EXHIBIT F

THERMAL PLUME SURVEYS ON THE LOWER DES PLAINES RIVER NEAR JOLIET STATIONS JUNE-SEPTEMBER 2002

Part 1 of 2

MIDWEST GENERATION EME, LLC
An EDISON INTERNATIONAL™ Company

Basil G. Constantelos
Director, Environmental, Health & Safety

VIA OVERNIGHT DELIVERY

February 25, 2003

Mr. Toby Frevert
Great Lakes Coordinator
Illinois Environmental Protection Agency
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Mr. James Filippini
Deputy Branch Chief
NPDES Programs Branch
Water Division, WN 16J
United States Environmental Protection Agency
77 W. Jackson Blvd.
Chicago, Illinois 60604-3590

Subject: Thermal Plume Study Report for Midwest Generation's Joliet Generating Stations 9 and 29

Dear Mr. Frevert and Mr. Filippini:

Enclosed for your review is a report prepared by EA Engineering, Science and Technology, Inc. ("EA") on the results of the thermal studies that Midwest Generation EME, LLC ("MWGen") commissioned during the summer of 2002 in the vicinity of the Joliet Station 9 and 29 discharges (the "EA" Thermal Studies Report"). The purpose was to study and gather additional information concerning the Joliet Stations' compliance with the existing Secondary Contact thermal water quality standards, as well as to test the validity and suitability of the near-field thermal compliance model that has been developed by MWGen for use in monitoring its compliance with the thermal water quality standards. A total of 8 individual studies were done from June through September, 2002, which is the time period coinciding with the highest expected river temperatures and lower river flows. EA collected surface thermal plume measurements on all 8 of the study dates, and conducted full three-dimensional thermal monitoring on 4 of the 8 dates. A summary table of all of the study results (see attached Table 1) is also enclosed to assist in your review of the EA Thermal Studies Report.

The results and findings based on the data gathered and analyzed from the thermal studies are consistent with the information we have previously presented to both U.S. EPA and the Illinois EPA. The key results and findings are:

1. The Joliet Stations' thermal plumes do not interact. Any interaction between the two plumes occurs after thermal water quality standards are attained. Thus, each of the Joliet Stations is entitled to a thermal mixing zone.

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2. Consistent with 35 Ill.Adm.Code § 302.102(b)(6) and (10), a zone of passage for aquatic life is maintained by the Joliet Stations' discharges and their associated allowed mixing zones. The Joliet Stations' current discharges are not using the entire flow of the river for mixing. These findings are consistent with the results of past thermal discharge studies of the Joliet Stations.

3. The Joliet Stations' discharges do not result in acutely lethal temperatures in the main body of the river. There were no temperatures in excess of 100 °F outside of the immediate discharge canal at either Joliet station.

4. With regard to the requirements of 35 Ill.Adm.Code § 302.102(b)(9), the thermal water quality standards are not already violated in the receiving water. There were no instances where the measured upstream temperature in the waterway exceeded either 93 °F or 100 °F. (Compliance monitoring data indicates that the maximum upstream water temperature over the past seven years has been consistently below the thermal water quality standards.)

5. Judicious use of Joliet 29's cooling towers, as well as unit deratings, when required, will ensure that both near and far-field thermal limits will continue to be maintained.

The EA Thermal Studies Report also includes information comparing the actual in-stream thermal measurements to the results of MWGen's proposed model for assessing near-field thermal compliance. The comparison shows that the near-field model is able to calculate the "fully mixed" river temperature downstream of the Joliet Stations conservatively to within 1° F of the actual, field-measured values.

Specifically, in Table 2 (see attached), the first column (average measured river temperature at the 7000 ft. transect) shows the actual field measurements taken during the thermal study, while the next two columns show the MWGen model-calculated "fully mixed" river temperature for the same time period that the field measurements were made, using both 25% and 50% dilution ratios, respectively. Comparison of these values for a given day/time period confirms that on 5 of the study dates, the actual versus modeled temperature is essentially identical; on the remainder of the 3 study dates, the model estimates are conservative by approx. 1° F or more (i.e. the actual water temperatures were lower than that projected by the model by 1° F or more).

Since the downstream-most field measurements (essentially equivalent to the "fully mixed" river temperatures) are all correlated with surface thermal plumes of less than 26 acres (with the exception of one date when the Joliet 29 plume was 27.4 acres), the results of this thermal plume monitoring study confirm the validity of the calculations used in MWGen's near-field model.

These results further support the suitability and reliability of the proposed Midwest Generation model for use as a means of documenting compliance with the applicable thermal water quality standards in the main body of the river. Although a surface thermal plume measurement of 27.4 acres for water in excess of the 93 ° F standard was calculated for one of the eight study days, MWGen was in compliance with the applicable thermal water quality standards on this date because it used a portion of the allowed excursion hours under the water quality thermal standards.

The correlation between the model results and the extent of the surface plume extent, with relation to the use of excursion hours, is much better than the correlation solely with the corresponding cross-sectional area measurements. The underlying reasons are likely due to the unavoidable river characteristics that prevent capturing the actual plume dimensions at a particular point in time. As more fully explained in the EA Thermal Studies Report, (see Section 4.2), the fact that this particular waterway is almost entirely artificially controlled by upstream lock and dams, with large and frequent changes in flow rate, makes it extremely difficult to capture and assimilate all of the changing variables that alter the morphology of the sub-surface plume at any given time and location into a precise model output that estimates temperature distributions in any given cross-sectional area of the waterway. The surface plumes are also transient in nature, but are better able to be mapped when temperature measurements are taken in a down-stream direction (as was done for this study), following the same segment of river flow as it moves downstream. The vertical survey data collected during the three-dimensional studies is likely skewed by the fact that the measurements were taken after completing the downstream surface measurements and moving back in an upstream direction. The additional lapse in time and upstream direction necessary to complete the vertical measurements results in the collection of vertical temperature data encompassing several different combinations of flow, discharge temperature and physical river channel configurations. Assimilation of all of this transient data taken over the course of several hours into a single cross-sectional area measurement is by necessity an extrapolation of the plume's constantly changing characteristics rather than an actual depiction of the plume at a given moment in time.

In any case, it has been definitely shown that the discharges from the Joliet Stations do not cause or contribute to temperatures in excess of 100° F anywhere in the river. Outside of the immediate discharge canal at the Joliet Stations, neither Joliet Station utilized any of the main body of the river for mixing purposes to comply with the 100 ° F thermal water quality standard. Further, for the 93 ° F thermal water quality standard, there is always a zone of passage present in the river. In addition, our on-going fisheries studies confirm that comparable fish assemblages are present both upstream and downstream of the stations and their movement is not precluded by the thermal discharges from either station. Since the zone of passage requirement strictly relates to the ability of mobile aquatic organisms to avoid the thermal discharge, if needed, the data collected by this study confirms that there is always an adequate proportion of the water column in which cooler temperatures exist.

However, given the unique flow regime characteristics of this lock and dam-controlled waterway, we could not measure for any given moment in time the specific percentage of the river volume that was below the 93 ° F thermal water quality standard. Admittedly, this is a very complex issue that cannot be accurately modeled or measured on a real-time basis in this particular waterway. Yet, given the standards' allowance for excursion hours, and the performance of this study during the warm weather months, it is also reasonable to conclude from the data that the Joliet Station discharges do not exceed the allowed excursion hours for the 93 ° F thermal water quality standard.

Despite certain inherent limitations, as described above, the information and data contained in this report represents MWGen's best effort to characterize the physical extent of the Joliet Stations' thermal discharges and how they are distributed in the main body of the lower Des Plaines River. The field data confirm the validity and accuracy of the proposed near-field model developed to assess thermal compliance in the main body of this complex waterway. While perhaps not perfect, this model has been proven by this study to be the most feasible and reliable means for documenting compliance with the near-field Secondary Contact thermal water quality standards, and as such, its use should be incorporated into the Joliet Stations' NPDES permits.

We believe that with the submittal of this report, MWGen has completed the submission of all the appropriate information and data necessary to allow the USEPA and the Illinois EPA to complete their review of the draft Joliet Station NPDES permits. We believe that the NPDES permit process should now move forward to incorporate the use of the proposed near-field thermal compliance model in the Joliet Stations' permits and to prepare them for public notice and final issuance.

Please call me if you have any questions or wish to discuss this matter further.

Sincerely,

Basil G. Constantelos
Director, Environmental Health and Safety

Attachments and Report

cc: Beth Unser--IEPA
Peter Howe--USEPA

TABLE 1: SUMMARY OF JOLIET STATION 2002 THERMAL PLUME STUDY RESULTS

Date	Joliet 9 >93 °F Surface Plume** (in acres)	Joliet 9 Excursion Hours Used* (25% dilution)	Joliet 9 Zone of Passage Maintained at <100 °F?	Joliet 29 >93 °F Surface Plume** (in acres)	Daily Average Number of Cooling Towers On	Joliet 29 Excursion Hours Used* (25% dilution)	Joliet 29 Excursion Hours Used* (50% dilution)	Joliet 29 Zone of Passage Maintained at <100 °F?
27 June	0	0	yes	8.3	24	1#	0	yes
11 July	0	0	yes	14.9	4***	0	0	yes
1 August	8.2	0	yes	22.0	24	0	0	yes
9 August	0	0	yes	27.4	11	1	0	yes
15 August	4.9	0	yes	25.7	6***	5	0	yes
20 August	0	0	yes	9.1	0	1	0	yes
28 August	0	0	yes	0	0	0	0	yes
4 September	0	0	yes	0	0	0	0	yes

*Based on Midwest Generation's excursion hour accounting method, as described in the proposed Near-Field Thermal Compliance Plan submitted to IEPA in April, 2001. (This model uses the 24-hour average antecedent river flow in the calculations).

**NOTE: At no time were water temperatures outside of the discharge canal in excess of 100°F

***Cooling towers were not operating during the time of the thermal plume study on indicated dates. Cooling tower operating status was held constant during the course of each study period, in order to minimize any additional variability in the field temperature measurements.

Cooling towers tripped for one hour early on the morning of 27 June, resulting in the use of one excursion hour.

TABLE 2: COMPARISON OF FIELD AND CALCULATED MIXED RIVER TEMPERATURES DURING TIME OF SURVEYS:**

Date	Average Measured River Temperature at 7000 ft. transect (in °F) (using EA data from vertical profile studies) (data in parentheses from 3-D studies)	Calculated "Fully Mixed" River Temperature (MWGen Model--25% dilution) (in °F) (data in parentheses using real-time flow values)	Calculated "Fully Mixed" River Temperature (MWGen Model--50% dilution) (in °F) (data in parentheses using real-time flow values)	Calculated "Fully Mixed" River Temperature (MWGen Model--100% dilution) (in °F) (data in parentheses using real-time flow values)	24-Hour Rolling Avg. River Flow (in cfs)	Average Real-Time. River Flow (in cfs)
27 June	90	90 (90)	89 (90)	88 (89)	3102	2748
11 July	89	90 (91)	88 (89)	86 (87)	4609	3575
1 August	92 (93)	93 (93)	92 (93)	91 (92)	3406	2729
9 August	90 (90)	91 (92)	91 (91)	89 (90)	2841	2541
15 August	89	95* (94)	92* (92)	90 (89)	4891	4721
20 August	88 (88)	90 (89)	88 (88)	86 (86)	3067	3404
28 August	85 (84)	87 (87)	85 (85)	83 (83)	4435	4100
4 September	90	93 (91)	91 (89)	90 (87)	2531	3910

*River flow on 8/15 was well over 4000 cfs for the entire day. The cooling towers were not in use during the study, but were so immediately before and after the measurements were made. Thus, there was a short period of higher discharge temps that were used in our model calculations, which resulted in the higher calculated mixed temp. values. There were also significant wind speeds on this date, which could have caused the field measurements to be several degrees cooler than the calculated values. (The Midwest Generation near-field compliance model does not incorporate weather data effects into the calculations). In this particular case, the calculated 100% dilution value is much closer to the actual field measurement.

**Survey times for specific study dates are listed in Table 3-1 of the Joliet Station Thermal Plume Survey Report.

Thermal Plume Surveys on the Des Plaines River Near Joliet Stations 9 and 29, June-September 2002

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EA Project 61393.08

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1. INTRODUCTION

On behalf of Midwest Generation EME, LLC (MWGen), EA Engineering, Science and Technology (EA) conducted thermal plume surveys during the summer of 2002 in the Des Plaines River near Joliet Stations 9 and 29. These thermal plume surveys obtained information concerning near-field thermal plume characteristics for each generating facility under a variety of summer operating, river flow, and meteorological conditions. Seasonal thermal plume surveys conducted in 1993-94[1] at the Joliet Power Plants showed that due to natural buoyancy, thermal plumes are primarily a surface phenomenon but also indicated that the plumes can have a depth component. Therefore, the 2002 surveys included surface plume measurements on all study dates and three-dimensional (3-D) profiles on half the study dates.

The near-field thermal water quality standards that apply to the Joliet Stations are the Secondary Contact and Indigenous Life Standards. These standards require that temperatures shall not exceed 93° F more than 5 percent of the time or 100° F at any time at the edge of the allowed mixing zone (35 Ill. Adm. Code § 302.408). The two-dimensional extent of the surface plume mapping was intended to delineate the >93° F and >100° F temperature contours and the areas encompassed by these contours for comparison to the maximum allowed 26-acre mixing zone. The mixing zone also must allow for a zone of passage in which water quality standards are met. Information on zone of passage was obtained from the 3-D temperature profiles.

[1] ENSR, 1995. Upper Illinois Waterway Study Summary Report: Physical - Chemical Study of the Upper Illinois Waterway, Summer 1993 - Spring 1994. Report by ENSR to Commonwealth Edison Company, Chicago Illinois

2. METHODS

Eight thermal plume surveys were conducted along the Des Plaines River at Joliet Station 9 and Station 29. Each survey consisted of surface plume mapping along predetermined transects and vertical profiles. Four surveys consisted of surface plume mapping and vertical profiles only at the center of each transect (centerline survey). The remaining four surveys were comprehensive 3-D plume surveys that included both surface plume mapping and 3 to 5 vertical profiles along each transect. This resulted in the collection of surface and centerline vertical profile temperatures on eight occasions and complete three-dimensional plume data on four occasions. One centerline survey was conducted in each of the four months June, July, August, and September. Four additional 3-D surveys were conducted in August. Thermal plume surveys were performed during months when worst case conditions were expected to occur.

2.1 TRANSECTS

The thermal plume mapping surveys at the Joliet Stations were performed along 16 transects that were located from 3,350-ft upstream of the Joliet 29 discharge to 7,000-ft downstream of it. Three transects were situated in the discharge canals and 13 were located in the river. Each thermal survey consisted of surface plume mapping and vertical temperature profiles. The surface plume mapping was performed by starting at the upstream-most transect and then proceeding in a downstream direction until each of the 16 transects had been mapped. This was followed immediately by the vertical profiles, which proceeded from downstream to upstream. In addition to the 16 transects, the surface plume mapping included a diagonal (e.g., moving from the left end of Transect 1 to the right end of Transect 2, etc.) between each of the 13 river transects. A surface centerline transect was also performed inside the Joliet Station 9 and Station 29 discharge canals. The 13 river transect locations are summarized in the following table.

Joliet Stations	
Transect	Distance from Joliet 29 Discharge (ft)
1	Upstream (-3,350)
2	-1,720
3	-1,250
4	-750
5	-250
6	250
7	750
8	1,250
9	2,000
10	2,750
11	4,000
12	5,500
13	7,000

The river transect distances are relative to the end of the Joliet Station 29 discharge canal. The discharge canal from Joliet Station 9 is located on the left bank (when facing downstream) just above the –1,720 ft transect. The discharge canal for Joliet Station 29 is located on the right bank between the –250 ft and 250 ft transects.

When 3-D surveys were conducted, vertical profiles were performed at 55 stations. More stations were established on transects closer to the discharge canals to better characterize the plumes in these areas. The stations on a transect were positioned so as to space the sampling points essentially equidistant from each other. The upstream transect and the downstream transects at 4,000 ft, 5,500 ft, and 7,000 ft contained 3 vertical stations. The stations were located at one-quarter, one-half, and three-quarters of the distance from the left to right bank. The remaining transects contained 4 vertical stations except for Transects 6-8 (250 ft, 750 ft, and 1,250 ft), which each contained 5 vertical stations; 1/6, 2/6, 3/6, 4/6 and 5/6 of the distance from left to right bank. Inside of the Joliet Station 29 discharge canal, two vertical stations were located at a transect downstream of the cooling towers (J29-DS-1/3, J29-DS-2/3), and 1 vertical station was located at a transect upstream of the cooling towers (J29-US-1/2). One vertical station was also located inside the Joliet Station 9 discharge canal (J#9-1/2). The thermal plume survey transects and vertical station locations are illustrated in Figure 2-1, corresponding GPS coordinates are provided in Appendix E.

2.2 SURVEY METHODS

All surveys were performed from a boat equipped with a temperature measuring system and a differential Trimble GPS system. The surface plume mapping was performed first in a downstream direction, immediately followed by the vertical profiles from downstream to upstream. The time and duration of each component of the study are listed in Table 3.1-1. In general, the surface plume mapping took approximately two hours to complete; each vertical survey took on the order one to three hours. During a surface plume survey, the boat was driven along an established lateral transect, turned as close as possible to the shoreline, and then moved on a diagonal to the next transect, producing a zigzag pattern. This method was used to better delineate the edge of the surface plume. As the boat moved, the GPS system stored the x, y coordinates of the temperature probe position at 1-sec intervals to internal memory and temperature was recorded continuously to a data logger at a 1-sec interval.

The temperature system consisted of a YSI-011-44018 probe interfaced with a Deban 500 module. The Deban module receives the signal from the thermistor and sends a voltage that responds linearly with temperature to the datalogger. According to the manufacturer, the YSI/Deban temperature system has an accuracy of 0.1% full span, which corresponds to 0.05° C (0.09° F). The output from the thermistor was stored at 1-sec intervals to a Campbell CR10X datalogger. The temperature and GPS data were recorded along both the established horizontal transects and the diagonal transects in between.

During a surface plume survey, the thermistor was attached to a fixed strut mounted on the side of the boat. The sampling depth was between 1 ft and 1.5 ft, depending on wave action at the time of the survey. When wave action was significant, the thermistor was positioned at a 1.5-ft depth to prevent it from coming out of the water when the boat was riding a wave. At these times, the 1.5-ft sampling depth was still representative of a surface temperature because the upper 1.5-ft of the water column was well mixed due to wave action. A 1-ft sampling depth was used during the majority of the surveys.

Plume definition within the water column was obtained by measuring vertical temperature profiles from surface to bottom at pre-established locations along the river transects and in the Joliet Station 9 and 29 discharge canals. A total of 55 vertical-profiling stations were established along the transects near the Joliet Stations (Section 2.1). Vertical profiles were measured using a Seabird CTD profiler (model SBE 19 plus). The instrument was set to collect temperature and depth data at 0.25-sec intervals as the unit was slowly lowered to the bottom and pulled back up to the surface. This typically resulted in the collection of four to six data points within every 1-ft depth interval. GPS was used to position the boat at the same vertical-profiling stations during all surveys.

2.3 INSTRUMENT CALIBRATION

2.3.1 Seabird CTD Profiler

The Seabird CTD Profiler received a pre- and post-calibration by the manufacturer. The pre-calibration was performed on 20 June 2002 (temperature) and 8 April 2002 (pressure). These calibration results are provided in Appendix Tables A-1 and A-2. The post-calibration was performed on 5 October 2002 for both temperature (Table A-3) and pressure (Table A-5). The pre- and post-calibration results for temperature indicated that the sensor drift was +0.00977° C (0.0176° F) (Table A-4). The pressure calibration was within 0.06-percent full scale during the pre- and within 0.04-percent full scale during the post-calibration.

2.3.2 Surface Temperature System

During the June to September survey period, four probe combinations were employed in the field as summarized in following table. Different probe combinations were used based on equipment availability, as well as damage to the E2-2 probe on 20 August.

Combination	Survey	Probe	Deban Module
1	27 June, 11 July	P4	285
2	(not used)	E2-5	352
3	1, 9, 15, 20 August	E2-5	352 extended range
4	20, 28 August, 4 September	E2-2	352 extended range

Probe Combination 1

Probe combination 1 was calibrated both before and after it was used in the field. The pre-calibration (10 June) was performed over a temperature range of 15 to 25° C (59.0° to 77.0° F) and resulted in the regression equation:

$$Tcalib = 1.0116\ T - 0.323 \quad (R^2 = 0.9999)$$

The post-calibration (6 August) was performed over the temperature range of 20° to 36° C (68.0° to 96.8° F) and resulted in the regression equation:

$$Tcalib = 0.9964\ T + 0.013 \quad (R^2 = 0.9999)$$

Over the temperature range 27.5° to 34° C, (81.5° to 93.2° F) which was typical of the 27 June and 11 July surveys, both calibrations resulted in temperature adjustments not exceeding 0.1° C (0.018° F). Since a 0.1° C calibration adjustment was considered representative of the accuracy of the calibration, the survey data were used without further correction. The temperature data for the pre- and post-calibrations are provided in Appendix Table A-6.

Probe Combination 2

The combination of probe E2-5 and Deban module 352 was calibrated by Deban prior to the thermal surveys (Appendix Table A-7). Over a temperature range of 15° to 40° C (59.0° to 104.0° F), the temperature deviation did not exceed 0.021° C (0.038° F). Although this combination was available, it was not necessary to utilize it during the course of the study.

Probe Combination 3 and 4

Preceding the 1 August survey, the Deban module was returned to the manufacturer and the output range was extended (Combination 3). During the 20 August survey, probe E2-5 was replaced with probe E2-2 (Combination 4). The pre-calibration of probes E2-5 and E2-2, both using module 352, were nearly identical. Deviation for Probe E2-5 did not exceed 0.021° C (Table A-7) and probe E2-2 deviation did not exceed 0.030° C (Table A-8) over a temperature range of 15° to 40° C (32.3° to 104.0° F). This indicates that these two YSI probes are nearly identical, and any subsequent differences are a function of the Deban Module. The combination of probe E2-2 with module 352 was post-calibrated on 4 October. The calibration over a temperature range of 26° to 39° C (78.8° to 102.0° F) resulted in the regression equation:

$$Tcalib = 0.9696\ T + 1.6141 \quad (R^2 = 0.9998)$$

The above equation results in a calibration adjustment that increased the recorded temperatures by 0.85° C (1.53 ° F) at 25° C (77.0° F) with the adjustment decreasing to 0.55° C (0.99 ° F) at 35° C (95.0° F). The temperature calibration data are provided in

Appendix Table A-9. The above regression equation was applied to the 1 August through 4 September surveys. This calibration is associated with the modification of the Deban module, which was common to both probe combinations 3 and 4.

2.4 DATA PROCESSING

The survey data were processed into standard file formats and converted to degrees Fahrenheit. The surface plume mapping data were displayed as surface temperature values from left to right bank at each of the 13 river transects. All of the vertical temperature profile data were placed in tables. Data processing procedures were also developed to provide surface plume areas, downstream distances, and cross-sectional profile statistics. The data processing procedures are discussed in the following sections.

2.4.1 CTD Profiler

The CTD unit records temperature and depth readings continuously every 0.25 second during the profile as the instrument is lowered and pulled back up to the surface. The data recorded during each vertical profile were averaged into 1-ft intervals from surface to bottom. Following manufacturer recommendations, only the data from the lowering were used in the analysis. When the probe is lowered, "new" water continuously flows pass the probe, which is located near the bottom of the instrument, and accurate ambient temperatures are recorded. During the retrieval, the instrument housing may cause entrainment of "old" water and the recorded temperatures may not represent existing ambient temperatures at the time of retrieval. For this reason, only the data from the lowering of the probe was used in the analysis.

Data in the 0.5-ft surface layer was averaged and reported as a 0.25-ft depth. The remaining data were averaged in 1-ft vertical intervals from surface to bottom and reported as the mid-depth of the interval. For example, data in the 0.5-ft to 1.5-ft interval were reported as 1 ft and the data in the 1.5-ft to 2.5-ft interval were reported as 2 ft. Pre- and post-calibrations of the CTD profiler performed by the manufacturer indicated that no additional calibration adjustment of recorded data was necessary (Section 2.3). All of the vertical temperature data were placed in tables.

2.4.2 Surface Temperature System

As discussed in Section 2.2, surface temperatures were recorded with a YSI probe interfaced with a Deban 500 module. The resulting output was recorded on a Campbell CR10 datalogger. Each survey resulted in a data file of temperature data and a second data file of the corresponding GPS coordinates, both at 1-sec intervals. The two files were examined for spurious data using several techniques. The examination of the surface data included calculating the minimum, maximum, and mean temperature along each transect. The GPS data was plotted to display the course steered by the boat during the survey. A calibration adjustment was applied to the data as indicated in Section 2.3. The resulting calibrated temperature file and the GPS coordinate file were merged using the survey times recorded in each file for synchronization. The system clocks on the datalogger and the Trimble GPS unit were set in the field to identical times at the beginning of each survey.

Figures displaying surface temperatures at each of the 13 river transects were generated for each survey. In these figures, temperatures were displayed at a distance from left to right bank (when facing downstream). For convenience in generating these figures, the survey data was transformed by calculating the distance of each data point from the known location of the left bank shoreline and by averaging the data into 10-ft horizontal intervals along each transect.

2.4.3 Plume Area and Cross-Sectional Characteristics

Surface plume, cross sectional contours and associated statistics were generated for the >90° F, >93° F and the >100° F temperatures corresponding to values in the Illinois thermal water quality standards. For each survey, figures present the surface temperatures and the cross-sectional temperature profiles in four temperature ranges; ≤90.49° F, 90.50 to 93.49° F, 93.5 to 100.49° F and ≥100.50° F. The temperature ranges incorporate the standard numerical rounding practice that is accepted for comparing in-situ measured values to whole number thermal stream standards[2]. These temperature ranges were chosen to correlate to the relevant secondary contact thermal water quality standards (e.g. 93° F, 93° F to 100° F with allowed excursion hours; and 100° F maximum).

Contoured surface plume maps were generated with AutoCAD using all of the surface survey data including all 16 horizontal transects and connecting diagonal transects. AutoCAD was used to determine the enclosed plume area outside of the discharge canal and downstream length of the >93° F contour individually for Joliet Station 29 and Joliet Station 9.

AutoCAD also was used to generate figures displaying the cross-sectional temperatures that were measured at each of the 13 river transects for the four 3-D surveys when all 55 vertical stations were performed. For each cross-sectional profile, temperature contours were developed at >90° F, >93° F, and >100° F and the percentage of the cross-section exceeding each temperature was tabulated.

[2] Standard Methods of the Examination of Water and Wastewater, 20th ed., 1998 at p. 1-26.

3. THERMAL SURVEY RESULTS

The data collected during the eight thermal plume-mapping surveys are displayed in a series of figures and tables. The surface plume mapping data at the 13 river transects extending from 3,350-ft upstream of Joliet Station 29 to 7,000-ft downstream of it are displayed as a set of figures (B-1a-e to B-8 a-e) and tables (B-1 to B-8) in Appendix B. In each figure, the surface temperature data are presented as a function of the distance from left bank to right bank. Typically, 3 transects were grouped on each figure, requiring 5 figures to display the entire survey. The vertical profiles were preformed at up to five stations along each transect (Figure 2-1). During four surveys, the complete set of 55 stations were monitored (3-D survey), and during the remaining four surveys only the 13 centerline vertical stations were monitored (centerline survey). As discussed in Section 2.4, the vertical profile data were averaged into 1-ft vertical intervals. All of the resulting vertical temperature data are displayed as tables in Appendix C. The following table summarizes the June to September survey dates, corresponding appendix figure and table numbers, and indicates whether a complete set of verticals (3-D Survey) were performed or whether only the centerline vertical stations were monitored.

Survey	Survey Type	Figures	Tables
27 June	Centerline	B-1 a-e	B-1, C-1 a-b
11 July	Centerline	B-2 a-e	B-2, C-2 a-b
1 August	3-D	B-3 a-e	B-3, C-3 a-g
9 August	3-D	B-4 a-e	B-4, C-4 a-g
15 August	Centerline	B-5 a-e	B-5, C-5 a-b
20 August	3-D	B-6 a-e	B-6, C-6 a-g
28 August	3-D	B-7 a-e	B-7, C-7 a-g
4 September	Centerline	B-8 a-e	B-8 C-8 a-b

The time intervals during which each surface plume mapping survey and each vertical survey were performed are provided in Table 3-1.

3.1 OPERATING CONDITIONS AT THE JOLIET STATIONS

Hourly operating conditions for the Joliet Stations on the day of each survey are provided in Appendix Tables D-1 to D-8. For each survey, a separate table is provided for Joliet Station 9 (table –a) and Joliet Station 29 (table -b). These tables include power production, intake temperature, discharge temperature, delta temperature rise through the station condensers, and station circulating water flow. For Joliet Station 29, the number of cooling towers in operation and the cooling tower discharge temperature is also provided. Joliet Station 29 has 24 helper towers with a total flow capacity of 802 cfs (33.4 cfs per tower). Joliet Station 29 discharge temperatures at the end of the discharge canal, based on a flow weighted average of the station and cooling tower discharge temperature (i.e. "effective discharge temperature") are also provided. The tables also include the Des Plaines River flow at Brandon Road Lock and Dam. The hourly operational and river flow data for the actual Joliet Station 9/29 thermal survey time periods are highlighted in Appendix Tables D-1 to D-8.

Daily average Joliet Station 9 and 29 operating conditions and river flow are summarized in Tables 3-2 and 3-3.

Table 3-2 indicates that for Joliet Station 9, daily average power production on survey days varied between 160 MWe on 11 July to 235 MWe on 4 September. July 11 and September 4 also corresponded to the smallest and largest delta temperature rise across the station condenser of 6.0° F and 8.3° F, respectively. Because of the uniformity in circulating water flow (constant 582 cfs during all surveys), it was expected that the delta temperature rise through the station would be proportional to power production.

At Joliet Station 29 (Table 3-3), the highest daily average power production was 939 MWe on 27 June resulting in a station delta temperature rise across the condensers of 14.5° F. However, on this day all 24 cooling towers were in operation and the calculated delta temperature rise from the station intake to the end of the discharge canal (after the cooling tower discharge) was only 5.6° F (Table 3-3, D-1b). On 20 August, 28 August, and 4 September, cooling towers were not in operation at any time and daily average delta temperature rise from the station intake to the discharge canal exceeded 10° F, including a value of 13.0° F on 28 August (859 MWe). The Joliet Station 29 circulating water flow was a uniform 1,537 cfs during all surveys.

The daily average intake temperatures at Joliet Station 9 and 29 were typically within 0.5° F of each other (Table 3-2 and 3-3). The average temperature at the upstream surface transect was also included in the Joliet Station 9 table. The upstream transect temperature was usually the same or slightly higher than the Station 9 intake temperature. The Joliet Station 9 intake is approximately 400-ft downstream and the Joliet Station 29 intake is located upstream of the upstream plume survey transect. Variation between the surface temperature at the upstream plume transect at the time of the survey and the daily average intake temperatures reflect natural diurnal variation and location in the water column.

Daily average flow in the Des Plaines River varied between 2,635 cfs (9 August) and 4,940 cfs (15 August) at the Brandon Road Lock and Dam. Actual river flows during the time of the thermal plume studies are noted in Table 3-1. River flow rate at times varied significantly, including considerable hourly fluctuations, during the performance of the plume surveys.

Hourly power production at both Joliet Stations 9 and 29 is characterized by a daily cycle. Examination of Tables D-1 to D-8 indicates that in the early morning, preceding 0800 hrs, Joliet Station 9 power production is typically below 140 MWe. Over the next several hours power production increases, typically reaching 250-300 MWe during the afternoon. At Joliet Station 29, power production is typically 500-700 MWe in the early morning, increasing to 900-1,000 MWe by afternoon on most days.

The survey times in Table 3-1 indicate that all of the thermal surveys were performed during a period of increased daily power production. All of the surveys were performed over the course of an operating day from approximately 11:00 am to approximately

5:00 pm, which excluded the lower power production hours of the early morning and late evening.

3.2 SUMMARY DESCRIPTION OF SURVEYS

A short description of the plume features during each of the eight thermal surveys is provided in the following section. As previously discussed, the surface temperature plume mapping data is presented as a series of figures and tables in Appendix B and all the vertical profile data is provided as tables in Appendix C. Plume area and cross-sectional characteristics will be presented in Section 4.

27 June-Centerline

During the 27 June plume mapping survey (Figure B-1, Table B-1), the average upstream (Transect 1) temperature was 84.6° F. The maximum temperature at the –1,250 ft transect, downstream of Joliet 9 discharge canal, was 89.7° F. Downstream of the Joliet 29 discharge canal at the 250 ft transect, surface temperatures varied between 90.1 and 95.2° F from left to right bank. Surface temperatures decreased downstream with maximum surface temperatures decreasing to less than 93° F beyond the 2,750 ft transect. The centerline vertical data (Table C-1), collected later in the day than the surface measurements, indicated that temperatures of less than 91° F were always present in at least the lower half of the water column at all river stations, except the two that were located directly downstream of Joliet 9's discharge canal (i.e., the 1/5 station at the –1,720 ft transect and the 2/5 station at the –1,250 ft transect). At these two shallow stations, temperatures exceeded 93° F at all or most depths by less than 1° F. Vertical temperature stratification was quite variable among all the river stations, ranging from 0.3 to 6.4° F.

11 July--Centerline

During the 11 July surface plume mapping survey (Figure B-2, Table B-2), the average upstream (Transect 1) temperature was 81.9° F. The maximum temperature at the –1,750 ft transect, just downstream of the Joliet 9 discharge canal, was 88.1° F. Downstream of the Joliet 29 discharge canal at the 250 ft transect, surface temperatures varied from 84.6 to 94.3° F. Maximum temperatures of approximately 94° F were also present at the 750 ft, and 1,250 ft transects, and surface temperatures were less than 93° F beyond the 2,750 ft transect. The centerline vertical data (Table C-2) indicate that temperatures of less than 90° F were always present in the lower half of the water column at all river stations.

1 August-3-D

During the 1 August surface plume mapping survey (Figure B-3, Table B-3), the average temperature at the upstream-most transect was 86.6° F. This survey contained the highest upstream (ambient) temperature of the eight 2002 surveys. The corresponding elevated intake temperatures resulted in higher discharge temperatures, which at the time of the survey were 95-96° F at Joliet 9 (Table D-3a). Downstream of the Joliet 9 discharge canal, at transects –1,750 ft and –1,250 ft, maximum surface temperatures were 95.2-95.7° F. Similarly, downstream of the Joliet 29 discharge canal at the 250 ft, 750 ft, and 1,250 ft transects, maximum surface plume temperatures varied between 95.0 and 95.7° F. Surface temperatures decreased downstream with maximum surface temperatures less than 93° F beyond the 4,000 ft transect. The 3-D vertical survey data (Table C-3) indicates that vertical temperature stratification was typically up to 3° F at the 750 ft transect, decreasing to approximately 1° F at the 2,000 ft to 7,000 ft transects.

