SECTION 6: In-Plant Waste Stream From AES Huntington Beach

6) In-Plant Waste Stream From AES Huntington Beach

A) Initialization

Under NPDES permit restrictions, the AES Huntington Beach Generating station can discharge up to 1.66 mgd of in-plant waste water. NPDES monitoring data in Appendix A indicates that maximum daily plant waste water discharges have not reached this limit in recent years, and that the highest discharges occur during wet weather conditions due to surface water runoff from plant facilities. The highest recorded daily discharge was 0.727 mgd (or 44% of certified limit) and occurred in February 1998 due to runoff from the El Niño storms studied in previous sections. The preponderance of in-plant waste water is therefore storm water runoff from the impervious surfaces of the plant facility.

In this section we evaluate the possible degree of recirculation of plant storm water between the plant outfall and infall while the proposed RO unit is producing 50 mgd of product water. We evaluate this recirculation potential using the oceanographic forcing for the storm series of late February 1998 as an extreme wet-weather model problem. However, rather than use the below certified limit data for in-plant waste streams recorded during that period, we will use the maximum certified discharge limit of 1.66 mgd to provide a low flow case assessment of recirculation potential. Furthermore we examine recirculation for both ends of the envelope of generation capacity, providing two separate model scenarios: 1) recirculation with 1 generating unit on-line with RO production at 50 mgd, and 2) recirculation with 4 generating units on-line with RO production at 50 mgd. We evaluate both of these scenarios for continuous plant operation over a 7 day period using 22-28 Feb 98 oceanographic forcing data.

From Table 2 in Section 3, we find that in the first of these two model scenarios that the generating station discharges 126.7 mgd of cooling water and 1.66 mgd of in-plant waste stream (storm water) for a combined plant discharge of 128.4 mgd. The RO unit removes 100 mgd of cooling water prior to the addition of the in-plant waste stream and returns 50 mgd of concentrated seawater by-product at 67.04 ppt (twice ambient seawater salinity). The resulting end-of-the-pipe effluent, (consisting of the plant cooling water, storm water, and of RO concentrated seawater by-product) is 78.36 mgd at 54.19 ppt. For the second recirculation model scenario, the generating station discharges 506.9 mgd of cooling water and 1.66 mgd of storm water for a combined discharge of 508.6 mgd. With the activity of the RO unit producing 50 mgd of product water, the resulting end-of-the-pipe effluent (cooling water, storm water, concentrated seawater) is 458.66 mgd at 37.05 ppt salinity. The specific volume of the cooling water discharge was based on a operating temperature of 10° C over ambient receiving water. Monitoring data for 22-28 February 1998 indicates that receiving water temperature averaged 17.5° C.

B) Results

Because the generating station infall draws source water from about the middle of the water column (4.8 meters above the bottom and 5.6 meters below the mean sea surface) we evaluate the recirculation at the depth of the infall velocity cap. The 7-day average of the dilution factor for the combined effluent with 1 generating unit operational is shown in Figure 6.1. The dilution of the effluent at the plant infall is 316 to 1, (where dilution factors are contoured on a log-10 scale). This implies that 0.32% (round off to 0.3%) of the combined plant effluent is recirculated to the infall, of which 2.1% is plant storm water. Hence 0.0066%

