CHAPTER IX

THE DETROIT RIVER

A. STATUS OF THE ECOSYSTEM

1. Ecological Profile

Watershed Characteristics

The Detroit River makes up the lower 51 km of the connecting channels between Lakes Huron and Erie. An international boundary divides the Detroit River about equally into United States (Michigan) and Canadian (Ontario) waters (Figures II-5 and IX-1).

The Detroit River is a hydrologically and ecologically distinct ecosystem compared to Lake St. Clair and the St. Clair River (1). It is limnologically mesotrophic and supports cold water fish from September to June. The Detroit River provides important habitat for fish, birds and the bottom dwelling life on which they feed. It is also an important source of potable water, with drinking water intakes near Belle Isle, Windsor, Amherstburg and Wyandotte (2). Water is also used to supply a major industrial complex consisting of automobile, steel and chemical companies.

The St. Lawrence Seaway utilizes the Detroit River for commercial shipping. This portion of the Seaway is presently the busiest in the upper Great Lakes, involving shipments of iron ore, coal, limestone, gypsum, oil, and wheat.

The topography of the Detroit River basin is flat, broken only by the valleys of the Rouge River and a few lesser tributaries. Low moraine deposits and beach ridges of ancestral Lake Erie provide slight relief. Land elevations range from 214 m above sea level near the tributary head waters to approximately 174 m along the Detroit River. The relative relief of the lake plain is 1 to 5 m/km^3, and most slopes are less than 3%.

The Detroit River courses through Pleistocene glacial drift

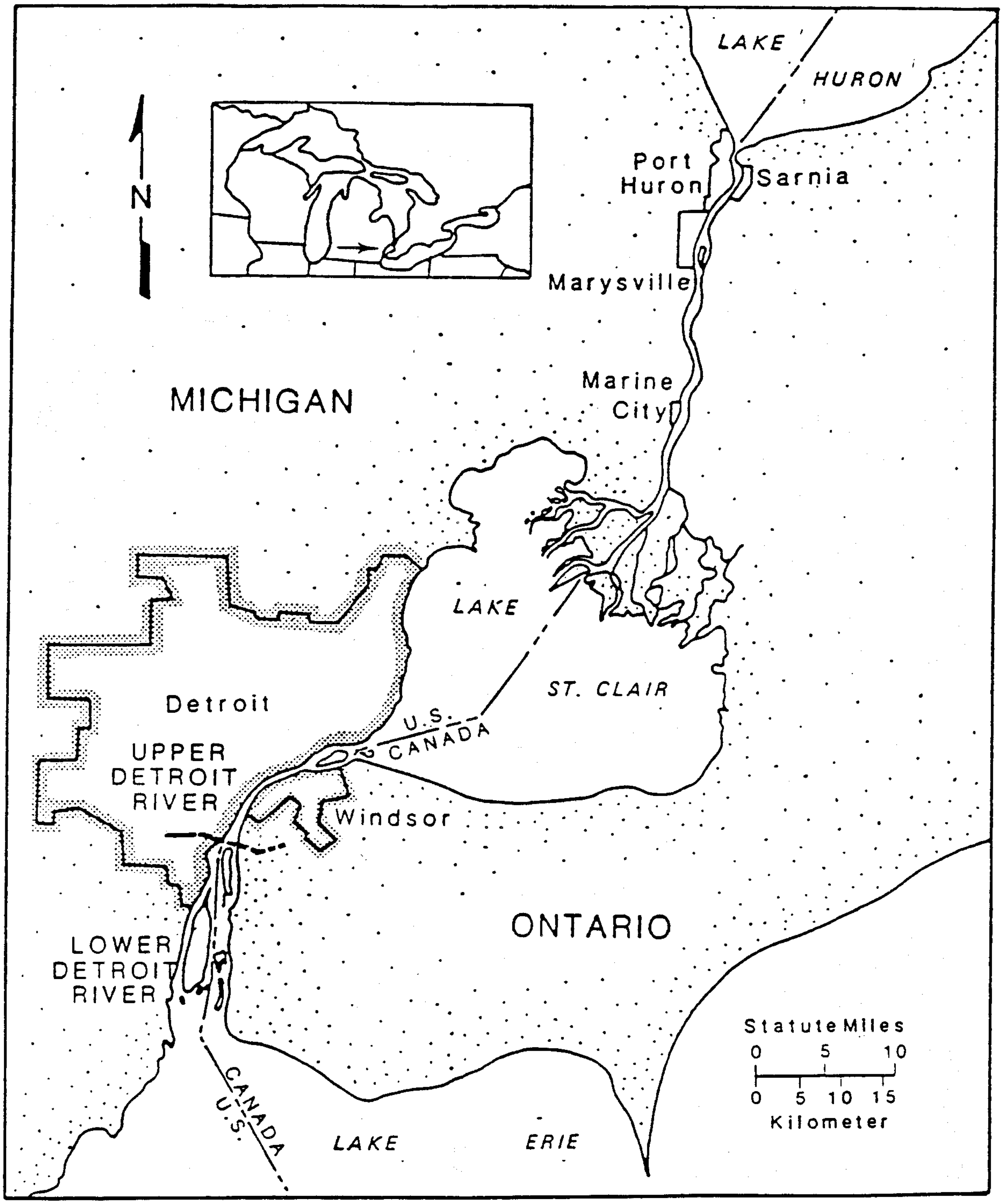


FIGURE IX-1. The Huron-Erie corridor.

underlain by Paleozoic sedimentary rock. The sedimentary rock beneath the river is the Detroit River Formation (primarily dolomite) which outcrops intermittently in the navigation channels east of Grosse Ile. On top of the bedrock is a mantle of glacial drift 0 to 30 m thick.

Lake plain soils are poorly drained loam and clay loams, which developed on former lake bottoms or lacustrine clay sediments. Sandy ridges mark former shorelines, and on the Michigan side, an isolated sand sheet marks remnants of the glaciofluvial delta of the post-glacial Huron River. When drained and tiled, the loamy lake plain soils are agriculturally productive. Many surface and subsurface soils are moderately permeable (0.25 and 1.27 cm/hour) with high surface runoff coefficients causing the local streams to be storm event responsive.

The Ontario shoreline, except for the City of Windsor and its docks, is less disturbed than the Michigan shoreline. North of the Canard River there are scattered marinas, canals, and private boat slips. In places, Ontario farmers have encroached upon the wetland margins of the Detroit River and its tributaries. Thus, a green buffer zone exists only intermittently between the farm fields and the riverine ecosystem. Access to the water for commercial navigation, business, pleasure boating, fishing and hunting is important locally on both sides of the river.

Hydrology

Nearly 98% of the Detroit River flow enters from Lake Huron via the St. Clair River and Lake St. Clair. The river discharge averages 5,300 m^3/sec and ranges from a low of 3,200 m^3/sec to a maximum discharge of 7,100 m^3/sec. The Fleming Channel in the upper Detroit River, north of Peach Island, accounts for 77% of total river flow. Flow distribution in the lower river is relatively complex downstream of Fighting Island, as several channels separate or combine the flow (2,3,4).

Flow velocities average 0.49-0.88 m/sec, but mid-surface velocities can be nearly twice that rate. Surface currents near the Ambassador Bridge and in the Amherstburg Channel reach 1.2 m/sec, while the Trenton Channel flow averages 0.6 m/sec.

Detroit River water depth and velocity are directly affected by water levels in Lakes St. Clair and Erie, which vary seasonally and annually. Lake Erie seiches and Lake St. Clair ice jams may also produce changes in Detroit River water levels and currents. The river slope is relatively uniform, and falls 0.9 m over its 51 km length. The average time of passage for water through the Detroit River is about 19 to 21 hours.

The Rouge River, the main tributary to the Detroit River, drains about 121,000 ha in Michigan, and consists of upper, main, middle and lower branches. The stream is very event-responsive and frequent flooding occurs along the middle Rouge. Its mean annual discharge is 26 m^3/sec, with over 75 percent of it draining through urban areas, collecting considerable stormwater runoff, overflow from combined sewers during wet weather, and over 500 million gallons per day (mgd) of waste water from municipal and industrial facilities. The lower Rouge is partially lined with concrete, so runoff rapidly reaches the Detroit River during storms.

Other tributaries include the Ecorse, Canard and Little rivers and Turkey Creek. The Ecorse River tributary drains 11,556 ha in Michigan, occupied by 2 communities with a total population of 198,000 in 1980. The Ecorse River has two open channel tributaries, the North Branch and the South Branch (or Sexton-Kilfoil Drain). These branches join approximately 1 km upstream from the confluence of the Ecorse and Detroit rivers near Mud Island. Ontario's Little River empties into the Detroit River at its mouth, by Peach Island. It drains approximately 5,750 ha of agricultural and industrial land. Turkey Creek enters the Detroit River just north of Fighting Island, draining 2,960 ha of primarily agricultural land in Ontario. The Canard River enters the Detroit River in Ontario, south of Windsor and east of Grosse Ile. It is a turbid, slow moving stream which discharges into diked wetlands just north of its mouth, and drains approximately 20,000 ha of primarily agricultural land (5). Other minor tributaries also exist, such as Monguagon Creek (in Michigan, by the northern end of Grosse Ile) and Conners Creek (in Michigan, by the eastern end of Belle Isle).

Effluent from the Detroit area wastewater treatment plants (WWTPs) discharge over 32 m^3/sec (1985), a volume equal to the combined tributaries flowing into the Detroit River. The Metropolitan Detroit WWTP alone discharges 30 m^3/sec near the mouth of the Rouge River (6).

Habitats and Biological Communities

The Detroit River ecosystem can be divided into an upper stretch (upstream of the Rouge River) and a lower river stretch. The Detroit River's biologic zones include deep channels, shallow water/nearshore zones, and terrestrial zones. Deep channel environments generally have water depths exceeding 7 m, relatively high flow velocities, and coarse sediments. Since the river channels are also used for shipping, the high sediment load and lack of anchorage prevent macrophyte growth. Macrophytes and associated periphyton and invertebrates are most abundant in the shallow water-nearshore zone, seldom occurring at depths greater than 4 m. The terrestrial biological zone includes undeveloped island habitat, coastal wetland and riparian environments along such less developed tributaries as the Canard River. The Wyandotte National Wildlife Refuge is located in the Detroit River, off the northern tip of Grosse Ile. This Refuge encourages shorebirds and waterfowl feeding, nursery and nesting activities. Stony, Celeron, Grassy and Mud Islands provide shorebird habitat.

The coastal wetlands and large, emergent and submersed macrophyte beds along the Detroit River were nearly continuous in colonial times. They now exist only in 31 small isolated remnants covering 1,382 ha (7). Most of the remaining vegetation along the river consists of submersed macrophytes because the land formerly occupied by the swamp-scrub-meadow communities along the terrestrial river margin has largely been converted to other uses. Fifty-four percent (748 ha) of the remaining wetlands are in Ontario. The single largest wetland, immediately north of the Canard River, is functional only along its outer, undiked margins. Functional wetlands also exist along the open water margins of a few islands.

A number of biological surveys have documented the biotic communities in the river (7,8,9,10,11,12,13,14,15,16). Although it is not well understood how the various trophic levels relate to one another, enough information exists to describe species composition, standing crop and biomass for a variety of primary and secondary producers.

i) Macrophytes

At least 21 submersed macrophyte taxa occur in the river, dominated by Vallisnera, Chara, Potamogeton, Myriophyllum and Heteranthia. Stands are typically composed of 2 or 3 species but as many as eleven have been recorded in a single stand. Chara is the only taxon consistently occurring in monotypic stands. The lower depth limit for plant colonization is not established, but most stands occur in water less than 3.7 m deep. In the Detroit River, the area of the river bed between shoreline and the 3.7 m depth contour is about 99 km^2, 72% of which is occupied by submersed plants. The wetlands and submersed macrophyte beds constitute the most critical areas for primary and secondary production for plants, fish and birds, and are the most stable habitat in the ecosystem (17). Their invertebrate populations include clams, snails, midges, caddisflies, mayflies, amphipods, springtails, and worms. Juvenile yellow perch and adult northern pike have been observed feeding along the wetland shoreline among the submersed macrophytes. These areas are also heavily used for spawning by numerous fish species. No detailed studies of species composition, distribution, and relative abundance of emergent macrophytes have been completed, although wetland communities have been mapped by remote sensing. Over 95% of the emergent beds occur in the lower river.

The St. Clair-Detroit River system produces about 264,000 tons of plant biomass each year, of which 19% originates in the Detroit River. Most of the plant biomass in the Detroit River is produced by submersed macrophytes.

ii) Phytoplankton

Phytoplankton standing crop and production values is assumed to have phytoplankton biomass and daily production similar to Lake St. Clair. Eighty two phytoplankton species are present in the river at low density (about 500 cells/ml), and are dominated by diatoms that are common in Lake Huron in July and August. Blue-green algae that are common in Lake St. Clair at that time dominate the Detroit River phytoplankton. No periphyton studies have been conducted to date, but a recent study in a wave exposed breakwater in western Lake Erie indicates that diatoms, green algae and red algae may be common over-wintering taxa in the Detroit River. Filamentous green algae can be expected to dominate during summer months.

Current information is inadequate to determine how much of the planktonic production of the river is used by river biota. If only moderate amounts of this biomass is retained, then the littoral plant complex of emergent and submersed macrophytes and macrozoobenthos are the main standing stock in the river. From calculations of drifting macrophytic plants, it appears that the Detroit River is a large source of detrital organic matter that supports productivity in western Lake Erie.

iii) Zooplankton

Detroit River zooplankton studies are not yet completed, but zooplankton composition and abundance seem to resemble those found in Lake St. Clair. Cladocera and several species of Cyclops and Diaptomus dominate the zooplankton in Lake St. Clair. Difflugia is the most common protozoan, and Conochilus, Keratella, Polyarthra, Synchaeta, and Brachionus are the most common rotifers. Maximum numbers of zooplankton may be expected between June and September. A study of foods eaten by larval yellow perch during passage through the Detroit River revealed that zooplankton, including copepod nauplii, older cyclopoids and copepods, cladocera and rotifers were eaten. Hence, zooplankton are likely the critical food resource for larval fish.

iv) Macroinvertebrates

The Detroit River benthic macroinvertebrate community includes over 300 species. Oligochaetes, chironomidae, gastropoda, ephemeroptera, trichoptera and amphipoda dominate the biomass. Chironomidae are common throughout the system while oligochaetes are dominant in the lower river. Hydropsychid caddisflies are the dominant trichoptera and Hyalella is the most common amphipoda.

Hexagenia is the most common mayfly, but density is lower in the Detroit River (88/m^2) than the St. Clair or the St. Marys Rivers (95/m^2 and 199/m^2), respectively. Detroit River benthic production (5.4 g ash-free dry weight/m^3/yr) is lower than the St. Clair River and Lake St. Clair (7.0 and 6.8 g ash-free dry weight/m^3/yr) with the annual production (440 metric tons ash-free dry weight/yr) equal to about 2% of the combined annual Detroit River phytoplankton, periphyton, macrophyte and zooplankton production (7,14,16).

v) Fish

The present Detroit River fish populations are a mixture of natural and introduced (exotic) species. Among the exotic fish is the common carp, which was introduced in 1883 in western Lake Erie. From there, it spread through the Detroit River to the upper Great Lakes, destroying beds of wild celery and wild rice, the preferred food of native waterfowl. Large carp populations continue to inhabit the Detroit River. Rainbow smelt and alewife, introduced in 1932, spread through the Detroit River and upper lakes. Alewives now comprise the bulk of forage fish in all the Great Lakes. The sea lamprey spread through the Detroit River to the upper Great Lakes in the 1940s, greatly reducing populations of desirable fish, such as the lake trout. The most recent exotic Detroit River fish, the white perch, was introduced into Lake Erie in 1953 and now hybridizes with native white bass. The Detroit River fish community presently has approximately 60 resident or migrant species, 32 of which use mainly the lower river along the islands and the mainland shoreline for spawning (18,19,20,21,22).

The Detroit River and its tributaries are important spawning, feeding and nursery areas for many species that support major fisheries in the river and Lakes Huron and Erie. There are 60 recorded resident or migrant fish species in the Detroit River, 32 of which spawn in the river. Townet catches of larval fish in the Detroit River in 1977-1978, 1983-1984 and 1986 show that the river is a nursery ground for at least 25 species of fish. Most abundant were alewife, rainbow smelt, and gizzard shad. Other species were much less abundant.

The river is part of a complex migration route for walleye and yellow perch, important recreational fish species, which move between Lake St. Clair and Lake Erie. Large walleye spawning runs once occurred in the lower river, the reduction of which is attributed to pollution and sedimentation. In the 1970s, spawning was again documented, and walleye larvae were collected in several locations in the lower 16 km of the Trenton Channel and the main river. Recently, yellow perch spawning has been observed in the Trenton Channel and near the mouth of the Detroit River in some areas previously used by walleye.

The Detroit river once supported a large commercial fishery for lake whitefish, lake herring, walleye, lake sturgeon, black bass, northern pike, muskellunge and carp. Overfishing, pollution and dredging contributed to the Detroit River commercial fishery decline (23,24,25).

Sport fishing is still an important activity in the Detroit River. In 1985, an estimated 1.4 million hours were spent harvesting approximately 1.4 million fish (22). The lower river harvest was 980,200 while the upper river was 440,600 annually. Dominant species were white bass (63%), walleye (12%), yellow perch (10%), and freshwater drum (7%).

A larval fish passage study from Lake St. Clair to Lake Erie was conducted along the Detroit River at 17 transects, 2.5 km apart (Figure IX-2)(22). Thirteen larval fish taxa were observed. Larval fish densities of walleye, yellow perch and white bass/white perch greatly increased in the mid-Trenton Channel (transect 12-13), suggesting spawning and rearing activities in the vicinity. Yellow perch showed a strong lateral distribution with greatest densities along the western near-shore, decreasing toward the main channel with lowest densities along the eastern shore. Surprisingly, the area containing the highest density of larval yellow perch coincides with the highest concentration of environmental contaminants in water or sediments. White bass/white perch and rainbow smelt did not exhibit significant east-west density gradations. Longitudinal distribution patterns were evident for larval bloaters, burbot and deep water sculpin. Deep water densities of these species were greatest in the upper Detroit River, but were present throughout, probably being transported from Lake Huron and Lake St. Clair. Walleye and white bass/perch were not found, and yellow perch and rainbow smelt exhibited relatively low abundances in the upper river. Yellow perch, white bass/white perch, rainbow smelt and walleye larval densities were greatest in the lower river.

vi) Waterfowl

At least 3 million waterfowl migrate annually through the Great Lakes region, which is situated at the intersection of the Atlantic and Mississippi flyways. An estimated 700,000 diving ducks, 500,000 dabbling ducks, and 250,000 Canadian geese migrate across Michigan each fall (1).

Important species of nesting ducks in the Detroit River wetlands include mallards, blue-winged teal, black ducks and, if nesting boxes are provided, wood ducks. In the past, 24 species of ducks regularly fed in the river. Each year, thousands of waterfowl, including scaup, goldeneyes, canvasbacks, black ducks, redheads, and mergansers congregate on the river to forage sediments. Major concentrations of feeding ducks are often found in littoral waters around Belle Isle, Grosse Ile and Mud, Fighting, Sugar and

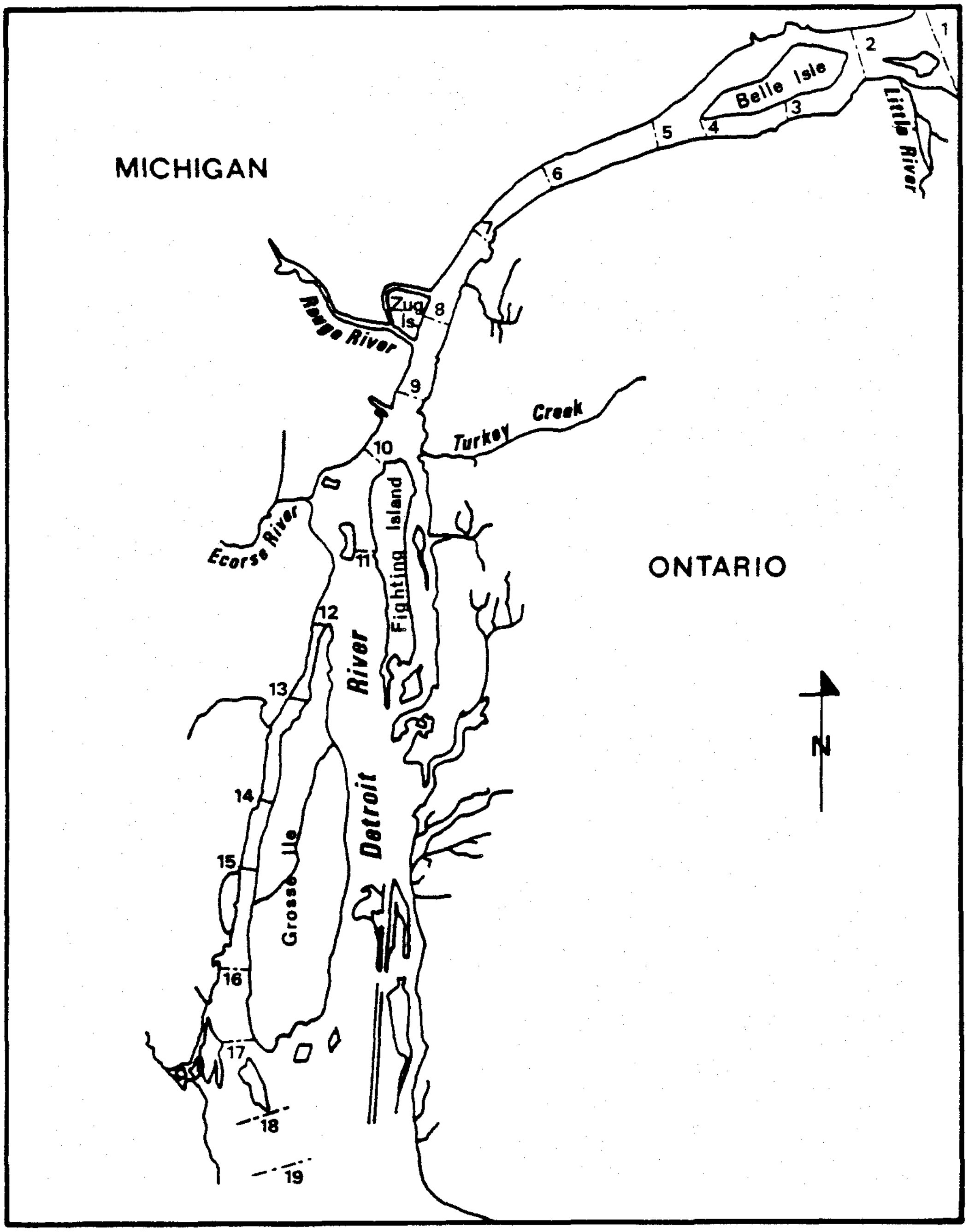


FIGURE IX-2. Detroit River water sampling transects and 24-hour sampling locations.

Celeron islands. Preferred foods vary among species. Mergansers feed primarily on fish, whereas American goldeneyes prefer crayfish, clams, and other invertebrates. Many diving ducks feed on submersed aquatic plants and their associated communities.

A recent survey of eelgrass tubers, a preferred food of many waterfowl, indicated that over the past 35 years, tuber densities have decreased substantially, resulting in a net loss of 4.6×10^9 tubers in the lower river. This large loss of eelgrass tubers in the Detroit River explains in part why fewer waterfowl now use the Michigan migration corridor.

Climate

The Detroit River area enjoys a mid-continental climate, with cold winters and relatively short hot summers, moderated somewhat by the Great Lakes. The average first frost is on October 21 and the average last freezing temperature is on April 23, with an annual growing season of 180 days. Precipitation averages about 76 cm per year, including 40 cm of snow. Prevailing winds are from the southwest, and average 16 km/hour.

During late autumn and early winter, water from Lake Huron cools rapidly as it flows through shallow Lake St. Clair. As a result, ice often enters the Detroit River from Lake St. Clair before it begins to form in the Detroit River itself. Before the 1930s, most of the Detroit River was ice covered in winter, but now large volumes of heated effluents entering the river usually prevent the upper river from freezing over, except between Belle Isle and the Michigan mainland. Extensive slush ice still develops in the lower river, especially in the broad shallow expanses adjacent to the islands. In general, ice may now be found in the river from early December to mid-March, but main navigation channels remain ice-free. Minor ice jams occur in the Detroit River with the breakup ice moving south from Lakes Huron and St. Clair from late March to early May. Easterly winds can also cause Lake Erie ice to reverse into the lower Detroit River. Monthly water temperature data show that the highest water temperatures occur in August, with an average of 22.2°C. In the shallow nearshore areas of the lower river, water temperatures may attain 25.2°C. Lowest temperatures occur in January-February, sometimes reaching 0°C.

2. Environmental Conditions

Water Quality

The Detroit River area is heavily industrialized and densely populated. Industrial and municipal raw water is taken from the river then returned after use. Due to its varying channel width and depth, berms and islands, the Detroit River is hydrologically complex, a fact which influences water quality and modifies the human impact on the Detroit River system.

Information on water quality was obtained as part of this study (26). To obtain a reliable data set which could provide a meaningful interpretation while minimizing the need for analyses, water sampling transects across the river were used. Figure IX-3 shows the location of the upper (DT 30.8W and DT 30.7E) and lower (DT 8.7W and DT 9.3E) transects and the major tributaries. The upper transects are at Peach Island near Lake St. Clair, upstream of Detroit and Windsor. The lower transects are near Grosse Ile, upstream of the Livingston Channel and Stoney Island in the east, and near the lower end of the Trenton Channel on the west. The lower transect was designed to avoid the influence of Lake Erie, and in the process was located upstream of two industrial facilities, General Chemical at Amherstburg and McLouth Steel, Gibraltar. Therefore, water quality data for the lower transect does not reflect these facilities. In addition, loadings from Frank and Poet Drain, which serves several permitted Michigan industrial discharges, were also excluded (26). Figure IX-4 describes the flow distribution in the channels of the Detroit River, and shows that approximately 21% of the total Detroit River flow passes through the Trenton Channel and approximately 26% and 47% through the Livingston and Amherstburg channels, respectively (27).

Three additional, partial river width water quality monitoring transects were established in the Trenton Channel between Grosse Ile and the Michigan shore at Point Hennepin (A), just south and parallel to the Grosse Ile toll bridge (C), just south and parallel to the Grosse Ile Parkway Bridge off the Monsanto Breakwall (D). Michigan's monthly Detroit River water sampling transect at the mouth of Detroit River between Bar Point and Maple Beach (DT 3.9) is also shown (Figure IX-3).

i) Cross-Channel Variations in Water Quality

Cross-channel variation of water quality occurs where large volumes of low concentrations or smaller volumes of higher concentrations of substances are discharged to the river. Cross-channel variations were demonstrated by dye studies below the Detroit WWTP outfall (Figure IX-5) (28). The upper Detroit River between Belle Isle and Fighting Island has a relatively constant channel width and depth where little or no cross-channel mixing occurs. In contrast, the lower river section is broken up into three major channels and several shallow embayments. There, and downstream of these islands and structures, increased cross-channel mixing may occur due to the generally lower current velocities, eddies below these structures, and wind driven currents cross and counter to the normal current direction.

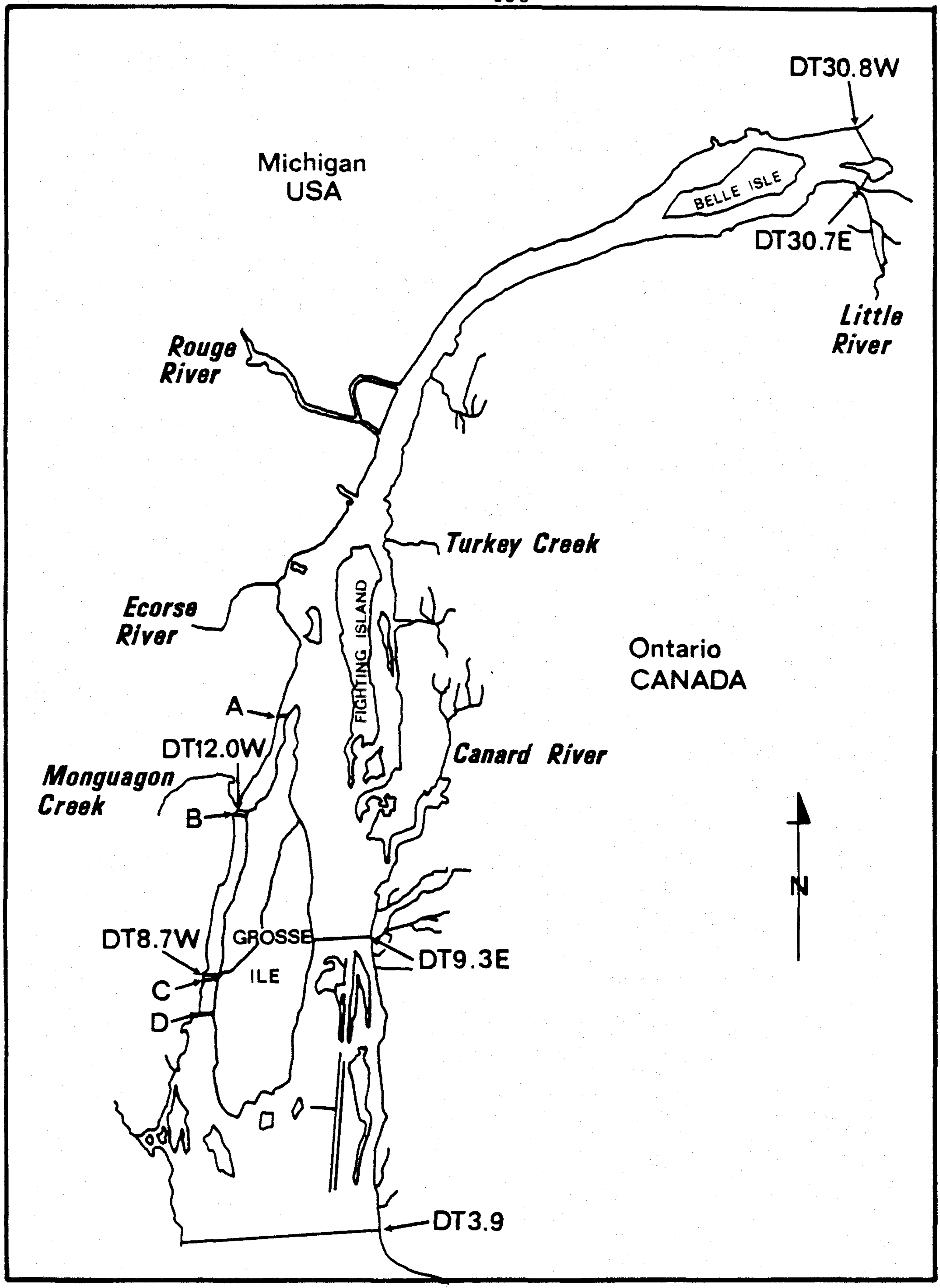


FIGURE IX-3. Detroit River mass balance sampling transects.

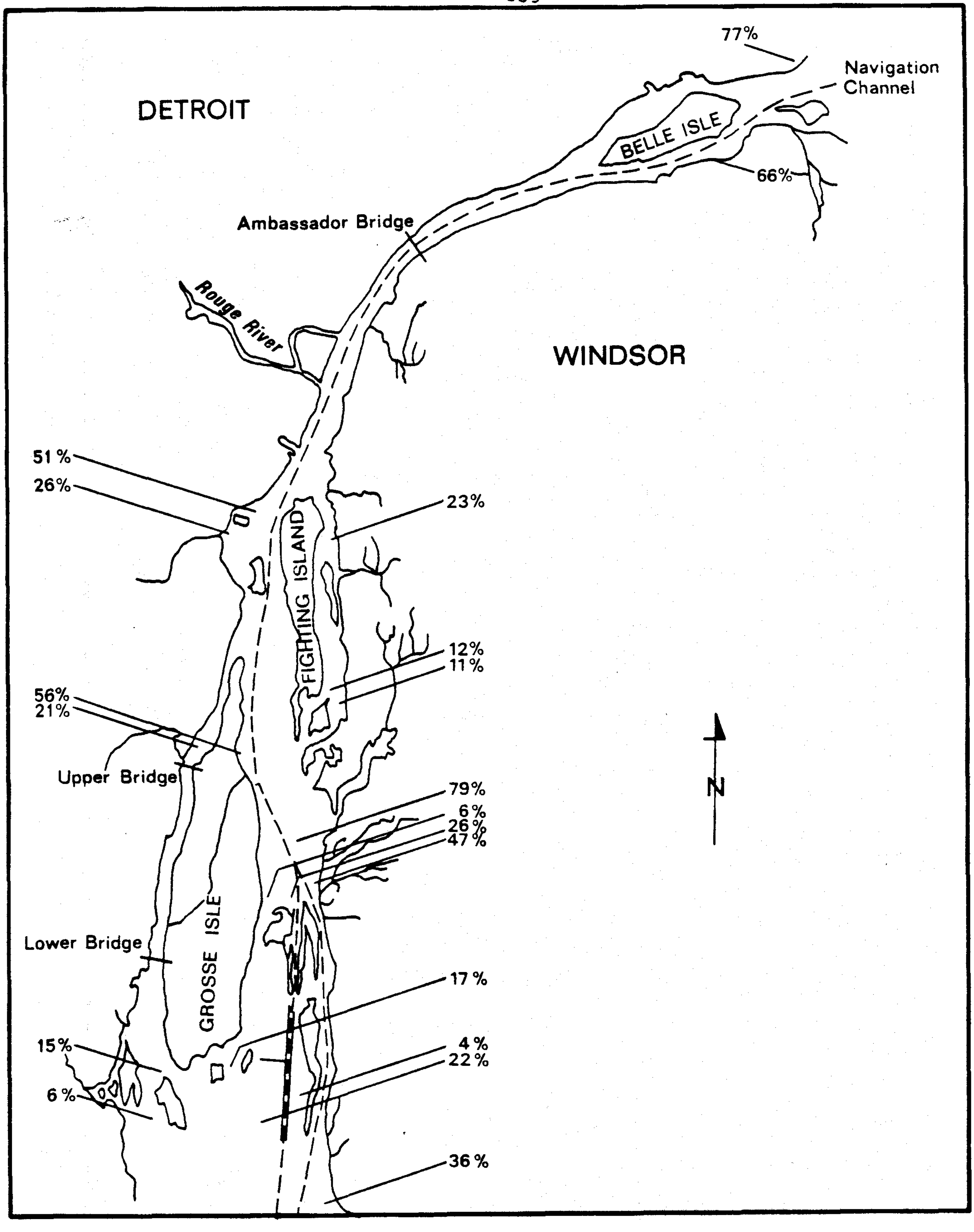


FIGURE IX-4. Flow distribution in the Detroit River (27).

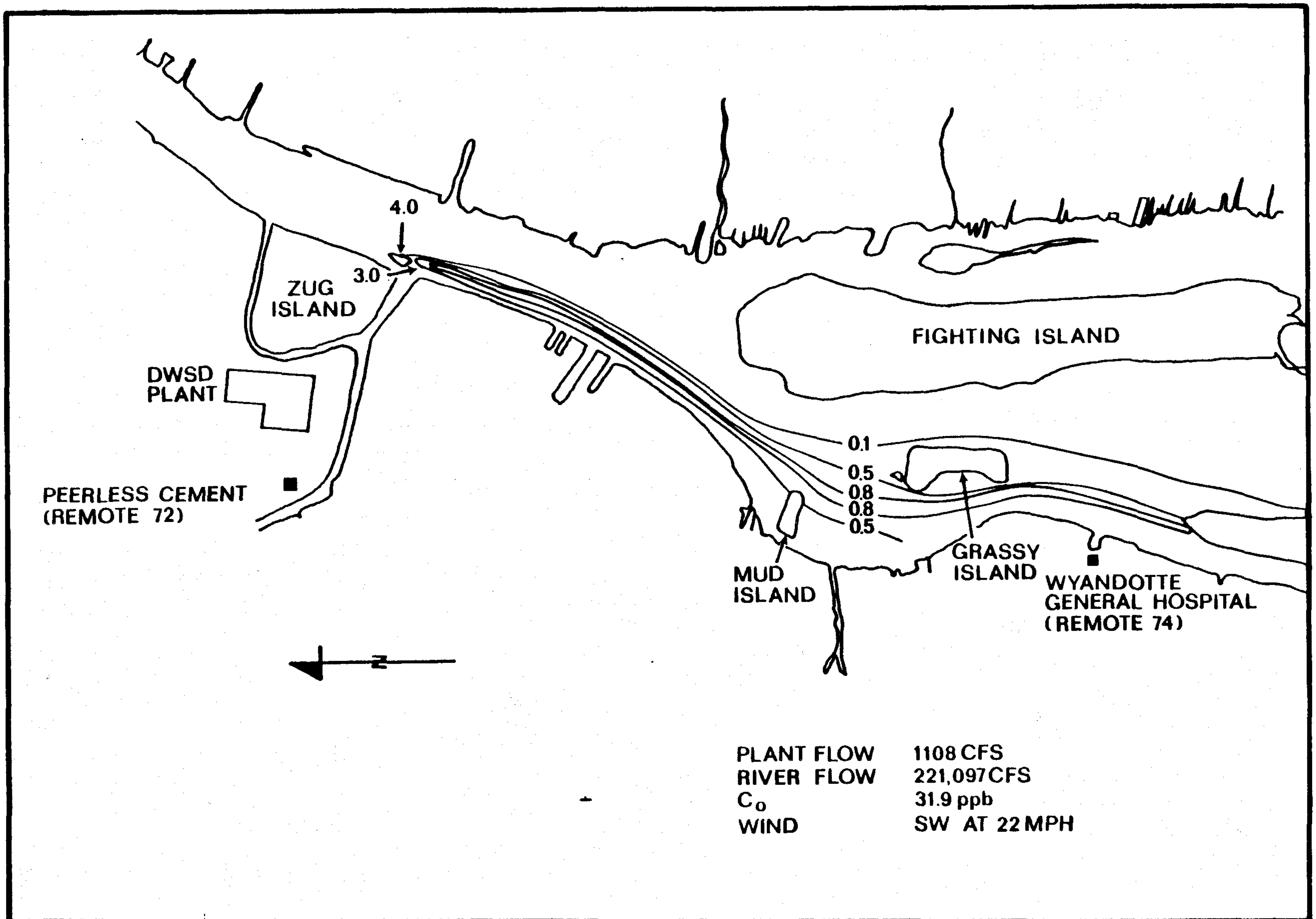


FIGURE IX-5. Plume from the City of Detroit WWTP, March 1985 (28).

Cross-channel variation in concentrations of some organochlorine contaminants (for example PCBs and chlorobenzenes) between water in the upper Detroit River and the Detroit River mouth has been shown (Figure IX-6). Organochlorine concentrations are similar at the head of the river along both the Michigan and Ontario shores (about 0.5 ng/L at stations 399 and 379, respectively) (29). Proceeding downstream, higher levels are found along the Michigan shore, with levels up to 209 ng/L (station 346), compared with 0.5 ng/L across the river. Station 269 (17 ng/L), on the Canadian side, may be influenced by U.S. sources as this station is well within the 50% flow panel of the Detroit River.

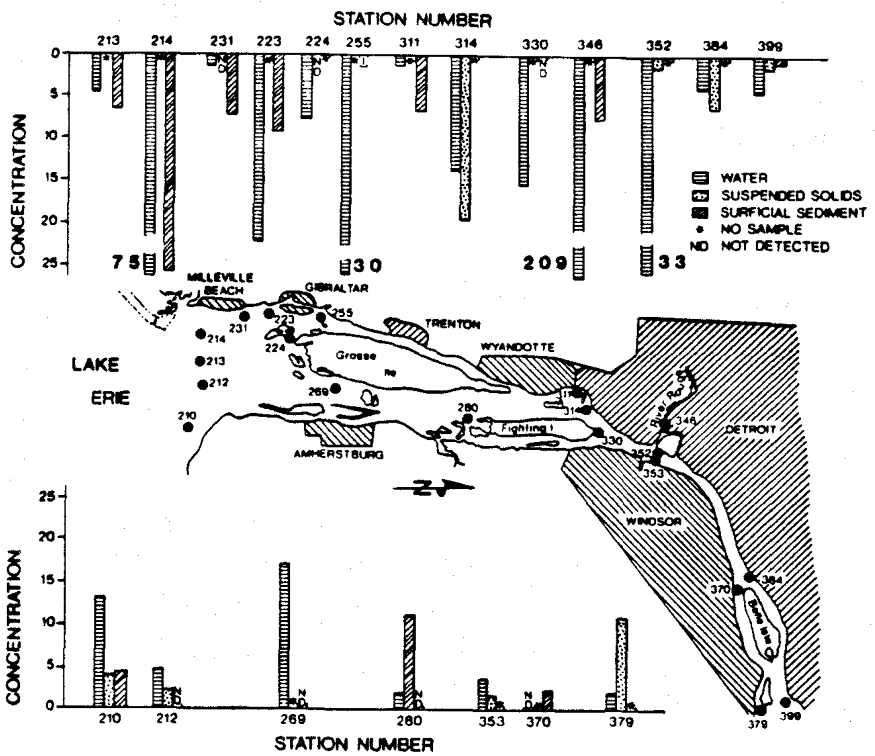
ii) Longitudinal Variations in Water Quality

The flow of the Detroit River ranges from 3,200 m^3/sec to 7,100 m^3/sec, constituting a large water mass. To detect statistically significant changes in water quality between the river head and mouth, inputs or sinks of such substances must be substantial. Due to natural fluctuations between seasons, shipping and dredging activities and both natural and man-induced fluctuations of in-coming water quality, any quantitative and even qualitative interpretation of data is difficult. Only a statistical evaluation of many samples will allow definite conclusions. That sampling intensity was not achieved in this study for most data, and comparisons made are primarily relative comparisons. Evaluation of relative changes in water quality parameters does not require absolute values, but compares the relative abundance or absence of materials, and may indicate temporal or spatial differences.

