.
- Boat drags: requires getting out of your boat to pull it off obstacles.
- Portages: requires taking your boat out of the channel to avoid unrunnable rapids or obstacles.

Curves based on mean reported numbers of hits and stops are shown in Figure D-1. They indicate that hits decrease as flows become higher (from about 11 at 665 cfs to about 3 at 1,220 cfs). Boaters reported less than one stop at the three lower flows and none at 1,220 cfs. (Note that hits are read from the left vertical axis in Figure D-1, while stops are read from the right vertical axis with a different scale).

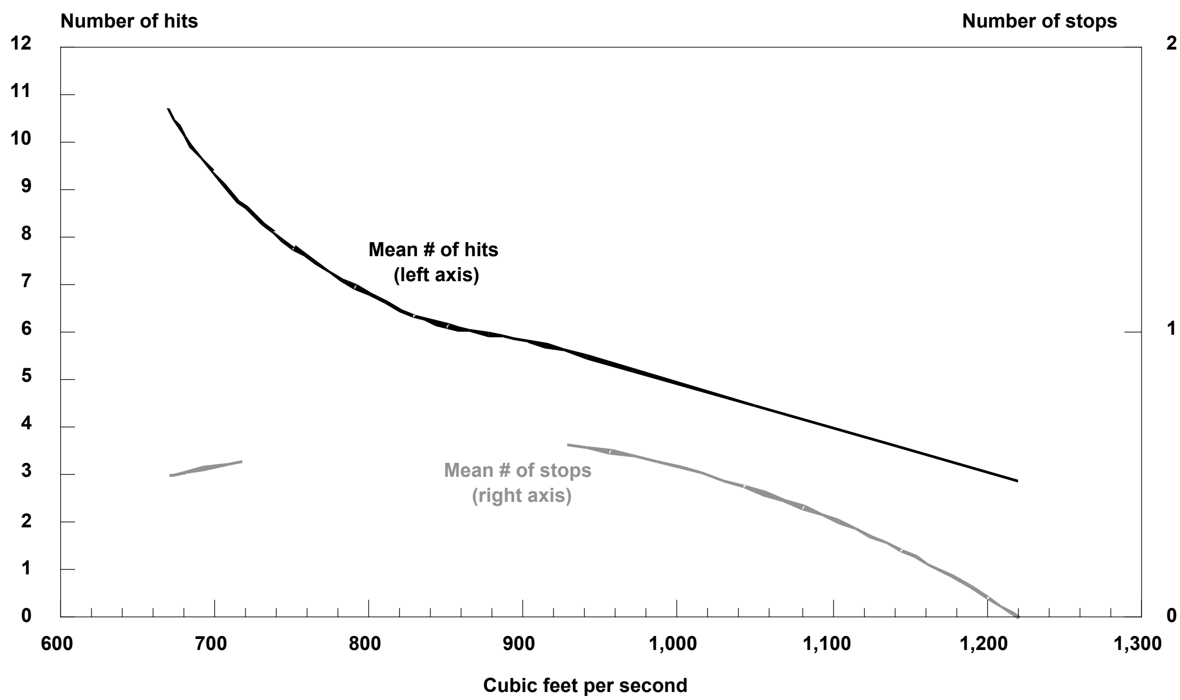

Figure D-1. Average number of "hits" and "stops" reported at different flow levels.
Hits = contact with an in-channel rock without loss of momentum.
Stops = contact that causes boat to stop; progress can continue with push of paddle.

There were no "boat drags" during the study. However, one boater flipped after contact with rocks in Chop Suey Rapid at 940 cfs; the boater got out of his boat after it became stuck on rocks. He swam to shore on his own, and was able to retrieve the kayak.

The only portages during the study were reported by the IK boater, who did not run General Tso's Rapid at any flow. These portage decisions were related to skill level considerations; a stronger Class IV IK boater probably would have run this rapid at the two highest flows.