9 August--3-D

During the 9 August surface plume mapping survey (Figure B-4, Table B-4), the average surface temperature at the upstream-most transect was 84.5° F. The maximum surface temperature at the -1,250 ft transect, downstream of the Joliet 9 discharge canal, was 93.1 ° F. Downstream of Joliet 29 at the 250-ft transect, temperatures increased from approximately 87 to 97° F from left to right bank. At the 2,000-ft transect, the maximum surface temperature was 94.7° F, and maximum plume temperatures were less than 93° F beyond the 4,000 ft transect. During the 3-D vertical survey (Table C-4), vertical temperature stratification at the 750 ft transect varied from less than 0.5° F near the left bank (1/6 station) to 8° F near the discharge bank (5/6 station). The near right bank vertical stratification decreased to 4° F at the 2,000 ft transect.

15 August--Centerline

During the 15 August surface plume mapping survey (Figure B-5, Table B-5), the average surface temperature at the upstream-most transect was 84.3° F. The maximum surface temperature at the -1,720 ft transect, downstream of the Joliet 9 discharge canal, was 94.0° F. At Joliet 29, the cooling towers were not in operation at the time of the plume mapping survey and temperatures in the upper discharge canal were approximately 100° F. Downstream of Joliet 29 at the 250-ft transect, surface temperatures ranged from 86.8 to 99.2° F. This transect is the closest to the Joliet 29 discharge and it extends across into the main body of the river. The maximum plume temperature decreased to 96.3° F at the 750 ft transect. Maximum plume temperatures were less than 93° F beyond the 2,750 ft transect. During the centerline vertical survey (Table C-5), temperatures of less than 90° F were always present in at least the lower half of the water column at all river stations from the –1,720 ft transect downstream to the 750 ft transect, except for the station at the mouth of Joliet 9's discharge canal (i.e., the 1/5 station at the –1,720 ft transect). At that station, as well as the one at the 1,250 ft transect, temperatures exceeded 93° F at all or most depths in the water column. Conversely, temperatures of less than 93° F were present in the lower half of the water column at the 2,000 and 2,750 ft transects and no temperatures of greater than 93° F were present in the water column at the 4,000, 5,500, and 7,000 ft transects. Vertical temperature stratification was apparent at all river stations from the –1,250 ft transect downstream to the 2,750 ft transect, ranging from 4.5 to 9.5° F. Conversely, vertical stratification was noticeably less apparent at the three furthest downstream transects, as water column temperatures differed by only 1.1 to 2.1° F.

20 August--3-D

During the 20 August surface plume mapping survey (Figure B-6, Table B-6), the average surface temperature at the upstream-most transect was 81.1° F. The maximum surface temperature at the -1,250 ft transect, downstream of the Joliet 9 discharge canal, was 86.1° F. Downstream of Joliet 29 at the 250-ft transect, surface temperatures ranged from 82.9 to 95.1° F. Maximum plume temperatures were less than 93° F beyond the 2,000 ft transect. The 3-D vertical survey data indicate that temperatures at all river stations were vertically mixed, as water column temperatures consistently differed by less than or equal to 0.8° F (Table C-6).

28 August--3-D

During the 28 August surface plume mapping survey (Figure B-7, Table B-7), the average temperature at the upstream transect was 77.6° F, the lowest ambient river temperature during the eight 2002 surveys. At the -1,720 ft transect, downstream of the Joliet 9 discharge canal, the maximum surface temperature was 83.1° F. Downstream of Joliet 29 at the 250-ft transect, surface temperatures ranged from 78.2 to 89.7° F. Maximum plume temperatures were less than 88° F beyond the 2,000 ft transect. During the 3-D vertical survey (Table C-7), vertical temperature stratification at the 750 ft transect varied from less than 0.5° F near the left bank (1/6 station) to 10° F near the discharge bank (5/6 station). The near right bank vertical stratification decreased to 6° F at the 2,000 ft transect. By the 7,000 ft transect, vertical temperature stratification decreased to 3.5° F at the deepest profile location (1/4 station).

4 September--Centerline

During the 4 September surface plume mapping survey (Figure B-8, Table B-8), the average upstream (Transect 1) temperature was 81.1° F. The maximum surface temperature at the -1,720 ft transect, downstream of the Joliet 9 discharge canal, was 91.9° F. The daily average power production of 615 MWe at Joliet 29 was the lowest of the eight surveys and the cooling towers were not in operation. Downstream of Joliet 29 at the 250-ft transect, surface temperatures ranged from 85.2 to 92.1° F. Maximum plume temperatures were less than 91° F beyond the 2,750 ft transect. The centerline vertical data (Table C-8) indicate that temperatures of less than 90° F were always present in the lower half (typically the lower two-thirds) of the water column at all river stations, except for the station at the mouth of Joliet 9's discharge canal (i.e., the 1/5 station at the –1,720 ft transect). At that station, temperatures exceeded 93° F at all depths in the water column. Vertical temperature stratification was apparent at all river stations from the -1,250 ft transect downstream to the 5,500 ft transect, ranging from 2.7 to 9.3° F. Conversely, vertical stratification was noticeably less apparent at the furthest downstream transect (i.e., 7,000 ft), as water column temperatures differed by only 0.5° F.

4. PLUME CHARACTERISTICS

The thermal water quality standards that apply to the Joliet Stations' mixing zones are Illinois' Secondary Contact and Indigenous Life Standards. These standards require that temperatures shall not exceed 93° F more than 5 percent of the time or 100° F at any time at the edge of the mixing zone (35 Ill. Adm. Code § 302.408). The allowed thermal mixing zone area is 26 surface acres.

4.1 PLUME AREA AND DOWNSTREAM LENGTH

The surface plume data were contoured using AutoCAD and the resulting plume maps are provided in Figures 4-1 to 4-8 for the eight Joliet 2002 surveys. The figures present the surface temperatures in four temperature ranges; ≤90.49° F, 90.50° to 93.49° F, 93.5 to 100.49° F and ≥100.50° F. Temperatures greater than 100° F were only occasionally present inside the Joliet Station 29 discharge canal. Plume areas enclosed by the >93° F temperature contours were calculated for each of the eight thermal plume surveys and these results are provided in Tables 4-1 to 4-8. An individual plume area was determined for both Joliet Station 9 and Joliet Station 29. The tables also include the downstream length of the >93° F plume, the minimum, maximum, and mean surface temperature at each transect, and the plume width as a percentage of the transect width at each of the 13 river transects. The methodology for performing these calculations was discussed in Section 2.4.3. The plume areas are summarized in the following table.

Surface Area (acres) of the >93° F Temperature Contour

Survey	Joliet 29	Joliet 9
27 June	8.3	0
11 July	14.9	0
1 August	22.0	8.2
9 August	27.4	0
15 August	25.7	4.9
20 August	9.1	0
28 August	0	0
4 September	0	0

With the exception of the Joliet 29 discharge canal, during the eight Joliet 2002 surveys, there were no occurrences of temperatures greater than 100° F in either the surface plume mapping surveys or the 3-dimensional vertical profile surveys.

There were only two survey dates when Joliet Station 9 had a discernable thermal plume within the allowed mixing zone, and on both dates, the surface area encompassed was relatively small. On 1 August, when Joliet 9 experienced the highest daily average intake temperature and the highest upstream temperature (86.6° F) was recorded, the measured plume area >93° F was the largest (8.2 acres). During the 15 August survey, Joliet 9 power production was the second highest of the study dates and the surface plume area >93° F was the second largest for the station (4.9 acres).

Joliet 29 utilized a portion of the allowed mixing zone on six of the eight survey dates.

- The 27 June survey had the highest Joliet Station 29 daily average power production (939 MWe) and all cooling towers were on. The resulting 8.3 acre >93° F plume area was one-third of the allowed 26-acre mixing zone.

- The 1 August survey had the highest upstream (ambient) river temperature, and the daily average Joliet Station 29 intake temperature was 87.3° F. However, with all cooling towers in operation, the measured 1 August Joliet 29 thermal plume did not exceed the 26-acre maximum mixing zone criteria, needing only a 22-acre mixing zone to attain compliance with the 93° F water quality standard.

- The 9 August survey at Joliet Station 29 recorded the only >93° F temperature contour greater than the 26-acre mixing zone criteria such that allowable excursion hours were used. The mixing zone area to attain the 93° F water quality standard was 27.4 acres. On the morning of 9 August, Joliet 29 was only operating 6 cooling towers. This number increased to 12 just before the survey period began, resulting in the use of only 50% of the total number of towers available. Cooling tower operating status was held constant through the course of all of the thermal plume surveys, so as not to introduce any additional variability into the temperature measurements. It is likely that if all of the cooling towers had been operating, the mixing zone area would have been less than the allowed 26-acre mixing zone and no excursion hours would have been used. (It should be noted that all 24 towers were put into operation shortly after the thermal study was completed).

- The thermal plume measured during the 15 August Joliet 29 survey was within the 26-acre mixing zone criteria even though the cooling towers were not in operation at the time of the survey.

- The 28 August Joliet 29 survey had the lowest upstream river temperature (77.6° F) resulting in no surface or vertical plume temperatures greater than 93° F

- The 4 September Joliet survey had the lowest Joliet Station 29 daily average power production, resulting in no surface or vertical plume temperatures greater than 93° F.

4.2 ZONE OF PASSAGE AND CROSS-SECTIONAL AREA

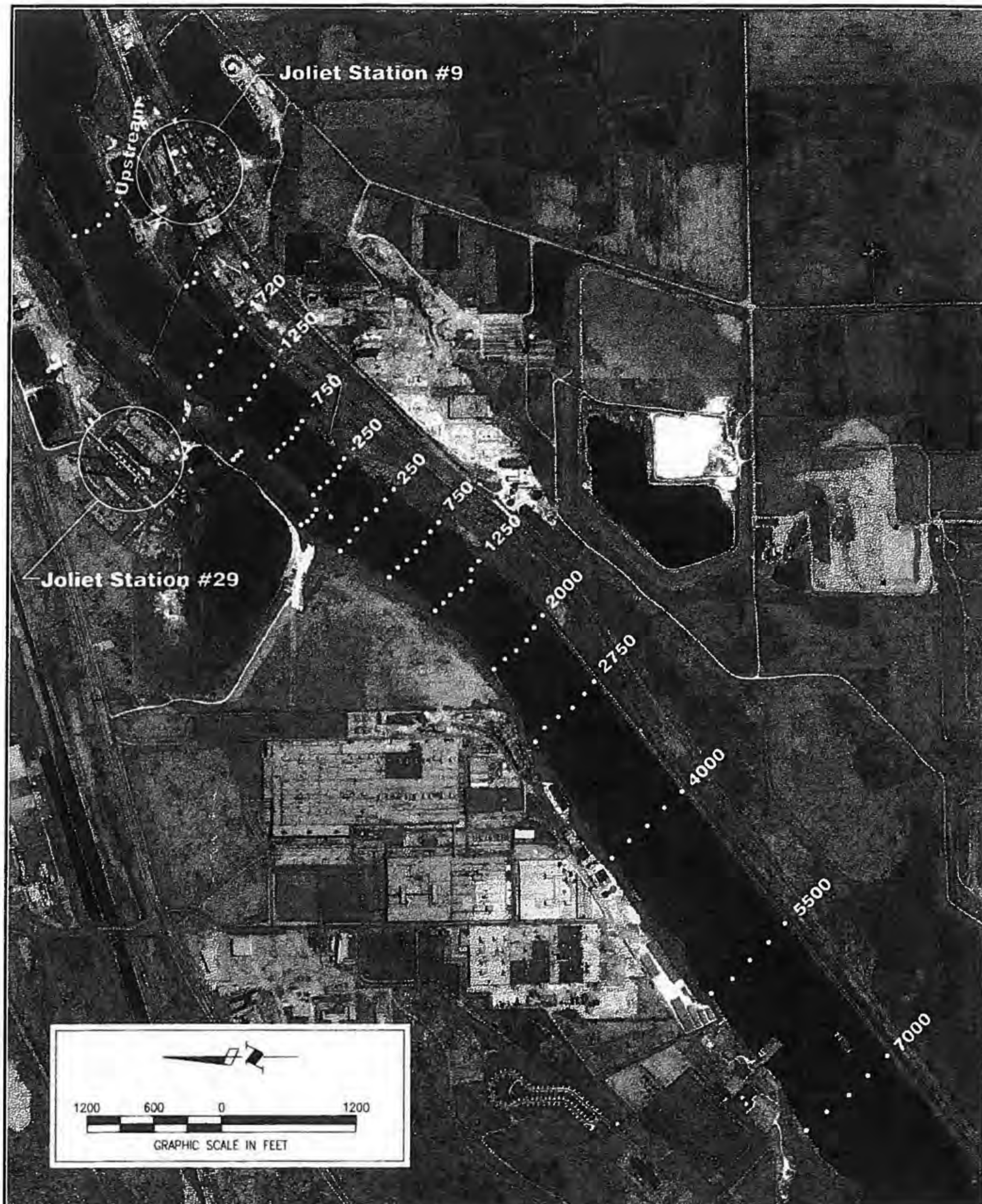
A zone of passage for aquatic life is required when mixing zones are allowed. Under Title 35 Illinois Administrative Code Section 302.102, the mixing zone must allow for a zone of passage in which water quality standards are met. Under these regulations, the following zone of passage requirement applies: "The area and volume in which mixing occurs, alone or in combination with other areas and volumes of mixing must not contain more than 25% of the cross-sectional area or volume of flow of a stream except for those streams where the dilution ratio is less than 3:1". In cases where river flows are below the 3:1 dilution ratio, Agency guidance and precedent supports the use of up to 50% of the cross-sectional area of the receiving water[3].

The vertical profile data for the four Joliet Station thermal plume surveys (1 August, 9 August, 20 August, and 28 August) that employed the full set of 55 vertical profile stations were contoured with AutoCAD at each transect. The resulting cross-sectional temperature profiles are displayed in Figures 4-9 to 4-20. As with the surface temperature figures, the cross-sectional profiles present the temperatures in four ranges; ≤90.49° F, 90.50 to 93.49° F, 93.5 to 100.49° F and ≥100.50° F. Cross-sectional areas enclosed by the >90° F, >93° F, and >100° F temperature contours were calculated at each transect. The resulting cross-sectional areas reported as a percentage of the total cross-sectional area are provided in Tables 4-9 to 4-12. These tables also contain the minimum, maximum and mean temperatures measured in the cross-section at each of the 13 transects. Although during the first two 3-D surveys in August, water temperatures exceeded 93° F at some transects, at no time did water temperature exceed 100° F within the mixing zone. Therefore, a >75% zone of passage of less than 100° F was maintained on all study dates. There were two dates during the course of the study (1 August and 9 August) when there were some transects at which the calculated zone of passage was less than 75% of the cross sectional area of the river, with water temperatures greater than 93° F, but less than 100° F.

In evaluating the data collected from the plume studies, it is important to recognize that due to the dynamic nature of the thermal plume at any given date or time, and the fact that the measurements documented by these studies represent, in essence, a "time lapse" picture of both the surface and vertical orientation of the thermal plume in space and time; precise, instantaneous documentation of the "true" percentage of cross-sectional area taken up by the subsurface component of the plume is not possible to measure. The methodology used to capture both the surface and subsurface thermal plume measurements, while standard for this type of study, cannot adequately compensate for the dynamic nature of this particular waterway. Consequently, the results of these studies cannot be considered as fully representative as they would be for a river where the flow is regulated by natural processes and hence is more constant over the course of a day. The plume dimensions presented in this report are more accurately described as estimated or extrapolated values.

The configuration of the thermal plumes in the waterway is primarily influenced by the river flow upstream of the plants. In addition, the facilities are located just downstream of the Brandon Road Lock and Dam. Since flow in this waterway is artificially regulated and is subject to frequent and often significant fluctuations, the magnitude and extent of both the surface and sub-surface components of the thermal plumes will be constantly changing and the duration of any specific thermal configuration is quite transient. The results of this study should be considered as a general indicator of the configuration of the Joliet Station's thermal plumes under typical summer operating and river flow conditions.

[3] Illinois Permitting Guidance for Mixing Zones, 1993 (IEPA) at p. 3.



EA ENGINEERING, SCIENCE, AND TECHNOLOGY

MIDWEST GENERATION
TEMPERATURE MAPPING
JOLIET, ILLINOIS

SAMPLING LOCATIONS
AT JOLIET STATIONS #9 & #29

PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO	FIGURE
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MIDWEST GENERATION EME, LLC
An EDISON INTERNATIONAL℠ Company

Basil G. Constantelos
Director, Environmental, Health & Safety

VIA OVERNIGHT DELIVERY

February 25, 2003

Mr. Toby Frevert
Great Lakes Coordinator
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, Illinois 62794-9276

Mr. James Filippini
Deputy Branch Chief
NPDES Programs Branch
Water Division, WN 16J
United States Environmental Protection Agency
77 W. Jackson Blvd.
Chicago, Illinois 60604-3590

Subject: Thermal Plume Study Report for Midwest Generation's Joliet Generating Stations 9 and 29

Dear Mr. Frevert and Mr. Filippini:

Enclosed for your review is a report prepared by EA Engineering, Science and Technology, Inc. ("EA") on the results of the thermal studies that Midwest Generation EME, LLC ("MWGen") commissioned during the summer of 2002 in the vicinity of the Joliet Station 9 and 29 discharges (the "EA" Thermal Studies Report"). The purpose was to study and gather additional information concerning the Joliet Stations' compliance with the existing Secondary Contact thermal water quality standards, as well as to test the validity and suitability of the near-field thermal compliance model that has been developed by MWGen for use in monitoring its compliance with the thermal water quality standards. A total of 8 individual studies were done from June through September, 2002, which is the time period coinciding with the highest expected river temperatures and lower river flows. EA collected surface thermal plume measurements on all 8 of the study dates, and conducted full three-dimensional thermal monitoring on 4 of the 8 dates. A summary table of all of the study results (see attached Table 1) is also enclosed to assist in your review of the EA Thermal Studies Report.

The results and findings based on the data gathered and analyzed from the thermal studies are consistent with the information we have previously presented to both U.S. EPA and the Illinois EPA. The key results and findings are:

1. The Joliet Stations' thermal plumes do not interact. Any interaction between the two plumes occurs after thermal water quality standards are attained. Thus, each of the Joliet Stations is entitled to a thermal mixing zone.

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2. Consistent with 35 Ill.Adm.Code § 302.102(b)(6) and (10), a zone of passage for aquatic life is maintained by the Joliet Stations' discharges and their associated allowed mixing zones. The Joliet Stations' current discharges are not using the entire flow of the river for mixing. These findings are consistent with the results of past thermal discharge studies of the Joliet Stations.

3. The Joliet Stations' discharges do not result in acutely lethal temperatures in the main body of the river. There were no temperatures in excess of 100 °F outside of the immediate discharge canal at either Joliet station.

4. With regard to the requirements of 35 Ill.Adm.Code § 302.102(b)(9), the thermal water quality standards are not already violated in the receiving water. There were no instances where the measured upstream temperature in the waterway exceeded either 93 °F or 100 °F. (Compliance monitoring data indicates that the maximum upstream water temperature over the past seven years has been consistently below the thermal water quality standards.)

5. Judicious use of Joliet 29's cooling towers, as well as unit deratings, when required, will ensure that both near and far-field thermal limits will continue to be maintained.

The EA Thermal Studies Report also includes information comparing the actual in-stream thermal measurements to the results of MWGen's proposed model for assessing near-field thermal compliance. The comparison shows that the near-field model is able to calculate the "fully mixed" river temperature downstream of the Joliet Stations conservatively to within 1° F of the actual, field-measured values.

Specifically, in Table 2 (see attached), the first column (average measured river temperature at the 7000 ft. transect) shows the actual field measurements taken during the thermal study, while the next two columns show the MWGen model-calculated "fully mixed" river temperature for the same time period that the field measurements were made, using both 25% and 50% dilution ratios, respectively. Comparison of these values for a given day/time period confirms that on 5 of the study dates, the actual versus modeled temperature is essentially identical; on the remainder of the 3 study dates, the model estimates are conservative by approx. 1° F or more (i.e. the actual water temperatures were lower than that projected by the model by 1° F or more).

Since the downstream-most field measurements (essentially equivalent to the "fully mixed" river temperatures) are all correlated with surface thermal plumes of less than 26 acres (with the exception of one date when the Joliet 29 plume was 27.4 acres), the results of this thermal plume monitoring study confirm the validity of the calculations used in MWGen's near-field model.

These results further support the suitability and reliability of the proposed Midwest Generation model for use as a means of documenting compliance with the applicable thermal water quality standards in the main body of the river. Although a surface thermal plume measurement of 27.4 acres for water in excess of the 93 ° F standard was calculated for one of the eight study days, MWGen was in compliance with the applicable thermal water quality standards on this date because it used a portion of the allowed excursion hours under the water quality thermal standards.

The correlation between the model results and the extent of the surface plume extent, with relation to the use of excursion hours, is much better than the correlation solely with the corresponding cross-sectional area measurements. The underlying reasons are likely due to the unavoidable river characteristics that prevent capturing the actual plume dimensions at a particular point in time. As more fully explained in the EA Thermal Studies Report, (see Section 4.2), the fact that this particular waterway is almost entirely artificially controlled by upstream lock and dams, with large and frequent changes in flow rate, makes it extremely difficult to capture and assimilate all of the changing variables that alter the morphology of the sub-surface plume at any given time and location into a precise model output that estimates temperature distributions in any given cross-sectional area of the waterway. The surface plumes are also transient in nature, but are better able to be mapped when temperature measurements are taken in a down-stream direction (as was done for this study), following the same segment of river flow as it moves downstream. The vertical survey data collected during the three-dimensional studies is likely skewed by the fact that the measurements were taken after completing the downstream surface measurements and moving back in an upstream direction. The additional lapse in time and upstream direction necessary to complete the vertical measurements results in the collection of vertical temperature data encompassing several different combinations of flow, discharge temperature and physical river channel configurations. Assimilation of all of this transient data taken over the course of several hours into a single cross-sectional area measurement is by necessity an extrapolation of the plume's constantly changing characteristics rather than an actual depiction of the plume at a given moment in time.

In any case, it has been definitely shown that the discharges from the Joliet Stations do not cause or contribute to temperatures in excess of 100° F anywhere in the river. Outside of the immediate discharge canal at the Joliet Stations, neither Joliet Station utilized any of the main body of the river for mixing purposes to comply with the 100 ° F thermal water quality standard. Further, for the 93 ° F thermal water quality standard, there is always a zone of passage present in the river. In addition, our on-going fisheries studies confirm that comparable fish assemblages are present both upstream and downstream of the stations and their movement is not precluded by the thermal discharges from either station. Since the zone of passage requirement strictly relates to the ability of mobile aquatic organisms to avoid the thermal discharge, if needed, the data collected by this study confirms that there is always an adequate proportion of the water column in which cooler temperatures exist.

However, given the unique flow regime characteristics of this lock and dam-controlled waterway, we could not measure for any given moment in time the specific percentage of the river volume that was below the 93 °F thermal water quality standard. Admittedly, this is a very complex issue that cannot be accurately modeled or measured on a real-time basis in this particular waterway. Yet, given the standards' allowance for excursion hours, and the performance of this study during the warm weather months, it is also reasonable to conclude from the data that the Joliet Station discharges do not exceed the allowed excursion hours for the 93 °F thermal water quality standard.

Despite certain inherent limitations, as described above, the information and data contained in this report represents MWGen's best effort to characterize the physical extent of the Joliet Stations' thermal discharges and how they are distributed in the main body of the lower Des Plaines River. The field data confirm the validity and accuracy of the proposed near-field model developed to assess thermal compliance in the main body of this complex waterway. While perhaps not perfect, this model has been proven by this study to be the most feasible and reliable means for documenting compliance with the near-field Secondary Contact thermal water quality standards, and as such, its use should be incorporated into the Joliet Stations' NPDES permits.

We believe that with the submittal of this report, MWGen has completed the submission of all the appropriate information and data necessary to allow the USEPA and the Illinois EPA to complete their review of the draft Joliet Station NPDES permits. We believe that the NPDES permit process should now move forward to incorporate the use of the proposed near-field thermal compliance model in the Joliet Stations' permits and to prepare them for public notice and final issuance.

Please call me if you have any questions or wish to discuss this matter further.

Sincerely,

Basil G. Constantelos
Director, Environmental Health and Safety

Attachments and Report

cc: Beth Unser--IEPA

Peter Howe--USEPA

TABLE 1: SUMMARY OF JOLIET STATION 2002 THERMAL PLUME STUDY RESULTS

Date	Joliet 9 >93 °F Surface Plume** (in acres)	Joliet 9 Excursion Hours Used* (25% dilution)	Joliet 9 Zone of Passage Maintained at <100 °F?	Joliet 29 >93 °F Surface Plume** (in acres)	Daily Average Number of Cooling Towers On	Joliet 29 Excursion Hours Used* (25% dilution)	Joliet 29 Excursion Hours Used* (50% dilution)	Joliet 29 Zone of Passage Maintained at <100 °F?
27 June	0	0	yes	8.3	24	1#	0	yes
11 July	0	0	yes	14.9	4***	0	0	yes
1 August	8.2	0	yes	22.0	24	0	0	yes
9 August	0	0	yes	27.4	11	1	0	yes
15 August	4.9	0	yes	25.7	6***	5	0	yes
20 August	0	0	yes	9.1	0	1	0	yes
28 August	0	0	yes	0	0	0	0	yes
4 September	0	0	yes	0	0	0	0	yes

*Based on Midwest Generation's excursion hour accounting method, as described in the proposed Near-Field Thermal Compliance Plan submitted to IEPA in April, 2001. (This model uses the 24-hour average antecedent river flow in the calculations).

**NOTE: At no time were water temperatures outside of the discharge canal in excess of 100° F

***Cooling towers were not operating during the time of the thermal plume study on indicated dates. Cooling tower operating status was held constant during the course of each study period, in order to minimize any additional variability in the field temperature measurements.

Cooling towers tripped for one hour early on the morning of 27 June, resulting in the use of one excursion hour.

TABLE 2: COMPARISON OF FIELD AND CALCULATED MIXED RIVER TEMPERATURES DURING TIME OF SURVEYS:**

Date	Average Measured River Temperature at 7000 ft. transect (in °F) (using EA data from vertical profile studies) (data in parentheses from 3-D studies)	Calculated "Fully Mixed" River Temperature (MWGen Model--25% dilution) (in °F) (data in parentheses using real-time flow values)	Calculated "Fully Mixed" River Temperature (MWGen Model--50% dilution) (in °F) (data in parentheses using real-time flow values)	Calculated "Fully Mixed" River Temperature (MWGen Model--100% dilution) (in °F) (data in parentheses using real-time flow values)	24-Hour Rolling Avg. River Flow (in cfs)	Average Real-Time. River Flow (in cfs)
27 June	90	90 (90)	89 (90)	88 (89)	3102	2748
11 July	89	90 (91)	88 (89)	86 (87)	4609	3575
1 August	92 (93)	93 (93)	92 (93)	91 (92)	3406	2729
9 August	90 (90)	91 (92)	91 (91)	89 (90)	2841	2541
15 August	89	95* (94)	92* (92)	90 (89)	4891	4721
20 August	88 (88)	90 (89)	88 (88)	86 (86)	3067	3404
28 August	85 (84)	87 (87)	85 (85)	83 (83)	4435	4100
4 September	90	93 (91)	91 (89)	90 (87)	2531	3910

*River flow on 8/15 was well over 4000 cfs for the entire day. The cooling towers were not in use during the study, but were so immediately before and after the measurements were made. Thus, there was a short period of higher discharge temps that were used in our model calculations, which resulted in the higher calculated mixed temp. values. There were also significant wind speeds on this date, which could have caused the field measurements to be several degrees cooler than the calculated values. (The Midwest Generation near-field compliance model does not incorporate weather data effects into the calculations). In this particular case, the calculated 100% dilution value is much closer to the actual field measurement.

**Survey times for specific study dates are listed in Table 3-1 of the Joliet Station Thermal Plume Survey Report.

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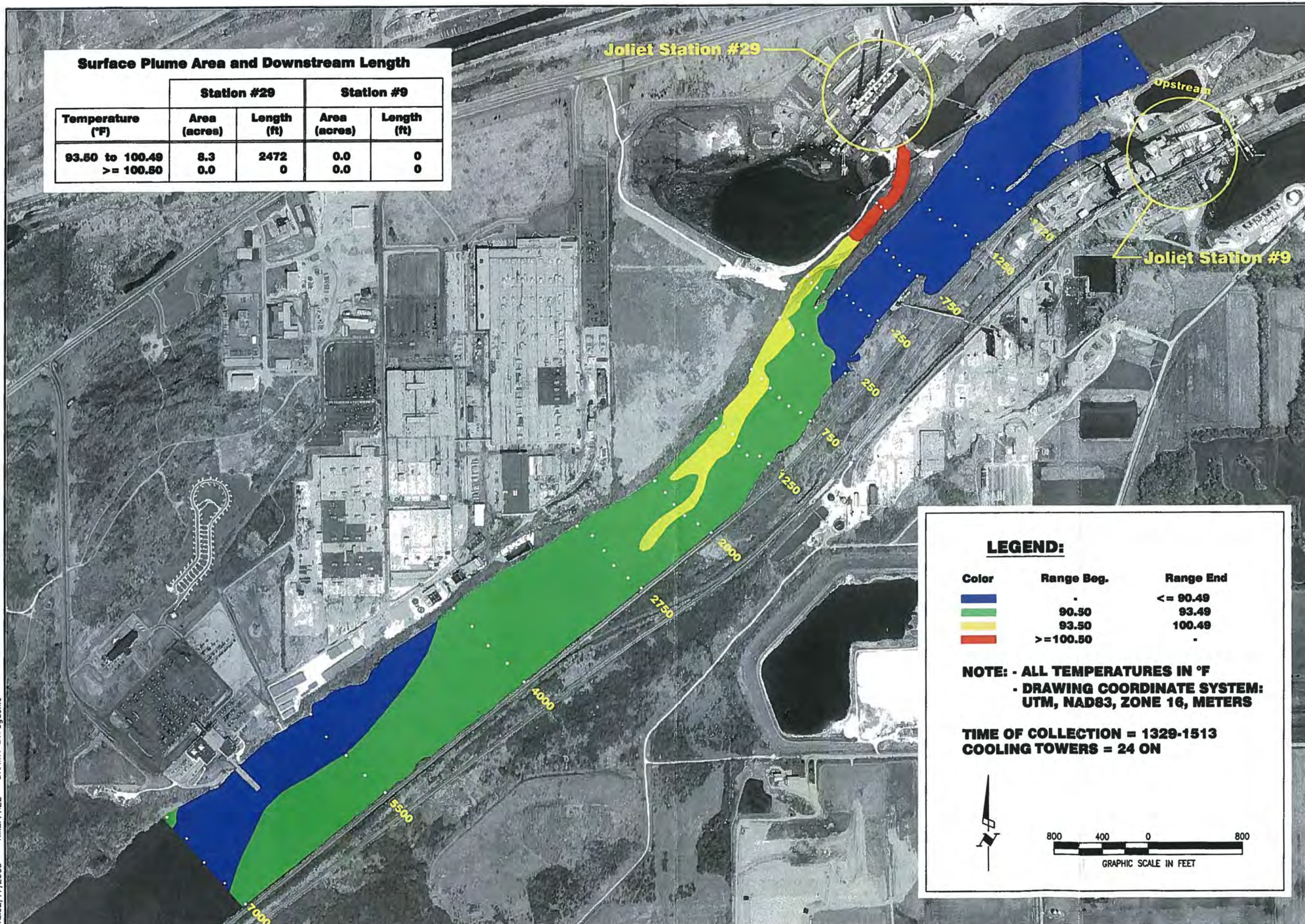

Surface Plume Area and Downstream Length

	Station #29		Station #9	
Temperature (°F)	Area (acres)	Length (ft)	Area (acres)	Length (ft)
93.50 to 100.49	8.3	2472	0.0	0
>= 100.50	0.0	0	0.0	0

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

MIDWEST GENERATION
TEMPERATURE MAPPING
JOLIET, ILLINOIS

JUNE 27, 2002
SURFACE TEMPERATURE MAPPING
NEAR JOLIET STATIONS #9 & #29

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
JV	-	EG	ML	DEC 2002	AS SHOWN	61393.08	-	-	4 - 1

