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Water quality changes caused by extension of the winter navigation season on the Detroit–St. Clair River System

Robert S. Sletten

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This study was conducted to determine how the water quality in the Detroit-St. Clair River System may change if the navigation season is extended from early January to the end of January. The study looked at background water quality, the effects of ship passage, and sedimentation rates. Background water quality in the study area has been continually improving since 1967. In the main shipping channel where ship passage studies were conducted, there were no significant relationships between the passage of a ship by a point and water quality. The rate of natural sediment accumulation increased during the winter.

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PREFACE

This report was prepared by Robert S. Sletten, Environmental Engineer, Civil and Geotechnical Engineering Research Branch, Experimental Engineering Division, U.S. Army Cold Regions Research and Engineering Laboratory. Technical review was provided by Sherwood C. Reed and Dr. George D. Ashton, both of CRREL. Additional review and comments provided by James L. Wuebben of CRREL and Donald Williams of the Detroit District, U.S. Army Corps of Engineers, were very helpful. Editorial review by David Cate of CRREL made the final report readable. Field and laboratory work by Carl Diener and Patricia Weyrick, both of CRREL, and data analysis by Diana Seely, formerly of CRREL, also contributed significantly to this study. Funding for this work was provided by the Detroit District, U.S. Army Corps of Engineers under Intra-Army Order for Reimbursable Services Agreement Number NCE-IS-82-0114.

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CONVERSION FACTORS: U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

These conversion factors include all the significant digits given in the conversion tables in the ASTM *Metric Practice Guide* (E 380), which has been approved for use by the Department of Defense. Converted values should be rounded to have the same precision as the original (see E 380).

Multiply	*By*	*To obtain*
foot	0.3048*	meter
inch	0.0254*	meter
mile per hour	1.609344*	kilometer per hour
ton	907.1847	kilogram

*Exact

Water Quality Changes Caused by Extension of the Winter Navigation Season on the Detroit–St. Clair River System

ROBERT S. SLETTEN

INTRODUCTION

The Corps of Engineers is considering extending operation of the locks at Sault St. Marie, Michigan, from within one week of 8 January to within two weeks of 31 January (St. Lawrence Seaway Authority 1976, U.S. Army Corps of Engineers 1979a,b). This action could be expected to increase the amount of vessel traffic in the Detroit–St. Clair River System (DSCRS) during that period of extended operation. This report presents data on past and current water quality and the expected changes in water quality in the DSCRS as a result of the proposed action. Although the data were taken only in the connecting waterways between Lakes Huron and Erie, the data and analysis should apply to other areas of the Great Lakes as well.

In September 1982 the Corps of Engineers Detroit District requested assistance from the Cold Regions Research and Engineering Laboratory (CRREL) in obtaining water quality data and assessing the changes in water quality that might result from extending the navigation season to as late as 15 February. (The exact season length would depend on the environmental conditions and the demands of commerce.) The geographic scope of the study was specified as the St. Clair and Detroit rivers and Lake St. Clair, which are the connecting waterways between Lakes Huron and Erie in the Great Lakes commercial navigation system. The study focused on these waterways as the places at which adverse water quality effects were most likely to occur. The study was composed of three distinct phases: background water quality studies, ship passage studies, and sedimentation rate studies. Data collection began in March 1983 and was concluded in March 1985.

The objective of this report is to present the results of these two years of data collection and to analyze and predict the probable effects on water quality of extending lock operation to within two weeks of 31 January each year.

STUDY AREA AND METHODS

Description of the study area

The project area includes the Detroit River, Lake St. Clair and the St. Clair River (Fig. 1). These waterways are a natural boundary separating Michigan to the west from Ontario to the east, and they connect Lakes Huron and Erie. The waterway is approximately 80 miles long, runs generally in a north–south direction, and is heavily used for commercial navigation, pleasure boating and sport fishing. In addition, there is a large amount of heavy industry along the entire waterway, particularly at the northern extreme of the St. Clair River (Sarnia, Ontario) and the southern portion of the Detroit River, along which sit the major population centers of Detroit, Michigan, and Windsor, Ontario (U.S. Dept. of Commerce 1979).

Recreational boating and commercial shipping on the system are seasonal, and traffic is sharply reduced during the winter months. Other uses, such as water supply and receipt of wastewater treatment plant effluent, continue year-round. The system supports some winter recreational use. There is some winter sport fishing, especially on Lake St. Clair. Limited winter navigation also occurs within the local areas during reasonably ice-free weather, usually by smaller tugboats, barges and some oil tankers that may be assisted by icebreakers.

During the winter, ice usually forms on the Great Lakes and can enter the connecting rivers. The St. Clair and Detroit rivers usually remain ice-free during the winter except in nearshore waters and embayments. Floe ice from Lake

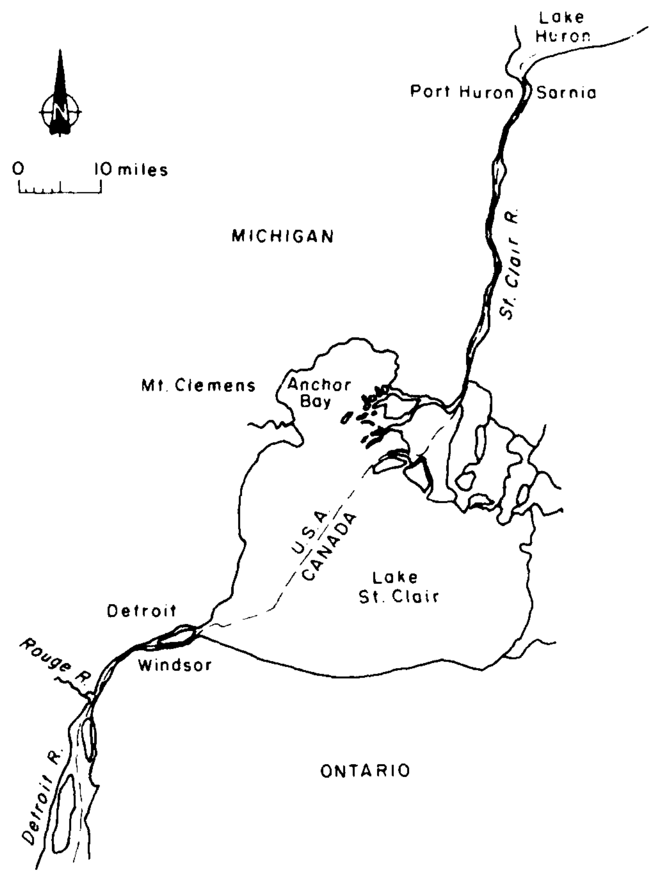


Figure 1. Detroit-St. Clair River System.

Huron enters the St. Clair River under the influence of northerly winds. Similarly ice enters the Detroit River from Lake St. Clair. In the St. Clair River, currents carry the floes downstream until they meet the resistance of the solid ice cover of Lake St. Clair. During a norn al winter, the ice cover can extend from the mouth of the river upstream 5–10 miles. In April 1984 the entire river became clogged with ice and stayed that way for several weeks, bringing ship traffic on the St. Clair River almost to a standstill. At the same time the Detroit River remained essentially ice-free.

Data collection

No attempt was made to understand the water quality of the system as a whole. Rather, the study concentrated on how a ship passing by a given point influences water quality in the vicinity of that point. This was done in both warm and cold water, that is, during the summer and either at the end or near the beginning of the present navigation season (1 April through 8 January ± 1 week). An attempt was also made to characterize the existing background water quality and the sediment flux rates at two points in both the St. Clair River and the Detroit River. These two characteristics might be affected by navigation during the extended season.

Background water quality data were first collected on-site, followed by in situ and laboratory analysis. This procedure was to have been followed on a monthly basis for the two years of the study. After the March and April 1983 sampling trips were made, it was determined that this procedure would be far too costly and that existing data would better serve the project purpose. Background water quality data were obtained primarily from the Environmental Protection Agency's STORET system. In addition, data and reports published by the Michigan Department of Natural Resources, the EPA, the USGS and water treatment plants in the project area were examined. These sources were searched for ex-

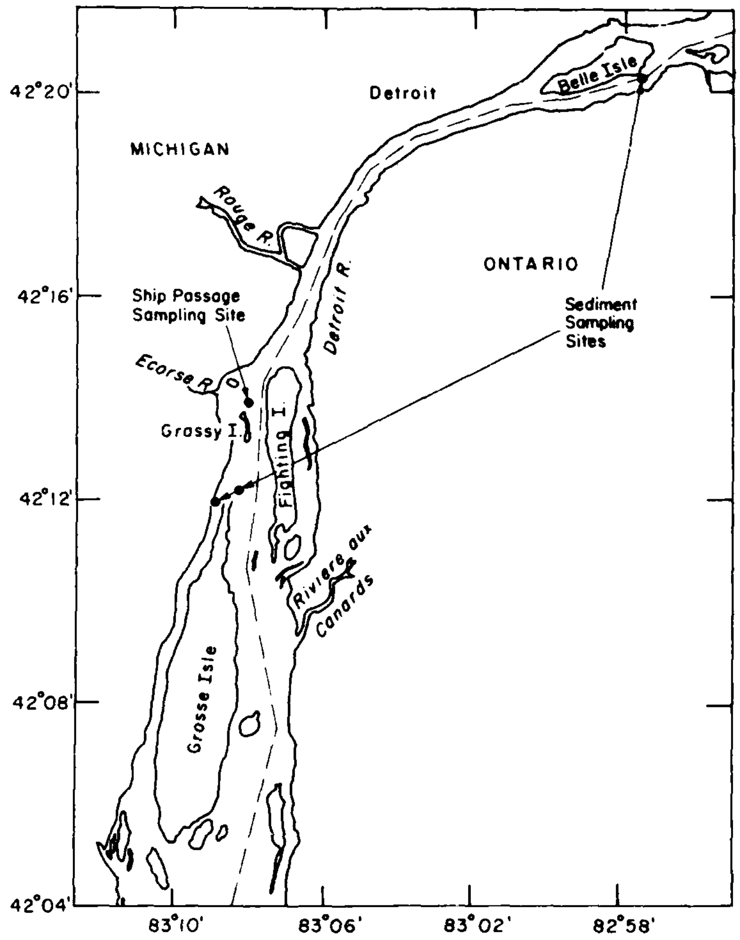


Figure 2. Ship passage and sediment sampling sites on the Detroit River.

treme values of total suspended solids and turbidity so that these values could be compared with those caused by ship passages. Other water quality characteristics were also examined to determine whether ship traffic could have an adverse effect on water quality. An analysis of the lower Detroit River using STORET data was made. The objective was to compare seasonal changes in water quality by dividing data into "warm" and "cold" readings based on the month in which the data were obtained. Throughout the study, the characteristics of interest were pH, temperature, turbidity, suspended solids and dissolved oxygen. No effort was made to look at organics, metals and other characteristics currently of concern to the International Joint Commission or other regulatory or study groups.

Water quality during ship passages was measured at one location in the Detroit River and one in the St. Clair River (Fig. 2 and 3). Each location was to have been sampled four times, twice in the summer and twice in the winter. (Winter sampling means either very late or very early in the navigation season.) The Detroit River was in fact sampled according to this schedule. One winter sampling on the St. Clair River was not done because of a major ice jam in the spring of 1984. Ship traffic was negligible, and ice conditions made it impossible to collect data (U.S. Army Corps of Engineers 1984). On each sampling occasion, data were collected for six ship passages. As shown in Table 1, 42 ship passages were sampled. These data collection trips were made in August 1983 (Summer 1), and April (Winter 1), August (Summer 2) and December 1984 (Winter 2).

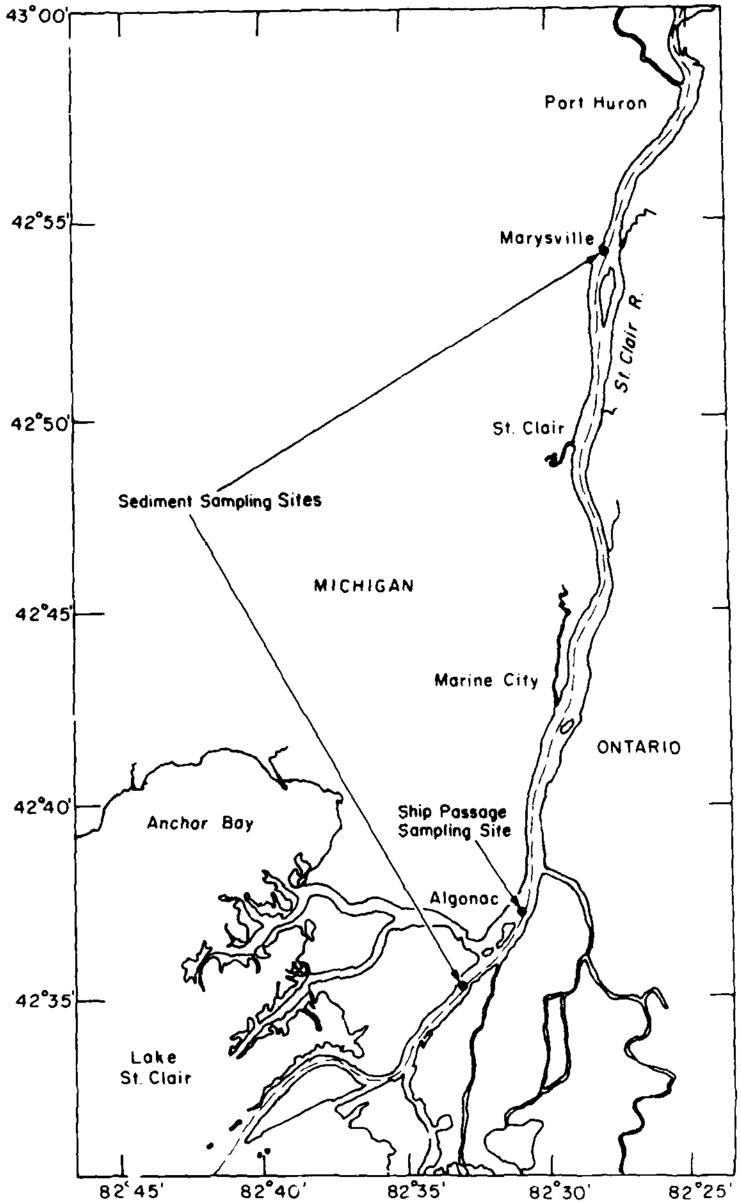


Figure 3. Ship passage and sediment sampling sites on the St. Clair River.

To obtain water samples and in situ data during ship passages, a small boat was anchored at the edge of the shipping channel. Figures 4 and 5 show how the boat and the samplers were situated with respect to the shipping channel for the Detroit and St. Clair Rivers, respectively. The sampling boat was anchored in approximately the same location for all sampling runs on each river. Two samplers were deployed from the boat so that they were on the edge of the channel and approximately 1–2 m from the river bottom.

Table 1. Ship passage data collection summary.

Season	*Dates*	*Detroit River*	*St. Clair River*
Summer 1	17–22 August 1983	6	6
Summer 2	20–24 August 1984	6	6
Winter 1	18–20 April 1984	6	0
Winter 2	4–11 December 1984	6	6
Total		24	18

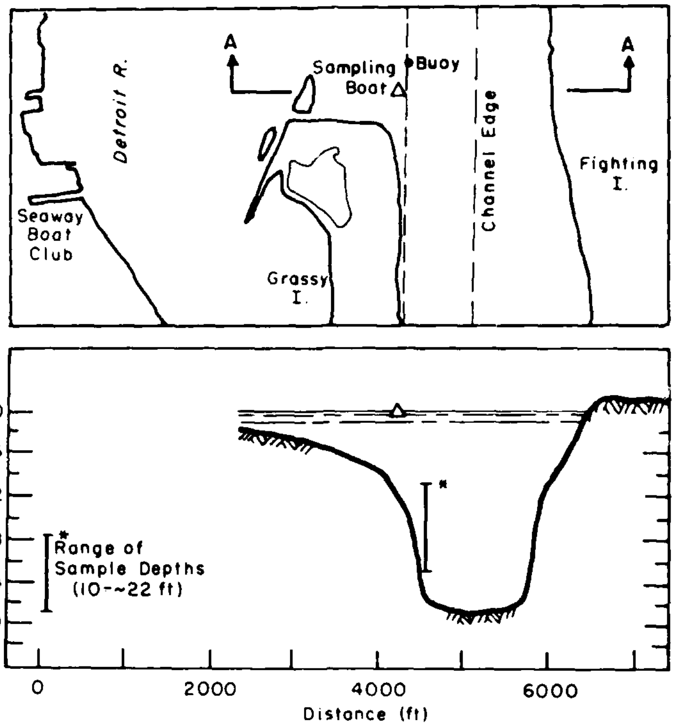


Figure 4. Sampler location and ship passage data collection on the Detroit River.

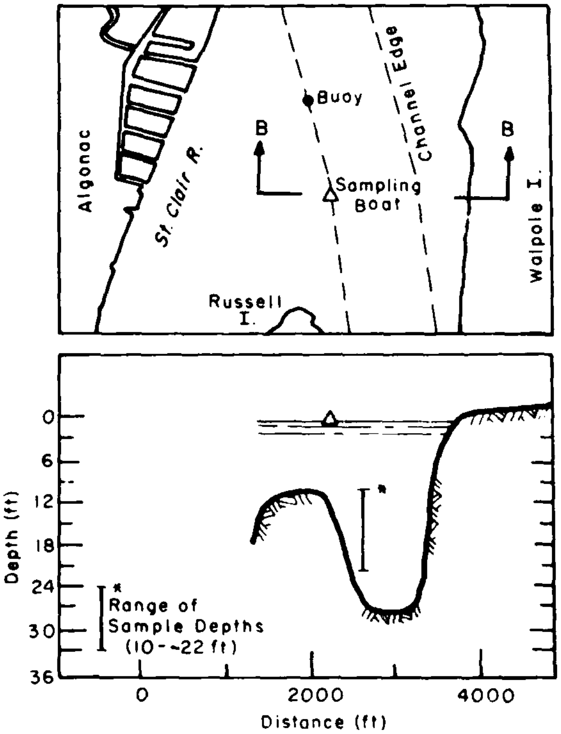


Figure 5. Sampler location and ship passage data collection on the St. Clair River.

A trap sampler designed and built by CRREL was used to obtain discrete water samples at specified times during the passage of the ship. As shown in Figure 6, the sampler consisted of eight 1.5-L Plexiglas cylinders. Spring-loaded ends were electrically triggered from the boat to obtain a discrete water sample. The trap samplers were triggered as the bow and stern of the ship came abreast of the sampling boat and at intervals of 1, 2, 5, 10, 20 and 30 minutes after the start of the sampling run. After all the traps were triggered, the sampler was retrieved, and samples were transferred to sample bottles, cooled and transported to the laboratory for analysis of turbidity and suspended and dissolved solids. Standard techniques (APHA, AWWA, WPCF 1983) were used in the laboratory analyses.

Transmissivity was measured as an indication of changes in turbidity caused when a ship passed close to the sampler and stirred up bottom sediments. A Martek transmissometer was used for underwater measurement of turbidity during and after ship passages. Transmissivity is determined by measuring the percent transmission of a light beam through a known path length in the water. During the first year's sampling runs, transmittance measurements were recorded on

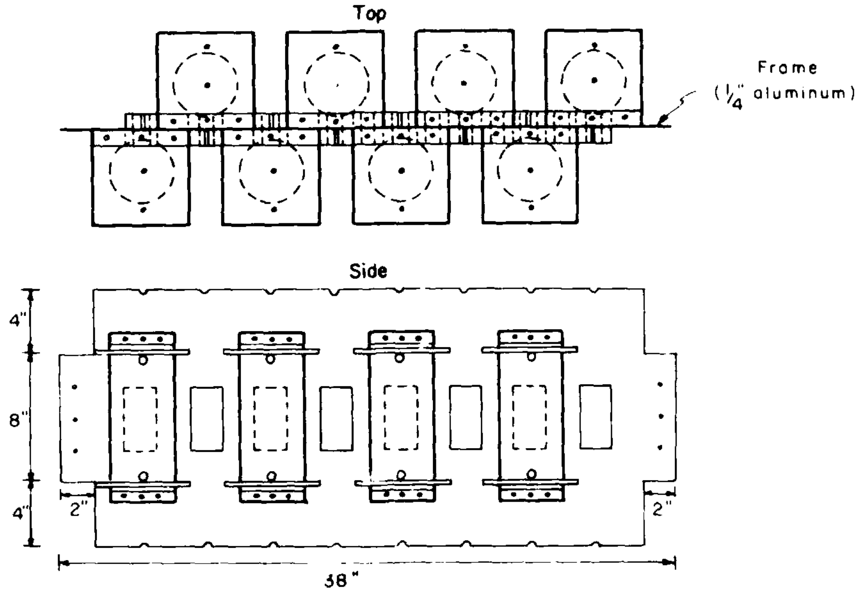


Figure 6. Trap sampler for collecting discrete water samples during ship passages.

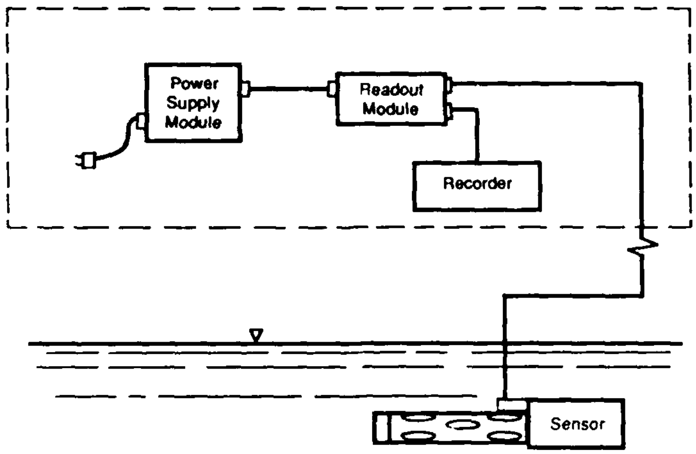


Figure 7. Schematic of transmissometer.

data sheets by hand at specified intervals. In the second year, depth and temperature sensors were added to the instrument, and all measurements were made and electronically recorded by a datalogger at one-minute intervals. Figure 7 shows a schematic of the transmissometer. The transmissometer was started just prior to the arrival of a ship at a location abreast of the sampling boat and was left on for either 30 minutes or one hour.