Boaters were also asked to report their tolerances for hits, stops, boat drags, and portages on a segment like the Faraday Bypass Reach. Mean tolerances are given in Table 3, and suggest that most kayakers will accept about ten hits and up to about two stops, but have less tolerance for any boat drags. Boaters also reported a willingness to accept about two portages on such a segment; discussion indicated that they would tolerate portages primarily if the segment otherwise provided exceptional play features or interesting rapids (e.g., if channel modifications provided additional play features).

Comparing reported boatability problems with reported tolerances suggests that the three higher flows (800, 940, and 1,220 cfs) provided "acceptable" boatability. However, the 665 cfs flow was probably close to marginal boatability, with slightly more hits but slightly fewer stops than boaters will tolerate.

Table D-1. Average tolerance levels for boatability problems.

	Hits	Stops	Boat Drags	Portages
Mean	9.9	1.6	0.4	2.6
Median	8.5	1.5	0.0	2.0

D-2. Post-Run Evaluations

Following each run, boaters were asked to rate nine attributes of their whitewater trips on a seven-point acceptability scale (1=unacceptable, 4= marginal, and 7=acceptable). The attributes included: boatability, safety, availability of technical rapids, availability of powerful hydraulics, overall challenge, availability of good playboating, aesthetics, rate of travel, and length of segment. Mean scores at each flow were used to develop flow evaluation curves for each attribute. Figures D-2 to D-5 show results for individual attributes, as well as an overall post-run evaluation curve. Discussion is organized by groups of attributes.

Overall Evaluations

Overall evaluations (Figure D-2) were acceptable at all four flows, but increased slightly through the range. However, ratings were never more than moderately acceptable during the post-run evaluations. Overall evaluations from the end of study surveys (after all four flows had been run) offer a more complete picture and are highlighted in the main body of the report.

Boatability and Safety

Figure D-2 shows boatability and safety evaluations after each run. Boatability ratings improved slightly as flows increased, but safety ratings were more uniform. Neither boatability nor safety appear to be key factors in overall post-run evaluations, which were acceptable (but not highly rated) for all four flows.

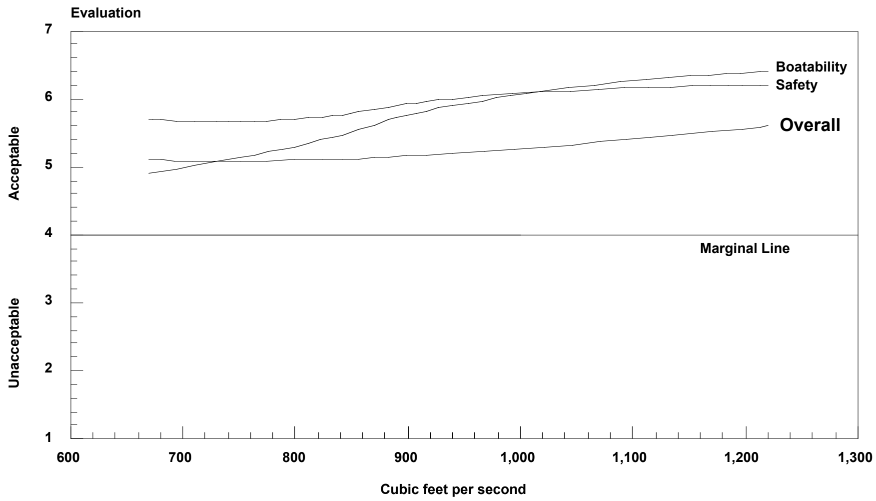

Figure D-2. Mean post-run evaluation curves for boatability and safety; overall post-run evaluations are also shown.