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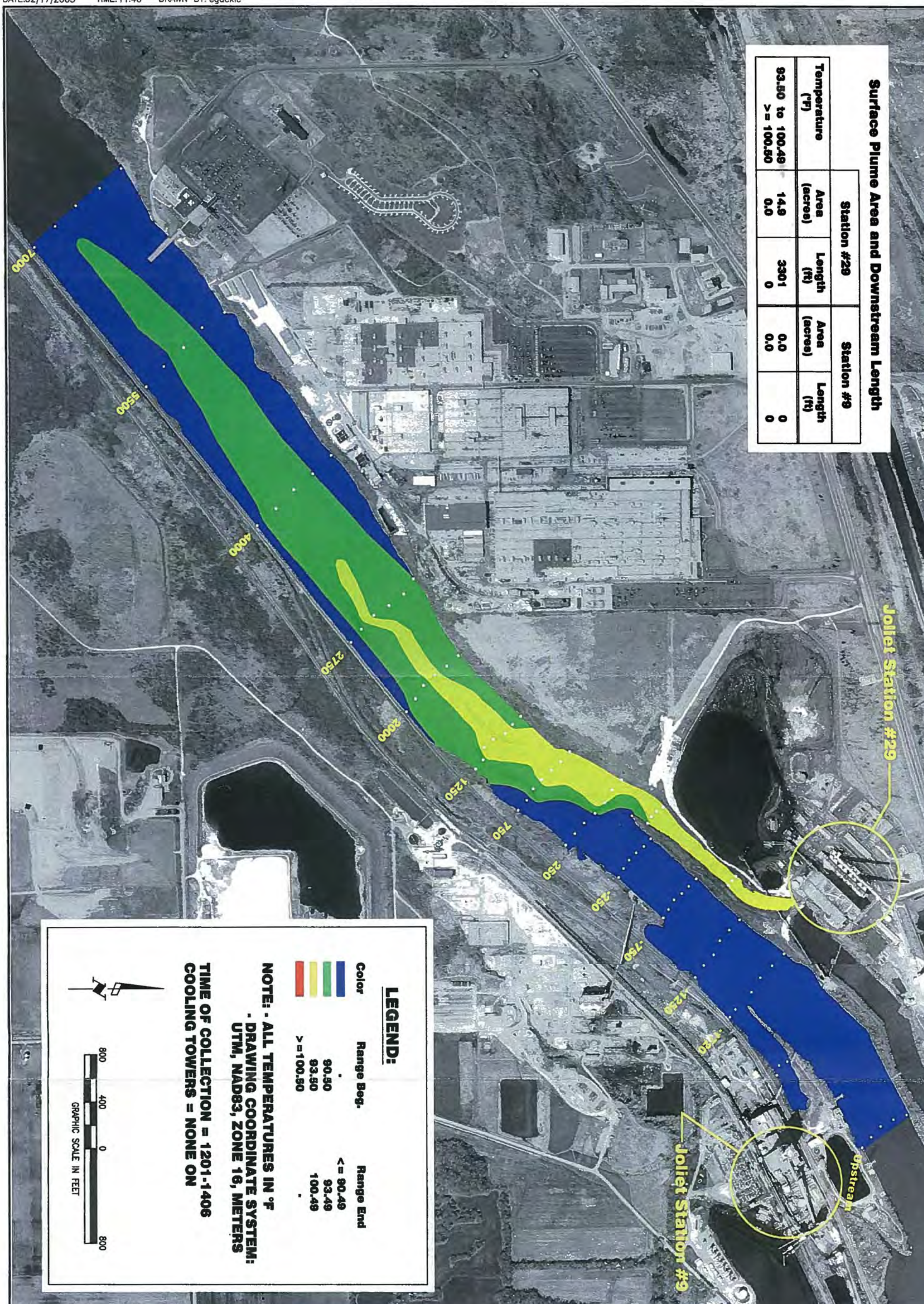

Temperature (°F)	Station #29 Area (acres)	Station #29 Length (ft)	Station #9 Area (acres)	Station #9 Length (ft)
93.50 to 100.49	14.9	3301	0.0	0
>= 100.50	0.0	0	0.0	0

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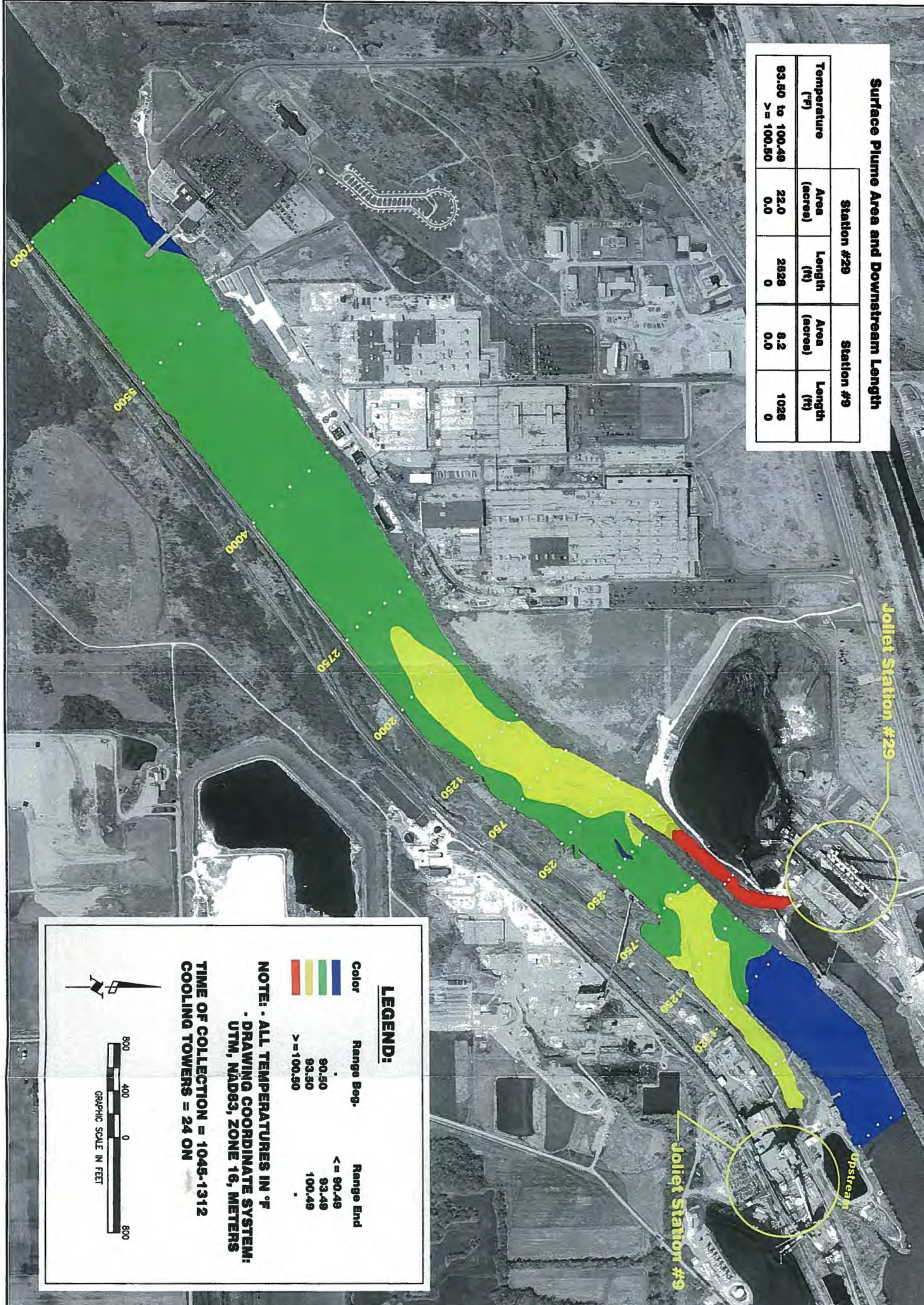
EA ENGINEERING, SCIENCE, AND TECHNOLOGY	MIDWEST GENERATION TEMPERATURE MAPPING JOLIET, ILLINOIS	JULY 11, 2002 SURFACE TEMPERATURE MAPPING NEAR JOLIET STATIONS #9 & #29

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
JV	-	EG	ML	DEC 2002	AS SHOWN	61393.08	-	-	4 - 2

DRAWING NAME: F:\Utility\MidGen\6139308\Figures\New-surfacetemp\dwg\J_01AUGF.dwg
DATE:02/17/2003 TIME:11:53 DRAWN BY: egackic

Surface Plume Area and Downstream Length

Temperature (°F)	Station #29 Area (acres)	Station #29 Length (ft)	Station #9 Area (acres)	Station #9 Length (ft)
93.50 to 100.49	22.0	2628	8.2	1026
>= 100.50	0.0	0	0.0	0



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EA ENGINEERING, SCIENCE, AND TECHNOLOGY

MIDWEST GENERATION
TEMPERATURE MAPPING
JOLIET, ILLINOIS

AUGUST 1, 2002
SURFACE TEMPERATURE MAPPING
NEAR JOLIET STATIONS #9 & #29

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
JV	-	EG	ML	DEC 2002	AS SHOWN	61393.08	-	-	4 -3

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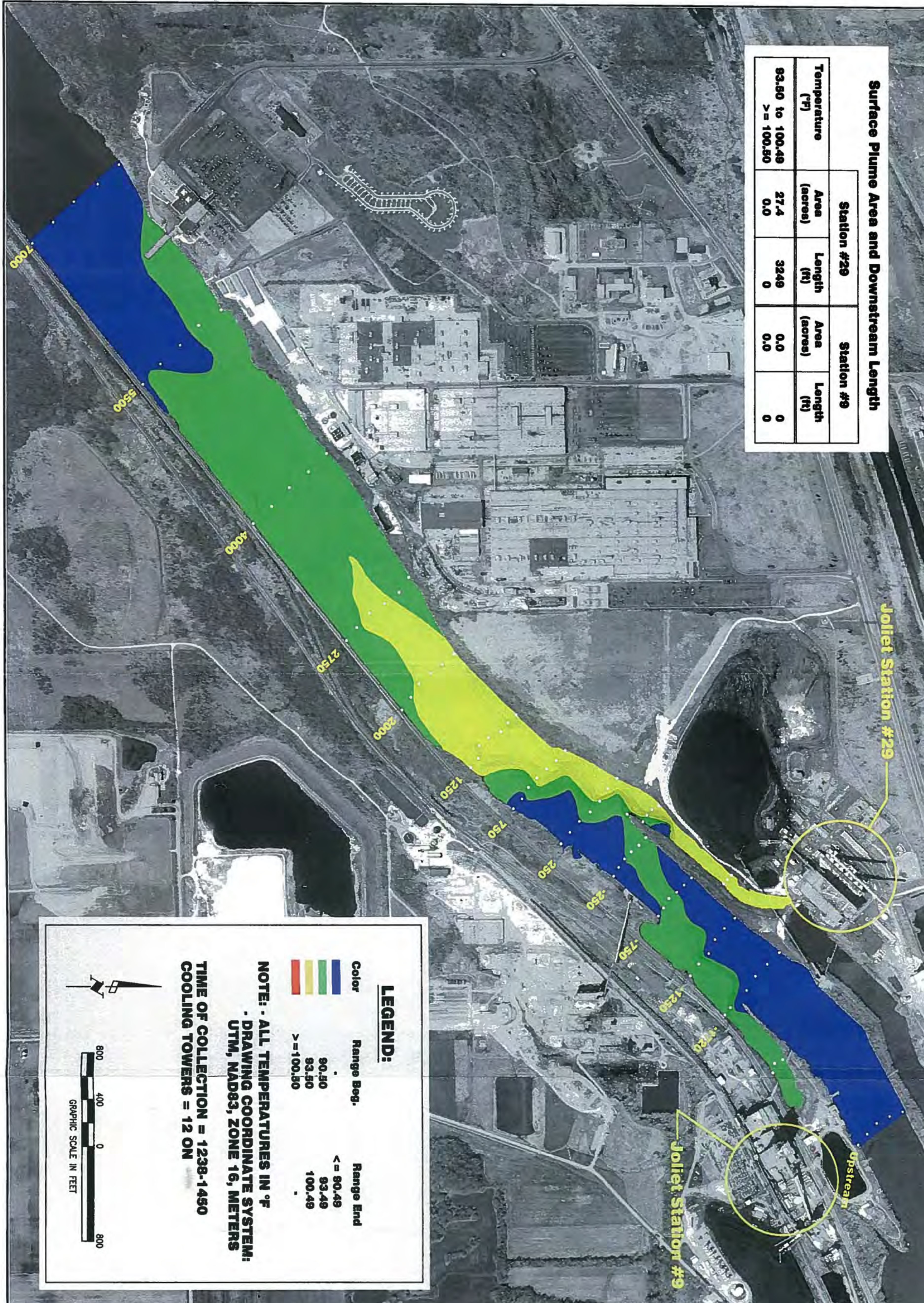

EA ENGINEERING, SCIENCE, AND TECHNOLOGY	MIDWEST GENERATION TEMPERATURE MAPPING JOLIET, ILLINOIS	AUGUST 9, 2002 SURFACE TEMPERATURE MAPPING NEAR JOLIET STATIONS #9 & #29

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
JV	–	EG	ML	DEC 2002	AS SHOWN	61393.08	–	–	4 - 4

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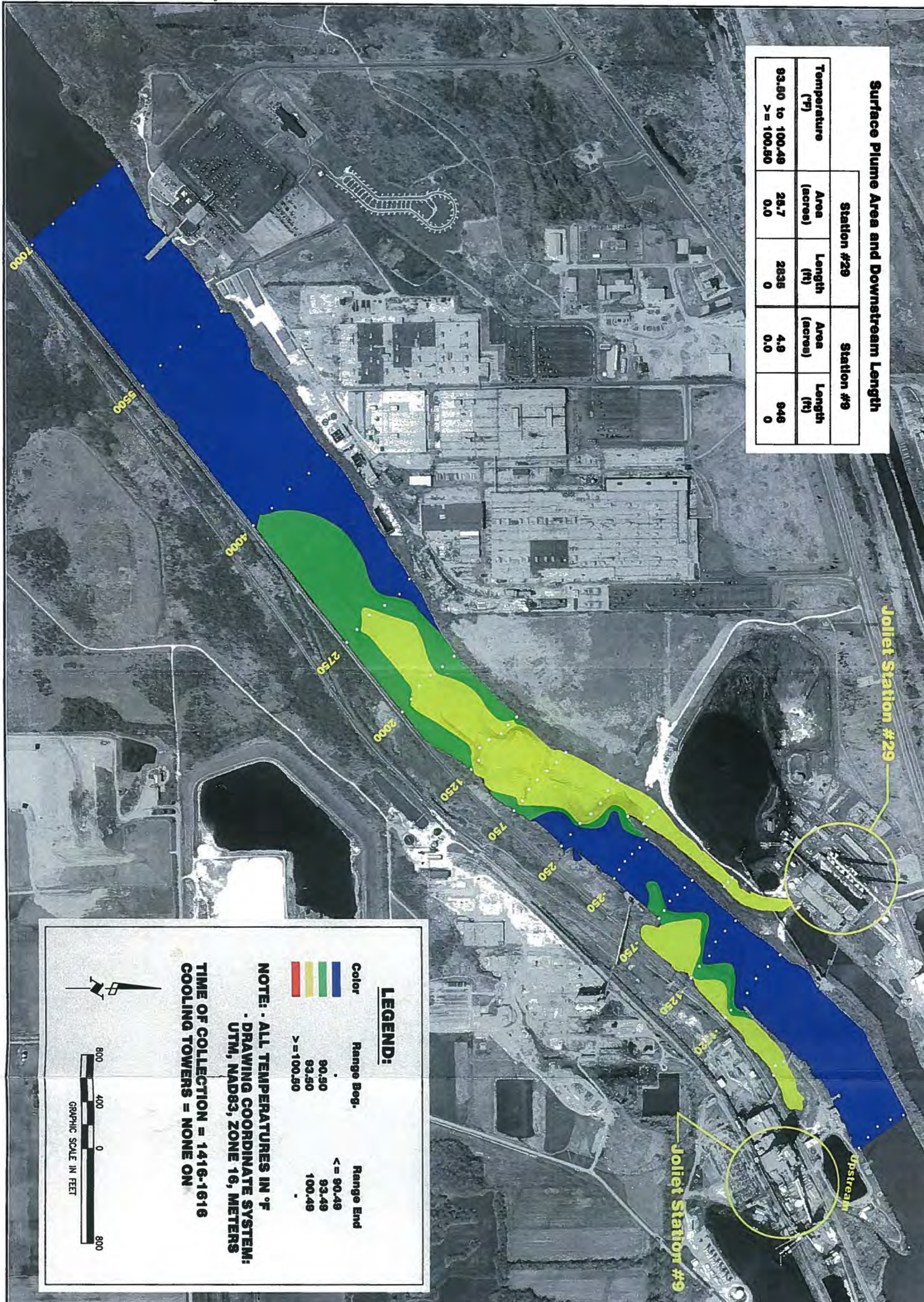

Temperature (°F)	Station #29 Area (acres)	Station #29 Length (ft)	Station #9 Area (acres)	Station #9 Length (ft)
83.50 to 100.49	25.7	2835	4.9	946
>= 100.50	0.0	0	0.0	0

EA ENGINEERING, SCIENCE, AND TECHNOLOGY	MIDWEST GENERATION TEMPERATURE MAPPING JOLIET, ILLINOIS	AUGUST 15, 2002 SURFACE TEMPERATURE MAPPING NEAR JOLIET STATIONS #9 & #29

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
JV	-	EG	ML	DEC 2002	AS SHOWN	61393.08	-	-	4 - 5

DRAWING NAME: F:\Utility\MidGen\6139308\Figures\New-surfacetemp\dwg\J_20AUGF.dwg
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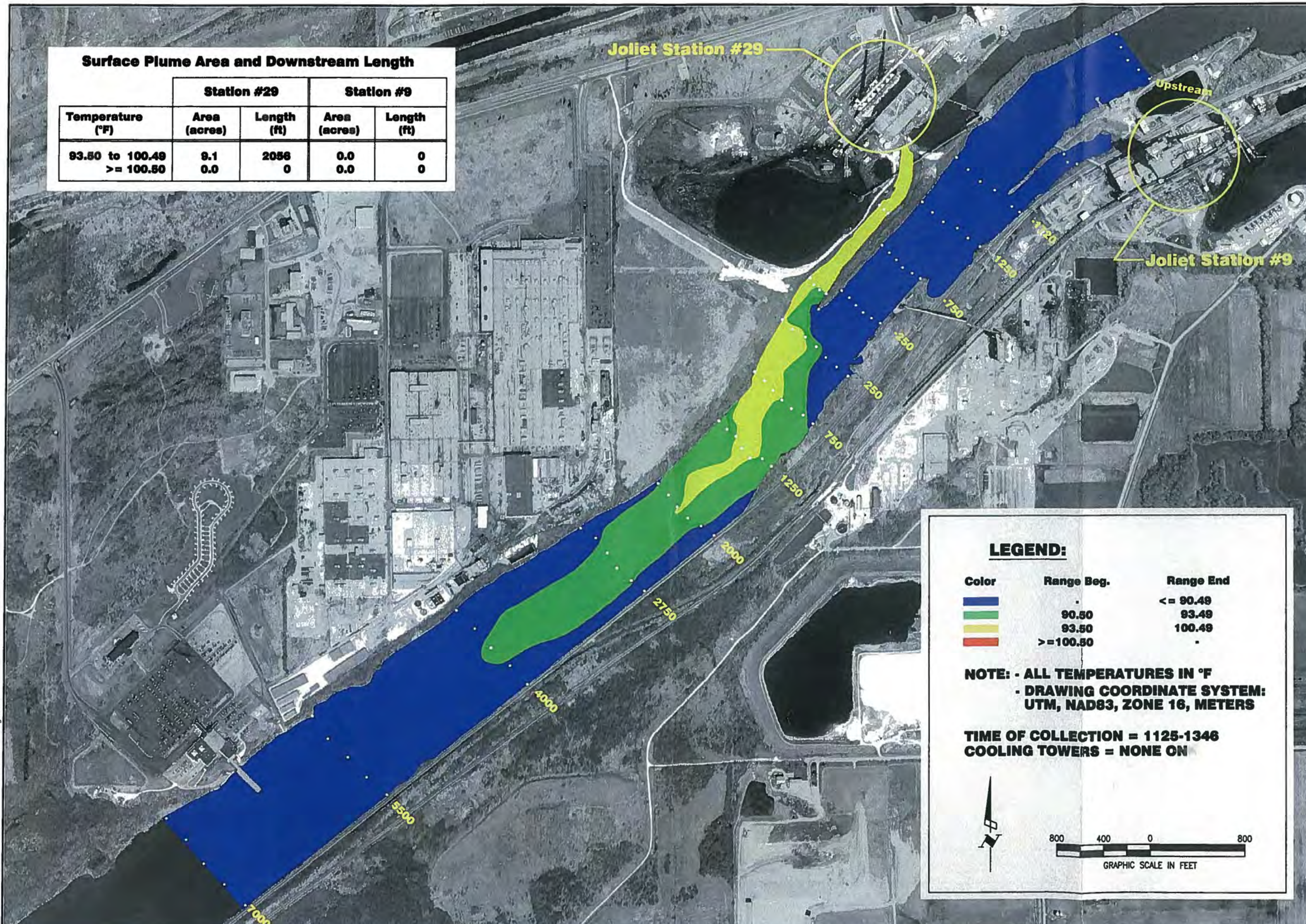

Surface Plume Area and Downstream Length

	Station #29		Station #9	
Temperature (°F)	Area (acres)	Length (ft)	Area (acres)	Length (ft)
93.50 to 100.49	9.1	2056	0.0	0
>= 100.50	0.0	0	0.0	0

LEGEND:

Color	Range Beg.	Range End
Blue	-	<= 90.49
Green	90.50	93.49
Yellow	93.50	100.49
Red	>=100.50	-

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

MIDWEST GENERATION
TEMPERATURE MAPPING
JOLIET, ILLINOIS

AUGUST 20, 2002
SURFACE TEMPERATURE MAPPING
NEAR JOLIET STATIONS #9 & #29

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
JV	-	EG	ML	DEC 2002	AS SHOWN	61393.08	-	-	4 - 6

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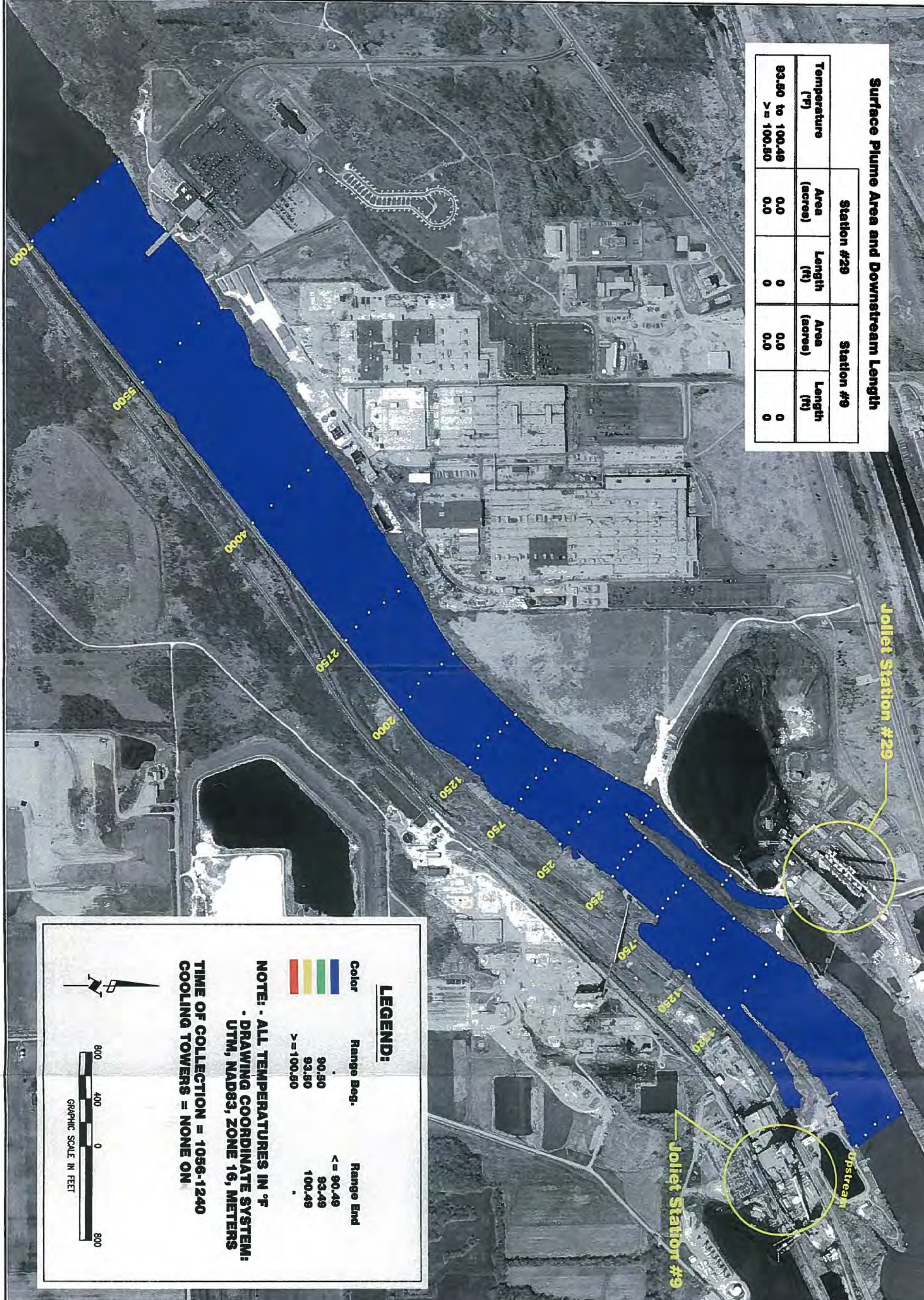

EA ENGINEERING, SCIENCE, AND TECHNOLOGY	MIDWEST GENERATION TEMPERATURE MAPPING JOLIET, ILLINOIS	AUGUST 28, 2002 SURFACE TEMPERATURE MAPPING NEAR JOLIET STATIONS #9 & #29

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
JV	-	EG	ML	DEC 2002	AS SHOWN	61393.08	-	-	4 - 7

DRAWING NAME: F:\Utility\MidGen\6139308\Figures\New-surfacetemp\dwg\J_04SEPF.dwg
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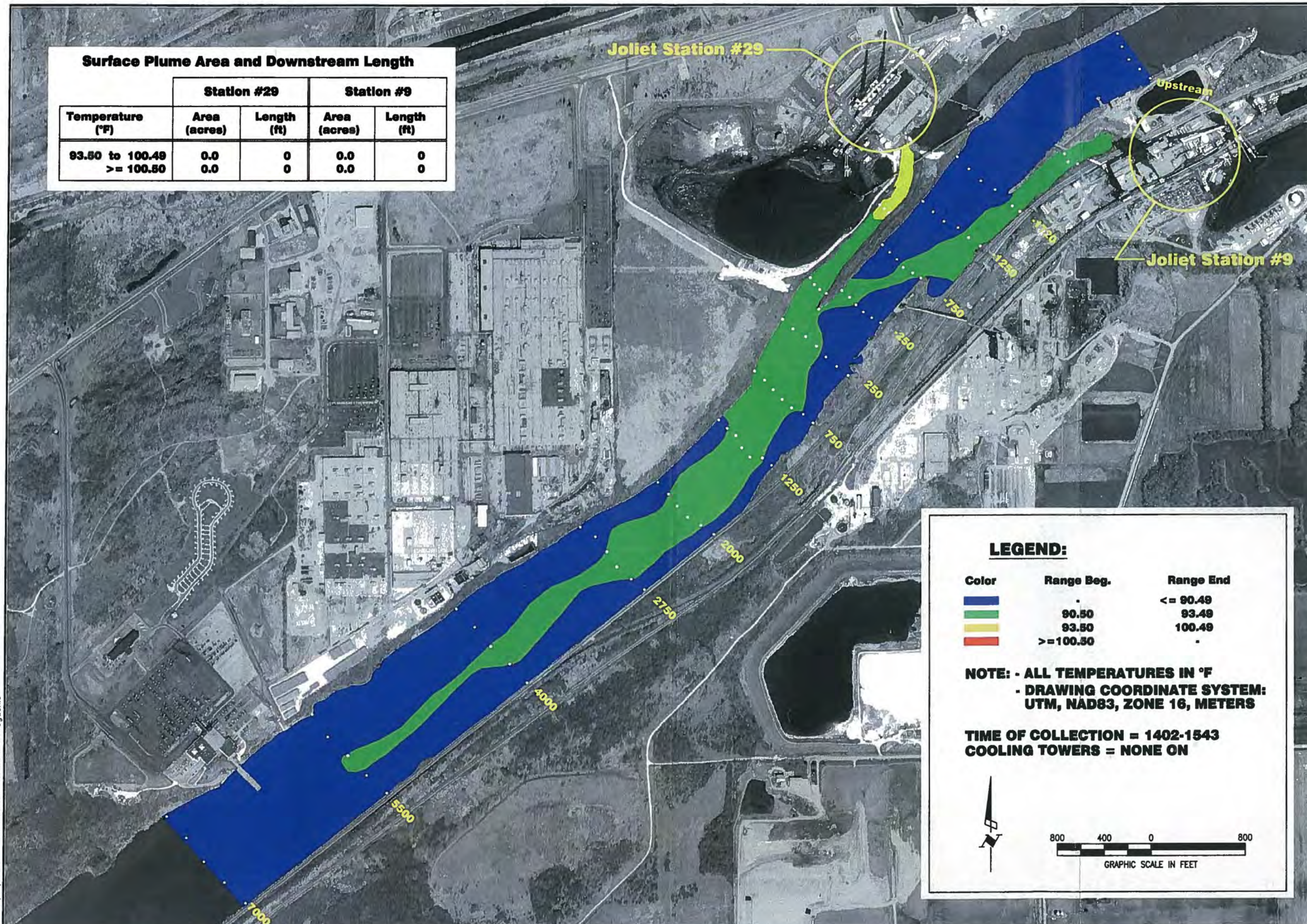


Surface Plume Area and Downstream Length

Temperature (°F)	Station #29 Area (acres)	Station #29 Length (ft)	Station #9 Area (acres)	Station #9 Length (ft)
93.50 to 100.49	0.0	0	0.0	0
>= 100.50	0.0	0	0.0	0

LEGEND:

Color	Range Beg.	Range End
Blue	-	<= 90.49
Green	90.50	93.49
Yellow	93.50	100.49
Red	>=100.50	-

NOTE: - ALL TEMPERATURES IN °F
- DRAWING COORDINATE SYSTEM: UTM, NAD83, ZONE 16, METERS

TIME OF COLLECTION = 1402-1543
COOLING TOWERS = NONE ON

EA ENGINEERING, SCIENCE, AND TECHNOLOGY	MIDWEST GENERATION TEMPERATURE MAPPING JOLIET, ILLINOIS	SEPTEMBER 4, 2002 SURFACE TEMPERATURE MAPPING NEAR JOLIET STATIONS #9 & #29

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
JV	-	EG	ML	DEC 2002	AS SHOWN	61393.08	-	-	4 - 8

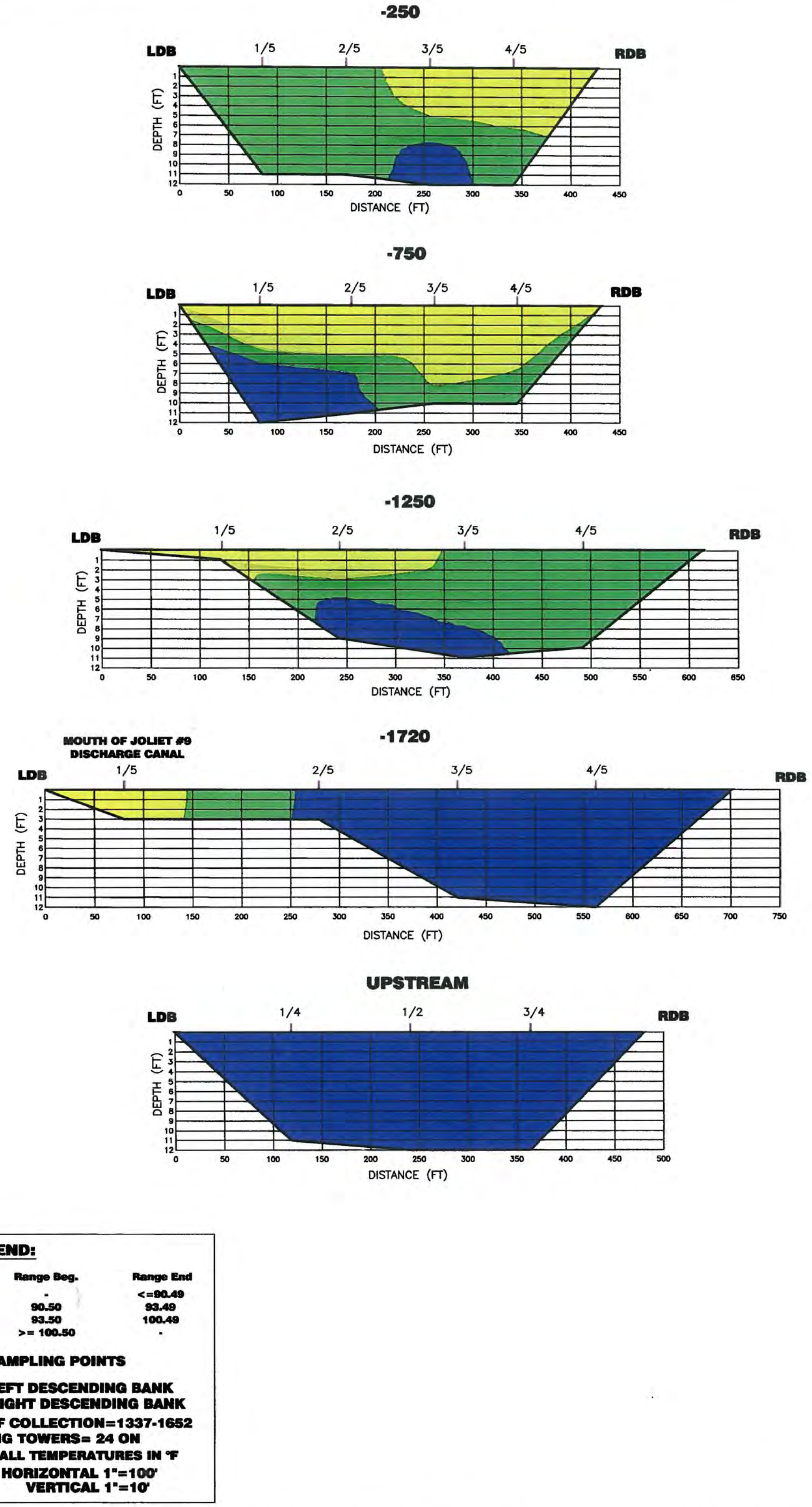


FIGURE 4 - 9. Cross Section Temperatures at the Upstream, -1720, -1250, -750, and -250 Transects, Near the Joliet Stations, August 1, 2002.

