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Synthetic Organic Compounds in Water and Bottom Sediment From Streams, Detention Basins, and Sewage-Treatment Plant Outfalls in Las Vegas Valley, Nevada, 1997

By Kenneth J. Covay *and* Thomas J. Leiker

Open-File Report 98-633

Prepared in cooperation with the
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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot (ft)	0.3048	meter
inch (in.)	25.40	millimeter
mile (mi)	1.609	kilometer
pound (lb)	.4536	kilogram
square mile (mi^2)	2.590	square kilometer

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929, formerly called "Sea-Level Datum of 1929"), which is derived from a general adjustment of the first-order leveling networks of the United States and Canada.

Additional abbreviation:
µg/kg (microgram per kilogram)

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ABSTRACT

The occurrence of organochlorine compounds and semivolatile organic compounds was investigated at 14 sites in the Las Vegas Valley in 1997. The investigation was a cooperative effort between the U.S. Geological Survey and the Clark County Regional Flood Control District. Semipermeable membrane devices (SPMD's) were used to sample synthetic organic compounds at five surface-water sites. Bottom-sediment samples were collected at six sites in valley streams and four sites in floodwater detention basins. One of the SPMD sites also was at a bottom-sediment site.

Compounds analyzed for include organochlorine pesticides and selected degradation products, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, phthalates, and phenols. Extracts from the SPMD's were analyzed and 18 organochlorine pesticides, compounds, and selected degradation products, and 7 polycyclic aromatic hydrocarbons (PAH's) were detected and quantified. Of the 81 targeted organic compounds, 56 were not detected in extracts from the SPMD's. In bottom-sediment samples, 11 organochlorine compounds, 20 PAH's, 6 phthalates, 5 phenols, and 11 other miscellaneous semivolatile organic compounds were detected. Of the 98 targeted organic compounds, 45 were not detected in bottom-sediment samples from the sites. In washes downstream from urban areas in Las Vegas Valley, 51 synthetic organic compounds were detected in bottom sediment. In other bottom sediment from floodwater detention basins, which generally are upstream from urban areas, only 17 compounds were detected.

INTRODUCTION

The U.S. Geological Survey (USGS), in cooperation with the Clark County Regional Flood Control District (CCRFCD), investigated the occurrence of organochlorine compounds and selected degradation products, and semivolatile organic compounds (SVOC's) in the water column and bottom sediment at 14 sites in the Las Vegas Valley (fig. 1, table 1). This investigation was initiated as a result of findings by the USGS Nevada Basin and Range (NVBR) study unit of the National Water-Quality Assessment (NAWQA) Program (Bevans and others, 1996; Neal and Schuster, 1996; Kilroy and Watkins, 1997; Kilroy and others, 1997).

Results from Bevans and others (1996) indicate that organochlorine compounds (pesticides, polychlorinated biphenyls, dioxins, and furans) and semivolatile organic compounds (polycyclic aromatic hydrocarbons, phthalates, and phenols) are present in Las Vegas Wash and Las Vegas Bay of the Colorado River system. Some of these compounds were identified in the water column, bottom sediment, or fish tissue of the common carp (*Cyprinus carpio*). Some of these organochlorine compounds and SVOC's have been linked to endocrine disruption in fish (Colburn and Clement, 1992; Colburn and others, 1993; Goodbred and others, 1997) and some are known carcinogens.

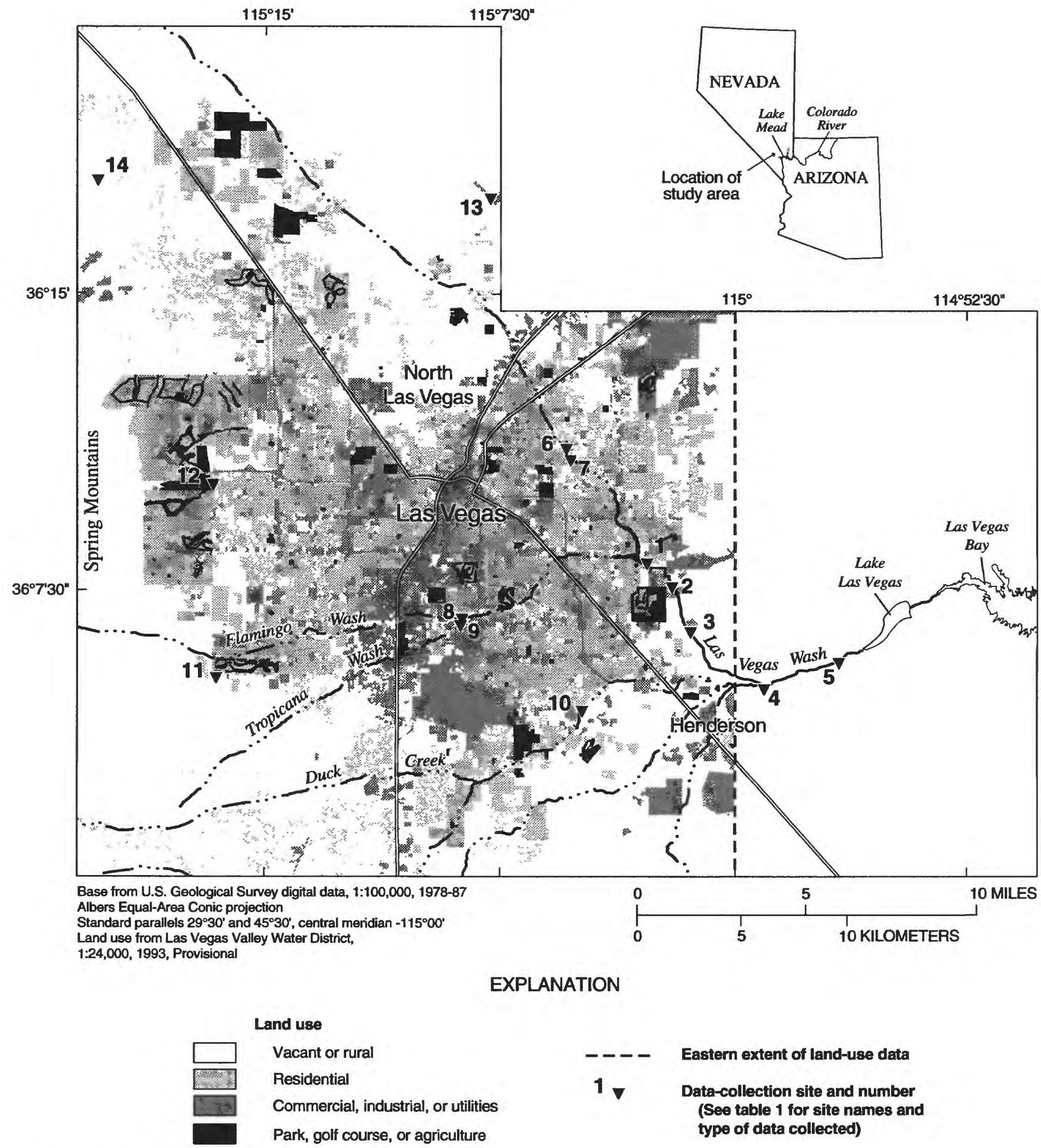

Figure 1. Sampling sites in Las Vegas Valley, Nevada, 1997.

