April 3, 2008

2008 CORPS SPILL CHANGE GUIDANCE
For Columbia and Snake Rivers

Introduction:

The voluntary spill program first began at the John Day dam in 1977, an extremely low water year. It was thought that spill would assist fish passage through the dam and increase fish survival. In 1981, spill began at Lower Monumental dam and the use of sonar to detect fish passage. The time and amount of water to be spilled was based on the numbers of fish detected with the sonar and the dam biologist's judgment. In 1989, there was a 10-year agreement established between Bonneville Power Administration (BPA), state and federal fish agencies and environmental organizations that called for daily spill at John Day, Lower Monumental, Ice Harbor, and The Dalles dams. The US Army Corps of Engineers (Corps) did not sign onto the agreement but agreed to implement the actions it described. This agreement stayed in effect for 3 years, through 1991 when Snake River sockeye salmon was declared endangered under the Endangered Species Act (ESA). As a result, the Corps went into consultation with NOAA Fisheries on how to protect listed salmon. Through the subsequent years, more fish were listed as endangered. In 1992, the spring/summer Chinook and fall Chinook were listed. In 1998, chum and steelhead were listed. By 2000, twelve different Evolutionarily Significant Units (ESU) of fish were listed. In 2005 19 more ESU were listed.

The spill program with daily spill was further developed and was written into the first Biological Opinion issued in 1994 and all the subsequent Biological Opinions. The 2004 Updated Proposed Actions required the Action Agencies (The Corps, BPA, and Bureau of Reclamation) to provide a certain amount of spill from the various dams to aid juvenile fish migration.

Judge Redden issued a December 29, 2005 court decision that declared the 2004 Biological Opinion as inadequate and the federal agencies were ordered to remand it. The new Biological Opinion is still under development and the Corps developed the Fish Operations Plan (FOP) which can be found at http://www.nwd-wc.usace.army.mil/tmt/documents/ops/FOP/FOP%202008%20final.pdf

As further fish operation decisions are made through court cases and as fish research provides more information about fish migration and technologies to assist it, the amount, method and approaches toward spill changes too. These changes are discussed and agreed upon through regional forums and incorporated into the Water Management Plan. As a result, this spill change guidance document is updated annually to reflect the various changes that were agreed upon regionally and that affect the Corps spill program.

The Voluntary Spill Program

The voluntary spill program is a set of actions taken to ensure that the agreed upon amount of water is spilled to aid fish migration and increase fish survival. The voluntary spill program described here involves the eight Corps dams on the Columbia and Snake Rivers. The actions taken are to ensure the appropriate amount of water is spilled includes:

1. Establish the order of which dams spill first in the event of involuntary spill, which is called spill priority list.

2. Review all of the real time data and various factors outlined in this spill change guidance document.
3. Based on the data review, develop a proposed spill level for the eight Corps dams on the Columbia and Snake Rivers.
4. Run simulation with the SYSTDG model to see what spill levels it suggest for the eight Corps dams.
5. Develop a final spill level for the eight Corps dams.
6. Coordinate changes to the spill levels with Bonneville Power Administration (BPA) real time operations staff, the dam operators and Corps RCC real time operations staff.
7. Send the CBT teletype out electronically to the BPA, the dam operators and RCC real time operations staff.
8. Review data and Corps reports that show the amount of spill for the previous date to ensure that the spill prescribed occurred. If not, call BPA real time operations staff, the dam operators or RCC real time operations staff to find out what happened.
9. Document when, where and why there are TDG exceedances of the 115% and 120% state water quality standards. Use this information to assist in changing the spill levels.

Setting Spill Priority

At least once during spill season, the Corps Water Quality Unit develops a spill priority list that gives the order of which dams should spill first in the event of involuntary spill. This list may change several times during the spill season depending on river conditions and other circumstances. It is important that the Corps RCC Fish Unit is consulted when new spill priority lists are developed and that the proposed spill priority list are discussed in the Regional forum of the TMT meetings. When establishing the order of which dams should spill first in the event of involuntary spill, the following factors are what the Corps considers:

- Location of Fish: Consider where the fish are. If TDG levels are at or below 120% with high involuntary spill put the projects with the most fish first on the priority list so the fish are benefited the most with the high spill and flows.
- Location of High TDG: When TDG levels are above 120 % with high involuntary spill, put the projects with the most fish last on the priority list so the fish are harmed the least with the high spill and flows.
- Location of Fish Studies: Consider where there are special fish studies and put those projects low on the priority list so the studies can remain intact as designed.
- River Reaches: Consider projects in one of three blocks: Lower Snake; Lower Columbia and Middle Columbia. For example, if several Lower Snake projects need to be moved to low priority on the list, then move the whole block of projects (LWG; LGS; LMN and IHR) to the last.
- Special Operations: Place projects with special operations such as maintenance or project gate malfunctioning last on priority list.
- Collector Projects: During low flow years, place the collector projects (LGS; LWG; LMN; MCN) low on the priority list so that spill is away from them.
- Special Fish Conditions: If there are special fish conditions, such as disease or a special release, then move the project to first place on the priority list so the fish receive the maximum spill.

