East River Tide Gates Operational Feasibility and Trade-offs

Douglas Hill
Robert E. Wilson
Malcolm J. Bowman

April 2004

Final Report to Greeley and Hansen on Contract CODE R909 ID: WP283
for
Facilities Planning for the Upgrading of the
Newtown Creek Water Pollution Control Plant
for
The City of New York
Department of Environmental Protection
in connection with
Capital Project No. WP-283
Newtown Creek Water Pollution Control Project
Upgrading Facilities

Marine Sciences Research Center
Stony Brook University
Stony Brook, NY 11794-5000

Table of Contents

Appendices

List of Tables

List of Figures

Acknowledgements

This project was funded by Greeley and Hansen on behalf of the New York City Department of Environmental Protection. We wish to thank in particular Warren Kurtz, Deputy Director, Facilities Planning, Bureau of Environmental Engineering, NYCDEP, for his support of the project. Thanks to Steve Gyory for his cooperation in administering the project, and to Robert Pennington of NYCDEP for his helpful corrections to the draft report.

In addition, we wish to acknowledge the generous assistance we received from many others.

Primary was the support we received from the U.S. Army Corps of Engineers, in the persons of Col. William H. Pearce, District Engineer, New York District, and members of his staff: Lt. Col. Joseph Muscarella, James Haggerty, Robert Will, and especially Frank Santangelo who provided us with the Corps publications on hydraulic design. Detailed data on East River traffic was provided by Michael G. LaMarca of the Waterborne Commerce Statistics Center, New Orleans, who made repeated computer runs at our request.

The U.S. Coast Guard gave us a maritime view at a meeting held by Captain Larry Brooks, Deputy Commander, Coast Guard Activities New York, and members of his staff: Lt. Cdr. Brian L. Krenzien, VTS Branch Chief (later succeeded by Lt. Cdr Christopher Nichols), Lt. Jess P. Lopez, and Joe M. Arca, Jr., Bridge Branch, as well as Edwin Levine, Scientific Support Coordinator, National Oceanic and Atmospheric Administration (NOAA). On Captain Brooks' recommendation, a second meeting was held at Coast Guard headquarters on Staten Island with the East River Subcommittee of the Harbor Safety, Navigation and Operations Committee. At that meeting we received additional helpful commentary from the maritime community. Three of those present represented the Sandy Hook Pilots Association: Captain Andrew McGovern, president, Captain J.H. Olthius, training director, and Captain Henry Mahlmann, senior East River pilot. Also participating were Ken Peterson of the Reinauer Transportation Company, William O. Gray of the Gray Marine Company, Kevin Harte of American Waterways Ops, Lt. Cdr. Krenzien and Cdr. D.R. Croce, USCG. Through CWO David Dillard, the Coast Guard also provided us with detailed traffic data from their Vessel Transportation Service (VTS). Ken Porter, who has captained yachts and tugboats navigating the East River, also briefed us on the operational problems.

Steven C. Resler, Supervisor of Consistency Review and Analysis, Division of Coastal Resources, New York Department of State, was particularly helpful in providing information on New York's coastal zone management program, and patiently reviewed successive drafts of that material. Dr. R.L. Swanson, Marine Sciences Research Center, State University of New York at Stony Brook, also informed us on the subject.

We thank Stephen K. Gill, Technical Director, Center for Operational Oceanographic Products and Services, National Ocean Service, NOAA, for his informative response to our inquiry about the effect of East River tide gates on NOAA's tide and tidal current products. Tom McEnerney of Hazen and Sawyer, Inc., provided data on combined sewer outfalls and regulators, and kindly reviewed our report on the possible effects of tide gates on their operation. Eddie Greenfield, New York City Department of City Planning, provided information on the New York/New Jersey Harbor Estuary Water Use Management Study.

For long hours spent by the waterside recording river traffic, we thank Faez Bakalian, Sereno Barr and Chandra Kumarakulasinghe, Brian Batten, Erinna Bowman, Hamish Bowman, Frank Buonaiuto, Heather Crowley, Nikitas Georgas, Jeffrey D. Hill, Keith Marcoe, Laura Oremland, Mercedes Wilson-Barthes, Brendan Wilson-Barthes, and Martha Young.

Finally, we especially thank Jeffrey D. Hill who developed the computer simulation of vessels transiting the East River that enabled us to compare traffic delays due to the presence of tide gates with the time saved by vessels traveling in slack water.

Of course, only the authors are responsible for the contents of this report.

1 INTRODUCTION AND SUMMARY

Tide gates in the East River have been proposed as a way to improve the water quality in the East River, western Long Island Sound, and New York Harbor.[1] They would accomplish this by stopping the flow of water to the north and east on flood tide, but allowing the flow to the west and south on the ebb tide. This would provide a flushing action, drawing clean water through Long Island Sound and forcing it through the East River and New York Harbor into the ocean. The continuing output of the six wastewater treatment plants that empty into the East River – or during rainstorms, the untreated wastewater that bypasses them – would be transported through New York City waters to the ocean, rather than endlessly flowing back and forth with the tides.

Used continuously, tide gates would significantly increase the level of dissolved oxygen in the East River, far more than further sewage treatment, and would be an order of magnitude more cost-effective than additional sewage treatment.[2] Whether the tide gates would be used year round or only in periods when the deterioration of water quality is most severe remains to be seen.

Tide gates would consist of a structure spanning the river. Various configurations have been suggested, including a set of buoyant slabs that normally rest on the bottom of the river but are pumped full of air to raise them when the gates are to be closed. Another design would have a string of piers across the river supporting the tide gates. With the gates open, river traffic would pass through unobstructed. With the gates closed, vessels would use navigation locks to pass through. A third alternative, which we introduce here, is to emplace two sets of tide gates spaced some distance apart along the river, making use of the river itself as the navigation lock.

1.1 Operational Feasibility

Whatever form the tide gates may take, they will make a major change in the East River. In operation, they will basically change the estuarine flow around New York City with environmental consequences that need to be examined. Most obviously, however, their presence will create a new situation for mariners. Perhaps surprisingly, the use of tide gates may provide a substantial operational benefit to the tug-and-barge traffic and tankers that constitute about 60 percent of the commercial traffic through the East River.

This is because tide gates would make it possible for slow-moving vessels to transit the central part of the river more than half the time. At present, these vessels can pass through Hell Gate, a treacherous kink in the river, only during a window of about 1½ hours when the tide is turning and the current is slack. With tide gates closed, the current

[1] M.J. Bowman. Tidal locks across the East River: an engineering solution to the rehabilitation of western Long Island Sound. *In* M. Wiley (ed.) Estuarine Processes Vol. 1. Academic Press. 1976.
[2] J.P. St. John and R. L. Miller, HydroQual, Inc. East River tidal barrier: solution to water quality problems in the NY/NJ harbor? The Hudson River Foundation Tuesday Seminars. April 6, 1999.

is slack at least half the time. During this period, vessels would “lock through” the tide gates.

Locking through would delay vessels, of course. The U.S. Army Corps of Engineers reports that the operation time of “very low-lift” locks like the ones that would be needed in the East River typically is 8 to 10 minutes, leading to a total transit time of 20 to 40 minutes. However, this delay would be offset by the time savings that would result from traveling up and down the river in slack water rather than with and against a current. According to our simulation, a 6-knot vessel making a round trip on the river would save as much as an hour and five minutes traveling in slack water.

As an alternative to one set of tide gates together with conventional navigation locks, we introduce the concept of two sets of tide gates, spaced some distance apart along the river, dispensing with conventional locks. In an ideal case, a vessel would pass the first set of tide gates which would then close behind it. The water level in the enclosed section of the river then rises or falls to the level of the river beyond, a maximum of 6 feet under normal tidal conditions. By the time the vessel reaches the other set of tide gates, the water level has equalized, the tide gates open, and the vessel passes through with virtually no delay.

If the two gates were one mile apart – for example, on the section of the river between Lawrence Point and Hell Gate – a vessel traveling at 5 knots would take 12 minutes to reach the second set of locks. Determining whether the water level could be equalized in this amount of time is beyond the scope of this work. If the river were separated into two parallel channels, for example, there is little doubt that the needed amount of water could be moved. However, according to Corps experience, a model would have to be built and tested to determine if surface currents and turbulence and the movement of unmoored vessels in the river would be acceptable.

Even if the ideal of no delay could not always be achieved, however, this arrangement could be expected to nearly eliminate queuing delays that might occur with heavy traffic through a conventional set of locks. A stretch of river a mile long could accommodate several tugs with barges and many pleasure boats. Vessels would wait only for the next operation of the lock, not wait in line for several operations.

1.2 Site Trade-offs

Three possible sites for tide gates along the river are compared. In addition to the one near Lawrence Point, these are at College Point to the east and a midtown location to the south of Roosevelt Island. The cross-sectional area of the river is smallest at Lawrence Point and largest at College Point. Accordingly, the constriction to the flow of the river with the tide gates open is likely to be least at Lawrence Point and most at College Point. The midtown alternative, originally chosen because it might double as a bridge crossing, would require that the entrance to the Harlem River also be blocked when the tide gates are closed. The College Point site is the only one of the three that has suitable adjacent anchorage areas for waiting vessels. However, on each side it abuts what New York City has designated "special natural waterfront areas" in which natural habitats are to be protected and restored.

There is some difference in the traffic through the three sites. The midtown site may catch more ferries and commercial sightseeing vessels. The College Point site may catch heavier recreational traffic in summer when boats from marinas in Flushing Bay head for Long Island Sound.

1.3 River Traffic

Ferry traffic accounts for more than half of the commercial trips in the East River. However, most of these trips are in the lower part of the river, and comparatively few pass the three candidate sites. Other than ferries, about two-thirds of commercial trips in the East River are local to New York City; the other third are coastwise traffic to and from New England. The commercial traffic varies little by month year round, but it is higher on weekdays than weekends. In our 121 hours of observing almost 2,000 vessels at three sites, the commercial traffic passing in both directions averaged about two vessels per hour.

By weight, 85 percent of commercial traffic is coastwise. About three-quarters of commercial traffic is petroleum carried in tankers and tanker barges: mostly gasoline, distillate oil, and residual oil. Other major commodities are sand and gravel, cement and concrete, and waste and scrap. Tugs and barges account for 59 percent of the non-ferry trips, dry cargo vessels 38 percent, and self-propelled tankers 3 percent.

The great majority of commercial vessels on the East River are between 60 and 120 feet in length, with another peak at about 300 feet; about 11 percent exceed 300 feet. Of the trips by loaded vessels, 98 percent have a draft of 15 feet or less; 99.15 percent of 20 feet or less. Of 97,893 loaded trips in 1997, only three were by vessels with drafts of more than 30 feet, but we are informed that new tanker barges will have a draft of 32 feet.

The "controlling depth" of the East River above the former Brooklyn Navy Yard is 35 feet at mean low water. Near Lawrence Point, the maximum depth of the main channel at mean low water is 36 feet; at the other sites it is deeper. Model results indicate that the operation of East River tide gates would lower the level of minimum low water by 0.5 feet just east of the tide gates. Although it is close, the 35 feet depth would be maintained. However, taking into account desired safety margins of a 3-foot clearance to a rock bottom, 2 or 3 feet for advance maintenance dredging, and one to 3 feet to allow for a fluctuating water surface, the clearance for new vessels with a 32-foot draft appears decidedly marginal, with or without tide gates.

There appears to be no official count of the number of pleasure boats on the river which, on a summer holiday weekend, we found to be as much as 96 percent of total daytime traffic. The number of boats registered in New York City grew at an annual rate of 3.4 per year from 1991, reaching a total of 26,807 in 1997.

In addition to commercial and recreational vessels, various government vessels are seen on the East River, including tankers operated by the New York City Department of Environmental Protection carrying sewage sludge, Coast Guard patrol boats, New York City police boats, and a patrol boat of the New York City Department of Correction operated near Rikers Island.

1.4 Permitting Criteria

For tide gates to be built, a construction permit would have to be obtained from the U.S. Army Corps of Engineers. Until 1968, the primary thrust of the Corps' regulatory program was the protection of navigation. As a result of several new laws and judicial decisions, however, the program has evolved into one involving consideration of the full public interest by balancing favorable impacts against detrimental impacts. This "public interest review" takes into account not only navigation but water quality and a number of other factors: conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, shoreline erosion and accretion, recreation, water supply and conservation, energy needs, safety, food and fiber production, mineral needs, consideration of property ownership and, in general, the needs and welfare of the people.

Under the Coastal Zone Management Act of 1972, federal actions that are reasonably likely to affect land use, water use, or natural resources of the coastal zone must also be consistent with enforceable policies of a coastal state's federally approved coastal management program. To be consistent with New York State coastal management program (CMP), it must be in accord with the State's 44 CMP policies, of which about eight may apply to East River tide gates. These are concerned with fish and wildlife habitats, coastal flooding and erosion, valuable coastal resource areas, access to recreational resources and land adjacent to the water's edge, wetlands, and local waterfront revitalization programs.

A local waterfront revitalization program (LWRP) approved by the state *sets the standard to which all coastal activities of local, state and federal agencies must adhere*. The guiding principle of New York City's LWRP is to maximize the benefits derived from economic development, environmental preservation, and public use of the waterfront, while minimizing the conflicts among these objectives. The New York City WRP coalesces its own previous policies and those of New York State into ten. One of the policies is to "protect and restore the quality and function of ecological systems within the New York City coastal area." Implementing this policy, the LWRP identifies three Special Natural Waterfront Areas, of which two bound the College Point site, as noted above. One of the other nine policies is to "protect and improve water quality in the New York City coastal area."

Moreover, since the hydrological changes due to East River tide gates would extend as far as New Jersey and Connecticut, those states as well as villages on Long Island Sound and the Hudson River would have an opportunity to review these consequences for consistency with their CMPs and LWRPs.

