5.0 LINKAGE ANALYSIS AND LOADING CAPACITY

5.1 Linkage Analysis

This linkage analysis investigates the relationship between OC pollutant loadings, targets, and adverse effects to beneficial uses, in order to calculate the loading capacity of each pollutant in each water body. The loading capacity is defined as the maximum amount of a pollutant that may be received by a water body and still achieve water quality standards (i.e., protect beneficial uses and meet numeric and narrative objectives). It is the critical link between applicable water quality standards (as interpreted through numeric targets) and the TMDL.

A conceptual depiction of the linkages between OCs in fish tissue, sediment and potential adverse effects to water quality standards is shown below in Figure 5-1; some of these processes have been discussed in previous sections of this document. Linkage (1) shows that the potential risk to human health and/or wildlife is proportional to the OC concentration in fish multiplied by the consumption rate.

Linkage (2) shows that the OC concentration in the tissue of fish and benthic invertebrates is proportional to the OC concentration in the sediments to which the organisms (or prey organisms) are exposed. This linkage is illustrated in Figure 2.1 in Section 2, which shows the linear relationship between DDE concentration in a benthic organism and in Newport Bay sediments. It is clear that by reducing the OC concentrations in sediment, the concentrations in aquatic food webs should likewise be reduced. The utilization of empirical and mechanistic models by San Francisco Estuary Institute (SFEI), to evaluate risk to humans and wildlife from exposure to OCs in Newport Bay, should further enhance the ability to predict the relationships between OCs in sediments and in fish and wildlife within a variety of food webs.

San Diego Creek provides up to 95% of the freshwater input to Newport Bay; and a substantial amount of suspended particulates are ultimately discharged from San Diego Creek to the bay, especially during large storms, where they may be subsequently deposited as bed sediments or flushed out of the bay into coastal waters. Water column concentrations of the OCs in the creek or the bay would include pollutants that are adsorbed to suspended particulates (f_p) as well as pollutants that are in the dissolved phase (f_d). When flows are relatively high in San Diego Creek, almost all of the OCs present in the water column are associated with particulates, and f_d is estimated to be very low (see Table 4.7). Therefore, linkage (3) shows the assumption that the OC pollutant concentration is proportional to the total suspended solids (TSS) concentration in the water column multiplied by the OC concentration of the suspended particulates. There are few data specific to the Newport Bay/San Diego Creek watershed with which to verify the Linkage (3) assumption; however, studies are underway that should provide these data. The linkage, however, has been observed in the Calleguas Creek Watershed in the Los

Angeles region (See Figure 5-2, below, which is specific for DDT. The other OCs are also associated with particulates, and results should be similar).

The linear relationship between OCs and TSS reveals a potential strategy for attaining the numeric water column targets (i.e., CTR values) and, ultimately, sediment target values. Logically, if the OC concentration in suspended particulates in San Diego Creek is reduced, if the TSS concentration is reduced, or if both the OCs and the TSS concentrations are reduced, then attainment of the CTR criteria and sediment targets may be feasible in both San Diego Creek and Newport Bay.

The OC concentration in sediments is clearly the primary variable dictating whether water quality objectives and beneficial uses can be attained. Linkage (4) shows that OC concentrations in sediment are a function of sediment transport and OC loading; this relationship provides the foundation for calculating the loading capacities for these TMDLs. This assumption can be represented via a one-box mixing model where the OCs, in association with sediments, enter a defined reach of the creek or the bay, and are deposited, mixed, and/or resuspended. Likewise, OCs, in association with sediments, leave the stream reach or the bay through current flow or tidal action (see Figure 5-1).

Sediment TMDLs for San Diego Creek and Newport Bay were adopted in 1998 and are being implemented; these TMDLs allow 62,500 tons per year of sediment to be deposited to San Diego Creek, and 62,500 tons per year of sediment to be discharged to Newport Bay. The loading capacities for the OCs can be calculated by using these allowable sediment loads and the target OCs concentrations in sediment. It is important to note that the OCs loading capacities in the USEPA technical TMDLs (2002) were based on the estimated *current* sediment loading to San Diego Creek and Newport Bay, resulting in much higher loads than would be obtained by using the sediment TMDL allowable loads for these waterbodies as limits. Therefore, Regional Board staff modified the USEPA TMDLs to ensure consistency between the OCs and sediment TMDLs for San Diego Creek and Newport Bay.

5.2 Loading Capacities

5.2.1 San Diego Creek

As shown below in Equation 13, loading capacity for each pollutant was calculated by multiplying the sediment target concentration by the allowable annual sediment load to San Diego Creek and tributaries, as identified in the sediment TMDLs (allowable load is 62,500 tons per year). This approach is much more simplified than that performed by USEPA (2002); their approach did not take into account sediment TMDL targets, but used a series of calculations to determine loading capacities (g/year).

$$LoadingCapacity = C_s \times D_s \times 907.185 \times 10^{-6} \quad (13)$$

where C_S = sediment target concentration (μg/kg dw)
D_S = Allowable sediment load (tons/year = 62,500)
907.185 = conversion from kg to tons
10^{-6} = conversion from g to μg

5.2.2 Upper and Lower Newport Bay

For Newport Bay, Resource Management Associates (RMA) has modeled the amounts and in-bay distribution of sediment based on the estimated existing sediment discharges to the Bay (RMA, 1997). The fraction of the allowable 62,500 tons of annual sediment loading to the bay estimated to be deposited within Upper Newport Bay and Lower Newport Bay was extrapolated from modeled sediment loads and in-bay distribution patterns. The RMA model predicted that 72.5 percent of sediment deposition would be to the Upper Bay, and 26.7 percent would be deposited within the Lower Bay. (A smaller fraction [0.8%] was estimated to be deposited within the Rhine Channel; TMDLs for the Rhine Channel are being developed independent of the Upper and Lower Newport Bay OCs TMDLs.) Applying these percentages to the 62,500-ton allowable annual load to the bay, staff calculated that 45,312 tons of sediment could be deposited to the Upper Bay per year, and 16,688 tons per year to the Lower Bay. While it is recognized that in order to accurately estimate the deposition patterns within the bay using the 62,500 tons per year of sediment loading as a constraint, the RMA model would likely need to be re-run, that is not feasible at this time. The present approach is considered to be a reasonable estimate based on best professional judgment. Additional modeling work will be identified in the OCs TMDLs implementation plan.

For each OC pollutant, the marine sediment target value (see Table 3-1) was applied to the estimated allowable sediment load for Upper and Lower Newport Bay to calculate the loading capacity (see Equation 13). Table 5-1 shows the loading capacity for each pollutant in San Diego Creek and Upper and Lower Newport Bay. Note that by ensuring consistency among the OCs and sediment TMDLs, the loading capacities for OCs in both San Diego Creek and Newport Bay are lower than those calculated by USEPA (2002).

Table 5.1. Loading capacities for San Diego Creek and Newport Bay.

Pollutant	Loading Capacity (g/year)		
	San Diego Creek	Upper Bay	Lower Bay
Total DDT	396	160	59
Chlordane	255	93	34
Toxaphene	5.67		
Total PCBs	1933	884	326