March 13, 2006

2006 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, 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 did not sign onto the agreement but agreed to implement the actions it described. This agreement stayed in effect for 3 years, until 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 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 species of fish 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 US Army Corps of Engineers; Bonneville Power Administration 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 decision concerning a motion for injunctive relief in *NWF v. NMFS* court case. Judge Redden granted in part and denied in part NWF's motion. The Court approved the Corps proposed amount and timing of spring and summer spill at the Columbia and Snake River dams except the spring spill operations are to be carried through the entire spring migration season and summer spill is to be continued through August 31st. The December 29, 2005 court decision also declared the 2004 Biological Opinion as inadequate and the federal agencies were ordered to remand it. In response to the court order, the Fish Passage Implementation Plan found at http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/ website was developed to describe the operations the Corps intends to initiate for fish passage at its FCRPS dams during the 2006 fish migration season.

As further decisions are make 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 SYTDG 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 real time operations staff, the dam operators and Corps RCC real time operations staff
7. Send the cbt teletype out electronically to the Bonneville Power Administration, the dams and 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 Bonneville Power Administration real time operations staff, the dam operators or Corps 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 Team 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. The spill priority lists are discussed in the TMT regional forum. 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.

It is important that the Corps the 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 Technical Management Team meetings.

The Factors that Affect Spill Levels:

There are a total of 19 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. **2006 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 the December 29, 2005 court order, and declarations from Colonel Martin and Rock Peter. . 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. Lower Granite has a maximum spill of 19 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
2006 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)	11.5 [a]
Lower Granite	June 21 - August 31	24 hours per day	18 kcfs (RSW with training)	11.5 [a]
Little Goose	April 3 - August 31	24 hours per day	To the spill cap up to 30% of project outflow	11.5 [a]
Lower Monumental	April 3 - June 20	24 hours per day	To the spill cap up to 40 kcfs	11.5 [a]
Lower Monumental	June 21 - August 31	24 hours per day	To the spill cap up to 17 kcfs	11.5 [a]
Ice Harbor	April 3 - July 21	24 hours per day	spill will alternate between 30% and 45kcfs/spill cap at night [b]	7.5 - 9.5 [a]
Ice Harbor	July 22 - August 31	500 - 1800	45kcfs	7.5 - 9.5 [a]
Ice Harbor	July 22 - August 31	1800 - 500	To the spill cap	7.5 - 9.5 [a]
McNary	April 10 - June 20	24 hours per day	spill will alternate between 40% and 0 kcfs/up to the spill cap or 150 kcfs at night [b]	50
McNary	June 21 - June 30	500 - 1800	0	50
McNary	June 21 - June 30	1800 - 500	To the spill cap or 150 kcfs	50
McNary	July 1 - August 31	24 hours per day	spill will alternate between to the spill cap or 40% and to the spill cap or 60% [b]	50
John Day	April 10 - June 20	600-1800	0	50
John Day	April 10 - May 15	1800 - 600 [e]	To the spill cap or 60 % of project outflow	50
John Day	May 15 - June 30	1900 - 600 [e]	To the spill cap or 60 % of project outflow	50
John Day	June 30 - August 31	24 hours per day	To the spill cap or 30% of project outflow	50
John Day	April 10 - August 31	24 hours per day	Minimum spill is 30% 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 30	24 hours per day	To the spill cap up to 100 kcfs	30
Bonneville	July 1 - August 31	daytime [d]	To the spill cap up to 75kcfs	30
Bonneville	July 1 - August 31	nighttime [d]	To the spill cap up to 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 Riverprojects may not be needed all the time.
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.
e- Day and nighttime for John Day usually changes on May 15 but this is not stated in the court order, General Martin's

2. **Fish Tests Cause Changes to the ESA Requirements:** The spill levels established in the 2006 Fish Passage Implementation Plan reflect the proposed fish tests planned for the 2006 spill season and have been negotiated through the federal courts. 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 2006 spill season that will change the spill regime are:

