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Director, Division of Water
New York State Department of Environmental Conservation
625 Broadway, 4th Floor
Albany, NY 12233-3500

Via email: Mark.Klotz@dec.ny.gov

Dear Mr. Klotz:

The Subcommittee of Ecological Flows (SEF) of the Regulated Flow Advisory Committee (RFAC) met over the past year to evaluate the interim Thermal Mitigation Guidelines for use of the 2,500 cfs bank established by the Flexible Flow Management Program approved in 2017 (FFMP2017). After much analysis and discussion, the SEF members developed a recommendation, called Simple 75, to modify the guidelines. SEF members also indicated additional areas of study the group would like to pursue. A summary of their analyses and the recommendation is attached. At this time, SEF members require additional time to consider use of the 1,000 cfs bank for Rapid Flow Change Mitigation and thus the recommendation is to use the interim guidelines provided for their consideration.

On July 9th, a special meeting of RFAC was convened to discuss SEF's recommendation to modify the Thermal Mitigation Guidelines. Daryl Pierce of PA Fish and Boat Commission explained the recommendation and answered questions from the RFAC members and public. The RFAC Members discussed the recommendation and made the determination to move forward with the Simple 75 approach and request that SEF focus their efforts on the Rapid Flow Change Mitigation guidelines, prior to continuing work on thermal issues. RFAC members voted, and unanimously agreed, to forward the recommendation of the Simple 75 program to the Decree Parties for their consideration. The meeting summary is attached for your reference.

My understanding is that if the Simple 75 recommendation is approved, the staff at the New York State Department of Environmental Conservation will develop the protocol for use of the Thermal Mitigation Bank using the Simple 75 guidelines. When available and with your permission, DRBC will distribute the modified protocol to SEF and RFAC members and/or post on the RFAC and/or SEF website(s).

Mr. Mark Klotz, P.E.

July 17, 2019

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Please let me know if you have any questions.

Sincerely,

A handwritten signature in black ink that reads "Amy L. Shallcross". The signature is written in a cursive style with a long, sweeping underline.

Amy L. Shallcross, P.E.

Manager, Water Resource Operations

C: David Wunsch
Michelle Putnam
Paul Rush
Aneca Atkinson
Robert Mason
Kendra Russell

SEF evaluation of Interim Guidance for Thermal Mitigation 2017 FFMP

June 2019 Progress Report

In August of 2018, the Regulated Flow Advisory Committee (RFAC) appointed 13 members to the Subcommittee on Ecological Flows (SEF) and charged the Subcommittee with reviewing the interim thermal mitigation in the Flexible Flow Management Program of 2017 (FFMP 2017).

This report summarizes SEF's research supporting our recommended alternative protocol. More detailed methods, results, and evaluations supporting this document can be provided to RFAC by request. SEF evaluations remain ongoing and we list below open issues and proposed additional research.

SEF's investigations relied on time-series trend analyses, simulations and statistical probability models. Development of a thermo-dynamic heat flux model could provide complementary findings and is part of the proposed continuation research. Additional progress reports will be submitted to RFAC as future investigations are completed. Eventually all analyses will be fully codified in a final report.

Evaluation

After reviewing and analyzing several alternate management protocols with a variety of thermal stress criteria ranging from 68°F to 77°F, SEF members conducted detailed evaluations of two alternatives:

“Interim Protocol” – The current Interim Guidance for Thermal Mitigation as described within the 2017 FFMP. This policy includes a phase 1 during which a single day at 75°F triggers a mitigation release, and a phase 2 during which two consecutive days at 75°F or a single day at 77°F triggers a release. This policy also constrains the amount of the thermal bank that can be expended during phase 1 to 1,250 CFS days. The amount of water in the thermal bank is set at 2,500 CFS days beginning on June 1, and this bank amount carries over, if not exhausted, to May 31 of the following year.

“Simple 75 Protocol” – a revision of the Interim Protocol that removes the 77°F maximum and two successive days at 75°F temperature triggers at Lordville during the Secondary Phase and instead uses a single 75°F maximum temperature trigger at Lordville during all time periods. The thermal bank is initiated as above at 2,500 cfs-days on June 1.

SEF evaluated the effectiveness of these two protocols using historical flows and temperature data at Lordville for the summers (May 1 to September 30) over the last 11 years, from 2008 – 2018, a period during which some version of the FFMP was in place. In all the evaluations discussed below, a day was considered in thermal stress if the maximum water daily temperature exceeded 75°F.

