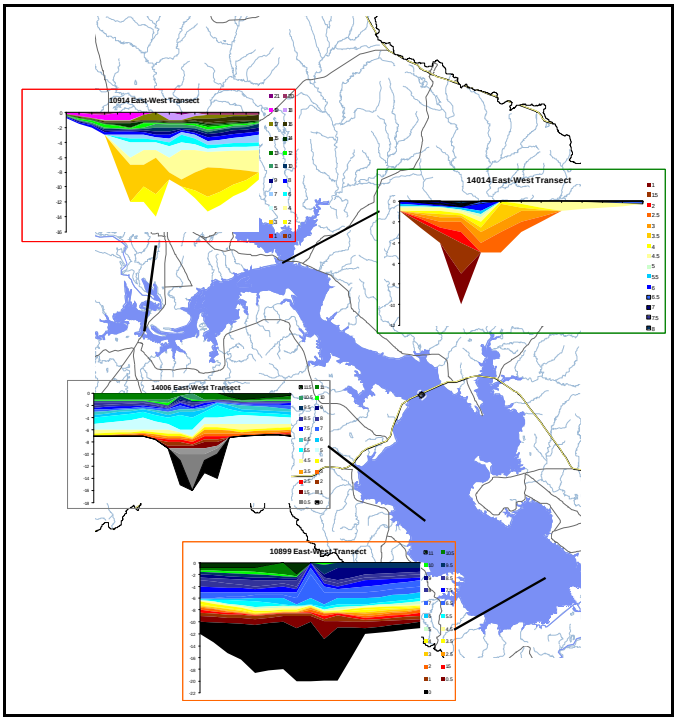
SPECIAL STUDIES

Special studies are short term intensive investigations into specific topics or areas of concern. These can be initiated by steering committee suggestions, in response to data analysis, or as a precursor to a TMDL. These studies are made possible by money that is saved due to coordinated monitoring efforts with WBPAs. In 2004, the five studies that were begun in 2003 were continued or completed. These studies and results are discussed on the following pages

LAKE LIVINGSTON DIURNAL DISSOLVED OXYGEN

Lake Livingston is located in the southern portion of the Trinity River basin approximately 70 miles north and east of downtown Houston. The lake is an on-channel reservoir that receives drainage from much of the basin's 18,000 square miles. In 1998, the State's first 303(d) list-a list which identifies waterbodies suspected of having water quality impairments-was prepared. On that list, Lake Livingston was identified as failing to support aquatic life due to low concentrations of dissolved oxygen. In 1999, the Trinity River Authority's Lake Livingston Project personnel began measuring dissolved oxygen concentrations over periods of 24 hours in order to confirm the suspected impairment. Data collection on dissolved oxygen concentrations has continued in this fashion off and on since that time, and although subsequent assessments have been performed, the lake has remained on the list.



During the course of the Livingston DO study, information was gathered concerning the spatial variability of oxygen concentrations. The graphs above depict oxygen concentration gradients at four sites within the reservoir. As expected, oxygen concentrations decreased with depth, but at most stations did not change significantly along surface transects.

Because the lake receives heavy nutrient loadings from both point and non-point sources, there has been concern that algal respiration is drawing down oxygen concentrations and potentially harming aquatic life. Based upon the diurnal data collected between April of 1999 and June of 2003, this does not appear to be the case. In fact at only one site, 10914 near Riverside in the lake's headwaters, were DO concentrations observed below the established criterion. At that location the violation appears to be related to high flow events that are suspected of washing large amounts of oxygen-consuming substances into the lake. Additional data collection and/or examination will need to be undertaken in order to confirm this conclusion.

Algal photosynthesis does, however, appear to be driving pH values above the criterion of 9.0SU. There is no evidence to suggest that these elevated levels of pH are causing any actual use impairments (e.g. affecting the lake's fish population). A recently completed TRA CRP study focusing on links between nutrient concentrations and use support examined Texas Parks and Wildlife Department fisheries data, and concluded that the reservoir appears to be supporting an appropriate fishery. Routine monitoring on the reservoir will continue, and data will be examined to determine if the frequency and severity of pH values increases. In addition, four of the eight areas on the reservoir, noted in the most recent water quality assessment as having potential impairments due to suppressed DO concentrations, now have enough data to allow them to be reassessed. Work will continue on the remaining sites until such time as these portions of the reservoir can be reassessed.

