Response to Comments on Draft Hydrodynamic Model Calibration Report for the greater LA/LB Harbor waters

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September 18, 2006

1. Los Angeles Regional Water Quality Control Board

1.1 Comment:

The modeling domain is to cover the Los Angeles and Long Beach Harbors and San Pedro Bay, including their tributaries, the Los Angeles and San Gabriel Rivers and Dominguez Channel. The initial draft report did not include the Dominguez Channel Estuary into the modeling domain and the model configurations of outer harbor are different between current model and POLA model. It is the concern that how to incorporate the Dominguez Channel and the Consolidated Slips from POLA model into the current model with different model configurations of outer harbor.

1.1 Response

The draft report failed to state that Dominguez Channel was incorporated into the model grid. The Dominguez Channel grid cells, just north of Consolidated Slip were extracted from the POLA model grid and inserted into the present grid. These additional cells were not shown in Figure 2. In addition, the POLA grid and current grid were compared in the LA inner Harbor and Consolidated Slip Region to ensure that even though the grids differ, bathymetry differences were minimal. Water surface elevation data at four stations used in the calibration of the POLA model were also used in the calibration of the current model and are shown in Tables 4-7. Agreement between the present model and the observations at two of the stations are quite good. Since the POLA model calibration results were not available, it was not possible to determine if the present model and the POLA model produces similar disagreements with observations at the other two stations.
This will be further investigated when the POLA model calibration is made available.

1.2 Comment

The water surface elevation at three open boundaries was specified as the sum of low frequency component and harmonic components. These harmonic components are subject to verify prior to being used in the model. However, the observed tidal water elevation data are available in the model area, it will be better to use the observed tide data instead of using harmonic components for ocean boundary.

1.2 Response

The only long-term record of water surface elevation record in the model domain is the NOAA gauge in LA Harbor, Figure 3. Applying this record as a water surface elevation boundary condition on the three open boundaries did reproduce the NOAA gauge observations in the model. However this resulted in the model producing a poor prediction of the currents at the six current meter locations in San Pedro Bay. This lead to the use of the proper open boundary condition for the shallow water equations, Equation (1) which specifies the characteristic of the incoming wave and eliminates false reflection of out going waves characteristic of using a surface elevation only boundary condition. Experience without multiple open boundary condition applications has indicated that splitting the interior records and boundary conditions into tidal and sub-tidal components is preferable. The sub-tidal component can be directly applied in the open boundary condition, Equation (1) since the sub-tidal component is approximately purely progress. Application of Equation (1) to the tidal component involved determining the right-side of the equation by an inverse optimization procedure to achieve a best fit to the NOAA gauge and the six current meters. The utility of this procedure for predicting interior water surface elevation is quite good as represented by the results in Tables 1-8 and Figure 4. Current meter observations are much more difficult to predict since the model predicts average currents over an area represented by the local cell size and observations are essential point values. With this in mind, current prediction, Tables 9-20 is still quite reasonable. An appendix will be included in the final Hydrodynamic calibration report to document the open boundary condition specification in further detail.

1.3 Comment

The salinity and water quality values specified at ocean boundary need to be explained and justified.

1.3 Response

Constant inflowing values of salinity and temperature are applied on the open boundary. This is quite appropriate for salinity which exhibits little variability in the model domain except for response to inflow events inside the breakwaters. Temperature observations were available at the six current meter locations in San Pedro Bay Figure 3 for a portion of the simulation period. Temperatures at these six stations exhibit complex temporal patterns in response to upwelling and down welling at the shelf break and have little coherent season signal, thus mean annual values were use. In applications such as this, temperature is driven primarily by local water column-atmospheric heat exchange and incoming solar radiation with boundary condition uncertainty being overshadowed by local forcing.

1.4 Comment

What model parameters that were calibrated in the hydrodynamic calibration should be indicated and expressed in the Table. The calibration results should be expressed in terms of time series with measured tidal elevation and current data.

1.4 Response

The primary calibration parameter in addition to the open boundary condition was bottom roughness. A bottom roughness corresponding to a log-law Zo of 1 cm, was used. Model response was not significantly changed using values of 0.5 and 2 cm. This will be added to the report text. Additional time series plots will be added for water surface elevation and current meters, similar to that shown in Figure 4. Although time series plots are useful to show general agreement and trends between observations and model predictions they do not quantify the level of agreement or disagreement. Instead, the choice was made in the draft report to present extensive quantitative comparisons of model predictions with observations in Tables 1-20. This allows comparison of model performance with similar studies for other water bodies. This will be elaborated on further in the final report.