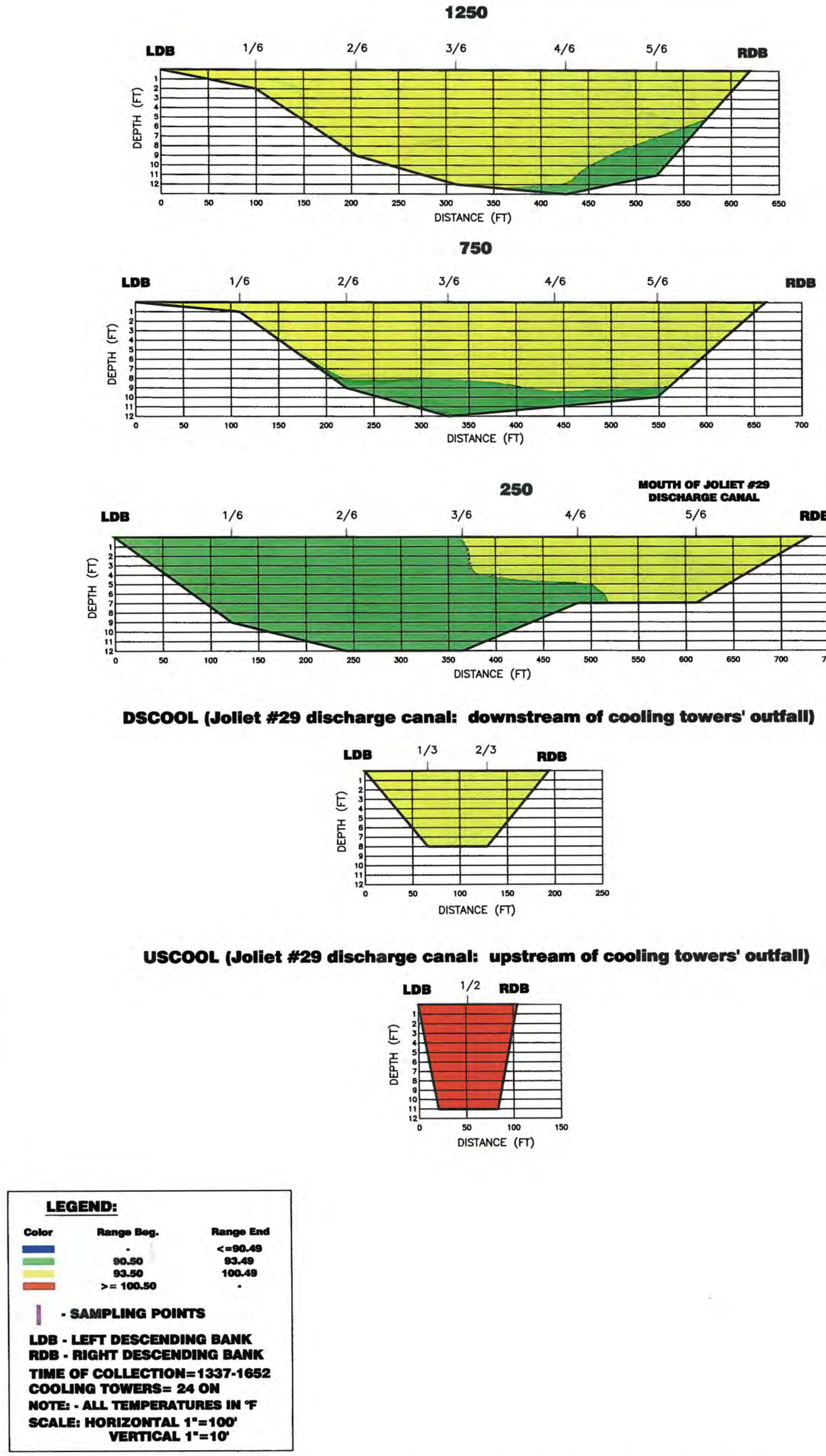
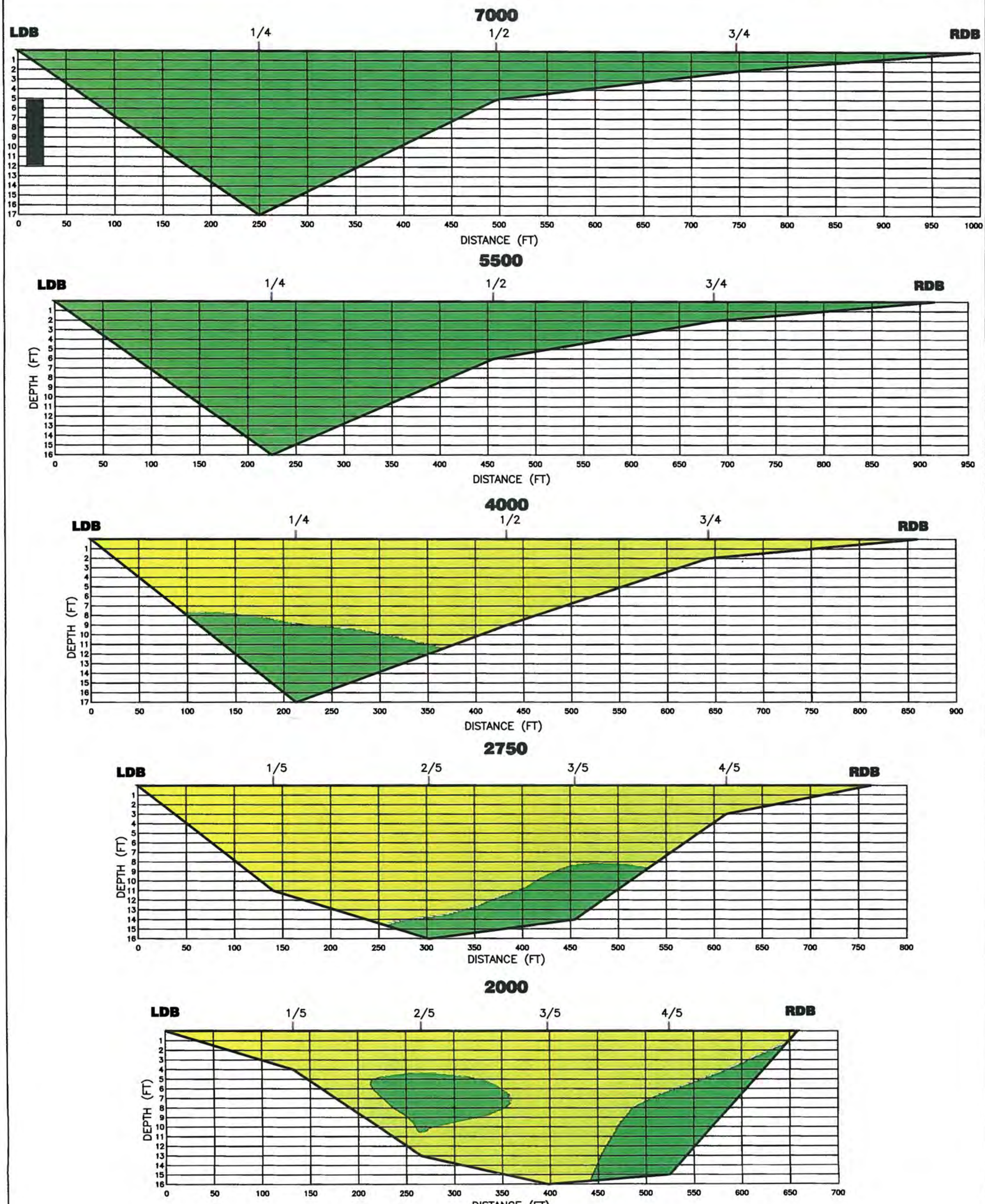


FIGURE 4 - 10. Cross Section Temperatures at the USCOOL, DSCOOL, 250, 750, and 1250 Transects, Near the Joliet Stations, August 1, 2002.



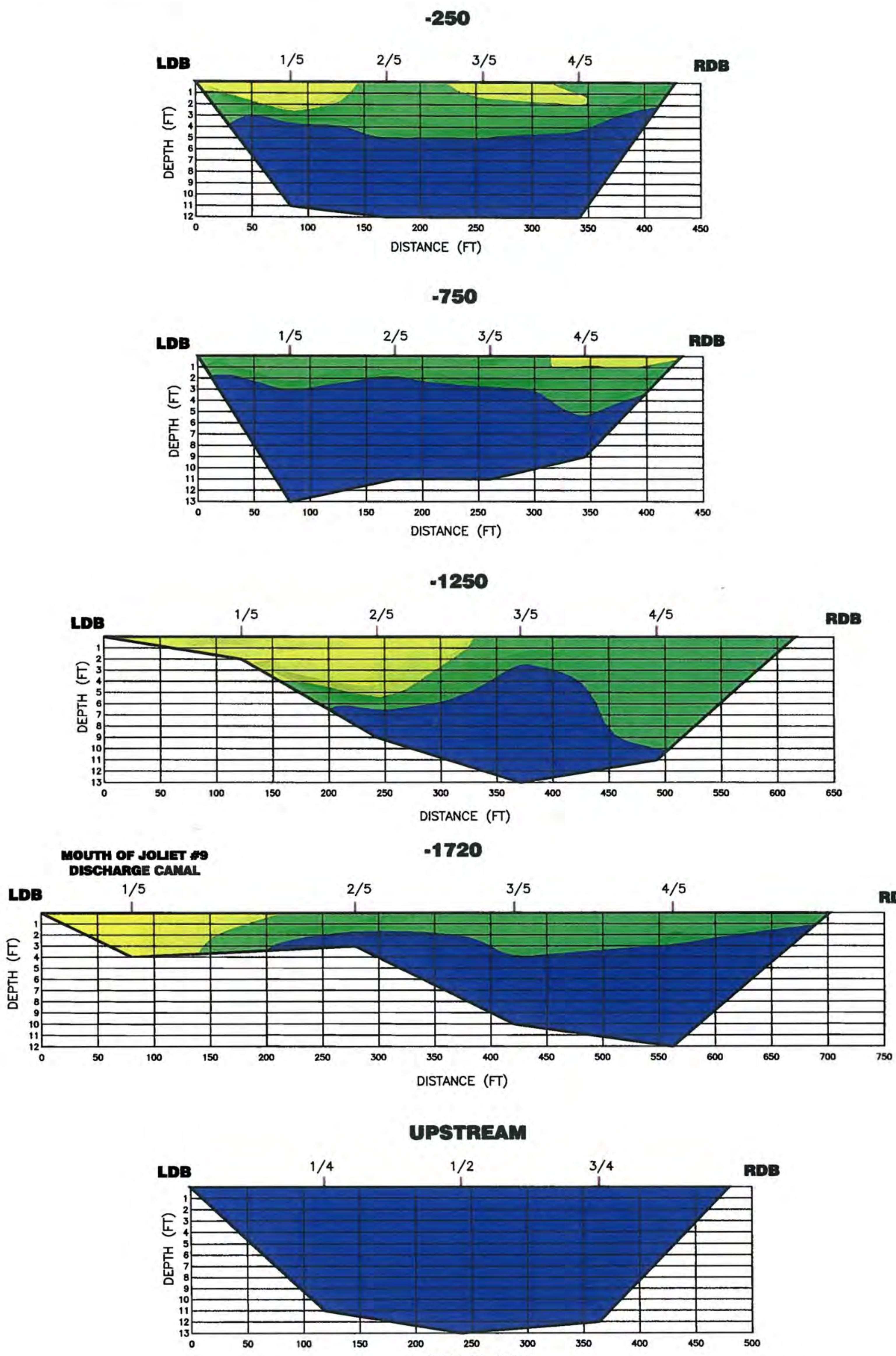
LEGEND:

Color	Range Beg.	Range End
Blue	-	<=90.49
Green	90.50	93.49
Yellow	93.50	100.49
Red	>= 100.50	-

- SAMPLING POINTS

LDB - LEFT DESCENDING BANK
RDB - RIGHT DESCENDING BANK
TIME OF COLLECTION=1337-1652
COOLING TOWERS= 24 ON
NOTE: - ALL TEMPERATURES IN °F
SCALE: HORIZONTAL 1"=100'
VERTICAL 1"=10'

FIGURE 4 - 11. Cross Section Temperatures at the 2000, 2750, 4000, 5500, and 7000 Transects, Near the Joliet Stations, August 1, 2002.



LEGEND:

Color	Range Beg.	Range End
Blue	-	<=90.49
Green	90.50	93.49
Yellow	93.50	100.49
Red	>= 100.50	-

- SAMPLING POINTS

LDB - LEFT DESCENDING BANK
RDB - RIGHT DESCENDING BANK
TIME OF COLLECTION=1520-1725
COOLING TOWERS= 12 ON
NOTE: - ALL TEMPERATURES IN °F
SCALE: HORIZONTAL 1"=100'
VERTICAL 1"=10'

FIGURE 4 - 12. Cross Section Temperature at the Upstream, -1720, -1250, -750, and -250 Transects, Near the Joliet Stations, August 9, 2002.

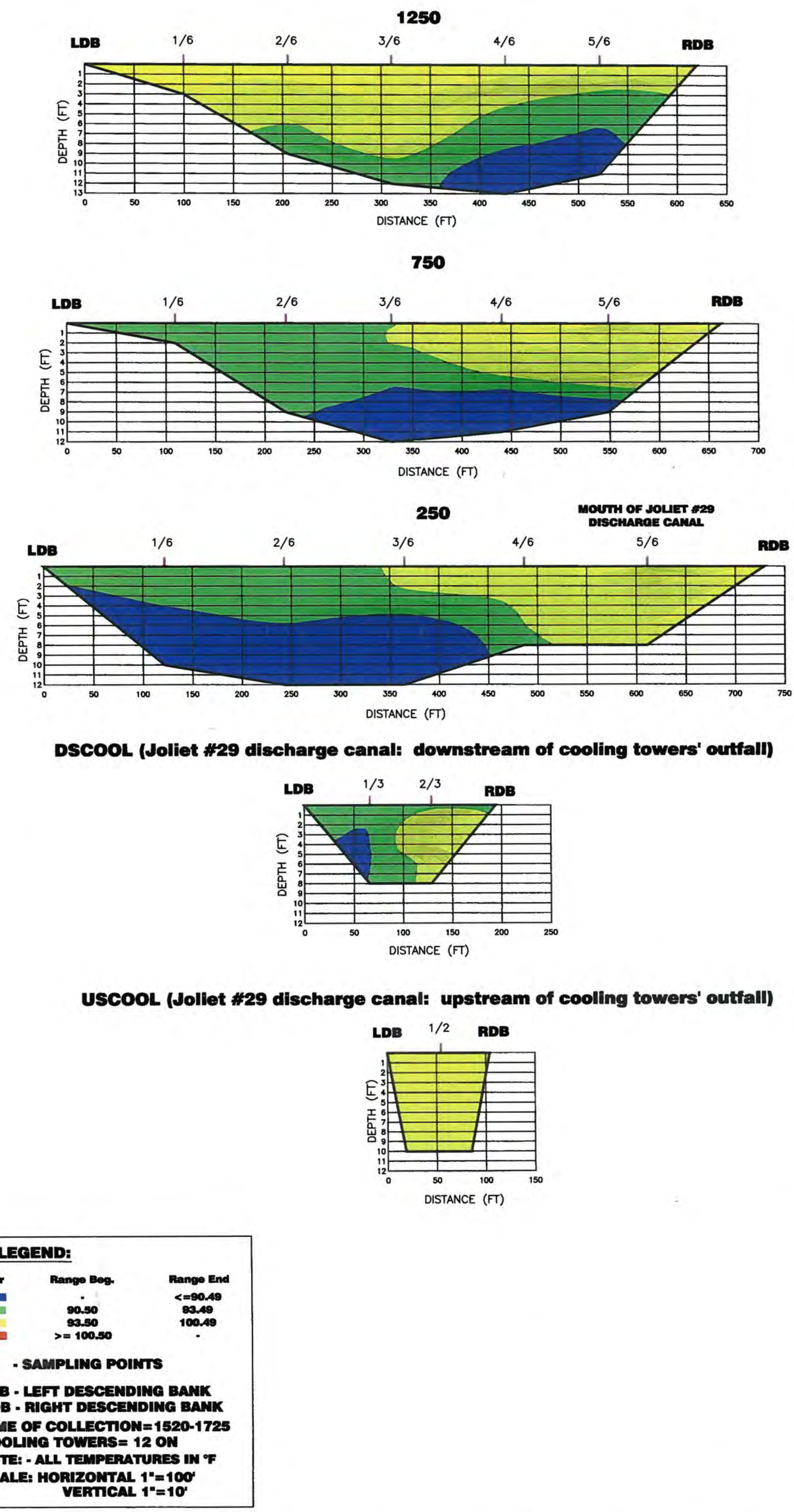
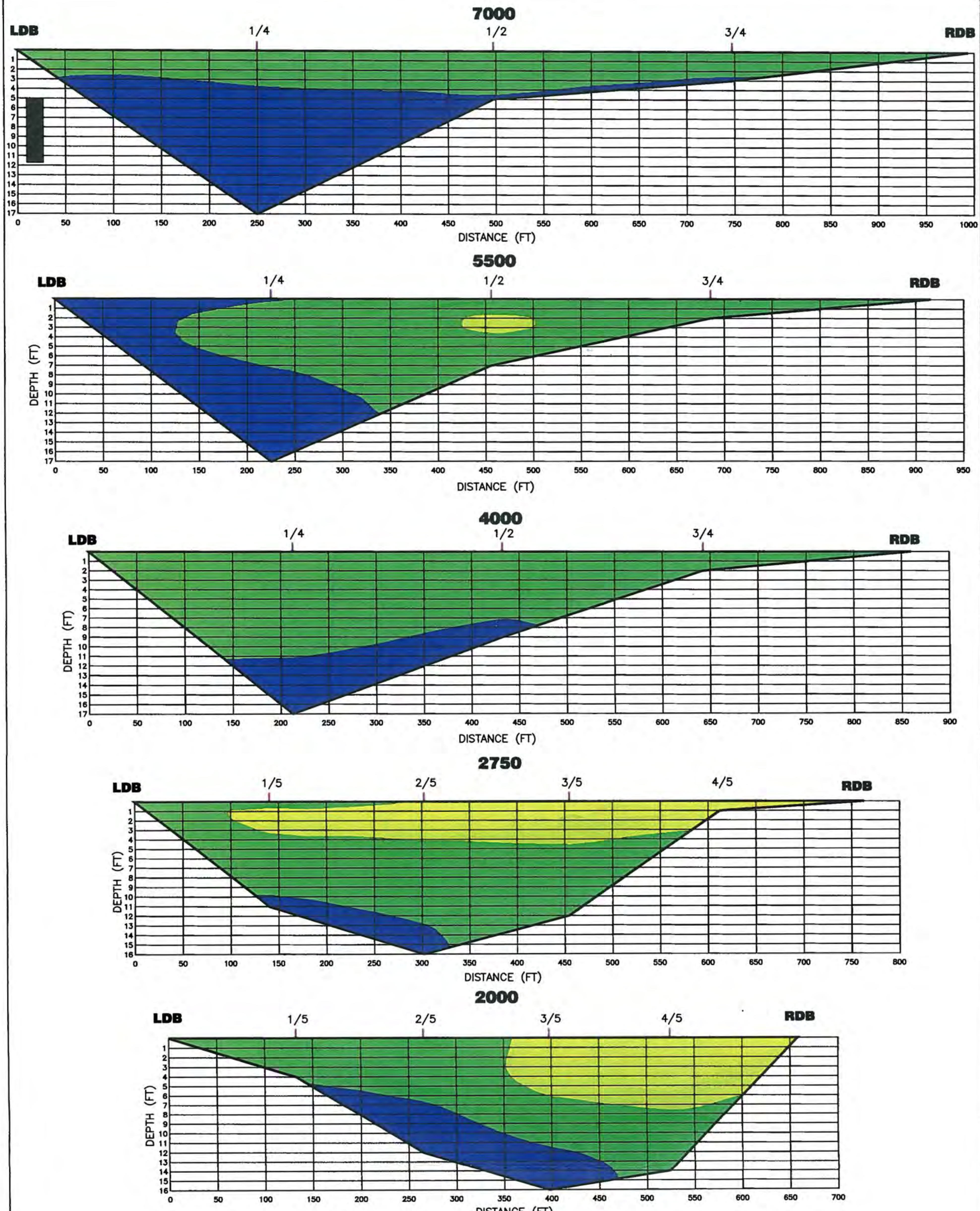


FIGURE 4 - 13. Cross Section Temperatures at the USCOOL, DSCOOL, 250, 750, and 1250 Transects, Near the Joliet Stations, August 9, 2002.



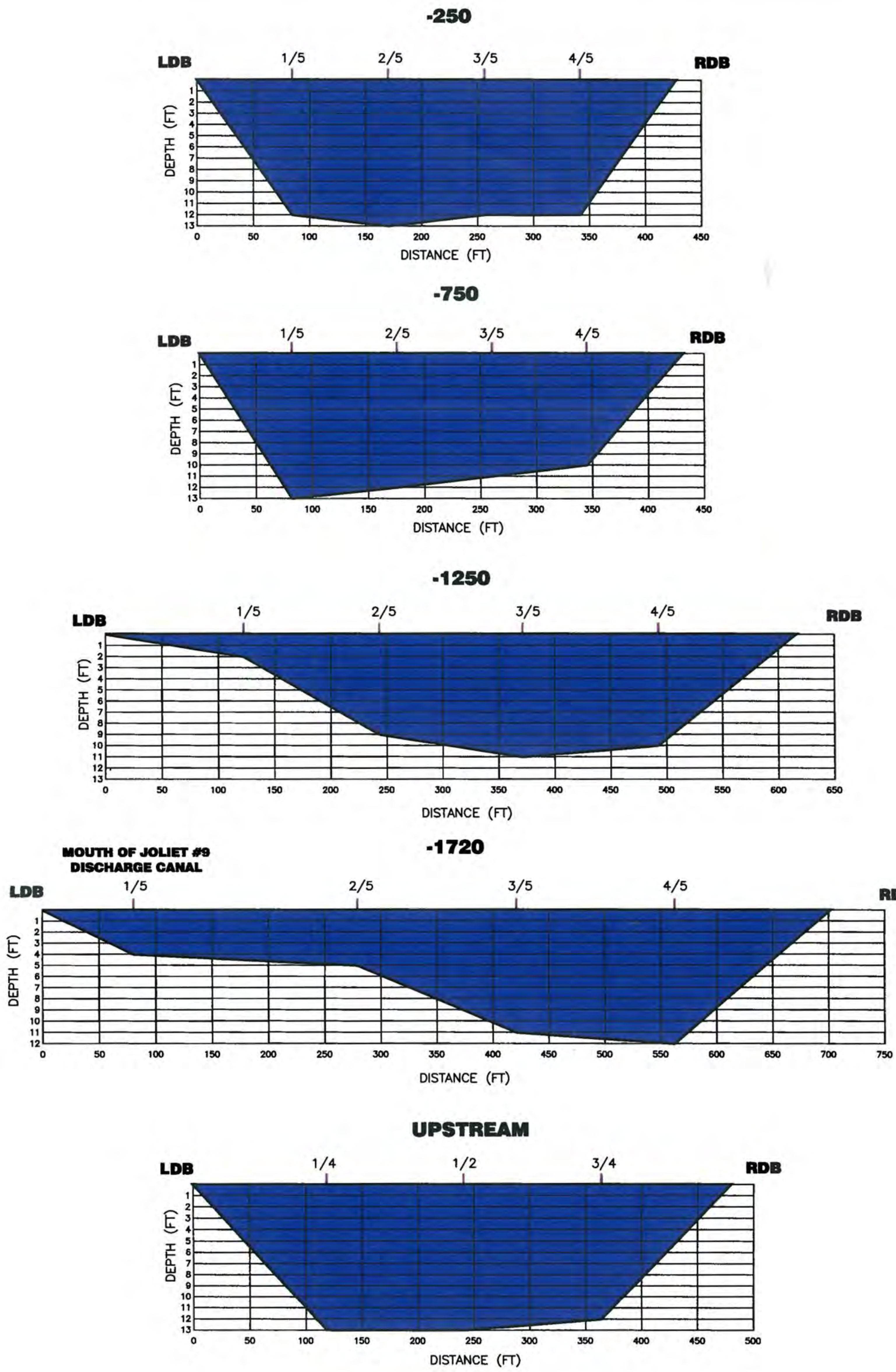
LEGEND:

Color	Range Beg.	Range End
Blue	-	<=90.49
Green	90.50	93.49
Yellow	93.50	100.49
Red	>= 100.50	-

| - SAMPLING POINTS

LDB - LEFT DESCENDING BANK
RDB - RIGHT DESCENDING BANK
TIME OF COLLECTION=1520-1725
COOLING TOWERS= 12 ON
NOTE: - ALL TEMPERATURES IN °F
SCALE: HORIZONTAL 1"=100'
VERTICAL 1"=10'

FIGURE 4 -14. Cross Section Temperatures at the 2000, 2750, 4000, 5500, and 7000 Transects, Near the Joliet Stations, August 9, 2002.



LEGEND:

Color	Range Beg.	Range End
Blue	-	<=90.49
Green	90.50	93.49
Yellow	93.50	100.49
Red	>= 100.50	-

- SAMPLING POINTS

LDB - LEFT DESCENDING BANK
RDB - RIGHT DESCENDING BANK

TIME OF COLLECTION=1409-1625
COOLING TOWERS= NONE ON
NOTE: - ALL TEMPERATURES IN °F
SCALE: HORIZONTAL 1"=100'
VERTICAL 1"=10'

FIGURE 4 - 15. Cross Section Temperatures at the Upstream, -1720, -1250, -750, and -250 Transects, Near the Joliet Stations, August 20, 2002.

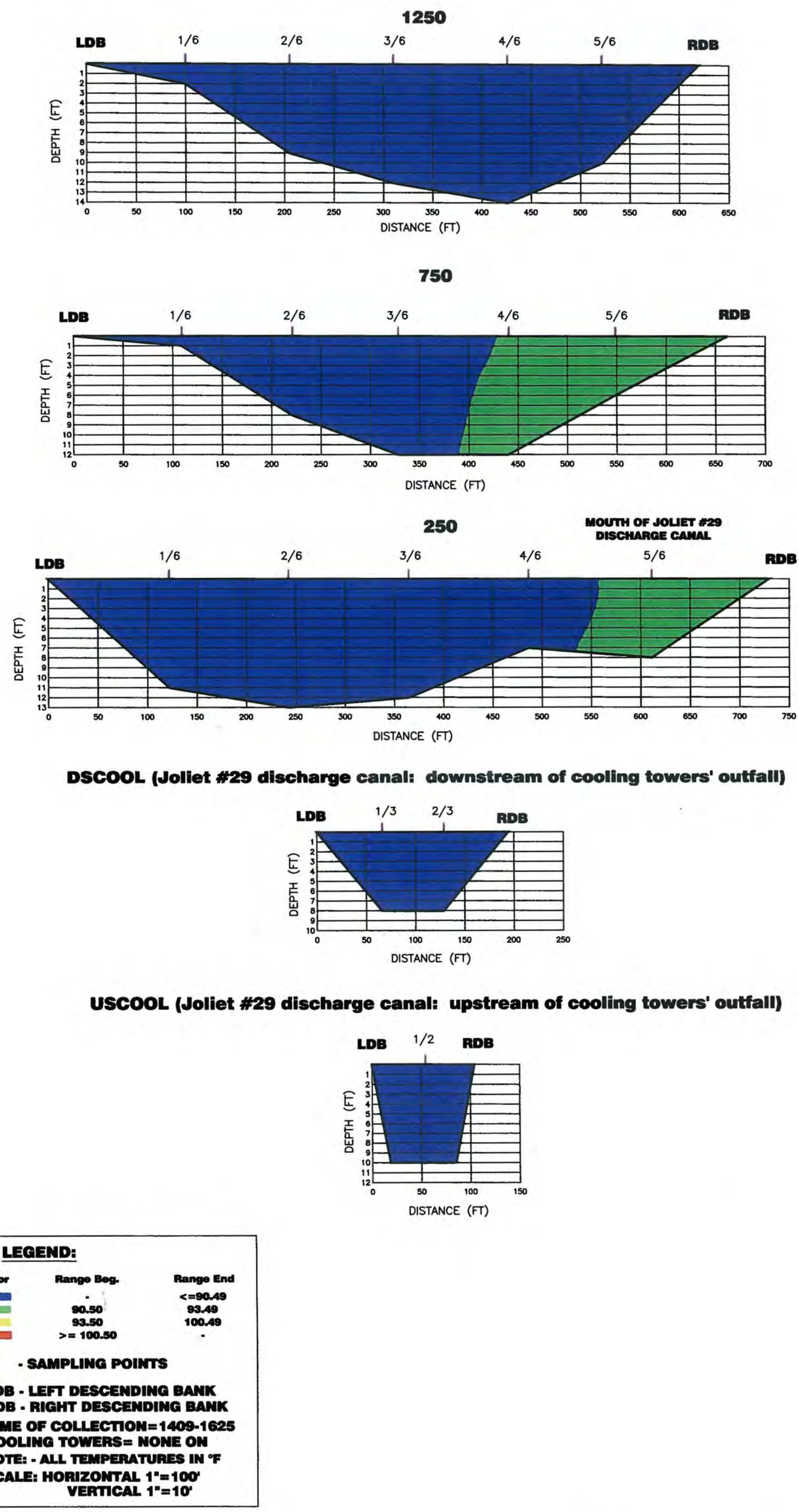


FIGURE 4 - 16. Cross Section Temperatures at the USCOOL, DSCOOL, 250, 750, and 1250 Transects, Near the Joliet Stations, August 20, 2002.

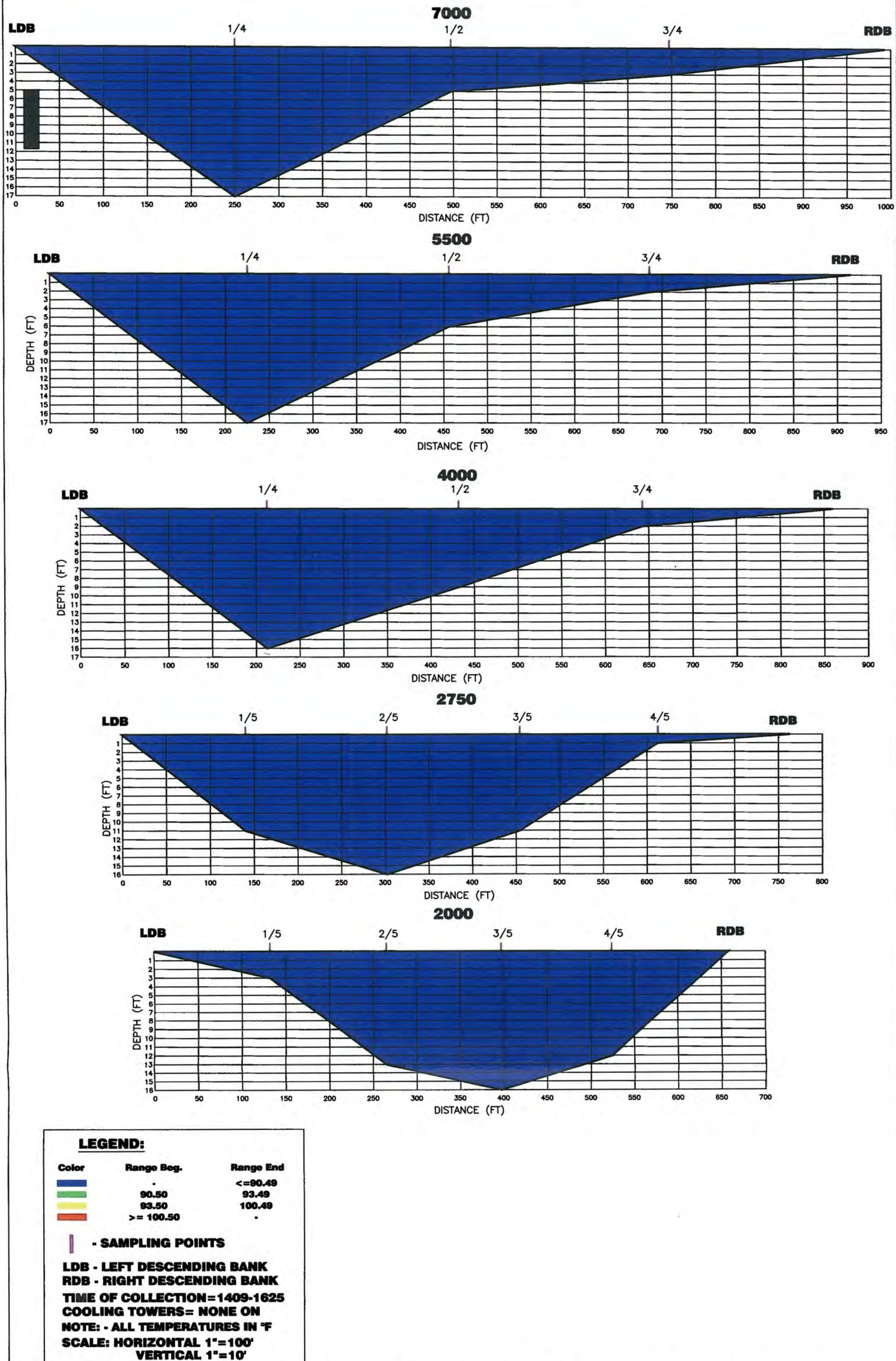
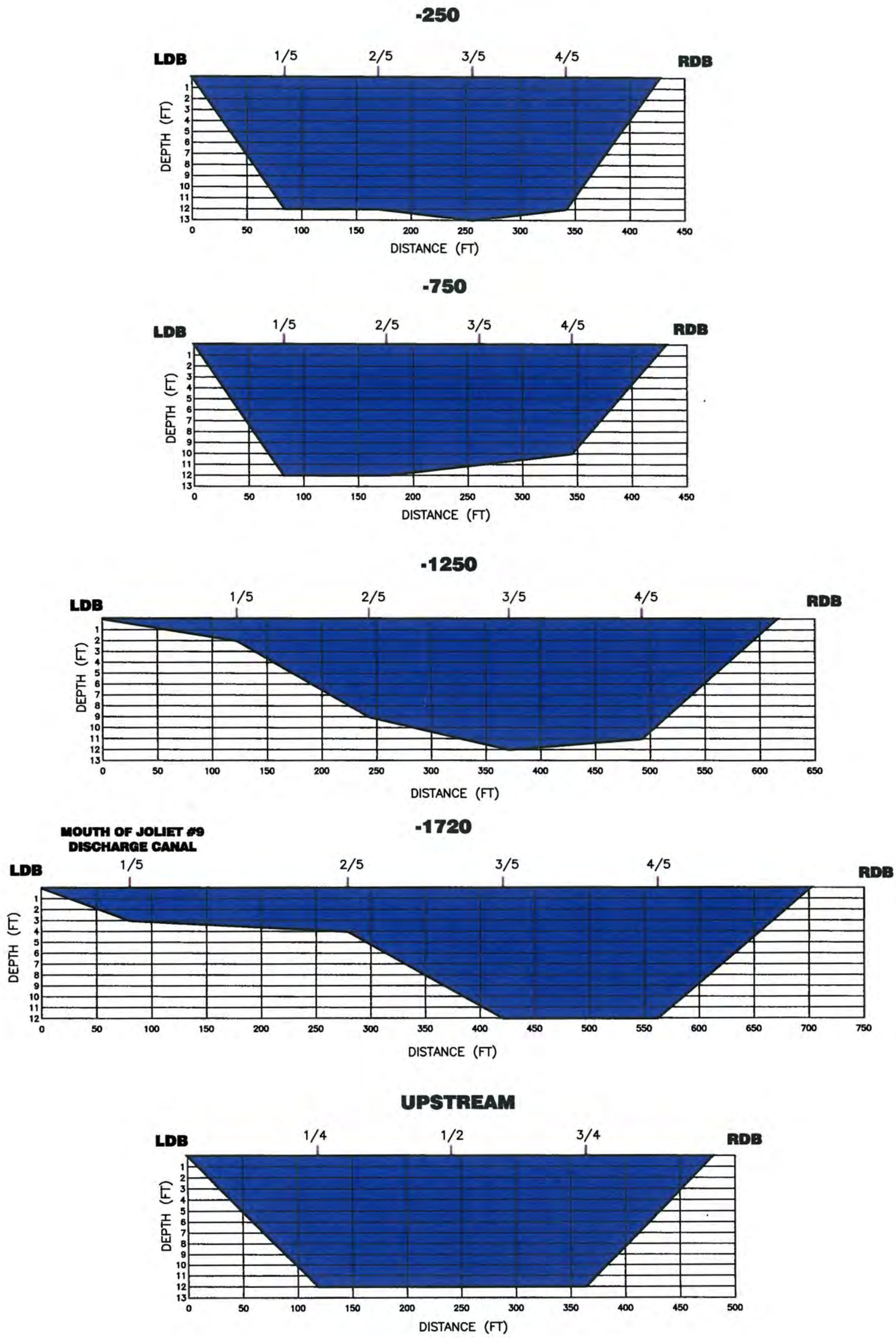


FIGURE 4 - 17. Cross Section Temperatures at the 2000, 2750, 4000, 5500, and 7000 Transects, Near the Joliet Stations, August 20, 2002.