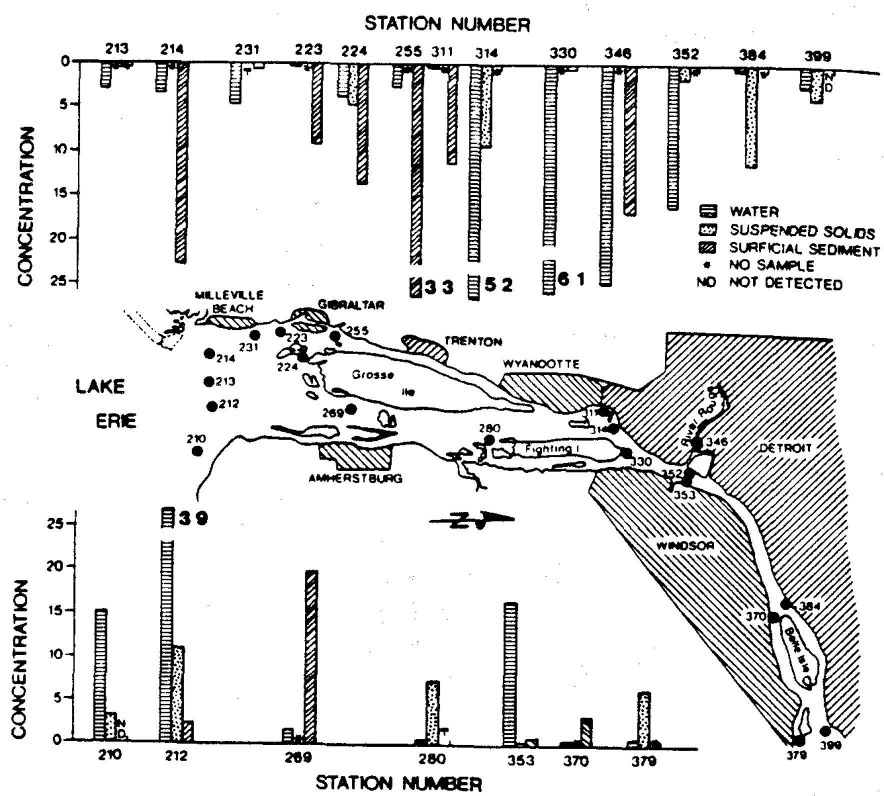
Polychlorinated Biphenyls (PCBs):

Qualitatively, the composition of PCBs in Detroit River water changes from the upper to the lower Detroit River transects (Figure IX-7). For nine commonly observed PCB homolog series (comprising approximately 100 of the theoretically possible 210 PCB isomers), a decrease of the lower chlorinated homologs (with one to four chlorines per biphenyl molecule) and an increase of the higher chlorinated homologs (6 to 10 chlorines per molecule) is observed as one moves downstream. Considering the stability of PCBs, it can be concluded that the observed change in PCB homolog distribution is due to inputs of higher chlorinated PCBs along the river stretch (26).

The observed qualitative changes in PCB composition are also supported by quantitative observations. PCB concentrations in water averaged approximately 0.6 ng/L at four stations above and below Belle Isle on both sides of the river from a 1985 survey (26). Downstream, at several locations along the Ontario side, PCB concentrations increased to approximately 1.0 ng/L, while PCB concentrations on the Michigan side in and downstream of the Trenton Channel increased to levels as high as 3.4 ng/L. In the

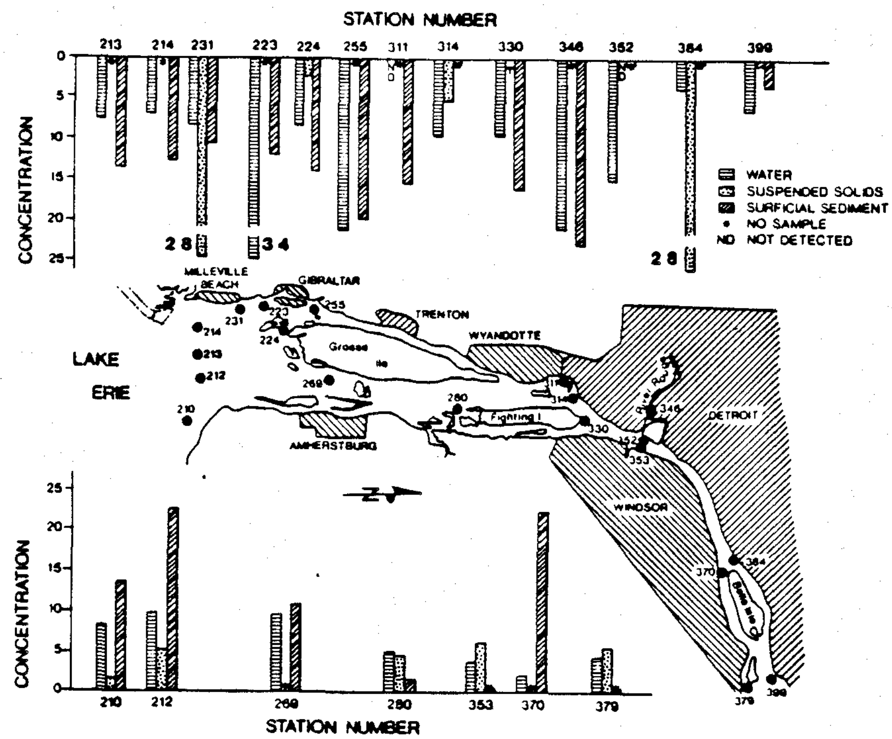


Organochlorine contaminants (OCs) in water, suspended solids, and surficial sediments of the Detroit River. Concentrations in 10^4 ng kg^{-1} (sediments, suspended solids) and 10^{-1} ng L^{-1} (water), respectively.

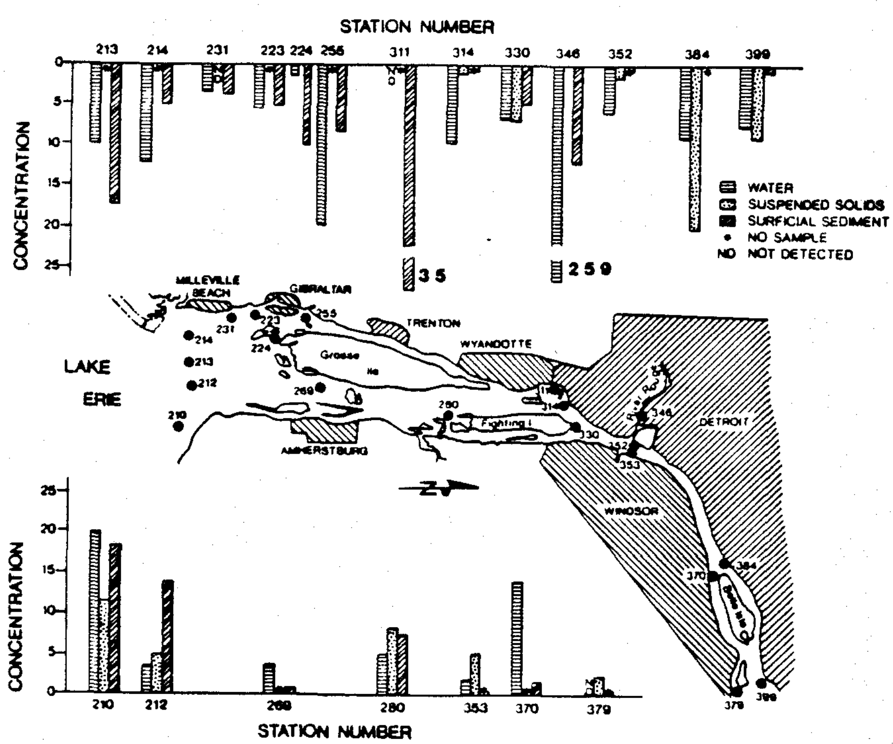


Polynuclear aromatic hydrocarbons (PNAs) in water, suspended solids, and surficial sediments of the Detroit River. Concentrations in 10^3 ng kg^{-1} (sediments), 10^4 ng kg^{-1} (suspended solids), and 10^2 ng L^{-1} (water), respectively.

FIGURE IX-6. PCBs, CBs, PAHs and OCS in Detroit River water, suspended solids and surficial sediments (29).



Polychlorinated biphenyls (PCBs) in water, suspended solids, and surficial sediments of the Detroit River. Concentrations in 10^4 ng kg^{-1} (sediments, suspended solids) and 10^{-1} ng L^{-1} (water), respectively.



Chlorobenzenes (CBs) in water, suspended solids, and surficial sediments of the Detroit River. Concentrations in 10^3 ng kg^{-1} (sediments, suspended solids) and 10^{-1} ng L^{-1} (water), respectively.

FIGURE IX-6. (Cont'd.) PCBs, CBs, PAHs and OCS in Detroit River water, suspended solids and surficial sediments (29).

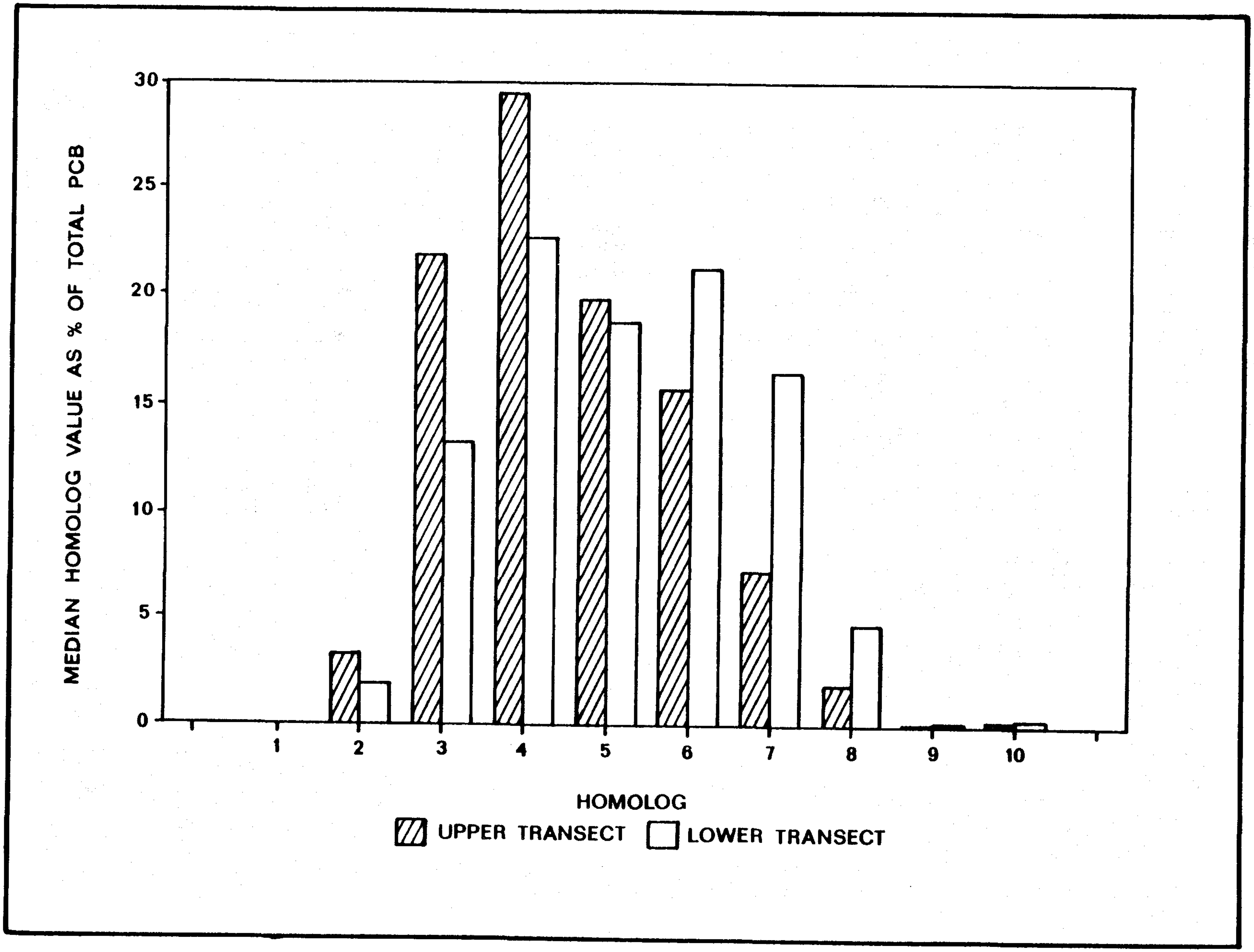


FIGURE IX-7. PCBs in Detroit River water.

Detroit River System Mass Balance Study (30), total PCB concentrations averaged 1.4 ng/L (plus or minus 0.6 ng/L) at the head of the river and 3.3 ng/L (plus or minus 1.3 ng/L) at the mouth, based on composite samples across the entire river at each respective transect. Total PCB concentrations in whole water samples from tributaries averaged 45.4 ng/L in the Rouge River, 47.9 ng/L in Turkey Creek, 33.3 ng/L in the Ecorse River and 7.6 ng/L in the Little River (Table IX-1). In the Trenton Channel Mass Balance Study (31), total PCBs in whole river water ranged from 1 ng/L to 385 ng/L. The highest concentrations were found along the western shore of the Trenton Channel, with daily variations ranging from 6.8 ng/L to 15.7 ng/L.

PCB concentrations throughout the Detroit River exceeded Michigan's Rule 57(2) allowable level of 0.02 ng/L, the Ontario Provincial Water Quality Objective (PWQO) of 1 ng/L and the U.S.EPA Ambient Water Quality Criteria (AWQC) for Human Health (based on fish and water consumption) of 0.079 ng/L, and some locations (e.g., Trenton Channel) exceeded the U.S.EPA chronic AWQC of 14 ng/L.

In suspended solids, PCB levels were at or below 50 ng/g at most locations on both sides of the river, except at two stations on the Michigan side, below Belle Isle and at the lower end of the Trenton Channel, where they reached 280 ng/g. Concentrations measured on suspended solids at the head of the Detroit River averaged 428 ng/g, largely due to one elevated measurement. A single suspended sediment sample collected in 1985 from the Canard River had a very high PCB concentration of 11,760 ng/g, but other data suggest that the Canard River is only an intermittent PCB source (32).

Chlorobenzenes:

Several of the 5 possible chlorobenzene homologs are commonly found in aquatic systems, of which hexachlorobenzene (HCB) is probably the most widely distributed congener. In Detroit River water, chlorobenzenes ranged from 0.3 to 1.0 ng/L at stations above Belle Isle and at all but two Ontario stations (maximum approximately 2 ng/L, Figure IX-6). On the Michigan side, chlorobenzene levels were somewhat higher, particularly at the mouth of the Rouge River, where chlorobenzene levels reached 25.9 ng/L (Figure IX-6). However, HCB concentrations were only 0.28 ng/L, indicating other chlorobenzenes are present. In a later study, concentrations of HCB remained virtually the same from the head (0.31 ng/L) to the mouth (0.33 ng/L) of the Detroit River (Table IX-1). In another survey, HCB in water and/or suspended particulates showed essentially the same HCB concentrations on both shores and at upstream and downstream transects. These results indicate small or intermittent sources of HCB along the Michigan side of the Detroit River, perhaps from the Rouge River, with important background concentrations of HCB entering the Detroit

TABLE IX-1

Mean concentrations of polychlorinated biphenyl, hexachlorobenzene, major trace metals, phosphorus and choride at the Detroit River head and mouth, and major tributary mouths (1984-1986)[1].

LOCATION	TOTAL CADMIUM (ug/L)	TOTAL COPPER (ug/L)	TOTAL MERCURY (ug/L)	TOTAL NICKEL (ug/L)	TOTAL ZINC (ug/L)	CHLORIDE (mg/L)	TOTAL PHOSPHORUS (ug/L)	TOTAL LEAD (ug/L)	TOTAL PCBs (ng/L)	HCB (ng/L)
Detroit-Head	0.023	1.29	0.008	0.97	1.22	6.7	8.6	-	1.4[4]	0.31[4]
Detroit-Mouth	0.035	1.64	0.008	1.15	3.30	8.4	15.7	-	3.3[4]	0.33[4]
Ecorse River	0.084	2.83	0.002	2.62	14.2	37.7	88.0	-	33.3[4]	0.39[4]
Rouge River	2.061	7.09	0.017	3.30	167.3	69.2	102.0	-	45.4[4]	0.28[4]
Turkey Creek	0.196 (0.2-3)[2]	4.38	0.016	8.76	21.2	105.6 (51-880)[2]	351.0 (47-7000)[2]	3-33[2]	47.9[4]	0.24[4]
Little River	0.058 (0.2-0.4)[2]	5.14	0.016	ND[3]	73.7	93.8 (16-215)[2]	473.0 (52-2400)[2]	3-13[2]	7.5	1.01
Canard River	0.2-0.4[2]	-	-	-	-	27-125[2]	57-550[2]	3-30[2]	-	-

[1] From U.S.EPA as reported in the Water Quality Workgroup Report (26), except as noted. Values are rounded. See Water Quality Workgroup report for reported values, sampling methodology and statistical information.
[2] Upper and lower values reported by Wall et al. (5). No average value reported.
[3] ND = not detected.
[4] Average of two surveys (26).

River from upstream. Data from a 1984 study, however, indicated increased HCB concentrations on suspended sediments, from approximately 3.5 ng/g at the river head to approximately 15 ng/g at the Detroit River mouth.

Other Organochlorine Compounds:

A variety of additional organochlorine contaminants (OCs) are frequently observed in Detroit River water and seston samples. Among these are DDT and its environmental metabolites, commonly referred to as total DDT, hexachlorocyclohexane (three isomers), chlordane (two isomers), heptachlor epoxide, endosulfan (two isomers), dieldrin, endrin, methoxychlor, and octachlorostyrene (OCS). These compounds, collectively referred to as OCs, were found at concentrations of 0.3 to 0.5 ng/L in upper Detroit River water on both shores (Figure IX-6). Significantly higher OC concentrations were observed at many downstream stations on the Michigan side, with values as high as 20 ng/L at the mouth of the Rouge River. OCS levels, however, were virtually constant throughout the river at 0.005 to 0.008 ng/L in water and at 2.0 to 4.3 ng/g on particulate matter as found in another survey. These data indicate sources of OCS are primarily upstream of the Detroit River but important loadings of other OC compounds occur along the Michigan side of the Detroit River (26,32,33).

Polynuclear Aromatic Hydrocarbons:

Polynuclear aromatic hydrocarbons (PAHs) are byproducts of incomplete combustion of fossil energy resources. PAHs are also associated with petroleum refining and steel-making operations (coking, in particular). Consequently, their presence in air and water in urban and industrial areas is not surprising. At the head of the Detroit River, PAH concentrations of 100-200 ng/L were found in water. Higher concentrations were observed at several downstream stations along the Ontario, and particularly, the Michigan side of the river, with values as high as 6,100 ng/L (Figure IX-6). Based on the high concentrations of PAH that were found at the mouth of the Rouge River and sampling locations immediately downstream, large sources for PAHs appear to exist in the Rouge River area (26,30,31). Water samples from the Ontario tributaries (Turkey Creek, Little River and the Canard River) obtained during 1984 revealed no PAHs were present at the limit of detection used (34). There is no appropriate ambient water quality guideline with which to compare PAH concentrations in Detroit River water.

Total Trace Metals, Total Phosphorus and Filtered Chlorides:

A 1987 survey of selected trace metals (copper, cadmium, mercury, nickel, and zinc), phosphorus and chloride concentrations resulted in the following general conclusions (Table IX-1)(26,30).

Total cadmium concentrations increased from the head to the mouth of the Detroit River from a mean of 0.023 ug/L to a mean of 0.035 ug/L. In general, Detroit River water concentrations were below relevant ambient water quality guidelines. The Trenton Channel Mass Balance Study found total cadmium concentrations ranging from 0.7 ug/L to 0.77 ug/L (data not shown in Table IX-1) in the vicinity of the Grosse Ile free bridge along the western shore of the Trenton Channel, three of the four times it was sampled. These concentrations exceeded Michigan's Rule 57(2) allowable level of 0.4 ug/L (assuming a water hardness of 100 mg/L calcium carbonate). High cadmium concentrations were found in the Rouge River (2.06 ug/L), the Canard River (0.2-0.4 ug/L), Turkey Creek (0.196 ug/L in one study and up to 3 ug/L in another), the Ecorse River (0.084 ug/L) and the Little River (0.058 ug/L in one study, and up to 0.4 ug/L in another). Concentrations in the Rouge River, Turkey Creek and the Canard River exceeded the Great Lakes Water Quality Agreement (GLWQA) specific objective and the PWQO of 0.2 ug/L, and concentrations in the Rouge River and Turkey Creek exceeded Michigan's Rule 57(2) allowable level.

Total copper concentrations were slightly higher at the Detroit River mouth than at the river head (1.64 ug/L vs. 1.29 ug/L). Total copper concentrations in the tributaries were between two and six times higher than in the Detroit River, with the Rouge River levels highest at 7.1 ug/L. In general, both Detroit River and tributary copper concentrations were below relevant guidelines, with the exception of the Rouge and Little rivers, which slightly exceeded the GLWQA specific objective and the PWQO of 5 ug/L.

Total mercury concentrations in Detroit River water did not show any change between river head and mouth (both 0.008 ug/L). Total mercury concentrations in the Detroit River and in the Trenton Channel ranged from 0.024 ug/L to 0.449 ug/L. Tributary mercury concentrations were approximately double those in the Detroit River, except in the Ecorse River, where they were lower. These concentrations generally exceeded the U.S.EPA chronic AWQC of 0.012 ug/L.

Total nickel concentrations in the Detroit River showed little change between upper (0.97 ug/L) and lower (1.1 ug/L) Detroit River transects. Nickel concentrations in the Ecorse and Rouge rivers, and Turkey Creek were from two to eight times the Detroit River level, with the highest concentration in Turkey Creek (8.8 ug/L). Especially high concentrations of nickel were noted in the Little River (676.2 ug/L)(26). With the exception of the Little River, all Detroit River and tributary concentrations of nickel were below ambient water quality guidelines. Little River exceeded U.S.EPA chronic, Ontario and Michigan ambient water quality guidelines.

Total lead concentrations were all below the method detection limit (MDL) of <0.1 ug/L in the Detroit River head and mouth transects. Several locations in the Trenton Channel contained total lead concentrations ranging from 3.24 ug/L to 10.61 ug/L, which exceeded Michigan Rule 57(2) allowable levels (3.0 ug/L) and the U.S.EPA chronic AWQC (3.2 ug/L). The highest concentration was upstream of the Grosse Ile toll bridge along the western shore of the Trenton Channel (transect A, Figure IX-3). Transects C and D also have total lead concentrations exceeding guidelines along the western shore of the channel. Total lead concentrations in Ontario tributaries were determined for the Little River (3-13 ug/L), the Canard River (3-30 ug/L) and Turkey Creek (3-33 ug/L). These tributaries all contain total lead concentrations above guidelines (26,35). Concentrations of total lead in Michigan tributaries were not available for this report.

Total zinc concentrations increased between upper (1.2 ug/L) and lower (3.3 ug/L) Detroit River transects. Each of the tributaries also had high mean zinc concentrations, with the Ecorse River having the least (14 ug/L) and the Rouge River the highest (167 ug/L) total zinc concentrations. With the exception of the Rouge River and the Little River (74 ug/L), water concentrations were below ambient water quality guidelines. Little River concentrations of total zinc exceeded GLWQA specific objectives (30 ug/L). Rouge River total zinc concentrations exceeded this guideline and also the U.S.EPA chronic and acute AWQC.

Total phosphorus concentrations were nearly twice as high at the Detroit River mouth (15.7 ug/L) compared to the river head (8.6 ug/L). Total phosphorus concentrations in the major Detroit River tributaries were much higher than concentrations in the Detroit River.

Filtered chloride concentrations increased from 6.7 mg/L to 8.4 mg/L between upper and lower Detroit River transects. The lower Detroit River transect was located above General Chemical, a major chloride loading source discussed later, and therefore this loading was not reflected in the Detroit River mouth transect value shown in Table IX-1. The filtered chloride concentrations in the Detroit River tributaries were one to two orders of magnitude greater than the Detroit River head. Total chloride concentrations (not shown) did not increase between the head and the mouth. The drinking water guideline for chlorides (250 mg/L) was exceeded in Turkey Creek and North Drain.

Nutrients, Dissolved Gases and Microorganisms:

The basic plant nutrients in the Detroit River include phosphates, nitrates, and silicates. Dissolved oxygen and the metals iron, sodium, calcium, magnesium, manganese and aluminum are also present in sufficient quantities. The oversupply of phosphate, chloride and ammonia has decreased substantially over the past 20 years.

Dissolved organic carbon (DOC) and particulate organic carbon (POC) are often many times greater than the organic carbon found in living plankton, macrophytes, and fauna produced in streams. DOC measurements available from Lake Huron, the St. Clair and Detroit Rivers are in the range of 2-3 g/m^3. The POC entering the St. Clair-Detroit River system from Lake Huron is about 0.7 g/m^3. An average of 1.4 g/m^3 was measured at the mouth of the St. Clair River, and up to 2.0 g/m^3 were found in Lake St. Clair. A single POC sample from the mouth of the Detroit River was 3.8 g/m^3. Suspended solids increased by a factor of six between Lake Huron and Lake Erie, and bed load POC has not been studied, so 3.8 g/m^3 may underestimate POC in the Detroit River.

Although not measured during these studies, fecal coliform bacteria are of concern in the Detroit River because fecal coliform bacteria standards and criteria have been violated on both sides of the river. The Ontario objective is 100 counts/100 ml and the Michigan standard is 200/100 ml fecal coliform bacteria. Beaches have been closed or not developed because of this continuing problem.

Water Bioassays:

Seven day chronic bioassays measured the impacts of Detroit River near-bottom water on Ceriodaphnia. Reproductive success was significantly reduced (mean young produced/female) relative to Lake Michigan controls at all four test sites. Station 83 near-bottom water collected along the southwestern shore of Fighting Island produced the greatest reduction in the number of young produced/female (70 to 100% reduction) followed by stations 34 (along the west shore of the Trenton Channel), 53 (at the southern tip of Grosse Ile and 30CR (in Monguagon Creek). These reductions were most severe from July to September (36).

Considering both exceedences of water quality and impacts on biota, the pollutants of concern in water of the Detroit River, or that of its tributaries, include PCBs, chlorobenzenes, PAHs, total cadmium, total mercury, total lead, total zinc, and total phosphorus, in addition to fecal coliform bacteria.

Biota

i) Phytoplankton, Macrophytes and Zooplankton

Detroit River phytoplankton communities consist of low densities (500 cells per ml) of 82 species dominated by diatoms (8,10,37). Summer blue-greens contribute to phytoplankton community, but Detroit River picoplankton, a large component of the phytoplankton biomass, were not surveyed.

Activity causing habitat loss, such as filling or dredging, water or sediment contaminants or simply continuous elevated suspended solids that reduce macrophyte production, reduces desirable fish and wildlife production in the Detroit River and western Lake Erie. Macrophyte production was estimated at 16,410 metric tons of ash-free dry weight/yr (12). Only 25% is from emergents reflecting the limited habitat presently available.

Detroit River zooplankton populations (potential larval fish food) were 85% copepods with other zooplankton populations at very low relative abundances. Zooplankton densities were greater during the night than the day with typically patchy distribution with peak numbers between June and September (36,38). Zooplankton are a critical component in the diet of many larval and some juvenile fish. Poor diversity or depressed zooplankton production is likely to result in poor fish year classes during naturally occurring or contaminant related stressful conditions.

ii) Benthic Macroinvertebrates

Diversity and abundance of benthic macroinvertebrates are lower in the deep, fast flowing areas of the river because the substrate is either difficult to adhere to or burrow into. Shallower, uncontaminated zones containing macrophytes are likely to yield the greatest diversity. The greatest densities are reached in strongly enriched, unconsolidated sediments where oligochaetes are often monotypic.

The Detroit River benthic community upstream of Zug Island is diverse and dominated by pollution intolerant organisms with the exception of the Windsor shoreline. Adjacent to Zug Island, the community is severely impacted, and downstream, especially in the Trenton Channel, the community is dominated by pollution tolerant oligochaetes (13,15,39). The Ontario shoreline is considerably better as evidenced by the presence of pollution intolerant mayflies (11,15).

Schloesser, et al. (40) demonstrated an inverse relationship between Hexagenia abundance and visible oil in sediments of the Connecting Channels. Edsall et al. (41) found Hexagenia averaging 2,086 mg dry wt/m^3/yr at three locations where sediment contaminants did not exceed sediment guidelines, but only 364 mg dry wt/m^3/yr where as many as seven contaminants exceeded these guidelines.

Native Detroit River *Lampsilis radiada siliquoidea*, at 4 stations along the Ontario shore, contained lead and cadmium ranging from 3 to 9 and 3.5 to 6.2 mg/kg respectively (42). PCBs ranged from 73 to 196 ug/kg at these same locations. Octachlorostyrene (OCS) in clams ranged from 31 to 57 ug/kg, 70 to 285 times higher than sediment concentrations.

Caged Elliptio compalanta placed in the Detroit River for 18 months accumulated HCB and OCS and a variety of organochlorine pesticides (43). Highest levels were found along the western Detroit River shore near Conners Creek, the lower Trenton Channel and the Rouge River. PCBs were the major organochlorine clam contaminant, ranging from 20 to 293 ug/kg along the Michigan shore; clams from the Ontario shore had much lower concentrations (Figure IX-8).

Polynuclear aromatic hydrocarbons (PAHs) were also reported in caged clams at elevated levels along the Michigan shoreline and downstream in the Trenton Channel ranging from 136 to 772 ug/kg. Along the Ontario shoreline PAHs ranged from 52 to 274 ug/kg.

iii) Fish

Five fish species were collected from six sites in the lower Detroit River and examined for external lesions, necropsied for internal abnormalities and tissues removed for histological examination (Figure IX-9) (44). Several neoplasms and pre-neoplastic lesions were found in Detroit River brown bullhead, walleye, redhorse sucker, white sucker and bowfin. Bullhead and walleye were the only two species exhibiting dermal/oral neoplasms at 14.4 and 4.8 %, respectively. Other species exhibited liver neoplasms with highest incidence observed for bowfin at 15.4%. In bullhead, no relationships between dermal/oral and liver tumors were found. Tumor incidence was age/size related since tumors were present in bullheads over 25 centimeters and in walleye over 50 centimeters. Of the six sites examined, bullheads at Point Hennepin and Gibraltar Bay, exhibited the greatest tumor incidence at 36.4% and 33.3%, respectively. Bullheads near Mud Island north of the Trenton Channel and in the lower end of the Trenton Channel did not exhibit tumors.

In this study (44), bile was analyzed for benzo(a)pyrene (BaP) and its metabolites. All species had BaP or its metabolites in their bile. Walleye and redhorse sucker contained the greatest BaP concentrations, with concentrations in bullhead substantially lower. The greatest BaP concentrations were in bowfin and redhorse sucker from Point Hennepin and in brown bullhead, walleye, and white sucker from Mud Island.

Contaminants exceeding relevant guidelines were found in the flesh of fish in the Detroit River. PCBs were found in carp, with concentrations exceeding the Ontario Ministry of Environment (OMOE) and Ontario Ministry of Natural Resources fish consumption guidelines and the U.S. Food and Drug Administration action level of 2 ppm, as well as the GLWQA specific objective of 0.1 ppm (Figure IX-10). PCBs in young-of-the-year spottail shiners were found at significantly ($p<0.01$) higher concentrations along the Michigan shoreline than along the Ontario, suggesting Michigan inputs of PCBs (45). High concentrations of mercury were found

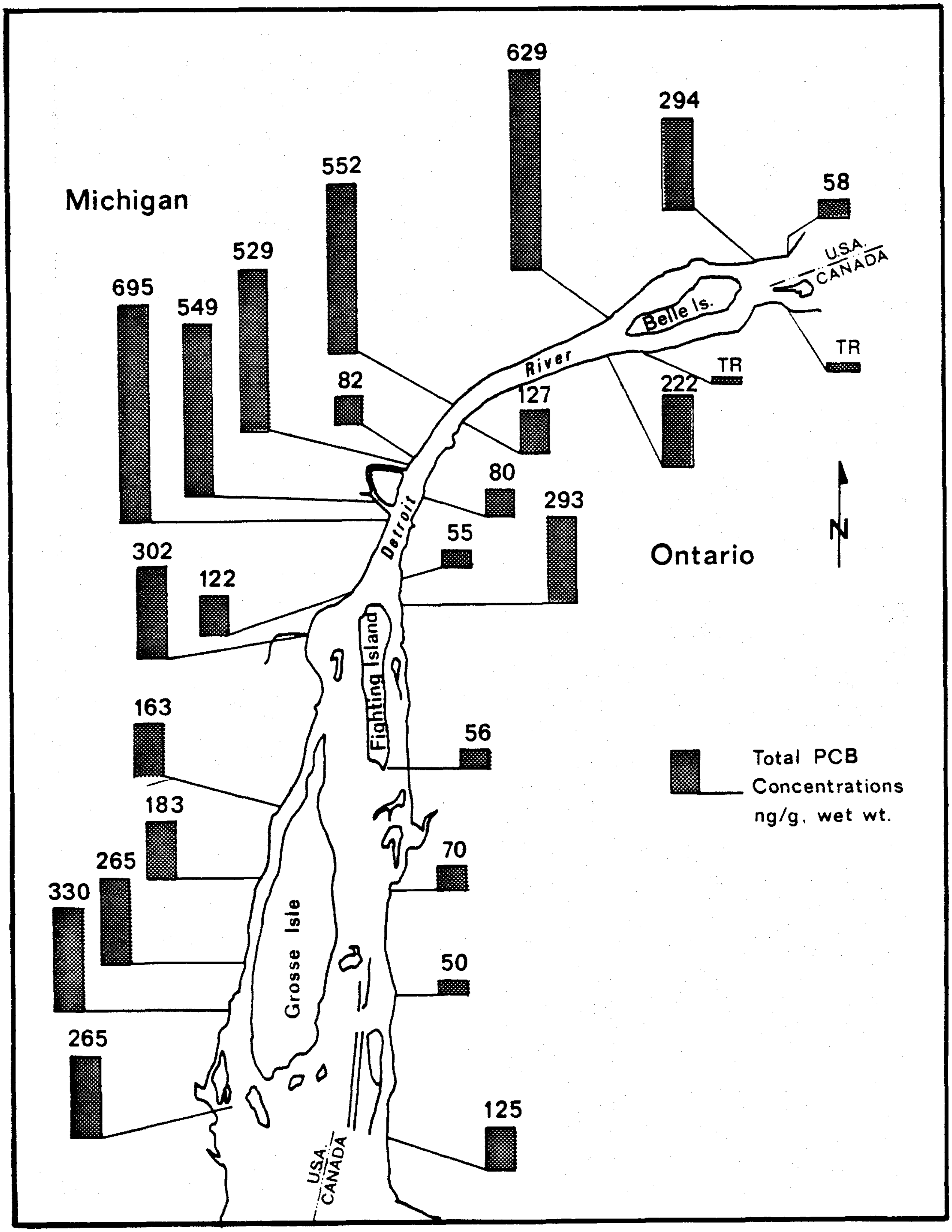


FIGURE IX-8. Total PCB concentrations in Detroit River caged clams.

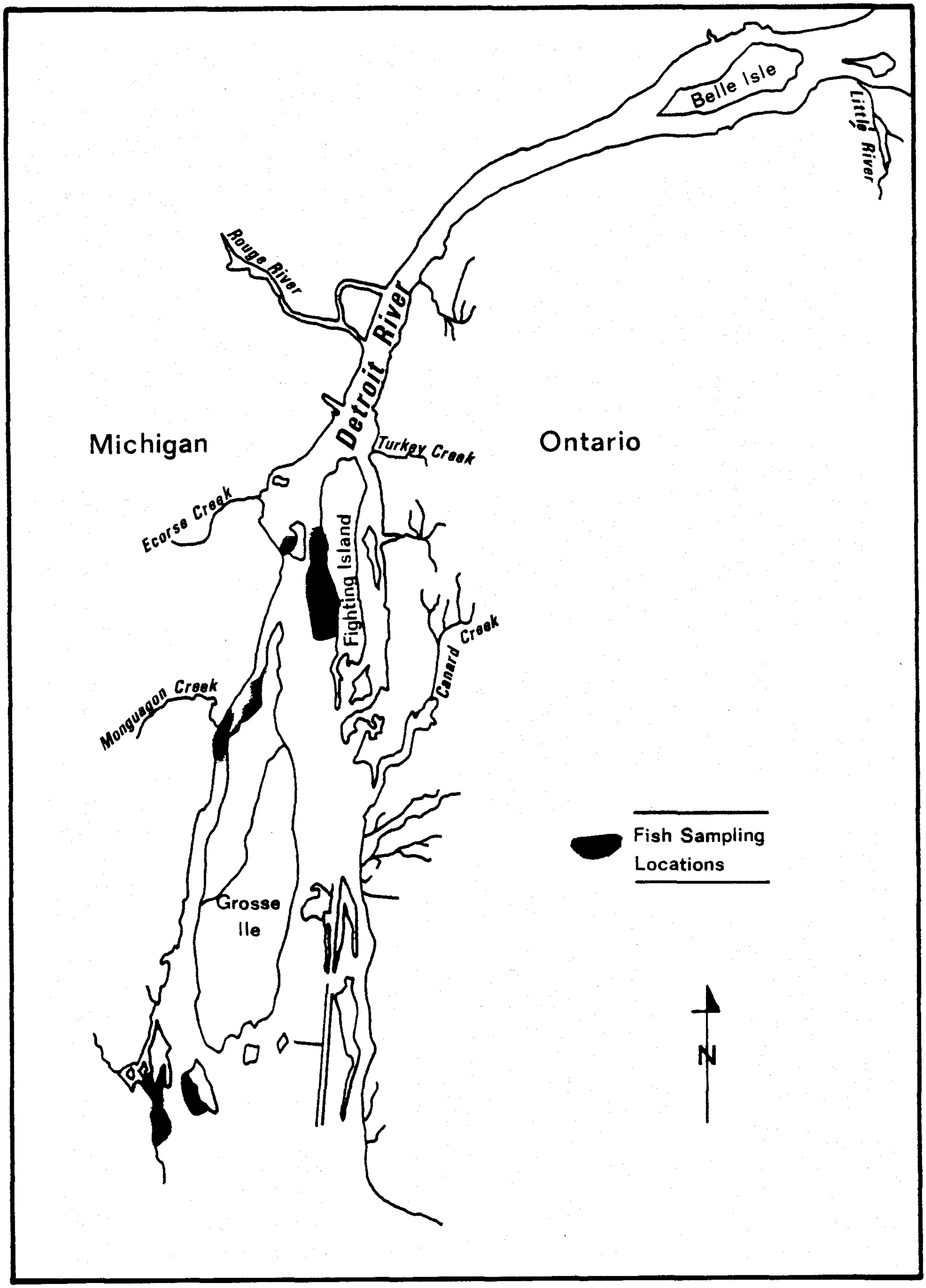


FIGURE IX-9. Fish sampling locations for tumor analysis.

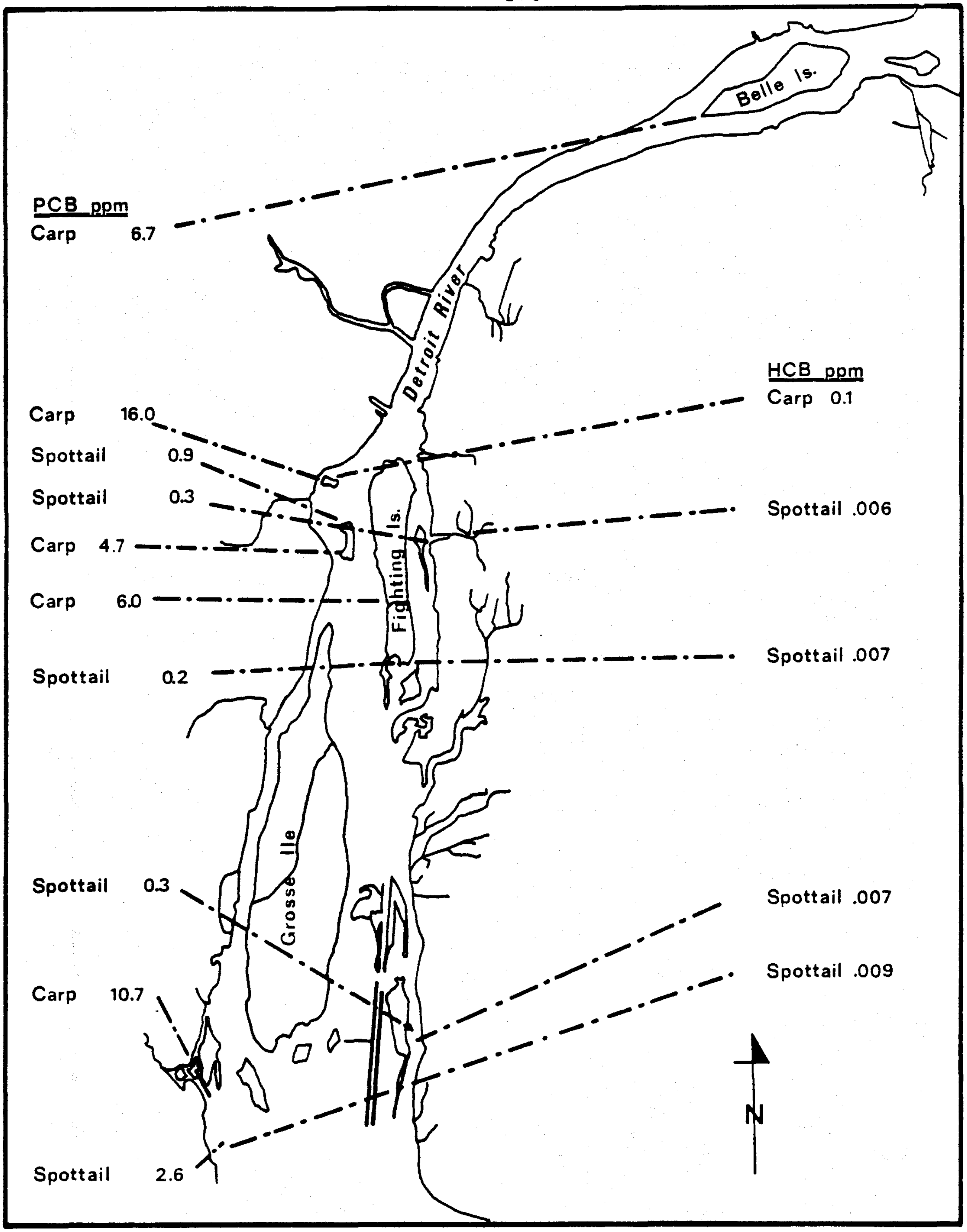


FIGURE IX-10. PCBs and HCB concentrations in Carp and Spottails shiners.

in the edible portion of several species of fish (rock bass, freshwater drum and walleye). Concentrations were above both the GLWQA specific objective and the Ontario fish consumption advisory of 0.5 ppm (46,47). Other chemicals, such as HCB, OCS, chlordane and DDT metabolites, were uniformly distributed in Detroit River spottail shiners, suggesting a diffuse source (45).

iv) Birds

Thirteen wintering lower Detroit River diving ducks (7 lesser and 3 greater scaups and three goldeneyes) were analyzed for organic chemical contaminants (48). Total PCBs ranged from 2 to 20 mg/kg, indicating significant bioaccumulation. Highest mean concentrations of other residues in ducks were 1.7 mg/kg hexachlorobenzene in goldeneyes, and trans-nonachlor (0.33 mg/kg) and 4,4' DDE (1.3 mg/kg) in greater scaups. Similar chemical residues were also found in some tern species. Concentrations of total PCBs in Detroit River seston (5.2 mg/kg) and oligochaete worms (0.44 mg/kg) mg/kg) were also noted.