1.5 Comment

What model parameters that were calibrated in the transport calibration should be indicated and expressed in the Table. The model predictions of salinity are under prediction compared with observed data. It is recommended to check with the specified open boundary values and stratification in vertical profiles at the sampling stations.

1.5 Response

Other than open boundary conditions, no calibration parameters were used for the salinity transport calibration. As previously noted, salinity variation in the greater harbor waters is less than approximately 1 ppt except during high inflow events and the salinity open boundary condition is judged appropriate. Salinity response is driven primarily by fresh water inflow events and transport of this low salinity water away from the source. The model's salinity under prediction could be associated with over prediction of freshwater inflows, primarily from the Los Angeles River, from the Watershed model and errors in predicting physical transport from this source to the observation locations near Pier 400. Sensitivity to inflows will be further investigated. The lack of current meter data in open water areas inside the breakwater precludes further evaluation of transport effects at this point.

2. Exxon Mobil (Lial Tischler of Tischler/Kocurek)

2.1 Comment

There seems to be a consistent pattern for the observed and modeled current angles at Stations PV A7 and A9 to differ by greater than 90%. Recognizing the variability of current meter data, this apparent consistency of poor comparison between the modeled and measured current angles at these two stations suggests a systematic error in the model. Has any explanation for this apparent systematic error been identified, and could it have any potential effects on the inner harbor simulations?

2.1 Response

See Response 1.2. The tidal frequency open boundary conditions were generated using an inverse optimization procedure such that the boundary conditions were determined to minimize the least squares error between the observed water surface elevation at the NOAA gauge in LA harbor and the observed tidal current ellipses at the 6 PV Shelf stations. The poor performance at A7 and A9, (see attached Figure 1.) is likely an artifact of this procedure which assigned equal weights to each current meter station.

2.2 Comment

I recognize that the salinity data for calibration are limited, but I'm very concerned about the poor calibration of salinity in the current model (Figures 6 and 7), which the report identifies as an area needing more work. Figures 6 and 7 show that salinity in both the surface and bottom waters is very poorly simulated during storm water runoff events. …………The poor salinity calibration during runoff events is a major impediment to satisfactory simulation of water and sediment quality in the inner harbor and bay system. …………..An additional concern is the lack of any salinity stations in the more constricted areas of the harbors (the Bight 03 data will add some stations that will help). ……………

2.2 Response

See Response 1.5. The model's poor predictions salinity magnitude and stratification in the vicinity of Pier 400, Figure 5, is of considerable concern. Potential causes include uncertainty in the freshwater inflow magnitude, the method of freshwater inflow introduction, transport between freshwater inflows and the observation sites, and excessive vertical mixing. Sensitivity runs are underway to investigate these potential causes. The Bight 03 study provides approximately six observational stations which have significant salinity variation to be useful in model calibration and are being incorporated into the model-observation comparison

3. Port of Los Angeles

3.1 Comment

Based on the presentation graphics displayed during the May meeting, Tetra Tech (TT) has been assuming that Everest will provide loadings from the Dominguez Channel Estuary (DCE) and, consequently, TT has not been planning to incorporate the model grid Everest developed for the DCE into the overall model grid. Instead, it appears that TT has been developing the model grid up to the Consolidated Slip and then they were planning to have Everest provide loadings into the system at the "upstream" boundary (i.e., the "upstream" end of the Consolidated Slip). The model domain developed by Everest for the Port (and ultimately the LARWQCB) was intended to be added to the model domain being developed by TT, which is one of the reasons the same receiving water body model (EFDC) was selected for use on the DCEMS.

3.1 Response

See Response 1.1. The model grid Everest developed upstream of Consolidated Slip was incorporated into the TMDL model grid for the model simulations reported in the Draft calibration report. Unfortunately this was not explicitly stated and the extended grid was not shown due of lack of model cell vertices for the Everest grid. Cell dimensions in the add Dominguez channel region upstream of Consolidated Slip were extracted from Everest model input file provided in January 2006. The TMDL model now has the capability to accept calibration parameters, inflows and load developed by Everest in this region when they are made available. It is also noted that water surface elevation and current meter observational data collected for the Everest modeling application was used for calibration of the Tetra Tech model. See Tables 4-7 and 15-20. Additions to observational data files for salinity sampling and a dye tracer study were made available, but documentation was not available prior to the preparation of the draft report to fully utilize this data. The documentation was subsequently received and these data sets will be used to refine the hydrodynamic model calibration.