Table 1. Sampling sites and types of samples collected for synthetic organic compounds in Las Vegas Valley, Nevada, 1997

Site number (fig. 1)	USGS site identification number [1]	Site name	Semi-permeable-membrane device	Deployment dates for semi-permeable-membrane devices	Bottom-sediment	Collection date for bottom sediment
1	094196783	Las Vegas Wash below Flamingo Wash confluence near Las Vegas	X	10-01-97 to 11-06-97	X	08-06-97
2	360747115020001	City of Las Vegas sewage treatment plant outfall	X	10-02-97 to 11-06-97		
3	360640115012501	Clark County sewage treatment plant outfall	X	10-01-97 to 11-06-97		
4	360512114590501	City of Henderson sewage treatment plant outfall	X	10-01-97 to 11-06-97		
5	09419753	Las Vegas Wash above Three Kids Wash below Henderson	X	10-02-97 to 11-06-97		
6	094196551	Las Vegas Wash at Owens Avenue			X	07-24-97
7	09419656	Las Vegas Creek above Las Vegas Wash			X	07-24-97
8	094196753	Flamingo Wash at Swenson Street			X	07-25-97
9	09419676	Tropicana Wash at Swenson Street			X	07-25-97
10	09419689	Duck Creek at Patrick Lane			X	07-24-97
11	360528115163301	Upper Flamingo Wash detention basin			X	08-12-97
12	361022115164101	Angel Park detention basin			X	08-11-97
13	361735115075001	North Las Vegas detention basin			X	08-11-97
14	361802115202001	Kyle Canyon detention basin			X	08-11-97

[1] The standard site identification is based on the grid system of latitude and longitude. The number consists of 15 digits. The first six digits denote the degrees, minutes, and seconds of latitude; the next seven digits denote the degrees, minutes, and seconds of longitude; and the last two digits (assigned sequentially) identify the sites within a 1-second grid. For example, site 360747115020001 is at 36°07′47″ latitude and 115°02′00″ longitude, and it is the first site recorded in that 1-second grid. The assigned number is retained as a permanent identifier even if a more precise latitude and longitude are later determined.

An eight-digit number is used to identify each stream-gaging station. For example, station number 09419656 consists of a two-digit part number (09) followed by a six-digit downstream-order number (419656). The part number refers to a drainage area or group of areas that is generally regional in extent. Records in this report are for sites in Part 09 (the Colorado River Basin). The downstream-order number is assigned according to the geographic location.

Numbers and combined concentrations of synthetic organic compounds in the water column were greater in Las Vegas Wash and Bay than in Calville Bay, an up-reservoir reference site in Lake Mead (Bevans and others, 1996). The most toxic synthetic organic compound detected in Las Vegas Wash was 2,3,7,8-tetrachlorodibenzofuran. The distribution of these synthetic organic compounds in Las Vegas Wash and Lake Mead indicated that Las Vegas Wash is a source of these compounds in Las Vegas Bay (Bevans and others, 1996).

Concentrations of synthetic organic compounds and SVOC's also were found in bottom sediments in Las Vegas Wash and Bay. Concentrations of these compounds decreased in Las Vegas Bay as distance from the mouth of Las Vegas Wash increased (Bevans and others, 1996).

Rapid population growth and changes in land and water use in urbanized areas such as Las Vegas Valley have increased the potential for contamination of water resources by pesticides (Kilroy and Watkins, 1997). In the United States, more than 600 million pounds of pesticides are used each year in urban and agricultural settings (U.S. Geological Survey, 1995). Possibly the greatest potential for adverse effects of pesticides is through contamination of the hydrologic system, which sustains aquatic life, human life, and related food chains (U.S. Geological Survey, 1995).

Four insecticides and four herbicides were detected in samples collected for pesticide analysis from April 1993 through March 1995 from Las Vegas Wash (Kilroy and Watkins, 1997). Metabolites of the pesticide DDT were found in bottom sediments near the mouth of Las Vegas Wash in Las Vegas Bay. A comprehensive discussion of pesticides in the water resources of Las Vegas Valley during 1969-90 is presented by Kilroy and others (1997).

The NVBR NAWQA, in conjunction with the National Park Service and U.S. Fish and Wildlife Service, investigated synthetic organic compounds in Las Vegas Wash and Las Vegas Bay and the effects that these compounds had on the endocrine systems of the common carp (Bevans and others, 1998).

In the NVBR NAWQA summary report, Bevans and others (1998, p. 3) state that in water samples from Las Vegas Wash downstream from Las Vegas urban area, the most commonly detected pesticides were simazine, prometon, diuron, dacthal, diazinon, and malathion. Volatile organic compounds, such as trihalomethanes and methyl-*tert*-butyl ether, were detected also in water samples collected from Las Vegas Wash downstream from the Las Vegas urban area. PAH's, phenols, and phthalates were commonly detected in surface-water sites downstream from the Las Vegas urban area.

Classes of hydrophobic, synthetic compounds referred to in this report include organochlorine compounds (pesticides and PCB's) and SVOC's (PAH's, phthalates, and phenols). Many of these compounds are persistent in the environment, are relatively insoluble in water, and can partition into inorganic sediment that have measurable levels of total organic carbon, non-living organic material, and lipophilic material (Smith and others, 1988; Bevans and others, 1996).

Purpose and Scope

This report presents data on hydrophobic, synthetic organic compounds in water-column and bottom-sediment samples collected in 1997 from the Las Vegas Valley Hydrographic Area[1]. Samples were collected from the water column of streams with perennial flow, including outfall sites from three sewage-treatment plants (City of Las Vegas, Clark County, and City of Henderson) and two sites on Las Vegas Wash upstream and downstream from sewage-treatment plants and industrial areas (sites 1-5, fig. 1, table 1). Samples were collected from bottom sediments of Las Vegas Wash, tributary washes, and floodwater detention basins upstream from and within the urban drainage system of Las Vegas Wash (sites 6-14, fig. 1, table 1). Samples collected from floodwater detention basins (sites 11-14) were selected to represent outlying areas and to provide background information. Urban development is minor in the drainage areas of North Las Vegas and Kyle Canyon detention basins; however, urban development is moderate in the Angel Park and Upper Flamingo Wash areas.

