Thermal Discharge
from the Toledo Edison Bayshore Power Plant:
An Update

The impacts of the thermal discharge from the Toledo Edison Bayshore Power Plant (Bayshore Plant) into Maumee Bay have been a matter of some controversy for a number of years. The operation of the facility's cooling water intake structure has been the focus of some concern as well. Citizens living on the south shore of Maumee Bay and commercial fishermen operating in Maumee Bay have made the following assertions:

- the Bayshore Plant's withdrawal of large quantities of water from the mouth of the Maumee River and discharge of heated water contributes to the bacteria problem experienced in the Bay area;

- the discharge of heated water results in low concentrations of dissolved oxygen which is harmful to aquatic life;

- the Bayshore Plant's thermal discharge does not comply with Ohio water quality standards for temperature;

- the thermal plume created by Bayshore's discharge is much too large and extends to the south shore of Maumee Bay, resulting in restrictions for recreational activities and water quality problems; and

- the operation of the Bayshore Plant results in significant mortality to fish and freshwater mussels.

As a result of requirements included in its current National Pollutant Discharge Elimination System (NPDES) discharge permit, Toledo Edison conducted a "Thermal Mixing Zone Study" for the Bayshore Plant during the summer of 2002 which provided data about some of these issues. Data has also been collected by local governments and agencies for subjects such as bacteria and water temperature profiles. While the available information provides answers for some of the above assertions, there are remaining questions and the need for additional data. The relevant findings of the "Thermal Mixing Zone Study" and the conclusions of other data-gathering efforts are discussed below, as well as a description of the work which is continuing in order to address the outstanding issues.

Bacteria Problem

High levels of bacteria have been an ongoing problem in Maumee Bay, and have resulted in the closure of the beach at Maumee State Park on numerous occasions. The "Thermal Mixing Zone

Study" included the results of bacteria monitoring by the Bayshore Plant during the summer of 2002. Samples were collected and analyzed for twenty-eight days during June through September at the water intake structure and the cooling water discharge for the Bayshore Plant. All of these samples showed bacterial counts less than the water quality standards for both fecal coliform and E. coli, and the majority of the samples were well below the water quality standards. There seemed to be no clear pattern regarding the relationship between the intake and discharge samples; on occasion, the intake sample showed higher bacterial counts while other days resulted in higher bacterial counts for the discharge sample. The highest bacterial counts for any single day were recorded for intake samples.

Sampling for bacteria was also conducted during the summer of 2001 at the Bayshore Plant. Once again, the results of this effort showed that the majority of bacterial counts were well below water quality standards for bacteria.

There have been concerns that the large water withdrawals of the Bayshore Plant include wastewater from the City of Toledo's combined sewer overflows (CSOs) that have been discharged into the Maumee River. However, the "Thermal Mixing Zone Study" showed during the summer of 2002 that the Bayshore Plant's water withdrawal rate was higher than the flow in the Maumee River for 74 days, indicating that the source of the intake water for the power plant is Lake Erie as well as the Maumee River. This finding suggests that the likelihood of any bacteria problems in Maumee Bay being caused from Toledo's CSOs[1] and water withdrawn by the Bayshore Plant is probably less than what may have been thought previously, at least during the summer season.

Bacteria studies have also been conducted by local municipalities and other entities to determine the source of the bacteria in the Bay. The Maumee Bay Bacteria Study is being conducted by the University of Toledo Lake Erie Center, the U.S. Geological Survey and the Toledo Metropolitan Area Council of Governments (TMACOG). Their 2003 sampling showed that the densities of E. coli on the outfall side of the power plant were no higher or less than the densities at the intake side of the plant. This included both water and sediment bacterial levels. Ohio EPA collected samples for fecal coliform bacteria (with one sample for E. coli in 1995) at similar locations in 1995 and 1996. Ohio EPA data reflected slight increases in fecal coliform bacteria from the inlet to the outlet in three of four samples and a somewhat higher increase in one sample. The single E. coli sample showed a decrease from inlet to outlet. In general, these results are quite similar to those shown in the "Thermal Mixing Zone Study." No bacteria sampling was performed on days when discharges from Toledo's CSOs were reported.

In the future, any potential impact from Toledo's CSOs on bacterial populations in Maumee Bay will be reduced due to improvements which are being undertaken by the City of Toledo. In 2002, U.S. EPA, Ohio EPA, and the City of Toledo entered into a Consent Decree to resolve a

[1] During the summer of 2002, none of the bacteria samples taken at the Bayshore Plant occurred on the same day as recorded discharges from Toledo's CSOs.

civil suit brought against the City for alleged violations of the Clean Water Act and non-compliance with the City's NPDES permit for the wastewater treatment plant (WWTP). The Consent Decree imposes numerous requirements on the City, including extensive improvements to the WWTP and the sewage collection system, and development of a long term control plan to minimize CSO discharges and associated water quality impacts.

Dissolved Oxygen

Monitoring for dissolved oxygen was conducted as part of the "Thermal Mixing Zone Study." Measurements were made on June 12th, July 9th, July 30th, August 20th, and September 17th in 2002 at various times throughout the day and at several different locations in Maumee Bay. For example, 24 measurements were made on July 30th beginning at 11:24 a.m. and ending at 3:34 p.m. These measurements were conducted at the surface, at a medium depth, and at the bottom of the Bay, which ranged from four feet to seven feet in depth at the sampling locations. In

