

Frequently Asked Questions: June 2020

1. How does Cornell University cool the Ithaca campus?

Since the 1960s, Cornell has relied on a District Cooling System to produce and circulate chilled water to campus buildings. The chilled water is used to air condition and dehumidify classrooms, research facilities, offices, libraries, and residential spaces. Until 2000, the District Cooling System relied on electrically driven chillers to remove heat from the circulating campus chilled water. As the chillers (akin to giant air conditioners) were reaching the end of their design life in the early 1990s, scientists across the globe were raising the alarm over the effect of refrigerant chemicals on the ozone layer. Most common refrigerants are also potent greenhouse gases. Engineers on the university's utilities team began to seek an environmentally sustainable alternative for campus cooling.

Lake Source Cooling (LSC) began operation in July 2000. This system relies on a renewable resource, cold water deep within Cayuga Lake, to remove heat from the circulating campus chilled water. The process takes place at a heat exchange facility located on East Shore Drive in Ithaca. LSC draws water from Cayuga Lake at a depth of about 250 feet, where temperatures remain around 40 degrees Fahrenheit year-round. It then circulates that cold water through the shoreline heat exchange facility in non-contact cooling heat exchangers. The lake water draws heat from a closed loop of chilled water connected to the campus District Cooling System. The lake water and campus chilled water never mix. Heat drawn from campus chilled water warms the circulating Cayuga Lake water to around 50 degrees Fahrenheit. The lake water is returned to southern Cayuga Lake through an underwater diffuser designed to enhance mixing. The return water is cooler than southern Cayuga Lake in the summer and warmer in the winter.

The flow rate of lake water through the LSC facility varies with the campus demand for cooling. It is highest in the summer and lowest in the winter. On the hottest and most humid summer days, the campus District Cooling System needs to supplement LSC with chlorofluorocarbon (CFC)-free electric chillers and a thermal storage tank. Cornell currently has no plans to expand the LSC facility's design capacity in preparing for a warmer climate. Rather, Cornell's focus is on campus energy conservation measures and maximizing system efficiency.

Information on the LSC process and photos of the heat exchange facility can be found at <https://fcs.cornell.edu/departments/energy-sustainability/utilities/cooling-home/cooling-distribution/lake-source-cooling>

2. How has energy use been affected by the switch to Lake Source Cooling?

The peak summer electricity demand of the entire campus would be about 40% higher with conventional chillers instead of Lake Source Cooling. The facility reduces the need for electricity to run the campus chilled water system by about 86%, with concurrent reductions in carbon air emissions and no risk of refrigerant leaks. Since July 2000, LSC has saved an average of 25 million kilowatt-hours of electricity per year compared to previous cooling methods — enough to supply electricity continually to 2,500 homes in Tompkins County.

The Ithaca City School District is realizing savings as well. In exchange for an easement to cross school property, Cornell agreed to provide cooling for the Ithaca High School complex for the life of the project, providing more than \$1 million in long-term benefits while reducing the school's electrical energy use for cooling by 90%.

Find more details on Lake Source Cooling in [this](https://medium.com/cornell-university/lake-source-cooling-d307913dfc47) article from 2017. [<https://medium.com/cornell-university/lake-source-cooling-d307913dfc47>]

3. Does operation of Lake Source Cooling affect Cayuga Lake?

Lake Source Cooling has shown positive environmental impacts and no significant adverse effects on Cayuga Lake. Years of research, monitoring, modeling, and analysis have examined the potential effects of this innovative system. Scientists and engineers have evaluated potential effects on the lake's temperature and mixing, water chemistry, and food web. A comprehensive Environmental Impact Statement (EIS) was prepared as part of the regulatory approval process and accepted in 1997. Key sections of the EIS can be found at: <https://fcs.cornell.edu/departments/energy-sustainability/utilities/cooling-home/cooling-distribution/lake-source-cooling-home/lsc-environmental-impact-statement>

The EIS identified the transfer of phosphorus (which is naturally present in deep lake water) through the LSC facility as an issue of concern. The LSC process does not add phosphorus, or anything except heat, to the circulating lake water. While phosphorus transfer does have the potential to increase phytoplankton, the EIS calculated that any effect from LSC would be negligible. However, phosphorus has remained the central concern for regulators over the ensuing decades of permit requirements. Since the beginning of the project, Cornell has actively collaborated with the regulatory and research communities to advance our collective understanding of the role of phosphorus in the Cayuga Lake ecosystem.