Environmental Setting

The Las Vegas Valley in southeastern Nevada (fig. 1) encompasses an area of about 1,640 mi^2. Altitudes range from about 11,900 ft above sea level in the headwater areas of the Spring Mountains west of Las Vegas Valley, to about 1,600 ft in Las Vegas Valley and about 1,200 ft at Lake Mead on the Colorado River. Average annual precipitation in the Las Vegas Valley ranges from more than 20 in. in the mountainous headwater areas to about 4 in. on the valley floor. Natural streamflow in the Las Vegas Valley is ephemeral. Flow in Las Vegas Wash downstream from Las Vegas, however, is perennial because of urban runoff from landscape irrigation and treated sewage effluent (Covay and others, 1996). Discharge of treated sewage to lower Las Vegas Wash has steadily

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[1]Formal hydrographic areas in Nevada were delineated systematically by the U.S. Geological Survey and Nevada Division of Water Resources in the late 1960's (Rush, 1968; Cardinalli and others, 1968) for scientific and administrative purposes. The official hydrographic-area names, numbers, and geographic boundaries continue to be used in Geological Survey scientific reports and Division of Water Resources administrative activities.

increased since the 1940's. In 1993, about 96 percent of the annual discharge into Las Vegas Wash was effluent from sewage-treatment plants (Bevans and others, 1996). The geology, climate, soils, vegetation, urbanization, and land and water use in the Las Vegas Valley area was summarized by Covay and others (1996).

In 1990, Nevada was the State with the greatest population growth, in percent, and had the fourth greatest percentage of total population residing in urban areas; about 710,000 people lived in the Las Vegas Valley (Nevada State Demographer, Bureau of Business and Economic Research, written commun., 1991).

Acknowledgments

The authors acknowledge the individuals and agencies who helped in this investigation. Kevin L. Eubanks, CCRFCD, provided cooperative and technical support. James R. Smitherman, Nevada Department of Environmental Protection, provided technical support and consultation. The Clark County Sanitation District, City of Las Vegas Department of Public Works, and the City of Henderson Utility Services Division granted permission to sample the outfall from their sewage-treatment plants.

INVESTIGATION METHODS

Two types of samples were collected and analyzed for this investigation—SPMD's and bottom sediment. SPMD's are low-density polyethylene tubes containing triolein, a fish lipid. SPMD's are an effective device for partitioning organochlorine compounds and SVOC's from water to assess the bioavailability of the compounds (Huckins and others, 1990, 1993; Ellis and others, 1995). The concentration of compounds partitioned into the SPMD's is controlled by the diffusion across the low-density polyethylene membrane. The diffusion is affected by the concentration of the compound in the water, the amount of time the SPMD has been deployed, properties of the compound, water temperature, and algal growth on the membrane. SPMD's were submerged in surface water at five locations in Las Vegas Valley (table 1) by attaching them to upright metal posts in the channel bottom. They were deployed for 5 weeks, from early October to mid-November 1997.

Organochlorine compounds and SVOC's were extracted from the SPMD's by dialysis using an organic solvent and then further purified by gel permeation chromatography at Environmental Sampling Technologies (Bevans and others, 1996). Extracts from SPMD's were concentrated with nitrogen at ambient temperature conditions. Two methods—gas chromatography with electron-capture, negative-ion mass spectrometry, and gas chromatography with electron-ionization mass spectrometry—were used to analyze the extracts at the USGS National Water Quality Laboratory (Arvada, Colo.). Concentrations of compounds from SPMD's are used to indicate the presence of these compounds and their relative concentrations at the different sampling sites.

Bottom-sediment samples were collected and field processed in accordance with NAWQA protocols (Shelton and Capel, 1994). Compounds in samples were analyzed in the clay-, silt-, and sand-size particles smaller than 2.0 millimeters. The samples were analyzed for dry-weight concentrations of organochlorines (Foreman and others, 1995) and SVOC's (Furlong and others, 1996) at the USGS National Water Quality Laboratory.

OCCURRENCE OF SYNTHETIC ORGANIC COMPOUNDS

Organochlorine compounds include chlorinated pesticides and selected degradation products, and PCB's. PCB's have been used as plasticizers and hydraulic lubricants, in heat-transfer systems, and in electrical capacitors and transformers (Smith and others, 1988). SVOC's include PAH's, phthalates, and phenols. PAH's originate from anthropogenic and natural sources. Mainly, PAH's are produced by high-temperature reactions such as incineration or fires; however, some are produced commercially for use in pesticides, resins, dyes, cutting fluids, solvents, and lubricants (Smith and others, 1988). Phthalates are used as plasticizers to manufacture products from polymers of vinyl chloride, propylene, styrene, and ethylene (Smith and others, 1988). Phenols are used to manufacture phenolic resins, herbicides, pharmaceuticals, dyes, plastics, and explosives (Smith and others, 1988).

Surface Water

SPMD's were deployed to sample the water column at two sites on Las Vegas Wash and at three treated-sewage sites tributary to Las Vegas Wash (sites 1-5, table 1). A total of 18 different organochlorine compounds were detected at these five sites (table 2). Organochlorine compounds detected at all five sites (table 2) were *cis*-chlordane, *cis*-nonachlor, dieldrin, endosulfan-I, *gamma*-HCH, heptachlor epoxide, hexachlorobenzene, pentachloroanisole, *trans*-chlordane, and *trans*-nonachlor. The greatest number of organochlorine compounds and degradation products detected (17) occurred at sites 2 and 3. The other sites had similar number of detections also—16 at site 4, 13 at site 5, and 11 at site 1. The organochlorine compound with the greatest concentration, *p,p'*-DDE (380 µg/kg), was detected in the sample from site 5 (table 2).

Seven different PAH's were detected in the SPMD's at the five sites (table 3). The seven PAH's were 1,2-dimethylnaphthalene, 1,6-dimethylnaphthalene, 2,6-dimethylnaphthalene, 2-ethylnaphthalene, fluoranthene, 9H-fluorene, and pyrene. All seven PAH's were detected at site 2, five at sites 1 and 3, four at site 4, and one at site 5 (table 3). The PAH with the greatest concentration, 2-ethylnaphthalene (160 µg/kg), was detected in the sample from site 3 (table 3).