   - **Ice Harbor:** A new RSW was installed in spillbay 2 at Ice Harbor in 2005. A RSW passage and survival Fish test will estimate the passage and survival rates of fish passing over the RSW, spillway and through the powerhouse. The tainter gate at spillbay 2, when operated, will be either fully open or fully closed. The flow over the RSW will be regulated by the project forebay elevation and not by the tainter gate. Projected flow through the RSW at the anticipated forebay elevation of MOP + 1 foot will be around 8,000 cfs. Project operations (spill levels and possibly patterns) will change according to a randomized block schedule. Operations include two treatments: Spill 30% for 24 hours vs. 45 kcfs during the day and to the gas cap at night. Schedule is mid April through August 31st. Further details of the schedule and operations are not available at this time, but will be developed through the SRWG and FFDRWG. Specifics will be coordinated with the fishery agencies and others as needed.

   - **McNary:** A fish survival test is scheduled for mid April through Mid June that includes two treatments for the purpose of better defining spill operations for 12 vs. 24 hour. Spill 40% for 24 hours vs. 0 kcfs during the day and to the gas cap at night. A second test for the purpose of better defining spill operations is schedule from July 1 through August 31st where spill will alternate between 40% for 24 hours and 60% for 24 hours.

   - **Lower Monumental:** A Radio Tag fish test is scheduled for early April through Mid June which currently includes one treatment but could become two. The purpose of the test is to provide a relative survival estimate of fish that travel volitional through the project. A single treatment test appears to have minimum to no effect on spill levels. If adequate tags become available, a two treatment approach will be undertaken to look at two patterns, bulk and flat with an RSW in spill bay 8. The objective of the two treatment test would be to calify that river volume and the subsequent higher elevation of the tailrace determine the spill survival rater than whether it is bulk or flat spill pattern. Updates on this issue will occur.

4. **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. <u>High 12-Hour Average TDG:</u> 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 compost list of spill caps for all of the projects can be found M://water quality/spill season information/2006 spill_season/2006 spill caps. Another list of spill caps that goes back eight years for one project is maintained in the internal RCC folder, "Project" folders, project file, project constants workbook for each project. This list provides the maximum and minimum spill caps that have ever been used. 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/

5. **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 check_spill program tracks of the amount of voluntary spill that represents UPA spill for fish. The check_spill program generates graphs of the UPA 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 on the Corps website located at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/spill/html/ (This link will not work from this page. The link must be placed in the Internet address to work.).

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. There are a total of 25 tributary gauges with flow and/or temperature and the report showing hourly data is shown at http://www.nwd-wc.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.

6. **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 on Table 2 taken from Table Bon –6 of the Fish Passage Plan, Bon-13

Table 2
BON Daytime/Nighttime

Date	Daytime Spill	
	Begin	End
Jan 01 – Jan 19	700	1730
Jan 20 – Feb 14	630	1800
Feb 15 – Mar 01	600	1830
Mar 02 – Apr 02	530	1900
Apr 03 – Apr 20	500	2030
Apr 21 – May 16	500	2100
May 17 – May 31	430	2130
[1]Jun 01 – Jul 31	430	2200
Aug 01 – Aug 15	500	2145
Aug 16 – Aug 31	500	2030
Sep 01 – Sep 16	530	2000
Sep 17 – Oct 04	600	1930
Oct 05 – Oct 19	630	1900
Oct 20 – Oct 29	630	1830
Oct 30 – Nov 30	600	1700
Dec 01 – Dec 31	630	1700

[1] Start date for sockeye passage varies.

7. Firm Generation Commitments

The various projects are entitled to a certain amount of flow for power generation at all times if they choose to use it. The information in Table 3 is taken from Table 4 of the Updated Proposed Action (UPA) and is a list of the flows associated with firm generation commitments.