LEGEND:

Color	Range Beg.	Range End
Blue	-	<=90.49
Green	90.50	93.49
Yellow	93.50	100.49
Red	>= 100.50	-

\| - SAMPLING POINTS

LDB - LEFT DESCENDING BANK
RDB - RIGHT DESCENDING BANK
TIME OF COLLECTION=1305-1513
COOLING TOWERS= NONE ON
NOTE: - ALL TEMPERATURES IN °F
SCALE: HORIZONTAL 1"=100'
VERTICAL 1"=10'

FIGURE 4 - 18. Cross Section Temperatures at the Upstream, -1720, -1250, -750, and -250 Transects, Near the Joliet Stations, August 28, 2002.

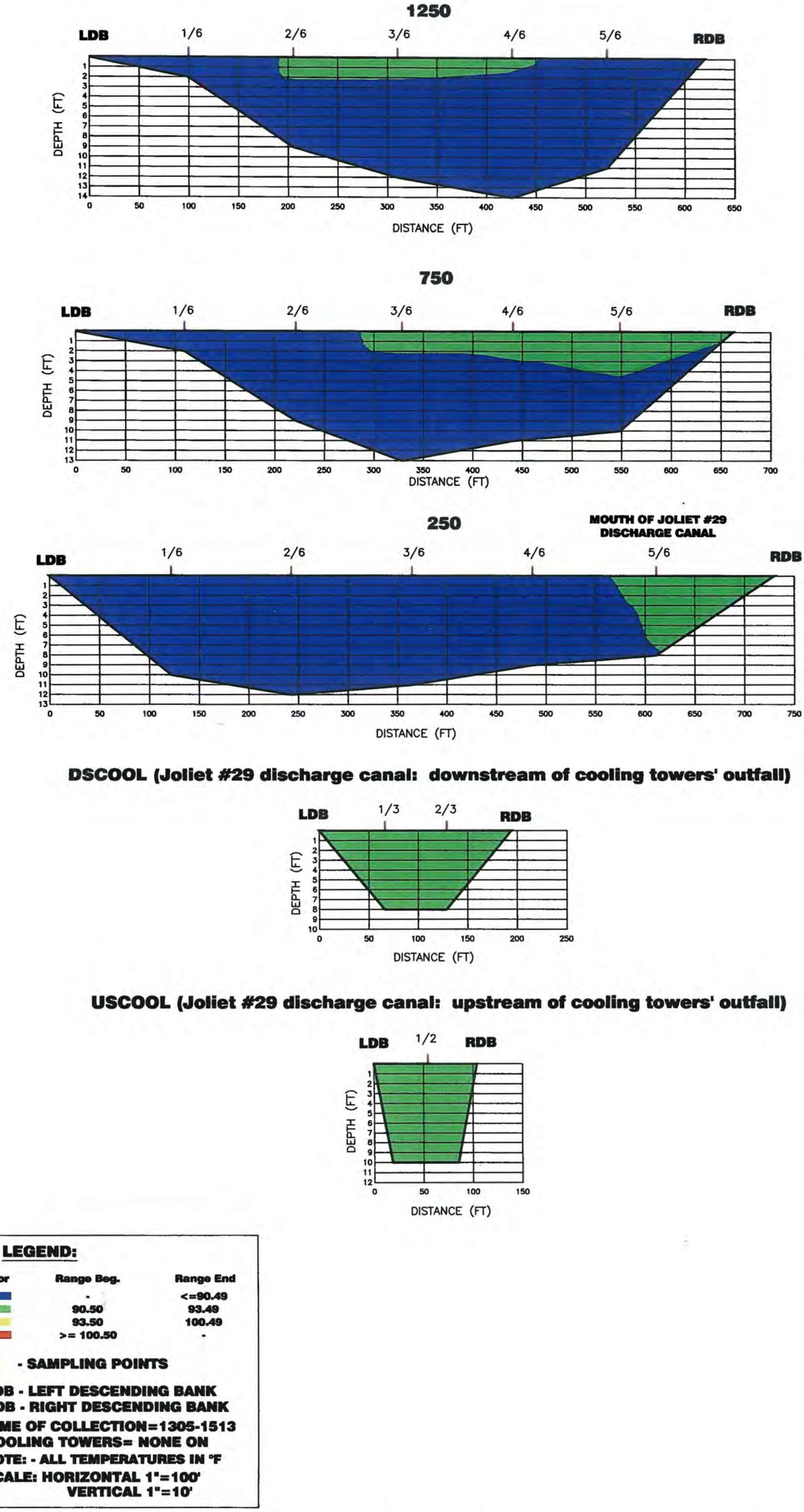


FIGURE 4 - 19. Cross Section Temperatures at the USCOOL, DSCOOL, 250, 750, and 1250 Transects, Near the Joliet Stations, August 28, 2002.

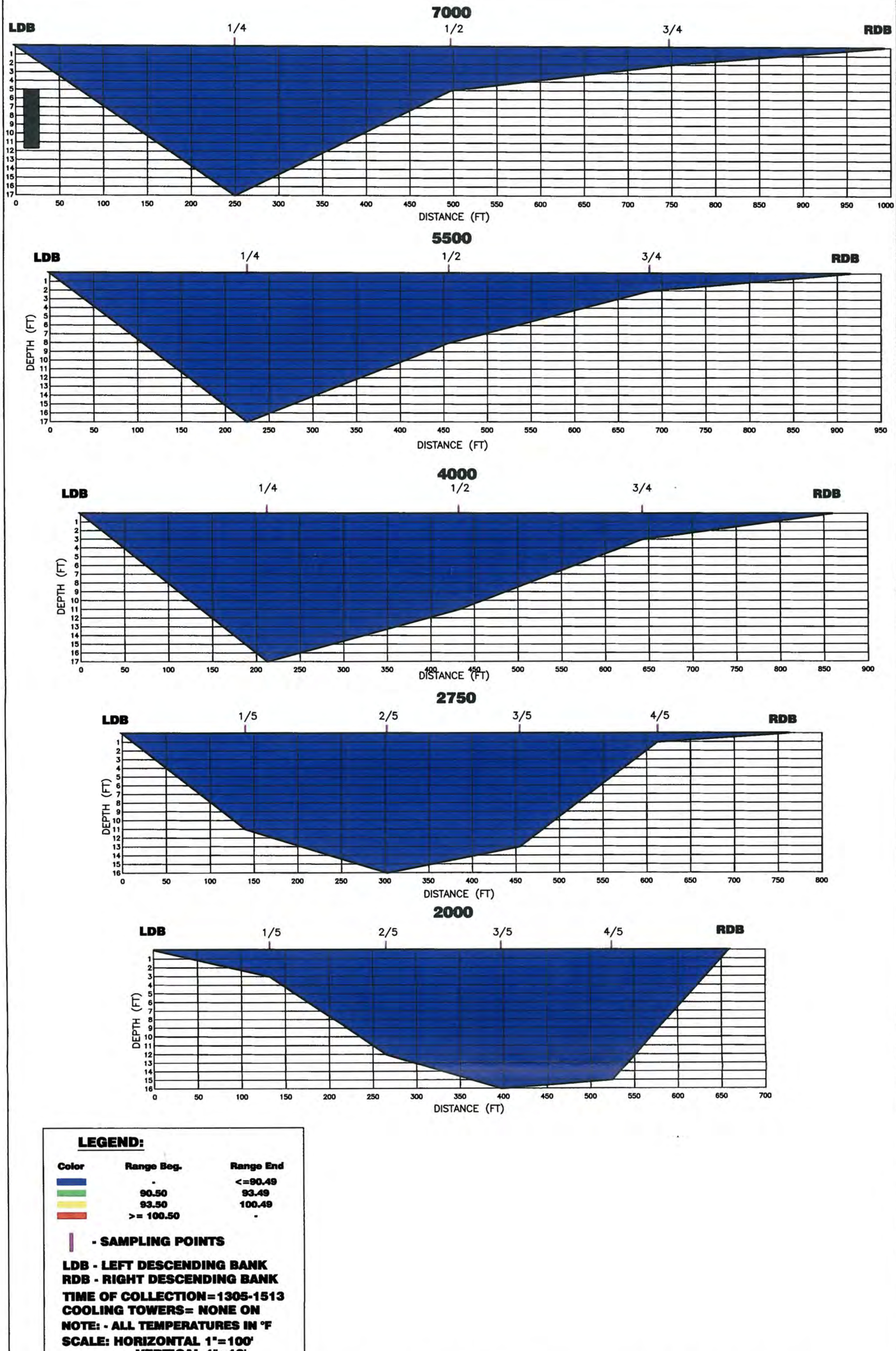


FIGURE 4 - 20. Cross Section Temperatures at the 2000, 2750, 4000, 5500, and 7000 Transects, Near the Joliet Stations, August 28, 2002.

Table 3-1 Survey Times and Corresponding River Flow Ranges for the 2002 Plume Survey Dates

Survey	Surface Survey (hrs)	Vertical Survey (hrs)	Survey Type	River Flow Range During Survey Time (cfs)
27 June	1329 - 1513	1522 - 1609	CL	2549 - 3005
11 July	1201 - 1406	1446 - 1556	CL	3223 - 3994
01 August	1045 - 1312	1337 - 1652	3D	2404 - 3604
09 August	1238 - 1450	1520 - 1725	3D	2415 - 2589
15 August	1416 - 1616	1700 - 1806	CL	4563 - 5515
20 August	1125 - 1346	1409 - 1625	3D	3161 - 3654
28 August	1056 - 1240	1305 - 1513	3D	3727 - 4442
04 Sept	1402 - 1543	1557 - 1653	CL	3846 - 3974

Table 3-2 Daily Average Joliet Station 9 Operating Data for the 2002 Plume Survey Dates

Survey	Power Production (MWe)	Delta Temperature (F)	Temperature (F) Intake	Temperature (F) Discharge	Temperature (F) Upstr(a)	Station Flow (cfs)	River Flow (cfs)
27 June	195	7.1	82.9	90.0	84.6	582	2723
11 July	160	6.0	81.3	87.3	81.9	582	3677
01 August	183	6.9	87.5	94.4	86.6	582	3018
09 August	178	6.5	84.1	90.6	84.5	582	2635
15 August	207	7.4	83.3	90.7	84.3	582	4940
20 August	174	6.5	80.9	87.4	81.1	582	3146
28 August	197	6.7	79.3	86.0	77.6	582	3720
04 Sept	235	8.3	81.8	90.1	81.1	582	2996

Table 3-3 Daily Average Joliet Station 29 Operating Data for the 2002 Plume Survey Dates

Survey	Power Production (MWe)	Temperature (F) Intake	Temperature (F) Discharge	Average Effective Discharge (b) Temperature On Dates When Towers Were in Operation	Delta Temperature (F) Station	Delta Temperature (F) Canal(c)	Number of Cooling Towers in Operation	Station Flow (cfs)	River Flow (cfs)
27 June	939	83.6	98.1	89.2	14.5	5.6	24	1537	2723
11 July*	668	81.8	91.7	90.1	9.9	8.3	4*	1537	3677
01 August	782	87.3	101.5	91.9	13.2	4.6	24	1537	3018
09 August	682	83.9	93.6	89.8	9.7	5.9	11	1537	2635
15 August*	728	83.2	95.2	93.0	12.0	9.8	6*	1537	4940
20 August	680	80.9	91.6	n/a	10.7	10.7	0	1537	3146
28 August	859	78.7	91.7	n/a	13.0	13.0	0	1537	3720
04 Sept	615	81.6	92.3	n/a	10.7	10.7	0	1537	2996

* Note that cooling towers were NOT in operation during the time when the thermal plume surveys were conducted on 11 July and 15 August

a) Average temperature at the upstream surface plume mapping transect.

b) The "Effective Discharge Temperature" is the flow weighted Joliet Station 29 discharge temperature calculated from condenser and cooling tower flows. When there are no towers in operation, the "effective discharge temperature" equals the circulating water discharge temperature.

c) Temperature difference between calculated effective discharge temperature and station intake temperature.

Table 4-1 Surface Plume Temperature Statistics at Transects During the 27 June 2002 Joliet Survey

93.5 F Plume Area

Station	Area (acres)	Length (ft)
Joliet 29	8.3	2472
Joliet 9	0	0

Surface Plume Width

	Temperature (F)			Transect Width (%) greater than Temperature		
Transect	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	84.3	85.0	84.6	0.0	0.0	0.0
-1720	84.4	89.7	86.1	0.0	0.0	0.0
-1250	85.3	89.7	87.6	0.0	0.0	0.0
-750	86.9	88.7	87.9	0.0	0.0	0.0
-250	86.1	87.7	87.1	0.0	0.0	0.0
250	90.1	95.2	92.2	81.8	23.0	0.0
750	90.9	95.0	92.6	100.0	30.4	0.0
1250	91.3	94.4	92.8	100.0	32.9	0.0
2000	91.9	94.0	92.8	100.0	12.7	0.0
2750	91.0	93.5	92.5	100.0	0.0	0.0
4000	89.8	92.2	90.6	100.0	0.0	0.0
5500	89.6	91.4	90.6	52.3	0.0	0.0
7000	89.4	91.4	90.2	30.1	0.0	0.0

Table 4-2 Surface Plume Temperature Statistics at Transects During the 11 July 2002 Joliet Survey

93.5 F Plume Area

Station	Area (acres)	Length (ft)
Joliet 29	14.9	3301
Joliet 9	0	0

Surface Plume Width

	Temperature (F)			Transect Width (%) greater than Temperature		
Transect	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	81.7	82.2	81.9	0.0	0.0	0.0
-1720	81.9	88.1	83.5	0.0	0.0	0.0
-1250	82.1	87.9	85.2	0.0	0.0	0.0
-750	84.5	87.9	86.2	0.0	0.0	0.0
-250	86.1	86.8	86.5	0.0	0.0	0.0
250	84.6	94.3	90.4	50.9	40.4	0.0
750	89.8	94.2	93.0	78.1	54.1	0.0
1250	91.4	94.2	93.3	100.0	58.4	0.0
2000	90.6	93.8	92.6	92.9	18.7	0.0
2750	89.4	93.7	92.3	88.5	10.2	0.0
4000	87.5	92.7	91.1	68.2	0.0	0.0
5500	87.1	91.6	90.1	34.8	0.0	0.0
7000	87.5	90.7	89.2	0.0	0.0	0.0

Table 4-3 Surface Plume Temperature Statistics at Transects During the 1 August 2002 Joliet Survey

93.5 F Plume Area

Station	Area (acres)	Length (ft)
Joliet 29	22.0	2528
Joliet 9	8.2	1026

Surface Plume Width

	Temperature (F)			Transect Width (%) greater than Temperature		
Transect	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	86.4	87.1	86.6	0.0	0.0	0.0
-1720	87.2	95.7	90.8	43.2	26.4	0.0
-1250	92.1	95.2	94.1	100.0	63.4	0.0
-750	91.1	94.3	92.9	100.0	35.8	0.0
-250	90.3	93.7	92.3	90.6	0.0	0.0
250	90.6	95.7	93.7	100.0	58.0	0.0
750	92.1	95.7	94.5	100.0	78.2	0.0
1250	92.2	95.0	94.3	100.0	72.3	0.0
2000	92.7	94.2	93.6	100.0	55.1	0.0
2750	91.7	93.2	92.8	100.0	0.0	0.0
4000	91.2	93.1	92.6	100.0	0.0	0.0
5500	91.2	92.9	92.3	100.0	0.0	0.0
7000	90.0	92.1	91.1	68.5	0.0	0.0

Table 4-4 Surface Plume Temperature Statistics at Transects During the 9 August 2002 Joliet Survey

93.5 F Plume Area

Station	Area (acres)	Length (ft)
Joliet 29	27.4	3249
Joliet 9	0	0

Surface Plume Width

Transect	Temperature (F)			Transect Width (%) greater than Temperature		
	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	84.3	84.9	84.5	0.0	0.0	0.0
-1720	84.0	90.9	86.8	17.7	0.0	0.0
-1250	86.9	93.1	89.9	34.3	0.0	0.0
-750	88.1	92.7	90.7	52.4	0.0	0.0
-250	88.3	91.7	90.5	63.0	0.0	0.0
250	86.6	97.8	92.7	65.1	37.0	0.0
750	90.6	97.2	94.9	75.5(a)	56.0	0.0
1250	93.4	97.0	95.8	100.0	100.0	0.0
2000	92.4	94.7	93.7	100.0	71.7	0.0
2750	91.9	94.7	93.4	100.0	43.9	0.0
4000	90.9	93.3	92.2	100.0	0.0	0.0
5500	87.8	91.3	90.5	48.7	0.0	0.0
7000	89.2	91.2	89.8	0 (a)	0.0	0.0

a) Variation occurs between the observed minimum and maximum transect temperatures and those resulting from the kriging used to contour the complete surface plume data set.

Table 4-5 Surface Plume Temperature Statistics at Transects During the 15 August 2002 Joliet Survey

93.5 F Plume Area

Station	Area (acres)	Length (ft)
Joliet 29	25.7	2835
Joliet 9	4.9	946

Surface Plume Width

	Temperature (F)			Transect Width (%) greater than Temperature		
Transect	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	84.2	84.5	84.3	0.0	0.0	0.0
-1720	84.2	94.0	86.3	19.2	8.2	0.0
-1250	84.4	93.8	88.3	24.8	4.3	0.0
-750	86.2	93.0	88.4	25.4	0.0	0.0
-250	85.5	88.1	86.9	0.0	0.0	0.0
250	86.8	99.2	95.2	71.0	66.2	0.0
750	93.0	96.3	94.8	100.0	79.7	0.0
1250	91.3	96.8	95.1	100.0	90.5	0.0
2000	91.9	94.9	93.8	100.0	49.9	0.0
2750	87.4	94.2	92.5	76.3	24.7	0.0
4000	86.1	90.7	89.1	13.4	0.0	0.0
5500	87.1	88.2	87.8	0.0	0.0	0.0
7000	84.7	87.9	86.2	0.0	0.0	0.0

Table 4-6 Surface Plume Temperature Statistics at Transects During the 20 August 2002 Joliet Survey

93.5 F Plume Area

Station	Area (acres)	Length (ft)
Joliet 29	9.1	2056
Joliet 9	0	0

Surface Plume Width

Transect	Temperature (F)			Transect Width (%) greater than Temperature		
	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	80.6	81.5	81.1	0.0	0.0	0.0
-1720	81.0	85.9	82.2	0.0	0.0	0.0
-1250	80.9	86.1	83.9	0.0	0.0	0.0
-750	83.7	85.7	84.8	0.0	0.0	0.0
-250	83.5	85.0	84.3	0.0	0.0	0.0
250	82.9	95.1	90.7	59.5	35.0	0.0
750	91.4	94.7	93.5	89.7(a)	49.0	0.0
1250	89.1	94.3	92.7	100(a)	44.7	0.0
2000	89.9	93.5	92.3	77.3	5.9	0.0
2750	87.6	93.0	91.4	59.1	0.0	0.0
4000	87.8	91.1	90.0	29.4	0.0	0.0
5500	85.3	89.8	88.2	0.0	0.0	0.0
7000	85.4	88.4	87.0	0.0	0.0	0.0

a) Variation occurs between the observed minimum and maximum transect temperatures and those resulting from the kriging used to contour the complete surface plume data set.

Table 4-7 Surface Plume Temperature Statistics at Transects During the 28 August 2002 Joliet Survey

93.5 F Plume Area

Station	Area (acres)	Length (ft)
Joliet 29	0	0
Joliet 9	0	0

Surface Plume Width

	Temperature (F)			Transect Width (%) greater than Temperature		
Transect	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	77.5	78.2	77.6	0	0	0
-1720	77.6	83.1	79.2	0	0	0
-1250	77.5	83.1	80.5	0	0	0
-750	80.6	83.5	82.2	0	0	0
-250	80.7	82.5	81.7	0	0	0
250	78.2	89.7	85.5	0	0	0
750	83.8	89.3	88.3	0	0	0
1250	84.9	89.0	87.8	0	0	0
2000	83.2	88.3	86.9	0	0	0
2750	84.6	87.9	86.7	0	0	0
4000	83.8	87.2	86.0	0	0	0
5500	84.0	86.3	85.7	0	0	0
7000	83.4	85.7	84.4	0	0	0

Table 4-8 Surface Plume Temperature Statistics at Transects During the 4 September 2002 Joliet Survey

93.5 F Plume Area

Station	Area (acres)	Length (ft)
Joliet 29	0	0
Joliet 9	0	0

Surface Plume Width

Transect	Temperature (F)			Transect Width (%) greater than Temperature		
	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	80.9	81.3	81.1	0.0	0.0	0.0
-1720	81.2	91.9	84.2	19.6	0.0	0.0
-1250	81.3	91.9	86.6	31.0	0.0	0.0
-750	84.2	91.7	89.0	46.9	0.0	0.0
-250	84.6	91.3	88.7	41.4	0.0	0.0
250	85.2	92.1	90.3	59.0	0.0	0.0
750	88.4	91.9	91.5	76.9	0.0	0.0
1250	89.3	91.6	91.0	70.1	0.0	0.0
2000	87.3	91.6	90.4	63.0	0.0	0.0
2750	88.6	91.4	90.2	45.0	0.0	0.0
4000	88.1	90.8	89.7	29.0	0.0	0.0
5500	88.1	90.9	89.5	20.6	0.0	0.0
7000	87.2	89.8	88.3	0.0	0.0	0.0

Table 4-9 Cross-Sectional Temperature Statistics at Transects During the 1 August 2002 Joliet Survey

Transect	Temperature (F)			Cross-Sectional Area (%) greater than Temperature		
	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	89.2	89.4	89.3	0	0	0
-1720	89.2	95.3	89.9	16	8	0
-1250	89.1	95.3	91.9	82	16	0
-750	89.0	95.1	92.6	82	57	0
-250	88.9	93.9	92.6	93	27	0
250	91.0	94.9	93.2	100	31	0
750	90.0	94.7	93.7	100	84	0
1250	92.7	95.0	94.1	100	92	0
2000	92.6	94.3	93.6	100	75	0
2750	92.9	94.7	94.1	100	88	0
4000	92.3	94.1	93.6	100	81	0
5500	92.4	93.5	93.1	100	0	0
7000	91.7	92.8	92.5	100	0	0

Table 4-10 Cross-Sectional Temperature Statistics at Transects During the 9 August 2002 Joliet Survey

Transect	Temperature (F)			Cross-Sectional Area (%) greater than Temperature		
	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	85.8	86.1	86.0	0	0	0
-1720	86.3	96.4	90.0	45	12	0
-1250	87.6	96.1	91.5	65	22	0
-750	85.9	93.6	88.6	32	3	0
-250	86.3	94.9	89.6	42	11	0
250	86.2	98.3	91.5	64	31	0
750	86.9	98.4	92.4	78	33	0
1250	88.0	98.2	93.8	86	58	0
2000	89.3	95.9	92.2	81	30	0
2750	90.0	95.1	92.5	93	31	0
4000	89.1	92.9	91.3	82	0	0
5500	88.5	93.8	91.3	65	2	0
7000	87.7	91.5	89.7	48	0	0

Table 4-11 Cross-Sectional Temperature Statistics at Transects During the 20 August 2002 Joliet Survey

Transect	Temperature (F)			Cross-Sectional Area (%) greater than Temperature		
	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	82.2	82.9	82.5	0	0	0
-1720	83.1	85.3	83.9	0	0	0
-1250	84.5	88.8	86.1	0	0	0
-750	84.1	84.8	84.3	0	0	0
-250	84.4	86.4	85.0	0	0	0
250	85.5	92.0	87.8	15	0	0
750	86.6	91.4	89.5	40	0	0
1250	86.7	88.4	87.8	0	0	0
2000	87.5	89.5	88.5	0	0	0
2750	87.3	90.1	88.3	0	0	0
4000	87.5	90.0	88.4	0	0	0
5500	86.4	88.5	87.1	0	0	0
7000	87.4	88.0	87.6	0	0	0

Table 4-12 Cross-Sectional Temperature Statistics at Transects During the 28 August 2002 Joliet Survey

	Temperature (F)			Cross-Sectional Area (%) greater than Temperature		
Transect	Min	Max	Mean	90.5 F	93.5 F	100.5 F
Upstr	79.8	80.4	80.0	0	0	0
-1720	79.8	87.7	80.8	0	0	0
-1250	79.7	87.6	81.3	0	0	0
-750	79.9	86.1	82.0	0	0	0
-250	79.8	82.6	80.6	0	0	0
250	79.9	92.1	83.4	11	0	0
750	80.5	91.9	85.6	21	0	0
1250	81.1	90.9	85.4	10	0	0
2000	80.6	89.1	84.5	0	0	0
2750	81.3	88.5	84.5	0	0	0
4000	81.2	86.5	83.3	0	0	0
5500	82.0	87.0	84.5	0	0	0
7000	81.3	86.0	84.4	0	0	0

APPENDIX A

CALIBRATION RECORDS

Table A-1 Pre-Calibration of Temperature for SBE 19plus SEACAT Profiler

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington 98005 USA
Phone: (425) 643 - 9866 Fax: (425) 643 - 9954 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = 4194
CALIBRATION DATE: 20-Jun-02

SBE 19plus
TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

a0 = 1.159623e-03
a1 = 2.842569e-04
a2 = -2.444222e-06
a3 = 2.319154e-07

BATH TEMP (ITS-90 °C)	INSTRUMENT OUTPUT: n	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
0.9999	679883.3	0.9999	0.0000
4.5000	606426.5	4.4999	-0.0001
15.0001	421743.3	15.0003	0.0002
18.5000	371601.5	18.4998	-0.0002
23.9999	303147.1	24.0000	0.0001
29.0000	250767.0	28.9999	-0.0001
32.5000	219012.6	32.5001	0.0001

MV = (n - 524288) / 1.6e7

R = (MV * 2.9e9 + 1.024e8) / (2.048e4 - MV * 2e5)

Temperature ITS-90 = $1 / \{ a0 + a1[\ell n(R)] + a2[\ell n^2(R)] + a3[\ell n^3(R)] \} - 273.15$ (°C)

Residual = instrument temperature - bath temperature

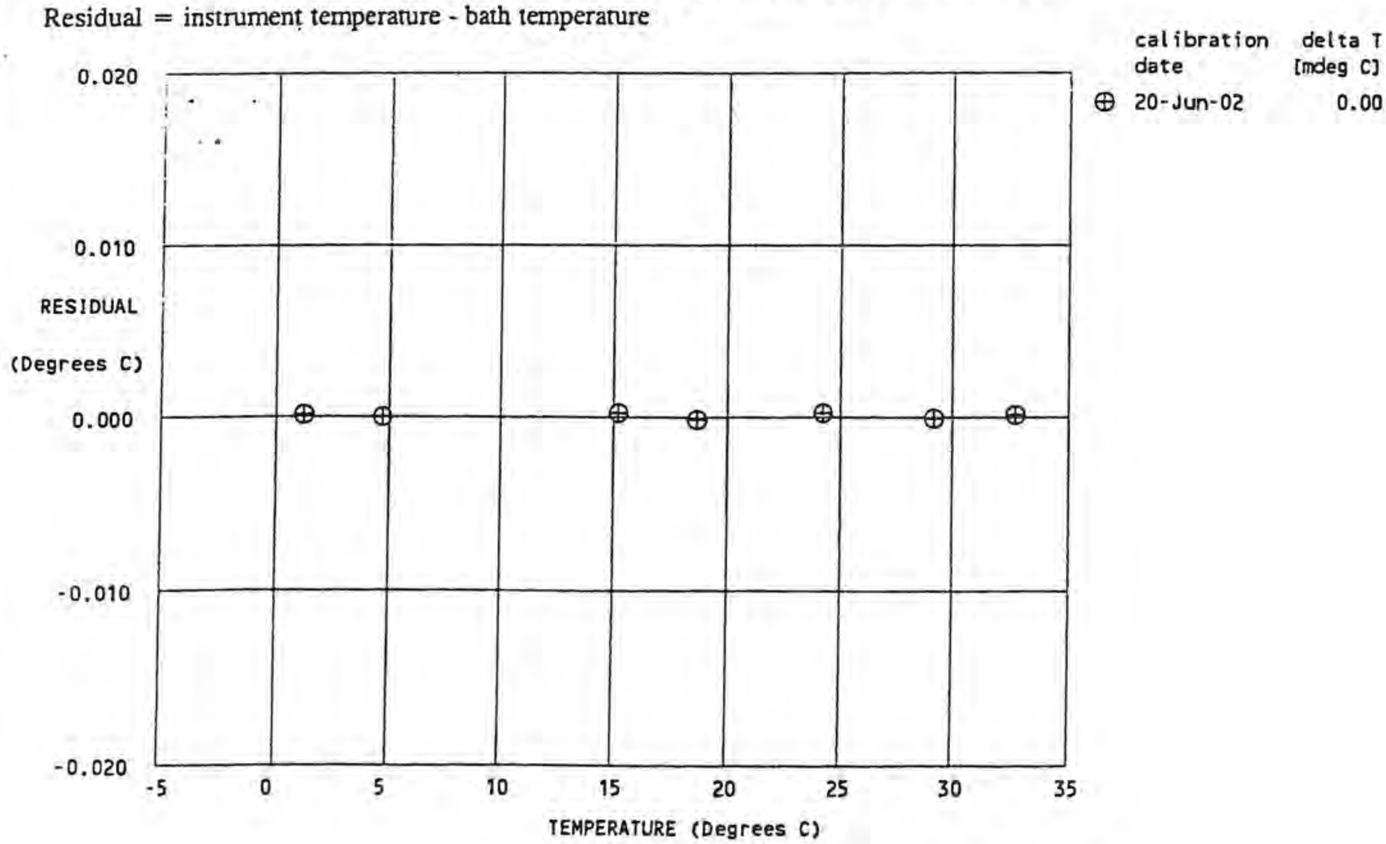


Table A-2 Pre-Calibration of Pressure (Depth) for SBE 19plus SEACAT Profiler

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington 98005 USA
Phone: (425) 643 - 9866 Fax: (425) 643 - 9954 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = 4194
CALIBRATION DATE: 08-Apr-02

PRESSURE CALIBRATION DATA
44 psia S/N 470

SBE 19plus PRESSURE COEFFICIENTS

PA0 = 9.713166e-03
PA1 = 1.334247e-04
PA2 = -7.406892e-13
PTEMPA0 = -5.882669e+01
PTEMPA1 = 5.487260e+01
PTEMPA2 = -5.681028e-01

PTCA0 = 5.252761e+05
PTCA1 = 7.174279e+00
PTCA2 = -1.731691e-01
PTCB0 = 2.498750e+01
PTCB1 = 5.000000e-04
PTCB2 = 0.000000e+00

PRESSURE SPAN CALIBRATION:

PRESSURE PSIA	PRESSURE OUTPUT	TEMPERATURE OUTPUT	COMPUTED PRESSURE	ERROR % FSR
14.70	635395.0	1.466	14.68	-0.05
24.76	711081.0	1.465	24.76	-0.00
29.76	748635.0	1.466	29.75	-0.02
34.75	786218.0	1.466	34.75	-0.00
39.76	823837.0	1.466	39.75	-0.00
44.75	861439.0	1.466	44.75	-0.00
39.75	823857.0	1.467	39.76	0.01
34.75	786271.0	1.467	34.76	0.01
29.75	748681.0	1.468	29.76	0.02
24.77	711123.0	1.468	24.76	-0.01
14.66	635437.0	1.469	14.68	0.06

THERMAL OFFSET AND TEMPERATURE CAL:

TEMPERATURE (ITS-90 °C)	TEMPERATURE OUTPUT	PRESSURE OUTPUT
32.50	1.694	637937.19
29.00	1.628	637911.88
24.00	1.534	637931.06
18.50	1.430	637957.00
15.00	1.365	637949.48
4.50	1.168	637883.53
1.00	1.103	637884.76

SPAN THERMAL SENSITIVITY:

TEMPERATURE (ITS-90 °C)	SPAN MV
-5.00	24.99
35.00	25.01

y = thermistor output; t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2
x = pressure output - PTCA0 - PTCA1 * t - PTCA2 * t^2
n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)
pressure (psia) = PA0 + PA1 * n + PA2 * n^2