An additional 57 synthetic organic compounds (table 4) were detected in the SPMD extracts, but could not be quantified due to the lack of authentic standards. Of the 81 targeted synthetic organic compounds, 56 were not detected in the SPMD extracts (table 5).

Organochlorine compounds and PAH's detected in SPMD's at sites 1-5 are summarized in table 6 by the total number of quantified compounds detected, the compound with the maximum concentration, and the corresponding maximum concentration. A total of 25 targeted organic compounds were detected and quantified in extracts from the SPMD's (table 6). The maximum number of quantified compounds detected in a SPMD extract was 24, at site 2. The minimum number was 14, at site 5.

Bottom Sediment

Bottom-sediment samples were collected from Las Vegas Wash (sites 1 and 6), other surface-water sites (sites 7-10), and outlying floodwater detention basins (sites 11-14; table 1). Compounds detected in bottom sediments from stream and detention-basin sites included organochlorine compounds and SVOC's (tables 7-11). A total of 53 synthetic organic compounds were detected in bottom-sediment samples from these sites. In washes downstream from urban areas in Las Vegas Valley, 51 synthetic organic compounds were detected in bottom sediment. In other bottom sediment from floodwater detention basins, which generally are upstream from urban areas, only 17 compounds were detected. In the following discussion, concentrations of these compounds in bottom sediment are expressed as dry weight.

Eleven organochlorine compounds (pesticides, pesticide degradation products, and polychlorinated biphenyls) were detected in bottom-sediment samples (table 7). The greatest number of organochlorine compounds (10) was detected in samples from sites 6 and 7. The greatest concentration was total PCB's, which was estimated at 49 µg/kg in the sample from site 8 (table 7).

Twenty PAH's were detected in bottom-sediment samples (table 8). The greatest concentrations of most PAH's (table 8) were detected in the sample from site 8. These included benzo[*b*]fluoranthene (1,900 µg/kg), benzo[*a*]pyrene (1,100 µg/kg), chrysene (1,500 µg/kg), flouranthene (6,000 µg/kg), and pyrene (4,700 µg/kg).

Six phthalates were detected in bottom-sediment samples (table 9). Bis(2-ethylhexyl) phthalate had a detected concentration of 93,000 µg/kg at site 8 and 8,600 µg/kg at site 7.

Five phenols were detected in bottom-sediment samples (table 10). The phenolic compound *p*-cresol was detected at 1,000 µg/kg in the sample from site 8.

Eleven miscellaneous SVOC's were detected in bottom-sediment samples (table 11). At site 1 these compounds were all below detection levels. The greatest number of these compounds (6) occurred at site 7. The compound 9,10-anthraquinone was detected at 200 µg/kg and carbazole was detected at 130 µg/kg in the sample from site 8.

Concentrations of organochlorine compounds and SVOC's detected in bottom-sediment samples from the four floodwater detention basins (sites 11-14, table 1) are listed in tables 7-11 also. The greatest number of synthetic organic compounds detected (11) was at site 12. The only organochlorine compounds detected in bottom-sediment samples from the detention basins were hexachlorobenzene (site 13) and *p,p'*-DDE (sites 12 and 14, table 7). Six PAH's, six phthalates, two phenols, and 2,6-dinitrotoluene were detected in bottom-sediment samples from the detention basins. Bis(2-ethylhexyl) phthalate, at site 12, had a concentration of 200 µg/kg (table 9). Pentachlorophenol was present at an estimated concentration of 220 µg/kg at site 11 and 200 µg/kg at site 14 (table 10). At site 13, only 2,6-dinitrotoluene was present at 260 µg/kg (table 11).

Of the 98 targeted synthetic organic compounds, 45 were not detected in bottom-sediment sampling sites in the Las Vegas Valley (table 12).

The number of synthetic organic compounds detected in bottom-sediment samples at sites 1 and 6-14 are summarized in table 13 by the total number of compounds detected, the compound with the maximum concentration, and the corresponding maximum concentration. The maximum number of synthetic organic compounds detected in bottom-sediment samples was 36 from site 7. The minimum number detected was five from site 10. Bis(2-ethylhexyl) phthalate was the phthalate with the maximum concentration at all bottom-sediment sites.

SUMMARY

The occurrence of synthetic organochlorine compounds and SVOC's was investigated in the Las Vegas Valley at 14 sites in 1997 as a cooperative effort between the U.S. Geological Survey and the Clark County Regional Flood Control District. Hydrophobic synthetic organic compounds were sampled at five surface-water sites using SPMD's. Three sites were at the three sewage-treatment plant outfalls to Las Vegas Wash, and two sites were on Las Vegas Wash itself. Bottom sediment was sampled at 10 sites in Las Vegas Valley. Six of these were stream sites and four were floodwater detention basins in outlying areas. One of the SPMD sites also was at a bottom-sediment site.

The compounds analyzed for at stream sites were organochlorine compounds (pesticides, selected pesticide degradation products, and PCB's) and SVOC's (PAH's, phthales, and phenols). A total of 18 organochlorine pesticides, compounds, and degradation products and 7 PAH's were detected and quantified in extracts from the SPMD's. The organochlorine pesticide *p,p'*-DDE was present at 380 µg/kg at site 5. The PAH 2-ethylnaphthalene was present at 160 µg/kg at site 3. An additional 57 synthetic organic compounds were detected but could not be quantified due to the lack of authentic standards. Of the 81 targeted organic compounds, 56 were not detected in extracts from the SPMD's. In washes downstream from urban areas in Las Vegas Valley, 51 synthetic organic compounds were detected in bottom sediment. In other bottom sediment from floodwater detention basins, which generally are upstream from urban areas, only 17 compounds were detected.

In bottom-sediment samples, 11 organochlorine compounds, 20 PAH's, 6 phthalates, 5 phenols, and 11 other miscellaneous SVOC's were detected. Total PCB's were detected at an estimated concentration of 49 µg/kg at site 8. At site 8, fluoranthene was present at 6,000 µg/kg, bis(2-ethylhexyl) phthalate was present at 93,000 µg/kg, and *p*-cresol was present at 1,000 µg/kg. The compound 2,6-dinitrotoluene was present at 260 µg/kg at site 13. Of the 98 targeted organic compounds, 45 were not detected in bottom-sediment samples from the sites.