Baseline winter sedimentation rate data were collected at four locations during the winters of 1983-84 and 1984-85. Two sites in each river were selected, and samplers were deployed at monthly intervals for four months. Figures 2 and 3 show the sites in the Detroit and St. Clair rivers, respectively. The locations of suspected sediment deposition were not the same as those selected for measurement of ship passage disturbances.

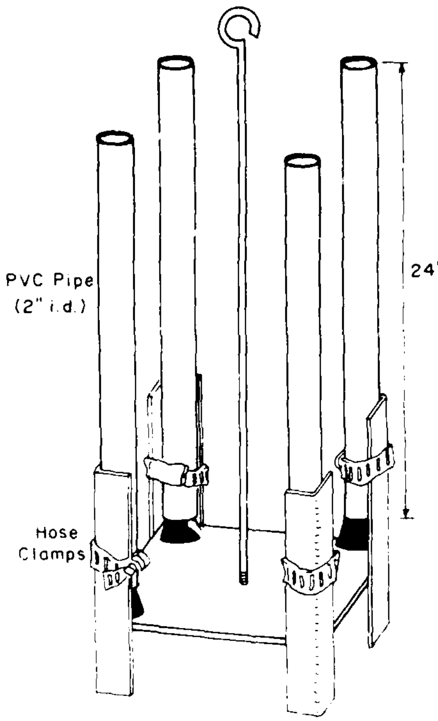


Figure 8. Sediment traps used during study.

Sediment deposition was measured in shallow, off-channel areas using the methods developed by Liston et al. (1982). The sediment traps were designed to measure the downward flux of particles in the water surrounding the trap. Liston stated that to ensure that the concentration of particles in the trap is the same as that in the surrounding water and that resuspension of settled sediment would not occur, simple cylindrical traps with an aspect ratio greater than ten should be used. (The aspect ratio is the ratio of the height to the inside diameter of the collection tube.) Sediment collectors were built at CRREL using specifications developed by Liston. Each trap consisted of four collection tubes attached with hose clamps to each corner of an iron frame (Fig. 8). An attachment rod extended from the center of each frame, where a line could be tied for lowering and retrieving the frame. The collection tubes were 24 in. long and 2.0 in. inside diameter, resulting in an aspect ratio of 12.

Sediment collectors were placed at each sample site at approximately monthly intervals by lowering them by rope to the river bottom, ensuring that they ended in an upright position. The locations were carefully marked for further deployment and final retrieval. At the end of the winter, divers carefully brought the samplers to the surface to minimize disturbance to the contents. At the surface the supernatant was carefully poured off, and the contents of the collector transferred to sample bottles. Rinse water was used to ensure that all collected sediment was transferred to the bottle. The bottles were transferred back to the laboratory, and the total sediment was determined according to *Standard Methods* (APHA, AWWA, WPCF 1980). The total sediment accumulated during the sampling period was determined from the first set of samplers, and by difference for the second and subsequent periods. The reported sedimentation rates were determined from the mean sediment accumulation in the four tubes on each trap.

RESULTS AND DISCUSSION

Background water quality

Background water quality was determined from data collected on-site during March and April 1983; from data in the Environmental Protection Agency's STORET water quality data base, including an in-depth analysis of the Detroit River; from recently collected seasonal data obtained by the EPA's Great Lakes National Program Office (GLNPO); and from published reports and data from various offices.

Table 2 presents the data collected during March and April 1983. Although limited, they indicate the low temperatures and high dissolved oxygen that would be expected in winter. There appear to be few turbidity or suspended solids

Table 2. Summary of background water quality data, March–April 1983.

	St. Clair River		*Detroit River*	
	March	*April*	*March*	*April*
Temperature (°C)	3	4	1	4
Dissolved oxygen (mg/L)	13.3	13.1	11.2	13.3
pH	7.9	7.9	8.0	7.9
Conductivity (μmho)	166	161	158	185
Turbidity (JTU)	19.0	4.5	10.1	11.1
Total suspended solids (mg/L)	38.0	11.8	17.2	29.9
Volatile suspended solids (mg/L)	4.4	2.2	2.7	2.9

problems. The higher levels of solids and turbidity in the St. Clair River can probably be attributed to the swifter current, which keeps more material in suspension than in the Detroit River. Generally, however, the background water quality in the two rivers is good.

The Environmental Protection Agency's STORET water quality data base was queried for data in the project area. As expected, the data base is very large. There are approximately 2000 stations in the project area where water quality data have been reported. Data were not requested from industrial and sewage treatment plant outfalls. Most of the data had been reported to STORET by the Michigan Department of Natural Resources, the EPA, the USGS, the International Joint Commission, and some university studies. Next, a summary of the data available at all these stations was requested. From this listing, pH, temperature, dissolved oxygen, turbidity and suspended solids data were extracted. Table 3 presents the range of values reported for each characteristic. These data show the average background conditions and variability for these five characteristics.

Further analysis of data from the STORET system was undertaken using contour mapping and trend analysis. This effort concentrated on the Detroit River from Dearborn, Michigan, to Windsor, Ontario, and was done to determine seasonal differences in water quality. That analysis focused on solids and turbidity, but it also examined temperature, pH and dissolved oxygen. The mean turbidity in the study area varied between 8.7 JTUs in the winter and 7.3 in the summer, with significant variation within each season. The variation between seasons was noticeable but barely significant at the 95% confidence level. The mean dissolved oxygen varied between 10.2 mg/L in the winter and 8.5 mg/L in the summer. At the 95% confidence level, there is a statistically significant difference between summer and winter dissolved oxygen concentration. The pH did not vary significantly on a seasonal basis. The mean annual pH was 8.1. Total residue was used as an indication of total sus-

Table 3. Range of values for each water quality variable from the STORET data base.

	Maximum	*Minimum*	*Range*	*Number of observations*
Temperature (°C)	50	1.5	≤14.4	272
			14.4–17.0	285
			17.0–21.0	260
			>21.0	279
Turbidity (JTU)	59	1	≤4.7	41
			4.7–5.9	43
			5.9–7.3	47
			>7.3	47
pH	12.3	2.2	≤7.8	269
			7.8–8.1	225
			8.1–8.2	308
			>8.2	209
Suspended solids (mg/L)	160,800	0	≤9.0	189
			9.0–15.6	175
			15.6–30.0	200
			>30.0	183
Dissolved oxygen	19	0	≤8.51	182
			8.51–9.35	187
			9.35–10.2	208
			>10.2	185

pended solids; there was no significant seasonal difference. The total residue averaged 13.4 mg/L year-round.

Unpublished data collected by the GLNPO during surveillance cruises in the spring, summer and fall of 1984 and the spring and summer of 1985 give further evidence of the seasonal and spatial variability of water quality. The cruises sampled seven stations along the waterway from near Sarnia, Ontario, on the St. Clair River to the mouth of the Rouge River on the Detroit. Their analysis of the data led them to conclude that the water quality in the project area was generally "very good," a conclusion that had also been reached by the State of Michigan from their water quality monitoring program (Michigan Department of Natural Resources 1982). The GLNPO reached this conclusion even though their sampling sites had been selected to confirm suspected problem areas rather than to provide a representative view of ambient water quality. Of the factors of interest to this study, only turbidity showed any unusual values. During the GLNPO's May 1984 spring cruise, turbidities of 145 and 155 JTUs were recorded in Lake St. Clair. These were attributed to resuspension of bottom sediment during turbulent weather. The GLNPO was probably referring to the serious ice jam in the St. Clair river a few weeks prior to the sample date.

A report prepared by Limno-Tech, Inc. (1985) for the Upper Great Lakes Connecting Channels (UGLCC) study summarized the available data in the project area, as well as examining environmental contamination issues and research needs. The study concluded that data available on the project area are extensive but may be unavailable or of doubtful quality. The study also pointed out that there are locales of contamination in the study area, with the Detroit River having the most problems. Areas with demonstrable impact tend to be near shore and in the vicinity of known point sources. Lateral pollutant transport in the study area does not occur rapidly. The water quality generally improves in response to remedial activity. The research needs include developing hydrodynamic models, with a special need for studies of sediment dynamics, since many of the factors of concern are toxicants that become sediment bound.

A comprehensive report, "Water Pollution Investigation: Detroit and St. Clair Rivers," was prepared for the EPA in 1974 by Environmental Control Technology, Inc. That report concluded that water quality throughout the length of the St. Clair River was generally good, with only minor changes in the chemical quality and with biological communities characteristic of unpolluted waters. There were some local problems below wastewater outfalls, and there was a minor degree of enrichment in downstream sediments. Although dredging operations would obviously affect the benthic community, this population was characterized by clean-water forms adapted to rapid current and hard substrates. The phytoplankton population was dominated by diatoms and did not vary significantly throughout the length of the river.

The water quality in the Detroit River, by contrast, changed substantially between the headwaters at Lake St. Clair and the mouth at Lake Erie (Environmental Control Technology, Inc. 1974). Most chemical characteristics increased in concentration as the water flowed downstream. This was especially true below the confluence of the Detroit and the heavily industrialized Rouge rivers, and below the outfall of the Detroit wastewater treatment plant. Downriver sediments also showed enrichment of most chemical characteristics. Biological communities were similarly affected, with upstream areas characterized by clean-water or intermediate benthic forms, intermediate areas between River Miles (RM) 18 and 12 (numbers are upstream from the mouth at Lake Erie) populated by pollution-tolerant organisms, and the area below RM 9 to Lake Erie populated by a limited number of benthic fauna. The phytoplankton community showed considerable variation with time and distance, although there was a slight increase in the number of individuals in the downstream region. The connecting waters of the Great Lakes in the Detroit area are significantly affected by surrounding land uses and pollution inputs. This is not surprising and has been observed since the earliest investigations of these waters. It is significant, however, that in the decade before the Environmental Control Technology, Inc. (1974) report, some improvement and recovery of water quality was observed.

Another report published by the Comprehensive Studies Section of the Michigan Department of Natural Resources (1982) described the monitoring program carried out by the Michigan DNR continuously since 1967, as well as data collected during water year 1981. In 1981 the 20 stations at the head and mouth were sampled monthly during warm weather (April to November) to compute materials loadings from Lake St. Clair to the head of the river and from the mouth of the river to Lake Erie. Intermediate stations were not sampled during 1981. The purpose of the monitoring program, aside from detecting long-term trends in water quality, is to determine if International Joint Commission (IJC) water quality objectives for several characteristics are being achieved. In 1981 the objectives for dissolved oxygen and pH, along with several other characteristics, were met. No objectives are set for turbidity or suspended solids. This report concluded that water quality at the mouth of the Detroit River has generally improved since 1967.

Although the Detroit–St. Clair River System has received considerable attention from water quality investigators over the years, very few data have been collected during the winter. None of the reports examined during this study referred to winter water quality. Winter water quality can only be surmised from what is known about summer conditions. Similarly no concern was evident in any of the reports about the possible effects of shipping on water quality in either summer or winter. The IJC sets no water quality objective for the characteristics that would most likely be affected by shipping (turbidity and suspended solids), indicating that there has been little concern about ship effects on water quality. Apparently, little is known about the seasonal differences, if any, of ship movements on water quality in this waterway, and investigating these effects has not been a priority.

Ship passages

Appendix A contains all the data collected during the 42 ship passages. Each ship's name, direction of travel, draft and estimated speed were noted for each passage, along with other ships passing during the data run. Water samples were collected for suspended and volatile solids and turbidity analysis. Data were recorded for transmissivity and, during the second year, for water temperature and depth at the transmissometer. The depth of the trap sampler was also noted. The *Great Lakes Red Book* (Buysse and Sasso 1980) or *Greenwood's Guide to Great Lakes Shipping* (Greenwood 1979) was used to gain additional information, such as the ship's registered gross tonnage, length, beam and draft when loaded.

Water quality data from the ship passages were analyzed to determine the magnitude of ship-induced changes. An attempt was then made to correlate the observed water quality changes to one or more of the study variables, such as season or ship size, speed or draft. The data were also looked at to see if there was any correlation in the variations of turbidity, suspended solids and transmittance. In the discussion that follows, total suspended solids, volatile suspended solids and turbidity values were used as they were recorded from the laboratory analyses. Transmittance, however, was converted from the percent transmittance recorded during the passage to a volume attenuation coefficient α, which depends on both absorption and scatter-

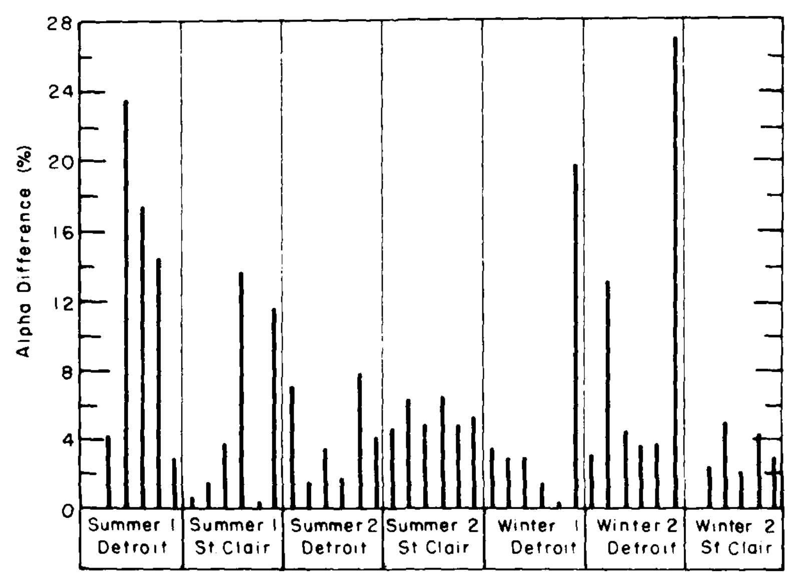


Figure 9. Percent difference in α by season and river.

ing along the path of the light beam. The transmittance data were obtained with a transmissometer using a 0.25-m path length. To convert the transmittance data shown in Appendix A to the volume attenuation coefficients shown in the rest of this discussion, the following equation was used:

$$\alpha = \ln\left(\frac{1}{T^{4}}\right)$$

where T is the transmittance along a path length of 0.25 m, and α is in units of m^{-1}.

This equation shows that a high transmissivity results in a low volume attenuation coefficient. The volume attenuation coefficient indicates the decrease in light transmittance caused by an increase in the number of particles in the light path. The volume attenuation coefficient is similar to, but not the same as, turbidity. In practical terms, though, the volume attenuation coefficient indicates the increased turbidity caused by resuspension of particles lying on the channel bottom and sides due to the motion of a ship as it passes. Turbidity is expressed in Jackson Turbidity Units (JTU), Formazin Turbidity Units (FTU) or Hach Turbidity Units (HTU) (Austin 1973, Zaneveld et al. 1980). A rough correlation between α and turbidity (JTU) is $\alpha \ m^{-1} \approx$ JTU/0.75.

Water quality changes. To assess the magnitude of ship-induced water quality changes, the maximum values for turbidity and total and volatile suspended solids were examined. In addition, the percent change in α during each ship passage was computed from the initial value at the start of each passage and the maximum value during the passage. This set of data was then sorted by season and ship passage to produce Figures 9–12.

Figure 9 reveals that the greatest change in α occurred in Winter 2 (December 1984) during the last run on the Detroit River. Only 8 of the 42 ship passages exhibited changes greater than 10%. In addition, there appears to be no correlation between a large change in α and the season in which the change occurred. Ranking the eight largest changes by season from largest to smallest results in Winter 2, Summer 1, Winter 1, Summer 1, Summer 1, Summer 1, Winter 2 and Winter 1. Ranking by river from largest to smallest results in Detroit, Detroit, Detroit, Detroit, Detroit, St. Clair, Detroit, St. Clair. Although the five largest changes all occurred in the Detroit River, they were in different seasons, so a positive correlation is unlikely.

Turbidities show a more distinct seasonal difference (Fig. 10). No winter maximum turbidity exceeded approximately 8 JTU, but six summer ship passages exceeded 10 JTU, with five of the six in the Detroit River. The maximum turbidity

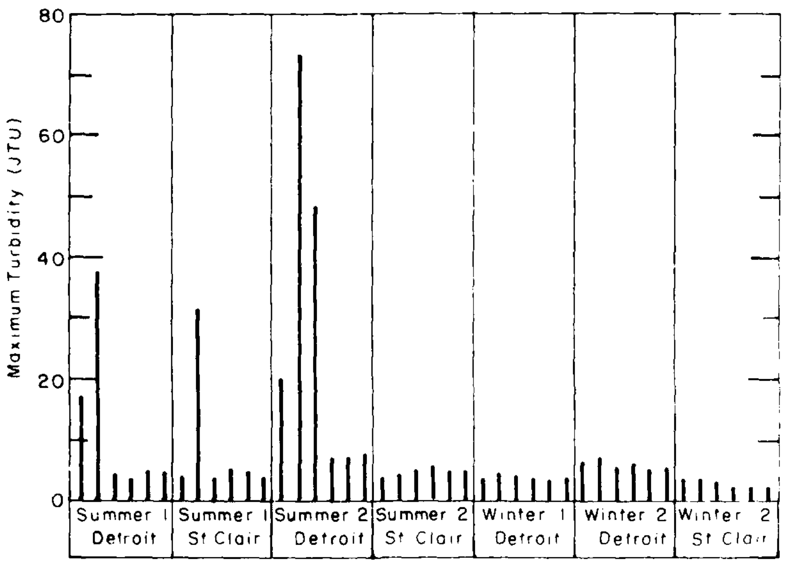


Figure 10. Maximum turbidities by season and river.

observed during this study was 73 JTU. This is only about half of the maximum turbidity observed in the background water quality section of this report (155 JTU) and only 14 JTU more than the maximum turbidity reported to the STORET system (59 JTU), as shown in Table 3. Although all six of the highest observed turbidities occurred in the summer, the maximum turbidities for the other 12 summer runs were the same as or lower than the winter runs. Thus, a seasonal correlation is again difficult to establish. The seasonal maximums in the Detroit River were generally higher than corresponding seasonal maximums in the St. Clair River. The highest levels for maximum turbidity for all six ship passages at a given location and season were in the Detroit River in Summer 2.

Figure 11 presents total suspended solids maximums. All maximums greater than 20 mg/L occurred during the summer, with the highest

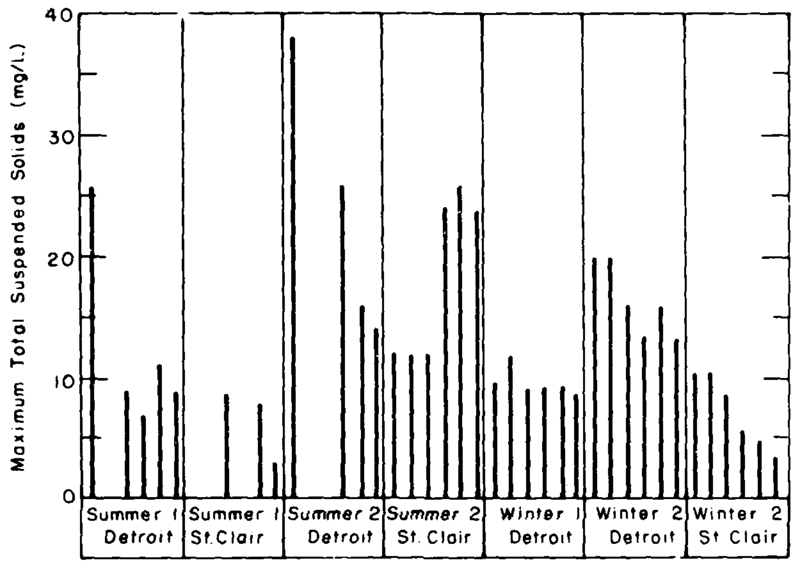


Figure 11. Maximum total suspended solids by season and river.

