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# Contaminant flux in Las Vegas Bay: Are sediments a sink or source?

**Alvarez, D.[1], Rosen, M.[2], Cranor, W.[1], Perkins, S.[1], Schroeder, V.[3]**

[1] U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO; [2] U.S. Geological Survey, Nevada Water Science Center, Carson City; [3] Arctic Slope Regional Corporation, Columbia, MO

## INTRODUCTION

Treated wastewater effluent from Las Vegas and surrounding communities flows through Las Vegas Wash into Lake Mead at Las Vegas Bay (LVB). Lake sediment is a likely sink for many organic wastewater contaminants (OWCs); however, partitioning between the sediment and the overlying water could result in the sediment acting as a secondary contaminant source.

Passive sampling devices (semipermeable membrane devices (SPMDs) and polar organic chemical integrative samplers (POCIS)) were placed in LVB between June and July of 2008 to determine the vertical gradient of OWCs in the water column and potential contribution of OWCs from the sediment.

## CHEMICALS OF INTEREST

SPMDs will be analyzed for polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides, polychlorinated biphenyls (PCBs), polybrominated diphenyl ether flame retardants (PBDEs), and OWCs (including includes fragrances, flame retardants, plasticizers, personal care products, and industrial and consumer chemicals).

POCIS will be analyzed for OWCs, hormones, pharmaceuticals, and illicit drugs.

POCIS extracts will also be screened for estrogens and/or estrogen mimicking chemicals using the yeast estrogen screen (YES).

## PROCESSING AND ANALYSIS OF PASSIVE SAMPLERS

The processing and analysis of the SPMDs and POCIS follows published procedures (Alvarez et al., 2008; Jones-Lepp et al., 2004) and newly developed methods (Echols et al., 2009).

In general, each field and quality control sample was processed using class-specific cleanup and fractionation schemes (i.e., size exclusion chromatography, silica gel, reactive silica gel, alumina, and solid-phase extraction. Analyses were performed using either a gas chromatograph with a mass selective detector (GC-MSD) for OWCs and hormones; GC with an electron capture detector (GC-ECD) for PCBs, PBDEs, and organochlorine pesticides; or a HPLC with an ion trap mass spectrometer (LC-ITMS) for pharmaceuticals and illicit drugs.

GC coupled to a high resolution mass spectrometer may also be used during the analysis of some samples for additional sensitivity and confirmation of measured contaminants.

Samples designated for the YES were screened prior to rigorous cleanup to prevent removal of unknown but bioactive (estrogenic) chemicals.

Quality control measures such as field and laboratory blanks, surrogate recovery spikes of target chemicals, and positive and negative controls for the YES assay were used throughout this work.

# SEDIMENT FLUX OF ORGANIC CONTAMINANTS

## STUDY DESIGN

A custom sediment sampling probe (Figure 1) was used to bury the SPMDs and POCIS in the sediment at depths of 0-10 cm, 10-20 cm, and 20-30 cm. This design had 6 perforated metal probes which contained SPMDs or POCIS at 3 depth intervals. A support rack was inserted in each probe to hold the SPMD or POCIS at the correct depth. Fine sediment and sediment pore water could enter the probes and come into contact with the passive sampler positioned at that depth.

The design held 3 SPMDs (1/6 standard size) and 6 POCIS (1/2 standard size) at each depth interval. Figures 2-3 show the assembly and field deployment steps.

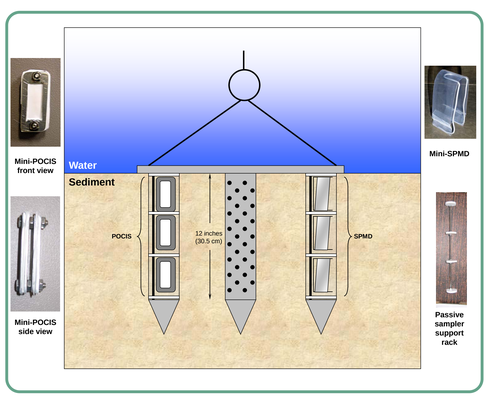


Figure 1. Representation of the sediment sampling probe used to bury SPMDs and POCIS at depths of 0-10 cm, 10-20 cm, and 20-30 cm.

Figure 2. Assembly of the sediment probe sampling apparatus.

Deployment Retrieval

Figure 3. Deployment and retrieval of the sediment probe sampling apparatus.

## PROGRESS AND RESULTS

All samplers and quality control samples from the Sediment Flux portion of the study have been extracted and are at various stages of processing and analysis. Data from completed analyses are shown below.

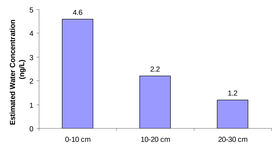


Figure 4. PAH concentrations in SPMDs buried in sediment.

