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MEMORANDUM

TO: Fish Passage Advisory Committee

FROM: Brandon R. Chockley

DATE: August 29, 2016

SUBJECT: Estimated closure dates for Little Goose Dam surface spill weir using different forebay temperature strings, under criteria outlined Draft Change Form 17LGS002.

At the August 23, 2016 conference call, several FPAC members requested that the Fish Passage Center review the criteria listed in a draft change form for the closure of the Little Goose Dam (LGS) surface spill weir (SW) (17LGS002). This draft change form was distributed to FPAC on August 16, 2016 and is attached at the end of this memo for reference. Specifically, FPAC requested the FPC to provide a table of the possible SW closure dates based on the criteria listed in the change form (17LGS002), with a focus on other depths for the temperature criteria (Criterion iii). For this request, we focused on the LGS temperature string data at the 3, 5, 10, and 15 meter depths. Below are our general findings followed by a detailed description of our interpretation of the criteria and results of our analysis.

- Regardless of which temperature string was used, the criteria outlined in 17LGS002 resulted in a SW closure that was earlier than the actual closure date (based on the current FPP criteria of 35 Kcfs for three consecutive days) for nearly all years and depths analyzed.
- In general, the 3 meter and 5 meter depths resulted in similar closure dates, with the biggest magnitude difference of five days between the two (2013).
- The deeper temperature strings (10 or 15 meters) often resulted in later closure dates than the shallower depths (3 or 5 meters), but this difference was variable between years and sometimes negligible (see 2016 and 2013).
- In nearly all the years and temperature strings we analyzed, the two flow criteria (i and ii) were generally met before the temperature criterion (iii) was met.

Methods:

Under the Draft Change Form (17LGS002), the surface spill weir (SW) at LGS will be closed for the remainder of the season when the following flow and temperature criteria are met:

i) Observed Little Goose day average total outflow < 50 Kcfs:
ii) AND, forecasted Little Goose inflow < 50 Kcfs for the next 10 days:
iii) AND, hourly Little Goose forebay temperature at 3 meters depth > 20.0°C (68°F) for at least 2 consecutive days.

Because this is an analysis of past conditions, we did not use forecasted data for the second flow criterion (ii) as it specifies. Instead, the two flow criteria (i and ii) were deemed met when daily average flow at LGS first dropped below < 50 Kcfs and was followed by 10 consecutive days of <50 Kcfs flows. For example, in 2013, flows at LGS first dropped below 50 Kcfs on June 16th. However, flows only remained below 50 Kcfs for three additional days. Flows at LGS again dropped below 50 Kcfs on June 22nd where they remained for only nine additional days. Finally, flows at LGS dropped below 50 Kcfs on July 3rd and remained below 50 Kcfs for the remainder of the spill season. Therefore, based on the flow criteria outlined in 17LGS002, criteria i and ii were deemed met on July 3rd for 2013.

Similarly, the temperature criterion (iii) is open to potential differences in interpretation. As it currently states, the criterion would be met when hourly LGS temperature >20°C for at least 2 consecutive days, which we interpreted as meaning when hourly temperatures >20°C for at least 48 consecutive hours. Different results may be obtained if the intent of this criterion was to use daily average temperatures >20°C, as is more commonly used for these types of criteria.

Finally, 17LGS002 mentions that the project will have 3 normal work days to complete the operation after RCC issues the teletype. For our estimates of closure dates, we assumed that the SW would be closed on the next available work day, after the criteria were first met. We assumed available work days to be Monday through Friday, unless a holiday were to fall on one of these days (e.g., 4th of July).

Results:

Based on our interpretation, the criteria listed in 17LGS002 resulted in a SW closure that was earlier than the actual closure date (based on the current FPP criteria of 35 Kcfs for three consecutive days) for nearly all years and depths analyzed (Table 1). The earlier closure dates from 17LGS002 were anywhere from 6 to 26 days earlier (at 3 meters) than the actual closure date. The only exceptions to this were in 2015 and 2011. In 2015, the actual closure date was June 18th. Based on 17LGS002, the SW at LGS would also have been closed on June 18th (at 5 meters) and June 22nd and June 23rd for the 10 and 15 meter strings, respectively. In 2011, the temperature criterion at the 15 meter string was never met, and, therefore, the 17LGS002 would not have resulted in a closure if this temperature string were to be used. This is similar to what actually occurred in 2011, as the SW was never closed due to not meeting the current flow criterion.

In general, the 3 meter and 5 meter depths resulted in similar closure dates (Table 1). The largest difference in closure dates between these two strings was five days, which occurred in 2013. The deeper temperature strings (10 or 15 meters) often resulted in later closure dates than the shallower depths (3 or 5 meters). However, the magnitude of this difference was variable between years and sometimes negligible. For example, in 2016, 2013, and 2012, the differences in closure dates between the shallower and deeper strings were only on the order of 0-3 days. On the other, in 2015, 2014, 2010, and 2009, the differences in closure dates between the shallower and deeper strings were on the order of 4-12 days.

Table 1. Estimated Little Goose Dam SW closure dates based on criteria outlined in 17LGS002, at various forebay temperature string depths, 2009-2016.

