REVISED FINAL

Report On the SYSTDG Modeling for AMT

With and without 115% TDG standard

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Introduction:

At the November 1, 2007 Adaptive Management Team (AMT) meeting, the Corps was requested to model the total dissolved gas (TDG) response if the 115% TDG standard was removed and provide the increase in the spill volumes for each of the projects. As a result, the 2007 actual spill season was modeled with SYSTDG and the results were presented at the December 13, 2007 AMT meeting and in the December 7, 2007 SYSTDG modeling report. At the March 11, 2008 AMT, the states requested additional years be modeled with the new 2008 Biological Opinion spill operations; so this report is a continuation of the modeling effort that began in November 2007.

The AMT meetings are organized by the states of Oregon and Washington with various regional representatives to discuss whether the total dissolved gas (TDG) forebay gages and the 115% TDG state standard are necessary to protect endangered salmon. A series of AMT meetings were held in order to gather technical information and to discuss the issue. The eight projects under consideration are the four Lower Columbia projects (McNary, John Day, The Dalles and Bonneville) and the four Lower Snake River projects (Lower Granite, Little Goose, Ice Harbor, and Ice Harbor).

At the March 11, 2008 AMT, the Corps, NOAA Fisheries, and Bonneville Power Administration (BPA) agreed to provide biological modeling results to aid Washington and Oregon states in assessing the effects of removing the 115% TDG forebay limit on fish passage and survival. The federal agencies modeling process involved the Corps providing seven spill caps per project per water year to BPA for use in their HYDSIM model. Spill caps are the operational limit on how much hourly spill in kcfs can occur and maintain the 115% and 120% TDG state water quality standards. Therefore, spill caps are a reflection of the 115% and 120% TDG state water quality standards affecting spill management decisions.

The HYDSIM is a monthly time step model takes into consideration all the power and non power operating requirements of Canadian and US-Canadian treaty projects, and federal and non-federal projects in western Montana, southern Idaho, Washington and Oregon. The operational requirements that HYDSIM considers are meeting generation loads, flood control, irrigation, navigation, recreation and fish measures. HYDSIM is used in the regional modeling process because it incorporates in all of the operational regulations that the hydrosystem experiences in an average water year and because the National Oceanic and Atmospheric Administration (NOAA**)** Fisheries Comprehensive Fish Passage (COMPASS) model was designed to receive its flow and spill outputs.

COMPASS is a daily time step model that estimates downstream passage survival of juvenile salmonids under specific FCRPS operations. It evaluates e: Snake River spring/summer Chinook salmon, Snake River steelhead, Upper Columbia River spring Chinook salmon, Upper Columbia River steelhead, and Mid Columbia River steelhead evolutionary significant units. COMPASS evaluation covers only the spring (April –

June) time period for the Lower Columbia and Lower Snake Rivers projects, reaches and systemwide.

The seven spill caps included two for April and August and one for May, June, and July. Three water years were selected to represent the low, medium and high water years. The spill caps were applied to the 70 year record used in HYDSIM. BPA uses HYDSIM to generate daily flow and spill volumes for the 70 year record for NOAA Fisheries to use in their COMPASS model to determine the effect of removing the 115% TDG forebay limit on fish passage and survival. NOAA Fisheries has prepared a presentation to AMT about the effects of removing the 115% TDG forebay limit on fish survival and smolt-to-adult returns (SARs). The federal agencies modeling process used in the Remand process, culminating in the NOAA Fisheries Biological Opinion dated May 5, 2008 is the same one used to develop the information on the removal of the 115% TDG standard found in this report.

The federal agencies modeling process used in the 2008 Biological Opinion is the same one used to develop the information on the removal of the 115% TDG standard found in this report.

Since COMPASS is designed to assess fish passage and survival for only the spring migration (April – June), NOAA Fisheries did not providing fish passage and survival information for the months of July and August. This model limitation was addressed during the April 8, 2008 AMT meeting when the Corps presented project specific fish passage and survival studies and research for April through August.

This report addresses two questions posed by AMT and the federal modeling process that will provide AMT with the fish passage and survival information they requested:

1. What are representative spill caps for low, medium and high water years, with and without the 115% TDG standard that can be used in the HYDSIM model?
2. When and where do the 115% TDG standard and the forebay gages control spill?

In order for the Corps to answer these two questions, it was necessary to use the SYSTDG to model two scenarios: with and without the 115% TDG standard for three water years.

Modeling Assumptions:

The following assumptions used in the SYSTDG modeling were developed through negotiations between the Corps, NOAA Fisheries, and BPA.

- **Dates for Beginning of Spring Spill**: Spring spill season begins April 3rd at the Lower Granite; April 5 at Little Goose; and April 7th at Ice Harbor and Ice Harbor. Spring spill season begins on April 10th at the four lower Columbia projects.

- **Date for End of Spring Spill**: For the purposes of SYSTDG modeling, termination of spring spill will be considered to be May 14th at the Lower Granite, Little Goose and Ice Harbor. Termination of spring spill will be considered to be June 15th for Ice Harbor the Lower Columbia River projects.

- **Date for Beginning of Summer Spill**: For the purposes of SYSTDG modeling, the beginning of summer spill will be considered to be June 5th at the Lower Snake River projects and June 16th at the Lower Columbia River projects.

- **End of Summer Spill**: For the purposes of SYSTDG modeling, the end of summer spill will be considered to be August 5th at the Lower Granite; Little Goose and Ice Harbor; August 7th at Ice Harbor and August 31st at the Lower Columbia River projects.

- **Spill Patterns**: Projects used the 2007 actual spill pattern.

- **Minimum generation**: Minimum generation levels are 9.5 kcfs at IHR; 11.5 kcfs at Ice Harbor; Little Goose; and Lower Granite; 50 kcfs at McNary, John Day and The Dalles; and 30 kcfs for Bonneville.

- **Actual Data is used**: The boundary conditions for the selected years will be used, which includes actual flows, tailwater elevations, initial TDG levels and weather (wind and water temperature). (see **Meteorological** data)

- **Priest Rapids Spill**: Priest Rapids spills 61% of total project flow from April 15th to June 15th and then 58% from June 15th to August 15th. (Although their BiOp calls for 39% spill at Priest Rapids during the summer, 58% is spilled because of spill trading to cover Wanapum.)

- **FMS stations moved:** The McNary forebay, Little Goose forebay, Ice Harbor forebay, Ice Harbor forebay and John Day forebay gauges were moved in 2004. The moving of these stations is believed to have little significant effect on the SYSTDG modeling.

- **Meteorological Data is missing –** For 1999 **w**ind data from Pasco AgriMet station will be used instead of Little Goose and Lower Granite meteorological data. Wind data from the Dalles airport national weather service data will be used instead of Bonneville meteorological data. For 2002, wind data is missing for the IHR and LMN so 2007 wind data is used.

- **Selected Years**: The selected water years for modeling are based on the April through August regulated runoff volumes compared to HYDSIM 70 year average. Table 1 provides these percentages for 1997 - 2007. The year 2007 is selected as the low water year, 2002 as the medium water year and 1999 as the high water year. As Table 1 shows, these three years provided a wide representation within recent years for the Lower Columbia and the Snake Rivers together. The high

(1999), medium (2002), and low (2007) water years selected for this analysis are highlighted in yellow.

TABLE 1
April - August Actual Regulated Volumes,
as a Percentage of the HYDSIM 70 Year Average Volumes

Year	LWG	TDA
1997	152	147
1998	110	95
1999	115	113
2000	81	87
2001	49	47
2002	85	96
2003	84	80
2004	70	73
2005	68	73
2006	112	104
2007	61	83
Overall average	90	91

- **Number or Exceedances**: The definition of a TDG exceedance is the only variable that changes between the two modeling scenarios of with or without the 115% TDG standard. An attempt will be made to keep the TDG exceedances at approximately the "same number by definition" between the two scenarios. It was agreed that approximately the same number by definition means within 15 % of each scenario in a water year. By keeping the number of TDG exceedances the same the spill volumes could be compared. This is more difficult to do in high water years when there are many exceedances.

- **Miscellaneous Flows:** The miscellaneous flows include the water that flows through the fish ladders, the navigational locks, corner collector and other fish structures. Table 2 provides the miscellaneous flow volumes that were used in SYSTDG:

TABLE 2
Total Miscellaneous Flows in kcfs

Project	Total Miscellaneous Flow in kcfs
Lower Granite	2
Little Goose	2.2
Lower Monumental	2.1
Ice Harbor	2
McNary	6.2
John Day	2.8
The Dalles	6.9
Bonneville	12.6

- **Units Available:** The percentages of units available at each of the projects are summarized on Table 3. The percentages of turbine capacity available consider adjustments for unit outages, 1% peak efficiency requirement and system reserve obligations. These unit outages 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 because of increased investments in recent years to accomplish more routine maintenance will reduce forced outages in the future.

TABLE 3
BPA HYDSIM Percent Unit Availability
During April through August

PROJECT	AP1	AP2	MAY	JUN	JUL	AG1	AG2
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	64	68	69	66	58	60	60

- **Structures:** The 2007 projects' physical structure configurations will be used. In terms of TDG production at spillways, this assumes that the new RSWs or TSWs at Lower Columbia projects will not affect the spill volume enough to change the spill caps substantially. While TSWs can concentrate spill, the effects are not seen as easily at the Lower Columbia River projects since there are more spillbays to spread the spill across. The TDG production effects of an RSW or TSW at a Lower Snake River project may be more significant since there are fewer bays to dilute the effects.

- **Spill Operations**: The agreed upon spill operations for mainstem projects is consistent with the HYDSIM Assumptions used for the October 31 NOAA Fisheries Draft FCRPS BiOp with certain modification. These operations are summarized in Table 4.

TABLE 4

Spill Operations at the Columbia and Snake River Dams

SPRING	**HYDSIM Assumptions for Final BiOp (March 17, 2008)**	
Project	**Spring Operation (Day/Night)**	**Spring Spill Dates**
Bonneville	100 kcfs/100 kcfs	4/10-6/15
The Dalles	40%/40%	4/10-6/15
John Day	30%/30%	4/10-6/15
McNary	40%/40%	4/10-6/15
Ice Harbor	30%/30%	4/7-6/15
Lower Monumental	Gas Cap/Gas Cap	4/7-5/6,5/21-6/4[3,6/]
Little Goose	30%/30%	4/5-5/6,5/21-6/4[3,6/]
Lower Granite	20 kcfs/20 kcfs	4/3-5/6,5/21-6/4[3,6/]
SUMMER	**HYDSIM Assumptions for Final BiOp (March 17, 2008)**	
Project	**Summer Operation (Day/Night)**	**Summer Spill Dates**
Bonneville	85 kcfs/Gas Cap[8/]	6/16-8/31
The Dalles	40%/40%	6/16-8/31
John Day	30%/30%	6/16-8/31
McNary	40%/40%	6/16-8/31
Ice Harbor	30%/30%	6/16-8/7[5/]
Lower Monumental	17 kcfs/17 kcfs	6/5[6/]-8/5[5/]
Little Goose	30%/30%	6/5[6/]-8/5[5/]
Lower Granite	18 kcfs/18 kcfs	6/5[6/]-8/5[5/]

[1/] Voluntary spill operations and planning dates may be adjusted (increased or decreased) for 1) research purposes, 2) to better match juvenile outmigration timing, and/or 3) to achieve or maintain performance standards through the adaptive management process.

[2/] John Day spill operation during the spring will likely shift to 24-hour operation after construction of surface flow outlets.

[3/] Maximized transport operations will occur from May 7-20 in years when flows are greater than 65 kcfs on the Snake River.

[4/] Transitions from spring to summer spill has changed from July 1 to June 16 based on updated run timing of subyearling fall Chinook salmon. For further information see the 2007 FCRPS BA, Appendix B.2.1.1, paragraph 3.5.

[5/] Termination of summer spill will occur at the four lower Snake projects when subyearling counts fall below 300 fish per day for 3 consecutive days on a per project basis, but no later than August 31 each year. Termination of spill at Ice Harbor Dam will be two days after Lower Monumental Dam spill ends. If after discontinuing spill at any of the Snake River projects after August 1, if subyearling Chinook collection again exceeds 500 fish per day for two consecutive days, spill will resume at that project. Thereafter, fish collection numbers will be reevaluated to determine if spill should continue, using the criteria above until August 31.

[6/] The actual start of summer spill will be initiated when subyearling Chinook exceed 50 % of the collection for a 3 day period for each Snake River project after June 1.

[7/] When seasonally average flows are projected to be less than 125 kcfs, voluntary spill will not be initiated at McNary Dam for spring run fish.

[8/] 85 kcfs daytime spill will be provided from June 16 - July 31 of each year to protect the great majority of the migrating ESA-listed SR fall Chinook salmon, then 75 kcfs during the day from August 1 – August 31 as proposed by the Action Agencies.

Transformation of SYSTDG Spill Caps to be HYDSIM Compatible:

In order for the Corps to provide seven spill caps per project per year, it was necessary to develop a methodology to transform the hourly spill caps used in SYSTDG to monthly or bi-monthly spill caps for HYDSIM, which is a monthly time step model. It is important that the spill caps that the Corps provides for use in HYDSIM are representative of how the spill caps control spill in SYSTDG. There is a concern that the monthly spill caps from SYSTDG would not produce representative modeling results in HYDSIM since the shaping of hourly flow is removed. BPA compared the spill volumes between SYSTDG and HYDSIM for each month, each project, and each year. As a quality check on the SYSTDG and HYDSIM modeling process and is a way to quantify the effects of removing hourly shaping has on spill volumes in HYDSIM.

The following methodology for calculating monthly spill caps from SYSTDG hourly simulations were used:

Methodology for Calculating Monthly Spill Caps from SYSTDG hourly spill caps:

The final spill caps provided to BPA for use in HYDSIM were the result of combined spill caps that were controlling in the SYSTDG model and those that are not, which are called defaults. The defaults spill caps that do not exert a controlling influence in SYSTDG are used to check if spill needed to be reduced because of TDG concerns. The following approaches and concepts were used to develop the final combined spill caps with certain considerations of pertinent factors.

Spill Caps that Exerted Control on Spill:

- If the spill cap exerted control on spill for 26 hours or more in a month, then the monthly spill cap was considered to be the average of all controlling spill caps for the month.
- If the spill cap exerted control on spill for 13 hours or more in half of a month, then the bi-monthly spill cap was considered to be the average of all controlling spill caps for the two week period. This applied to April_1 and April_2 and August_1 and August_2.
- If the spill cap exerted control on spill in the SYSTDG model for 25 hours or less during the month, then the spill caps was a time weighted average of the controlling spill cap and the default spill caps.
- If the spill cap exerted control on spill in the SYSTDG model for one or two hours in a month, it is treated as controlling for a 24 hours period since spill caps are typically set for at least one day.
- When spill caps are controlling for several hours and they are together, they are treated as a group within the 24 hr period. Then the spill cap is time weighted

averaged with the default spill cap to produce a spill cap that is a combination of spill caps controlling and default spill caps.

- When the controlling spill caps developed from the SYSTDG modeling don't follow the principle that in high water years the spill caps are lower and in low water years the spill caps are higher, the spill caps are retained anyway. The deviations from this principle are considered realistic and as natural variability that can occur in daily spill caps because of the unique nature of TDG production and environmental conditions at Bonneville and John Day.

Developing Default spill caps

- The default spill caps for the 2007 SYSTDG model simulation of the115 & 120% TDG scenario were the actual average monthly or bimonthly spill caps in 2007. They are considered representative because the spill operations and physical structures were similar to the 2008 BiOp modified spill operations for all the projects except John Day summer.
- Default spill caps for the 2002 and 1999 SYSTDG model simulation of the 115 & 120% TDG scenario were the actual monthly or bimonthly average spill caps for only projects that did not have a change in spill operations or physical structures between the model years compared and the 2008 BiOp modified spill operations. This approach applied to only The Dalles in 2002. In 1999, The Dalles used both the adult and juvenile fish passage spill patterns but in 2000, only the juvenile fish passage spill patterns were used, which resulted in much lower spill caps.
- The 2007 defaults spill caps in the 115 & 120% TDG scenario for Lower Granite, Little Goose, Ice Harbor, Ice Harbor, McNary, John Day summer, The Dalles and Bonneville were used as defaults spill caps for 2002 and 1999 SYSTDG model simulation of the 115 & 120% TDG scenario.
- Since there are no actual spill caps at John Day using 30% spill 24 hours/day during the spring, the following approach and concepts were used to develop default spill caps for 2007, 2002 and 1999:
    1. Spill caps used in the SYSTDG model simulation of the 115 & 120% TDG scenario that didn't exert any control on spill because the spill operations were the limiting factor for that period.
    2. Spill caps that appeared to be reasonable in comparison with the other spill caps that exerted control in the SYSTDG model.
    3. The principle that in high water years the spill caps are lower and in low water years the spill caps are higher.

- In the 120% TDG scenario, in the months when there are no spill caps controlling spill, the average of the top three highest hourly spill volumes plus 2 kcfs became the default spill cap as long as it is reasonably high in comparison with the spill caps used in the 115 & 120% TDG scenarios. If it is not reasonably high, then the default spill caps used in the 115 & 120% TDG scenarios are used in the only 120% scenarios.

- The principle that in high water years the spill caps are lower and in low water years the spill caps are higher were applied to all default spill caps resulting in a change of 1 or 2 kcfs between the water years.

Final Spill Caps for Use in HYDSIM:

The spill caps summarized in Tables 5 – 10 are the final spill caps that the Corps provided BPA after the above transformation process was applied to the hourly spill caps used in the SYSTDG model.

TABLE 5
2007 Spill Caps for HYDSIM
2007 water year with BIOP spill regime with 115% TDG
Mixture of Defaults and Spill Caps controlling

	LWG	LGS	LMN	IHR	MCN	JDA	TDA	BON
April_1	42	30	26	99	119	100	126	102
April_2	42	30	25	99	119	100	128	100
May	42	28	22	99	124	102	135	98
June	42	30	21	99	127	100	119	109
July	42	30	26	99	140	100	126	117
August_1	42	30	26	99	150	100	126	140
August_2	42	30	26	99	150	100	126	146

TABLE 6
2007 Spill Caps for HYDSIM
2007 water year with BIOP spill regime without 115% TDG
Mixture of Defaults and Spill Caps controlling

	LWG	LGS	LMN	IHR	MCN	JDA	TDA	BON
April_1	42	30	40	99	119	100	125	100
April_2	42	30	40	99	119	100	125	100
May	42	32	40	99	124	105	136	100
June	42	30	35	99	127	100	132	130
July	42	30	26	99	140	100	126	173
August_1	42	30	26	99	150	100	126	155
August_2	42	30	26	99	150	100	126	155

TABLE 7

2002 Spill Caps for HYDSIM

2002 water year with BIOP spill regime with 115% TDG

Mixture of Defaults and Spill Caps controlling

	LWG	LGS	LMN	IHR	MCN	JDA	TDA	BON
April_1	40	30	26	97	117	96	124	100
April_2	40	30	25	97	117	90	131	98
May	40	28	22	97	122	95	132	95
June	40	30	19	97	125	95	137	109
July	40	28	24	97	138	95	139	130
August_1	40	28	24	97	148	98	125	135
August_2	40	28	24	97	148	98	125	135

TABLE 8

2002 Spill Caps for HYDSIM

2002 water year with BIOP spill regime without 115% TDG

Mixture of Defaults and Spill Caps controlling

	LWG	LGS	LMN	IHR	MCN	JDA	TDA	BON
April_1	40	32	40	97	117	97	129	100
April_2	40	32	40	97	117	97	147	100
May	40	30	40	97	122	98	137	100
June	40	32	19	97	125	100	144	122
July	40	28	24	97	138	99	140	170
August_1	40	28	24	97	148	98	132	150
August_2	40	28	24	97	148	98	132	140

TABLE 9

1999 Spill Caps for HYDSIM

1999 water year with BIOP spill regime with 115% TDG

Mixture of Defaults and Spill Caps controlling

	LWG	LGS	LMN	IHR	MCN	JDA	TDA	BON
April_1	38	27	26	95	115	95	122	97
April_2	38	25	25	95	115	95	118	92
May	38	25	21	95	120	83	125	85
June	38	20	12	95	123	75	124	75
July	38	21	22	95	136	80	130	95
August_1	38	26	22	95	146	96	130	134
August_2	38	26	22	95	146	96	124	139

TABLE 10

1999 Spill Caps for HYDSIM

1999 water year with BIOP spill regime without 115% TDG

Mixture of Defaults and Spill Caps controlling

	LWG	LGS	LMN	IHR	MCN	JDA	TDA	BON
April_1	38	23	41	95	115	95	130	100
April_2	38	31	41	95	115	90	137	100
May	38	32	41	95	120	95	137	99
June	38	32	26	95	123	95	137	94
July	38	26	22	95	136	96	134	134
August_1	38	26	22	95	146	95	128	175
August_2	38	26	22	95	146	95	128	174

Flow, Spill and Generation Volumes at Each Project:

The flow, spill and generation volumes at each project were obtained from the SYSTDG model simulations of the 2007, 2002 and 1999 water years. Tables 11 through 13 provide those volumes and show the differences between the modeling scenarios of with and without the 115% TDG standard. These tables also show the total spill volume that would result if the 115% TDG standard was removed. As Tables 11 – 13 shows,

- For a low water year like 2007, removal of the 115% TDG standard would result in an additional 2.5 MAF spill and 100 % of it would come from Ice Harbor and Bonneville.
- For a medium water year like 2002, removal of the 115% TDG standard would result in an additional 2.3 MAF spill and 85% would come from Ice Harbor and Bonneville. The remaining 15% of increased spill would come from John Day, The Dalles and Little Goose.
- For a high water year like 1999, removal of the 115% TDG standard would result in an additional 5.9 MAF spill and 61% would come from Ice Harbor and Bonneville. The remaining 39% of the increased spill would come from Little Goose (9.5%); John Day (18%); and The Dalles (11.5%).

- Since SYSTDG isn't capable of analyzing spill due to lack of market, the HYDSIM spill volumes are considered more reflective of reality for use in COMPASS than the SYSTDG spill volumes.

- An evaluation of the percentage of increased spill per project shows that in 2007 Ice Harbor and Bonneville attributed 100% of the spill increase, but in 2002 they attributed 85% of the total increased spill and in 1999 they attributed only 61% of the total increased spill. This says that removal of the 115% TDG standard would impact Bonneville and Ice Harbor to a significant degree.