State legislation also authorizes the City to prepare a harbor management plan. This would provide the City with direct authority to regulate in-water structural uses. There is also a Long Island Sound CMP which, if approved by the federal government, may bear on actions in the East River.

Unless the East River tide gates are combined with a bridge, the U.S. Coast Guard does not have a primary role in granting a permit. In its regulatory program, the Corps of Engineers consults the Coast Guard on aids to navigation, shipping safety fairways, and anchorage areas.

1.5 Views of the Maritime Community

In December 1998, we met with Col. William H. Pearce, District Engineer, New York District, U.S. Army Corps of Engineers, and members of his staff. With regard to obtaining a permit to construct East River tide gates, we were told that the Corps would pay particular attention to the views of the local maritime community. We had the opportunity to sample these views at two meetings at U.S. Coast Guard Activities New York on Staten Island, and two subsequent visits to tug-and-barge operators. One meeting was with Captain Larry Brooks, Deputy Commander, Coast Guard Activities New York, and his staff. A second was with the newly established East River Subcommittee of the Harbor Safety, Navigation and Operations Committee. This subcommittee consists of members of the Sandy Hook Pilots Association and the shipping industry as well as two Coast Guard officers.

Generally, the groups offered advice on practical operational matters and safety considerations. They provided information on vessels using the East River and on navigation aids. They described the problems of operating vessels at slow speed in the river. They expressed concern about vessels maneuvering through tide gates and navigation locks. In particular, they were concerned that there would be eddies in the East River at the mouth of the Harlem River unless it is closed off when the tide gates are closed. They pointed out the need for nearby anchorages for vessels waiting to pass through locks. They said that the commercial community would want to know the cost of using locks. They said that fast ferry operators – not represented on the subcommittee – will oppose the idea of tide gates. However, no one present at the meetings seemed to be unalterably opposed.

1.6 National Ocean Service Tidal Current Information

In response to our inquiry, the National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, said that all of NOAA's suite of nautical chart products would be affected over a fairly large geographic area by the operation of East River tide gates. In brief, the NOAA chart products, tidal datums, and tide and tidal current predictions could become obsolete. The tide and tidal current reference system would have to be re-established through new surveys after the completion of the tide gate construction.

It may be noted that National Ocean Service tide and tidal current information is now made available in real time and does not depend as much on previously printed publications. NOAA will provide a tide gage at no charge if local authorities pay for its operation and maintenance.

1.7 Combined Sewer Outfalls

Concern has been expressed as to whether the elevations and operations of the tide gate/regulator assemblies on combined sewer outfalls in the East River will limit the permissible rise in the level of high water in the East River. According to the latest modeling results, operation of the East River tide gates would lead to a rise of 0.8 feet in high water on their west/south side. This rise gradually diminishes to 0.2 feet below The Battery.

Almost without exception the tidal elevations at the 220 regulator locations on the East River lie within the maximum tidal range, so that they are below sea level only part of the time. For all but a handful of regulators, this will continue to be the case with a sea level rise of 0.8 feet. If there proved to be a problem, the East River tide gates could simply be left open during tidal extremes in order to avoid exacerbating high tide conditions that might contribute to flooding.

1.8 Other Uses of East River Tide Gates

New York City not infrequently experiences flooding in lower Manhattan, the lower East Side and elsewhere during Nor'easter storms. The orientation of Long Island Sound makes it a natural funnel into New York City for water driven by strong northeast winds over a period of days. In addition, northeast winds along the south shore of Long Island move surface water to the right of the wind direction due to the earth's rotation, which drives water through The Narrows. These two forces combine with sea level rise due to reduced atmospheric pressure to cause the flooding.

This flooding could be reduced by closing tide gates in the upper East River. Calculations indicate that the storm surge in western Long Island Sound is unlikely to increase significantly as a consequence. Numerical simulations of storm surge under a variety of storm scenarios are needed to determine more precisely how effective East River tide gates might be – according to their location – in reducing New York City flooding.

A third possible use of East River tide gates is the containment of oil spills. As noted above, petroleum products constitute about three-quarters by weight of the commodities shipped into and through the East River. Precautions are already taken to limit the damage from oil spills at places in the East River by pre-positioning booms locally near unloading docks. However, such protection or exclusionary techniques are not likely to be effective in the open river. Closing the tide gates could prevent a major spill from extending throughout the river. The tide gates could be designed to allow the free flow of the river while containing surface slicks.

2 DESCRIPTION OF RIVER TRAFFIC

Data on traffic in the entire East River are compiled by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, and the U.S. Coast Guard, Vessel Transportation Service (VTS). These numbers are higher than we observed in the upper East River in 121 hours of characterizing almost 2,000 vessels at three candidate tide gate sites on summer and winter weekdays and weekends.

The Corps data are published as annual summaries in *Waterborne Commerce of the United States, Part 1 – Waterways and Harbors, Atlantic Coast* by the Waterborne Commerce Statistics Center, New Orleans, under the supervision of the Water Resources Support Center, Fort Belvoir. At our request, the New Orleans center supplied us with the monthly breakdown for the most recently published report for calendar year 1997. The Coast Guard data are collected in conjunction with the operation of the Vessel Transportation Service, a monitoring and information system operated U.S. Coast Guard Activities New York located on Staten Island. These data are not routinely published, but the Coast Guard kindly supplied us with their VTS record.

The Corps data are strictly limited to commercial vessels which are required to report on vessels, passengers, freight and tonnage for each trip. The Coast Guard data are obtained on large vessels tracked by the VTS. These also are primarily commercial vessels, but include fishing boats, large privately owned vessels, and government service vessels.

There is apparently no official count made of the numerous small recreational craft that crowd the river in summer, especially on weekends. As a surrogate, the number of boat registrations in the New York City counties over a period of nine years was obtained.

2.1 Commercial traffic on the East River

As reported by the Corps and shown in Figure 2-1, commercial traffic on the entire East River consists, in order of the number of trips: ferries, dry cargo vessels, dry cargo barges, tugboats without tows, tanker barges, and tankers. (Barges are of course pushed or pulled by tugboats.) By “on” the East River, we mean that vessels arrive at, depart from, or pass through the East River. According to the Corps data, more than half of commercial trips are made by ferries. Most of these ply the lower East River; the percentage of ferries we observed from midtown Manhattan north was a very small proportion of the total. (Our observations are reported below.)

The variety in the types of vessels and their cargoes is shown in Figure 2-2, tracked by the Coast Guard during a one-year period from May 1998 to April 1999. The majority in this sample are tugs with barges, tugboats alone, tank ships, and traprock barges.

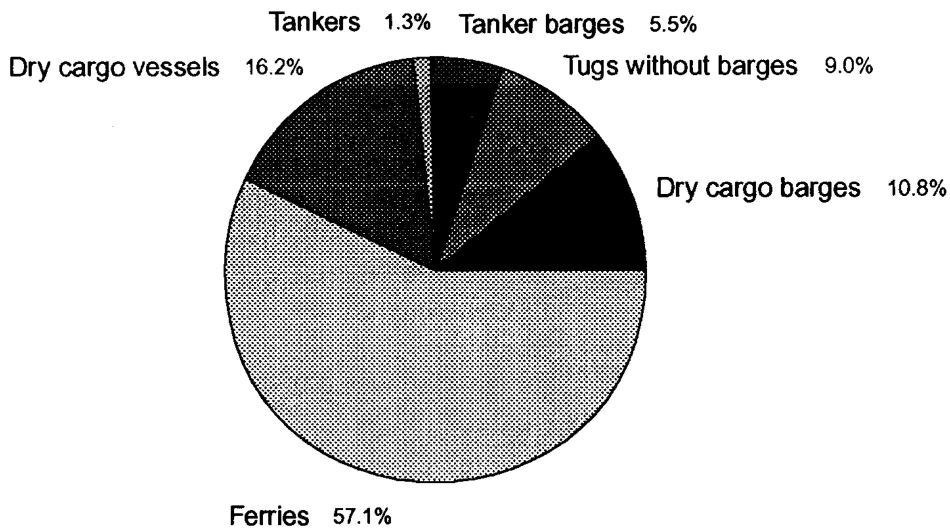


Figure 2-1 Distribution of number of trips by commercial vessels on the entire East River, 1997. Source: Corps of Engineers, Waterborne Commerce Statistics Center.

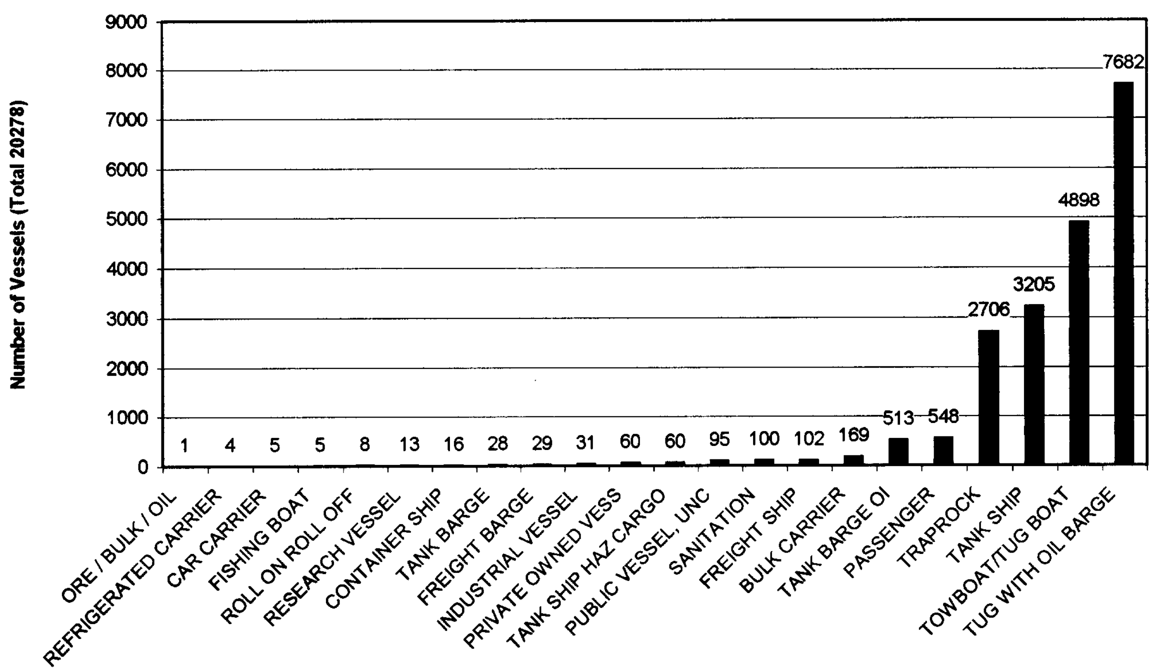


Figure 2-2. Vessels in the East River tracked with the U.S. Coast Guard Vessel Transportation Service (VTS) from May 1998 to April 1999 consisted mostly of tugs, barges and tankers. Source: U.S. Coast Guard VTS New York.

By weight, about three-quarters of the 33.6 million tons of commodities shipped in 1997 consisted of petroleum products, principally gasoline, distillate oil, and residual oil, as shown in Figure 2-3. (Tonnage is measured in short tons of 2,000 pounds.) Other major

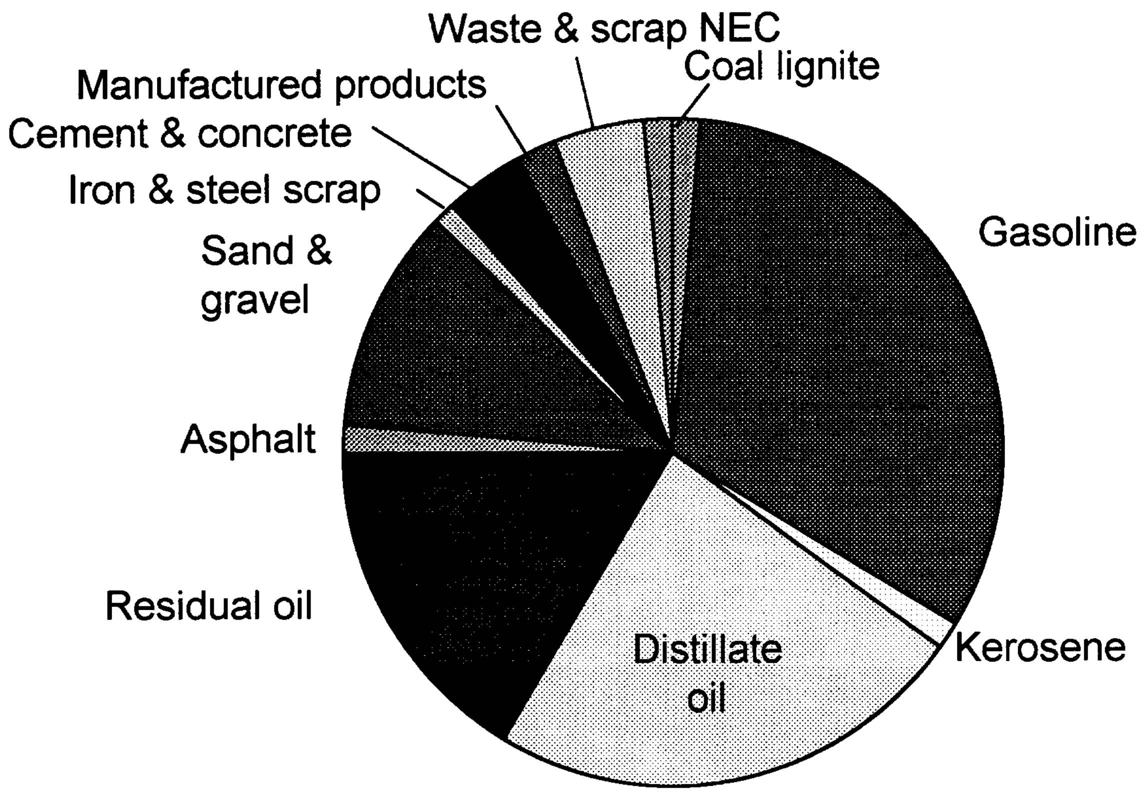


Figure 2-3. By weight, petroleum products constituted about three-quarters of the tonnage shipped on the East River in 1997. Source: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

commodities are, in decreasing order: sand & gravel, waste & scrap, and cement & concrete. Locally, there are small quantities of sugar and wood in the rough, as well as miscellaneous petroleum products such as asphalt and kerosene.

