SECTION 7: Storm Water From Santa Ana River and Talbert Channel

7) Dilution and Dispersion of Storm Water From Santa Ana River and Talbert Channel

A) Initialization

To determine the source water make-up, the model was run for solutions to 24 hour, 7 day and 30 day average contribution of seawater and storm water at the AES Huntington Beach infall during extreme runoff conditions. For all simulations, AES Huntington Beach was initialized for maximum cooling water flow rate (506.9 mgd), to determine the maximum amount of potential entrainment of storm water. The extreme runoff conditions were derived from the 1998 El Niño for the month of February as detailed in Section 3.

B) Results

Because the generating station outfall has no velocity cap, the combined discharge of the generating station and RO plant creates a jet of negatively buoyant fluid directed vertically upward at the sea surface at a flow rate of 456.9 mgd in the absence of any plant storm water. Figure 7.1 shows that this jet broaches the sea surface, creating a boil of high salinity water with a core at 36.7 ppt directly above the outfall. This result excludes any storm water discharge from the Santa Ana River or Talbert Channel. When those storm water discharges are superimposed, the surface boil acts to displace and dilute those runoff constituents on the surface and in the upper water column. Figure 7.2 gives the 24-hour average of the salinity at the sea surface during the peak flow day of the El Niño storm of 24 February 1998. The plume is due to the combined discharge of the Santa Ana River and Talbert Channel which averaged 8890 cfs over this 24 hour period (Figure 3.2). The hyper-saline surface boil produces a small hole in the river plume around the outfall (Figure 7.3), where local surface salinities exceed

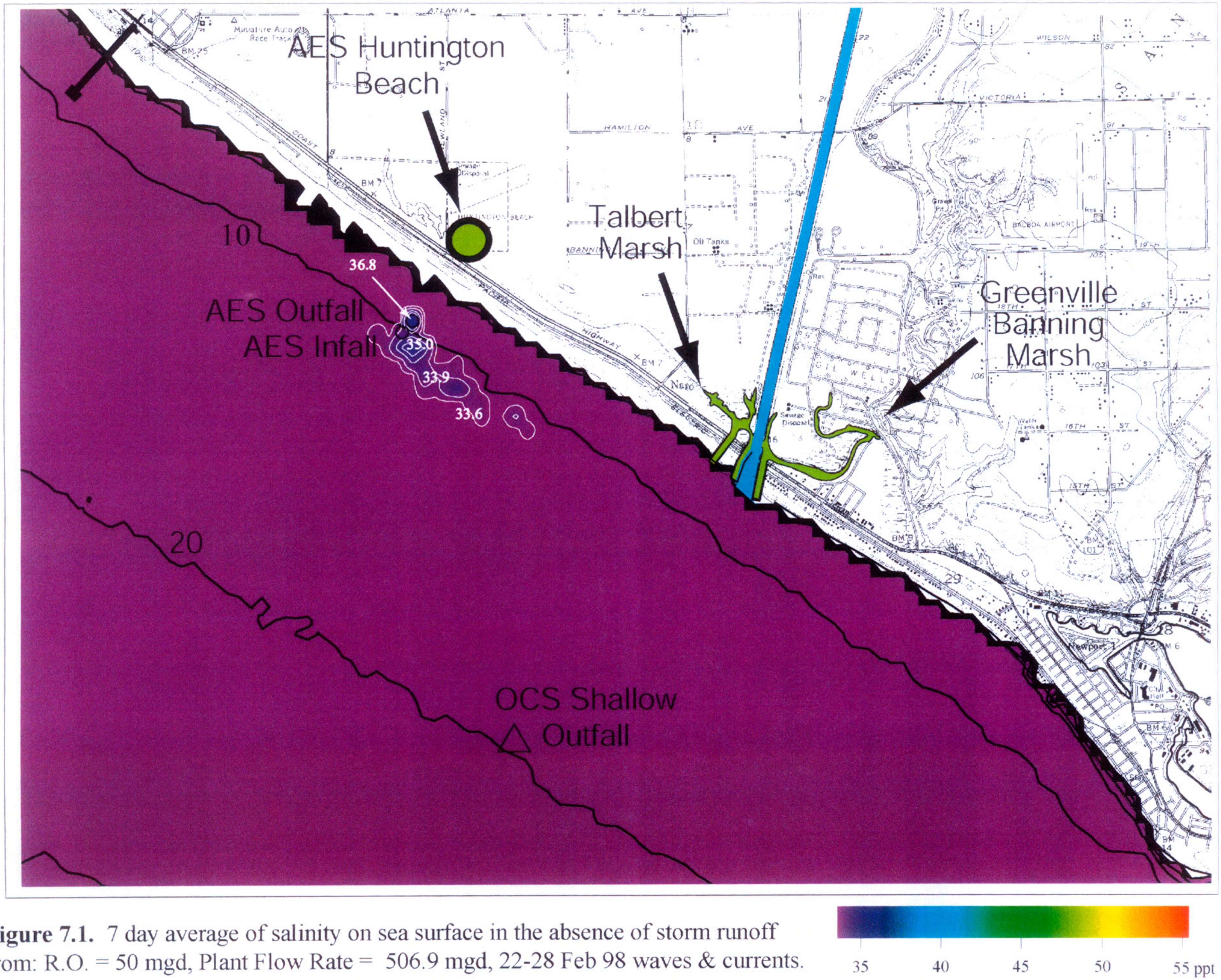


Figure 7.1. 7 day average of salinity on sea surface in the absence of storm runoff from: R.O. = 50 mgd, Plant Flow Rate = 506.9 mgd, 22-28 Feb 98 waves & currents.