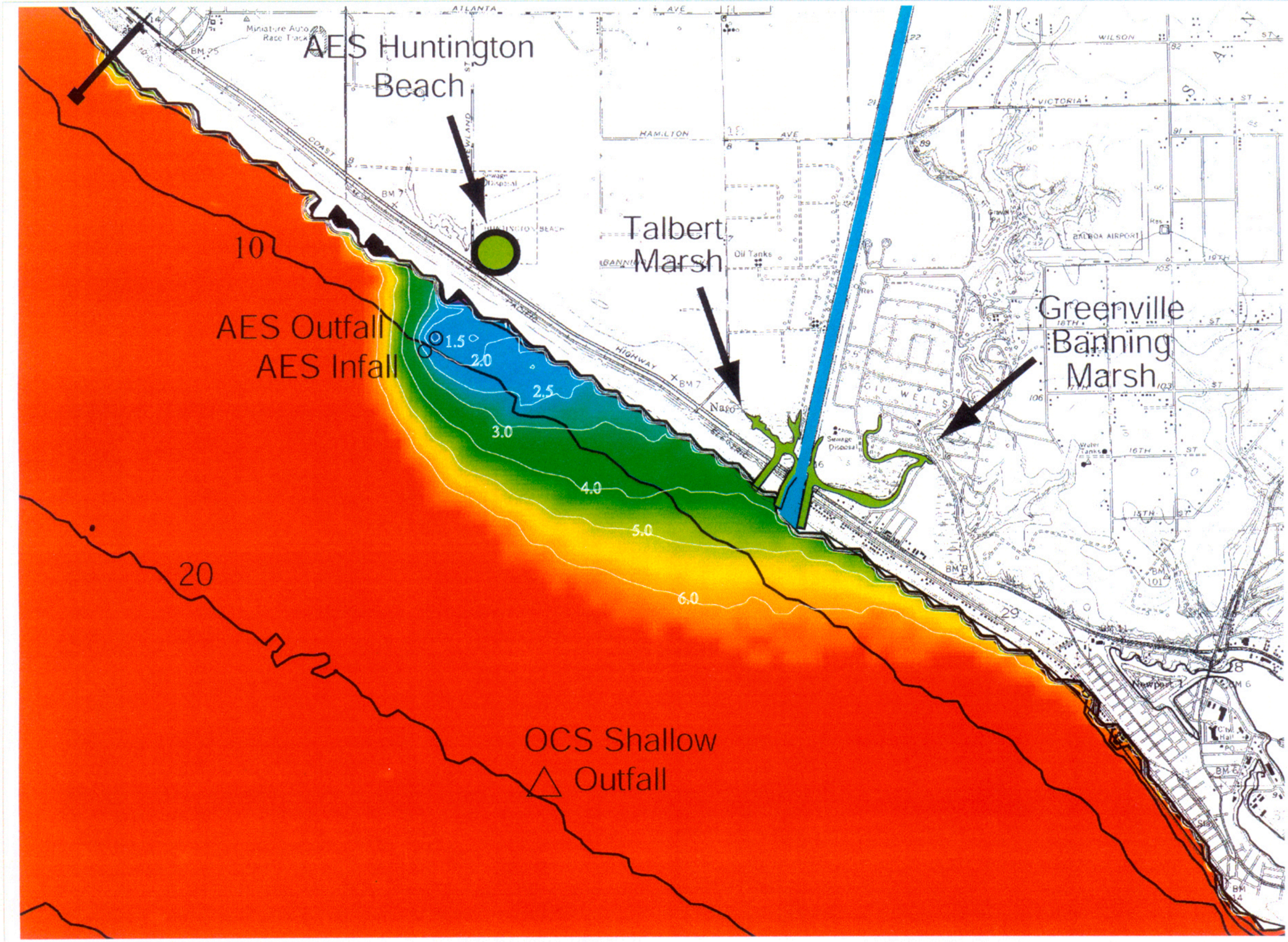


Figure 6.1. Dilution of combined cooling and storm water discharge at depth of velocity cap: R.O. = 50 mgd, cooling water= 126.7 mgd, storm water = 1.66 mgd (7 day ave). Values default to bottom dilution for depths greater than velocity cap.

(round off to 0.007%) of the source water uptake is plant storm water during a 7-day period of extreme wet weather conditions with only one generation unit on-line.

In Figure 6.2 the depth averaged dilution field is shown for all four plant generation units in operation continuously over a 7-day wet weather period. The dilution of the combined effluent is 1000 to 1 over the plant infall. Consequently 0.1% of the plant effluent is recycled through the infall of which 0.36% is plant storm water. This reduces the plant storm water constituent to only 0.00036% (round off to 0.0004%) of the source water uptake at the infall.