Herring gull eggs from Fighting Island contained high PCB and HCB concentrations in 1985 and 1986 studies. Detroit River herring gull eggs contained the lowest concentrations of dieldrin, heptachlor epoxide, photomirex, oxychlordane and alpha hexachlorocyclohexane in the Great Lakes (49).

Detroit River waterfowl surveys completed in 1982 showed dramatic declines in merganser and black ducks, and dramatic increase in canvasbacks and redheads since 1974 (50). It was postulated that loss of emergent macrophytes caused by high Great Lakes water levels caused this reduction in dabbling ducks.

In summary, the pollutants of concern in Detroit River biota include PCBs, PAHs, HCB, OCS, mercury, lead, cadmium and oil and grease. Other biota concerns include habitat alteration and fish tumors.

Sediment Quality

i) Sediment Characteristics

Sediments in the Detroit River are generally sandy, consolidated clay or bedrock because of the relatively high flow velocities. Sediment particle size analysis conducted in 1980 revealed that surficial sediments were generally sand, but gravel dominated areas of high velocity along the Detroit waterfront, the entrance of the Trenton Channel and the upper Amherstburg Channel. Fine-grained samples were collected in slow waters near tributary mouths. Silts and clays were found downstream of Zug Island, in the Rouge River, the Trenton Channel near Trenton and the Detroit River mouth (51,52).

Detroit River sediment thickness over bedrock revealed a maximum sediment thickness of 33 m near Belle Isle, which declined steadily southward to nearly zero in the Trenton Channel and zero in the main channel (53). The outer and Amherstburg Channel silt layer averaged 0.45 to 0.50 m near Lake Erie and zero in the Amherstburg Channel at Bois Blanc Island and in the Ballard Reef Channel.

The Michigan Detroit River tributaries which were not sampled in 1982 were sampled in 1985, revealing fine-grained, anthropogenic sediments frequently of sludge-like consistency (54,55). Samples in Monguagon Creek and downstream of the Rouge River contained very fine sands, silt, and coarse sand and gravel. The upper Rouge River sediments were coarser than elsewhere, consisting of medium to fine sands with little very fine sand sediments. Conners Creek sediments also had only minor amounts of fine to very fine sands. Studies conducted in 1986 at 47 sites (56,57), generally confirmed the earlier findings.

ii) Sediment Transport

Detroit River average main channel velocities are 0.49 to 0.88 m/sec, but surface velocities may be nearly twice that rate in the main channels (0.9 to 1.2 m/sec)(58). Sand is transported in the main channels when the velocity exceeds 0.42 m/sec, while along the shore and in shallow water areas, where velocities may drop to 0.25 m/sec or less, sand deposition occurs. Navigation channel bottoms are scoured by currents leaving few sediments to resuspend, and no significant relationships between ship passage and turbidity has been found (59).

A field portable shaker device was used to measure sediment resuspendability at eight Trenton Channel locations from Monguagon Creek to Celeron Island. Lick et al. predicted that resuspension could occur regularly in the Trenton Channel (60). Direct instantaneous measurements of flow velocity, turbidity and sediment concentration at four locations in the Trenton Channel using instrumented towers assisted the above researchers (61).

iii) Navigation and Dredging

Until recently, the entire Detroit River commercial navigation system was dredged by the U.S. Army Corps of Engineers (USCOE) to a depth of 8.2 m below low water datum. At present, the Ontario portion of these channels are dredged by Public Works Canada under contract to Transport Canada. Before enactment of the Rivers and Harbors Act of 1970, nearly 3 million m^3 of dredged materials were disposed of in the open lake at two sites in Lake Erie south of the Detroit River mouth (62). In addition, an unknown amount of Detroit River dredged materials were placed in Lake St. Clair, near the head of the Detroit River. Since 1970, about 30,100 m^3 of polluted dredged materials were placed on

Grassy Island. From 1979 to 1984, 3.1 million m^3 of dredged material were deposited in the Pointe Mouillee confined disposal facility (CDF) near the Huron River mouth (58). In 1985, 814,000 m^3 of polluted Detroit River material was scheduled for disposal in the Point Mouillee CDF. Rouge River sediments, since 1950, have been placed on Grassy Island (62). Some polluted dredged materials were also disposed of along the lower Raisin River prior to 1979. Mud Island, a small containment site near Grassy Island, was also used for dredged material disposal.

iv) Sediment Contamination

Results of the six major surveys conducted since 1982 include contaminant chemistry at approximately 135 sites (51,54,55,63,64, 65,66,67,68,69,70,71,72,73). For ease of presentation, the Detroit River was divided up into seven subareas (Figure IX-11). Because the purposes for the survey, sampling gear, analytical methods, depth of sample collection, compositing techniques and sampling locations varied considerably between the studies, comparison of these data from year to year may not be entirely valid. However, an attempt was made to make some comparison.

Organics - Polychlorinated Biphenyls:

High total PCB concentrations were found by six surveys in all subareas except subarea 7 (Table IX-2, Figure IX-11). The highest mean sediment PCB concentrations were found in subarea 2, just below Belle Isle, where 5 of 10 samples exceeded 10,000 ug/kg in 1986. These were associated with sewer system outfalls, and indicate that combined sewer overflows have historically been, and may still be, an important source of PCBs (64).

The 1984 analyses of Oliver and Pugsley (74) noted localized areas of high concentrations of PCBs downstream of the Detroit WWTP and the Rouge River (in subarea 3), at concentrations higher than reported in 1980 (75), assuming the methodologies of the 1980 and 1984 studies were comparable. Comparison of 1982 and 1985 collections are supportive of the conclusion that subarea 2 sources were more significant than the Rouge River. Rouge River sediments collected at the mouth in 1986 revealed total PCBs up to 3,500 ug/kg (76). Samples collected downstream of the Detroit WWTP outfall and off the Rouge River mouth in 1985 and 1986 revealed PCBs up to 2,840 ug/kg near Zug Island (28). Concentrations up to 3,800 ug/kg were found in the Ecorse River (subarea 4). The highest concentrations in the navigation channel (subarea 4) was 140 ug/kg, between Grosse Ile and Fighting Island (77). Sediments analyzed from along the Windsor waterfront showed PCB concentrations ranging from less than 1 ug/kg to 370 ug/kg.

Sediment collections made in 1982 and 1985 also indicate PCB sources in subarea 6, the Trenton Channel. Highest levels were

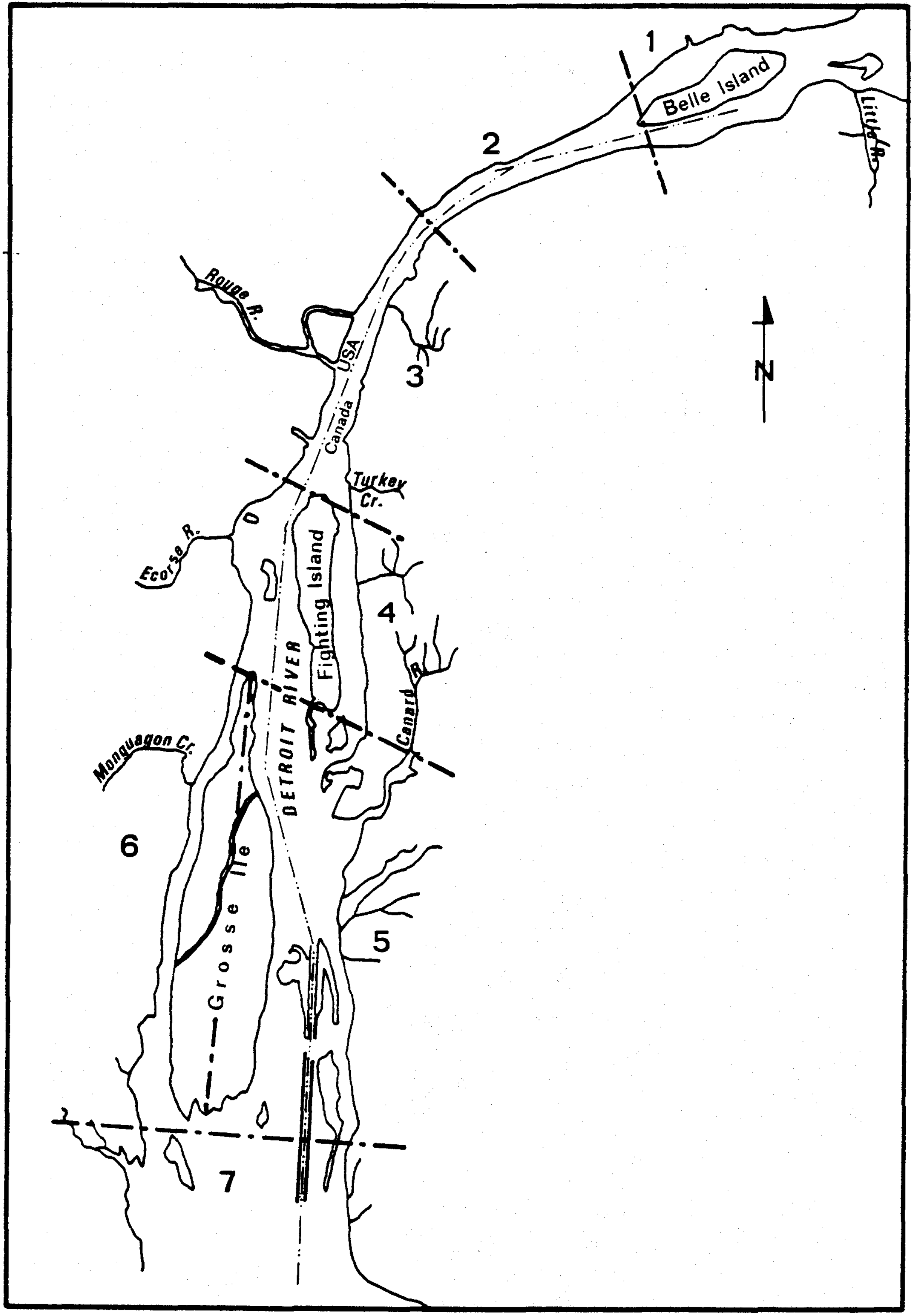


FIGURE IX-11. Detroit River sub-areas for sediment sampling.

TABLE IX-2

Polychlorinated biphenyl (PCB) concentrations in Detroit River sediments (ug/kg)[1,2].

SUB-AREA[3]		MDNR	OMOE	EPA82	EPA85	DOE	U.S.FWS
1	MAX	2900	420	9133	2020	470	358
	MIN	100	35	116	962	0	0
	MEAN	674	110	2351	1491	91	79
	n	9	7	7	2	6	8
	SD	608	524	2704	529	170	111
2	MAX	4000		12010		190	5410
	MIN	1910		6200		190	153
	MEAN	147		9636		190	1494
	n	10		3		1	4
	SD	10561		2705		0	2261
3	MAX	4800	1815	9647	2213	7900	4000
	MIN	970	25	1229	958	7	135
	MEAN	3007	551	3901	1538	1506	1166
	n	7	8	8	7	10	4
	SD	1357	524	2609	399	2921	1637
4	MAX	1000		12810	588	8000	1038
	MIN	290		0	206	41	0
	MEAN	645		4095	417	1462	274
	n	2		25	3	6	8
	SD	355		3815	158	2927	357
5	MAX		11760			320	957
	MIN		40			3	0
	MEAN		5900			85	961
	n		2			8	10
	SD		5860			107	319
6	MAX			13870	1590	1400	9130
	MIN			2350	149	29	336
	MEAN			7526	1090	642	2471
	n			6	2	6	6
	SD			9988	440	437	3093
7	MAX			2827	604	510	359
	MIN			22	368	10	154
	MEAN			985	509	158	267
	n			8	8	6	7
	SD			1303	10218	188	87

n = number of samples.

[1] Kizlauskas and Pranckevicius (63).

[2] The six surveys were performed by the Michigan Dept. of Natural Resources (MDNR), Ontario Ministry of the

in Monguagon Creek (13,870 ug/kg), although very high PCB concentrations were found near BASF/Federal Marine Terminal Properties and below McLouth Steel, near Trenton. Tributary data collected in 1985 also targets Monguagon Creek as a PCB source, with concentrations in the creek of up to 1,530 ug/kg (55). Since PCB concentrations of up to 9,130 ug/kg were reported in the Trenton Channel proper, other sources are contributing PCBs to the Trenton Channel in addition to Monguagon Creek (56).

Bottom sediments from Ontario tributaries obtained during the 1984-1985 survey revealed PCB concentrations of 1,305 ug/kg, 248 ug/kg and 20 ug/kg at the mouths of Turkey Creek, the Little River and the Canard River, respectively (5).

Many of these PCB sediment concentrations in the Detroit River and its tributaries, in Michigan and Ontario (particularly adjacent to and downstream of Detroit, Windsor and Amherstburg and in the Trenton Channel), exceed dredging guidelines. Guidelines exceeded include the OMOE dredging guidelines (50 ug/kg), the U.S.EPA dredging guidelines (10,000 ug/kg) and are higher than the guidelines recommended for Lake Erie by the Dredging Subcommittee of the Great Lakes Water Quality Board (up to 252 ug/kg).

Hexachlorobenzene:

Sediments collected in 1982 and 1985 in subareas 3, 6 and 7 contained hexachlorobenzene (HCB) exceeding 100 ug/kg. Concentrations of HCB in 1985 downstream of Monguagon Creek ranged from 26 to 140 ug/kg. Inputs from the St. Clair River are probably minor since loadings between the St. Clair River mouth and the head of the Detroit River were reduced at least 95%. Increases noted within the Detroit River may arise through diffuse or unknown minor inputs. The highest concentrations of HCB were found, in Michigan at the mouth and downstream of the Rouge River and in the Trenton Channel; and in Ontario adjacent to Amherstburg and east of Fighting Island. There are no dredging guidelines for HCB.

Polynuclear Aromatic Hydrocarbons:

Polynuclear aromatic hydrocarbon (PAH) analyses were performed on Detroit River sediments in 1982 and 1985. Total PAH values ranged from 620 to 265,000 ug/kg along the Michigan shore downstream of Belle Isle. High total PAH levels (up to 125,000 ug/kg) were also reported in the lower Rouge River. In 1985, PAHs were reported in the Detroit Dearborn Channel and all Michigan Detroit River tributaries, ranging from a low concentration of 600 ug/kg to a high concentration of 600,100 ug/kg in Monguagon Creek. Most tributary PAH samples were dominated by 3-, 4-, and 5-ring PAH compounds. Two-ring naphthalenes were found in appreciable quantities only in the Monguagon Creek and the Rouge River. There are no dredging guidelines for total PAHs.

Phenols:

Phenols ranged from nondetectable to 44,000 ug/kg in localized areas within subarea 6 along the Michigan shore. High levels were generally found in subareas 1, 2, and 3 near the Edward C. Levy Company. There are no dredging guidelines for total phenols.

DDT and Metabolites:

DDT analyses were performed on Detroit River sediments collected in 1982 and 1985. In 1982, the highest total DDT concentrations were found near Belle Isle (2,265 ug/kg). In 1985, total DDT was highest in subarea 1. DDT and metabolites were found in all 1985 samples ranging from 7 to 482 ug/kg (Conners Creek). High levels of total DDT were also found in the Rouge River mouth and Trenton Channel, suggesting recent additions that have not been degraded.

Sediments from the mouths of Ontario tributaries generally contained less than 5 ug/kg p'p'-DDT, while breakdown products p'p'-DDE and p'p'-DDD approached maximum levels of 36 ug/kg and 20 ug/kg, respectively. There are no dredging guidelines for DDT or its metabolites.

Other Pesticides:

Approximately 34 other pesticides were analyzed in sediments in 1985, 14 of which were found in bottom sediments. Alpha-chlordane, gamma-chlordane, dieldrin and methoxychlor were most commonly found. Highest dieldrin levels were found in subarea 5, at the Canard River mouth (30 to 55 ug/kg). Methoxychlor and gamma-chlordane were highest in sub-area 3. Maximum levels in bottom sediments for methoxychlor were 86 ug/kg while gamma-chlordane levels were 10 ug/kg.

Several chlorinated pesticides were found in the Detroit River sediments collected in 1985 with highest levels in Monguagon and Conners Creek sediments. Highest levels of trifluralin (19 ug/kg) were present in the Frank and Poet Drain and the only occurrences of DCPA (Dacthal) were in the Ecorse River and the Detroit River Dearborn Channel, a tributary to the Rouge River. Dieldrin (14 ug/kg) was highest in the Detroit-Dearborn Channel, while aldrin was found primarily in the Rouge River and Conners Creek sediments.

Beta-BHC concentrations were elevated at Belle Isle (170 ug/kg) and near the Ecorse River (195 ug/kg) in 1982 collections. Gamma-chlordane was found throughout the study area with peaks at Conners Creek and the Ecorse River. Concentrations of other pesticides in sediments showed no distinct relation to potential sources.

Phthalate Esters:

Phthalate esters were found in 14 of the 20 Detroit River tributary samples in 1985. Highest levels were found on the Michigan side in Conners Creek, the Rouge River and near the Federal Marine Terminals and BASF properties (17,600 ug/kg). There are no dredging guidelines for phthalate esters.

Volatile Organic Compounds:

Volatile organic compounds were found in 15 of 20 sediment samples analyzed from the Detroit River tributaries in 1985. Dichloromethane appeared in 9 of the 20 samples ranging from 0.8 to 6.9 ug/kg in Monguagon Creek where the great variety of volatile organic compounds were found. Highest concentrations were found in subarea 7, in the Frank and Poet Drain. There are no dredging guidelines for specific volatile compounds.

Metals - Mercury:

Mercury analyses were performed on sediments collected in 1982, 1985 and 1986. The highest levels in subarea 6 (Trenton Channel) were located below the mouth of Monguagon Creek near the Edward C. Levy Company (55.8 mg/kg). However, a 1985 sample in Monguagon Creek (1.5 mg/kg) indicated that Monguagon Creek was not a prominent mercury source. Mercury analyses of sediments in subarea 6 exceeded 3.0 mg/kg, while bottom sediments in subarea 1 exceed 2.5 mg/kg. U.S.EPA and Ontario dredging guidelines for mercury were exceeded at many sampled locations along the Michigan and Ontario shores throughout the length of the river.

Lead:

Lead concentrations exceeded 200 mg/kg in subareas 1, 2 and 6 in 1982 and 1985. Tributary sediment levels were highest in Conners Creek and the Detroit-Dearborn Channel of the Rouge River, ranging from 500 to 750 mg/kg, but declined downstream to less than 100 mg/kg in subarea 1. Sediment lead concentrations for samples collected in 1982 and 1985 were similar at subarea 6 above Elizabeth Park Canal (1,750 mg/kg). Dredging guidelines were exceeded along most of the Michigan shore and downstream of Windsor and Amherstburg in Ontario.

Arsenic:

Sediment data for 1982 and 1985 indicate that Detroit River sediments contain approximately 10 mg/kg arsenic throughout, with elevated levels of 36 and 54 mg/kg found at Elizabeth Park Canal and the Rouge River, respectively. The uniformity of the data suggests no major point or nonpoint sources of arsenic to the Detroit River; however, dredging guidelines for arsenic were exceeded.

Cadmium:

Peak cadmium concentrations were in subareas 1, 3 and 6, ranging between 25 and 96 mg/kg. Cadmium concentrations in suspended and bottom sediments were approximately equal, perhaps indicating a persistent local source. Dredging guidelines for cadmium were exceeded along the full length of the Michigan shore (especially adjacent to Detroit and in the Trenton Channel) and adjacent and downstream of Windsor and Amherstburg.

Copper:

Sediment data from 1986 show copper peaks exceeding 100 mg/kg in subareas 2,3,4, and 6. Sediment data for 1985 showed generally higher copper levels in subarea 1 and 3, than in 5 or 7 (approximately 100 mg/kg versus approximately 50 mg/kg). In 1982 and 1985, copper values exceeded 700 mg/kg in subarea 3, Turkey Creek and the Rouge River. Dredging guidelines for copper were exceeded along the Michigan and Ontario shores, specifically adjacent to the cities of Detroit, Windsor and Amherstburg and in the Trenton Channel.

Zinc:

Sediment data for 1986 indicate levels of zinc exceeding 500 mg/kg in subareas 2 and 6. The 1982 and 1985 sediment data show zinc exceeding 1,000 mg/kg in subareas 1, 2, 3 and 6. The Rouge River, Conners, Turkey and Monguagon Creeks all appear to be contributing zinc to the Detroit River. Dredging guidelines for zinc were generally exceeded at the same locations as for copper.

Chromium:

Sediment data for 1986 indicate chromium levels exceeding 100 mg/kg in subareas 2 and 6. The 1985 sediment data show tributary sediments as chromium sources in subareas 1 and 3, where suspended and bottom sediments contained greater than 300 mg/kg total chromium, indicating a continuing source. Chromium levels were nearly twice as high in the Detroit Dearborn Channel of the Rouge River as the lower Rouge River sediments. The 1982 chromium peaks were not apparent in the 1985 subarea 6 sediments samples, perhaps indicating some source control. Dredging guidelines were exceeded at several locations in the Detroit River (as per copper).

Nickel:

High nickel levels (500 mg/kg) were found in bottom sediments from the Ontario tributary in subarea 1, the Little River. Sediment nickel levels exceeded 50 mg/kg in subareas 2, 3 and 6 in 1986, while 1985 data indicate subareas 1 and 3 as having high nickel contamination. The high nickel levels found during the 1982 survey in subareas 4 and 6 were not evident in 1985 data. Dredging Guidelines were exceeded at several locations (as per copper).

Manganese:

Manganese levels exceeding 1,000 mg/kg were found in subareas 3,4 and 6 (the Rouge and Ecorse Rivers and Monguagon Creek) in 1985, which was about the same as in 1982. High manganese in subarea 7 in 1982 was not reported in 1985, but 5,000 mg/kg manganese was reported in the Ecorse River in 1985 that was not noted in 1982. Dredging guidelines for manganese were exceeded along the Michigan shore. Manganese concentrations in Ontario sediments were not determined.

Iron:

Sediment concentrations of iron from the 1982 survey reached 180,000 mg/kg above Elizabeth Park (subarea 6). Iron levels along the Michigan shore were very high in 1982, with some stations in all subareas exceeding 25,000 mg/kg. The highest iron concentration found during the 1985 survey was 120,000 mg/kg from the Ecorse River. Dredging guidelines were exceeded along the Michigan shore. Iron concentrations were not determined for sediments along the Ontario shore.

Cobalt:

Cobalt was analyzed in 1982, 1985 and 1986. The 1986 cobalt concentrations were relatively uniform with a slight increase downstream. Highest levels (over 10 mg/kg) were found in subarea 6. The 1982 samples were also relatively uniform, although slightly higher than 1986 samples. The highest cobalt levels were found in the 1985 tributary samples in subarea 3 in the Detroit Dearborn Channel (17 mg/kg). No exceedences of dredging guidelines were noted.

Nutrients and Conventional Pollutants - Cyanide:

In 1982, cyanide levels exceeding 10 mg/kg were present in subareas 1,3 and 6. In 1985, high cyanide concentrations were present in subareas 1 and 3 (Conners Creek and Detroit Dearborn Channel). Lower levels were found in the Lower Rouge and Monguagon Creek, indicating that sources other than Monguagon Creek were responsible for high levels found in subarea 6 in

1986. Exceedence of dredging guidelines for cyanide occurred in Michigan and Ontario adjacent to Detroit, Windsor and Amherstburg and in the Trenton Channel.

Oil and Grease:

The highest oil and grease levels found during the 1986 survey were reported in subarea 6 with concentrations over 24,000 mg/kg. In 1985, oil and grease levels were highest in subareas 1 (44,800 mg/kg) and 3 (28,600 mg/kg), and generally decreased downstream from the Detroit River head to its mouth. In 1982, peak oil and grease levels exceeding 30,000 mg/kg were present in subareas 1, 2,3 and 6. Dredging guidelines for oil and grease were exceeded in many areas, primarily along the Michigan shoreline adjacent to and downstream of Detroit and in the Trenton Channel, as well as adjacent to the cities of Windsor and Amherstburg.

Total Phosphorus:

Most total phosphorus concentrations in sediments were lower than 5,000 mg/kg. Along the Michigan side, phosphorus levels up to 6,200 mg/kg in 1982 were found in subarea 6, whereas the highest level in 1985 (6,200 mg/kg) was found in the Detroit Dearborn Channel. Exceedences of phosphorus dredging guidelines were noted in the majority of samples analyzed in both Michigan and Ontario.

Ammonia:

The 1982 concentrations of ammonia exceeded 500 mg/kg in subareas 1,3,4, and 6 with highest levels (1,400 mg/kg) in the Rouge River. In 1985, ammonia levels were below 500 mg/kg in all sub-areas except subarea 1, where 900 mg/kg was found in Conners Creek. Dredging guidelines for ammonia were exceeded along the Michigan shore. Ammonia concentrations were not determined for sediments from the Ontario shore.

v) Sediment Bioassays

Certain Detroit River depositional zone sediments have demonstrated a range of toxicity to various forms of aquatic life, and some Detroit River sediments have been tentatively classified as hazardous waste. Figure IX-12 shows the status of macrobenthic communities along the Detroit River. Bacterial bioluminescence (*Phosphobacterium phosphoreum*) assays (Microtox^R) conducted on Detroit River sediment porewater provided dose-response relationships with degree of toxicity inferred by a decrease in light emission. Figure IX-13 indicates that localized western near-shore Trenton Channel stations caused a 50% reduction in bioluminescence with less than 100% porewater while other stations elicited lesser responses and 30 percent of the stations were nonresponsive (78).

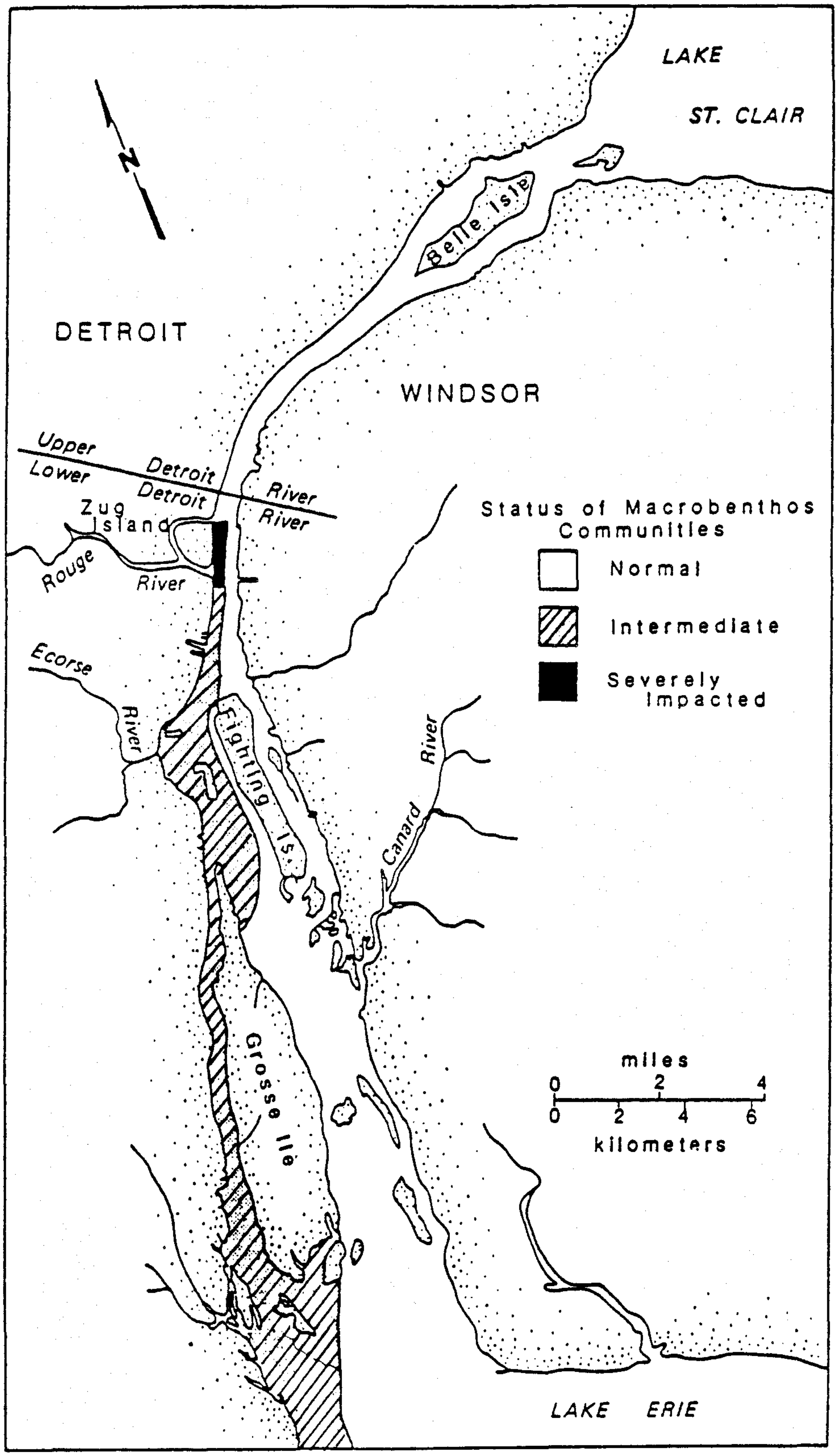


FIGURE IX-12. Macrobenthos distribution in the Detroit River.

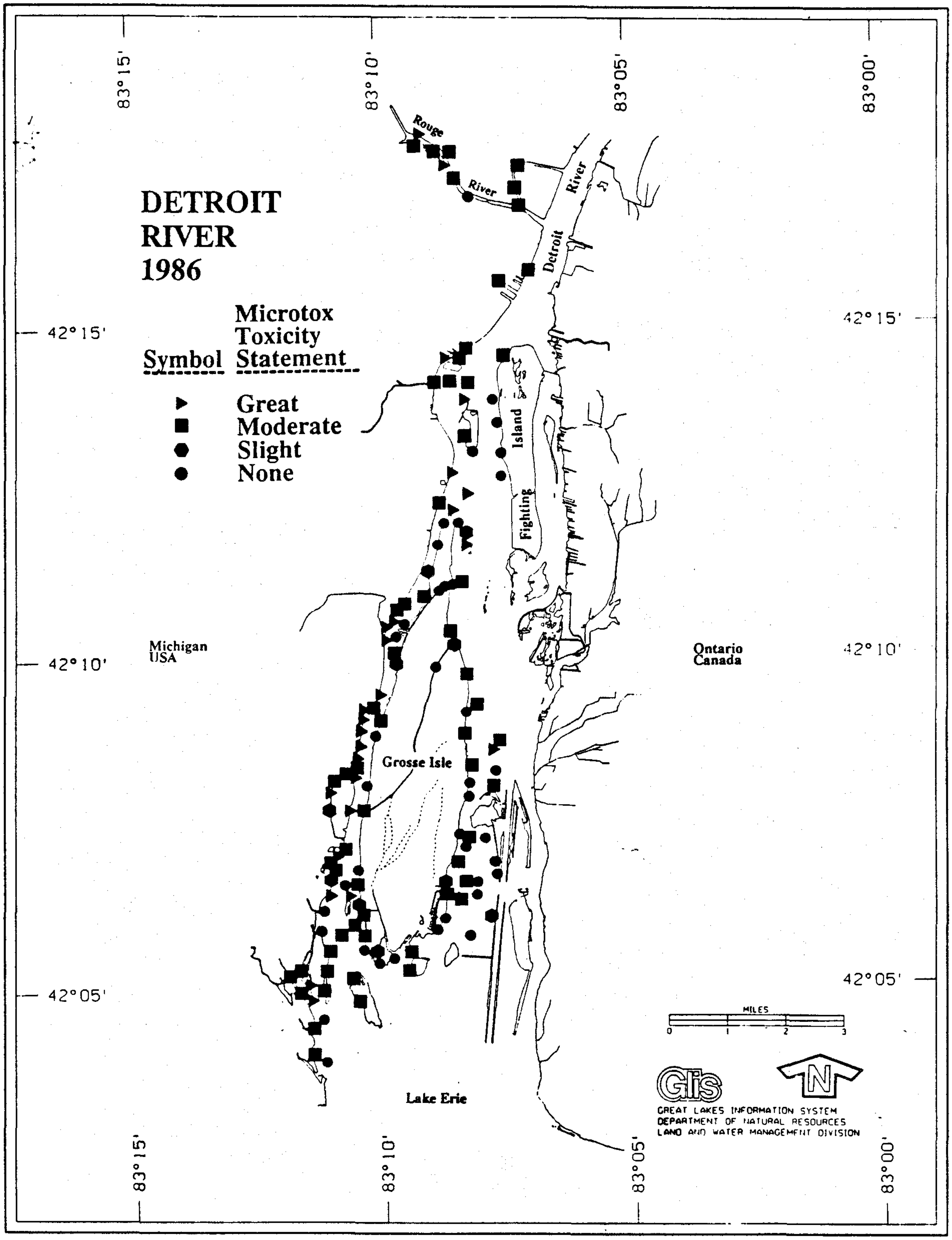


FIGURE IX-13. Detroit River sediments porewater Microtox toxicity.

Mutagenic potential of sediment extracts were measured by the bacterial Salmonella/microsome assay (Ames test). Some mutagenicity was noted at 28 of 30 Detroit River stations, with the most strongly mutagenic sediments from the Trenton Channel (Figure IX-14). Moderately mutagenic sediments were primarily concentrated in the lower river near Lake Erie (44).

Bacterial and phytoplankton bioassays were conducted on control sediments and water along the west end of Fighting Island and the southern end of Grosse Ile, measuring changes in the rate of food uptake in bacteria and phytoplankton photosynthesis. Bacterial uptake rates were suppressed by control and contaminated sediments when sediments exceeded 12 to 1,200 ppm of suspended solids. At 120 ppm suspended solids, control sediments inhibited uptake by 50% whereas contaminated Trenton Channel sediments inhibited uptake by 75%. The impact of sediments on phytoplankton was similar to bacteria, but less accentuated (36).

Daphnia pulicaria feeding was generally inhibited 50 to 75% by Detroit River elutriate with an approximately three fold decrease in ingestion rate at station 34, downstream of McLouth Steel near Trenton. Slight feeding suppression of the control at stations 83 (along the west shore of Fighting Island) and 53 (at the southern tip of Grosse Ile) were reported at high elutriate concentrations (36).

The acute toxicity of Detroit River sediment porewater to Daphnia magna was demonstrated in a study where ten of the thirty stations in the Trenton Channel caused 50% mortality in a 96-hour exposure to 50% or less concentration of porewater (78).

Ten day Chironomus tentans growth tests using whole sediments found the greatest growth inhibition (up to 95%) along the western near-shore Trenton Channel. Growth rates for these stations ranged from 0.02 to 0.08 mg/day, whereas reference stations and three other stations ranged from 0.48 to 0.53 mg/day (36).

Stylodrilus was used to determine avoidance response to Detroit River sediments. In control sediments, all worms burrowed and remained buried with no mortality. At other stations, 70% of the worms remained buried, but a slight increase in mortality rate was evident. At station 34, downstream of McLouth Steel near Trenton, only 10% remained buried, with a 53% mortality (36).

Chironomus tentans respiration, undulation, turning and crawling movements and rest responses to Detroit River sediments showed significant differences in escape, respiration and rest responses, relative to Lake Michigan control sediments. Escape time was higher and respiration and rest time were lower at these stations compared to the Lake Michigan sediments (36).

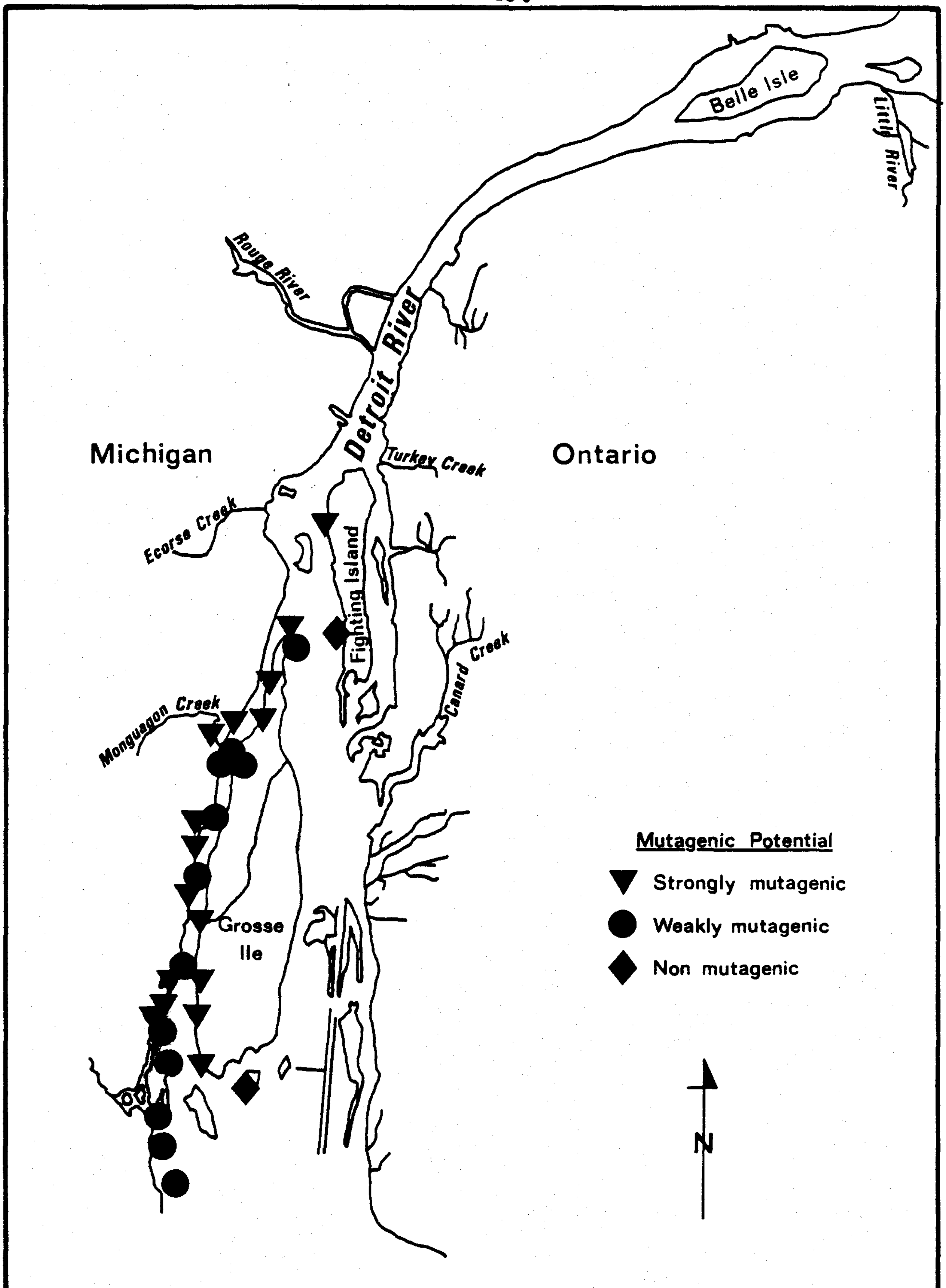


FIGURE IX-14. Mutagenic potential of Detroit River sediments (Ames test).

Feeding rates of larval channel catfish exposed to Detroit River contaminated and control sediments and sediment porewater indicate the greatest inhibition of feeding rates occurred from exposure to Trenton Channel sediments. There were no differences in feeding rates when porewater and water column assays were completed on Trenton Channel stations (36).

Late-eyed stage rainbow trout eggs were injected with serial dilutions of Detroit River sediment extracts; all sediment extracts increased embryo mortality two to three fold relative to the solvent carrier control. Incubated eggs and fry were monitored but increased mortality was not evident in the early sac fry stages. One year after injection, 3% of the survivors' livers exposed to Monguagon Creek sediment extract at 100 ug/egg had liver neoplasms (44).

Schloesser et al. (40) demonstrated an inverse relationship between Hexagenia abundance and visible oil in Detroit River sediments. Edsall et al. (41) found Hexagenia averaging 2,086 mg dry wt/m^3/year at three locations where sediment contaminants did not exceed dredging guidelines, but only 364 mg dry wt/m^3/year where as many as seven contaminants exceeded these guidelines. Both studies indicate that sediment contaminants had notable negative impacts on the benthic community.

In summary, sediments of the Detroit River were found to be severely impacted by a variety of compounds, including PCBs, HCB, PAHs, total phenols, total cyanide, oil and grease, total phosphorus, ammonia and metals (total mercury, total lead, total arsenic, total cadmium, total copper, total zinc, total chromium, total nickel, total manganese, total iron). In addition, some non-UGLCCS parameters were also found in sediments (pesticides, phthalate esters and volatile organic compounds). Several tributaries appear to be sources of many of these contaminants. Toxic effects of the sediments and sediment porewater on benthic biota were also noted by a variety of toxicity tests.

B. SPECIFIC CONCERNS

The specific chemicals which are impacting the Detroit River ecosystem, as determined in this study, and other concerns, are identified in this section. They are summarized in Table IX-3.

1. Conventional Pollutants

In the past, severe oxygen depletion in the Lake Erie hypolimnion was associated with excessive inputs of phosphorus, and corrective action was undertaken by most jurisdictions to reduce phosphorus loadings. Since the Detroit River is the major tributary to Lake Erie, all phosphorus loadings from the Detroit River are considered important. Concentrations of total phosphorus in the Detroit River have steadily decreased since the late 1960s and are presently below 20 ug/L. Tributary concentrations, however, still currently exceed ambient water quality guidelines.

Chloride concentrations in the Detroit River water were relatively constant, and not excessive; however, one industry which was found to be discharging high levels of chlorides (i.e., General Chemical) was not represented by the water quality survey. High chloride levels may encourage the growth of halophilic phytoplankton in the Great Lakes which could cause a shift in the phytoplankton community and upper trophic levels.

Fecal coliform bacteria are of concern because fecal coliform bacteria standards and criteria are routinely violated on both sides of the river. Beaches along both shores have been closed or not developed because of this continuing problem. Although not demonstrated in this study, ammonia is also problematic, since calculated levels of nonionized ammonia have periodically exceeded the chronic criteria for coldwater fisheries (0.02 mg/L) along the western Detroit River shoreline.