Eighty-seven percent of tonnage on the river in 1997 was through traffic. Miscellaneous other commodities shipped through in small amounts are coal lignite, sodium hydroxide, chemical additives and other chemical products, metallic salts, limestone, alcohols, and fabricated metal products.

Over time, the annual tonnage of commodities shipped on the East River declined from 40 million tons in 1988 to below 30 million from 1992 to 1995, as shown in Figure 2-4. Subsequently, tonnage increased to 33.6 million tons in 1997.

Throughout the year 1997, the number of trips by tugs, barges and tankers remained about the same, as shown in Figure 2-5. There was greater variation in the monthly number of trips by dry cargo vessels. In the figure, it can be seen that barges – both tanker and dry cargo barges – generally return light, that is, without cargo. Moreover, tugboats operate without barges (10,705 trips in 1997) slightly more often than barges are accompanied by tugs (6,557 dry cargo barge trips and 3,304 tanker barge trips). Dry cargo vessels, on the other hand, are almost always loaded in both directions.

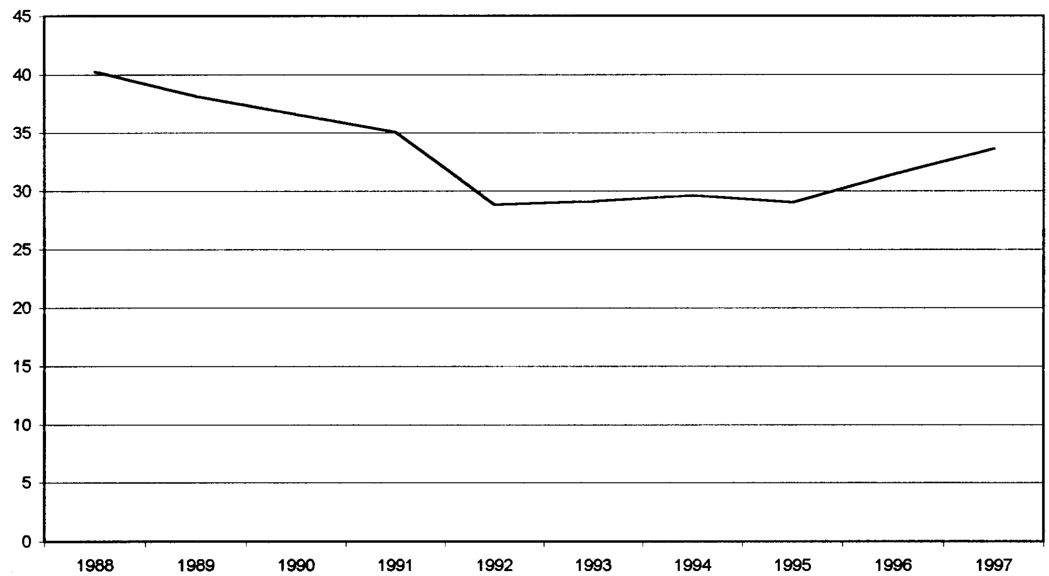


Figure 2-4. Annual tonnage of commodities shipped on the East River from 1988 to 1997 (million short tons per year). After 1992, commercial tonnage held steady or increased slightly. Source: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

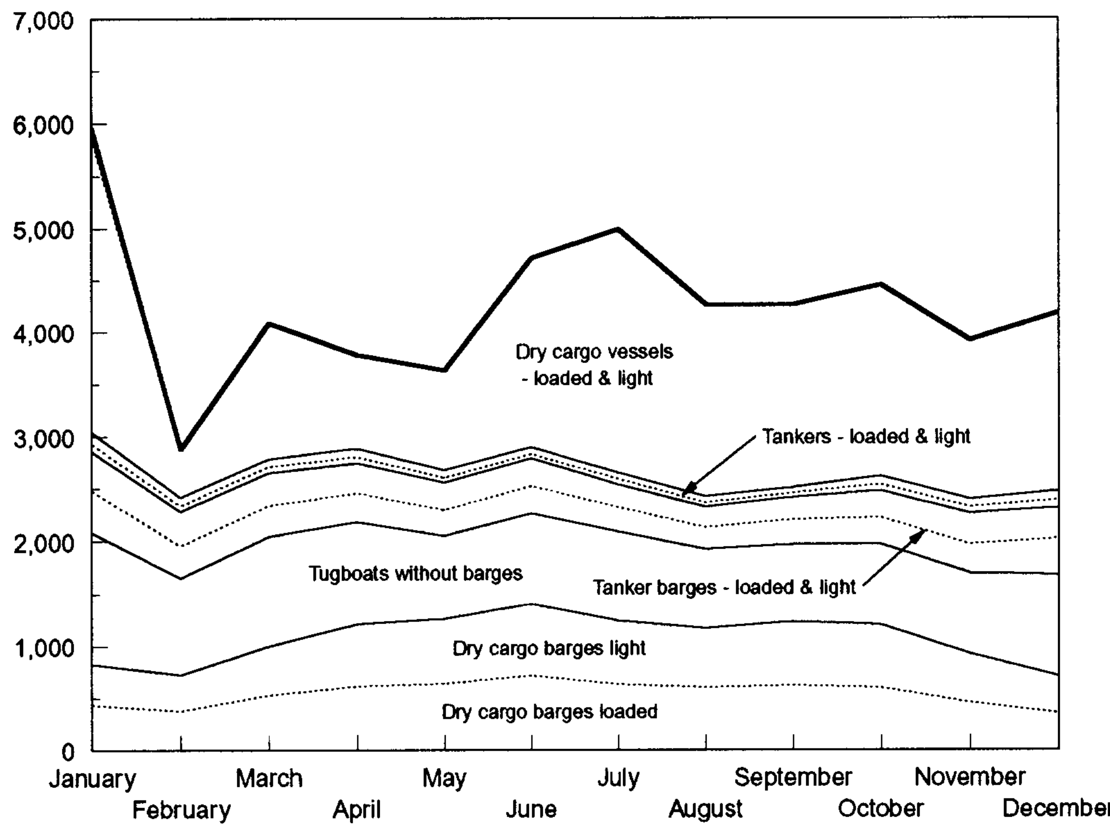


Figure 2-5. Monthly number of trips by cargo vessels in 1997. The monthly level of tug-and-barge and tanker traffic is essentially the same throughout the year; dry cargo trips may vary more. (Note: January figure is distorted because some data reported annually or quarterly is lumped with January.) Source: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

2.2 Commercial vessel sizes

The drafts of tugboats and *loaded* vessels in 1997 reported to the Corps are tabulated in Table 2-1. The drafts are shown by type of vessel and totaled with and without ferries. Without ferries, the modal draft is 7 feet. Three-quarters of ferries have a draft of 13 feet, and most of the rest have a draft of 8 feet. Ninety-eight percent of all trips are by vessels with a draft of 15 feet or less; 99.15 percent are 20 feet or less. Of 97,893 loaded trips, only 3 were by vessels with a draft of more than 30 feet (2 at 32 feet, and one at 36 feet).

On the other hand, of 10,747 *light* trips (excluding tugboats), there were 23 vessels reporting drafts of more than 30 feet, up to a maximum of 38 feet. Nineteen of these were overseas trips, presumably touching only the lower East River. Three of these were listed as coastwise (drafts of 31 feet) and one as intraport (34 foot draft).

Table 2-1. Drafts of loaded vessels on the East River in 1997. Source: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

DRAFTS OF LOADED VESSELS IN EAST RIVER - 1997

Draft (ft)	Tugboat	Dry cargo barge	Tanker barge	Tanker	Dry cargo	**Total no**	Ferries	**Total+ferries**
1	0	0	0	0	0	**0**	0	**0**
2	588	3	1	0	28	**32**	0	**32**
3	0	13	0	0	0	**13**	0	**13**
4	1	13	4	2	28	**47**	0	**47**
5	0	27	8	0	8131	**8166**	0	**8166**
6	4	40	14	0	1846	**1900**	0	**1900**
7	915	2803	20	26	7453	**10302**	576	**10878**
8	1435	356	27	3	1697	**2083**	13696	**15779**
9	1925	268	82	12	0	**362**	0	**362**
10	447	2271	122	330	0	**2723**	1308	**4031**
11	1246	377	298	81	0	**756**	0	**756**
12	749	83	379	47	0	**509**	0	**509**
13	1427	25	363	17	0	**405**	52583	**52988**
14	677	6	173	78	0	**257**	0	**257**
15	637	142	186	22	0	**350**	0	**350**
16	408	1	154	27	0	**182**	0	**182**
17	134	68	304	18	0	**390**	0	**390**
18	78	2	99	7	0	**108**	0	**108**
19	0	0	123	0	0	**123**	0	**123**
20	30	2	187	0	0	**189**	0	**189**
21	0	23	135	0	0	**158**	0	**158**
22	0	15	142	0	0	**157**	0	**157**
23	0	1	85	0	0	**86**	0	**86**
24	0	6	162	0	0	**168**	0	**168**
25	0	1	61	0	0	**62**	0	**62**
26	0	3	57	0	0	**60**	0	**60**
27	0	8	66	0	0	**74**	0	**74**
28	0	0	53	0	0	**53**	0	**53**
29	2	0	13	0	0	**13**	0	**13**
30	0	0	2	0	0	**2**	0	**2**
31	0	0	0	0	0	**0**	0	**0**
32	2	0	0	0	0	**0**	0	**0**
33	0	0	0	0	0	**0**	0	**0**
34	0	0	0	0	0	**0**	0	**0**
35	0	0	0	0	0	**0**	0	**0**
36	0	0	0	1	0	**1**	0	**1**
	10705	6557	3320	670	19183	**29730**	68163	**97893**

Vessel lengths were reported in the Coast Guard VTS data for the period May 1998 to April 1999 as shown in Figure 2-6. The great majority were between 60 and 120 feet in length. There is also a peak at about 300 to 310 feet. About 11 percent of the vessels exceed 300 feet, with the longest at 1,480 feet.

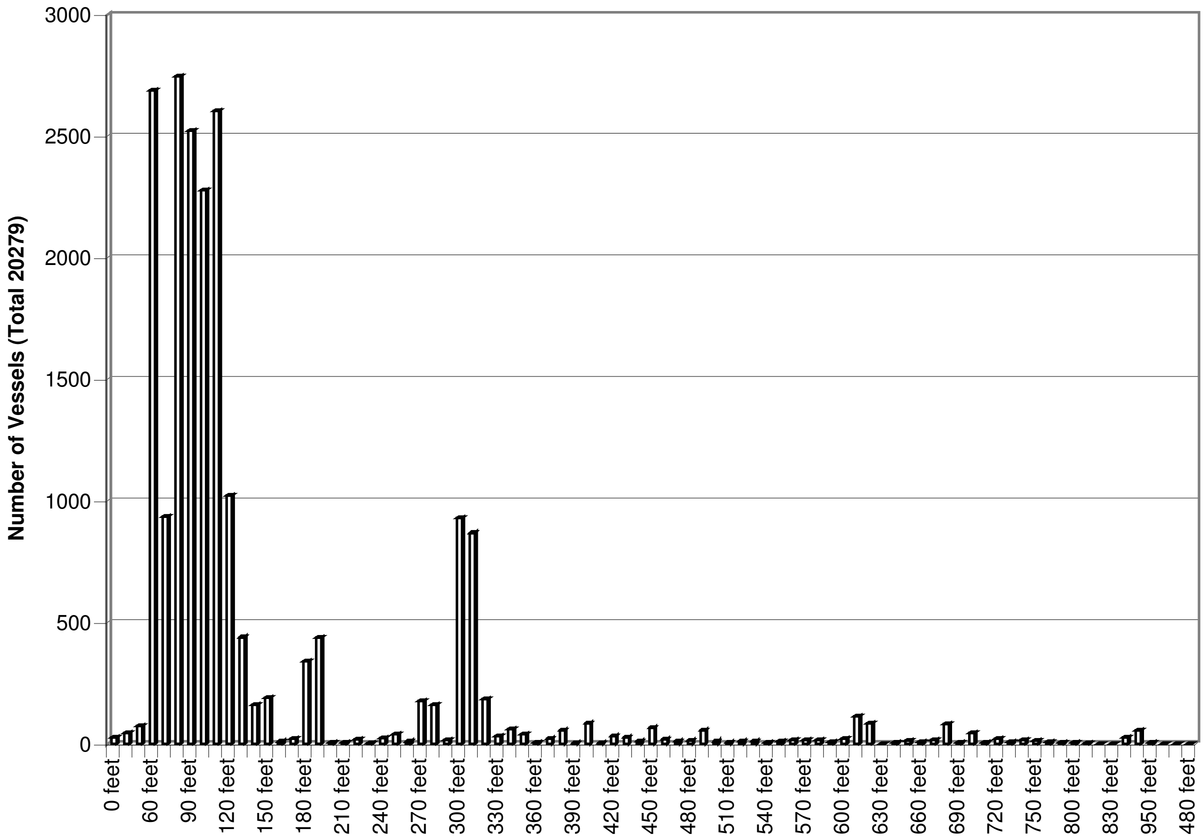


Figure 2-6. Vessel lengths on the East River, May 1989 to April 1999. Source U.S. Coast Guard VTS New York.