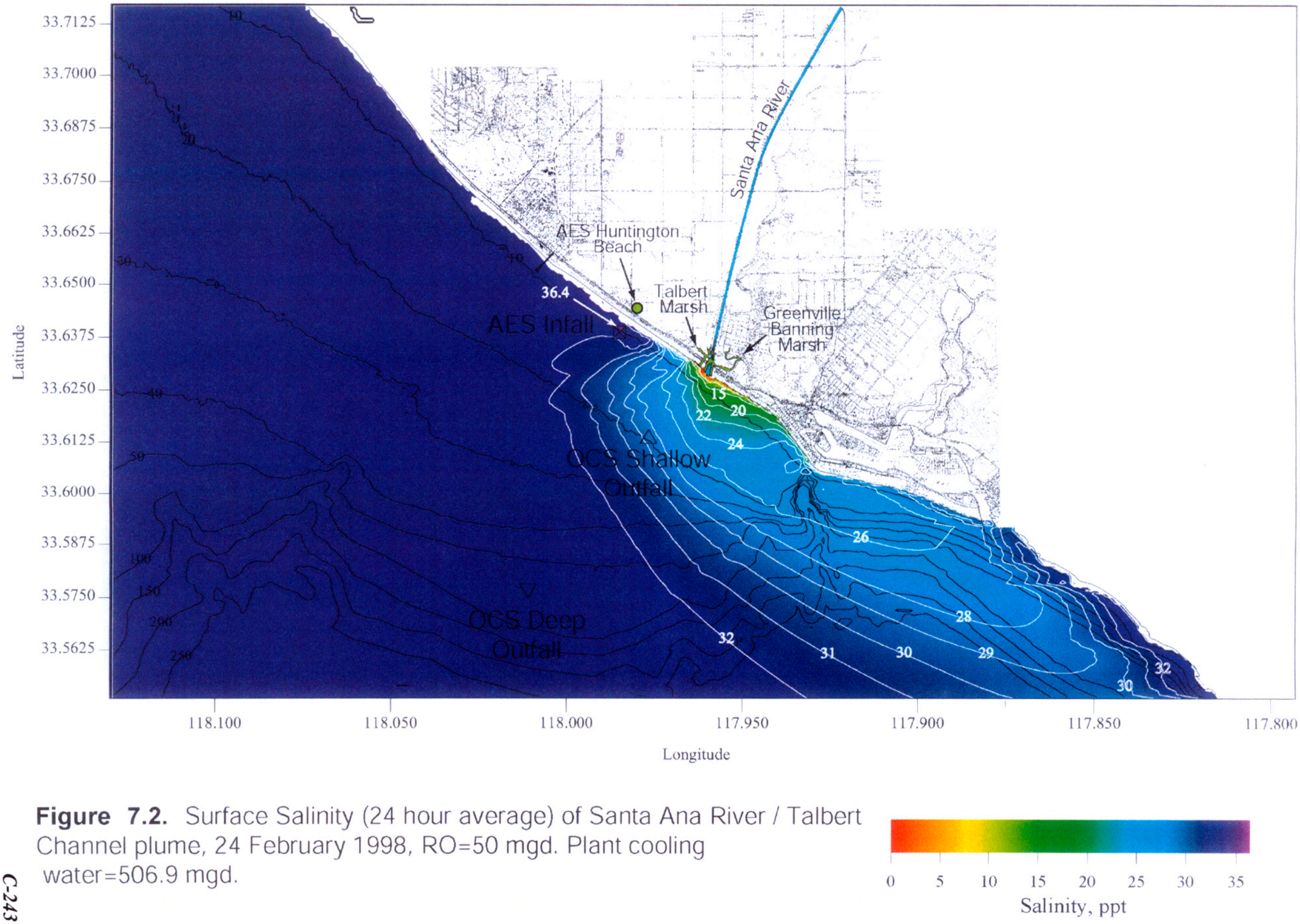


Figure 7.2. Surface Salinity (24 hour average) of Santa Ana River / Talbert Channel plume, 24 February 1998, RO=50 mgd. Plant cooling water=506.9 mgd.

