MONITORING PLAN
FOR
SWAN FALLS MINIMUM FLOWS AT MURPHY GAGING STATION

1.0 Swan Falls Settlement

On October 25, 1984, the State of Idaho entered into a historic agreement with the Idaho Power Company ("Idaho Power" or "Company" or "IPC") commonly known as the "Swan Falls Agreement." This Agreement was subsequently ratified by the 1985 Idaho Legislature at the same time legislation implementing the Agreement was enacted.

Under paragraph 7.A. of the Agreement, Idaho Power retained an unsubordinated water right defined as an average daily flow of 3,900 cfs measured at the Murphy gage[1] from April 1 through October 31 of each year, and an average daily flow of 5,600 cfs measured at the Murphy gage from November 1 through March 31 of each year.[2] Under paragraph 7.B. of the Agreement, Idaho Power is "entitled to use the flow of the Snake River at its facilities to the extent of its actual beneficial use but not to exceed" the licensed amounts, and such use "shall be subordinate to subsequent beneficial upstream uses upon approval of such uses by the State in accordance with State law unless the depletion violates or will violate paragraph 7(A)." Pursuant to Idaho Code §§ 42-203B(2) and (5), the water rights enumerated in the Agreement for Idaho Power's generating facilities along the Snake River and its tributaries downstream of Milner Dam and upstream of the Murphy gage in excess of the retained water right described in paragraph 7,A. are held in trust by the State of Idaho. The water rights held in trust are "subject to subordination to and depletion by future upstream beneficial users whose water rights are acquired pursuant to state law, including compliance with the requirements of section 42-203C, Idaho Code."[3]

"Average daily flow" as measured at the Murphy Gaging Station is defined for purposes of the Swan Falls Agreement as follows:

> Average daily flow, as used herein, shall be based upon actual flow conditions; thus, any fluctuations resulting from the operation of Company facilities shall not be considered in the calculation of the minimum daily stream flows set forth herein.[4]

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[1] U. S. Geological Survey ("USGS') gage no. 13172500 located 7.5 miles northeast of Murphy at Lat 43º 17' 31", Long 116º 25' 12" in NW¼ NE¼ SE¼ Sec 35, T.1S., R.1W., Ada County, ID, at river mile 453.5, on right bank, 4.2 miles downstream from Idaho Power's Swan Falls powerplant. The gaging station was operated by USGS beginning in August of 1912 until Idaho Power began operating the gaging station in July of 2001.

[2] While the water right retained by the Company under paragraph 7.A. is not subordinated to future beneficial uses authorized by state law, it is subordinated to those water rights described in paragraphs 7.C. and D. and the 1180 Contract.

[3] Idaho Code § 42-203B(2).

[4] Swan Falls Agreement, paragraph 7.B.

The parties to the Agreement did not define the methodology or procedures for calculating "actual flow conditions" except to exclude fluctuations resulting from the operation of Idaho Power's generating facilities. Water acquired by Idaho Power "from sources upstream of its power plants" for conveyance "to and past its power plants below Milner Dam … shall be considered fluctuations resulting from operation of Company facilities."[5]

As more fully discussed below, the current Snake River water measurement program is inadequate to determine the average daily flow at the Murphy gage. The purpose of this memorandum is to propose a process for determining and documenting the "actual flow conditions" for purposes of implementation of the Swan Falls Agreement.[6]

2.0 Fluctuations at Murphy Gage Resulting from Operations of Idaho Power's Facilities

Operations at the following Idaho Power hydroelectric generating facilities downstream from Milner Dam are potentially capable of causing fluctuations in the average daily flow at the Murphy gage:

Hydropower Project	Installed Capacity (MW)	Dam Height (ft)	Reservoir Capacity (acre-feet)	Active Storage (acre-feet)
Lower Salmon Falls	60.0	110[a]	10,900[b]	-[c]
Bliss	75.0	84[b]	11,100[b]	-[c]
C.J. Strike	82.8	115[b]	240,000[b]	36,800[d]
Swan Falls	25.0	107[a]	7,425[e]	6,745[e]

[a] National Performance of Dams Program (NPDP), Stanford University
[b] Federal Energy Regulatory Commission (FERC) License
[c] FERC License anticipates that outflows equal inflows over 24-hour period
[d] Usable, Idaho Power website
[e] Usable, License Application, Swan Falls Project FERC No. 503, page B-4

Idaho Power's Twin Falls, Shoshone Falls, and Upper Salmon hydropower projects include reservoirs having capacities of 955 acre-feet,[a] 1,500 acre-feet,[b] and 600 acre-feet,[b] respectively. The FERC licenses for these projects require "run-of-river" operations where run-of-river is typically defined as:

> … minimize the fluctuation of the reservoir surface elevation by maintaining a discharge from the project so that, at any point in time, flows measured immediately downstream from the project tailrace approximate the sum of inflows to the project reservoir.

[5] Swan Falls Agreement, paragraph 7.E.

[6] Swan Falls Agreement, paragraph 7.B.