2.3 Recreational boating

As noted previously, there appears to be no official count of recreational boats which, on summer weekends, vastly outnumber commercial vessels on the East River. However, the trends over time can be estimated by the number of boats registered with the New York State Bureau of Motor Vehicles, as shown Figure 2-7. From the lowest numbers, generally in the early 1990s, there has been a gradual increase in the number of registrations up to a total of 26,807 in New York City in 1997. From 1989, the growth has averaged 2.1 percent per year in New York City compared to 2.5 percent in New York State as a whole. Among the New York City counties, the annual growth rate has ranged from a low of 0.6 percent in Queens to 5.3 percent in Richmond, with The Bronx at 1.8 percent and Manhattan at 3.3 percent.

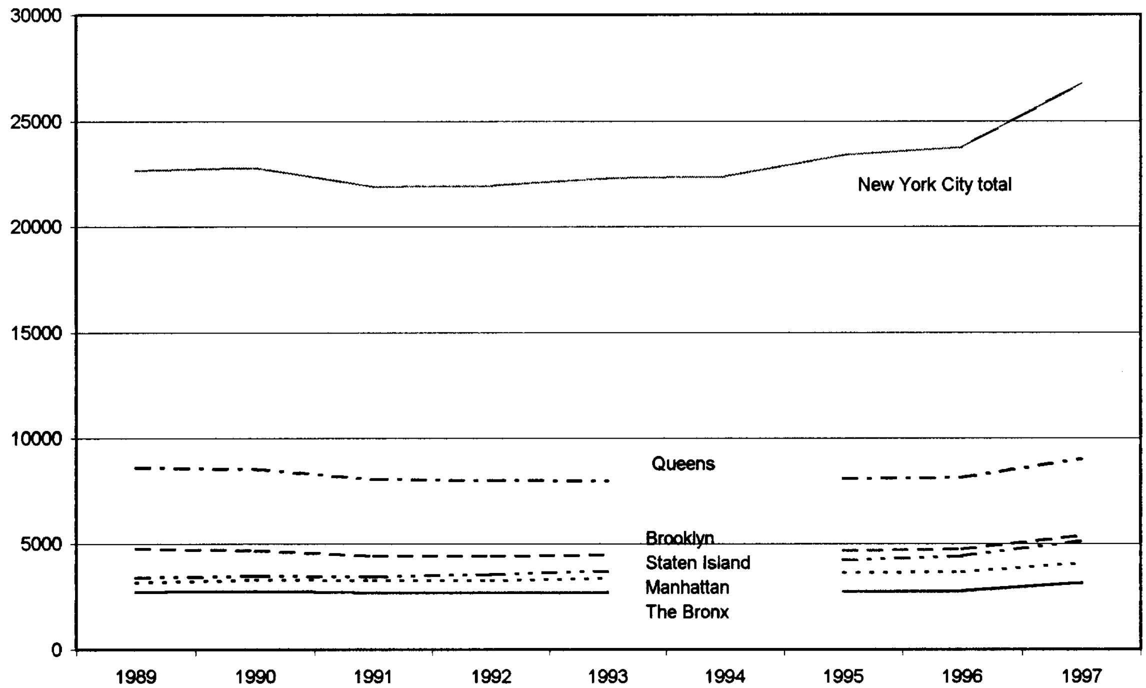


Figure 2-7. Number of boats in New York City registered with the New York State Bureau of Motor Vehicles

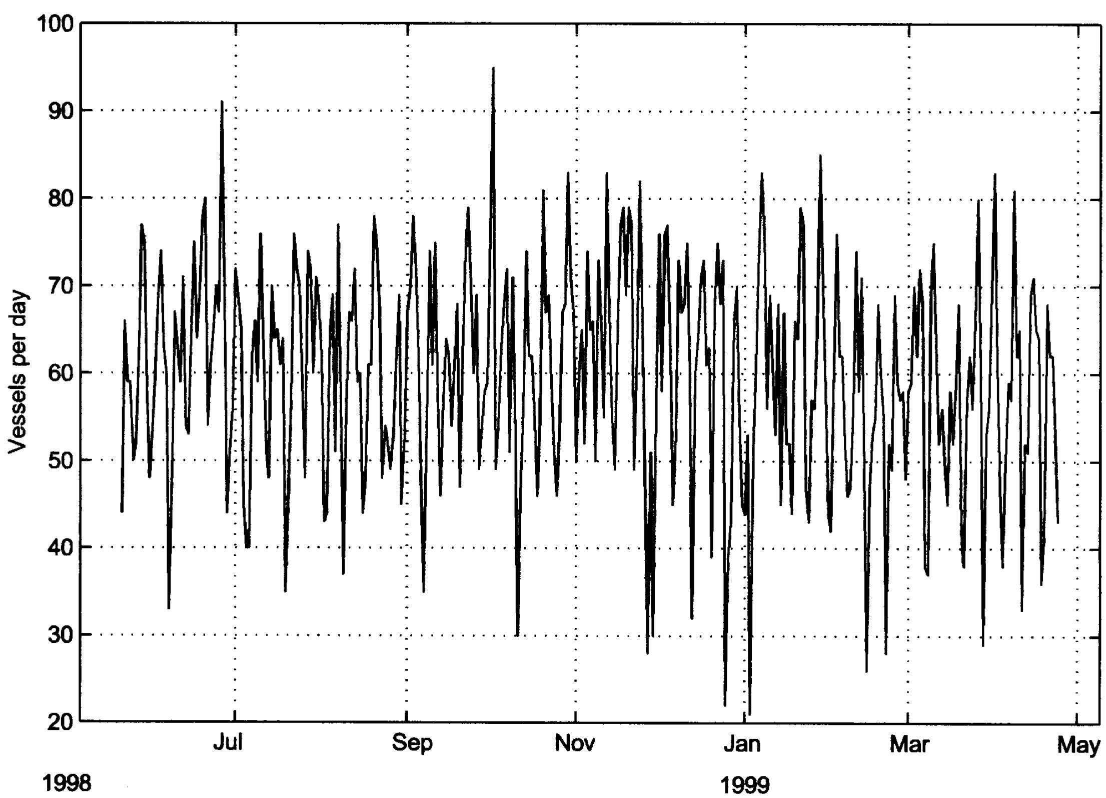


Figure 2-8. Daily vessel counts in the East River, May 1998 to April 1999, showing day-to-day variability. Source: U.S. Coast Guard VTS.

2.4 Day-by-day variability in river traffic

Although there is little variation in the month-by-month commercial river traffic, as shown previously in Figure 2-5, there is considerable variation day by day, as shown by the fluctuations in Figure 2-8 for the more recent period May 1998 to June 1999. In this period, the range of the daily number of vessels is shown for months of the year in Figure 2-9. There is little difference in the mean and median number from month to month, on the order of 59 vessels per day. However, there appears to be a seasonal change in the minimum number of vessels per day. The minimum is higher in summer, with a local peak of 43 in May, and lowest in the winter months of January and December with a little more than 20 per day. The maximum number holds at about 80 per day, except for local peaks in June and October.

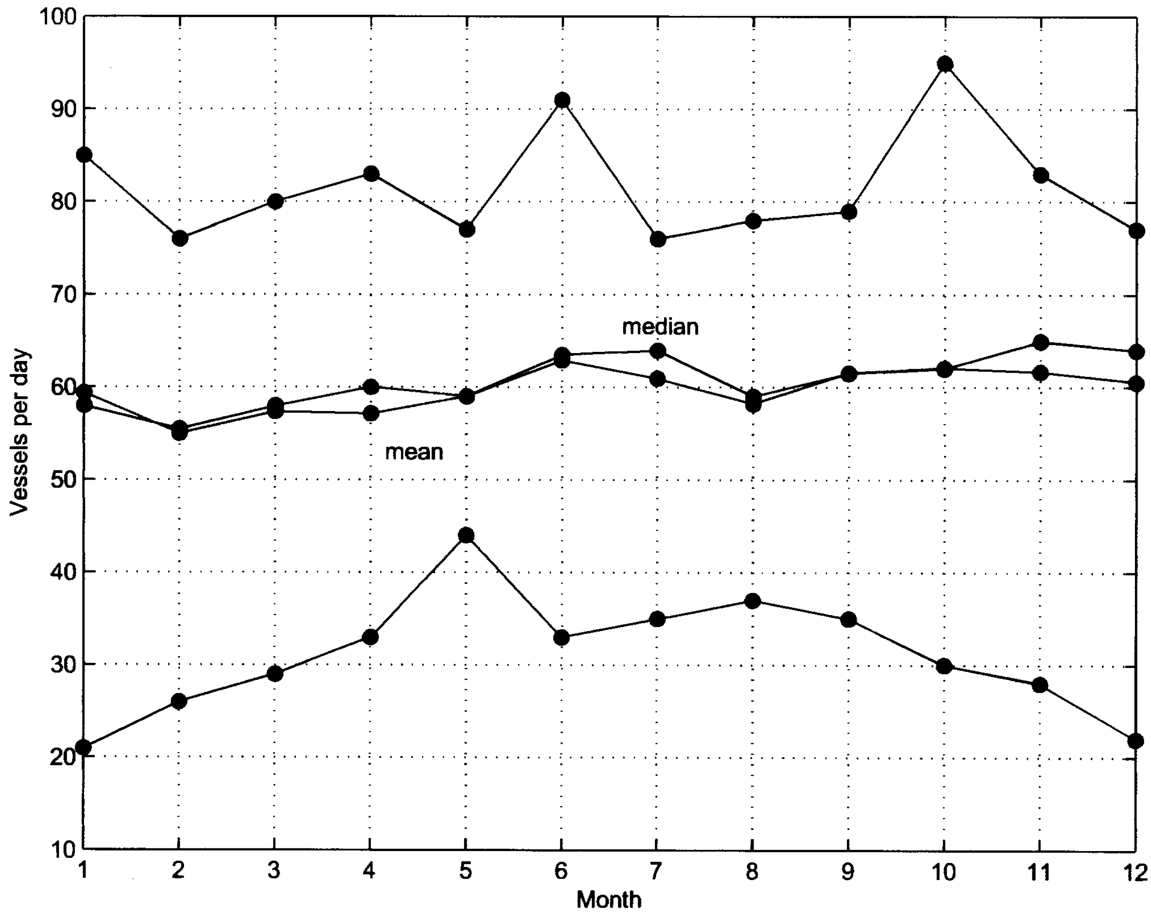


Figure 2-9. Mean, median and range of daily vessel counts on the East River, May 1998 to April 1999. Source: U.S. Coast Guard VTS.

Note that these data recorded by the Coast Guard VTS system, averaging about 59 vessels per day, or 1,800 vessels per month, are lower than those reported to the Corps of

Engineers which, excluding ferries, averaged 4,270 per month in 1997. Evidently, the VTS system tracks about half of the vessels that report to the Corps.

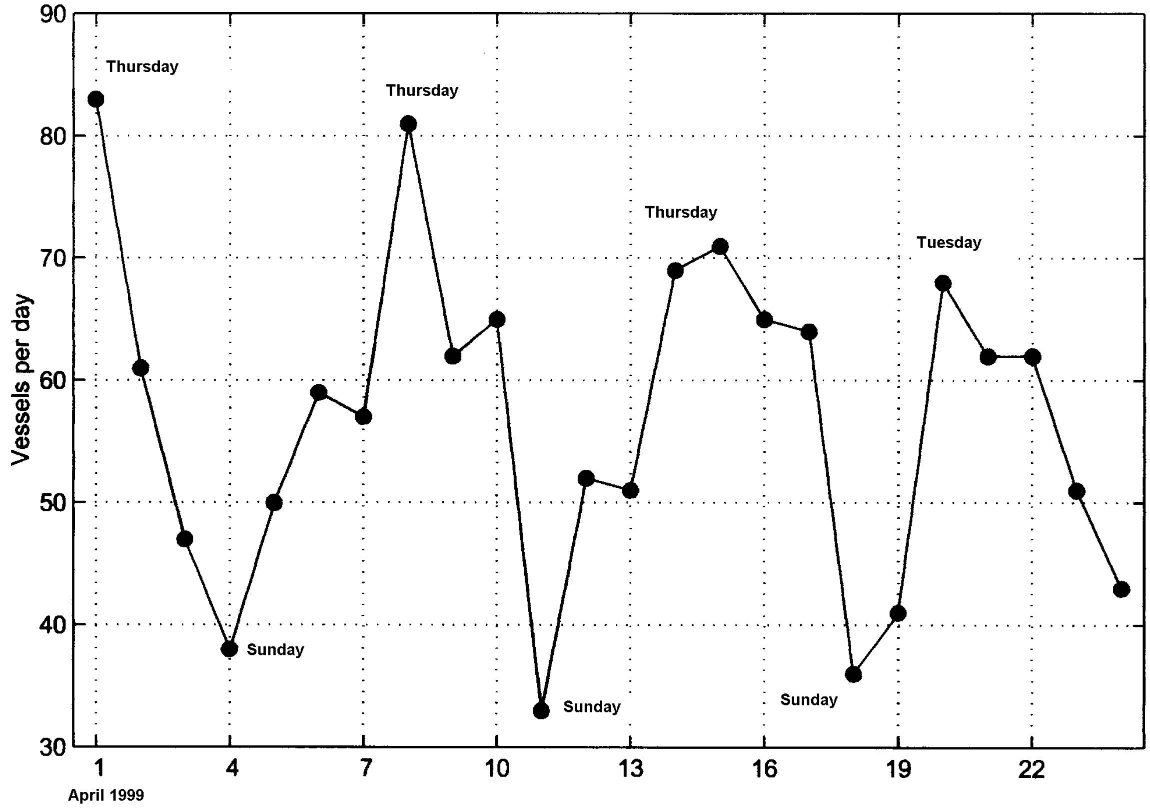


Figure 2-10. Daily traffic count, April 1999. Source: U.S. Coast Guard VTS

A weekly pattern in the number of daily trips is evident in Figure 2-10 for the month of April 1999. Traffic peaks on three successive Thursdays, April 1, 8, and 15, then a Tuesday, April 20, and declines to a minimum on Sundays, April 4, 11, and 18.

2.5 Samples of Daily Traffic by Type of Vessel

The VTS date base does not afford a description of the variations in vessel arrival rates throughout the day and the dependence on tidal current phase. Nor does it include recreational traffic. To complement the Corps and Coast Guard data on commercial traffic, we made minute-by-minute observations of all river traffic at the three proposed sites for tide gates. The minute-by-minute data is used in Section 5 to estimate the delays in river traffic that would be occur as vessels pass through navigation locks when the tide gates are closed.

River traffic was characterized at the three sites, shown in Table 2-2, on winter and summer weekdays and weekends. The summer weekends were Labor Day weekend in 1998 and July 4th, 1999. Most striking is the difference in recreational traffic between winter and summer. On the two summer holiday weekends, pleasure boats accounted for 79 to 96 percent of the total limited the traffic. On summer weekday they ranged

Table 2-2. Daily number of observed vessels by type, winter and summer weekends and weekdays.

Number of vessels -- winter and summer weekends and weekdays

	Winter weekend	Summer weekend	Summer weekend	Winter weekday	Summer weekday
Lawrence Pt	13 March 1999	5 September 1998	4 July 1999	18 March 1999	18 August 1999
Recreational	4	350	228	13	62
Commercial	24	21	16	35	14
Sightseeing	0	2	0	0	2
Ferry	0	12	0	18	10
Government	4	12	6	4	11
TOTAL	32	397	250	70	99
Duration	*12 hours*	*12 hours*	*6.5 hours*	*9.75 hours*	*7.5 hours*
College Point	20 March 1999	5 september 1998		17 March 1999	18 August 1999
Recreational	16	448		9	91
Commercial	13	16		24	21
Sightseeing	0	0		0	2
Ferry	0	0		0	0
Government	6	0		0	8
TOTAL	35	465		33	122
Duration	*11 hours*	*11 hours*		*9 hours*	*6 hours*
Midtown	14 March 1999	5 September 1998		19 March 1999	18 August 1999
Recreational	0	248		4	25
Commercial	29	29		23	13
Sightseeing	4	19		5	11
Ferry	2	3		45	4
Government	5	14		4	3
TOTAL	42	314		81	56
Duration	*12 hours*	*11.5 hours*		*10.5 hours*	*2.25 hours*

from 43 to 66 percent. On winter weekends, recreational traffic ranged from none at Midtown to 46 percent at College Point. On winter weekdays, from 5 percent at Midtown to 27 percent at College Point.

Ferry traffic was most evident on weekdays at the Midtown site where trips back and forth between Manhattan and Queens were observed: more than half the sightings on a winter day. Ferries accounted for from 10 percent, in summer, to 26 percent, in winter, of the traffic on weekdays at Lawrence Point. No ferry traffic and almost no sightseeing traffic was observed at College Point.

The *number* of commercial vessels was of the same order year round, weekdays or weekends, ranging from 1.2 to 3.6 vessels per hour (in both directions) with median values of 2.2 to 2.4. (This excludes the summer weekday report at Midtown when circumstances limited the sighting to 2¼ hours.) The mean values for observed commercial traffic excluding sightseeing vessels and ferries, shown below in Table 5-1, are lower than 2 vessels per hour.

By comparison, the year-round Coast Guard VTS data reported above for the entire East River is equivalent to 2.48 vessels per hour. The Corps data is equivalent to 5.85 vessels per hour. The Corps data can be broken down as follows: 1.8 vessels per hour coastwise, 0.6 internal, and 3.45 intraport. How many of these trips pass through the tide gate sites cannot be identified in the published data.

The number of government boats ranged from none up to 14 per day.

To visualize the typical differences in observed traffic between winter and summer weekends and weekdays, Figure 2-11 shows pie charts for Lawrence Point.

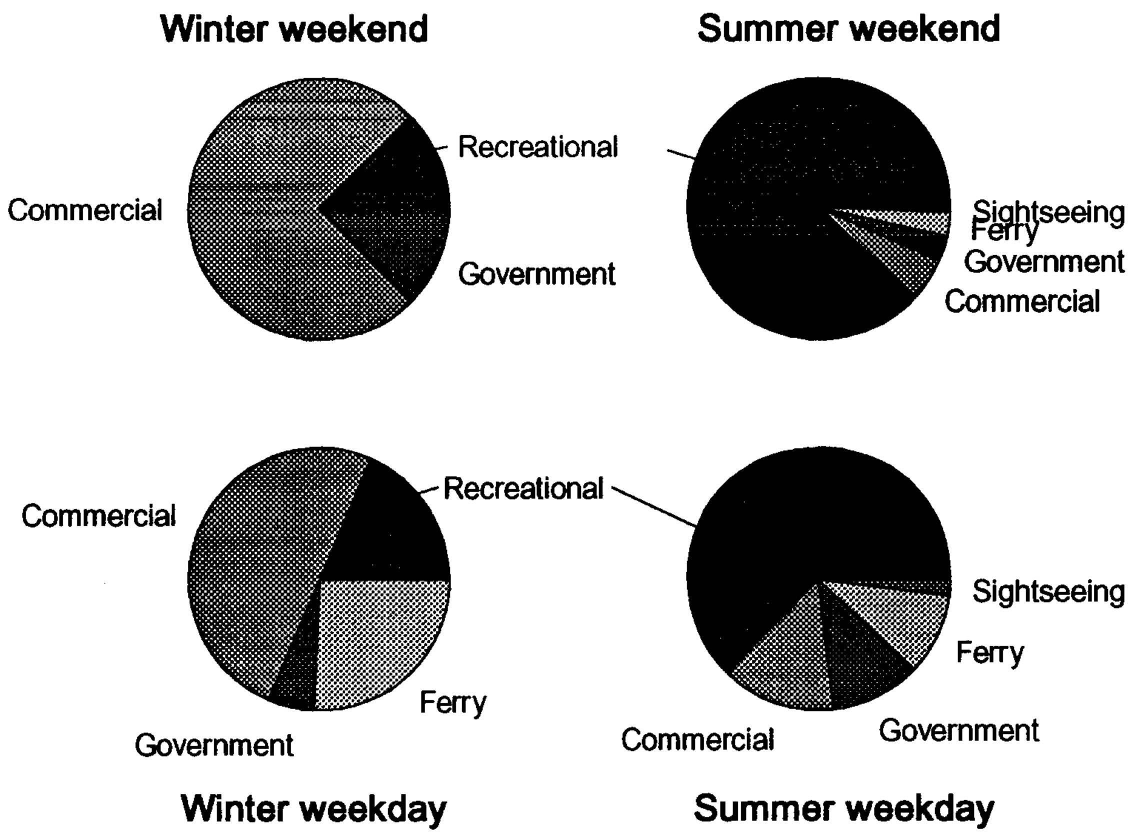


Figure 2-11. Distribution of observed river traffic at Lawrence Point, summer and winter weekends and weekdays.

3 TRADE-OFFS IN LOCATION OF TIDE GATES

Three candidate sites were identified by the two engineering firms that prepared conceptual designs of the East River tidal barrage for the 1993 conference:[1,2]

- Midtown location in the vicinity of 37th Street, Manhattan, and 51st Avenue, Queens
- From Lawrence Point, Queens, to Randalls Island Park (Sunken Meadow)
- From College Point, Queens, to Clason Point, The Bronx.

This section compares the three sites from the standpoint of the operational feasibility of East River tide gates. The locations are shown in Figures 3-1, 3-2, 3-3 and 3-4.

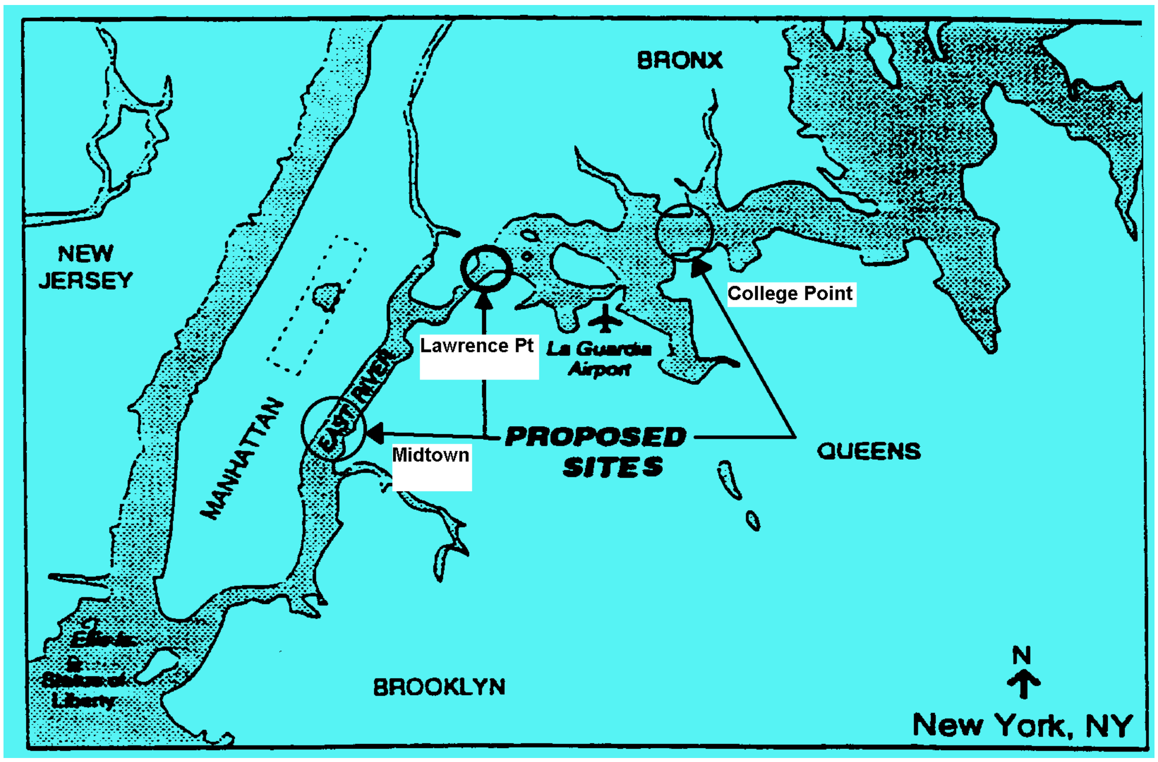


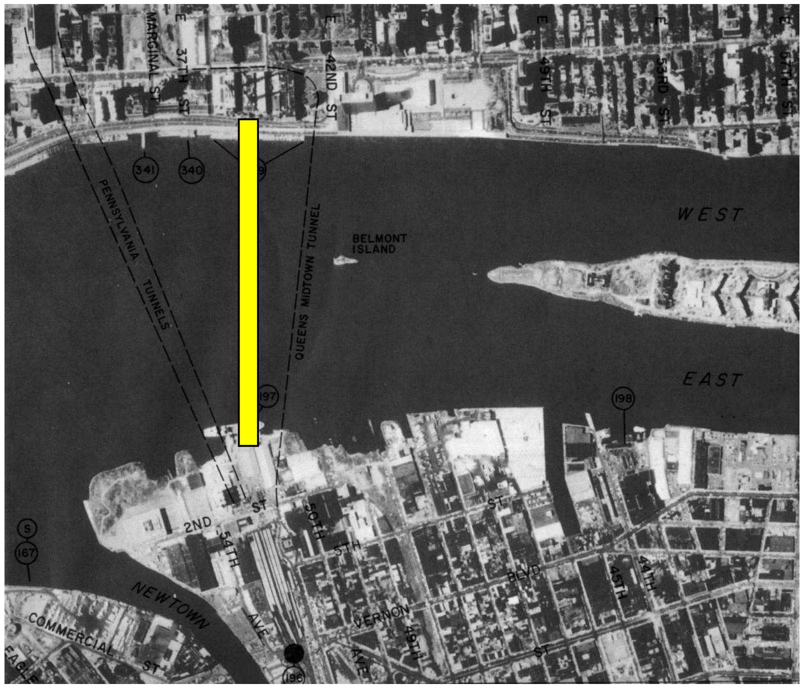
Figure 3-1. Locations of the three candidate sites.

From the standpoint of the improvement in water quality due to the operation of tide gates, the effect of the three locations would be essentially the same because they all achieve the same flushing action through the river. There would be some minor difference due to the diffusion of wastewater from treatment plants located on the river toward Long Island Sound when the tide gates are closed. The treatment plant closest to Long Island Sound is Tallman Island which is upstream of all three sites. A total of three wastewater treatment plants are upstream of the Lawrence Point site, and four of the

---

[1] M.J. Abrahams and A. Matlin. East River tidal barrage. In D. Hill (ed.) The East River tidal barrage: a symposium on a multipurpose addition to New York City's infrastructure. Volume 742, Annals of the New York Academy of Sciences. 1994.

[2] J.J. Szeligowski, H. Ezekian and L.H. Hixenbaugh. General concepts for and design issues related to an East River tidal barrage. In D. Hill, ibid.