Phosphorus and ammonia concentrations in sediments exceeded dredging guidelines at a number of locations in the Detroit River and in some tributaries.

2. Organic Contaminants

Polychlorinated biphenyl (PCB) concentrations in the Detroit River were found at concentrations exceeding guideline levels. Although the levels are below acutely toxic concentrations, high persistence and bioaccumulative properties of PCBs may (and in fact has) resulted in bioaccumulation of PCBs in aquatic organisms. Similar findings are made for several organochlorine compounds, including hexachlorobenzene, dieldrin, heptachlor, heptachlor epoxide, chlordane and endosulfan. The effects of these contaminants may not be found in the Detroit River itself

TABLE IX-3

Specific concerns and use impairments in the Detroit River, 1988

Impairment or Concern	Causes of Impairment or Concern	Location where Impairment or Concern is Found	Probable Sources of Contaminants Causing Impairment or Concern
Consumption advisory for carp, rock bass, walleye and freshwater drum	Body burdens of PCB or mercury (Other organochlorine compounds and some pesticides may be present but have no criteria	Carp-whole river; other species-limited river sections for some larger sizes	Upstream of Detroit River Watershed; point and nonpoint sources; food chain
Changes in fish species composition and fish toxicity	Toxic concentrations of organic compounds, heavy metals and possibly ammonia in water and sediments	Primarily U.S. shoreline downstream of Rouge River, Detroit River Tributaries	Point and non-point sources; food chain; habitat changes
Tumors and deformities in fish	PNA's, PCB and other organochlorine contaminants, perhaps heavy metals	Primarily lower river and downstream of the Rouge River	Point and nonpoint sources; food chain
Elevated body burdens of organic contaminants in waterfowl and forage fish	PCB, HCB and other organochlorine compounds	Primarily lower Detroit River	Upstream Detroit River watershed; point and nonpoint souces; food chain
Elevated concentrations of organic contaminants in bird livers and eggs	PCB, HCB and other organochlorine compounds	U.S. Detroit River shoreline and Fighting Island	Point and nonpoint sources; food chain
Loss of fish and wildlife habitat	Bulkheading, filling, dredging navigation channels; organics and heavy metals; commercial and industrial development	Primarily along the U.S. Detroit River Shoreline and in navigation channels	Point and nonpoint sources; dredging/filling
Loss of aquatic animals	Contaminants? urbanization? habitat loss	All U.S. Shoreline and most of the Canadian shoreline	Point and nonpoint sources; urbanization? dredging/filling
Phytoplankton population changes	Chlorides and heavy metals	Chlorides-lower Detroit River especially Canadian shoreline Heavy metals-primarily U.S. shoreline and Trenton Channel	Industrial and municipal discharges
Zooplankton toxicity	Organic compounds and heavy metals	Where sediments are heavily contaminated, in Trenton Channel especially	Industrial and municipal discharges
Benthic macroinvertabrate community changes	Heavy metals and organic compound contamination in sediments and water, also nutrient enrichment and oil and grease	From Zug Island downstream along the U.S. shoreline, Trenton Channel and Windsor shoreline	Point and nonpoint sources
Aesthetic degradation-eutrophication	Nutrients, BOD5, oil and grease and organic and heavy metal contaminants	Near shore, U.S. Michigan side, downstream of CSO's and some Canadian and U.S. tributaries	Primarily municipal discharges and CSO's
Sediment contamination and potential loading to the water column	Organic and heavy metals and phenols	Primarily depositional zones near the U.S. shore, Trenton Channel, lower Detroit River and localized spots	Point and nonpoint sources; CSO's
Contaminated Groundwater loadings	Organics, heavy metals phenols, other?	At waste disposal sites	Primarily local industrial waste or spills
Loss of total body contact recreation	Fecal coliform bacteria	Tributaries and both shores of the entire length of the Detroit River into Lake Erie	CSO's, stormwater, municipal WWTP's and septic tank leachate reaching tributaries
Added cost of treatment to industry and agriculture	Excessive concentrations of contaminants from other dischargers leaves little assimilative capacity for other dischargers	Primarily along the U.S. shoreline downstream of the Rouge River	Industrial and municipal discharges
Potential contamination of public potable water supply	Primarily organic chemicals and spills of materials	At public drinking water supply intakes throughout the Detroit River	Upstream industrial discharges waste disposal sites, spills from ships, and WWTP bypasses and upsets

but in Lake Erie, particularly its Western Basin. Significant concentrations of polynuclear aromatic hydrocarbons (PAHs) enter the Detroit River at and near the Rouge River mouth. There is no water quality guideline for PAHs for aquatic life; however, many of these compounds are known or suspected animal or human carcinogens.

Fine-grained sediments in the river are excessively contaminated by a variety of organic contaminants. Several areas along the Michigan shore contain excessive PCB concentrations. Organochlorine contaminants other than PCBs are also found in most Detroit River and tributary sediments. DDT and its metabolites, dieldrin, methoxychlor, chlordane, trifluralin, hexachlorocyclohexane and hexachlorobenzene are present. Polynuclear aromatic hydrocarbons (PAHs) have been found at high concentrations in Detroit River sediments. Excessive phenols were present in sediments of the Trenton Channel. High concentrations of phthalates were present in many sediment samples from Detroit River tributaries, particularly Conners Creek and the Rouge River. Excessive concentrations of oil and grease are present in many Detroit River depositional zone sediments, and have degraded benthic macroinvertebrate communities (24).

Fish from several stations in the lower Detroit River had elevated levels of certain organic chemicals. PCB concentrations exceed consumption guideline levels in the edible portion of Detroit River carp. Consequently, the Michigan Department of Public Health has issued a consumption advisory for these fish. Several Detroit River fish species exceed the GLWQA objective of 0.1 mg/kg (wet weight) total PCBs in whole fish tissue. OMOE has also issued a fish consumption advisory for Detroit River carp because of elevated body burdens of PCBs.

Waterfowl contain elevated PCB levels and other persistent organic chemicals. There are no existing criteria for a consumption advisory to protect children and women of child-bearing age from the potential effects resulting from consumption of these birds. Herring gull eggs collected from Fighting Island in 1985 and 1986 contained high concentrations of PCBs and PAHs, and contained several other organochlorine pesticides.

Native and caged Detroit River clams showed increased levels of PCBs, PAHs and several organochlorine pesticides. Some PAHs found in Detroit River sediments are probable human carcinogens, and are thought to be responsible for some liver, lip and dermal tumors in fish.

3. Metals

Concentrations of metals measured in water during the study were generally all below the ambient water quality guideline, with the exception of mercury, which exceeded Michigan's Rule 57(2) allowable levels throughout the river. Generally, water in the Trenton Channel was of a poorer quality than other portions of the river. During the 1986 Detroit River System Balance Study, some localized areas exceeded water quality guidelines for iron (GLWQA specific objective) cadmium, lead and mercury (Michigan's Rule 57(2) allowable level). Water quality in the Little River, Rouge River, Turkey Creek, the Canard River and Ecorse River is impaired with respect to certain metals.

Heavy metal contamination of Detroit River sediments is found in most depositional areas, with concentrations of many metals exceeding guidelines. Lead, cadmium, copper and zinc levels are significantly elevated in the Rouge River and Turkey Creek and in Detroit River sediments downstream of their confluences. High levels of chromium and nickel are present in the Little River. Manganese and especially iron are strongly elevated in Trenton Channel sediments and other Michigan nearshore and sedimentary zones.

Overall, certain Detroit River sediments are severely degraded by heavy metals, especially in the Trenton Channel. This contamination may reduce or eliminate the viability of Detroit River and Lake Erie sediments as substrate for benthic organisms. Desorption of contaminants and re-solubilization through chemical and biological processes make an unknown portion of these chemicals available to higher aquatic organisms.

OMOE has issued a fish consumption advisory on several fish species because mercury concentrations exceed 0.5 mg/kg in the edible portion of the larger sizes of these fish. Native and caged Detroit River clams showed increased levels of several metals, particularly lead and cadmium.

4. Habitat Alterations

Eighty-five percent of the wetlands and littoral zones along the Michigan Detroit River shoreline have been eliminated by filling, dredging and bulkheading. Aquatic plants which live only in the littoral zone provide food, substrate, cover and nursery production for aquatic organisms, and drive the production and energy flow through the aquatic ecosystem. Loss of the littoral zone results in the loss of large segments of the upper trophic levels, including fish. Habitat loss was the major factor, along with pollution and overfishing, in the demise of the Detroit River commercial fishery around the turn of the century. Large areas of shallow water and marshes associated with tributaries are still found on the Ontario shore, below Fighting Island. Seventy percent of the remaining littoral zone is occupied by submerged plants, macrophytes and other wetland plants.

In the Detroit River, upstream of Zug Island, the benthic community is diverse and dominated by pollution intolerant organisms, except along the Windsor shoreline. Adjacent to Zug Island the community is severely impacted, and downstream, especially in the Trenton Channel, the benthos is dominated by pollution tolerant oligochaetes.

Overall, aquatic biota, especially benthos, show detrimental responses to contamination of Detroit River sediments with organic and inorganic substances, particularly in the lower river and in the Trenton Channel. Laboratory tests with sediments and sediment extracts indicate higher toxicity and increased mutagenicity on a variety of native species. Fish species diversity and fecundity may also be negatively affected in some areas.

C. SOURCES

This section discusses contaminant inputs from point and non-point sources in the Detroit River which were analyzed between 1984 and 1987.

1. Point Sources

Introduction, Qualifications and Criteria

During 1985, 1986 and 1987 the Michigan Department of Natural Resources (MDNR), OMOE, U.S.EPA and Environment Canada collectively monitored flow and effluent quality of major direct and indirect point source dischargers to the Detroit River (direct sources are those which discharge directly to the river and indirect sources discharge to the river via tributaries or drains). Nine municipal treatment plants and 20 industrial facilities were sampled over a 24 hour period (Michigan sources) or 3 to 6 days (Ontario Sources) during 1985 and 1986. Composite samples were analyzed for conventional pollutants, metals and trace organics, including the list of contaminants chosen for the UGLCC Study (Chapter I, Table I-1). Table IX-4 presents the industries surveyed and the parameters which are regulated in their effluent. Table IX-5 presents the municipal facilities and their regulated parameters. Figures IX-15 and 16 show the locations of these, and other, industrial and municipal facilities along the Detroit River.

Shortcomings limit the inferences that can be drawn from the survey, including the small data base, differences in survey timing, and differences in sampling and analytical methods. The U.S. surveys were performed in May, and July through September, 1986, while the Ontario data were collected between October and December, 1985. The U.S. composited four grab samples (1 every 6 hrs), while Ontario samples were collected by automatic composite samplers (1 portion every 15 min).

Differences in detection limits further hinder comparisons. The U.S. generally used lower detection limits than did Canada, allowing calculated loadings from Michigan facilities with no corresponding loadings from Ontario facilities for some parameters (e.g., OCS and HCB). Consequently, the percent of the total point source loadings to the Detroit River for some parameters (depending on corresponding flow volumes) may be skewed towards Michigan dischargers.

Flows

There were a total of 75 known point sources discharging 9,233 x 10^3 m^3/d) to the Detroit River basin in 1986. Three Detroit

TABLE IX-4

Surveyed U.S. and Canadian industrial facilities in the Detroit River area and regulated parameters [1,2].

U.S. FACILITIES	OPERATION	REGULATED PARAMETERS[3]
BASF Corporation	Chemical production	TSS, TOC, alkalinity*, ammonia-N*, temperature*, 1,2-dichloroethane*, 1,2-dichloropropane*, bis(2-chloroisopropyl)ether*
Chrysler Chemical-Trenton	Chemical compounding	TRC, pH, oil and grease, temperature*
Chrysler-Trenton Engine	Auto engine manufacture	BOD_5, TSS, total phosphorus, pH, oil and grease,total phenol
Detroit Coke Corp.	Coke production	pH, temperature, oil and grease*
Double Eagle Steel	Steel galvanization	TSS (noncompliant), oil and grease, total zinc (noncompliant), dissolved oxygen, total toxic organics, pH (noncompliant), temperature*. Entered into Consent decree in October 1986.
Ford-Wayne Assembly	Auto assembly plant	no NPDES permit
Great Lakes Steel (National Steel Corp) 80" Mill	Steel mfg & processing	TSS, oil and grease
Great Lakes Steel Ecorse Plant	Steel mfg and processing	TSS, total lead, total zinc, acrolein (22/365), oil and grease
Great Lakes Steel Zug Island Plant	Pig iron, coke and coke-by-products production	pH, oil and grease, ammonia-N, cyanide, total phenols, total lead, total zinc, TRC, TSS
McLouth Steel-Gibralter	Steel processing	TSS, oil and grease, total lead, total zinc, total iron*
McLouth Steel-Trenton	Steel & pig iron production	pH, TSS, oil and grease, temperature*, unionized ammonia*, free cyanide*, total phenol*
Monsanto Inorganic Chemical Corp	Food-grade specification products manufacture	TSS, phosphorus, arsenic, ammonia-N, temperature* alkalinity*, total cadmium*, hexavalent chromium*, amenable cyanide*, total lead*, total mercury*, total silver*
Pennwalt	Chemical production	TSS (16/365), BOD_5, total zinc, TRC, total phenols, chloride, ammonia-N, total copper, total lead, oil and grease, pH, COD, temperature*,
Rouge Steel	Steel and auto mfg	TSS, total lead, total zinc, oil and grease, ammonia-N, total and oxidizable cyanide, total phenol, TRC, temperature*

TABLE IX-4· (cont'd).

U.S. FACILITIES	OPERATION	REGULATED PARAMETERS[3]
St. Mary's Peerless Cement Company-Foreman Plant	Cement production	pH, temperature*
St. Mary's Peerless Cement Company-Brennan Plant	Clay slip production	pH, TSS, temperature*
Union Carbide-Linde Div.	Nitrogen & argon production	Phosphorus (3/12), TSS (3/12), TRC, oil and grease, temperature*
CANADIAN FACILITIES	**OPERATION**	**REGULATED PARAMETERS[4]**
Ford Motor Company	Auto parts manufacture	No regulated parameters (exceeded TSS and phenol objectives in 1985 and 1986).
General Chemical (Allied Chemical)	Chemical manufacture	TSS, chlorides, ammonia-N, fluorides
Wickes Manufacturing	Auto/truck bumper mfg	No regulated parameters (exceeded objectives for nickel [8/24] and TSS [23/24])

* indicates that monitoring of the parameter is required; however, there is no concentration or loading limit.

1 From the UGLCCS Point Source Workgroup Report (6).

2 Exceedences of limitations during 1986 for Michigan facilities and 1985-1986 for Ontario facilities are denoted in parentheses. For example (16/365) indicated that parameter's daily limitation was exceeded 16 days of 365.

3 Parameters listed comprise the total regulated by all NPDES permits for all outfalls. Not all outfalls at a facility are necessarily regulated for all parameters. The Point Source Workgroup Report should be consulted for a more thorough and comprehensive description of the facility's discharge requirements.

4 All Ontario industrial facilities are encouraged to comply with the Ontario Industrial Effluent Objectives, which are described in Chapter III of this report.

TABLE IX-5

Surveyed U.S. and Canadian municipal facilities in the Detroit River area and regulated parameters [1,2].

U.S. FACILITIES	REGULATED PARAMETERS
City of Trenton WWTP	BOD_5 (5/12), TSS (5/12), pH, FC, DO (8/12), TRC, total phosphorus (5/12), ammonia-N, cadmium, silver, mercury, chloroform
Detroit WWTP	BOD_5, TSS, pH, FC, DO, total phosphorus, temperature
Grosse Ile Township WWTP	BOD_5, TSS (11/12 removal; 4/12 loading), pH, FC, DO, TRC, total phosphorus, ammonia-N
Walled Lake-Novi WWTP	BOD_5, TSS, pH, FC, DO, total phosphorus, ammonia-N (9/12), $CBOD_5$
Wayne County-Trenton WWTP	BOD_5, TSS (9/12), pH, FC (8/12), total phosphorus (6/12), oil and grease
Wayne County-Wyandotte WWTP	BOD_5, TSS (4/12), pH, FC (12/12), DO, TRC, total phosphorus, ammonia-N, phenol, oil and grease
CANADIAN FACILITIES	
Amherstburg WPCP	BOD_5 (removal in 1985), TSS (removal in 1985 and 1986), total phosphorus (18/24)
Little River WPCP	BOD_5, TSS, total phosphorus (4/24)
West Windsor WPCP	BOD_5, TSS, total phosphorus (2/24)

Abbreviations: BOD_5 = 5-day biological oxygen demand; TSS = total suspended solids; FC = fecal coliform bacteria; DO = dissolved oxygen; TRC = total residual chlorine; $CBOD_5$ = 5-day carbonaceous biological oxygen demand; COD = chemical oxygen demand.

1 From the UGLCCS Point Source Workgroup Report (6).

2 Exceedencs of limitations during 1986 for Michigan facilities and 1985-1986 for Ontario facilities are denoted in parentheses. For example, (2/24) indicated that a monthly limitation was exceeded 2 times in a 24 month period.

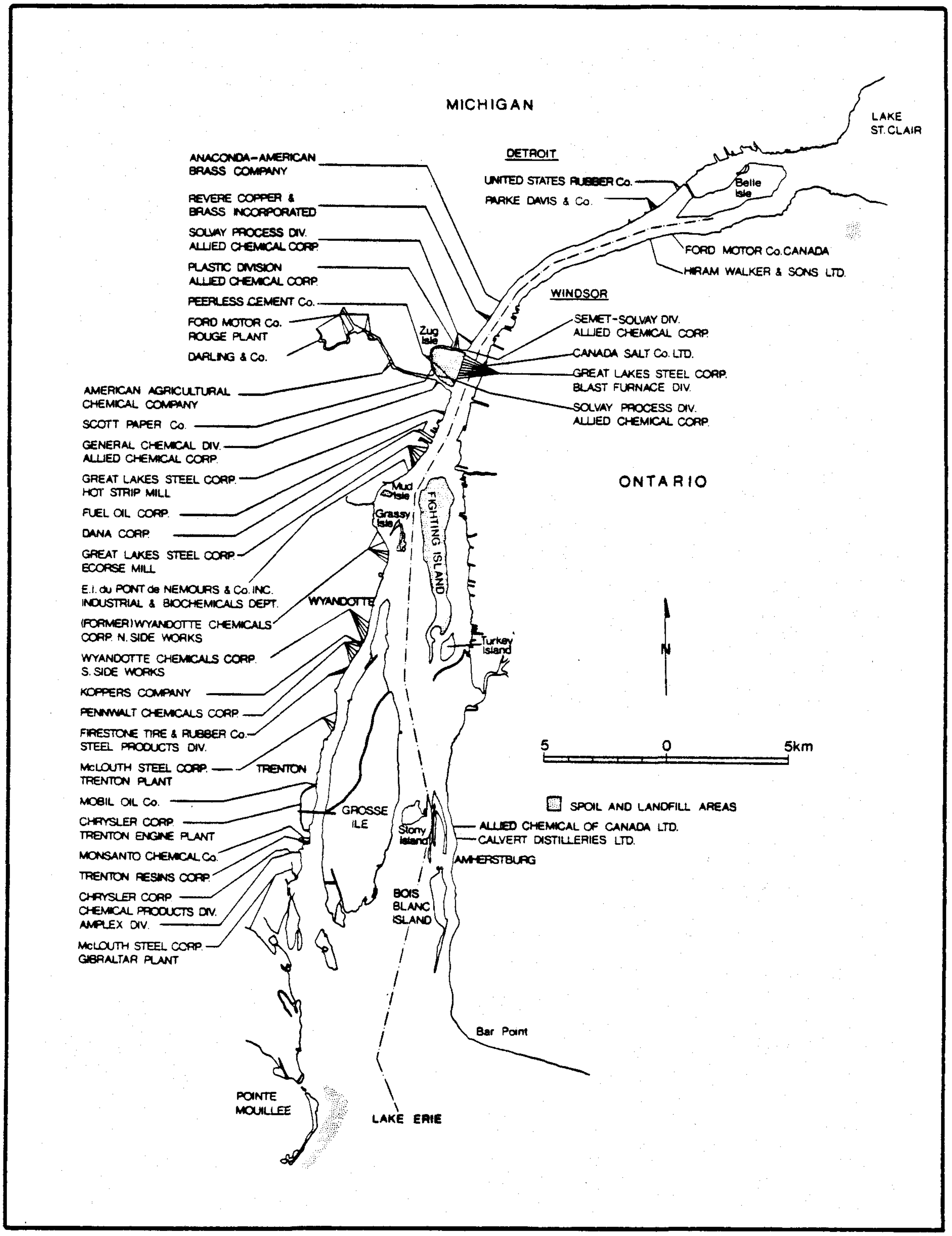


FIGURE IX-15. Industrial dischargers to the Detroit River.

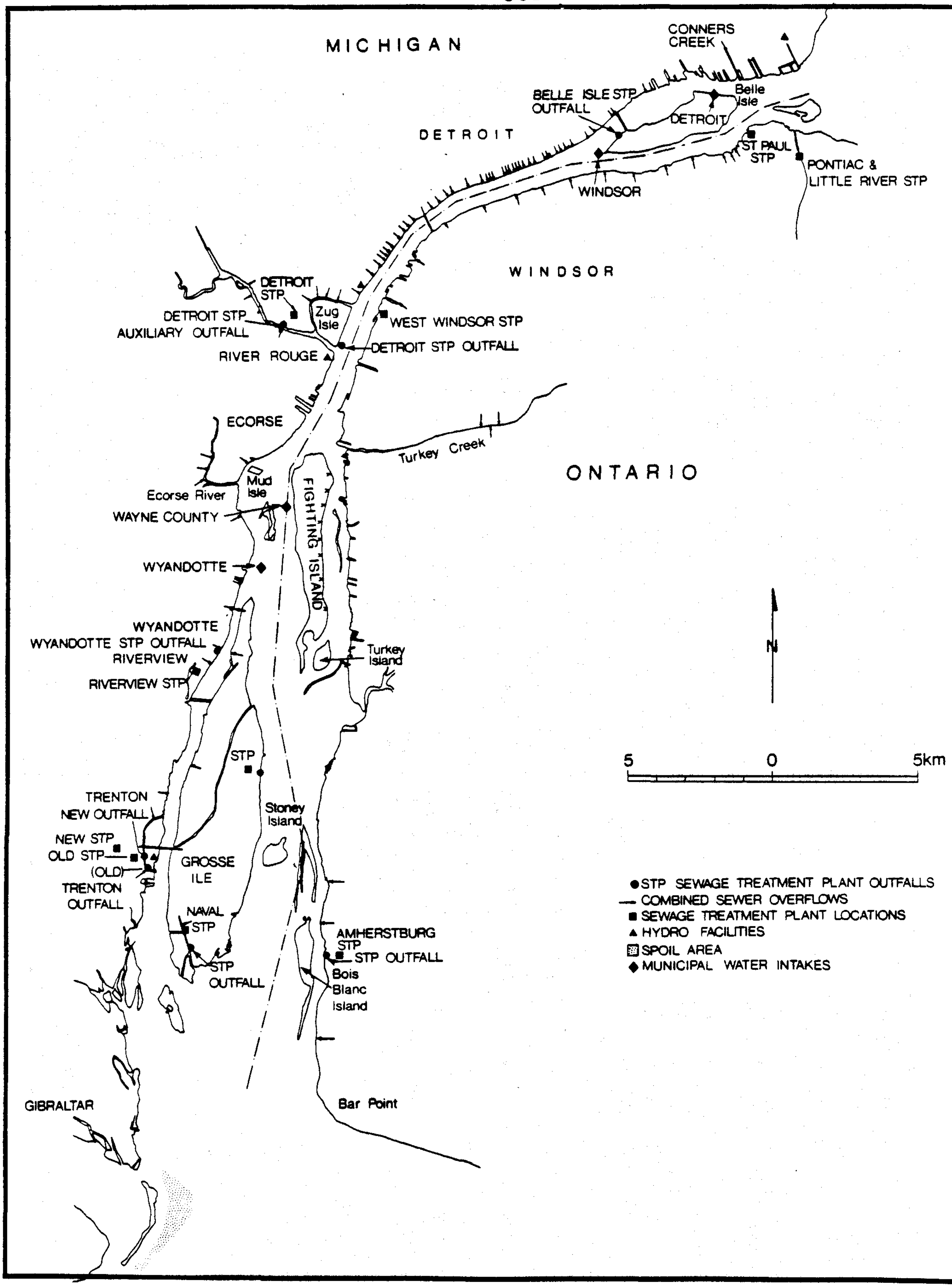


FIGURE IX-16. Municipal dischargers to the Detroit River.

TABLE IX-6. (cont'd 2).

PARAMETER	METHOD DETECTION LIMIT ug/L	FACILITY	FLOW $10^3 m^3/d$	AVERAGE CONC. ug/L	LOADING kg/d	% TOTAL POINT SOURCE CONTRIBUTION[2]
Cobalt	5.0	General Chemical	18.8	300	5.64	43.7
	0.001	Detroit WWTP	2160	1.20	2.59	20.1
	5.0	West Windsor WPCP	142	14.0	1.95	15.1
	0.001	GLS-Zug Island	99.8	19.0	1.9	14.7
	5.0	Little River WPCP	52.5	9.0	0.53	4.1
				Total:	12.61	97.7
Phenols	1.0	Ford Canada	71.3	658	48.2	35.7
	10.0	Detroit WWTP	2160(2695)	21.0(14)	45.4(39)	33.6
	10.0	Rouge Steel	1810	9.53	17.3	12.8
	10.0	Wayne Co-Wyandotte WWTP	268	36.0	9.7	7.2
	10.0	McLouth Steel-Trenton	227	24.0	5.4	4.0
	10.0	GLS-Zug Island	99.8	32.0	3.2	2.4
				Total:	129.2	95.7
Cadmium	0.2	Wayne Co-Wyandotte WWTP	268	22.8	6.1	67.0
	0.2	Detroit WWTP	2160(2695)	0.65(5)	1.4(13)	15.4
	5.0	Ford Canada	71.3	11.2	0.797	8.8
	0.2	Rouge Steel	1810	0.3	0.55	6.0
	0.2	McLouth Steel-Trenton	60	0.6	0.136	1.5
				Total:	8.983	98.7
Lead	5.0	Ford Canada	71.3	425	30.3	58.2
	1.0	Rouge Steel	1810	4.7	8.53	16.4
	1.0	Detroit WWTP	21602695	3.3(51)	7.13 (137)	13.7
	1.0	McLouth Steel-Trenton	227	16.6	3.77	7.2
				Total:	49.73	95.5
Zinc[4]	2.0	Detroit WWTP	2160(2695)	103(106)	223 (283)	34.8
	2.0	McLouth Steel-Trenton	227	603	137	21.4
	5.0	Ford Canada	71.3	1850	132	20.6
	2.0	Rouge Steel	1810	41.1	74.8	11.7
	2.0	Wayne Co-Wyandotte WWTP	268	120	32.3	5.0
				Total:	599.1	93.5

TABLE IX-6. (cont'd 3).

PARAMETER	METHOD DETECTION LIMIT ug/L	FACILITY	FLOW $10^3 m^3/d$	AVERAGE CONC. ug/L	LOADING kg/d	% TOTAL POINT SOURCE CONTRIBUTION[2]
Copper	5.0	General Chemical	174	99	17.2	31.4
	1.0	Rouge Steel	1810	8.3	15.1	27.6
	1.0	Detroit WWTP	2160(2695)	3.3(3.3)	7.13(92.0)	13.0
	1.0	Wayne Co-Wyandotte WWTP	268	18.4	4.95	9.0
	5.0	Ford Canada	71.3	48	3.44	6.2
	5.0	West Windsor WPCP	142	24	3.43	6.2
				Total:	51.25	93.4
Iron	14	Rouge Steel	1810	850	1550	43.4
	14	Detroit WWTP	2160(2695)	274(700)	592(1887)	16.6
	14	McLouth Steel-Trenton	227	2390	545	15.3
	14	Wayne Co-Wyandotte WWTP	268	887	239	6.7
	5.0	Ford Canada	71.3	470	222	6.2
	14	GLS-80" Mill	223	863	215	6.0
				Total:	3363	94.2
Chloride	500	General Chemical	18.9	5.6%	1,050,000	73.3
	1000	Detroit WWTP	2160	130,000	281,000	19.3
	1000	Rouge Steel	1810	20	36,400	2.5
				Total:	1,367,400	95.1
Ammonia-N	10	Detroit WWTP	2160(2695)	9100(2458)	19,700(6628)	79.0
	10	Wayne Co-Wyandotte WWTP	268	12,000	3230	13.0
				Total:	22,930	92.0
Phosphorus-P	10	Detroit WWTP	2160(2695)	430(750)	930(2023)	63.3
	10	Wayne Co-Wyandotte WWTP	268	910	245	16.7
	10	West Windsor WPCP	142	1060	150	10.2
				Total:	1325	90.2
Oil&Grease	2000	Detroit WWTP	2160(2695)	4200(5208)	9090(14,042)	25.7
	2000	Rouge Steel	1810	7080	8090	22.9
	2000	McLouth Steel-Trenton	227	31,100	7060	19.9
	2000	GLS-80" Mill	223	19,000	4260	12.0
	2000	GLS-Ecorse	29.1	125,000	3650	10.3
	100	West Windsor WPCP	142	7900	1130	3.2
	2000	Wayne Co-Wyandotte WWTP	268	2700	727	2.1

TABLE IX-6. (cont'd 4).

PARAMETER	METHOD DETECTION LIMIT ug/L	FACILITY	FLOW $10^3 m^3/d$	AVERAGE CONC. ug/L	LOADING kg/d	% TOTAL POINT SOURCE CONTRIBUTION[2]
Cyanide	5.0	Detroit WWTP	2160(2695)	49(22)	106 (59)	87.6
	5.0	Rouge Steel	1810	3.32	6.12	5.1
	5.0	Wayne Co-Wyandotte WWTP	268	21	5.6	4.6
	1.0	Ford Canada	71.3	20	2.28	1.9
				Total:	120.0	99.2
Total PAH	1-15	Rouge Steel	1810	2.0	5.15	85.0
	1-2	Ford Canada	71.3	6.0	0.44	7.0
	1-2	West Windsor WPCP	142	2.0	0.311	6.0
				Total:	5.90	98.0
Chromium	3.0	Detroit WWTP	2160(2695)	7.1(30)	15.3 (80.8)	29.8
	5.0	Wickes Manufacturing	2.6	3800-6700	13.8	26.8
				Total:	29.1	56.6

[1] From Table 3-4 of the Point Source Workgroup Report (6) (data collected in 1985-86).

[2] >95% of identified point source total unless multiple diffuse sources.

[3] Values in parentheses are based on the City of Detroit 1987 Annual Self-Monitoring Report; see text for more information.

[4] Does not include zinc loadings from Double Eagle Steel. If Double Eagle Steel average loading of 312 kg/day (from 4/86 to 2/87 self-monitoring data) is included, Double Eagle Steel becomes the major contributor at 33%, with Detroit WWTP's contribution falling to 23%. For the period July 1 to December 31, 1987, Double Eagle Steel discharged an average of 0.68 kg/d total zinc.

are placed in parentheses to set them apart from the point source survey data. In the text, these data are referred to as "SMR" data.

Parameters which were "of concern", (by virtue of media guidelines being exceeded or by impacts upon biota), and the point sources which provided inputs, are discussed below.

i) Conventional Pollutants

i) Total Phosphorus: The total loading for the UGLCCS survey was 1,470 kg/d, contributed primarily by the Detroit WWTP (930 kg/d; self monitoring report for 1987 (SMR) indicates loading of 2,023 kg/d), the Wayne County-Wyandotte WWTP (245 kg/d) and the West Windsor WWTP (150 kg/d). The Wayne County-Trenton WWTP (1.6 mg/L) and the City of Trenton WWTP (4.7 mg/L), discharged concentrations in excess of the GLWQA effluent objective of 1.0 mg/L. Both the Detroit and Wayne County-Wyandotte facilities are generally in compliance with their permitted concentrations for total phosphorus.

ii) Ammonia-nitrogen: The total loading was 25,000 kg/d, contributed primarily by the Detroit WWTP (19,700 kg/d; SMR=6,628 kg/d) and the Wayne County-Wyandotte WWTP (3,230 kg/d; 12 mg/L). General Chemical (14.3 mg/L) discharged ammonia in excess of the Ontario Industrial Discharge Objectives of 10 mg/L. The Wayne County-Trenton WWTP effluent concentration for ammonia-nitrogen was 15 mg/L.

iii) Chloride: The total point source loading was 1,440,000 kg/d, contributed primarily by General Chemical (1,050,000 kg/d). Concentrations in the General Chemical North Drain ranged from 5.5 to 6.6% (55-66 gm/L). No effluent guidelines exist for chlorides; but these concentrations do greatly exceed drinking water recommendations of 250 mg/L. The Detroit WWTP and Rouge Steel discharged 281,000 kg/d and 36,400 kg/d of chloride, respectively, to the Detroit River.

ii) Organic Pollutants

i) Polychlorinated Biphenyls (PCB): The total loading was 0.296 kg/d, contributed primarily by the Detroit WWTP (0.2 kg/d; SMR=0.256 kg/d) and by Ford Canada (0.039 kg/d). Elevated concentrations were found above the method detection limit (MDL, which was 0.0001 ug/L for Michigan and 0.1 ug/L for Ontario), at Ford Canada (0.55 ug/L) and the Wayne County-Wyandotte WWTP (0.088 ug/L).

ii) Hexachlorobenzene (HCB): The total loading was 0.0024 kg/d, contributed primarily by the Detroit WWTP (0.001 kg/d; SMR=0.011 kg/d). HCB was not detected at Ontario sources at their MDL of 0.02 ug/L. Pennwalt discharged the highest concentrations (0.012 ug/L).

iii) Octachlorostyrene (OCS): The loading from the seven Michigan sources surveyed was 0.000087 kg/d, and only detected at or near the MDL (0.000001 ug/L). Wayne County-Wyandotte had the highest concentration (0.21 ng/L) and loading (45 mg/d). OCS was not found in Ontario effluents (MDL 0.02 ug/L).

iv) Polynuclear Aromatic Hydrocarbons (PAHs): The total loading was 6.0 kg/d, contributed primarily by Rouge Steel (5.2 kg/day), at a concentration of 2 ug/L. Other point sources contributed PAHs at loadings over an order of magnitude less.

v) Total Phenols: The total loading was 135 kg/d, contributed primarily by Ford Canada (48.2 kg/d; 658 ug/L), the Detroit WWTP (45.4 kg/d; 21 ug/L) and Rouge Steel (17.3 kg/d). Concentrations for the Wayne County-Wyandotte WWTP, McLouth Steel-Trenton and Great Lakes Steel-Zug Island were 36 ug/L, 24 ug/L and 32 ug/L, respectively. The Ontario Industrial Discharge Objective is 20 ug/L.

vi) Oil and Grease: The total loading was 35,400 kg/d, contributed primarily by the Detroit WWTP (9,090 kg/d, 4.2 mg/L; SMR=14,041 kg/d, 5.2 mg/L), Rouge Steel (8,090 kg/d, 7 mg/L) and McLouth Steel-Trenton (7,060 kg/d, 31.1 mg/L). Great Lakes Steel-Ecorse (125 mg/L), Great Lakes Steel-80" Mill (19 mg/L), and Mclouth Steel-Trenton (31 mg/L) discharged elevated concentrations of oil and grease through their combined outfalls.

iii) Metals

i) Total Cadmium: The total loading was 9.1 kg/d, contributed primarily by the Wayne County-Wyandotte WWTP (6.1 kg/d, 23 ug/L) and the Detroit WWTP (1.4 kg/d, 0.65 ug/L; SMR=13 kg/d, 5 ug/L). Elevated concentrations were also discharged from Ford Canada (11.2 ug/L) and General Chemical (10-21 ug/L). The Ontario Industrial Effluent Objective for total cadmium is 1 ug/L.

ii) Total Copper: The total loading was 54.9 kg/d, contributed primarily by General Chemical (17.2 kg/d, 99 ug/L), Rouge Steel (15 kg/day, 8.3 ug/L) and the Detroit WWTP (7.1 kg/d, 3.3 ug/L; SMR=92 kg/d).

iii) Total Cyanide: The total loading was 121 kg/d, contributed primarily by the Detroit WWTP (106 kg/day; SMR=59 kg/d). This facility also discharged the highest concentration of cyanide in effluent (49 ug/L; SMR=22 ug/L). Other facilities contributed loadings over one order of magnitude less than the Detroit WWTP.

iv) Total Iron: The total loading was 3,570 kg/d, contributed primarily by Rouge Steel (1,550 kg/d, 850 ug/L), the Detroit WWTP (592 kg/d, 274 ug/L; SMR=1,887 kg/d) and McLouth Steel-Trenton (545 kg/d, 2,400 ug/L). Wayne County-Trenton WWTP discharged concentrations of 6,960 ug/L.

v) Total Lead: The total loading was 52.1 kg/d, contributed primarily by Ford Canada (30.3 kg/d, 425 ug/L), Rouge Steel (8.53 kg/d, 4.7 ug/L) and the Detroit WWTP (7.13 kg/d, 3.3 ug/L; SMR=137 kg/d).

vi) Total Mercury: The total loading was 0.115 kg/d, contributed primarily from the Detroit WWTP (0.064 kg/d, 0.029 ug/L; SMR=0.54 kg/d, 0.2 ug/L) and the Wayne County-Wyandotte WWTP (0.014 kg/d, 0.05 ug/L).

vii) Total Nickel: Total loading was 120 kg/d, contributed primarily by the Detroit WWTP (95.8 kg/d, 44.3 ug/L; SMR=197 kg/d). Concentrations at Wickes Manufacturing (average 3,500 ug/L) exceeded the Ontario Industrial Discharge Objective of 1,000 ug/L.

viii) Total Zinc: The total loading from all sources, except Double Eagle Steel, was 641 kg/d, contributed primarily by the Detroit WWTP (223 kg/d, 103 ug/L; SMR=283 kg/d), McLouth Steel-Trenton (137 kg/d, 603 ug/L) and Ford Canada (132 kg/d, 1,850 ug/L). Extremely high loadings of zinc were found at Double Eagle Steel during the survey and were rectified soon after discovery, so were not included in the total loading. Effluent concentrations at Ford Canada exceeded the Ontario Industrial Discharge Objective of 1,000 ug/L.

iv) Non-UGLCCS Parameters

i) Total Suspended Solids (TSS): The total loading was 65,300 kg/d, contributed primarily by the Detroit WWTP (21,610 kg/d, 10 mg/L; SMR=35,490 kg/d), Rouge Steel (7,160 kg/d, ND-17 mg/L) and General Chemical (North Drain; 6,930 kg/d, 7-353 mg/L). Wickes Manufacturing (48-89 mg/L) and Ford Canada (24-44 mg/L) discharged concentrations in excess of the Ontario Industrial Discharge Objective of 15 mg/L. The Wayne County-Trenton WWTP (53 mg/L) and the City of Trenton WWTP (240 mg/L) discharged similarly elevated concentrations.

ii) Total Chromium: The total loading was 51.4 kg/d, contributed primarily by the Detroit WWTP (15 kg/d, 7 ug/L; SMR=70 kg/d) and Wickes Manufacturing (13.8 kg/d, 3,800-6,700 ug/L). Wickes Manufacturing discharged concentrations of chromium exceeding the Ontario Industrial Discharge Objective of 1,000 ug/L.

iii) Total Volatiles: The total loading was 220 kg/d, contributed primarily by the Wayne County-Wyandotte WWTP (94 kg/d, 348 ug/L), the Detroit WWTP (85.4 kg/d, 39.5 ug/L) and the West Windsor WWTP (37.6 kg/d, ND-298 ug/L).

Major Loading Contributors

Summarized below are eleven point source facilities which were found to be major contributors of chemicals of concern in the Detroit River, contributing 10% or more of the total identified point source load. Primary contributors indicate the parameters for which the identified facility is the largest single source, based on the UGLCCS point source data.

i) Michigan Facilities

Detroit WWTP

Primary contributor: Total PCBs, HCB, total mercury, total nickel, total chromium, total zinc, ammonia-nitrogen, total phosphorus, oil and grease, total cyanide, suspended solids

Additional: OCS, total cobalt, total phenols, total cadmium, total lead, total copper, total iron, chlorides, total volatiles

Wayne County-Wyandotte WWTP

Primary contributor: OCS, total cadmium, total volatiles

Additional: HCB, total mercury, ammonia-N, total phosphorus

McLouth Steel-Trenton

Primary contributor: None

Additional: HCB, total zinc, total iron, oil and grease

Rouge Steel

Primary contributor: Total iron, PAHs

Additional: Total phenols, total lead, total zinc, total copper, oil and grease, suspended solids

Great Lakes Steel-Ecorse

Primary contributor: None

Additional: OCS, oil and grease

Great Lakes Steel 80" Mill
Primary contributor: None

Additional: Oil and grease

Monsanto
Primary contributor: None

Additional: HCB

ii) Ontario Facilities

Ford Canada
Primary contributor: Total phenols, total lead

Additional: PCBs, total zinc

General Chemical
Primary contributor: Total copper, chlorides

Additional: Suspended solids

Wickes Manufacturing
Primary contributor: None

Additional: Total chromium

West Windsor WWTP
Primary contributor: None

Additional: Total phosphorus, total volatiles

Loading estimates are based on limited sampling, and contain some inherent uncertainty. Comparisons based on these estimates contain that uncertainty, as well.

A summary of parameters considered in the National Pollution Discharge Elimination System (NPDES) permit effluent limits for major Michigan Detroit River dischargers were presented in Tables IX-4 and 5. For a more in-depth description of the permit limitations for each facility, the Point Source Workgroup Report (6) should be consulted. Also shown are the effluent requirements for Ontario facilities. Ontario industrial facilities are also encouraged to comply with the Ontario Industrial Effluent Objectives, discussed in Chapter III. Most facilities have only a few constituents which they are required to measure. Most constituents monitored are conventional pollutants, although some monitor regularly for metals. Only a few have monitoring requirements for organic contaminants.

An effort was made to determine if the facilities surveyed were in compliance with the appropriate effluent requirements, by comparing the effluent with such requirements. Occurrences of effluent limitation exceedences are noted for the appropriate parameters in Tables IX-4 and 5.

2. Urban Nonpoint Sources

United States Storm and Combined Sewer Overflows

Stormwater reaches the Detroit River directly through storm sewers and CSOs or through tributaries receiving storm and CSO discharges. Contaminant loading from stormwater and CSOs discharging directly to the Detroit River were measured or estimated. Contaminant loadings from storm water and CSOs to tributaries are reflected by the contaminant loading of the tributaries themselves.