There are two factors which contribute the reduction in the recirculation of plant storm water as generation levels increase above the minimal levels modeled in Figure 6.1. The first is that the 1.66 mgd of storm water discharge experiences about 4 times more initial dilution in the pipe when all 4 generation units are operational versus the minimum generation configuration in Figure 6.1. The second is that the change in specific volume of the combined effluent relative to ambient seawater is less when all four generating units operate in tandem with the RO unit. With only one generating unit on-line, the change in specific volume of the effluent relative to seawater is -1.49% (Table 2 in Section 3) making it considerably heavier than seawater. In this case the effluent sinks immediately to the seafloor and dilutes relatively slowly on the bottom as a stable stratified bottom boundary layer. On the other hand the specific volume change of the effluent with all 4 units on-line is only -0.08% relative to ambient seawater, allowing it to be more readily overturned by wave mixing in the bottom boundary layer and thereby more rapidly diluted into the complete water column. The combined effect of higher-in-the-pipe dilutions and diminished specific volume

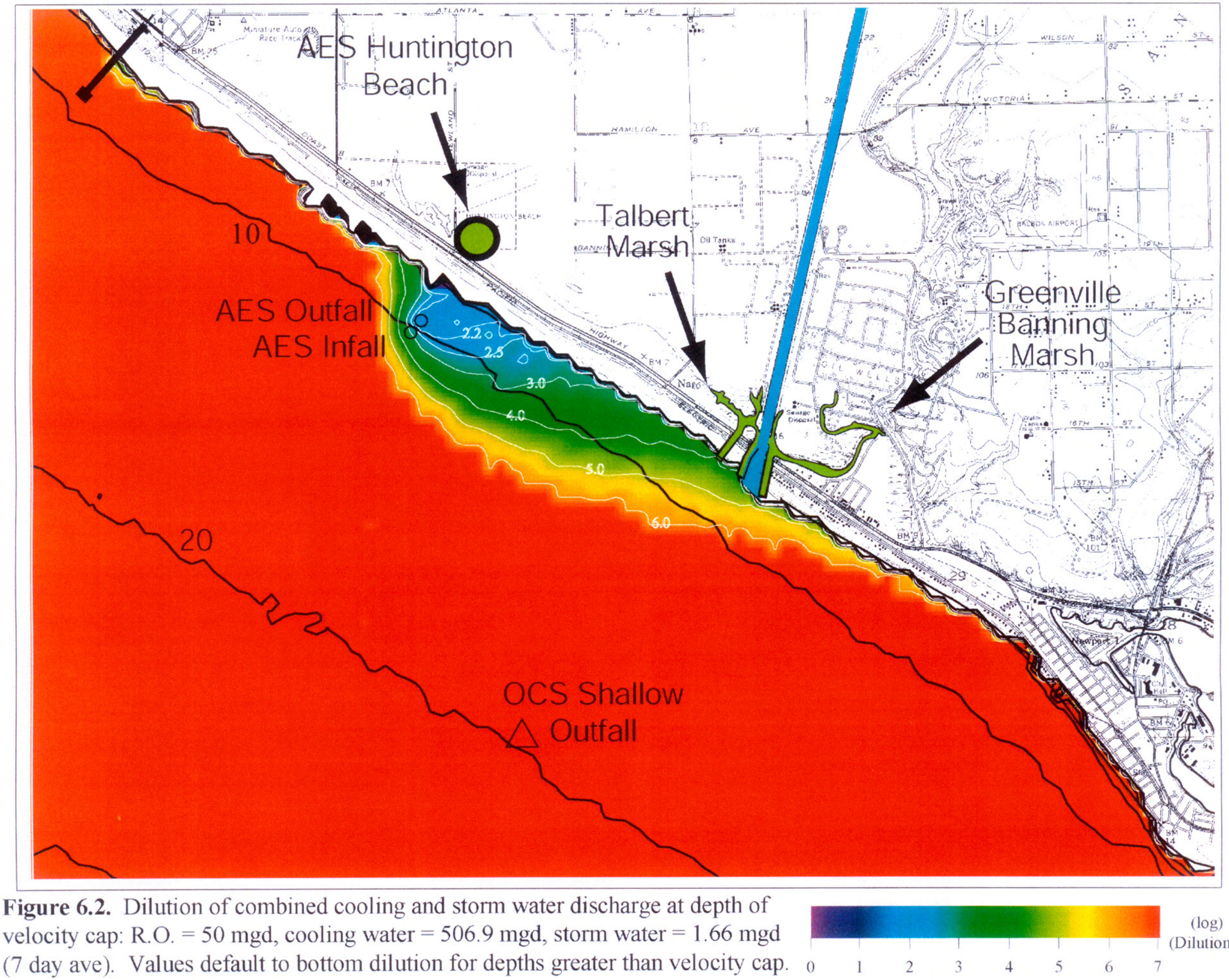


Figure 6.2. Dilution of combined cooling and storm water discharge at depth of velocity cap: R.O. = 50 mgd, cooling water = 506.9 mgd, storm water = 1.66 mgd (7 day ave). Values default to bottom dilution for depths greater than velocity cap.

contrast with receiving waters allows the plant storm water to be diluted significantly faster with all generating units on-line and thereby contribute a negligible fraction to recirculation in the source water. These results indicate that for normal plant operations with 2 generating units on-line that recirculated plant storm water would constitute 0.003% of the source water make-up.