3.2 Comment

For Dominguez Channel, Tetra Tech is planning to use wet weather watershed loadings from the LSPC model developed by the Southern California Coastal Water Research Project (SCCWRP) as input to the EFDC receiving water body model.

3.2 Response

Specifying flows and loads for Dominguez Channel remains somewhat problematic. Currently the period 2003-2005 is being used for the greater harbors TMDL model calibration and all or portions of this period will be used for TMDL scenarios. The current LSPC model does not span the entire period and observed flows, with some significant data gaps, are currently being used. The Dominguez Channel flows and possible storm loads selection should be discussed at the TAC and some consensus arrived at.

3.3 Comment

For DDT, PCB, and Chlordane the method utilized to calibrate the TT model is based on the assumption that the pollutant concentration from the watershed during wet weather is similar to the pollutant concentration in the harbor bottom sediments. This assumption is likely to over predict the watershed pollutant loading because the pollutants in the bottom sediments are likely to be more concentrated than in the water column.

3.3 Response

The calibration of the hydrodynamic model driven contaminant transport and fate model will likely resolve these concerns. Setup of the greater harbors contaminant transport and fate model will focus on achieving a best initial condition for contaminants in the sediment bed using historical data and additional sediment sampling and analysis currently underway. Contaminant loads from the watershed model will be subjected to sensitivity analysis during the calibration and modified if required.

3.4 Comment

The comparison of the model-predicted velocities and water surface elevations with the field data are based on a comparison between the predicted and observed amplitudes and phases instead of time series. The time period of the field data being used for model calibration was not stated. If the full year of the DCEMS data were used for model calibration, it is not clear whether precipitation has been included in the modeling.

3.4 Response

See Response 1.4. As noted in Response 1.4, time series plots will be added to the final report. However, it is widely accepted that least squares harmonic analysis and comparison of model and observation harmonic properties yield the most rigorous quantitative approach for hydrodynamic model calibration in tidal environments. The water surface elevation and current meter comparisons shown Tables 4-7 and 15-20 utilized the full observational records. Direct precipitation and land based runoff from the LSPC watershed model was used for the simulations. It is noted that the DCEMS data was provided to Tetra Tech without documentation. Complete documentation was received subsequent to preparation of the draft report.

3.5 Comment

It is indicated in the report that the wind data used for modeling were based on data collected at the Los Angeles and Long Beach Airports. We recommend incorporating wind data that are readily available at multiple locations within the LA/LB Harbor Complex. Our work with the DCEMS project indicated that local winds have a significant effect on hydrodynamic circulation

3.5 Response

Tetra Tech would be pleased to incorporate additional local wind data when it is provided to us. As a point of clarification, the LAX airport data was not used. Wind and atmospheric data utilized included the Long Beach Airport and data from the California Irrigation Management System (CIMS) database. If other local met stations exist within the watershed or close to LA/LB Harbor waters, then we can incorporate this information into the EFDC model.

3.6 Comment

The model under predicts the salinity at the 20 locations where field data in the harbor are available. In some cases, the under prediction is severe and would have implications for the mass balance of freshwater (and potentially contaminants) entering the system. We recommend careful attention to resolving this issue so that errors are not carried forward. In addition, while the field data showed some stratification in the system (i.e., lower salinity at the water surface compared to those near the bottom), the model predicts the water column to be well mixed (i.e., salinities near the water surface are similar to those near the bottom). Therefore, we believe that further calibration with additional salinity data (e.g., salinity data collected for the DCEMS) should be performed to improve the predictive ability of the model in terms of the overall level of under predictions and the high level of predicted vertical mixing.

3.6 Response

See Responses 1.5 and 2.2. As noted previously, the DCEMS salinity data was provided without documentation and the raw data sheets are difficult to decipher. For the high inflow events of early January 2004, the flow data for Dominguez is somewhat uncertain and use of DCEMS model flows for this period could be helpful. Fully documentation of the DCEMS model data sets were subsequently received and are being used in incorporating the additional data into the model calibration.

4. Port of Long Beach (Weston Solutions)

4.1 Comment

By way of an introduction to the physical setting of the study area, an overall “regional” location map of the modeled watersheds discharging to San Pedro Bay would be helpful to place the hydrodynamic model domain in a larger spatial scale context. San Pedro Bay should be identified on the map.