TABLE 11

2007 WATER YEAR WITH 2008 BIOP SPILL REGIME
OUTFLOW, SPILL AND GENERATION COMPARISON

	Scenario A				Scenario B				Difference between A and B
	115% and 120% TDG standards Applying				Only 120% TDG standard Applying				
LWG	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Difference between A and B in kcfs**
April_1	43	22	21	567	43	22	21	567	0
April_2	51	22	29	655	51	22	29	655	0
May	80	13	67	800	80	13	67	800	0
June	46	20	26	1,206	46	20	26	1,206	0
July	32	19	12	1,190	32	19	12	1,190	0
August_1	26	7	19	214	26	7	19	215	0
August_2	22	2	20	63	22	2	20	63	0
Totals in KAF	13,708	4,696	9,013		13708	4696	9013		0
LGS	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	42	13	29	283	42	13	29	283	0
April_2	49	17	32	506	49	17	32	506	0
May	77	14	63	858	77	14	63	862	0
June	46	16	30	951	46	16	30	951	0
July	32	12	20	717	32	12	20	717	0
August_1	26	5	21	146	26	5	21	146	0
August_2	22	2	20	70	22	2	20	70	0
Totals in KAF	13,415	3,583	9,832		13415	3587	9828		4
LMN	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	43	21	23	367	43	30	14	532	9
April_2	50	27	23	806	50	42	8	1,253	15
May	78	15	63	918	78	24	54	1,493	9
June	45	20	25	1,214	45	21	24	1,274	1
July	31	17	14	1,016	31	18	13	1,112	2
August_1	25	6	19	193	25	7	18	203	0
August_2	21	2	19	67	21	2	19	67	0
Totals in KAF	13,399	4,745	8,655		13399	6170	7230		1,425

2007 WATER YEAR WITH 2008 BIOP SPILL REGIME
OUTFLOW, SPILL AND GENERATION COMPARISON

	Scenario A				Scenario B				Difference between A and B
	115% and 120% TDG standards Applying				Only 120% TDG standard Applying				
IHR	Avg Outflow kcfs per hr	Avg Spill kcfs per hr	Avg Generation kcfs per hr	Total Spill KAF	Avg Outflow kcfs per hr	Avg Spill kcfs per hr	Avg Generation kcfs per hr	Total Spill KAF	Spill Difference (kcfs)
April_1	45	12	33	212	45	12	33	212	0
April_2	52	18	34	522	52	18	34	522	0
May	79	26	53	1,579	79	26	53	1,579	0
June	46	16	30	938	46	16	30	938	0
July	31	11	20	691	31	11	20	691	0
August_1	25	5	20	155	25	5	20	155	0
August_2	22	2	20	63	22	2	20	63	0
Totals in KAF	13,613	4,254	9,360		13613	4254	9360		0
MCN	Avg Outflow kcfs per hr	Avg Spill kcfs per hr	Avg Generation kcfs per hr	Total Spill KAF	Avg Outflow kcfs per hr	Avg Spill kcfs per hr	Avg Generation kcfs per hr	Total Spill KAF	Spill Difference (kcfs)
April_1	223	95	128	1,136	223	95	128	1,136	0
April_2	225	96	129	2,865	225	96	129	2,865	0
May	266	115	151	7,074	266	115	151	7,074	0
June	222	95	127	5,681	222	95	127	5,681	0
July	179	78	101	4,788	179	78	101	4,788	0
August_1	160	70	90	2,084	160	70	90	2,085	0
August_2	136	61	75	1,923	136	61	75	1,923	0
Totals in KAF	59053	25553	33501		59053	25553	33501		0
JDA	Avg Outflow kcfs per hr	Avg Spill kcfs per hr	Avg Generation kcfs per hr	Total Spill KAF	Avg Outflow kcfs per hr	Avg Spill kcfs per hr	Avg Generation kcfs per hr	Total Spill KAF	Spill Difference (kcfs)
April_1	222	69	153	826	222	69	153	826	0
April_2	219	68	150	2,037	219	68	150	2,037	0
May	258	80	178	4,930	258	80	178	4,930	0
June	211	66	145	3,932	211	66	145	3,932	0
July	168	53	115	3,267	168	53	115	3,267	0
August_1	149	48	102	1,416	149	48	102	1,417	0
August_2	127	41	86	1,303	127	41	86	1,303	0
Totals in KAF	56370	17711	38659		56370	17712	38659		1

TABLE 11

REVISED FINAL

2007 WATER YEAR WITH 2008 BIOP SPILL REGIME
OUTFLOW, SPILL AND GENERATION COMPARISON

	Scenario A				Scenario B				Difference between A and B
	115% and 120% TDG standards Applying				Only 120% TDG standard Applying				
TDA	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	217	94	123	1,116	217	94	123	1,116	0
April_2	215	93	122	2,764	215	93	122	2,764	0
May	254	108	145	6,664	254	108	145	6,666	0
June	208	90	118	5,350	208	90	118	5,358	0
July	163	72	91	4,430	163	72	91	4,430	0
August_1	145	65	80	1,923	145	65	80	1,924	0
August_2	123	56	67	1,774	123	56	67	1,774	0
Totals in KAF	55179	24022	31157		55179	24033	31146		11
BON	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	239	113	127	1,340	239	113	127	1,340	0
April_2	231	113	118	3,350	231	113	118	3,350	0
May	270	111	159	6,801	270	113	157	6,924	2
June	219	108	111	6,441	219	111	109	6,602	3
July	174	107	67	6,553	174	117	57	7,216	11
August_1	156	107	50	3,171	156	109	47	3,242	2
August_2	134	100	34	3,185	134	100	34	3,185	0
Totals in KAF	58932	30836	28096		58932	31858	27074		1,023
Seasonal Totals in KAF	**283,671**	**115,399**	**168,273**		**283,671**	**117,862**	**165,809**		**2,463**

TABLE 12

2002 WATER YEAR WITH 2008 BIOP SPILL REGIME
OUTFLOW, SPILL AND GENERATION COMPARISON

	Scenario A				Scenario B				Difference between A and B
	115% and 120% TDG standards Applying				Only 120% TDG standard Applying				
LWG	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Difference between A and B in kcfs**
April_1	74	23	52	588	74	23	52	588	0
April_2	74	22	51	655	74	22	51	655	0
May	82	14	69	832	82	14	69	832	0
June	94	22	72	1,331	94	22	72	1,331	0
July	38	19	20	1,153	38	19	20	1,153	0
August_1	28	7	22	201	28	7	22	201	0
August_2	30	2	28	63	30	2	28	63	0
Totals in KAF	18,923	4,824	14,099		18923	4824	14099		0
LGS	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KSFD**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	72	21	51	453	72	21	51	456	0
April_2	72	24	48	703	72	24	48	710	0
May	79	16	63	976	79	16	63	1,004	0
June	91	28	63	1,666	91	28	62	1,693	0
July	38	14	24	831	38	14	24	831	0
August_1	29	5	24	142	29	5	24	142	0
August_2	30	2	28	0	30	2	28	65	0
Totals in KAF	18,388	4,923	13,465		18388	4991	13397		68
LMN	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	76	21	56	367	76	30	47	529	9
April_2	76	27	48	806	76	41	34	1,227	14
May	82	15	67	918	82	24	58	1,492	9
June	93	20	73	1,214	93	22	71	1,319	1
July	39	17	22	1,015	39	17	22	1,015	0
August_1	29	7	23	193	29	7	23	193	0
August_2	31	2	29	67	31	2	29	67	0
Totals in KAF	19,066	4,745	14,322		19066	6077	12989		1,333

TABLE 12

2002 WATER YEAR WITH 2008 BIOP SPILL REGIME
OUTFLOW, SPILL AND GENERATION COMPARISON

	Scenario A				Scenario B				Difference between A and B
	115% and 120% TDG standards Applying				Only 120% TDG standard Applying				
IHR	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	77	20	58	348	77	20	58	348	0
April_2	78	25	53	756	78	25	53	756	0
May	85	27	57	1,678	85	27	57	1,678	0
June	95	30	65	1,805	95	30	65	1,805	0
July	41	14	27	883	41	14	27	883	0
August_1	32	6	26	165	32	6	26	165	0
August_2	33	2	31	63	33	2	31	63	0
Totals in KAF	19,716	5,855	13,862		19716	5855	13862		0
MCN	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	197	87	110	1,032	197	87	110	1,032	0
April_2	259	119	140	3,534	259	119	140	3,534	0
May	235	105	130	6,476	235	105	130	6,476	0
June	324	166	159	9,865	324	166	159	9,865	0
July	231	103	127	6,351	230	103	127	6,348	0
August_1	157	69	88	2,047	157	69	88	2,047	0
August_2	140	62	78	1,965	140	62	78	1,965	0
Totals in KAF	67060	31268	35792		67060	31268	35792		0
JDA	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	207	64	142	765	207	65	142	771	1
April_2	267	80	186	2,392	267	82	185	2,431	1
May	237	74	163	4,534	237	74	163	4,539	0
June	326	94	231	5,620	326	97	229	5,758	2
July	229	71	158	4,362	229	71	158	4,375	0
August_1	158	50	108	1,491	158	50	108	1,491	0
August_2	140	45	95	1,416	140	50	108	1,590	5
Totals in KAF	67564	20579	46985		67564	20782	46782		203

TABLE 12

2002 WATER YEAR WITH 2008 BIOP SPILL REGIME OUTFLOW, SPILL AND GENERATION COMPARISON

	Scenario A				Scenario B				Difference between A and B
	115% and 120% TDG standards Applying				Only 120% TDG standard Applying				
TDA	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	203	88	115	1,048	203	88	115	1,048	0
April_2	260	111	149	3,298	260	111	149	3,299	0
May	232	100	132	6,129	232	100	132	6,130	0
June	317	131	186	7,817	317	133	185	7,885	1
July	225	96	129	5,900	225	96	129	5,895	0
August_1	156	69	87	2,056	156	69	87	2,056	0
August_2	139	63	77	1,988	139	63	77	1,988	0
Totals in KAF	66156	28236	37920		66156	28302	37854		66
BON	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	203	113	90	1,340	203	113	90	1,340	0
April_2	252	113	139	3,359	252	113	139	3,359	0
May	221	111	110	6,815	221	113	108	6,924	2
June	303	114	188	6,810	303	114	188	6,808	2
July	210	110	100	6,763	210	118	92	7,242	8
August_1	142	97	45	2,895	142	98	44	2,917	1
August_2	127	94	33	2,997	127	95	32	3,008	0
Totals in KAF	62658	30983	31675		62658	31599	31059		616
Seasonal Totals in KAF	**339,533**	**131,412**	**208,121**		**339,533**	**133,698**	**205,835**		**2,285**

TABLE 13

1999 WATER YEAR WITH 2008 BIOP SPILL REGIME
OUTFLOW, SPILL AND GENERATION COMPARISON

	Scenario A				Scenario B				Difference between A and B
	115% and 120% TDG standards Applying				Only 120% TDG standard Applying				
LWG	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Difference between A and B in kcfs**
April_1	79	22	57	567	79	22	57	567	0
April_2	108	23	85	686	108	23	85	686	0
May	112	24	89	1,452	112	24	89	1,452	0
June	134	45	89	2,679	134	45	89	2,679	0
July	55	20	35	1,230	55	20	35	1,230	0
August_1	42	8	34	236	42	8	34	236	0
August_2	34	2	32	63	34	2	32	63	0
Totals in KAF	25,808	6,915	18,893		25808	6915	18893		0
LGS	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KSFD**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	76	21	55	453	76	21	55	455	0
April_2	104	28	76	819	104	33	71	982	5
May	108	23	85	1,405	108	24	83	1,498	2
June	129	36	93	2,133	129	41	88	2,418	0
July	55	18	37	1,128	55	19	36	1,150	0
August_1	41	7	35	199	41	7	35	201	0
August_2	34	2	32	0	34	2	32	65	0
Totals in KAF	24,999	6,289	18,711		24999	6857	18143		568
LMN	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	80	20	60	359	80	31	49	546	10
April_2	109	28	82	824	109	43	66	1,283	15
May	112	25	87	1,513	112	32	79	1,991	8
June	134	35	99	2,108	134	36	98	2,167	1
July	57	18	38	1,136	57	19	38	1,148	0
August_1	43	8	36	226	43	8	36	229	0
August_2	35	2	33	63	35	2	33	67	0
Totals in KAF	26,086	6,390	19,695		26086	7673	18413		1,283

TABLE 13

REVISED FINAL

1999 WATER YEAR WITH 2008 BIOP SPILL REGIME
OUTFLOW, SPILL AND GENERATION COMPARISON

	Scenario A				Scenario B				Difference between A and B
	115% and 120% TDG standards Applying				Only 120% TDG standard Applying				
IHR	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	83	20	63	359	83	20	63	359	0
April_2	113	37	76	1,095	113	37	76	1,095	0
May	116	44	72	2,675	116	44	72	2,675	0
June	138	50	87	2,989	138	50	87	2,989	0
July	60	20	40	1,229	60	20	40	1,229	0
August_1	46	8	38	237	46	8	38	237	0
August_2	37	2	35	63	37	2	35	63	0
Totals in KAF	27,073	8,808	18,265		27073	8808	18265		0
MCN	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	204	88	116	1,047	204	88	116	1,047	0
April_2	268	124	144	3,683	268	124	144	3,683	0
May	283	130	152	8,023	283	130	152	8,023	0
June	331	171	160	10,180	331	171	160	10,180	0
July	248	108	140	6,665	248	108	140	6,663	0
August_1	216	93	124	2,756	216	93	124	2,756	0
August_2	201	87	115	2,751	201	87	115	2,751	0
Totals in KAF	75520	35100	40420		75520	35100	40420		0
JDA	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	211	66	145	786	211	66	145	786	0
April_2	277	84	193	2,503	277	84	193	2,503	0
May	295	86	209	5,286	295	89	206	5,445	3
June	344	83	261	4,929	344	97	246	5,795	15
July	250	77	173	4,738	250	78	172	4,770	0
August_1	211	66	145	1,964	211	66	145	1,964	0
August_2	199	63	137	1,988	199	66	145	2,094	3
Totals in KAF	77294	22190	55104		77294	23250	54044		1,060

TABLE 13

1999 WATER YEAR WITH 2008 BIOP SPILL REGIME
OUTFLOW, SPILL AND GENERATION COMPARISON

	Scenario A				Scenario B				Difference between A and B
	115% and 120% TDG standards Applying				Only 120% TDG standard Applying				
TDA	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	211	91	120	1,087	211	91	120	1,087	0
April_2	275	112	163	3,332	275	116	159	3,458	0
May	289	119	170	7,300	289	121	168	7,439	2
June	336	130	206	7,735	336	137	199	8,136	7
July	248	106	142	6,520	248	106	142	6,527	0
August_1	208	90	118	2,677	208	90	118	2,677	0
August_2	195	85	110	2,696	195	85	110	2,696	0
Totals in KAF	76063	31344	44720		76063	32019	44045		675
BON	**Avg Outflow kcfs per hr**	**Avg Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Avg Outflow kcfs per hr**	**Spill kcfs per hr**	**Avg Generation kcfs per hr**	**Total Spill KAF**	**Spill Difference (kcfs)**
April_1	222	110	112	1,304	222	113	109	1,340	3
April_2	282	109	174	3,235	282	115	167	3,435	7
May	301	107	194	6,596	301	118	183	7,275	11
June	345	132	212	7,870	345	134	210	7,982	2
July	256	102	154	6,297	256	113	143	6,955	11
August_1	217	105	112	3,115	217	115	101	3,436	11
August_2	202	108	94	3,414	202	116	86	3,676	8
Totals in KAF	78668	31833	46835		78668	34098	44569		2,266
Seasonal Totals in KAF	**411,511**	**148,869**	**262,642**		**411,511**	**154,721**	**256,791**		**5,852**

TABLE 14

Each Project's Contribution to Total Spill Increase in Percent
If 115% TDG Standard is removed

	2007		2002		1999	
	Spill Increase in KAF	% of Total	Spill Increase in KAF	% of Total	Spill Increase in KAF	% of Total
Lower Granite	0	0	0	0	0	0
Little Goose	4	0	68	3	568	10
Lower Monumental	1,425	58	1,333	58	1,283	22
Ice Harbor	0	0	0	0	0	0
McNary	0	0	0	0	0	0
John Day	1	0	203	9	1,060	18
The Dalles	11	0	66	3	675	12
Boneville	1,023	42	616	27	2,266	39
Total spill increase	2,463	100	2,285	100	5,852	100

Quality Check of the SYSTDG – HYDSIM Modeling Process

It was agreed that a quality check should be performed on the Corps - BPA modeling process that used SYSTDG, an hourly time step model to develop monthly spill caps to be used in HYDSIM. This quality check was considered especially important since the hourly flow shaping is removed in HYDSIM. BPA wrote the following brief review of the quality check process and the Corps accepts it as representative and accurate

HYDSIM spill results were compared with the average spill for the three years modeled in SYSTDG to represent the low (2007), medium (2002) and high (1999) flow years in HYDSIM. Since SYSTDG isn't capable of analyzing spill due to lack of market and HYDSIM does, that spill (overgeneration spill) was removed from the HYDSIM project spill totals before comparison with the SYSTDG results. After that adjustment, and taking into consideration that HYDSIM modeled different flow conditions (1929-1998), it was determined that the HYDSIM results were close (within about 10% seasonal total) to those in years similar to the low and medium years chosen for all projects. In the high flow condition, the four lower Columbia projects were close but the lower Snake projects showed larger differences. This larger variation was judged acceptable since it was attributable to the fact that lower Snake flows in May 1999 (month with largest variation) increased very rapidly from levels well below turbine capacity in the first two weeks of the month to more than twice that in about a week. Further, juvenile transportation was maximized (no spill) for two weeks in May and was reflected in HYDSIM operation as a weighted average for the month. SYSTDG, being an hourly model, was more capable of capturing those types of short duration effects than HYDSIM. The relative differences in the model capabilities in high flow conditions were also mitigated by HYDSIM's ability to capture the spill due to lack of market which tended to occur more often in those flow conditions. The final result, once overgeneration spill was included, was that HYDSIM total spill routinely exceeded the SYSTDG spill levels in both scenarios modeled.

Factors That Controlled Spill

In order to fully assess where and when the 115% TDG standard and forebay gages are controlling spill, it is necessary to consider the subject project by project, and day by day. It is also necessary to understand that the 115% TDG standard is only one of the four factors that determine how much spill occurs and these four factors are:

1. <u>The 115% or 120% TDG standards</u>- The TDG standards are embodied in the “spill caps” concept. In order for spill caps to control spill, the total river flow must be high enough but not too high or else the situation transitions to involuntary or forced spill.
2. <u>The spill operations</u> – At many projects, the spill operations of spilling 30% or 40% of the total river flow limits spill to such a degree that the spill levels never reaches the 120% TDG spill caps at any time during any type of water year.

3. Involuntary or forced spill– Involuntary or forced spill occurs when river flows are so high that there is too much water for the hydrosystem to handle. In these cases, the powerhouse capacity is maximized and the required spill is being passed, and yet there is still more water that must pass the project.
4. Minimum generation requirements – Minimum generation requirements occur when the total river flow is so low, that it is not possible to meet the required spill operations and generate enough electricity to meet the electrical needs to keep the electrical grid stable. In a minimum generation situation, the projects are entitled to generate enough electricity to meet the project's needs and the minimum electricity required to keep the electrical grid stable.

The following is a discussion of how these four factors controls spill at each of the projects:

When Spill Caps Control Spill:

In order to know where and when the 115% TDG standard is controlling spill, it is important to understand the spill caps concept since spill caps are a reflection of the 115% and 120% TDG state water quality standards affecting spill management decisions.

Spill caps is the second most influential factor controlling spill system wide, and spill caps control spill at an average of 12% of the time. Tables 15 – 22 summarize what factors were controlling spill at each project during the times when spill caps were the controlling factor. As these tables shows, spill caps exert the strongest controlling influences at Ice Harbor during the spring and Bonneville during the summer, which can be expected since these two projects' spill operations include spilling up to the spill caps. Ice Harbor is the only project that spill caps control spill the highest percent of the time. This fact suggests that of all the eight projects, the removal of the 115% TDG standard would have the largest impact on spill at Ice Harbor and Bonneville. This fact correlates well with Tables 11 – 13 which shows that spill volumes would increase 1.3 to 1.4 MAF at Ice Harbor and 0.6 to 2.2 MAF at Bonneville if the 115% TDG standard was removed. Table 14 shows the percentage of the increased spill for each project and it shows that in 2007 Ice Harbor and Bonneville attributed 100% of the spill increase, but in 2002 they attributed 85% of the total increased spill and in 1999 they attributed only 61% of the total increased spill. This says that removal of the 115% TDG standard would impact Bonneville and Ice Harbor to a significant degree, which makes sense since they are the only projects with spill operations spilling to the spill cap.

The spill caps exerted some control at Little Goose, John Day and The Dalles but as Tables 11 – 13 shows, the spill volume for these three projects do not increase or increase only a small amount when the 115% TDG standard is removed except during a high water year like 1999. During a high water year, these are modest increases in spill at these three projects. This correlates with the information in Table 23 which shows that forebay gages control spill 100% of the time at John Day and 58 to 72% of the time at Little Goose. The impact of removing the 115% TDG standard on a project's spill depends on how many hours the spill cap exerts control. In general, the spill caps controls spill at John Day and The Dalles for low number of hours in an entire spill season but this is not true in a high water year when the spill caps would exert control for a greater number of hours. This says that in low and medium water years, removal of the 115% TDG standard would have a small amount of effect on spill at Little Goose and John Day. Spill caps at these projects control spill for more hours in a high water year resulting in a modest spill volume increase.

The forebay gage at The Dalles controls spill 100% of the time but the spill volumes did not significantly increases in any water year. This is attributed to the fact that there are typically very few high 12 hr average TDG exceedances at Bonneville forebay or The Dalles tailwater that must be managed with lower spill caps at The Dalles. For instance, in the 1999 high water year, there were only 11 TDG exceedances at Bonneville forebay and zero tailwater exceedances, which is very few compared to other projects like Bonneville tailwater and Camas/Washougal that had 76 TDG exceedances. The result of this fact is that the hours that spill caps exerted a controlling influence is minimal. As Table 21 shows, the predominant controlling factor on spill at The Dalles is the spill operations so a few hours when spill caps exert control does not affect the spill volume to any significant extent. This says that removal of the 115% TDG standard would have no very little effect on spill at The Dalles

As Table 15, 18 and 19 show, the spill cap exerts no influences at Lower Granite, Ice Harbor and McNary during any type of water year at any time. This fact harmonizes with the spill volume Tables 11 – 13 which show no additional spill at Lower Granite, Ice Harbor and McNary. This says that removal of the 115% TDG standard would have not effect on spill at Lower Granite, Ice Harbor and McNary.

TABLE 15

Factors Controlling Spill at Lower Granite in %

	Cap			Spill Operations			Minimum Gen			Invol Spill		
	2007	2002	1999	2007	2002	1999	2007	2002	1999	2007	2002	1999
Apr_1	0	0	0	100	95	100	0	0	0	0	5	0
Apr_2	0	0	0	100	99	81	0	0	0	0	1	20
May	0	0	0	100	94	74	0	0	0	0	6	26
June	0	0	0	99	82	23	1	0	0	0	18	77
July	0	0	0	72	77	100	28	23	0	0	0	0
Aug_1	0	0	0	23	23	98	78	77	3	0	0	0
Aug_2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Average	0	0	0	82	78	79	18	17	0	0	5	20

TABLE 16

Factors Controlling Spill at Little Goose in %

	Cap			Spill Operations			Minimum Gen			Invol Spill		
	2007	2002	1999	2007	2002	1999	2007	2002	1999	2007	2002	1999
Apr_1	0	10	6	100	90	94	0	0	0	0	0	0
Apr_2	0	14	76	100	87	14	0	0	0	0	0	10
May	4	26	27	96	74	49	0	0	0	0	0	24
June	0	28	40	100	72	1	0	0	0	0	0	59
July	0	0	4	100	97	95	0	3	0	0	0	0
Aug_1	0	0	0	100	83	97	0	17	3	0	0	0
Aug_2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Average	1	13	26	99	84	58	0	3	1	0	0	16

TABLE 17

Factors Controlling Spill at Ice Harbor in %

	Cap			Spill Operations			Minimum Gen			Invol Spill		
	2007	2002	1999	2007	2002	1999	2007	2002	1999	2007	2002	1999
Apr_1	100	95	100	0	0	0	0	0	0	0	5	0
Apr_2	100	100	87	0	0	0	0	0	0	0	0	13
May	55	19	26	45	76	45	0	0	0	0	5	29
June	13	0	13	85	90	17	2	0	0	0	10	71
July	0	0	0	55	72	93	45	28	7	0	0	0
Aug_1	1	0	0	14	43	93	85	57	8	0	0	0
Aug_2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Average	45	36	38	33	47	41	22	14	2	0	3	19

TABLE 18

Factors Controlling Spill at Ice Harbor in %

	Cap			Spill Operations			Minimum Gen			Invol Spill		
	2007	2002	1999	2007	2002	1999	2007	2002	1999	2007	2002	1999
Apr_1	0	0	0	100	100	100	0	0	0	0	0	0
Apr_2	0	0	0	100	100	79	0	0	0	0	0	21
May	0	0	0	100	100	73	0	0	0	0	0	27
June	0	0	0	100	100	65	0	0	0	0	0	35
July	0	0	0	100	98	99	0	2	1	0	0	0
Aug_1	0	0	0	100	99	100	0	1	0	0	0	0
Aug_2	0	0	0	100	99	100	0	1	0	0	0	0
Average	0	0	0	100	99	88	0	1	0	0	0	12

TABLE 19

Factors Controlling Spill at McNary in %

	Cap			Spill Operations			Minimum Gen			Invol Spill		
	2007	2002	1999	2007	2002	1999	2007	2002	1999	2007	2002	1999
Apr_1	0	0	0	94	85	99	0	0	0	6	15	1
Apr_2	0	0	0	97	51	36	0	0	0	3	50	64
May	0	0	0	38	67	44	0	0	0	62	33	56
June	0	0	0	88	5	1	0	0	0	12	95	99
July	0	0	0	100	75	57	0	0	0	0	25	43
Aug_1	0	0	0	100	100	100	0	0	0	0	0	0
Aug_2	0	0	0	100	98	100	0	2	0	0	0	0
Average	0	0	0	88	69	62	0	0	0	12	31	38

TABLE 20

Factors Controlling Spill at John Day in %

	Cap			Spill Operations			Minimum Gen			Invol Spill		
	2007	2002	1999	2007	2002	1999	2007	2002	1999	2007	2002	1999
Apr_1	0	8	0	100	92	100	0	0	0	0	0	0
Apr_2	0	25	28	100	73	72	0	0	0	0	2	1
May	1	4	26	99	96	62	0	0	0	0	0	13
June	0	52	72	100	42	1	0	0	0	0	6	27
July	0	8	6	100	92	94	0	0	0	0	0	0
Aug_1	0	0	0	100	100	100	0	0	0	0	0	0
Aug_2	0	0	0	100	100	100	0	0	0	0	0	0
Average	0	14	19	100	85	76	0	0	0	0	1	6

TABLE 21

Factors Controlling Spill at The Dalles in %

	Cap			Spill Operations			Minimum Gen			Invol Spill		
	2007	2002	1999	2007	2002	1999	2007	2002	1999	2007	2002	1999
Apr_1	0	0	0	100	100	100	0	0	0	0	0	0
Apr_2	0	1	31	100	99	68	0	0	0	0	0	1
May	1	0	27	99	100	71	0	0	0	0	0	2
June	1	24	61	99	75	28	0	0	0	0	1	11
July	0	1	3	100	97	97	0	2	0	0	0	0
Aug_1	0	0	0	99	100	100	1	0	0	0	0	0
Aug_2	0	0	0	100	100	100	0	0	0	0	0	0
Average	0	4	18	100	96	80	0	0	0	0	0	2

TABLE 22

Factors Controlling Spill at Bonneville in %

	Cap			Spill Operations			Minimum Gen			Invol Spill		
	2007	2002	1999	2007	2002	1999	2007	2002	1999	2007	2002	1999
Apr_1	0	0	100	100	100	0	0	0	0	0	0	0
Apr_2	0	0	66	100	89	0	0	0	0	0	11	34
May	35	35	68	64	65	0	0	0	0	1	0	32
June	11	32	1	89	44	1	0	0	0	0	24	97
July	27	25	21	73	71	53	0	5	0	0	0	26
Aug_1	28	2	29	71	71	71	1	28	0	0	0	0
Aug_2	4	1	27	69	68	68	27	31	5	0	0	0
Average	15	14	45	81	72	28	4	9	1	0	5	27

When Spill Operations Control Spill

Spill operations are the number one most influential factor determining spill system wide, and spill operations control spill an average of 76 % of the time. As Tables 15 through 22 shows, the spill operations are the number one controlling factor of spill at all projects except Ice Harbor, which is why the largest spill increases associated with removal of the 115% TDG standard occur there. As Tables 15 through 22 shows the average percent of time that spill operations controlled spill at the projects varies from 28 to 100% with an overall of average of 76%. This suggests that changing the spill operations results in the largest changes in spill volumes and can have the largest impact on fish survival. This fact played an instrumental role in the 2008 Biological Opinion modeling efforts where many different spill operations were considered and modeled.