> Run-of-river operation may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon mutual agreement between the licensee and the Idaho Department of Fish and Game.[7]

Even when these projects may not be strictly operated as run-of-river because of circumstances beyond Idaho Power's control, the reservoir volumes associated with these projects are too small to allow for storage and subsequent release of water in quantities that could cause significant fluctuations in the average daily flow at the Murphy gage, barring substantial operational abnormalities. Additionally, Idaho Power's Clear Lake, Thousand Springs, Upper Malad, and Lower Malad hydropower projects do not include reservoirs. These latter four hydropower projects are truly run-of-river and operations at these facilities can not cause fluctuations in the average daily flow at the Murphy gage.

2.1 Operations at Lower Salmon Falls and Bliss Projects. As for the Twin Falls, Shoshone Falls, and Upper Salmon Falls projects, Article 401 of the FERC licenses for the Lower Salmon Falls and Bliss Projects call for the operation of the latter projects "in a run-of-river mode for the protection of federally listed snails in the project area … ." However, pursuant to the Settlement Agreement[8] by and between Idaho Power and the U. S. Fish and Wildlife Service entered into for the purpose of resolving certain issues in the FERC proceedings to relicense Idaho Power's Shoshone Falls, Upper Salmon Falls, Lower Salmon Falls, Bliss, and C.J. Strike hydroelectric projects, project operations are to be altered to conduct studies on the effects of project operations on federally listed snails inhabiting the project area. Attachment 2 to the Settlement Agreement provides that during the study period (which extends from April 1, 2004, to March 31, 2010) Idaho Power is to operate the Lower Salmon Falls and Bliss projects such that:

> Operations during the first five years of the Study Period will consist of at least two run of river operational years and two load following operational years as determined consistent with the discussion below. The project operations for Lower Salmon Falls and Bliss for the remaining year of the first five years of the Study Period will be run of river unless a mutually agreed upon load following operation is necessary to collect required information and hydrologic conditions allow, and operations during the sixth year of the Study Period will be as determined pursuant to the terms of the Settlement Agreement.[9]

Attachment 2 to the Settlement Agreement defines run-of-river operations as:

> … holding Lower Salmon Falls and Bliss project reservoirs full while passing inflows. It should be noted that under run of river operations, variations in project inflow and subsequent project outflow may occur due to circumstances and events beyond the

[7] Federal Energy Regulatory Commission (FERC), Order Issuing New License, Shoshone Falls Project No. 2778-005, Article 401, 108 FERC ¶ 61,125; and Order Issuing New License, Upper Salmon Falls Project No. 2777-007, Article 401, 108 FERC ¶ 61,126; August 4, 2004.

[8] Settlement Agreement Concerning the Relicensing of Idaho Power Company's Mid-Snake and C.J. Strike Hydroelectric Projects (Settlement Agreement), filed with FERC on February 12, 2004, and included as Appendix B to FERC Order Issuing New License, Bliss Project No. 1975-014, 108 FERC ¶ 61,128; August 4, 2004.

[9] *Ibid*, p. 113.

> control of IPC. Examples include but may not be limited to upstream dam and hydro project operations, irrigation return flows, canal operational spills, irrigation pumping plant operations and hydrologic events. Equipment failures and forced unit outages at the Lower Salmon Falls and Bliss projects may also contribute to infrequent variations between inflows and outflows. Variations in project outflow during run of river operations may also occur infrequently due to required IPC emergency and ancillary service operations.[10]

Idaho Power subsequently applied to FERC and was granted license amendments[11] that for run-of-river operations, the project reservoirs at Lower Salmon Falls and Bliss would be held at elevations below normal full pool elevations of 1 ft and 1.5 ft, respectively. The purpose for lowering the reservoir pool elevations to be maintained was to minimize fluctuations in the discharge from the Bliss project caused by headwater controllers making discharge adjustments when inflows into the projects increased significantly, or when wind pushed the water in the reservoirs up against the respective dams or away from the respective dams.

Based on stream flow data published by Idaho Power on its website, both the Lower Salmon Falls and Bliss projects were operated in load-following modes in 2008. As described in the Bliss Rapids Snail Protection Plan,[12] Idaho Power apparently plans to operate both the Lower Salmon Falls and Bliss projects in load-following modes in the future.

Although the FERC licenses for these projects appear to anticipate that that outflows are to equal inflows over any daily 24-hour period, whether operated as load-following or run-of-river, there is insufficient published stream flow data to confirm that project operations at Lower Salmon Falls and Bliss do not affect flows at the Murphy gage downstream. Although stream flows below both the Lower Salmon Falls and Bliss projects are made available at 15-minute intervals by Idaho Power on its website, measured inflows to these projects are not publicly available. Consequently, it is not currently possible to readily confirm whether outflows are equal to inflows over any daily 24-hour period and whether project operations do or do not affect flows at the Murphy gage.

2.2 Operations at C.J. Strike Project. Pursuant to both the FERC license for the C.J. Strike Project[13] and the Settlement Agreement,[7] Idaho Power's C.J. Strike hydroelectric project is operated in a load-following mode.

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[10] *Ibid*, p. 114.

[11] FERC Order Amending License Article 401, Lower Salmon Falls Project No. 2061-030, 108 FERC ¶ 62,033; and FERC Order Amending License Article 401, Bliss Project No. 1975-040, 108 FERC ¶ 62,032; January 17, 2006.