The potential impacts on Cayuga Lake from water circulation through the LSC facility have been monitored since 1998, before the facility began operation in 2000. The most recent round of research, monitoring, and modeling was completed in 2016. Cornell submitted all findings to the New York State Department of Environmental Conservation (NYSDEC) and met all required deadlines. The [NYSDEC Cayuga Lake webpage](https://www.dec.ny.gov/lands/88250.html) [<https://www.dec.ny.gov/lands/88250.html>] includes links to the data and reports.

The findings of the multi-year investigations are clear. Operation of the facility and the circulation of water have had no adverse impacts on Cayuga Lake. In fact, the enhanced mixing induced by the addition of cool water drawn from deep within the lake serves to dilute sediment-laden stream water and move it off the southern shelf more quickly. After two decades of monitoring and statistical analysis, there is no evidence that phosphorus concentrations have increased due to the LSC facility. Annual water quality monitoring of Cayuga Lake will continue through the NYSDEC Citizen Statewide Lake Assessment Program (CSLAP), which is in place for more than 100 lakes, including all 11 Finger Lakes.

4. How is the Lake Source Cooling system regulated?

The New York State Department of Environmental Conservation (NYSDEC) issues permits for discharges to surface waters, including return of non-contact cooling water, through their State Pollutant Discharge Elimination System (SPDES) program. After the Environmental Impact Statement (EIS) was accepted, NYSDEC granted a permit to Cornell to operate the LSC facility. SPDES permits are regularly renewed every five years.

The permit was first issued in 1998 and included requirements for extensive monitoring and reporting to screen for any adverse impacts on the lake ecosystem. As anticipated, many of the regulatory requirements were related to detecting any adverse impacts of phosphorus transfer. The permit was renewed without substantive changes until 2013. The 2013 permit required Cornell to complete many additional studies, including mathematical models of Cayuga Lake and its watershed to identify the sources, transport, and fate of phosphorus (see FAQ #5). All the studies were completed by the end of 2016 in accordance with permit required deadlines. The permit was renewed without substantive changes in 2018 and extended the current phosphorus limit from the previous permit. In May 2020, NYSDEC issued a modified SPDES permit effective June 1, 2020.

Cornell has continually operated the LSC facility in full compliance with its SPDES permit. Monitoring data is available at <https://fcs.cornell.edu/departments/energy-sustainability/utilities/cooling-home/cooling-distribution/lake-source-cooling-monitoring-data>.

A link to the current SPDES permit, effective June 1, 2020 is here:

<https://fcs.cornell.edu/sites/default/files/2020-06/7-5099-00009%20Cornell%20LSC%20DIM%20Final%20Permit.pdf>

5. What types of monitoring and research were required by the 2013 permit conditions and what was learned?

The 2013 State Pollutant Discharge Elimination System (SPDES) permit for continued operation of the Lake Source Cooling facility required Cornell to fund and manage four complex investigations under New York State Department of Environmental Conservation (NYSDEC) oversight.

1. Develop and test a mathematical model of the watershed to simulate sources and transport of nutrients (phosphorus and nitrogen) and sediment to Cayuga Lake.
2. Develop and test a mathematical model of Cayuga Lake that predicts how lake water quality responds to nutrient and sediment inputs.

Final reports and related files for the watershed model and in-lake model prepared by the contracted researchers were submitted to NYSDEC in December 2016. NYSDEC has applied the models to evaluate the effectiveness of alternative measures to protect Cayuga Lake. These model projections will be reflected in the pending Cayuga Lake phosphorus Total Maximum Daily Load (TMDL) (see FAQ #6).