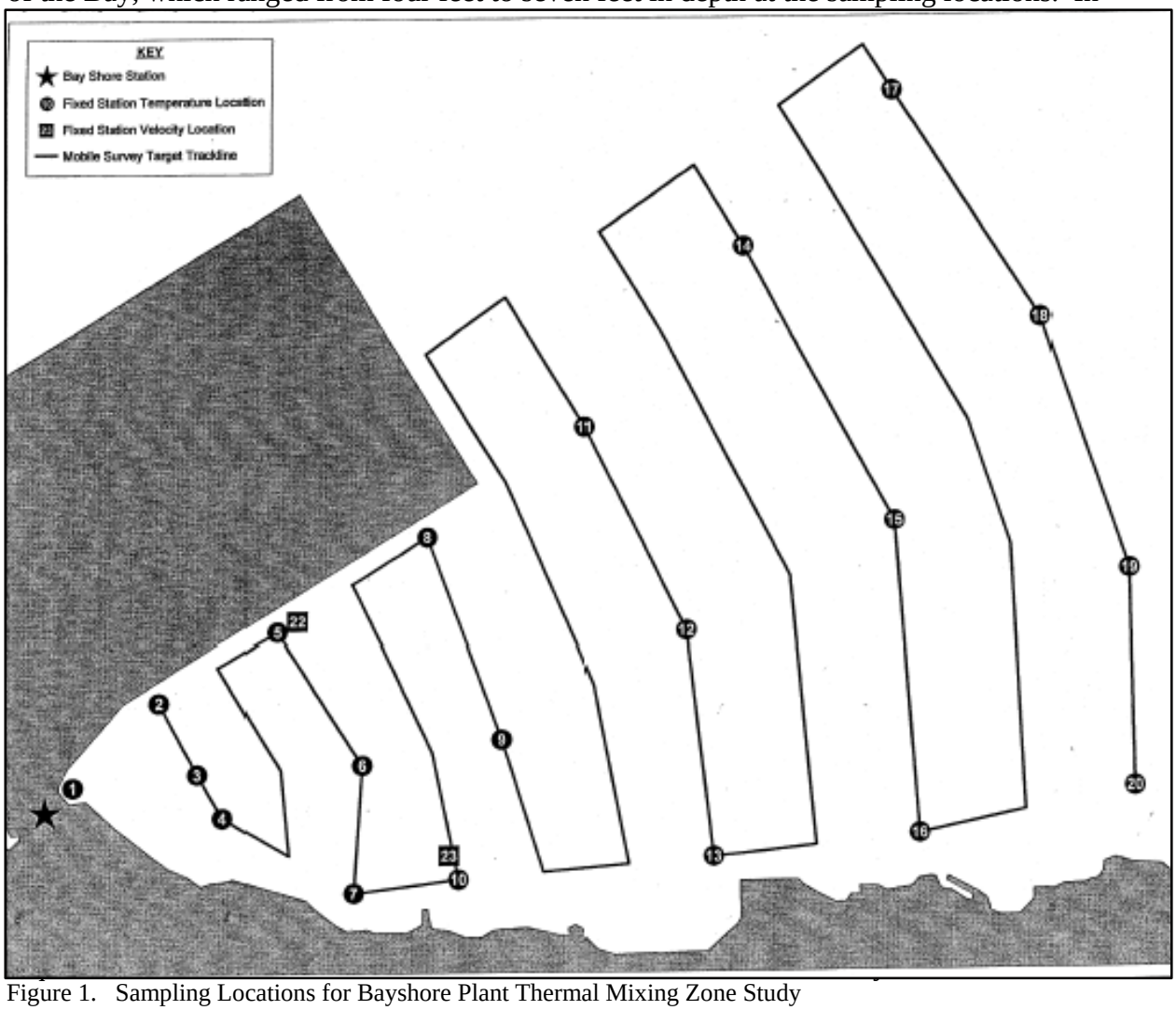

Figure 1. Sampling Locations for Bayshore Plant Thermal Mixing Zone Study

determining if the size of the mixing zone is in compliance with the OAC. [Attachment I lists each required documentation and demonstration in rule 3745-2-08(C) of the OAC.]

The documentation and demonstrations necessary for making the determination regarding compliance have been provided and/or are available. For example, a description of "...the amount of dilution...at the boundaries of the proposed mixing zone and the size, shape and location of the area of mixing..." is available from the "Thermal Mixing Zone Study." In addition, information is available documenting background water quality and demonstrating that the "...mixing zone will not jeopardize the continued existence of any endangered or threatened species..." Attachment I shows each documentation and demonstration required under rule 3745-2-08(C) of the OAC and includes a brief discussion of Ohio EPA's evaluation in the context of the Bayshore Plant. In summary, Ohio EPA believes the available information demonstrates that the Bayshore Plant discharge does exceed water quality standards for temperature within the thermal plume near the facility, however, the facility's impacts on aquatic life and designated uses of the Bay do not justify restricting the size of the thermal mixing zone at this time.

The Thermal Plume

The primary objective of the "Thermal Mixing Zone Study" was to determine the size and spatial distribution of the thermal plume resulting from the Bayshore Plant's discharge. The sampling and the predictive computer model developed for this study shows the areas of the thermal plume (or mixing zone) in which the temperature decreases sufficiently to meet the daily maximum and 30-day average aquatic water quality standards for temperature. Using this information, the study suggests a number of conclusions which are discussed below.

- Spatial distribution. The sampling performed during the summer of 2002 showed that the spatial distribution of the thermal plume is variable. On June 26th, the thermal plume extended in a northeasterly direction, parallel with the Confined Disposal Facility (CDF). (See Figure 5 in Attachment II.) On other occasions such as July 30th (Figure 7), the plume extended in a wider area to the south shore of Maumee Bay. At times, the plume also extended more than a mile beyond the end of the CDF. The spatial distribution of the thermal plume is undoubtedly affected by wind patterns and other phenomenon such as seiche effects (i.e., the naturally-occurring back and forth movement of water in Lake Erie and Maumee Bay, resulting in constantly changing water levels).

- Temperatures at the south shore. Assuming that temperatures measured at the water intake structure for the Bayshore Plant are a reasonable measure of background (or ambient) temperatures in Maumee Bay, the "Thermal Mixing Zone Study" showed that the temperature of water reaching the south shore during the summer are roughly 3 to 5° F. higher than ambient temperatures. (See Figures 3 - 9.) For example, temperatures measured near the south shore on July 30th were 86° F. while the intake or ambient temperature for July 30th was 81° F. In addition, the data shows that temperatures at the south shore are

slightly less than the daily maximum water quality standards while it is possible that south shore temperatures exceed the 30-day average water quality standards during certain months. The 30-day average water quality standard for July is 83° F. and the temperatures recorded near the south shore were 82° F. and 86° F. for July 9th and July 30th, respectively.

- Size of the thermal plume. The largest thermal plume observed during the summer of 2002 was approximately 2,000 acres, or 3.1 square miles. The average plume size observed was 216 acres. The predictive computer model developed in the "Thermal Mixing Zone Study" projects a typical plume size of 84 acres. However, Ohio EPA believes that the predictive model underestimates the size of the thermal plume, especially as the plume size increases.

Recreation

Ohio does not have numeric temperature water quality criteria for recreation. Instead, Ohio regulations contain narrative requirements which can apply to recreational uses. Paragraphs (C) and (D) of rule 3745-1-04 of the Ohio Administrative Code (OAC) state that Ohio waters shall be free from materials entering the water which produce "...color, odor, or other conditions in such a degree as produce a nuisance..." and which result "...in concentrations that are toxic or harmful to human, animal, or aquatic life..."

The Bayshore Plant's thermal discharge does interfere with peoples' access to certain portions of the Bay with regard to recreational uses. It is likely that the area of the Bay nearest the thermal discharge would not be suitable for swimming or jet-skiing even if the thermal discharge were not present, however, the high water temperatures from the discharge makes this area even less desirable for these activities.[2] In addition, ice-fishing in this area of Maumee Bay is apparently prevented, at least in part, due to the Bayshore Plant discharge. Ohio EPA believes that more information would be needed in order to determine if the discharge were in violation of rule 3745-1-04 of the OAC. Likewise, more information would be needed in order to determine if the discharge constituted a nuisance for recreation in the context of this rule.

Fish and Freshwater Mussels

The operation of power plants which withdraw large amounts of water for cooling purposes can result in significant mortality to fish and shellfish through impingement (or becoming trapped) on intake structure screens and entrainment (or the passing through screens into a cooling water system) into the power plant. In order to address these problems, U.S. EPA has developed regulations for existing power plants which have been adopted, and became effective on September 7, 2004. These regulations require the Bayshore Plant to meet standards designed to minimize impingement and entrainment.

