Department of Environmental Conservation – Watershed Management Division

Update on the 2019 Performance of the Lake Carmi Aeration System, December 2, 2019

Introduction: This document contains a summary of the 2019 performance of the Lake Carmi Aeration System, installed in June 2918. If there are outstanding questions, DEC welcomes a continued exchange of information; if you have questions or comments, please send them by email to ANR.WSMDLakes@vermont.gov or by USPS to:
Renita Marshall, Office of the Commissioner, VT DEC, 1 National Life Drive, Main 2, Montpelier VT 05620-3522

Background: On June 23rd, 2019, the Lake Carmi aeration system was turned on in order to mix the water column and allow dissolved oxygen to reach the lake bottom. The presence of dissolved oxygen at the lake bottom is important to reduce internal phosphorus loading (release of phosphorus from the sediments which can become available to microorganisms and fuel algal blooms). This strategy of aeration/circulation has been determined to be the best in-lake approach to reduce the release of legacy phosphorus from sediment in the oxygen-depleted deep zone of the lake during the summer, and in turn cut down the amount of nutrients available to support harmful cyanobacteria blooms while watershed best management practices continue to be implemented. The aeration system, the first of its kind in Vermont, is part of a broader effort to reduce phosphorus loading to Lake Carmi that also includes numerous interventions in the watershed to reduce phosphorus inputs to the lake from surface water runoff (see the ANR Lake Carmi Lake in Crisis Response Plan). The performance targets for the aeration system are to maintain water temperature within 2.5 degrees C from one meter above the bottom to one meter below the surface, and to maintain a minimum dissolved oxygen level of 2.5 mg/l one meter above the bottom in the treatment zone, in both cases for at least 80% of the recorded measurements each summer. Finally, while the aeration system will not eliminate cyanobacteria blooms on its own, it is expected to reduce their occurrence and duration.

2019 System Performance: Because of the permitting and construction timeline, the aeration system was turned on 7 – 10 days after the stratification of the lake into zones with different temperatures and dissolved oxygen concentrations, and after some internal phosphorus loading had already occurred. There were also some operational challenges with the system compressors, including overheating, that led to some downtime in early July. However, these issues were rapidly addressed, and overall the system achieved a 95% uptime performance this season. Additionally, within 33 days, the system had achieved its goal of mixing or "destratifying" the lake, resulting in near uniform temperatures between the surface and bottom of the lake (Figure 1). This outcome proved that the system was properly designed and could achieve its performance targets (Figure 2). The system ran until October 25, 2019, at which point it was turned off as monitoring data indicated that water temperatures were cold enough to allow the lake to continually mix on its own. Total 2019 electricity costs for the two compressors running the aeration system were $16,816 or $3,564 per month.

2019 Preliminary Results: The Lake Carmi aeration system is working as intended and was responsible for limiting phosphorus loading from the lake's bottom sediments this summer. Specifically, when the aeration system was fully operational, preliminary monitoring data indicate that it accomplished our goals of mixing the water column to allow dissolved oxygen to reach the lake bottom, thereby significantly reducing internal phosphorus loading from the sediments (Figures 3-4). Lake Carmi did experience cyanobacteria blooms this summer, as did other lakes in the state. Large flow/rainfall events and high temperatures this summer (Figures 5-7) created ideal conditions for cyanobacteria blooms in Vermont and around the Northeast. ANR staff are still reviewing data to finalize analysis of the aeration system's 2019 performance, and a final report will be available in early 2020.

Planning for 2020: In reviewing the 2019 data for temperature, dissolved oxygen and phosphorus levels at the bottom of the lake, ANR was able to identify an optimal lake temperature and oxygen level for restarting the aerator next summer, which will also guide future operations. As stewards of both fish habitat as well as the water quality of the lake, ANR staff must balance the sensitive life cycle requirements of the walleye population with the goal of reducing the release of legacy phosphorus. The aeration system can be optimized in 2020 to reduce sediment phosphorus release even further. In addition to the reduction of phosphorus loading from the sediment, efforts to reduce nutrient loading from the Lake Carmi watershed will continue as outlined in the ANR Lake Carmi Lake in Crisis Response Plan.