The Factors that Affect Spill Levels:

There are a total of 22 factors to consider when determining how much water will be spilled at the Corps dams. The following is a list of these factors with a discussion:

1. **2008 Spill Guidance Table:** The Spill Guidance Table called Table 1 provides spill amounts, times, planning dates, and minimum generation requirements for the projects that provides voluntary spill for juvenile fish passage. This table is derived from many discussions and agreement with Corps attorneys and policy people like Rudd Turner. Since the spill levels at each project may be modified from year-to-year based on decisions made through the regional forum process or through the court, this table is updated annually. The spill levels are expressed as a minimum or maximum spill in kcfs, as a % of river flow, or as a spill cap. For example, Bonneville's *minimum* spill level is 50 kcfs and Lower Granite has a *maximum* spill of 20 kcfs using the RSW for 24 hours. Examples of spill in % of the total river flow are JDA with 60% at night and zero spill during the day until June 20th. The state standards gas cap of 120% in the tailwater and 115% in the forebay is examples of state standards restricting spill levels based on the total dissolved gas levels.

Table 1
2008 FOP Spill Guidance Table

Project	Planning Dates	Time	Amount [c]	Minimum Generation Requirements kcfs
Lower Granite	April 3 - June 20	24 hours per day	20 kcfs (RSW with training)	11 - 12 [a]
Lower Granite	June 21 - August 31	24 hours per day	18 kcfs (RSW with training)	11 - 12 [a]
Little Goose	April 3 - August 31	24 hours per day	To the spill cap up to 30% of project outflow	11 - 12 [a]
Little Goose	Two weeks during April 22 – May 15	1800 - 500	To the spill cap	11 - 12 [a]
Lower Monumental	April 3 - June 20	24 hours per day	To the spill cap (~27 kcfs)	11 - 12 [a]
Lower Monumental	June 21 - August 31	24 hours per day	To the spill cap up to 17 kcfs	11 - 12 [a]
Ice Harbor	April 3 - May 1 July 17 - August 31	500 - 1800	45 kcfs	7.5 - 9.5 [a]
Ice Harbor	April 3 - May 1 July 17 - August 32	1800 - 500	To the spill cap	7.5 - 9.5 [a]
Ice Harbor	May 2 - July 16	24 hours per day	Test conditions of spill alternating between to the spill cap up to 30% of project outflow and 45kcfs daytime/spill cap at night [b]	7.5 - 9.5 [a]
McNary	April 10 - approximately June 14	24 hours per day	To the spill cap up to 40% of project flow	50
McNary	Approximately June 15 - August 31	24 hours per day	Spill will alternate between to the spill cap up to 40% of project flow and to the spill cap up to 60% of project flow [b]	
John Day	April 10 - April 20	600 - 1800	0 kcfs	50
John Day	April 10 - April 20	1800 - 600	To the spill cap up to 60% of project outflow	
John Day	April 21 - July 20	24 hours per day	Test days with spill of either 30% or approximately 40% of project outflow	50
John Day	July 21 - August 31	24 hours per day	To the spill cap up to 30% of project outflow	50
John Day	April 10 - August 31	24 hours per day	Minimum spill is 25% of project outflow	50
The Dalles	April 10 - August 31	24 hours per day	To the spill cap or 40% of project outflow	50
Bonneville	April 10 - June 20	24 hours per day	To the spill cap up to 100 kcfs	30
Bonneville	June 21 - approximately July 20	daytime [d]	To the spill cap up to 85kcfs	30
Bonneville	Approximately July 21 - August 31	daytime [d]	To the spill cap up to 75kcfs	30
Bonneville	June 21 - August 31	nighttime [d]	To the spill cap (~120 kcfs)	30
Bonneville	April 10 - August 31	24 hours per day	minimum spill is 50 kcfs	30

a - Minimum generation requirements at the Lower Snake River projects depend on the status of generation at other projects as well as the status of the transmission system and may not be needed all the time. Specific details of the minimum generation requirement is provided in the 2008 Water Management Plan and the 2008 Fish Operations Plan.

b - There is a fish test occurring at this project. See Fish test section

c - Spill cap is defined as the maximum spill amount that will keep the High 12 hr %TDG average within the State WQ standards of 115% in the forebay or 120% in the tailwater

d - Day and nighttime for Bonneville vary during the spill season and are set in the Fish Passage Plan.

2. **Fish Tests Cause Changes to the ESA Requirements:** The spill levels established in the 2008 Fish Operation Plan reflect the proposed fish tests planned for the 2008 spill season. When fish tests are planned, the Water Management Plan is modified and the proposed fish tests are discussed in the Spring Summer Update of the Water Management Plan. The tests that are planned for each spill season is also discussed in the Fish Passage Plan, Appendix A. When a fish passage test is planned that will modify the regularly established spill regime, then it receives special attention since it would cause TDG levels to fluctuate. The fish tests for the 2008 spill season that will change the spill regime are:

    - **Ice Harbor:** *Fish Passage and Survival Evaluation Test* – Test conditions will include spill alternating between to the spill cap up to 30% of project outflow and 45 kcfs daytime/spill cap at night. Test starts on April 3 and will continue through August 31, 24 hours per day.
    - **McNary:** *Fish Passage and Survival Evaluation Test* – Acoustic telemetry will be used to evaluate the performance of two Top Spillway Weirs (TSW) during the spring and summer. The spring test conditions will include spilling to the spill cap up to 40% of project outflow from April 10 to approximately June 14. Summer test conditions will include alternating spill between to the spill cap up to 40% of project outflow and to the spill cap up to 60% of project outflow. The summer test will occur from approximately June 15 through August 31. Both spring and summer tests will continue for 24 hours per day.
    - **John Day:** *Fish Passage and Survival Evaluation Test* – Acoustic telemetry will be used to evaluate the performance of two Top Spillway Weirs (TSW) from approximately April 27 through July 20. Test conditions will include spill of either 30% or approximately 40% of project outflow for 24 hours per day.
    - **Bonneville:** *Spillway Survival Study* - Acoustic telemetry will be used to estimate the survival of yearling Chinook salmon that pass through the spillway and dam. The purpose of this study is to evaluate the effect of spilling 100 kcfs 24-hours per day during the spring migration.