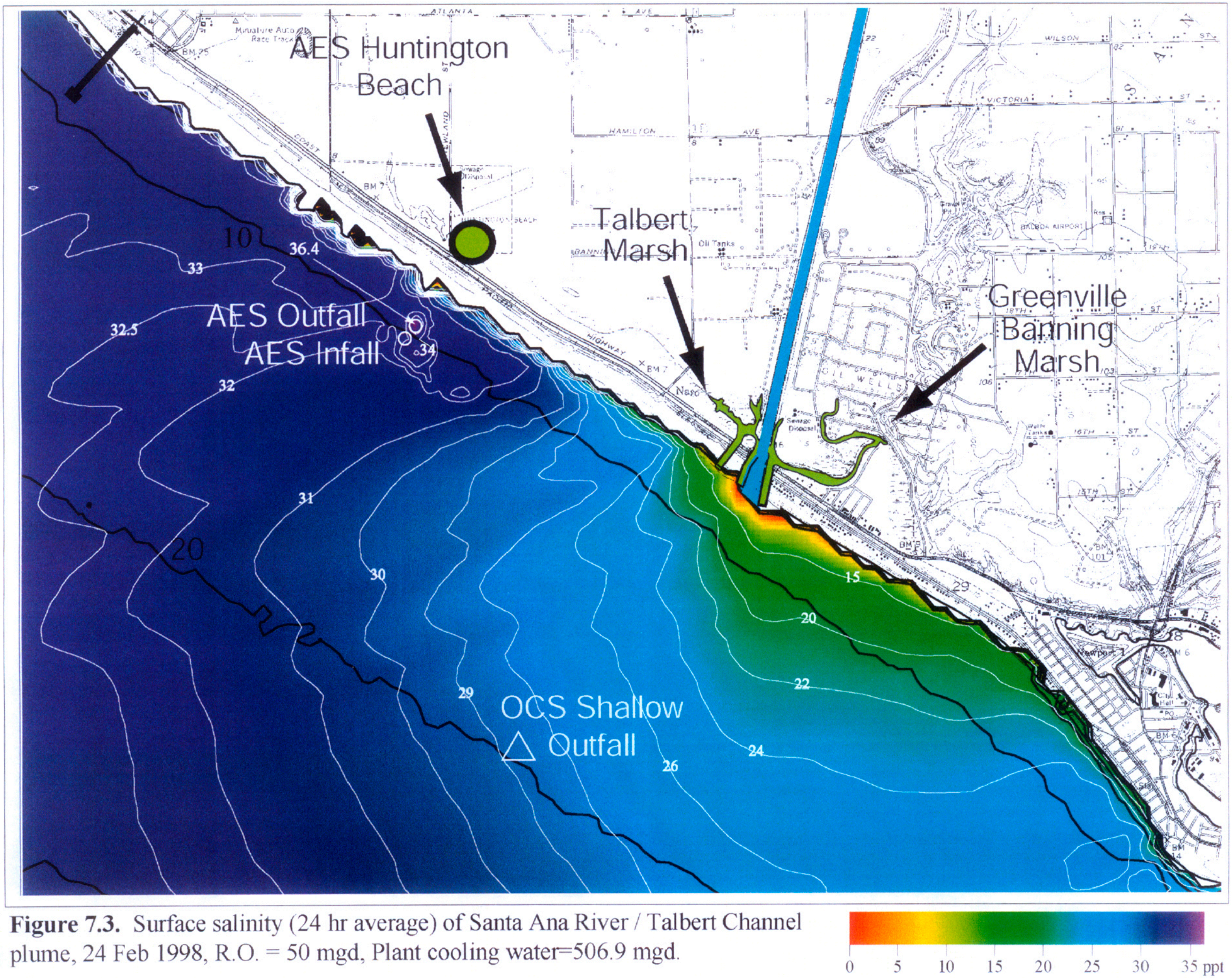
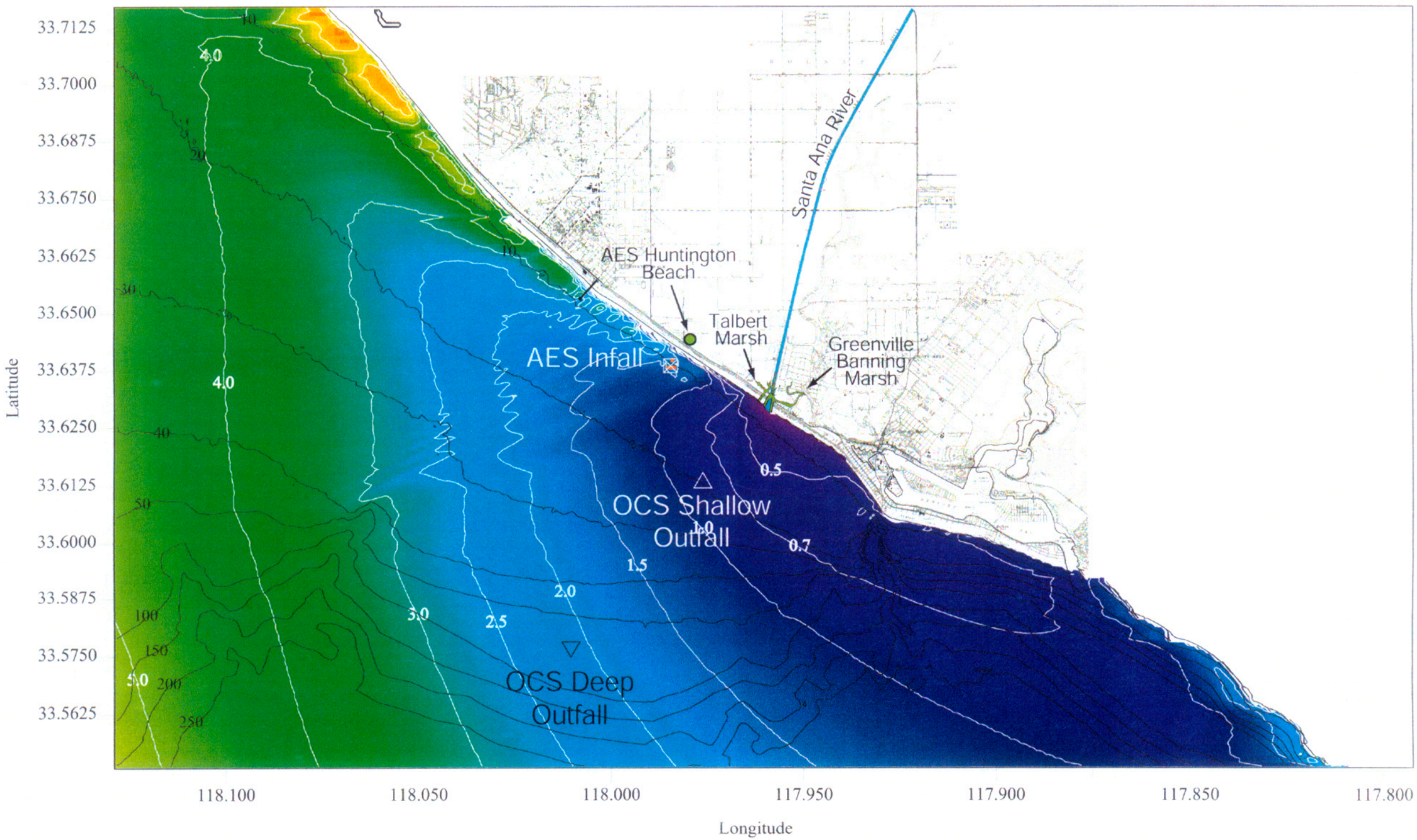


Figure 7.3. Surface salinity (24 hr average) of Santa Ana River / Talbert Channel plume, 24 Feb 1998, R.O. = 50 mgd, Plant cooling water=506.9 mgd.

the ambient deep water ocean salinity. Figure 7.4 shows the corresponding dilution field averaged over 24 hours on a log-10 scale. The AES Huntington Beach infall is denoted by a square symbol with an X through the center located near the 10 meter depth contour. The ebb dominance of the current field over a 24 hour period deflects the low salinity surface water mass in a downcoast direction toward the southeast. Inspection of the salinity and dilution contours in Figures 7.2 through 7.4 indicate that the storm water on the sea surface over the infall is diluted by a factor of 32 to 1. If the generating station infall were able to entrain water directly from the sea surface, the source water make-up would be 97% seawater and 3% storm water from the Santa Ana River and Talbert Channel. However the velocity cap of the infall tower is located 5.6 m below mean sea level. The dilution field at the depth from which the infall is drawing source water is calculated in Figure 7.5. At this depth (-5.6 m MSL) we find that the dilution of Santa Ana and Talbert Channel storm water is 316 thousand to 1. Because infall velocities are vanishingly small at the sea surface (CWQCB, 1993), the infall is more likely to entrain the preponderance of source water from depths near the depth of the velocity cap. Hence, the source water make-up for worst case floods is probably closer to being 99.9997% seawater and 0.0003% storm water according to dilutions shown in Figure 7.5.