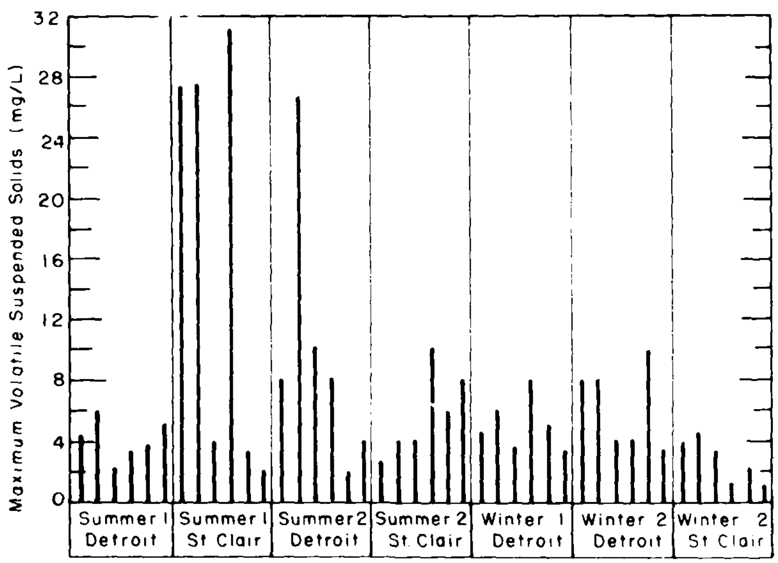
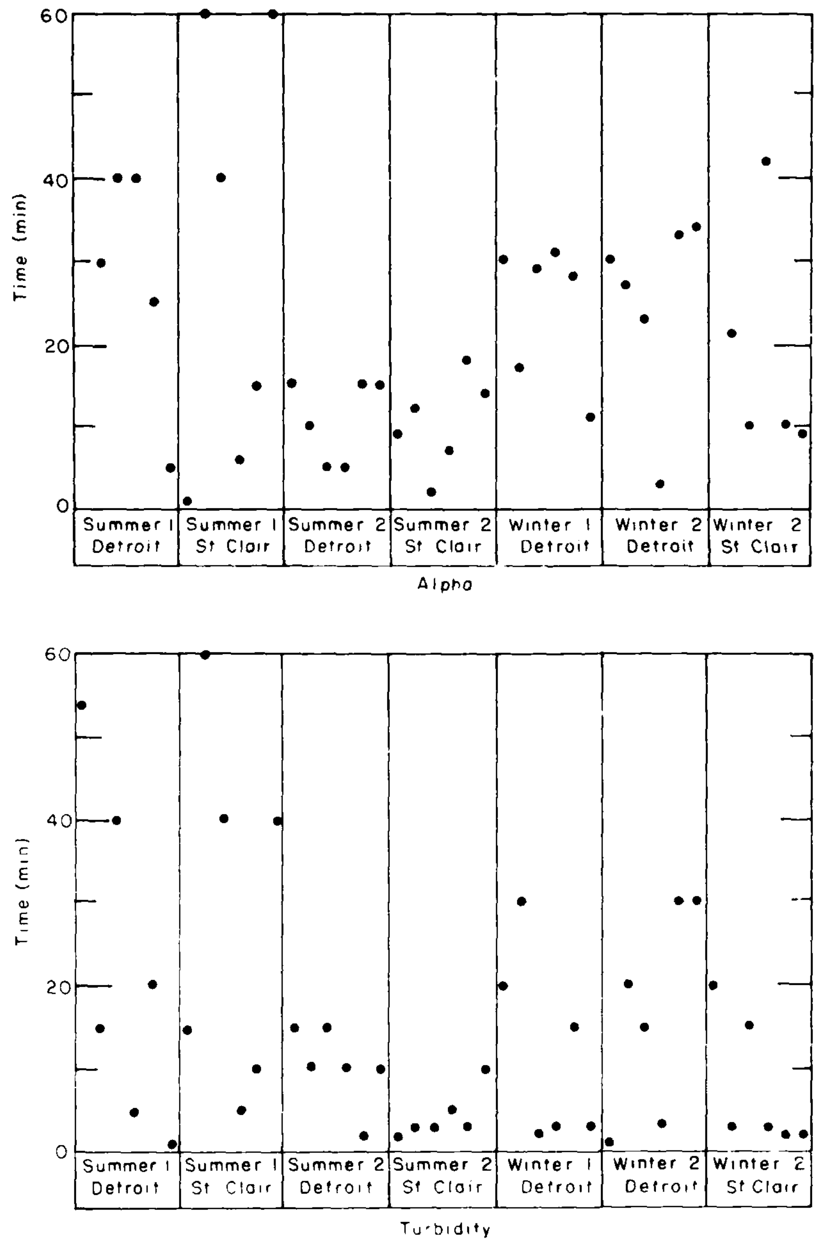


Figure 12. Maximum volatile suspended solids by season and river.

value being 38.0 mg/L in Summer 2 in the Detroit River. None of the total suspended solids values seen in this study approached the maximum of 160,800 reported to the STORET system (Table 3). Also the distribution of values reported in Table 3 (approximately 25% of values greater than 30 mg/L) appears to be higher than that seen during this study. In general, the St. Clair River shows lower total suspended solids maximums than the Detroit River, especially in winter.

Volatile suspended solids maximums are shown in Figure 12. The maximum value during this study was 31 mg/L, only 4 of the 42 ship passages produced values in excess of 10 mg/L, and all winter passages had values less than 10 mg/L. The maximum value of 31 mg/L is far below what would be seen below a sewage treatment plant outfall. Neither sampling location used during this study appeared to have a high organic content in the channel bottom, so the relatively low



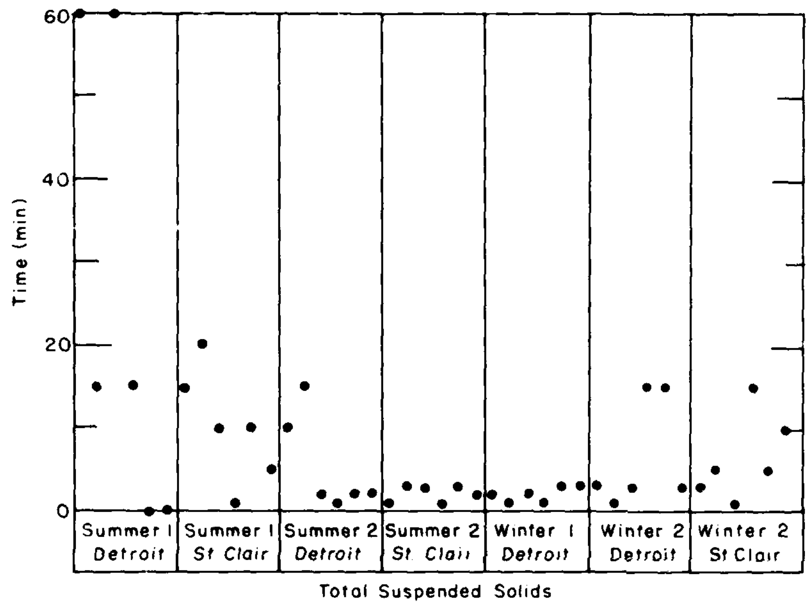
a. Difference in α.

b. Turbidity.

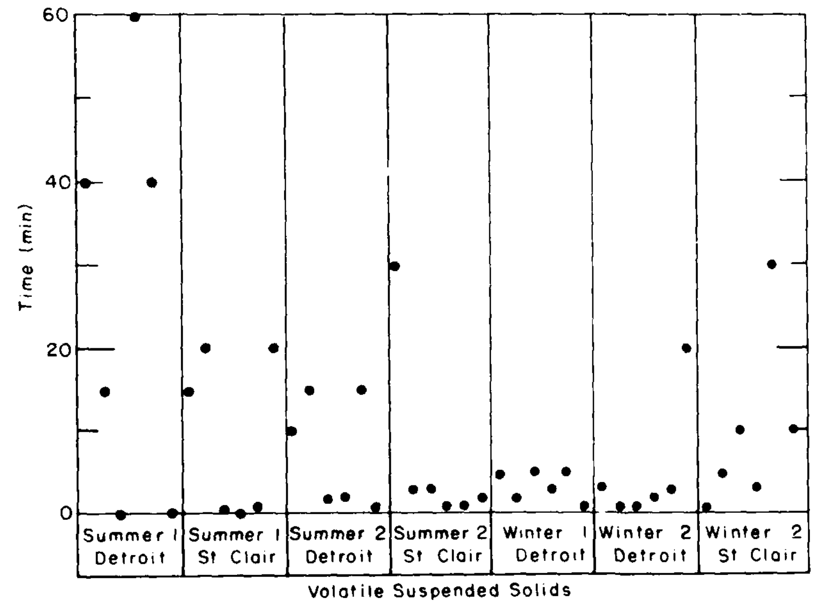
Figure 13. Times to parameter maximums.

values for volatile suspended solids during the study are not surprising. Except for Summer 1, the Detroit River values were generally higher than those from the St. Clair; the lowest overall values came from the St. Clair River runs during Winter 2. Resuspension of bottom sediment during vessel passage did not appear to result in high volatile suspended solids during this study.

Times to variable maximums were also noted and are presented for all runs in Figure 13. No pattern is apparent. The majority of maximum disturbances occurred within 30 minutes after the ship passage. In fact, a significant number of maximum disturbances were within a few minutes of the passing of the ship. In many cases, the time of maximum disturbance was the same for different variables (Fig. 13). This appears to be true more often for α and turbidity than for other combinations of characteristics. However, it would be difficult to predict the time of maximum



c. Total suspended solids.



d. Volatile suspended solids.

Figure 13 (cont'd). Times to parameter maximums.

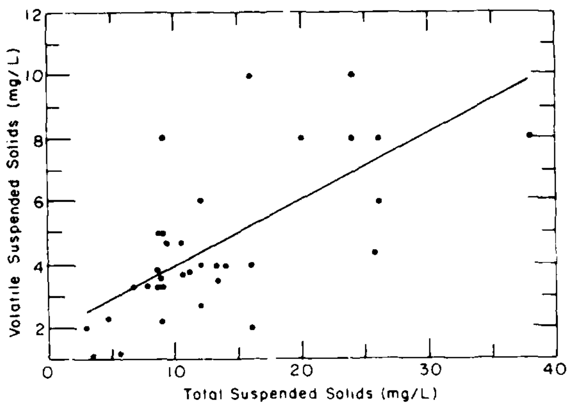


Figure 14. Regression anaylsis for total suspended solids vs volatile suspended solids.

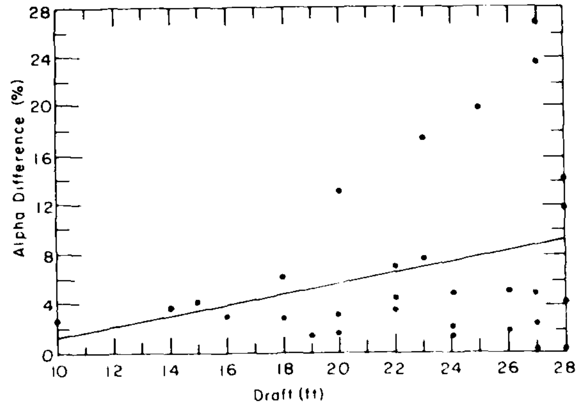


Figure 16. Regression analysis for ship draft vs the difference in α.

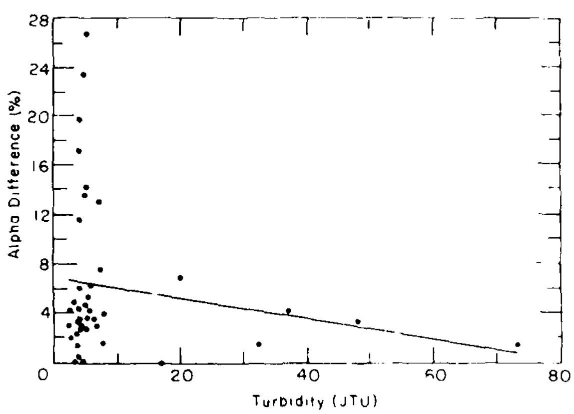


Figure 15. Regression analysis for turbidity vs α.

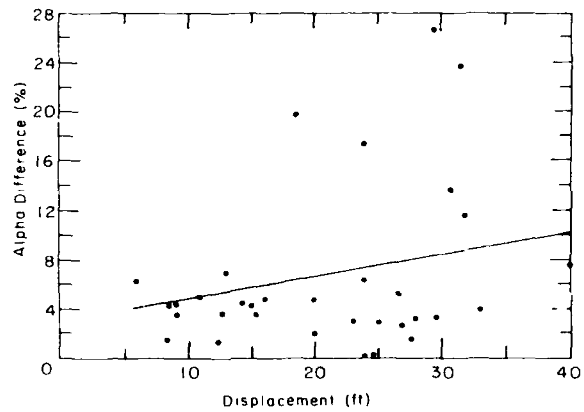


Figure 17. Regression analysis for ship displacement vs the difference in α.

disturbance for any characteristic. This is no doubt due to uncontrolled variables, such as current, ship speed, displacement and direction of travel.

Variable Correlations. Linear regressions were made on several pairs of variables to determine whether relationships existed in the data. No r^2 value greater than 0.46 was found in this analysis, and most were near zero, indicating no correlation. Two sets of water quality characteristics were examined, and three ship variables were individually regressed with α. Total and volatile solids were assumed to be correlated to some degree; they showed the highest r^2 of 0.46, a weak correlation. Figure 14 presents these data. It was also thought that the difference in α should be related to turbidity. Figure 15 shows that this is not the case. Many high percentage changes in α were accompanied by low maximum turbidities. The reason for this is not known. However, only six turbidity maximums exceeded 10 JTU.

Absolute α was correspondingly low in almost all cases. Ship draft, displacement and speed were analyzed to determine if the percent change in α was related to any of these variables. Figures 16–18 show that no significant relationships were apparent during this study.

The possibility of seasonal and location relationships in ship-induced water quality changes was examined, but none were evident during this study. The overall lack of relationships between water quality characteristics and between ship passages and magnitudes of disturbance, as well as the lack of a clearcut difference in seasonal effects, indicate that extension of the navigation season should not result in adverse consequences along the ship channel. There are several possible explanations for these lack of relationships. First, it is possible that they simply do not exist. Given all the natural uncontrolled variables during the passage of a ship by a point, it is possible that the situation is so complex that relationships do not exist or that they are not possible to find with present sampling and analytical capabilities. Second is the possibility that the samplers were placed in the wrong location. Hodek et al. (1986) suggested that "the temporary turbidity increase from a vessel passage varies little, if any, near the navigation channel to a maximum adjacent to the shores. This is due to the increasing turbulence as the water shoals, and in great part to the direct attack of the surge on soil above normal water level." No indication was given in that draft report why turbidities do not increase to a greater extent in or very near the shipping channels. The sampling sites selected during this study were those most likely to have adverse environmental consequences due to extension of the navigation season. If the methods used to assess this possibility were valid, the lack of significant disturbance of water quality due to vessel passage should allay those concerns. If other environmentally sensitive areas exist closer to shore, controlled testing to determine the magnitude of those effects may be called for.

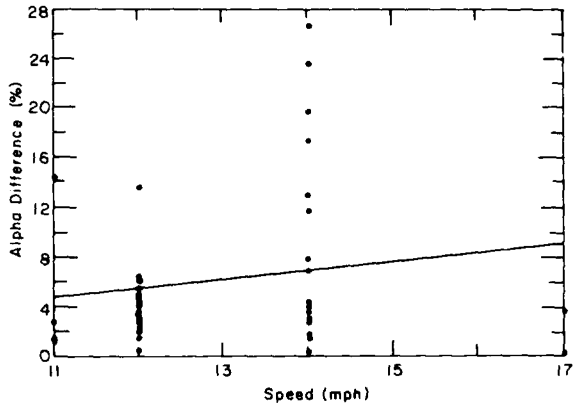


Figure 18. Regression analysis for ship speed vs the difference in α.

Table 4. Sediment accumulation data for all seasons.

Sample location	*River and season*	*Beginning date*	*Ending date*	*Exposure time (days)*	*Average weight (mg)*	*Accumulation rate (mg/day)*
Belle	Detroit	3 Jan 84	23 Apr 84	111	63.1	0.57
Isle	Winter 1	5 Mar 84	23 Apr 84	49	48.8	1.00
		4 Apr 84	23 Apr 84	19	30.0	1.58
Point	Detroit	14 Mar 84	23 Apr 84	40	43.2	1.08
Hennepin	Winter 1	5 Apr 84	23 Apr 84	18	11.3	0.63
Belle	Detroit	14 Jan 85	8 Apr 85	84	39.0	0.46
Isle	Winter 2	12 Feb 85	8 Apr 85	55	36.9	0.67
		7 Mar 85	8 Apr 85	32	24.2	0.76
Wyandotte	Detroit	12 Dec 84	8 Apr 85	117	83.7	0.72
	Winter 2	14 Jan 85	8 Apr 85	84	84.6	1.01
		12 Feb 85	8 Apr 85	55	42.1	0.77
		7 Mar 85	8 Apr 85	32	44.2	1.38
Harsen's	St. Clair	6 Dec 84	10 Apr 85	125	24.3	0.19
Island	Winter 2	9 Jan 85	10 Apr 85	91	31.0	0.34
		13 Feb 85	10 Apr 85	56	29.4	0.53
Marysville	St. Clair	6 Dec 84	9 Apr 85	124	121.8	0.98
	Winter 2	9 Jan 85	9 Apr 85	90	97.5	1.08
		8 Mar 85	9 Apr 85	32	54.9	1.72

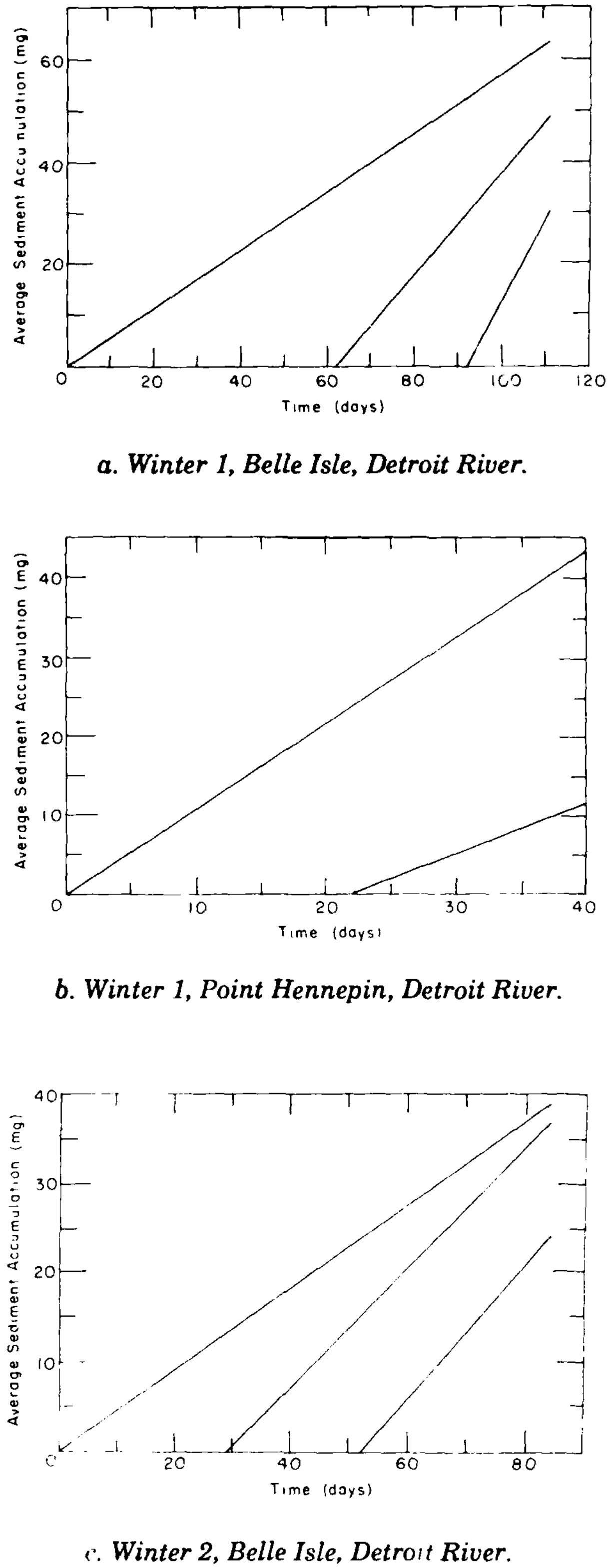
Winter sedimentation

Sediment data were collected during the winters of 1983-84 and 1984-85 using the methods of Liston et al. (1982). Table 4 shows the average amount of sediment collected over each winter at two stations in the Detroit River and two stations in the St. Clair River. Sediment samplers in the St. Clair River during Winter 1 were not recovered due to severe ice conditions at the sampling locations during April 1984. Samplers were put in the water at intervals over the winter, and all samplers were collected at the same time at the end of the winter. After the samplers were collected, the dry weight of the contents of each sampler tube was determined. The numbers shown in the table represent an average of the four tubes on each sampler.

Figure 19 depicts the rate of sediment accumulation at each site. Each straight line in the figures corresponds to a sampler in Table 4. The accumulations have been shown as straight lines in all cases. An idea of the variation in accumulation rates during the winter can be obtained by comparing the slopes of each of the lines at a site. For instance, each line in Figure 19a has a slope greater than the preceding one. The last column in Table 4 corresponds to the slopes shown in the figures.

Figure 19a indicates that sediment accumulated at an increasing rate at Belle Isle during Winter 1, while at Point Hennepin (Fig. 19b) the opposite was true. The same pattern was observed at Belle Isle in Winter 2 as in Winter 1 (Fig. 19c). At Wyandotte during Winter 2 (Fig. 19d) the second and fourth samplers actually collected slightly more sediment over a shorter period of time than the first and third. The reason for this is unknown. In the St. Clair River during Winter 2, the second and third samplers at Harsen's Island collected more sediment than the first one (Fig. 19e). Again it is unclear why this occurred. There was a slightly greater rate of accumulation for the third sampler than the second, similar to the pattern seen at Belle Isle. At Marysville (Fig. 19f) the first and second lines have almost identical slopes, while the third shows a significantly greater rate of accumulation at the end of the winter.

The absolute accumulations varied significantly from station to station but are difficult to compare because of the different lengths of time the samplers were in the water. For the four samplers with the longest submergence times (111, 117, 125 and 124 days), accumulations varied

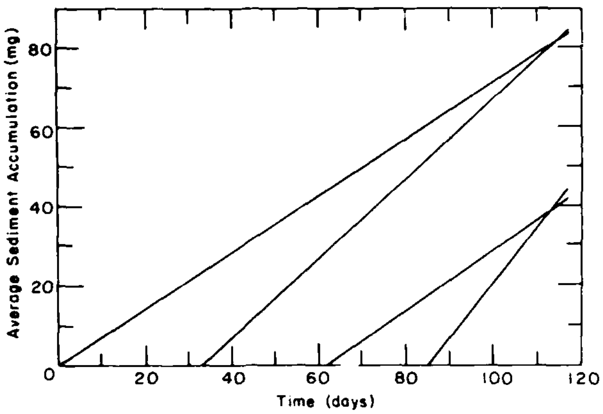


a. Winter 1, Belle Isle, Detroit River.