3. **Gas Caps:** The Oregon and Washington variances establish TDG limits of 115% for forebay's and 120% for tailwater's which are called gas caps. These state standards TDG gas cap are embodied in spill caps that are issued in spill priority list to the projects during spill season. In order to address the conditions of the variances, the Corps tracks the following information:
    a. High 12-Hour Average TDG: Both the Oregon and Washington variances set TDG standards based on the average of the 12 highest TDG levels measured in a given calendar day. Calculated High 12-Hour Averages for TDG are posted on the web at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/html/ .

    b. Daily TDG Spill Decisions Form: The Corps fills out daily TDG spill decision form with the information that caused us to change the spill levels. The type and degree of exceedance is also documented. This form documents the spill changes.

    c. Exceedences Tracking: The Corps keeps track of the date, number, reason and actions taken for the exceedences that occur. The exceedence tracking summary is discussed at the TMT meeting and available on the TMT web page at http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/

d. List of Daily Spill Caps: The Corps maintains a list of the spill caps determined for each project. An annual list of spill caps for all of the projects can be found on the "M" server (rccfiles wmserver): M://Water Quality/Spill Caps/2007_Spill_Caps. There is also a historical spill cap list that goes back to 1997, which can be found at the same location under /SpillCaps_1977_2007. An annul summary of the spill caps for all the projects can be found at http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/

4. **Programs to Evaluate Spill Data:** The Corps has developed several programs that summarize spill data, which are used in spill level change decisions. These programs are:

   a. Amount of Voluntary Spill: The Corps Project Plots program tracks of the amount of voluntary spill that represents FOP spill for fish. The Project Plots program generates graphs of the FOP spill, actual spill, TDG levels and flow that are used during the daily spill evaluations and changes.

   b. Percent Spill: There is a program that calculates the percent of total river flow that is spilled at Little Goose; Ice Harbor; McNary; John Day and The Dalles. This is a simple calculation that uses the following equation: % Spill= spillway discharge/total project flow. The results of this calculation can be found at the following public website: http://www.nwdwc.usace.army.mil/tmt/documents/ops/spill/

   c. Tributary Data Reports: There is a report that shows the flow and water temperature for the tributaries that flow into the Lower Snake and Columbia Rivers. The Tributary Data report for a total of 25 tributary gauges with hourly flow and/or temperature data can be found at: http://www.nwdwc.usace.army.mil/ftppub/water_quality/wqreport.txt . This data was added to the SYSTDG model so the tributary influences to TDG levels on the Lower Snake and Columbia Rivers will be considered.

5. **Bonneville Daytime Spill Schedule:** The definition of daytime and nighttime effects how long the spill levels are maintained. At Bonneville, the definition changes frequently throughout the spill season and the definitions are listed in Table 2 taken from Table BON – 5 of the Fish Passage Plan, page BON-13

Table 2

Bonneville Daytime Table

Date	Hours
Jan 1 – Jan 19	700 - 1730
Jan 20 – Feb 14	630 - 1800
Feb 15 – Mar 1	600 - 1830
Mar 2 – Apr 2	530 - 1900
Apr 3 – Apr 20	500 - 2030
Apr 21 – May 16	500 - 2100
May 17 – May 31	430 - 2130
Jun 1 – Jun 30	430 - 2130
Jul 1 – Jul 31	430 - 2200
Aug 1 – Aug 15	500 - 2145
Aug 16 – Aug 31	500 - 2030
Sep 1 – Sep 16	530 - 2000
Sep 17 – Oct 4	600 - 1930
Oct 5 – Oct 19	630 - 1900
Oct 20 – Oct 29	630 - 1830
Oct 30 – Nov 30	600 - 1700
Dec 1 – Dec 31	630 - 1700

6. **Minimum Operating Pool:** The Minimum Operating Pool (MOP) is maintained as part of the fish passage effort. The MOP operations typically begin on the first day of spill season and ends in September to October for the Lower Snake River projects. The MOP forebay elevation becomes important when calculating how much spill can occur. In Table 3, MOP forebay elevations are:

Table 3

MOP and MOP + 1		
Project	**MOP in ft**	**MOP + 1 in ft**
Lower Granite	733	734
Little Goose	633	634
Lower Monumental	537	538
Ice Harbor	437	438

7. **Minimum Spill and Generation During Low Flows:**
When the river discharges are low then low flow conditions exist and minimum spill and minimum generation are an issue. The various projects are entitled to a certain amount of flow for power generation at all times if they choose to use it. Table 4 shows the minimum spill amount that is allowable during low flow and the amount of flow (kcfs) associated with the minimum generation requirements. The information in Table 4 is taken from the 2008 FOP.