Migration Year	Proposed SW Closure Date[A]				Actual Closure Date[B]
	3 meters	5 meters	10 meters	15 meters	
2016	5-July	5-July	5-July	7-July	11-July
2015	17-June	18-June	22-June	23-June	18-June
2014	14-July	14-July	21-July	22-July	4-August
2013	7-July	12-July	15-July	15-July	1-August
2012	17-July	17-July	19-July	20-July	6-August
2011	8-August	9-August	9-August	N/A[C]	N/A[D]
2010	27-July	30-July	11-August	13-August	5-August
2009	20-July	20-July	23-July	27-July	15-August

[A] Dates indicated are next available work day from when criteria were first met.
[B] Actual closure dates were based on what was originally presented in draft change form 17LGS002.
[C] Temperature criterion was never met at this depth.
[D] Actual flow criterion was not met in this year.

One other pattern worth noting is that the two flow criteria (i and ii) were generally met before the temperature criterion (iii) was met, with just a few exceptions. Among these exceptions were: 1) in 2013 when the flow criteria were first met on July 3rd but the temperature criterion (at 3 meters) was first met on July 1st and 2) in 2009 when the flow criteria were first met on July 16th but the temperature criterion (at 3 and 5 meters) was met on July 12th.

Fish Passage Plan (FPP) Change Request Form

Change Form # & Title: 17LGS002 – SW Close Criteria (*revised/resubmitted 17LGS001*)
Date Submitted: August 11, 2016
Project: LGS
Requester Name, Agency: Corps NWW and Russ Kiefer, ID
Final Action:

FPP SECTION: LGS 2.3.3.7. Juvenile Facilities - Fish Passage Season – Spillway Weir (SW).

JUSTIFICATION:

Change Forms **16LGS003** and **17LGS001** proposed to change FPP criteria for closing the Little Goose spillway weir (SW) based on performance studies showing lower juvenile survival when the SW is open at lower flows and follow-up modeling at ERDC in Sept 2014. Several proposals were discussed, but FPOM did not reach consensus and both Change Forms were withdrawn.

This Change Form proposes flow and temperature criteria to close the SW for the benefit of adult passage and juvenile egress at a time that avoids or minimizes risk to subyearlings from closing the surface passage route. As the river warms, subyearlings likely migrate deeper in the water column to stay in an optimal temperature range (Li et al., 2015) and limit their exposure to temperatures above 20°C (Tiffan et al., 2009). Therefore, when temperatures exceed 20°C at the SW crest (approximately 3 meters deep), the benefit of surface spill is reduced and subyearlings are more likely to benefit from deep spill (approximately 15m).

The proposed criteria to close the SW are:

- observed day average LGS outflow <50 kcfs and forecasted to stay <50 kcfs for 10 days;
- *AND*, hourly average LGS forebay temperature at 3 meters depth >20.0°C (68.0°F) for at least 2 consecutive days.

The table below shows the date these proposed criteria would have been met in previous years (the SW would have been closed the next available work day). The date the SW was actually closed that year is included for comparison.

Year	Proposed Criteria Met *	Actual SW close date
2016	7/1	7/11
2015	6/17	6/18
2014	7/13	8/4
2013	7/1	8/1
2012	7/15	8/6
2011	8/6	n/a (flow criteria not met)
2010	7/22	8/5
2009	7/18	8/15

*SW would have been closed on the next available work day.

PROPOSED CHANGES: (see next page)

Current Language in 2016 FPP:

c. Close SW: On or after August 1, when daily average discharge drops below 35 kcfs and forecast indicates flow will remain below 35 kcfs for at least 3 days, the SW will be closed for the remainder of the spill season. The SW will be closed within 3 normal work days after RCC issues the teletype and coordinated through CENWW-OD-T. During work to close the SW, spill will be distributed in "Alternate Uniform" patterns (**Table LGS-11**) and Bay 2 will be closed to ensure worker safety in adjacent Bay 1. After the SW is closed, spill will be distributed in "Uniform" patterns with No SW (**Table LGS-10**).

c.1. The SW will not be closed prior to August 1 in order to enhance subyearling migration even if flow drops below 35 kcfs, unless an adult passage delay is observed or if necessary due to turbine unit operational constraints at low flow. Closing the SW prior to August 1 will be coordinated through FPOM by CENWW-OD-T.

Proposed Language for 2017 FPP:

c. Close SW.

c.1. Unless otherwise coordinated with FPOM and/or TMT, the SW will be closed for the remainder of the season when flow and temperature criteria defined below are met. CENWW-OD-T will coordinate with the Project and RCC to schedule closing the SW and notify FPOM of the planned operation. The Project will have 3 normal work days to complete the operation after RCC issues the teletype in the event of weather delays or other complications:

i) observed Little Goose day average total outflow < 50 kcfs: www.nwd-wc.usace.army.mil/dd/nwdp/project_daily/webexec/rep?r=lgs&ago=0

ii) *AND*, forecasted Little Goose inflow < 50 kcfs for the next 10 days: www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?LGSW1

iii) *AND*, hourly Little Goose forebay temperature at 3 meters depth > 20.0°C (68.0°F) for at least 2 consecutive days: www.nwd-wc.usace.army.mil/ftppub/water_quality/tempstrings/

c.2. During work to close the SW, spill will be distributed in "Alternate Uniform" patterns in **Table LGS-11** and Bay 2 will be closed to ensure worker safety in adjacent Bay 1. After the SW is closed, spill will be distributed in "Uniform" patterns with No SW in **Table LGS-10**.

COMMENTS (listed oldest to newest):

RECORD OF FINAL ACTION: