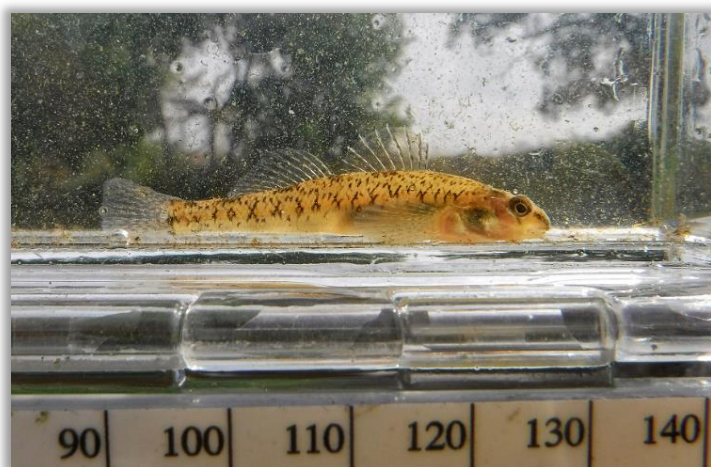




Thermal Pollution and Temperature Standards

In 2007, the Colorado Water Quality Control Commission adopted statewide temperature standards for both cold and warm water systems based on the protection of aquatic life (fish and macroinvertebrates). In order to assess attainment of the adopted temperatures standards, Metro District staff has maintained hourly temperature loggers in both the Robert W. Hite Treatment Facility (RWHTF) and the Northern Treatment Plant (NTP) final effluents and at various South Platte River locations upstream and downstream of the effluent discharges.

During the winter months (December – February), the RWHTF final effluent is about four degrees Celsius warmer than the chronic stream standard, resulting in regular exceedances of the instream temperature standard as far as seven miles downstream at 104th Avenue. Many of these exceedances occur during the abrupt transition to the wintertime temperature standards in early December. Currently, there are no exceedances of the instream temperature standards downstream of the NTP outfall.



Johnny darter (Etheostoma nigrum) collected during a Metro District fish survey along the South Platte River in Brighton



Outfall area at RWHTF, where treated wastewater (effluent) is returned to the South Platte River

The Warm Stream Tier I winter temperature standards assigned to this portion of the South Platte River are based on the presence of the Johnny darter, a small native fish found in shallow water throughout North America east of the Rocky Mountains. The South Platte River basin is on the far western edge of their native range. Metro District fish surveys have demonstrated Johnny darters are not abundant in the mainstem and are more likely to be present in shallow, sandy-bottom tributaries.

The Johnny darter is considered the most thermally sensitive fish in this river segment and the winter stream standards have been developed to protect this species. Past studies supported by the Metro District have shown elevated winter water temperatures common in effluent-dominated streams can promote out-of-season spawning in Johnny darter populations and contribute to reduced reproductive success in the spring. Future research will focus on assessing what is the most appropriate chronic winter season temperature standard needed to protect these thermally sensitive fish populations.

Temperature Standards and the Johnny Darter

The Metro District has an extensive history of working with temperature standards. Prior to the adoption of statewide temperature standards in 2007, a stakeholder process resulted in tiered criteria based on the most sensitive fish species in warm and cold waters in Colorado.