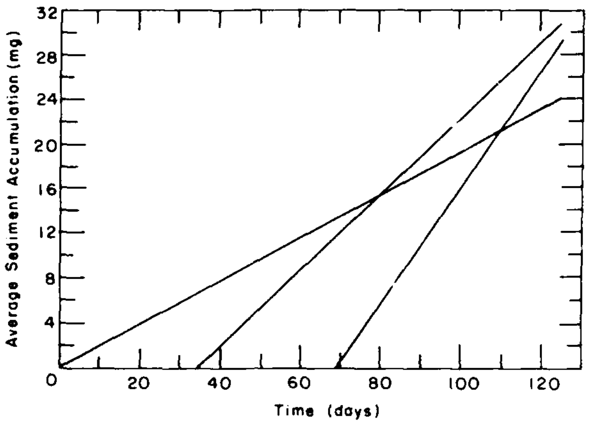
b. Winter 1, Point Hennepin, Detroit River.

c. Winter 2, Belle Isle, Detroit River.

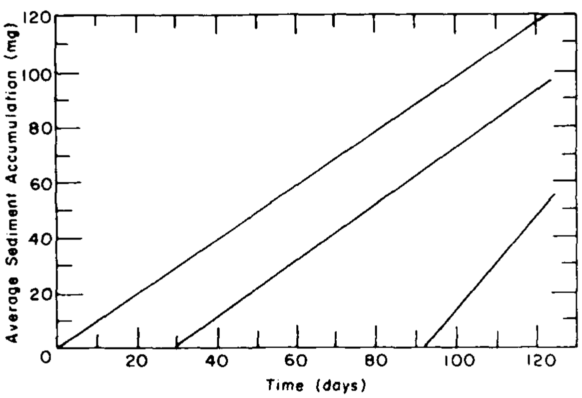
Figure 19. Rates of sediment accumulation.



d. Winter 2, Wyandotte, Detroit River.



e. Winter 2, Harsen's Island, St. Clair River.



f. Winter 2, Marysville, St. Clair River.

Figure 19 (cont'd). Rates of sediment accumulation.

from 24.3 to 121.8 mg. Both the highest and lowest absolute sediment accumulations were in the St. Clair River. The highest rate of accumulation, 1.72 mg/day, was at Marysville in the St. Clair River during the final part of the winter; the lowest, 0.19 mg/day, was at Harsen's Island over the entire winter (Table 4). In the Detroit River the rates of accumulation at Belle Isle were quite similar in both years. The Point Hennepin station on the Detroit River was changed to Wyandotte in the second winter for ease of access; the rates of accumulation at those stations also appear to be similar and higher than those at Belle Isle.

A pattern of increasing accumulation rate of sediment is evident at Belle Isle in the upper Detroit River during both winters. This also appears to be true at both stations in the St. Clair River, with the exception of the sampler that was in the water over the entire winter at Harsen's Island. In the lower Detroit River, this pattern is reversed at Point Hennepin and inconclusive at Wyandotte. Although there was some shipping activity at all of these points toward the end of the winter, there is no way to tell if the observed increase in the rate of accumulation at the end of the winter is related to shipping. Since the sampling sites were chosen to indicate sedimentation during the winter when shipping was minimal, these data should represent natural background sediment accumulation. The increase in accumulation rate is believed to be related to the increase in the flow of the river in the spring. There is little to suggest that it is related to either shipping activity or ice conditions.

CONCLUSIONS

The background water quality has been continually improving at least since 1967. There is significant seasonal variation in temperature and dissolved oxygen not related to shipping activity. The background variation in all characteristics studied during this project as reported to the Environmental Protection Agency's STORET system was greater than any observed variation due to ship passages. Although seasonal variation is clearly evident for temperature and dissolved oxygen, no seasonal variation was evident for turbidity, suspended or volatile solids, or pH. It is concluded that natural background variation is greater than and independent of ship-induced variation.

During the ship passage studies, data were collected for 42 ship passages. Data were analyzed for relationships between seasons, locations and characteristics. No significant relationships were found. Either such relationships do not exist or, as Hodek et al. (1986) concluded, "the temporary turbidity increase from a vessel passage varies little, if any, near the navigation channel...." The sampling sites chosen for this study were the ones most likely to have adverse environmental consequences from extension of the navigation season; this study shows that adverse environmental consequences are not likely to occur at those sites. If concerns exist for other areas, site-specific studies should be undertaken at those sites.

Winter sediment accumulation data collected during two winters showed a pattern of increasing rate of accumulation at the head of the Detroit River over both winters. This pattern was also evident but less clearly defined for both stations in the St. Clair River during the one winter data were collected there. In the lower Detroit River the pattern was reversed at one station and inconclusive at the other. Although some shipping activity occurred at all of these sites during the winter, there is no way to correlate shipping activity with the observed data. Due to the location of the sampling sites, the observed data probably represent natural background sediment accumulation. The rate of increase in accumulation toward the end of the winter is probably related to the increase in the flow of the river rather than shipping activity or ice conditions.

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APPENDIX A. SHIP PASSAGE DATA RUNS.

Table A1. Ship passage data runs during summer 1. August 1983

D for Detroit River, S for St. Clair River

RUN NO.	DAY OF MO.	START TIME	SHIP NAME	UP OR DOWN RIVER	LENGTH FEET	WIDTH FEET	DRAFT FEET	EST SPEED MPH	GROSS DISPL TONS
D1	17	1727	CVIJETA ZUZORIC	UP	*	*	*	*	*
D2	18	1017	ERINDALE	UP	550	60	*	*	14800
D3	18	1530	CANADIAN ENTERPRISE	DOWN	730	75	27	17.0	31300
D4	18	1650	FRED R. WHITE, JR.	DOWN	635	68	23	19.2	23800
D5	19	1300	ISLAND TRANSPORT	UP	349	43	*	11.0	5902
D6	19	1549	BEECHGLEN	UP	*	*	*	42SEC	*
S1	20	1212	SEAWAY TRADER	DOWN	*	*	*	*	*
S2	20	1702	LADY MARINA	DOWN	*	*	19	35SEC	*
S3	21	1140	SILVERDALE	DOWN	596	60	14	16.6	12600
S4	21	1250	SAGUENAY	DOWN	730	75	28	*	30600
S5	22	1130	AGAWA CANYON	*	642	72	27	17.4	24500
S6	22	1323	H.M. GRIFFITH	*	730	75	28	14.3	31770

DETROIT RIVER
PASSAGE #1
DATE AUG. 17, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1727
SHIP: CVIJETAZUZORIC
DIRECTION: UPBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	41.5	6.67	2.22	3.6
2	1	42.0	3.75	2.50	3.3
3	2	42.0	*	*	*
4	3	42.0	*	*	*
5	4	42.1	*	*	*
6	5	42.2	4.44	2.22	3.1
7	10	42.2	4.44	0.00	3.5
8	15	42.3	2.2	*	3.2
9	20	42.3	5.56	1.11	3.4
10	25	42.2	*	*	*
1755	"WOLVERINE" DOWNBOUND				
11	30	41.9	*	*	*
1802	"SAM LAUD" UPBOUND				
12	40	41.6	6.67	4.44	4.2
13	54	41.5	25.56	0.00	17.0

DETROIT RIVER
PASSAGE #2
DATE AUG. 18, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1017
SHIP: ERINDALE
DIRECTION: UPBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1014	"MELDRUM" DOWNBOUND				
1	0	41.3	8.89	1.11	5.2
2	1	41.3	8.39	2.22	4.7
3	2	41.6	*	*	*
4	3	41.6	*	*	*
5	4	41.6	*	*	*
6	5	41.4	10.00	3.33	4.2
7	10	40.3	*	*	*
8	15	40.0	163.53	5.88	37.0
9	20	39.9	50.67	4.00	8.6
10	25	39.9	*	*	*
11	30	39.8	*	*	*
12	40	40.1	13.33	1.11	6.2
1057	"J. L. MAUTHE" UPBOUND				
13	60	40.0	16.67	1.11	5.4

DETROIT RIVER
PASSAGE #3
DATE AUG. 18, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1529
SHIP: CANADIAN ENTERPRISE
DIRECTION: DOWNBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	45.3	7.78	2.22	3.3
2	1	45.6	6.67	2.22	3.7
3	2	45.5	*	*	*
4	3	45.5	*	*	*
5	4	45.5	*	*	*
6	5	45.7	7.78	2.22	4.5
7	10	45.0	6.67	2.22	4.0
8	15	44.8	4.44	1.11	3.3
9	20	45.6	5.60	1.11	3.3
10	25	45.8	*	*	*
11	30	44.3	*	*	*
12	40	37.6	6.67	1.11	4.7
13	60	44.2	8.89	2.22	3.7

DETROIT RIVER
PASSAGE #4
DATE AUG. 18, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1651
SHIP: FRED R. WHITE
DIRECTION: DOWNBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	45.5	6.67	1.11	2.9
2	1	44.7	5.00	2.50	3.3
3	2	44.6	*	*	*
4	3	44.9	*	*	*
5	4	44.6	*	*	*
6	5	44.6	5.56	2.22	3.9
7	10	44.5	3.33	0.00	3.9
8	15	44.1	6.67	1.11	3.6
9	20	44.0	5.56	2.22	3.5
1711	"JOHN G. MUNSON" UPBOUND				
10	25	44.0	*	*	*
11	30	44.7	*	*	*
12	40	39.7	*	*	*
13	60	43.4	5.56	3.33	3.5

DETROIT RIVER
PASSAGE #5
DATE AUG. 19, 1983
SUMMER 1
CLOCK TIME IN MINUTES 1256
SHIP: ISLAND TRADER
DIRECTION: UPBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
0	0	35.0	11.1	3.3	4.4
1	1	34.0	8.89	1.11	4.4
2	2	34.1	*	*	*
1258	"SEWAY TRADER" UPBOUND				
3	3	33.9	*	*	*
4	4	32.4	*	*	*
5	5	33.0	7.78	1.11	4.4
6	10	32.0	7.50	0.00	3.9
7	15	33.6	10.00	3.33	4.4
8	20	34.0	6.67	2.22	5.1
9	25	30.1	*	*	*
10	30	31.7	*	*	*
11	40	30.6	7.50	3.75	4.7
12	60	31.0	10.59	2.35	4.4

DETROIT RIVER
PASSAGE #6
DATE AUG. 19, 1983
SUMMER 1
CLOCK TIME 0 MINUTES 1549
SHIP: BEECHGLEN
DIRECTION: UPBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	32.5	8.75	5.00	4.4
2	1	32.5	3.75	1.25	4.9
3	2	33.3	*	*	*
4	3	32.5	*	*	*
5	4	31.9	*	*	*
6	5	31.5	6.25	1.25	4.7
7	10	34.0	5.00	3.75	4.4
8	15	33.0	7.06	1.18	3.9
9	20	32.8	3.75	*	3.4
1612	"VANDOC" UPBOUND				
10	25	35.0	*	*	*
11	30	34.0	*	*	*
12	40	35.0	5.56	0.00	3.6
1629	"TARANTAU" DOWNBOUND				
13	60	33.0	7.78	2.22	3.6

ST. CLAIR RIVER
PASSAGE #1
DATE AUG. 20, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1212
SHIP: SEWAY TRADER
DIRECTION: DOWNBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	54.1	5.6	1.4	2.2
2	1	53.9	91.1	6.7	3.5
3	2	54.0	*	*	*
4	3	54.4	*	*	*
5	4	54.2	*	*	*
6	5	54.8	13.0	3.0	2.0
7	10	54.5	26.0	3.0	2.3
8	15	54.9	1018.2	27.3	3.8
9	20	55.1	198.9	8.9	2.8
10	25	55.0	*	*	*
11	30	55.6	*	*	*
12	40	55.5	208.6	8.6	1.8
13	60	55.9	724.0	18.0	1.7

ST CLAIR RIVER
PASSAGE #2
DATE AUG 20, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1702
SHIP: LADY MARINA
DIRECTION: DOWNBOUND

ROW	TIME	TRANS	TSS	VSS	TURB
1	0	53.3	243.33	7.78	3.2
2	1	54.9	16.67	0.00	2.4
3	2	54.5	*	*	*
4	3	54.5	*	*	*
5	4	54.7	*	*	*
6	5	54.7	153.68	5.26	3.0
7	6	54.4	*	*	*
8	7	54.9	*	*	*
9	8	54.4	*	*	*
10	9	54.5	*	*	*
11	10	54.6	*	*	*
12	15	54.2	627.78	13.33	2.8
13	20	55.1	996.25	27.50	24.0
14	25	*	*	*	*
15	30	54.7	*	*	*
16	40	54.7	*	*	*
17	60	52.8	33.68	3.16	32.0

ST CLAIR RIVER
PASSAGE #3
DATE AUG. 21, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1140
SHIP: SILVERDALE
DIRECTION: DOWNBOUND

ROW	TIME	TRANS	TSS	VSS	TURB
1	0	52.5	4.4	1.1	2.0
2	1	52.0	6.3	3.3	3.0
3	2	52.2	*	*	*
4	3	52.5	*	*	*
5	4	52.4	*	*	*
6	5	52.4	2.4	0.0	2.6
7	6	52.6	*	*	*
8	7	52.0	*	*	*
9	8	51.9	*	*	*
10	9	52.4	*	*	*
11	10	52.1	8.6	0.0	2.7
12	15	52.9	6.7	2.2	2.4
13	20	52.6	6.7	1.7	3.2
14	25	51.9	*	*	*
15	30	52.7	*	*	*
16	40	51.3	3.5	2.4	3.7
17	60	51.6	3.5	0.0	2.8

ST CLAIR RIVER
PASSAGE #4
DATE AUG. 21, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1252
SHIP: SAGUENAY
DIRECTION: DOWNBOUND

ROW	TIME	TRANS	TSS	VSS	TURB
1	0	*	*	*	*
2	1	*	1253.3	31.1	4.8
3	2	52.5	*	*	*
4	3	52.8	*	*	*
5	4	52.1	*	*	*
6	5	50.9	1140.0	26.7	5.0
7	6	48.1	*	*	*
8	7	48.7	*	*	*
9	8	50.1	*	*	*
10	9	50.1	*	*	*
11	10	50.3	17.6	3.5	4.9
12	15	52.4	5.9	0.0	3.7
13	20	51.8	6.7	2.2	2.8
14	25	52.5	*	*	*
15	30	52.9	*	*	*
16	40	51.7	7.8	2.2	2.1
17	60	52.2	7.5	2.5	2.4

ST CLAIR RIVER
PASSAGE #5
DATE AUG. 22, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1130
SHIP: AGAWA CANYON
DIRECTION: DOWNBOUND

ROW	TIME	TRANS	TSS	VSS	TURB
1	0	54.3	7.8	1.1	2.6
2	1	54.3	5.6	3.3	2.6
3	2	54.7	*	*	*
4	3	54.6	*	*	*
5	4	54.7	*	*	*
6	5	54.7	7.5	2.5	3.4
7	6	54.6	*	*	*
8	7	55.2	*	*	*
9	8	55.2	*	*	*
10	9	55.0	*	*	*
11	10	54.8	7.8	2.2	4.6
12	15	54.2	4.4	1.1	2.6
13	20	55.1	3.3	2.2	2.6
14	25	55.0	*	*	*
15	30	55.1	*	*	*
16	40	54.5	4.0	0.0	2.6
17	60	54.5	3.0	1.0	3.4

ST CLAIR RIVER
PASSAGE #6
DATE AUG. 22, 1983
SUMMER 1
CLOCK TIME AT 0 MINUTES 1323
SHIP: H. M. GRIFFITH
DIRECTION: DOWNBOUND

ROW	TIME	TRANS	TSS	VSS	TURB
1	0	54.4	*	*	*
2	1	54.1	2	1	3.4
3	2	53.8	*	*	*
4	3	54.0	*	*	*
5	4	54.4	*	*	*
6	5	54.8	3	1	3.3
7	6	54.9	*	*	*
8	7	54.6	*	*	*
9	8	54.3	*	*	*
10	9	54.3	*	*	*
11	10	54.2	3	1	2.4
12	15	54.4	2	1	2.1
13	20	53.8	1	2	2.3
1343 "ALGOSOO" UPBOUND					
1344 "ST CLAIR" DOWNBOUND					
14	25	54.1	*	*	*
15	30	52.7	*	*	*
16	40	52.3	2	0	3.9
17	60	50.7	2	0	2.6

Table A2. Ship passage data runs during winter 1. April 1984

*** Detroit River only ***

RUN NO.	DAY OF MO.	START TIME	SHIP NAME	UP OR DOWN RIVER	LENGTH FEET	WIDTH FEET	DRAFT FEET	EST SPEED MPH	GROSS DISPL TONS
D1	18	0900	STOLT CASTLE	UP	520	73	EMPTY	*	29365
D2	18	1130	EDWARD B. GREENE	DOWN	767	70	10	*	26640
D3	18	1415	AMALIA	UP	525	70	*	*	22830
D4	19	1430	ROYALTON	DOWN	550	58	24	*	12200
D5	20	1235	FRED R. WHITE, JR.	DOWN	635	68	28	*	23800
D6	20	1330	ERNEST R. BREECH	DOWN	642	67	25	*	18500

DETROIT RIVER
PASSAGE #1
DATE APR. 18, 1984
WINTER 1
CLOCK TIME AT 0 MINUTES 0900
SHIP: STOLT CASTLE
DIRECTION: UPBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	32.7	*	*	*
2	0	32.6	5.9	3.5	2.9
3	1	32.7	*	*	*
4	2	32.7	*	*	*
5	3	32.6	*	*	*
6	4	32.7	*	*	*
7	5	32.9	7.8	3.3	2.8
8	10	33.0	9.4	4.7	3.0
9	15	31.5	8.9	2.2	3.5
10	20	32.5	*	*	*

DETROIT RIVER
PASSAGE #2
DATE APR. 18, 1984
WINTER 1
CLOCK TIME AT 0 MINUTES 1130
SHIP: CONRAD B. GREEN
DIRECTION: DOWNBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	*	7.8	2.2	3.6
2	0	*	3.3	2.2	3.6
3	1	36.0	7.8	1.1	3.6
4	2	36.0	*	*	*
5	3	35.6	*	*	*
6	4	35.8	*	*	*
7	5	35.5	5.7	2.2	3.2
8	10	35.0	5.6	0.0	4.2
9	15	35.5	12.0	6.0	1.9
10	20	35.2	5.6	2.2	3.7

DETROIT RIVER
PASSAGE #3
DATE APR. 18, 1984
WINTER 1
CLOCK TIME AT 0 MINUTES 1415
SHIP: AMAZONIA
DIRECTION: UPBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	36.0	8.6	2.9	2.7
2	0	35.7	7.5	2.5	3.9
3	1	35.6	3.6	3.6	2.9
4	2	36.0	8.9	2.2	3.8
5	3	35.4	*	*	*
6	4	35.7	*	*	*
7	5	34.9	5.6	1.1	3.3
8	10	36.2	6.7	3.3	3.9
9	15	36.2	8.9	1.1	4.1
10	20	36.0	8.9	3.3	4.0

DETROIT RIVER
PASSAGE #4
DATE APR. 19, 1984
WINTER 1
CLOCK TIME AT 0 MINUTES 1430
SHIP: ROYALTON
DIRECTION: DOWNBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	41.5	7.3	1.8	2.1
2	0	41.0	9.1	5.5	2.6
3	1	41.3	8.0	8.0	1.6
4	2	41.3	8.0	4.0	1.3
5	3	41.8	*	*	*
6	4	41.1	*	*	*
7	5	41.0	6.7	1.1	2.6
1435 "CANADIAN LEADER" DOWNBOUND					
8	10	41.0	5.6	0.0	3.7
9	15	41.0	5.6	2.2	2.5
10	20	41.0	6.7	0.0	1.4

DETROIT RIVER
PASSAGE #5
DATE APR. 20, 1984
WINTER 1
CLOCK TIME AT 0 MINUTES 1235
SHIP: FRED R. WHITE
DIRECTION: DOWNBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	40.7	3.3	3.3	2.3
2	0	40.9	6.7	3.3	3.0
3	1	40.6	9.1	0.0	1.6
4	2	40.6	2.2	0.0	3.3
5	3	40.7	*	*	*
1238 "ALBERTA" UPBOUND					
6	4	41.0	*	*	*
7	5	41.0	7.7	4.6	2.3
8	10	41.1	4.3	2.9	2.0
9	15	40.6	8.7	5.0	3.1
1250 "JOHN A. FRANCE"					
10	20	41.0	3.3	0.0	2.9

DETROIT RIVER
PASSAGE #6
DATE APR. 20, 1984
WINTER 1
CLOCK TIME AT 0 MINUTES 1330
SHIP: ERNEST R. BEECH
DIRECTION: DOWNBOUND

ROW	.TIME.	.TRANS.	.TSS.	.VSS.	.TURB.
1	0	37.8	*	*	*
2	0	37.5	4.4	3.3	2.7
3	1	37.0	8.6	0.0	2.8
4	2	37.1	6.3	1.3	3.9
5	3	36.0	*	*	*
6	4	35.0	*	*	*
7	5	36.0	5.6	3.3	3.3
8	10	33.9	7.4	2.1	3.8
9	15	31.2	6.7	1.1	4.0
10	20	*	*	*	*

Table A3. Ship passage data runs during summer 2. August 1984

D for Detroit River, S for St. Clair River

RUN NO.	DAY OF MO.	START TIME	SHIP NAME	UP OR DOWN RIVER	LENGTH FEET	WIDTH FEET	DRAFT FEET	EST SPEED MPH	GROSS DISPL TONS
D1	20	1245	CALCITE II	DOWN	604	50	22	*	12991
D2	20	1412	CONSUMERS POWER	UP	600	60	20	*	8217
D3	20	1510	LAWRENCE-CLIFFE HALL	UP	730	75	22	*	27738
D4	21	0845	MURRAY BAY	DOWN	730	75	26	*	27400
D5	21	0955	ST. CLAIR	DOWN	770	92	23	*	40044
D6	21	1134	JEAN PARISIEN	DOWN	730	75	28	*	32800
S1	23	0955	S. T. CRAPO	DOWN	420	60	*	*	9000
S2	23	1112	FRED R. WHITE	UP	635	68	18	*	23800
S3	23	1209	CANADOC	DOWN	606	62	24	*	15900
S4	24	0833	ISLAND TRANSPORT	DOWN	349	43	*	*	5902
S5	24	0954	WOLVERINE	DOWN	630	68	27	*	19800
S6	24	1152	FRONTENAC	DOWN	730	75	*	*	26370