Over a 7-day period that encompassed the peak runoff event and several following storms between 22-28 February 1998, the Santa Ana River and Talbert Channel averaged a combined discharge of 5,798 cfs. The 7-day average of the surface salinity over this period delineates the plume shown in Figure 7.6. Like the 24-hour average case in Figure 7.2, ebb dominance prevails in the current pattern over this 7 day period (Figure 3.18) and causes the plume to elongate in



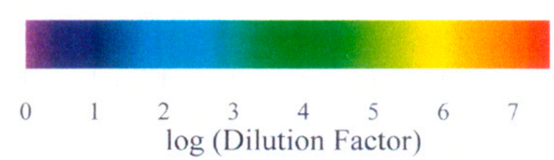


Figure 7.4. Surface dilution (24 hour average) of Santa Ana River / Talbert Channel plume, 24 February 1998, RO=50 mgd, Plant cooling water= 506.9 mgd.

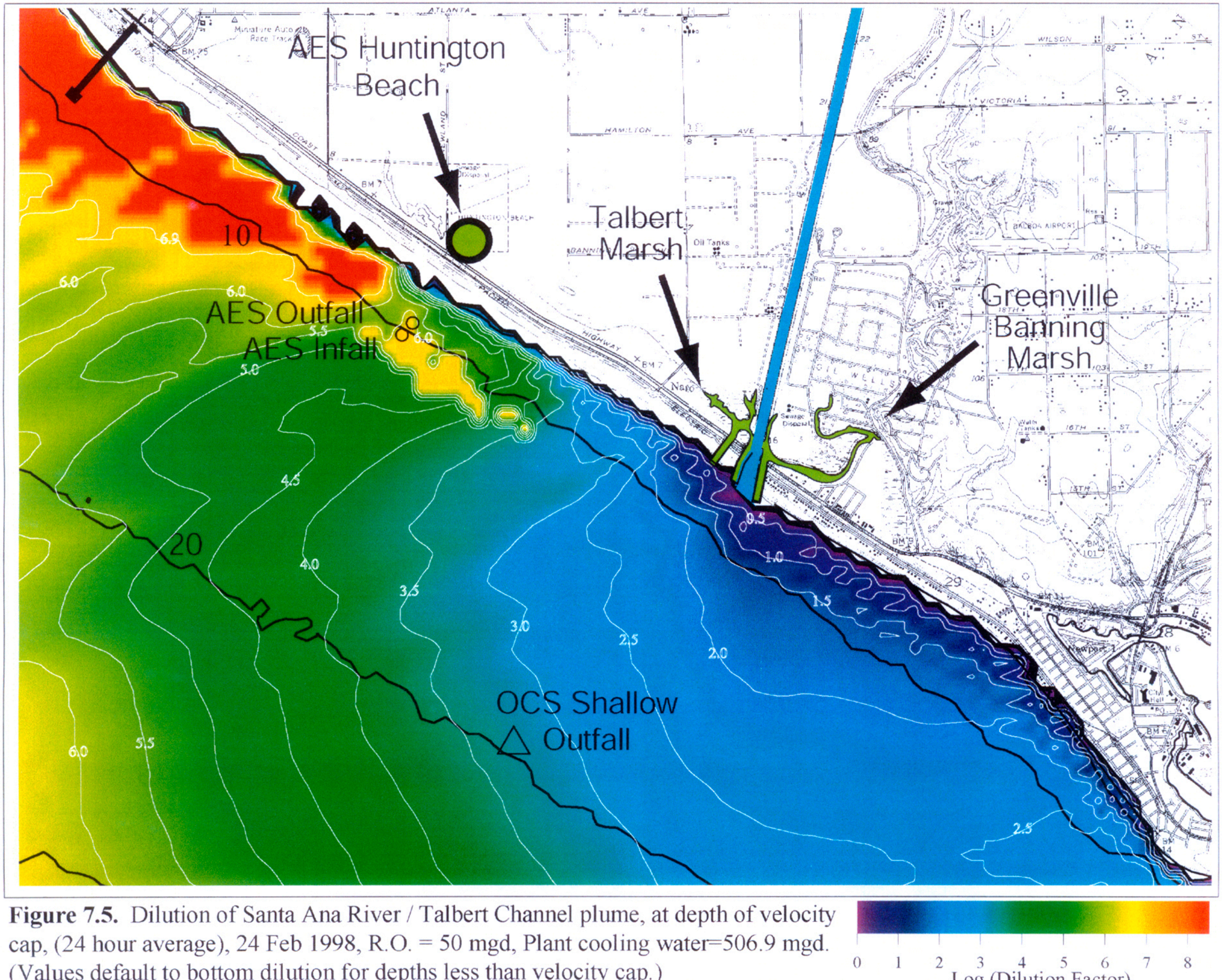


Figure 7.5. Dilution of Santa Ana River / Talbert Channel plume, at depth of velocity cap, (24 hour average), 24 Feb 1998, R.O. = 50 mgd, Plant cooling water=506.9 mgd. (Values default to bottom dilution for depths less than velocity cap.)