Table 3

Firm Generation Commitments Flows	
Project	**Flows in kcfs**
Lower Granite	11.5
Little Goose	11.5
Lower Monumental	11.5
Ice Harbor	7.5 - 9.5
McNary	50
John Day	50
The Dalles	50
Bonnesville	30

8. Basic Adjustment 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.

9. **DGAS Report Project-by-Project Guidance**, There are 60% DGAS Report. Project TDG Performance Graphs that provide the relationship between spill flows and TDG levels at a constant temperature. Figure 1 is an example of graphs that exist for the eight Corps projects on the Columbia and Snake Rivers. (Use existing conditions)

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 decision. Table 4 provides estimated travel times for water to travel from one project to the next on the Columbia and Snake Rivers.

Table 4

COLUMBIA/SNAKE RIVER TRAVEL TIMES
Days for Water to Travel through Reservoirs

PROJECT	VARIABLE RIVER FLOW RANGES						
	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 5 and 6 show the information used to get the travel time for the Dworshak to Lower Granite reach.

Table 5

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 6

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 must be 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 must be 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 must be 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°C or 1.8°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 post 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 near the projects can be found at the Corps website: http://www.nwd-wc.usace.army.mil/tmt/documents/ops/temp/

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 120 KCFS generate much higher TDG levels than at 80 or 140 KCFS. This anomaly causes difficulty in regulating spill levels.
- 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 of the time.
- BON Flow Deflectors: The flow deflectors no longer perform their function when the tailwater elevation reaches 26 ft or higher. Flow deflectors on spillbays 1-3 and 16-18 were built at 7ft. They function until there are 12 ft of water over them, so at a Bon tailwater elevation of 19 ft, six flow defectors are not functioning, causing TDG levels to rise. Flow deflectors on spillbays 4 - 16 were built at 14ft. They function until there are 12 ft of water over them, so at a Bon tailwater elevation of 26 ft, all of the flow defectors are not functioning, causing TDG levels to rise sharply.

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
- **Mechanical Failure at The Dalles**: During 2005, the cables involved in lifting the spillway gates were found to be deteriorating to such an extent that spillway bay gates 3 –

6 needed to be established at a fixed setting with the use of pendants. The repair of the spillway gates 1 – 6 is expected to be completed by April 4th which means that the project will be able to spill the necessary amount up to flows of 315 kcfs. The repair of the spillway gates 7 – 9 is expected to be completed by May 15th which means that the project will be able to spill the necessary amount up to flows of 500 kcfs. The repair of the spillway gates 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.

TDA Spill bay Available		
Spill bays	**Date Available**	**Highest total river Q**
1 - 6	4/10/2006	315
1 - 7	4/20/2006	360
1 - 8	4/30/2006	405
1 - 9	5/15/2006	450

- **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:

  - Bonneville - BON U-10 out of service until 1/1/07
  - Lower Granite - LWG U-2 out of service until 1/1/07
  - The Dalles – TDA U-12 will be out of service until 6/1/06 and TDA U-13 will be out of service until 9/14/06
  - John Day – Transformer T-1 failed March 2th. Since Transformer T-1 handles the power generated from Units 1-2-3-4, these units will not be able to operate until repairs are completed, which is estimated to be at least until at least Sept.

- **Mechanical Repairs of Spillway Gates at McNary:** Rehabilitation of three or four spillway gates is scheduled to begin in May or June 2006, if funding is available. The work involves 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. This swapping of gates would require a four to six hour outage in one spillway bay at a time, about one swap per month. All 22 spillway bays would be operable except during the gate.

18. **Flow Forecast**: The Corps reservoir regulators run computer programs that generate flow forecast for the Columbia and Snake Rivers. For further information call: 503-808-3936.

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. It will also be used to hind cast to see what the TDG levels would have been if conditions for a day in the past were entered.

    A statistical evaluation of the predictive errors on how well SYSTDG performed was completed on the 2004 and 2005 spill season data and will be on the 2006 spill season data

too. The results of the evaluation will be included in the 2006 Annual TDG and Temperature Report.