DETROIT RIVER
PASSAGE #1
DATE AUG. 20, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES 1245
SHIP: CALCITE 2
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	0.0	0.00	0.0	38.0	6.0	9.6
2	2	0.0	0.00	0.0	44.0	6.0	20.0
3	3	0.0	0.00	0.0	*	*	*
4	4	11.6	2.15	22.0	*	*	*
5	5	10.9	-2.05	22.9	*	*	*
6	6	10.4	6.70	20.2	*	*	*
7	7	10.7	6.20	20.3	*	*	*
8	8	11.8	6.50	20.3	*	*	*
9	9	10.0	6.30	20.2	*	*	*
10	10	10.5	6.15	20.3	*	*	*
11	11	10.5	6.10	20.3	21.3	2.6	14.0
12	12	13.1	5.85	20.3	*	*	*
13	13	11.6	6.15	20.3	*	*	*
14	14	12.6	6.15	20.3	*	*	*
15	15	12.5	5.80	20.3	*	*	*
16	16	10.7	6.05	20.3	24.0	6.0	14.0
17	17	11.4	6.30	20.3	*	*	*
18	18	12.4	6.10	20.3	*	*	*
19	19	10.0	6.00	20.3	*	*	*
20	20	10.6	6.10	20.3	*	*	*
21	21	11.1	5.85	20.3	24.0	0.0	17.0
22	22	11.7	5.95	20.3	*	*	*
23	23	11.6	6.10	20.4	*	*	*
24	24	12.2	5.90	20.3	*	*	*
25	25	10.9	6.10	20.3	*	*	*
26	26	12.8	5.90	20.3	*	*	*
27	27	12.9	6.10	20.3	*	*	*
28	28	11.2	5.90	20.3	*	*	*
29	29	11.8	5.90	20.3	*	*	*
30	30	12.2	5.65	20.3	*	*	*
1315	"GEORGE A. STINSON" DOWNBOUND						
31	31	11.0	5.85	20.3	26.0	8.0	18.0
32	32	11.3	5.90	20.3	*	*	*
33	33	10.3	5.90	20.3	*	*	*
1318	"JOHN J. BOLAND" UPBOUND						
34	34	10.6	5.70	20.2	*	*	*
35	35	10.6	5.45	20.3	*	*	*
36	36	10.4	5.90	20.3	*	*	*
37	37	11.6	7.80	20.3	*	*	*
38	38	10.4	5.65	20.3	*	*	*
39	39	11.0	6.35	20.3	*	*	*
40	40	11.8	6.50	20.3	*	*	*
41	41	12.5	6.15	20.3	*	*	*
42	42	9.4	4.80	20.3	*	*	*
43	43	10.5	5.55	20.3	*	*	*
44	44	10.5	5.55	20.3	*	*	*
45	45	11.2	5.80	20.3	*	*	*
46	46	10.5	5.80	20.3	*	*	*
47	47	11.3	5.95	20.3	*	*	*
48	48	10.4	5.80	20.3	*	*	*
49	49	10.9	5.60	20.3	*	*	*
50	50	11.5	5.95	20.3	*	*	*
51	51	10.9	6.00	20.3	*	*	*
52	52	10.6	5.70	20.3	*	*	*
53	53	11.8	5.35	20.3	*	*	*
54	54	10.6	5.55	20.3	*	*	*
55	55	9.7	5.55	20.2	*	*	*
56	56	9.5	5.55	20.2	*	*	*
57	57	7.9	5.55	20.1	*	*	*
58	58	9.4	5.50	20.2	*	*	*
59	59	7.0	5.65	20.1	*	*	*
60	60	8.6	5.80	20.1	*	*	*

DETROIT RIVER
PASSAGE #2
DATE AUG. 20, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES 1412
SHIP: CONSUMERS POWER
DIRECTION: UPBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	8.3	6.55	20.2	32.0	8.0	15
2	2	8.7	6.35	20.2	30.0	6.6	18
3	3	8.4	6.45	20.2	160.0	26.6	73
4	4	9.2	6.40	20.2	*	*	*
5	5	9.5	6.55	20.2	*	*	*
6	6	8.5	6.30	20.2	*	*	*
7	7	8.9	6.60	20.2	*	*	*
8	8	9.8	6.45	20.2	*	*	*
9	9	11.5	6.60	20.3	*	*	*
10	10	8.9	6.30	20.2	*	*	*
11	11	9.9	6.50	20.2	33.3	*	17
12	12	8.0	6.75	20.2	*	*	*
13	13	11.0	6.25	20.2	*	*	*
14	14	10.1	6.35	20.2	*	*	*
15	15	9.5	6.40	20.2	*	*	*
16	16	8.7	6.15	20.1	32.0	4.0	22
17	17	8.7	6.30	20.2	*	*	*
18	18	8.6	6.30	20.2	*	*	*
19	19	8.8	6.25	20.2	*	*	*
20	20	9.3	6.30	20.2	*	*	*
21	21	8.8	6.70	20.2	30.0	6.0	18
22	22	9.1	6.50	20.2	*	*	*
23	23	9.6	6.25	20.2	*	*	*
24	24	9.3	6.50	20.2	*	*	*
25	25	9.2	6.80	20.2	*	*	*
26	26	9.8	6.45	20.2	*	*	*
27	27	9.8	6.15	20.2	*	*	*
28	28	10.2	6.35	20.3	*	*	*
29	29	9.3	6.35	20.2	*	*	*
30	30	8.8	6.45	20.2	*	*	*
31	31	10.3	6.10	20.2	28.0	4.0	17
32	32	9.0	6.60	20.2	*	*	*
33	33	9.6	6.30	20.2	*	*	*
34	34	9.9	6.55	20.2	*	*	*
35	35	9.6	6.35	20.3	*	*	*
36	36	10.5	6.55	20.2	*	*	*
37	37	9.6	6.75	20.2	*	*	*
38	38	10.5	6.35	20.3	*	*	*
39	39	11.0	6.60	20.3	*	*	*
40	40	10.3	6.70	20.2	*	*	*
41	41	11.1	6.35	20.3	*	*	*
42	42	10.6	6.50	20.3	*	*	*
43	43	9.8	6.60	20.3	*	*	*
44	44	10.6	6.15	20.2	*	*	*
45	45	10.1	6.50	20.2	*	*	*
46	46	9.3	6.50	20.3	*	*	*
47	47	9.3	6.65	20.2	*	*	*
48	48	9.1	6.80	20.2	*	*	*
49	49	9.4	6.85	20.2	*	*	*
50	50	9.1	6.65	20.2	*	*	*
51	51	8.9	6.75	20.2	*	*	*
52	52	9.8	6.35	20.2	*	*	*
53	53	9.3	6.70	20.2	*	*	*
54	54	9.6	6.80	20.2	*	*	*
55	55	10.0	6.80	20.2	*	*	*
56	56	0.0	0.00	0.0	*	*	*
57	57	0.0	0.00	0.0	*	*	*
58	58	0.0	0.00	0.0	*	*	*
59	59	0.0	0.00	0.0	*	*	*
60	60	0.0	0.00	0.0	*	*	*

DETROIT RIVER
PASSAGE #3
DATE AUG. 20, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES 1510
SHIP: LAWRENCE CLIFFE HALL
DIRECTION: UPBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	9.1	6.15	20.2	10.0	0	11
2	2	8.4	5.55	20.2	30.0	6	20
3	3	8.7	6.15	20.2	93.3	10	48
4	4	9.1	6.25	20.2	*	*	*
5	5	9.7	6.40	20.2	*	*	*
6	6	9.4	6.80	20.2	*	*	*
7	7	9.1	6.55	20.2	*	*	*
8	8	9.7	6.60	20.2	*	*	*
9	9	9.9	6.05	20.2	*	*	*
10	10	9.6	6.50	20.2	*	*	*
11	11	10.0	6.60	20.2	34.0	6	16
12	12	9.8	6.35	20.2	*	*	*
13	13	9.8	6.55	20.2	*	*	*
14	14	9.4	6.25	20.2	*	*	*
15	15	9.7	6.25	20.2	*	*	*
16	16	9.8	6.30	20.2	28.0	0	17
17	17	10.2	6.40	20.2	*	*	*
18	18	10.2	6.50	20.2	*	*	*
19	19	10.2	6.35	20.2	*	*	*
20	20	11.3	6.30	20.3	*	*	*
21	21	10.1	6.50	20.3	24.0	2	14
22	22	12.5	6.30	20.2	*	*	*
23	23	10.3	6.70	20.2	*	*	*
24	24	12.1	6.45	20.3	*	*	*
25	25	9.6	6.25	20.2	*	*	*
26	26	9.1	6.35	20.2	*	*	*
27	27	9.4	6.65	20.2	*	*	*
28	28	9.4	6.95	20.2	*	*	*
29	29	9.6	6.85	20.3	*	*	*
30	30	9.9	6.50	20.2	*	*	*
31	31	9.1	6.55	20.2	25.0	0	14
32	32	10.5	6.10	20.2	*	*	*
33	33	10.5	6.10	20.2	*	*	*
34	34	9.9	6.45	20.2	*	*	*
35	35	9.5	6.45	20.2	*	*	*
36	36	8.7	6.10	20.2	*	*	*
37	37	8.8	6.95	20.2	*	*	*
38	38	9.1	6.90	20.2	*	*	*
39	39	9.8	6.80	20.2	*	*	*
40	40	9.9	6.80	20.2	*	*	*
41	41	9.3	6.95	20.2	*	*	*
42	42	12.2	6.45	20.2	*	*	*
43	43	9.8	6.25	20.2	*	*	*
44	44	12.1	6.15	20.2	*	*	*
45	45	9.8	6.40	20.2	*	*	*
46	46	9.8	6.35	20.2	*	*	*
47	47	10.3	6.35	20.2	*	*	*
48	48	9.7	6.55	20.2	*	*	*
49	49	9.6	6.60	20.2	*	*	*
50	50	9.8	6.50	20.2	*	*	*
51	51	11.6	6.50	20.2	*	*	*
52	52	9.5	6.45	20.2	*	*	*
53	53	9.7	6.10	20.2	*	*	*
54	54	9.6	6.40	20.1	*	*	*
55	55	10.8	6.35	20.2	*	*	*
56	56	10.2	6.25	20.1	*	*	*
57	57	10.6	6.50	20.2	*	*	*
58	58	10.2	6.60	20.2	*	*	*
59	59	10.7	6.60	20.2	*	*	*
60	60	10.4	6.25	20.2	*	*	*

DETROIT RIVER
PASSAGE #4
DATE AUG. 21, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES 0845
SHIP: MURRAY BAY
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	16.7	6.50	22.6	26	8	6.2
2	2	16.7	9.90	22.5	14	0	6.1
3	3	16.9	4.45	22.6	16	4	6.5
4	4	16.4	6.55	20.1	*	*	*
5	5	16.7	6.95	20.1	*	*	*
6	6	16.6	6.80	20.1	13	6	7.4
7	7	16.2	6.75	20.1	*	*	*
8	8	16.6	6.75	20.1	*	*	*
9	9	17.2	6.90	20.2	*	*	*
10	10	17.2	6.75	20.2	*	*	*
11	11	17.4	6.60	20.2	6	4	6.0
12	12	16.4	6.45	20.1	*	*	*
13	13	17.4	6.70	20.2	*	*	*
14	14	17.6	6.75	20.1	*	*	*
15	15	17.3	6.85	20.1	*	*	*
16	16	17.1	6.65	20.2	10	2	6.3
17	17	17.1	7.05	20.2	*	*	*
18	18	17.8	6.75	20.1	*	*	*
19	19	18.0	6.95	20.1	*	*	*
20	20	17.7	7.00	20.1	*	*	*
21	21	17.8	7.10	20.1	8	0	6.4
22	22	17.6	6.95	20.1	*	*	*
0907 "COLUMBIA STAR" UPBOUND							
23	23	17.9	6.95	20.1	*	*	*
24	24	17.8	5.60	20.1	*	*	*
25	25	17.7	6.20	20.1	*	*	*
26	26	18.6	6.15	20.2	*	*	*
27	27	18.1	6.45	20.2	*	*	*
28	28	17.7	6.90	20.2	*	*	*
29	29	16.8	6.40	20.1	*	*	*
30	30	17.1	6.85	20.1	*	*	*
31	31	17.6	6.50	20.1	10	0	6.9
32	32	17.8	6.35	20.2	*	*	*
33	33	18.0	6.65	20.2	*	*	*
34	34	17.3	7.05	20.2	*	*	*
35	35	15.0	6.55	20.0	*	*	*
36	36	16.3	6.35	20.1	*	*	*
37	37	16.0	6.80	20.1	*	*	*
38	38	16.0	5.50	20.1	*	*	*
39	39	16.3	5.00	20.1	*	*	*
40	40	16.6	5.15	20.1	*	*	*
41	41	17.0	4.55	20.1	*	*	*
42	42	16.6	4.50	20.1	*	*	*
43	43	13.9	3.20	20.1	*	*	*
44	44	17.7	7.45	20.1	*	*	*
45	45	2.6	0.00	0.0	*	*	*
0930 "MONTREALIS' DOWNBOUND							
46	46	17.1	6.35	20.1	*	*	*
47	47	16.9	6.40	20.1	*	*	*
48	48	16.8	6.35	20.1	*	*	*
49	49	16.4	6.25	20.1	*	*	*
50	50	16.7	6.20	20.1	*	*	*
51	51	17.3	6.25	20.1	*	*	*
52	52	16.7	6.40	20.1	*	*	*
53	53	17.4	6.65	20.1	*	*	*
54	54	17.6	6.75	20.1	*	*	*
55	55	16.7	6.45	20.1	*	*	*
56	56	16.9	6.35	20.1	*	*	*
57	57	16.6	6.70	20.1	*	*	*
58	58	17.2	6.80	20.2	*	*	*
59	59	17.0	6.85	20.1	*	*	*
60	60	16.5	6.65	20.1	*	*	*

DETROIT RIVER
PASSAGE #5
DATE AUG. 21, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES 0955
SHIP: ST. CLAIR
DIRECTION: DOUNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	17.8	6.80	20.1	10	2	5.7
2	2	17.7	7.00	20.2	6	0	6.6
3	3	17.4	6.60	20.1	16	0	7.3
4	4	18.1	6.40	20.1	*	*	*
5	5	18.3	6.75	20.1	*	*	*
6	6	18.4	6.70	20.1	*	*	*
7	7	18.3	6.65	20.1	*	*	*
8	8	17.1	6.65	20.1	*	*	*
9	9	17.3	6.55	20.1	*	*	*
10	10	17.4	6.75	20.1	*	*	*
11	11	17.6	6.90	20.1	14	0	6.5
12	12	18.1	6.40	20.2	*	*	*
13	13	17.9	6.50	20.2	*	*	*
14	14	16.7	6.75	20.1	*	*	*
15	15	17.1	6.70	20.1	*	*	*
16	16	16.6	6.75	20.1	10	0	4.0
17	17	16.0	6.55	20.1	*	*	*
18	18	15.6	6.55	20.1	*	*	*
19	19	15.7	6.85	20.1	*	*	*
20	20	16.5	6.70	20.1	*	*	*
21	21	16.0	6.55	20.1	8	0	6.2
1026	BOBLO BOAT	DOWNBOUND					
22	22	16.3	4.20	22.0	*	*	*
23	23	16.9	5.65	22.2	*	*	*
1029	"SAGUENAY"	UPBOUND					
24	24	16.2	5.20	20.1	*	*	*
25	25	16.8	6.35	20.1	*	*	*
26	26	16.6	6.55	20.1	*	*	*
27	27	17.2	6.65	20.1	*	*	*
28	28	17.7	6.55	20.2	*	*	*
29	29	17.4	6.65	20.1	*	*	*
30	30	17.3	6.55	20.1	*	*	*
31	31	17.7	6.65	20.1	10	0	6.1
32	32	17.6	6.40	20.1	*	*	*
33	33	17.6	6.20	20.1	*	*	*
34	34	17.8	6.55	20.1	*	*	*
35	35	17.8	6.40	20.1	*	*	*
36	36	17.6	6.70	20.1	*	*	*
37	37	17.1	6.35	20.1	*	*	*
38	38	16.0	5.95	20.1	*	*	*
39	39	16.6	6.35	20.1	*	*	*
40	40	16.4	6.40	20.1	*	*	*
41	41	16.4	6.10	20.0	*	*	*
42	42	16.8	6.50	20.1	*	*	*
43	43	15.9	6.70	20.0	*	*	*
44	44	16.0	6.80	20.1	*	*	*
45	45	16.4	6.55	20.1	*	*	*
46	46	16.6	6.55	20.1	*	*	*
47	47	16.7	6.75	20.1	*	*	*
48	48	17.2	6.60	20.1	*	*	*
49	49	16.8	6.75	20.1	*	*	*
50	50	16.8	6.70	20.1	*	*	*
51	51	16.6	6.50	20.1	*	*	*
52	52	16.7	6.60	20.1	*	*	*
53	53	16.7	6.40	20.0	*	*	*
54	54	17.0	6.45	20.1	*	*	*
55	55	16.9	6.15	20.1	*	*	*
56	56	16.6	6.30	20.1	*	*	*
57	57	15.9	6.50	20.0	*	*	*
58	58	16.1	6.50	20.0	*	*	*
59	59	15.9	6.35	20.0	*	*	*
60	60	17.0	6.80	20.1	*	*	*

DETROIT RIVER
PASSAGE #6
DATE AUG. 21, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES 1134
SHIP: JEAN PARISIEN
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	13.2	6.70	20.1	10	2	5.6
2	2	17.6	6.20	20.1	14	4	5.3
3	3	18.4	6.50	20.1	8	0	6.3
4	4	18.2	6.45	20.1	*	*	*
5	5	18.0	6.55	20.1	*	*	*
6	6	17.7	6.20	20.1	10	0	5.1
7	7	17.5	6.20	20.1	*	*	*
8	8	18.3	6.10	20.1	*	*	*
9	9	17.4	6.25	20.1	*	*	*
10	10	17.6	6.35	20.1	*	*	*
11	11	17.4	6.20	20.1	16	2	7.8
12	12	17.5	6.20	20.1	*	*	*
13	13	17.4	6.00	20.1	*	*	*
14	14	17.0	5.95	20.0	*	*	*
15	15	18.0	6.30	20.1	*	*	*
16	16	17.6	6.30	20.1	14	2	7.1
17	17	17.4	6.20	20.1	*	*	*
18	18	18.1	6.20	20.1	*	*	*
19	19	18.2	6.20	20.1	*	*	*
20	20	18.0	6.10	20.1	*	*	*
21	21	17.8	6.20	20.1	10	0	6.8
22	22	17.9	6.20	20.1	*	*	*
23	23	17.8	6.60	20.1	*	*	*
24	24	17.6	6.20	20.1	*	*	*
25	25	17.9	6.10	20.1	*	*	*
26	26	16.8	6.15	20.1	*	*	*
27	27	16.8	6.10	20.1	*	*	*
28	28	17.6	6.20	20.1	*	*	*
29	29	17.3	6.05	20.1	*	*	*
30	30	17.2	6.05	20.0	*	*	*
31	31	17.3	6.10	20.1	*	*	*
32	32	16.9	5.90	20.1	*	*	*
33	33	17.0	5.80	20.1	*	*	*
34	34	17.1	6.00	20.1	*	*	*
35	35	17.3	6.25	20.1	*	*	*
36	36	17.9	5.70	20.1	*	*	*
37	37	16.9	5.75	20.1	*	*	*
38	38	17.1	6.05	20.0	*	*	*
39	39	17.1	5.85	20.1	*	*	*
40	40	17.6	5.80	20.1	*	*	*
41	41	16.7	5.70	20.0	*	*	*
42	42	17.0	6.05	20.1	*	*	*
43	43	17.7	6.00	20.1	*	*	*
44	44	17.7	5.90	20.0	*	*	*
45	45	17.0	6.05	20.0	*	*	*
46	46	17.5	5.95	20.1	*	*	*
47	47	17.1	6.10	20.1	*	*	*
48	48	17.6	5.70	20.1	*	*	*
49	49	17.6	6.30	20.1	*	*	*
50	50	17.3	6.10	20.1	*	*	*
51	51	16.7	5.95	20.0	*	*	*
52	52	17.1	6.05	20.1	*	*	*
53	53	17.0	5.95	20.1	*	*	*
54	54	16.8	6.20	20.1	*	*	*
55	55	17.1	6.15	20.1	*	*	*
56	56	17.1	6.10	20.1	*	*	*
57	57	17.0	6.10	20.1	*	*	*
58	58	17.1	6.05	20.1	*	*	*
59	59	16.8	6.00	20.0	*	*	*
60	60	16.5	6.20	20.0	*	*	*