The lake and watershed modeling report is posted here:

https://www.dec.ny.gov/docs/water_pdf/clmpqapp20150115.pdf

3. Investigate the feasibility and impacts of relocating the LSC facility outfall into deeper water.

The 2013 SPDES permit required completion of a detailed Outfall Redesign Study. This multi-year, peer-reviewed study confirmed that operation of the LSC facility has no adverse impact on Cayuga Lake water quality, lake-wide or on the southern shelf. Rather, the LSC return flow has a positive impact on water quality when compared to relocating the outfall to a deeper location in the lake. The return flow of cool, clear water at the current outfall location serves to reduce water residence time (increase the flushing rate) of the shallow southern shelf. The enhanced circulation reduces the risk of phytoplankton blooms and helps to move sediment-laden stream water off the southern shelf. Extending the outfall would not improve Cayuga Lake water quality.

The 2016 Outfall Redesign Study Final Report is posted at http://www.dec.ny.gov/docs/water_pdf/cornellscoutfall4.pdf.

4. Verify that the LSC intake structure complies with all current regulations designed to protect aquatic life.

All non-contact cooling water intakes in New York state are required to monitor aquatic organisms drawn into their facility (referred to as “entrainment”) and demonstrate that their intake’s design and operation comply with Best Technology Available (BTA) standards. Fisheries scientists completed detailed field studies to sample, identify and enumerate organisms drawn through the intake screen to the LSC facility. These counts are compared with samples collected near the shore of the LSC facility. Results confirm that the current LSC facility intake design and location reduces entrainment of fish by more than 95% and thus meets BTA standards.

The final report on the LSC intake evaluation is posted at http://www.dec.ny.gov/docs/water_pdf/cornellscbta2.pdf.

6. How will regulators use the findings of these studies to manage Cayuga Lake in the future?

Since 2002, the New York State Department of Environmental Conservation (NYSDEC) has stated their intent to develop a phosphorus Total Maximum Daily Load (TMDL) for southern Cayuga Lake. A TMDL calculates the amount of a substance that can be safely added to a waterbody from all sources while protecting human health and the environment. Sources include both watershed inputs (referred to as nonpoint sources) and discharges from regulated municipal and industrial facilities (referred to as point sources).

NYSDEC required Cornell to fund development of mathematical models of the lake and watershed under their supervision as a condition of the 2013 permit renewal for the Lake Source Cooling facility. The models were provided to NYSDEC in 2016. NYSDEC will apply these modeling tools to determine the total acceptable phosphorus load to Cayuga Lake and allocate it among all the point and nonpoint sources. The draft TMDL is expected to be released for public comment in the coming months.

The TMDL will include an implementation plan, prepared by the NYSDEC and approved by the United States Environmental Protection Agency, outlining specific actions and milestones to bring phosphorus inputs from all sources to the target level.

For more information, refer to the [NYSDEC FAQ for the Cayuga Lake TMDL](https://www.dec.ny.gov/docs/water_pdf/cayugatmdlfaq.pdf).
[https://www.dec.ny.gov/docs/water_pdf/cayugatmdlfaq.pdf]

7. How does the 2020 State Pollutant Discharge Elimination (SPDES) permit for the Lake Source Cooling (LSC) facility differ from the prior permit?

The 2020 State Pollutant Discharge Elimination System (SPDES) permit for the Lake Source Cooling (LSC) facility continues to limit the lake water flow rate through the LSC facility to 2 cubic meters per second (m³/sec). This limit on daily maximum lake water flow through the facility has remained the same since the first SPDES permit was issued in 1998. The 2020 permit also continues to restrict the amount of lake water phosphorus that can be transferred from deep within the lake to 6.4 pounds per day (ppd) as a monthly average. This phosphorus limit has been in effect since 2013.