[12] Idaho Power, Bliss Rapids Snail Protection Plan; Lower Salmon Falls, FERC 2061 (Article 403); Bliss, FERC 1975 (Article 403); C.J. Strike, FERC 2055 (Article 411); March 2010, p. 3.

[13] FERC Order Issuing New License, C.J. Strike Project No. 2055-010, 108 FERC ¶ 61,129; August 4, 2004.

> The project is block-loaded to meet daily system demands, *i.e*, one, two, or three units are brought on- and off-line as demand and water availability dictate. The project also operates in conjunction with the upstream Bliss and Lower Salmon Falls Projects to meet short-term load demands. This operation results in reservoir and tailwater level fluctuations.[14]

Article 401 of the FERC license requires that the C.J. Strike project be operated such that:

> … the maximum daily project reservoir drawdown does not exceed 1.5 feet below the normal maximum full pool elevation of 2,455 feet above mean sea level.[15]

However, Article 401 of the FERC License for C.J. Strike also provides that:

> The maximum reservoir drawdown limit may be temporarily modified, if required by operating emergencies beyond the control of the licensee, and for short periods upon mutual agreement among the licensee, U.S. Fish and Wildlife Service (FWS), and Idaho Department of Fish and Game (Idaho DFG). Temporary modifications may include the need to:
>
> (1) protect the performance, integrity, reliability, or stability of the licensee's electrical system or any electrical system with which it is connected, including the need to provide the Western Electric Coordinating Council and North American Electric Reliability Council reserves;
>
> (2) compensate for an unscheduled loss of generation;
>
> (3) provide generation during severe weather, energy shortages or periods of market instability;
>
> (4) inspect, maintain, repair, replace, or improve the licensee's electrical system, including the system associated with the project;
>
> (5) prevent injury to person(s) or damage to property;
>
> (6) assist in search and rescue activities;
>
> (7) respond to emergencies beyond the control of the licensee; and
>
> (8) address other situations when the licensee, FWS, and Idaho DFG agree upon variation in operations in advance.[16]

Clearly, project operations at C.J. Strike can affect measured stream flows at the Murphy gage. Figure 1 shows stream flows measured at the Murphy gage together with the volume of water in storage in the reservoir for the C.J. Strike project for the period October 1, 2006, through

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[14] *Ibid*, ¶ 7.

[15] *Ibid*, Article 401.

[16] *Ibid*.

September 30, 2007. Although the stream flow downstream of the C.J. Strike project is dependent on both inflow to the project and project operations, Figure 1 shows that in general as Idaho Power increases storage in the reservoir stream flows decrease, and as Idaho Power makes releases from reservoir storage stream flows increase. As an example, note the decrease in storage from 248,700 acre-feet to 246,500 acre-feet during the 13-day period beginning March 28, 2007. This change in storage accounted for an average increase in the discharge from the C.J. Strike project of about 85 cfs. Operations at the C.J. Strike project affect both inflows to the Swan Falls project as well as flows further downstream at the Murphy gage.

2.3 Operations at Swan Falls Project. In Idaho Power's application for a new FERC license for the Swan Falls Project, the following statement is made concerning project operations:

> The Swan Falls Project is considered a run-of-river project under all water conditions. That is, the reservoir is not used to store water on a **seasonal** basis. The available reservoir storage is used to reregulate inflows resulting from operations of the upstream C.J. Strike Project, and the power plant is normally operated to comply with the ramping rate restriction at the ramping gauge [sic] located approximately one mile below Swan Falls. The ramping rate restriction for the Swan Falls Project is 1 foot per hour and 3 feet per day. Although the Swan Falls Reservoir has minimal storage, it can be used to meet short-term, unexpected peak load requirements.[17] [emphasis added]

This described mode of operation is not run-of-river on a daily basis, under which outflow would equal inflow during daily 24-hour periods. Consequently, operations of the Swan Falls project can affect flows at the downstream Murphy gage. Figure 2 shows stream flows measured downstream of the C.J. Strike project (inflow to Swan Falls project) compared with stream flows measured at the Murphy gage for the period October 1, 2006, through September 30, 2007. The stream flows downstream of the C.J. Strike project have been shifted one day later than the date of measurement at the Murphy gage to account for the time between when water is discharged from the C.J. Strike project to the arrival of that water 36 miles downstream at the Swan Falls project.[18] Also shown on Figure 2 is the difference between the stream flows measured at the Murphy gage and the discharge from the C.J. Strike project shifted one day.[19]

The magnitude of the differences between the discharges from the C.J. Strike project and the stream flows at the Murphy gage are significant; often reaching $\pm$500 cfs with relatively infrequent differences of between $\pm$1,000 cfs to $\pm$2,000 cfs. Differences of this magnitude can only be attributed to gaging errors or anomalies, fluctuations in stream flows resulting from project operations at Swan Falls, or a combination of the two.

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[17] Idaho Power Company Application for New License for Major Project – Existing Dam, Swan Falls Project No. 503, June 6, 2008, p. B-2.

[18] Assumes an average, mean channel velocity of 1.5 miles per hour (see Attachment 1).

