FISH PASSAGE CENTER

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March 21, 2007

Mr. Chris Maynard
Water Quality Program
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

Dear Chris,

You recently contacted us regarding the potential ways to calculate total dissolved gas in the Columbia and Snake Rivers to determine compliance with the water quality standard. We understand that Washington Department of Ecology (DOE) as well as Oregon Department of Environmental Quality (DEQ) are contemplating changing the measurement from the average of the 12 highest total dissolved gas (TDG) readings in a 24-hour period to the average of twelve consecutive hours. You requested our input on which period made the most sense for use in this new compliance standard. We agree with both DOE and DEQ that changing to the average of twelve consecutive hours is a better measure of actual fish exposure to total dissolved gas levels. However, we are concerned that changes in how TDG is measured should not unnecessarily impose additional restrictions regarding the ability to provide spill for fish mitigation.

In order to respond to your question regarding the definition of a "day" time period, we analyzed the resulting TDG values for the average of twelve consecutive hours over different definitions of "a day" and compared them to the data collected over the past several years using the current procedure of determining compliance. The current procedure for reporting daily TDG is one that averages the 12-highest hours in one day, from midnight to midnight. On the basis of our analysis we would recommend that the 12 consecutive hour average be implemented with compliance relative to a defined, specific 24-hour day. The 24 hour period chosen as a day is not particularly important, except for the projects where spill occurs for only 12 hours during the nighttime hours (see Appendix table A1 for the number of hours spilled in a given year). Here the existing midnight to midnight definition of a compliance period does not encompass the full spill period at the projects that spill for only twelve hours. We recommend that the 24-hour period should be consistent in that it captures both peak spill and peak fish passage hours. We examined a noon-to-noon day and a 0700 to 0659 day and found only minor differences between the two. Arbitrarily, we recommend the noon to noon reporting period based on the ability to make within day decisions regarding spill implementation.

The following is an explanation of each alternative reviewed:

1. The first alternative defined one day from midnight to midnight (existing definition of a 24-hour day for compliance monitoring). This alternative contained thirteen twelve-hour periods in one day over which averages were calculated. The maximum of each day's thirteen twelve-hour averages was utilized to represent the day's highest 12-consectutive hour TDG average.
2. The second alternative defined one day from 7am to 7am. This alternative contained thirteen twelve-hour periods over two days in which averages were calculated. This alternative was difficult to assign a date to, as 18 hours were in one day and 6 hours in the next day. For this analysis, it was decided to assign this as the day with the majority of hours used in averaging. The maximum of each day's thirteen twelve-hour averages was utilized to represent the day's highest 12-consectutive hour TDG average.
3. The third alternative defined one day from noon to noon. This alternative contained thirteen twelve-hour periods over two days in which averages were calculated. This alternative was also difficult to assign a date to, as 12 hours were in one day and 12 hours in the next day. For this analysis, it was decided to assign this as the day with the first 12 hours. The maximum of each day's thirteen twelve-hour averages was utilized to represent the day's highest 12-consectutive hour TDG average.
4. Rolling 12-hour average: This alternative continually averages 12-consecutive hours. With this alternative, many 12-hour averages contained hourly readings from two different days. When a 12-hour period was encountered that contained six hours in one day and six hours in the next day, it was assumed that the 12-hr average would be labeled as the previous day. For all other 12-hour periods, the 12-hour average would be labeled as the day with the majority of hours in the average. The maximum of each day's twelve-hour averages was utilized to represent the day's highest 12-consectutive hour TDG average.