Figure 6.3 maps the temperature for the combined effluent of cooling water, storm water, and concentrated sea water from RO production as computed in the middle of the water column. The simulation is based on a $\Delta T = 10^{\circ}$ C for the generating station thermal effluent. The plant generation was assumed to be at nominal operation levels with 2 generating units on line and a combined discharge of 255.1 mgd. The footprint of the thermal plume has been averaged over a 7 day period for ambient ocean conditions of 22-28 February 1998. Because thermal diffusivity is several orders of magnitude greater than mass diffusivity, the temperature anomaly of the combined plant discharge decays rapidly in the direction of net transport (toward the southeast). The largest temperature anomalies are found in the immediate neighborhood of the outfall tower, where a maximum temperature in the mid-water column is found to reach 26.7° C, ($\Delta T = 9.2^{\circ}$ C). Once the discharge broaches the sea surface, the maximum temperature in the core of the surface boil falls to 25.0° C, ($\Delta T = 7.5^{\circ}$ C), see Figure 6.4. The discharge plume then subsides around the perimeter of the surface boil, engaging the entire water column in the thermal dilution process as it sinks to the seafloor. This discharge trajectory leads to greatly increased rates of heat dissipation. This increased heat dissipation is augmented by the effluent heat lost to the exported stream of product water (50 mgd) from the desalination plant. In general the thermal plume in Figure 6.3 shows that the temperature anomaly is reduced to