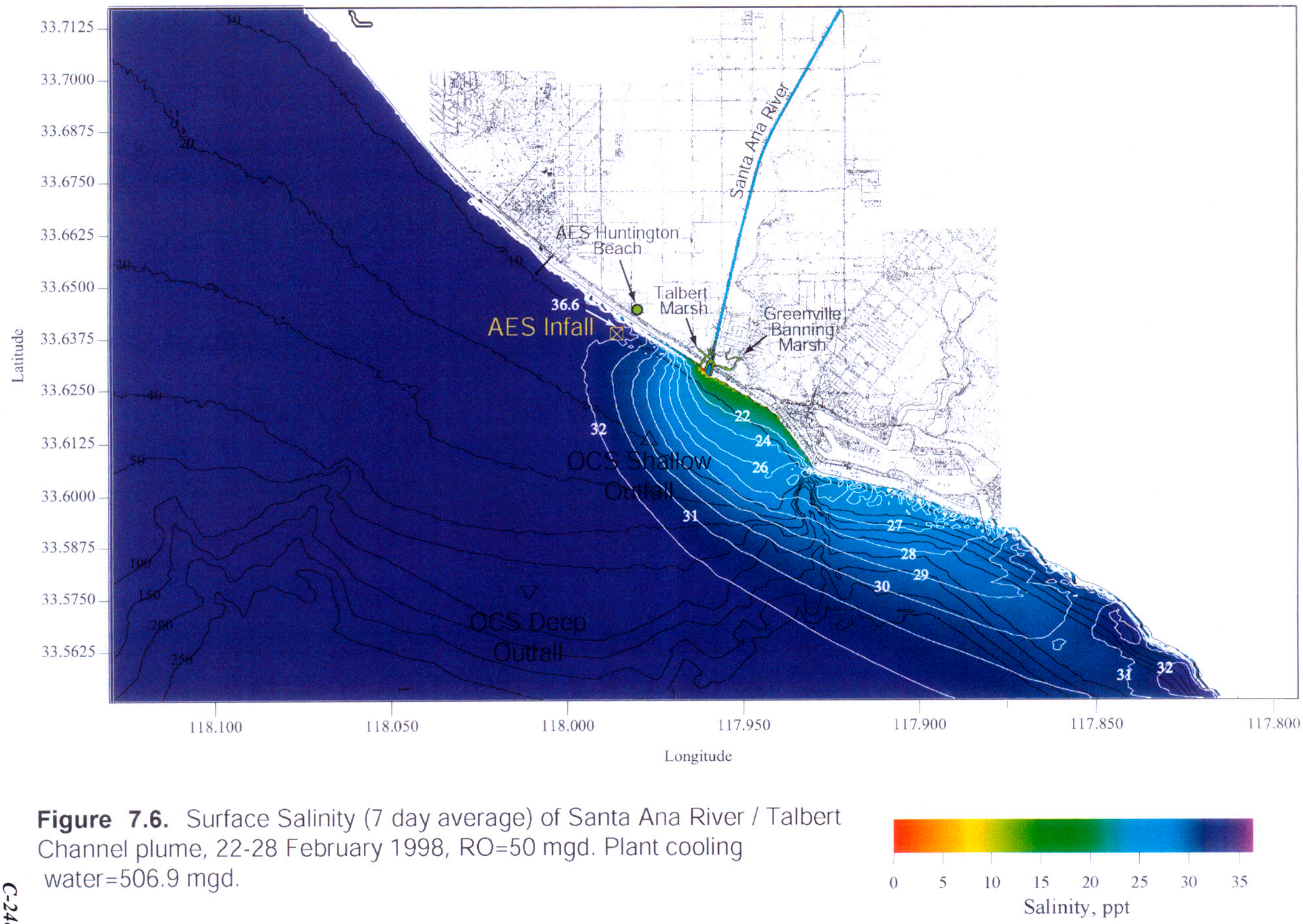


Figure 7.6. Surface Salinity (7 day average) of Santa Ana River / Talbert Channel plume, 22-28 February 1998, RO=50 mgd. Plant cooling water=506.9 mgd.

the downcoast direction towards Newport Harbor and Crystal Cove State Beach. The corresponding 7-day average of the surface dilution field in Figure 7.7 shows that the storm water is diluted 50 to 1 on the sea surface over the plant infall. Therefore, over a 7-day period surrounding peak runoff, the sea surface water make-up is at most 2% storm water and 98% seawater. But entrainment velocity due to the outfall vanishes at the sea surface, and the source water is instead drawn from below the surface at depths comparable to the infall velocity cap. The dilution factor at the velocity cap of the infall is shown in Figure 7.8 to average at least 1 million to 1 over a 7-day period around peak runoff. Thus the source water make-up is likely to be as little as 0.0001% storm water and 99.9999% seawater.

Over a 30-day period encompassing the peak runoff month of February 1998, the combined flow of the Santa Ana River and Talbert Channel averaged 2,732 cfs. This discharge produced a 30-day average of the sea surface salinity computed in Figure 7.9. Again the ebb dominance of the current system produces a net downcoast dispersion of the salinity anomaly of the discharge plume. The corresponding surface dilution field in Figure 7.10 indicates that the storm water on the sea surface over the infall is diluted to 100 to 1. Consequently surface water comprises only 1% storm water in a 30 day wet weather period, and that figure represents an upper bound limit on the source water. At the depth of the infall velocity cap, the 30-day average dilution factor in Figure 7.11 drops to 10 million to 1. In essence, the storm water becomes non-detectable in source water at the velocity cap over 30-day wet weather time scales.