[2] Maumee Bay is designated as "bathing waters" in Ohio's water quality standards, and bathing waters are defined as areas suitable for swimming where a lifeguard and/or bathhouse facilities are present. However, the portion of Maumee Bay near the Bayshore Plant discharge does not have lifeguards and/or bathhouse facilities.

While the regulations allow the Bayshore Plant until January 2008 to submit the necessary studies and plans which are designed to demonstrate compliance with the new rules, Ohio EPA will be working with Toledo Edison to expedite their submittal of this information. After review and approval of Toledo Edison's plans for reducing impingement and entrainment, a compliance schedule will be included in Bayshore's NPDES permit to implement the approved plans. The plans may involve installing new technology, making operational changes at the facility, making provisions for the restoration of aquatic species in Maumee Bay, or a combination of these approaches.

Attachment I. Required Documentation and Demonstrations under Rule 3745-2-08(C) of the Ohio Administrative Code

Each of the requirements included in rule 3745-2-08(C) of the Ohio Administrative Code are listed in this attachment in *italics*. Below each requirement is a discussion of the requested information with regard to the thermal mixing zone resulting from the Bayshore Plant discharge. For purposes of the following discussion, the mixing zone is defined as the area where mixing of the effluent (discharge) and the waters of Maumee Bay is actively taking place. The edge of the mixing zone is defined as the area where the temperatures decrease sufficiently to meet the water quality standards for the outside mixing zone maximum temperature criteria.[3]

- *Describe the amount of dilution occurring at stream design flow conditions, or other conditions found to be most critical with respect to effluent and receiving water mixing, at the boundaries of the proposed mixing zone and the size, shape and location of the area of mixing, including the manner in which diffusion and dispersion occur.*

  The "Thermal Mixing Zone Study" provides valuable information regarding the size, spatial distribution, and location of the mixing zone. As discussed previously, the size and spatial distribution of the mixing zone tend to vary considerably from one day to another. However, in general, the size of the mixing zone extends to the east and northeast to the end of the Confined Disposal Facility (CDF). On occasion, the mixing zone extends to the southeast to the south shore of Maumee Bay.

  The data collected for the "Thermal Mixing Zone Study" indicates that beyond the northeast end of the CDF, the diffusion and dispersion (or distribution) of the thermal plume tends to be much more random and widespread. As the thermal plume extends beyond the CDF another one-half to one mile, temperatures generally decrease to the ambient Maumee Bay temperatures as defined by the intake temperatures for the Bayshore Plant.

- *For sources discharging to Lake Erie or other non-flowing waters, define the location where discharge-induced mixing ceases.*

  Discharge-induced mixing is generally defined as the area where active mixing of the discharge plume and dilution water is occurring. The area where discharge-induced mixing ceases can be characterized as the location where mixing becomes more passive or random while the plume becomes much more disperse. Given these characterizations, the data collected for the "Thermal Mixing Zone Study" suggests that discharge-induced mixing generally ceases just beyond the northeast end of the CDF.

[3] The outside mixing zone maximum temperature criteria can also be described as the daily maximum temperature which is allowed at the edge of the mixing zone.

Using a simple mass balance equation is another approach which can help approximate the area where discharge induced mixing ceases. The amount of dilution water from Maumee Bay required to decrease the Bayshore effluent temperatures to the daily maximum water quality standards for the edge of the mixing zone during summer months is approximated by the area from the Bayshore Plant discharge to just beyond the end of the CDF. This is admittedly a simplistic approach since it does not address effects such as convection of heat from wind or the rather stagnant nature of this area of Maumee Bay, potentially resulting in under-estimating the size of the area required for dilution. However, Ohio EPA believes that this approach remains valid for purposes of supporting the conclusions discussed in the previous paragraph.

- *Document the substrate character and geomorphology within the mixing zone.*

  Table 1 below shows the characteristics of the substrate (or the material at the bottom) in Maumee Bay in the vicinity of the Bayshore Plant's thermal discharge plume. Substrate samples were obtained during the summer of 2004. Locations of the sampling sites are shown on page 9 in Figure 2.

Table 1. Substrates in Maumee Bay in Vicinity of Bayshore Plant

Site	Water Depth (in meters)	Mixing Zone Substrate Characteristics
BST01	1.3	Cobble/Large # of Asian Clams (*Corbicula*)
BST02	1.2	Some Fine Silts w/Sand, Mainly Asian Clams (*Corbicula*)
BST03	1.45	Fine Silts w/Sand, Large # of Asian Clams (*Corbicula*)
BST04	1.85	Mainly Sand w\Fine Silts
BST05	1.8	Sandy/Silts
BST06	1.9	Fine Silts/Clays
BST07	2.1	Fine Silts/Clays
BST09	0.7	Fine Silts/Clays w/sands, Large # of Asian Clams (*Corbicula*), Aquatic Vegetation
BST08	2	Fine Silts/Clays
BST10	1.5	Fine Silts/Clays
BST11	1.65	Fine Silts/Clays
BST12	1.8	Fine Silts
BST13	1.8	Fine Silts/Clays
BST14	1.95	Fine Silts/Clays, Aquatic Vegetation

Table 1. Substrates in Maumee Bay in Vicinity of Bayshore Plant

Site	Water Depth (in meters)	Mixing Zone Substrate Characteristics
BST15	2.8	Fine Silts/Clays w/Sand
BST16	0.75	Fine Sand
BST17	1.2	Fine Silts w/Sand, Aquatic Vegetation
BST18	1.5	Fine Silts w/Sand, Aquatic Vegetation
BST19	1.65	Fine Silts/Clays w/Sand, Aquatic Vegetation
BST20	1.75	Fine Silts/Clays w/Sand
REF21	1.7	Mainly Clay w/Fine Silts
REF22	1.6	Fine Silts, Aquatic Vegetation

- Lake level +29.8 to +33.5 LWD during collection period.
- Asian Clams (*Corbicula*) were present at all sites except one reference site (REF21) located near Cedar Point Peninsula.
- Sample site REF22 was collected North of Grassy Island.
- Population densities of Asian Clams (*Corbicula*) increased at sites closest to the thermal discharge.