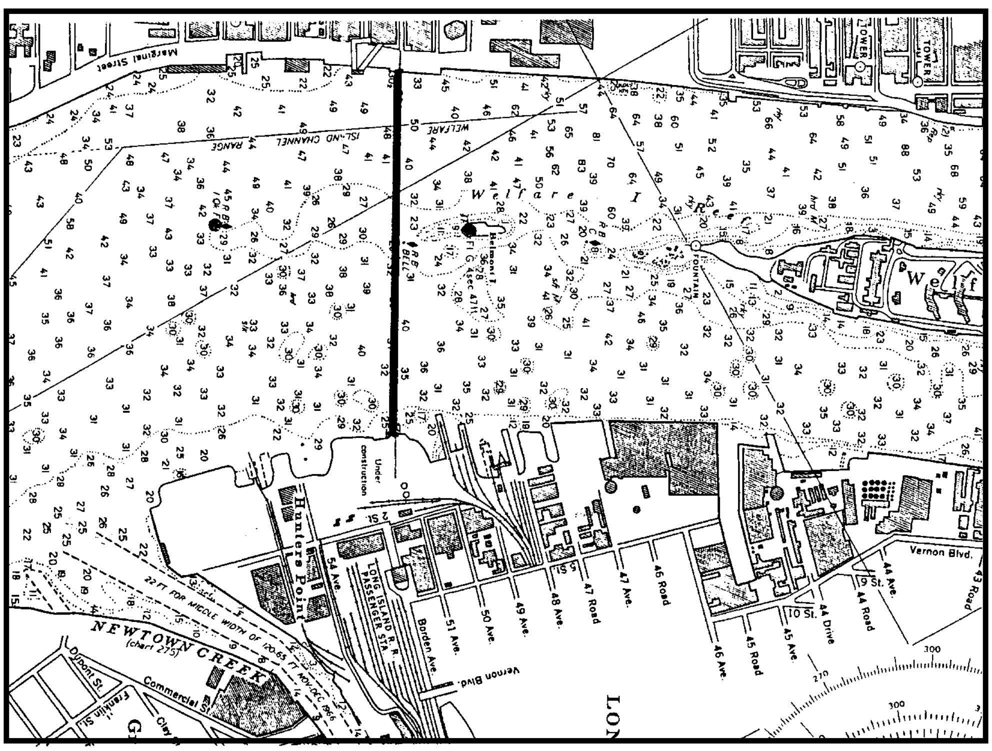


Figure 3-2. Midtown location. Sources: U.S. Army Corps of Engineers, The port of New York, NY, and NJ and ports on Long Island, NY. Port Series No. 5, revised 1988, Map 3. National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Hudson and East Rivers, Governors Island to 67th Street, Chart No. 745.

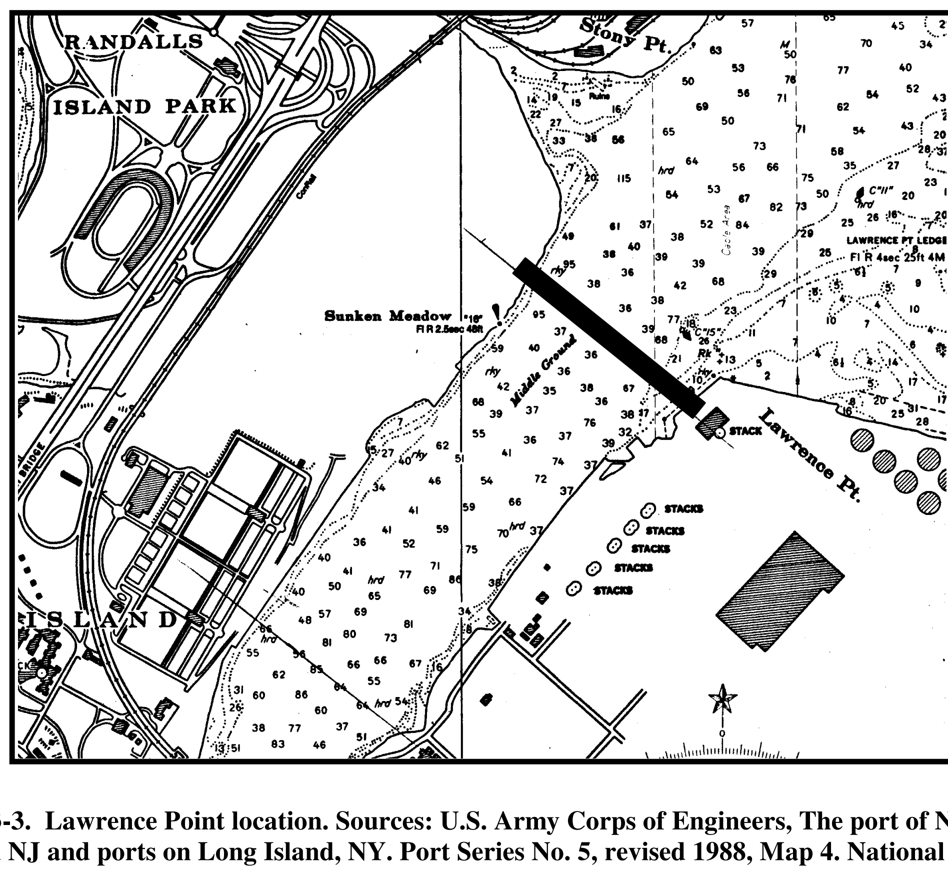


Figure 3-3. Lawrence Point location. Sources: U.S. Army Corps of Engineers, The port of New York, NY, and NJ and ports on Long Island, NY. Port Series No. 5, revised 1988, Map 4. National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Hudson and East Rivers, Governors Island to 67th Street, Chart No. 12339.

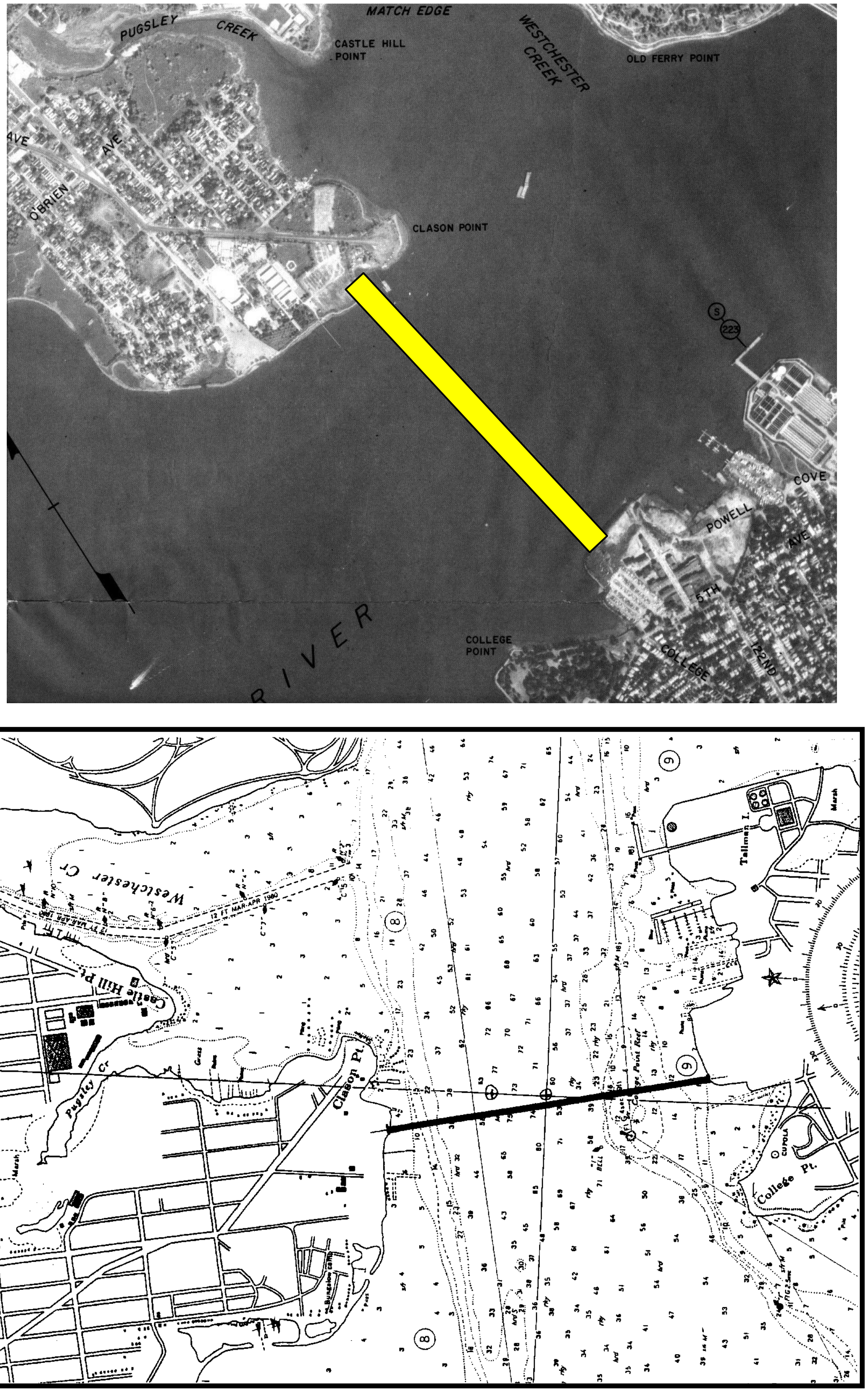


Figure 3-1. College Point location. Sources: U.S. Army Corps of Engineers, The port of New York, NY, and NJ and ports on Long Island, NY. Port Series No. 5, revised 1988, Map 4. National Ocean

Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Hudson and East Rivers, Governors Island to 67th Street, Chart No. 12339.

Table 3-1. Comparison of three candidate sites

Criteria	*Midtown*	*Lawrence Point*	*College Point*
Improvement in water quality	Great	Greater	Greatest
Flushes Harlem River also	Not with Harlem River blocked	Yes	Yes
Upstream wastewater treatment plants	Tallman Island Hunts Point Bowery Bay Wards Island	Tallman Island Hunts Point Bowery Bay	Tallman Island
River width (ft)	2,600	1,400	3,400
Maximum depth (ft)	50	74	75
Approximate cross-sectional area (sq ft)	89,000	50,000	112,000
Relative construction cost based on cross-sectional area	1.8	1.0	2.25
Constriction of river flow when open	More	Least	Most
Simultaneous closing of Harlem River mouth	Yes	Possibly, to avoid local eddies	Possibly, to avoid local eddies
Relative effect on river traffic	Catches sightseeing boats, ferry traffic to Queens and fuel tankers to La Guardia Field	Catches ferry traffic to Queens and fuel tankers to La Guardia Field	Heavy recreational traffic from Flushing Bay to LIS on summer weekends
Straight approaches	Yes	River bend 1 mile north; Hell Gate 1 mile south	Yes
Adjacent anchorages for staging/queuing	No	No	Yes
Adjacent land use	Dense urban/ commercial	Randalls Island Park/Electric power plant	"Special Natural Waterfront Areas"*
Effect on combined sewer outfalls	Not unusual	Not unusual	Not unusual
Other	In the vicinity of 3 tunnels and a pipeline under the river		
*Note: See Section 6.3			

midtown site, as listed in Table 3-1.

3.1 Turnover rates

An estimate of the rate at which water quality in western Long Island Sound and the East River is expected to improve can be made by calculating the residence times, or turnover rates, of water in bands separated by parallel north-south boundaries. For example, the residence time of a band bracketing the upper East River, from Lawrence Point to Willets

Point, is estimated by dividing the volume of water by the modified westward flow of the East River induced by the tide gates, which is approximately 2,500 m^3 sec^{-1}.[1]

This gives a measure of the time taken to replace polluted western Long Island Sound water with cleaner central Sound water. Water quality will approach that of the central Sound asymptotically, with a time scale as indicated in Table 3-2.

Table 3-2. Turnover rates by region

Region	Turnover rate (days)
Upper East River	0.5
West of Hempstead Harbor	5.5
West of Oyster Bay	15
West of Huntington Bay	32

A similar calculation for New York Harbor and the Lower Bay shows that approximately 30 percent of Harbor water will be replaced each tidal cycle, giving a turnover rate of about 1.5 days. Water quality, estimated by reductions in nitrogen, improves by about 55 percent.[2]

3.2 River Cross Sections

Approximate cross sections of the river at the three sites are shown in Figure 3-5, with the dimensions at mean low water shown there and in Table 3-1. Distances and water depths were obtained from National Ocean Service charts.[3] The river width is least at Lawrence Point, nearly twice as great at Midtown, and nearly 2½ times as great at College Point. Also, the river cross section at about 50,000 square feet is least at Lawrence Point, next at 89,000 square feet at Midtown, and largest at 112,000 square feet at College Point. Assuming that construction cost is roughly proportional to the river cross section, the relative costs at the three sites are Lawrence Point 1.0, Midtown 1.8, and College Point 2.25.

The tide gates would have to maintain the controlling depth of 35 feet, shown for reference in Figure 3-5. Assuming that the tide gate structure would allow only a rectangular opening with the gates open, it would to some degree restrict the normal flow of the river. The extent of this restriction can be visualized as the area outside a rectangle (or at Midtown, the rectangles) inscribed in the cross section above 35 feet. This restriction would be least at Lawrence Point, and probably most at College Point.

[1] Bowman, ibid., p. 541.
[2] Ibid.
[3] National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. East River: Tallman Island to Queensboro Bridge, Chart No. 12339, and Hudson and East Rivers: Governors Island to 67th Street, Chart No. 745.