Figure 1. 2016-2019 Lake Carmi Station #1 (UVM Mid-Lake Buoy) VTDEC TMDL Monitoring
Lake Surface and Bottom Temperature

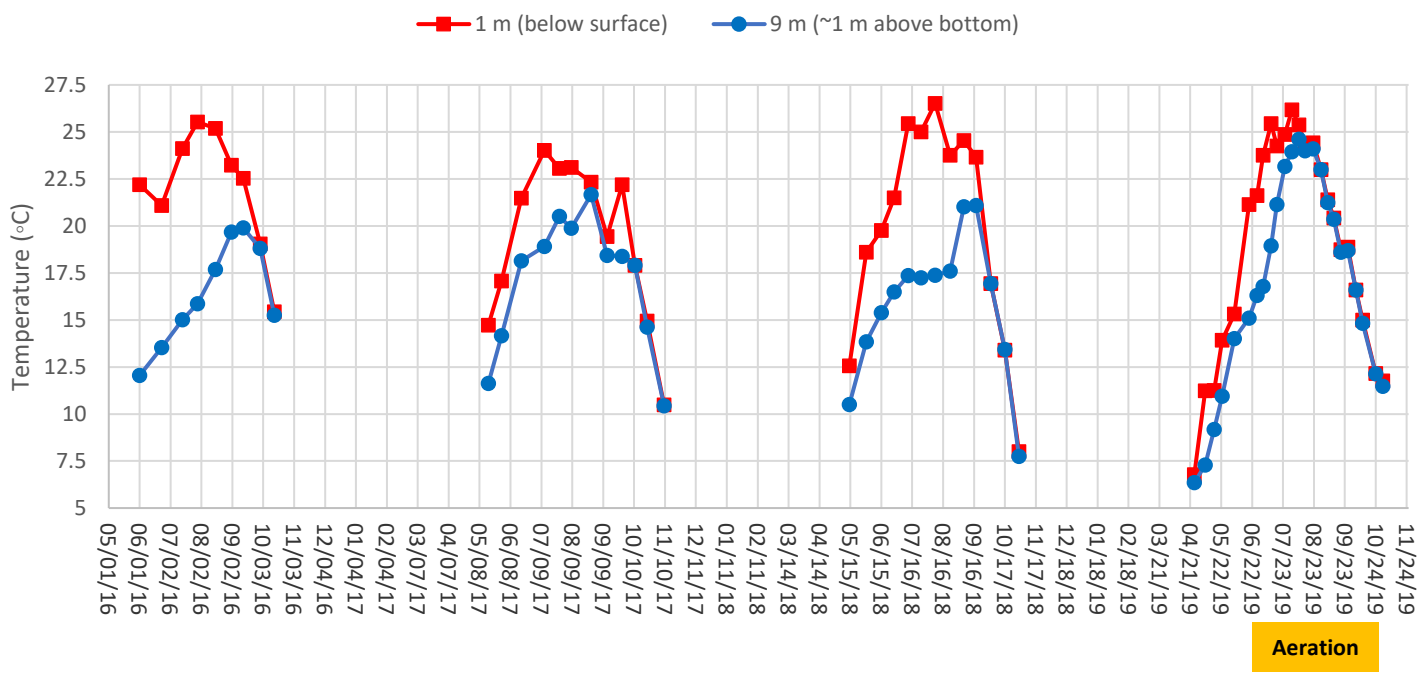

Figure 2. 2016-2019 Lake Carmi Station #1 (UVM Mid-Lake Buoy) VTDEC TMDL Monitoring
Lake Bottom Dissolved Oxygen

