Appendix A: Calculation of Recreational Boat Discharges of Dissolved Copper to the Harbors Back Basins

This is an update to Appendix B included in the Staff Report for the original Marina del Rey Harbor Toxic Pollutants TMDL. Modeling has been updated based on new information and to include the entirety of Marina del Rey Harbor, rather than solely the back basins as was included in the original TMDL.

Passive Leaching

Based on the information provided by the Los Angeles County Department of Beaches and Harbors, there are 4,754 vessel slips in Marina del Rey Harbor and the average slip length is 34.25 feet. Based on the studies conducted for Shelter Island Yacht Basin TMDL (San Diego Regional Water Quality Control Board), average wetted hull surface area is calculated based on an average size vessel, which is then used to calculate the amount of passive leaching over time per vessel. Wetted hull surface area is calculated using the following equation: Wetted hull surface area = (Overall length) * (Beam width) * (0.85). Overall length is set equivalent to the average slip length of 34.25 feet. The average beam width used in the Shelter Island Yacht Basin TMDL, 11 feet, is applied here as this information is unavailable for Marina del Rey Harbor.

Annual copper load (kg/year) = P*S*N, and S=L*B*0.85

Where:
P = Passive leaching rate = 6.5 ug/cm^2/day
N = Number of vessels = 4,754 (set equal to # of boat slips)
S = Wetted hull surface area = Overall length * Beam * 0.85
L = Average length = 34.25 feet = 10.4m
B = Average beam width = 11 feet = 3.4m

Wetted hull surface area = (10.4m)*(3.4m)*(0.85) = 30.1 m^2
Annual load (dissolved copper) = (6.5 ug/cm^2/day) * (30.1m^2) * (4,754 vessels)*(10,000 cm^2/m^2)*(kg/10^9ug)(365day/yr)
= 3,390 kg/year = 7,474 lb/year

Hull Cleaning

Underwater hull cleaning is a common maintenance practice designed to prevent buildup of marine organisms on a ship's hull. The growth of marine organisms may be removed from recreational vessel hulls either through haul-out at boatyard, or manually while the boat is in-water using underwater hull cleaning techniques. It has been estimated that almost all of the pleasure crafts in Marina del Rey undergo periodic underwater hull cleaning.

The physical process of removing marine growth on the ship's hull underwater results in a release of dissolved copper from the paints. The amount of copper released from hull cleaning is dependent on cleaning frequency, method of cleaning, type of paint, and frequency of paining. Estimated underwater hull cleaning frequency is 2 times per month in the summer months (May through October) and once per month in the winter months for regularly maintained recreational boats.

The calculation is based on the information utilized for the Shelter Island Yacht Basin TMDL. In order to determine the load from underwater hull cleaning, it was assumed that approximately half of the vessels are painted with epoxy paints and half with vinyl paints, and that MPs are used to clean hulls on approximately half of the vessels. For epoxy paints, cleaning without MPs doubled the dissolved copper flux, from 8.6 µg/cm^2/event to 17.4 µg/cm^2/event (Schiff et al., 2003). The response from hard vinyl paints remained similar whether or not BMP/MPs were used (3.8 versus 4.2 µg/cm^2/event) (Schiff et al., 2003). Using these assumptions, the rates for the epoxy and vinyl paints were averaged to arrive at an emissions rate for underwater hull cleaning.

Determination of Hull Cleaning Rate
Average dissolved copper emissions rate from epoxy paints
= (8.6 µg/cm^2/event + 17.4 µg/cm^2/event)/2
= 13 µg/cm^2/event

Average dissolved copper emissions rate from vinyl paints
= (3.8 µg/cm^2/event + 4.2 µg/cm^2/event)/2
= 4 µg/cm2/event

Average dissolved copper emissions rate (both paint types)
= (13 µg/cm^2/event + 4 µg/cm^2/event)/2
= 8.5 µg/cm^2/event

Determination of Source Loading Using Hull Cleaning Rate
Annual copper load (kg/year) = P*S* Nv, and S = L*B*0.85
Where:
P = Underwater hull cleaning rate
Nv = Number of vessels
S = Wetted hull surface area = Overall length*Beam*0.85
L = Average boat length
B = Average beam width
Cu = Copper

Given:
P = 8.5 µg/cm^2/event
Nv = 4,754
L = 10.4 m
B = 3.4 m
Nh = 18 events/year
Wetted hull surface area = L*B*(0.85)
Wetted hull surface area = (10.4 m)*(3.4 m)*(0.85) = 30.1 m^2
Annual load = (8.5 µg/cm^2/day)*(30.1 m^2)*(4,754 vessels)*(10,000 cm^2/m^2)*(kg Cu/10^9 µg)*(18 events/year)
= 219 kg/year = 482 lbs/year

Total Annual Copper Load from Antifouling Paint

=Annual Copper Load from Passive Leaching + Annual Copper Load from Hull Cleaning
= 3,390 kg/yr + 219 kg/yr **= 3,609 kg/yr**
= 7,474 lb/yr + 482 lb/yr **= 7956 lb/yr**