**Annex A**
**Narrative Rationale: Interim Guidance for Thermal Mitigation**

## Need

Thanks to a combination of FFMP operating principles and the absence of drought conditions, the coldwater species assemblage of the Delaware River between the confluence of the East and West Branches and Lordville has enjoyed a reduction in thermal stress since the initial implementation of FFMP. However, thermal stress days (defined by NYSDEC as a maximum temperature $\geq$ 75°F and/or minimum temperature $\geq$ 72°F over 24 hours) still occur frequently enough that a further reduction is desirable for the protection of the fishery resource. Also, it must be remembered that, for brown and rainbow trout, the *thermal stress day* metric does not represent the onset of thermal stress but rather the beginning of acute stress. The adaptive response of adult trout to avoid extreme temperatures by moving within the Delaware tailwaters[1] provides some margin of safety. However, such behavioral responses are energetically costly and the risk of mortality remains when episodes of thermal stress are extraordinary in duration, magnitude, or frequency.[2]

## Approach

Consistent with the management objectives articulated in the 2010 Joint Fisheries White Paper and with the 2,500 cfs days provided by the decree parties for the purpose of thermal stress mitigation in FFMP 2017, the following operational protocol is designed to defer and/or mitigate the frequency, magnitude, and duration of extraordinary thermal stress in the above defined reach. Accordingly, thermal releases may not fully eliminate all thermal stress experienced by the trout population. Thermal releases are solely intended to temporarily mitigate acute peak warming, not for upgrading the protection level of the upper mainstem from the "Good" to "Excellent" category. The protocol consists of two operational phases designed make maximal use of the water provided while addressing the biological and fishery concerns described below.

**Primary Phase: September 15 through July 6 (Maximum of 1,250 cfs days)**
**Goal:** Proactively prevent occurrences of any thermal stress day(s) at Lordville NY of $\geq$ 75°F maximum, or 72°F over 24 hours.
**Operational objective:** Thermal releases will be structured to prevent thermal stresses beginning Day 1
**Rationale:** Trout populations inhabiting productive main stem habitats tend to accumulate in thermal refuges during the course of the summer in response to cumulative thermal stress.[3] While adaptive in the short term, the energetic costs of this response in terms of restricted feeding opportunity, competition and the cost of migration itself render trout progressively less resilient to further stress including that of parasites and pathogens. Minimizing migratory responses to isolated and unusual thermal events in late spring and early summer and deferring the abandonment of productive mainstem habitat should improve the capacity of the population to withstand thermal stress later in the summer. The goal of preventing thermal stress days during primary phase has the additional merit avoiding disruptions to the recreational fishery during its period of most intensive use. Finally, preventing thermal stress days is a reasonable goal during the final month of the water year (May) to take advantage of any unused water remaining in the bank. To prevent premature exhaustion of the bank ahead of the hottest part of the summer, the use of the bank to meet phase one standards is capped at 1,250 cfs days.

**Secondary Phase: July 7 through September 14**
**Goal:** Reduce extraordinary thermal stress at Lordville NY by limiting the magnitude, duration and frequency of water temperatures exceeding the thermal stress day benchmark. It is anticipated, some level of thermal stress will be incurred to the trout population.

**Operational objective:** Depending on the forecasted severity, thermal releases will be structured to mitigate peak warming events beginning Day 3.
**Rationale:** Given the size of the bank to be managed and the potential for extended heat waves during the hottest part of the summer, it is unreasonable to maintain the primary phase goal year-round. To do so would create an unacceptable risk of facing an extraordinarily severe thermal stress event in late summer with an exhausted bank. Under the secondary phase, water is reserved to mitigate the most severe episodes of thermal stress where a direct and immediate mortal risk to trout exists due to the magnitude, duration, or frequency of water temperatures equal to or in excess of the thermal stress day benchmark. By definition, thermal releases under Phase 2 will accept some level of thermal stress on the trout population without jeopardizing population failure. Thermal releases during this phase are also intended to aid/encourage trout in seeking thermal refugia, rather than attempting to maintain trout *in situ* in the Delaware River. The more restrictive secondary phase operating rule is essential to protect the trout fishery during hot summers.

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[1] McBride, Norman 2002. Radiotelemetry Study of Trout Movements in the Delaware Tailwaters and the Beaver Kill: 1995-1997. New York State Department of Environmental Conservation, Region 4 Fisheries Office, Stamford: 43 pp.

[2] McCullough, D. A., J. M. Bartholow, H. I. Jager, R. L. Beschta, E. F. Cheslak, M. L. Deas, J. L. Ebersole, J. S. Foott, S. L. Johnson, K. R. Marine, M. G. Mesa, J. H. Petersen, Y. Souchon, K. F. Tiffan, and W. A.Wurtsbaugh 2009. Research in thermal biology: burning questions for coldwater stream fishes. Reviews in Fisheries Science 17:90–115.

[3]Petty, J. Todd, Jeff L. Hansbarger, Brock M. Huntsman & Patricia M. Mazik 2012. Brook Trout Movement in Response to Temperature, Flow, and Thermal Refugia within a Complex Appalachian Riverscape, Transactions of the American
Fisheries Society, 141:4, 1060-1073