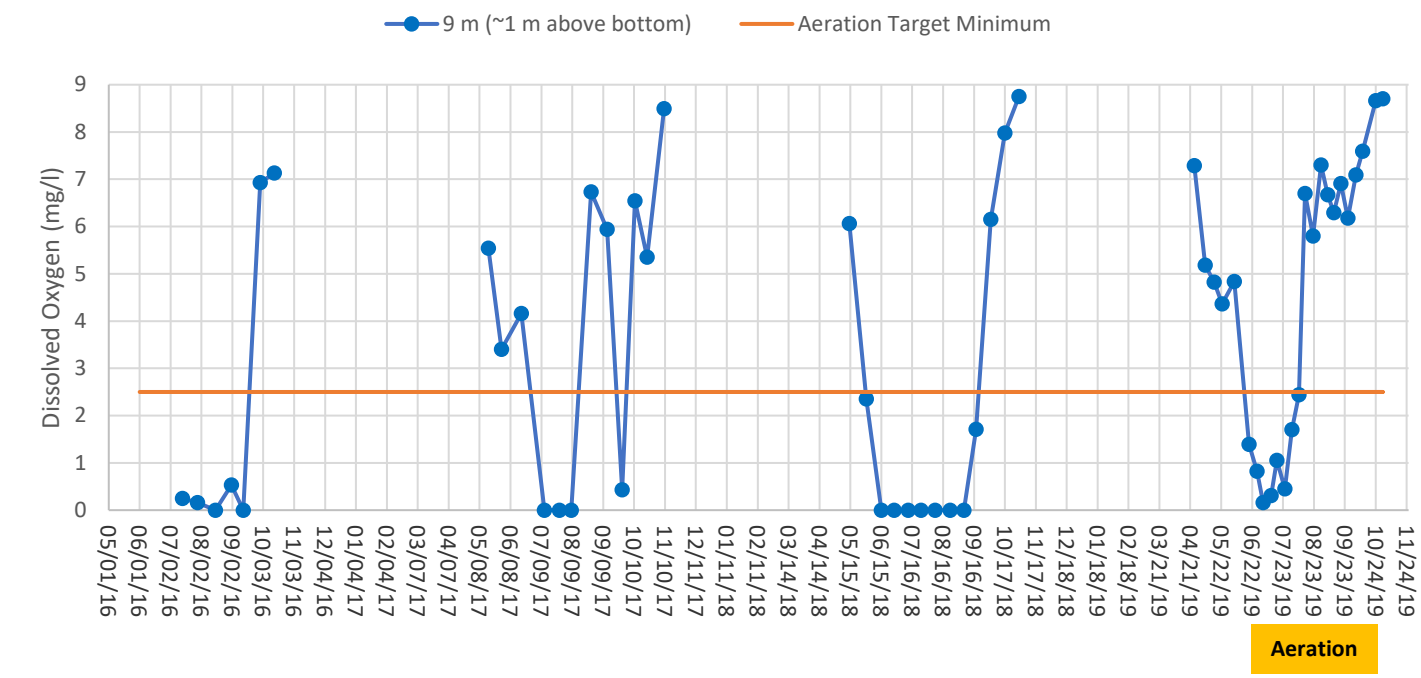

Figure 3. 2016-2019 Lake Carmi Station #1 (UVM Mid-Lake Buoy) VTDEC TMDL Monitoring
Lake Bottom Total Phosphorus