[19] Negative difference means measured discharge from C.J. Strike project is greater than stream flow measured at the Murphy gage.

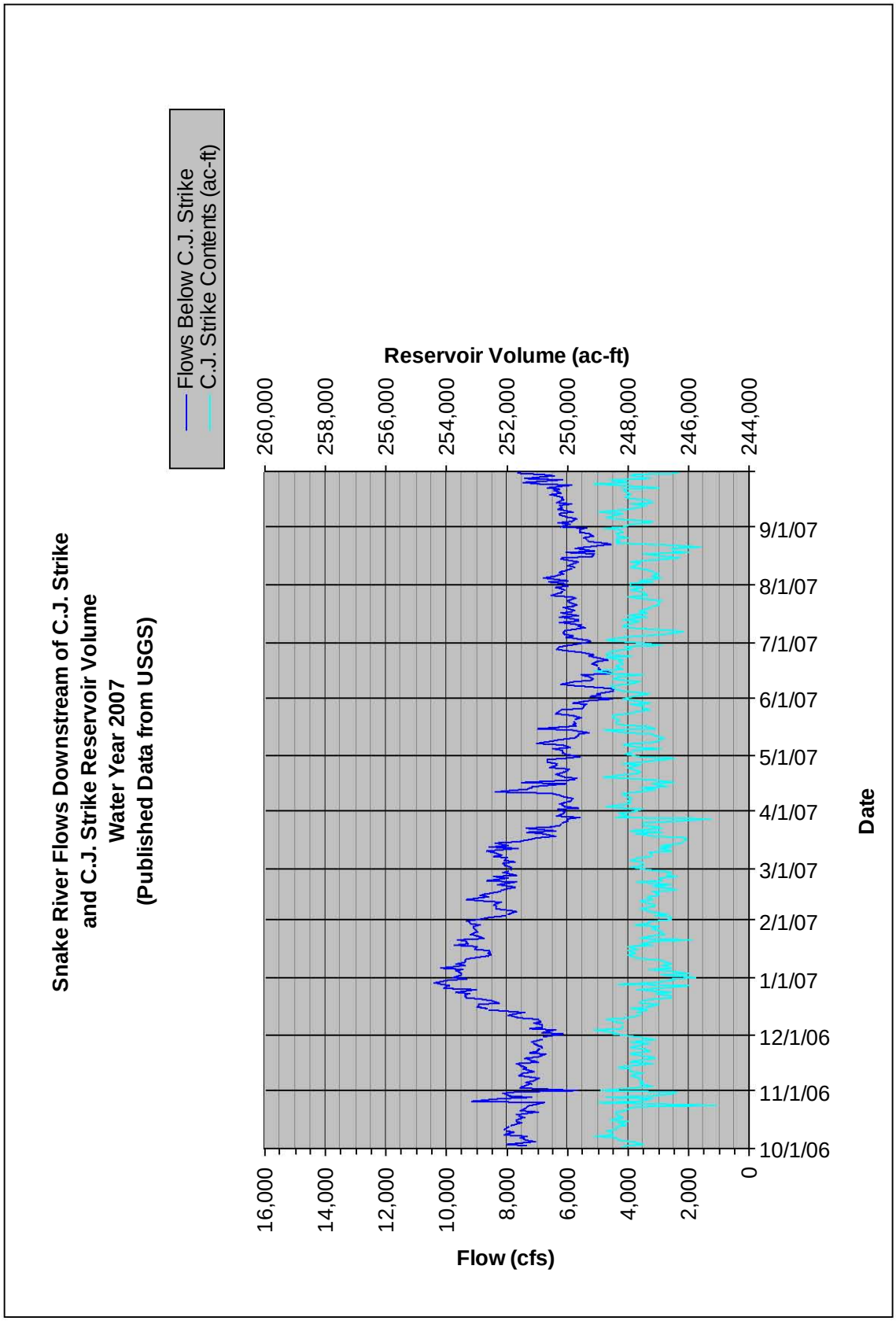


Figure 1. Stream Flows at the Murphy Gage and Reservoir Storage at the C.J. Strike Project.