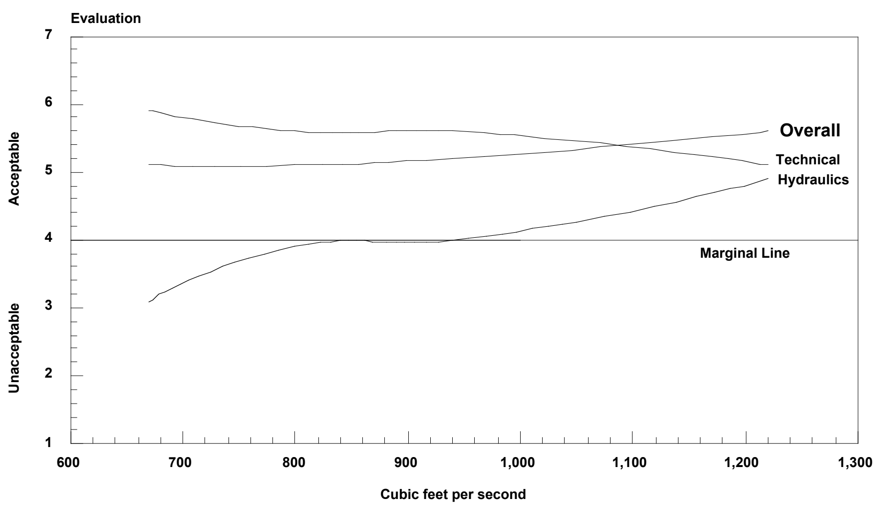

Figure D-3. Mean post-run evaluation curves for the availability of technical rapids and powerful hydraulics; overall post-run evaluations are also shown.

Availability of Technical Rapids and Powerful Hydraulics

Figure D-3 shows post-run evaluations for technical rapids and powerful hydraulics, the two basic attributes that "drive" overall whitewater challenge. Lower flows provided higher quality technical whitewater (although all four flows provided acceptable technical conditions). In contrast, only the highest flow provided acceptable power in the river. The lack of power at low appears to influence on overall evaluations.

Whitewater Challenge and Availability of Play Features

Figure D-4 shows post-run evaluations for whitewater challenge and playboating. Results show that the best playboating was available at 800 and 1,220 cfs, with the 665 cfs and 940 cfs flows rated slightly lower; all four flows were rated acceptable for playboating, but were never rated higher than 5 on the seven point scale. The reach simply does not offer stellar playboating features at the flows studied. Whitewater challenge generally increased as flows increased, with the 1,220 cfs flow rated best. The challenge attribute appears to have relatively strong influences on overall evaluations (both curves are similar).

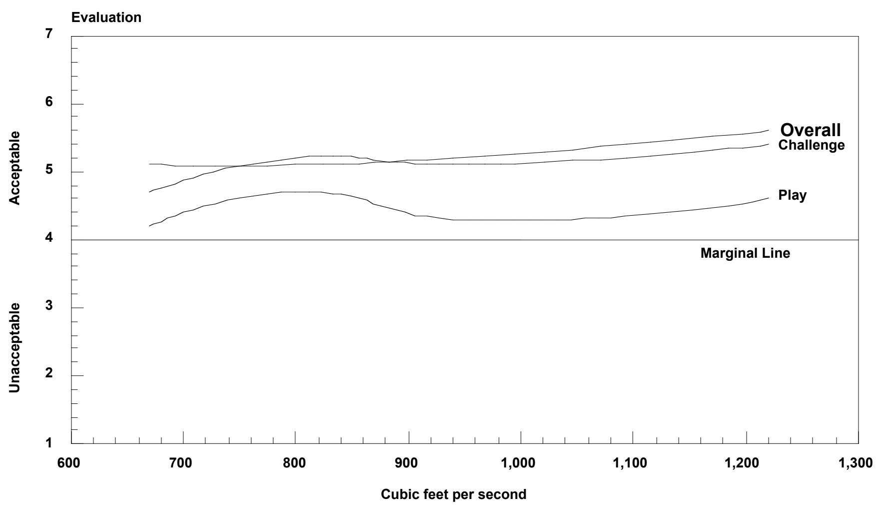

Figure D-4. Mean post-run evaluation curves for whitewater challenge and the availability of whitewater play features; overall post-run evaluations are also shown.