Hourly % TDG data was used for the following locations: Lower Granite Tailrace, Lower Granite Forebay, Little Goose Tailwater, Little Goose Forebay, Lower Monumental Tailrace, Lower Monumental Forebay, Ice Harbor Tailrace, Ice Harbor Forebay, McNary Tailrace, McNary Forebay Oregon Side, McNary Forebay Washington Side, John Day Tailrace, John Day Forebay, The Dalles Tailrace, The Dalles Forebay, Bonneville Forebay, Cascade Island, Warrendale, and Camas/Washougal. Hourly % TDG data was obtained from April through June over the last five years (2002, 2003, 2004, 2005, 2006) at each location. Hourly data was obtained from the COE's online data query at:

http://www.nwd-wc.usace.army.mil/perl/dataquery.pl.

The daily average of the twelve highest hourly %TDG recordings were obtained through the following COE website over the period of April through June from 2002-2006:

http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/html/.

On this site, many of the projects did not report a daily average of the 12-highest TDG recordings in June of 2002, in this case the average of the highest 12-hours was calculated

manually using hourly data from the COE's data query website listed above. Also, in the case where the average of the 12-highest TDG recordings were missing for a single day, these values were estimated through trend fitting, which was based on recordings from the day before and the day after the missing date. These missing dates were infrequent and only accounted for 0% to 0.88% of all dates analyzed for any given site.

Results and Conclusions:

After calculating daily average % TDG using alternatives #1, #2, #3 and #4 above and obtaining the daily average of the 12-highest hours of TDG from the COE website, five estimations of daily average % TDG were available for each day: 1) The current procedure that averages the 12-highest (non-consecutive) hours in each day 2) Alternative #1 which used the highest 12-consecutive hour average between midnight and midnight 3) Alternative #2 which used the highest 12-consecutive hour average between 7am and 7am , 4) Alternative #3 which used the highest 12-consecutive hour average between noon and noon and 5) Alternative #4 – the rolling 12-hour average was investigated separately since the question regarding this alternative was a fixed or moving compliance day.

The analysis evaluated how each of the different alternatives, using consecutive hourly averages, differed from the current procedure of calculating daily average TDG. Daily deviations were calculated between the current procedure and each of the three alternatives that used highest consecutive averages. Daily deviations were summarized in terms of a 95% Confidence Interval range at each site, both yearly and over the entire five-year period. Tables A2 and A3display these results.

Several patterns have emerged from the results of this study.

1. Forebay TDG stations are the least impacted by any of the alternatives used in calculating daily average % TDG. That is, 95% confidence intervals rarely exceeded a deviation of ± 1% TDG from the current procedure. However, both the alternatives of using consecutive hours between 7am-7am and noon-noon more often contained 95% Confidence Intervals of deviations that included zero. A confidence interval of deviation that contains zero indicated that there was no difference between the "current" alternative and the "new" alternative. For example, under the midnight-midnight alternative, only 23.5% of the forebay confidence intervals of deviations contained zero. In comparison, 86.3% and 94.1% of the forebay confidence intervals of deviations contained zero when using the noon-noon and 7am-7am alternatives, respectively (Tables A2 and A3).
2. Tailrace stations are the most impacted by the alternative of calculating daily average % TDG and appear to be especially susceptible to daily patterns of spill i.e., 12-hr or 24-hr. Again, as expected the midnight-to-midnight alternative seemed to deviate the most from the current procedure of calculating average TDG, with only 7.1% of the confidence intervals of deviations containing zero. Interestingly, under this alternative, the projects that showed the most deviation from zero were those that spilled 12-hours per day (usually from 1800 to 0600). For example, John Day was on a 12-hr spill pattern (Table A1) from 2002 to 2005 and during this time the 95% confidence intervals of deviations at the John Day Tailwater were 1.04-1.81, 1.87-2.6, 2.35-3.18, and 2.54-3.43, respectively

(Tables A2 and A3). When John Day switched to a 24-hour spill program in 2006 (Table A1), the 95% confidence interval of deviations shifted closer to zero, at 0.05-0.8, while still covering a similar spread (Table A3). Generally, the midnight-to-midnight alternative does not seem to predict average TDG levels that are similar to the current procedure, especially under a 12-hr spill pattern. The reason for the differences is that only six hours of any one 12-hr consecutive hour average would be associated with a period of spill. For this reason, the midnight-to-midnight alternative would consistently yield a lower average of TDG than would the current procedure, which averages the twelve highest hours in one day.