Table 4

*2007 Minimum Spill & Generation Table			
Project	**Minimum Spill in kcfs**	**Units**	****Minimum Generation Requirements kcfs**
Lower Granite	None	Units 1-3	11 - 12
		Units 4 - 6	12.5 - 13.5
Little Goose	None	Units 1-3	11 - 12
		Units 4 - 6	13 - 14
Lower Monumental	6.8	Unit 1	17 - 19
		Units 2-3	11 - 12
		Units 4 - 6	12 - 14
Ice Harbor	15.2	Units 1-3	9 - 10
		Units 4 - 6	11 - 12
McNary	None	N/A	50
John Day	25%	N/A	50
The Dalles	None	N/A	50
Bonneville	50	N/A	30
*At typical head. **These minimum generation ranges are reflective of FOP, but may need further development, therefore deviations of 0.1 or 0.2 kcfs for one or two hours are not reported.			

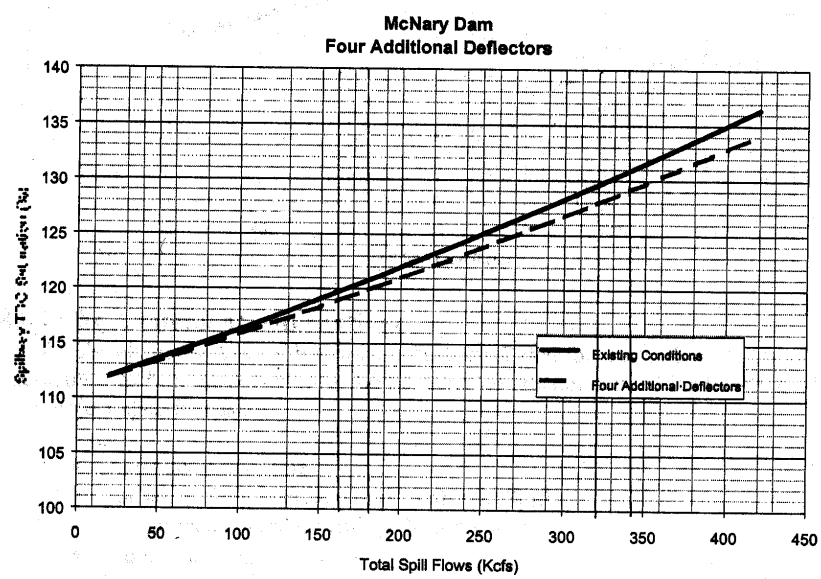
8. **General Rule of Thumb Guidance:** The following basic adjustment guidance is a rule-of-thumb method used in a general way.

   a. Snake projects – 5 kcfs change in spill results in about 2% change in TDG.
   b. Columbia projects – 10 kcfs change in spill results in about 2% change in TDG.
   c. 1 ^{0}F water temperature rise will result in about 1% TDG rise. See #15 for more information.
   d. Little Goose tailwater TDG levels need to be at about the same as Lower Monumental forebay because there is no degassing between the two dams. There are times when the % TDG in the Lower Monumental forebay can be higher than the Little Goose tailwater.

9. **DGAS Report Project-by-Project Guidance**: Project TDG Performance Graphs, derived from the DGAS studies, provide the relationship between spill flows and TDG levels at a

constant temperature. Figure 1 is an example of one of the graphs that exists for the eight Corps projects on the Lower Columbia and Snake Rivers (use existing conditions).

Figure 1



10. **Travel Time Guidance:** Knowing the amount of time it takes for water to travel from one project to the next is important in making TDG decisions. Table 5 provides estimated travel times for water to travel from one project to the next on the Columbia and Snake Rivers.

Table 5

COLUMBIA/SNAKE RIVER TRAVEL TIMES Days for Water to Travel through Reservoirs							
	VARIABLE RIVER FLOW RANGES						
PROJECT	50K*	75K*	100K*	150K*	200K*	250K*	300K*
From the Confluence of the Snake and Clearwater Rivers to Lower Granite Dam	4.44	2.96	2.22	1.48	1.11	0.89	0.74
From RM 146.5 (Six miles up the Snake River and the beginning of the Lower Granite	4.72	3.15	2.36	1.57	1.18	0.94	0.79
From Lower Granite to Little Goose	5.35	3.57	2.68	1.78	1.34	1.07	0.89
From Little Goose to Lower Monumental	3.73	2.49	1.86	1.24	0.93	0.75	0.62
From Lower Monumental to Ice Harbor	4.02	2.68	2.01	1.34	1.00	0.80	0.67
From Ice Harbor to McNary	13.05	8.70	6.53	4.35	3.26	2.61	2.18
From McNary to John Day	22.86	15.24	11.43	7.62	5.72	4.57	3.81
From John Day to The Dalles	3.11	2.08	1.56	1.04	0.78	0.62	0.52
From The Dalles to Bonneville	7.18	4.79	3.59	2.39	1.80	1.44	1.20
From Bonneville to Camas/Washougal	----	1.3	1	0.8	0.6	0.56	0.49

* These are estimated travel times determined from the theoretical residence time in each pool (volume/discharge). Mike Schneider is the author of these times and they are in agreement with TDG fronts observed with actual data

In order to know the travel time for water to flow from Dworshak to Lower Granite, it is necessary to calculate it in two parts and add them together. The two parts are the travel time from Dworshak to the confluence of the Snake River and the travel time from the confluence of the Snake River to Lower Granite. Tables 6 and 7 show the information used to get the travel time for the Dworshak to Lower Granite reach.