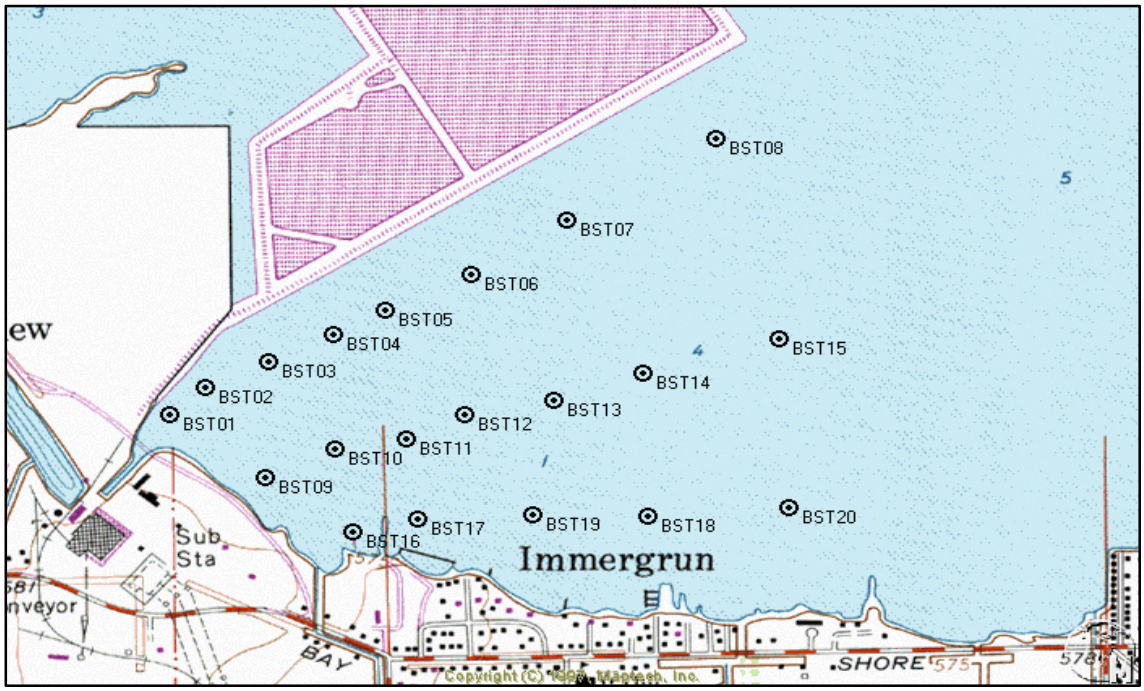

Figure 2. Locations of Substrate Sampling in Maumee Bay

- *Demonstrate that the mixing zone does not interfere with or block passage of fish or aquatic life.*

  Biological sampling has shown in general that the same fish communities are present throughout this portion of Maumee Bay. As a result, there is no evidence which suggests that the mixing zone is interfering with or blocking the passage of fish.

- *Demonstrate that the mixing zone will not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of such species' critical habitat.*

  Ohio EPA is not aware of any endangered or threatened species within the mixing zone or which might be affected by the mixing zone.

- *Demonstrate that the mixing zone does not extend to drinking water intakes.*

  There are no public drinking water intakes within the mixing zone in Maumee Bay.

- *Demonstrate that the mixing zone would not otherwise interfere with the designated or existing uses of the receiving water or downstream waters.*

  With the possible exception of recreation, there is no evidence that the mixing zone interferes with designated or existing uses of the receiving waters. (See the section entitled, "Recreation" on page 6 of this document.) Biological sampling in Maumee Bay shows that fish communities are fair to poor at sites both within and outside of the mixing zone. This data suggests that the mixing zone is not affecting the designated use with regard to aquatic life.

- *Document background water quality concentrations.*

  The temperature monitored at the Bayshore Plant's intake structure has been used in the "Thermal Mixing Zone Study" as an approximation of background temperatures for Maumee Bay. The following table shows a summary of the temperatures reported for the intake structure and compares them to the plant discharge temperatures for the period of August 2001 through June 2004.

Table 2. Intake vs. Discharge Temperatures at Bayshore Plant (8/2001 - 6/2004)

Season	Intake (°C.)	Discharge (°C.)
Summer months (June - August)		
50th percentile	24.8	29.6
95th percentile	27.8	33.4

Table 2. Intake vs. Discharge Temperatures at Bayshore Plant (8/2001 - 6/2004)

Season	Intake (°C.)	Discharge (°C.)
Maximum	28.9	34.3
Minimum	17.9	21.4
Winter months (November - March)		
50th percentile	4.2	8
95th percentile	11.1	15.4
Maximum	13.8	18.1
Minimum	1.1	3.4

In general, historical surface water and sediment sampling results indicate that overall water quality and sediment quality are degraded within the Maumee River and Bay area compared to other areas of Lake Erie.

- *Demonstrate that the mixing zone does not promote undesirable aquatic life or result in a dominance of nuisance species.*

  Based on bottom substrate grab samples collected during June and July 2004, it is apparent that the near-field thermal plume is resulting in the domination of the Asian clam *Corbicula*. Population densities of *Corbicula* increased at sites closest to the thermal discharge, and comprised the primary substrate at these sites. (See Table 1.)

- *Provide that by allowing additional mixing/dilution:*
  - pollutants will not settle to form objectionable deposits;
  - floating debris, oil, scum, and other matter in concentrations that form nuisances will not be produced;
  - objectionable color, odor, taste, or turbidity will not be produced.

  Ohio EPA is not aware of the production of any of these conditions as a result of the mixing zone.

- *Demonstrate whether or not adjacent mixing zones overlap.*

  No other thermal mixing zones exist in the area of the Bayshore Plant's mixing zone.

- *Demonstrate whether organisms would be attracted to the area of mixing as a result of the effluent character.*

As stated above, the Asian clam *Corbicula* is attracted to the thermal plume from the Bayshore Plant. Fish are generally attracted to warm water discharges in the winter, but there is no recent data for the Bayshore Plant demonstrating this phenomenon.

- *Demonstrate whether the habitat supports endemic or naturally occurring species.*

  Biological samples collected from Maumee Bay outside the thermal mixing zone but in the vicinity of the plume demonstrated poor to fair scores for the health of the fish community. But the scores in the vicinity of the discharge are generally no worse than those in other areas of the Bay. The area of the discharge does have some of the better habitat in the eastern portion of Maumee Bay.

- *Demonstrate that the mixing zone does not substantially interfere with the migratory routes, natural movements, survival, reproduction, or growth, or increase the vulnerability to predation, of any representative aquatic species.*

  Ohio EPA is not aware of any evidence showing that the mixing zone substantially interferes with the migratory routes, natural movements, survival, reproduction, or growth, or increases the vulnerability to predation of any representative aquatic species.

- *Demonstrate that the mixing zone does not interfere with or prevent the recovery of an aquatic community or species population that could reasonably be expected when previously limiting water quality conditions improve.*

  Numerous conditions in Maumee Bay may be responsible for the poor fish communities. It is not possible to determine if the quality of these fish communities would improve without the presence of the Bayshore Plant mixing zone.

- *Demonstrate that the mixing zone does not include any bathing area where bathhouses and/or lifeguards are provided.*

  There are no bathing areas having bathhouses and/or lifeguards within the area of the mixing zone.