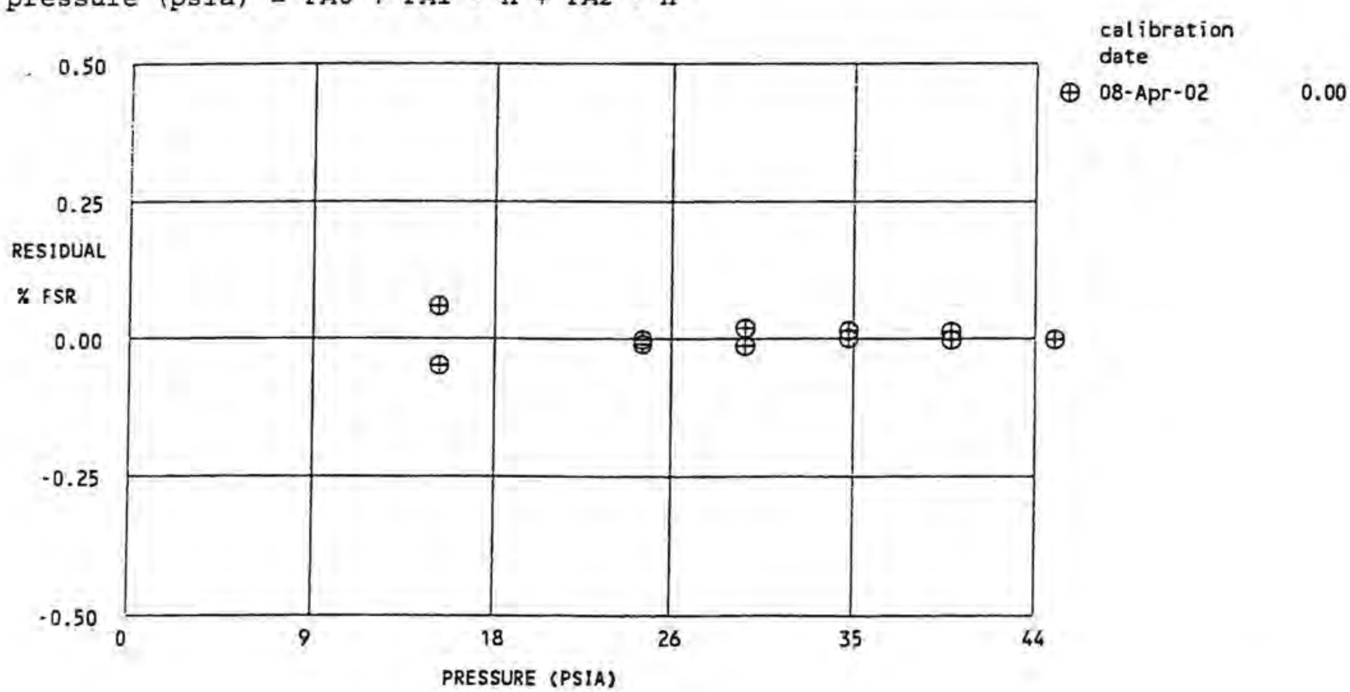


Table A-3 Post-Calibration of Temperature for SBE 19plus SEACAT Profiler

SEA-BIRD ELECTRONICS, INC.
1808 136th Place N.E., Bellevue, Washington 98005 USA
Phone: (425) 643 - 9866 Fax: (425) 643 - 9954 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = 4194
CALIBRATION DATE: 05-Oct-02

SBE 19plus
TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

a0 = 1.188278e-03
a1 = 2.736347e-04
a2 = -1.134308e-06
a3 = 1.782420e-07

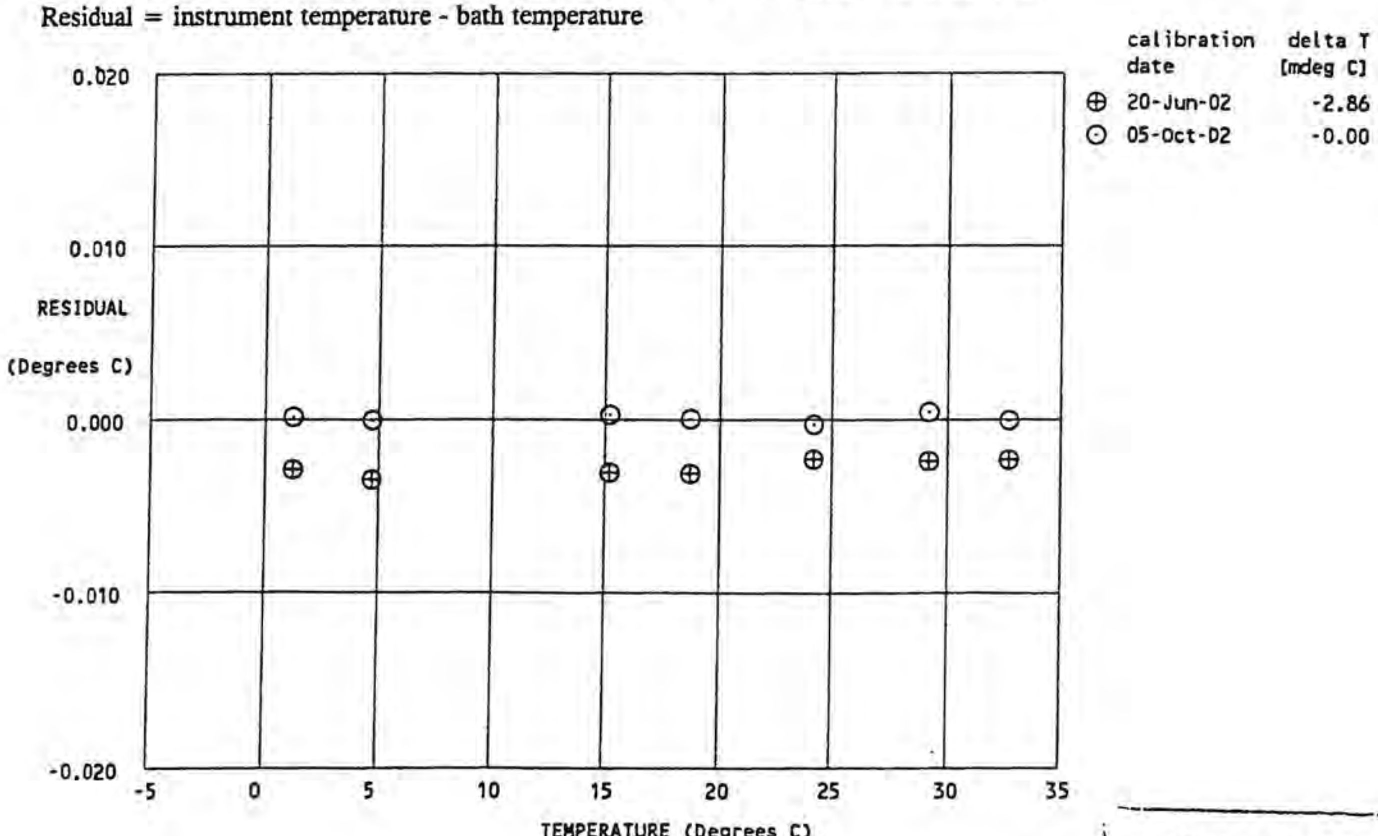
BATH TEMP (ITS-90 °C)	INSTRUMENT OUTPUT: n	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
1.0000	679815.2	1.0001	0.0001
4.5000	606357.0	4.4999	-0.0001
15.0000	421694.5	15.0002	0.0002
18.4999	371560.0	18.4999	-0.0000
24.0000	303123.2	23.9997	-0.0003
29.0000	250739.8	29.0004	0.0004
32.5000	218993.4	32.4999	-0.0001

MV = (n - 524288) / 1.6e7

R = (MV * 2.9e9 + 1.024e8) / (2.048e4 - MV * 2e5)

Temperature ITS-90 = $1 / \{ a0 + a1[\ell n(R)] + a2[\ell n^2(R)] + a3[\ell n^3(R)] \} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SBE
SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	EA Engineering, Science & Technology, Inc.		
Job Number:	30480R	*Date of Report:*	07-Oct-02
Model Number:	SBE 19Plus	*Serial Number:*	19P29566-4194

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED' CALIBRATION ☑ *Performed* ☐ *Not Performed*

Date: 05-Oct-02 ***Drift since last cal:*** +.00977 ***Degrees Celsius/year***

Comments:

'CALIBRATION AFTER REPAIR' ☐ *performed* ☑ *Not Performed*

Date: ***Drift since last cal:*** ***Degrees Celsius/year***

Comments:

Table A-5 Post-Calibration of Pressure (Depth) for SBE 19plus SEACAT Profiler

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington 98005 USA
Phone: (425) 643 - 9866 Fax: (425) 643 - 9954 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = 4194
CALIBRATION DATE: 08-Oct-02

PRESSURE CALIBRATION DATA
44 psia S/N 470

SBE 19plus PRESSURE COEFFICIENTS

PA0 = -4.609632e-02
PA1 = 1.328293e-04
PA2 = 4.602444e-13
PTEMPA0 = -5.906922e+01
PTEMPA1 = 5.508782e+01
PTEMPA2 = -6.097727e-01

PTCA0 = 5.248646e+05
PTCA1 = -2.187843e+01
PTCA2 = 2.485356e-01
PTCB0 = 2.498750e+01
PTCB1 = 5.000000e-04
PTCB2 = 0.000000e+00

PRESSURE SPAN CALIBRATION:

PRESSURE PSIA	PRESSURE OUTPUT	TEMPERATURE OUTPUT	COMPUTED PRESSURE	ERROR % FSR
14.74	635689.0	1.472	14.72	-0.04
24.83	711780.0	1.472	24.83	0.00
29.82	749299.0	1.472	29.82	0.01
34.82	786876.0	1.472	34.82	-0.00
39.82	824468.0	1.472	39.82	-0.00
44.82	862060.0	1.472	44.82	0.00
39.83	824491.0	1.473	39.82	-0.00
34.83	786921.0	1.473	34.83	-0.00
29.83	749361.0	1.473	29.83	-0.00
24.85	711883.0	1.474	24.85	-0.00
14.71	635777.0	1.474	14.73	0.04

THERMAL OFFSET AND TEMPERATURE CAL:

TEMPERATURE (ITS-90 °C)	TEMPERATURE OUTPUT	PRESSURE OUTPUT
32.50	1.694	637719.86
29.00	1.628	637694.40
24.00	1.534	637719.75
18.50	1.431	637815.30
15.00	1.365	637928.70
4.50	1.169	638009.92
1.00	1.104	638134.30

SPAN THERMAL SENSITIVITY:

TEMPERATURE (ITS-90 °C)	SPAN MV
-5.00	24.99
35.00	25.01

y = thermistor output; $t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2$

$x = \text{pressure output} - PTCA0 - PTCA1 * t - PTCA2 * t^2$

$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)$

$\text{pressure (psia)} = PA0 + PA1 * n + PA2 * n^2$

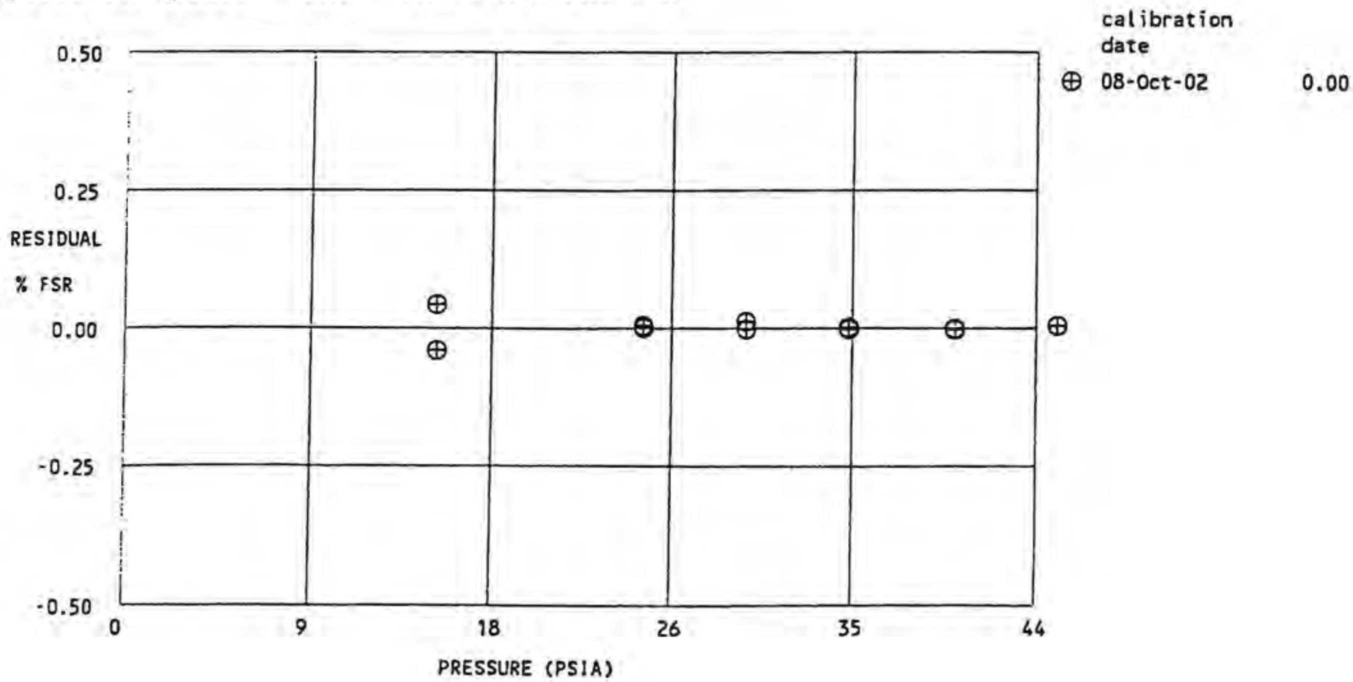


Table A-6 Pre- and Post-Calibration of YSI Probe P4 and Deban Module 285

Pre-Calibration, 10 June

Calib Temp (C)	YSI Temp (C)
14.65	14.82
14.70	14.88
14.75	14.92
20.38	20.43
20.38	20.41
20.36	20.41
20.38	20.44
25.20	25.27
25.16	25.22
25.16	25.19
25.12	25.15
25.08	25.12

Post-Calibration, 6 August

Calib Temp (C)	YSI Temp (C)
36.86	36.97
36.72	36.86
36.60	36.72
36.38	36.47
32.38	32.49
32.26	32.34
32.05	32.19
31.80	31.89
29.12	29.23
29.09	29.18
29.02	29.15
28.90	28.97
20.69	20.73
20.69	20.76
20.69	20.75
20.69	20.76

Table A-7. Pre-Calibration of YSI Probe E2-5 and Deban Module 352

PROBE SERIAL # E2-5 USED WITH INSTURMENT 500 # 352

RESISTANCE= 36.05195 TIMES TEMPERATURE PLUS 4962.915

TEMP DEG.C	LINEARITY DEVIATION	RESISTANCE ERROR	NOMINAL RESISTANCE	CAL RESISTANCE
15.00	-0.009	0.318	4422.136	14976.22
17.50	0.012	-0.426	4332.006	13990.44
20.00	0.020	-0.739	4241.876	13092.06
22.50	0.019	-0.688	4151.746	12269.94
25.00	0.011	-0.379	4061.616	11514.79
27.50	-0.002	0.057	3971.486	10818.72
30.00	-0.013	0.478	3881.357	10175.08
32.50	-0.021	0.739	3791.227	9578.146
35.00	-0.019	0.702	3701.097	9023.021
37.50	-0.007	0.242	3610.967	8505.455
40.00	0.020	-0.739	3520.837	8021.766

R1= 6275 R2= 12700

E OUT/DEG	E OUT AT 0 DEG	RT/DEG	RT AT 0 DEG
5.745332E-03	.7909028	-36.05195	4962.915

R CAL AT 0 DEG	R CAL AT F.S.	R CAL AT LO
23734.97	8021.766	14976.22

DATA USED:
46381 15 29932 25 16172 40 9426 6006 3202

Table A-8 Pre-Calibration of YSI Probe E2-2 and Deban Module 352

BACKU,

PROBE SERIAL # E2-2 USED WITH INSTURMENT 500 # 352

RESISTANCE= 36.0187 TIMES TEMPERATURE PLUS 4961.188

TEMP DEG.C	LINEARITY DEVIATION	RESISTANCE ERROR	NOMINAL RESISTANCE	CAL RESISTANCE
15.00	0.022	-0.807	4420.908	14962.15
17.50	0.030	-1.095	4330.861	13978.5
20.00	0.029	-1.027	4240.814	13081.94
22.50	0.019	-0.677	4150.768	12261.4
25.00	0.004	-0.151	4060.721	11507.59
27.50	-0.012	0.417	3970.674	10812.7
30.00	-0.024	0.881	3880.627	10170.07
32.50	-0.030	1.095	3790.58	9574.024
35.00	-0.025	0.917	3700.534	9019.675
37.50	-0.006	0.220	3610.487	8502.793
40.00	0.030	-1.095	3520.44	8019.707

R1= 6275 R2= 12700

E OUT/DEG	E OUT AT 0 DEG	RT/DEG	RT AT 0 DEG
5.740035E-03	.7906276	-36.0187	4961.188

R CAL AT 0 DEG	R CAL AT F.S.	R CAL AT LO
23695.52	8019.707	14962.15

DATA USED:
46250 15 29906 25 16152 40 9397 6002 3206

Table A-9 Temperature Calibration Data for YSI Probe E2-2 and Deban Module 352, 4 October 2002

Time hhmm	ss	Calib Temp (C)	YSI Temp (C)	Time hhmm	ss	Calib Temp (C)	YSI Temp (C)
1723	10	25.72	24.92	1744	10	35.40	34.79
	20	25.72	24.93		20	35.40	34.79
	30	25.70	24.91		30	35.40	34.79
	40	25.70	24.92		40	35.40	34.79
	50	25.70	24.92		50	35.40	34.79
1724	0	25.70	24.92	1745	0	35.40	34.79
	10	25.70	24.91		10	35.40	34.79
	20	25.70	24.90		20	35.40	34.77
	30	25.70	24.91		30	35.40	34.78
	40	25.70	24.90		40	35.40	34.77
	50	25.70	24.90		50	35.40	34.77
1725	0	25.70	24.90	1746	0	35.38	34.77
	10	25.70	24.90		10	35.38	34.75
	20	25.70	24.90		20	35.35	34.75
	30	25.70	24.90		30	35.35	34.74
	40	25.70	24.89		40	35.32	34.73
	50	25.70	24.89		50	35.32	34.73
1726	0	25.70	24.89	1747	0	35.32	34.73
1733	10	30.60	29.79	1756	10	39.30	38.93
	20	30.60	29.80		20	39.30	38.92
	30	30.60	29.81		30	39.30	38.91
	40	30.60	29.82		40	39.28	38.90
	50	30.60	29.82		50	39.25	38.89
1734	0	30.60	29.83	1757	0	39.25	38.88
	10	30.60	29.83		10	39.22	38.86
	20	30.60	29.84		20	39.22	38.85
	30	30.60	29.85		30	39.20	38.84
	40	30.60	29.84		40	39.20	38.83
	50	30.62	29.85		50	39.18	38.82
1735	0	30.62	29.85	1758	0	39.18	38.81
	10	30.62	29.85		10	39.15	38.78
	20	30.62	29.84		20	39.15	38.77
	30	30.62	29.85		30	39.12	38.76
	40	30.62	29.84		40	39.10	38.74
	50	30.62	29.85		50	39.10	38.73
1736	0	30.62	29.84	1759	0	39.10	38.72