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INVESTIGATING THE SEASONAL EFFECTS OF MUNICIPAL WASTEWATER DISCHARGES ON SMALL RECEIVING STREAMS

The vast majority of streams into which municipal wastewater is discharged are small. Due to the semi-arid conditions of North-Central Texas, these streams provide little in-stream water for dilution. This situation is particularly acute during the region's long hot summer months. It is at this time when flows typically reach their lowest levels. Simultaneously, temperatures soar, reducing the solubility of oxygen in water. With this combination of low flows and high temperatures, oxygen levels often plummet. It is believed that this is caused by a combination of heat induced low oxygen solubility and the respiration (a process that consumes oxygen) of bacteria as they feed on ubiquitous organic material present in the water and stream sediments, such as leaves, grass clippings, etc. In higher flows, oxygen removed through the respiration process is replenished as the turbulent water tumbles along the stream bed. During periods of low flow, however, the water becomes more quiescent, and reaeration must occur through the slow process of diffusion. This deadly combination creates a critical situation for aquatic organisms such as fish and insects.

It has long been held that the effects of municipal discharges on small receiving streams is most detrimental during this critical, summer period. This fact is intuitive, since municipal discharges are typically rich in organic substances upon which bacteria can feed (i.e. respire), consuming the precious little oxygen that remains in the stream. Observations in the Clear Fork and elsewhere, however, indicate that in lieu of reducing oxygen concentrations, municipal discharges into receiving streams with extremely low summertime flows actually increase oxygen concentrations. It is believed that this is a result of the increased volume and thus velocity caused by the additional water. It is hypothesized that the increased velocities cause the stream to become more turbulent, thus increasing reaeration rates. These observations and logical deductions begat the question of whether the addition of municipal discharges could actually be providing seasonal habitat that would not otherwise exist, and therefore work to the advantage of aquatic organisms. Or, alternatively, does the poorer water quality of the reclaimed water, despite the observed increases in dissolved oxygen, worsen an already desperate situation. The study here discussed was designed to provide insight into those questions. The upper Elm Fork was selected due to its seasonal low flows, known high-value habitat and chain of two municipal discharges. Because this section of the river had been noted by the TCEQ as having elevated concentrations of chlorophyll-*a*, nutrients and bacteria, along with depressed dissolved oxygen, a secondary objective was to evaluate these concerns.

To accomplish the objectives of this study, four sampling sites were identified and reconnoitered. The sites were situated above, between and below the outfalls of the cities of Lindsay and Gainesville. Lindsay, the furthest discharger upstream within the study area, is a small plant with a permitted discharge of 0.066 MGD. The city of Gainesville's discharge is substantially larger, with

Photograph of reclaimed water from the Lindsay wastewater treatment plant.