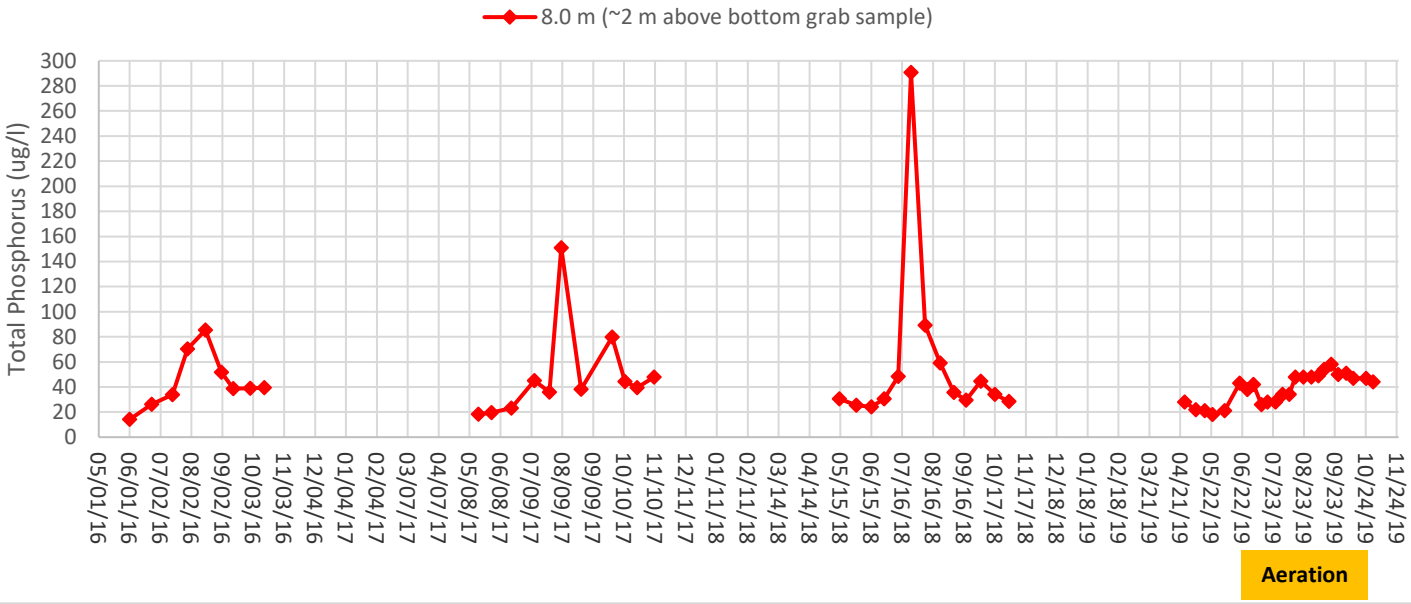

Figure 4. 2016-2019 Lake Carmi Station #1 (UVM Mid-Lake Buoy) VTDEC TMDL Monitoring
Lake Bottom Dissolved Phosphorus

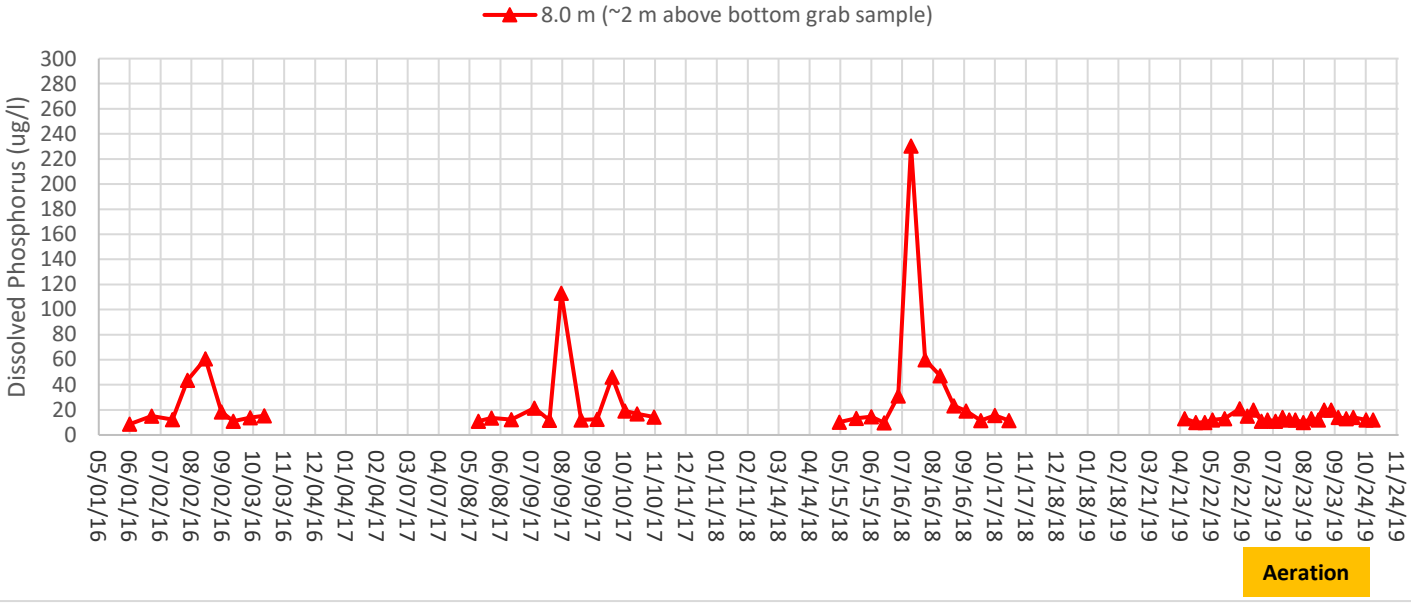

Figure 5.