Table 6

DWORSHAK TO CONFLUENCE RIVER TRAVEL TIMES						
Days for Water to Travel through Reservoirs						
PROJECT	**VARIABLE RIVER FLOW RANGES**					
	5K*	**10K****	**20K***	**30K****	**40K***	**50K****
From Dworshak Dam to Confluence of the Snake and Clearwater Rivers	19 hrs	15.6 hrs	12.6 hrs	11.1 hrs	10.2 hrs	9.5 hrs
From Dworshak Dam to Confluence of the Snake and Clearwater Rivers	0.79	0.65	0.53	0.46	0.43	0.40

Note: These are estimated theoretical retention times based on information from Mike Schneider.

Table 7

DWORSHAK TO LOWER GRANITE RIVER TRAVEL TIMES						
Days for Water to Travel through Reservoirs						
PROJECT	**VARIABLE RIVER FLOW RANGES**					
	50K on Snake & 5K on Clearwater	**75K on Snake & 10K on Clearwater**	**100K on Snake & 20K on Clearwater**	**150K on Snake & 30K on Clearwater**	**200K on Snake & 40K on Clearwater**	**250K on Snake & 50K on Clearwater**
From Dworshak Dam to Lower Granite Dam	5.23	3.33	2.53	1.80	1.43	1.20

* These are estimated travel times determined from the theoretical residence time in each pool (volume/discharge). Mike Schneider is the author of these times and they are in agreement with TDG fronts observed with actual data.

11. **Weekend Guidance:** Total River Flow can significantly decrease on weekends, causing a resulting increase in TDG. As a result, the spill caps are usually decreased on Friday.

12. **Monday Guidance**: Beginning-of-the-Week Total River Flows on Monday increase, causing the TDG level to decrease. As a result, the spill caps are usually increased on Monday.

13. **Holiday Guidance**: Total River Flow can significantly decrease on holidays, causing a resulting increase in TDG. As a result, the spill caps are usually decreased on before a holiday.

14. **Degassing Guidance**:
    a. Winds above 10 mph enhance degassing in Columbia Gorge.
    http://www.wunderground.com/US/OR/Hood_River/KDLS.html
    Go to Personal Weather Station: Hood River (near bottom of the webpage)
    b. At flows **above** 200 kcfs at BON, little degassing occurs between BON and Camas.

c. At flows **below** 200 kcfs at BON, significant degassing occurs between BON and Camas.

15. **Water Temperature Guidance**: Climatic conditions can cause increases in water temperatures, which in turn can cause increases in TDG levels. Using Boyle's gas law, a rule of thumb was developed that 1^{o}C or 1.8^{o}F water temperature change can result in a 2 to 3 % change in TDG saturation. Since we cannot predict water temperature, we use air temperature as found in weather forecast, as a surrogate. The National Weather Service, the Northwest River Forecast Center posts information daily on the forecasted temperatures, which are available at http://137.161.65.209/weather/10_day.cgi. Real-time and historical water temperatures at the projects can be found at the external website: http://www.nwd-wc.usace.army.mil/tmt/documents/ops/temp/ and the temperature string for Dworshak can be found at the internal location: http://www.nwd-wc.usace.army.mil//tmt/documents/ops/temp/carroll/DWR_S1_2005_12.html

16. **Physical Designs**: There are physical designs and system features that have unique affects on spill decisions and spill caps. The spill pattern at John Day and the bottleneck influence at Camas/Washougal are two examples.

- John Day Spill Pattern – The spill patterns at John Day are such that to spill at low levels (80 kcfs) generate the same amount of TDG as spill at high levels (140 kcfs). Spill at about 108 kcfs generate much higher TDG levels than at 80 or 140 kcfs. This anomaly causes difficulty in regulating spill levels. Avoid spilling between 102 and 115 kcfs, especially at 108 kcfs. Spilling at 130 kcfs generates more TDG than 140 kcfs.
- Bottlenecks in the Rivers: – The flow deflectors at certain projects allow higher spill levels than in the past. But as a result, certain projects become bottlenecks in segments of the river. For example, if Warrendale were operated at 120% then Camas/Washougal would be in exceedance of the 115% TDG gas cap most of the time when the total river flow is above 200 kcfs. Similar phenomena occur at Lower Granite, Little Goose and Lower Monumental river segments in the Snake. If Little Goose is operated at 120% then Lower Monumental forebay would be in exceedance of the 115% TDG gas cap most
- Bonneville's Uniqueness: There are several factors that are unique to Bonneville which play a significant role in producing high number of TDG exceedances at Cascade Island and Camas/Washougal. The factors are:
  1. Flow Deflectors: There are flow deflectors at two different levels, both need 12 feet of head to be fully functional as designed. Flow deflectors on bays 1-3 and 16-18 were built at 7 ft, so at a 19ft tailwater elevation or higher, these flow deflectors are not functioning. Flow deflectors on bays 4 -15 were built at 14 ft, so at a 26ft tailwater elevation or higher, these flow deflectors are not functioning. Since the tailwater elevation during April and May was above 19ft all the time, and above 26 ft some of the time, some or all flow deflectors were not functioning resulting in numerous TDG exceedances.
  2. Topography: The topography of the reach below Bonneville is such that the water can go to a much greater depth (100ft) than other projects where depth is 15 to 20ft. This results in more gas being produced.

3. Stage Elevation: The stage elevation can experience huge changes, between 6 and 30 ft. This is much more than other projects where the elevation change is between 4 and 6ft.