APPENDIX B

SURFACE TEMPERATURE DATA FOR EACH TRANSECT AND SAMPLING DATE

Figure B-1a
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 27 June 2002

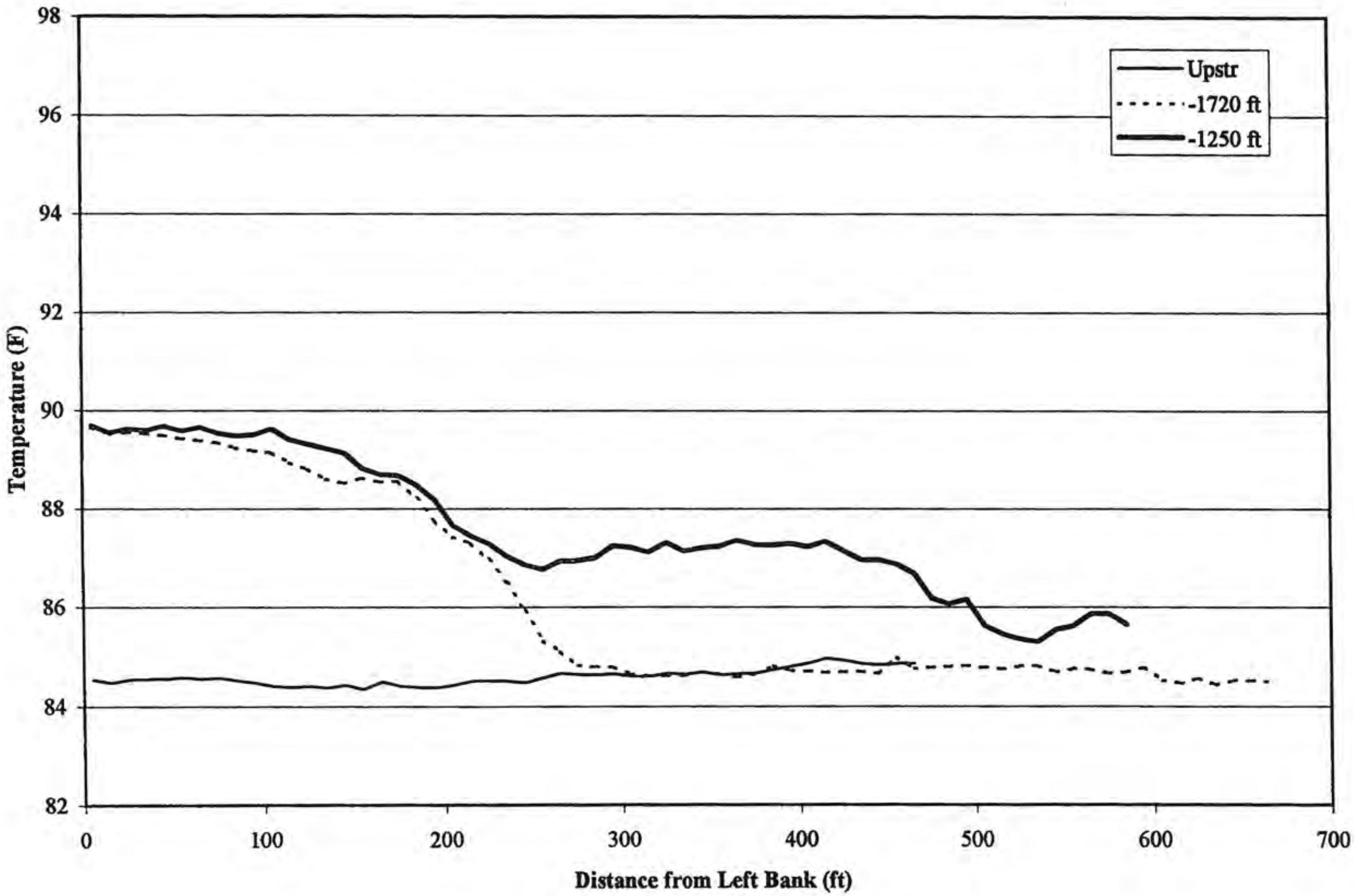


Figure B-1b
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 27 June 2002

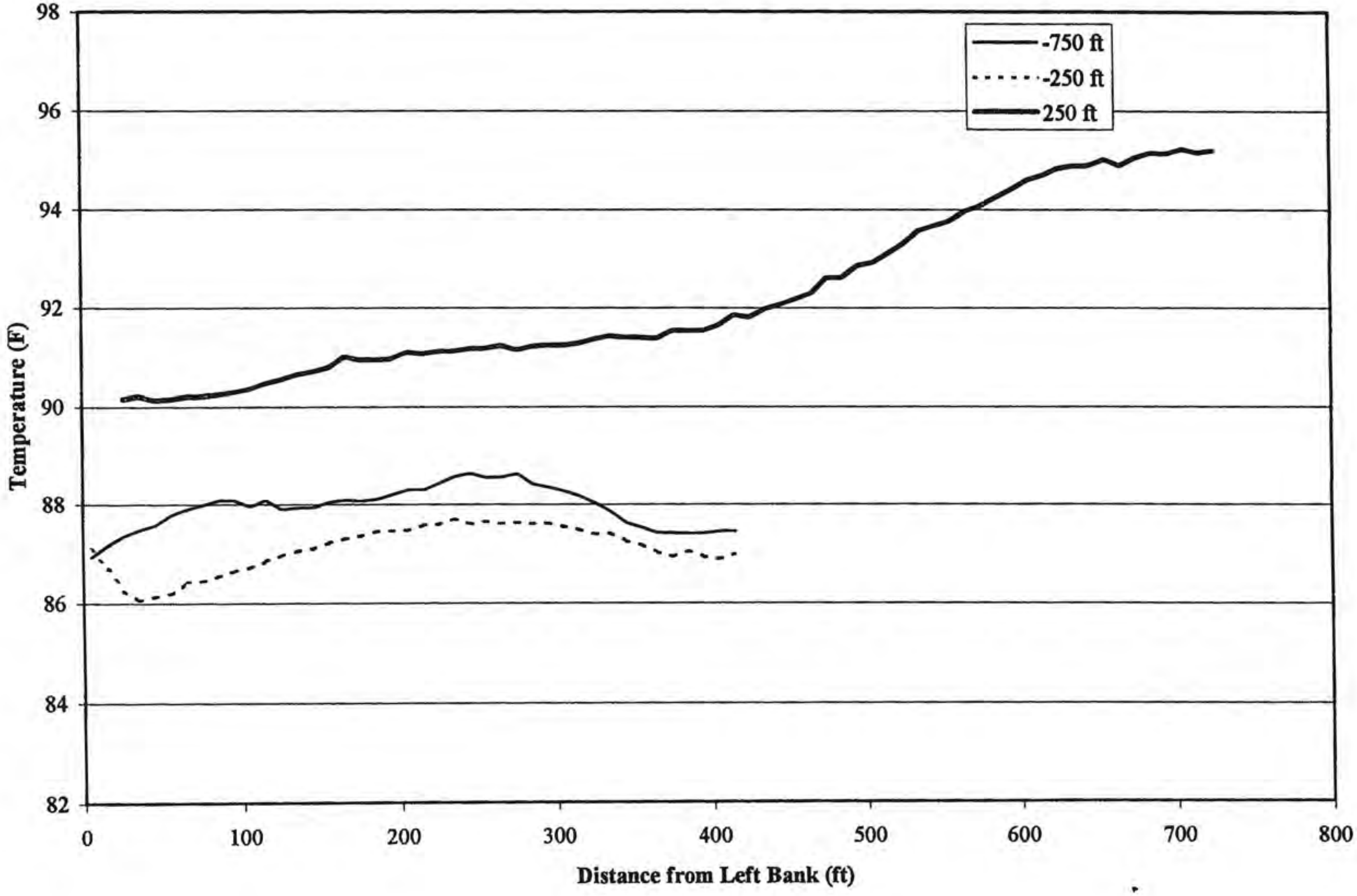


Figure B-1c
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 27 June 2002

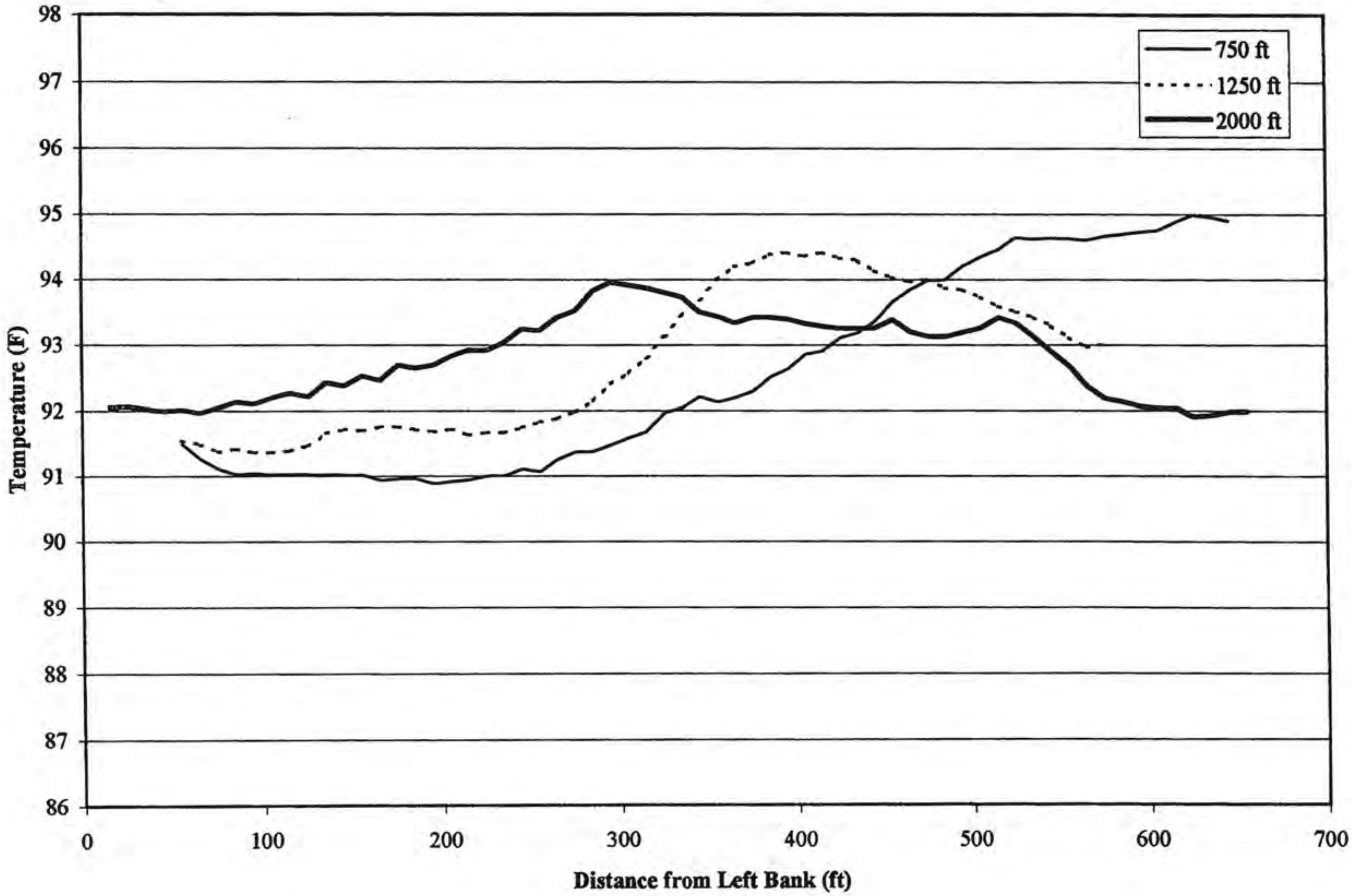


Figure B-1d
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 27 June 2002

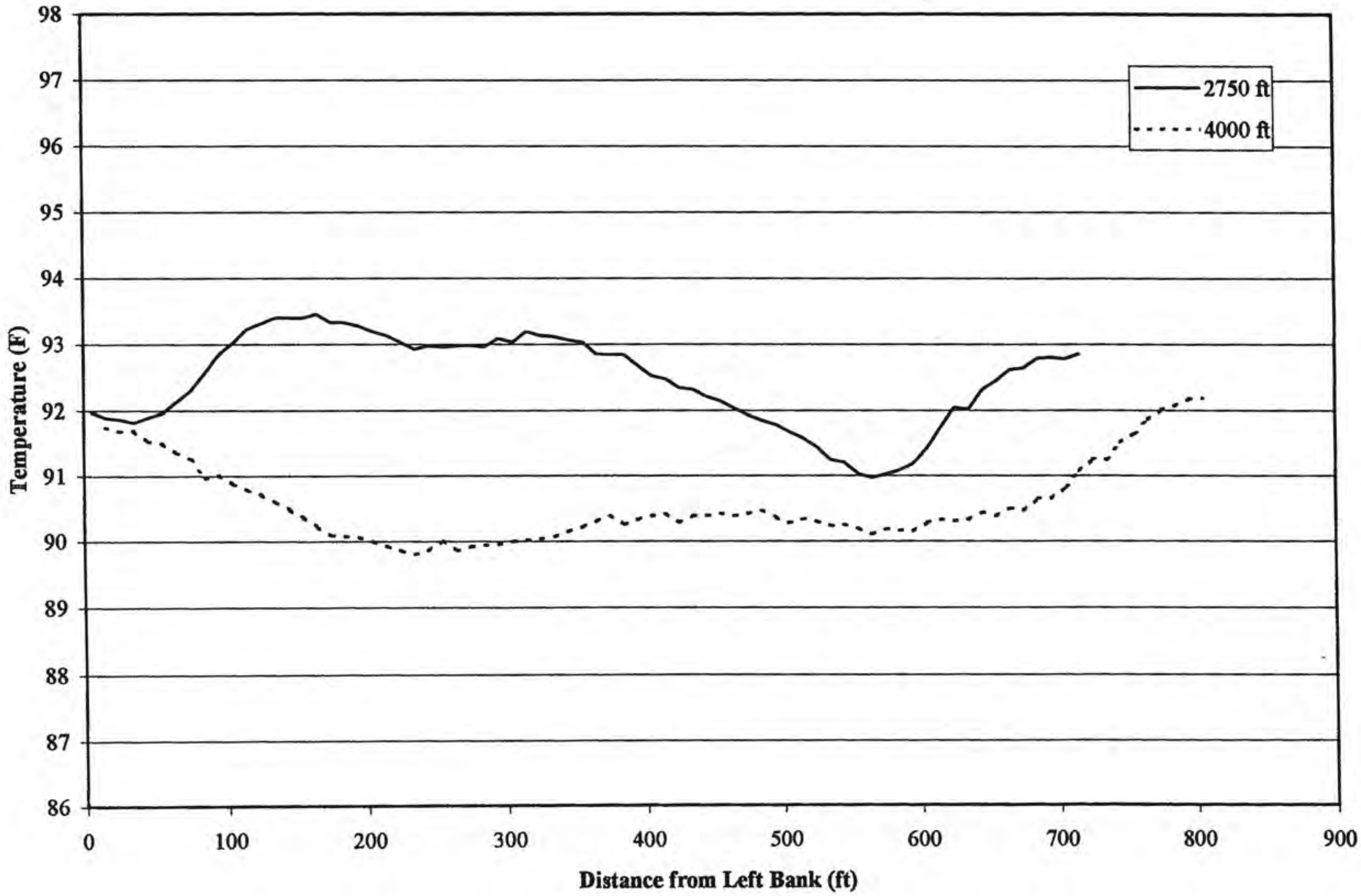


Figure B-1e
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 27 June 2002

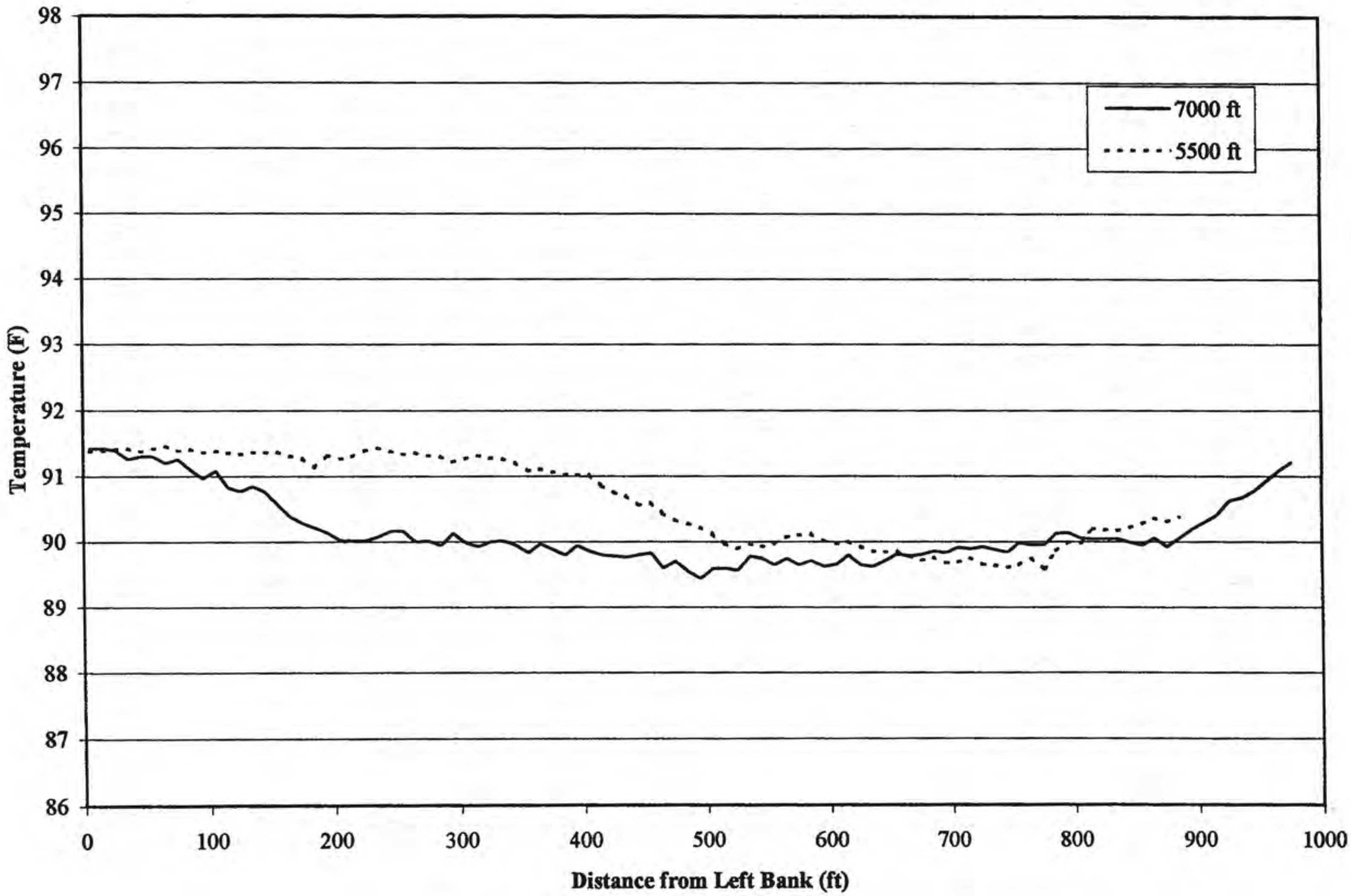


Table B-1 Surface Temperature Data near Joilet Stations 9 and 29, 27 June 2002

Distance (ft)	Transect												
from Left Bank	Upstr	-1720 ft	-1250 ft	-750 ft	-250 ft	250 ft	750 ft	1250 ft	2000 ft	2750 ft	4000 ft	5500 ft	7000 ft
5	84.5	89.7	89.7	86.9	87.1					92.0		91.4	91.4
15	84.5	89.5	89.5	87.2	86.7				92.1	91.9	91.8	91.4	91.4
25	84.5	89.5	89.6	87.4	86.3	90.2			92.1	91.9	91.7	91.4	91.4
35	84.6	89.5	89.6	87.5	86.1	90.2			92.0	91.8	91.7	91.4	91.3
45	84.6	89.5	89.7	87.6	86.1	90.1			92.0	91.9	91.5	91.4	91.3
55	84.6	89.4	89.6	87.8	86.2	90.2	91.5	91.5	92.0	92.0	91.5	91.4	91.3
65	84.6	89.4	89.7	87.9	86.4	90.2	91.3	91.5	92.0	92.1	91.4	91.5	91.2
75	84.6	89.3	89.5	88.0	86.4	90.2	91.1	91.4	92.0	92.3	91.3	91.4	91.3
85	84.5	89.2	89.5	88.1	86.5	90.3	91.0	91.4	92.1	92.6	91.0	91.4	91.1
95	84.5	89.2	89.5	88.1	86.7	90.3	91.0	91.4	92.1	92.9	91.0	91.4	91.0
105	84.4	89.1	89.6	88.0	86.7	90.4	91.0	91.4	92.2	93.0	90.9	91.4	91.1
115	84.4	88.9	89.4	88.1	86.9	90.5	91.0	91.4	92.3	93.2	90.8	91.4	90.8
125	84.4	88.8	89.3	87.9	87.0	90.6	91.0	91.5	92.2	93.3	90.7	91.3	90.8
135	84.4	88.6	89.2	87.9	87.1	90.7	91.0	91.7	92.4	93.4	90.6	91.4	90.8
145	84.4	88.5	89.1	87.9	87.1	90.7	91.0	91.7	92.4	93.4	90.5	91.4	90.8
155	84.3	88.6	88.8	88.1	87.2	90.8	91.0	91.7	92.5	93.4	90.4	91.4	90.6
165	84.5	88.5	88.7	88.1	87.3	91.0	90.9	91.8	92.5	93.5	90.2	91.3	90.4
175	84.4	88.6	88.7	88.1	87.4	91.0	91.0	91.8	92.7	93.3	90.1	91.3	90.3
185	84.4	88.2	88.5	88.1	87.4	91.0	91.0	91.7	92.7	93.3	90.1	91.1	90.2
195	84.4	87.8	88.2	88.2	87.5	91.0	90.9	91.7	92.7	93.3	90.1	91.3	90.1
205	84.4	87.4	87.7	88.3	87.5	91.1	90.9	91.7	92.8	93.2	90.0	91.3	90.0
215	84.5	87.3	87.4	88.3	87.6	91.1	90.9	91.6	92.9	93.1	89.9	91.3	90.0
225	84.5	87.0	87.3	88.4	87.6	91.1	91.0	91.7	92.9	93.0	89.9	91.4	90.0
235	84.5	86.5	87.0	88.6	87.7	91.1	91.0	91.7	93.0	92.9	89.8	91.4	90.1
245	84.5	85.9	86.9	88.7	87.6	91.2	91.1	91.7	93.3	93.0	89.9	91.4	90.2
255	84.6	85.3	86.8	88.6	87.7	91.2	91.1	91.8	93.2	93.0	90.0	91.3	90.2
265	84.7	85.1	86.9	88.6	87.6	91.2	91.3	91.9	93.4	93.0	89.9	91.4	90.0
275	84.6	84.8	86.9	88.6	87.6	91.2	91.4	92.0	93.5	93.0	89.9	91.3	90.0
285	84.6	84.8	87.0	88.4	87.6	91.2	91.4	92.2	93.8	93.0	89.9	91.3	89.9
295	84.7	84.8	87.2	88.4	87.6	91.3	91.5	92.4	94.0	93.1	90.0	91.2	90.1
305	84.6	84.7	87.2	88.3	87.5	91.2	91.6	92.6	93.9	93.0	90.0	91.3	90.0
315	84.6	84.6	87.1	88.2	87.5	91.3	91.7	92.8	93.9	93.2	90.0	91.3	89.9
325	84.7	84.6	87.3	88.0	87.4	91.4	92.0	93.1	93.8	93.1	90.0	91.3	90.0

Table B-1 Surface Temperature Data near Joilet Stations 9 and 29, 27 June 2002

Distance (ft) from Left Bank	Transect												
	Upstr	-1720 ft	-1250 ft	-750 ft	-250 ft	250 ft	750 ft	1250 ft	2000 ft	2750 ft	4000 ft	5500 ft	7000 ft
335	84.6	84.6	87.1	87.9	87.4	91.4	92.0	93.5	93.7	93.1	90.1	91.3	90.0
345	84.7	84.7	87.2	87.6	87.3	91.4	92.2	93.7	93.5	93.1	90.2	91.2	90.0
355	84.6	84.6	87.2	87.5	87.2	91.4	92.1	94.0	93.4	93.0	90.2	91.1	89.8
365	84.7	84.6	87.4	87.4	87.0	91.4	92.2	94.2	93.3	92.9	90.3	91.1	90.0
375	84.7	84.7	87.3	87.4	86.9	91.5	92.3	94.3	93.4	92.8	90.4	91.1	89.9
385	84.7	84.8	87.3	87.4	87.1	91.5	92.5	94.4	93.4	92.8	90.2	91.0	89.8
395	84.8	84.7	87.3	87.4	86.9	91.5	92.6	94.4	93.4	92.7	90.3	91.0	89.9
405	84.9	84.7	87.2	87.4	86.9	91.7	92.9	94.4	93.3	92.5	90.4	91.0	89.9
415	85.0	84.7	87.3	87.5	87.0	91.9	92.9	94.4	93.3	92.5	90.4	90.9	89.8
425	84.9	84.7	87.1			91.8	93.1	94.3	93.3	92.3	90.3	90.8	89.8
435	84.9	84.7	87.0			92.0	93.2	94.3	93.3	92.3	90.4	90.7	89.8
445	84.8	84.7	87.0			92.1	93.4	94.1	93.3	92.2	90.4	90.6	89.8
455	84.9	85.0	86.9			92.2	93.7	94.0	93.4	92.1	90.4	90.6	89.8
465	84.9	84.8	86.7			92.3	93.9	94.0	93.2	92.0	90.4	90.4	89.6
475		84.8	86.2			92.6	94.0	94.0	93.1	91.9	90.4	90.3	89.7
485		84.8	86.1			92.6	94.0	93.9	93.1	91.9	90.5	90.3	89.5
495		84.8	86.2			92.9	94.2	93.9	93.2	91.8	90.4	90.2	89.4
505		84.8	85.6			92.9	94.4	93.7	93.3	91.7	90.3	90.1	89.6
515		84.7	85.5			93.1	94.5	93.6	93.4	91.6	90.3	90.0	89.6
525		84.8	85.4			93.3	94.7	93.5	93.3	91.4	90.3	89.9	89.6
535		84.8	85.3			93.6	94.6	93.4	93.1	91.2	90.2	90.0	89.8
545		84.7	85.5			93.7	94.6	93.3	92.9	91.2	90.3	89.9	89.7
555		84.8	85.6			93.8	94.6	93.1	92.7	91.0	90.2	90.0	89.6
565		84.7	85.9			94.0	94.6	93.0	92.4	91.0	90.1	90.1	89.7
575		84.7	85.9			94.1	94.7	93.0	92.2	91.0	90.2	90.1	89.6
585		84.7	85.7			94.2	94.7		92.1	91.1	90.2	90.1	89.7
595		84.8				94.4	94.7		92.1	91.2	90.2	90.0	89.6
605		84.5				94.6	94.8		92.0	91.4	90.3	90.0	89.7
615		84.5				94.7	94.9		92.0	91.8	90.3	90.0	89.8
625		84.6				94.8	95.0		91.9	92.1	90.3	89.9	89.6
635		84.4				94.9	95.0		91.9	92.0	90.3	89.9	89.6
645		84.5				94.9	94.9		92.0	92.3	90.4	89.8	89.7
655		84.5				95.0			92.0	92.5	90.4	89.9	89.8

Table B-1 Surface Temperature Data near Joilet Stations 9 and 29, 27 June 2002

Distance (ft)	Transect												
from Left Bank	Upstr	-1720 ft	-1250 ft	-750 ft	-250 ft	250 ft	750 ft	1250 ft	2000 ft	2750 ft	4000 ft	5500 ft	7000 ft
665		84.5				94.9				92.6	90.5	89.8	89.8
675						95.1				92.7	90.5	89.7	89.8
685						95.2				92.8	90.6	89.8	89.9
695						95.1				92.8	90.6	89.7	89.8
705						95.2				92.8	90.8	89.7	89.9
715						95.2				92.9	91.1	89.8	89.9
725						95.2					91.3	89.7	89.9
735											91.2	89.6	89.9
745											91.5	89.6	89.8
755											91.7	89.6	90.0
765											91.9	89.8	90.0
775											92.0	89.6	90.0
785											92.1	89.9	90.1
795											92.2	90.0	90.1
805											92.2	90.0	90.1
815												90.2	90.0
825												90.2	90.0
835												90.2	90.1
845												90.2	90.0
855												90.3	90.0
865												90.4	90.1
875												90.3	89.9
885												90.4	90.1
895													90.2
905													90.3
915													90.4
925													90.6
935													90.7
945													90.8
955													90.9
965													91.1
975													91.2

Figure B-2a
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 11 July 2002

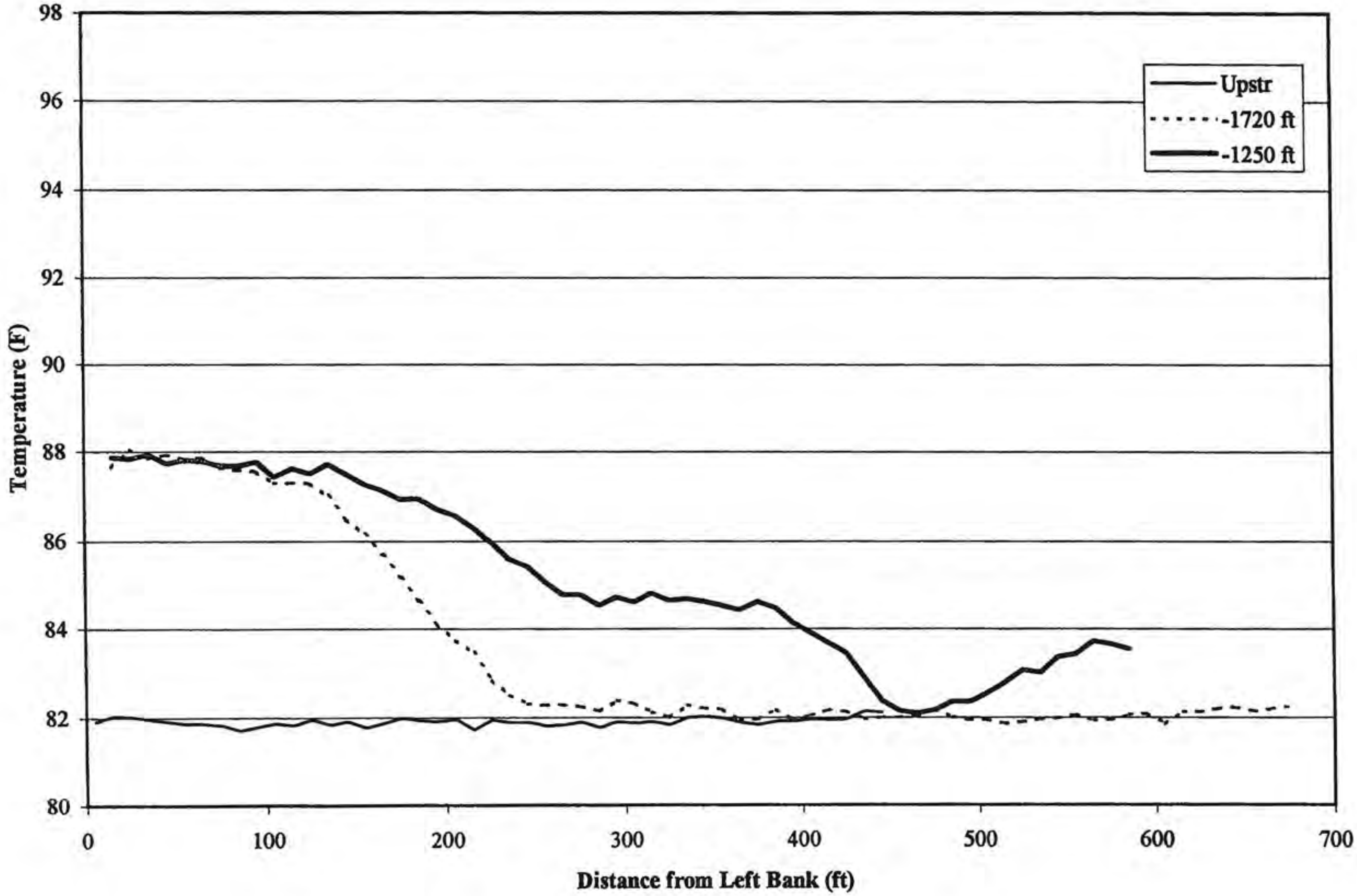


Figure B-2b
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 11 July 2002

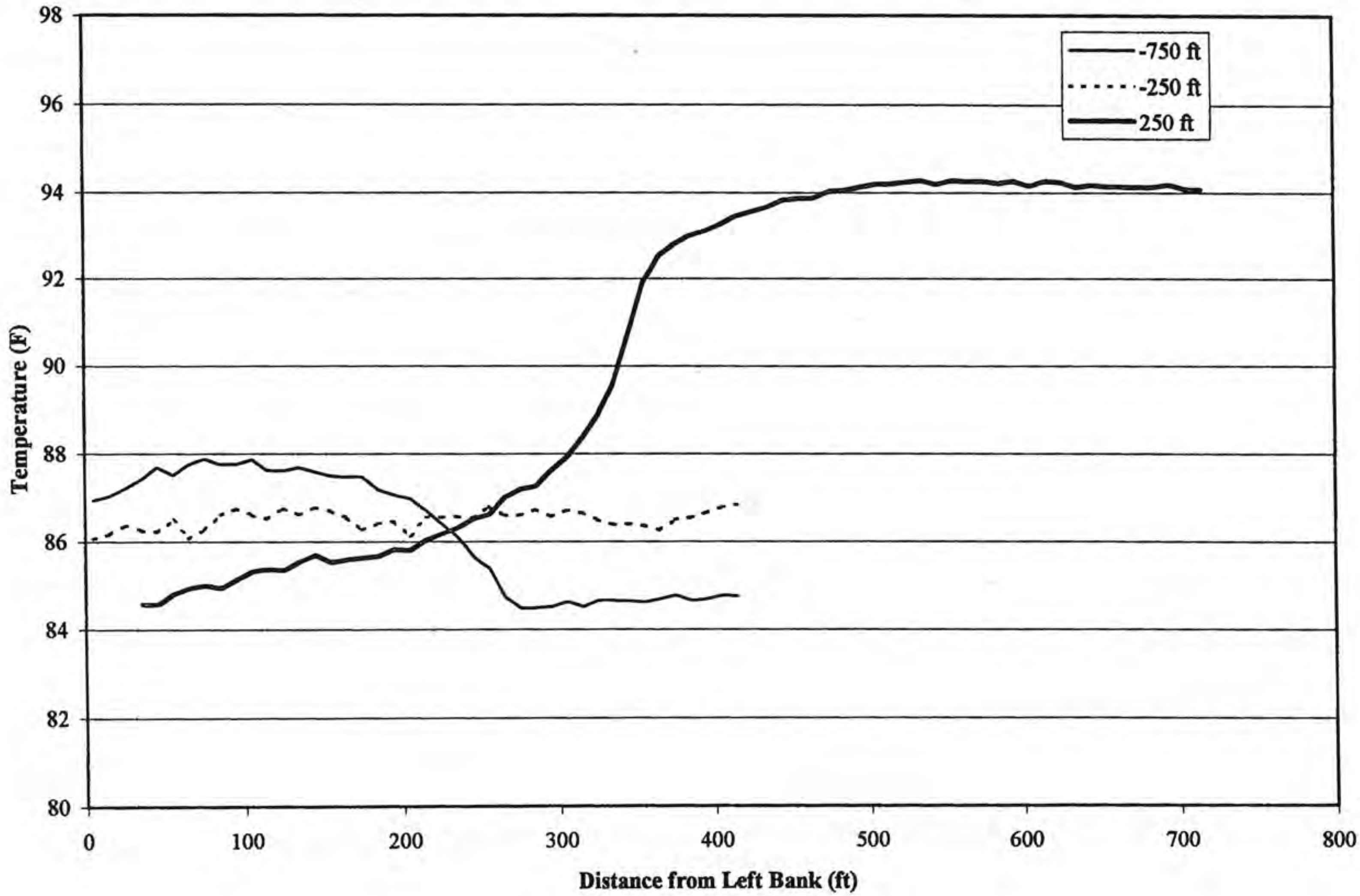


Figure B-2c
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 11 July 2002

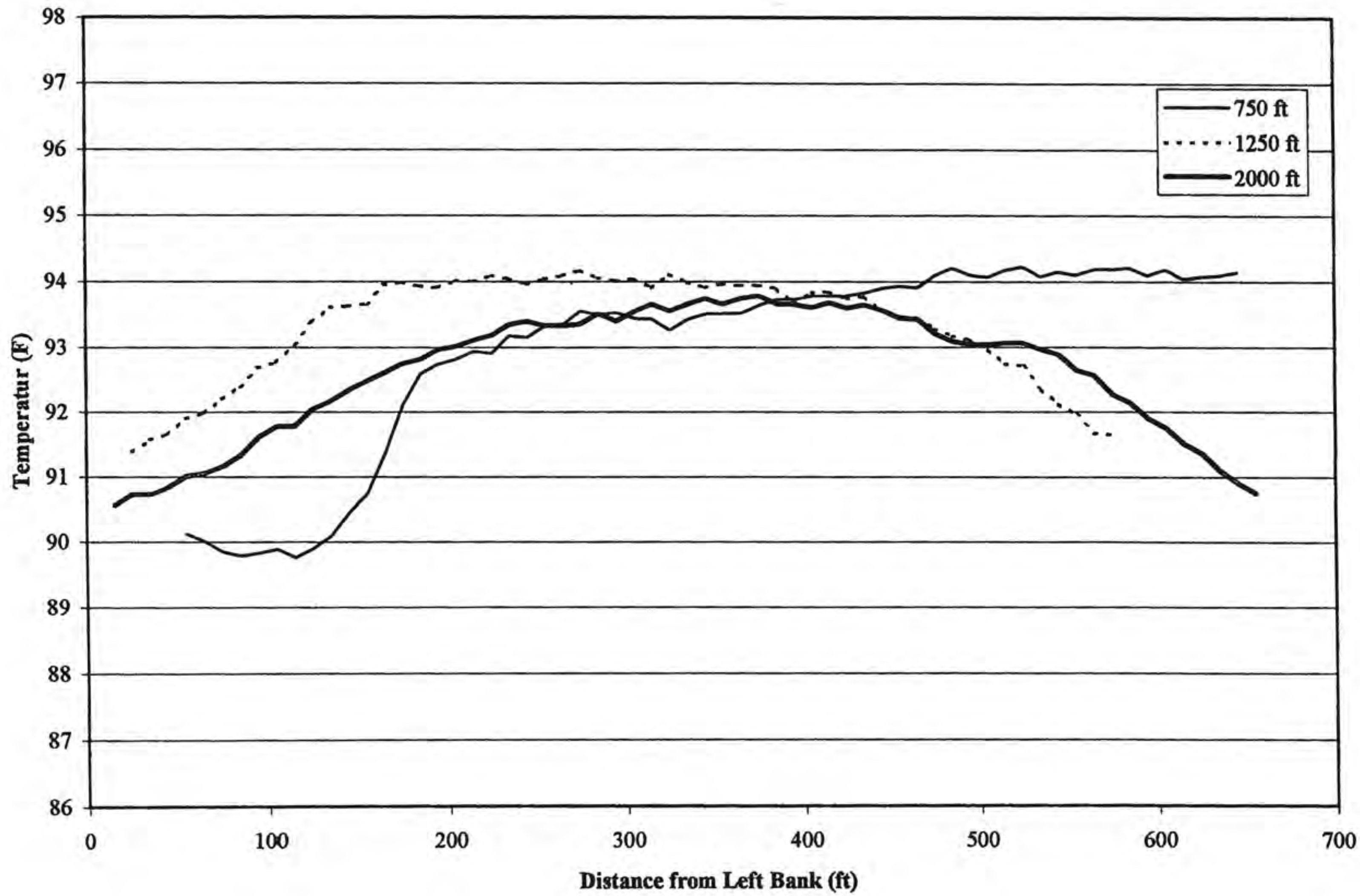


Figure B-2d
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 11 July 2002

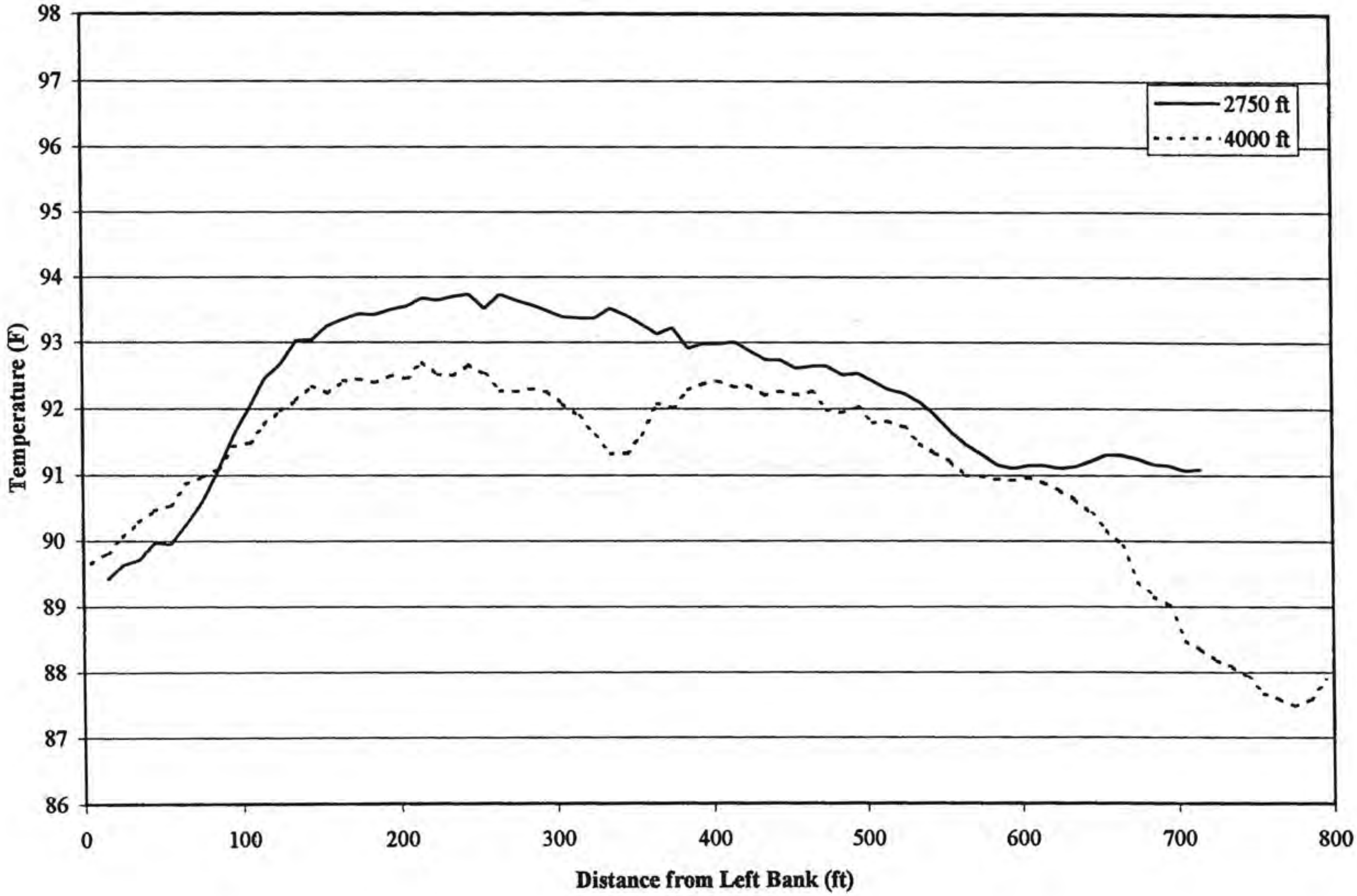


Figure B-2e
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 11 July 2002

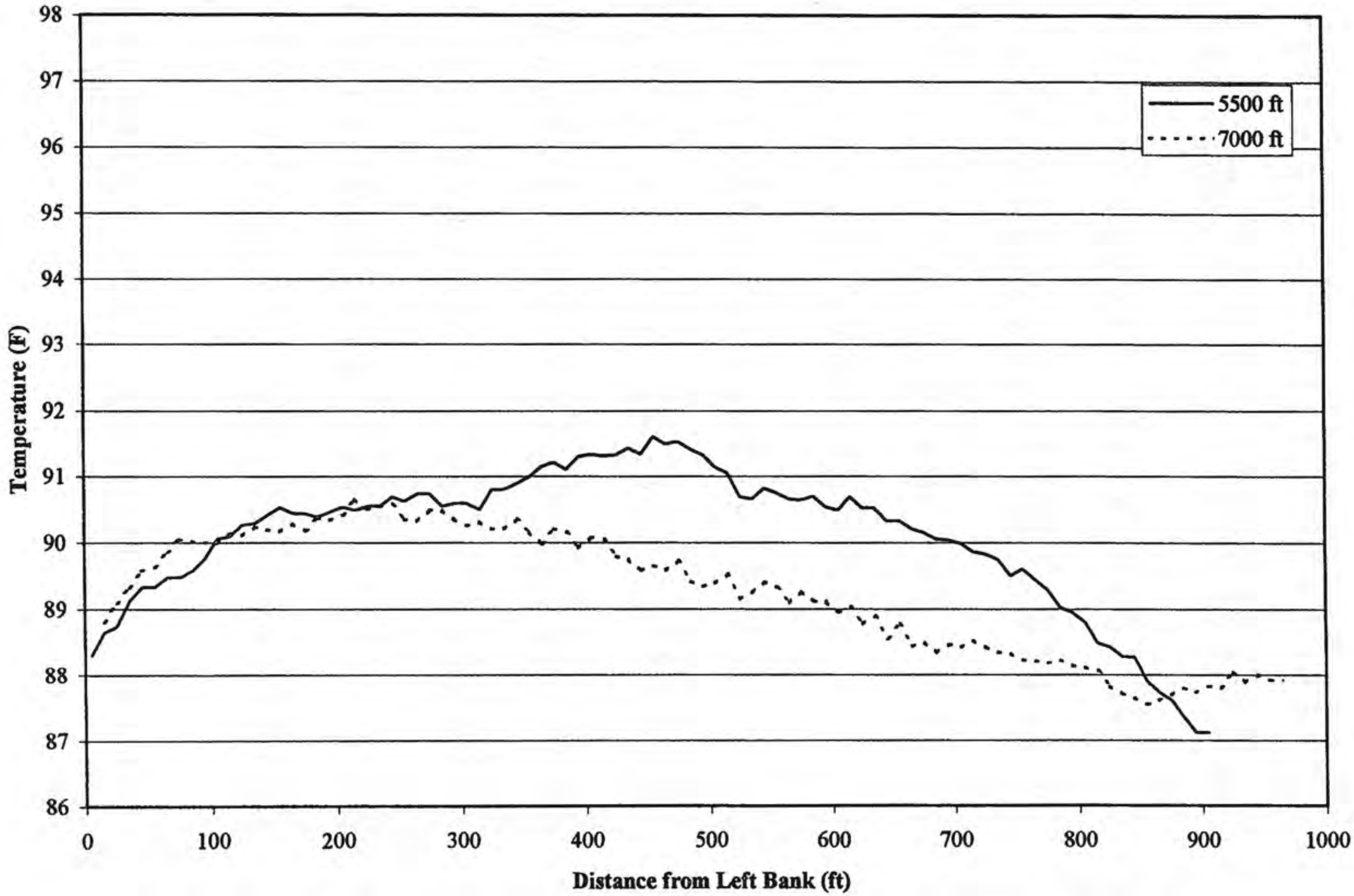


Table B-2 Surface Temperature Data near Joilet Stations 9 and 29, 11 July 2002

Distance (ft) from Left Bank	Transect												
	Upstr	-1720 ft	-1250 ft	-750 ft	-250 ft	250 ft	750 ft	1250 ft	2000 ft	2750 ft	4000 ft	5500 ft	7000 ft
5	81.9			86.9	86.1						89.7	88.3	
15	82.1	87.7	87.9	87.0	86.2				90.6	89.4	89.8	88.7	88.8
25	82.0	88.1	87.8	87.2	86.4			91.4	90.7	89.6	90.1	88.7	89.1
35	82.0	87.8	87.9	87.4	86.3	84.6		91.6	90.7	89.7	90.3	89.1	89.3
45	81.9	87.9	87.7	87.7	86.2	84.6		91.7	90.8	90.0	90.5	89.3	89.6
55	81.9	87.8	87.8	87.5	86.5	84.8	90.1	91.9	91.0	90.0	90.5	89.3	89.6
65	81.9	87.9	87.8	87.8	86.1	84.9	90.0	92.0	91.1	90.3	90.9	89.5	89.9
75	81.8	87.7	87.7	87.9	86.3	85.0	89.9	92.2	91.2	90.6	91.0	89.5	90.1
85	81.7	87.6	87.7	87.8	86.6	84.9	89.8	92.4	91.3	91.1	91.1	89.6	90.0
95	81.8	87.6	87.8	87.8	86.8	85.1	89.8	92.7	91.6	91.6	91.4	89.8	90.0
105	81.9	87.3	87.4	87.9	86.6	85.3	89.9	92.8	91.8	92.0	91.5	90.1	90.0
115	81.8	87.3	87.6	87.6	86.5	85.4	89.8	93.0	91.8	92.5	91.8	90.1	90.1
125	82.0	87.3	87.5	87.6	86.8	85.4	89.9	93.4	92.0	92.7	92.0	90.3	90.1
135	81.8	87.0	87.7	87.7	86.6	85.5	90.1	93.6	92.2	93.0	92.1	90.3	90.2
145	81.9	86.5	87.5	87.6	86.8	85.7	90.5	93.6	92.3	93.1	92.3	90.4	90.2
155	81.8	86.2	87.3	87.5	86.7	85.5	90.8	93.7	92.5	93.3	92.2	90.5	90.2
165	81.9	85.7	87.1	87.5	86.6	85.6	91.4	94.0	92.6	93.4	92.4	90.5	90.3
175	82.0	85.2	86.9	87.5	86.3	85.6	92.1	94.0	92.8	93.4	92.5	90.4	90.2
185	81.9	84.6	87.0	87.2	86.4	85.7	92.6	93.9	92.8	93.4	92.4	90.4	90.4
195	81.9	84.1	86.7	87.1	86.5	85.8	92.7	93.9	93.0	93.5	92.5	90.5	90.3
205	82.0	83.8	86.6	87.0	86.1	85.8	92.8	94.0	93.0	93.6	92.5	90.5	90.4
215	81.7	83.5	86.3	86.7	86.6	86.0	92.9	94.0	93.1	93.7	92.7	90.5	90.7
225	81.9	82.9	86.0	86.4	86.6	86.2	92.9	94.1	93.2	93.7	92.5	90.6	90.5
235	81.9	82.5	85.6	86.1	86.6	86.3	93.2	94.0	93.4	93.7	92.5	90.6	90.6
245	81.9	82.3	85.4	85.7	86.6	86.5	93.2	94.0	93.4	93.7	92.7	90.7	90.6
255	81.8	82.3	85.1	85.4	86.8	86.6	93.3	94.0	93.3	93.5	92.5	90.6	90.4
265	81.8	82.3	84.8	84.7	86.6	87.0	93.4	94.1	93.3	93.7	92.3	90.7	90.3
275	81.9	82.3	84.8	84.5	86.6	87.2	93.6	94.2	93.4	93.7	92.3	90.7	90.5
285	81.8	82.2	84.5	84.5	86.7	87.3	93.5	94.1	93.5	93.6	92.3	90.6	90.5
295	81.9	82.4	84.7	84.5	86.6	87.6	93.5	94.0	93.4	93.5	92.3	90.6	90.4
305	81.9	82.3	84.6	84.6	86.7	87.9	93.4	94.0	93.6	93.4	92.1	90.6	90.3
315	81.9	82.1	84.8	84.5	86.7	88.4	93.4	93.9	93.7	93.4	91.9	90.5	90.3
325	81.8	82.0	84.7	84.7	86.5	88.9	93.3	94.1	93.6	93.4	91.6	90.8	90.2