There are 243 CSOs discharging to the Detroit River from Michigan and Ontario. Seventy-six discharge directly to the river and 167 discharge indirectly via tributaries. There are 45 directly discharging CSOs along the Michigan shoreline and 28 discharging to the Rouge River (Figure IX-17), and a few others discharging to small creeks, such as Conners and Fox creeks. The mean concentration and loading of selected chemical constituents from the discharge of 42 City of Detroit CSOs to the Detroit River and three City of Detroit CSOs to the Rouge River (downstream of the tributary monitoring location) are shown in Tables IX-7 and 8, respectively. Major loadings are from the Lieb (4,957 million gal/yr) and Conners Creek/ Freud/Fairview (2,766 million gal/yr) overflows located near Belle Isle along the western shore, and the First Hamilton/ Bates/Woodward (386 million gal/yr) and Summit CSOs located approximately 1 km up and downstream, respectively, of the Ambassador Bridge (79).

As an illustration, (79), in the late 1970s Detroit CSOs accounted for 13% of the total phosphorus, 15% of the suspended solids, 21% of the oil and grease, 25% of the cadmium, 29% of the chromium, 20% of the copper, 32% of the lead, 96% of the mercury and 34% of the total PCB loading to the Detroit River. Subsequent more restrictive controls as well as industrialization changes are believed to have reduced these contributions, however, this has not been documented.

There are no documented direct stormwater discharges to the Detroit River from the municipalities of Detroit, River Rouge,

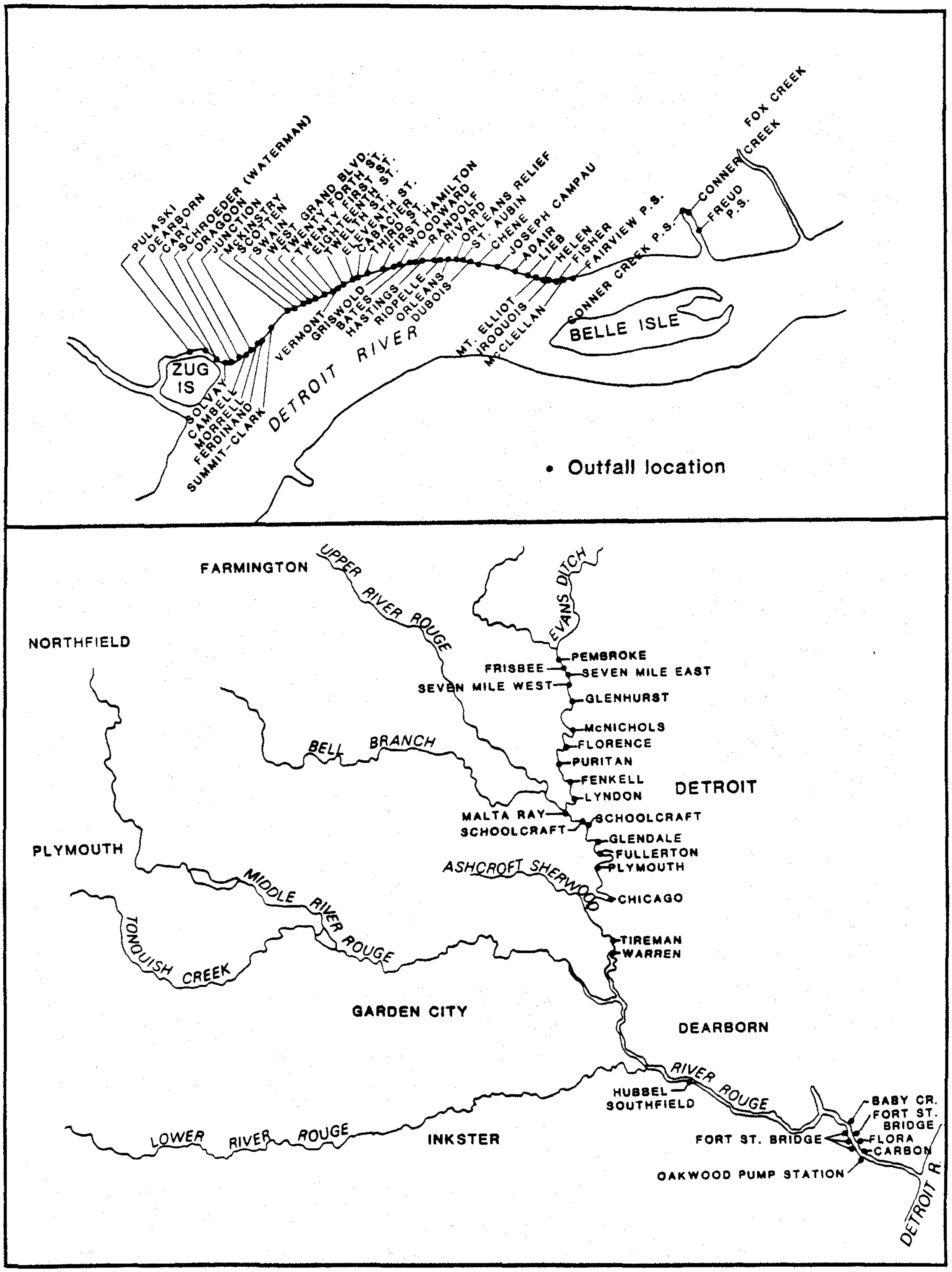


FIGURE IX-17. U.S. Combined sewer overflows discharging to the Detroit and Rouge Rivers.

TABLE IX-7

Mean contaminant concentrations measured in stormwater and combined sewer overflows in Windsor (1985-1986) and Detroit (1979).

		WINDSOR[1]				DETROIT[2]
		Storm Water			Combined Sewer Overflows	Combined Sewer Overflows
Parameters	Units	Residential	Commercial	Industrial		
Ammonia	mg/L	0.28	0.30	0.43	2.5	-
Total Phosphorus	mg/L	0.24	0.17	0.31	0.54	3.9
Chloride	mg/L	-	120[3] 240[3]	-	26.0	44.0
Susp. Solids	mg/L	-	-	-	-	205
Arsenic	mg/L	-	-	-	-	0.069
Cadmium	mg/L	0.00 0.01	0.001 0.009 0.006[4]	0.0006 0.0086	0.001 0.0072 0.008[4]	0.041
Chromium	mg/L	-	-	-	-	0.129
Cobalt	mg/L	0.00 0.02	0.0014 0.017 0.0035[4]	0.0004 0.017	0.0006 0.017 0.003[4]	-
Copper	mg/L	0.018	0.03	0.048	0.10	0.218
Iron	mg/L	5.8	3.0	6.9	1.2	2.27
Lead	mg/L	0.13	0.184	0.21	0.05	0.447
Mercury	ug/L	0.018 0.06	0.03	0.043 0.05	0.043	45.0
Nickel	mg/L	0.008 0.021	0.026	0.017 0.028	0.010 0.044	0.139
Silver	mg/L	-	-	-	-	0.038
Zinc	mg/L	0.16 0.25	0.23	0.30	0.34 0.50	0.555
Oil/Grease	mg/L	1.4	2.3	1.7 5.8	12.3	94.0
Phenols	mg/L	0.0025	0.004	0.005	0.008	0.017
Cyanide	mg/L	0.003	0.003	0.003	0.003	-
HCB	ng/L	1.4	0.0 0.4	0.2 0.92	1.09	-
OCS	ng/L	-	-	-	-	-
Total PCBs	ng/L	31.6	25.8	109.0	100.0	2.4
PAHs (17)	ug/L	1.1 1.6	2.1 2.6	4.6 5.7	4.0 4.4	-

[1] From Marsalek and Ng (80).
[2] From Giffles *et al*. (79).
[3] Equivalent mean concentration.
[4] Mean of concentrations detected in all three subareas.

TABLE IX-8

Contaminant loadings to the Detroit River from stormwater and combined sewer overflow from the cities of Detroit and Windsor (kg/yr).

Parameter	WINDSOR[1]			DETROIT[2]
	Stormwater	Combined Sewer Overflows	Total	Combined Sewer Overflows
Ammonia (as N)	7,200	13,000	20,200	-
Total Phosphorus	5,600	2,800	8,400	116,514
Chloride	2,550,000	135,000	2,685,000	1,545,713
Cadmium	6.5	5.2	11.7	1,440
	133.8[3]	41.6[3]	175.4[3]	
Cobalt	6	3	9	-
	420(78)[3]	88(16)[3]	508(94)[3]	
Chromium	-	-	-	4,532
Copper	613	520	1,133	7,658
Iron	127,600	6,200	133,800	79,745
Lead	3,539	260	3,790	15,703
		830	4,360	
Mercury	0.6	0.2	0.8	1,581
	1.1		1.3	
Nickel	285	52	337	4,883
	524	229	753	
Zinc	4,600	1,770	6,370	19,497
		2,600	7,200	
Oil and Grease	35,700	64,000	99,700	3,302,206
	59,700		123,700	
Total Phenols	75	42	117	597
Cyanide	67	16	83	-
HCB	0.021	0.006	0.027	-
	0.026		0.032	
OCS[4]	0.045	0.010	0.055	-
Total PCBs	0.5	0.5	1.0	84.31
	1.1		1.6	
PAHs (17)	49	21	70	-
	63	23	86	
Susp. Solids	-	-	-	7,201,609

[1] From Marsalek and Ng (80).
[2] From Giffles *et al*. (79).
[3] Calculated from data above detection limit.
[4] Based on Sarnia data (St. Clair River area).

Ecorse, Lincoln Park, Grosse Ile or Gibraltar. Stormwater from these cities enters the combined sewer system and is treated at the Detroit WWTP, or is discharged directly through CSO outfalls to the Detroit River. The municipalities of Wyandotte and Trenton have 13 and 18 direct stormwater discharges to the Detroit River, respectively. Riverview has 17 and Trenton has 19 stormwater discharges through Monguagon Creek and Frank and Poet Drains. The contaminant loadings from these outfalls are unknown.

Ontario Storm and Combined Sewer Overflows

Mean concentration and loadings of selected chemical constituents discharged in stormwater and CSOs in Windsor are shown in Tables IX-7 and 8 (80). Windsor has 28 CSOs which discharge directly to the Detroit River, these are shown in Figure IX-18. Industrial runoff and CSOs contained higher concentrations of most constituents than commercial and residential land use areas. Some constituents (ammonia and lead) were an order of magnitude lower in residential than in other areas. Approximately 72 to 94% of the Windsor loads occurred during storm events (about twice a month and 20 to 42 hours per event). Sixty-five percent of the load occurred in February, March and April with the greatest loads during March. Mixed stormwater/sanitary waste water discharges to the river whenever flow in the combined sewers exceeded 2.5 times the dry weather flow, otherwise the mixed waste water discharges to one of the two Windsor WWTPs. Based on these data, Windsor CSOs contribute from less than 1 to 9% of the conventional, metal, and organic contaminant loading to the Detroit River.

3. Groundwater Contamination/Waste Sites

Groundwater movement was investigated in an area extending 19 km (12 mi) along the Detroit River, which is about 50 km (31 mi) long. Factors which control and influence groundwater movement, such as geological formations, were investigated for this study (53,70,71,81,82,83).

In Michigan, general groundwater flow is east towards the Detroit River. Locally, the direction of groundwater flow is influenced by surface water drainage, dewatering projects (such as in the Sibley Quarry in Wayne County) and glacial landforms. Groundwater discharges to the Detroit River from two hydrogeologic units: a shallow glacial unit and a bedrock unit. The shallow glacial unit consists of mostly silty-clay till and glaciolacustrine deposits with discontinuous stringers of sand and gravel. In the upper river (down to about Fighting Island), the bedrock unit is comprised of carbonate rocks of the Traverse and Dundee formations, overlain by at least 15 m of glacial deposits.

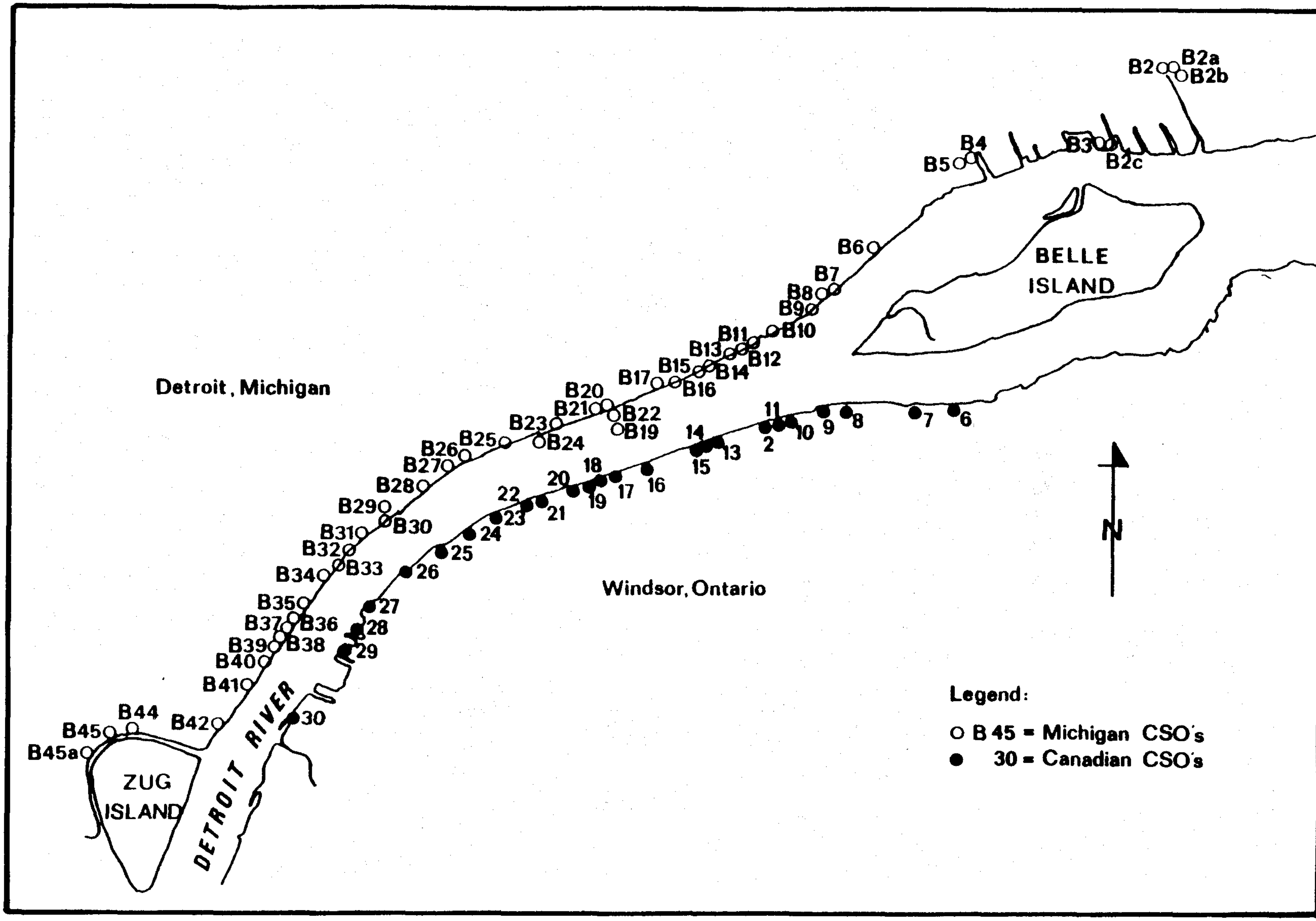


FIGURE IX-18. Detroit and Windsor combined sewer overflows to the upper Detroit River.

South of Fighting Island, the bedrock is comprised of limestone, dolomite and sandstone of the Detroit River Group, overlain by about 8 m of fine-grained glacial deposits. Near the mouth of the river, the Detroit River Group forms the river channel.

In Ontario, the groundwater flow is generally west towards the Detroit River. Three levels of groundwater discharge exist: local, intermediate and regional (or bedrock). The local unit is contained in surficial sands and gravels, and the weathered and fractured zone of lake clay and clay tills. Similar to the Michigan surficial unit, flow in this system is influenced strongly by local surface events and conditions. The intermediate unit is comprised of intact lacustrine clay and clay till, ranging from less than 3 meters to 40 meters in thickness. It is believed most of the groundwater flow from this unit is downward towards the bedrock unit. The bedrock unit is comprised primarily of carbonate rocks of the Hamilton and Dundee Formations and the Detroit River Group. Flow in this unit is towards the Detroit River and Lake Erie.

The estimated total discharge of groundwater from the Michigan side of the Detroit River study area (from Belle Isle to Point Mouillee) is between 1.5 m^3/sec (54 ft^3/sec) and 3 m^3/sec (107 ft^3/sec)(82,83). Rates of groundwater seepage are highest in the northern portion of the Detroit River, in the vicinity of Belle Isle, and generally decrease downstream, increasing again below the Ecorse River mouth. Groundwater and surface water systems are highly interconnected in the Trenton Channel and the lower Detroit River, due to thin or absent sediments overlying bedrock. Estimates of groundwater seepage to the Detroit River from Ontario were not made. In relation to the flow of the Detroit River, the groundwater discharge to the river is approximately 0.05%; therefore, quantitatively, contributing a very small amount to the total river flow.

Waste Disposal Sites

An inventory of active and inactive waste sites within 19 km of the Detroit River was conducted as part of this investigation. Ninety four sites of known and potential groundwater contamination have been found in Monroe and Wayne counties as of January 1987. The majority of sites are solid waste landfills, hazardous waste disposal sites, regulated storage sites and spills. Twenty three sites along the Ontario side of the Detroit River were also identified (84,85). Locations of selected Michigan waste sites and monitoring wells are shown in Figure IX-19.

Sites which are located in groundwater discharge areas directly discharging to the Detroit River were ranked and prioritized for potential impacts upon the Detroit River. Ranking of sites was based on their potential for contributing contaminants to the

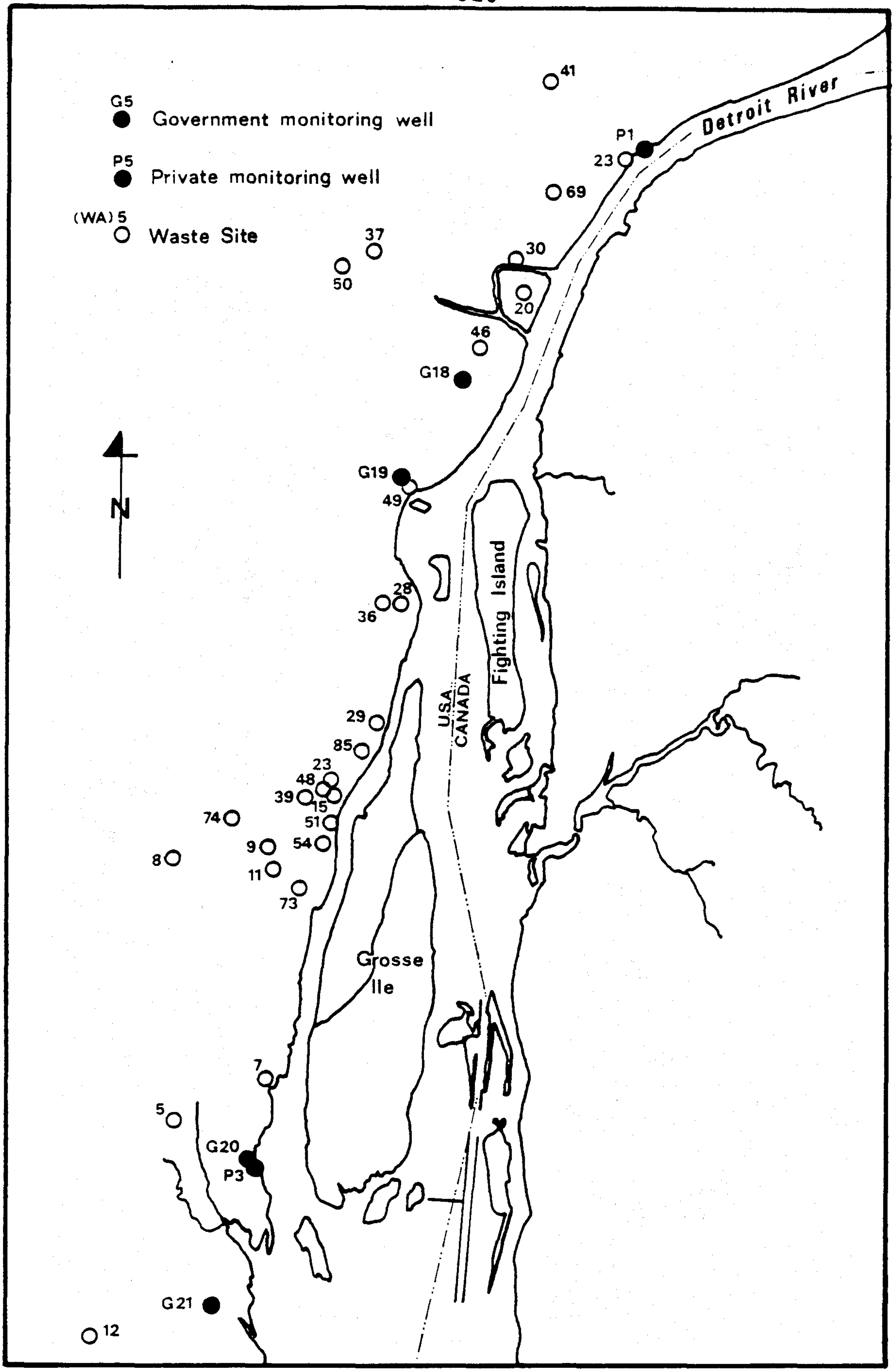


FIGURE IX-19. Sites of known or suspected groundwater contamination and private wells located near the Detroit River.

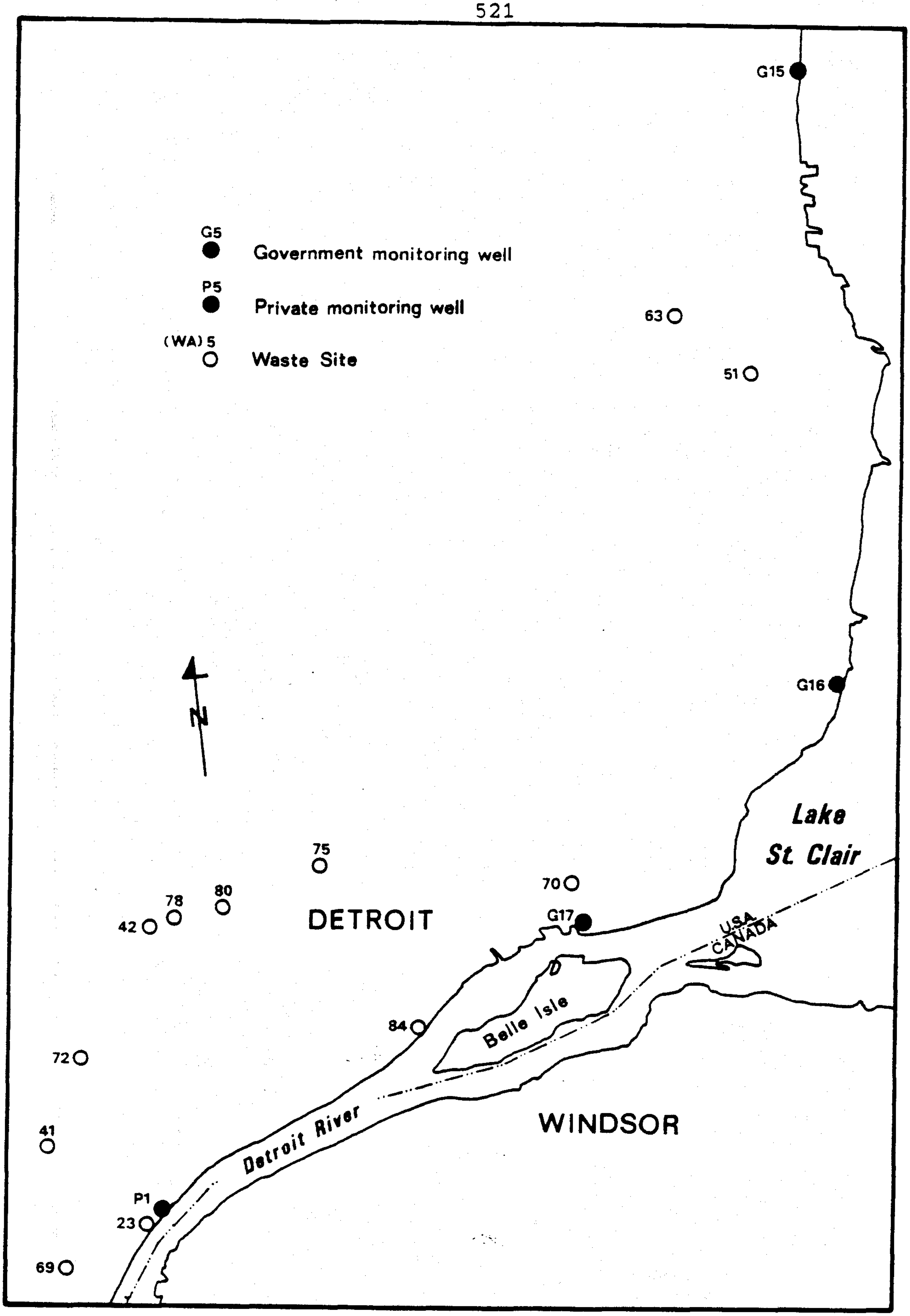


FIGURE IX-19. (Cont'd.) Sites of known or suspected groundwater contamination and private well located near the Detroit River.

Detroit River via groundwater. Sites were ranked by the United States Geological Survey (USGS) using the U.S.EPA'S DRASTIC system, with additions and minor modifications. The USGS ranking system assesses the potential impact of a site by evaluating the hydrogeology, nature of the waste material and the distance to the Detroit River. Table IX-9 lists the 16 highest ranked sites of the 94 sites considered in the Detroit River area. In general, these sites are in areas of sandy, unconsolidated surficial materials, and are located adjacent to, or near, the Detroit River. The water table at the highest ranked sites is generally less than 4.5 m below land surface.

i) Michigan Waste Sites

Analysis of groundwater quality from eight wells (5 observation and 3 private) within the Michigan Detroit River discharge area was obtained. Of these eight wells, three were located downgradient of 3 of the 15 top ranked waste sites: Michigan Consolidated-Riverside Park (P1 on Figure IX-19), Pennwalt Corporation (P2) and Petro-Chem Processing (G17). Unfiltered groundwater samples from these wells were found to contain concentrations of organic and inorganic constituents suggesting groundwater contamination, as shown below:

P1: Total volatiles 1,440 ug/L; total PAHs 287 ug/L; dissolved barium 2,000 ug/L; total cadmium 40 ug/L; total arsenic 58 ug/L; total chromium 120 ug/L; total cobalt 160 ug/L; total copper 660 ug/L; total lead 2,500 ug/L; total mercury 55 ug/L.

P2: Total volatiles 5.9 ug/L; total PAHs 269 ug/L; total phthalates 150 ug/L; total phenolics 95 ug/L; total copper 530 ug/L; total lead 800 ug/L; total nickel 1,500 ug/L.

G17: Total PAHs 58 ug/L; total phthalates: 364 ug/L; total copper 2,500 ug/L; total lead 4,700 ug/L; dissolved barium 2,400 ug/L; dissolved beryllium 13 ug/L; total cobalt 50 ug/L; total iron 570 ug/L; total mercury 2.2 ug/L.

Other wells located downgradient of other lower-ranked waste sites also showed some contamination. On-site monitoring wells at each waste site generally revealed much higher concentrations of metal and organic contaminants. These data are provided in the Nonpoint Source Workgroup Report (86). The contaminant concentrations of the analyses are based on unfiltered samples and are not indicative of contaminant loadings to the Detroit River from groundwater discharge. However, it is clear that groundwater at some of these locations contain high chemical concentrations. This suggests that important loadings of contaminants to the Detroit River may be occurring through contaminated groundwater discharge. A quantitative estimate of such input cannot be determined with the present data.

TABLE IX-9

Confirmed or Possible Michigan Contamination Sites Within Detroit River Groundwater Discharge Areas[1].

1. Zug Island Great Lake Steel (CERLIS/RCRA/Act 307)
The Zug Island Great Lake Steel site is an island in the Detroit River near the mouth of the River Rouge. Industrial wastes were used to enlarge the island. Wastes which have been disposed of here contained heavy metals, asbestos and oily wastes and sludges.

2. Federal Marine Terminal Properties (CERCLIS/RCRA/Act 307)
The Federal Marine Terminal Properties site is an unpermitted landfill located adjacent to the Trenton Channel of the Detroit River. Mercury, chlorinated hydrocarbons, phenols and anthracene have been identified in the groundwater, ponded surface water and sediments on the site (MDNR). One-half of the on-site groundwater drains to the Detroit River and one-half drains to Monguogon Creek.

Unpermitted dumping of chemical manufacturing waste, primarily soda ash, from BASF Wyandotte took place prior to initial efforts to prepare the site as a docking facility. Mercury, arsenic, naphthalene, and benzo(a)pyrene have been found in groundwater samples. The Consent Agreement signed by BASF, USEPA, and MDNR outlines a Remedial Action plan for the site, and the provisions of the Consent Decree include clay capping of the site, shoreline stabilization, and a monitoring and inspection program.

3. Industrial Landfill (Firestone) (CERCLIS/RCRA/Act 307)
The Industrial Landfill was owned and operated by Firestone Steel Products Company. General plant wastes including scrap metal, phosphate sludge, paint sludge, treatment pond sludge and degreasing solvent residue were placed in the landfill. The site is crossed by surface drainage (Monguagon Creek and Huntington Drain) which empties into the Trenton Channel of the Detroit River. Groundwater and surface water contamination is indicated in the Act 307 listing. There are some monitoring wells located on-site.

4. Michigan Consolidated Riverside Park (CERCLIS/RCRA/Act 307)
The Michigan Consolidated Riverside Park site is a former coal gasification facility which has been converted to a park. All waste materials are covered by at least 2 feet of soil. The soils consist primarily of sandy clay and rubble interspersed with sands and organic material. Groundwater contamination is not indicated in the Act 307 listing. There are no monitoring wells.

5. B.A.S.F. Wayandotte South Works (CERCLIS/RCRA/Act 307)
The B.A.S.F. Wayandotte South Works site is a former chemical company plant site. The plant has been closed and demolished. The eastern half of the site is mostly reclaimed river bottom and marsh land consisting of fill material. There are several groundwater contamination sites on the South Works property. Ground and surface water contamination are indicated in the Act 307 listing. There are some monitoring wells onsite.

6. B.A.S.F. Wyandotte North Works (CERCLIS/RCRA/Act 307)
The B.A.S.F. Wyandotte North Works site is a chemical company plant site. In addition to permitted solid waste management units, there are several sites of unidentified fill material. The fill sites contain black odoriferous "cinders" and clay-like sludge material. Groundwater, surface-water, and soil contamination are indicated in the Act 307 listing. There are some monitoring wells located on-site.

MDNR sampling of groundwater showed contamination of the top aquifer with chloroform, and of the lower aquifer with lead, cyanide and benzo(a)pyrene. MDNR sampling of a site outfall shows contamination with 1,2-dichloropropane, 1,2-dichloroethane, phenol and benzene.

7. Huron Valley Steel Corporation (RCRA)
The Huron Valley Steel Corporation site is a RCRA-permitted facility that stores emission control dust/sludge (from the primary production of steel in electric furnaces) in tanks. There are no monitoring wells.

8. Edward C. Levy Co. Plant No. 3 (RCRA)
The Edward C. Levy Co. Plant No. 3 site is a RCRA transporter and treatment/storage/disposal facility. This plant stores and treats spent pickle liquor from steel finishing operations. There are 4 monitoring wells.

9. Edward C. Levy Co. Trenton Plant (RCRA)
The Edward C. Levy Co. Trenton Plant site is a RCRA transporter and treatment/storage/disposal facility. This plant stores and treats spent pickle liquor from steel finishing operations. There are 4 monitoring wells.

10. McLouth Steel Products Corporation (RCRA)
The Edward C. Levy Trenton Plant is located on the property of McLouth Steel Products Corporation. The facility is located in a mainly heavy industrial area. There is a small strip of residential land within 1000 feet of the facility to the west. The Detroit River borders the facility on the east. Inspection of tanks storing spent pickle liquor (K062) indicate that releases to the surrounding soils have occurred. The company has not performed closure including cleanup of their releases. No known hydrogeological information on the site exists.

11. Diversey Corporation (CERCLIS/RCRA)
The Diversey Corporation site is a generator and treatment, storage and/or disposal facility. There are no monitoring wells.

The site received a high modified DRASTIC score due to a shallow water table, sandy surficial material and close proximity, within one-half mile of the Detroit River.

12. Pennwalt Corporation (CERCLIS/RCRA/Act 307)
The Pennwalt Corporation site is a RCRA generator and treatment, storage and/or disposal facility. The Pennwalt property east of Jefferson Avenue consists of 50% fill which was placed along the Detroit River. The nature of the material used for filling is not known. Groundwater contamination is not indicated in the Act 307 listing.

13. Monsanto Company (CERCLIS/RCRA)
The Monsanto Company site is a RCRA generator and a treatment, storage and/or disposal facility located on the shore of the Trenton Channel of the Detroit River. One-half of the site property is composed of fill which was placed in the river. A monitoring system consisting of twenty wells have documented groundwater contamination with arsenic.

Monsanto has been on location since 1941. The 175 acre facility, which is bounded on the east by the Detroit River produces, or has produced phosphate for industrial metal cleaning, food-grade inorganic chemicals and plastic sheet for safety glass. Like virtually all industrial riverfront sites in the down-river area, land facing the river has been considerably modified by fill, much of which came from industrial sources. Groundwater here contains elevated levels of arsenic, as well as elevated pH, sodium, and sulphates. Groundwater elevations are significantly affected by recharge from wastewater ponds. Groundwater discharge is to the Detroit River and Elizabeth Park Canal.

TABLE IX-9. (cont'd 3).

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14. Jones Chemicals Inc. (RCRA)
The Jones Chemicals Inc. site is a RCRA transporter and treatment, storage and/or disposal facility. Corrosive wastes are treated, or stored in tanks. There are no monitoring wells.

15. Petro-Chem Processing Inc. (RCRA)
The Petro-Chem Processing site is a RCRA generator, transporter, and treatment, storage and/or disposal facility. This company processes petroleum products, the primary product produced is Chem-Fuel #5. The site is underlain by 6 to 10 ft of heterogeneous fill which overlies 1 to 5 ft of peat, and a thick layer of clay. Groundwater chemical analysis revealed only trace levels of petroleum-related chemicals despite nearly a century of heavy industry in the area. There are no underground storage tanks and the above ground tanks are diked. There are 6 monitoring wells. Petro-Chem has only been in operation since 1982, but previous site owners have carried out fuel blending since 1976 (KOI Petroleum) and petroleum distribution activities for many years prior to that (Amoco).

16. Chrysler Trenton Plant (RCRA/Act 307)
A MDNR site inspection discovered 3000 drums of solvents on site as well as saturated, ignitable soils. Wells are located on-site.

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[1] From the addendum to the Nonpoint Source Workgroup Report (86).

CERCLIS: Site is listed within the information system for Superfund and is considered for clean-up under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended.

RCRA: Facility has a Resource Conservation and Recovery Act (RCRA) identification number.

ACT 307: Site is listed on Michigan's compilation of sites of known and possible environmental degradation.

ii) Ontario Waste Sites

One Ontario waste disposal site was determined to have potential for impact on human health and safety. This site, used by Wickes Manufacturing Ltd., is located near the Little River and had elevated levels of chromium and iron in the groundwater. The waste ponds were drained in 1985 and the materials moved to a certified disposal site in 1986. Subsequent tests indicate some limited remaining groundwater contamination. This site is presently under investigation. Little information on other Ontario waste disposal sites in the Detroit River area was available.

iii) Island Waste Sites

In addition to shoreline waste sites, two waste disposal sites are located on islands in the Detroit River: Fighting Island (Ontario) and Point Hennepin, Grosse Ile (Michigan).

Fighting Island, the second largest island in the Detroit River, has an area of approximately 3 km^2. Except for its northern tip, the entire island was used by BASF Wyandotte Corporation (North Works) to dispose of chemical process wastes. Samples from 51 test sites on Fighting Island were collected between 1982 and 1984. Groundwater and leachate samples contained high levels of zinc, cadmium, phenols, phthalates, and other chemicals (87). Compared to groundwater contaminant levels at some Michigan waste sites, the Fighting Island concentrations are low and the volume of leachate is small, but all the leachate and groundwater will eventually reach the Detroit River.

Point Hennepin, on Grosse Ile, has an area of approximately 1 km^2. This site was an industrial waste lagoon/disposal site by BASF Wyandotte (South Works). Little is known about the type and quantity of wastes disposed here, but other waste sites operated by this corporation (eg., site 5, Table IX-9) contain high concentrations of zinc, copper, lead, chromium, mercury, and several organic compounds including tetrachlorobutadienes and trichloroethylenes. Also, large sinkholes exist on this peninsula which may provide a connection between the surface water and groundwater aquifers. A surface leachate sample taken on the eastern side of the peninsula in 1983 was highly toxic in the Microtox toxicity bioassay (88). More detailed investigations of this site appear warranted.

Underground Injection Wells

Pressurized injection of industrial liquid wastes has occurred in the Detroit River watershed for many years at depths ranging from 200 m to over 1,200 m and injection pressures ranging from 580 to 1,600 psi (approximately 20 to 50 kBar). There are five classes of injection wells regulated by U.S. law. Class I wells are industrial and municipal wells which discharge below the lowermost formation containing an underground source of drinking water (USDW). Class II injection wells are associated with oil and gas production and liquid hydrocarbon storage. Class III wells are special process wells used in conjunction with solution mining of minerals. Class IV wells, which were banned in 1985, are hazardous waste wells which inject into or above a USDW, and Class V injection wells are those not fitting into any of the above categories, such as cesspools and heat exchange wells.

On the Michigan side of the Detroit River, 234 injection wells have operated or are currently operating. Of the six Class I wells, three are plugged and abandoned and three are currently operating at the Detroit Coke facility. The facility disposed of waste that contained chloride, ammonia, phenols, cyanide and sulfide. Class II well records indicate a total of 12 wells operating near the Detroit River, and consist of six salt water disposal wells and six hydrocarbon storage wells. Two Class III facilities (Pennwalt and BASF-Wyandotte) operated a total of 150 wells, of which only five are still active, and are scheduled to be plugged and abandoned soon. Approximately 66 Class V wells are presently operating in the Detroit River area. The impact of these underground injection wells on the Detroit River and its ecosystem is unknown, and warrants investigation.

It is beyond the scope of this investigation to determine the environmental soundness of the injection well disposal method. Historically, there is evidence for problems resulting from such wastes. In general, there is little knowledge of the pathways and fates of injected solutions.

4. Spills

An inventory of Michigan and Ontario spills occurring in or to the Detroit River in 1986 is contained in Table IX-10. A variety of chemical, oil and raw sewage spills occurred during 1986 (presumably indicative of present day spill events). Since insufficient information was available from spill reports on all spill events, such as volume or constituents of spills, no contaminant loading estimates were made. It is difficult to ascertain the impact of spills to the Detroit River ecosystem relative to point source inputs, but what is known suggests that contaminant loading from spills may be important.

5. Rural Runoff and Tributary Input

Land use determines the type, quantity and quality of chemical constituents present in tributaries which contribute approximately 117,900 million gal/year to the total Detroit River flow.

TABLE IX-10

Reported U.S. and Canadian spill incidents to the Detroit River (1986)[1].

U.S. SPILLS

Constituent	Source	Volume	Receiving Water	Amount Recovered
Unknown	Pennwalt Corp.	850 barrels	Detroit River	unknown
Metal finishing wash solution	GMC Truck & Bus	40,000 gal	Upper Rouge	30,000 gal
Raw sewage	Detroit Boat Club	5000 gal/min	Detroit RIver	none
Raw sewage	Beverly Hills Water Department	unknown	Rouge River	none
Raw sewage	Michigan Industrial Mechanical Co.	68 gal	Rouge River	none
Raw sewage	Hubble So. Field Interceptor	unknown	Rouge River	none
Raw sewage	Trenton WWTP	unknown	Detroit River	none
Raw sewage	Detroit Boat Club	unknown	Detroit River	none
Raw sewage	Trenton WWTP	7200 gal/min	Rouge River	none
Raw sewage	City of Farmington	1000 gal	Rouge River	none
Raw sewage	Wayne Co-Wyandotte WWTP	130×10^6 gal	Detroit River	none
Raw sewage	Wayne Co-Wyandotte WWTP	140×10^6 gal	Detroit River	none
Ferrous chloride	Pennwalt Corp.	unknown	Detroit River	none
Trivalent chromium-containing water conc: 3 ug/L	Detroit Diesel	10,000 gal	Rouge River	none
Xylene washwater	Ford Motor Co.	500-750 gal	Rouge River	none
Hydrochloric acid	Pennwalt Corp.	10 gal	Detroit River	none
Ammonia and mono-ethylene	Pennwalt Corp.	10 gal	Detroit River	8 gal

TABLE IX-10. (cont'd).

U.S. SPILLS				
Constituent	Source	Volume	Receiving Water	Amount Recovered
Oil[2]	Unknown	100 gal	Rouge River	none
Oil	Trailer Park	300 gal	Detroit River	unknown
Oil	McLouth Steel	unknown	Detroit River	none
Oil	Unknown	unknown	Trenton Channel	none
Oil	Grosse Ile Airport	2-3 gal	Trenton Channel	none
Oil	Consolidated Freight	230 gal	Rouge River	none
CANADIAN SPILLS				
Oil	Ford Engine Plant	unknown	Detroit River	none
Oil	Allied Chemical (General Chemical)	15-25 gal	Detroit River	none
Chromic acid and nickel salts	Wickes Manufacturing	unknown	Little River[3]	none

[1] From the Point Source Workgroup Report (6).
[2] "Oil" refers to non-PCB-containing oil.
[3] per R. Bowen, OMOE (Point Source Workgroup Report reports as occurring to Detroit River).

Land use in the Detroit River area is almost equally divided between urban/residential/industrial and agriculture (5,86,89).

Forty six percent of the approximately 200,000 hectare watershed is intensively farmed, primarily for corn and soy beans. Beef and swine are the dominant livestock, but dairy cattle are also raised. Fertilizer and manure have the potential to be a major nitrogen and phosphorus source to the Detroit River since approximately 17,100 tons per year (11,355 in Ontario and 5,755 in Michigan) are applied within the Detroit River watershed. This could be substantially reduced, since phosphorus and fertilizer application rates are generally more than twice the required amount in these areas, and only 8% of the Michigan and 10 to 20% of the Ontario Detroit River watershed farms use recommended agricultural soil and water conservation practices (5,86).