20. **Generation Capacity Limitations:** There are limitations on how much water the powerhouse generators can physically handle. These powerhouse generator capacities are shown on the following Table 7 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 7

Powerhouse Capacities

Project	Powerhouse Capacities (kcfs)	One Unit capacity (kcfs)	# of Units
Bonneville	288	16.0	18
The Dalles	281	12.8	22
John Day	322	20.1	16
McNary	232	16.6	14
Ice Harbor	106	17.7	6
Lower Monumental	130	21.7	6
Little Goose	130	21.7	6
Lower Granite	130	21.7	6

21. **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

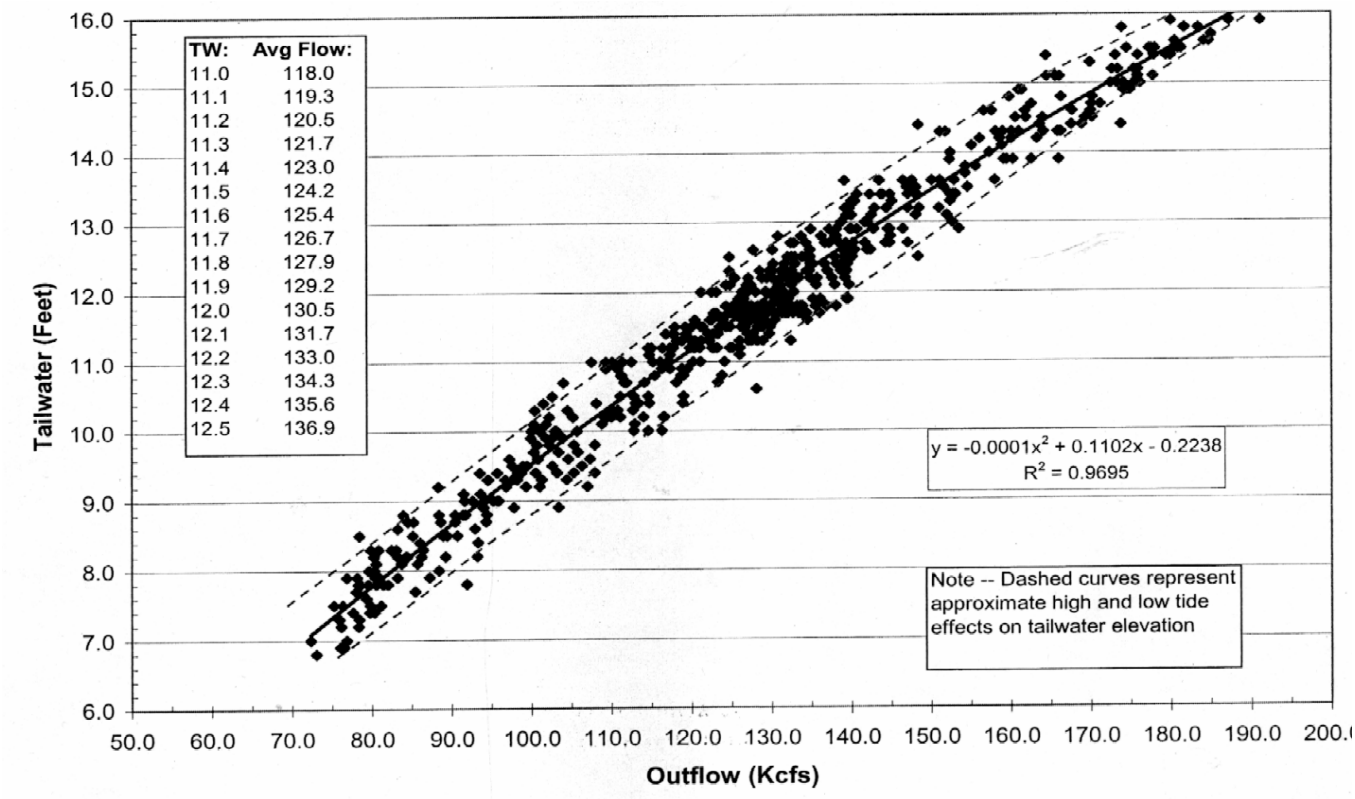
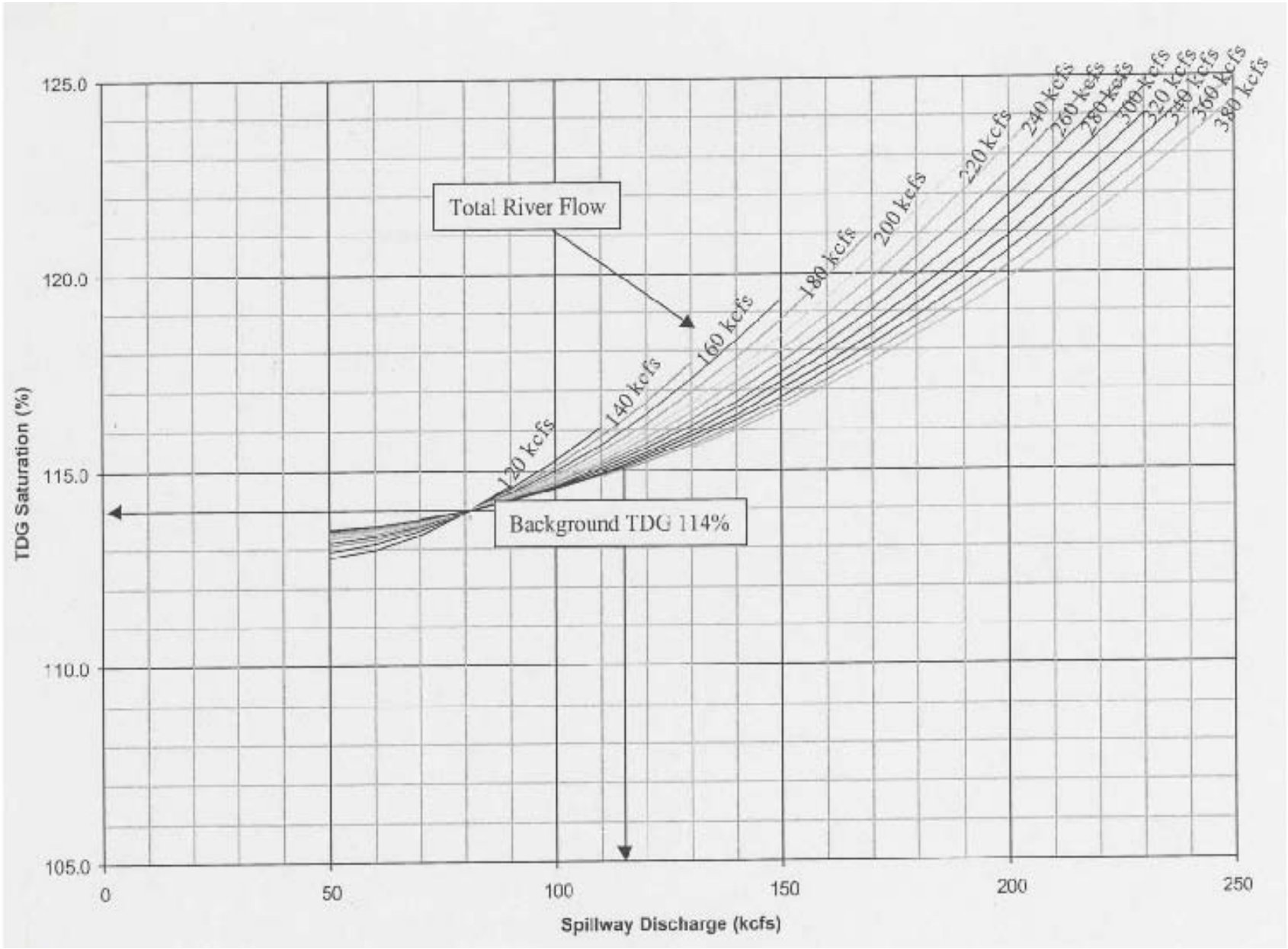


Figure 3


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