As Tables 15 - 22 shows, the spill operations are the predominant controlling factor for spill at Lower Granite, Little Goose, Ice Harbor, McNary, John Day and The Dalles for all water years. This suggests that removal of the 115% TDG standard would have little to no effect on spill volumes which the spill volume Tables 11- 13 verify. Five of the six projects where the spill operations are the predominant controlling factor of spill has spill operations that are a percentage of the total river flow. Spill operations can range from 30 to 40% of the total river flow, which for most water years, is far below the spill caps.

When Involuntary Spill Controls Spill

Involuntary spill is the third most influential factor determining spill system wide, and involuntary spill controlled spill only 8% of the time. Involuntary or forced spill occurs when river flows are so high that there is too much water for the hydrosystem to handle. As to be expected, involuntary spill is mainly an issue during medium and high water year and usually occur in May or June but can occur earlier or later depending on flows and powerhouse capacity limitations.

Tables 15 - 22 show the percentage of times that involuntary spill is the controlling factor for determining the amount of spill. Involuntary spill is not a dominant controlling factor of spill at any of the project during most months in most water year except at McNary. At McNary, involuntary spill can occurs in April, May or June of any water year, which can be expected since it has the lowest powerhouse capacities of the four Lower Columbia Snake Projects. Because of the role that involuntary spill can play at McNary spill, removal of the 115% TDG standard will have no effect is McNary spill is further guaranteed.

During a high water year like 1999, involuntary spill will become the predominant controlling factor of spill at all projects except Ice Harbor; John Day and The Dalles. As Tables 15-22 shows, projects like Bonneville and McNary can be spilling involuntarily for 97 to 99% of June in a high water year. Other projects little Lower Granite and Ice Harbor can be spilling involuntarily for 71 to 77 % of June in a high water year.

When Minimum Generation Controls Spill

Minimum generation is the fourth and least influential factor determining spill system wide, and minimum generation controls spill an average of 4 % of the time. Minimum generation requirement occurs when the total river flow is so low, that it is not possible to meet the required spill operations and generate enough electricity to keep the electrical grid stable which usually occurs in August but can occur in April and July too. Tables 15-22 show the percentage of time that the minimum generation determined the amount of spill that occurred. Minimum generation is a dominant controlling factor of spill at Lower Granite and Ice Harbor during a low and medium water year during August. Minimum generation is not a dominant controlling factor of spill during high water years like 1999.

When and Where Forebay Gages Control Spill

Once the four controlling factors of spill are considered, then Table 23 can be used in conjunction with Tables 15 - 22 to understand where and when the forebay gages are controlling spill to such a significant degree that they play a role influencing whether the 115% TDG standard can be removed. As Table 23 shows, there are certain forebay gages that exert varying degrees of influence on the spill of the project directly upstream such as:

- The impact of removing the 115% TDG standard on a project's spill depends on how many hours the spill cap exerts control. Even though the Ice Harbor forebay gage can affect the Little Goose spill caps and Bonneville forebay gage can affect The Dalles spill caps, the number of hours that the spill caps control spill is so small in low and medium water years, that there is not a spill increase. Spill caps at these projects control spill for more hours in a high water year resulting in a modest spill volume increase.

- Neither the forebay nor tailwater gages were controlling spill at Lower Granite; Ice Harbor and McNary during all water years and with or without the 115% TDG standard.

- The Ice Harbor forebay gage exerts considerable control on Ice Harbor spill which is why there is such a large increase in spill volumes at Ice Harbor during any water year if the 115% TDG standard is removed.

- The Ice Harbor forebay gage exerts minimal control on Little Goose spill which is why there is such a small increase in spill volumes at Little Goose during any water year if the 115% TDG standard is removed.

- The Dalles forebay gage exerts minimal control on John Day spill which is why there is such a small increase in spill volumes at John Day during any water year if the 115% TDG standard is removed.

- The Bonneville forebay gage exerts minimal control on The Dalles spill which is why there is such a small increase in spill volumes at The Dalles during any water year if the 115% TDG standard is removed.

- The Camas/Washougal forebay gage exerts some control on Bonneville spill which is why there is some increase in spill volumes at Bonneville during any water year if the 115% TDG standard is removed.

As Table 23 shows, the forebay gages do not exert any influence on the spill at Lower Granite, Ice Harbor and McNary.

TABLE 23

Percent of Time that Downstream Forebay and Tailwater Gages Control Spill

	2007			2002			1999		
	Forebay	Tailwater	Both	Forebay	Tailwater	Both	Forebay	Tailwater	Both
Lower Granite	0	0	0	0	0	0	0	0	0
Little Goose	0	0	0	28	72	0	3	58	39
Lower Monumental	100	0	0	100	0	0	39	0	61
Ice Harbor	0	0	0	0	0	0	0	0	0
McNary	0	0	0	0	0	0	0	0	0
John Day	0	0	0	0	100	0	0	100	0
The Dalles	0	0	0	100	0	0	100	0	0
Bonneville	88	0	12	37	5	58	9	28	63

High 12 Hours Average TDG levels:

Since each SYSTDG simulation generates five pages of high 12 hour average TDG data and there were six simulations in this effort, it was necessary to summarize the high 12 hour TDG data into a manageable size. As a result, the data was summarized into two categories:

1. The entire spill season, from April through August, average maximum, minimum and average of the 12 hour average TDG levels for each water year, each project, and with and without the 115% TDG standard. Table 24 provides this seasonal average data.
2. The monthly average maximum, minimum and average of the 12 hour average TDG levels for April through August for each water year, each project, and with and without the 115% TDG standard. Tables 25 through 41 provide this monthly average data.

The purple highlighted numbers in the tables are emphasizing the percent of change between two scenarios. The following is a discussion of the summarized TDG data.

Overall Comments on TDG levels:

There are several overall general comments that are important to be made as a summary of the TDG data on the SYSTDG six simulations. These comments are the result of comparing the seasonal averages with the monthly averages to identify significant trends and general TDG comments on the SYSTDG model simulations not included elsewhere. The following are a summary of the overall general comments:

- The increases in the monthly TDG levels at Ice Harbor tailwater, the Ice Harbor forebay, Bonneville tailwater and Camas Washougal can persist for one to three months.

- These increased monthly TDG levels can be seen in elevated monthly maximum, minimum and averages for each of the projects.

- For Ice Harbor tailwater and Ice Harbor forebay, these persistent elevated TDG levels occur from April through May.

- For Bonneville tailwater and Camas Washougal, these persistent elevated TDG levels occur from July through August.

- Removal of the 115% TDG standard will result in a significant increase in TDG exceedances.

- The total number of TDG exceedances of the 115% and 120% TDG standards would go up by 161 to 330% if the 115% TDG standards are removed. An increase of 161 to 330% in the number of TDG exceedances represents 83 to 193 more exceedances.

- The assumption that an attempt would be made to keep the TDG exceedances at approximately the "same number by definition" between the two scenarios within 15% was applied with success. The number of TDG exceedances "by definition" for the with and without 115% TDG standard simulations were within 14% of each other for 1999, within 8% of each other for 2002, and within 14% of each other for 2007.

Seasonal Average of the 12 hour Average TDG levels:

The numbers on Table 24 that show a increase of 0.6 or greater in the high 12 hour average TDG levels between scenarios with and without the 115% TDG standards were highlighted in purple and are meant to draw your attention to the specific projects that are most effected. As the highlighted numbers on Table 24 show, if the 115% TDG standard was removed, the largest increases in TDG levels would occur at the Ice Harbor tailwater, Ice Harbor forebay, Bonneville tailwater and Camas Washougal gages. The high 12 hour average TDG levels in Table 24 correlate with the increases in spill volume and spill caps that would occur at Ice Harbor and Bonneville if the 115% TDG standard was removed.

Looking at the seasonal average of the maximum, minimum and average of the high 12 hour average can provide a general, big picture overview of the impacts of removing the 115% TDG standard. The following are the highlights from an evaluation of the seasonal average statistics of the high 12 hour average TDG levels.

Seasonal Average of the High 12 Hour Average TDG

The largest increase in the April through August average high 12 hour average TDG levels occurred at Ice Harbor forebay, Ice Harbor tailwater, and Camas Washougal which correlates with the increases in spill volumes and spill caps that would occur at Ice Harbor and Bonneville if the 115% TDG standard was removed.

Ice Harbor forebay: The largest increase in TDG levels would occur at the Ice Harbor forebay with April through August average for all high 12 hour average TDG levels increasing 0.5% in a low water year; 0.9% in a medium water year; and 3.0 % in a high water year.

Camas Washougal Gage: The second largest increase in TDG levels would occur at the Camas Washougal gage with April through August average of all high 12 hour average TDG levels increasing 0.5% in a low water year; 0.3% in a medium water year; and 1.3 % in a high water year.

Seasonal Maximum of the High 12 Hour Average TDG

The largest increase in the April through August maximum high 12 hour average TDG levels occurred at Ice Harbor forebay, Ice Harbor tailwater, and Bonneville tailwater which correlates with the increases in spill volumes and spill caps that would occur at Ice Harbor and Bonneville if the 115% TDG standard was removed.

The largest increase in TDG levels would occur at the Ice Harbor forebay with the April through August seasonal average maximum of the high 12 hour average TDG levels increasing 4.1 % in a low water year.

The second largest increase in TDG levels would occur at the Ice Harbor tailwater with the April through August seasonal average maximum of the high 12 hour average TDG levels increasing 2.3 % in a low water year.

The third largest increase in TDG levels would occur at the Bonneville tailwater with the April through August seasonal average maximum of the high 12 hour average TDG levels increasing 1.3 % in a low water year.

Seasonal Minimum of the High 12 Hour Average TDG

The largest increase in the April through August minimum high 12 hour average TDG levels occurred at Camas Washougal gage and Ice Harbor forebay which correlates with the increases in spill volumes and spill caps that would occur at Ice Harbor and Bonneville if the 115% TDG standard was removed.

The Camas Washougal gage had the largest increase in the April through August minimum of the high 12 hour average TDG and it increased 2.9 % in a medium water year and 0.1% in a high water year.

The Ice Harbor forebay gage had the second largest increase in the April through August minimum of the high 12 hour average TDG and it increased 0.6 % in a low water year.

TABLE 24

Lower Columbia and Snake River Projects Seasonal Average Statistics
of High 12 Hour Average % TDG Levels

April through August

Year	Project	With 115% Max	Without 115% Max	Difference Max	With 115% Min	Without 115% Min	Difference Min	With 115% Average	Without 115% Average	Difference Avg
2007	LWG forebay	105.0	105.0	0.0	98.7	98.7	0.0	101.9	101.9	0.0
2002	LWG forebay	104.7	104.7	0.0	97.9	97.9	0.0	101.7	101.7	0.0
1999	LWG forebay	111.8	111.8	0.0	96.8	96.8	0.0	106.1	106.1	0.0
2007	LWG Tailwater	111.4	111.4	0.0	98.7	98.7	0.0	108.5	108.5	0.0
2002	LWG Tailwater	117.6	117.6	0.0	97.9	97.9	0.0	108.8	108.8	0.0
1999	LWG Tailwater	129.9	129.9	0.0	96.8	96.8	0.0	112.2	112.2	0.0
2007	LGS forebay	110.8	110.8	0.0	99.7	99.7	0.0	106.8	106.8	0.0
2002	LGS forebay	112.2	112.2	0.0	100.1	100.1	0.0	106.1	106.1	0.0
1999	LGS forebay	128.6	128.6	0.0	103.9	103.9	0.0	109.2	109.2	0.0
2007	LGS Tailwater	119.5	119.6	0.1	99.7	99.7	0.0	113.8	113.8	0.0
2002	LGS Tailwater	120.6	120.6	0.0	100.1	100.1	0.0	114.6	114.6	0.0
1999	LGS Tailwater	127.7	127.7	0.0	103.9	103.9	0.0	116.0	116.2	0.1
2007	LMN forebay	115.1	115.1	0.0	100.4	100.4	0.0	109.8	109.8	0.0
2002	LMN forebay	116.3	116.3	0.0	100.3	100.3	0.0	110.7	110.7	0.0
1999	LMN forebay	128.2	128.2	0.0	103.4	103.4	0.0	113.3	113.7	0.5
2007	LMN Tailwater	117.9	120.2	2.3	102.1	102.1	0.0	113.2	114.1	0.9
2002	LMN Tailwater	118.7	118.7	0.0	100.3	100.3	0.0	113.1	113.1	0.0
1999	LMN Tailwater	122.9	122.9	0.0	103.4	103.4	0.0	114.4	115.2	0.8
2007	IHR forebay	116.6	120.6	4.1	102.8	102.3	-0.6	110.8	111.7	0.9
2002	IHR forebay	116.3	116.3	0.0	99.3	99.3	0.0	110.8	111.3	0.5
1999	IHR forebay	121.9	121.8	0.0	103.0	103.0	0.0	112.2	115.2	3.0
2007	IHR Tailwater	116.1	116.1	0.0	104.4	104.4	0.0	113.4	113.4	0.0
2002	IHR Tailwater	117.6	117.6	0.0	101.8	101.8	0.0	113.9	113.9	0.0
1999	IHR Tailwater	130.3	130.3	0.0	103.4	103.4	0.0	115.1	115.1	0.0
2007	MCN forebay	117.3	117.3	0.0	102.9	102.9	0.0	109.5	109.5	0.0
2002	MCN forebay	116.0	116.0	0.0	102.4	102.4	0.0	109.0	109.0	0.0
1999	MCN forebay	117.0	117.0	0.0	103.4	103.4	0.0	109.4	109.4	0.0
2007	MCN Tailwater	117.5	117.5	0.0	110.8	110.8	0.0	114.7	114.7	0.0
2002	MCN Tailwater	120.9	120.9	0.0	102.7	102.7	0.0	116.0	116.0	0.0
1999	MCN Tailwater	121.0	121.0	0.0	113.7	113.7	0.0	116.5	116.5	0.0
2007	JDA forebay	111.5	111.5	0.0	104.6	104.6	0.0	107.6	107.6	0.0
2002	JDA forebay	113.0	113.0	0.0	101.9	101.9	0.0	106.9	106.9	0.0
1999	JDA forebay	111.9	111.9	0.0	102.2	102.2	0.0	108.1	108.1	0.0
2007	JDA Tailwater	120.7	120.7	0.0	115.3	115.3	0.0	117.5	117.5	0.0
2002	JDA Tailwater	142.6	142.6	0.0	103.4	103.4	0.0	118.2	118.2	0.0
1999	JDA Tailwater	122.1	122.3	0.2	104.1	104.1	0.0	118.9	119.2	0.3
2007	TDA forebay	113.2	113.2	0.0	106.6	106.6	0.0	109.8	109.8	0.0
2002	TDA forebay	113.7	113.7	0.0	103.4	103.4	0.0	108.8	108.8	0.0
1999	TDA forebay	115.3	115.3	0.0	105.3	105.3	0.0	110.4	110.6	0.2
2007	TDA Tailwater	117.3	117.3	0.0	109.9	109.9	0.0	115.1	115.1	0.0
2002	TDA Tailwater	118.5	118.5	0.0	104.5	104.5	0.0	115.0	115.0	0.0
1999	TDA Tailwater	118.3	119.5	1.2	105.7	105.7	0.0	115.7	115.2	-0.5
2007	BON forebay	115.9	115.9	0.0	104.3	104.3	0.0	111.2	111.2	0.0
2002	BON forebay	116.2	116.2	0.0	103.1	103.1	0.0	110.1	110.1	0.0
1999	BON forebay	116.3	116.9	0.7	103.9	103.9	0.0	112.2	112.4	0.2
2007	BON Tailwater	118.7	119.9	1.3	108.6	108.6	0.0	117.1	117.6	0.5
2002	BON Tailwater	124.3	124.3	0.0	109.1	109.1	0.0	117.7	117.7	0.0
1999	BON Tailwater	128.1	128.1	0.0	108.9	108.9	0.0	119.6	120.8	1.2
2007	Camas Forebay	116.4	116.5	0.0	110.0	110.0	0.0	113.3	113.8	0.5
2002	Camas Forebay	117.6	117.6	0.0	105.9	105.9	0.0	113.0	113.0	0.0
1999	Camas Forebay	118.1	118.3	0.2	107.7	107.8	0.1	113.9	115.2	1.3

Monthly Average of the 12 hour Average TDG levels

The numbers on Tables 25 through 41 that show a increase of 0.6 or greater changes in the high 12 hour average TDG levels between scenarios with and without the 115% TDG standards were highlighted in purple and are meant to draw your attention to the specific projects that are most effected. As the highlighted numbers on Tables 25 through 41 shows, if the 115% TDG standard was removed, the largest increases in maximum, minimum and average TDG levels would be occur at the Ice Harbor tailwater, Ice Harbor forebay, Bonneville tailwater and Camas Washougal gages. The high 12 hour average TDG levels in Tables 25 through 41 correlate with the increases in spill volume and spill caps that would occur at Ice Harbor and Bonneville if the 115% TDG standard was removed.

Looking at the monthly average of the maximum, minimum and average of the high 12 hour average gives an enhanced view of the impacts of removing the 115% TDG standard compared to the seasonal average. The following are the highlights from an evaluation of the monthly averages of the maximum, minimum and average of the high 12 hour average TDG levels.

Monthly Average of the High 12 Hour Average TDG

The largest increase in the monthly average of the high 12 hour average TDG levels occurred at Ice Harbor tailwater; Ice Harbor forebay, Bonneville tailwater, and Camas Washougal which correlates with the increases in spill volumes and spill caps that would occur at Ice Harbor and Bonneville if the 115% TDG standard was removed.

Lowe r Monumental Tailwater: As Table 30 shows, there are consistently higher TDG levels in all water years when the 115% TDG standard is removed. The largest increase in the monthly average TDG levels of all the eight projects would occur at the Ice Harbor tailwater during April and May with an increase of high 12 hour average TDG levels of 2.5% as an April monthly average and 1.9% as a May monthly average in a low water year. During a medium water year, TDG increases could include a 2.4% % increase in the April monthly average and a 1.6% increase in the May monthly average. During a high water year, TDG increases could include a 2.5% increase in the April monthly average, a 1.5% increase in the May monthly average, and 0.7% increase in June monthly average.

Ice Harbor forebay: As Table 31 shows, there are consistently higher TDG levels in all water years when the 115% TDG standard is removed. The second largest increase in the monthly average TDG levels would occur at the Ice Harbor forebay during April and May with an increase of high 12 hour average TDG levels of 1.5% as an April monthly average in a low water year and 2.4% as a May monthly average in a low water year. During a medium water year, TDG increases could include 2.8 % in the April monthly average and 2.0% in the May monthly average. During a high water year, TDG increases could include 2.8 % in the April monthly average and 1.5% in the May monthly average.

Bonneville tailwater: As Table 40 shows, the third largest increase in monthly average TDG levels would occur at the Bonneville tailwater during July and August with an increase of high 12 hour average TDG levels for July monthly average ranging from 1.5 % in a low water year, 1.1 % in a medium water year; and to 2.2 % in a high water year.

In August, increase of high 12 hour average TDG levels included 2.0 % as an August monthly average in a high water year.

Camas Washougal: As Table 41 shows, there are consistently higher TDG levels in all water years when the 115% TDG standard is removed. The fourth largest increase in monthly average TDG levels would occur at the Camas Washougal gage during July and August with an increase of high 12 hour average TDG levels for July monthly average ranging from 1.6 % in a low water year, 1.2 % in a medium water year; and to 1.3 % in a high water year.

There were six gages that had increases in their monthly average TDG levels that are between 1.3 and 0.7% and the following is a brief summary:

- Little Goose tailwater monthly average increases 1.2% in August of a high water year
- Ice Harbor tailwater monthly average increases 1.0% in April of a high water year and 0.9% in June of a high water year
- John Day tailwater monthly average increases 1.3% in June for a high water year
- The Dalles forebay monthly average increases 0.7% in June for a high water year
- The Dalles tailwater monthly average increases 0.7% in June for a high water year
- Bonneville forebay monthly average increases 0.6% in June for a high water year

Monthly Maximum of the High 12 Hour Average TDG

The largest increase in the monthly maximum of the high 12 hour average TDG levels occurred at Ice Harbor forebay, Ice Harbor tailwater; Camas Washougal and Bonneville tailwater which correlate with the increases in spill volumes and spill caps that would occur at Ice Harbor and Bonneville if the 115% TDG standard was removed.

As Table 31 shows, the largest increase in the monthly maximum TDG levels would occur at the Ice Harbor forebay during April and May with an increase of high 12 hour average TDG levels reaching a high of 4.1 % as a May monthly average and 4.0 % as a June monthly average in a low water year. A 4.1 % increase in the maximum high 12 hour average TDG levels is the largest increase as a monthly average of any of the projects. It is also important to note that these elevated TDG levels persist throughout April and May for all water years and this can be seen in the increases in the monthly averages and maximums.

As Table 30 shows, the second largest increase in TDG levels would occur at the Ice Harbor tailwater with maximum average of the high 12 hour average TDG levels increasing to 3.1 % in a low water year in June to 2.5% in a high water year in April. Elevated high 12 hour average TDG levels persist from April through June at Ice Harbor in all water years as a result of removing the 115%.

As Table 41 shows, the third largest increase in TDG levels would occur at the Camas Washougal gage with maximum average of the high 12 hour average TDG levels increasing to 0.8 % in July of a low water year; 2.1 % in August of a high water year and to 1.2% in July of a high water year. Elevated high 12 hour average TDG levels persist from July through August at Camas Washougal as a result of removing the 115%.

As Table 40 shows, the fourth largest increase in TDG levels would occur at the Bonneville tailwater gage with maximum average of the high 12 hour average TDG levels increasing to 2.8 % in August of a high water year; 0.6 % in July of a high water year, 1.5% in July of a low water year, and to 1.7% in July of a medium water year. Elevated high 12 hour average TDG levels persist from July through August at Camas Washougal as a result of removing the 115%.

When the increases in the monthly maximum averages are considered with the increases in the monthly averages, an important trend appears: The elevated TDG levels resulting from removing the 115% TDG standard persist in the hydrosystem for up to two months at Camas Washougal and three months at Ice Harbor forebay.