In addition to maintaining the flow and monthly load limits, the 2020 permit further restricts the amount of phosphorus transferred through the LSC facility if new buildings are connected to the District Cooling system in the future. In order to connect new buildings to the District Cooling system, Cornell will be required to calculate the additional volume of water circulated through the LSC facility to serve the new building, estimate the amount of phosphorus associated with that additional water volume, and implement a Best Management Practice (BMP) designed to limit an equivalent amount of external phosphorus from entering the lake ecosystem. This permit condition is referred to as a “phosphorus offset.” Moreover, any phosphorus offset must offer a 2:1 reduction. That is, for each additional pound of phosphorus circulated through the LSC facility above permit baseline conditions, Cornell will be responsible for implementing a BMP within the lake watershed that will reduce the external phosphorus load by 2 pounds. The United States Environmental Protection Agency regularly uses this standard 2:1 requirement to account for uncertainty in the estimated effectiveness of proposed BMPs.

8. Are phosphorus offset programs included in other State Pollutant Discharge Elimination (SPDES) permits?

Phosphorus offset programs are included in certain State Pollutant Discharge Elimination System (SPDES) permits to allow flexibility for future growth and adaptation to changing conditions. For example, a portion of New York lies within the Chesapeake Bay watershed. There are TMDL allocations for phosphorus, nitrogen, and sediment in place across the multi-state watershed that ultimately flows into the bay. The option of offset programs enables permit holders within the watershed to increase their discharges beyond the allocation set in the TMDL if a corresponding reduction can be demonstrated. These offsets require review and approval by the United States Environmental Protection

Agency. To our knowledge, the 2020 Lake Source Cooling SPDES permit includes the first formal inclusion of a phosphorus offset program in the Finger Lakes region.

9. Will Cornell continue to be involved in Cayuga Lake and watershed issues?

Yes. Cornell will continue to partner with New York state and federal agencies and engage our students, faculty, researchers, and extension specialists in finding effective solutions to water quality and environmental challenges. Cornell will also remain an active participant in community organizations involved with implementing the recommendations of the Cayuga Lake Restoration and Protection Plan. The university will continue to make data gathered as part of the Lake Source Cooling permit requirements available. Lake water quality data collected since 1998 is publicly available and represents a valuable long-term data set. Link to data: <https://fcs.cornell.edu/departments/energy-sustainability/utilities/cooling-home/cooling-distribution/lake-source-cooling-monitoring-data>

In 2006, the Cayuga Lake Monitoring Partnership, a group of local water quality professionals and other stakeholders, began developing a plan for tracking water quality in southern Cayuga Lake. Since completing the plan in 2008, the Monitoring Partnership has transitioned into a forum for agencies and organizations monitoring Cayuga Lake and its watershed to share their findings and explore opportunities for collaboration. The Monitoring Partnership served on the Technical Advisory Committee to the New York State Department of Environmental Conservation during development of the lake and watershed models. We anticipate that the Monitoring Partnership will remain active and that Cornell faculty and staff will continue to participate.

The NYS Water Resources Institute (WRI), housed in Riley-Robb Hall in the College of Agriculture and Life Sciences, will serve as the hub for future collaboration on watershed management programs and projects. Leaders of the WRI have begun identifying partnerships and initiatives designed to improve lake and watershed management across the Finger Lakes and New York state. Cornell looks forward to continued collaboration between the New York state resource management agencies and our faculty, students, researchers, and extension specialists.

10. How will the 2020 State Pollutant Discharge Elimination System (SPDES) permit affect Cornell's commitment to a carbon neutral campus?

Cornell remains fully committed to maximizing the use of renewable resources. The Lake Source Cooling facility is a cornerstone of our commitment to energy efficiency and climate mitigation. Moving from a fossil-fuel based system to this renewable resource was a major step toward meeting Cornell's energy and climate goals and has reduced energy used for cooling the Ithaca campus by around 86%.

The phosphorus offset program included in the 2020 SPDES permit (see FAQ #7) provides an opportunity to reduce the external phosphorus load to Cayuga Lake while not curtailing the future use of the LSC

facility. NYSDEC and other resource management agencies recognize the value of continued operation of the LSC facility and have stated a shared commitment to meeting the aggressive climate goals of New York, Tompkins County, and the City of Ithaca as well as Cornell University. We anticipate that NYSDEC will continue to work with Cornell in a collaborative manner in the decades ahead.

Cornell's Climate Action Plan is available at <https://sustainablecampus.cornell.edu/our-leadership/cap>.