The summaries of data sources presented in Table 1 and Table 2 should include the periods of record available for development of the model. It would be helpful to present station location maps for the key data sets to identify the spatial distribution and availability of the different data sources used for the study.

4.1 Response

Appropriate graphics will be added to clarify locations noted above.

4.2 Comment

Model Geometry Identify the horizontal grid reference system used for XY coordinate data (e.g., UTM Zone; California State Plane Coordinates etc.). Also, identify the vertical grid reference system for Z coordinate data. Indicate units for bathymetry are in meters.

4.2 Response

Coordinate system references will be added to the text.

4.3 Comment

Open Boundary Hydrodynamic Forcing The Open Boundary Dynamic Tidal Forcing calibration appears sound in theory and will provide a good boundary condition for the ocean-side limits of the model. However, there is no discussion (or consideration) of the influence of gravity waves and sub-gravity waves from wave groupings.

4.3 Response

The Harbors breakwater reduces the influence of high frequency gravity wave in the primary modeling domain. The influence of such wave passing through the breakwater openings and locally generated high frequency surface gravity wave may contribute to sediment resuspension and will be considered further in the sediment-contaminant transport calibration, and if judged to be of significance a spectral wave model such as SWAN will be used to further quantify wave-current boundary layer effects on sediment resuspension. Sub-gravity waves are the source of a number of oscillation problems in slips in the Harbor system. For the resolution scale being used in this study, they are not judged to be significant with respect to sediment processes.

4.4 Comment

Since observed sea surface elevation data is not available to define the open boundaries for the model, the tidal frequency components of the incoming wave open boundary condition was estimated using interior tide gage data sets. It would be useful to show the time series of water surface elevation that is used to define this open boundary condition for model calibration. A subset of the model calibration period could be plotted to show a time series for approximately 30 days to illustrate the neap and spring tide variability of tidal forcing characteristic of the study area. Will identical time series of water surface elevation be applied at all grid cells of the 3 open boundaries?

4.4 Response

See Responses 1.2 and 2.1. Three separate hydrodynamic open boundary conditions are developed using an inverse optimization procedure for the three open boundaries. Details of this procedure were omitted from the Draft report in the interest of brevity. An appendix describing the procedure will be added to the report. Comparison of model predictions and observations in Table 3-20 do however substantiate its utility.

4.5 Comment

Salinity and Temperature Open Boundary Conditions. Salinity and temperature boundary conditions are based on seasonal signals derived from monitoring station observations. NOAA National Oceanographic Data Center (NODC) and the Southern California Coastal Water Research Project (SCCWRP) most likely have a very large database of historical hydrographic observations for the coastal region of San Pedro Bay. Were these agencies considered as sources of historical data sets that could be obtained and used to construct open ocean and coastal boundary conditions for salinity and temperature?

4.5 Response

See Response 1.3. Unfortunately the amount of actual data for San Pedro is much less than would be anticipated. Tetra Tech has worked with SCCWRP to identify their data with the study area. Both the NODC and NDBC databases were searched as well as a number of databases maintained by Scripps Institute of Oceanography. The various data sets obtained and reviewed indicate salinity variations near the open boundary in San Pedro Bay to be less than 1 ppt. Indeed salinity variation, including stratification, is so small that it was not reported in the Palos Verde shelf study. Temperature data near the open boundary at the Palos Verde shelf stations (see Figure 1 attached) show complex variability associated with upwelling and down welling events and weak season signal. Temperature response in the model domain is primarily driven by local incoming solar radiation and air-sea heat exchange. It is also noted that temperature is a secondary variable in this study and is simulated primarily to account for evaporative water loss and the associated salinity source.

4.6 Comment

Wind and Atmospheric Forcing Show map identifying how wind forcing data was weighted for assignment to different spatial areas of the model domain. If there were data gaps, and/or anomalous data “spikes”, in the winds and atmospheric forcing data sets, how was missing data filled in, or how were anomalous data spikes repaired to assign a continuous time series of forcing data?

Fresh Water Inflows Show location map identifying freshwater inflows. Show time series plots of river and wastewater flow rates used for model calibration period.

4.6 Response

Plots of Atmospheric Forcing and Freshwater Inflows were omitted for brevity and can be included as Appendices in the final report

4.7 Comment

What targets have been defined as acceptable relative error tolerances (as %) for the match between model results vs. observed data for water surface elevation, salinity and temperature?