Attachment II. Surface Temperature Contours: Describing the Thermal Plume for the Bayshore Plant

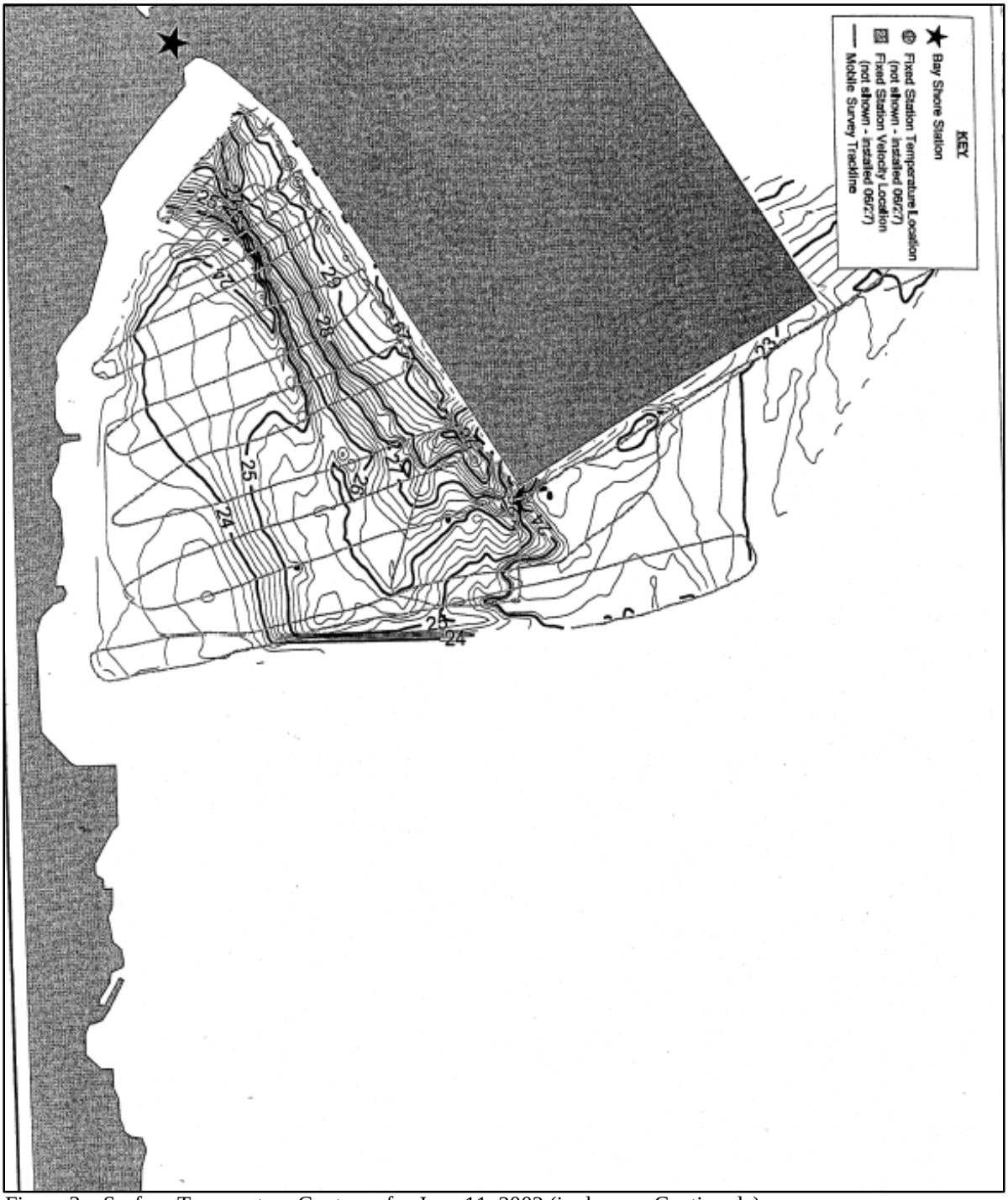

Figure 3. Surface Temperature Contours for June 11, 2002 (in degrees Centigrade)

Attachment II. Surface Temperature Contours: Describing the Thermal Plume for the Bayshore Plant (continued)

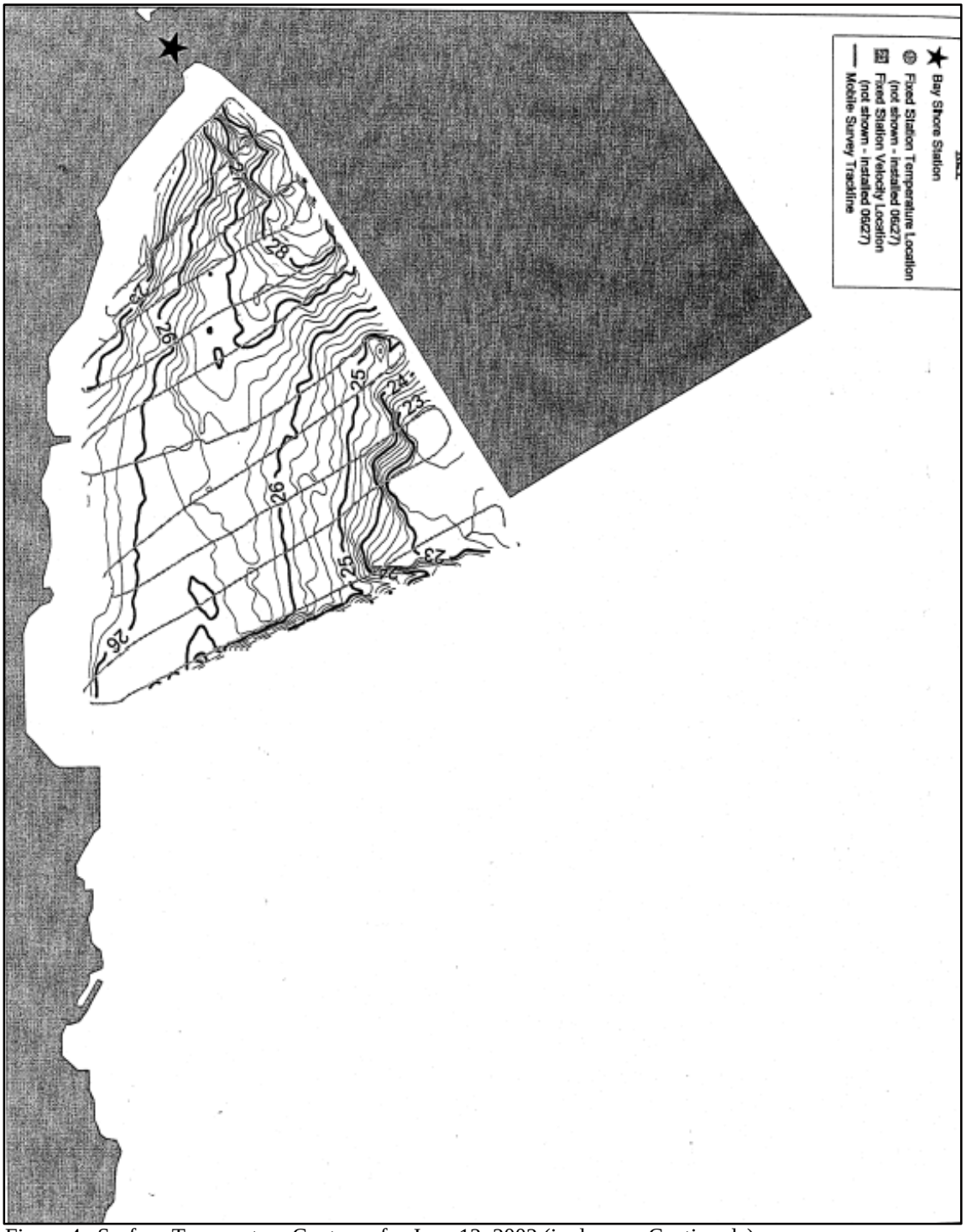

Figure 4. Surface Temperature Contours for June 12, 2002 (in degrees Centigrade)