REFERENCES CITED

Bevans, H.E., Goodbred, S.L., Miesner, J.F., Watkins, S.A., Gross, T.S., Denslow, N.D., and Schoeb, T., 1996, Synthetic organic compounds and carp endocrinology and histology in Las Vegas Wash and Las Vegas and Callville Bays of Lake Mead, Nevada, 1992 and 1995: U.S. Geological Survey Water-Resources Investigation Report 96-4266, 12 p.

Bevans, H.E., and Kilroy, K.C., 1991, National Water-Quality Assessment Program—Nevada Basin and Range: U.S. Geological Survey Open-File Report 91-154, 2 p. (Water Fact Sheet).

Bevans, H.E., Lico M.S., and Lawrence, S.J., 1998, Water quality in the Las Vegas Valley area and the Carson and Truckee River Basins, Nevada and California, 1992-96: U. S. Geological Survey Circular 1170, 47 p.

Cardinalli, J.L., Roach, L.M., Rush, F.E., and Vasey, B.J., comps., 1968, State of Nevada hydrographic areas: Nevada Division of Water Resources map, scale 1:500,000.

Colburn, Theo, and Clement, Coralie, eds., 1992, Chemically induced alterations in sexual and functional development—The wildlife/human connection: Princeton, N.J., Princeton Scientific Publishing Co., Advances in Modern Environmental Toxicology, v. 21, 7 p.

Colburn, Theo, Von Saal, F.S., and Soto, A.M., 1993, Developmental effects of endocrine disrupting chemicals on wildlife and humans: Environmental Health Perspectives, v. 101, no. 5, p. 378-384.

Conner, B.F., Rose, D.L., Noriega, M.C., Murtagh, L.K., and Abney, S.R., 1998, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of 86 volatile organic compounds in water by gas chromatography/mass spectrometry, including detections less than reporting limit: U.S. Geological Survey Open-File Report 97-829, 76 p.

Covay, K.J., Banks, J.M., Bevans, H.E., and Watkins, S.A.,1996, Environmental and hydrologic settings of the Las Vegas Valley area and the Carson and Truckee River Basins, Nevada and California: U. S. Geological Survey Water-Resources Investigations Report 96-4087, 72 p.

Ellis, G.S., Huckins, J.N., Rostad, C.E., Schmitt, C.J., Petty, J.D., and MacCarthy, Patrick, 1995, Evaluation of lipid-containing semipermeable membrane devices for monitoring organochlorine contaminants in the upper Mississippi River: Environmental Toxicology and Chemistry, v. 14, no. 11, p. 1875-1884.

Foreman, W.T., Conner, B.F., Furlong, E.T., Vaught, D.G., and Merten, L.M., 1995, Methods on analysis by the U. S. Geological Survey National Water Quality Laboratory—Determination of organochlorine pesticides and polychlorinated biphenyls in bottom sediment by duel capillary-column gas chromatography with electron-capture detection: U.S. Geological Survey Open-File Report 95-140, 78 p.

Furlong, E.T., Vaught, D.G., Merten, L.M., Foreman, W.T., and Gates, P.M., 1996, Methods of analysis by the U. S. Geological Survey National Water Quality Laboratory—Determination of semivolatile organic compounds in bottom sediment by solvent extraction, gel permeation chromatographic fractionation, and capillary-column gas chromatography-mass spectrometry: U. S. Geological Survey Open-File Report 95-719, 67 p.

Goodbred, S.L., Gilliom, R.J., Gross, T.S., Denslow, N.P., Bryant, W.L., and Schoeb, T.R., 1997, Reconnaissance of 17β-estradiol, 11-ketotestosterone, vitellogenin, and gonad histopathology in common carp of United States streams—Potential for contaminant-induced endocrine disruption: U. S. Geological Survey Open-File Report 96-627, 47 p.

Huckins, J.N., Manuweera, G.K., Petty, J.D., Mackey, D., and Lebo, J.A., 1993, Lipid-containing semipermeable membrane devices for monitoring organic contaminants in water: Environmental Science and Technology, v. 27, no. 12, p. 2489-2496.

Huckins, J. N., Tubergen, M. W., and Manuweera, G. K.,1990, Semipermeable membrane devices containing model lipid—A new approach to monitoring the bioavailability of lipophilic contaminants and estimating their bioconcentration potential: Chemosphere, v. 20, no. 5, p. 533-552.

Kilroy, K.C., Lawrence, S.J., Lico, M.S., Bevans, H.E., and Watkins, S.A., 1997, Water-quality assessment of the Las Vegas Valley area and the Carson and Truckee River Basins, Nevada and California—Nutrients, pesticides, and suspended sediment, October 1969-April 1990: U. S. Geological Survey Water-Resources Investigations Report 97-4106, 144 p.

Kilroy, K.C., and Watkins, S.A., 1997, Pesticides in surface water, bottom sediment, crayfish, and shallow ground water in Las Vegas Valley area, Carson River Basin, and Truckee River Basin, Nevada and California, 1992-95: U.S. Geological Survey Fact Sheet FS-075-97, 6 p.

Neal, E.G., and Schuster, P.F., 1996, Data on quality of shallow ground water, Las Vegas urban area, Nevada, 1993: U.S. Geological Survey Open-File Report 96-552, 1 sheet.

Rush, F.E., 1968, Index of hydrographic areas in Nevada: Nevada Division of Water Resources, Information Report 6, 38 p.

Shelton, L.R., and Capel, P.D., 1994, Guidelines for collecting and processing samples of streambed sediment for analysis of trace elements and organic contaminants for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 94-458, 20 p.

Smith, J.A., Witkowski, P.J., and Fusillo, T.V., 1988, Manmade organic compounds in the surface water of the United States—A review of current understanding: U.S. Geological Survey Circular 1007, 92 p.

U.S. Geological Survey, 1995, Pesticides in the atmosphere—Current understanding of distribution and major influences: U.S. Geological Survey Fact Sheet FS-152-95, 6 p.