4.7 Response

Target values were not set. An appendix summarizing model performance measures achieved on similar studies will be included in the final report.

4.8 Comment

The amount of water current data available is not adequate for model calibration. Water current data are only available at 4 locations. Given the spatial expanse of the tidally influenced area and the importance of the understanding of currents in contaminant fate, several more current meters should be deployed to collect additional data. If more current meters are not available, the existing current meters should be relocated to other areas of interest and a second calibration and sensitivity analysis performed.

4.8 Response

Tetra Tech concurs with this comment. However this type of field work was not in our scope and apparently stakeholders were not interested in funding additional studies. Interestingly the US Army Corp of Engineers ERDC (WES) has extensive modeled the greater Harbors system for more than 20 years. The only current meter deployment was in the late 1980 at locations that have now been filled in by Pier 400. In studies conducted after 1990 they made no comparisons of model predictions to observed currents because there were no relevant observed current and it is presumed given their vast experience in this type of work, they did not see fit to collect current meter data.

4.9 Comment

In Table 3 of the cited memo, predicted vs. observed data comparison is presented for NOAA Gage in Los Angeles Harbor. The NOAA CO-OPS website for the PORTS program identifies 10 different station locations where real-time data is available online for Los Angeles-Long Beach Harbor. What tide gage station was selected for this comparison?

4.10 Response

Nine of the ten stations shown in NOAA CO-OP are inferences and not real time data. The only ‘real’ real time data is at the permanent tide gauge in LA Harbor. Further comparing the inferred elevations and phase at these 9 sites will reveal that they are for all purposes identical to the ‘real’ gauge. Note that Tables 4-7 show comparisons for four other actual tide gauges in the Harbor in addition to the NOAA reference gauge shown in Table 4.

4.11 Comment

Time series plot of observed and simulated water surface elevation for a composite of all frequencies should be presented in the report to show match between model results and observed data. What is the computed relative error of the model (as %) with respect to water surface elevation at the selected station for model vs. data comparison?

4.11 Response

Table 8 provides time series error measures for both instantaneous and low frequency components o the water surface elevation at the long term NOAA reference tide gauge.

4.12 Comment

Identify the current meter station names in Figure 3 location map to facilitate evaluation of results given in Table 4. What vertical layers are included in the summary statistics of the model velocity vs. current meter data results—surface layer only?; depth averaged surface to bottom? What time period of data is included in the summary statistics? What is an explanation for such a discrepancy in the comparison between model velocity vs. current meter observations?

4.12 Response

Table 4-7 refer to water surface elevation comparisons rather than current comparisons. Current meter comparisons are provided in Tables 9-20. All comparisons are based on depth averages of ADCP profiles and depth average model outputs for the full period of record of observations falling within the model simulation period. Tables will be added to clarify this. One challenging task for modelers is to achieve high levels of agreement between model predictions, representing velocities averaged over thousands of square meters with point or vertical profiles current meter measurements. Localized bathymetric variations not accounted for at the model scale or inaccurate bathymetry in the model are the most likely sources. For example, the attached Figure 1 shows extreme bathymetric variations in the vicinity of a number of the PV shelf current meters.

4.13 Comment

Salinity Time series plot of observed and simulated salinity should be presented for the model calibration period to show match between model results and observed data for (a) surface layer and (b) bottom layer. What is the computed relative error of the model (as %) with respect to salinity at the stations selected for model vs. data comparison? What is the sensitivity of the contaminant transport to salinity in the model? If salinity is used strictly as a calibration tool, then it is imperative that the salt over-prediction be resolved for the final calibration. However, it is understood that the salinity calibration results are preliminary since the full atmospheric forcing, including evaporation, has not yet been incorporated into the calibration of the water temperature model.

4.13 Response

See Responses 1.5, 2.2, and 3.6. Salinity time series plots of observed and predicted salinity are shown in Figures A.1 – A.20 of Appendix A where the model tends to under predict rather than over predict the salinity. Causes of this under prediction are discussed in Responses 1.5, 2.2 and 3.6

4.14 Comment

Temperature results are not presented in the cited memo since work on this component of the project was not completed on the date the memo was written. Questions and comments refer to the approach for temperature calibration that is discussed in the cited memo. How is the solar radiation attenuation coefficient derived for model calibration? Is it based on light extinction relationships for chlorophyll and/or total suspended solids? If not, is the attenuation coefficient consistent with the range of light extinction coefficients that will be used in the eutrophication model component for the overall project? Is the attenuation coefficient considered to be spatially variable based on within harbor and offshore differences in chlorophyll and/or total suspended solids? Is the sediment bed temperature considered to be an adjustable parameter for temperature simulation?