17. **Physical Limitations:** There are four physical limitations that effects how the fish move or the amount and manner of spill distribution across the channel. These physical limitation are:

- **Screen Lengths**: Because of the screen lengths at Lower Monumental; Little Goose and Lower Granite, it is helpful to fish survival to have a balance of spill amounts between the three projects. Lower Monumental has standard length submersible traveling screens, which are 20 ft long. More fish are able to get under them and end up going through the turbines, resulting in higher fish mortality. Little Goose and Lower Granite has extended length screens, which are about 40 ft long. Less fish are able to get under them
- **The Dalles**: During 2005, the cables involved in lifting the spillway gates were found to be deteriorating. During 2005 and 2006 spill bays 1 – 9 were repaired completely. The repair of the spill bays 10 – 13 will be completed when funding ($450,000) is available. Repair of gates 10-13 are left as an option in the current contract and will be available in the future. Spill bays 10 – 22 can be operated in an emergency. See Appendix 1 in FOP.
- **Turbines Out of Service:** On a weekly or daily basis, there are unit outages that will affect the spill volume at the projects. There are four turbines on the Columbia or Snake River that will be out of service for two to ten months and they are:

  - Lower Granite: Unit 2 out of service through September (Linear Cavitation & Generator Rewind - Turbine)
  - Little Goose: Unit 6 out of service through September (F-Winding Repair)
  - Ice Harbor: Unit 1 out of service July through August (Main Unit Strainers)
  - Ice Harbor: Unit 6 out of service through June (F-high gas readings/T6 Repair)
  - McNary: Unit 5 out of service July through September (9-Yr Overhaul)
  - McNary: Unit 7 out of service during July (ETBOC)
  - John Day: Units 1 and 3 out of service July 28 through September 4 (Overhaul)
  - The Dalles: Unit 4 out of service through May 22 (Cavitation Repair)
  - The Dalles: Unit 22 out of service May 27 through July 31 (5-yr/Blade Cavitation, Seals/Servo Motors)
  - Bonneville: Unit 7 out of service through spill season (Rehab Turbine, Stator)
  - Bonneville: Unit 3 out of service through May 30 (PH1 5-Yr-Overhaul, Turbine Obstructions)
  - Bonneville: Unit 1 out of service July 5 through August 20 (5-yr Overhaul, Turbine Obstruction, 300 G ins)
  - Bonneville: Unit 15 out of service July 28 through September (Cavitation Repair)

- **Mechanical Repairs of Spillway Gates at McNary:** Rehabilitation of three or four spillway gates was scheduled to begin in May or June 2006, but funding was not available. As of April 24, 2008, gates 3, 8, 11 continue to require work involving resurfacing wheels, installing low-friction seals, and painting. One gate would be rehabbed at a time, over about a four-week period. A gate would be removed from its slot for rehab and be replaced with a spare gate. Funding is still not available at this time.

18. **Flow Forecast**: The Corps -reservoir regulators run computer programs that generate flow forecast for the Columbia and Snake Rivers. These can be found on an internal server location that are not available to the public.

19. **SYSTDG Model**: The Corps will continue to use the SYSTDG model to run daily simulations forecasting the TDG levels. It will be used as a real time operations tool forecasting and hind casting to see what the TDG levels will be or would have been if conditions for a day in the past were entered.

20. **Exceedance Types**: The classification of what types of TDG exceedance at listed in Table 8 and are documented in the annual TDG and Temperature report. There is a spreadsheet called (The current year) Exceedance Types that summarize this information.

Table 8

TDG EXCEEDANCE TRACKING
Types of Exceedances:
1. Exceedance due to high runoff flows and flood control efforts.
2. Exceedance due to Intertie line outages.
3. Exceedance due to unit outages during repair or maintenance.
4. Exceedance due to BPA inability to handle load so water was spilled.
5. Exceedance due to a break down in communication. Teletype went out but no change occurred or Project operator interpreted teletype differently than what was intended.
6. Exceedance due to uncertainties when using best professional judgment to apply the spill guidance criteria, e.g., travel time, degassing, water temperature effects, spill patterns.
7. Exceedance due to high TDG levels coming from the Mid Columbia River Dam (see Pasco FMS readings).
8. Exceedance due to high TDG levels coming from the Snake River projects (see Ice Harbor Dam FMS readings).
9. Exceedance due to a load rejection; the powerhouse was not working and the river was spilled.
10. Exceedance due to lack of information; the FMS gage malfunctioned and we had no information at the time of making spill change decisions.
11. Exceedance due to mechanical problems, e.g., gate was stuck open, passing debris.
12. Exceedance due to sharp rise in water temperature (a 3 degree F. or greater change in a day).
13. Exceedance due to bulk spill pattern being used which generated more TDG than expected.
14. Exceedance due to non-functioning of flow deflectors during tailwater elevation above 19 ft and especially above 26 ft.

21. **Unit Availability Assumption**: During an average spill season, there are many units that are out of service for various reasons. Table 9 provides the percentage of turbine capacity available after adjustment for unit outages, 1% peak efficiency requirement, and system reserve obligations. BPA developed these percentages and the Corps reviewed and approved them so that the federal agencies had representative unit outage percentages. These unit outages percentages are the average of the actual month averages in 1999-2001 by project. BPA's Federal Hydro Resources determined those years to be more representative of the future expectation than any periods since due to increased investments in recent years to accomplish more routine maintenance that will pay dividends in reducing forced outage rates in the future.