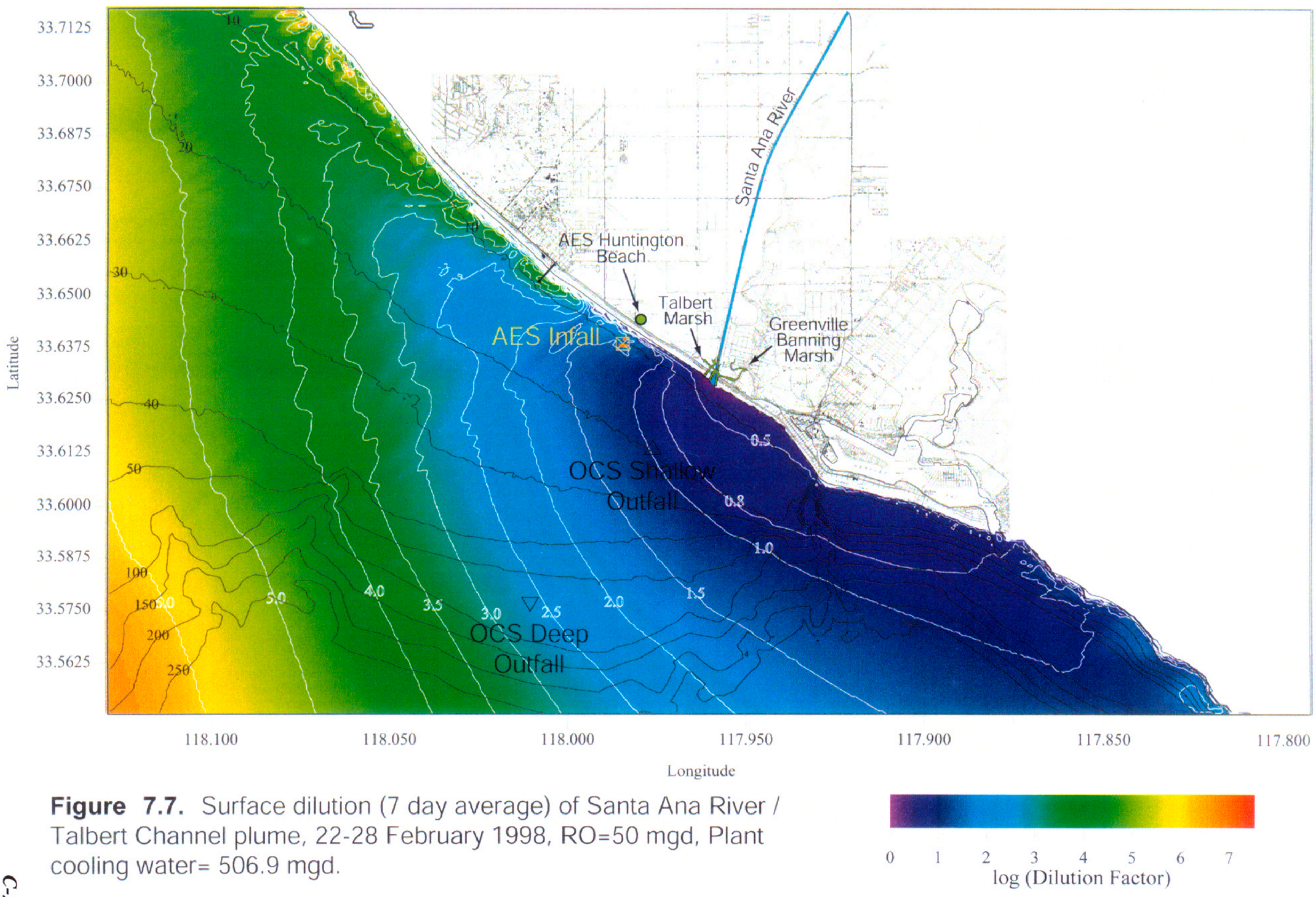


Figure 7.7. Surface dilution (7 day average) of Santa Ana River / Talbert Channel plume, 22-28 February 1998, RO=50 mgd, Plant cooling water= 506.9 mgd.

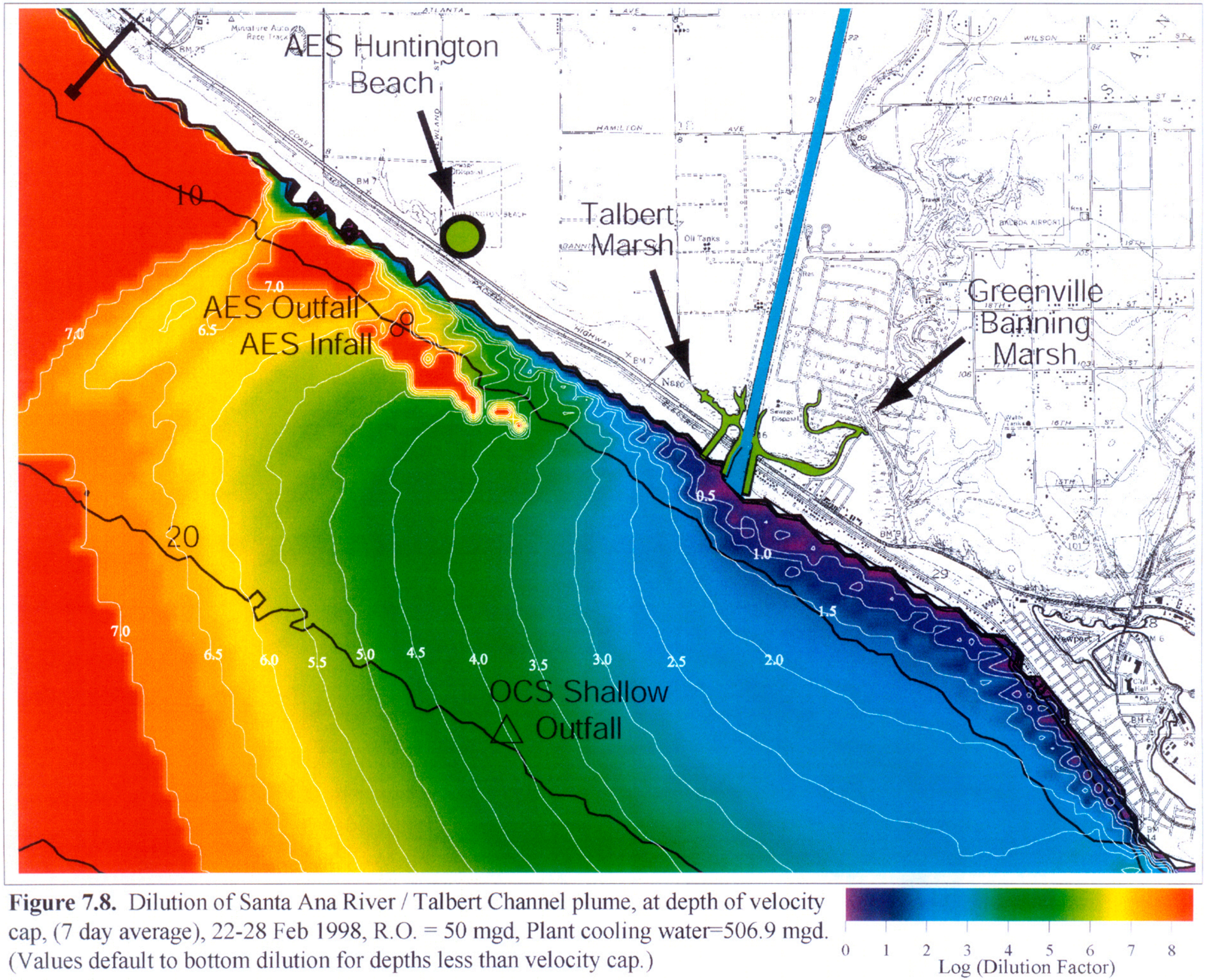


Figure 7.8. Dilution of Santa Ana River / Talbert Channel plume, at depth of velocity cap, (7 day average), 22-28 Feb 1998, R.O. = 50 mgd, Plant cooling water=506.9 mgd. (Values default to bottom dilution for depths less than velocity cap.)