4.14 Response

Temperature is a secondary variable in the calibration and included to account for evaporation and the associated source of salinity. The TMDL to be developed in this study is for toxic organics and metals and there associated transport and fate which is highly coupled with sediment transport. Eutrophication will not be simulated in this study.

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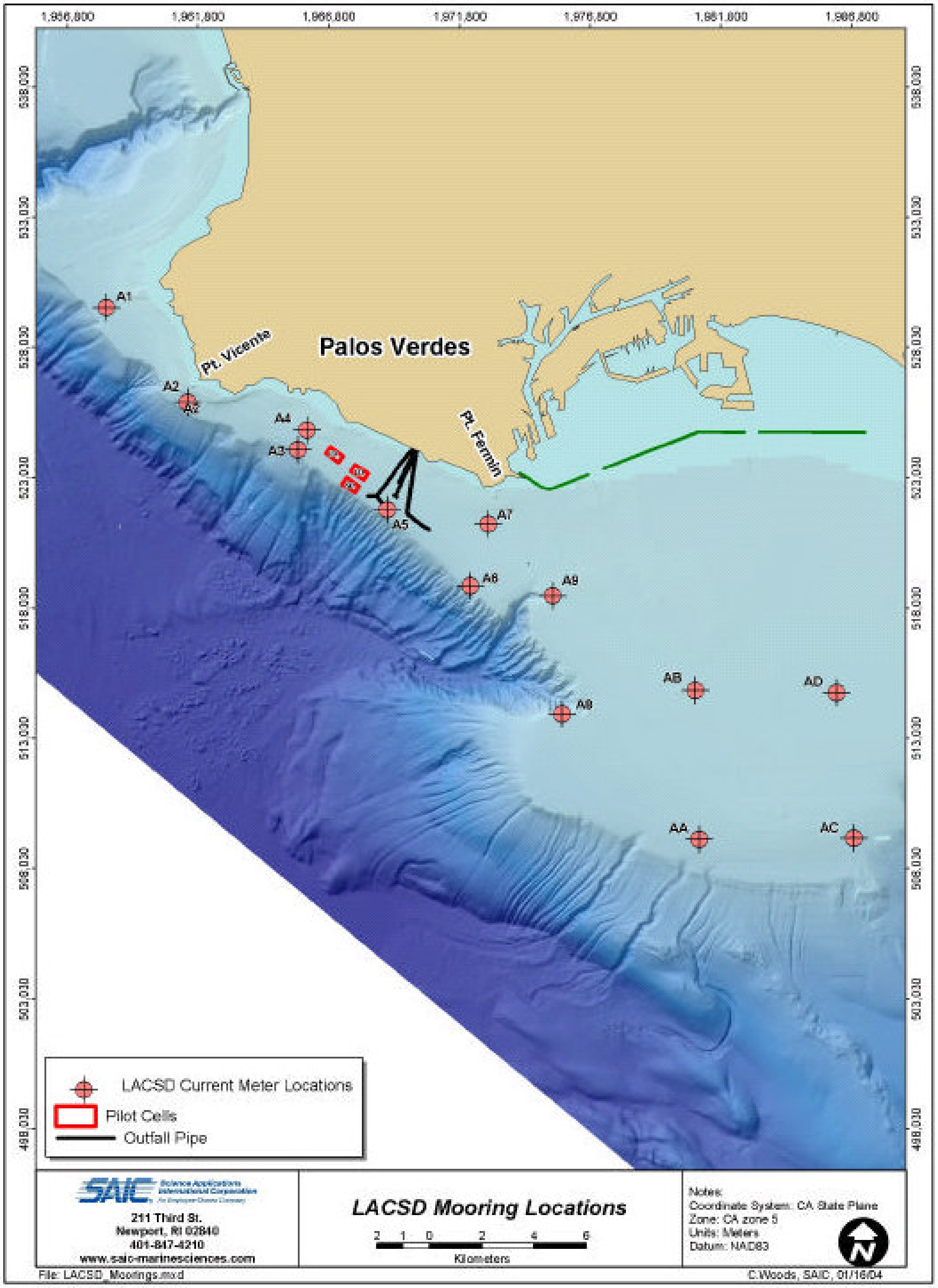

Figure 1. Location of PV Shelf Current Meters