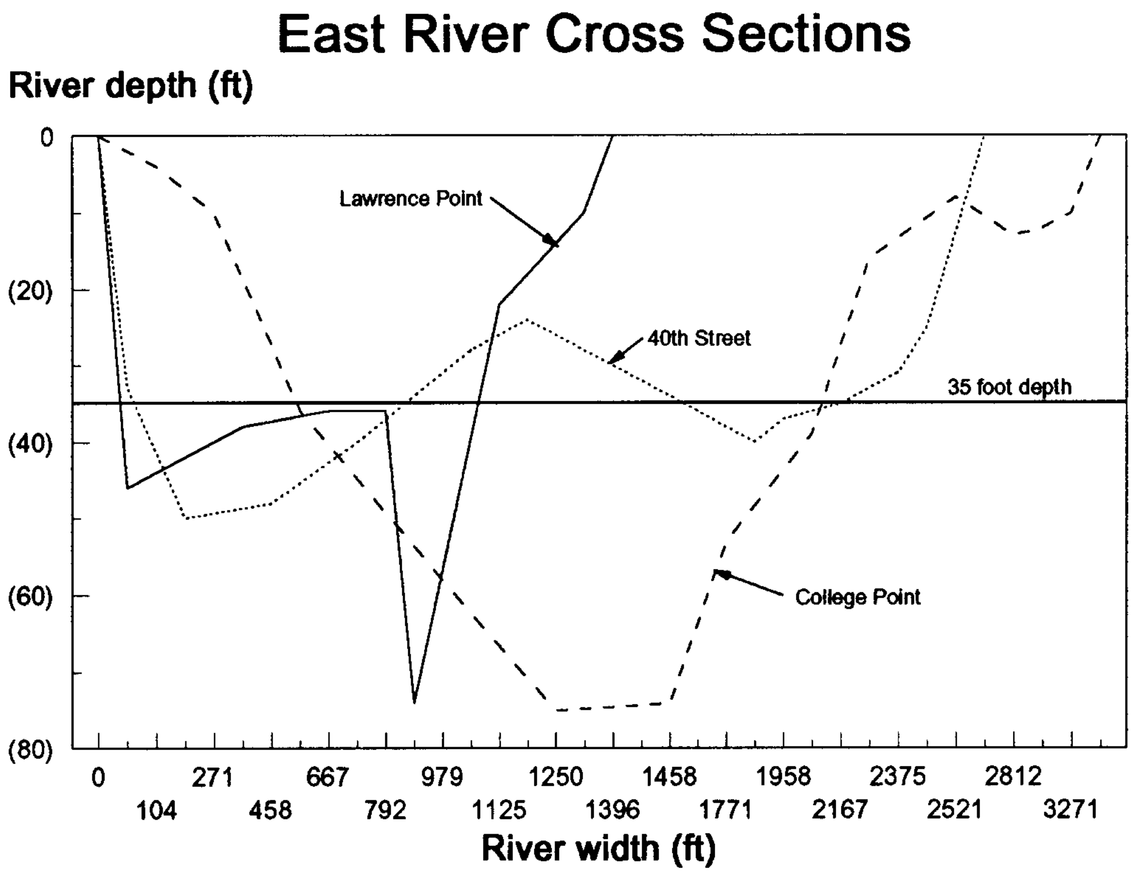


Figure 3-5. Cross sections of the East River at the three candidate sites for tide gates

3.3 Effect on River Traffic

The presence of tide gates will, of course, interfere with river traffic when the gates are closed. While about 87 percent of commercial tonnage is through traffic passing each of the three locations, there are some local variations observed in our traffic sampling. College Point catches heavy recreational traffic between marinas in Flushing Bay and Long Island Sound during summer weekends. Passing Lawrence Point without reaching College Point is some ferry traffic from lower Manhattan to Flushing Bay, and some petroleum traffic to La Guardia Field. That traffic also passes the Midtown site, as do sightseeing boats that circumnavigate Manhattan Island.

It is desirable that there be a straight channel in and out of the locks that would be used when the tide gates are closed. This is limited to about one mile in each direction at Lawrence Point, and is much longer at the other two sites.

If large vessels must wait in a queue to pass through the locks, a nearby anchorage area is likely to be needed because vessels traveling at less than about 4 knots lose rudder control. (Accompanying tugboats are used to control some stopped vessels.) Suitable anchorage areas exist on both sides of the College Point site, but not at the other two. In the absence of such anchorages, some arrangement must be made to deal with this problem.

For example, a control system could conceivably be instituted strictly to deal with traffic through the tide gate locks. The Coast Guard Vessel Transportation Service (VTS) now monitors large vessels using New York Harbor, but it does not provide traffic control in the same way an airport does. According to Coast Guard officials, such traffic control may be 25 years away (See Section 7). Alternatively, the locks may be designed with a large enough capacity to avoid, or keep to a small minimum, queuing delays. (See Section 4.3 below.)

3.4 Adjacent Land Use

The three sites differ in the nature of the adjacent land. The Midtown site has Manhattan commercial buildings on the west and commercial land in Queens on the east. The Lawrence Point site has an electric power plant in Queens on the east and Randalls Island Park on the west. The most problematic is the College Point site which abuts land on both sides designated by the city as "Special Natural Waterfront Areas" (SNWA).[4] (See Appendix 3 and Figure A3-1.)

Under the U.S. Coastal Zone Management Act of 1972, reflected in the New York State Waterfront and Revitalization and Coastal Resources Act of 1981, all discretionary land use actions and projects involving the use of federal or state funds within the mapped coastal zone boundary must be found *consistent* with the policies and intent of New York City's Waterfront Revitalization Program (WRP). This is in addition to the requirement for consistency with the New York State Coastal Management Program (CMP) and the permitting requirements of the Corps of Engineers. These requirements are discussed in detail in Appendix 3.

The WRP identifies three SNWAs, two of which bound the College Point site. These areas are regarded as having natural habitat features "that should be considered" in connection with any waterfront activity. Activities that protect and restore these features would be consistent with waterfront policy for these areas. Activities that do *not* directly foster the goals for these areas may also be found consistent, but they would be analyzed to ensure that the special characteristics of these areas are not substantially impeded or destroyed.

Under the WRP, Policy 4.1A states:

> Avoid activities that may cause or cumulatively contribute to permanent adverse changes to the ecological complexes and the natural processes (in these areas). When avoidance is not possible, minimize the impacts of the project to the extent feasible and mitigate any physical loss or degradation of ecological elements. Use

[4] R.W. Giuliani and J.B. Rose. The new waterfront revitalization program: a proposed 197a plan. NYC DCP 97-12. New York City Department of City Planning. May 1997. p. 6, 7.

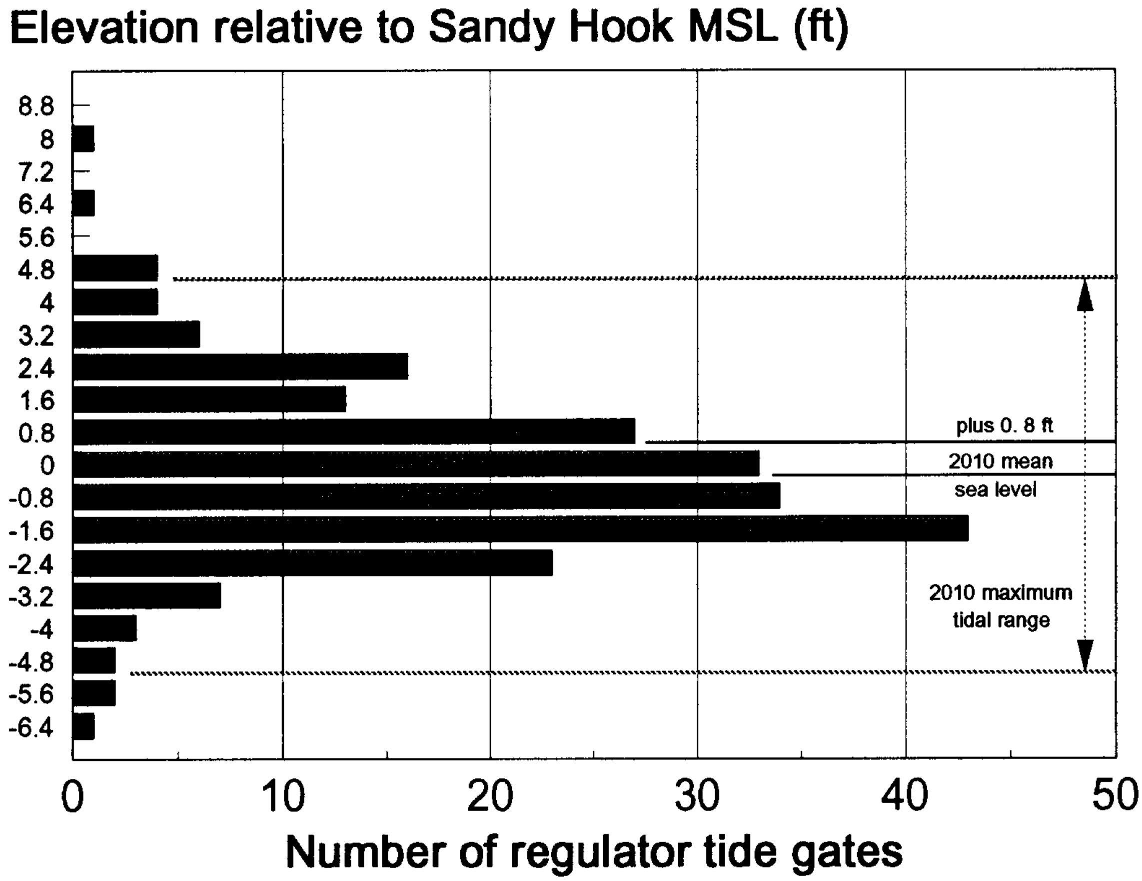


Figure 3-6. With a few exceptions, the elevation of tide gates on combined sewer outfalls emptying into the East River will be within maximum tidal range, with or without East River tide gates in operation.

mitigation measures that are likely to result in the least environmentally damaging feasible alternative.[5]

3.5 Effect on Combined Sewer Outfalls

New York City has a system of combined sewers that normally carry wastewater to treatment plants, six of which are located on the East River, but which discharge directly into the river when they are overloaded with storm water. There are 220 places along the river where the regulators are located that automatically redirect the wastewater to combined sewer outfalls (CSO) in storms. These regulators are placed approximately at mean sea level and almost all are within the normal tidal range (Figure 3-6). Small tide gates within the regulators prevent the river water from backing up into the sewers when they are below sea level.

[5] Ibid. p. 18, 19.

Operation of the East River tide gates to control river flows would affect the tidal elevations in their general vicinity. According to recent results with the Systemwide Eutrophication Model (SWEM)[6] there would be a maximum increase of 0.8 feet in maximum high water on the west/south side of the East River tide gates when they are closed. With the tide gates located in the vicinity of the Whitestone Bridge, this diminishes to 0.2 feet at Gowanus.

The question is whether this increase in maximum tidal heights would interfere with the normal operation of the regulators because of higher hydrostatic pressure on the river side. This question is analyzed in Appendix 4.

Even with an increase in maximum high water of as much as 0.8 feet, under most conditions the tidal elevations to which regulator tide gates would be subjected are within the range to which they are routinely exposed already. An increase of 0.8 feet above extreme high tides could contribute to more frequent and extensive sewer surcharge and flooding. This potential would need to be examined on a regulator-by-regulator basis.

However, the higher tidal elevations associated with operation of the East River tide gates would not necessarily have to increase extreme high tide elevations. The East River tide gates could simply be left open during tidal extremes to avoid exacerbating high tide conditions that might contribute to flooding.

[6] J.P. St. John and R.L. Miller, ibid.

4 ALTERNATIVE TIDE GATE AND LOCK DESIGNS

The purpose of this study is to determine the impact of tide gates in the East River on river traffic. To that end, we provide a brief description of tide gate designs that exist or have been proposed. Information is provided on standard procedures of the U.S. Army Corps of Engineers in the design of the navigation locks that would normally accompany the tide gates. However, we also introduce a new concept: two sets of tide gates spaced some distance apart along the river, without navigation locks. We note the extent to which the various designs would restrict river traffic. However, it is not within our scope to make a detailed evaluation of the comparative merits of the several types of design.

4.1 Alternative tide gate designs

4.1.1. Shinnecock Canal tide gates

The simplest design for tide gates is illustrated by those at the Shinnecock Canal, Long Island (Figure 4-1). The canal is spanned by three sets of tide gates and a lock for bypassing boats when the tide gates are closed. Each set of tide gates consists of two door-shaped structures, known as mitre locks, which meet when the gates are closed. The doors, rotating about a vertical axis, are opened and shut automatically by the current in the canal. When the current is flowing south, it pushes the doors open. Vessels can then use the full width of the canal. They keep to the right, those going north passing through the open lock; those going south passing through the open tide gates.