Aesthetics, Rate of Travel, and Trip Length

Figure D-5 shows post-run evaluations for aesthetics of the river, the rate of travel, and trip length. Aesthetics were rated highly acceptable at all four flows, but ratings were slightly lower for the 665 cfs and 1,220 cfs flows. Rate of travel varied little across all four flows, and was rated moderately acceptable. Trip length was rated near marginal levels for the 800 and 1,220 cfs flows, and was only slightly acceptable at 665 cfs and 940 cfs. Discussions in focus groups suggest that without better play features with good eddy service, the run simply ends too quickly. This was particularly true at the highest flow, which offers a more standard trip.

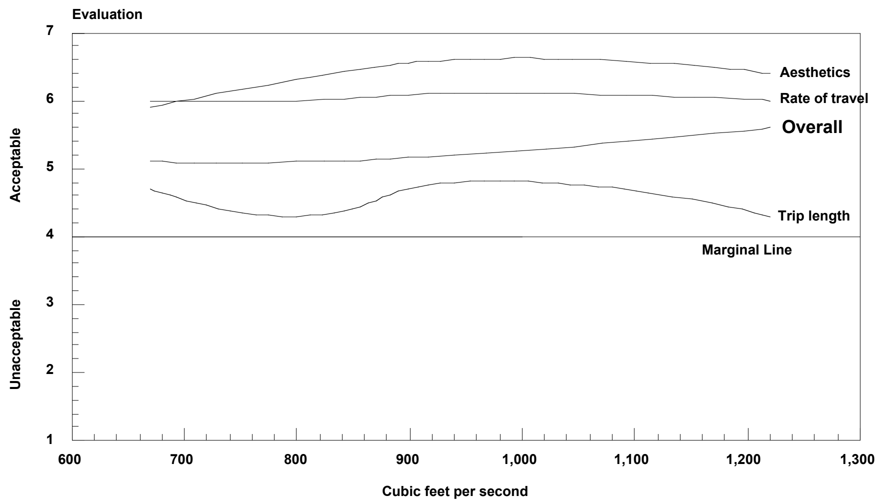

Figure D-5. Mean post-run evaluation curves for aesthetics, rate of travel, and trip length; overall post-run evaluations are also shown.

D-3. Post-run Preferences for Higher or Lower Flows

After each run, boaters were asked to indicate their preference for similar, higher, or lower flow levels (Table D-2). Results indicate that most boaters prefer higher flows than all four study flows, but they particularly prefer higher flows than the 665 cfs level (no boaters preferred about the same or a lower flow). At the highest study flow, three of the ten boaters preferred flows at that level, although 40% wanted higher flows and 30% wanted much higher flows.

Table D-2. Post-run preferences for flow levels (percent preferring flows higher, the same, or lower).

Response option	665 cfs	800 cfs	940 cfs	1,220 cfs
Prefer much higher	60	50	10	30
Prefer higher	40	30	70	40
Prefer the same	0	20	10	30
Prefer lower	0	0	10	0
Prefer much lower	0	0	0	0

D-4. Post-Run Likelihood of Return

Boaters were also asked whether they would be likely to return at the flow level they just ran (Table D-3). Results suggest that none of the four flows is likely to attract many return visits, but the two higher study flows appear more likely to attract visitation, at least from boaters in this panel (who are highly skilled). Discussion in focus groups indicated that the lack of playboating features and short length of the run were the primary reasons for the lack of interest in the reach.

Table D-3. Post-run likelihood of returning at various flows (percent).

Response option	665 cfs	800 cfs	940 cfs	1,220 cfs
Would not return	10	0	0	10
Possibly return	60	90	70	60
Probably return	30	10	30	20
Definitely return	0	0	0	10

Appendix E: Photo Gallery