Attachment II. Surface Temperature Contours: Describing the Thermal Plume for the Bayshore Plant (continued)

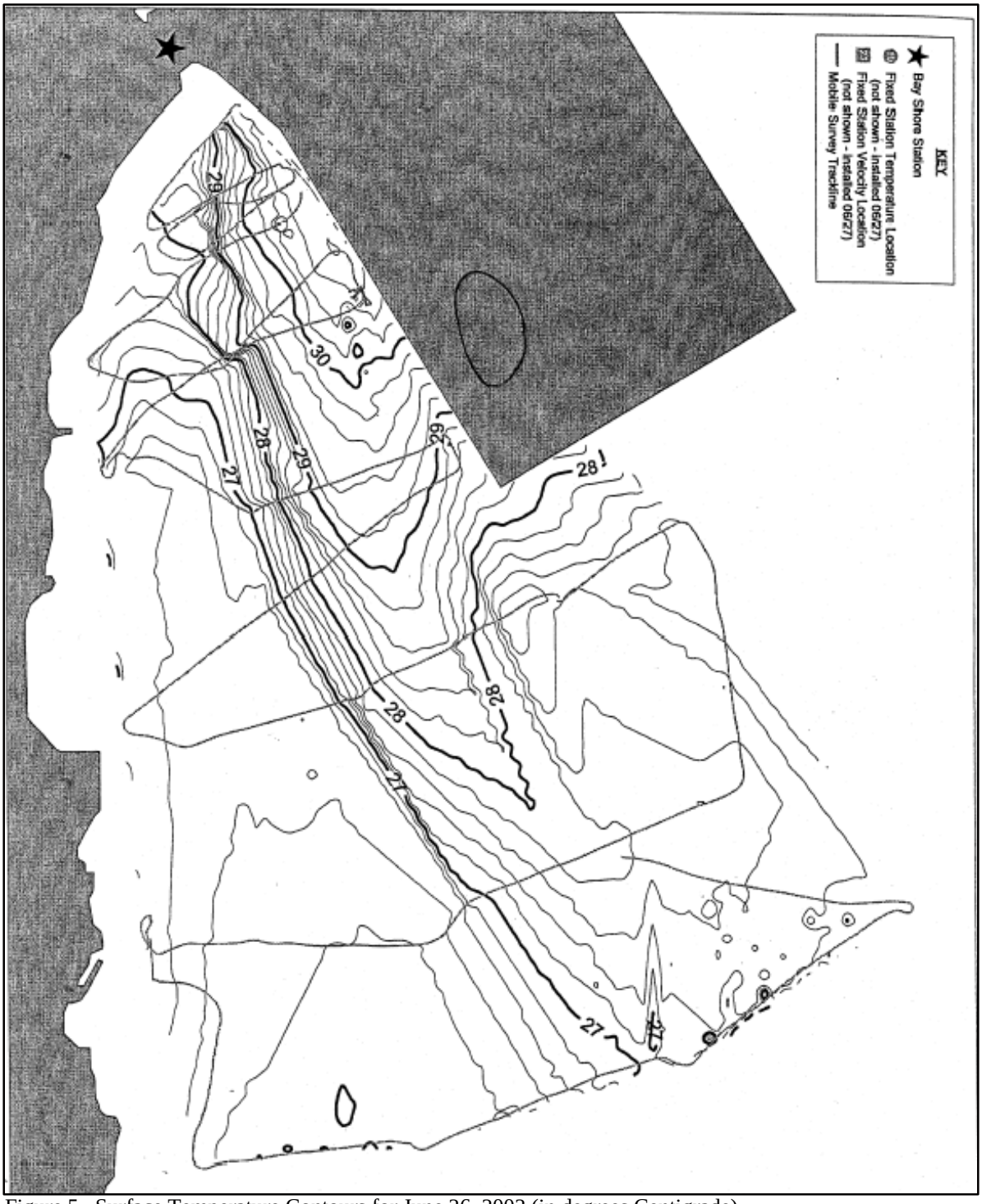

Figure 5. Surface Temperature Contours for June 26, 2002 (in degrees Centigrade)

Attachment II. Surface Temperature Contours: Describing the Thermal Plume for the Bayshore Plant (continued)