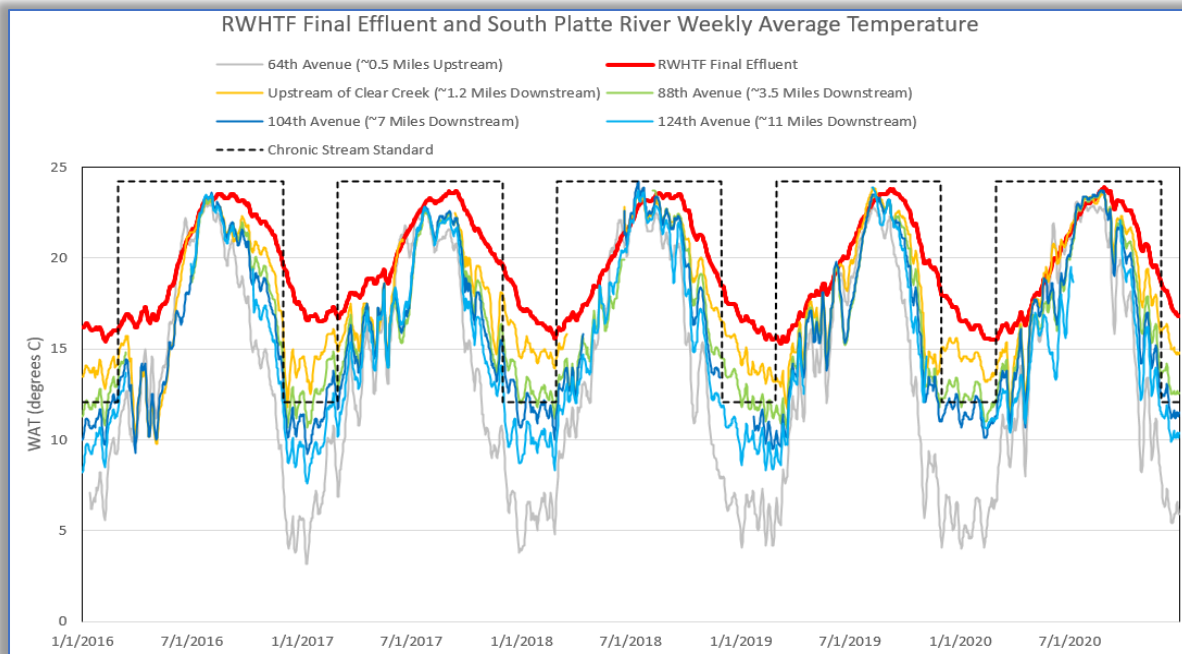
Due to the presence of the Johnny darter, Warm Water Tier I standards were placed on Segment 15 during the initial Regulation 38 hearing after the adoption of the standards. During the hearing process, the Metro District requested a site-specific standard be placed on Segment 15. However, after many discussions with the regulatory agencies, the proposal was not deemed appropriate, and it was agreed a temporary modification would provide time for the District to perform additional studies to determine an appropriate temperature standard for the segment.

After collecting continuous temperature data, modeling temperature, and evaluating what factors influence the river temperatures in the segment in 2009, Metro District staff made a second attempt to institute a site-specific standard for Segment 15. Again, the regulatory agencies still felt there was more work needed to be done and the temporary modification was extended. Based on feedback from the regulatory agencies, staff determined a better understanding of the Johnny darter's thermal tolerance was needed.

Metro District staff entered into a contract with the University of Wyoming to study the thermal tolerances of Johnny darters collected from the South Platte River near Denver. Completed in 2016, results indicated it was possible the current standard was potentially not low enough. Based on the results of this study, the District started evaluating other regulatory alternatives to address the temperature issue and this is when the Discharger Specific Variance (DSV) effort began.

Season	Maximum Weekly Average Temperature (Chronic)	Daily Maximum Temperature (Acute)
March–November	24.2°C	29.0°C
December–February	12.1°C	24.6°C

Top right: South Platte River Segment 15 Temperature Standards



Bottom Right: Rolling weekly average temperatures at the RWHTF final effluent and various monitoring locations along the South Platte River

What are we Doing?

Both RWHTF and NTP have compliance schedules for temperature which expire at the beginning of 2030 and 2026, respectively. Ahead of these deadlines, the Metro District has taken a multi-pronged approach to lessen the extent and impact of thermal pollution, initially focusing on RWHTF since the South Platte River currently exceeds the chronic standard in the winter months downstream of the outfall.

One approach the Metro District has taken is to improve aquatic habitat and promote mixing of the river and tributaries. In 2019, the District completed construction of PAR 1323 (South Platte River Instream Temperature Habitat Improvements). This project involved the construction of two riffles (rocky or shallow part of stream or river with rough water), six spur dikes (elongated structure with one end anchored to the shore and the other jutting into the current), a hardened channel bar (spit of land in middle of stream or river), backwater pool (water held back by a dam or other obstruction), bank stabilization and the repair of a grade control structure. These improvements were designed to more rapidly mix the relatively warm South Platte River water with cooler Clear Creek water in order to create a more consistent thermal environment for aquatic life, increase heat dissipation, and lower overall instream temperatures downstream of the confluence. Preliminary monitoring results from before and after construction demonstrate these habitat improvements are achieving the goal of more efficient instream thermal mixing while also providing important and diverse microhabitats preferred by the native fish of the South Platte River.