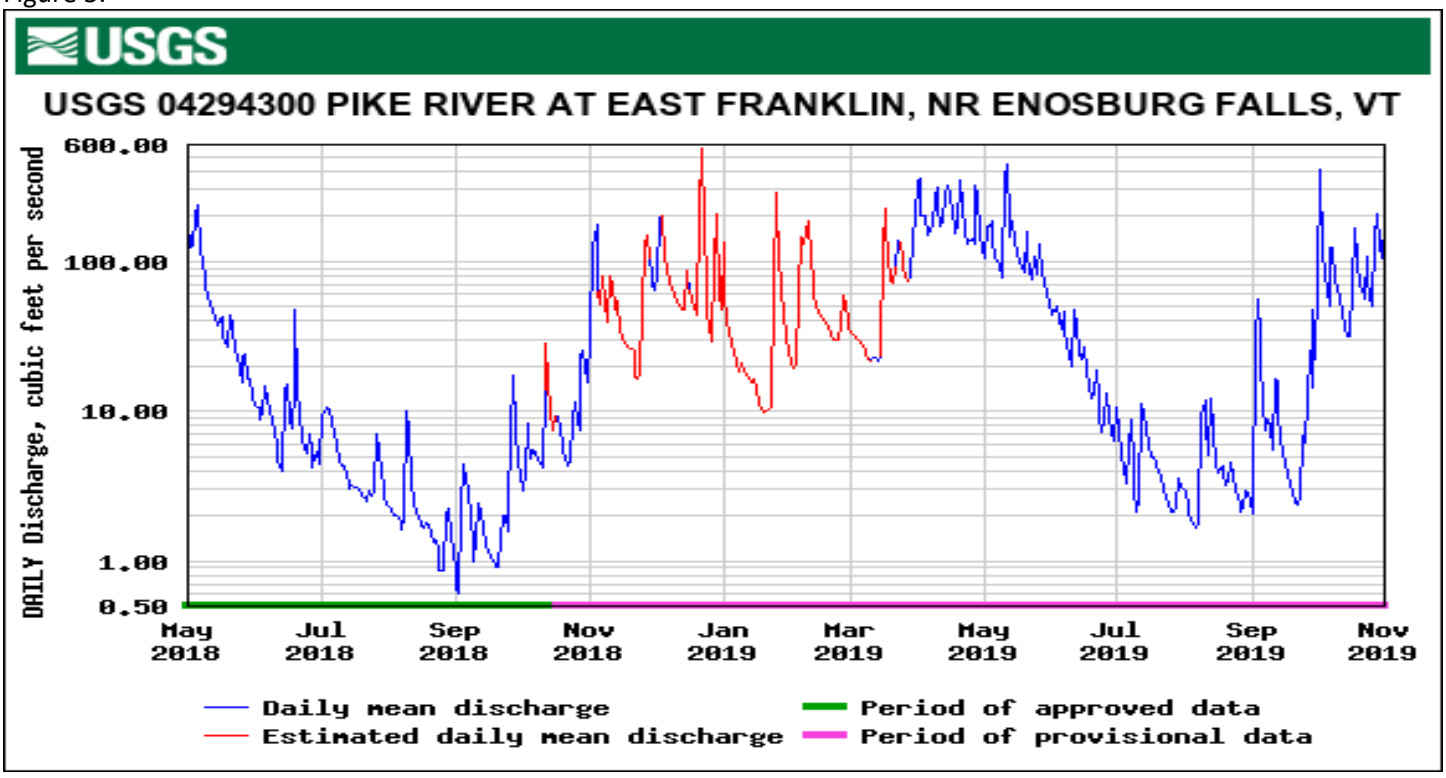

Figure 6.