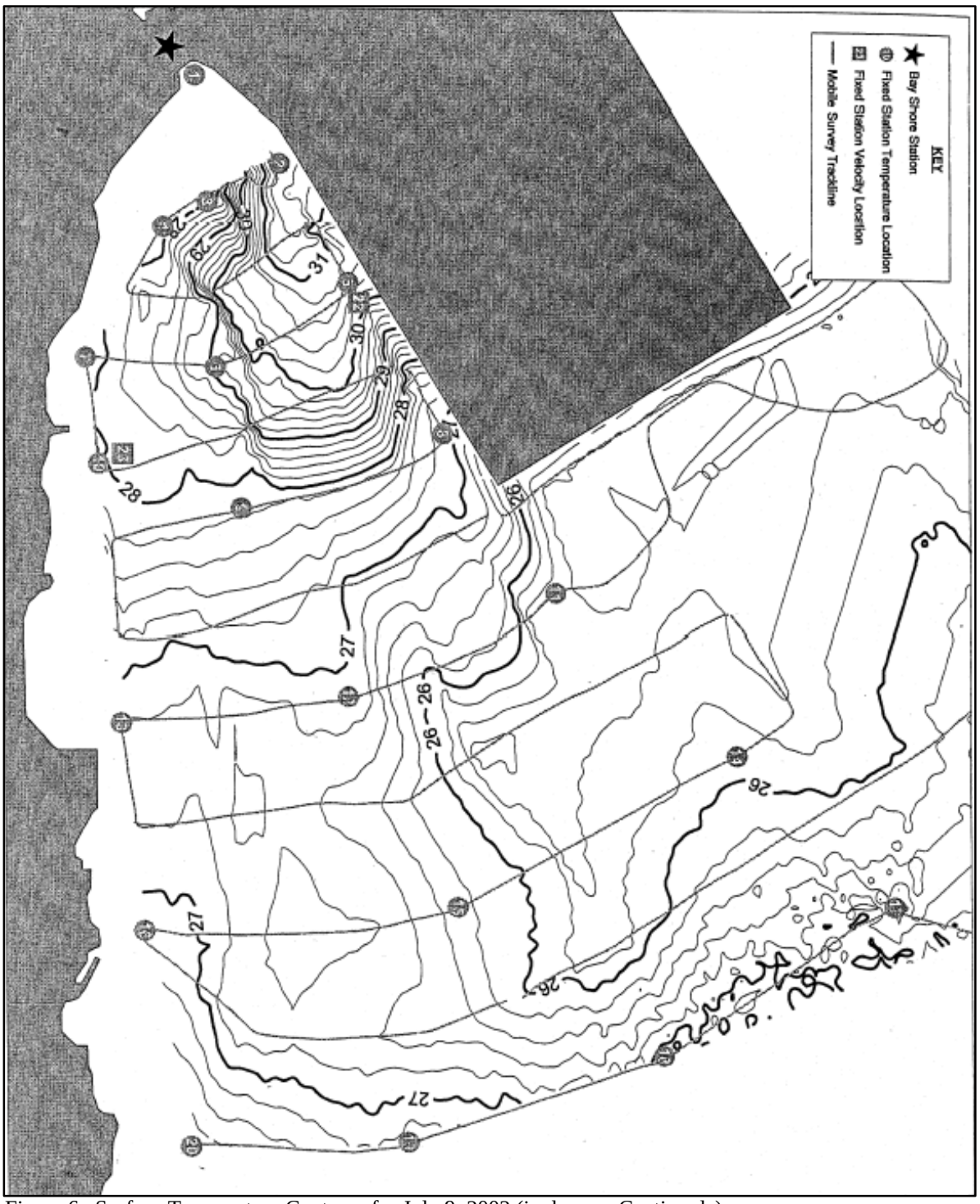

Figure 6. Surface Temperature Contours for July 9, 2002 (in degrees Centigrade)

Attachment II. Surface Temperature Contours: Describing the Thermal Plume for the Bayshore Plant (continued)

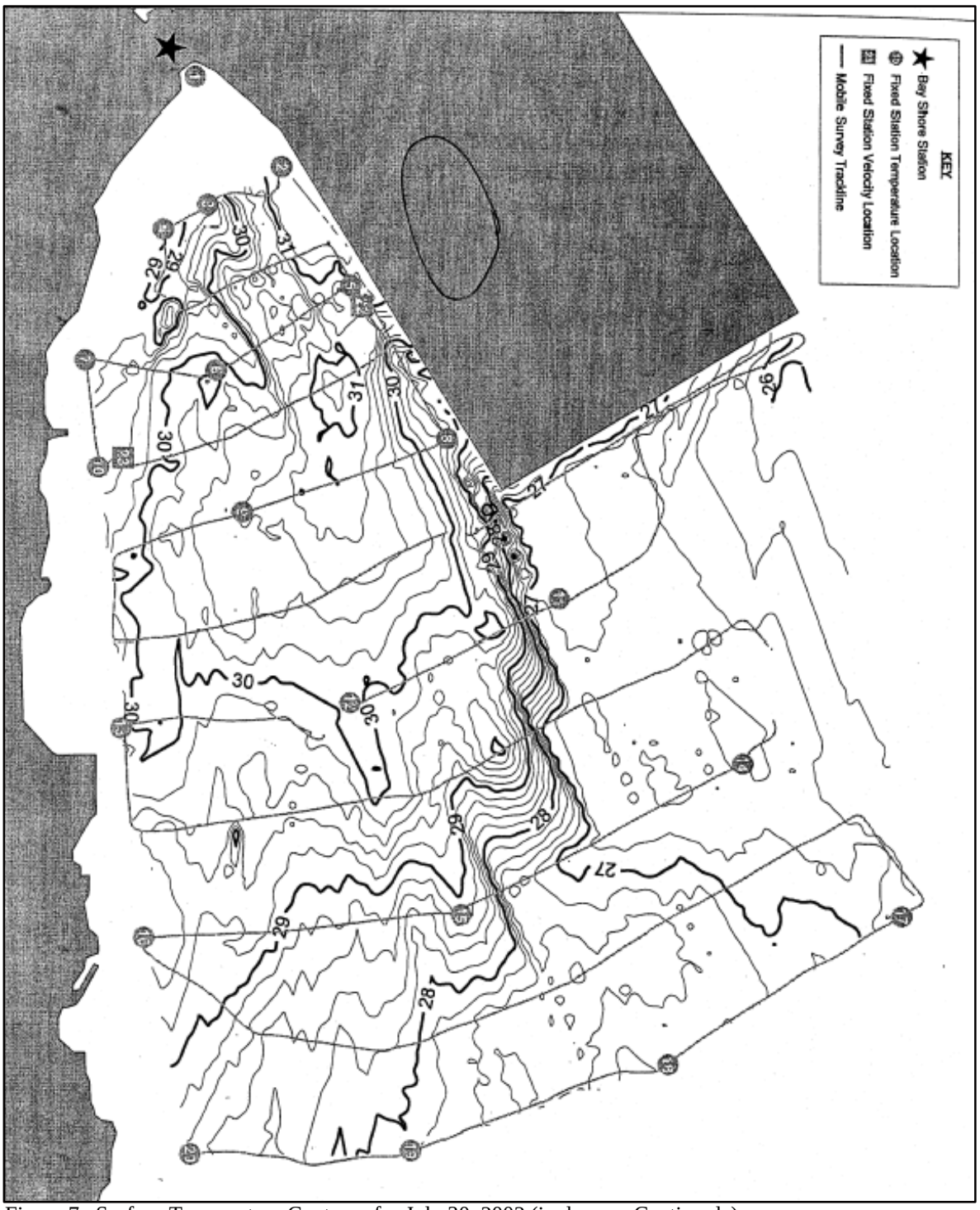

Figure 7. Surface Temperature Contours for July 30, 2002 (in degrees Centigrade)

Attachment II. Surface Temperature Contours: Describing the Thermal Plume for the Bayshore Plant (continued)