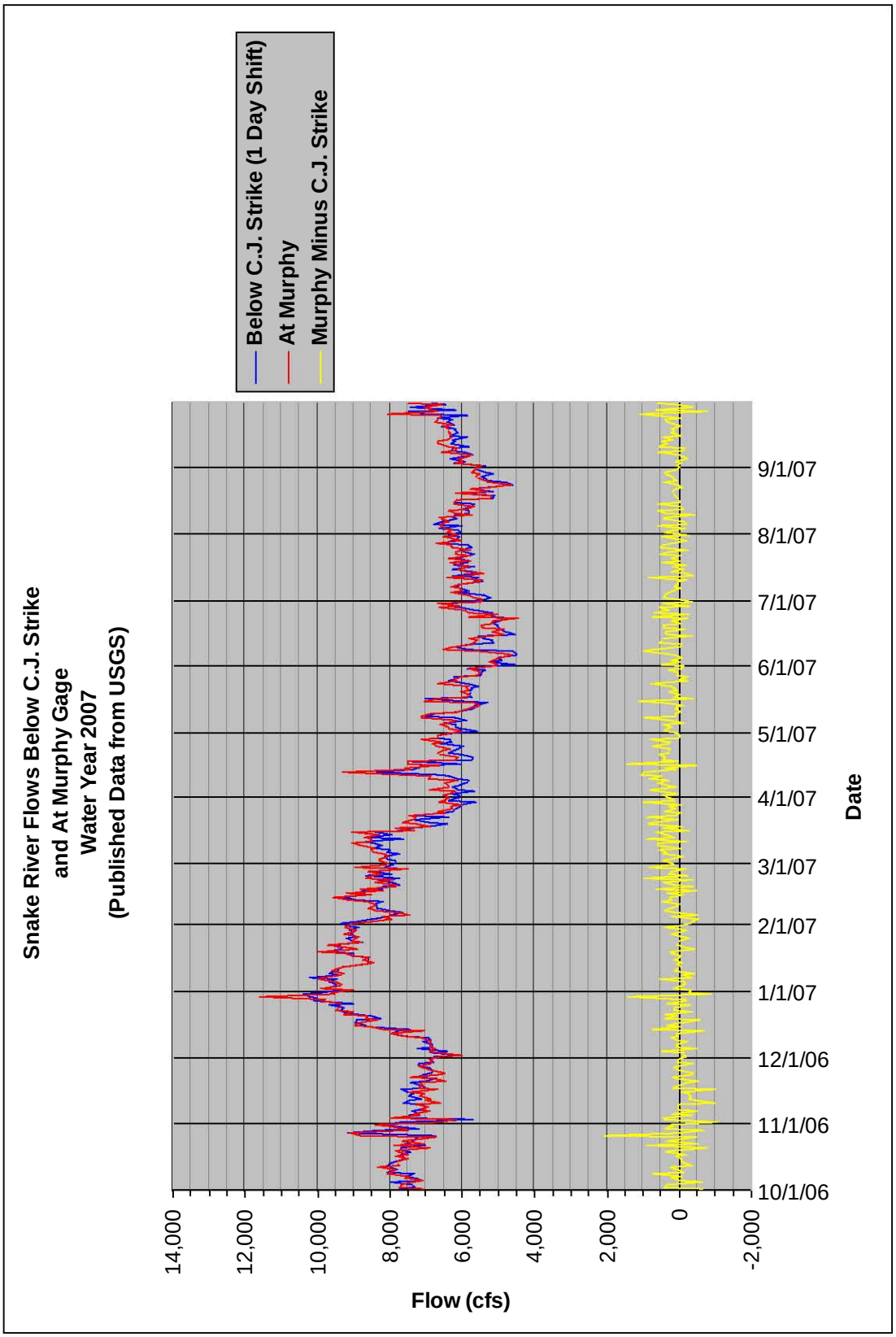


Figure 2. Stream Flows Downstream of C.J. Strike Project and at the Murphy Gage.

3.0 Fluctuations at the Murphy Gage and Compliance with the Swan Falls Agreement

3.1 Present IDWR Methodology. Fluctuations in stream flows measured at the Murphy gage caused by operations at Idaho Power's hydroelectric projects downstream from Milner Dam range from immeasurable to potentially significant. IDWR's present methodology for factoring out fluctuations caused by operations at Idaho Power's hydroelectric projects is to use a 3-day moving average for the stream flows measured at the Murphy gage. This is based on the premise that: (1) gaging errors, once appropriate gage shifts are applied, will be both positive and negative, and therefore offsetting; and (2) increases in stream flows because of the discharge from storage reservoirs for Idaho Power's projects will be offset by decreases in stream flows when reservoir storage at Idaho Power's facilities is refilled. However, these premises appear to be flawed.

Figure 3 shows the stream flows downstream of the C.J. Strike project, stream flows at the Murphy gage, the numerical differences between the two, and a 10-day moving average of the differences.