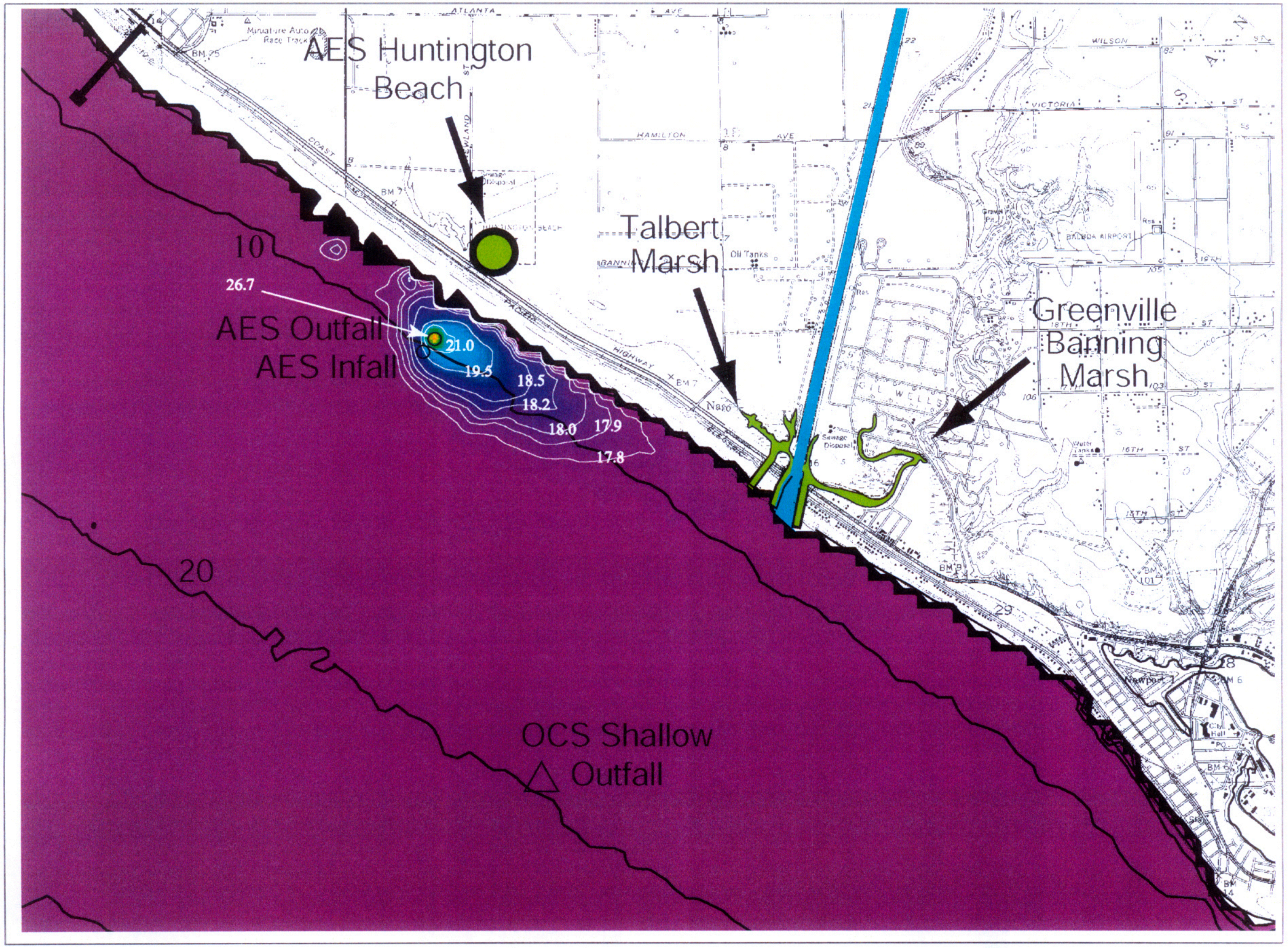


Figure 6.3. Temperature at mid-depth for combined cooling, storm water, and R.O. discharge. Cooling water = 253.4 mgd, storm water = 1.66 mgd, RO = 50 mgd, 22-28 February 1998 (7 day average).