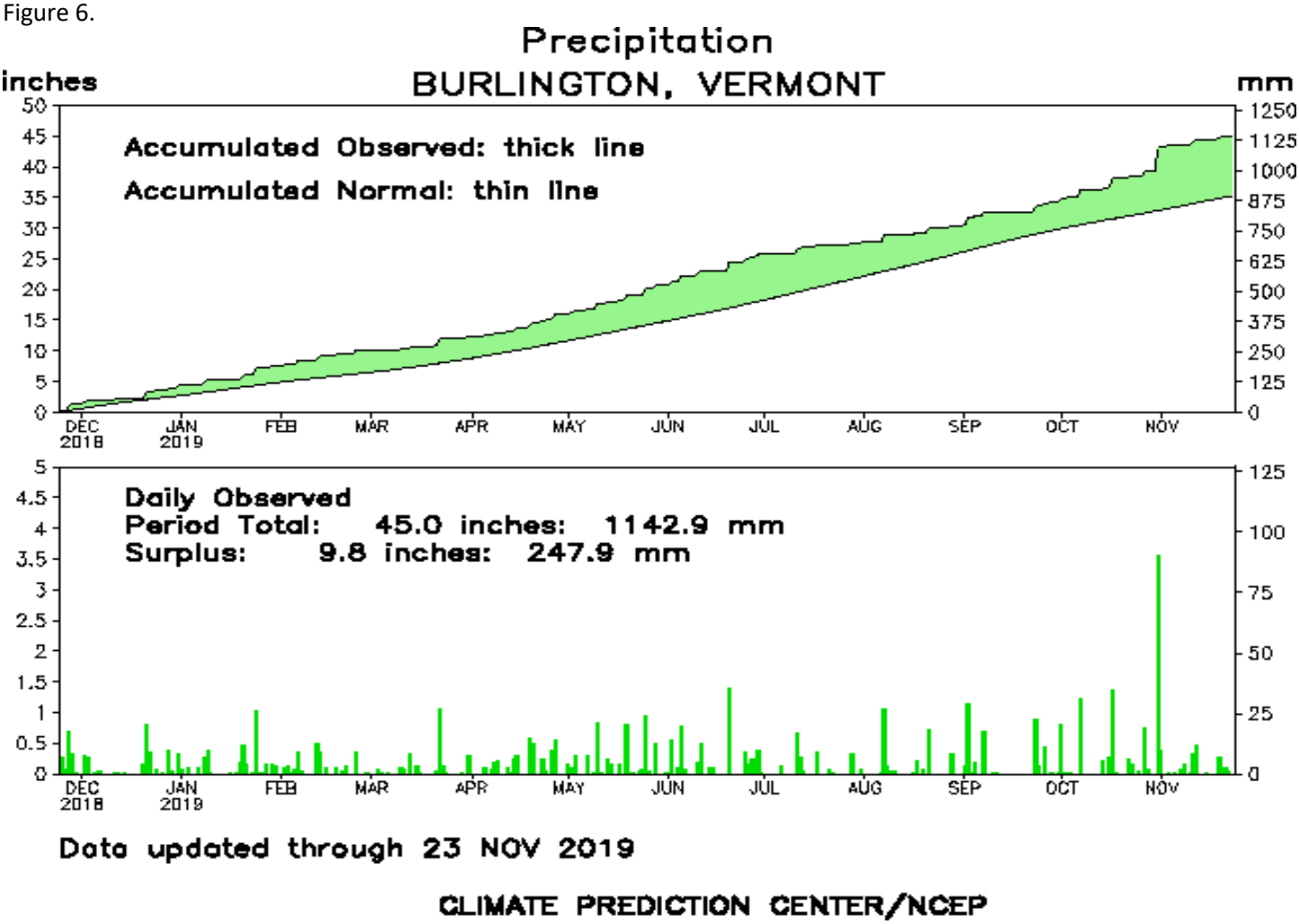

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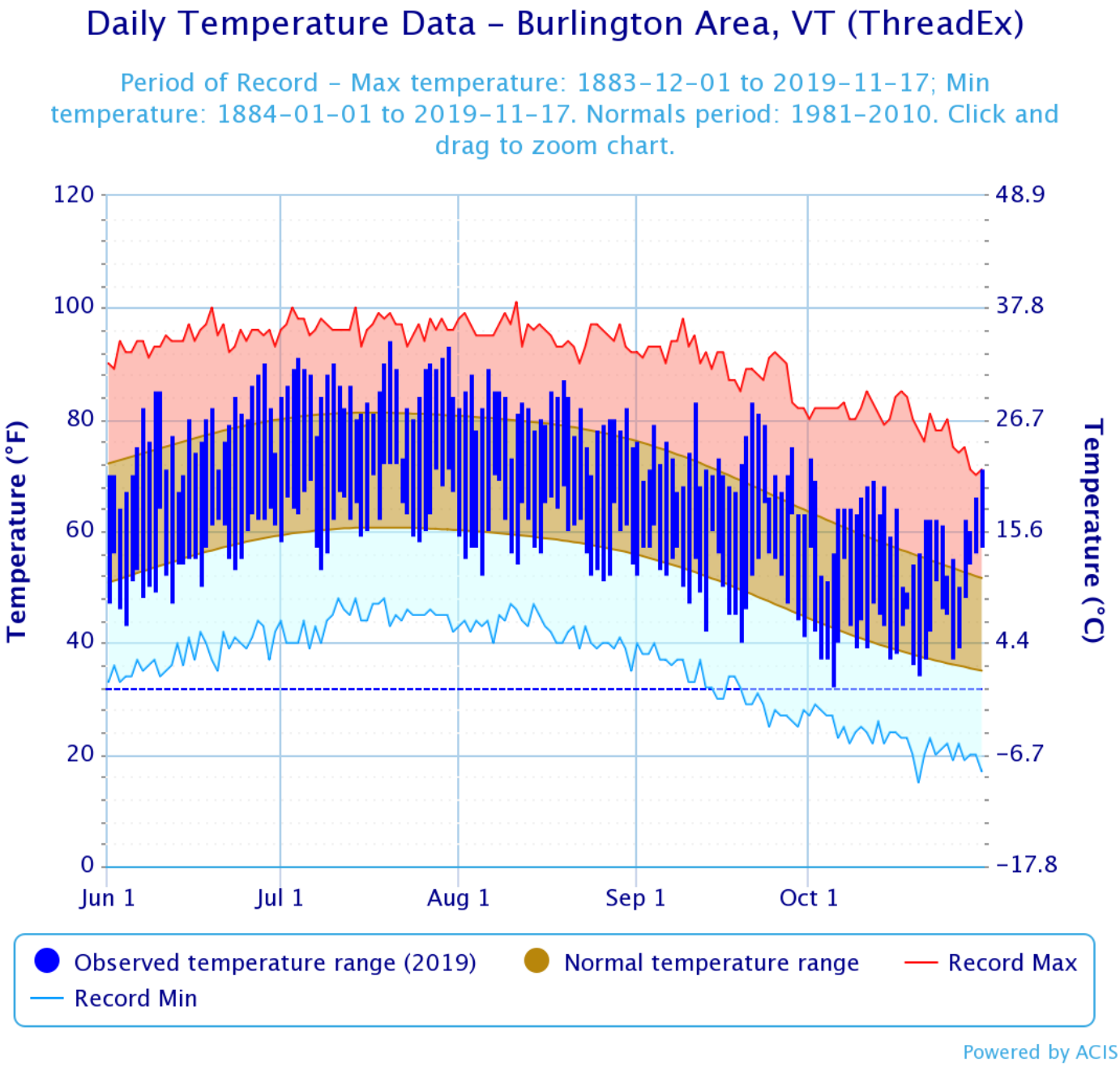
Figure 7.


Daily Temperature Data – Burlington Area, VT (ThreadEx)
Period of Record – Max temperature: 1883-12-01 to 2019-11-17; Min temperature: 1884-01-01 to 2019-11-17. Normals period: 1981-2010. Click and drag to zoom chart.
Temperature (°F)
120
100
80
60
40
20
0
Temperature (°C)
48.9
37.8
26.7
15.6
4.4
-6.7
-17.8
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Observed temperature range (2019)
Normal temperature range
Record Max
Record Min
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