ST. CLAIR RIVER
PASSAGE #1
DATE AUG. 23, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES 0905
SHIP: S. T. CRAPC
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	42.1	6.90	18.9	9.3	1.3	3.1
2	2	42.1	6.70	18.9	12.0	1.3	3.3
3	3	41.9	6.90	18.9	*	*	*
4	4	42.2	7.10	18.9	*	*	*
5	5	42.0	*	*	*	*	*
1000	"ERNEST R. BEECH" DOWNBOUND						
6	6	42.0	6.60	18.9	8.0	2.7	3.2
7	7	41.8	6.55	18.9	*	*	*
8	8	42.2	6.80	18.9	*	*	*
9	9	41.4	6.40	18.9	*	*	*
10	10	42.1	6.90	18.9	*	*	*
11	11	42.4	6.80	19.0	10.7	2.7	3.3
12	12	42.1	6.85	18.9	*	*	*
13	13	42.4	6.75	18.9	*	*	*
14	14	42.2	7.35	18.9	*	*	*
15	15	42.1	6.45	18.9	*	*	*
16	16	41.9	7.10	18.9	9.3	0.0	3.3
17	17	41.6	7.05	19.0	*	*	*
18	18	41.9	7.05	18.9	*	*	*
19	19	42.2	7.05	18.9	*	*	*
20	20	42.1	7.25	18.9	*	*	*
21	21	41.5	7.25	18.9	4.0	0.0	3.7
22	22	41.8	7.05	18.9	*	*	*
23	23	42.4	6.70	18.9	*	*	*
24	24	41.8	6.55	18.9	*	*	*
25	25	42.3	6.80	18.9	*	*	*
26	26	42.7	7.00	18.9	*	*	*
27	27	42.0	6.70	19.0	*	*	*
28	28	42.0	6.65	18.9	*	*	*
29	29	41.2	6.85	18.9	*	*	*
30	30	40.5	6.85	18.9	*	*	*
1025	"BUFFALO" DOWNBOUND						
31	31	40.6	6.75	19.0	*	*	*
32	32	41.7	6.60	19.0	*	*	*
33	33	40.6	6.90	18.9	*	*	*
34	34	41.6	6.70	18.9	*	*	*
35	35	41.4	6.80	18.9	*	*	*
36	36	42.1	6.30	18.9	*	*	*
37	37	41.5	7.00	18.9	*	*	*
38	38	41.9	6.70	18.9	*	*	*
39	39	42.4	6.55	18.9	*	*	*
40	40	42.3	6.75	18.9	*	*	*
41	41	41.7	6.75	18.9	*	*	*
42	42	41.8	6.70	18.9	*	*	*
43	43	41.5	7.15	18.9	*	*	*
44	44	41.4	6.85	18.9	*	*	*
45	45	41.4	6.55	18.9	*	*	*
46	46	41.6	6.10	18.9	*	*	*
47	47	41.5	6.80	18.9	*	*	*
48	48	41.5	6.95	19.0	*	*	*
49	49	41.5	6.60	18.9	*	*	*
50	50	41.3	10.65	20.4	*	*	*
51	51						
52	52						
53	53						
54	54						
55	55						
56	56						
57	57						
58	58						
59	59						
60	60						

ST. CLAIR RIVER
PASSAGE #2
DATE AUG. 23, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES 1112
SHIP: FRED R. WHITE JR.
DIRECTION: UPBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	40.5	6.70	18.9	12.0	2.7	3.7
2	2	40.3	6.85	18.9	9.3	4.0	3.6
3	3	40.0	6.95	18.9	6.7	2.7	3.2
4	4	40.3	6.90	18.9	*	*	*
5	5	40.3	7.05	18.9	*	*	*
6	6	39.9	6.90	18.9	*	*	*
7	7	39.4	6.95	18.9	*	*	*
8	8	39.6	6.70	19.0	*	*	*
9	9	39.4	7.15	18.9	*	*	*
10	10	39.4	7.15	19.0	*	*	*
11	11	39.4	6.70	18.9	*	*	*
12	12	40.0	6.85	18.9	*	*	*
13	13	39.2	7.25	18.9	*	*	*
14	14	39.5	6.50	18.9	*	*	*
15	15	39.7	7.00	18.9	*	*	*
16	16	39.7	6.70	18.9	9.3	2.7	3.6
17	17	38.3	7.00	18.9	*	*	*
18	18	38.5	7.05	18.9	*	*	*
19	19	38.7	7.05	18.9	*	*	*
20	20	38.4	7.35	18.9	*	*	*
21	21	39.6	6.85	19.0	6.7	0.0	2.7
22	22	38.9	6.85	18.9	*	*	*
23	23	40.1	6.60	18.9	*	*	*
24	24	39.4	7.05	18.9	*	*	*
25	25	39.2	6.70	18.9	*	*	*
26	26	39.1	6.90	19.0	*	*	*
27	27	38.8	7.40	18.9	*	*	*
28	28	39.3	6.85	18.9	*	*	*
29	29	39.3	6.60	19.0	*	*	*
30	30	39.3	6.80	18.9	*	*	*
31	31	38.9	6.95	18.9	9.3	2.7	4.1
32	32	38.8	6.80	19.0	*	*	*
33	33	38.7	7.20	18.9	*	*	*
34	34	39.1	6.45	18.9	*	*	*
35	35	39.1	6.95	19.0	*	*	*
36	36	38.9	7.35	19.0	*	*	*
37	37	39.3	6.80	18.9	*	*	*
38	38	39.0	6.90	19.0	*	*	*
39	39	39.0	6.25	18.9	*	*	*
40	40	38.9	6.60	18.9	*	*	*
41	41	38.2	6.50	19.0	*	*	*
42	42	39.1	6.40	18.9	*	*	*
43	43	39.0	6.60	19.0	*	*	*
44	44	38.7	6.35	19.0	*	*	*
45	45	38.7	6.75	19.0	*	*	*
46	46	38.6	6.95	18.9	*	*	*
47	47	38.6	6.75	18.9	*	*	*
1159 "RAPH MISENER" DOWNBOUND							
48	48	38.5	6.95	18.9	*	*	*
49	49	38.6	6.70	18.9	*	*	*
50	50	38.9	6.25	19.0	*	*	*
51	51	38.5	6.75	18.9	*	*	*
52	52	38.3	6.65	19.0	*	*	*
53	53	38.3	6.95	19.0	*	*	*
54	54	38.5	6.65	18.9	*	*	*
55	55	37.5	6.35	19.0	*	*	*
56	56	37.3	6.85	19.0	*	*	*
57	57	37.4	7.00	19.0	*	*	*
58	58	0.0	0.00	0.0	*	*	*
59	59	0.0	0.00	0.0	*	*	*
60	60	0.0	0.00	0.0	*	*	*

ST. CLAIR RIVER
PASSAGE #3
DATE AUG. 23, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES 1209
SHIP: CANADOC
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	37.9	7.10	18.9	9.3	2.7	4.0
2	2	37.3	7.30	18.9	10.7	2.7	5.0
3	3	38.5	6.75	18.9	12.0	1.3	4.2
4	4	38.6	6.55	18.9	*	*	*
5	5	38.5	7.00	18.9	*	*	*
6	6	38.8	7.05	18.9	9.3	4.0	3.4
7	7	38.6	6.90	18.9	*	*	*
8	8	38.3	7.05	18.9	*	*	*
9	9	38.7	6.35	19.0	*	*	*
10	10	38.4	6.35	19.0	*	*	*
11	11	37.7	7.05	19.0	8.0	1.3	3.9
12	12	38.2	6.70	19.0	*	*	*
13	13	38.1	6.75	18.9	*	*	*
14	14	38.3	6.70	19.0	*	*	*
15	15	37.5	6.65	19.0	*	*	*
16	16	37.5	6.90	18.9	*	*	*
17	17	38.3	6.30	18.9	*	*	*
18	18	38.1	6.75	18.9	*	*	*
19	19	38.2	6.55	18.9	*	*	*
20	20	38.3	6.60	19.0	*	*	*
21	21	38.1	6.55	19.0	10.7	2.7	3.8
22	22	37.9	7.05	18.9	*	*	*
23	23	37.3	6.90	18.9	*	*	*
24	24	37.8	6.85	18.9	*	*	*
25	25	38.0	6.75	19.0	*	*	*
26	26	37.3	6.45	19.0	*	*	*
27	27	36.9	6.60	19.0	*	*	*
28	28	36.4	6.70	19.0	*	*	*
29	29	36.2	6.70	19.0	*	*	*
30	30	36.3	6.55	19.0	*	*	*
31	31	36.5	6.75	19.0	12.0	0.0	3.9
32	32	36.8	6.55	19.0	*	*	*
33	33	37.1	6.75	18.9	*	*	*
34	34	36.8	6.85	19.0	*	*	*
35	35	37.6	6.40	18.9	*	*	*
36	36	37.6	6.65	18.9	*	*	*
37	37	37.6	6.75	19.0	*	*	*
38	38	37.9	6.40	18.9	*	*	*
39	39	38.1	7.05	18.9	*	*	*
40	40	37.9	6.85	18.9	*	*	*
41	41	38.0	6.15	18.9	*	*	*
42	42	37.6	6.55	18.9	*	*	*
43	43	37.2	6.70	18.9	*	*	*
44	44	36.6	6.45	18.9	*	*	*
45	45	37.0	6.85	18.9	*	*	*
46	46	37.2	6.95	18.9	*	*	*
47	47	37.5	6.65	18.9	*	*	*
48	48	37.1	6.30	19.0	*	*	*
49	49	37.0	6.65	18.9	*	*	*
50	50	37.0	6.60	18.9	*	*	*
51	51	36.9	6.70	18.9	*	*	*
52	52	37.2	6.95	18.9	*	*	*
53	53	37.9	6.55	18.9	*	*	*
54	54	37.5	6.70	18.9	*	*	*
55	55	37.6	6.65	18.9	*	*	*
56	56	37.5	7.25	19.0	*	*	*
57	57	37.6	6.95	18.9	*	*	*
58	58	37.5	6.95	19.0	*	*	*
59	59	37.3	6.65	19.0	*	*	*
60	60	37.5	6.80	19.0	*	*	*

ST. CLAIR RIVER
PASSAGE #4
DATE AUG. 24, 1985
SUMMER 2
TIME AT 0 MINUTES 0333
SHIP: ISLAND TRANSPORT
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	0.0	0.00	0.0	24	4	5.2
2	2	21.6	6.75	18.4	24	0	4.4
3	3	20.0	6.85	18.4	22	10	5.6
4	4	22.0	6.65	18.4	*	*	*
5	5	22.3	6.90	18.4	*	*	*
6	6	20.4	6.80	18.4	28	2	4.7
7	7	20.7	7.00	18.4	*	*	*
8	8	21.0	6.70	18.4	*	*	*
9	9	20.5	6.50	18.4	*	*	*
10	10	22.0	6.55	18.4	*	*	*
11	11	21.1	6.85	18.4	18	4	4.2
12	12	21.8	6.65	18.4	*	*	*
13	13	21.1	6.65	18.4	*	*	*
14	14	22.8	6.25	18.4	*	*	*
15	15	21.6	6.70	18.4	*	*	*
16	16	20.9	6.85	18.4	20	6	4.6
17	17	20.7	6.70	18.4	*	*	*
18	18	20.6	6.65	18.4	*	*	*
19	19	21.1	6.85	18.4	*	*	*
20	20	21.9	6.65	18.4	*	*	*
21	21	22.0	6.50	18.4	18	2	4.4
22	22	21.0	6.80	18.4	*	*	*
23	23	21.2	6.95	18.4	*	*	*
24	24	21.9	6.60	18.4	*	*	*
25	25	21.0	6.75	18.4	*	*	*
26	26	21.4	7.15	18.4	*	*	*
27	27	20.8	6.30	18.4	*	*	*
28	28	21.1	6.65	18.4	*	*	*
29	29	21.2	6.55	18.4	*	*	*
30	30	20.2	6.75	18.5	*	*	*
31	31	19.6	6.20	18.4	14	0	4.1
32	32	20.3	6.60	18.4	*	*	*
33	33	20.7	6.60	18.4	*	*	*
34	34	21.6	6.60	18.5	*	*	*
35	35	22.2	6.40	18.4	*	*	*
36	36	20.9	6.55	18.4	*	*	*
C909	"SENNEVILL	DOWNBOUND					
37	37	20.6	6.70	18.4	*	*	*
38	38	20.6	6.50	18.4	*	*	*
39	39	21.2	7.05	18.4	*	*	*
40	40	21.4	6.50	18.4	*	*	*
41	41	21.0	6.70	18.4	*	*	*
42	42	20.5	6.95	18.4	*	*	*
43	43	20.3	6.60	18.4	*	*	*
44	44	20.8	6.95	18.4	*	*	*
45	45	21.1	6.30	18.4	*	*	*
46	46	22.1	6.55	18.4	*	*	*
47	47	20.6	6.55	18.4	*	*	*
48	48	20.7	7.35	18.4	*	*	*
49	49	21.5	6.90	18.4	*	*	*
C922	"SUNWARD 2"	DOWNBOUND					
50	50	21.4	6.70	18.4	*	*	*
C923	"T.R. MCLAGAN"	UPBOUND					
51	51	23.1	-1.85	21.1	*	*	*
52	52	23.8	13.30	21.4	*	*	*
53	53	21.6	-1.60	20.9	*	*	*
54	54	21.6	-0.35	20.7	*	*	*
55	55	21.8	6.45	18.4	*	*	*
56	56	21.3	6.80	18.4	*	*	*
57	57	21.4	6.80	18.4	*	*	*
58	58	22.3	7.20	18.4	*	*	*
59	59	20.6	7.05	18.4	*	*	*
60	60	21.3	6.55	18.4	*	*	*

ST. CLAIR RIVER
PASSAGE #5
DATE AUG. 24, 1984
SUMMER 2
TIME AT 0 MINUTES 0954
SHIP: WOLVERINE
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	9.5	2.65	2.5	18	2	5.0
2	2	21.6	7.00	18.4	24	0	4.1
3	3	22.0	6.90	18.4	26	2	4.7
4	4	21.3	6.65	18.4	*	*	*
5	5	21.0	6.65	18.4	*	*	*
6	6	20.6	6.95	18.4	18	6	4.6
7	7	20.5	6.70	18.4	*	*	*
8	8	20.5	6.65	18.4	*	*	*
9	9	20.3	6.95	18.4	*	*	*
10	10	22.0	6.65	18.4	*	*	*
11	11	20.5	6.70	18.4	20	6	4.4
12	12	21.6	6.45	18.4	*	*	*
1006	'SAM LAUD" UPBOUND						
13	13	21.3	6.95	18.4	*	*	*
14	14	21.7	5.95	18.4	*	*	*
15	15	21.5	6.60	18.4	*	*	*
16	16	21.6	6.40	18.5	26	2	5.1
17	17	20.3	6.65	18.4	*	*	*
18	18	20.3	7.00	18.4	*	*	*
19	19	22.2	6.85	18.4	*	*	*
20	20	21.1	6.90	18.5	*	*	*
21	21	21.7	6.35	18.4	20	2	4.2
22	22	20.9	6.60	18.4	*	*	*
23	23	21.3	6.95	18.5	*	*	*
24	24	20.9	6.45	18.5	*	*	*
25	25	20.9	6.70	18.4	*	*	*
26	26	20.4	6.65	18.5	*	*	*
27	27	20.8	6.65	18.5	*	*	*
28	28	20.1	6.40	18.4	*	*	*
29	29	20.9	6.70	18.4	*	*	*
30	30	20.7	6.90	18.4	*	*	*
31	31	21.2	6.25	18.4	22	2	4.5
32	32	22.5	6.55	18.4	*	*	*
33	33	23.5	6.60	18.4	*	*	*
34	34	22.4	6.05	18.5	*	*	*
35	35	20.9	6.35	18.5	*	*	*
36	36	21.9	6.75	18.5	*	*	*
37	37	21.3	6.60	18.5	*	*	*
38	38	20.4	6.30	18.5	*	*	*
39	39	21.5	6.70	18.4	*	*	*
40	40	21.2	6.40	18.5	*	*	*
41	41	21.0	6.80	18.5	*	*	*
42	42	22.3	6.60	18.5	*	*	*
43	43	21.5	6.55	18.5	*	*	*
44	44	21.9	6.60	18.4	*	*	*
45	45	21.6	6.40	18.5	*	*	*
46	46	21.7	6.30	18.4	*	*	*
47	47	21.3	6.50	18.5	*	*	*
48	48	20.8	6.30	18.5	*	*	*
49	49	21.2	6.60	18.5	*	*	*
50	50	21.4	6.50	18.5	*	*	*
51	51	21.4	6.15	18.5	*	*	*
52	52	21.4	7.10	18.4	*	*	*
53	53	20.7	7.05	18.5	*	*	*
54	54	21.6	6.90	18.5	*	*	*
55	55	21.9	6.65	18.4	*	*	*
56	56	21.3	6.65	18.5	*	*	*
57	57	21.9	6.85	18.5	*	*	*
58	58	22.0	6.65	18.5	*	*	*
59	59	22.0	6.45	18.5	*	*	*
60	60	21.6	6.50	18.5	*	*	*

ST.CLAIR RIVER
PASSAGE #6
DATE AUG. 20, 1984
SUMMER 2
CLOCK TIME AT 0 MINUTES
SHIP: FROUTUNAR
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	21.9	6.85	18.5	14	8	4.2
2	2	20.9	6.95	18.4	12	4	4.2
3	3	20.8	2.10	21.6	24	2	5.1
4	4	21.9	0.20	21.7	*	*	*
5	5	21.6	14.15	21.6	*	*	*
6	6	22.1	0.40	21.8	18	2	4.3
7	7	21.5	4.65	21.8	*	*	*
8	8	22.0	14.65	21.8	*	*	*
9	9	22.9	14.20	21.7	*	*	*
10	10	21.7	10.80	21.6	*	*	*
11	11	20.2	12.50	21.5	14	4	3.9
12	12	23.0	2.50	21.7	*	*	*
13	13	23.5	-3.10	21.8	*	*	*
14	14	22.6	4.05	21.7	*	*	*
15	15	22.5	3.35	21.6	*	*	*
16	16	21.9	-1.75	21.7	9	0	3.5
17	17	21.9	-3.20	21.8	*	*	*
18	18	21.8	-0.30	21.5	*	*	*
19	19	22.0	5.55	21.6	*	*	*
20	20	21.6	6.25	21.6	*	*	*
21	21	21.6	-1.30	21.5	12	4	4.3
22	22	21.9	20.90	21.5	*	*	*
23	23	21.9	15.65	21.7	*	*	*
24	24	22.8	3.00	21.5	*	*	*
25	25	23.1	-6.50	21.1	*	*	*
26	26	22.2	18.45	21.5	*	*	*
27	27	23.3	13.10	21.2	*	*	*
28	28	23.4	-1.95	21.5	*	*	*
29	29	22.6	8.60	21.7	*	*	*
30	30	21.7	-1.30	21.1	*	*	*
31	31	22.8	-1.60	21.3	20	6	4.4
32	32	22.4	4.60	21.5	*	*	*
33	33	22.0	-4.25	21.5	*	*	*
34	34	22.5	-2.05	21.7	*	*	*
35	35	21.8	-0.40	21.7	*	*	*
36	36	22.2	-5.40	21.7	*	*	*
37	37	21.5	-3.20	21.6	*	*	*
38	38	21.7	8.75	21.6	*	*	*
39	39	22.0	-1.70	21.7	*	*	*
40	40	23.0	13.60	21.6	*	*	*
41	41	21.8	0.60	21.5	*	*	*
42	42	22.7	9.15	21.5	*	*	*
43	43	22.1	-5.20	21.6	*	*	*
44	44	21.5	-2.35	21.6	*	*	*
45	45	21.4	1.90	21.6	*	*	*
46	46	21.3	-0.70	21.6	*	*	*
47	47	22.3	12.85	21.7	*	*	*
48	48	21.9	-1.35	21.3	*	*	*
49	49	22.5	-4.00	21.5	*	*	*
50	50	22.7	-7.00	21.5	*	*	*
51	51	23.4	-0.40	21.6	*	*	*
52	52	24.2	14.05	21.5	*	*	*
53	53	22.9	2.55	21.4	*	*	*
54	54	24.0	3.80	21.2	*	*	*
55	55	24.4	-4.10	21.5	*	*	*
56	56	23.3	-2.85	21.6	*	*	*
57	57	23.0	13.95	21.6	*	*	*
58	58	23.0	-0.10	21.6	*	*	*
59	59	23.1	-2.55	21.6	*	*	*
60	60	23.0	-2.65	21.7	*	*	*

Table A4. Ship passage data runs during winter 2. December 1984

D for Detroit River, S for St. Clair River

RUN NO.	DAY OF MO.	START TIME	SHIP NAME	UP OR DOWN RIVER	LENGTH FEET	WIDTH FEET	DRAFT FEET	EST SPEED MPH	GROSS DISPL TONS
D1	4	1005	IMPERIAL BEDFORD	DOWN	486	70	>20	*	*
D2	4	1355	SOREN TOUBRO	DOWN	*	*	>20	*	*
D3	5	0945	RICHARD J. REISS	DOWN	621	60	22	*	14100
D4	5	1041	S.T. CRAPO	DOWN	420	60	*	*	9000
D5	5	1129	SENATOR OF CANADA	UP	605	62	14	*	15250
D6	11	1015	CHARLES E. WILSON	DOWN	680	78	27	*	29300
S1	8	0940	WOLVERINE	DOWN	630	68	26	*	19800
S2	8	1108	AMERICAN MARINER	DOWN	728	78	*	*	*
S3	8	1235	DOAN TRANSPORT	DOWN	431	63	26	*	10729
S4	9	1039	WILLIAM R. ROESCH	DOWN	630	68	24	*	19800
S5	9	1157	INDUSTRIAL TRANSPORT	UP	391	55	15	*	8423
S6	9	1324	WILLIAM CLAY FORD	UP	767	70	16	*	25000