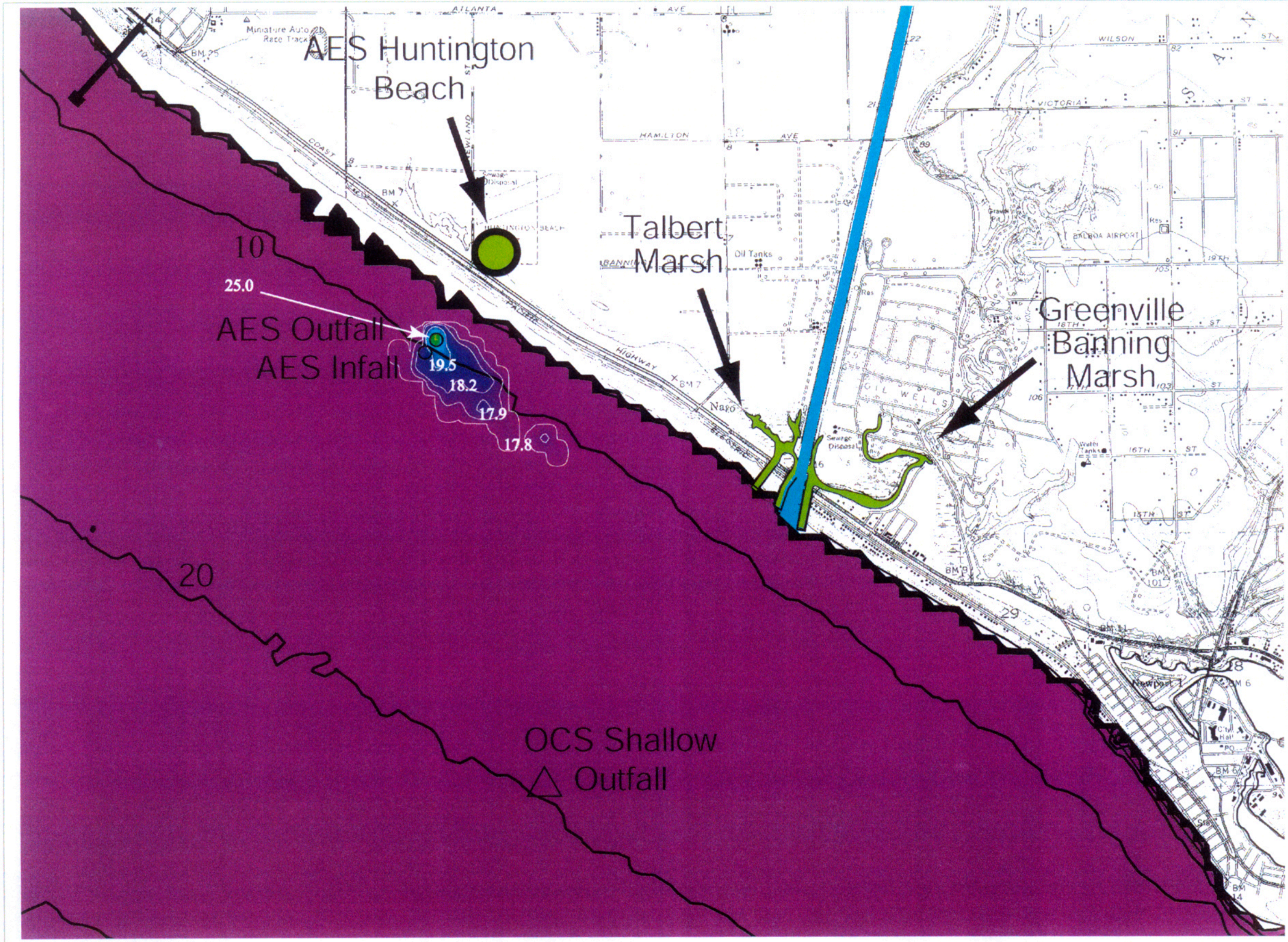
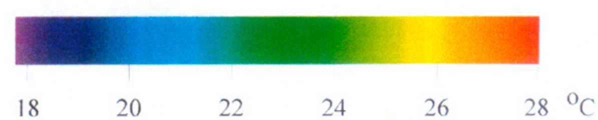


Figure 6.4. Temperature at sea surface for combined cooling, storm water, and R.O. discharge. Cooling water = 253.4 mgd, storm water = 1.66 mgd, RO=50 mgd, 22-28 February 1998 (7 day average).



$\Delta T = 1.5^{\circ}$ C above ambient in the water column over an area of about 6-8 acres surrounding the outfall tower. Applying the standards of the Thermal Plan, the foot print of the $\Delta T = 2.0^{\circ}$ F (1.1° C) temperature anomaly is only 74.6 acres anywhere in the water column. At the bottom (Figure 6.5) the combined effluent remains heavier than ambient seawater due to the presence of the by-product from RO production. This further promotes dilution because turbulence in the wave and current boundary layer increases mixing while greater dilution volume is provided by the overlying water column (as opposed to a thermal plume that floats on the sea surface in the absence of the concentrated seawater from RO production) . The bottom foot print of the 2.0° F (1.1° C) temperature anomaly is 101 acres while the footprint of the 4.0° F (2.2° C) temperature anomaly is only 13.1 acres (Figure 6.5). These footprints represent about a 46% reduction in the average planar area of the thermal plume under existing conditions (MBC 1978-2003) . Thus, the reduction in buoyancy of the thermal plume caused by the RO concentrated seawater has increased the dilution of the thermal plume of the AES cooling water effluent.

Thermal plan objectives give particular attention to temperatures on ocean substrate. Figure 6.5 shows a maximum bottom temperature of 24.1° C (6.6° C temperature anomaly). This occurs only on the rock footing of the outfall tower and not on the soft bottom benthic habitat. The seasonal temperature maximums of the ambient ocean waters at Huntington Beach commonly reach 25° C (Figure 3.23, Panel C).