Because low base releases in the early years of the FFMP possibly contributed to the amount of thermal stress experienced historically, we also simulated the operations of FFMP 2017 in the years 2008 to 2012. With DRBC collaboration, this was done via OASIS modified hydrology and water temperatures for the period 2008-2012. These simulations validated our hypothesis that had FFMP 2017 been in operation throughout, thermal stress would have been less frequent.

In addition to these analyses, we conducted detailed analyses of the nine thermal releases that were made by NYSDEC over the 11 years of FFMP operations (Table 1).

	June of 2008	July of 2010	July of 2011	June of 2012	July of 2013	July of 2016	17-Jun-18	30-Jun-18	15-Jul-18
Bing MaxTemp at Pulse Start °F	89	90	93	90	87	88	84	88	84
Stilesville Base Rate (cfs)	253	372	598	510	567	498	389	383	389
Stilesville Pulse Level (cfs)	631	510	1050	897	923	776	677	709	637
Stilesville Pulse Magnitude (cfs)	378	138	387	387	356	278	288	326	248
Stilesville Ending Rate (cfs)	263	340	598	510	567	498	389	389	389
Lordville Base Rate (cfs)	852	662	1200	1350	1260	953	990	1260	918
Lordville Level During Pulse (cfs)	1100	835	1570	1600	1550	1200	1170	1460	1060
Release Start Time	6/9 21:30	7/5 23:30	7/22 14:25	6/20 5:15	7/16 23:30	7/23 15:00	6/17 11:45	6/30 12:30	7/15 15:45
Time Reached Pulse Level	6/10 2:15	7/6 2:30	7/22 19:00	6/20 20:00	7/17 4:45	7/23 19:00	6/18 16:15	6/30 15:45	7/15 19:15
Time Pulse Reached Lordville	6/10 11:30	7/6 16:30	7/23 6:15	6/21 7:15	7/17 14:45	7/24 7:15	6/18 2:15	7/1 4:00	7/16 8:45
Time Start Drop	6/11 7:30	7/9 22:30	7/24 12:00	6/21 11:30	7/19 0:00	7/25 15:15	6/18 10:30	7/4 11:30	7/16 14:45
Time Return to Base Rate	6/11 18:00	7/10 5:30	7/24 16:15	6/21 16:15	7/19 10:30	7/25 20:45	6/18 16:45	7/4 22:30	7/16/22:00
Total Additional Water	552	513	849	342	794	563	291	1202	268
Release Duration (days)	1.85	4.25	2.06	1.03	10.48	2.24	1.17	9.31	1.26
Pulse Duration (days)	1.22	3.83	1.7	0.64	1.8	1.84	0.78	3.76	0.81
Relative Temp Drop °C	1.70	-0.3	2.6	1.7	2.2	1.9	1.45	1.743	1.15
Impact Metric I (cfs/°C)	222	-460	149	227	162	146	199	187	216
Impact Metric II (°C/100 cfs)	0.45	-0.22	0.67	0.44	0.62	0.68	0.50	0.53	0.46

Table 1. Summary Analyses of Nine Thermal Releases: 2008 to 2018

Evaluations were predicated on the magnitude and duration of simulated thermal releases. Two release regimes were evaluated:

“**STATS**”, (100 cfs per 1.242°F [0.69°C]) a regime based on a statistical calibration regression predicting water temperatures at Lordville based on up-river observations and prevailing meteorological conditions.

“**EXPER**”, an experience-based release (331 cfs per thermal stress event day, actual average daily use in existing FFMP) was also evaluated as an alternative to the rate inferred by the STATS model. Duration of thermal releases in all scenarios were simulated to fully encompass all identified thermal stress days. The efficacy of the thermal bank (i.e., 2,500 cfs-days) was estimated by a statistical multiple linear regression inclusive of upriver observations and meteorological conditions.

A general note is worth adding for all the analyses. These simulations assume perfect forecasting of stress conditions, and hence are optimistic regarding policy performance.

Based on historical USGS gage data at Lordville, a total of 78 days exceeded the 75°F stress definition. (Table 2).