Table 2. Organochlorine pesticides, compounds, and degradation products detected in semipermeable membrane devices at surface-water sampling sites in Las Vegas Valley, Nevada, 1997

[Concentrations in micrograms per kilogram; ND, not detected]

Site no. (fig. 1, table 1)	*alpha*-HCH	*cis*-Chlordane	*trans*-Chlordane	Dacthal	*p,p'*-DDE	*p,p'*-DDT
1	ND	19	16	0.4	ND	ND
2	3	72	71	9.1	97	24
3	3	77	84	0.9	19	34
4	1.7	18	19	1.7	210	ND
5	100	110	2.2	ND	380	ND

Site no. (fig. 1, table 1)	Dieldrin	Endo-sulfan-I	Endo-sulfan-II	Endo-sulfan-sulfate	Endrin	*gamma*-HCH
1	58	0.9	ND	ND	ND	6.9
2	60	4.7	2.6	4.3	2.6	120
3	80	4.7	1.3	0.9	ND	240
4	30	1.7	0.9	0.9	ND	99
5	72	0.4	0.9	ND	ND	100

Site no. (fig. 1, table 1)	Heptachlor	Heptachlor epoxide	Hexa-chlorobenzene	*cis*-Nonachlor	*trans*-Nonachlor	Penta-chloroanisole
1	ND	6.5	5.6	3.4	11	18
2	ND	15	24	6.0	35	99
3	18	16	48	5.6	21	130
4	2.2	13	260	1.3	6.9	130
5	ND	9.9	92	18	52	73

Table 3. Polycyclic aromatic hydrocarbons detected in semipermeable membrane devices at surface-water sampling sites in Las Vegas Valley, Nevada, 1997

[Concentrations in micrograms per kilogram; ND, not detected]

Site no. (fig. 1, table 1)	1,2-Dimethyl-naphthalene	1,6-Dimethyl-naphthalene	2,6-Dimethyl-naphthalene	2-Ethyl-naphthalene
1	ND	14	ND	37
2	38	36	84	130
3	ND	22	ND	160
4	ND	3.3	ND	ND
5	ND	ND	ND	0.4

Site no. (fig. 1, table 1)	Fluor-anthene	9H-Fluorene	Pyrene
1	13	5.9	37
2	62	26	140
3	30	25	150
4	79	4.8	68
5	ND	ND	ND

Table 4. Synthetic organic compounds detected, but not quantifiable, in semipermeable membrane devices at surface-water sampling sites in Las Vegas Valley, Nevada, 1997. Number(s) in parenthesis indicate site(s) where compound was detected.

Acetylethyl tetramethyltetralin (2, 3, 4, 5)	Dimethyl phenanthrene (1, 2, 3)	Nonanal (1, 2)
Adamantane (4)	Dimethyl-(phenylmethyl) benzene (3)	Nonanoic acid (1)
Amino pteridinone (4)	*cis,cis*-Dimethylspirodecane (2)	Octadecanoic acid (5)
Bromo tetramethyl benzene (4)	*cis,trans*-Dimethylspirodecane (3)	Octahydrodimethyl naphthalene (1)
Butenylbenzene (2)	Dimethyltrichloroanisole (2, 4)	Octahydro tetramethyl methanoazulen (2)
Butenyl cycloheptadiene (1)	Diphenylmethyl pentene (3)	Octanoic acid (1, 5)
Chlorpyrifos (2)	Dodecamethyl cyclohexasiloxane (1, 3)	Octyl cyclopropane (2)
(Chloromethyl)-trimethyl benzene (4)	Dodecane (1, 2)	Pentadecane (1, 2)
Decamethyl cyclopentasiloxane (1, 2, 5)	Dodecanoic acid (1, 3, 4, 5)	Tetradecane (1)
Decahydrodimethyl naphthalene (2, 3, 4)	Ethyl biphenyl (3)	Tetradecanoic acid (1)
Decahydromethyl naphthalene (1, 2, 3, 4)	Ethyldimethyl azulene (2)	Tetrahydrodimethyl napthalene (2)
Decahydronaphthalene (4)	Hexadecane (1)	Tetrahydrotrimethyl naphthalene (2, 3)
Decahydropentamethylnapthalene (4)	Hexadecanoic acid (1, 5)	Tetramethylacenaphthylene (2, 3)
N,N-Dibutyl formamide (1)	Hyroxymethyl-1,4-naphthalenedione (3)	Tetramethyl benzene (2)
Diethylmethyl cyclohexanae (4)	Indenothienothiopyran (2)	Trimethyl (methylpropenyl) cyclopentane (4)
Dihydrotrimethyl-1H-indene (2, 3)	Methoxy-(phenylmethoxy)-1H-indole (4)	Trimethylnaphthalene (3)
Dimethyl adamantane (4)	Methylene-bis(chloro) benzene (5)	Undecane (1, 2)
Dimethylbiphenyl (1, 2, 3)	Methyl-(methylethyl) naphthalene (2)	
Dimethylnaphthalene (1, 2, 3)	Methylnaphthalene (1)	
Dimethyl-9H-flourene (2, 3)	Methylpheneanthrene (3)	

Table 5. Targeted synthetic organic compounds not detected in semipermeable membrane devices at surface-water sampling sites in Las Vegas Valley, Nevada, 1997

Acenaphthylene	C8-Alkylphenol	1-Methyl-9H-fluorene
Acenaphthene	Dibenz[*a,h*]anthracene	1-Methylphenanthrene
Acridine	Dibenzothiophene	1-Methylpyrene
Anthracene	2,4-Dichlorophenol	Mirex
Anthraquinone	Diethyl phthalate	Naphthalene
Benz[*a*]anthracene	2,4-Dinitrotoluene	Nitrobenzene
Benzo[*a*]pyrene	2,6-Dinitrotoluene	2-Nitrophenol
Benzo[*b*]fluoranthene	4,6-Dinitro-2-methylphenol	*N*-Nitrosodiphenylamine
Benzo[*c*]cinnoline	Di-*n*-butylphthalate	Pentachloroanisole
Benzo[*g,h,i*]perylene	Di-*n*-octylphthalate	Pentachlorophenol
Benzo[*k*]fluoranthene	Endrin-aldehyde	Phenthracene
2,2'-Biquinoline	bis (2-Ethylhexyl) phthalate	Phenanthridine
4-Bromophenyl-phenylether	*delta*-HCH	Quinoline
Butylbenzylphthalate	Hexachlorobutadiene	1,2,4-Trichlorobenzene
9H-Carbazole	Hexachlorocyclopentadiene	2,4,6-Trichlorophenol
		2,3,6-Trimethylnaphthalene
4-Chloro-3-methylphenol	Hexachloroethane	
bis (2-Chloroethoxy) methane	Indeno[1,2,3-*c,d*]pyrene	
bis (2-Chloroisopropyl) ether	Isophorone	
2-Chloronaphthalene	Isoquinoline	
Chrysene	2-Methylanthracene	

Table 6. Summary of synthetic organic compounds and maximum concentrations detected in semipermeable membrane devices at surface-water sampling sites in Las Vegas Valley, Nevada, 1997

[Abbreviations and symbols: µg/kg; micrograms per kilogram]