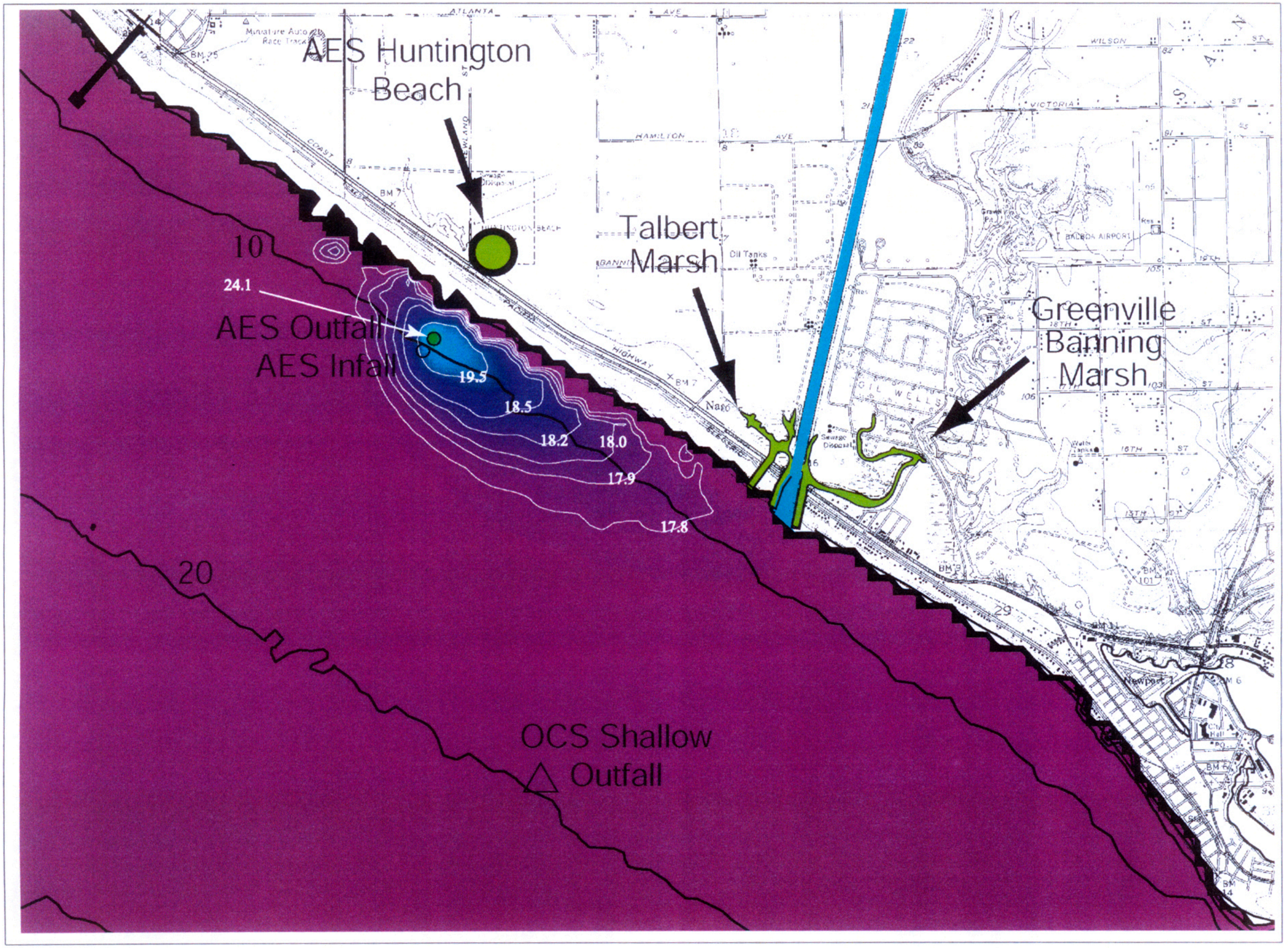


Figure 6.5. Bottom temperature for combined cooling, storm water, and R.O. discharge. Cooling water = 253.4 mgd, storm water = 1.66 mgd, RO=50 mgd, 22-28 February 1998 (7 day average).