Days When Tmax >= 75 F Exceeded						
	May	Jun	Jul	Aug	Sep	Season
2008	0	8	9	1	0	18
2009	0	0	0	0	0	0
2010	4	2	15	1	2	24
2011	0	0	3	0	0	3
2012	0	1	5	8	0	14
2013	0	0	2	0	0	2
2014	0	0	0	0	0	0
2015	0	2	0	0	0	2
2016	4	0	4	1	0	9
2017	0	0	0	0	0	0
2018	0	0	6	0	0	6
11 Years	8	13	44	11	2	78

Table 2. Frequency of Thermal Stress at Lordville by Year and Month: 2008 to 2018

Application of OASIS/PST adjustment/simulation of FFMP 2017 in 2008 to 2012 reduced the total thermal stress days to 41 days (Table 3), suggesting the 2017 FFMP conservation releases (i.e., Table 3) are inherently proactive in mitigating the frequency of thermal stress at Lordville.

Actual Stress Days						
	May	Jun	Jul	Aug	Sep	Season
2008	0	8	9	1	0	18
2009	0	0	0	0	0	0
2010	4	2	15	1	2	24
2011	0	0	3	0	0	3
2012	0	1	5	8	0	14
Five Years	4	11	32	10	2	59

Sttess Days Under Simulated FFMP 2017						
	May	Jun	Jul	Aug	Sep	Season
2008	0	4	0	0	0	4
2009	0	0	0	0	0	0
2010	1	1	1	1	0	4
2011	0	1	4	0	0	5
2012	3	4	1	1	0	9
Five Years	4	10	6	2	0	22

Table 3. Historical vs. OASIS Simulated Lordville Stress Days: 2008to 2012

Performance of the “Interim Protocol” Under the STATS release regime (100 cfs per 1.242°F [0.69°C]), because lower volumes of water are used for each thermal event, there were no “unmitigated stress days”, and the Thermal Mitigation Bank was never completely utilized in any year (An average of 640 cfs-days was used per year) (Table 4).

Under the EXPER release regime (331 cfs per event day), the average amount of water used for thermal mitigation was 962 cfs-days. The maximum used was 2,472 cfs-days in 2011. Thus, the thermal bank of 2,500 cfs-days was never exhausted in any of the 11 years evaluated (2008-2018). However, 14 unmitigated thermal stress days were experienced -- all due to the Second Phase constraints which conserved water while Lordville was already in stress at 75°F. These occurred in 2008, 2010, 2011, 2012, and in 2018. (Table 4)

Year	Release 100 cfs per 0.69°C				Release 331 cfs per stress day			
	Oasis 75/77	Oasis Stress Days?	Oasis No Phase 75	Oasis Stress Days?	Oasis 331 Per Diem 75/77	Oasis Stress Days?	Oasis 331 Per Diem 75	Oasis Stress Days?
	Release 100 cfs per 0.69°C	Release 100 cfs per 0.69°C	Release 100 cfs per 0.69°C	Release 100 cfs per 0.69°C	Release 331 cfs per stress day	Release 331 cfs per stress day	Release 331 cfs per stress day	Release 331 cfs per stress day
2008	1241	None	1241	None	1585	1x (Phase 2)	1916	None
2009	95	None	95	None	331	None	331	None
2010	543	2x (Phase 2)	653	None	874	2x (Phase 2)	1536	None
2011	1528	4x (Phase 2)	1826	None	2472	3x (Phase 2)	3465	3x NO WATER
2012	563	2x (Phase 2)	616	None	1358	3x (Phase 2)	2351	none
2013	671	-	685	-	671	-	1002	-
2014	0	-	0	-	0	-	0	-
2015	101	-	101	-	993	-	993	-
2016	510	-	597	-	510	-	1172	-
2017	0	-	0	-	0	-	0	-
2018	1793	5x total all in phase 2 (1x - 1250 water exceeded, 4x date)	2039	None	1793	5x (Phase 2)	3448	2x NO WATER

Table 4. Comparison Table of Interim Protocol and Simple 75 Protocol with both lower thermal releases (100 cfs per 0.69°C) and experienced based thermal releases (331 cfs per stress day)

Performance of the “Simple 75 Protocol”

As with the “Interim Protocol,” under the STATS release regime (100 cfs per 1.242°F [0.69°C]), there were no “stress days” that went unmitigated, and the Thermal Mitigation Bank was never completely utilized in any year (average of 714 cfs-days used per year) (Table 4).

Under EXPER release regime (331 cfs per event day), the average amount of water needed for thermal mitigation was 1,474 cfs-days. The maximum needed was 3,465 cfs-days in 2011, and in 2018 3,448 cfs-days were needed. Thus, the thermal bank of 2,500 cfs-days was exhausted in 2 of the 11 years evaluated. There were 5 unmitigated thermal stress days in the simulations due to the exhaustion of the 2,500 cfs-day bank (3 in 2011, 2 in 2018) (Table 4).