Site no. (fig. 1, table 1)	Number of compounds detected and quantified	Compound(s) with maximum concentration quantified at each site			
		Organochlorine	Concentration (µg/kg)	Polycyclic aromatic hydrocarbons	Concentration (µg/kg)
1	16	Dieldrin	58	2-Ethylnaphthalene	37
				Pyrene	37
2	24	*gamma*-HCH	120	Pyrene	140
3	22	*gamma*-HCH	240	2-Ethylnaphthalene	160
4	20	Hexachlorobenzene	260	Fluoranthene	79
5	14	*p,p'*-DDE	380	2-Ethylnaphthalene	0.4

Table 7. Organic carbon, organochlorine pesticides, compounds, degradation products, and polychlorinated biphenyls detected in bottom-sediment sampling sites in Las Vegas Valley, Nevada, 1997

[Concentrations of compounds determined on clay-, silt-, and sand-size particles in less-than-2-millimeter fraction and reported in micrograms per kilogram. Abbreviations; E, estimated [1], ND, not detected]

Site no. (fig.1, table1)	Organic carbon	*cis*-Chlordane	*trans*-Chlordane	Dacthal	*p,p'*-DDD	*p,p'*-DDE	*p,p'*-DDT	Dieldrin	Hexa-chloro-benzene	*cis*-Nonachlor	*trans*-Nonachlor	Total polychlorinated biphenyls
						Stream Sites						
1	9	E0.7	E0.8	<5	<1	E0.7	<2	1.3	<1	<1	E0.8	<50
6	8	3	3.4	<5	E0.8	1.4	2.8	E0.6	E0.4	E0.6	2.4	E29
7	10	3	2.9	<5	E0.8	3.3	2.2	E0.7	1	E0.7	2.1	E32
8	29	2	E0.4	<5	E0.6	2	<2	1.4	<1	E0.6	1.7	E49
9	20	E0.5	E0.8	E4	<1	E0.5	<2	<1	E0.6	<1	E0.6	E18
10	16	<1	<1	<5	<1	E0.3	<2	<1	<1	<1	<1	<50
						Detention Basin Sites						
11	10	<1	<1	<5	<1	<1	<2	<1	<1	<1	<1	<50
12	14	<1	<1	<5	<1	E0.9	<2	<1	<1	<1	<1	<50
13	9	<1	<1	<5	<1	<1	<2	<1	2.2	<1	<1	<50
14	22	<1	<1	<5	<1	E0.8	<2	<1	<1	<1	<1	<50

[1] When an "E" is reported, the compound has passed all criteria used to identify its presence, and only the concentration is estimated (Conner and others, 1998).

Table 8. Polycyclic aromatic hydrocarbons detected at bottom-sediment sampling sites in Las Vegas Valley, Nevada, 1997

[Concentrations of compounds determined on clay-, silt-, and sand-size particles in less-than-2-millimeter fraction and reported in micrograms per kilogram. Abbreviations; E, estimated [1], ND, not detected]

Site no. (fig. 1, tab.1)	Ace-naph-thy-lene	Anthra-cene	Benz [a] anthra-cene	Benzo [b] fluor-an-thene	Benzo [k] flour-an-thene	Benzo [a] pyrene	Benzo [g,h,i] pery-lene	Chry-sene	Di-benz [a,h] anthra-cene	1,2-Di-methyl-naph-thalene	1,6-Di-methyl-naph-thalene	2,6-Di-methyl-naph-thalene	Fluor-an-thene	9-H-Fluor-ene)	In-deno-[1,2,3-cd] pyrene)	1-Methyl-pyrene	4,5-Methyl-ene-phen-anth-rene	Naph-tha-lene	Phen-an-threne	Py-rene
Stream Sites																				
1	<50	E9.5	E22	E32	E29	E25	<50	E30	<50	<50	<50	E22	E41	<50	E32	<50	<50	<50	E15	E42
6	<50	E22	E36	63	E33	E46	E42	58	<50	<50	<50	<50	67	<50	E33	E8.4	<50	<50	E43	69
7	<50	E33	92	180	92	130	91	150	<50	E13	<50	E44	240	<50	79	<50	<50	E20	120	250
8	E24	140	660	1,900	630	1,100	420	1,500	150	<50	E48	180	6,000	E41	430	140	150	68	630	4,700
9	<50	<50	75	150	70	110	77	150	<50	<50	<50	130	150	<50	68	<50	<50	<50	E47	160
10	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	140	<50	<50	<50	<50	<50	<50	<50	<50
Detention Basin Sites																				
11	<50	<50	<50	<50	<50	E9.1	<50	<50	<50	<50	<50	<50	E14	<50	<50	<50	<50	<50	<50	E10
12	<50	<50	<50	<50	<50	<50	<50	E10	<50	<50	<50	<50	E13	<50	<50	<50	<50	<50	E7.8	E11
13	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	E10	<50	<50	<50	<50	<50	<50	E6.7
14	E4.5	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50

[1] When an "E" is reported, the compound has passed all criteria used to identify its presence, and only the concentration is estimated (Conner and others, 1998).

Table 9. Phthalates detected at bottom-sediment sampling sites in Las Vegas Valley, Nevada, 1997

[Concentrations of compounds determined on clay-, silt-, and sand-size particles in less-than-2-millimeter fraction and reported in micrograms per kilogram. Abbreviations; E, estimated [1], ND, not detected]

Site no. (fig. 1, table 1)	*bis* (2-Ethylhexyl) phthalate	Butylbenzyl-phthalate	Di-*n*-butyl-phthalate	Diethyl-phthalate	Dimethyl-phthalate	Di-*n*-octyl-phthalate
			Stream Sites			
1	350	E23	E28	E10	<50	E39
6	1,000	<50	61	<50	<50	60
7	8,600	120	85	<50	<50	230
8	93,000	130	200	<50	<50	460
9	1,000	82	65	<50	<50	110
10	710	<50	<50	<50	<50	<50
			Detention Basin Sites			
11	E30	E26	E29	E10	<50	<50
12	200	E23	E38	E11	<50	E32
13	E36	E21	E31	E11	E6.8	<50
14	E30	E18	E29	E12	<50	<50

[1] When an "E" is reported, the compound has passed all criteria used to identify its presence, and only the concentration is estimated (Conner and others, 1998).