3. In comparison to the midnight-to-midnight alternative, the noon-noon alternative resulted in 95.2% of the confidence intervals of deviations containing zero. Under the 7am-7am alternative, this percentage decreased to 78.6%(Tables A2 and A3). It appears that the noon to noon time period would both capture the peak consecutive TDG readings at the projects that only spill for 12 hours and not introduce additional unwarranted exceedences.

The analysis then looked at the potential exceedences that would occur if the 12 consecutive hours employed a running 12-hour average for compliance versus designating a fixed period for compliance. For comparison purposes, it was useful to calculate the number of TDG exceedences produced by each alternative and compare them to the current procedure of estimating daily average TDG. This exercise simply summed each daily TDG value that exceeded either the 120% TDG criteria at tailrace locations or the 115% TDG criteria at forebay locations at each site over the period of April through June in the years 2002 to 2006. The results of this summation are displayed in Table 1.

Table 1. Summation of each daily TDG value that exceeded either the 120% TDG criteria at tailrace locations or the 115% TDG criteria at Forebay locations for each alternative at each site over the period of April through June in the years 2002 to 2006[1].

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	Number of Days Exceeding TDG Criteria (Apr-June 2002-2006)				
	Current ave. of highest 12-hrs	Alternative 1 midnight-midnight	Alternative 2 7am-7am	Alternative 3 noon-noon	Alternative 4 rolling
LGR-tw	55	43	55	58	62
LGR-fb	0	0	0	0	0
LGS-tw	30	25	30	29	37
LGS-fb**	36	33	41	43	45
LMN-tw	51	54	50	48	61
LMN-fb**	81	76	79	78	89
IHR-tw	37	35	40	39	52
IHR-fb**	93	93	93	93	98
MCN-tw	78	59	86	86	108
MCN-fb-OR	74	77	77	73	81
MCN-fb-WA**	71	71	81	78	90
JDA-tw	70	63	62	54	74
JDA-fb**	11	13	12	12	13
TDA-tw	22	18	18	18	23
TDA-fb	80	77	85	81	96
Warrendale	18	17	18	19	22
Casc-Island**	67	65	63	64	72
Cam/Wash	157	158	159	157	167
BON-fb	100	100	102	95	111

From Table 1, several points are clear:

1) The alternative of using rolling averages (rather than a fixed day for compliance) always contained more exceedences of the TDG criteria than did the current procedure of calculating daily average TDG[2].
2) The alternative of using noon-to-noon consecutive averages did not display any noticeable trend when comparing its exceedences of the TDG criteria to exceedences produced under the current procedure of calculating daily average TDG.

There is at least one possible explanation as to why the rolling average alternative appears to produce more exceedences than does the current procedure for calculating daily average TDG. An examination of the data showed many circumstances where the current procedure produced a grouping of exceedences and the rolling average alternative contained the same grouping of exceedences but also included an exceedence either on the day ahead of the grouping or a day behind. Any particular rolling average can contain hours from the previous day or from the next day. If these "edge" hours contain high TDG, the average for a particular day can be impacted.

[1] At Sites with an asterisk, the number of days of data varied between the normal method (high 12hr ave) and the methods that used consecutive averages. At these sites, datesets were shortened to the one with the least data. By shortening these data sets, each method contained the same excact days to compare exceedences.
[2] With the exception of the Lower Granite Forebay, which had no exceedences under any alternative.

The following figure displays an actual example of the impact of the "edge" hour at the Bonneville Dam Forebay.