Monthly Minimum of the High 12 Hour Average TDG

There were significantly large increases in the monthly minimum average of the high 12 hour average TDG levels that occurred at nine gages and the following is a brief summary:

- Ice Harbor Tailwater increased 3.4% in April of low water year, 2.8% in April of a medium water year, 2.5% in April of a high water year, and 2.0 % in June of a high water year
- Camas Washougal increased 3.4% in April of a medium water year, and 1.3 % in July of a low water year
- Ice Harbor forebay increased 2.8 % in April of a high water year
- The Dalles forebay increased 3.1 % in April of a medium water year
- Ice Harbor forebay increased 2.8 % in June of a high water year
- Bonneville tailwater increased 1.7% in May and 0.6 % in June and 2.6 % in July of a high water year and 0.9% in June of a low water year
- The Dalles tailwater increased 2.4 % in April of a medium water year
- John Day tailwater increased 1.5 % in April of a June water year
- Ice Harbor forebay increased 1.0 % in June of a high water year

Ice Harbor Tailwater had the largest increases in the minimum average TDG levels which included 3.4% in April of low water year, 2.8% in April of a medium water year, 2.5% in April of a high water year, and 2.0 % in June of a high water year

TABLE 25

Lower Granite Forebay Monthly Statistics

Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Differ ence	2002 w/115%	2002 wo/115%	Differ ence	1999 w/115%	1999 wo/115%	Differ ence
April	Max	103.3	103.3	0.0	103.7	103.7	0.0	109.5	109.5	0.0
April	Min	99.2	99.2	0.0	99.8	99.8	0.0	103.6	103.6	0.0
April	Avg	101.4	101.4	0.0	101.3	101.3	0.0	105.5	105.5	0.0
May	Max	105.0	105.0	0.0	104.7	104.7	0.0	109.3	109.3	0.0
May	Min	101.1	101.1	0.0	100.7	100.7	0.0	102.0	102.0	0.0
May	Avg	103.1	103.1	0.0	103.0	103.0	0.0	105.8	105.8	0.0
June	Max	104.9	104.9	0.0	104.5	104.5	0.0	108.5	108.5	0.0
June	Min	99.6	99.6	0.0	98.9	98.9	0.0	104.7	104.7	0.0
June	Avg	102.2	102.2	0.0	102.0	102.0	0.0	107.1	107.1	0.0
July	Max	103.4	103.4	0.0	103.7	103.7	0.0	108.1	108.1	0.0
July	Min	99.8	99.8	0.0	99.9	99.9	0.0	101.2	101.2	0.0
July	Avg	101.9	101.9	0.0	101.6	101.6	0.0	105.4	105.4	0.0
August	Max	103.0	103.0	0.0	102.2	102.2	0.0	111.8	111.8	0.0
August	Min	98.7	98.7	0.0	97.9	97.9	0.0	96.8	96.8	0.0
August	Avg	100.7	100.7	0.0	100.3	100.3	0.0	106.9	106.9	0.0

TABLE 26

Lower Granite Tailwater Monthly Statistics

Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Differ ence	2002 w/115%	2002 wo/115%	Differ ence	1999 w/115%	1999 wo/115%	Differ ence
April	Max	111.3	111.3	0.0	116.9	116.9	0.0	113.6	113.6	0.0
April	Min	110.8	110.8	0.0	110.9	110.9	0.0	110.9	110.9	0.0
April	Avg	111.0	111.0	0.0	111.3	111.3	0.0	111.5	111.5	0.0
May	Max	111.4	111.4	0.0	117.6	117.6	0.0	129.9	129.9	0.0
May	Min	102.4	102.4	0.0	102.3	102.3	0.0	103.4	103.4	0.0
May	Avg	108.3	108.3	0.0	108.3	108.3	0.0	112.5	112.5	0.0
June	Max	111.2	111.2	0.0	117.5	117.5	0.0	126.9	126.9	0.0
June	Min	110.8	110.8	0.0	111.1	111.1	0.0	111.4	111.4	0.0
June	Avg	111.0	111.0	0.0	111.9	111.9	0.0	118.2	118.2	0.0
July	Max	111.0	111.0	0.0	111.4	111.4	0.0	111.4	111.4	0.0
July	Min	110.8	110.8	0.0	111.1	111.1	0.0	111.1	111.1	0.0
July	Avg	110.9	110.9	0.0	111.3	111.3	0.0	111.2	111.2	0.0
August	Max	111.0	111.0	0.0	111.2	111.2	0.0	111.8	111.8	0.0
August	Min	98.7	98.7	0.0	97.9	97.9	0.0	96.8	96.8	0.0
August	Avg	101.8	101.8	0.0	101.5	101.5	0.0	106.9	107.5	0.6

TABLE 27
Little Goose Forebay Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Difference	2002 w/115%	2002 wo/115%	Difference	1999 w/115%	1999 wo/115%	Difference
April	Max	109.8	109.8	0.0	108.5	108.5	0.0	108.9	108.9	0.0
April	Min	100.6	100.6	0.0	102.4	102.4	0.0	105.3	105.3	0.0
April	Avg	107.0	107.0	0.0	106.1	106.1	0.0	107.4	107.4	0.0
May	Max	109.7	109.7	0.0	108.6	108.6	0.0	128.6	128.6	0.0
May	Min	102.4	102.4	0.0	102.3	102.3	0.0	103.9	103.9	0.0
May	Avg	106.2	106.2	0.0	105.4	105.4	0.0	109.0	109.0	0.0
June	Max	110.5	110.5	0.0	112.2	112.2	0.0	124.3	124.3	0.0
June	Min	105.4	105.4	0.0	103.7	103.7	0.0	107.1	107.1	0.0
June	Avg	107.0	107.0	0.0	106.7	106.7	0.0	114.7	114.7	0.0
July	Max	109.8	109.8	0.0	110.4	110.4	0.0	109.6	109.6	0.0
July	Min	106.6	106.6	0.0	104.0	104.0	0.0	105.9	105.9	0.0
July	Avg	108.8	108.8	0.0	108.0	108.0	0.0	107.8	107.8	0.0
August	Max	110.8	110.8	0.0	109.4	109.4	0.0	109.5	109.5	0.0
August	Min	99.7	99.7	0.0	100.1	100.1	0.0	104.6	104.6	0.0
August	Avg	105.1	105.1	0.0	104.6	104.6	0.0	107.5	106.8	-0.8

TABLE 28
Little Goose Tailwater Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Difference	2002 w/115%	2002 wo/115%	Difference	1999 w/115%	1999 wo/115%	Difference
April	Max	119.3	119.4	0.0	120.6	120.7	0.1	120.2	120.6	0.5
April	Min	116.5	116.5	0.0	117.8	117.8	0.0	118.6	118.6	0.0
April	Avg	117.5	117.5	0.0	118.7	118.7	0.0	119.3	119.6	0.2
May	Max	119.5	119.6	0.1	120.3	120.4	0.1	127.7	127.7	0.0
May	Min	103.0	103.0	0.0	103.9	103.9	0.0	103.9	103.9	0.0
May	Avg	112.8	112.8	0.0	112.8	112.8	0.0	114.2	114.3	0.1
June	Max	118.3	118.3	0.0	120.0	120.2	0.1	124.7	124.7	0.0
June	Min	116.2	116.2	0.0	118.3	118.3	0.0	119.0	119.5	0.5
June	Avg	117.3	117.3	0.0	119.5	119.5	0.0	120.9	121.3	0.4
July	Max	116.9	116.9	0.0	118.3	118.3	0.0	119.6	119.6	0.0
July	Min	114.7	114.7	0.0	115.4	115.4	0.0	117.6	117.6	0.0
July	Avg	116.1	116.1	0.0	117.1	117.1	0.0	118.5	118.5	0.0
August	Max	115.7	115.7	0.0	116.1	116.1	0.0	118.3	118.3	0.0
August	Min	99.7	99.7	0.0	100.1	100.1	0.0	104.6	104.6	0.0
August	Avg	105.8	105.8	0.0	105.5	105.5	0.0	106.8	108.0	1.2

TABLE 29

Lower Monumental Forebay Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Difference	2002 w/115%	2002 wo/115%	Difference	1999 w/115%	1999 wo/115%	Difference
April	Max	115.0	115.0	0.0	115.2	115.2	0.0	115.9	117.4	1.5
April	Min	104.0	104.0	0.0	110.2	110.2	0.0	112.4	112.4	0.0
April	Avg	110.3	110.3	0.0	113.0	113.1	0.1	114.2	115.1	1.0
May	Max	115.1	115.1	0.0	115.9	116.1	0.1	128.2	128.2	0.0
May	Min	103.3	103.3	0.0	103.3	103.3	0.0	104.7	104.7	0.0
May	Avg	110.1	110.1	0.0	109.9	110.1	0.2	112.5	112.9	0.4
June	Max	115.0	115.0	0.0	116.3	116.3	0.0	124.6	124.6	0.0
June	Min	109.1	109.1	0.0	112.7	112.8	0.0	112.6	115.4	2.8
June	Avg	111.6	111.6	0.0	114.3	114.4	0.1	118.4	119.3	0.9
July	Max	111.6	111.6	0.0	113.5	113.5	0.0	116.1	116.1	0.0
July	Min	108.6	108.6	0.0	108.1	108.1	0.0	111.3	111.3	0.0
July	Avg	110.4	110.4	0.0	111.1	111.1	0.0	113.4	113.6	0.1
August	Max	111.1	111.1	0.0	110.8	110.8	0.0	114.3	114.3	0.0
August	Min	100.4	100.4	0.0	100.3	100.3	0.0	104.6	103.4	-1.2
August	Avg	106.6	106.6	0.0	106.0	106.0	0.0	108.0	108.3	0.4

TABLE 30

Lower Monumental Tailwater Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Difference	2002 w/115%	2002 wo/115%	Difference	1999 w/115%	1999 wo/115%	Difference
April	Max	117.9	120.2	2.3	118.7	120.2	1.5	118.0	120.5	2.5
April	Min	116.5	119.9	3.4	116.8	119.6	2.8	117.0	119.5	2.5
April	Avg	117.6	120.1	2.5	117.6	120.0	2.4	117.7	120.1	2.5
May	Max	117.3	120.2	2.9	118.4	120.2	1.9	122.9	122.9	0.0
May	Min	103.8	103.8	0.0	103.9	103.9	0.0	105.3	105.3	0.0
May	Avg	112.6	114.5	1.9	112.5	114.1	1.6	113.9	115.4	1.5
June	Max	116.5	119.6	3.1	117.3	120.1	2.7	121.9	121.9	0.0
June	Min	114.8	114.8	0.0	114.8	114.8	0.0	112.9	114.9	2.0
June	Avg	115.1	115.4	0.3	115.1	115.3	0.2	117.9	118.1	0.2
July	Max	115.0	115.0	0.0	115.1	115.1	0.0	115.2	115.2	0.0
July	Min	113.3	113.3	0.0	114.6	114.6	0.0	114.9	114.9	0.0
July	Avg	114.7	114.7	0.0	114.9	114.9	0.0	115.1	115.1	0.0
August	Max	115.0	115.0	0.0	114.9	114.9	0.0	115.1	115.1	0.0
August	Min	102.1	102.1	0.0	100.3	100.3	0.0	103.4	103.4	0.0
August	Avg	107.2	107.2	0.0	106.6	106.6	0.0	108.3	108.5	0.2

TABLE 31
Ice Harbor Forebay Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Difference	2002 w/115%	2002 wo/115%	Difference	1999 w/115%	1999 wo/115%	Difference
April	Max	115.5	118.8	3.3	115.6	118.8	3.2	115.5	118.5	3.0
April	Min	104.4	102.3	-2.2	99.3	99.3	0.0	105.0	105.4	0.3
April	Avg	113.1	114.6	1.5	113.1	115.9	2.8	113.3	116.1	2.8
May	Max	116.6	120.6	4.1	115.9	118.7	2.8	121.9	121.8	0.0
May	Min	103.4	103.4	0.0	104.7	104.7	0.0	104.3	104.3	0.0
May	Avg	110.3	112.7	2.4	110.9	112.9	2.0	111.4	112.9	1.5
June	Max	115.8	119.8	4.0	116.3	117.3	1.0	121.0	121.0	0.0
June	Min	109.3	109.3	0.0	112.6	112.8	0.2	112.3	113.3	1.0
June	Avg	111.8	112.5	0.7	113.9	114.2	0.3	116.7	117.2	0.6
July	Max	113.4	113.4	0.0	115.2	115.2	0.0	114.6	114.6	0.0
July	Min	110.7	110.7	0.0	109.1	109.1	0.0	110.6	110.6	0.0
July	Avg	111.7	111.7	0.0	111.8	111.8	0.0	112.2	112.4	0.2
August	Max	111.5	111.5	0.0	110.9	110.9	0.0	112.9	112.9	0.0
August	Min	102.8	102.8	0.0	101.5	101.5	0.0	103.4	103.0	-0.3
August	Avg	107.7	107.7	0.0	107.3	107.3	0.0	108.5	107.8	-0.7

TABLE 32
Ice Harbor Tailwater Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Difference	2002 w/115%	2002 wo/115%	Difference	1999 w/115%	1999 wo/115%	Difference
April	Max	115.7	115.7	0.0	117.3	117.3	0.0	117.7	117.7	0.0
April	Min	114.1	114.1	0.0	114.3	114.3	0.0	114.9	114.9	0.0
April	Avg	114.4	114.4	0.0	115.3	115.3	0.0	116.1	116.1	0.0
May	Max	116.1	116.1	0.0	117.6	117.6	0.0	130.3	130.3	0.0
May	Min	114.5	114.5	0.0	114.4	114.4	0.0	115.3	115.3	0.0
May	Avg	115.3	115.3	0.0	115.6	115.6	0.0	118.0	118.0	0.0
June	Max	114.8	114.8	0.0	117.3	117.3	0.0	123.7	123.7	0.0
June	Min	114.1	114.1	0.0	115.2	115.2	0.0	115.8	115.8	0.0
June	Avg	114.5	114.5	0.0	116.1	116.1	0.0	118.3	118.3	0.0
July	Max	114.7	114.7	0.0	115.0	115.0	0.0	115.6	115.6	0.0
July	Min	114.0	114.0	0.0	114.0	114.0	0.0	114.6	114.6	0.0
July	Avg	114.4	114.4	0.0	114.5	114.5	0.0	114.9	114.9	0.0
August	Max	114.5	114.5	0.0	114.5	114.5	0.0	114.7	114.7	0.0
August	Min	104.4	104.4	0.0	101.8	101.8	0.0	103.0	103.4	0.4
August	Avg	108.4	108.4	0.0	108.4	108.4	0.0	107.8	108.5	0.6

TABLE 33
McNary Forebay Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Differ ence	2002 w/115%	2002 wo/115%	Differ ence	1999 w/115%	1999 wo/115%	Differ ence
April	Max	114.9	114.9	0.0	114.6	114.6	0.0	114.5	114.5	0.0
April	Min	105.9	105.9	0.0	104.9	104.9	0.0	104.5	104.5	0.0
April	Avg	109.8	109.8	0.0	109.4	109.5	0.1	109.5	109.5	0.0
May	Max	117.3	117.3	0.0	116.0	116.0	0.0	117.0	117.0	0.0
May	Min	107.8	107.8	0.0	107.7	107.7	0.0	107.4	107.4	0.0
May	Avg	111.6	111.6	0.0	111.2	111.2	0.0	111.5	111.5	0.0
June	Max	115.5	115.5	0.0	114.7	114.7	0.0	115.2	115.2	0.0
June	Min	105.7	105.7	0.0	105.1	105.1	0.0	105.7	105.7	0.0
June	Avg	110.2	110.2	0.0	109.9	109.9	0.0	110.4	110.4	0.0
July	Max	113.5	113.5	0.0	112.8	112.8	0.0	113.5	113.5	0.0
July	Min	107.0	107.0	0.0	106.5	106.5	0.0	106.9	106.9	0.0
July	Avg	110.0	110.0	0.0	109.5	109.5	0.0	109.8	109.8	0.0
August	Max	109.6	109.6	0.0	109.0	109.0	0.0	109.4	109.4	0.0
August	Min	102.9	102.9	0.0	102.4	102.4	0.0	103.4	103.4	0.0
August	Avg	105.9	105.9	0.0	105.1	105.1	0.0	105.9	105.9	0.0

TABLE 34
McNary Tailwater Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Differ ence	2002 w/115%	2002 wo/115%	Differ ence	1999 w/115%	1999 wo/115%	Differ ence
April	Max	116.3	116.3	0.0	119.1	119.1	0.0	118.8	118.8	0.0
April	Min	114.1	114.1	0.0	113.4	113.7	0.2	113.7	113.7	0.0
April	Avg	114.9	114.9	0.0	116.0	116.1	0.1	116.1	116.1	0.0
May	Max	117.5	117.5	0.0	120.0	120.0	0.0	120.9	120.9	0.0
May	Min	115.2	115.2	0.0	113.5	113.5	0.0	114.8	114.8	0.0
May	Avg	116.4	116.4	0.0	116.2	116.2	0.0	117.1	117.1	0.0
June	Max	117.1	117.1	0.0	120.9	120.9	0.0	121.0	121.0	0.0
June	Min	113.3	113.3	0.0	117.6	117.6	0.0	117.6	117.6	0.0
June	Avg	114.8	114.8	0.0	119.2	119.2	0.0	119.2	119.2	0.0
July	Max	114.3	114.3	0.0	119.8	119.8	0.0	118.3	118.3	0.0
July	Min	113.6	113.6	0.0	113.8	113.8	0.0	113.7	113.7	0.0
July	Avg	113.8	113.8	0.0	115.2	115.2	0.0	115.5	115.5	0.0
August	Max	114.1	114.1	0.0	114.0	114.0	0.0	115.4	115.4	0.0
August	Min	110.8	110.8	0.0	102.7	102.7	0.0	113.7	113.7	0.0
August	Avg	113.6	113.6	0.0	113.4	113.4	0.0	114.4	114.4	0.0

TABLE 35
John Day Forebay Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Differ ence	2002 w/115%	2002 wo/115%	Differ ence	1999 w/115%	1999 wo/115%	Differ ence
April	Max	111.4	111.4	0.0	110.3	110.3	0.0	110.1	110.1	0.0
April	Min	105.9	105.9	0.0	104.7	104.7	0.0	105.6	105.6	0.0
April	Avg	107.7	107.7	0.0	107.4	107.6	0.1	108.2	108.2	0.0
May	Max	110.2	110.2	0.0	112.1	112.1	0.0	111.7	111.7	0.0
May	Min	105.5	105.5	0.0	103.5	103.5	0.0	107.5	107.5	0.0
May	Avg	108.1	108.1	0.0	107.7	107.7	0.0	108.9	108.9	0.0
June	Max	111.5	111.5	0.0	113.0	113.0	0.0	111.9	111.9	0.0
June	Min	104.6	104.6	0.0	106.5	106.5	0.0	106.9	106.9	0.0
June	Avg	106.3	106.3	0.0	109.1	109.1	0.0	109.4	109.4	0.0
July	Max	110.8	110.8	0.0	109.2	109.2	0.0	110.8	110.8	0.0
July	Min	105.1	105.1	0.0	102.5	102.5	0.0	106.4	106.4	0.0
July	Avg	107.8	107.8	0.0	106.6	106.6	0.0	108.3	108.3	0.0
August	Max	110.6	110.6	0.0	107.1	107.1	0.0	108.8	108.8	0.0
August	Min	106.5	106.5	0.0	101.9	101.9	0.0	102.2	102.2	0.0
August	Avg	108.0	108.0	0.0	103.9	103.9	0.0	105.5	105.5	0.0

TABLE 36
John Day Tailwater Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Differ ence	2002 w/115%	2002 wo/115%	Differ ence	1999 w/115%	1999 wo/115%	Differ ence
April	Max	119.5	119.5	0.0	121.0	121.6	0.6	121.4	121.2	-0.2
April	Min	116.5	116.5	0.0	115.6	115.6	0.0	116.4	116.4	0.0
April	Avg	117.6	117.6	0.0	118.4	118.6	0.2	119.0	118.9	-0.1
May	Max	120.7	120.7	0.0	121.3	121.7	0.4	121.8	121.8	0.0
May	Min	117.7	117.7	0.0	116.0	116.0	0.0	118.0	118.0	0.0
May	Avg	119.6	119.6	0.0	118.3	118.3	0.0	119.9	120.1	0.2
June	Max	120.5	120.5	0.0	142.6	142.7	0.1	122.1	122.3	0.2
June	Min	115.5	115.5	0.0	119.5	119.5	0.0	118.6	120.1	1.5
June	Avg	117.7	117.7	0.0	121.5	121.8	0.3	120.1	121.4	1.3
July	Max	118.1	118.1	0.0	121.2	121.6	0.3	120.1	120.3	0.1
July	Min	115.5	115.5	0.0	115.5	115.5	0.0	116.1	116.1	0.0
July	Avg	116.6	116.6	0.0	117.9	117.9	0.0	118.5	118.5	0.0
August	Max	116.8	116.8	0.0	116.1	116.1	0.0	119.2	119.2	0.0
August	Min	115.3	115.3	0.0	103.4	103.4	0.0	104.1	104.1	0.0
August	Avg	115.9	115.9	0.0	115.1	115.1	0.0	116.9	116.9	0.0

TABLE 37
The Dalles Forebay Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Difference	2002 w/115%	2002 wo/115%	Difference	1999 w/115%	1999 wo/115%	Difference
April	Max	113.2	113.2	0.0	112.9	112.9	0.0	112.1	111.9	-0.2
April	Min	108.2	108.2	0.0	104.2	107.2	3.1	109.4	109.4	0.0
April	Avg	110.3	110.3	0.0	109.3	109.6	0.3	110.8	110.7	-0.1
May	Max	112.3	112.3	0.0	113.7	113.7	0.0	113.2	113.2	0.0
May	Min	108.2	108.2	0.0	106.4	106.4	0.0	109.8	109.8	0.0
May	Avg	110.5	110.5	0.0	109.7	109.7	0.0	111.4	111.5	0.1
June	Max	112.6	112.6	0.0	113.7	113.9	0.2	114.6	115.3	0.7
June	Min	106.6	106.6	0.0	108.8	108.9	0.1	109.3	110.3	1.0
June	Avg	108.5	108.5	0.0	111.3	111.5	0.1	111.4	112.1	0.7
July	Max	112.9	112.9	0.0	111.7	111.7	0.0	112.9	112.9	0.0
July	Min	107.0	107.0	0.0	104.1	104.1	0.0	108.7	108.7	0.0
July	Avg	109.5	109.5	0.0	108.5	108.5	0.0	110.6	110.6	0.0
August	Max	112.8	112.8	0.0	108.8	108.8	0.0	109.9	109.9	0.0
August	Min	108.1	108.1	0.0	103.4	103.4	0.0	105.3	105.3	0.0
August	Avg	110.2	110.2	0.0	105.6	105.6	0.0	108.0	108.0	0.0

TABLE 38
The Dalles Tailwater Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Difference	2002 w/115%	2002 wo/115%	Difference	1999 w/115%	1999 wo/115%	Difference
April	Max	117.3	117.3	0.0	117.5	117.5	0.0	117.3	117.2	-0.1
April	Min	113.9	113.9	0.0	111.8	114.2	2.4	114.7	114.7	0.0
April	Avg	115.5	115.5	0.0	115.4	115.6	0.2	115.9	116.0	0.1
May	Max	117.3	117.3	0.0	118.5	118.5	0.0	118.3	118.4	0.1
May	Min	114.6	114.6	0.0	113.5	113.5	0.0	115.2	115.2	0.0
May	Avg	116.0	116.0	0.0	115.6	115.6	0.0	116.5	116.7	0.2
June	Max	117.1	117.1	0.0	118.5	118.6	0.1	118.3	119.5	1.2
June	Min	113.1	113.1	0.0	115.5	115.6	0.1	115.4	116.1	0.7
June	Avg	114.5	114.5	0.0	117.0	117.1	0.1	116.7	117.4	0.7
July	Max	117.0	117.0	0.0	116.9	116.9	0.0	117.0	117.0	0.0
July	Min	112.8	112.8	0.0	111.4	111.4	0.0	114.1	114.1	0.0
July	Avg	114.9	114.9	0.0	114.7	114.7	0.0	115.8	115.8	0.0
August	Max	117.1	117.1	0.0	114.8	114.8	0.0	115.2	115.2	0.0
August	Min	109.9	109.9	0.0	104.5	104.5	0.0	105.7	105.7	0.0
August	Avg	114.9	114.9	0.0	112.3	112.3	0.0	113.8	113.8	0.0

TABLE 39
Bonneville Forebay Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Differ ence	2002 w/115%	2002 wo/115%	Differ ence	1999 w/115%	1999 wo/115%	Differ ence
April	Max	113.9	113.9	0.0	113.9	114.0	0.1	115.2	116.1	0.9
April	Min	110.1	110.1	0.0	103.2	104.0	0.7	108.8	108.8	0.0
April	Avg	112.0	111.9	-0.1	110.6	110.9	0.4	112.7	112.8	0.1
May	Max	115.9	115.9	0.0	114.4	114.4	0.0	116.1	116.2	0.1
May	Min	108.6	108.6	0.0	105.8	105.8	0.0	110.8	110.8	0.0
May	Avg	112.4	112.4	0.0	110.9	110.9	0.0	113.4	113.5	0.2
June	Max	113.9	113.9	0.0	116.2	116.3	0.1	116.3	116.9	0.7
June	Min	106.8	106.8	0.0	110.1	110.1	0.0	111.5	111.9	0.4
June	Avg	109.9	109.9	0.0	112.9	113.0	0.1	113.1	113.7	0.6
July	Max	113.5	113.5	0.0	114.2	114.3	0.1	114.1	114.1	0.0
July	Min	107.0	107.0	0.0	103.1	103.1	0.0	110.3	110.3	0.0
July	Avg	110.6	110.6	0.0	109.6	109.6	0.0	112.4	112.4	0.0
August	Max	114.1	114.1	0.0	109.8	109.8	0.0	111.9	111.9	0.0
August	Min	104.3	104.3	0.0	103.2	103.2	0.0	103.9	103.9	0.0
August	Avg	111.1	111.1	0.0	106.5	106.5	0.0	109.7	109.7	0.0

TABLE 40
Bonneville Tailwater Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Differ ence	2002 w/115%	2002 wo/115%	Differ ence	1999 w/115%	1999 wo/115%	Differ ence
April	Max	118.0	118.1	0.1	120.6	120.6	0.0	123.7	123.7	0.0
April	Min	117.0	117.0	0.0	116.7	116.9	0.2	116.9	117.2	0.3
April	Avg	117.5	117.5	0.0	117.9	118.0	0.1	118.6	119.0	0.4
May	Max	118.3	118.4	0.1	121.9	121.9	0.0	127.2	127.2	0.0
May	Min	117.2	117.4	0.1	116.7	116.7	0.0	115.6	117.3	1.7
May	Avg	117.9	118.0	0.1	117.6	117.7	0.1	119.2	120.1	1.0
June	Max	118.2	118.2	0.0	124.3	124.3	0.0	128.1	128.1	0.0
June	Min	116.0	116.8	0.9	117.7	117.6	0.0	118.7	119.3	0.6
June	Avg	117.1	117.5	0.4	119.7	119.5	-0.1	123.8	123.8	0.0
July	Max	118.4	119.9	1.5	119.3	121.0	1.7	122.3	122.9	0.6
July	Min	115.3	115.8	0.5	115.9	115.9	0.0	116.6	119.2	2.6
July	Avg	116.9	118.4	1.5	118.0	119.1	1.1	117.7	119.9	2.2
August	Max	118.7	118.6	-0.1	117.9	117.9	0.1	120.4	123.2	2.8
August	Min	108.6	108.6	0.0	109.1	109.1	0.0	108.9	108.9	0.0
August	Avg	116.3	116.5	0.2	115.3	115.4	0.1	118.7	120.6	2.0

TABLE 41

Camas Washougal Monthly Statistics
Of High 12 Hour Average % TDG Levels

Month	Parameter	2007 w/115%	2007 wo/115%	Differ ence	2002 w/115%	2002 wo/115%	Differ ence	1999 w/115%	1999 wo/115%	Differ ence
April	Max	114.8	114.8	0.0	115.0	115.0	0.0	116.8	117.2	0.4
April	Min	111.5	110.0	-1.5	105.9	109.2	3.4	107.7	107.8	0.1
April	Avg	113.5	113.4	-0.1	112.4	112.7	0.3	113.0	113.3	0.3
May	Max	116.1	116.2	0.0	116.1	116.3	0.2	117.8	118.1	0.3
May	Min	112.0	112.1	0.1	110.6	110.6	0.0	110.8	111.1	0.3
May	Avg	113.6	113.7	0.1	113.3	113.4	0.1	113.8	114.3	0.5
June	Max	116.1	116.1	0.0	117.6	117.3	-0.3	118.1	118.3	0.2
June	Min	110.3	110.3	0.0	111.5	111.4	-0.2	112.9	113.1	0.2
June	Avg	112.8	113.2	0.4	114.7	114.6	-0.1	115.7	116.0	0.3
July	Max	115.6	116.5	0.8	116.2	117.7	1.5	115.4	116.6	1.2
July	Min	111.6	113.0	1.3	109.4	109.7	0.3	110.9	111.8	0.9
July	Avg	113.5	115.1	1.6	113.5	114.7	1.2	113.4	114.8	1.3
August	Max	116.4	116.3	-0.1	113.2	113.2	0.0	115.8	117.9	2.1
August	Min	110.0	110.0	0.0	108.7	108.7	0.0	109.9	109.9	0.0
August	Avg	113.3	113.5	0.2	110.9	110.9	0.1	113.4	115.4	2.0

Graphs of the High 12 Hour Average TDG

As Tables 25 through 41 shows, there are many TDG gages that will not be impacted if the 115% TDG standard is removed and several gages that will. In order to visually show the impacts for each gage, the daily high 12 hour average TDG data was graphed and are shown in Figures 1 – 33.