Table 9

Unit Availability Assumptions During Spill Season in %

PROJECT	APR 1-15	APR 16-30	MAY	JUN	JUL	AUG 1-15	AUG 16-31
Lower Granite	71	80	80	72	59	56	53
Little Goose	71	77	80	78	71	61	54
Lower Monumental	77	82	78	81	75	65	61
Ice Harbor	83	85	85	81	74	72	62
McNary	68	68	69	69	66	64	65
John Day	85	87	86	89	92	88	87
The Dalles	69	71	73	71	70	69	69
Bonneville	72	76	77	74	66	68	68

22. **Full Powerhouse Information**: If any project has a full powerhouse available, than Table 10 provides the turbine capacity available for outside and within the 1% peak efficiency requirement. The Fish Passage Plan proscribes that project turbines are operated within 1% during spill season. Operation outside of 1 % generates more TDG so it is not as fish friendly and is allowed during non-spill season months

Table 10

Full Powerhouse Capacity

Project	Powerhouse capacities outside of 1% (kcfs)	Powerhouse capacities within 1% (kcfs)	One unit capacity (kcfs) - avg	# of Units	Flows that involuntary spill begins	Typical spill cap
Bonneville	288	257	14.3	18	357	100
The Dalles	281	288	13.1	22	408	120
John Day	322	331	20.7	16	491	160
McNary	232	172	12.3	14	312	140
Ice Harbor	106	92	15.3	6	184	92
Lower Monumental	130	115	19.2	6	139	24
Little Goose	130	112	18.7	6	142	30
Lower Granite	130	112	18.7	6	150	38

23. **Actual Powerhouse Generation Capacity Limitations:** There are limitations on how much water the powerhouse generators can physically handle. The full (maximum) powerhouse generation capacity, with all units in operation, is listed below in Table 11. The percentage unit availability shown in Table 11 is multiplied by maximum powerhouse capacity to give the true actual powerhouse capacity. These capacities are lower than full powerhouse and are used to calculate a realistic volume of involuntary spill. These powerhouse generator capacities are shown in Table 11 for the Columbia and Snake Rivers projects. It is important to note that McNary has the lowest generator capacity of the projects on the Lower Columbia and as a result, it will have involuntary spill during June and/or July when other projects are not.

Table 11

Actual Powerhouse Capacity after Adjustments for Outages (in kcfs)

PROJECT	APR 1-15	APR 16-30	MAY	JUN	JUL	AUG 1-15	AUG 16-31
Lower Granite	92	104	104	94	77	73	69
Little Goose	92	100	104	101	92	79	70
Lower Monumental	100	107	101	105	98	85	79
Ice Harbor	88	90	90	86	78	76	66
McNary	158	158	160	160	153	148	151
John Day	276	283	280	289	299	286	283
The Dalles	259	266	274	266	263	259	259
Bonneville	207	221	222	213	190	196	196

24. **Chum Redds Emergence –** During low flow years, the Chum Redds emergence presents a limitation on the amount of spill that can occur at Bonneville Dam and the levels of TDG that the redds can endure. The % TDG that redds can endure is influenced by the Bonneville tailwater elevation.

Two graphs are used together to determine the amount of spill that can occur with a specific tailwater elevation. Figure 2 is the Bonneville Powerhouse Tailwater rating curve from the Bonneville Water Control Manual and it illustrates the relationship between project outflow to tailwater elevation. Figure 2 is used in conjunction with Figure 3, which is a graph that shows the % TDG to outflow that can be used to establish spill levels. Usually this graph or the data is provided to us, which we use to regulate spill levels.