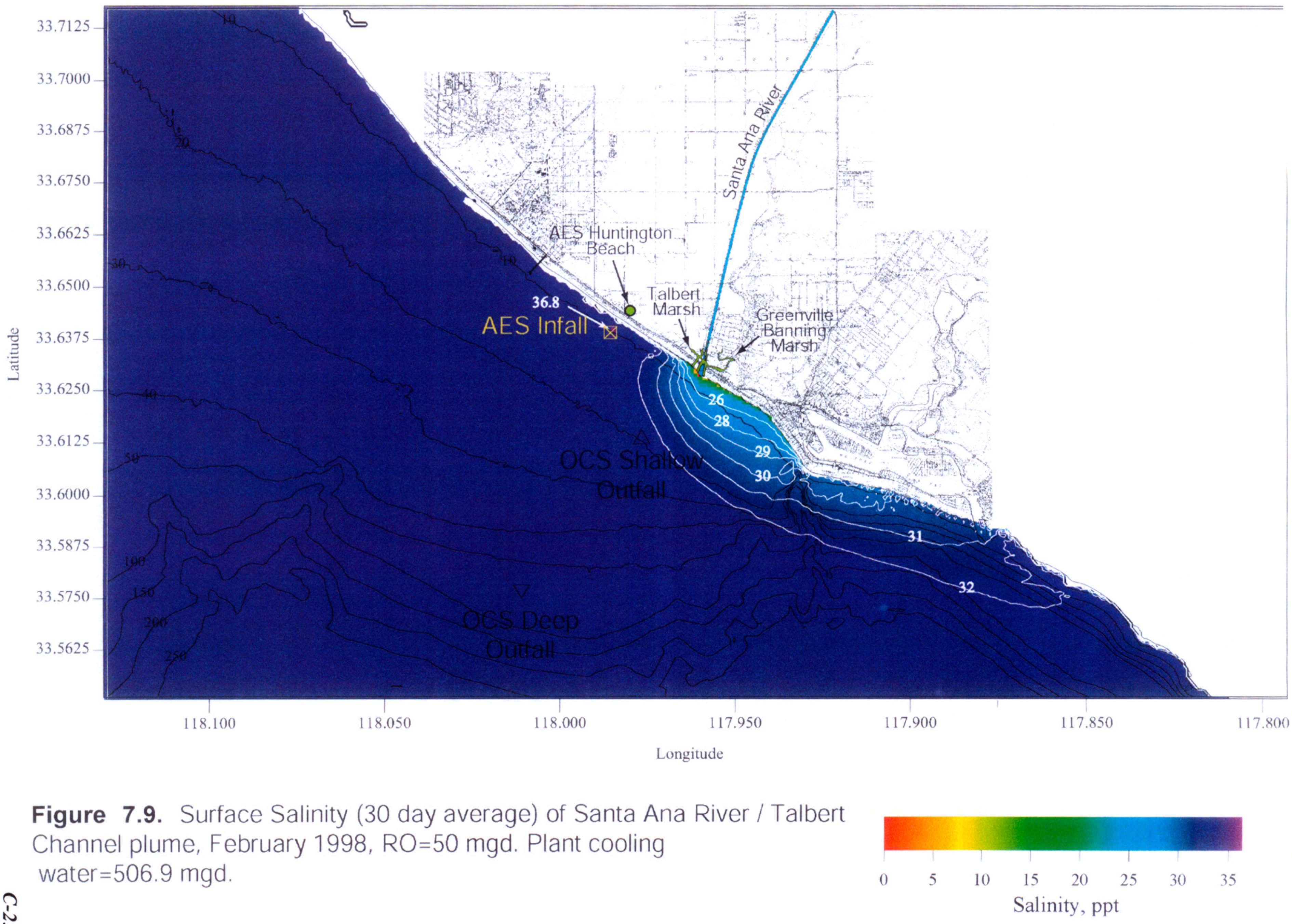


Figure 7.9. Surface Salinity (30 day average) of Santa Ana River / Talbert Channel plume, February 1998, RO=50 mgd. Plant cooling water=506.9 mgd.