Recommendation from SEF

The Subcommittee on Ecological Flows recommends eliminating the two-phase approach within the Interim Protocol; and, retain only Phase 1 which is consistent with the “Simple 75 Protocol” evaluated in these simulations.

While SEF acknowledges trade-offs among different strategies for using the 2,500 cfs-day Thermal Mitigation Bank, the Subcommittee feels this revised “Simple 75 Protocol” makes important improvements to the Interim Protocol by eliminating potentially stressful maximum temperatures of 77°F as was originally permitted in Phase II. The elimination of Phase II will, by mitigating more 75°F stress days, offer better protection for the cold-water fishery of the upper mainstem Delaware River while better utilizing the available bank of cold-water releases.

The Subcommittee wishes to emphasize the adaptive nature of this thermal mitigation protocol, and with implementation experience with our suggested protocol and further research adding to our understanding of the trade-offs among different strategies, additional improvements are possible. As a result, SEF requests that RFAC charge the subcommittee with continued evaluation of thermal mitigation issues in the expectation that additional revisions to the protocol could be recommended in future years.

SEF also acknowledges that, similar to deliberations for thermal events prior to the 2017 FFMP and the establishment of the 2500 cfs-day bank, extraordinary thermal events may occur after the bank is exhausted for which RFAC and the Decree Parties may be petitioned for special releases, should sufficient water be available in the New York City reservoirs.

Continued Work under RFAC Charge

SEF members request additional time to evaluate items related to the August 2018 RFAC charge, including:

- The ability of the Thermal Mitigation Bank to adequately reduce or prevent a standard which considers the average water temperatures at Lordville from exceeding 72°F over a 24-hour period.
- An evaluation of other more protective temperature triggers or targets;
- The adequacy of the size of the Thermal Mitigation Bank for protecting the upper mainstem Delaware River in a manner consistent with the goals identified in the FFMP.
- Develop and evaluate thermal dynamic models, as complementary to the statistical probability model.

Acknowledgements

The Subcommittee wishes to acknowledge and express our deepest appreciation to Ross Shramko, Scott Collenburg, Jim Serio, and Peter Kolesar for their dedication. These gentlemen collectively conducted the historical analyses, regressions and simulations that served as the basis for this report. Thank you.

DRAFT MEETING SUMMARY

For Special Meeting of the Regulated Flow Advisory Committee (RFAC)

Meeting on July 9, 2019

A special meeting of the Regulated Flow Advisory Committee was convened for the purpose of considering the recommendation by the Subcommittee on Ecological Flows (SEF) related to the FFMP Thermal Mitigation Guidelines and Rapid Flow Change Guidelines.

Steve Domber, RFAC Chair, started the meeting by thanking the members of SEF for all the hard work they have completed thus far. He noted that SEF was charged with evaluating the interim guidelines for two banks established by the Flexible Flow Management Program of 2017 (FFMP2017 or FFMP). One is a 2,500 cfs-day bank for the mitigation of thermal events. The other is 1,000 cfs-day for the mitigation of rapid flow changes as the result of changes to the releases, directed by the Delaware River Master, from the NYC reservoirs.

Daryl Pierce of PA Fish and Boat Commission, representing Pennsylvania on the Subcommittee on Ecological Flows (SEF), presented the recommendations from SEF related to the guidelines for thermal mitigation and rapid flow change mitigation from two banks established by the FFMP2017. SEF submitted a progress report to RFAC on June 13, 2019 outlining the findings and including a recommendation related to the thermal guidelines. The report also documented their analyses

The interim guidelines, which they were asked to review, consists of a two-phased approach. Phase 1 is in effect from 6/1 – 7/6 and is intended to prevent any exceedance of 75°F at Lordville, as measured at the USGS gage or half (1,250 cfs) of the 2,500 cfs-days of the bank has been expended. Phase 2, in effect beginning 7/7, is intended to prevent exceedances of 75°F for 2 consecutive days or any exceedance of 77°F, prior to initiating mitigation release. The use of the banks would occur if the flow at Lordville is less than 1,360 cfs, because at higher flows releases from Cannonsville have little effect. Their analyses showed that Phase 2 allows some increased thermal stress (i.e., > 75°F, > 77°F) on coldwater fishes. The analysis also showed that under the Interim guidelines, the thermal bank was not exhausted in any year, but allowed 14 days of unmitigated thermal stress due to the Phase 2 goal of preventing exceedances of 75°F for 2 consecutive days or any exceedance of 77°F. The conclusion was that the Interim Guidelines conserve water in the bank and are less protective of the coldwater community.