DERTCIT RIVER
PASSAGE #1
DATE DEC. 4, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 1005
SHIP: IMPERIAL BEDFORD
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	0.0	0.00	0.0	14	2	6.0
2	2	3.2	0.05	0.4	12	0	6.1
3	3	17.4	3.50	3.5	20	8	6.3
4	4	17.5	3.80	3.5	*	*	*
5	5	17.8	3.80	3.5	*	*	*
6	6	17.4	3.75	3.5	12	2	5.7
7	7	17.4	3.55	3.5	*	*	*
8	8	17.5	3.45	3.5	*	*	*
9	9	17.7	3.75	3.5	*	*	*
10	10	18.1	3.55	3.5	*	*	*
11	11	18.1	3.90	3.5	12	4	4.8
12	12	17.9	3.85	3.5	*	*	*
13	13	17.8	3.75	3.5	*	*	*
14	14	18.3	3.45	3.5	*	*	*
15	15	17.9	3.50	3.5	*	*	*
16	16	17.8	3.45	3.5	18	2	5.0
17	17	17.5	3.65	3.5	*	*	*
18	18	17.6	3.85	3.5	*	*	*
19	19	17.7	3.70	3.5	*	*	*
20	20	18.0	3.55	3.5	*	*	*
21	21	17.6	3.70	3.5	16	8	5.4
22	22	17.4	3.50	3.5	*	*	*
23	23	18.3	3.60	3.5	*	*	*
24	24	18.3	3.55	3.5	*	*	*
25	25	18.6	3.35	3.5	*	*	*
26	26	18.5	3.70	3.5	*	*	*
27	27	18.3	3.65	3.5	*	*	*
28	28	17.0	3.55	3.6	*	*	*
29	29	18.1	3.65	3.5	*	*	*
30	30	16.5	3.75	3.5	*	*	*
31	31	17.9	3.65	3.5	12	8	5.7
32	32	18.5	3.40	3.6	*	*	*
33	33	18.2	3.80	3.6	*	*	*
34	34	18.4	3.50	3.5	*	*	*
35	35	18.2	3.75	3.5	*	*	*
36	36	15.6	4.10	3.5	*	*	*
37	37	18.2	3.20	3.5	*	*	*
38	38	16.7	3.35	3.5	*	*	*
39	39	18.4	3.45	3.5	*	*	*
40	40	18.7	3.40	3.5	*	*	*
1425 "ROGER SIMON" DOWNBOUND							
41	41	16.9	3.55	3.5	*	*	*
42	42	17.9	3.55	3.5	*	*	*
43	43	18.5	3.50	3.5	*	*	*
44	44	17.7	3.20	3.5	*	*	*
45	45	18.4	3.60	3.5	*	*	*
1430 "PHILLIP CLARK" DOWNBOUND							
46	46	18.4	3.40	3.5	*	*	*
47	47	17.8	3.15	3.5	*	*	*
48	48	18.6	4.00	3.5	*	*	*
49	49	18.1	3.25	3.5	*	*	*
50	50	17.9	3.50	3.5	*	*	*
51	51	17.6	3.40	3.6	*	*	*
52	52	17.1	3.25	3.5	*	*	*
53	53	17.8	3.25	3.5	*	*	*
54	54	18.6	3.45	3.5	*	*	*
55	55	18.4	3.40	3.5	*	*	*
56	56	18.5	3.40	3.5	*	*	*
57	57	18.1	3.50	3.5	*	*	*
58	58	17.5	3.40	3.5	*	*	*
59	59	17.8	3.55	3.5	*	*	*
60	60	18.5	3.30	3.6	*	*	*

DETROIT RIVER
PASSAGE #2
DATE DEC. 4, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 1355
SHIP: SOREN TOUBRO
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	18.1	3.80	3.3	20.0	8.0	6.3
2	2	17.6	3.55	3.3	17.3	4.0	5.8
3	3	18.2	3.85	3.3	20.0	4.0	5.7
4	4	15.1	3.55	3.3	*	*	*
5	5	17.8	3.40	3.3	*	*	*
6	6	17.9	3.60	3.3	10.6	4.0	5.9
7	7	18.3	3.60	3.3	*	*	*
8	8	18.0	3.50	3.3	*	*	*
9	9	18.3	3.50	3.3	*	*	*
10	10	18.0	3.70	3.4	*	*	*
11	11	17.9	3.60	3.3	16.0	1.3	6.2
12	12	17.8	3.45	3.3	*	*	*
13	13	15.1	3.65	3.3	*	*	*
14	14	17.7	3.75	3.3	*	*	*
15	15	17.8	3.65	3.3	*	*	*
16	16	18.1	3.65	3.3	10.0	6.0	6.3
17	17	17.8	3.75	3.3	*	*	*
18	18	18.0	3.65	3.3	*	*	*
19	19	18.0	3.75	3.3	*	*	*
20	20	18.3	3.50	3.3	*	*	*
21	21	16.4	3.70	3.3	20.0	5.3	7.0
22	22	18.0	3.45	3.3	*	*	*
23	23	17.6	3.60	3.3	*	*	*
24	24	18.2	3.90	3.3	*	*	*
25	25	18.0	3.75	3.3	*	*	*
26	26	18.3	3.75	3.3	*	*	*
27	27	14.5	3.35	3.3	*	*	*
28	28	18.0	3.65	3.3	*	*	*
29	29	18.3	3.65	3.4	*	*	*
30	30	16.1	3.70	3.3	*	*	*
31	31	17.4	3.60	3.3	*	*	*
32	32	18.3	3.85	3.4	*	*	*
33	33	16.6	3.95	3.3	*	*	*
34	34	17.7	3.65	3.3	*	*	*
35	35	19.2	3.65	3.3	*	*	*
36	36	17.8	3.75	3.3	*	*	*
37	37	18.1	4.20	3.3	*	*	*
38	38	17.8	3.95	3.3	*	*	*
39	39	17.5	4.00	3.3	*	*	*
40	40	17.4	3.95	3.2	*	*	*
41	41	17.4	3.85	3.3	*	*	*
42	42	16.1	3.90	3.3	*	*	*
43	43	17.1	4.15	3.3	*	*	*
44	44	17.0	4.00	3.3	*	*	*
45	45	16.1	3.30	3.3	*	*	*
46	46	17.9	3.70	3.3	*	*	*
47	47	17.6	3.75	3.3	*	*	*
48	48	17.6	4.10	3.3	*	*	*
49	49	17.5	3.90	3.3	*	*	*
50	50	17.7	3.75	3.3	*	*	*
1445 "ASTIR" DOWNBOUND							
51	51	17.4	3.80	3.3	*	*	*
52	52	16.2	3.35	3.3	*	*	*
53	53	17.1	3.75	3.3	*	*	*
54	54	17.6	3.95	3.3	*	*	*
55	55	17.7	3.90	3.3	*	*	*
56	56	18.0	3.90	3.3	*	*	*
57	57	17.6	3.60	3.3	*	*	*
58	58	14.8	4.10	3.3	*	*	*
59	59	17.7	3.80	3.3	*	*	*
60	60	15.6	3.75	3.3	*	*	*

DETROIT RIVER
PASSAGE #3
DATE DEC. 5, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 0945
SHIP: RICHARD J. REISS
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	26.2	5.90	2.8	8.0	4.0	4.8
2	2	25.8	5.65	2.8	14.6	2.6	4.6
3	3	25.6	5.70	2.8	16.0	*	4.8
4	4	26.2	5.75	2.8	*	*	*
5	5	25.6	5.55	2.8	*	*	*
6	6	26.2	5.50	2.8	9.3	2.6	5.2
7	7	25.9	5.60	2.8	*	*	*
8	8	25.4	-2.45	5.1	*	*	*
9	9	26.2	7.40	5.3	*	*	*
10	10	26.2	5.60	2.8	*	*	*
11	11	25.5	5.40	2.8	12.0	4.0	4.6
12	12	25.4	5.65	2.8	*	*	*
13	13	25.2	5.85	2.8	*	*	*
14	14	25.3	5.70	2.8	*	*	*
15	15	26.0	5.70	2.8	*	*	*
16	16	26.1	5.45	2.8	9.3	2.6	5.4
17	17	25.6	5.75	2.8	*	*	*
18	18	25.3	5.40	2.8	*	*	*
19	19	25.5	5.80	2.8	*	*	*
20	20	25.6	5.70	2.8	*	*	*
21	21	25.1	5.45	2.8	6.6	0.0	4.7
22	22	25.1	5.40	2.7	*	*	*
23	23	24.7	5.50	2.8	*	*	*
24	24	25.1	5.45	2.7	*	*	*
25	25	25.6	5.50	2.8	*	*	*
1010	"SAGUENAY"	DOWNBOUND					
26	26	25.2	5.45	2.7	*	*	*
27	27	25.6	5.45	2.8	*	*	*
28	28	25.5	5.95	2.8	*	*	*
29	29	25.6	6.35	2.8	*	*	*
30	30	25.8	5.75	2.7	*	*	*
31	31	25.6	5.75	2.7	8.0	0.0	4.7
32	32	25.6	5.75	2.8	*	*	*
33	33	25.6	5.70	2.8	*	*	*
34	34	25.1	5.00	2.8	*	*	*
35	35	26.0	5.60	2.8	*	*	*
36	36	25.1	5.70	2.8	*	*	*
37	37	25.4	5.65	2.8	*	*	*
38	38	25.3	5.70	2.8	*	*	*
39	39	24.6	5.65	2.8	*	*	*
40	40	24.7	6.00	2.8	*	*	*
41	41	24.6	5.80	2.8	*	*	*
42	42	24.4	5.95	2.7	*	*	*
43	43	24.5	5.85	2.8	*	*	*
44	44	24.6	5.55	2.7	*	*	*
45	45	24.9	5.60	2.8	*	*	*
46	46	24.9	5.50	2.8	*	*	*
47	47	24.9	5.55	2.7	*	*	*
48	48	24.8	5.70	2.7	*	*	*
49	49	25.5	6.25	2.7	*	*	*
50	50	26.0	5.45	2.7	*	*	*
51	51	25.3	5.55	2.8	*	*	*
52	52	25.0	5.40	2.7	*	*	*
53	53	25.0	5.35	2.8	*	*	*
54	54	24.6	5.40	2.8	*	*	*
55	55	25.2	5.50	2.7	*	*	*
56	56	25.1	5.55	2.3	*	*	*
57	57	24.1	5.35	2.8	*	*	*
58	58	24.9	5.40	2.8	*	*	*
59	59	0.0	0.00	0.0	*	*	*
60	60	0.0	0.00	0.0	*	*	*

DETROIT RIVER
PASSAGE #4
DATE DEC. 5, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 1041
SHIP: S. T. CRAPO
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	25.2	5.55	2.8	10.6	1.3	5.3
2	2	25.0	5.90	2.8	8.0	4.0	4.6
3	3	24.0	5.40	2.7	6.6	0.0	6.3
4	4	24.3	5.70	2.7	*	*	*
5	5	24.5	5.60	2.8	*	*	*
6	6	24.6	5.70	2.8	6.0	0.0	4.8
7	7	24.8	5.40	2.8	*	*	*
8	8	24.9	5.45	2.8	*	*	*
9	9	25.2	5.45	2.8	*	*	*
10	10	24.9	5.55	2.7	*	*	*
11	11	25.7	5.30	2.8	*	*	*
12	12	25.7	5.40	2.8	*	*	*
13	13	26.2	5.55	2.7	*	*	*
14	14	26.3	5.80	2.7	*	*	*
15	15	26.8	5.55	2.8	*	*	*
16	16	27.0	5.40	2.8	13.3	1.3	4.8
17	17	26.5	5.40	2.8	*	*	*
18	18	26.3	5.45	2.8	*	*	*
19	19	26.2	5.35	2.8	*	*	*
20	20	26.4	5.50	2.8	*	*	*
21	21	26.4	5.40	2.8	13.3	0.0	5.3
22	22	26.3	5.25	2.8	*	*	*
23	23	26.5	5.40	2.8	*	*	*
24	24	26.0	5.25	2.8	*	*	*
25	25	25.7	5.40	2.8	*	*	*
26	26	26.2	5.55	2.8	*	*	*
27	27	26.0	5.40	2.8	*	*	*
28	28	25.6	5.25	2.8	*	*	*
29	29	25.9	5.60	2.8	*	*	*
30	30	26.0	5.75	2.8	*	*	*
31	31	25.6	5.35	2.8	13.3	2.6	4.8
32	32	26.2	5.65	2.7	*	*	*
33	33	25.5	5.25	2.7	*	*	*
34	34	25.3	5.25	2.8	*	*	*
35	35	25.1	5.20	2.8	*	*	*
36	36	24.3	5.20	2.7	*	*	*
37	37	24.9	5.55	2.7	*	*	*
38	38	25.0	5.35	2.8	*	*	*
39	39	25.1	5.55	2.7	*	*	*
40	40	24.8	5.35	2.8	*	*	*
41	41	25.1	5.60	2.7	*	*	*
42	42	24.2	5.50	2.7	*	*	*
43	43	24.6	5.65	2.7	*	*	*
44	44	24.5	5.30	2.7	*	*	*
45	45	24.5	5.70	2.8	*	*	*
46	46	25.0	5.95	2.8	*	*	*
47	47	0.0	0.00	0.0	*	*	*
48	48	0.0	0.00	0.0	*	*	*
49	49	0.0	0.00	0.0	*	*	*
50	50	0.0	0.00	0.0	*	*	*
51	51	0.0	0.00	0.0	*	*	*
52	52	0.0	0.00	0.0	*	*	*
53	53	0.0	0.00	0.0	*	*	*
54	54	0.0	0.00	0.0	*	*	*
55	55	0.0	0.00	0.0	*	*	*
56	56	0.0	0.00	0.0	*	*	*
57	57	0.0	0.00	0.0	*	*	*
58	58	0.0	0.00	0.0	*	*	*
59	59	0.0	0.00	0.0	*	*	*
60	60	0.0	0.00	0.0	*	*	*

DETROIT RIVER
PASSAGE #5
DATE DEC. 5, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 1129
SHIP: SENATOR OF CANADA
DIRECTION: UPBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	25.4	5.65	2.8	14.0	2.0	4.4
2	2	25.6	5.15	2.8	12.0	5.3	4.7
3	3	26.3	5.25	2.8	12.0	10.0	4.7
4	4	26.3	5.55	2.7	*	*	*
5	5	26.6	5.55	2.8	*	*	*
6	6	26.3	5.25	2.8	8.0	0.0	5.0
7	7	25.7	5.20	2.7	*	*	*
8	8	25.5	5.25	2.8	*	*	*
9	9	24.6	5.10	2.7	*	*	*
10	10	25.3	5.55	2.8	*	*	*
11	11	25.4	5.55	2.7	14.6	5.3	5.1
12	12	24.5	5.50	2.7	*	*	*
13	13	25.1	5.50	2.8	*	*	*
14	14	25.3	5.45	2.8	*	*	*
15	15	24.8	5.40	2.7	*	*	*
16	16	24.8	5.30	2.7	16.0	2.6	4.1
17	17	25.2	5.55	2.8	*	*	*
18	18	25.2	5.80	2.7	*	*	*
19	19	25.1	5.45	2.7	*	*	*
20	20	24.7	5.35	2.8	*	*	*
21	21	25.5	5.45	2.7	14.0	6.0	5.1
22	22	25.3	5.50	2.8	*	*	*
23	23	24.8	5.30	2.7	*	*	*
24	24	25.3	5.25	2.8	*	*	*
25	25	25.6	5.70	2.8	*	*	*
26	26	26.0	5.55	2.8	*	*	*
27	27	25.7	5.70	2.8	*	*	*
28	28	25.5	5.10	2.7	*	*	*
29	29	25.4	5.15	2.8	*	*	*
30	30	25.5	5.30	2.8	*	*	*
31	31	25.4	5.45	2.7	12.0	4.0	5.2
32	32	25.2	5.40	2.8	*	*	*
33	33	24.2	4.95	2.8	*	*	*
34	34	24.9	5.60	2.7	*	*	*
35	35	25.4	5.65	2.8	*	*	*
36	36	25.3	5.25	2.8	*	*	*
37	37	25.2	5.60	2.8	*	*	*
38	38	25.1	5.65	2.8	*	*	*
1207 "BLACK BAY" UPBOUND							
39	39	25.3	5.45	2.7	*	*	*
40	40	25.2	5.50	2.8	*	*	*
41	41	24.8	4.95	2.7	*	*	*
42	42	24.8	5.10	2.8	*	*	*
43	43	25.0	5.25	2.8	*	*	*
44	44	25.0	5.35	2.7	*	*	*
45	45	25.2	5.35	2.8	*	*	*
46	46	25.4	5.55	2.8	*	*	*
47	47	24.8	5.35	2.8	*	*	*
48	48	25.3	5.55	2.7	*	*	*
49	49	25.5	5.45	2.8	*	*	*
50	50	25.6	5.65	2.8	*	*	*
51	51	25.8	5.50	2.7	*	*	*
52	52	25.8	5.25	2.8	*	*	*
53	53	26.0	5.45	2.8	*	*	*
54	54	25.8	5.35	2.7	*	*	*
55	55	26.0	5.30	2.7	*	*	*
56	56	26.2	5.20	2.8	*	*	*
57	57	26.3	5.25	2.7	*	*	*
58	58	26.0	5.15	2.7	*	*	*
59	59	25.6	5.15	2.7	*	*	*
60	60	25.7	5.15	2.8	*	*	*

DETROIT RIVER
PASSAGE #6
DATE DEC. 11, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 1015
SHIP: CHARLES E. WILSON
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	36.2	9.20	4.7	5.3	1.3	4.4
2	2	36.5	10.60	4.9	4.6	0.0	3.4
3	3	36.2	9.85	3.3	13.3	1.3	4.3
4	4	35.8	10.10	4.6	*	*	*
5	5	36.2	10.50	2.8	*	*	*
6	6	36.3	10.20	3.5	5.8	1.1	4.2
7	7	36.3	10.70	2.3	*	*	*
8	8	36.0	10.05	4.6	*	*	*
9	9	36.1	9.90	3.5	*	*	*
10	10	35.8	9.40	4.3	*	*	*
11	11	36.1	10.20	3.0	10.0	0.0	4.2
12	12	36.3	9.95	5.3	*	*	*
13	13	36.3	9.60	3.3	*	*	*
14	14	36.4	9.15	5.7	*	*	*
15	15	36.3	9.80	5.5	*	*	*
16	16	36.2	9.25	5.4	5.8	0.0	4.8
17	17	36.4	9.80	5.7	*	*	*
18	18	36.4	10.55	5.4	*	*	*
19	19	36.2	9.80	6.6	*	*	*
20	20	36.5	9.40	11.8	*	*	*
21	21	36.8	10.10	12.4	9.4	3.5	4.6
22	22	36.7	10.35	57.6	*	*	*
23	23	36.7	9.35	73.9	*	*	*
24	24	36.9	9.60	57.0	*	*	*
25	25	36.8	9.40	21.0	*	*	*
26	26	36.7	9.85	73.9	*	*	*
27	27	36.5	9.10	34.8	*	*	*
28	28	36.4	9.40	75.1	*	*	*
29	29	31.4	9.15	64.5	*	*	*
30	30	30.8	9.45	43.2	*	*	*
31	31	29.9	9.50	56.2	4.7	1.1	5.2
32	32	28.2	10.50	76.3	*	*	*
33	33	28.5	10.65	7.0	*	*	*
34	34	27.6	9.85	1.6	*	*	*
35	35	28.8	10.70	1.2	*	*	*
36	36	30.4	10.55	1.3	*	*	*
37	37	32.9	10.35	1.3	*	*	*
38	38	33.2	10.60	3.2	*	*	*
39	39	34.6	10.65	1.8	*	*	*
40	40	35.9	10.70	0.8	*	*	*
41	41	35.1	11.20	1.0	*	*	*
42	42	36.7	11.25	1.3	*	*	*
43	43	37.0	10.70	0.9	*	*	*
44	44	37.2	11.15	1.3	*	*	*
45	45	37.0	10.45	26.9	*	*	*
46	46	37.0	10.65	15.1	*	*	*
47	47	36.8	11.15	0.4	*	*	*
48	48	36.8	11.00	0.5	*	*	*
49	49	36.7	10.80	1.2	*	*	*
50	50	36.3	9.05	79.1	*	*	*
51	51	36.4	10.50	1.8	*	*	*
52	52	36.5	10.55	78.5	*	*	*
53	53	36.5	10.10	78.2	*	*	*
54	54	36.5	10.90	11.1	*	*	*
55	55	36.6	10.00	79.2	*	*	*
56	56	36.3	10.25	1.1	*	*	*
57	57	34.7	10.25	5.9	*	*	*
58	58	36.8	11.25	0.3	*	*	*
59	59	36.6	10.60	34.6	*	*	*
60	60	36.7	9.95	65.9	*	*	*