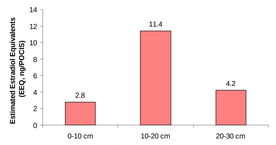


Figure 5. Estimated estradiol equivalents determined in POCIS buried in sediment.

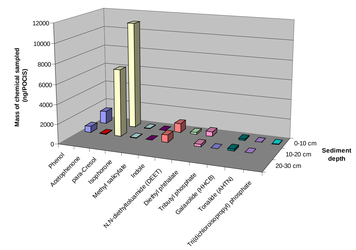


Figure 6. Distribution of OWCs in POCIS buried in sediment.

## OBSERVATIONS

The greatest concentration of targeted chemicals are present at the 0-10 cm depth (Figures 4 and 6).

The greatest estrogenic response was measured at the 10-20 cm depth (Figure 5). This does not match the rest of the chemical distribution profile; however, analyses for the steroidal hormones have not been completed to determine if this response is due to hormones or other currently unidentified estrogen-mimicking chemicals.

The data in this portion of the study is in agreement with the data from the vertical gradient portion of the study where phenol, *para*-cresol, and indole were at the highest concentrations in the top 0-10 cm of the sediment and also greatest in the water column at the 6.7 m (lake bottom) depth.

# VERTICAL GRADIENT OF ORGANIC CONTAMINANTS IN THE WATER COLUMN

## STUDY DESIGN

SPMDs and POCIS were suspended from a water quality monitoring station in LVB (Figure 7). They were placed in the water column at depths of 3.0, 4.7, and 6.7 m (lake bottom). Four SPMDs and six POCIS were deployed at each depth.

Figures 8-10 show the deployment and retrieval of the passive samplers.

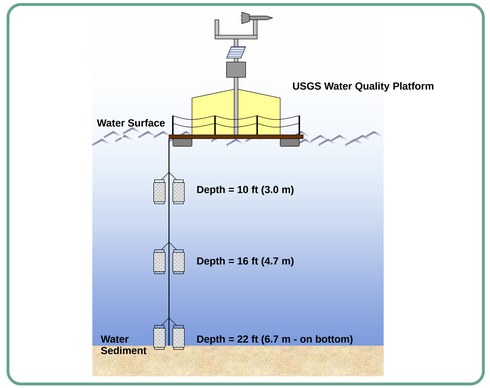


Figure 7. Representation of the vertical gradient sampling study using SPMDs and POCIS at depths of 3.0 m, 4.7 m, and 6.7 m below the water surface.

Figure 8. USGS water quality platform in Las Vegas Bay where the passive samplers were deployed.

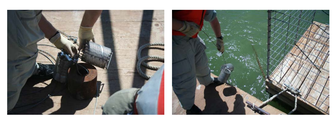

Figure 9. Securing SPMD and POCIS canisters for deployment.

Figure 10. Retrieval of SPMD and POCIS canisters.

## PROGRESS AND RESULTS

All samplers and quality control samples from the Vertical Gradient portion of the study have been extracted and are at various stages of processing and analysis. Data from completed analyses are shown below.

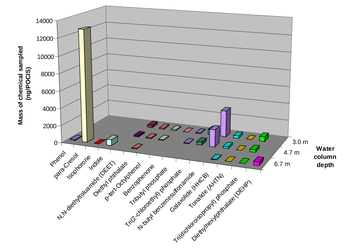


Figure 11. Distribution of OWCs in POCIS suspended in the water column.

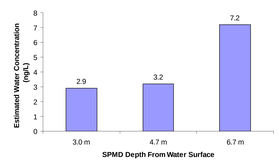


Figure 12. PAH concentrations from SPMDs suspended in the water column.

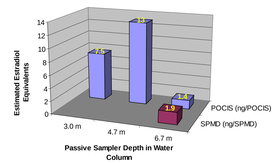


Figure 13. Estimated estradiol equivalents determined in POCIS and SPMDs suspended in the water column.

## OBSERVATIONS

Most of the OWCs were detected at the 3.0 and 4.7 m depths (Figure 11). Many of these OWCs have lower log octanol-water partition coefficients (1.6-3.5) and therefore are more water soluble.

The more hydrophobic chemicals such as phthalates and PAHs (Figures 11-12) were present at the highest concentrations at the 6.7 m depth (lake bottom).

SPMD and POCIS extracts were screened for estrogenic chemicals using the YES (Figure 13). The POCIS, which samples the more hydrophilic organic chemicals, had the highest estrogenic responses at the 3.0 and 4.7 m depths. SPMDs, which sample hydrophobic organic chemicals, were estrogenic only at the 6.7 m depth. The vertical gradient profile of the estrogenic response is in good correlation with the distribution of targeted chemicals.

## REFERENCES

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Echols, K.R., Rosen, M.R., Goodbred, S.L., Orsak, E. 2009. Endocrine Disrupting Contaminants in Common Carp from Lake Mead. Poster C3 presented at the Lake Mead Symposium, Jan 13-14, 2009.

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