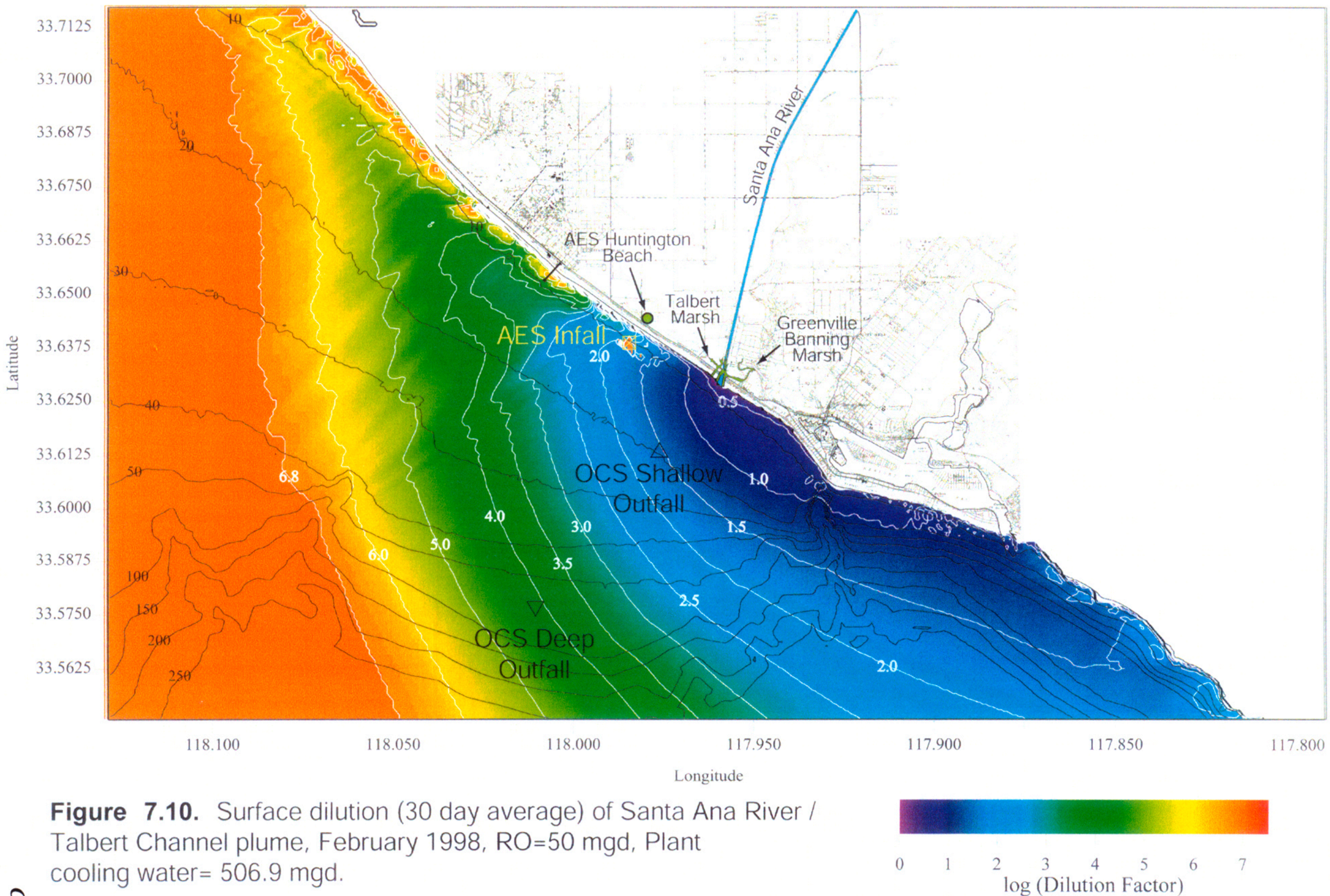


Figure 7.10. Surface dilution (30 day average) of Santa Ana River / Talbert Channel plume, February 1998, RO=50 mgd, Plant cooling water= 506.9 mgd.

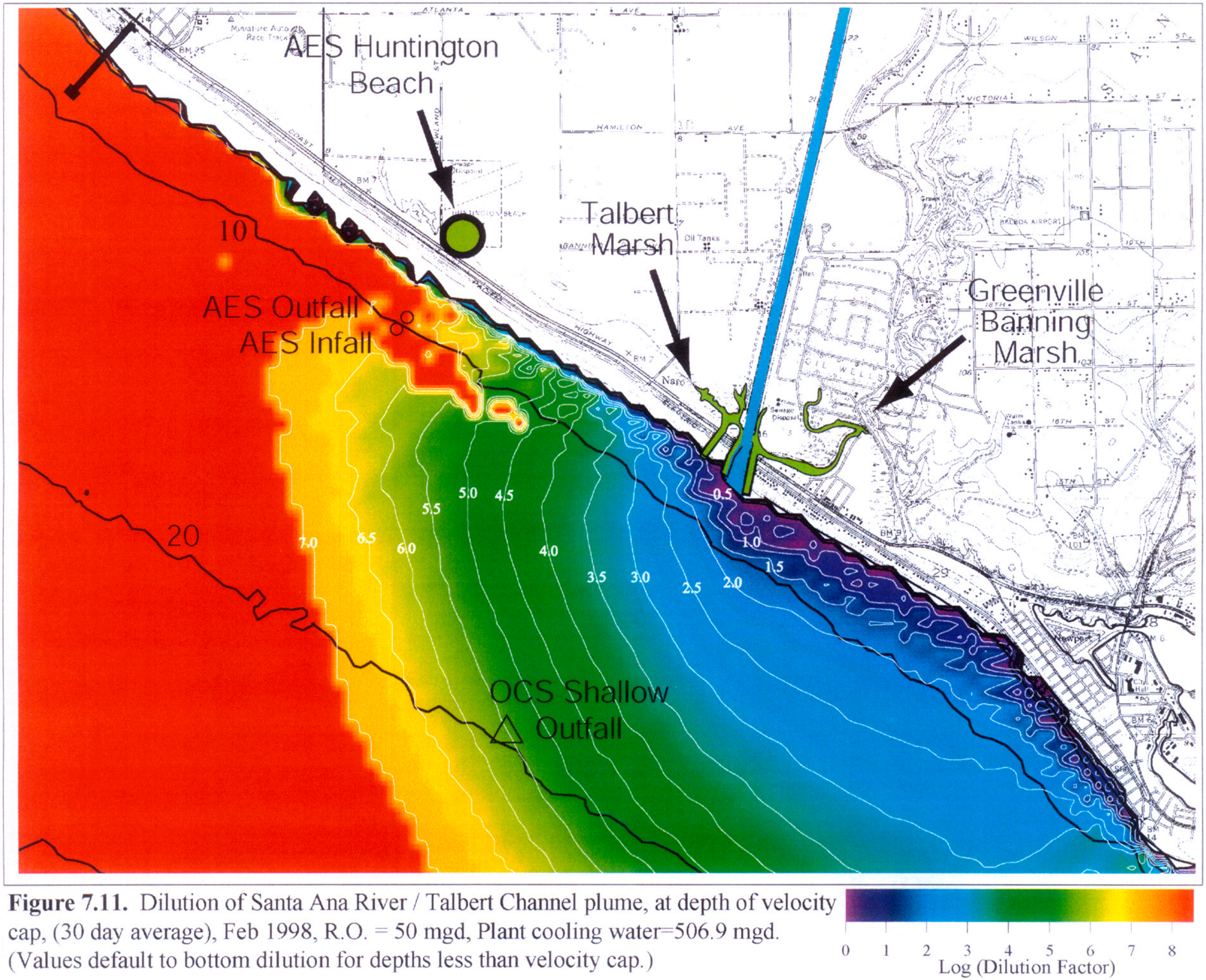


Figure 7.11. Dilution of Santa Ana River / Talbert Channel plume, at depth of velocity cap, (30 day average), Feb 1998, R.O. = 50 mgd, Plant cooling water=506.9 mgd. (Values default to bottom dilution for depths less than velocity cap.)