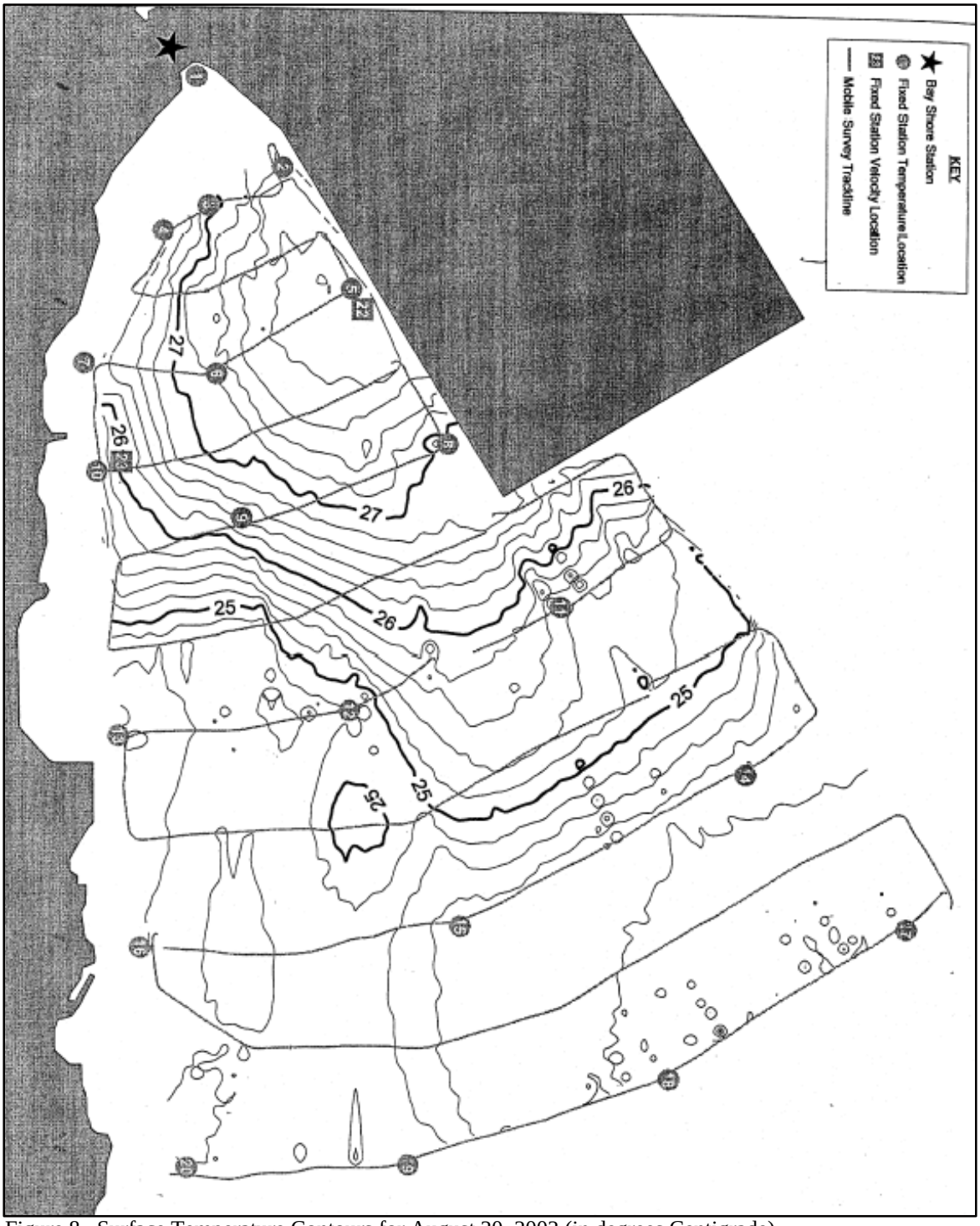

Figure 8. Surface Temperature Contours for August 20, 2002 (in degrees Centigrade)

Attachment II. Surface Temperature Contours: Describing the Thermal Plume for the Bayshore Plant (continued)

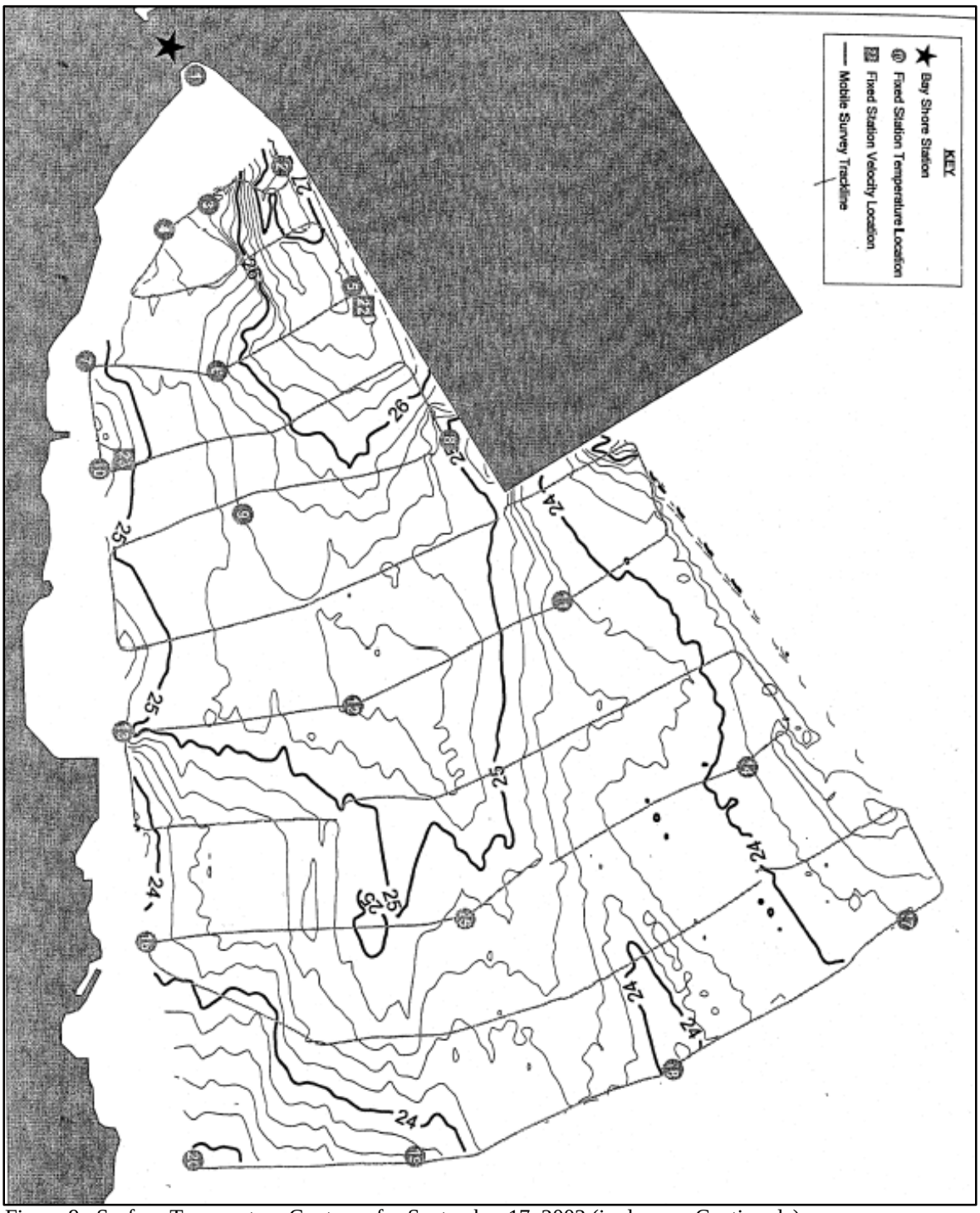

Figure 9. Surface Temperature Contours for September 17, 2002 (in degrees Centigrade)