ST CLAIR RIVER
PASSAGE #1
DATE DEC. 3, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 0940
SHIP: WOLVERINE
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURE
1	1	52.3	-1.85	3.2	5.0	3.7	3.1
2	2	52.4	-4.25	2.9	9.4	1.1	3.4
3	3	51.9	-3.00	3.8	10.5	2.3	3.3
4	4	52.1	-0.85	3.6	*	*	*
5	5	51.6	0.55	3.0	*	*	*
6	6	51.8	0.45	3.0	5.3	1.3	3.3
7	7	51.4	-1.50	7.3	*	*	*
8	8	52.2	-4.60	9.9	*	*	*
9	9	51.8	-19.45	11.1	*	*	*
10	10	9.7	-22.95	9.0	*	*	*
11	11	5.8	54.35	17.1	7.0	1.1	3.5
12	12	5.9	50.75	8.3	*	*	*
13	13	5.7	53.15	2.9	*	*	*
14	14	51.2	85.95	4.6	*	*	*
15	15	51.9	86.70	0.4	*	*	*
16	16	0.2	86.20	4.4	8.2	2.3	3.3
17	17	82.5	75.55	3.1	*	*	*
18	18	52.1	-46.45	23.6	*	*	*
19	19	40.4	-42.40	20.0	*	*	*
20	20	52.1	-15.50	3.8	*	*	*
21	21	51.7	-30.00	1.9	8.2	1.1	3.8
22	22	51.5	-7.85	3.3	*	*	*
23	23	52.2	-4.55	2.3	*	*	*
24	24	52.1	-2.35	2.3	*	*	*
25	25	51.9	-2.20	1.9	*	*	*
1015 "AMERICAN REPUBLIC" DOWNBOUND							
26	26	51.9	-15.00	0.7	*	*	*
27	27	51.5	-13.75	22.1	*	*	*
28	28	51.3	-1.20	13.1	*	*	*
29	29	51.1	-0.70	0.3	*	*	*
30	30	51.6	-0.05	0.1	*	*	*
31	31	52.3	-8.85	21.6	9.4	0.0	3.1
32	32	51.5	-3.20	20.9	*	*	*
33	33	51.6	0.90	0.9	*	*	*
34	34	52.3	1.15	1.1	*	*	*
35	35	52.3	1.20	1.7	*	*	*
36	36	52.1	1.45	1.5	*	*	*
37	37	51.8	1.55	1.9	*	*	*
38	38	52.1	2.10	2.1	*	*	*
39	39	52.1	2.05	1.9	*	*	*
40	40	52.1	2.50	2.0	*	*	*
41	41	52.1	2.50	2.0	*	*	*
42	42	52.1	2.65	1.5	*	*	*
43	43	0.0	0.00	0.0	*	*	*
44	44	0.0	0.00	0.0	*	*	*
45	45	0.0	0.00	0.0	*	*	*
46	46	0.0	0.00	0.0	*	*	*
47	47	0.0	0.00	0.0	*	*	
48	48	0.0	0.00	0.0	*	*	*
49	49	0.0	0.00	0.0	*	*	*
50	50	0.0	0.00	0.0	*	*	*
51	51	0.0	0.00	0.0	*	*	*
52	52	0.0	0.00	0.0	*	*	*
53	53	0.0	0.00	0.0	*	*	*
54	54	0.0	0.00	0.0	*	*	*
55	55	0.0	0.00	0.0	*	*	*
56	56	0.0	0.00	0.0	*	*	*
57	57	0.0	0.00	0.0	*	*	*
58	58	0.0	0.00	0.0	*	*	*
59	59	0.0	0.00	0.0	*	*	*
60	60	0.0	0.00	0.0	*	*	*

ST. CLAIR RIVER
PASSAGE #2
DATE DEC. 8, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 1108
SHIP: AMERICAN MARINER
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	52.7	4.70	2.8	4.7	1.1	2.7
2	2	52.6	4.30	2.4	5.8	0.0	2.8
3	3	52.6	4.30	2.9	8.2	3.5	3.5
4	4	52.9	4.80	3.1	*	*	*
5	5	53.0	4.60	1.9	*	*	*
6	6	52.7	4.50	2.2	10.5	4.7	3.1
7	7	53.0	4.75	2.0	*	*	*
8	8	52.4	4.55	3.1	*	*	*
9	9	52.1	5.05	1.4	*	*	*
10	10	52.6	4.95	2.5	*	*	*
11	11	52.7	4.15	6.0	7.0	4.7	2.6
12	12	53.0	4.60	4.6	*	*	*
13	13	53.2	5.15	36.5	*	*	*
14	14	53.1	5.00	21.6	*	*	*
15	15	52.8	5.05	9.1	*	*	*
16	16	52.7	5.25	1.4	9.4	2.3	2.7
17	17	52.0	5.05	0.3	*	*	*
1117	"FEDERAL SCHELDE" DOWNBOUND						
18	18	52.1	5.40	26.9	*	*	*
19	19	52.3	3.95	6.1	*	*	*
20	20	52.1	4.95	2.1	*	*	*
21	21	51.9	5.00	1.1	5.8	2.3	2.7
22	22	52.6	4.00	30.0	*	*	*
23	23	52.5	4.90	3.9	*	*	*
24	24	52.9	5.15	2.0	*	*	*
25	25	53.6	4.95	0.8	*	*	*
26	26	53.7	4.75	2.8	*	*	*
27	27	54.3	4.90	1.8	*	*	*
28	28	54.0	5.05	3.0	*	*	*
29	29	54.3	5.25	2.7	*	*	*
30	30	53.6	4.95	2.9	*	*	*
31	31	53.0	4.15	26.2	7.0	3.5	2.8
32	32	52.8	5.45	2.9	*	*	*
33	33	52.7	5.40	3.0	*	*	*
34	34	52.2	5.45	3.1	*	*	*
35	35	52.0	5.40	3.2	*	*	*
36	36	52.0	5.60	3.3	*	*	*
37	37	52.2	5.15	3.2	*	*	*
38	38	53.0	5.30	3.3	*	*	*
39	39	52.3	5.35	2.1	*	*	*
40	40	53.2	5.55	2.0	*	*	*
41	41	53.4	5.35	2.4	*	*	*
42	42	54.5	5.60	0.9	*	*	*
43	43	53.8	5.50	2.9	*	*	*
44	44	53.2	5.35	3.1	*	*	*
45	45	53.0	5.40	3.3	*	*	*
46	46	53.2	5.60	2.7	*	*	*
47	47	53.0	5.55	3.6	*	*	*
48	48	53.2	5.75	3.6	*	*	*
49	49	53.3	5.30	3.6	*	*	*
50	50	52.9	5.85	3.6	*	*	*
51	51	52.7	5.60	3.8	*	*	*
52	52	52.4	5.30	3.8	*	*	*
53	53	52.6	5.75	3.7	*	*	*
54	54	52.8	5.45	4.0	*	*	*
55	55	53.1	5.45	4.0	*	*	*
56	56	53.3	5.40	4.1	*	*	*
57	57	53.4	5.80	4.2	*	*	*
58	58	53.8	5.10	4.1	*	*	*
59	59	53.0	5.10	4.2	*	*	*
60	60	53.7	5.85	4.3	*	*	*

ST CLAIR RIVER
PASSAGE #3
DATE DEC. 3, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 1235
SHIP: DOAN TRANSPORT
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	54.1	6.15	4.2	8.8	2.2	2.5
2	2	53.8	5.80	4.5	5.8	0.0	2.6
3	3	53.9	5.65	3.9	5.5	2.2	2.3
4	4	53.9	5.55	5.7	*	*	*
5	5	53.8	5.95	17.5	*	*	*
6	6	53.4	5.80	3.5	4.4	0.0	2.7
7	7	53.4	5.95	3.3	*	*	*
8	8	53.6	6.25	4.0	*	*	*
9	9	53.4	5.85	4.0	*	*	*
10	10	52.5	6.25	4.0	*	*	*
11	11	53.1	5.80	4.1	8.8	3.3	2.9
12	12	53.5	5.95	4.1	*	*	*
13	13	54.4	5.95	4.2	*	*	*
14	14	54.3	5.65	4.2	*	*	*
15	15	54.8	6.10	4.1	*	*	*
16	16	55.1	6.05	22.3	5.7	0.0	3.2
17	17	54.9	5.75	4.1	*	*	*
18	18	54.6	6.05	4.2	*	*	*
19	19	54.4	5.95	4.0	*	*	*
20	20	54.3	6.00	4.2	*	*	*
21	21	54.3	5.30	4.0	6.6	3.3	2.5
22	22	54.0	5.55	4.1	*	*	*
23	23	54.7	5.70	4.1	*	*	*
24	24	54.4	5.65	4.1	*	*	*
25	25	54.8	6.00	4.0	*	*	*
26	26	54.6	6.15	4.1	*	*	*
27	27	54.3	5.85	4.0	*	*	*
28	28	54.5	5.70	4.0	*	*	*
29	29	54.1	5.65	4.1	*	*	*
30	30	54.5	5.95	4.4	*	*	*
1305 "ROGER M. KYES" DOWNBOUND							
31	31	54.8	6.60	4.1	5.2	1.0	2.9
32	32	53.7	5.70	3.9	*	*	*
33	33	54.0	5.90	3.7	*	*	*
34	34	54.0	5.65	4.0	*	*	*
35	35	54.1	5.65	3.6	*	*	*
36	36	54.0	5.75	4.0	*	*	*
37	37	53.9	6.00	4.1	*	*	*
38	38	53.8	6.10	4.1	*	*	*
39	39	54.5	6.20	4.2	*	*	*
40	40	54.4	6.25	4.2	*	*	*
41	41	54.7	6.35	4.2	*	*	*
42	42	55.2	5.95	4.0	*	*	*
43	43	55.0	6.15	4.2	*	*	*
44	44	54.7	5.90	4.1	*	*	*
45	45	54.3	6.00	3.9	*	*	*
46	46	54.4	5.90	3.8	*	*	*
47	47	54.4	6.05	3.9	*	*	*
48	48	54.3	5.75	4.6	*	*	*
49	49	54.7	6.20	3.8	*	*	*
50	50	54.6	6.30	3.7	*	*	*
51	51	54.6	6.30	4.4	*	*	*
52	52	54.9	5.75	4.3	*	*	*
53	53	54.6	5.80	4.1	*	*	*
54	54	55.0	6.00	4.1	*	*	*
55	55	55.3	6.10	3.9	*	*	*
56	56	55.1	5.55	4.1	*	*	*
57	57	54.8	6.15	4.2	*	*	*
58	58	55.3	6.15	4.0	*	*	*
59	59	55.3	6.10	4.0	*	*	*
60	60	55.6	5.90	3.6	*	*	*

ST. CLAIR RIVER
PASSAGE #4
DATE DEC. 9, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 1039
SHIP: WILLIAM R. ROESCH
DIRECTION: DOWNBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	63.4	5.85	4.2	1.1	0.0	2.2
2	2	63.9	5.85	4.2	2.3	0.0	2.1
3	3	63.4	5.70	4.3	5.0	1.2	2.5
4	4	63.7	5.80	4.1	*	*	*
5	5	63.4	5.75	3.9	*	*	*
6	6	63.5	5.75	3.9	1.2	0.0	1.8
7	7	63.6	6.25	3.9	*	*	*
8	8	63.5	5.50	3.9	*	*	*
9	9	63.4	5.90	3.8	*	*	*
10	10	63.1	5.90	3.8	*	*	*
11	11	63.5	6.15	3.9	*	*	*
12	12	63.6	5.80	3.6	*	*	*
13	13	63.4	5.95	3.5	*	*	*
14	14	63.2	5.85	3.5	*	*	*
15	15	63.4	6.15	3.5	*	*	*
16	16	63.3	6.55	3.6	5.5	0.0	2.1
17	17	63.4	5.70	6.5	*	*	*
18	18	63.2	5.90	3.8	*	*	*
19	19	63.7	5.95	4.6	*	*	*
20	20	63.6	5.85	6.1	*	*	*
21	21	63.7	6.00	8.0	4.4	0.0	2.0
22	22	63.0	5.75	9.4	*	*	*
23	23	63.0	5.60	9.3	*	*	*
24	24	63.3	5.75	10.0	*	*	*
25	25	63.3	6.00	10.3	*	*	*
26	26	63.3	5.65	9.9	*	*	*
27	27	63.5	5.45	10.7	*	*	*
28	28	63.6	5.95	10.0	*	*	*
29	29	63.9	5.80	11.3	*	*	*
30	30	63.9	5.80	10.6	*	*	*
31	31	64.0	5.25	11.5	4.4	1.1	1.7
32	32	63.8	5.50	11.7	*	*	*
33	33	63.6	5.75	9.2	*	*	*
34	34	63.9	5.90	10.2	*	*	*
35	35	63.9	6.05	9.1	*	*	*
36	36	64.0	5.50	7.8	*	*	*
37	37	64.2	5.65	8.9	*	*	*
38	38	64.3	5.75	7.5	*	*	*
39	39	63.6	5.75	7.8	*	*	*
40	40	63.0	5.75	10.0	*	*	*
41	41	62.9	5.60	9.5	*	*	*
42	42	62.8	5.85	7.9	*	*	*
43	43	62.9	5.60	6.3	*	*	*
44	44	62.9	5.25	7.8	*	*	*
45	45	63.3	5.50	6.3	*	*	*
46	46	63.2	5.20	9.2	*	*	*
47	47	63.0	4.65	7.7	*	*	*
48	48	63.1	5.35	7.5	*	*	*
49	49	63.9	5.25	7.5	*	*	*
50	50	64.3	4.80	5.5	*	*	*
51	51	64.3	5.65	4.7	*	*	*
52	52	64.3	5.30	4.6	*	*	*
53	53	64.1	6.20	4.6	*	*	*
54	54	64.3	5.85	4.5	*	*	*
55	55	63.9	5.45	4.7	*	*	*
56	56	63.9	5.70	4.7	*	*	*
57	57	63.7	5.65	5.3	*	*	*
58	58	63.7	5.65	5.2	*	*	*
59	59	63.9	5.70	5.2	*	*	*
60	60	63.9	5.80	5.3	*	*	*

ST. CLAIR RIVER
PASSAGE #5
DATE DEC. 9, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES
SHIP: INDUSTRIAL TRANSPORT
DIRECTION: UPBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	64.0	5.70	6.0	3.3	0.0	2.1
2	2	64.0	5.90	5.8	3.3	1.1	2.4
3	3	64.0	6.05	4.8	3.5	0.0	1.9
4	4	63.8	5.65	5.1	*	*	*
5	5	63.8	5.55	5.0	*	*	*
6	6	63.4	5.40	5.1	4.7	3.5	1.6
7	7	63.6	5.85	5.6	*	*	*
8	8	63.6	5.55	5.8	*	*	*
9	9	63.6	5.55	5.9	*	*	*
10	10	62.8	5.70	4.6	*	*	*
11	11	63.3	5.80	4.0	1.1	0.0	1.5
12	12	63.7	5.30	3.9	*	*	*
13	13	63.3	5.10	4.7	*	*	*
14	14	63.6	5.55	3.3	*	*	*
15	15	63.6	5.10	3.3	*	*	*
16	16	63.6	5.20	3.4	1.1	0.0	1.5
17	17	63.5	5.55	3.5	*	*	*
18	18	64.0	5.45	4.0	*	*	*
19	19	63.7	5.70	3.7	*	*	*
20	20	63.9	5.45	3.9	*	*	*
21	21	63.7	5.20	4.0	0.0	0.0	1.7
22	22	63.6	5.00	4.3	*	*	*
23	23	63.5	5.55	3.4	*	*	*
24	24	63.8	5.65	4.2	*	*	*
25	25	63.7	5.00	4.7	*	*	*
26	26	64.0	5.45	4.6	*	*	*
27	27	63.8	5.60	3.6	*	*	*
28	28	64.0	5.15	4.0	*	*	*
29	29	64.0	5.25	3.6	*	*	*
30	30	64.0	5.15	4.6	*	*	*
31	31	64.2	5.15	4.2	3.5	2.3	1.8
32	32	64.0	5.45	3.7	*	*	*
33	33	64.3	5.55	3.9	*	*	*
34	34	64.1	5.35	4.3	*	*	*
35	35	64.1	5.10	4.8	*	*	*
36	36	63.9	5.50	5.0	*	*	*
37	37	63.9	5.50	5.4	*	*	*
38	38	63.6	5.50	5.3	*	*	*
39	39	63.9	5.15	5.5	*	*	*
40	40	63.7	5.25	4.8	*	*	*
41	41	63.7	5.45	4.8	*	*	*
42	42	63.9	5.40	4.7	*	*	*
43	43	64.0	5.60	4.8	*	*	*
44	44	64.0	5.50	4.7	*	*	*
45	45	63.5	5.45	3.6	*	*	*
46	46	63.6	5.70	3.7	*	*	*
47	47	63.5	5.50	3.6	*	*	*
48	48	63.5	5.55	3.7	*	*	*
49	49	64.0	5.10	3.7	*	*	*
50	50	63.8	5.05	3.6	*	*	*
51	51	64.2	5.15	3.7	*	*	*
52	52	64.0	5.15	3.7	*	*	*
53	53	64.1	5.40	3.9	*	*	*
54	54	63.7	5.45	3.8	*	*	*
55	55	63.3	5.50	3.7	*	*	*
56	56	63.5	5.25	3.9	*	*	*
57	57	63.6	4.90	3.9	*	*	*
58	58	63.9	5.00	3.9	*	*	*
59	59	63.3	5.55	3.9	*	*	*
60	60	63.7	5.25	3.9	*	*	*

ST. CLAIR RIVER
PASSAGE #6
DATE DEC. 9, 1984
WINTER 2
CLOCK TIME AT 0 MINUTES 1323
SHIP: WILLIAM CLAY FORD
DIRECTION: UPBOUND

ROW	TIME/MIN	TRANS	DEPTH	TEMP	TSS	VSS	TURB
1	1	64.1	5.40	3.6	2.2	0.0	1.9
2	2	63.9	4.70	3.5	2.3	0.0	2.3
3	3	64.2	5.25	3.5	1.1	0.0	2.2
4	4	63.8	5.25	3.5	*	*	*
5	5	63.6	5.40	3.5	*	*	*
6	6	63.5	5.15	3.7	1.2	0.0	1.6
7	7	63.4	5.30	4.6	*	*	*
8	8	63.4	5.00	4.0	*	*	*
9	9	63.3	5.45	3.5	*	*	*
10	10	63.3	5.25	3.5	*	*	*
11	11	63.3	5.70	3.6	3.5	1.1	1.7
12	12	63.7	5.40	3.6	*	*	*
13	13	63.7	5.50	3.7	*	*	*
14	14	63.7	5.40	3.9	*	*	*
15	15	64.1	5.30	5.1	*	*	*
16	16	63.8	5.20	4.6	3.3	1.1	1.7
17	17	64.0	5.35	3.5	*	*	*
18	18	63.8	5.35	3.6	*	*	*
19	19	63.8	5.20	4.0	*	*	*
20	20	63.9	5.30	3.6	*	*	*
21	21	63.7	5.30	3.6	3.5	0.0	1.7
22	22	63.6	5.40	3.6	*	*	*
23	23	63.8	4.95	4.8	*	*	*
24	24	64.0	5.25	4.7	*	*	*
25	25	63.7	4.90	4.0	*	*	*
26	26	63.5	5.25	3.6	*	*	*
27	27	63.5	5.50	4.0	*	*	*
1350	"WOLVERINE"	UPBOUND					
28	28	63.9	5.35	3.6	*	*	*
29	29	63.8	5.30	3.9	*	*	*
30	30	63.8	5.35	3.7	*	*	*
31	31	63.7	5.65	4.5	3.5	1.1	1.5
32	32	63.6	5.15	4.7	*	*	*
33	33	63.4	5.70	3.6	*	*	*
34	34	63.5	5.45	3.7	*	*	*
35	35	63.6	5.35	3.7	*	*	*
36	36	63.3	5.40	3.7	*	*	*
37	37	63.5	5.35	3.7	*	*	*
38	38	63.5	5.05	5.1	*	*	*
39	39	63.4	5.45	3.7	*	*	*
40	40	63.4	5.65	3.7	*	*	*
41	41	63.3	5.05	5.0	*	*	*
42	42	63.3	5.15	3.7	*	*	*
43	43	63.6	5.60	3.8	*	*	*
44	44	63.5	5.15	3.7	*	*	*
45	45	63.7	5.55	3.8	*	*	*
46	46	63.5	5.70	3.9	*	*	*
47	47	63.3	5.35	3.8	*	*	*
48	48	63.3	5.45	4.0	*	*	*
49	49	63.7	5.10	3.9	*	*	*
50	50	63.7	5.00	3.8	*	*	*
51	51	63.7	5.40	3.9	*	*	*
52	52	63.3	5.25	3.9	*	*	*
53	53	63.4	5.30	3.8	*	*	*
54	54	63.5	5.65	3.9	*	*	*
55	55	63.3	5.65	3.9	*	*	*
56	56	63.4	5.40	4.0	*	*	*
57	57	63.2	5.65	3.7	*	*	*
58	58	63.5	5.50	3.7	*	*	*
59	59	63.5	5.70	3.7	*	*	*
60	60	63.4	5.60	3.9	*	*	*

AUGUST 27TH BACKGROUND DATA

ROW	TIME	TRANS	DEPTH	TEMP
1	1	37.2	6.15	23.1
2	2	37.3	8.00	21.0
3	3	37.9	8.05	21.0
4	4	38.1	8.10	21.0
5	5	27.6	8.10	21.0
6	6	34.8	8.10	21.1
7	7	35.9	8.10	21.0
8	8	37.6	8.15	21.0
9	9	33.1	8.15	21.0
10	10	37.7	8.15	21.0
11	11	38.1	8.20	21.0
12	12	39.2	8.20	21.0
13	13	38.7	8.25	21.0
14	14	38.8	8.25	21.1
15	15	38.5	8.25	21.1
16	16	38.5	8.25	21.1
17	17	38.5	8.25	21.1
18	18	39.3	8.25	21.1
19	19	39.1	8.25	21.1
20	20	33.6	8.25	21.1
21	21	37.0	8.25	21.1
22	22	37.4	8.25	21.1
23	23	37.4	8.25	21.1
24	24	37.8	8.25	21.1
25	25	35.9	8.25	21.1
26	26	36.9	8.25	21.0
27	27	35.9	8.25	21.0
28	28	37.8	8.30	21.0
29	29	36.3	8.25	21.0
30	30	34.5	8.20	21.0
31	31	33.4	8.15	21.0
32	32	35.7	8.20	21.0
33	33	35.4	8.15	20.9
34	34	29.3	8.10	20.9
35	35	33.9	8.10	20.9
36	36	36.0	5.50	24.3
37	37	33.0	7.90	20.9
38	38	35.8	7.35	20.9
39	39	36.1	7.95	20.9
40	40	35.3	7.95	20.9
41	41	35.0	7.50	20.9
42	42	34.7	1.70	20.9
43	43	33.5	7.45	20.9
44	44	30.2	6.75	20.9
45	45	33.7	7.85	20.9
46	46	31.7	8.05	21.0
47	47	34.1	5.50	21.0
48	48	36.5	7.25	21.0

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