Michigan applies about 37,000 kg and Ontario applies about 53,000 kg of pesticides annually, including atrazine, alachlor, cyanazine and metolachlor. Reports indicate that 60% of the Detroit River watershed has a high potential for pesticide transport to the surface and groundwater systems. Instantaneous pesticide loadings were calculated for all Ontario tributaries for total atrazine, lindane, and p'p-DDE. Loadings were estimated at 33 ug/sec, 13.4 ug/sec and 4.4 ug/sec, respectively (34).

Tributary contaminant loadings were determined for the Ecorse and Rouge rivers in Michigan, and Turkey Creek and Little and Canard rivers in Ontario. Selected chemical constituents were measured every 12 hours for two 1 week periods during 1986. Concentrations multiplied by tributary flow determined chemical mass loadings to the Detroit River. Calculated contaminant loadings for these tributaries are shown in Table IX-11 (5,30). Tributary loadings generally account for only a minor portion of that contributed by point sources. However, for some parameters, tributary loadings (when expressed as kg/d), approach some point source loadings.

6. Atmospheric Deposition

No data were obtained for direct atmospheric deposition of contaminants to the Detroit River by this study. Contaminant loadings from indirect atmospheric deposition to the watershed are reflected in tributary contributions. Air concentrations of selected constituents for Wayne County are shown in Table IX-12, and sampling locations are shown in Figure IX-20. The highest concentrations of these constituents are near Zug Island. Areas located 2 to 3 km north of Zug Island generally had the lowest concentrations. Total suspended particulates exceeded the primary annual geometric mean of 75 ug/m^3 at station 5 just north of Zug Island during the 1980 to 1986 period. Cadmium and chromium also exceeded the primary annual geometric mean at all three stations monitored.

TABLE IX-11

Comparison of U.S. and Canadian Detroit River tributary contaminant loadings, 1984-1986 (kg/yr).

	CANADIAN TRIBUTARIES		U.S. TRIBUTARIES	
Tributaries Sampled	Little, Canard and Turkey	Little and Turkey	Rouge	Rouge and Ecorse
Year Sampled	1984 & 1985	1986	1984-1986	1986
Number of Samples	7-31	2-28	36-167	2-28
% of Drainage Basin	20%	4%	54%	77%
Reported by:	Wall *et al.*[1]	Richardson[2]	MDNR[3]	Richardson[2]
Chemical Constituents				
Total Phosphorus	103,689	15,547	151,718	109,903
Nitrate-N	628,404	-	720,267	-
Chloride	7,334,728	3,579,336	76,771,600	76,564,047
Suspended Solids	-	1,103,445	28,944,500	30,231,356
Total Lead	836	-	9,624	-
Total Cadmium	-	3.4	740	2,151
Total Copper	-	178	9,587	7,496
Total Iron	-	1,313	-	41,394
Total Mercury	-	0.6	-	18.2
Total Nickel	-	17,941	7,373	3,541
Total Zinc	-	1,947	53,582	174,896
Total PCBs	-	0.36[4]	-	55.1

1 From Wall *et al.* (5).
2 From Detroit River System Mass Balance Study (30).
3 Michigan DNR data from high flow event monitoring, 1984-1986 (unpublished).
4 This value applies to Turkey Creek only.

TABLE IX-12

Mean concentrations of selected chemical constituents in air of Wayne County, Michigan, within four miles of the Detroit River, 1980-1986[1].

	STATION NUMBER							
CONSTITUENT	2	60/61	4	5	9	8	10	34
Benzo(a)pyrene ng/m^3	1.27	-	1.50	3.49	-	1.10	-	-
Beryllium ug/m^3	-	-	0.0004	0.0003	-	-	-	0.0007
Cadmium ug/m^3	-	-	0.027	0.058	-	-	-	0.0038
Carbon Monoxide ug/m^3	-	-	1.16	-	-	1.06	-	-
Chromium ug/m^3	-	-	0.007	0.012	-	-	-	0.009
Iron ug/m^3	-	-	0.99	1.53	-	-	-	1.21
Lead ug/m^3	-	-	0.24	0.27	-	-	-	0.14
Mercury ug/m^3	-	-	0.0003	0.0003	-	-	-	0.0004
Nickel ug/m^3	-	-	0.015	0.013	-	-	-	0.010
Nitrogen Dioxide ug/m^3	-	65	51	-	-	-	-	-
Ozone ppm	-	-	0.022	-	-	0.019	-	-
Sulfur Dioxide ug/m^3	16	34	-	39	24	18	-	-
Total Susp. Particles ug/m^3	57	66	-	89	68	59	52	-
Zinc ug/m^3	-	-	0.24	0.33	-	-	-	0.37

[1] From Michigan DNR, Wayne County yearly air quality data.

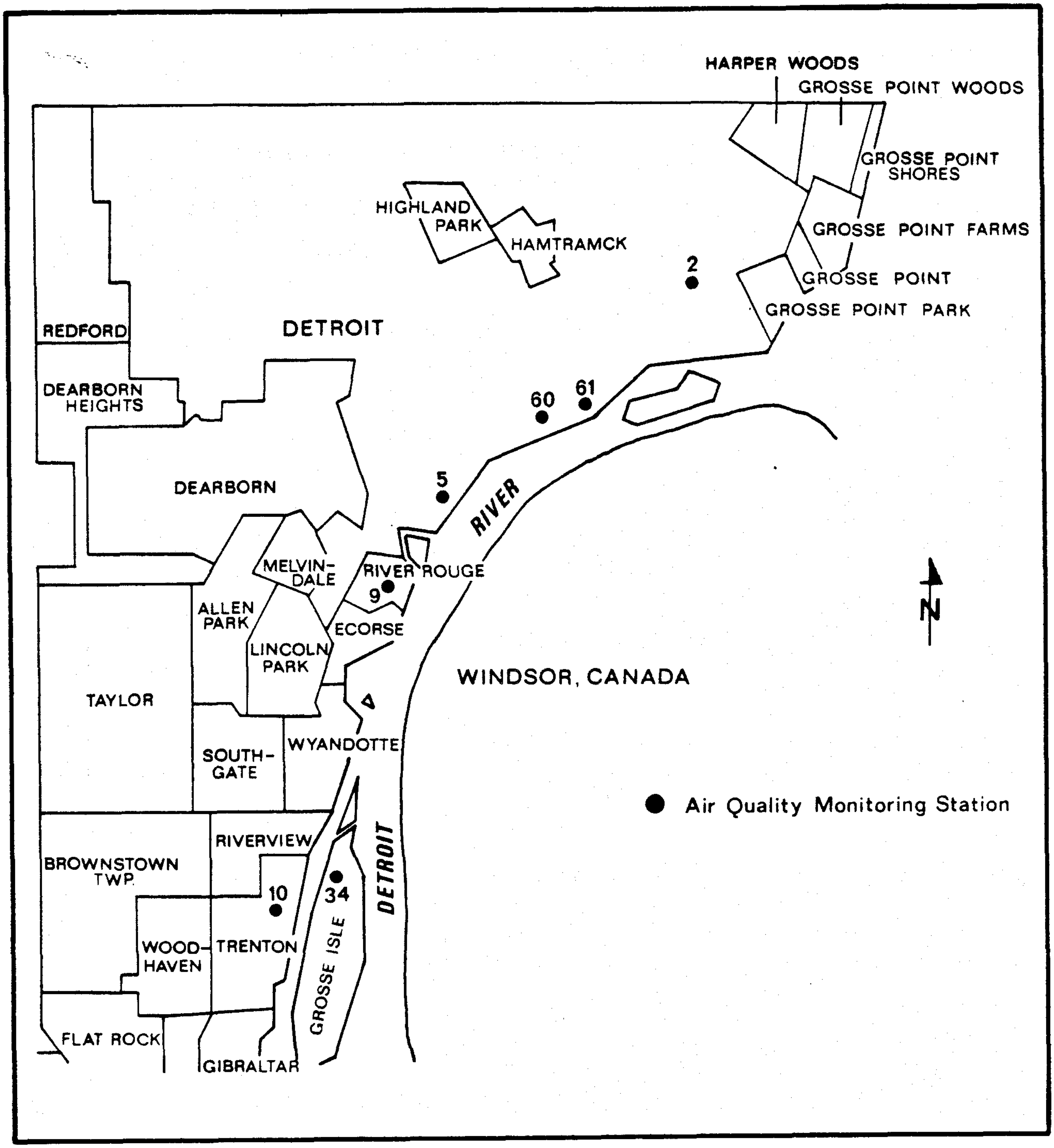


FIGURE IX-20. Wayne County air quality monitoring network.

7. Integrated Contaminant Input

The total measured loadings of UGLCCS parameters from all point source facilities were added to the combined measured loadings of stormwater, combined sewer overflows and tributary loadings to determine the total measured loading of each UGLCCS parameter discharged to the Detroit River. These loadings and their respective percentages by various categories are shown in Tables IX-13 and 14.

Michigan's point sources contribute 49% or more of the measured ammonia, total phosphorus, oil and grease, cadmium, chromium, cobalt, iron, nickel, zinc, cyanide, total phenols, HCB, PCBs and PAHs. Ontario point sources contributed 64% of the measured chlorides. Michigan CSOs contributed a substantial proportion of total phosphorus, suspended solids, oil and grease, cadmium, chromium, copper, lead and mercury loadings as of 1979. There are no data on contaminant loadings from Michigan CSOs more recent than 1979.

An attempt was made to determine changes in concentrations of UGLCCS parameters between the Detroit River head and mouth during the Detroit River System Mass Balance Survey, described in a later section. Most parameters measured had higher concentrations at the mouth than the head, indicating input of these materials along the river. Measured point sources, tributaries and CSO loadings accounted for 50% or more of these increases (30). These data suggest that other sources, possibly including atmospheric deposition, direct shoreline runoff, groundwater discharge, spills and sediments may be contributing to increases in these chemical constituents between Lake St. Clair and Lake Erie. Uncertainty in the measurements resulting from limited sampling may also play a part. These data also suggest that the Detroit River corridor is a source for waterborne phosphorus, copper, zinc, suspended solids, chloride and PCB, but is a sink for waterborne mercury, nickel, iron and cadmium. These latter metals may be adsorbing or chemically bonding to particulate matter which settles in Detroit River depositional zones. Some portion of these substances probably settle out, but during this study their export exceeded the measured input.

TABLE IX-13

Total loadings of selected chemical constituents of the Detroit River from Michigan and Ontario point and nonpoint sources measured between 1979 and 1986 (kg/yr).

PARAMETER	TOTAL MEASURED LOADING	MEASURED MICHIGAN POINT SOURCE LOADINGS[1]	MEASURED ONTARIO POINT SOURCE LOADINGS[2]	MEASURED DETROIT CSO LOADINGS[3]	MEASURED WINDSOR STORMWATER & CSO LOADINGS[4]	MEASURED MICHIGAN TRIBUTARY LOADINGS	MEASURED ONTARIO TRIBUTARY LOADINGS
Ammonia	11,692,656	9,088,500	617,000	618,285	20,200	720,267[5]	628,404[6]
Phosphorus	915,821	452,600	82,900	166,514	8,400	151,718[5]	103,689[6]
Chloride	623,207,041	134,320,000	398,000,000	1,545,713	5,235,000	76,771,600[5]	7,334,728[6]
Susp. Solids	57,607,849	19,199,000	-	8,360,904	-	30,231,356[8]	1,103,445[7]
Oil/Grease	15,719,506	12,227,500	66,800	3,302,206	123,000	-	-
Cadmium	5,681	2,986	337	1,440	175	740[5]	3.4[7]
Cobalt	17	1,737	8	-	9	-	-
Chromium	15,774	11,242	-	4,532	-	-	-
Copper	38,554	10.548	9,450	7,658	1,133	9,587[5]	178[7]
Iron	1,560,852	1,182,600	122,000	79,745	133,800	41,394[8]	1,313[7]
Lead	49,490	8,067	10,900	15,703	4,360	9,624[5]	836[7]
Mercury	1,642	39.4	2	1,581	1	18.2[8]	0.6[7]
Nickel	74,005	36,865	6,190	4,883	753	7,373[5]	17,941[7]
Zinc	316,006[9]	172,280	61,500	19,497	7,200	53,582[5]	1,947[7]
Total Phenols	50,061	32,047	17,300	597	117	-	-
Cyanide	44,361	43,435	843	-	83	-	-
HCB	0.9	0.9	-	-	0.03	-	-
Total PCBs	249	94	14	84.3	1.6	55.1[8]	0.36[10]
17 PAHs	2,281	1,891	304	-	86	-	-

1 Based on UGLCCS 1986 Point Source Survey (6).
2 Based on UGLCCS 1985 Point Source Survey (6).
3 Based on City of Detroit CSOs (1979), from Giffles <u>et al</u>. (79).
4 Based on Windsor stormwater and CSOs 1985-1986, Marsalek and Ng (80).
5 Based on Rouge River loadings, 1984-1986, Michigan DNR, unpublished data, 1988.
6 Based on loadings from the Little and Canard rivers and Turkey Creek, 1984-1985. Wall <u>et al</u>. (5).
7 Based on loadings from the Little River and Turkey Creek, 1986 (30).
8 Based on loadings from the Rouge and Ecorse rivers, 1986 (30).
9 Does not include loadings from Double Eagle Steel.
10 Based on loadings from Turkey Creek only, 1985. Wall <u>et al</u>. (5).

TABLE IX-14

Estimated annual contaminant loadings to the Detroit River based on measured point and nonpoint sources between 1979 and 1986, and the percent of this total loading contributed by the sources compared with measured increased loadings between the head and the mouth of the Detroit River.

Parameter	Total Measured Loading kg/yr	Michigan Point Source[1] %	Ontario Point Source[2] %	Detroit CSOs[3] %	Windsor Storm-water & CSOs[4] %	Michigan Tribu-taries %	Ontario Tribu-taries %	Changes Between Head & Mouth kg/yr	Percent Change Accounted for by Measured Point & Non-Point Sources	Source or Sink
Ammonia	11,692,656	77.7	5.3	5.3	0.2	6.2[6]	5.4[7]	---	--	---
Phosphorus	915,821	49.4	9.1	12.7	1.0	16.6[6]	11.3[7]	+ 1,450,656	63	Source
Chloride	623,207,041	21.6	63.9	0.2	0.8	12.3[6]	1.2[7]	+ 729,625,072[10]	85	Source
Susp.Solids	57,607,849	33.9	NM	14.5	NM	50.2	1.9[5]	+ 527,660,352	11	Source
Oil&Grease	15,719,506	77.8	0.4	21.0	0.8	NM	NM	---	--	---
Cadmium	5,681	52.6	5.9	25.3	3.1	13.0[6]	0.1[5]	+ 2,586	220	Sink
Cobalt	17	99.0	0.5	NM	0.5	NM	NM	---	--	---
Chromium	15,774	71.3	NM	28.7	NM	NM	NM	---	--	---
Copper	38,554	27.4	24.5	19.9	2.9	24.9[6]	0.5[5]	+ 73,006	53	Source
Iron	1,560,852	75.8	7.8	5.1	8.6	2.7[9]	0.1[5]	- 199,717	--	---
Lead	49,490	16.3	22.0	31.7	8.8	19.4[6]	1.7[5]	---	--	---
Mercury	1,642	2.4	0.1	96.3	0.1	1.1[9]	0.1[5]	+ 45.4	3,617	Sink
Nickel	74,005	49.6	8.4	6.6	1.0	10.0[6]	24.3[8]	+ 37,149	200	Sink
Zinc	316,006[11]	54.5	19.5	6.2	2.3	17.0[6]	0.6[8]	+ 429,835[12]	74[13]	Source[13]
Total Phenols	50,061	64.0	34.6	1.2	0.2	NM	NM	---	--	---
Cyanide	44,361	97.9	1.9	NM	0.2	NM	NM	---	--	---
HCB	0.9	96.7	NM	3.3	NM	NM	NM	---	--	---
Total PCBs	249	37.8	5.6	33.9	0.6	22.1[9]	0.1[14]	+ 364	68	Source
17 PAHs	2,281	82.9	13.3	NM	3.8	NM	NM	---	--	---

NM Not Measured
1 Based on 1986 Point Source Surveys (6).
2 Based on 1985 Point Source Surveys (6).
3 Based on City of Detroit CSOs, 1979 and Giffles et al (79).
4 Based on Windsor Stormwater and CSOs in 1985-1986. Marsalek and Ng (80).
5 Based on U.S.EPA's System Mass Balance (30). Measured loading changes between the Detroit River head and mouth from ambient monitoring. (+) equals mouth loading greater than the head value shown; (-) equals mouth loadings less than value shown.
6 Based on loadings from the Rouge River, 1984-1986. MDNR unpublished data, 1988.
7 Based on loadings from the Little River, Canard River and Turkey Creek, 1984 and 1985 (5).
8 Based on loadings from the Little River and Turkey Creek, 1984 and 1985 (5).
9 Based on loadings from the Rouge River and Ecorse River, 1986 (30).
10 Includes the discharge from General Chemical (390,550,000 kg/yr) discharging below the Detroit River System Mass Balance lower transect.
11 Does not include loadings from Double Eagle Steel.
12 Includes loading from Double Eagle Steel.
13 This is uncertain due to footnotes 11 and 12.
14 Based on loadings from Turkey Creek only, 1985 (5).

D. DATA QUALITY ASSURANCE AND CONTROL

1. Limitations

A total of 13 interlaboratory performance evaluation studies were conducted for the UGLCC Project. All laboratories supplying analytical data participated in at least one of these round-robin studies. The parameters tested in the interlaboratory studies were: PCBs, PAHs, organochlorine pesticides, chlorinated hydrocarbons, total phenol, chlorophenols, trace metals, major ions, nutrients, and cyanide (see Chapter IV).

2. General Observations

The Michigan Department of Natural Resources laboratory results for the UGLCC studies were compared with similar effluent and surface water samples collected in years in other river systems. Point sources were evaluated based on field blanks replicates, reagent blanks, duplicates, sample spikes, annual laboratory precision and accuracy summaries and UGLCCS interlaboratory comparisons (round robin). Field blanks contained only a few constituents and did not impact loadings estimates. Field replicates, describing the relative system variation, varied by less than 20% for all parameters with three or more field replicates. Accuracy, described as the percent recovery, was 80 to 100% for most organic compounds, and 70 to 130% for most conventional compounds. Precision control (duplicate analyses) showed recoveries of 98 to 100% with a mean of 99%.

The U.S.EPA Large Lakes Research Station Laboratory, also did quality control analysis for PCBs and metals. For PCBs, average blank concentrations were substantially less than the concentrations observed in the samples. The duplicate analyses were within 17%. Additionally, the analyses of the 111 prepared laboratory standards were within 20% of the known concentration. Based on this summary, the PCB data are considered adequate. For metals, blanks were all less than the river or point source samples. Duplicate analyses were within 16%. Replicate analyses were within 27%. Reference standards were within 16% of known concentration except for chrome which was within 30%. Based on this information, the point source workgroup concluded the data were adequate and within the confines of the quality control-quality assurance management plan for the UGLCCS.

E. MODELING AND MASS BALANCE CONSIDERATIONS

Mass balance and process oriented models were developed for the Detroit River. These are identified in Chapter V along with an explanation of mass balance and process modeling.

1. Mass Balance Models

Mass balance models permit the evaluation of whole rivers or river segments as a source or sink of measured contaminants.

Mass balance studies were conducted for the entire Detroit River system and a section of the lower Detroit River, the Trenton Channel. These studies represent snapshots of contaminant conditions. Figure IX-21 shows the relative importance of loads in the Detroit Systems Mass Balance (DRSMB) including Michigan and Ontario tributaries and the Detroit WWTP (90). Figure IX-22 shows the same relationship for the Trenton Channel Mass Balance (TCMB) but also includes some tributaries and point sources. The arrow shaft width indicates the importance of the average contaminant load or loss. Estimates marked with a `?' denote data unavailability. At the bottom is a mass balance interpretation with statistical conclusions. Diagrams for each contaminant during the DRSMB periods and diagrams for each contaminant during the TCMB periods can be compared directly. Missing data for the Detroit River System Mass Balance include loadings from the Canard River, all direct point sources except the City of Detroit WWTP, nonpoint sources including CSOs, storm water, atmospheric deposition, groundwater, sediment fluxes, and contaminants associated with floating aquatic macrophytes. Missing data for the Trenton Channel Mass Balance include all of the above except direct point source discharges within the Trenton Channel.

Errors in these calculations may be due to 1) insufficient temporal or spatial sampling, or 2) analytical analysis. Concentrations less than the analytical detection level are particularly difficult to incorporate into modeling efforts. In the Detroit River Systems Mass Balance (30) and Trenton Channel Mass Balance (31), these errors were minimized by using only data generated by the U.S.EPA Large Lakes Research Station (LLRS) for the Detroit River, the tributaries and point sources, and City of Detroit WWTP daily monitoring data for the precise days of each survey. The method of managing values at less than detection is called the maximum likelihood method of singly censored data and has been applied to all U.S.EPA-LLRS results.

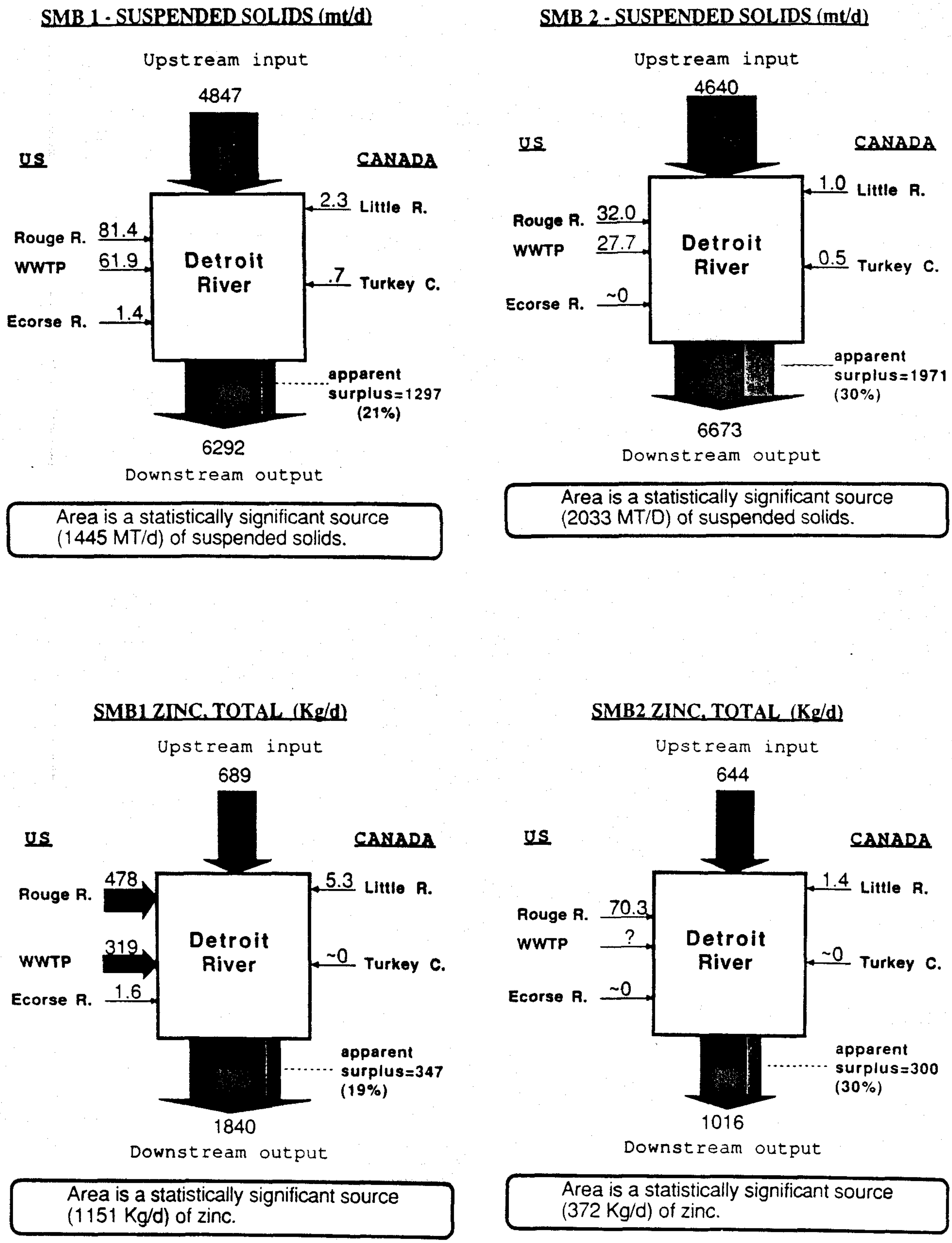


FIGURE IX-21. Detroit River mass balance results.

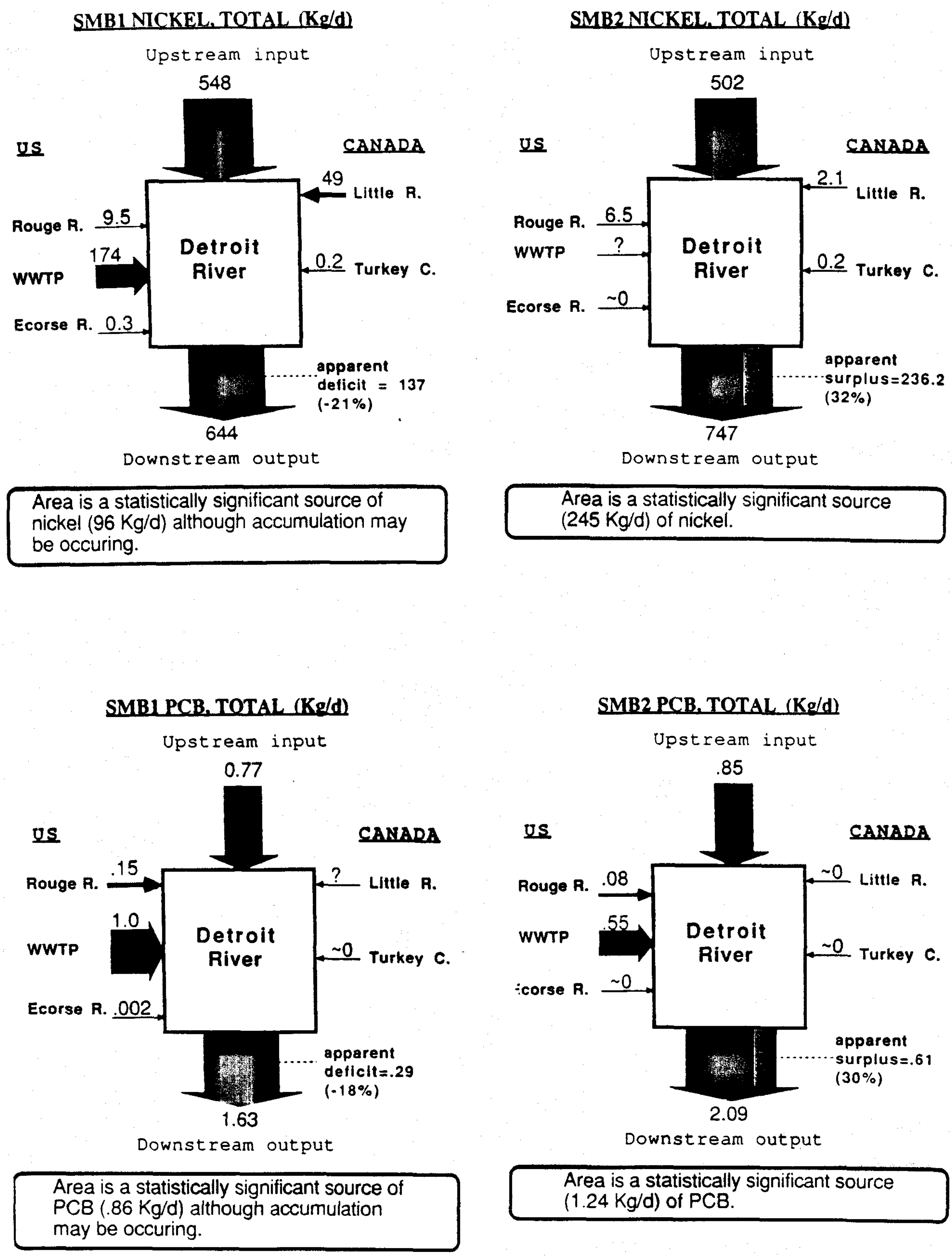


FIGURE IX-21. (Cont'd.) Detroit River mass balance results.

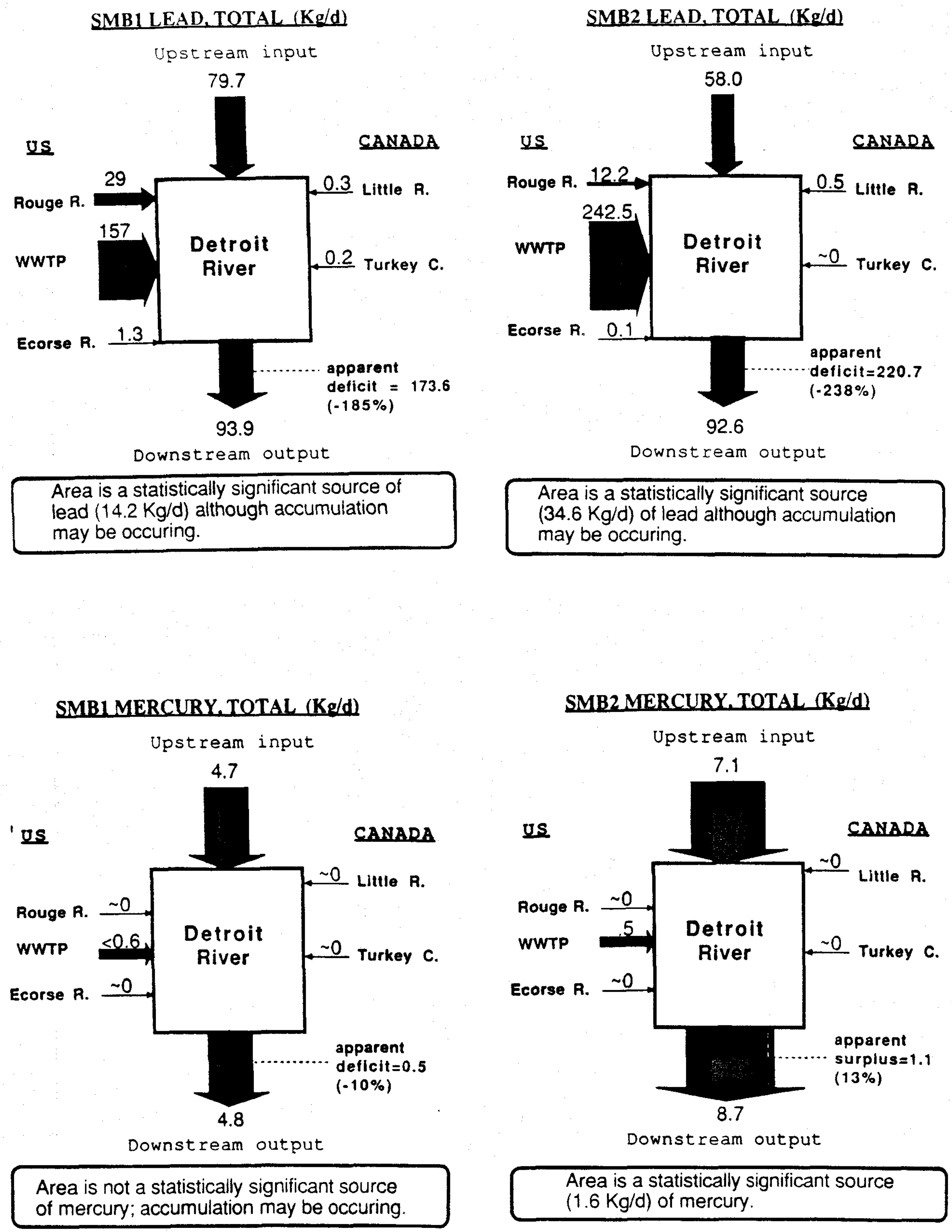


FIGURE IX-21. (Cont'd.) Detroit River mass balance results.

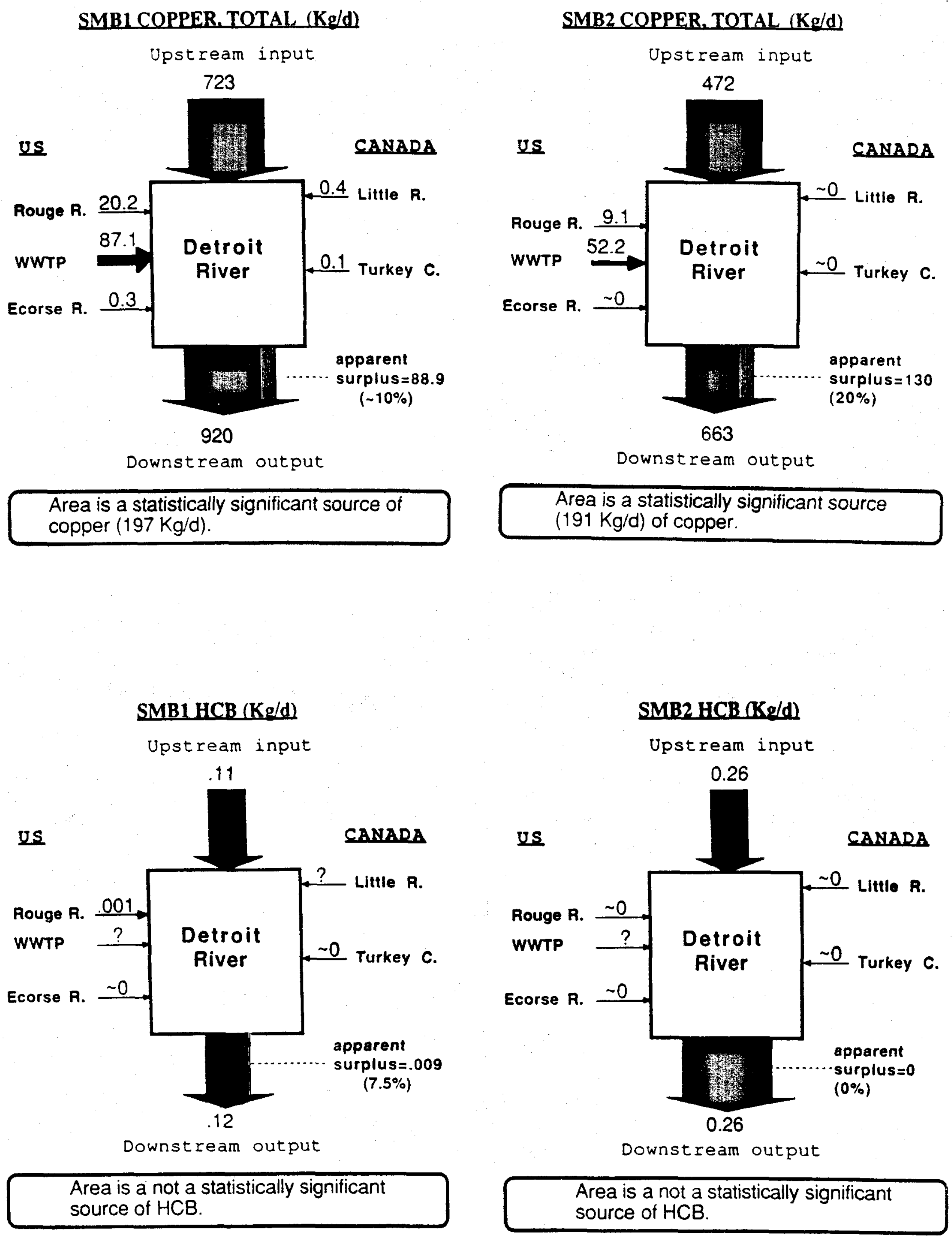


FIGURE IX-21. (Cont'd.) Detroit River mass balance results.

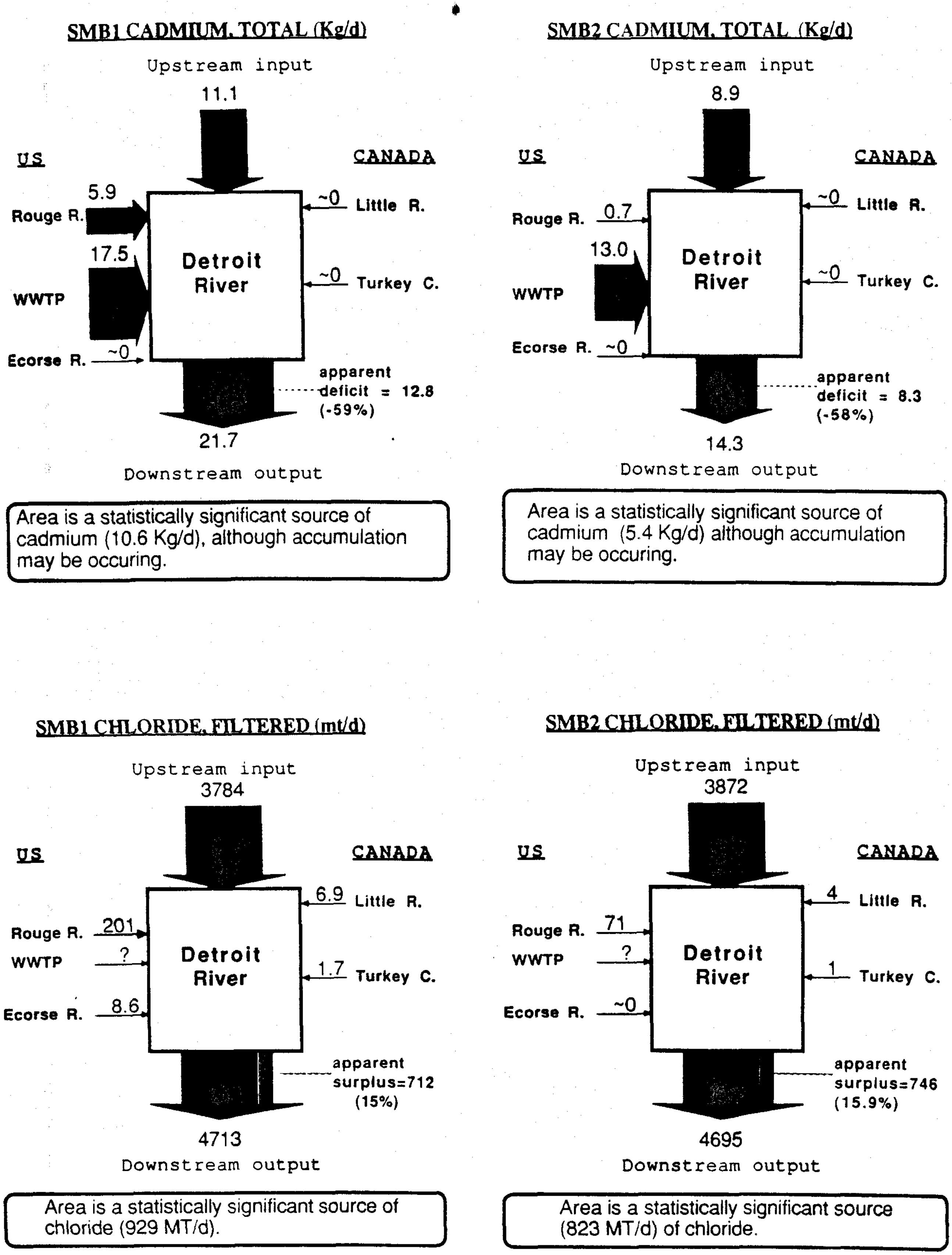


FIGURE IX-21. (Cont'd.) Detroit River mass balance results.

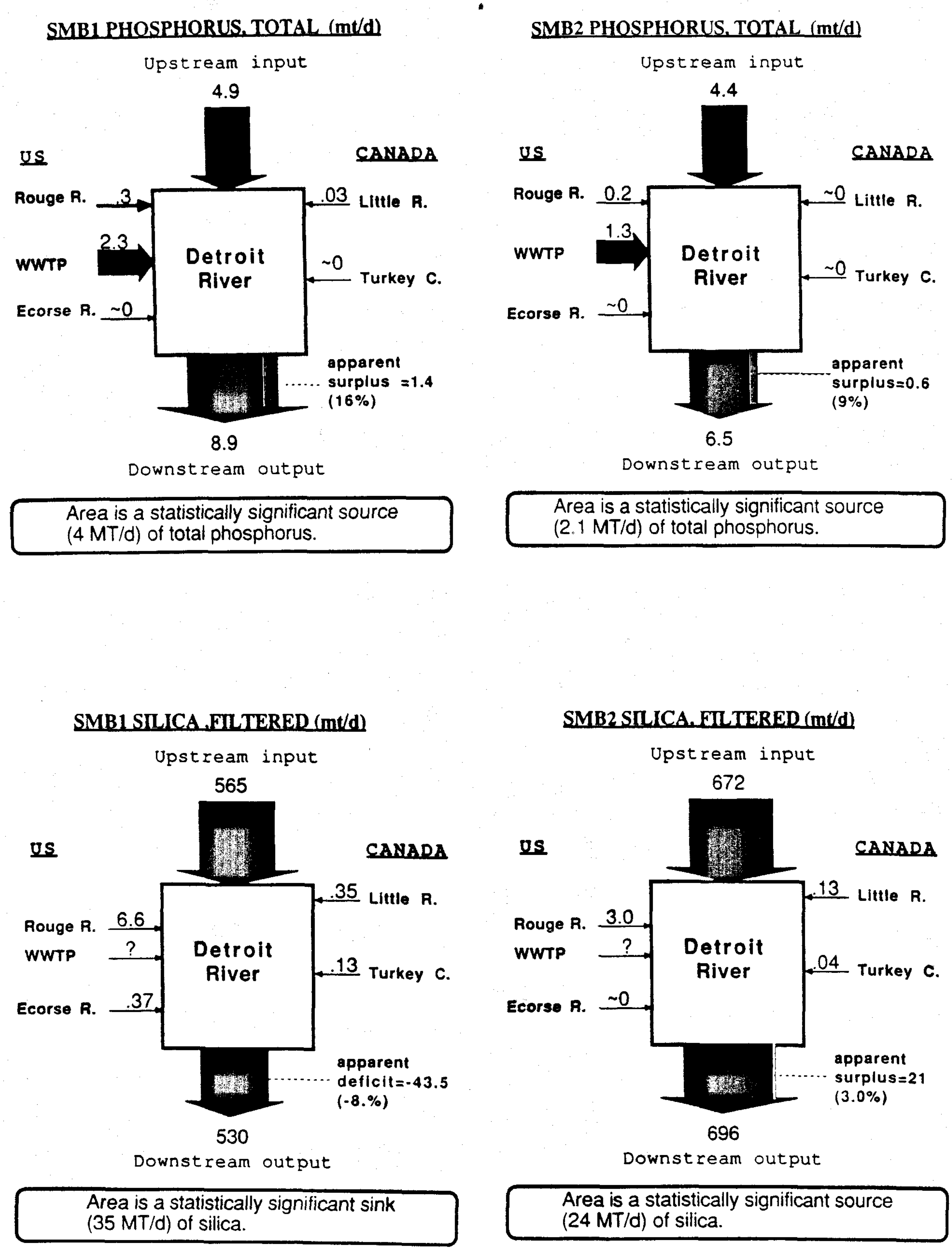


FIGURE IX-21. (Cont'd.) Detroit River mass balance results.