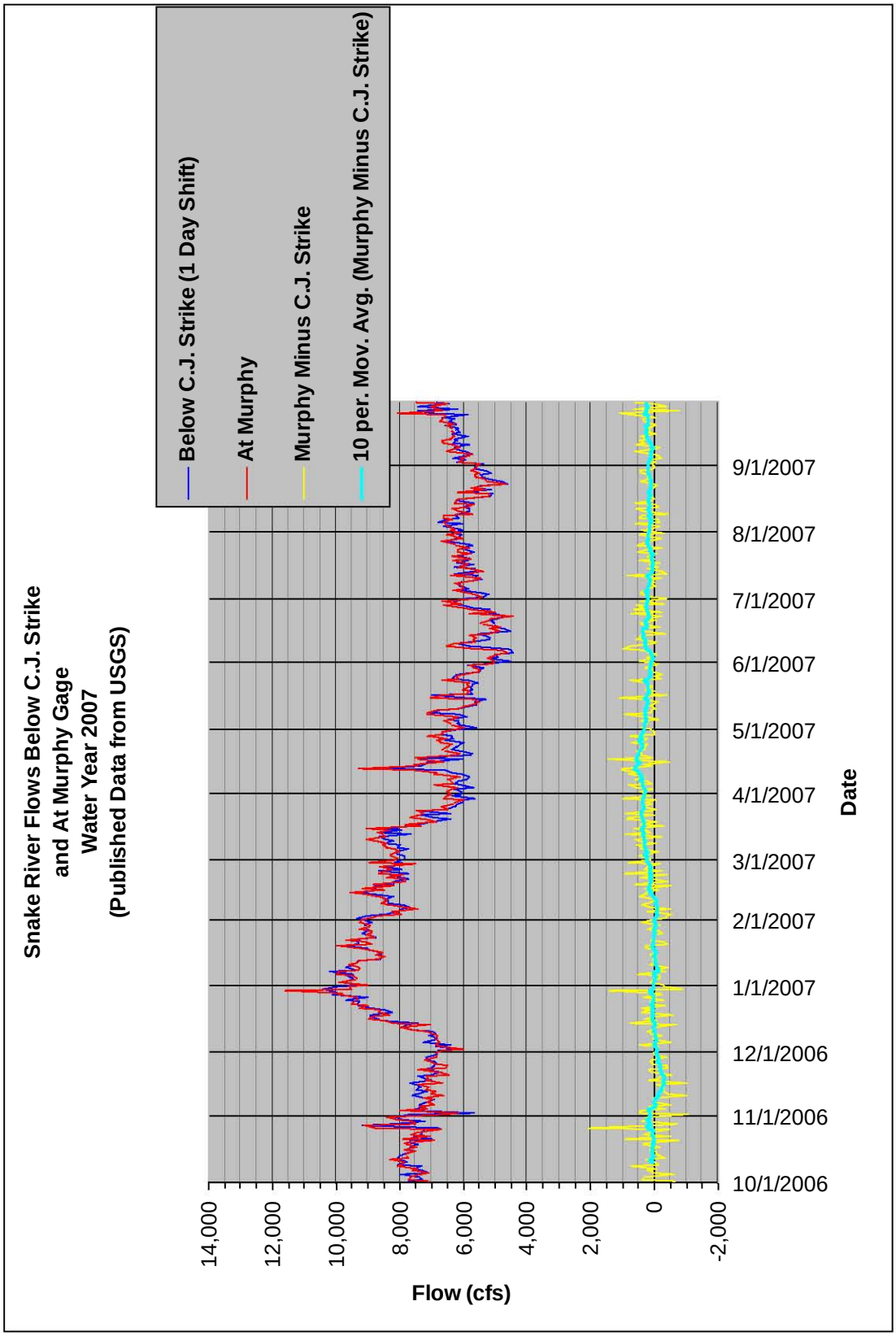


Figure 3. Differences Between Stream Flows Downstream of C.J. Strike Project and at the Murphy Gage with 10-day Moving Average.

If the discharge from the C.J. Strike project is the inflow to the Swan Falls project with a time delay of one day, and if the Swan Falls project is operated as run-of-river, and if there are no systemic gaging errors, then the 10-day moving average of the differences between stream flows below C.J. Strike and the Murphy gage should be close to zero. Instead, the 10-day moving average of the flow differences approaches -500 cfs in mid-November and +500 cfs in mid-April. If a 10-day moving average does not adequately factor-out stream flow fluctuations, then the 3-day moving average presently used by IDWR will not remove such fluctuations either.

3.2 Recommended Methodology for Measuring Stream Flows Under the Swan Falls Agreement. Although subject to gaging errors, the recommended methodology for determining the "actual flow conditions" excluding fluctuations resulting from the operation of Idaho Power's generating facilities, as required by the Swan Falls Agreement, is to have a reliable stream gage operating at both the upstream and downstream ends of the reservoirs at each Idaho Power hydropower project downstream from Milner Dam that is capable of causing flow fluctuations at the Murphy gage from project operations. The fluctuations caused by project operations for each project should be determined on a daily basis, when there is likelihood that average daily stream flows at the Murphy gage are approaching the seasonal minimum flows. The fluctuations should be determined by subtracting average daily project discharge from average daily project inflow and adding the difference for each project to the average daily flows measured at the Murphy gage, after applying appropriate timing shifts to account for the travel time for the fluctuations to be expressed in stream flows at the Murphy gage.

3.3 Existing Stream Gages on Snake River Below Milner Dam.

The following stream gages are presently operated on the Snake River downstream from Milner Dam:

Station Name	USGS Site No.	River Mile[20]	Owner/Operator	Telemetry	USGS Review & Annual Report
At Milner	13087995	638.7	USGS	Yes	Yes
Low. Milner Plant	13087505	638.0	Idaho Power	Not Published	Yes
At Milner Combined	13088000	638.7	USGS	Yes	Yes
Near Kimberly	13090000	617.2	Idaho Power	Yes	Yes
Below Shoshone Falls	13090355	615	Idaho Power	Not Published	Yes
Near Buhl	13094000	596.8	USGS	No	Yes
Upper Salmon "B"	13134520	579.7	Idaho Power	Not Published	No
Upper Salmon "A"	13134550	580.8	Idaho Power	Not Published	No
N. Chan. Up. Salmon	13134556	580.3	Idaho Power	Not Published	Yes
Below L Salmon Falls	13135000	572.5	Idaho Power	Yes	Yes
Below Bliss Dam	13153776	559	Idaho Power	Yes	Yes
At King Hill	13154500	546.6	USGS	Yes	Yes
Below C.J. Strike	13171620	493.8	Idaho Power	Yes	Yes
Near Murphy	13172500	453.5	Idaho Power	Yes	Yes

The existing network of stream gages on the Snake River below Milner Dam is inadequate for determining the fluctuations resulting from the operation of Idaho Power's generating facilities,

[20] River miles derived from USGS descriptions, FERC licenses, and Idaho Power's website.

as required by the Swan Falls Agreement, because there is not a stream gage at both the upstream and downstream ends of the reservoirs at each Idaho Power hydropower project that is capable of causing flow fluctuations at the Murphy gage from project operations.