Figure 2
Bonneville Powerhouse Tailwater
Rating Curve

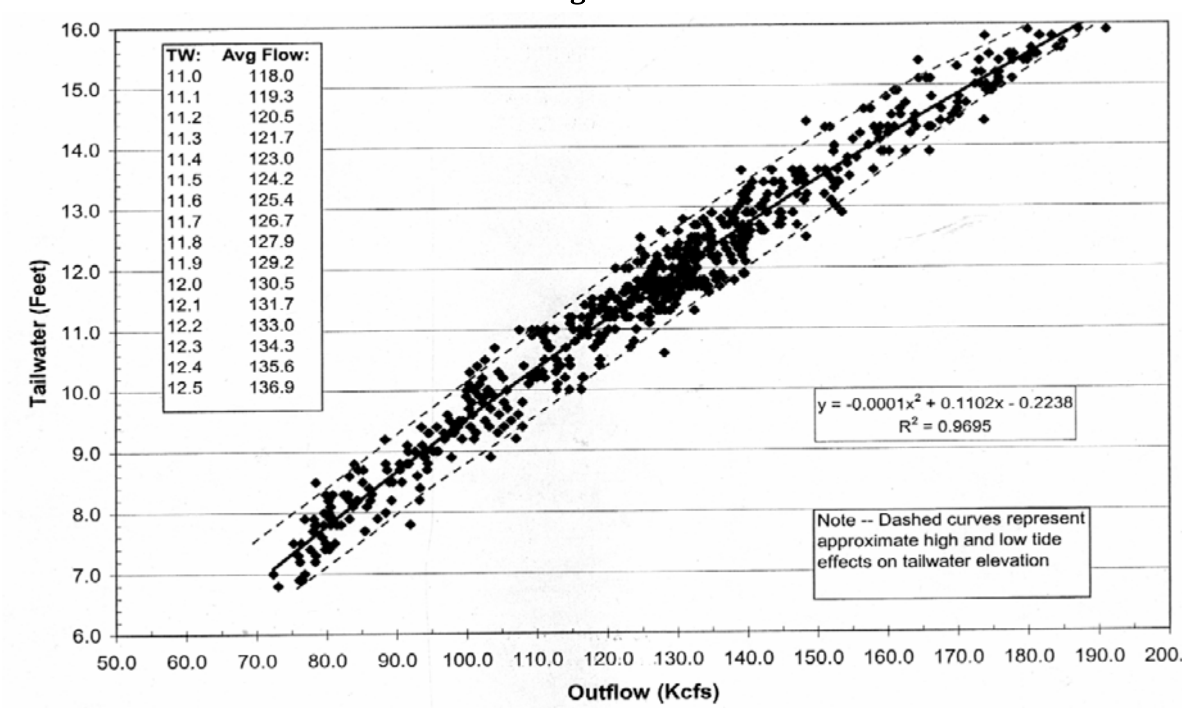
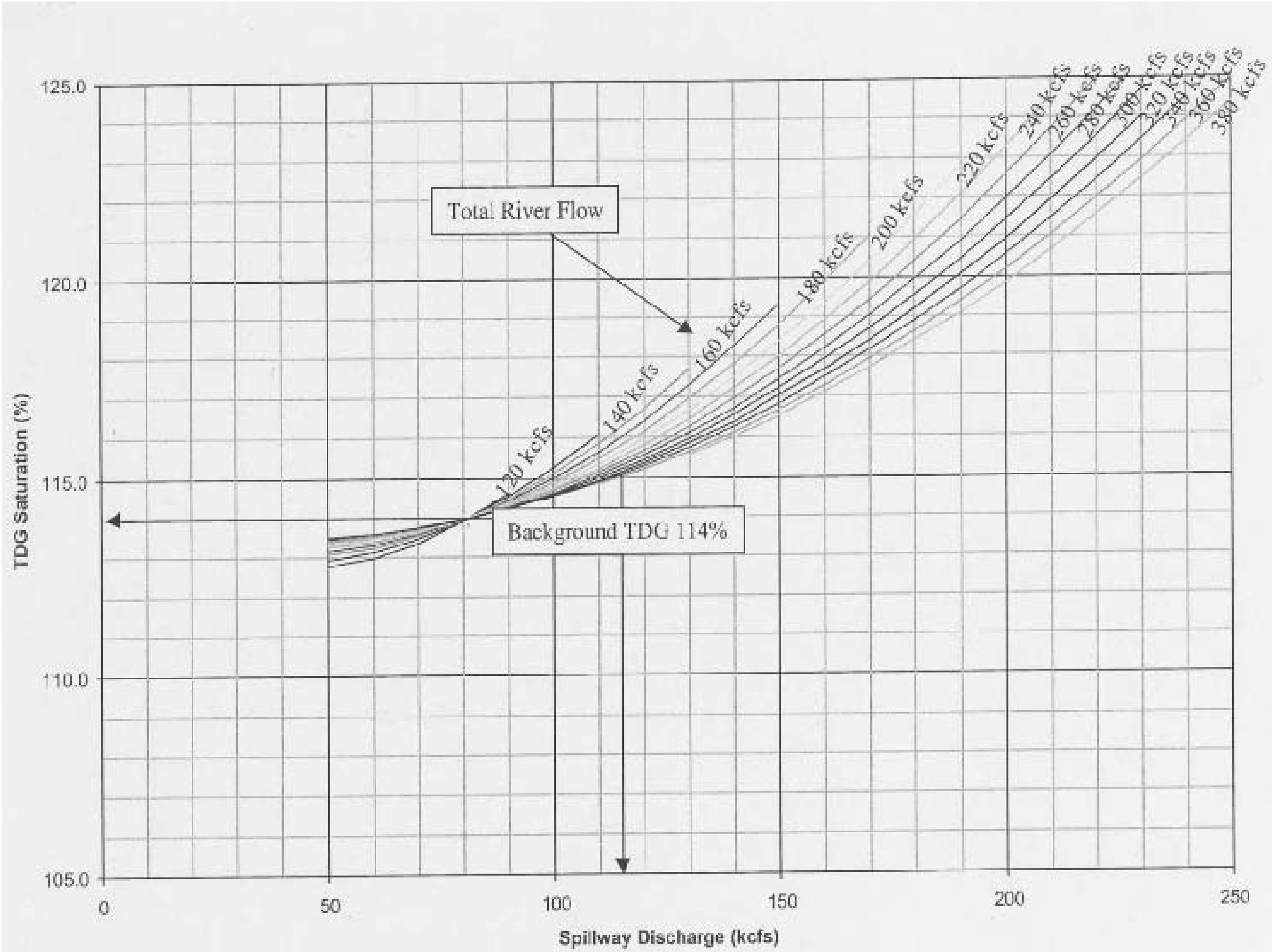


Figure 3


125.0
120.0
115.0
110.0
105.0
TDG Saturation (%)
0
50
100
150
200
250
Spillway Discharge (kcfs)
Total River Flow
Background TDG 114%
120 kcfs
140 kcfs
160 kcfs
180 kcfs
200 kcfs
220 kcfs
240 kcfs
260 kcfs
280 kcfs
300 kcfs
320 kcfs
340 kcfs
360 kcfs
380 kcfs