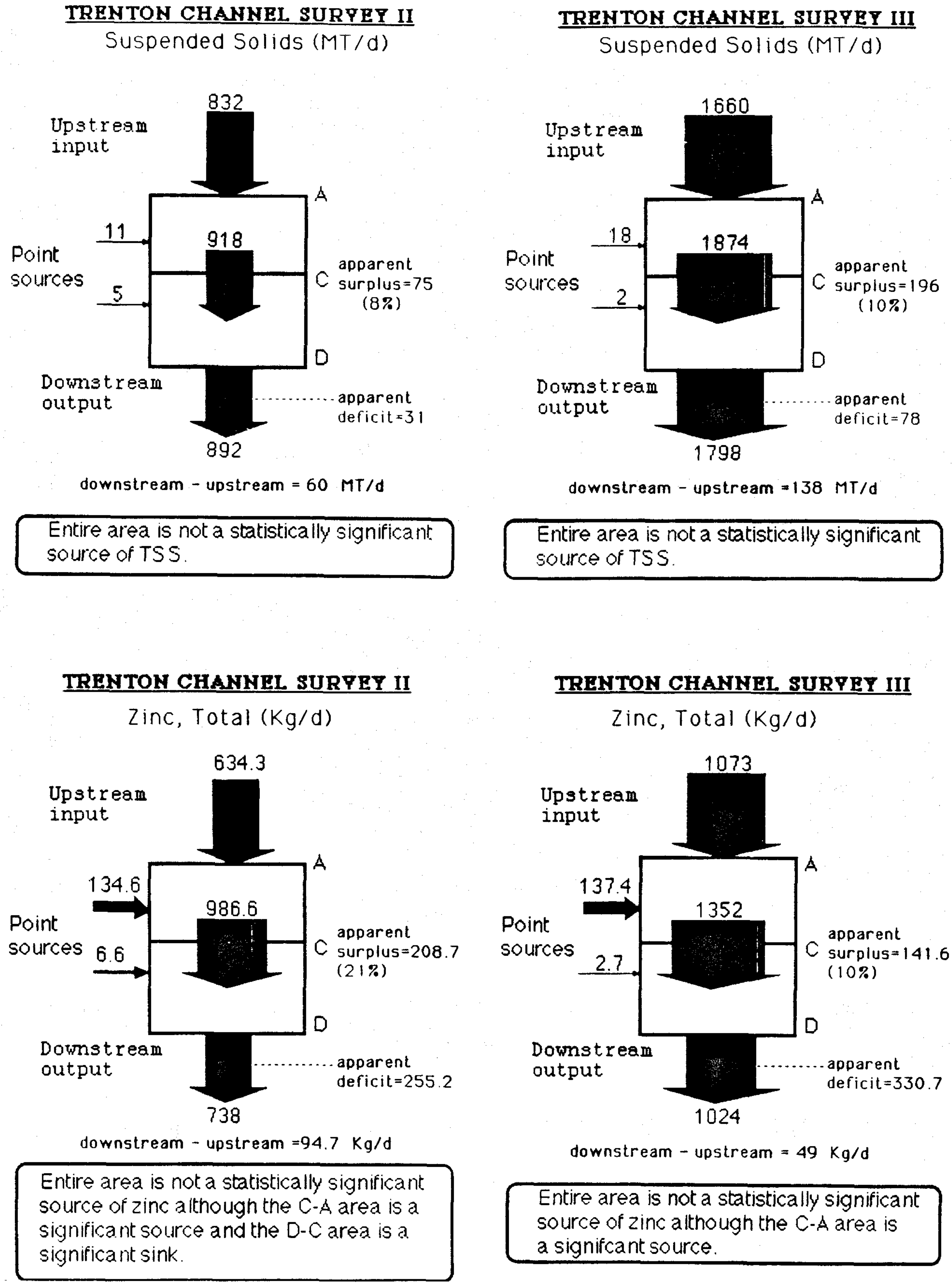
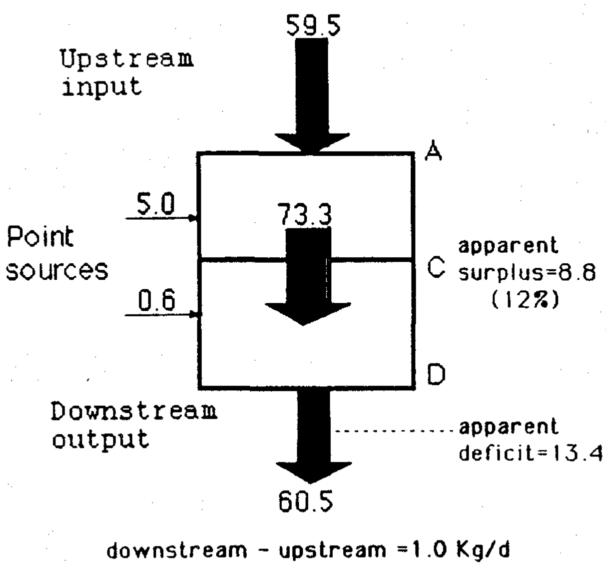


FIGURE IX-22. Trenton Channel mass balance results.

TRENTON CHANNEL SURVEY II

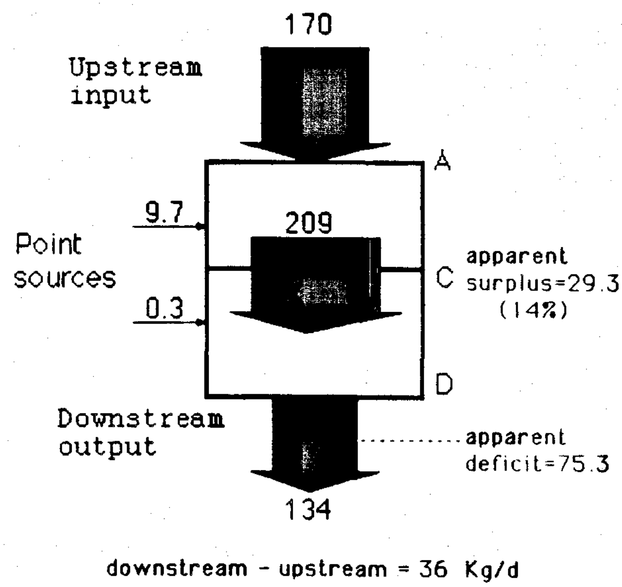
Lead, Total (Kg/d)



Entire area is not a statistically significant source of lead although the C-A area is a significant source.

TRENTON CHANNEL SURVEY III

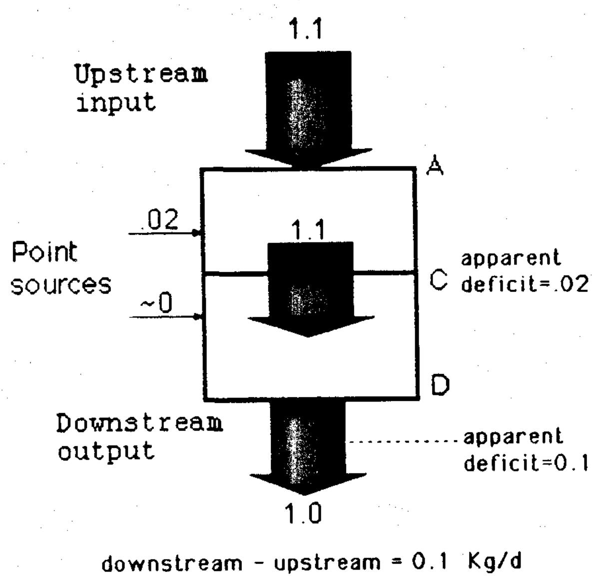
Lead, Total (Kg/d)



Entire area is not a statistically significant source of lead although the C-A area is a significant source.

TRENTON CHANNEL SURVEY II

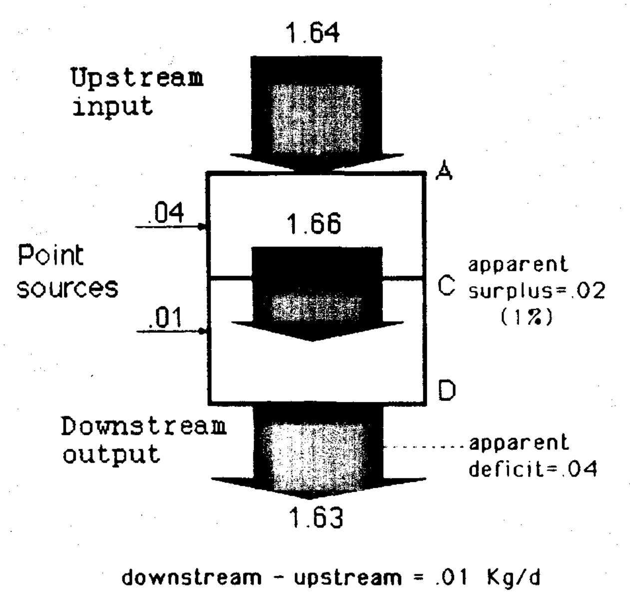
Mercury, Total (Kg/d)



Entire area is not a statistically significant source of mercury.

TRENTON CHANNEL SURVEY III

Mercury, Total (Kg/d)



Entire area is not a statistically significant source of mercury.

FIGURE IX-22. (Cont'd.) Trenton Channel mass balance results.

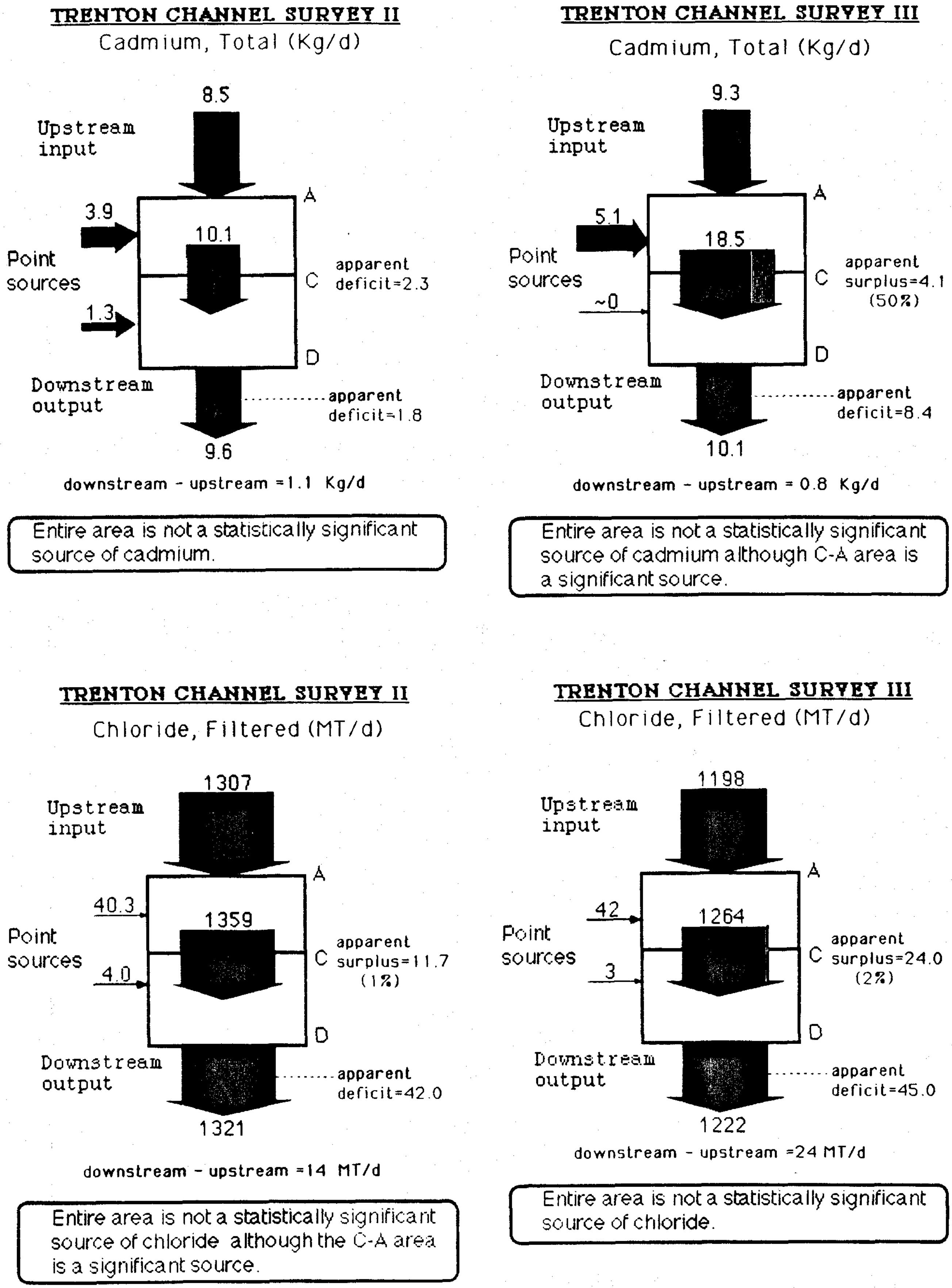
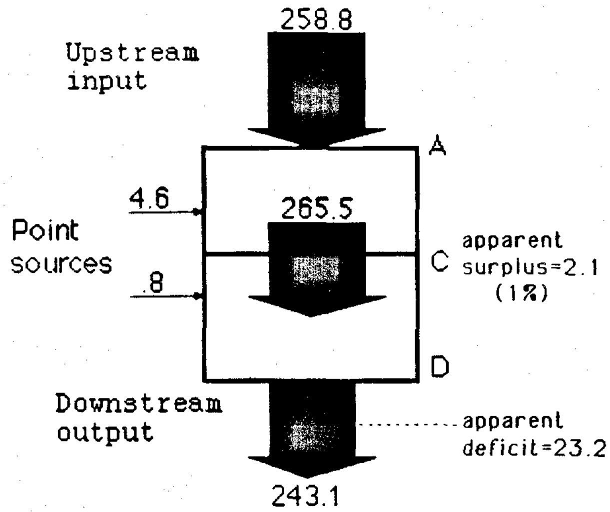


FIGURE IX-22. (Cont'd.) Trenton Channel mass balance results.

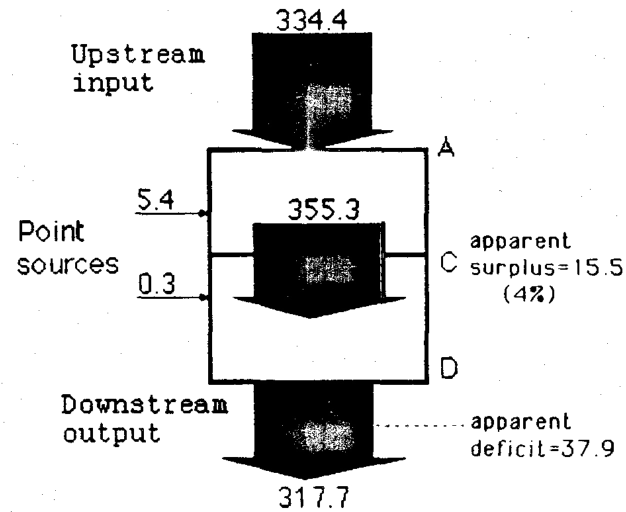
TRENTON CHANNEL SURVEY II
Nickel, Total (Kg/d)



downstream - upstream = 15.7 Kg/d

Entire area is not a statistically significant source of nickel.

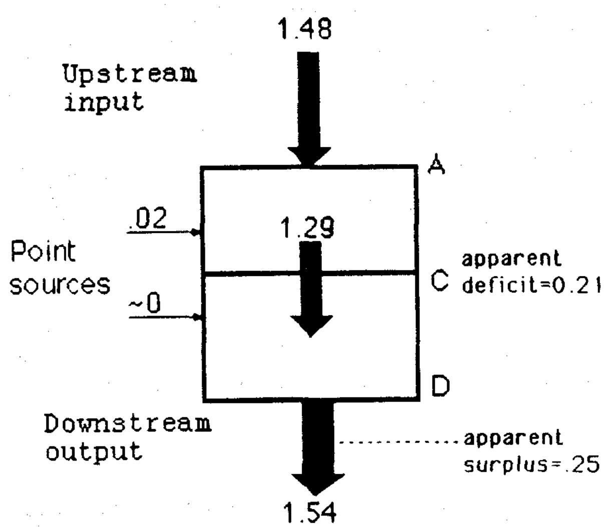
TRENTON CHANNEL SURVEY III
Nickel, Total (Kg/d)



downstream - upstream = 16.7 Kg/d

Entire area is not a statistically significant source of nickel.

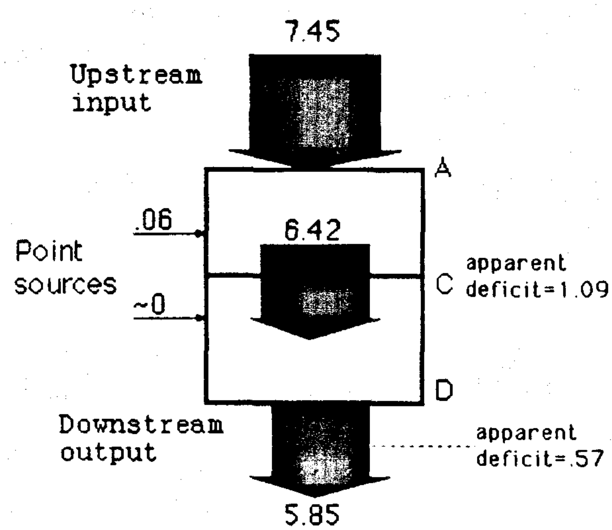
TRENTON CHANNEL SURVEY II
Total PCB's (Kg/d)



downstream - upstream = .06 Kg/d

Entire area is not a statistically significant source of PCB.

TRENTON CHANNEL SURVEY III
Total PCB's (Kg/d)



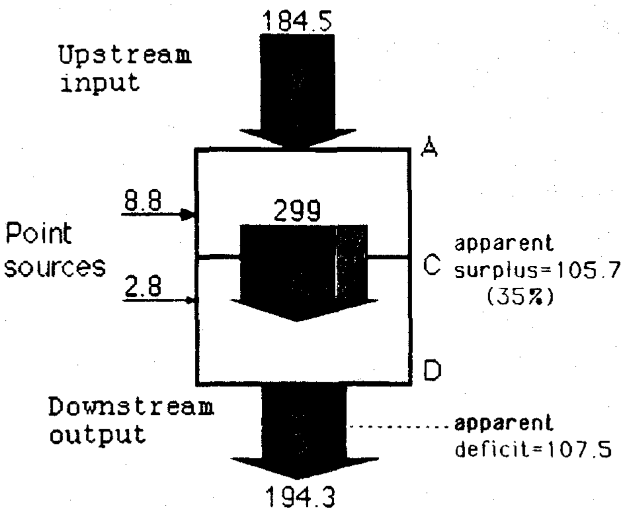
downstream - upstream = 1.6 Kg/d

Entire area is not a statistically significant source of PCB.

FIGURE IX-22. (Cont'd.) Trenton Channel mass balance results.

TRENTON CHANNEL SURVEY II

Copper, Total (Kg/d)

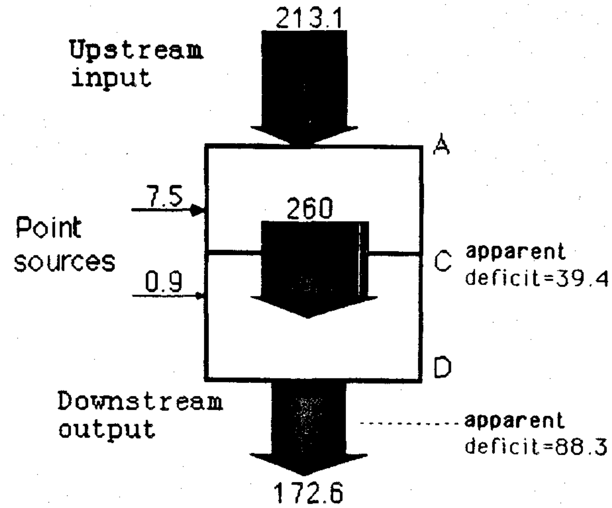


downstream - upstream =9.8 Kg/d

Entire area is not a statistically significant source of copper . Significant accumulation occured in the D-C area.

TRENTON CHANNEL SURVEY III

Copper, Total (Kg/d)

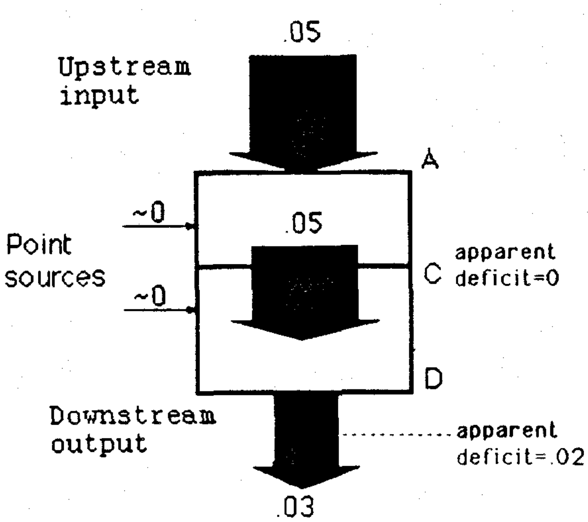


downstream - upstream =40.5 Kg/d

Entire area is not a statistically significant source of copper . Significant accumulation occured in the D-C area.

TRENTON CHANNEL SURVEY II

HCB (Kg/d)

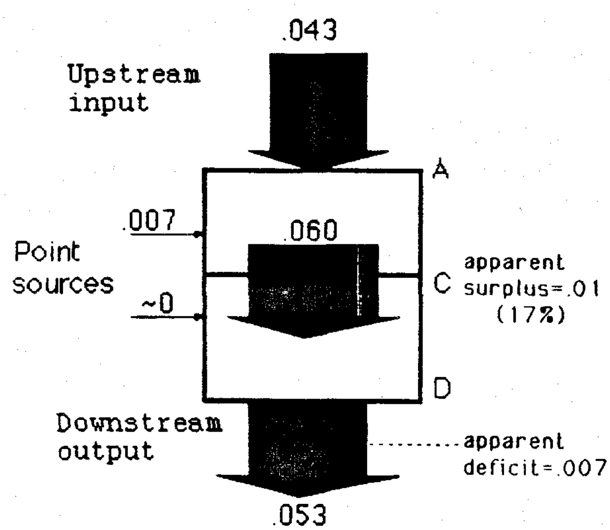


downstream - upstream =.02 Kg/d

Entire area is not a statistically significant source of HCB.

TRENTON CHANNEL SURVEY III

HCB (Kg/d)



downstream - upstream = .01 Kg/d

Entire area is not a statistically significant source of HCB although the C-A area is a siginificant source.

FIGURE IX-22. (Cont'd.) Trenton Channel mass balance results.

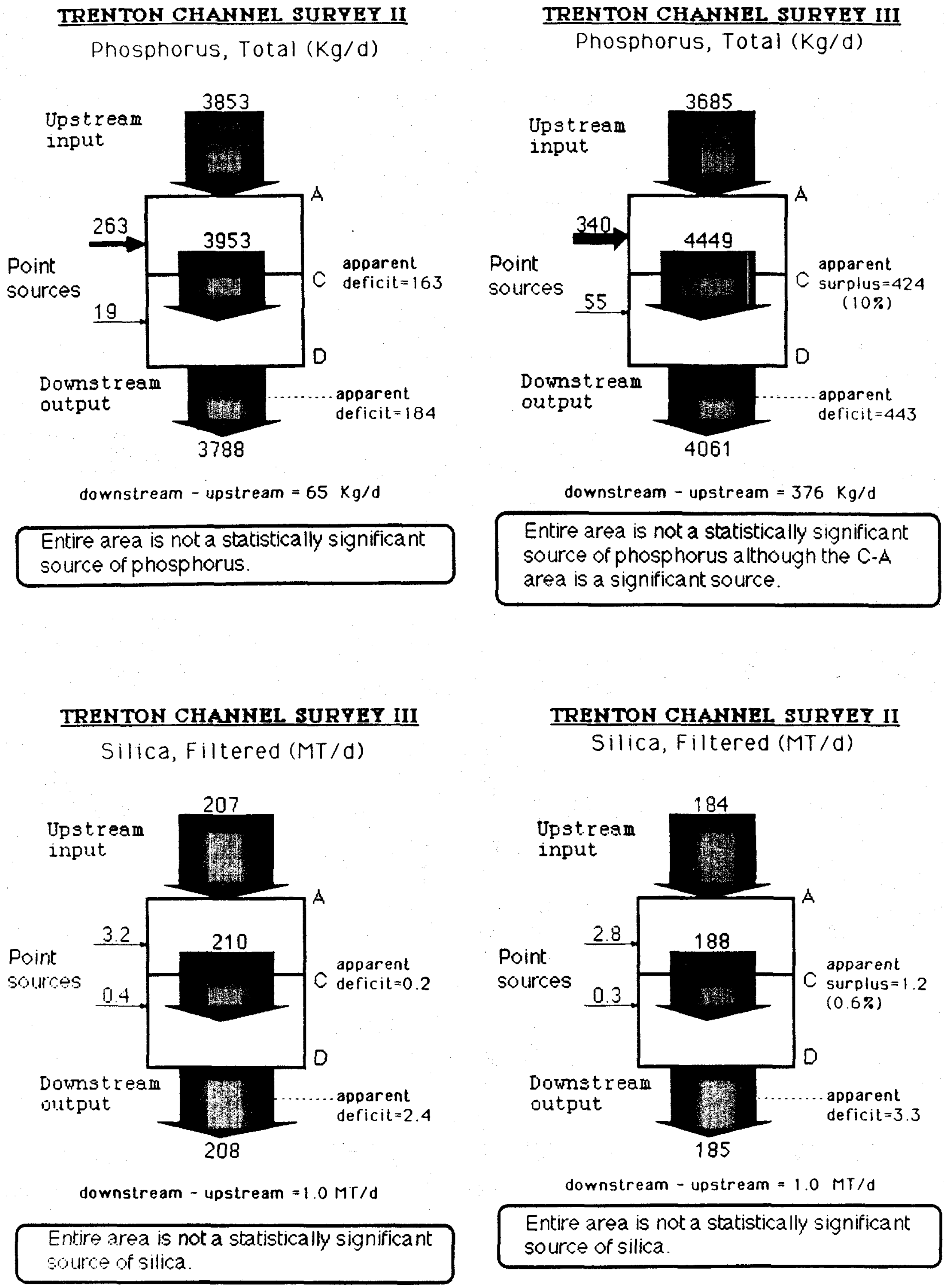


FIGURE IX-22. (Cont'd.) Trenton Channel mass balance results.

Detroit River System Mass Balance 1 and 2

The Detroit River System Mass Balance studies 1 and 2 were conducted between April 21 to 29, 1986, and July 25 to August 5, 1986, respectively (30). Sampling transects were located at the head of the Detroit River at Peach Island and the mouth of the Detroit River just downstream of the Grosse Ile bridge (see Figure IX-3). The results of these analyses indicate that the Detroit River is statistically significant source of several heavy metals (Cd, Cu, Pb, Ni and Zn) total phosphorus and PCBs. These data also suggest that some contaminants may be continuing to accumulate in the sediments.

Trenton Channel Mass Balance

The Trenton Channel Mass Balance II and III were conducted between May 6 and 7, 1986, and August 26-27, 1986 (31). Results of these analyses are shown in Figure IX-22. Letters on the right hand side of the diagrams refer to the transects indicated in Figure IX-23. These data suggest that lead and zinc enter the Trenton Channel in significant amounts. The data also suggest that cadmium and copper may also enter the Trenton Channel in significant amounts between certain transects. During the TCMB II, zinc was a source in segment A-C and a sink in segment C-D indicating rapid loss of zinc from the water column, probably to the sediments.

2. Process Modeling

Process oriented models investigate the relative importance of the processes controlling the simulated system to identify needed field measurements and experimental studies. Process models developed for the Detroit River range from physical water movement models to temporal and spatially complex contaminant fate and behaviour models. Verification is difficult without the necessary data, but these models can be used to speculate upon the contaminant fate and organism exposure. Process model output is uncertain because loading information, boundary conditions, initial conditions, and parameter estimates are uncertain. Uncertainty analyses were not completed for these data. Sensitivity analysis helped to identify some parameters and processes needing further research to improve contaminant fate models.

Detroit River, Detroit WWTP Plume Model

A two dimensional hydrodynamic and water quality model of the Detroit River was developed to simulate the impact of the Detroit WWTP effluent on water quality (28). The model contains two independent finite elements, a hydrodynamic model which predicts

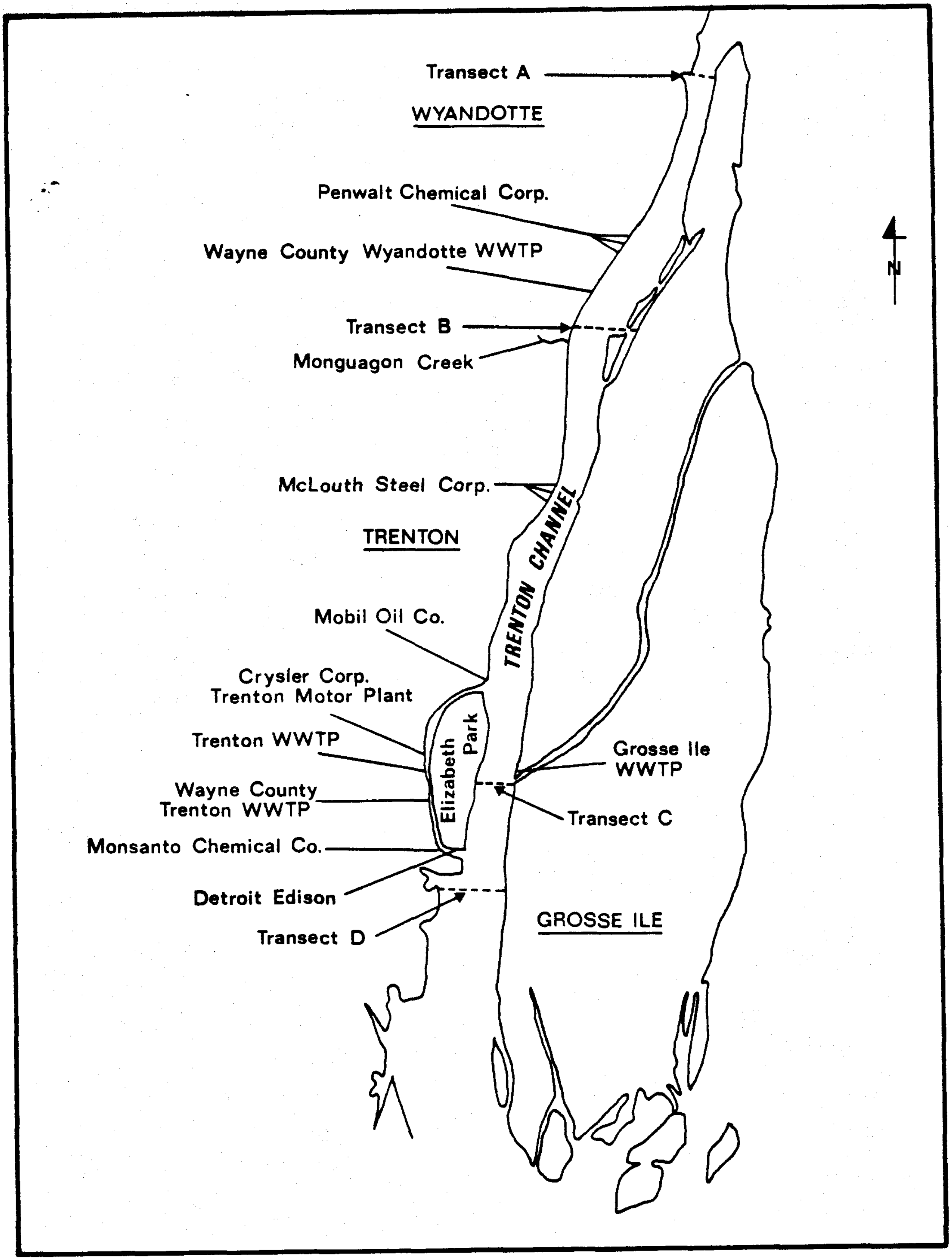


FIGURE IX-23. Major point source dischargers and Trenton Channel mass balance sampling transects, Detroit River (1986).

the two dimensional flow field and river water concentrations and a finite element transport and kinetic model.

The two dimensional model was used because the river is not laterally mixed, has rapidly changing bottom geometry, and flow is divided by islands. The NELEUS TM model simulates and assesses environmental impacts under varied ambient and effluent conditions including 1) two dimensional velocity flow fields; 2) free surface elevations; and 3) flow distribution in individual panels and branches. The contaminant transport component simulates the temporal and two dimensional contaminant concentration distribution using the predicted flow field.

This model was validated with intensive water quality surveys and could provide a basis for evaluating water quality issues from upstream of the Detroit WWTP discharge downstream to the Trenton Channel. The NELEUS TM contaminant transport model was calibrated and verified using survey data from both dye and water quality surveys. Model coefficients were developed for longitudinal and lateral diffusion partitioning coefficients describing the distribution of contaminants between particulates and dissolved fractions, characteristic suspended solids concentrations, settling velocities and decay rates for each contaminant.

Eight effluent management scenarios were chosen by the Detroit WWTP for model evaluation of environmental fate. Results indicate incremental impacts of Detroit WWTP effluent on the Detroit River and the water quality responses to various management alternatives. Although the model made these predictions, unfortunately the results were not compared to Michigan Rule 57(2) allowable levels. Mercury and PCB concentrations would both exceed these levels at all points in the river. In addition, the size of the mixing zone for the Detroit WWTP is currently under review. A reduction in its size will alter the interpretation of model conclusions.

Trenton Channel Transport Model

A transport model is being developed and calibrated for the Trenton Channel using specific conductance as a tracer for toxics. When completed, it will calculate the probability distribution of toxicity in water due to sediment resuspension. The model requires specific locations of toxic sediments, time between resuspension events, magnitude of sediment resuspension and toxicity associated with resuspended materials.

A hypothetical application was developed to predict water column toxicity resulting from sediment resuspension in the Trenton Channel near Monguagon Creek. Introduced toxicity was assumed to remain in the water with no settling occurring. The time between resuspension events were assumed to follow a Poisson distribution. During resuspension, both porewater and suspended solids are scoured into the water column. Resuspension magnitude was assumed to be a random variable described by a log-normal distribution with a median resuspension volume of 4,300 cubic meters of bed material (the top 3 cm).

Toxic unit concentrations were assigned to the resuspension volume. The equivalent mass input of toxicity to the water column was the product of a toxic unit concentration and the resuspension volume. A single sediment concentration determined from the dose response analyses of bioassays from the site were used to describe the site.

Model results for this hypothetical application indicate that sediment resuspension below Monguagon Creek will increase water column toxicity along the western shore of the channel. Toxicity increased as the time between events decreased or as the sediment toxicity increased. An approximately 1:1 relationship existed between sediment toxicity and water column toxicity. Toxicity ranged over several orders of magnitude as a consequence of the large resuspension variability. Resuspension frequency had the largest impact on the aquatic toxicity.

The model predicted a slight overall decline in toxicity between Monguagon Creek and the end of the modeled segment near the bottom of the Trenton Channel.

F. OBJECTIVES AND GOALS FOR REMEDIAL PROGRAMS

By evaluating the specific concerns in the Detroit River identified by this survey, in light of the contaminant input provided by point and nonpoint sources, an overall approach to addressing contaminant inputs can be derived. Remedial programs are to be developed in areas that fail to meet the general or specific objectives of the Great Lakes Water Quality Agreement of 1978, as amended (1987), where such failure has caused or is likely to cause a change in the chemical, physical or biological integrity of the Great Lakes. The general goals and objectives for remediation of the Detroit River and contaminant sources are discussed below. Specific recommendations are provided in Section H.

1. Water Quality

Water quality in the Detroit River, as determined by this study, is generally better than applicable water quality guidelines for most parameters measured. However, there are some exceptions. PCB concentrations exceeded various water quality guidelines throughout the river. Homologue analysis suggests that an active source of PCB exists in the river. Chlorobenzene concentrations in the Detroit River are below the Ontario water quality objective for hexachlorobenzene. However, concentrations of chlorobenzenes at the mouth of the Rouge River exceed this and other guidelines for HCB. A substantial increase in PAH concentration from the head of the Detroit River to the mouth, especially along the Michigan shoreline, indicates an input source. No appropriate ambient water quality guideline exists for total PAHs. Several metals exceeded water quality guidelines throughout, or at specific locations, in the Detroit River, specifically mercury, lead and cadmium.

Objective 1: **Reduction, with the goal of virtual elimination, of industrial and municipal point source inputs of contaminants to the Detroit River which are resulting in exceedences of ambient water quality guidelines.**

Objective 2: **Development of ambient water quality guidelines for contaminants without such guidelines, which are present in the Detroit River water.**

Tributaries of the Detroit River exceeded applicable water quality guidelines for several parameters: the Rouge River (total cadmium, total phosphorus, total zinc, total mercury), the Canard River (total cadmium, total phosphorus, total mercury, total lead), Turkey Creek (total cadmium, total phosphorus, total lead, total mercury, chlorides), the Little River (total cadmium, total phosphorus, total lead, total mercury, total zinc) and the Ecorse River (total phosphorus, total mercury). These tributaries provide inputs of these parameters approaching that provided by point sources. Of all Detroit River tributaries, the Rouge River provides the largest loading of most contaminants.

Objective 3: **Identification of contaminant input sources to tributaries of the Detroit River, and reduction, with the goal of virtual elimination, of such inputs.**

Contaminants in the Detroit River may have occurred, in part, through the discharge of groundwater contaminated by waste disposal sites or underground injection wells. Actual loadings of contaminants from groundwater were not obtained. However, confirmed or possible contamination sites within the Detroit River groundwater discharge areas were identified. The information was inadequate to assess the impact of the site on the Detroit River.

Objective 4: **Verification of groundwater contamination from waste sites or underground injection wells which threaten the ecosystem quality of the Detroit River, and removal or control of wastes and resulting contaminated groundwater.**

Detroit WWTP combined sewer overflows (CSOs) were a major contributor (>10%) of PCBs, total mercury, oil and grease, total cadmium, total chromium, total lead, total copper and total phosphorus to the Detroit River. About 55% of the CSOs discharge directly into the Detroit River and about 40% discharge to the Rouge River.

Objective 5: **Eliminate the impact of City of Detroit CSOs on water quality of the Detroit River and its tributaries.**

Limited information on Windsor urban runoff to the Detroit River suggests that urban runoff (stormwater) may be a source of certain contaminants. While stormwater runoff from many municipalities in and around Detroit is treated at the Detroit WWTP through its combined sewer system, other municipalities (Wyandotte, Trenton and Riverview) have numerous stormwater discharges to the Detroit River or its tributaries.

Objective 6: **Determine the significance of Michigan urban runoff through monitoring and sampling. Remedial or management action may be required.**

Numerous spills of chemicals, oil and raw sewage to the Detroit River or its tributaries were reported during 1986, which is presumably representative of present day spill incidents. Pennwalt Corporation experienced several chemical spills during 1986; Wickes Manufacturing experienced a spill of nickel salts and chromic acid; large volumes of raw sewage were spilled from

Michigan, as well. Information regarding spills is inadequate and incomplete, providing no information on spill volume or constituents, making impact assessment difficult.

Objective 7: **Ensure that accurate and complete spill incident reports are maintained at the appropriate agencies, to allow proper remediation, enforcement and preventive measures to be taken.**

To protect human health, there are periodic beach closings along the Detroit River, due to elevated bacterial concentrations. Standards and guidelines for fecal coliform bacteria concentrations have been exceeded in the Detroit River.

Objective 8: Ensure that the Detroit River water is of high quality to permit total body contact without deleterious human health impacts.

2. Sediments

Detroit River sediments, especially on the Michigan side and particularly in the Trenton Channel, contain elevated concentrations of several contaminants. Concentrations of PCBs, cyanide, oil and grease, cadmium, zinc, mercury, lead, copper, nickel, iron, chromium, arsenic, manganese, total phosphorus and nitrogen exceed dredging guidelines at various river locations. Sediments also contain concentrations of contaminants, such as total phenols and total PAHs, for which no guidelines exist. Other chemicals, such as pesticides, phthalates and volatile chemicals, were also found.

Objective 9: Reduction, with virtual elimination as a goal, of industrial and municipal point source inputs of contaminants resulting in sediment contaminant concentrations exceeding dredging guidelines.

Objective 10: Reduction, with virtual elimination as a goal, of nonpoint sources of contaminants (tributaries, urban runoff, waste sites, CSOs, spills) resulting in sediment concentrations exceeding dredging guidelines.

Objective 11: **Determination of the areal and vertical extent of seriously contaminated sediments, to permit classification and prioritization of sediment remediation.**

Objective 12: Development of sediment criteria based on aquatic life health effects and other pertinent parameters for contaminants found in the Detroit River which do not currently have such guidelines.

Certain Detroit River sediments, sediment porewater and near-bottom water were toxic to benthic and/or pelagic organisms. Nearshore Trenton Channel sediment porewater was toxic in bacterial luminescence assays. Sediment extracts were mutagenic in the Ames test, particularly those from Trenton Channel and the lower river, near Lake Erie. Comparable toxicity was demonstrated in Daphnia pulicaria feeding studies, Daphnia magna acute toxicity tests, Ceriodaphnia reproduction assays, Chironomus tentans growth tests, and others. Studies on the effect of Detroit River sediments and sediment porewater on feeding rates of larval channel catfish and on toxicity to rainbow trout eggs confirms sediment toxicity to fish species, as well. The greatest degree of toxicity was invariably found in Trenton Channel sediments.

Objective 13: **Eliminate sediments in the Trenton Channel and elsewhere in the Detroit River which are toxic to benthic and pelagic organisms. Work presently taking place to determine the specific reasons for degradation and toxicity to benthic organisms should be supported.**

Contaminated Detroit River dredged materials require disposal in confined disposal facilities and, in some cases, hazardous waste landfills. Costs for such disposal are high, and may result in future restrictions on recreational and other uses of the Detroit River.