SEF's recommendation is known as the Simple 75 alternative. The recommendation eliminates the phases and has the goal of preventing any exceedance of 75°F at Lordville. The benefits are that use of the bank with no phases and the goal of not exceeding 75°F at Lordville is more proactive at preventing thermal stress, however, there is a greater risk of depleting the bank prior to the end of the summer. SEF members reviewed the eleven-year (2008-2018) time-series and found that 78 days exceeded 75°F

at Lordville. They used output from PST to estimate what the temperatures in the river would have been under FFMP2017 for the period of 2008-2012 and the number of thermal stress days were reduced from 78 days to 41 days (prevented 37 days). The 2017 FFMP was determined to be proactive in preventing thermal stress at Lordville. Using the Simple 75 approach resulted in exhaustion of the bank in two years (2008 and 2011), allowing 5 unmitigated days due to depletion of the bank. Overall, the Simple 75 guidelines result in mitigation of 9 more days than the Interim Guidelines.

SEF recommends that the Simple 75 be used in place of the Interim Guidelines for the following reasons:

- The Simple 75 approach offers a slight improvement for mitigation of 75°F thermal stress days over Interim Guidelines.
- Analyses show that using Simple 75 results in a net increase of mitigated days (N = 9) and eliminates the potential lethal 77°F maximum criteria as was originally permitted in Phase 2

SEF would also like to continue to work on thermal mitigation guidelines as follows:

- Validate findings using thermal dynamic model (heat flux)
- Alternative thermal criteria
- Adequacy of bank allocation, potential to combined Thermal Mitigation Band with Rapid Flow Change (RFC).

SEF has not yet completed their analyses for the Rapid Flow Change Guidelines. They have recommended using the Interim Guidelines for 2019. They are continuing to evaluate the and expect to have a recommendation by April 15, 2019.

There was discussion about the details of the guidelines. There was a thermal release of July 5-6 that followed the Simple 75 guidelines because it was anticipated that RFAC members would be amenable to the guidelines. A graphic prepared by Peter Kolesar was presented that showed the release and temperatures at Lordville. The potential thermal stress day was mitigated.

There was consensus among the Committee to submit the recommendation of SEF regarding modifications to the interim thermal mitigation guidelines and their proposed topics for future study to the Decree Parties for formal approval. After some discussion among the members, to vote on the recommendation with the added condition that SEF was to focus on evaluating the Rapid Flow Change Guidelines, prior to continuing evaluation on thermal issues. Stefanie Baxter moved to submit the SEF recommendation with the caveat that SEF focus on the Rapid Flow Change Guidelines to the Decree Parties for approval. The motion was seconded by Jen Garigliano. All approved.

There was a proposal to amend the SEF procedures to provide a deadline for recommendations that SEF wants implemented in any release season starting on June 1. Any recommendation may be considered at the discretion of RFAC. Recommendations may be made to RFAC at any time. For recommendations related to the use of releases from NYC reservoirs, it is desirable to receive the recommendation(s) prior to April 15 if they are to be implemented at the beginning of the release year starting June 1. The April

15 deadline will provide enough advance notice for consideration by RFAC, submission to the Decree Parties, development of implementation guidelines and training of NYSDEC, NYCDEP and ODRM staff. Amendments to the SEF procedures will be shared with SEF and considered at the next RFAC meeting.

The meeting was adjourned at 10:45 AM.

Members in attendance:

In person: Steven Domber, NJDEP (co-chair); Stefanie Baxter, DGS; Jen Garigliano, NYCDEP

By phone: Brenan TARRIER, NYSDEC; Hoss Liaghat, PADEP; Laura Bittner, USACE; Kelly Anderson, PWD; Kendra Russell, USGS; William Cocke, DNREC.

Others in attendance:

In Person: Daryl Pierce, Vince Monaco, Nick Carbon

Phone: Sheila Eyler, Jim Mayfield, Molly Hesson, Peter Kolesar, Jeff Skelding, Molly Oliver, Lee Hartman, Adao Matonse, Angela Padeletti

Staff:

Amy Shallcross, John Yagecic, Fanghui Chen, Anthony Preucil; Donna Woolf