Monitor	Actual Date	Actual hour	Actual Hourly % TDG	Rolling Average Date	12-hour rolling Average (%TDG)
bon-fb	29-Apr-02	1	112.2	29-Apr-02	112.2
bon-fb	29-Apr-02	2	112.0	29-Apr-02	112.3
bon-fb	29-Apr-02	3	112.0	29-Apr-02	112.4
bon-fb	29-Apr-02	4	112.0	29-Apr-02	112.5
bon-fb	29-Apr-02	5	112.0	29-Apr-02	112.7
bon-fb	29-Apr-02	6	112.0	29-Apr-02	112.8
bon-fb	29-Apr-02	7	112.2	29-Apr-02	113.0
bon-fb	29-Apr-02	8	112.3	29-Apr-02	113.3
bon-fb	29-Apr-02	9	112.2	29-Apr-02	113.5
bon-fb	29-Apr-02	10	112.5	29-Apr-02	113.8
bon-fb	29-Apr-02	11	112.6	29-Apr-02	114.0
bon-fb	29-Apr-02	12	112.7	29-Apr-02	114.2
bon-fb	29-Apr-02	13	112.9	29-Apr-02	114.5
bon-fb	29-Apr-02	14	113.3	29-Apr-02	114.7
bon-fb	29-Apr-02	15	113.5	29-Apr-02	114.9
bon-fb	29-Apr-02	16	113.9	29-Apr-02	115.1
bon-fb	29-Apr-02	17	113.9	29-Apr-02	115.3
bon-fb	29-Apr-02	18	114.3	29-Apr-02	115.5
bon-fb	29-Apr-02	19	114.9	29-Apr-02	115.6
bon-fb	29-Apr-02	20	115.5	30-Apr-02	115.7
bon-fb	29-Apr-02	21	115.1	30-Apr-02	115.7
bon-fb	29-Apr-02	22	115.4	30-Apr-02	115.7
bon-fb	29-Apr-02	23	115.2	30-Apr-02	115.7
bon-fb	29-Apr-02	24	115.7	30-Apr-02	115.7
bon-fb	30-Apr-02	1	115.7	30-Apr-02	115.7
bon-fb	30-Apr-02	2	115.8	30-Apr-02	115.7
bon-fb	30-Apr-02	3	116.1	30-Apr-02	115.6
bon-fb	30-Apr-02	4	115.6	30-Apr-02	115.5
bon-fb	30-Apr-02	5	116.1	30-Apr-02	115.4
bon-fb	30-Apr-02	6	115.8	30-Apr-02	115.3
bon-fb	30-Apr-02	7	116.1	30-Apr-02	115.2
bon-fb	30-Apr-02	8	115.8	30-Apr-02	115.0
bon-fb	30-Apr-02	9	115.5	30-Apr-02	114.9
bon-fb	30-Apr-02	10	115.4	30-Apr-02	114.7
bon-fb	30-Apr-02	11	115.4	30-Apr-02	114.5
bon-fb	30-Apr-02	12	115.3	30-Apr-02	114.4
bon-fb	30-Apr-02	13	115.0	30-Apr-02	114.2
bon-fb	30-Apr-02	14	115.0	30-Apr-02	114.1
bon-fb	30-Apr-02	15	115.0	30-Apr-02	114.0
bon-fb	30-Apr-02	16	114.9	30-Apr-02	113.9
bon-fb	30-Apr-02	17	114.6	30-Apr-02	113.8
bon-fb	30-Apr-02	18	114.5	30-Apr-02	113.7
bon-fb	30-Apr-02	19	114.2	30-Apr-02	113.5
bon-fb	30-Apr-02	20	113.8	01-May-02	113.4
bon-fb	30-Apr-02	21	113.4	01-May-02	113.3
bon-fb	30-Apr-02	22	113.3	01-May-02	113.3
bon-fb	30-Apr-02	23	113.4	01-May-02	113.3
bon-fb	30-Apr-02	24	113.1	01-May-02	113.1

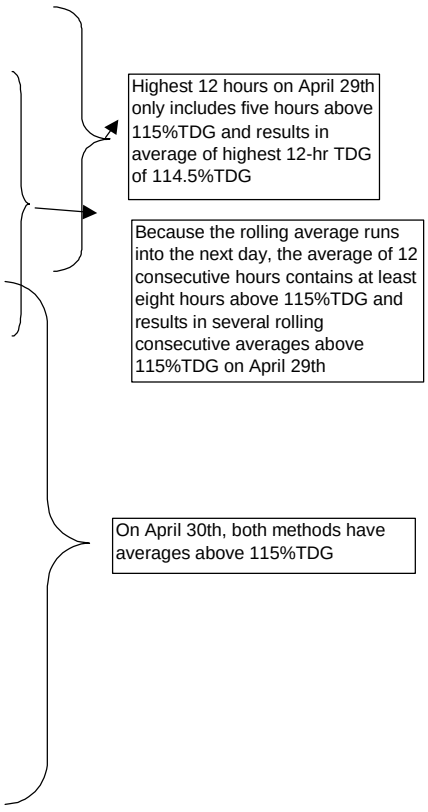


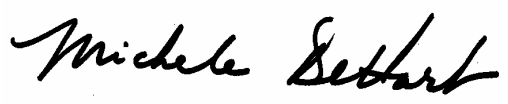
Figure 2. Example of the impact of the "edge" hours on TDG exceedences produced by the rolling average alternative at the Bonneville Forebay.

In conclusion, both the noon-to-noon and 7am-to-7am alternative of calculating daily average TDG using consecutive averages resulted in daily average TDG that was similar to that calculated using the current procedure of using the average of the highest 12-hours in one day. Both these alternatives seemed to track the current procedure reasonable well at both forebay and tailrace locations and under 24-hour or 12-hour daily spill periods, as would any designated "day" the included the peak hours of spill. As expected, if one were to implement an alternative using the midnight-to-midnight period as a day it would not track the current procedure well, especially at projects that are spilling only 12-hour per day.

After considering the use of a fixed 24-hour period versus a rolling 12 hour average for compliance monitoring, it is our recommendation that the WDOE not use the rolling average alternative. This alternative will artificially produce more days of TDG exceedences in comparison to the current procedure. This will unnecessarily result in less spill, or longer periods of reduced spill for juvenile anadromous fish. Instead, we suggest that the WDOE consider a alternative that uses consecutive 12-hour averages from noon-to-noon. The noon-to-noon alternative of calculating daily average TDG did not display any noticeable trend when comparing exceedences to the current procedure.

Thank you for your consideration. Please contact us if you need any additional information.

Sincerely,



Michele DeHart

cc:
Agnes Lut, Oregon DEQ
Fish Passage Advisory Committee

Appendix Tables

	Spill Operation by Year				
	2002	2003	2004	2005	2006
Lower Granite	12-hr	12-hr	24-hr Apr 3-23	No Planned Spill	24-hr
Little Goose	24-hr April 12-hr May-June	12-hr	12-hr April 7-23	No Planned Spill	24-hr
Lower Monumental	No spill	24 hr	Variable Mostly 24-hr	No Planned Spill	24-hr
Ice Harbor	24-hr	24-hr	24-hr	24-hr	24-hr
McNary	12-hr	12-hr	12-hr	12-hr	24-hr
John Day	12-hr	12-hr	12-hr	12-hr	24-hr
The Dalles	24-hr	24-hr	24-hr	24-hr	24-hr
Bonneville	24-hr	24-hr	24-hr	24-hr	24-hr

Table A1. Daily period of spill over the years between 2002 and 2006 at each Snake River and lower Columbia project.

	2002			2003			2004		
	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3
LGR-tw	1.66 - 3.07	-0.05 - 0.8	-0.22 - 0.92	1.98 - 3.28	-0.9 - 0.28	-0.87 - 0.34	-0.24 - 0.38	-0.44 - 0.26	-0.43 - 0.34
LGR-fb	0.04 - 0.07	-0.01 - 0.07	0 - 0.11	0.02 - 0.07	-0.01 - 0.13	-0.01 - 0.17	0.06 - 0.11	-0.02 - 0.17	0 - 0.26
LGS-tw	1.02 - 1.66	-0.29 - 0.26	-0.33 - 0.32	1.65 - 2.29	-0.43 - 0.08	-0.42 - 0.12	0.26 - 0.73	-0.2 - 0.2	-0.18 - 0.26
LGS-fb	-0.16 - 1.32	-0.5 - 1.4	-0.49 - 1.75	0.05 - 0.17	-0.08 - 0.24	-0.13 - 0.29	0.08 - 0.23	-0.09 - 0.19	-0.13 - 0.27
LMN-tw	0.07 - 0.19	-0.06 - 0.13	-0.09 - 0.29	0.01 - 0.13	-0.15 - 0.17	-0.03 - 0.51	-1.55 - -0.1	-1.67 - -0.18	-1.62 - -0.07
LMN-fb	0.1 - 0.3	-0.49 - 0.65	-0.74 - 0.84	0.14 - 0.31	-0.07 - 0.26	-0.15 - 0.3	0.09 - 0.16	-0.02 - 0.13	-0.03 - 0.19
IHR-tw	0.49 - 1.04	-0.08 - 0.27	-0.12 - 0.26	0.01 - 0.29	-0.11 - 0.43	-0.14 - 0.54	-0.23 - 0.28	-0.11 - 0.52	-0.32 - 0.37
IHR-fb	-0.05 - 0.36	-0.12 - 0.49	-0.11 - 0.73	0.03 - 0.1	0 - 0.16	0 - 0.23	0.06 - 0.12	-0.06 - 0.11	-0.12 - 0.16
MCN-tw	1.1 - 1.74	-0.15 - 0.32	-0.25 - 0.49	1.45 - 2.27	-0.35 - 0.15	-0.39 - 0.13	1.84 - 2.5	-0.04 - 0.31	-0.22 - 0.13
MCN-fb-OR	0 - 0.13	-0.03 - 0.11	0.07 - 0.28	-0.07 - 0.1	-0.07 - 0.11	0.01 - 0.23	0.06 - 0.16	0.06 - 0.18	0.14 - 0.28
MCN-fb-WA	0.05 - 0.32	-0.03 - 0.24	-0.03 - 0.28	0.05 - 0.12	-0.52 - 0.32	-0.86 - 0.76	0.06 - 0.16	-0.17 - 0.06	-0.14 - 0.15
JDA-tw	1.04 - 1.81	0 - 0.44	-0.2 - 0.31	1.87 - 2.6	0.16 - 0.63	-0.42 - 0.12	2.35 - 3.18	0.3 - 0.82	-0.22 - 0.28
JDA-fb	-0.02 - 0.22	0.03 - 0.34	0.06 - 0.67	0.01 - 0.09	-0.03 - 0.12	0.03 - 0.24			
BON-fb	0.06 - 0.11	-0.15 - 0.12	-0.16 - 0.24	0.05 - 0.12	-0.08 - 0.16	-0.11 - 0.29	0.07 - 0.14	-0.06 - 0.15	-0.18 - 0.17
Cam/Wash	0.03 - 0.08	-0.07 - 0.05	-0.07 - 0.16	-0.06 - 0.11	-0.13 - 0.06	-0.08 - 0.12	0 - 0.09	-0.05 - 0.05	-0.03 - 0.08
Warrendale	0.16 - 0.36	0.05 - 0.55	-0.33 - 0.38	0.12 - 0.22	0.08 - 0.52	-0.38 - 0.17	0.13 - 0.24	0.27 - 0.61	-0.13 - 0.35
Casc-Island									
TDA-tw	0.11 - 0.21	-0.06 - 0.21	-0.1 - 0.32	0.16 - 0.31	-0.15 - 0.09	-0.21 - 0.1	0.11 - 0.3	-0.09 - 0.17	-0.15 - 0.16
TDA-fb	0.08 - 0.54	-0.01 - 0.28	0.1 - 0.87	0.12 - 0.34	-0.08 - 0.11	-0.03 - 0.2	0.27 - 0.53	-0.09 - 0.18	-0.12 - 0.23

Table A2. 95% Confidence Intervals of the difference between the current procedure of calculating daily average TDG and three alternate alternatives for calculating daily average TDG.