Objective 14: **Anticipate future dredging rates through planning and prioritization, and identify potential disposal sites.**

3. Biota and Habitat

There is currently a Michigan consumption advisory for carp due to elevated body burdens of PCBs. OMOE has also issued a fish consumption advisory for certain sizes of rock bass, freshwater drum, and walleye for mercury, and carp for PCBs. PCBs were found in young-of-the-year spottail shiners at highest concentrations in the lower, western reach of the river (Trenton Channel and below) and near Grassy Island (by the Ecorse River), indicating localized Michigan inputs.

Objective 15: **Reduction of contaminant concentrations in Detroit River fish tissue to eliminate all fish consumption advisories.**

Objective 16: Reduction, with the goal of virtual elimination, of industrial and municipal point sources of contaminants to the Detroit River which are bioaccumulative in aquatic biota, and have or may result in fish consumption advisories.

Objective 17: Elimination of nonpoint sources of PCB, mercury and other persistent, bioaccumulative compounds to the Detroit River which have or may result in fish consumption advisories.

Caged and native clams in the Detroit River contained elevated concentrations of several contaminants: PAHs, HCB, OCS, lead and cadmium. No consumption advisories or other guidelines exist for these chemicals in aquatic biota tissue, except for lead (Ontario). Although Detroit River clams are not a common food source for humans, they are for certain wildlife.

Objective 18: Determination of the importance of clams as a wildlife food source and the impact of contaminants contained in clam tissue on wildlife health.

Serious impacts to waterfowl, wildlife and fish, and their habitats, have occurred in the Detroit River. Waterfowl, some tern species, and their eggs contain high concentrations of persistent compounds (PCB, DDT and other organochlorine compounds), affecting organism health, reproduction and survival. Oral/dermal tumors and liver tumors are present in brown bullhead, walleye, white sucker and other species in the lower Detroit River.

Objective 19: Identification of the chemicals responsible for such impacts on fish, wildlife and aquatic life, and the virtual elimination of point and nonpoint source inputs of these contaminants.

Objective 20: Development of consumption advisories for waterfowl and wildlife to protect human consumers of these organisms.

Bulkheading and/or backfilling of wetlands, littoral zones, bayous and small embayments in the Detroit River, especially in the Trenton Channel, have resulted in extensive losses of spawning grounds and nursery areas for desirable fish, and has prevented use by waterfowl, aquatic mammals and other aquatic organisms. The fish community has changed over time resulting in losses of coldwater species. Channel dredging near the turn of the century destroyed whitefish spawning habitat near the mouth of the Ecorse River. In addition to providing habitat, wetlands also serve to remove contaminants by natural filtering.

Objective 21: Preservation and enhancement of existing fish and wildlife habitats, and development of new habitats. Maintenance of the Wyandotte National Wildlife Refuge and protection of Grassy Island need to be enhanced to encourage wildlife, especially waterfowl.

4. Other Issues

The contribution made by atmospheric deposition of contaminants to the Detroit River system was not examined by this study. Certain contaminants affecting the Detroit River system may be contributed, in part, through atmospheric deposition, such as lead (auto exhaust) and cadmium (steel industries). Loadings of these contaminants were often relatively high for rural and urban runoff, suggesting a diffuse source.

Objective 22: Determine the significance of atmospheric deposition as a contaminant input mechanism in the Detroit River system, identification of contaminant origins and reduction of such input to its lowest achievable level.

G. ADEQUACY OF EXISTING PROGRAMS AND REMEDIAL OPTIONS

1. Projection of Ecosystem Quality Based on Present Control Programs

Trend Analysis

The general media quality and aesthetics of the Detroit River have improved over recent years. However, a number of particular concerns remain.

Generally, water in the Detroit River is of a higher quality than in the recent past. However, in the present survey, concentrations of a number of contaminants and conventional pollutants increased from the head to the mouth of the Detroit River, although the statistical significance of these increases is not known. Other conventional water quality parameters, including ammonia and phenols, were found to have declining trends. Ammonia concentrations have decreased by approximately 50% between 1969 and 1981. Data on chloride concentration in the river indicate that although sources still exist on both sides, especially in the lower river, concentrations and loadings have declined from 1969 to 1981 (30).

Sediment contamination in the Detroit River is continuous along the Michigan shoreline and appears to be localized near known sources along the Ontario shoreline (39). Trend data from 1970 to 1980 indicate levels of mercury in sediments have decreased, in part a result of improvements in industrial treatment facilities (e.g. replacement of mercury cells by diaphragm cells at chlor-alkali plants at Wyandotte) (39). Results of two sediment studies indicated that mercury contamination is higher in surficial sediments than in the deeper layers, suggesting that there may still be active sources (76). Significant increases in sediment levels of cadmium, chromium, copper, lead, nickel, and zinc were noted near the mouth of the Rouge River from 1970 to 1980, suggesting recent inputs.

Data on contaminant levels in fish from the Detroit River is insufficient to determine trends for many chemicals; however, some research has been done with young-of-the-year spottail shiners, which are sensitive biomonitors for organochlorine compounds. High PCB residue accumulations were found in spottail shiners along the Michigan shoreline in the lower Detroit River, suggesting the continuing presence of inputs of biologically available PCBs to the river. DDT residues were found, but consisted of metabolites only, indicating that use restrictions have effectively reduced DDT inputs to the river. Chlordane residues were elevated in all spottail shiner samples from urban areas compared to rural collections (45).

Fish consumption advisories are currently in effect for rock bass, freshwater drum, walleye and carp due to mercury or PCB contamination (46,47). Population studies of bottom fauna have shown organisms characteristic of higher water quality are increasing in some areas, but degraded benthic macroinvertebrate populations are present especially on the Michigan side of the river (39).

2. Assessment of Technical Adequacy of Control Programs

Adequacy of Present Technology

i) Municipal Wastewater Treatment Facilities

There are five municipal waste water treatment plants in Ontario and six in Michigan which discharge into the Detroit River. The levels of treatment vary, but all have phosphorus removal. The facilities which provided inputs of contaminants of concern are discussed below.

The Detroit WWTP provides secondary treatment (activated sludge) for up to 3,047 x 10^3 m^3/day of wastes tributary to the combined sewer system. During wet weather periods, incremental flows above 3,047 x 10^3 m^3/day are provided primary treatment and disinfection prior to discharge to the Detroit River. Secondary effluent is combined with any primary effluent and discharged to the Detroit River at a rate determined by river elevation and the portion of flow receiving secondary treatment. Combined sewers discharge directly to the Rouge and Detroit rivers when the hydraulic capacity of the system is exceeded. About 284 x 10^3 m^3/day of wastewater flow is generated by industrial indirect dischargers. Presently, there are no data available on the percentage of industries which are in compliance with the Industrial Pretreatment Program since the program is new. The Detroit WWTP facility was generally in compliance with its NPDES permit during 1986, which was confirmed by 1986 wastewater survey. The present technology is adequate to control the facility's regulated and monitored parameters based on existing water quality criteria. The Detroit WWTP's permit is scheduled for reissuance in 1989 and some facility upgrading may be required.

The Wayne County-Wyandotte WWTP is a pure oxygen, activated sludge facility with a design capacity of 375 x 10^3 m^3/day. The Wayne County-Wyandotte WWTP and the South Huron Valley WWTP (which discharges into Lake Erie) jointly have an Industrial Pretreatment Program. In 1986, the facility exceeded its NPDES monthly average permit limitation for total suspended solids (4 of 12 months), and exceeded its fecal coliform monthly average limitation for all 12 months of the year. A 1986 wastewater survey indicated the facility was in compliance with NPDES permit at the time of the survey. For the purposes of controlling the facility's regulated parameters, the present technology is not adequate, since exceedences of permit limitations have occurred. As of December 1988, this facility is being sued in federal court for permit and schedule violations. A consent decree is being negotiated. The facility has begun construction on two new clarifiers in its treatment system and is planning additional repairs.

The Wayne County-Trenton WWTP is operated as a primary treatment facility with a design capacity of 13 x 10^3 m^3/day. Treated wastewater was discharged to the Elizabeth Park Canal, a tributary of the Trenton Channel. This facility served a separate sewer system, with no combined sewer discharges to the Detroit River. This facility was in significant noncompliance with its total suspended solids monthly average loading limitation (5 of 12 months), total phosphorus monthly average concentration limit (6 of 12 months) and fecal coliform monthly average concentration limit (8 of 12 months) during 1986. The 1986 wastewater survey indicated the facility met the NPDES final effluent limitations at the time of the survey. For the purposes of controlling the facility's regulated parameters, the technology was not adequate. This facility has been decommissioned (as of December 1988). Flows are being directed to the new South Huron Valley WWTP, which discharges directly into Lake Erie.

The City of Trenton WWTP is an activated sludge secondary treatment system with an average daily flow of 22 x 10^3 m^3/day, and is discharged to the Elizabeth Park Canal. The City of Trenton has an approved Industrial Pretreatment Program with 9 major participants. Wastewater flow generated by these industries is approximately 5.3 x 10^3 m^3/day. In 1986, this facility was in noncompliance for BOD concentration and loading limits (5 of 12 months), total suspended solids concentration and loading limits (5 of 12 months), total phosphorus monthly average concentration (5 of 12 months), and dissolved oxygen minimum concentration (8 of 12 months). A wastewater survey conducted in 1987 showed this facility to be in noncompliance with its NPDES permit limitations for dissolved oxygen, and concentrations of other parameters (BOD_5, phosphorus, suspended solids and fecal coliforms) were higher than would be desired (the permit does not have daily maximum limits for these parameters, so noncompliance cannot be construed). For the purposes of controlling the facility's regulated parameters, the present technology is not adequate, since exceedences of effluent limitations have occurred. No federal action has been taken against this facility, as of December 1988, however, the state has notified the facility of its noncompliance status.

The West Windsor WWTP currently uses a physical-chemical treatment process with a capacity of 160 x 10^3 m^3/day. The Windsor catchments receive a large quantity of industrial wastewater. However, sampling data indicate concentrations compare favorably with concentrations in less industrialized catchments. This facility was in compliance with its effluent requirements for BOD_5 and suspended solids during 1985 and 1986.

ii) Industrial Point Sources

The UGLCCS Point Source Workgroup identified seventeen Michigan and four Ontario industries as major point source dischargers into the Detroit River (directly or indirectly). These industries include automotive, chemical, cement and steel, and were presented in Table IX-4.

It is not practicable to discuss the technology used at each industrial facility. The Point Source Workgroup Report (6) should be consulted for such detail. However, the attainment (or lack) of effluent limitations provides insight into the adequacy of the technology used. Eleven of the Michigan facilities were in general compliance with their 1986 NPDES Permits (Table IX-4), one facility did not have a permit (Ford-Wayne Assembly Plant; but institution of one is being considered), and another facility began discharging to a sanitary sewer as a result of problems meeting its permit effluent limits (Chrysler-Trenton Engine Plant). For the purposes of controlling contaminants at regulated levels, the technology employed at most Michigan industrial facilities appear to be adequate.

Of the three Ontario industrial facilities surveyed, only one fully met the Ontario Industrial Effluent Objectives during 1985 and 1986. Ford Canada exceeded total suspended solids and phenol objectives, and Wickes Manufacturing exceeded total suspended solids and nickel objectives. The present technology at Wickes Manufacturing and Ford Canada does not appear to be adequate to control certain parameters with industrial effluent objectives.

Adequacy of Best Available Technology

The best available technology economically achievable (BAT) for every industrial and municipal sector has not yet been defined, although some U.S.industries have BAT in place. The U.S.EPA and the OMOE (through its MISA program) are currently developing BAT for various sectors.

3. Assessment of Regulatory Adequacy

Adequacy of Present Laws and Regulations

Existing legislation in the United States, Canada, Michigan and Ontario addressing ecosystem quality of the Detroit River has been discussed elsewhere in this report (Chapter III). Many acts, regulations and programs are currently in place, addressing the control of point and nonpoint sources of contaminants, management of solid and hazardous waste, acceptable contaminant concentrations in various media, and other environmental concerns. Despite the considerable, and often complex, collection of laws and regulations, serious contamination is apparent in the Detroit River system, and exceedences of requirements and guidelines have been documented. This may indicate that the existing legislation is inadequate, or is not properly enforced.

Michigan industrial and municipal point source dischargers in the Detroit River area are generally meeting the effluent limitations set by the state government. Michigan effluent limits address conventional pollutants, such as total suspended solids, and nonconventional or toxic parameters. Unless the facility is out of compliance with effluent limits, contaminants are discharged at concentrations within discharge limits. However, the large volume of effluents results in very large total loadings of contaminants to the river. NPDES permits are reviewed every five years, providing the opportunity to address specific concerns highlighted by the UGLCC Study.

All Michigan municipal facilities impacting the Detroit River receive waste water from industrial facilities. All have some regulatory mechanism for controlling the input of contaminants from industries (the Industrial Pretreatment Program - IPP). However, pretreatment requirements may have not been addressing all contaminants being introduced to the municipal facility, or controlling them adequately, as evidenced by the large loadings of some parameters by the municipal facility. From a practical viewpoint, controlling the influx of contaminants to the municipal facility from industrial facilities is the most effective method of preventing ultimate discharge. The IPP program at each Michigan facility needs to be examined for adequacy and compliance.

Only one Ontario industrial facility studied in the Detroit River area has effluent requirements (General Chemical); the others are encouraged to attain Provincial Industrial Effluent Objectives. The Objectives are nonenforceable goals in and of themselves, although they can be made enforceable through incorporation into Control Orders or Certificates of Approval. Effluent objectives are not consistently being met by all Ontario industrial facilities. In other instances, these Objectives were met, yet impacts in media were seen. For example, General Chemical, Amherstburg was identified as a major contributor of copper to the Detroit River, yet discharged copper at concentrations below the Provincial Industrial Effluent Objective of 1 mg/L. However, high copper concentrations, exceeding dredging guidelines, were found in sediments along the Amherstburg shoreline. This suggests that the Objectives may not be stringent enough, particularly for compounds with sediment binding capabilities.

The West Windsor WWTP was the only Ontario municipal facility identified as a major discharger of contaminants to the Detroit River (total phosphorus). This facility receives industrial waste water, and adheres to the Windsor By-Law (#8319) which regulates the discharge of conventional pollutants, metals and total phenolics to sanitary sewers. Since its total phosphorus discharge was less than 1 mg/L (annual average) in 1985 and 1986, it appears that the By-Law regulations are adequate and effective, in the context of this study.

The new MISA program being implemented by Ontario should improve discharge regulations in the province. Identification of effluent contaminants in specific municipal and industrial sectors will enable the instatement of limits for all potentially harmful contaminants. To be effective, it is necessary for sector requirements to contain both concentration and mass loading limits. Customizing of regulations to fit the industrial sectors should reduce treatment costs and the associated analytical costs for monitoring.

Present regulations and guidelines, particularly in Ontario, are media-specific in scope and do not offer the flexibility needed to address multimedia contamination, as found in the Detroit River system.

Adequacy of Enforcement Authority and Programs

Michigan and Ontario programs which regulate discharges require monitoring and reporting. Facilities are required to inform the regulating agency of all effluent limit exceedences. In addition, audit samples may be obtained by the regulating agency, often with the facility's pre-knowledge. Violations of effluent limitations can be handled in a variety of fashions, ranging from monetary fines to criminal prosecution. Criminal prosecution rarely occurs. Civil and administrative enforcement actions, often involving negotiations between the facility and the regulating agency, are undertaken to ensure future compliance. Adequate enforcement authority for point sources appears to exist; however, strengthening of penalties and an increase in self-monitoring and auditing actions may prevent or hinder exceedences which are occurring.

In the Detroit River, the majority of point source dischargers are in compliance with effluent limitations. The weakness, therefore, does not lie with the authority of the regulatory agencies to enforce effluent limitations. It is more the result of the traditional reliance on concentration based water quality guidelines rather than on total loadings as well as, in many cases, the limited number of parameters with which each facility is legally bound to comply or monitor.

Some Ontario industrial point sources are experiencing exceedences of the Provincial Industrial Effluent Objectives, which are nonenforceable goals for the industrial facilities. Requiring the attainment of the Objectives (or a more stringent value) is a mechanism by which to gain more control over the discharges. The new MISA program will establish effluent requirements which are specific to each industrial sector. Until these become effective, regulation through requirement of effluent objectives appears needed.

Regulations and enforcement authorities are limited or absent for contamination resulting from nonpoint sources.

Adequacy of Governmental and Institutional Authority and Jurisdictions

Federal, state, provincial, and municipal governments have the authority to regulate chemical discharges to the Detroit River. Thus, the lack of authority is not the problem. Ongoing environmental concerns related to chemical contaminants result, in part, from a fragmented approach to controlling discharges. Different priorities among agencies result in a lack of co-ordination and proper long-term planning.

H. RECOMMENDATIONS:

Actions which can result in improvements in ecosystem quality in the Detroit River system are many and varied. Generally, recommendations made for the Detroit River are in four forms: recommendations directed at specific sources which can be implemented with existing regulatory authorities, recommendations which may require process or treatment changes, management issues and applications or other voluntary (as opposed to regulatory) measures, and recommendations which identify further needed research and study.

A. Industrial and Municipal Point Source Remedial Recommendations

1. Ontario and Michigan should incorporate the Great Lakes Water Quality Agreement's goal of the virtual elimination of all persistent toxic substances into their respective regulatory programs.

2. The Detroit WWTP was a major discharger of numerous compounds which impact water, sediment and biota quality in the Detroit River. Contaminant loadings from this facility should be evaluated to ensure compliance with Michigan water quality standards.

a) In general, contaminant concentrations in the effluent of the Detroit WWTP are low; major loadings result from the large volume and rate of effluent discharged. Control of contaminants may be obtained through the Industrial Pretreatment Program (IPP). The IPP of the Detroit WWTP should be examined and compliance of contributors of industrial waste water should be determined. The adequacy of the pretreatment requirements should be assessed. Pretreatment requirements should be assessed to determine if parameters of concern in the Detroit River system are adequately regulated. A notice of violation was issued (September 1988) to the Detroit WWTP for problems found in its IPP program.

b) The Detroit WWTP currently performs secondary treatment on a large portion of its effluent. During wet weather flow, some effluent receives only primary treatment prior to being mixed with secondary treated effluent and discharged. Metals and organics which may be contained on suspended solids not removed in primary treatment are of concern. The City of Detroit should complete its studies of treatment plant capacities started in 1985 and upgrade its treatment process to provide secondary treatment for all effluent.

c) The effluent limitations contained in the Detroit WWTP NPDES permit should be re-examined in light of the findings of this study to ensure compliance with Michigan water quality standards. Consideration should be given to increasing the number of parameters monitored by the permit. All effluent limitations should be the lowest technically feasible. Bioassays of the effluent to determine both acute and chronic impacts to aquatic organisms should be considered as a condition of the permit. The Detroit WWTP NPDES permit is scheduled for reissuance in 1989.

3. The Wayne County-Wyandotte WWTP was a major discharger of numerous compounds which impact water, sediment and biota quality in the Detroit River. Although the facility was generally in compliance with its effluent limitations, the NPDES permit monitors very few parameters found to be of concern in the Detroit River.

   In general, contaminant concentrations in the effluent of the Wayne County-Wyandotte WWTP are low; major loadings result from the large volume and rate of effluent discharged. Control of contaminants may be obtained through the Industrial Pretreatment Program (IPP). The IPP of the Wayne County-Wyandotte WWTP should be examined. The compliance of industrial contributors should be determined, and the adequacy of the pretreatment requirements should be assessed. Pretreatment requirements should be considered for all parameters of concern in the Detroit River system which are being discharged by the industrial dischargers. Contaminant loadings from this facility should be evaluated to ensure compliance with Michigan water quality standards and BAT requirements.

4. The City of Trenton WWTP exceeded its permit limitations for regulated parameters. The treatment provided by this facility should be examined and upgraded to ensure compliance with effluent requirements.

5. Several industrial facilities were identified as major dischargers of parameters that impact media quality in the Detroit River. These facilities are presented below with a discussion of facility-specific issues.

   a) Rouge Steel was a major contributor of total iron, total copper, total lead, total zinc, and oil and grease to the Detroit River, chemicals which were present in the sediments at concentrations exceeding dredging guidelines. Rouge Steel was the major contributor of total PAHs and a source of total phenols which were found in sediments, but have no sediment dredging or quality guidelines. Rouge Steel's NPDES permits do not regulate total PAHs nor monitor iron or copper. The discharge of these 3 parameters should be evaluated to ensure compliance with Michigan water quality standards and BAT requirements. Rouge Steel was in compliance with its permit limitations for total lead (applicable at 3 of 11 outfalls), total zinc (applicable at 3 outfalls), total phenols (applicable at one outfall) and oil and grease (applicable at two outfalls). Considerable amounts of phenol were discharged from outfalls not monitored for phenol, and oil and grease were also discharged from nonregulated outfalls. Discharge of total phenols and oil and grease from all outfalls should be reduced to ensure compliance with Michigan water quality standards and BAT requirements.

b) Ford Canada was a major contributor of total lead, total zinc, PCBs and total phenols, chemicals which impact the Detroit River system. The stretch of river downstream of Ford Canada (sediment subarea 2) had the highest average sediment concentration of PCBs. Sources other than Ford Canada were suggested, but Ford Canada cannot be ruled out as a source. All sources of PCBs should be identified and eliminated. High total phenol, total lead and total zinc concentrations in sediments were also found in subarea 2. This facility met the Ontario Industrial Effluent Objective for lead and zinc of 1 mg/L, but exceeded the Ontario Industrial Effluent Objective of 20 ug/L for total phenols by a substantial amount during the survey (almost two orders of magnitude). Discharge of total phenols should be reduced to ensure compliance with the Ontario Industrial Effluent Objective. Discharges of PCBs should be reduced to the lowest level technologically achievable.

c) Wickes Manufacturing was a major contributor of chromium to the Detroit River, and discharged nickel, as well. High bottom and suspended sediment concentrations of chromium were found in Little River, to which Wickes Manufacturing discharges. Wickes Manufacturing did not meet the Ontario Industrial Effluent Objective for chromium during the survey. Nickel impacted Detroit River sediments in the upper (as well as lower) Detroit River. High water concentrations of nickel were also found in the Little River. Wickes Manufacturing did not achieve the effluent objective for nickel eight times during 1985 and 1986, in addition to exceeding it during the survey. Discharges of chromium and nickel should be reduced to ensure consistent attainment of the Ontario Industrial Effluent Objective. An effluent requirement should be developed for Wickes Manufacturing at the lowest level technologically feasible.

d) McLouth Steel-Trenton was a major contributor of zinc, iron, HCB and oil and grease, chemicals which impact the Detroit River system. Of these, McLouth Steel-Trenton has an effluent limitation for oil and grease, with which it was in compliance. This facility has no effluent monitoring requirements for zinc, iron or HCB. Such effluent monitoring should be considered for McLouth Steel-Trenton.

e) General Chemical, Amherstburg was a major discharger of copper to the Detroit River. High copper sediment concentrations were found adjacent to Amherstburg. Since the time of the point source survey, General Chemical has split into two distinct companies, Allied Chemical and General Chemical. The two new companies should be surveyed to determine the extent of present day copper discharge, and contingent upon the results, remedial action taken. General Chemical was also a major source of chlorides to the Detroit River; however, the lower Detroit River transect measuring water quality was upstream of General Chemical and did not reflect the facility's impact on water quality. Although no impacts due to elevated concentrations of chlorides were noted during this study, the potential for an increase in halophilic organisms exists. Additional surveys downstream of the General Chemical complex outfalls should be performed to determine if such a shift in organisms has occurred.

f) Great Lakes Steel-Ecorse and Great Lakes Steel-80" Mill both contributed large loadings of oil and grease to the Detroit River, pollutants found to be impacting sediments in the Detroit River. Both facilities have effluent limitations for oil and grease; both were in compliance with these limits in 1986. Consideration should be given to instituting more stringent effluent limitations for oil and grease at these facilities.

B. Nonpoint Source Remedial Recommendations

6. The extent of contaminant input to the Detroit River system resulting from Detroit WWTP combined sewer overflows is largely unknown, although some estimates have been made. Information available suggests that contaminant inputs may be substantial. The required study on the Detroit WWTP CSOs (order issued September 1988) should be expedited, and an area-wide remediation plan should be developed. Upgrading of the Detroit sewer system by increasing treatment capacities of the facility and eventually separating storm and sanitary sewer to eliminate CSOs should be undertaken.

7. Due to the significance of the Rouge River as a source of loadings of organic and inorganic substances to the Detroit River, the Rouge River Remedial Action Plan should be developed and implemented as expeditiously as possible. The implementation of recommendations for the Clinton and St. Clair Rivers' RAPs will also assist remediation efforts for the Detroit River.

8. Confirmed or possible groundwater contamination sites within the Detroit River discharge area were identified for this

study. Extensive recommendations were made for these sites by the Nonpoint Source Workgroup. The main focus of the Workgroup's recommendations are:

a) Zug Island Great Lakes Steel: MDNR should perform a site visit to clarify the facilities' proper RCRA status, to perform sampling of monitoring wells, to determine the contaminant release to groundwater and to provide information for rescoring of the site for the National Priorities List (NPL) using the new Hazard Ranking System (HRS).

b) Federal Marine Terminal Properties: U.S.EPA should monitor site closure to assess closure impacts and to study groundwater discharge to surface water.

c) Industrial Landfill (Firestone): This site should be rescored for the NPL using data generated by the UGLCC Study and other current studies.

d) Michigan Consolidated Gas-Riverside Park: Remedial action proposed by the company should be reviewed to assess its adequacy in controlling groundwater discharge to surface water.

e) BASF/Wyandotte South Works and Chrysler-Trenton: Prompt assessment of site waste operations should be performed by MDNR. Determination of any contaminant releases to groundwater and/or surface water should be made.

f) BASF/Wyandotte North Works, Monsanto Company, Huron Valley Steel Corp and Jones Chemical: Prompt performance of a RCRA Facility Assessment should be undertaken by the U.S.EPA, utilizing data generated by the UGLCC Study and other current studies.

g) Edward C. Levy Co, Trenton Plant and Plant #3: The U.S.EPA should monitor the Consent Agreement and Final Order signed by the facility to ensure compliance. Data generated for the UGLCC Study should be used in the evaluation of the recently performed RCRA Facility Assessment.

h) Pennwalt and Petrochemical Processing: Data generated for the UGLCC Study should be used in the evaluation of the recently performed RCRA Facility Assessment.

9. The integrity of the abandoned underground injection wells at Pennwalt and BASF/Wyandotte should be evaluated through a U.S.EPA inspection to determine if injection of spent waste into caverns at Grosse Ile has led to releases.

10. Michigan and Ontario should develop a five year strategy aimed at reducing spill occurrences and improving spill

responses within their jurisdictions. Spill reports from the Michigan Pollution Emergency Alerting System (PEAS), the Ontario Spills Action Centre (SAC) and other agencies should be enhanced to provide accurate information on spill volume and composition, recovery and resolution. Facilities which experience frequent spills should be required to develop stricter spill management plans. Michigan and Ontario should prepare a yearly spill report for public release and for submission to the IJC, to stimulate interaction and follow-up, and to ensure appropriate enforcement and preventive measures.

11. Use of phosphorus and nitrogen fertilizers on agricultural lands and handling of livestock manure in both Ontario and Michigan need to be conservatively managed. Federal, state and provincial environmental and agricultural agencies need to collaborate to develop a comprehensive soil and water management system to reduce impacts on ecosystem quality from these activities. Education on the proper use and application of fertilizers should be provided to farmers, and measures, such as conservation tillage and proper livestock waste management, should be encouraged to ensure minimal loss of phosphorus, nitrogen and other associated chemicals from agricultural lands.

12. The extent of required dredging and remediation of sediments in the Detroit River and its tributaries should be planned and prioritized. To do this, estimations of the volume of sediments required to be removed should be made, and an overall plan for handling these materials should be developed. Financial requirements for such plans should be analyzed, and incorporated into future agency commitments.

C. Surveys, Research and Development

13. Tributaries to the Detroit River were found to provide major loadings of several contaminants, particularly metals and total phosphorus (not all UGLCC Study parameters were analyzed). A thorough investigation of the Rouge, Little, Canard and Ecorse Rivers, Turkey and Monguagon Creeks, and the Frank and Poet Drain, if not presently being performed, should be undertaken. An inventory of all point source dischargers to the tributaries, and an assessment of all nonpoint contaminant inputs (urban and rural runoff, waste sites/contaminated groundwater, spills, CSOs, etc.) should be performed. Water, sediment and biota quality in these tributaries should be determined for the full stretch of the tributary. For tributaries where extensive investigation is presently being undertaken, information provided by this study should be used to supplement ongoing work.

14. A study of the significance of atmospheric deposition of contaminants as a contaminant input mechanism should be undertaken, in conjunction with a survey and evaluation of point sources of atmospheric emissions to the Great Lakes basin.

15. Ambient water quality guidelines for total PAHs need to be developed and adopted, along with guidelines for specific PAH compounds (e.g., benzo[a]pyrene) known to be of importance. Further research on the effects of individual and total PAHs in water on a variety of aquatic species is needed for guideline development.

16. The importance of clams as a food source for wildlife and waterfowl, and the effect of clam flesh contaminants on such wildlife should be studied.

17. Consumption advisories for waterfowl and wildlife should be developed as necessary by federal, state and provincial public health agencies, for the protection of human consumers of these animals.

18. Contaminant concentrations in other biota, such as muskrats which are consumed by native populations, should be determined, and the need for consumption advisories considered.

19. Studies to determine the cause/effect linkages of Detroit River contaminants to waterfowl and fish need to be performed.

20. Fish and wildlife habitats along the Detroit River should be protected to the greatest extent possible. The extent of filling or bulkheading of wetlands should be reduced. Remedial plans should be developed for those habitats which are severely impacted, and/or alternative habitats developed to accommodate displaced wildlife.

21. Sediment bioassays should be used to make site-specific determinations of sediment quality. Dischargers responsible for contaminated sediments should be required to conduct bioassays of these contaminated sediments to determine possible impacts. The need for acute and chronic bioassays on the effluent should be considered for all point source discharges to the Detroit River.

22. Development of sediment criteria for organic contaminants found in Detroit River sediments, specifically total phenols and total PAHs, is needed to assess the level of sediment contamination. The U.S.EPA is intending to develop such criteria; such development should be expedited.

23. A study of the significance and impact of urban runoff from Michigan municipalities should be performed. The study should be performed in a manner similar to that of the Ontario study, for comparability purposes. Contingent on the results, remedial and management action may be necessary.

24. The role played by sinkholes and carbonate solution channels on Point Hennepin in the transport of contaminants from these disposal sites should be investigated.

D. Management Strategy for Remedial Programs

25. Further regulatory actions in this Area of Concern must be co-ordinated among the various agencies and governments responsible. They should also be developed utilizing a long-term planning framework.

26. Regulatory actions must take multi-media and synergistic concerns into account with regard to contaminant management.

The correction of long-term contamination requires that contaminant sources be significantly controlled by requiring a reduction in the use of hazardous materials, or by ceasing to use hazardous materials altogether. However, limited control provided by regulation over many of the sources of contamination prevents this encompassing approach. Although regulations provide limited control over permitted discharges of industrial process and cooling water, minimum or no legal control over sources such as stormwater, combined sewer overflows, tributary loadings, contaminated groundwater, atmospheric deposition, contaminated sediments, spills from vessels, "midnight dumpers", hidden outfalls and others, is provided.

In the past, attempts to control most contaminants originating from point sources have relied upon NPDES permits, Certificates of Approval, control orders, notices of noncompliance or court orders, and have partially succeeded. For other chemicals, elimination or restrictions on production, use or sales (e.g., PCBs, DDT) have been implemented. These control methods have resulted in varying degrees of reduction of these chemicals in the environment. Once persistent and bioaccumulative chemicals are in the environment, options for control are limited to remediation or isolation of the contaminated medium, and monitoring of the environmental effects.

For the Detroit River and its tributaries, loading data dictate that the highest priority for contaminant source control is the direct regulation of point sources through NPDES permits and the MISA program. More stringent and extensive effluent limits need to be placed upon those facilities impacting the Detroit River system, to reduce the discharge of toxic chemicals, and should be expressed in terms of both concentrations and mass loadings.

The second priority is urban combined sewer overflow (CSO) control, as CSOs discharge untreated industrial and sanitary waste directly to sensitive areas of the river. Combined sewer systems in the Detroit River area receiving industrial process wastewater need to be controlled so that contaminants do not reach the river untreated.

Containing, purging and treating contaminated groundwater before discharge to the Detroit River or its tributaries is the third priority. Groundwater contaminant loadings to the river were not determined, but based on the number of Michigan contaminated groundwater sites along the Detroit River and its tributaries, Michigan is likely a major source of contaminants through groundwater inputs. A plan must be developed to identify, isolate and treat these contaminated groundwater discharges.

The fourth priority is identification and reduction of atmospheric loadings of contaminants from all sources.

The remaining sources mentioned above (other than sediments) are more difficult to control, since they are generally nonpoint in origin, and are less amenable to immediate, regulatory control. However, control of nonpoint sources of contaminants is an equal priority.

The extent of contaminant transfer from sediments to the water column and biota is unknown, since complex chemical, physical and biological factors influence these interactions. However, adverse impacts on biota have been shown. Remediation of contaminated Detroit River sediments is a difficult task. Detroit River depositional sediments have a pudding-like consistency and are not amenable to burial or coverage. Solidification and chemical treatment are also not practical alternatives for in-place sediment control. Although expensive and having the potential to release contaminants to the environment during the process, dredging of severely contaminated sediments may be the only method to reduce sediment contaminant loadings to the water column and biota and to restore impaired uses in the Detroit River.

I. LONG TERM MONITORING

1. Purposes for Monitoring and Relationships Between UGLCCS and Other Monitoring Programs.

The purposes for monitoring and surveillance are included under Annex 11 of the GLWQA, and considerations are found in Chapter 7 of the Report of the Niagara River Toxics Committee (91). The focus of the UGLCC Study was to determine where problems in the ecosystem exist and how to remedy the problem. Long term monitoring recommendations focus on trends in environmental quality to assess the effectiveness of remedial actions. Monitoring should be sufficient to 1) detect system-wide trends noted by the UGLCCS, and 2) detect changes resulting from specific remedial actions.

The Great Lakes International Surveillance Plan (GLISP) and the Remedial Action Plans (RAPs) also contain plans for long term monitoring. The GLISP for the Upper Great Lakes Connecting Channels is incomplete, pending results of the UGLCC Study. The Detroit River RAP being developed jointly by Michigan and Ontario will list impaired uses, sources of contaminants, specific remedial actions, schedules for implementation, resources permitted by Michigan and Ontario, target cleanup levels and monitoring requirements. Results from this study will be incorporated into the RAP, and will influence state and provincial Detroit River programs.

2. System Monitoring for Contaminants

Water

The principal Detroit River contaminants indicate general trends, exposure levels and contaminant impacts on biota. Parameters to be monitored include PCBs, chlorobenzenes (HCB), PAHs, oil and grease, total phenols, total volatiles, mercury, cadmium, chromium, cobalt, copper, iron, nickel, lead, zinc, total phosphorus, ammonia, suspended solids and chlorides. Monitoring stations should be located where elevated concentrations are known or predicted, including downstream of the Detroit WWTP, and Rouge River, Little River, Turkey Creek, Canard River, Ecorse River and within the Trenton Channel. Sampling locations may include horizontal and vertical distributions. Sampling frequency should bracket contaminant variability and flow fluctuations.

A mass balance approach will help identify changes in the contaminant masses over time, and target future remedial actions. It should be conducted about once every five years, assuming remedial actions have been implemented. Locations to be measured should include:

1) Head and mouth transects. The dissolved and particulate fractions and quantity of suspended sediment flux should be measured. Chemical water monitoring locations in the Detroit River should be expanded as needed for conventional pollutants, to isolate localized significant sources. Metals and organic contaminants should be added to the list of parameters measured, and appropriately low detection levels should be used. Detroit River shorelines, beaches and marinas should be monitored for evidence of human sanitary waste. The present human health sanitary waste indicator is fecal coliform bacteria, but development of a better indicator of human health wastes is needed.

2) Municipal and industrial point sources. Monitor frequently enough to calculate accurate loadings from the major point sources, including the Detroit WWTP, Wayne County-Wyandotte WWTP, McLouth Steel, Rouge Steel, Ford Canada, General Chemical, West Windsor WWTP, and Wickes Manufacturing.

3) Tributary monitoring efforts should focus on seasonal and storm event loadings from the Ecorse, Rouge, Canard and Little Rivers and Turkey Creek for dissolved and sediment associated contaminants. Best management practices should be initiated in the Detroit River tributary watersheds to more effectively manage flow, contaminants and sediment sources.

4) CSOs and urban runoff. Estimates of CSOs and contaminant loadings from Detroit and Windsor urban runoff should be repeated. Contaminant loadings should be estimated for the Riverview and Trenton storm sewers. Sewer sediments should be monitored to locate significant PCB sources to the Detroit WWTP and CSOs. Track PCBs upstream within the sewer system to isolate areas or facilities contributing PCBs. Monitor outfalls and overflows to determine loading reductions.

5) The quantity and quality of groundwater inflow from waste disposal sites adjacent to the Detroit River and its tributaries should be determined. The well drilling initiated during the UGLCCS should be expanded to determine the amount and severity of contaminated groundwater entering the Detroit River from identified CERCLA and 307 sites. The study should be designed to measure contaminated groundwater entering the river without requiring access to the shoreline property. Studies should be initiated to determine the types and amounts of materials disposed of in the Point Hennepin and Fighting Island sites, and their effects on the Detroit River. Eliminate (excavate and/or secure) the sources of ground and surface water contamination in these landfills.

6) Studies indicate that bed load sediments carry contaminant masses similar to other sources, and that mass flux should be quantified. The quantity of contaminants being desorbed from sediments should also be quantified.

7) Direct atmospheric deposition to the Detroit River is minor, but deposition within the drainage basin could be an important source of wet and dry contaminants, and estimates should be made. Expand and enforce local air monitoring efforts in the Detroit RIver watershed to isolate local sources.

Sediments

Sediment monitoring should be conducted every five years in conjunction with the biota survey to assess trends and movement of contaminants within the river. Analyses should include bulk chemistry for organic and inorganic contaminants and particle size distribution. Particular attention should be given to PCBs, PAHs, phenols, phthalates, oil and grease, and heavy metals. Sediment stations at tributary mouths should be monitored for organic and inorganic contaminants on a biannual basis if remedial actions occur. A suite of bioassays should be performed in conjunction with these chemical analyses to determine the impact these sediments are having on Detroit River biota. A map of the areal extent of Detroit River sediment contamination and one characterizing areas that are or may be toxic to aquatic life need to be developed. These maps will allow identification of areas needing to be dredged.

Biota

Long term monitoring of contaminants in biota will track contaminants in representative organisms. Three programs already exist in the Detroit River:

i) Sport fish monitoring

This program should focus on persistent, bioaccumulative chemicals, such as PCBs, mercury and other contaminants (e.g. dioxins and dibenzofurans) known or suspected of being human health hazards. Important sport species that have an extended river residence time should be sampled. Monitoring should continue beyond the point that action levels are met. Monitoring of chemical contaminants in fish livers and recording of tumors and other deformities should be done while making fish community and chemical contaminant assessments. Studies to determine the causes of tumors and reproductive problems need to be initiated for the Detroit River.

ii) Spottail shiner monitoring

This program is designed to identify local sources of bioavailable contaminants. Where spottail shiners contained elevated levels of contaminants, sources of the contaminants should be identified. Spottails should also be used to demonstrate results of remedial actions.

iii) Caged clams monitoring.

Caged clams should be used to monitor results of remedial actions. Clams may be located at tributary mouths and downstream of suspected source areas. Repeated assays at the same locations should confirm the results. A series of caged fish or clams should be placed along the Detroit River to identify inputs of persistent, bioaccumulative contaminants.

iv) Benthic Macroinvertebrate Community

The Detroit River benthic community should be quantitatively assessed every five years to monitor results of remedial actions. Sampling should be based on grid or sediment type patterns to be consistent between years. Selected persistent compound levels in benthic organisms should be monitored.

v) Waterfowl and Wildlife

Waterfowl and wildlife communities should be monitored for lowered reproduction rates, tumors and other deformities. The causes of any deformities or tumors need to be determined. Contaminant levels in flesh, livers, eggs and/or young should be determined.

vi) Ecological Significance and Interaction

Biological surveys should be designed within each tributary watershed or ecoregion to determine if there are ecosystem problems. Biological monitoring should be performed to isolate problem areas within the ecoregion, and efforts should be focused where problems have been identified. Studies should be designed to determine fish and wildlife species composition, life history, habitat requirements, movement, and spawning and nesting sites for fish and wildlife in the Detroit River ecosystem, and interactions and interdependency among these communities should be defined.

3. Habitat Monitoring

Habitat monitoring should detect and describe changes in the Detroit River ecological characteristics through periodic analysis of key ecosystem elements. The following items are recommended:

a) The abundance and distribution of _Hexagenia_ should be determined every five years. The U.S. Fish and Wildlife Service grid used during 1985 would be appropriate. Bulk sediment chemistry, organic and inorganic contaminants, particle size analyses and a suite of bioassays should be conducted on samples taken concurrently with the _Hexagenia_ survey.

b) Quantification of the extent of Detroit River wetlands should be conducted every five years, along with the _Hexagenia_ survey. Aerial photography or remote sensing could discern emergent and submergent macrophyte beds important to larval fish and wildlife. Verification of aerial data should be conducted by inspection of selected transects for plant species identification and abundance. Changes in wetlands should be correlated with water level fluctuations and other natural documentable influences so that long term alterations in wetlands can be tracked and causes identified.

4. Sources Monitoring for Results of Specific Remedial Actions

Remedial actions intended to reduce contaminants from point sources require compliance monitoring. Attention must be given to sampling schedules and analytical methods. Nearfield monitoring should be conducted regularly to document contaminant reductions and recovery of impaired communities. Monitoring may be required for a "long time" in a limited area, depending on impact severity and degree of contaminant reduction that is achieved.

The following ten specific sources are recommended for contaminant monitoring:

- Detroit WWTP (PCBs, heavy metals, volatile organics, phenols, ammonia, oil and grease, cyanide, total phosphorus)
- Wayne County-Wyandotte WWTP (PCBs, heavy metals, volatile organics, ammonia, total phosphorus, total suspended solids, fecal coliform bacteria)
- City of Trenton WWTP (suspended solids, BOD, total phosphorus, dissolved oxygen)
- West Windsor WWTP (total phosphorus)
- McLouth Steel-Trenton (oil and grease, zinc, phenol, iron)
- Great Lakes Steel-Ecorse Mill (oil and grease)
- Ford Canada (phenols, heavy metals, PCBs)

- Wickes Manufacturing (chromium, nickel)
- General Chemical (chloride, copper)
- Rouge Steel (heavy metals, PAHs, phenols, oil and grease)

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