When the removal of the 115% TDG standard resulted in no or minimal impacts on the gage's TDG levels, then all three water years and both scenarios were shown on one graph since there is minimal variability. Some gages had impacts only in high water years, such as John Day tailwater, The Dalles forebay, The Dalles tailwater and Bonneville forebay. When there were noticeable impacts with the removal of the 115% TDG standard in all water years, then the TDG levels for each water year with both scenarios were graphed for each gage, resulting in three graphs per gage. Gages with significant TDG impacts in all water years when the 115% TDG standard is removed included Lower Monumental tailwater; Ice Harbor forebay, Bonneville tailwater and Camas.

As Figures 6-11, 17, 28-33 shows, the elevated TDG can be persist for weeks. As the rest of the graphs show, at certain gages there can be no change in TDG levels if the 115% TDG standard is removed.

Graphs of the High 12 Hour for Lower Snake River Gages

There are eight gages on the Lower Snake River and the following graphs show the TDG impacts if the 115% TDG standard is removed.

FIGURE 1

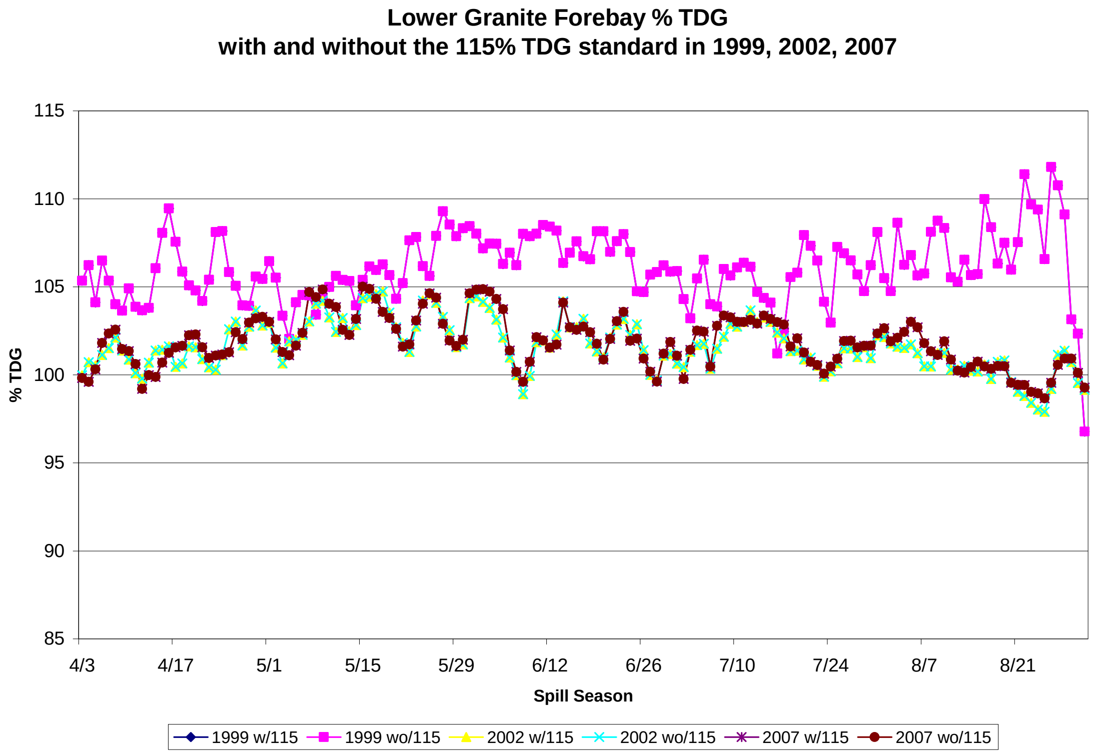


FIGURE 2

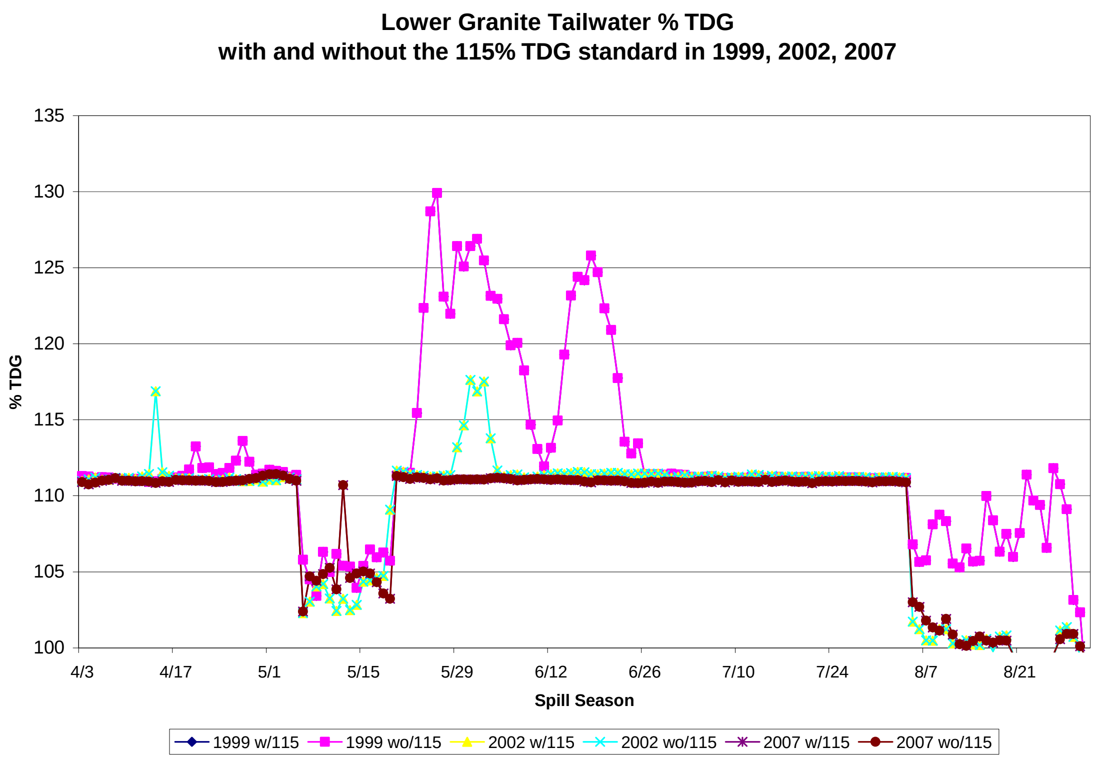


FIGURE 3

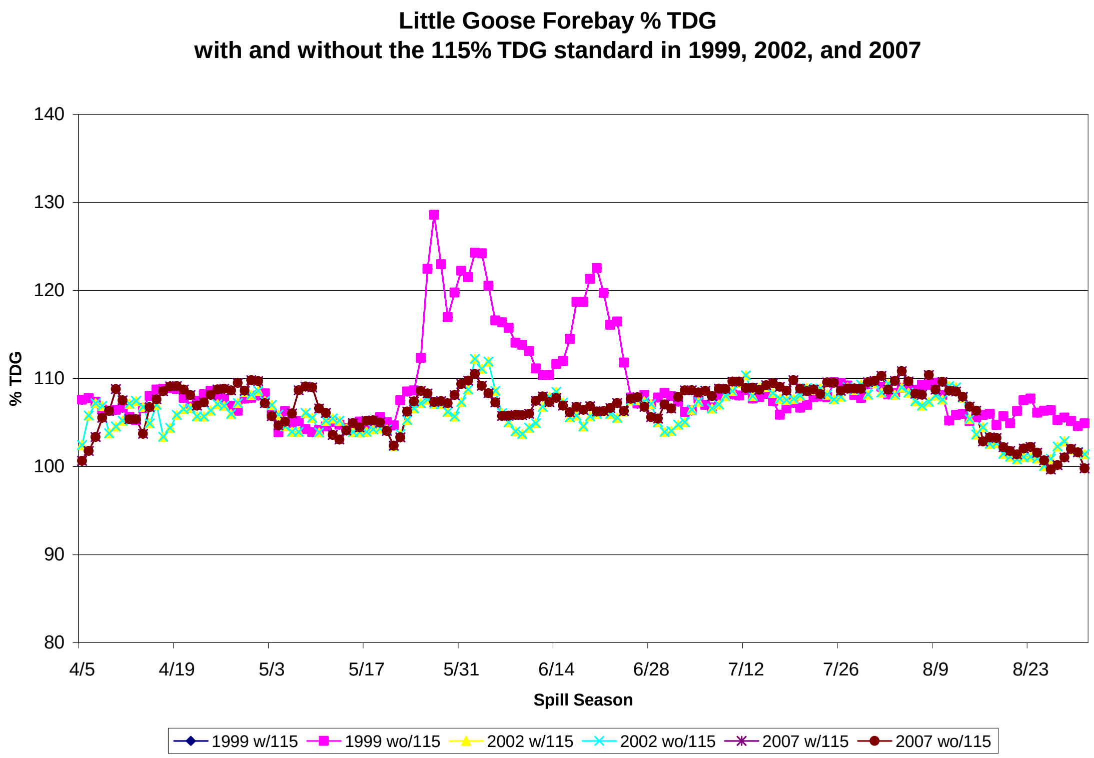


FIGURE 4

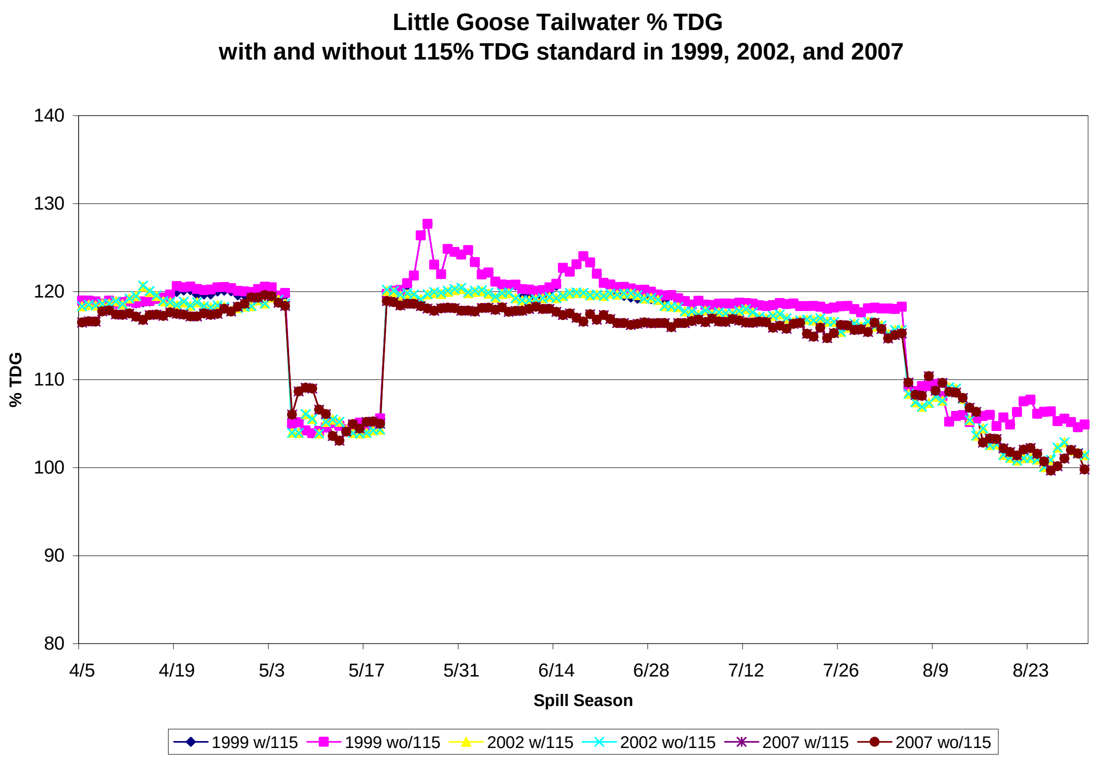


FIGURE 5

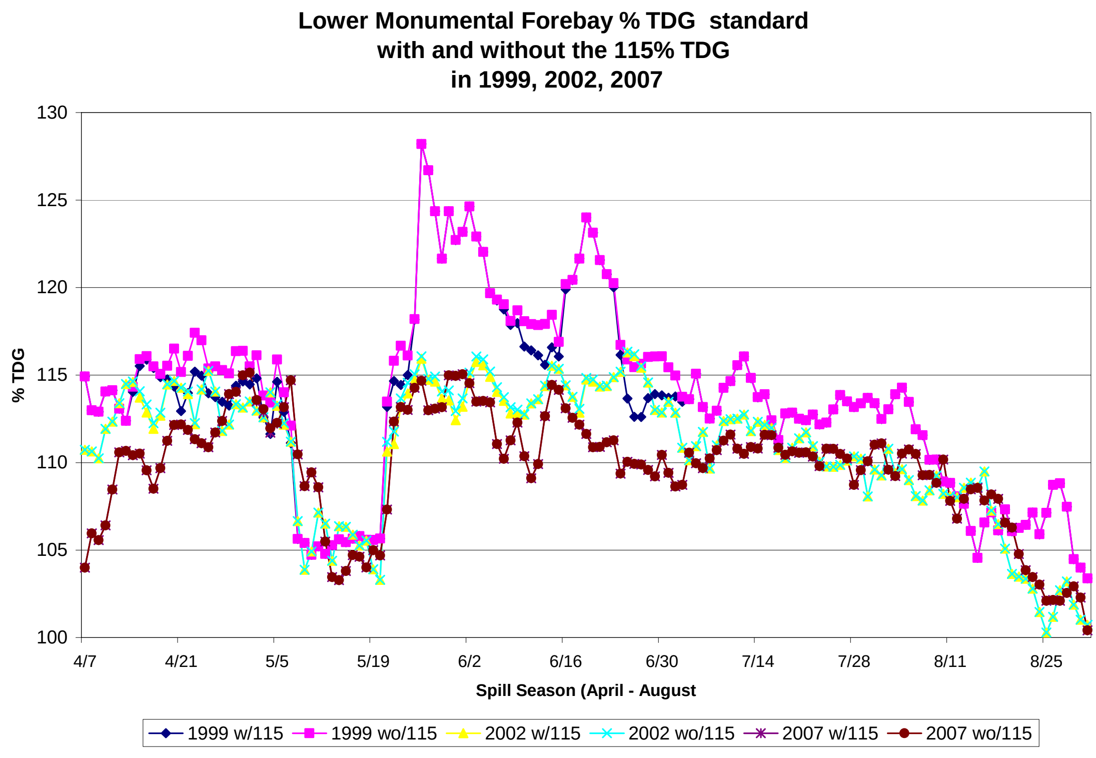


FIGURE 6

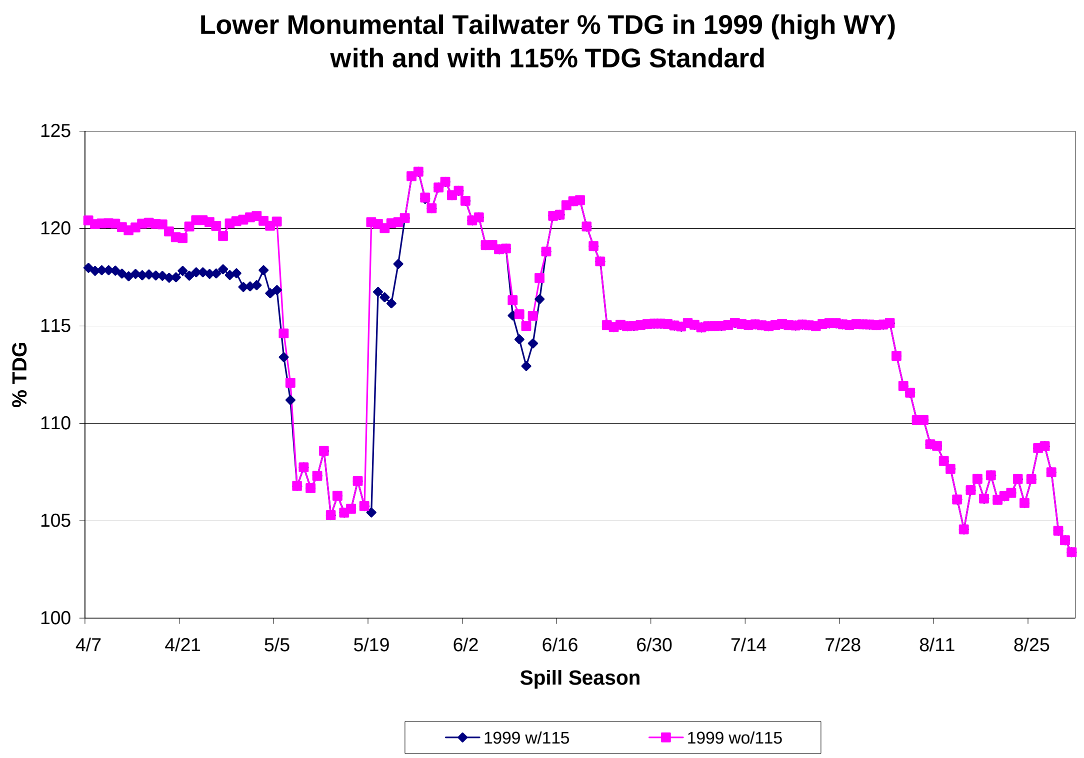


FIGURE 7

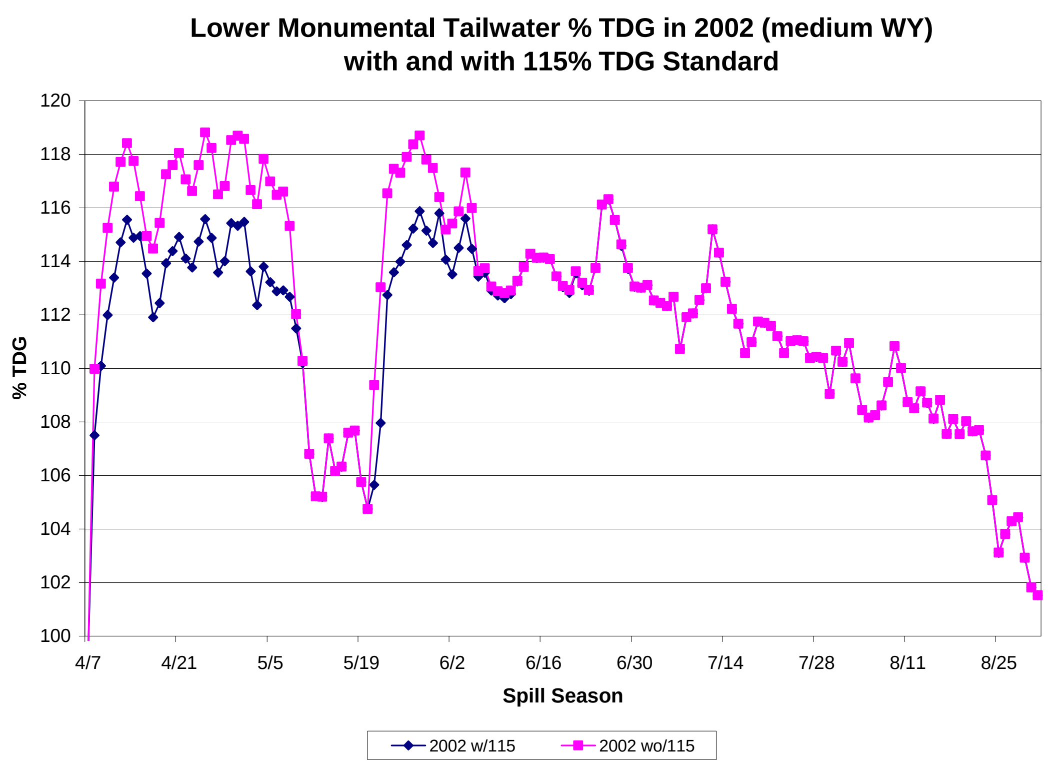


FIGURE 8

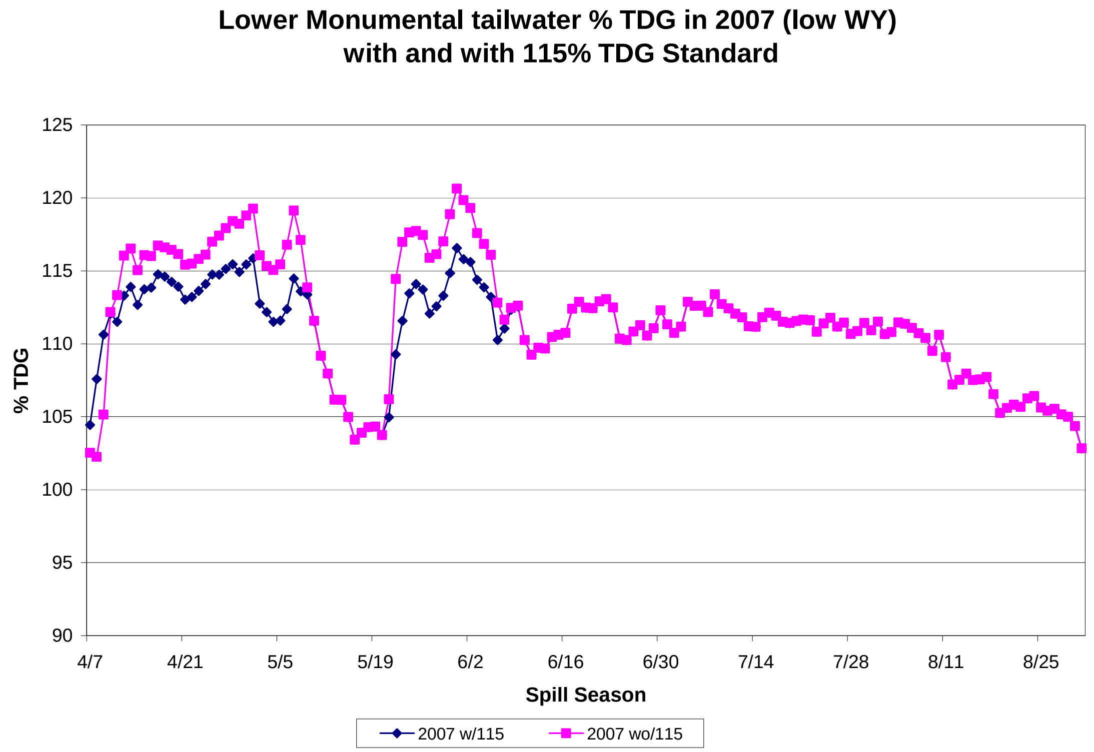


FIGURE 9

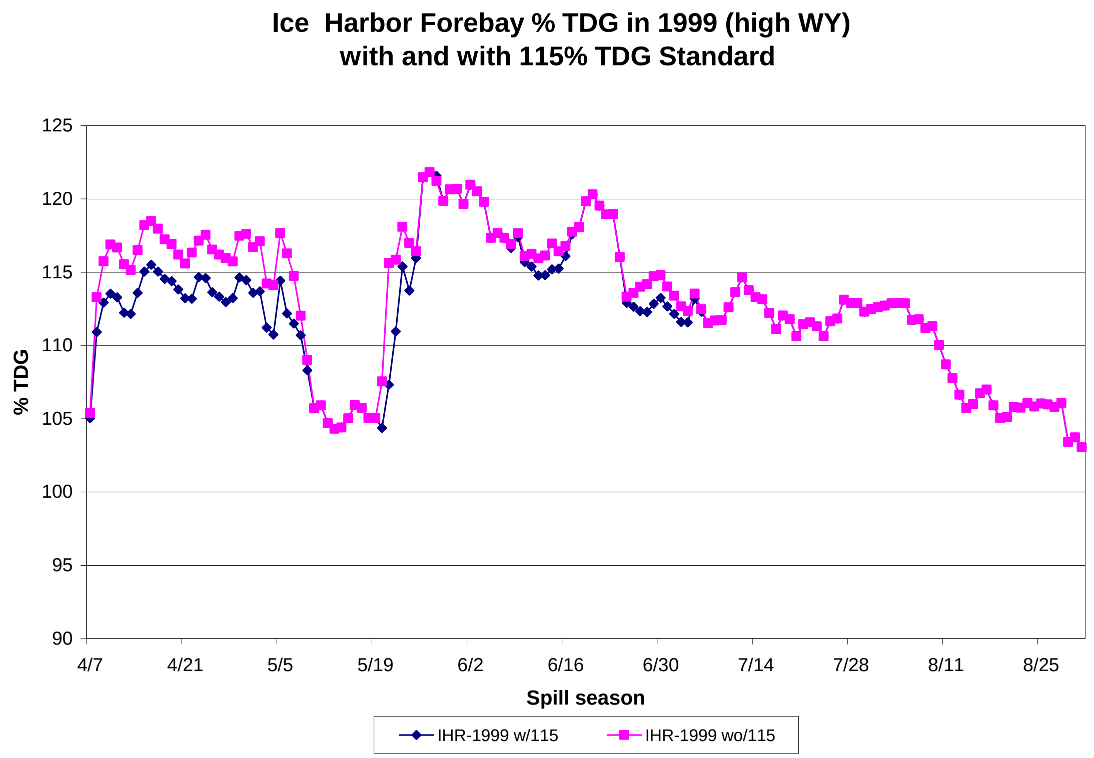


FIGURE 10

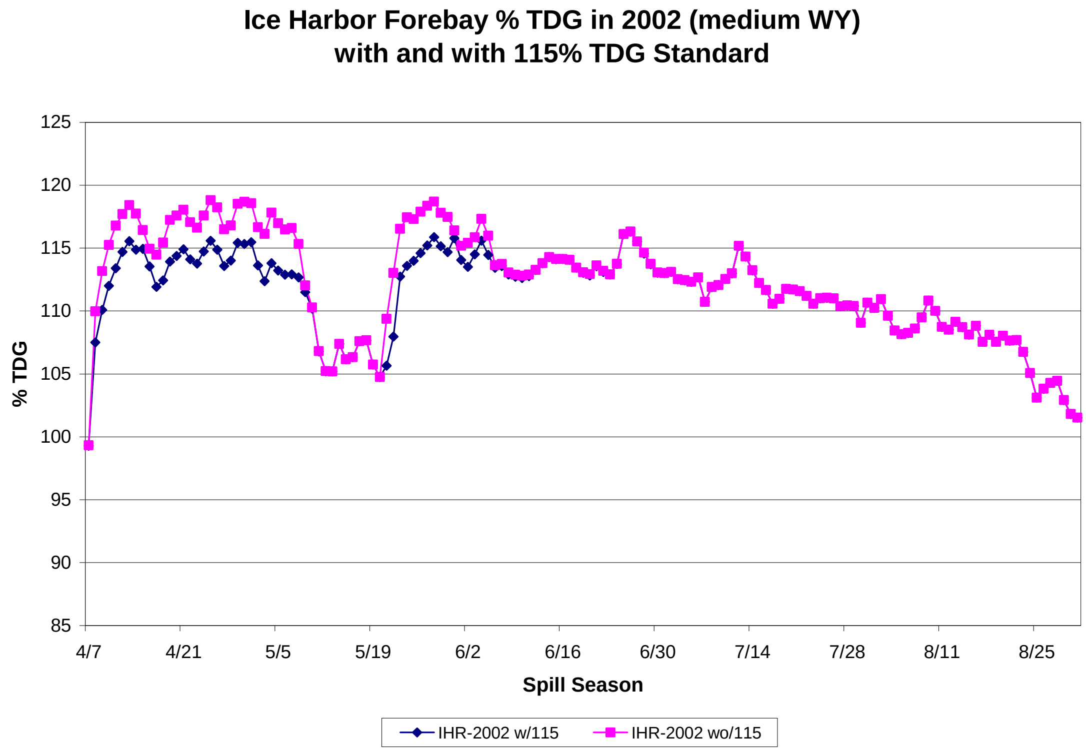
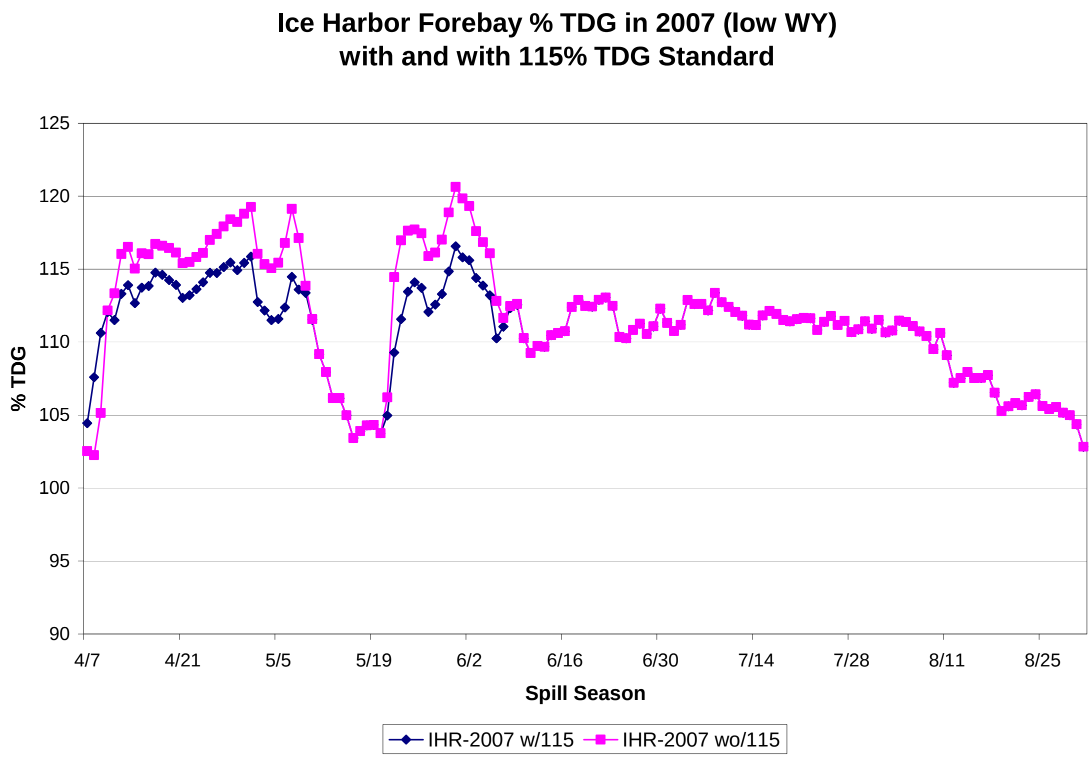


FIGURE 11



Graphs of the High 12 Hour for Lower Columbia River Gages

There are nine gages on the Lower Columbia River and the following graphs show the TDG impacts if the 115% TDG standard is removed.

FIGURE 12

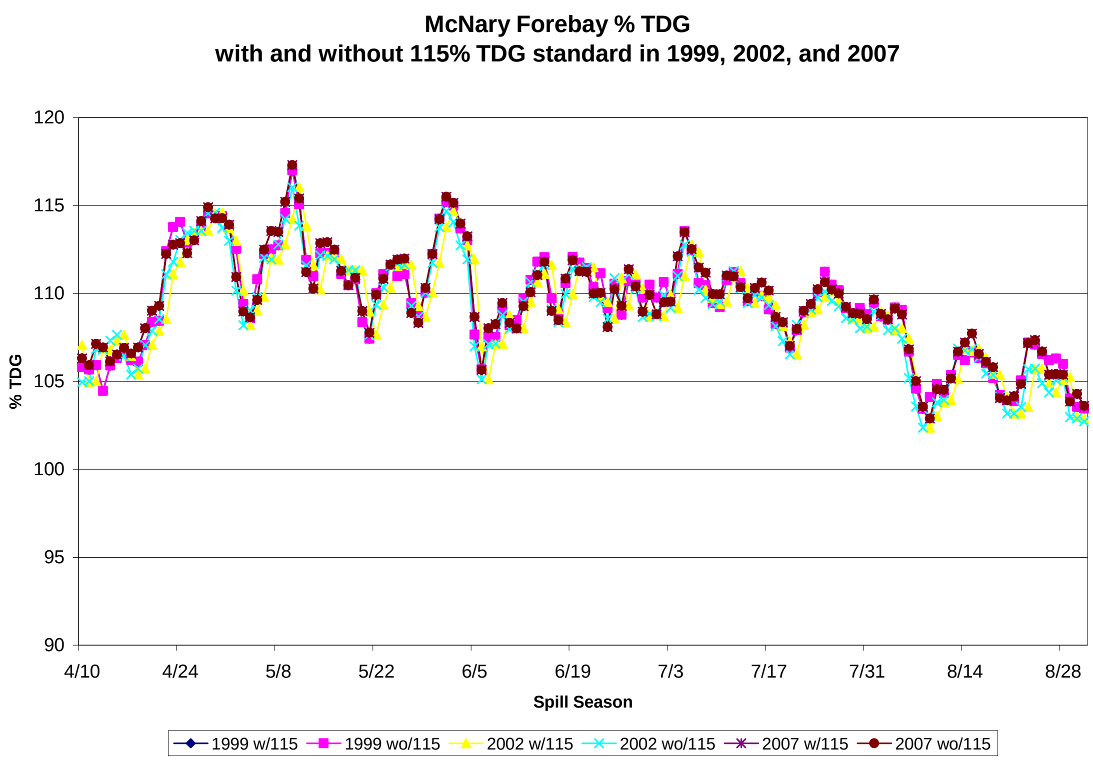


FIGURE 13

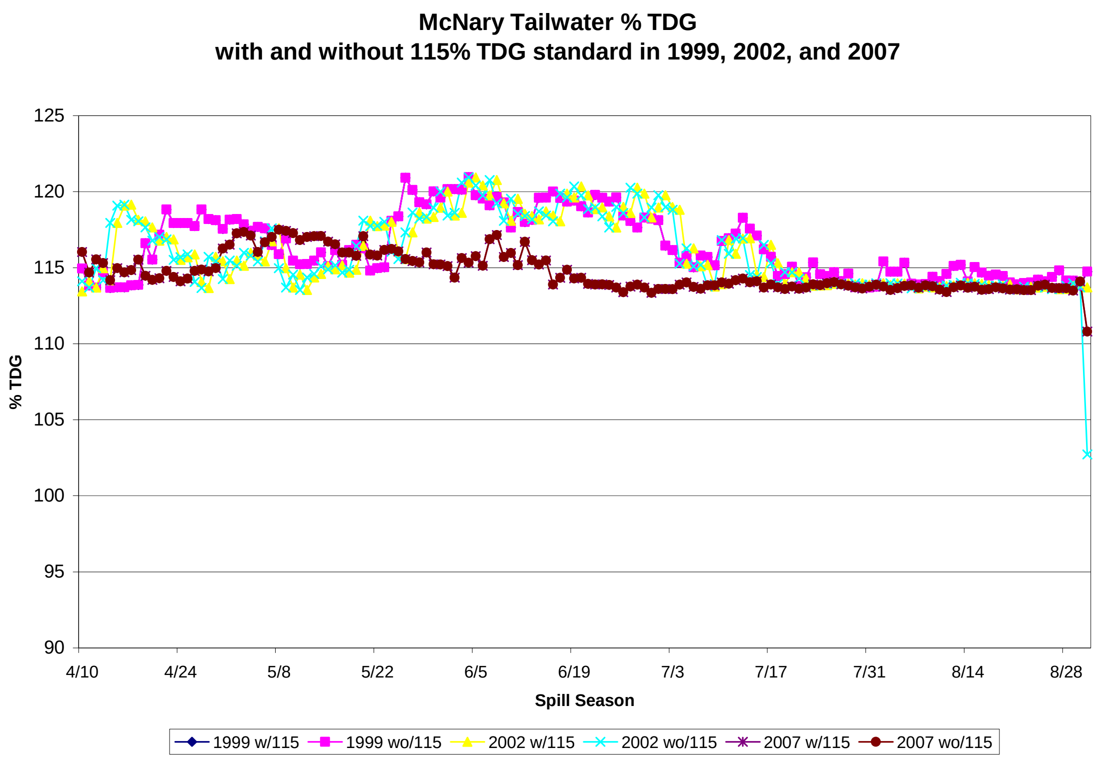


FIGURE 14

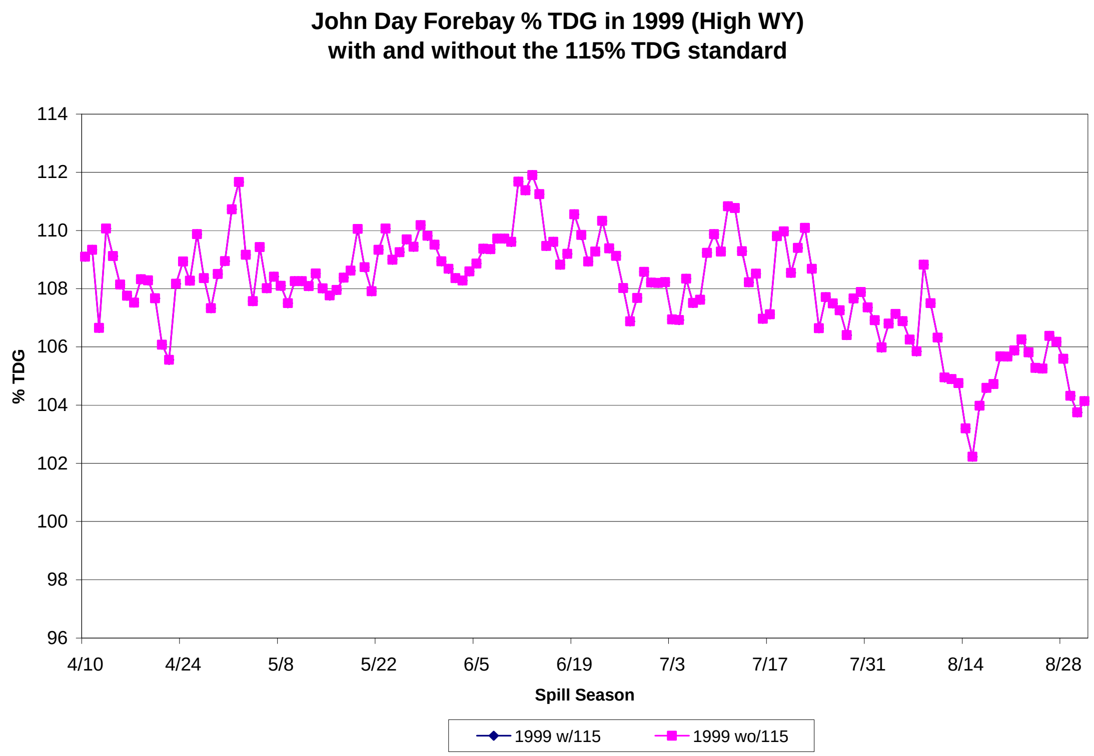


FIGURE 15

John Day Forebay % TDG in 2002 (Medium WY) with and without the 115% TDG standard