Table B-2 Surface Temperature Data near Joilet Stations 9 and 29, 11 July 2002

Distance (ft) from Left Bank	Transect												
	Upstr	-1720 ft	-1250 ft	-750 ft	-250 ft	250 ft	750 ft	1250 ft	2000 ft	2750 ft	4000 ft	5500 ft	7000 ft
335	82.0	82.3	84.7	84.7	86.4	89.6	93.4	94.0	93.7	93.5	91.3	90.8	90.2
345	82.0	82.2	84.6	84.6	86.4	90.7	93.5	93.9	93.8	93.4	91.3	90.9	90.4
355	82.0	82.2	84.5	84.6	86.4	91.9	93.5	94.0	93.7	93.3	91.6	91.0	90.2
365	81.9	81.9	84.4	84.7	86.3	92.5	93.5	93.9	93.8	93.1	92.1	91.1	90.0
375	81.8	82.0	84.6	84.8	86.5	92.8	93.6	93.9	93.8	93.2	92.0	91.2	90.2
385	81.9	82.2	84.5	84.7	86.6	93.0	93.7	93.9	93.7	92.9	92.3	91.1	90.2
395	81.9	81.9	84.1	84.7	86.7	93.1	93.7	93.7	93.7	93.0	92.4	91.3	89.9
405	82.0	82.0	83.9	84.8	86.8	93.3	93.8	93.8	93.6	93.0	92.4	91.3	90.1
415	81.9	82.2	83.7	84.8	86.9	93.4	93.8	93.9	93.7	93.0	92.3	91.3	90.0
425	82.0	82.1	83.5			93.6	93.8	93.7	93.6	92.9	92.4	91.3	89.8
435	82.2	82.0	82.9			93.7	93.8	93.8	93.7	92.8	92.2	91.4	89.8
445	82.1	82.0	82.4			93.8	93.9	93.6	93.6	92.7	92.3	91.3	89.6
455		82.0	82.2			93.9	93.9	93.5	93.5	92.6	92.2	91.6	89.7
465		82.0	82.1			93.9	93.9	93.5	93.4	92.7	92.3	91.5	89.6
475		82.2	82.2			94.0	94.1	93.3	93.2	92.7	92.0	91.5	89.7
485		82.0	82.4			94.1	94.2	93.2	93.1	92.5	91.9	91.4	89.4
495		81.9	82.4			94.1	94.1	93.1	93.1	92.5	92.0	91.3	89.3
505		81.9	82.6			94.2	94.1	93.0	93.0	92.4	91.8	91.1	89.4
515		81.9	82.8			94.2	94.2	92.8	93.1	92.3	91.8	91.1	89.5
525		81.9	83.1			94.2	94.2	92.7	93.1	92.2	91.7	90.7	89.2
535		82.0	83.0			94.3	94.1	92.4	93.0	92.1	91.5	90.7	89.3
545		82.0	83.4			94.2	94.2	92.1	92.9	91.9	91.3	90.8	89.4
555		82.1	83.4			94.3	94.1	92.0	92.7	91.7	91.2	90.8	89.3
565		81.9	83.7			94.3	94.2	91.7	92.6	91.5	91.0	90.7	89.1
575		81.9	83.7			94.3	94.2	91.6	92.3	91.3	91.0	90.6	89.3
585		82.1	83.6			94.2	94.2		92.1	91.2	90.9	90.7	89.1
595		82.1				94.3	94.1		91.9	91.1	90.9	90.5	89.1
605		81.9				94.2	94.2		91.8	91.2	91.0	90.5	89.0
615		82.1				94.3	94.0		91.5	91.2	90.9	90.7	89.0
625		82.1				94.2	94.1		91.4	91.1	90.8	90.5	88.8
635		82.2				94.1	94.1		91.1	91.1	90.6	90.5	88.9
645		82.2				94.2	94.1		90.9	91.2	90.4	90.3	88.6
655		82.1				94.1			90.8	91.3	90.2	90.3	88.8

Table B-2 Surface Temperature Data near Joilet Stations 9 and 29, 11 July 2002

Distance (ft)	Transect												
from Left Bank	Upstr	-1720 ft	-1250 ft	-750 ft	-250 ft	250 ft	750 ft	1250 ft	2000 ft	2750 ft	4000 ft	5500 ft	7000 ft
665		82.2				94.1				91.3	89.9	90.2	88.4
675		82.3				94.1				91.3	89.4	90.2	88.5
685						94.1				91.2	89.2	90.1	88.4
695						94.2				91.2	89.0	90.0	88.5
705						94.1				91.1	88.5	90.0	88.4
715						94.1				91.1	88.4	89.9	88.5
725											88.2	89.8	88.4
735											88.1	89.8	88.4
745											87.9	89.5	88.3
755											87.7	89.6	88.2
765											87.6	89.4	88.2
775											87.5	89.3	88.2
785											87.6	89.0	88.2
795											87.9	89.0	88.1
805												88.8	88.1
815												88.5	88.1
825												88.4	87.8
835												88.3	87.7
845												88.3	87.6
855												87.9	87.5
865												87.7	87.6
875												87.6	87.7
885												87.4	87.8
895												87.1	87.7
905												87.1	87.8
915													87.8
925													88.1
935													87.9
945													88.0
955													87.9
965													87.9

Figure B-3a
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 1 August 2002

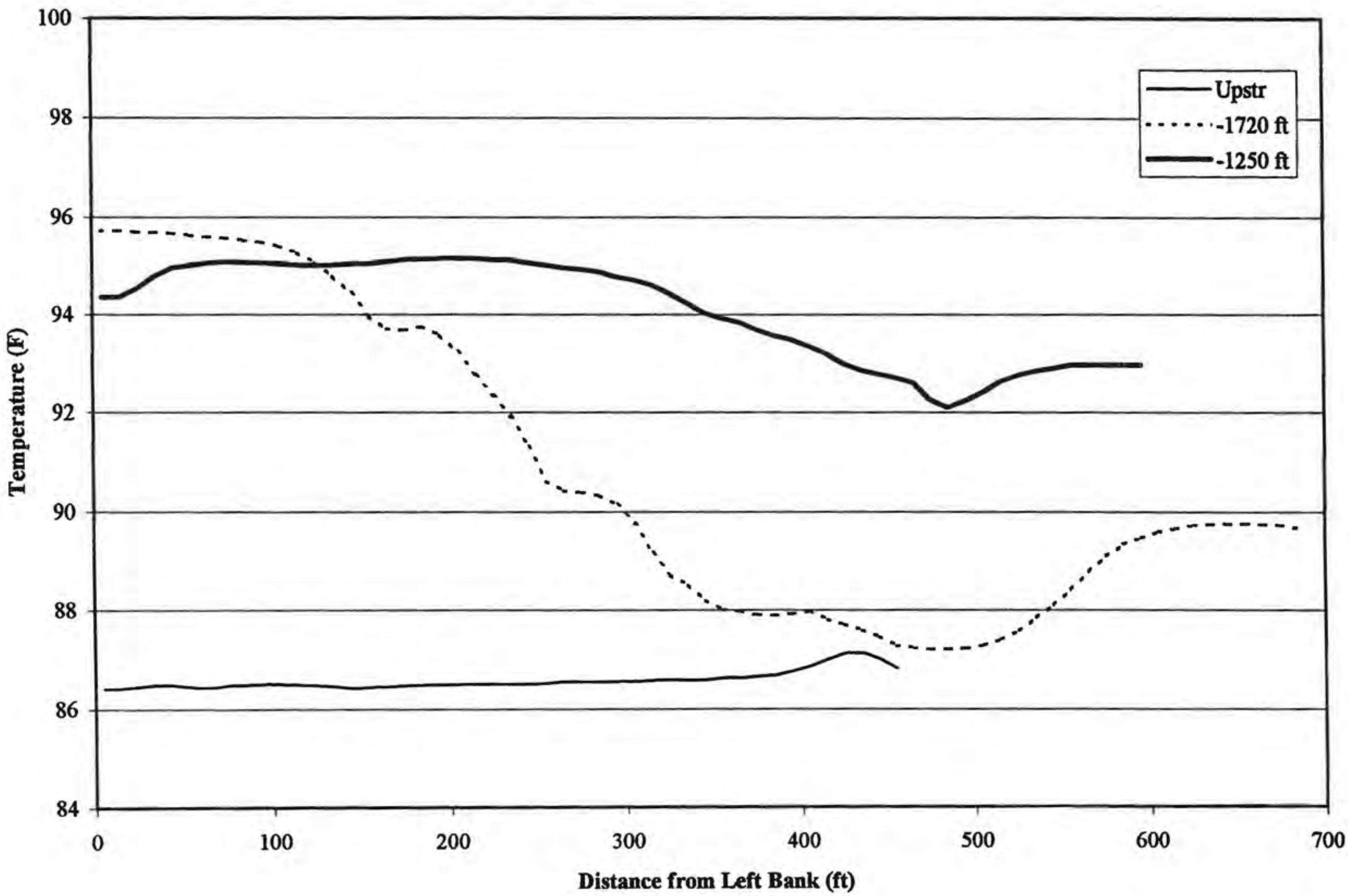


Figure B-3b
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 1 August 2002

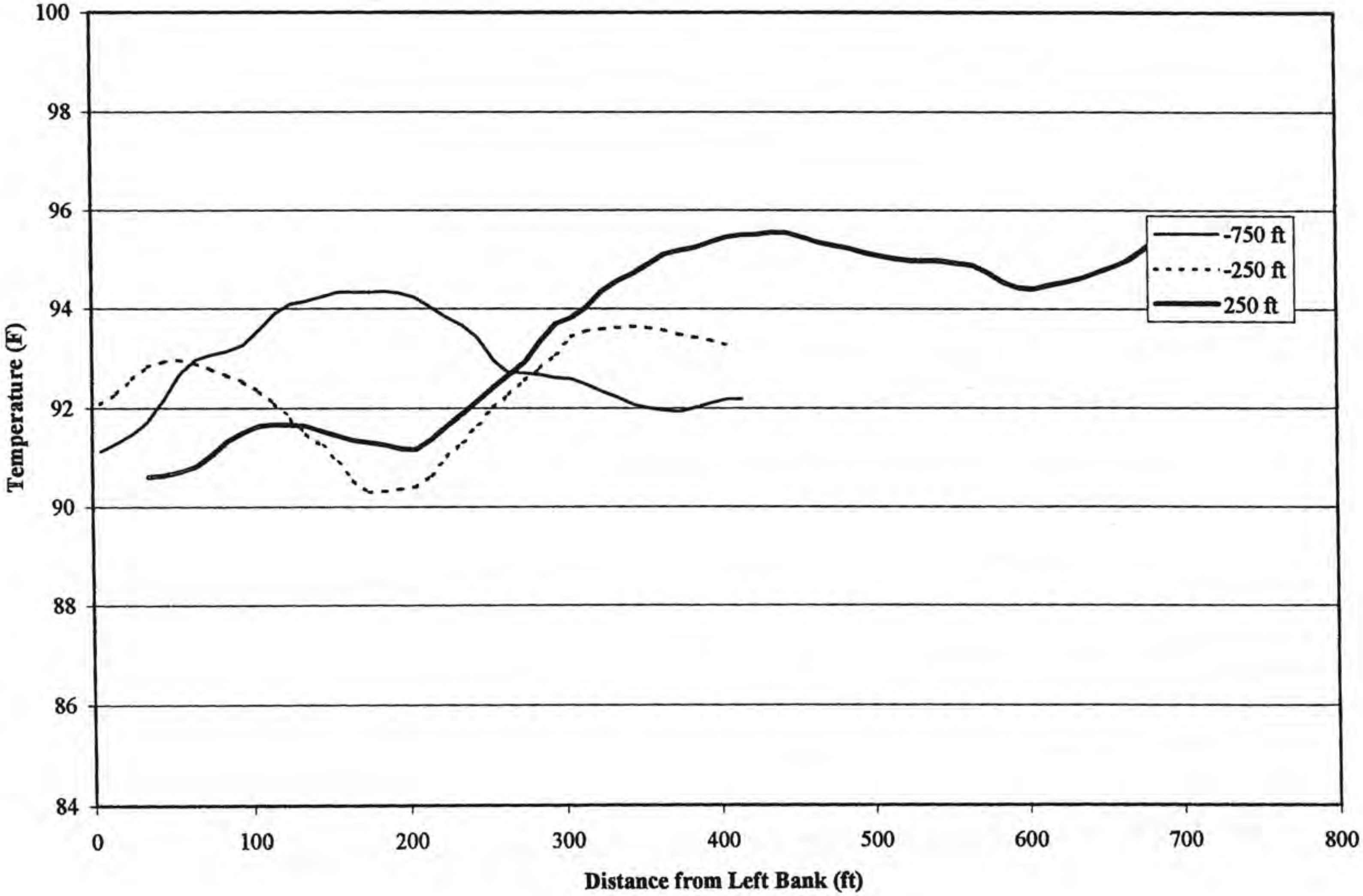


Figure B-3c
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 1 August 2002

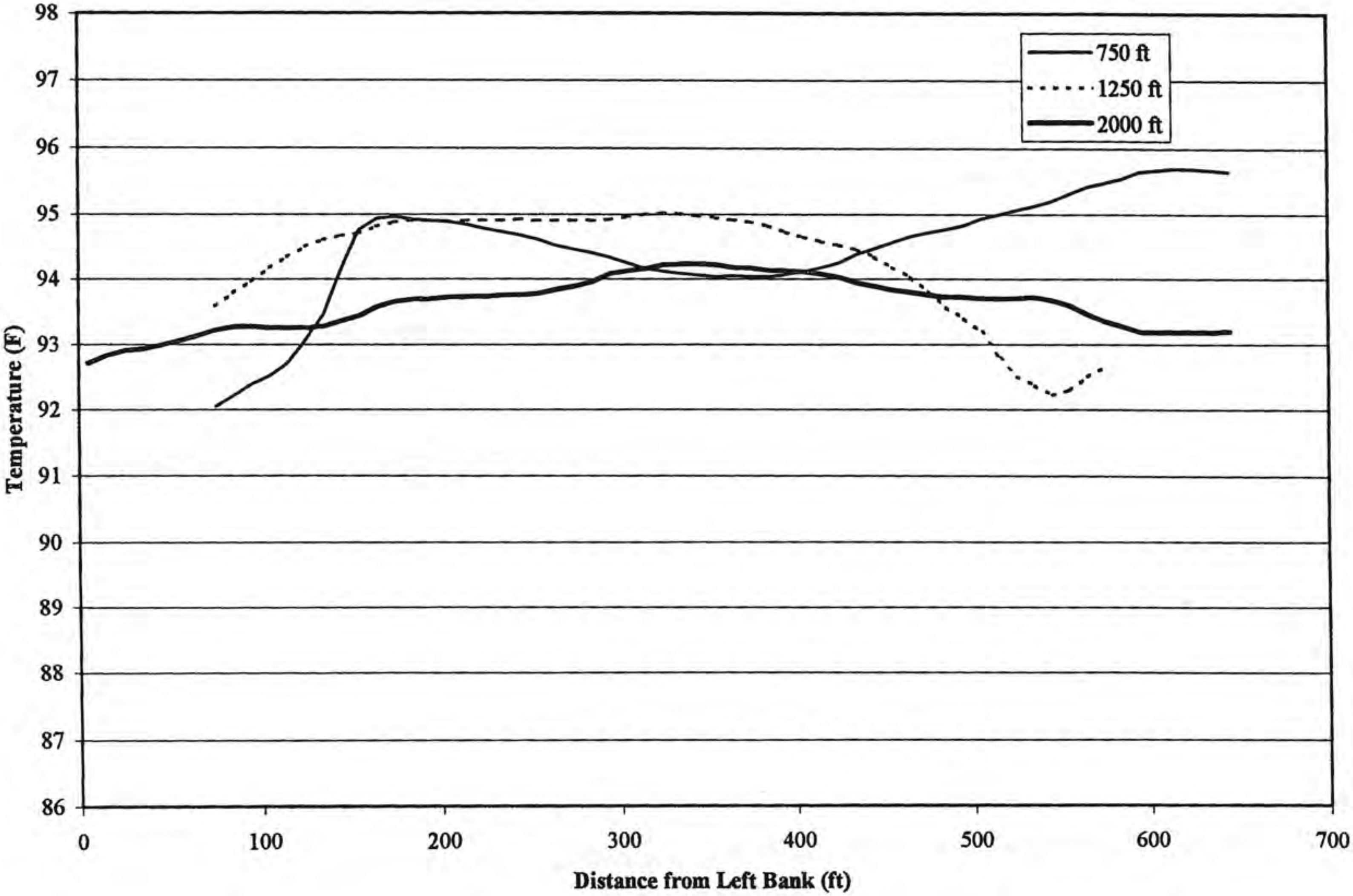


Figure B-3d
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 1 August 2002

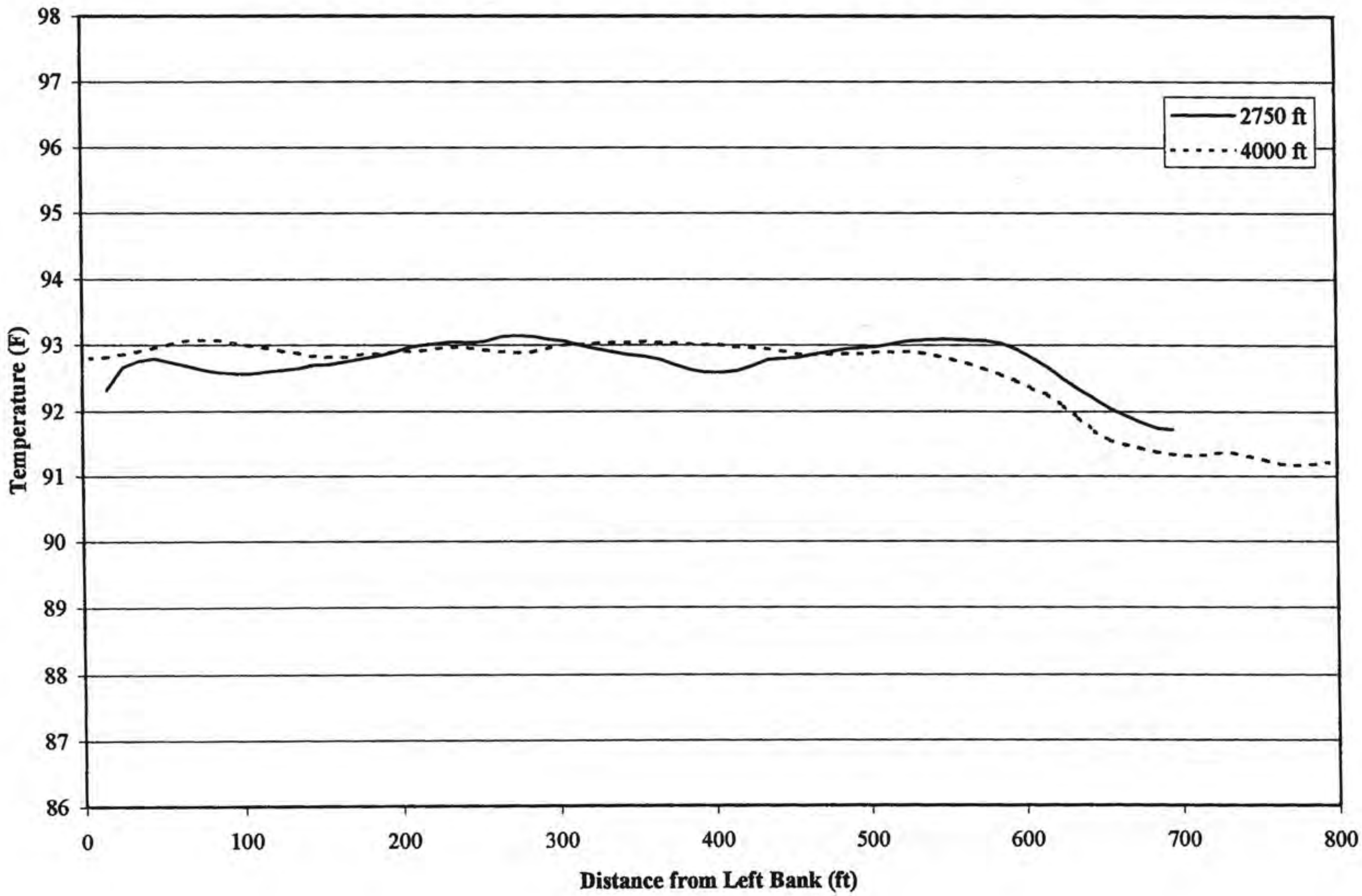


Figure B-3e
Surface Temperature along Horizontal Transects at Joliet Stations #9 and #29, 1 August 2002

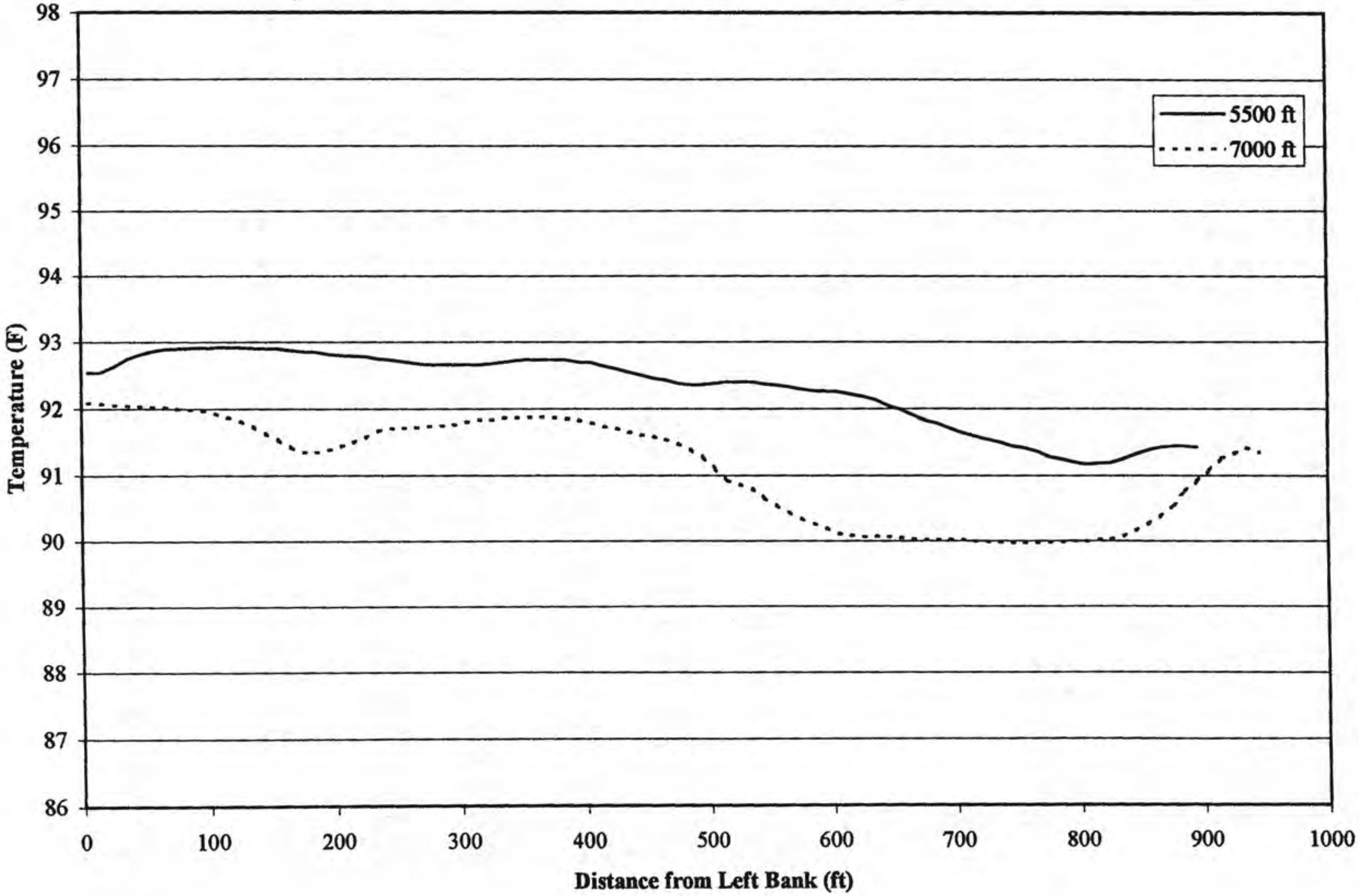


Table B-3 Surface Temperature Data near Joilet Stations 9 and 29, 1 August 2002

Distance (ft)	Transect												
from Left Bank	Upstr	-1720 ft	-1250 ft	-750 ft	-250 ft	250 ft	750 ft	1250 ft	2000 ft	2750 ft	4000 ft	5500 ft	7000 ft
5	86.4	95.7	94.4	91.1	92.1				92.7		92.8	92.5	92.1
15	86.4	95.7	94.4	91.3	92.3				92.8	92.3	92.8	92.6	92.1
25	86.5	95.7	94.6	91.5	92.6				92.9	92.7	92.9	92.6	92.1
35	86.5	95.7	94.8	91.7	92.8	90.6			92.9	92.8	92.9	92.7	92.0
45	86.5	95.7	95.0	92.2	92.9	90.6			93.0	92.8	93.0	92.8	92.0
55	86.4	95.6	95.0	92.7	93.0	90.7			93.1	92.7	93.0	92.9	92.0
65	86.4	95.6	95.1	93.0	92.9	90.8			93.1	92.7	93.1	92.9	92.0
75	86.5	95.6	95.1	93.1	92.8	91.1	92.1	93.6	93.2	92.6	93.1	92.9	92.0
85	86.5	95.5	95.1	93.2	92.7	91.3	92.2	93.8	93.3	92.6	93.1	92.9	92.0
95	86.5	95.5	95.1	93.3	92.5	91.5	92.4	94.0	93.3	92.6	93.0	92.9	92.0
105	86.5	95.4	95.0	93.6	92.3	91.7	92.5	94.2	93.3	92.6	93.0	92.9	91.9
115	86.5	95.3	95.0	93.9	92.1	91.7	92.7	94.4	93.3	92.6	93.0	92.9	91.9
125	86.5	95.1	95.0	94.1	91.8	91.7	93.1	94.5	93.3	92.6	92.9	92.9	91.8
135	86.5	94.8	95.0	94.2	91.5	91.7	93.5	94.6	93.3	92.7	92.9	92.9	91.7
145	86.4	94.4	95.0	94.2	91.2	91.5	94.2	94.7	93.4	92.7	92.8	92.9	91.6
155	86.4	94.0	95.0	94.3	90.9	91.4	94.8	94.7	93.4	92.7	92.8	92.9	91.5
165	86.5	93.7	95.1	94.3	90.5	91.4	94.9	94.8	93.6	92.8	92.8	92.9	91.4
175	86.5	93.7	95.1	94.3	90.3	91.3	95.0	94.9	93.7	92.8	92.9	92.9	91.3
185	86.5	93.8	95.1	94.4	90.3	91.3	94.9	94.9	93.7	92.8	92.9	92.9	91.3
195	86.5	93.6	95.2	94.3	90.4	91.2	94.9	94.9	93.7	92.9	92.9	92.8	91.4
205	86.5	93.2	95.2	94.2	90.4	91.2	94.9	94.9	93.7	93.0	92.9	92.8	91.4
215	86.5	92.8	95.2	94.0	90.6	91.4	94.9	94.9	93.7	93.0	92.9	92.8	91.5
225	86.5	92.3	95.1	93.8	91.0	91.6	94.8	94.9	93.7	93.0	93.0	92.8	91.6
235	86.5	91.9	95.1	93.7	91.3	91.9	94.7	94.9	93.8	93.1	93.0	92.8	91.7
245	86.5	91.3	95.1	93.4	91.7	92.1	94.7	94.9	93.8	93.0	93.0	92.7	91.7
255	86.5	90.6	95.0	93.0	92.0	92.4	94.6	94.9	93.8	93.1	92.9	92.7	91.7
265	86.6	90.4	95.0	92.7	92.3	92.7	94.5	94.9	93.8	93.1	92.9	92.7	91.7
275	86.5	90.4	94.9	92.7	92.6	92.9	94.5	94.9	93.9	93.2	92.9	92.7	91.7
285	86.5	90.3	94.9	92.7	92.8	93.4	94.4	94.9	94.0	93.1	92.9	92.7	91.7
295	86.6	90.1	94.8	92.6	93.1	93.7	94.3	94.9	94.1	93.1	93.0	92.7	91.8
305	86.6	89.8	94.7	92.6	93.4	93.8	94.3	95.0	94.1	93.1	93.0	92.7	91.8
315	86.6	89.2	94.6	92.5	93.6	94.0	94.2	95.0	94.2	93.0	93.0	92.7	91.8
325	86.6	88.7	94.5	92.3	93.6	94.4	94.1	95.0	94.2	92.9	93.0	92.7	91.8

Table B-3 Surface Temperature Data near Joilet Stations 9 and 29, 1 August 2002

Distance (ft)	Transect												
from Left Bank	Upstr	-1720 ft	-1250 ft	-750 ft	-250 ft	250 ft	750 ft	1250 ft	2000 ft	2750 ft	4000 ft	5500 ft	7000 ft
335	86.6	88.5	94.2	92.2	93.6	94.6	94.1	95.0	94.2	92.9	93.0	92.7	91.9
345	86.6	88.2	94.0	92.1	93.7	94.7	94.1	95.0	94.2	92.9	93.0	92.7	91.9
355	86.6	88.0	93.9	92.0	93.6	94.9	94.0	95.0	94.2	92.8	93.1	92.7	91.9
365	86.6	88.0	93.9	92.0	93.6	95.1	94.1	94.9	94.2	92.8	93.0	92.7	91.9
375	86.7	87.9	93.7	91.9	93.5	95.2	94.0	94.9	94.2	92.7	93.0	92.7	91.9
385	86.7	87.9	93.6	92.0	93.4	95.2	94.0	94.8	94.1	92.6	93.0	92.7	91.9
395	86.8	87.9	93.5	92.1	93.4	95.3	94.1	94.7	94.1	92.6	93.0	92.7	91.8
405	86.9	88.0	93.4	92.2	93.3	95.5	94.1	94.7	94.1	92.6	93.0	92.7	91.8
415	87.0	87.8	93.2	92.2		95.5	94.2	94.6	94.1	92.6	93.0	92.6	91.7
425	87.1	87.7	93.0			95.5	94.3	94.5	94.0	92.7	93.0	92.6	91.7
435	87.1	87.6	92.9			95.6	94.4	94.5	93.9	92.8	92.9	92.6	91.7
445	87.0	87.5	92.8			95.5	94.5	94.4	93.9	92.8	92.9	92.5	91.6
455	86.8	87.3	92.7			95.4	94.6	94.2	93.8	92.8	92.9	92.5	91.6
465		87.2	92.6			95.3	94.7	94.0	93.8	92.9	92.9	92.4	91.5
475		87.2	92.3			95.3	94.7	93.8	93.8	92.9	92.9	92.4	91.5
485		87.2	92.1			95.2	94.8	93.6	93.7	92.9	92.9	92.4	91.4
495		87.2	92.2			95.1	94.8	93.4	93.7	93.0	92.9	92.4	91.3
505		87.3	92.4			95.1	94.9	93.2	93.7	93.0	92.9	92.4	91.1
515		87.4	92.6			95.0	95.0	92.8	93.7	93.0	92.9	92.4	90.9
525		87.6	92.8			95.0	95.1	92.5	93.7	93.1	92.9	92.4	90.9
535		87.9	92.8			95.0	95.1	92.4	93.7	93.1	92.9	92.4	90.8
545		88.1	92.9			95.0	95.2	92.2	93.7	93.1	92.8	92.4	90.7
555		88.4	93.0			94.9	95.3	92.3	93.6	93.1	92.8	92.4	90.5
565		88.8	93.0			94.9	95.4	92.5	93.5	93.1	92.7	92.3	90.4
575		89.1	93.0			94.7	95.5	92.7	93.4	93.1	92.7	92.3	90.3
585		89.3	93.0			94.5	95.6		93.3	93.0	92.6	92.3	90.3
595		89.5	93.0			94.4	95.7		93.2	92.9	92.5	92.3	90.2
605		89.6				94.4	95.7		93.2	92.8	92.4	92.3	90.1
615		89.7				94.5	95.7		93.2	92.7	92.3	92.2	90.1
625		89.7				94.5	95.7		93.2	92.5	92.1	92.2	90.1
635		89.7				94.6	95.7		93.2	92.3	91.9	92.1	90.1
645		89.8				94.7	95.7		93.2	92.2	91.7	92.1	90.1
655		89.8				94.8				92.0	91.6	92.0	90.1