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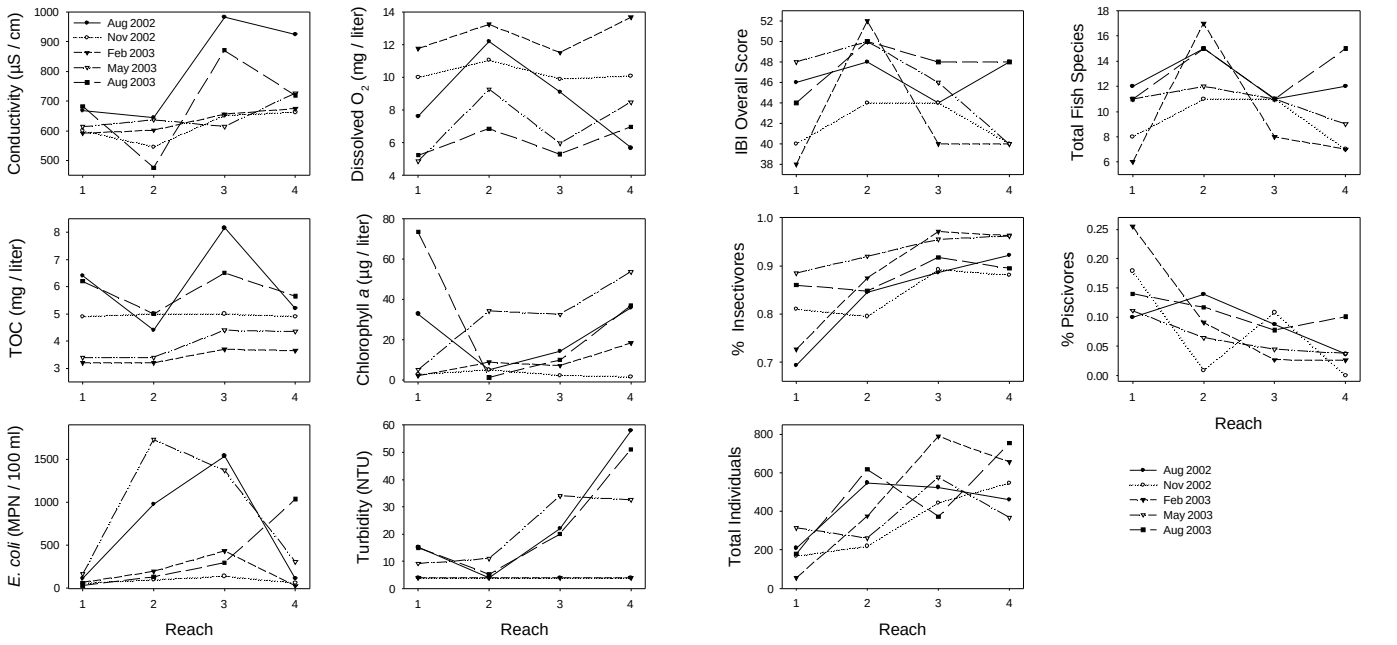
a permitted discharge of 4 MGD. Data were collected on water quality conditions, benthic macroinvertebrates and fish community structures as well as habitat.

Results indicated that the Lindsay discharge is not impacting water quality or aquatic life. Although the small size of this plant makes this observation plausible, it was believed that the minimal summertime low flows would not provide sufficient dilution to mask the affects of the plant, particularly on water quality. The Gainesville discharge, however, was found to be impacting water quality. This impact was most notable in elevated concentrations of nutrients during periods of low flow.

Although general measures of fish community health (i.e. IBI scores) did not exhibit any uniform temporal or spatial trends, three other measures (total number of individuals, percent insectivores and percent piscivores) did. The total number of individual fish tended to increase in a downstream fashion, as did the percent of fish that were insectivores. The number of piscivorous fish however, decreased downstream. While the increase in individuals with increasing hydrologic order might be expected, the latter two are somewhat surprising. Regardless of these trends, there does not appear to be any obvious relationships between fish communities and the municipal discharges. This conclusion also held true for benthic macroinvertebrates communities, which did not appear to be significantly affected by the discharges.

Despite pre-sampling reconnaissance, conditions along the study reach were different than anticipated. Specifically, summertime base flows were greater than expected, and only two sites were ever effluent dominated, and then only on one occasion. These higher than expected flows meant that the impact of the discharges, either positive, negative or a combination of both, were somewhat muted. Nevertheless, the data did not indicate that the affects of the discharges on the biology of the Elm Fork differed from season to season. Impacts on water chemistry did vary seasonally, and were most pronounced during the lower summertime flows. In regards to the concerns noted by the TCEQ, only concentrations of bacteria (i.e. *E. coli*), were found to be in violation of the segment's stream standards. The source of the bacteria is believed to be agricultural as cattle and cattle dung were observed in the river on numerous occasions, and warrants further investigation.



Results of fish community surveys and water quality sampling on the Elm Fork. Reach 1 is above all point sources. Reach 2 is below the city of Lindsay discharge but above the city of Gainesville's. Reach 3 is located a short distance below the Gainesville discharge. Reach 4 is located further down stream and reflects the cumulative impacts of the discharges while avoiding immediate, detrimental affects from the plants.