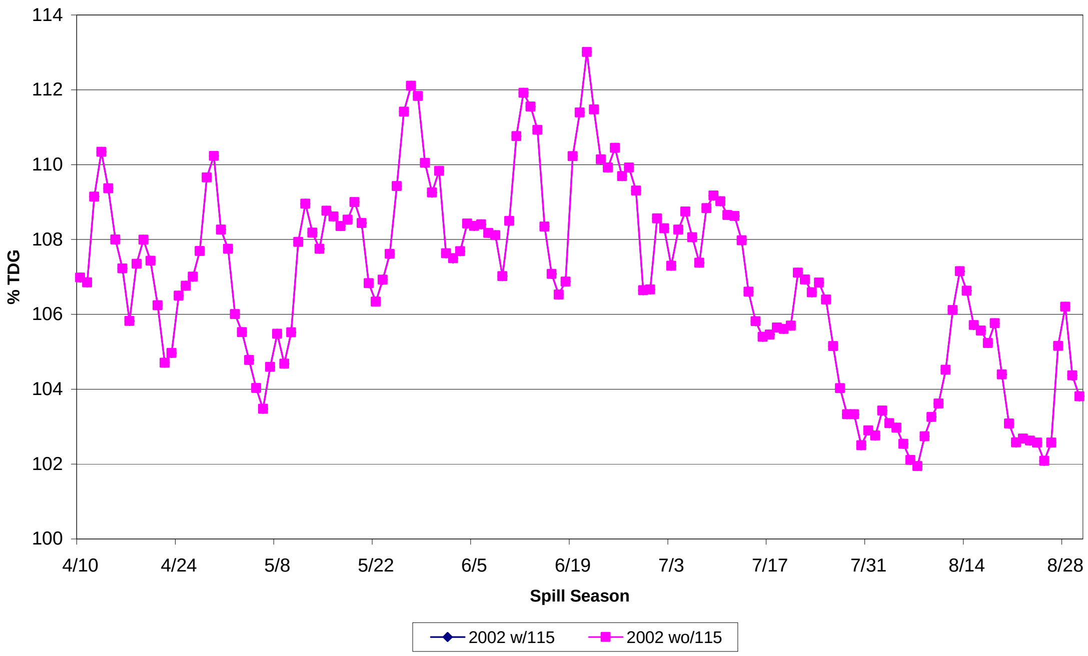


FIGURE 16

John Day Forebay % TDG in 2007 (Low WY) with and without the 115% TDG standard

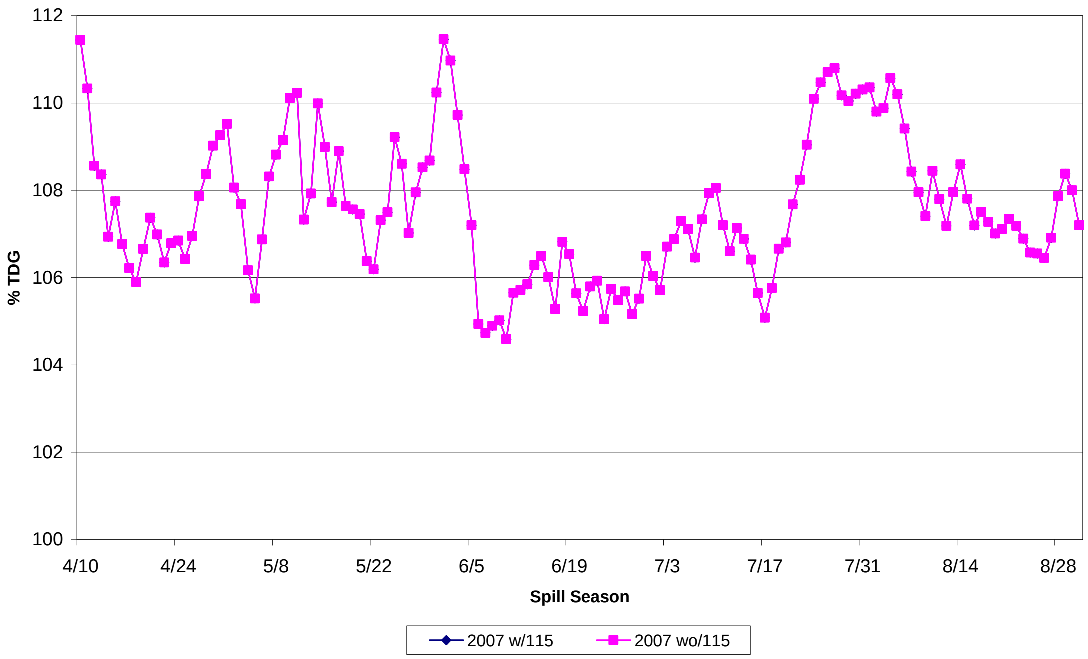


FIGURE 17

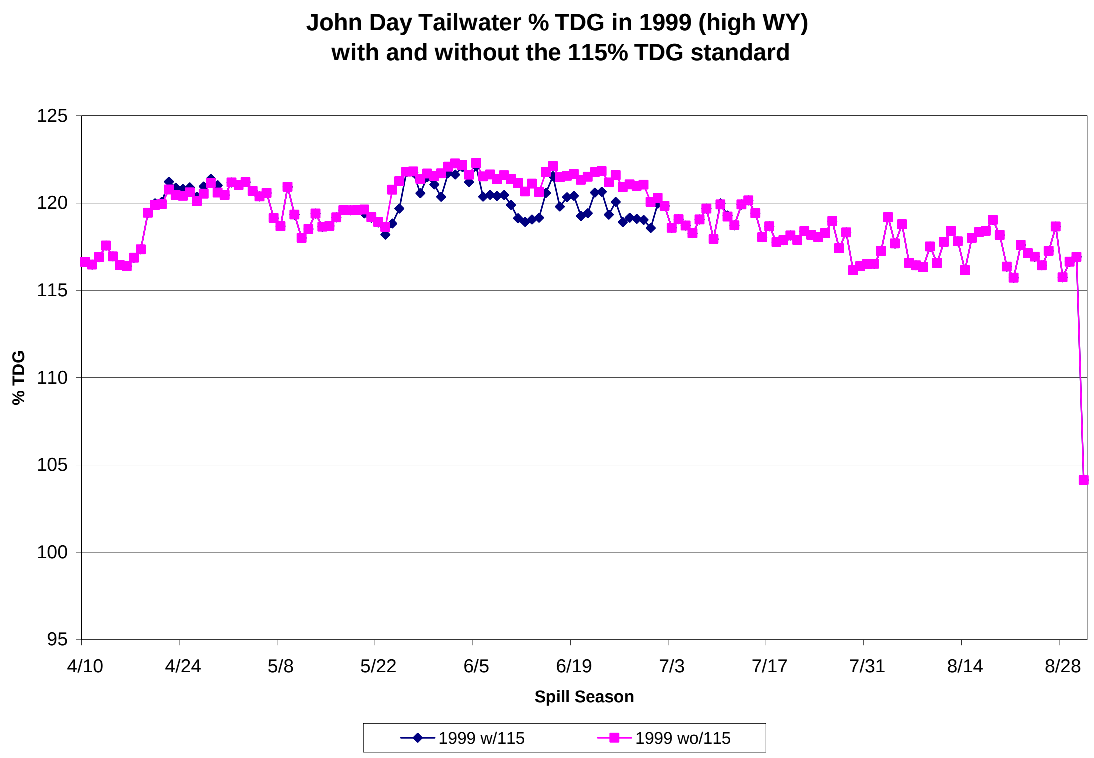


FIGURE 18

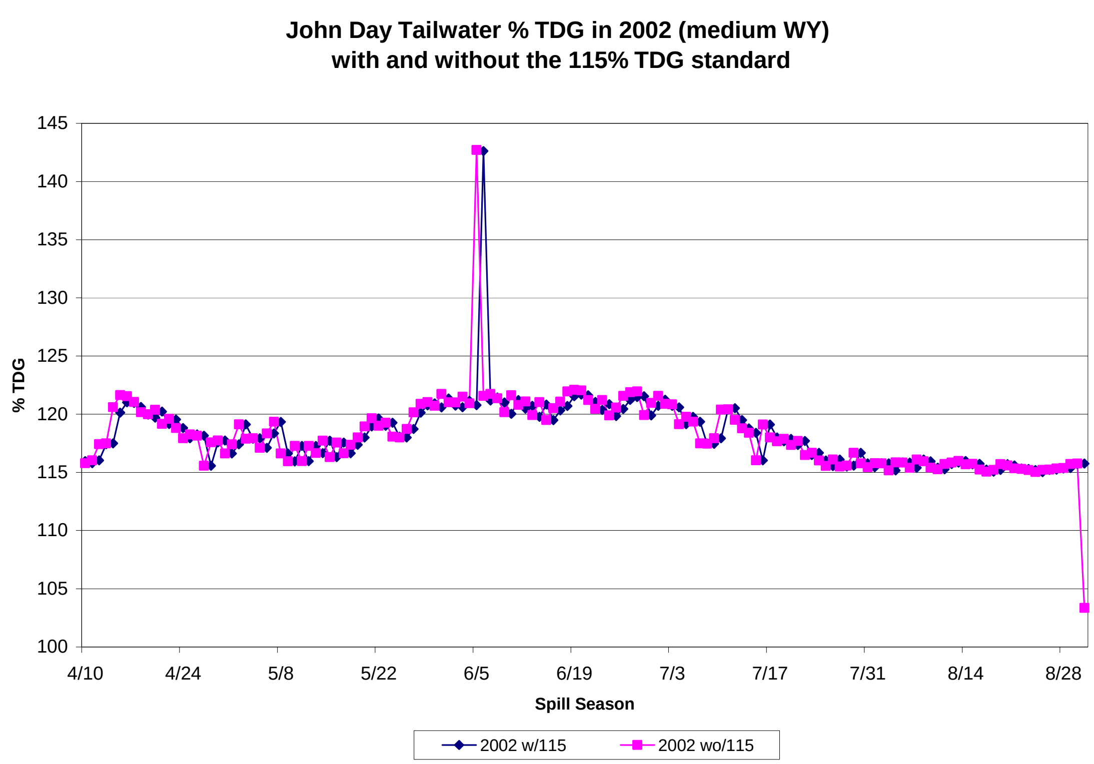


FIGURE 19

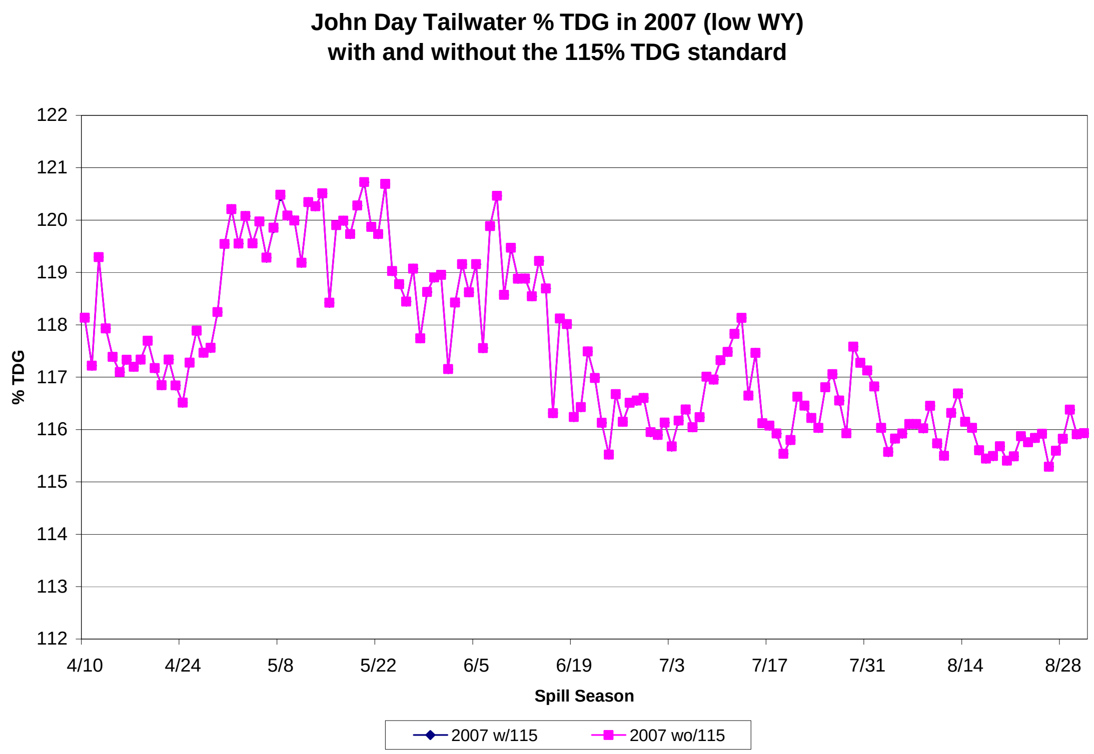


FIGURE 20

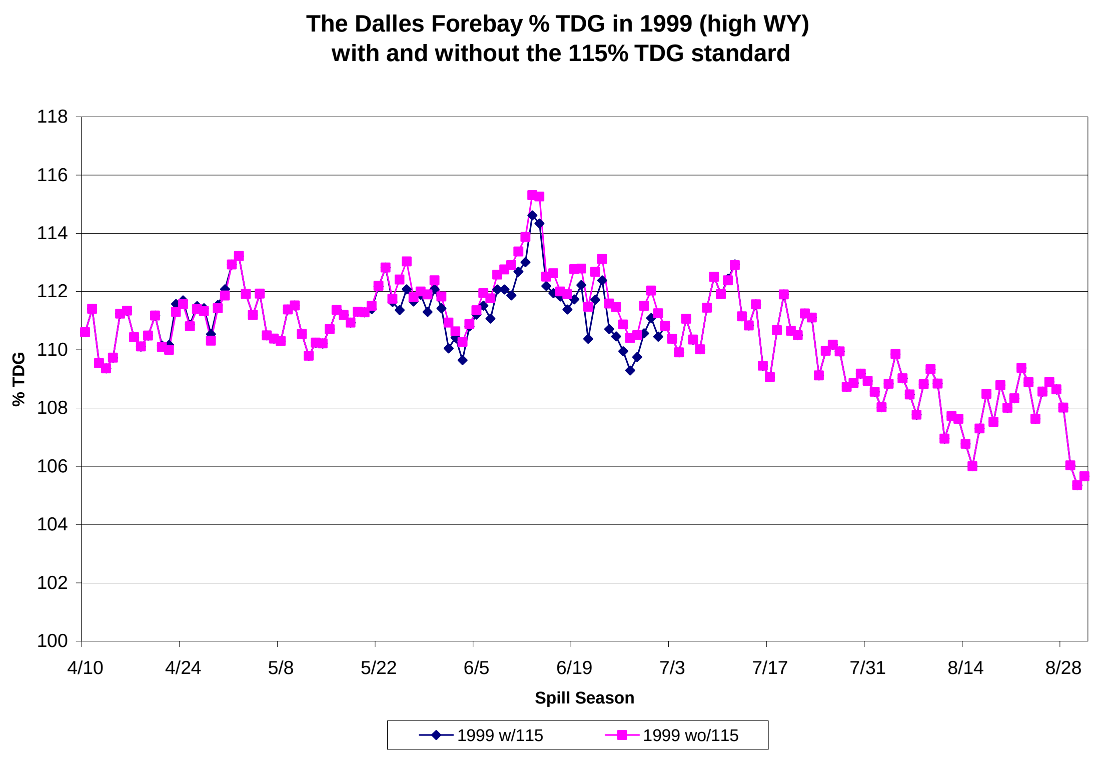


FIGURE 21

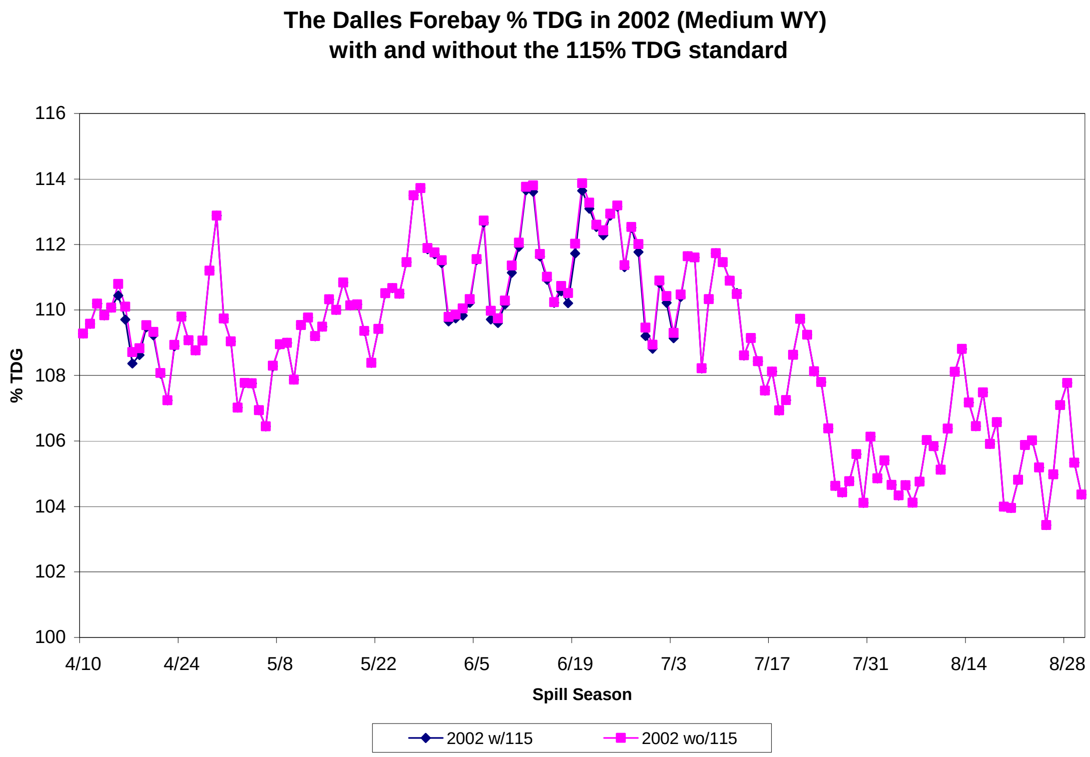


FIGURE 22

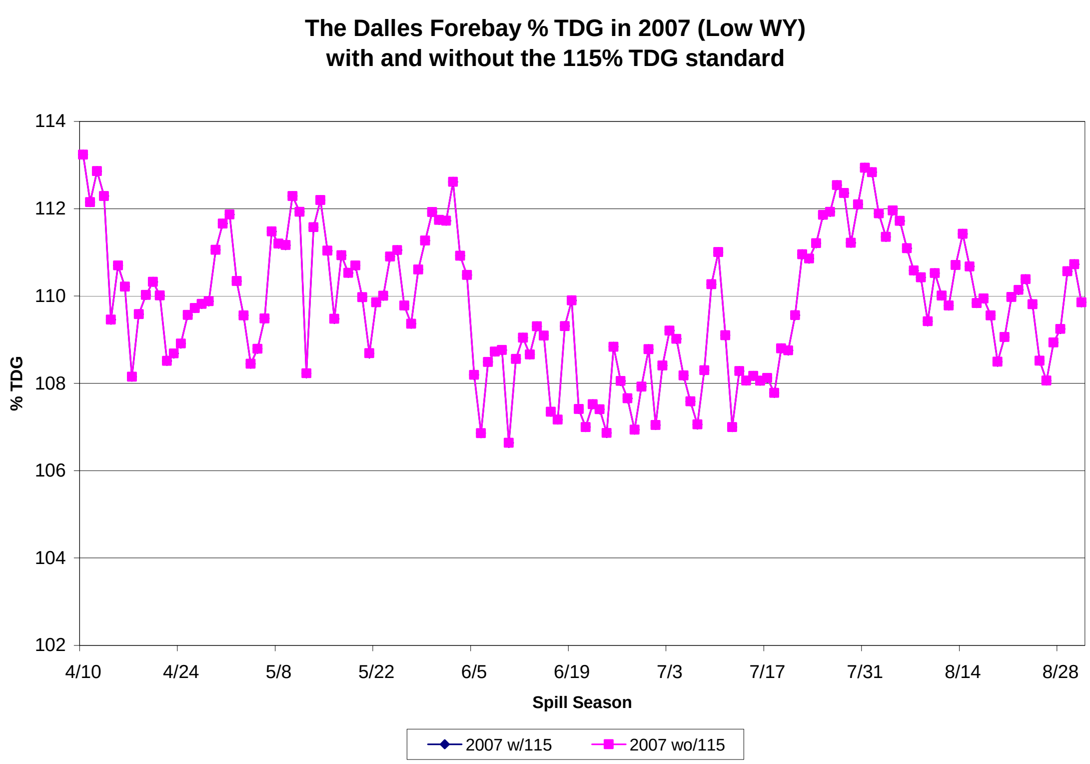


FIGURE 23

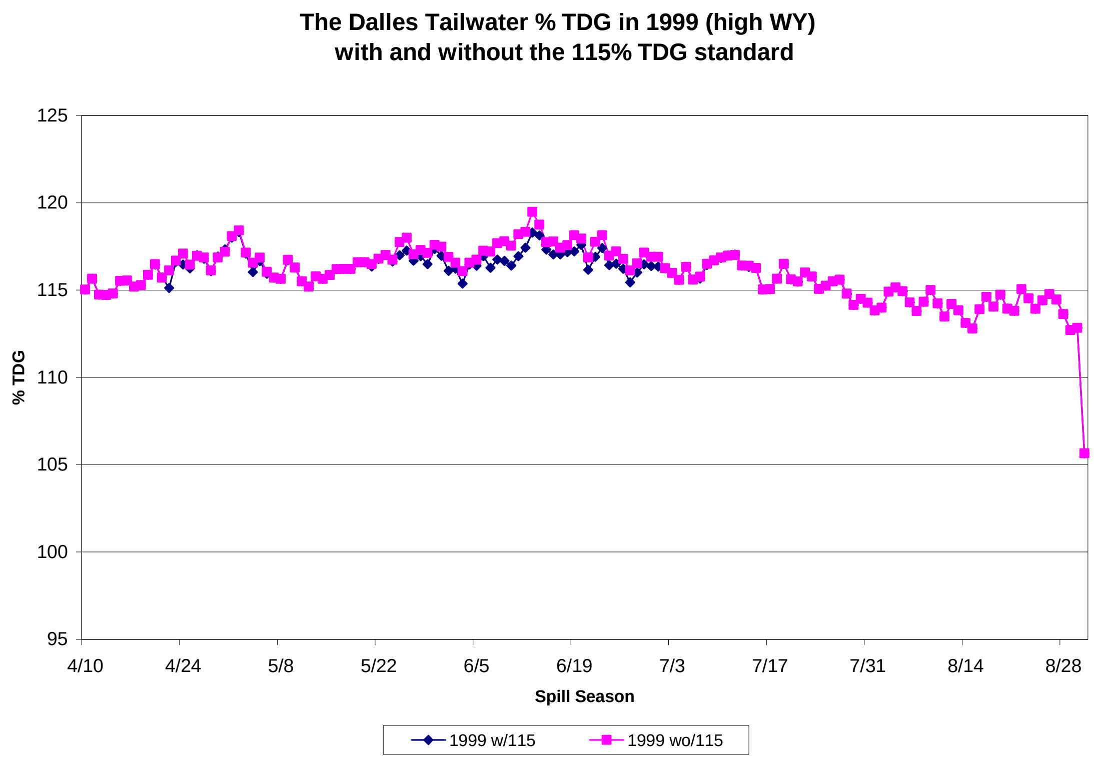


FIGURE 24

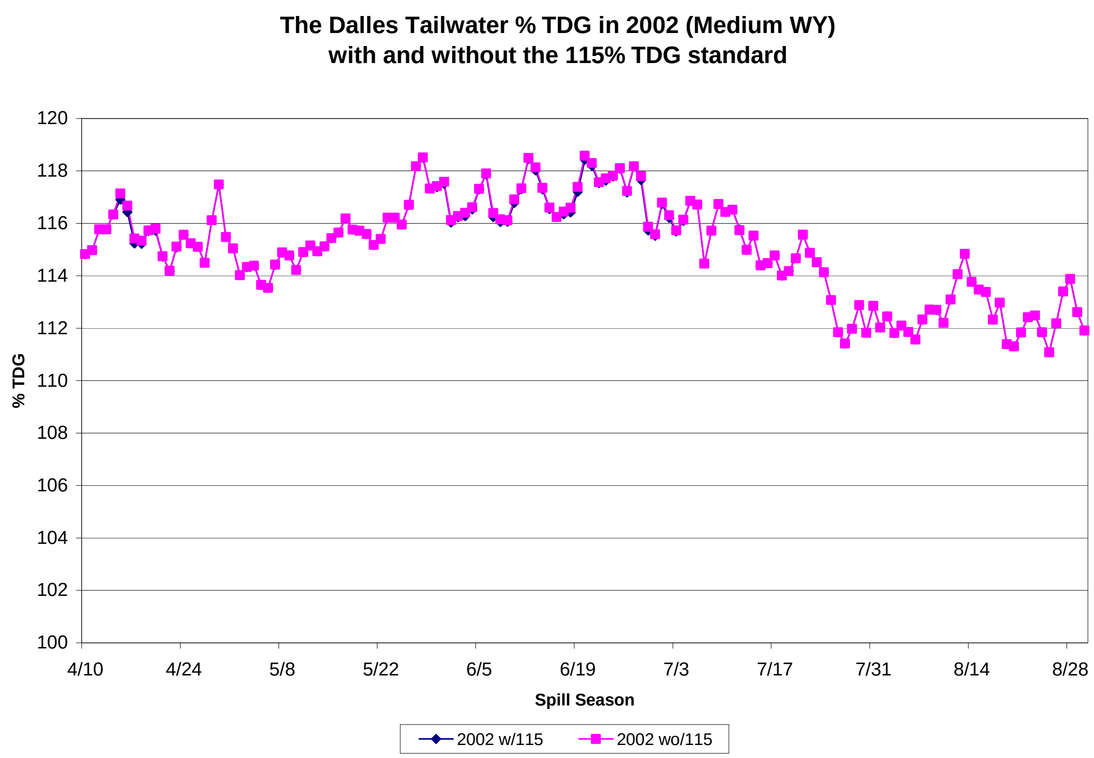


FIGURE 25

The Dalles Tailwater % TDG in 2007 (Low WY) with and without the 115% TDG standard

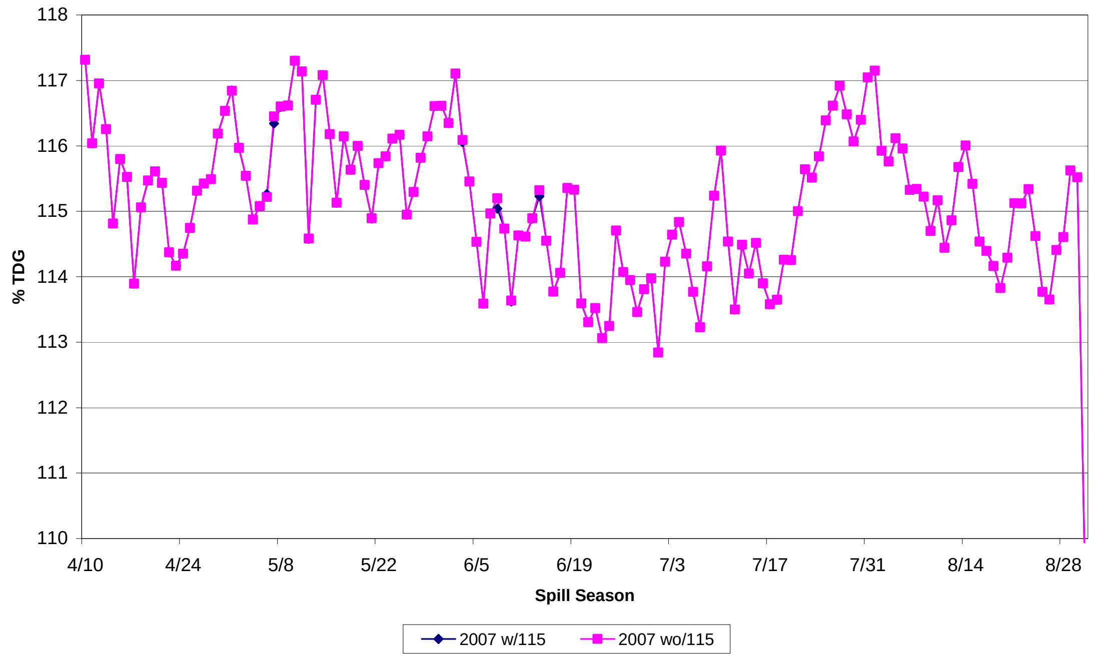


FIGURE 26

Bonneville Forebay % TDG in 1999 (high WY) with and without the 115% TDG standard

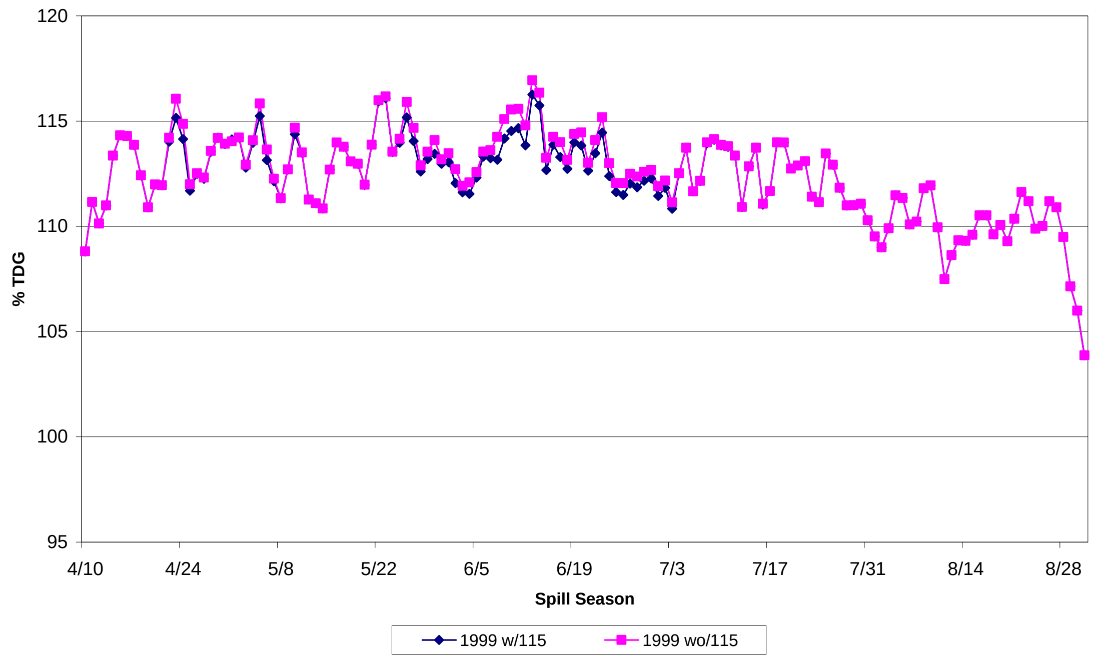


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FIGURE 27

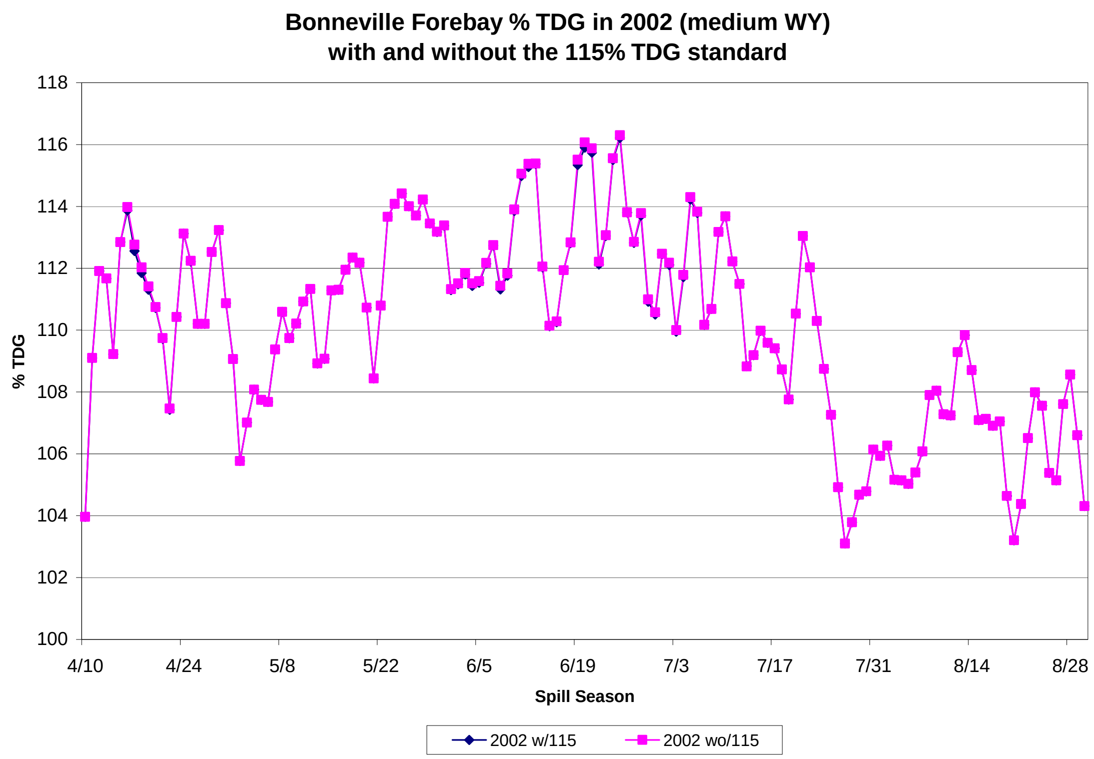


FIGURE 28

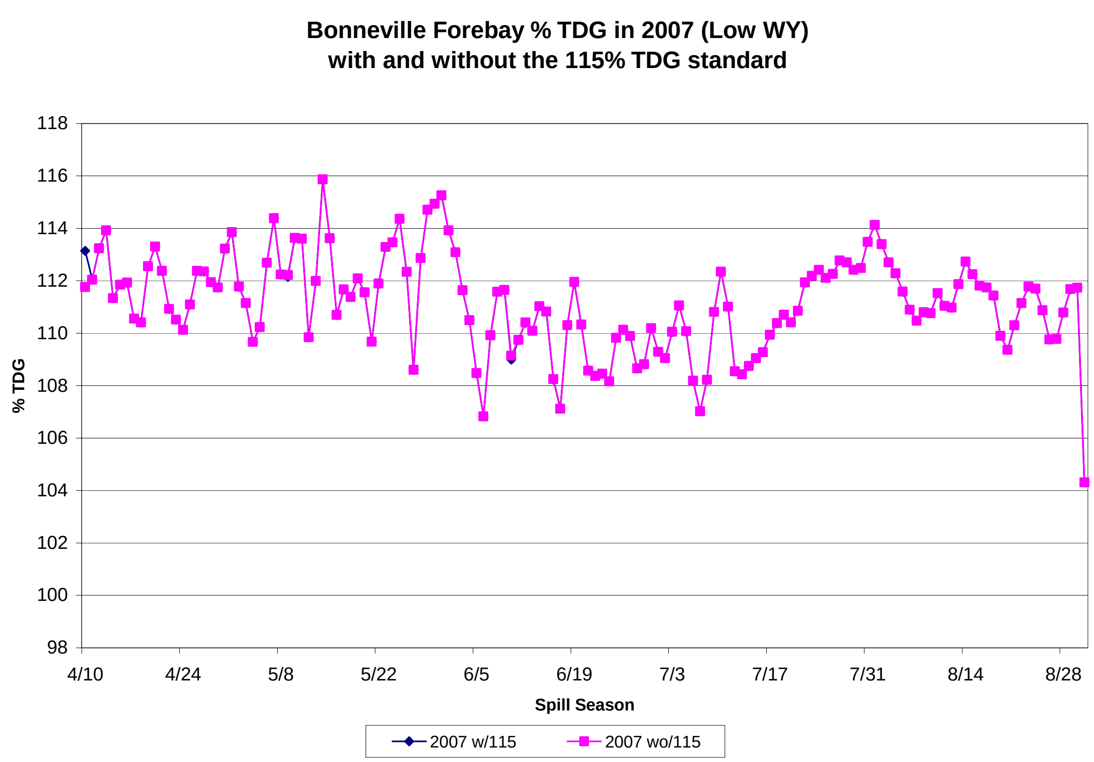


FIGURE 29

Bonneville Tailwater % TDG in 1999 (high WY)
with and without the 115% TDG standard