4.0 Implementation of Recommended Methodology for Compliance with the Swan Falls Agreement

For the reasons and under the conditions described above, operations at Idaho Power's Twin Falls, Shoshone Falls, Upper Salmon, Clear Lake, Thousand Springs, Upper Malad, and Lower Malad hydropower projects should not cause fluctuations in stream flows at the Murphy gage. Project operations at both the C.J. Strike and Swan Falls projects are capable of and likely to cause fluctuations in stream flows at the Murphy gage. Whether project operations at the Lower Salmon Falls and Bliss projects cause such stream flow fluctuations is dependent on how those projects are operated. If these latter two projects are operated run-of-river as defined in the applicable FERC licenses, then these projects will not cause fluctuations in stream flows at the Murphy gage, under normal operating conditions. If operated as load-following, then whether these projects will cause fluctuations in stream flows at the Murphy gage depends on the time periods over which load-following occurs. If the discharge from these projects equals project inflows over daily, 24-hour periods, then average daily stream flows at the Murphy gage should not be affected.

4.1 Enhancements Required for Implementation of Recommended Methodology. At a minimum, the following enhancements to the network of stream gages on the Snake River upstream from the Murphy gage should be made to administer the water right held by Idaho Power, pursuant to paragraph 7.A. of the Agreement, based on average daily stream flows measured at the Murphy gage excluding fluctuations resulting from the operation of Idaho Power's generating facilities:

1. A new stream gaging station should be installed with telemetry near the upstream end of the reservoir formed by the dam for the C.J. Strike project at a location that is preferably not in the backwater of the reservoir. If located in backwater, acoustic Doppler devices will be required, which will likely increase the costs of installation and operation.

2. A re-evaluation of the existing stream gage below the C.J. Strike dam[21] should be performed to determine whether the existing location and equipment are adequate to minimize gaging errors that are likely part of the reason for the differences between stream flows measured at this location and stream flows measured at the Murphy gage, as depicted in Figure 2.

3. A new stream gaging station should be installed with telemetry near the upstream end of the reservoir formed by the dam for the Swan Falls project at a location that is preferably not in the backwater of the reservoir. If located in backwater, acoustic Doppler devices will be required, which will likely increase the costs of installation and operation.

[21] USGS gage no. 13171620 located on downstream left bank end of bridge about 0.25 mile below dam.

4. A determination needs to be made whether the Lower Salmon Falls and Bliss projects will individually be operated as run-of-river or load-following. If either of these projects is to be operated as load-following, then a determination needs to be made as to whether the operations will result in outflows equaling inflows over daily, 24-hour periods. If not, or if it is determined that there is sufficient probability that variations in project inflow and subsequent project outflow may occur due to circumstances or events beyond the control of Idaho Power, then installing a new stream gaging station with telemetry should be considered near the upstream end of the reservoir for each project where outflow is not expected to equal inflow over 24-hour periods. Again, it is preferable to locate such new gaging stations above the backwater of the reservoir. This may not be practical in the case of the Lower Salmon Falls project, in which case inflow would need to be determined as the outflow from the Upper Salmon Falls project by using the existing gaging at Upper Salmon "A", Upper Salmon "B", and the North Channel, with modifications as needed.

5. The rating at each gage location upstream and downstream of the projects where project operations can cause fluctuations in stream flows measured at the Murphy gage should be checked at least every 2 weeks during the period from April 1 through October 31 of each year, unless or until such frequent rating checks are shown to be unnecessary.

6. Fluctuations due to operations at each project should be determined by subtracting the average daily discharge from each project from the average daily inflow to that project. (When the average daily discharge is greater than the average daily inflow, the fluctuation will be negative.) Calculated fluctuations from project operations at C.J. Strike should be added to the average daily stream flow measured at the Murphy gage one day later. This shift is based on the distance of C.J. Strike from the Murphy gage and the mean velocity measurements in Attachment 1. Different shifts can be calculated for different stream flows, but the shifts become less important for stream flows that are well above the minimum stream flows of 3,900 cfs and 5,600 cfs administered at the Murphy gage.

7. If new stream gages are installed at either the Lower Salmon Falls or Bliss projects, calculated fluctuations from operations at either project should be added to the average stream flow measured at the Murphy gage 3 days later. This shift is based on the distances these projects are located upstream from the Murphy gage and the mean velocity measurements in Attachment 1.