	2005			2006		
	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3
LGR-tw	0.04 - 0.14	-0.14 - 0.34	-0.43 - 0.43	0.14 - 0.31	0.01 - 0.48	-0.23 - 0.46
LGR-fb	0.05 - 0.09	-0.01 - 0.16	0 - 0.23	0.04 - 0.08	-0.07 - 0.07	-0.09 - 0.11
LGS-tw	0.03 - 0.07	-0.15 - 0.18	-0.33 - 0.28	0.09 - 0.28	-0.13 - 0.41	-0.25 - 0.47
LGS-fb	0.05 - 0.08	-0.07 - 0.06	-0.14 - 0.07	0.03 - 0.07	-0.09 - 0.17	-0.19 - 0.24
LMN-tw	0.04 - 0.15	-0.11 - 0.18	-0.01 - 0.55	0.12 - 0.23	-0.06 - 0.31	-0.23 - 0.43
LMN-fb	0.03 - 0.07	-0.1 - 0.06	-0.16 - 0.08	0.04 - 0.08	-0.2 - 0.07	-0.34 - 0.17
IHR-tw	-0.01 - 0.62	-0.17 - 0.6	-0.62 - 2.03	0.21 - 0.38	-0.09 - 0.3	-0.26 - 0.35
IHR-fb	0.03 - 0.06	-0.08 - 0.07	-0.11 - 0.1	0.03 - 0.06	-0.1 - 0.07	-0.16 - 0.13
MCN-tw	1.24 - 1.83	-0.06 - 0.42	-0.25 - 0.28	0.05 - 0.22	-0.03 - 0.19	-0.13 - 0.22
MCN-fb-OR	0.05 - 0.09	0.06 - 0.13	0.11 - 0.23			
MCN-fb-WA	0.04 - 0.09	-0.13 - 0.05	-0.17 - 0.11	0.05 - 0.09	-0.07 - 0.09	-0.04 - 0.16
JDA-tw	2.54 - 3.43	-0.14 - 0.27	-0.22 - 0.2	0.05 - 0.8	0.06 - 0.6	0.09 - 0.68
JDA-fb						
BON-fb	0.11 - 0.19	-0.1 - 0.12	-0.14 - 0.18	0.06 - 0.12	-0.18 - 0.12	-0.3 - 0.16
Cam/Wash	0.06 - 0.11	-0.07 - 0.02	-0.08 - 0.03	0.03 - 0.08	-0.01 - 0.09	0 - 0.17
Warrendale	0.03 - 0.08	0.44 - 0.79	-0.15 - 0.26	0.04 - 0.07	-0.08 - 0.12	-0.18 - 0.16
Casc-Island	0.49 - 0.68	-0.1 - 0.09	-0.15 - 0.1	0.14 - 0.24	0.07 - 0.43	-0.02 - 0.5
TDA-tw	0.16 - 0.29	-0.01 - 0.18	-0.05 - 0.22	0.06 - 0.16	-0.07 - 0.18	-0.16 - 0.26
TDA-fb	0.34 - 0.61	-0.13 - 0.25	-0.23 - 0.32	0.04 - 0.08	-0.11 - 0.11	-0.1 - 0.24

Table A3. 95% confidence intervals of the difference between the current procedure of calculating daily average TDG and three alternate alternatives for calculating daily average TDG.