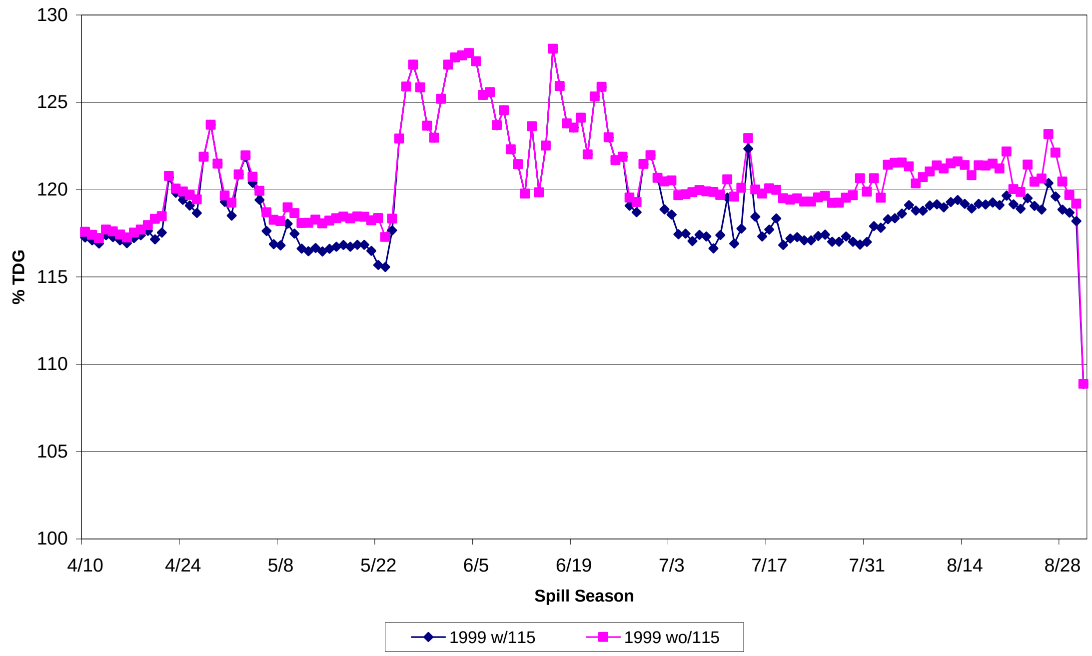


FIGURE 30

Bonneville Tailwater % TDG in 2002 (Low WY)
with and without the 115% TDG standard

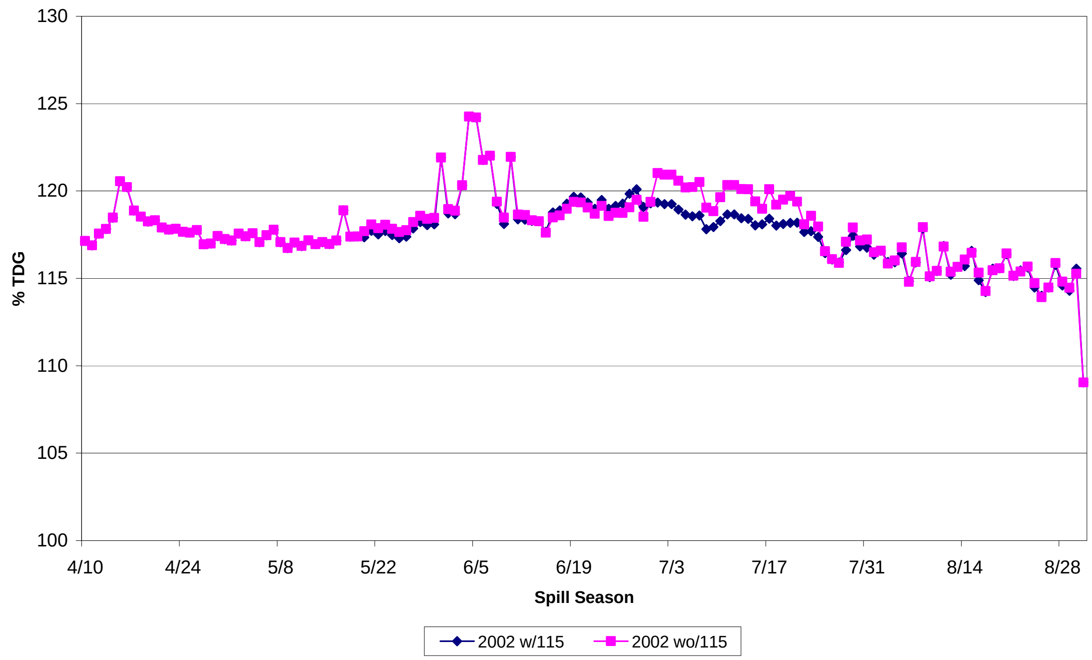


FIGURE 31

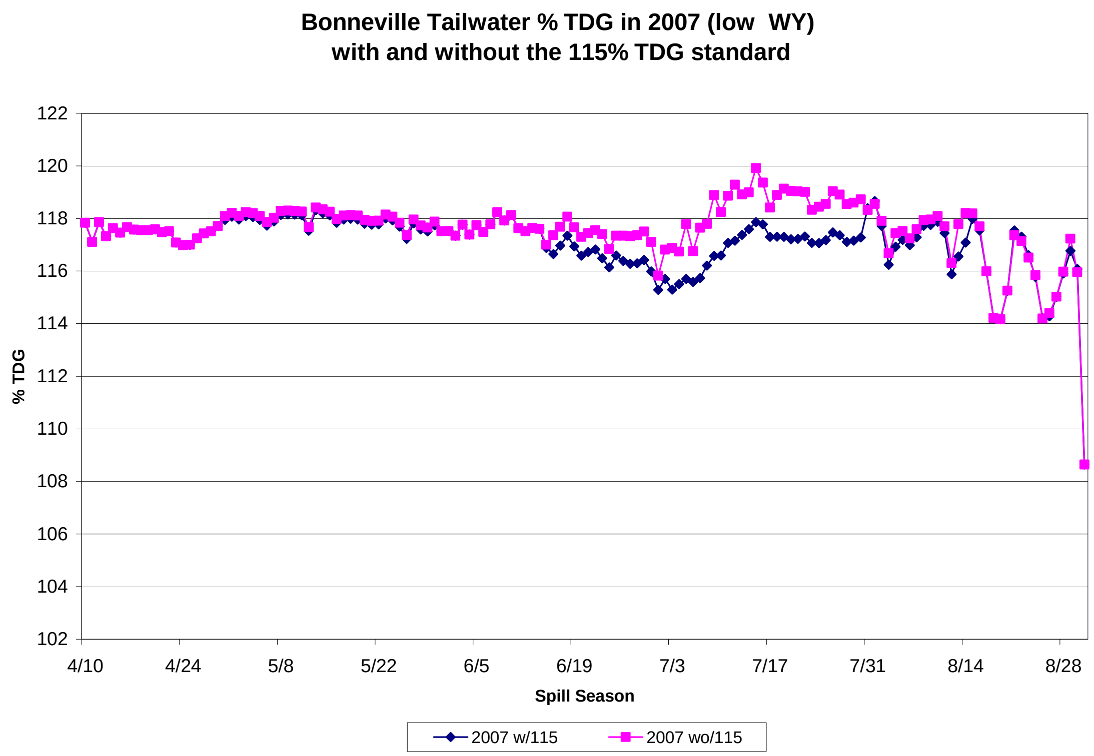


FIGURE 32

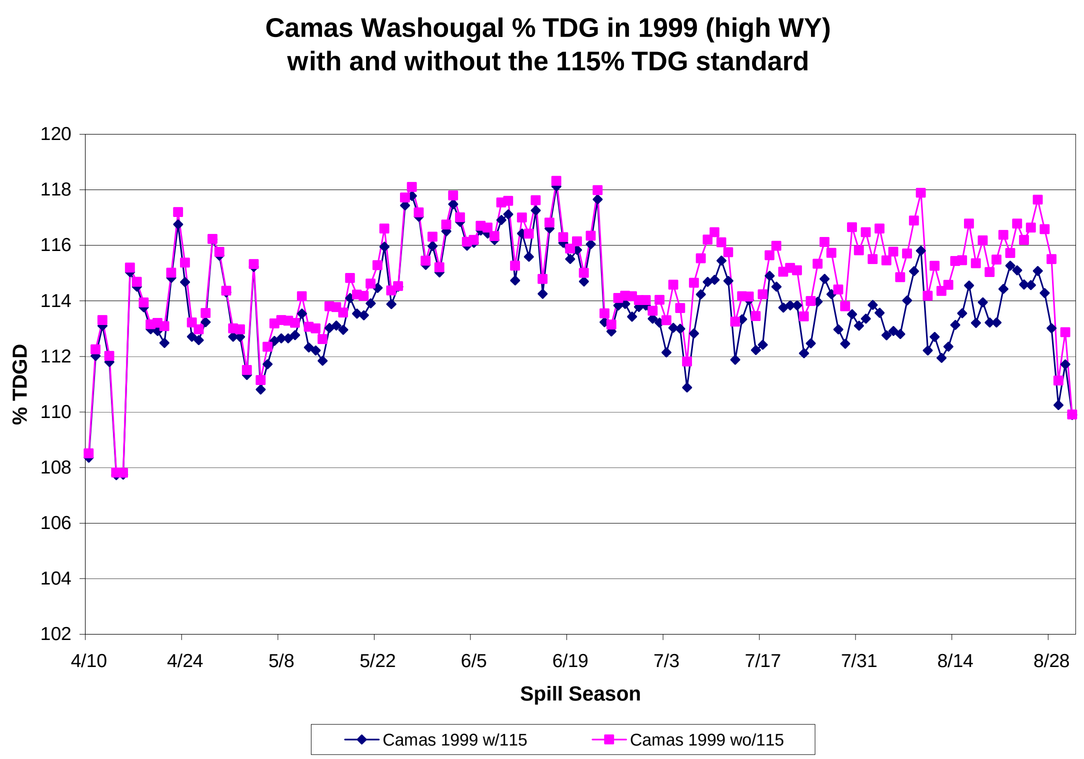


FIGURE 33

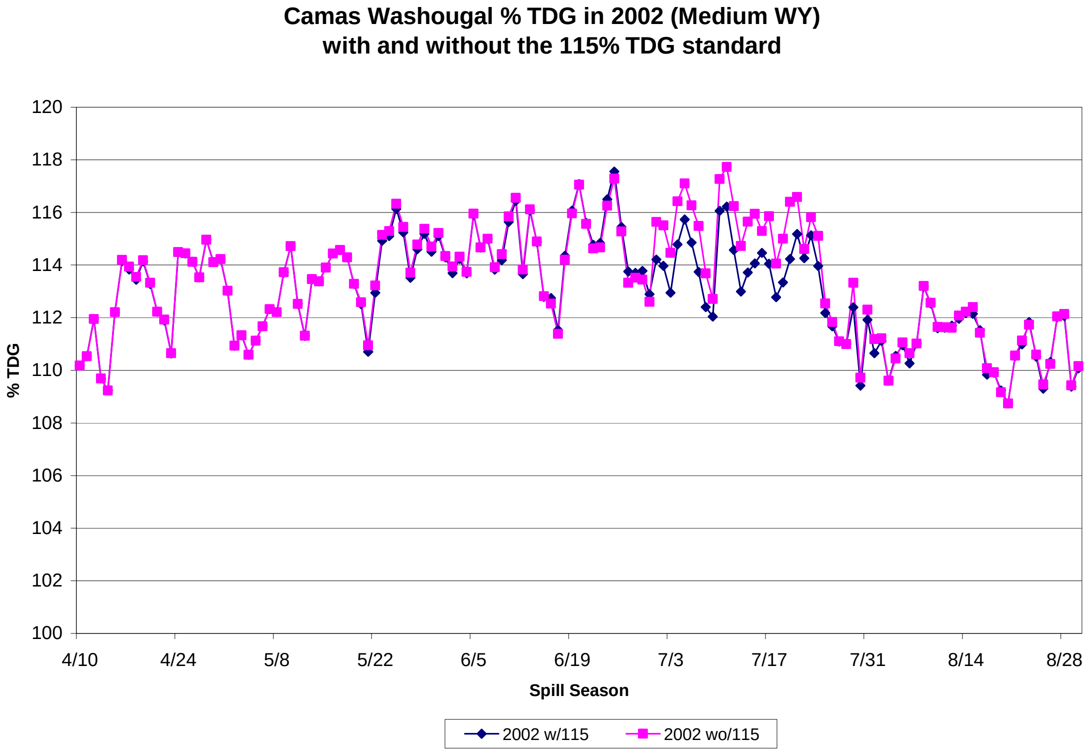
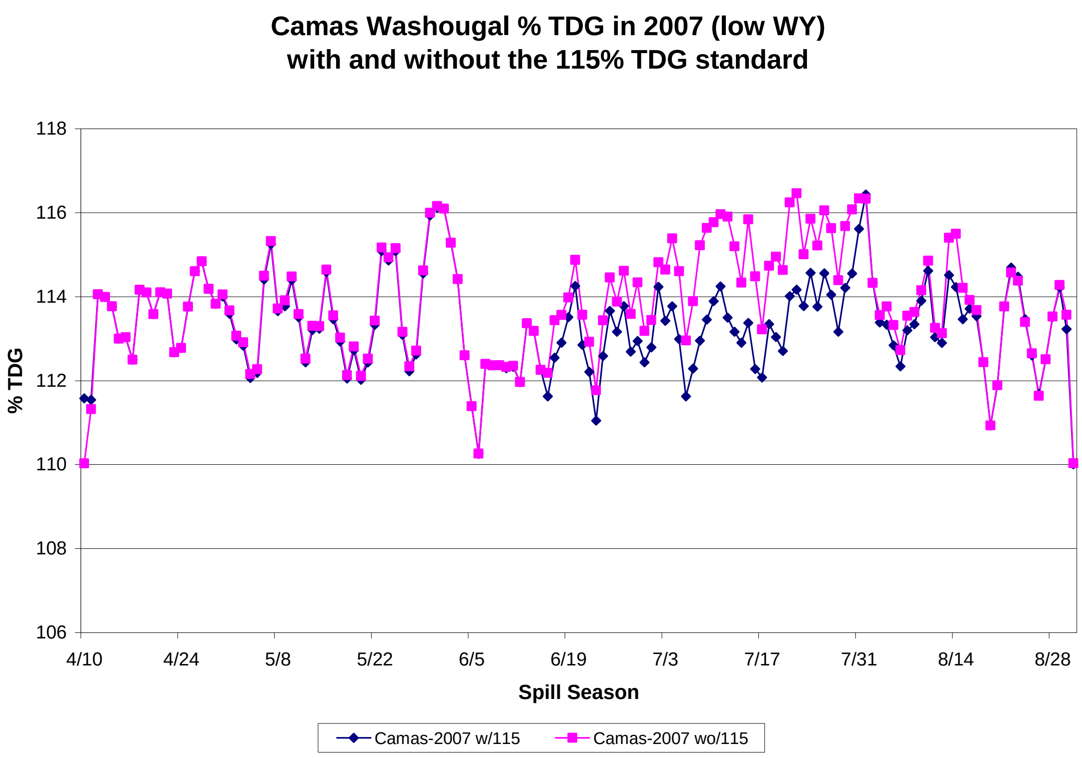


FIGURE 34



Conclusions:

This conclusion contains the highlights of this report and covers five main areas:

1. HYDSIM - SYSTDG Modeling Process
2. Factors Controlling Spill
3. Forebay Gages Controlling Spill
4. Spill volume increases from removing 115% TDG standard
5. TDG level increases from removing 115% TDG standard

SYSTDG - HYDSIM Modeling Process:

- HYDSIM spill results were compared with the average spill for the three years modeled in SYSTDG to represent the low (2007), medium (2002) and high (1999) flow years in HYDSIM and were found to be similar in the low and medium year and not in the high water year.

- Differences between HYSDIM and SYSTDG spill volumes were credited to the fact that SYSTDG isn't capable of analyzing spill due to lack of market (overgeneration spill) and the HYDSIM model does.

- After adjustments for overgeneration and lack of market, and taking into consideration that HYDSIM modeled different flow conditions (1929-1998), it was determined that the HYDSIM results were close (within about 10% seasonal total) to those in years similar to the low and medium years chosen for all projects.

- In the high flow condition, the four lower Columbia projects HYDSIM spill volumes were close to the SYSTDG spill volumes but the lower Snake projects showed larger differences. This larger variation was judged acceptable since it was attributable to the fact that lower Snake flows in May 1999 (month with largest variation) increased very rapidly from levels well below turbine capacity in the first two weeks of the month to more than twice that in about a week.

- The final result, once overgeneration spill volume was included, was that HYDSIM total spill volume routinely exceeded the SYSTDG spill volumes in both scenarios modeled.

Factors Controlling Spill:

- Spill operations are the most influential factor system wide, controlling spill 76% of the time. Spill operations are the predominant controlling factor for all projects except Ice Harbor.

- Spill caps are the manifestation of when the 115% or the 120% TDG standard is controlling spill and is the second most influential factor controlling spill system-wide. Spill caps control spill only 12% of the time system wide. Spill caps are the predominant controlling factor for only Ice Harbor.

- Involuntary spill is the third most influential factor determining spill system wide; involuntary spill controlled spill only 8% of the time. Involuntary spill is a dominant controlling factor of spill at McNary during some months in any type of water year.

- Minimum generation is the fourth and least influential factor determining spill system wide, minimum generation controls spill an average of 4 % of the time. Minimum generation is a dominant controlling factor of spill at Lower Granite and Ice Harbor during a low and medium water year during August.

- At some projects during some periods, the spill cap may control spill for only one or two hours.

- In general, the principle that in high water years the spill caps is lower and in low water years the spill caps are higher was illustrated in the SYSTDG modeling results.

Forebay Gages Controlling Spill:

- The impact of removing the 115% TDG standard on a project's spill depends on how many hours the spill cap exerts control. Even though the Ice Harbor forebay gage can affect the Little Goose spill caps and Bonneville forebay gage can affect The Dalles spill caps, the number of hours that the spill caps control spill is so small in low and medium water years, that there is not a spill increase. Spill caps at these projects control spill for more hours in a high water year resulting in a modest spill volume increase.

- Neither the forebay or tailwater gages were controlling spill at Lower Granite; Ice Harbor and McNary during all water years with or without the 115% TDG standard.

- The Ice Harbor forebay gage exerts considerable control on Ice Harbor spill which is why there is such a large increase in spill volumes at Ice Harbor during any water year if the 115% TDG standard is removed.

- The Ice Harbor forebay gage exerts minimal control on Little Goose spill which is why there is such a small increase in spill volumes at Little Goose during any water year if the 115% TDG standard is removed.

- The Bonneville forebay gage exerts minimal control on The Dalles spill which is why there is such a small increase in spill volumes at The Dalles during any water year if the 115% TDG standard is removed.

- The Dalles forebay gage exerts minimal control on John Day spill which is why there is such a small increase in spill volumes at John Day during any water year if the 115% TDG standard is removed.

- The Camas/Washougal forebay gage exerts some control on Bonneville spill which is why there is some increase in spill volumes at Bonneville during any water year if the 115% TDG standard is removed.

Spill Volume Increases from Removing 115% TDG Standard:

- For a low water year like 2007, removal of the 115% TDG standard would result in an additional 2.5 MAF spill and 100 % of it would come from Ice Harbor and Bonneville.

- For a medium water year like 2002, removal of the 115% TDG standard would result in an additional 2.3 MAF spill and 85% would come from Ice Harbor and Bonneville. The remaining 15% of increased spill came from John Day, The Dalles and Little Goose.

- For a high water year like 1999, removal of the 115% TDG standard would result in an additional 5.9 MAF spill and 61% would come from Ice Harbor and Bonneville. The remaining 39% of the increased spill came from Little Goose (9.5%); John Day (18%); and The Dalles (11.5%).

- Since SYSTDG isn't capable of analyzing spill due to lack of market, the HYDSIM spill volumes are considered more reflective of reality for use in COMPASS than the SYSTDG spill volumes.

- An evaluation of the percentage of increased spill per project shows that in 2007 Ice Harbor and Bonneville attributed 100% of the spill increase, but in 2002 they attributed 85% of the total increased spill and in 1999 they attributed only 61% of the total increased spill. This says that removal of the 115% TDG standard would impact Bonneville and Ice Harbor to a significant degree the most.

TDG level Increases from Removing 115% TDG Standard:

The impacts of removing the 115% TDG standard on TDG levels are summarized into two categories: overall general comments and detailed evaluation of comparing the seasonal averages with the monthly averages to identify significant trends. The following are a summary of the overall general comments:

General Comments

- The increases in the monthly TDG levels at Ice Harbor tailwater, the Ice Harbor forebay, Bonneville tailwater and Camas Washougal can persist for one to three months.
- These increased monthly TDG levels can be seen in elevated monthly maxima, minima and averages for each of the projects.
- For Ice Harbor tailwater and Ice Harbor forebay, these persistent elevated TDG levels occur from April through May.
- For Bonneville tailwater and Camas Washougal, these persistent elevated TDG levels occur from July through August.
- Removal of the 115% TDG standard will result in a significant increase in TDG exceedances.
- The total number of TDG exceedances of the 115% and 120% TDG standards would go up by 161% or 193 TDG exceedances in a high water year; 181% or 93 TDG exceedances in a medium water year; and 330% or 83 TDG exceedances in a low water year if the 115% TDG standards are removed.
- The assumption that an attempt would be made to keep the TDG exceedances at approximately the "same number by definition" between the two scenarios within 15% was applied with success. The number of TDG exceedances "by definition" for the with and without the 115% TDG standard simulations were within 14% of each other for 1999and were within 8% of each other for 2002 simulations and were within 14% of each other for 2007.

Detailed Evaluation - Seasonal

- The largest seasonal average increase in TDG levels would occur at the Ice Harbor forebay with April through August average for all high 12 hour average TDG levels increasing 0.5% in a low water year; 0.9% in a medium water year; and 3.0 % in a high water year.
- The second largest seasonal average increase in TDG levels would occur at the Camas Washougal gage with April through August average of all high 12 hour average TDG levels increasing 0.5% in a low water year; 0.3% in a medium water year; and 1.3% in a high water year.
- The largest seasonal average increase in TDG levels would occur at the Ice Harbor forebay with the April through August maximum of the high 12 hour average TDG levels increasing 4.1% in a low water year.

- The second largest seasonal average increase in TDG levels would occur at the Ice Harbor tailwater with the April through August maximum of the high 12 hour average TDG levels increasing 2.3% in a low water year.

- The third largest seasonal average increase in TDG levels would occur at the Bonneville tailwater with the April through August maximum of the high 12 hour average TDG levels increasing 1.3% in a low water year.

<u>Detailed Evaluation - Monthly</u>

- There were consistently higher TDG levels at the Ice Harbor tailwater in all water years when the 115% TDG standard is removed. The largest increase in the monthly average TDG levels of all the eight projects would occur at the Ice Harbor tailwater during April and May with an increase of high 12 hour average TDG levels of 2.5% as an April monthly average and 1.9% as a May monthly average in a low water year. An increase of 2.4% as an April monthly average and 1.6% as a May monthly average in a medium water year. During a high water year, TDG increases could include a 2.5% increase in the April monthly average, a 1.5% increase in the May monthly average and 0.7% increase in June monthly average.

- There were consistently higher TDG levels at the Ice Harbor forebay in all water years when the 115% TDG standard is removed. The second largest increase in the monthly average TDG levels would occur at the Ice Harbor forebay during April and May with an increase of high 12 hour average TDG levels of 1.5% as an April monthly average in a low water year and 2.4% as a May monthly average in a low water year. During a medium water year, TDG increases could include a 2.8 % in the April monthly average and 2.0% in the May monthly average. During a high water year, TDG increases could include a 2.8% in the April monthly average and 1.5% in the May monthly average.

- The third largest increase in monthly average TDG levels would occur at the Bonneville tailwater with during July and August with an increase of high 12 hour average TDG levels ranging from to 1.5% as a July monthly average in a low water year, 1.1% as a July monthly average in a medium water year; to 2.2% as a July monthly average in a high water year. In August, increase of high 12 hour average TDG levels included 2.0% as an August monthly average in a high water year.

- There were consistently higher TDG levels at the Camas Washougal gage in all water years when the 115% TDG standard is removed. The fourth largest increase in monthly average TDG levels would occur at the Camas Washougal gage with during July and August with an increase of high 12 hour average TDG levels ranging from to 1.6% as a July monthly average in a low water year, 1.2% as a July monthly average in a medium water year; to 1.3% as a July monthly average in a high water year.

- The largest increase in the monthly maximum TDG levels would occur at the Ice Harbor forebay during April and May with an increase of high 12 hour average TDG levels reach a high of 4.1% as a May monthly average and 4.0% as a June monthly average in a low water year. A 4.1% increase in the maximum high 12 hour average TDG levels is the largest increase as a monthly average of the any of the projects. It is also important to note that these elevated TDG levels persist throughout April and May for all water years and this can be seen in the increases in the monthly averages and maximums.