Table 10. Phenols detected at bottom-sediment sampling sites in Las Vegas Valley, Nevada, 1997

[Concentrations of compounds determined on clay-, silt-, and sand-size particles in less-than-2-millimeter fraction and reported in micrograms per kilogram. Abbreviations; E, estimated [1], ND, not detected]

Site no. (fig. 1, table 1)	*p*-Cresol	3,5-Dimethyl-phenol	Penta-chloro-phenol	Phenol	2,4,6-Tri-chloro-phenol
			Stream Sites		
1	<50	<50	ND	E25	ND
6	<50	E12	ND	E24	ND
7	E45	<50	ND	E35	ND
8	1,000	<50	ND	120	ND
9	<50	<50	ND	<50	ND
10	<50	<50	ND	<50	E17
			Detention Basin Sites		
11	<50	<50	E220	<50	ND
12	<50	<50	ND	E17	ND
13	<50	<50	ND	<50	ND
14	<50	<50	E200	E7.0	ND

[1] When an "E" is reported, the compound has passed all criteria used to identify its presence, and only the concentration is estimated (Conner and others, 1998).

Table 11. Miscellaneous semivolatile organic compounds detected at bottom-sediment sampling sites in Las Vegas Valley, Nevada, 1997

[Concentrations of compounds determined on clay-, silt-, and sand-size particles in less-than-2-millimeter fraction and reported in micrograms per kilogram. Abbreviations; E, estimated [1], ND, not detected]

Site no. (fig. 1, tabie 1)	9,10-Anthraquinone	bis (2-Chloroisopropyl) ether	Carbazole	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Hexachloroethane	*N*-Nitrosodi-*n*-propylamine	*N*-Nitrosodiphenylamine	Phenanthridine	Quinoline	2,6-Dinitrotoluene
Stream Sites											
1	<50	ND	<50	<50	<50	ND	<50	<50	<50	<50	<50
6	<50	ND	<50	<50	<50	ND	<50	E11	<50	<50	E22
7	<50	ND	<50	E27	E45	E11	E18	<50	62	<50	E30
8	200	ND	130	<50	<50	ND	<50	<50	<50	<50	<50
9	<50	ND	<50	<50	<50	ND	<50	E11	<50	E15	<50
10	<50	E19	<50	<50	<50	ND	<50	<50	<50	<50	<50
Detention Basin Sites											
11	<50	ND	<50	<50	<50	ND	<50	<50	<50	<50	<50
12	<50	ND	<50	<50	<50	ND	<50	<50	<50	<50	<50
13	<50	ND	<50	<50	<50	ND	<50	<50	<50	<50	260
14	<50	ND	<50	<50	<50	ND	<50	<50	<50	<50	<50

[1] When an "E" is reported, the compound has passed all criteria used to identify its presence, and only the concentration is estimated (Conner and others, 1998).

Table 12. Targeted synthetic organic compounds not detected at bottom-sediment sampling sites in Las Vegas Valley, Nevada, 1997

Acenaphthene	*m*-Cresol	Lindane
Acridine	*o,p'*-DDD	2-Methylanthracene
Aldrin	*o,p'*-DDE	1-Methylphenanthrene
Azobenzene	*o,p'*-DDT	*o,p'*-Methoxychlor
Benzo[*c*]cinnoline	Dibenzothiophene	*p,p'*-Methoxychlor
alpha-BHC	*o*-Dichlorobenzene	Mirex
beta-BHC	2,4-Dinitrotoluene	Nitrobenzene
4-Bromophenyl-phenylether	Endosulfan-I	Oxychlordane
2,2'-Biquinoline	Endrin	Pentachloroanisole
C8-Alkylphenol	9H-Fluorene	Pentachloronitrobenzene
bis (2-Chloroethoxy) methane	Heptachlor	*cis*-Permethrin
2-Chloronaphthalene	Heptachlor epoxide	*trans*-Permethrin
Chloroneb	Isodrin	Toxaphene
2-Chlorophenol	Isophorone	1,2,4-Trichlorobenzene
4-Chlorophenyl-phenylether	Isoquinoline	2,3,6-Trimethylnapthalene

Table 13. Summary of synthetic organic compounds and maximum concentrations detected in bottom-sediment samples, Las Vegas Valley, Nevada, 1997

[Concentrations of compounds determined on clay-, silt-, and sand-size particles in less-than-2-millimeter fraction and reported in micrograms per kilogram. Abbreviations; E, estimated [1], ND, not detected]

Site no. (fig. 1, table 1)	Number of organic compounds detected	Compound with maximum concentration quantified at each site									
		Organochlorine	Concentration	Polycyclic aromatic hydrocarbon	Concentration	Phthalate	Concentration	Phenol	Concentration	Miscellaneous semivolatile organic compound	Concentration
						Stream Sites					
1	22	Dieldren	1.3	Pyrene	E42	bis(2-Ethylhexyl) phthalate	350	Phenol	E25	ND	--
6	29	Polychlorinated biphenyls	E29	Pyrene	69	bis(2-Ethylhexyl) phthalate	1,000	Phenol	E24	2,6-Dinitrotoluene	E22
7	36	Polychlorinated biphenyls	E32	Pyrene	250	bis(2-Ethylhexyl) phthalate	8,600	*p*-Cresol	E45	Phenanthridine	62
8	35	Polychlorinated biphenyls	E49	Fluoranthene	6,000	bis(2-Ethylhexyl) phthalate	93,000	*p*-Cresol	1,000	9,10-Anthraquinone	200
9	24	Polychlorinated biphenyls	E18	Pyrene	160	bis(2-Ethylhexyl) phthalate	1,000	ND	--	Quinoline	E15
10	5	*p,p'*-DDE	E0.3	2,6-Dimethyl-naphthalene	140	bis(2-Ethylhexyl) phthalate	710	2,4,6-Trichloro-phenol	E17	bis(2-Chloro-isopropyl) ether	E19
						Detention Basin Sites					
11	8	ND	--	Fluoranthene	E14	bis(2-Ethylhexyl) phthalate	E30	Pentachloro-phenol	E220	ND	--
12	11	*p,p'*-DDE	E0.9	Fluoranthene	E13	bis(2-Ethylhexyl) phthalate	200	Phenol	E17	ND	--
13	9	Hexachloro-benzene	2.2	Fluoranthene	E10	bis(2-Ethylhexyl) phthalate	E36	ND	--	2,6-Dinitrotoluene	260
14	8	*p,p'*-DDE	0.8	Acenaphthylene	4.5	bis(2-Ethylhexyl) phthalate	E30	Pentachloro-phenol	200	ND	--

[1] When an "E" is reported, the compound has passed all criteria used to identify its presence, and only the concentration is estimated (Conner and others, 1998).