Climate change presents an additional challenge to reducing overall stream temperatures in Segment 15. Most climate change projections for the South Platte basin predict reductions in the annual average streamflow and increases in stream temperature (1,2). Given these projections, the potential warming and declines of upstream and tributary streamflows could serve to counteract temperature reduction efforts undertaken by the Metro District.



*Top: Constructed riffle at South Platte/Clear Creek confluence, part of PAR 1323 project to improve thermal mixing and diversify fish habitat.
Below: Repaired grade control structure.*

The Metro District has been actively engaging in additional environmentally sustainable efforts specifically targeted at reducing thermal pollution of the effluent. Sewer heat recovery systems can reduce the thermal load of wastewater discharge and reduce energy use in residential areas by providing a sustainable means of heating water and cooling in buildings. The National Western Center (NWC) is currently undergoing major redevelopment and has offered an opportunity to incorporate sewer heat recovery as a sustainable approach to heating and cooling of the development, assisting with the development goal of achieving a net-zero energy landscape.

1. Woodbury, M., M. Baldo, D. Yates and L. Kaatz (2012). [Joint Front Range Climate Change Vulnerability Study](#).

2. [Colorado Climate Change Vulnerability Study: A Report by the University of Colorado Boulder and Colorado State University to the Colorado Energy Office](#) (2015).



Jordan Parman (Water Quality Scientist) deploying temperature loggers in the South Platte River at Fort Lupton

The basis of the NWC campus energy design was to install a sewer heat recovery system which uses the water in the Delgany (DG) Interceptor as a thermal source and sink. The system will use a heat pump to transfer heat from the DG Interceptor to a hot water loop which will supply heat to the NWC to meet building demands in the winter and will provide cooling by transferring heat from the buildings to the DG Interceptor as a sink in the summer. The initial phase of the system is designed to recover four megawatts (MW) of thermal energy. Future expansions may meet heating demands of up to 12 MW. It is anticipated the initial phase will provide cooling of the RWHTF effluent temperature by 0.11°C, while the expansion would cool the influent by as much as 0.23°C.

Construction of a new Operations Services and Controls Building (OSCB) at RWHTF was completed in February 2021. The design of the OSCB includes the incorporation of a heat recovery system, which uses a water-to-water heat pump to transfer heat from a portion of the secondary effluent to the OSCB's hot water supply loop. The heat pump will meet building heat demands for an estimated 70 percent of the time and will additionally be capable of providing cooling service during summer months by using the wastewater as a heat sink.

The portion of the secondary effluent used for heat recovery in this installation is very small compared to the total secondary effluent flow, and it is not anticipated the Metro District will measure an impact to the effluent temperature at this time.

The Metro District is implementing the small-scale heat recovery system in the OSCB to assess the potential to apply this technology to the current on-site heating needs as well as additional support buildings currently planned for construction and to offer an on-site demonstration for education.

The Metro District is also investigating more traditional cooling technologies. This work has been ongoing at RWHTF where these potential solutions present several challenges due to space constraints, potentially challenging water quality, and need to align infrastructure with future tertiary treatment. Cooling towers and chillers are potentially feasible but require additional analysis; a pilot of cooling tower technologies is anticipated for winter 2021 to better inform analysis. These technologies are expensive, energy intensive, and have significantly larger carbon footprints when compared to solutions which include heat recovery. At NTP – which has available land, tertiary treatment, and less significant thermal loading – cooling towers may be a viable option, but staff is also investigating low-tech and cost spray ponds.

Future Efforts

The technical investigation of cooling alternatives at NTP is anticipated to be complete by the fourth quarter of 2021. At which time, the Metro District anticipates initiating a project to ensure compliance by the end of the schedule. The technical and environmental feasibility analysis at RWHTF is anticipated to be complete in the second quarter of 2022. Due to the proximity of interceptors which feed RWHTF to new developments and the technical and environmental challenges of installing cooling technologies in that location, District staff will continue to work on the development of on- and off-site heat recovery projects which offer a sustainable solution to thermal pollution while providing environmental benefit. A modest estimate of potential heat recovery projects would result in a 1.13 °C reduction in temperature at of the effluent while offering a nearly 400,000 metric tons of CO₂-equivalent emissions reduction over a 25-year timespan. This development will include outreach to developers, regulators, partner utilities, and local officials in order to spread awareness and interest.

The Emerging Issues report highlights important regulatory topics impacting the Metro District and beyond. Contact Jennifer Robinett at jrobinett@mwr.dst.co.us for more information.