4.2 Cost of Enhancements Implementation of Recommended Methodology. The capital costs for installing new stream gages will range from about $15,000 per gaging station to about $20,000 per gaging station, including telemetry, depending on whether acoustic Doppler devices are required.[22] Annual costs for the USGS to operate and maintain either existing gaging stations or new gaging stations will also range from about $15,000 per gage per year to about $20,000

[22] In 2008 dollars. Personal communication with Greg Clark, USGS, Boise, Idaho.

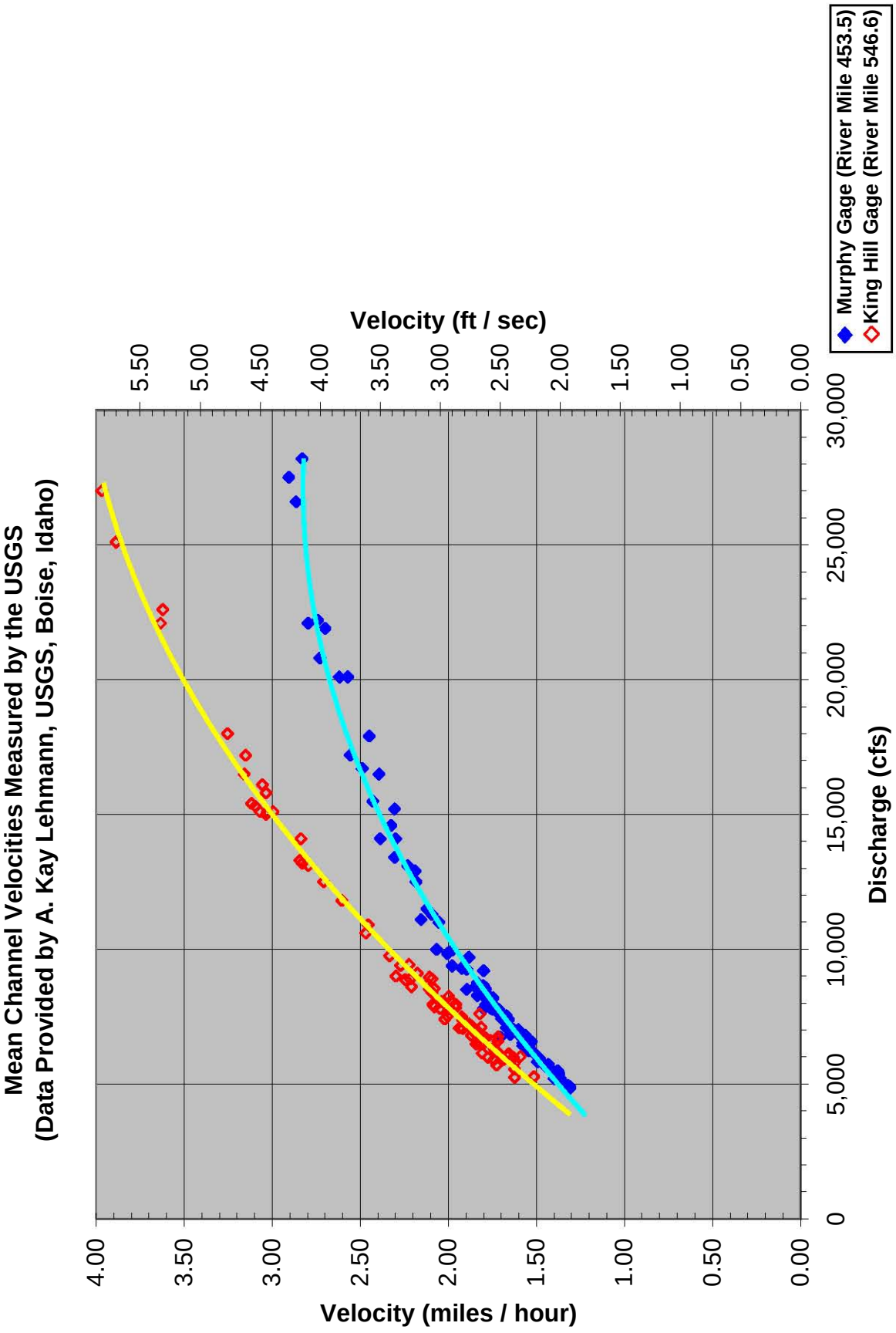
per gage per year, again depending on whether acoustic Doppler devices are required and the frequency that the rating at each gage location is checked.[23]

5.0 Conclusion

The enhancements to the stream gaging on the Snake River downstream of Idaho Power's Upper Salmon Falls project, to and including the Murphy gage, are necessary to reliably and accurately determine the "average daily flows" at the Murphy Gage pursuant to the Swan Falls Agreement. Without these enhancements, the "actual flow conditions" referred to in paragraph 7.B. of the Agreement can not be reliably determined.

[23] *Ibid*.

ATTACHMENT 1


Mean Channel Velocities Measured by the USGS
(Data Provided by A. Kay Lehmann, USGS, Boise, Idaho)
Velocity (ft / sec)
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Discharge (cfs)
30,000
25,000
20,000
15,000
10,000
5,000
0
Velocity (miles / hour)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Murphy Gage (River Mile 453.5)
King Hill Gage (River Mile 546.6)