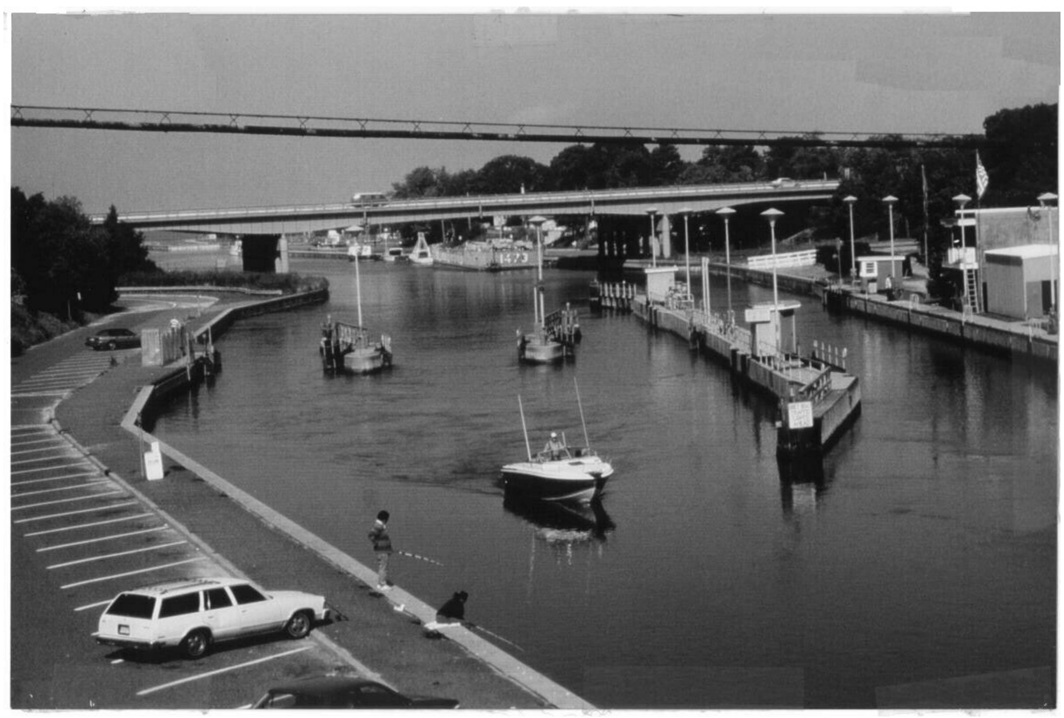


Figure 4-1. Shinnecock Canal tide gates and navigation lock, looking north.

When the current turns to flow north, it pushes the doors shut. In the shut position, the doors meet at an angle of about 130 degrees to each other and 25 degrees to the plane of the tide gates. The tide gate opening is 30 feet wide, and the gates measure 14½ feet vertically. The lock is 41 feet wide and 250 feet long, with sills 12 feet below mean low water. All boats must then “lock through,” passing through the lock, usually in groups, southbound and northbound traffic alternating in turn.

Tide gates have been in operation at this location since 1892. The present structure was built in 1968. On Labor Day weekend 1998, we counted 377 boats passing through the canal in 12 hours.

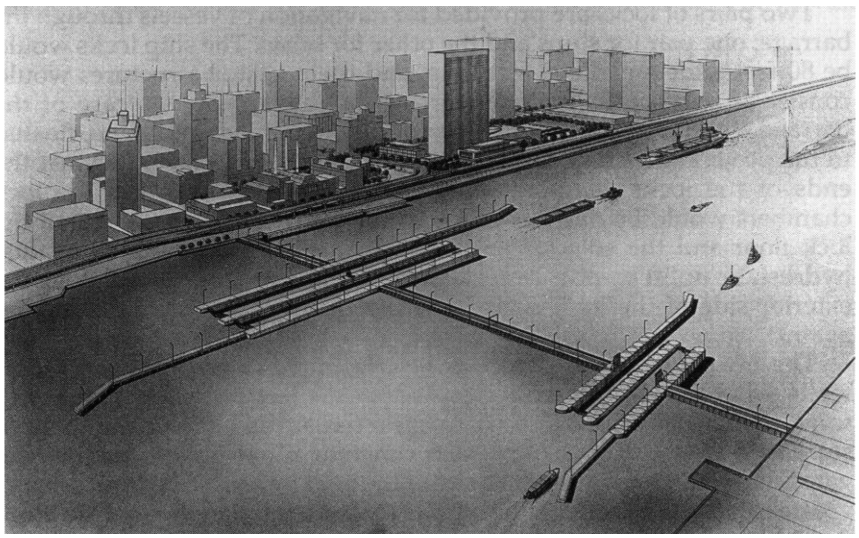


Figure 4-2. Tide gates and locks at the midtown location. Source: TAMS Consultants, Inc.

4.1.2 Passive tiered tide gates

A design suitable for the Midtown location was proposed at the 1993 symposium on the East River Tidal Barrage (Figure 4-2).[1] Like the Shinnecock gates, this is a passive system in which the gates, in this case hinged horizontally at the top, are opened and closed automatically by the river currents. The design has the following features:

- The gates would be neutrally buoyant and open when the river flows from Long Island Sound to New York Harbor
- Gates would be approximately 13 by 21 feet in area and would be arrayed in three tiers within a supporting structure
- A gantry crane would be available to pull the gates for maintenance
- A typical gate structure would be constructed of reinforced concrete and could house four gate sets
- The gate housing structure could be built in graving docks such as those found at the nearby Brooklyn Navy Yard
- Once a gate structure has been completed, it would be floated into place and founded on a prepared level bed of crushed stone or sand

[1] J.J. Szeligowski, H. Ezekian and L.H. Hixenbaugh, ibid. p. 118ff.

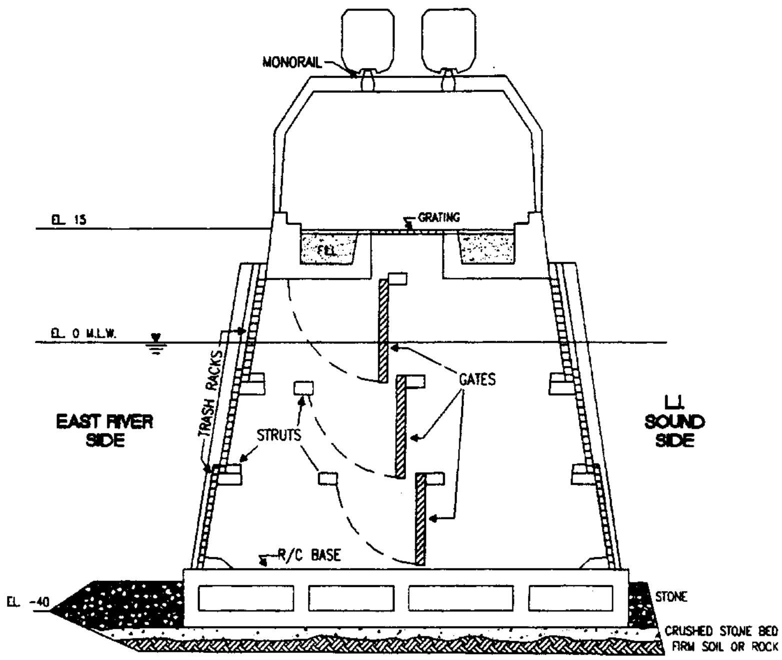


Figure 4-3. Typical cross section of the passive tiered tide gates, with a structure for monorails superimposed. Source: J.J. Szeligowski, H. Ezekian and L.H. Hixenbaugh.

In Figure 4-3, the basic concrete frame is shown in section with two maintenance roadways on top and a grating covering the space through which the gates would be pulled for maintenance. The tide gate structure could be used as the foundation for a bridge, for example, or a light rail transit system. Indeed, the midtown location was chosen for the symposium design to illustrate the possibility of this combined use of the tide gate structure.

All river traffic would pass through ship locks accompanying the tide gate structure. Two locks were envisioned: one for large vessels and one for small boats. As with all other systems, the gates and locks would be closed on the flood tide. Vessels would need to lock through to the different water elevation on the other side. With the current flowing south on the ebb tide, the locks would remain open, and all vessels would pass through the open locks. With only the width of the locks to pass through, however, this design would restrict river traffic more than the other designs.

4.1.3 Buoyant slab tide gates

A design for buoyant tide gates at the Lawrence Point location was proposed at the symposium on the East River Tidal Barrage (Figure 4-4).[2] The design is patterned after

[2] M.J. Abrahams and A. Matlin, ibid. p. 111.

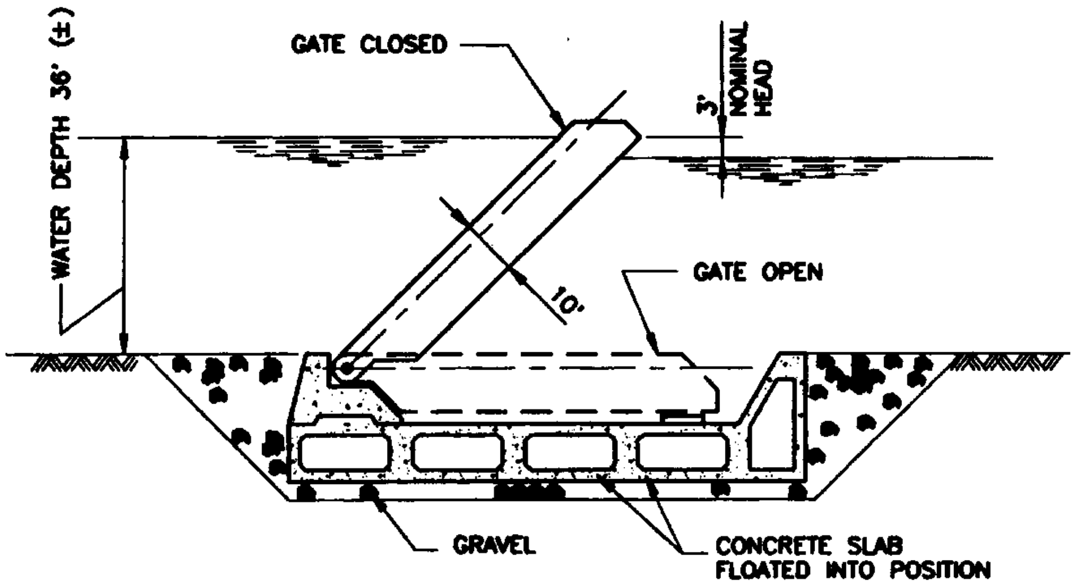


Figure 4-4. Cross section of proposed buoyant slab tide gates. Source: M.J. Abrahams and A. Matlin.

tide gates developed and tested for Project Moses (not Robert), a plan to protect Venice, Italy, from recurring flooding. The project would deploy a series of hinged flaps underwater at the entrances to the lagoon where Venice is located. Normally, they would be invisible, lying beneath the water, but when tides become high enough they could be raised within an hour to seal off the lagoon. A prototype of the Italian structure has been built and tested. However, Project Moses, which has been around for about 20 years, has recently again been postponed for reasons that do not have to do with the technical feasibility of the buoyant tide gates.[3]

As proposed at the symposium, the East River gates, or rather the sections of a continuous barrier, lay flat on the bottom when open. There are no piers or other structures extending above the bottom, so when the gates are open they are not in evidence. To raise the gates, air is pumped into them. When floating, the gate sections, which are assumed to be 100 feet long, are sealed at overlaps with rubber gaskets for water tightness. In the raised position, the gates float at an angle of approximately 45 degrees above horizontal. This angle may be controlled, if necessary, by the amount of ballast water that is left inside the gate.

The gate foundations would be constructed using immersed caissons floated into position and installed on a gravel bed in a screeded trench. This type of construction has been used to build a number of structures, including the 63rd Street tunnel under the East River and the IRT tunnels under the Harlem River.

A clear advantage of the buoyant tide gate design is that it would eliminate any river obstruction when in the lowered position. In our meeting with the East River

[3] M. Specter. A sinking feeling; doesn't Venice want to be saved? The New Yorker. July 12, 1999. pp. 40-43.

Subcommittee of the Harbor Operations Committeee, they made it clear that they would prefer having no obstruction in the river with the tide gates open.

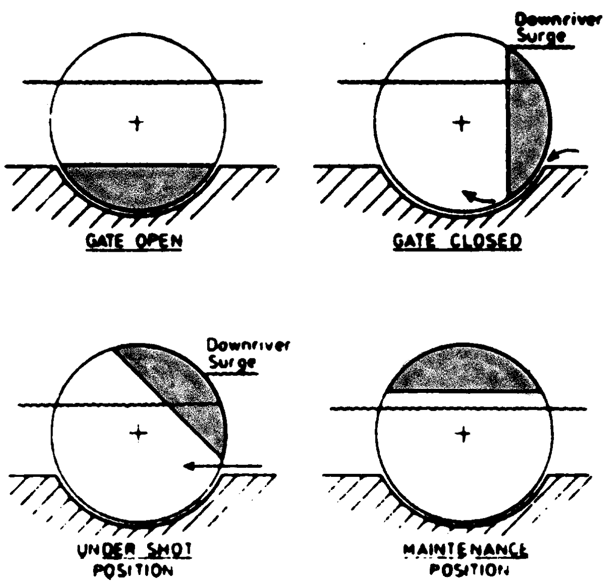


Figure 4-5. Thames Tidal Barrier. In cross section, each tide gate is a segment of a circle. The gate spans the distance between two circular supports attached to piers in the river. These supports can rotate around an axis that is below water level. When open, the gate lies flush with the bottom of the opening through which the river water passes. The gate is rotated 90 degrees to close it. Rotating the gate more than 90 degrees to the undershot postion opens a space below the bottom of the gate that would allow a controlled flow of water from the high-water side, as illustrated above. For maintenance, the gate is rotated to the overhead position.

4.1.4 Thames Barrier type

An alternative suggested in the East River Tidal Barrage proceedings is similar to the Tidal Barrier in the Thames River, below London, England, designed to be closed when a storm surge coming up the river threatens to flood London.[4] A portion of the Thames Barrier is illustrated in Figure 4-5 together with a diagram showing how the gates can be positioned.

The Thames Barrier extends 1,700 feet from shore to shore with four main spans of 200 feet each. Each gate is a hollow steel-plated structure over 65 feet high, weighing with counterweights about 3,700 metric tons. The gates take 30 minutes to close (too long for East River tide gate operations).

The variation on this idea examined in the proceedings for the Lawrence point site is shown in Figure 4-6. In this design, the axis is below water level and the gates are buoyant, filled with water to open and pumped out to close. The gates are 200 to 250 feet long, supported by piers in the river.

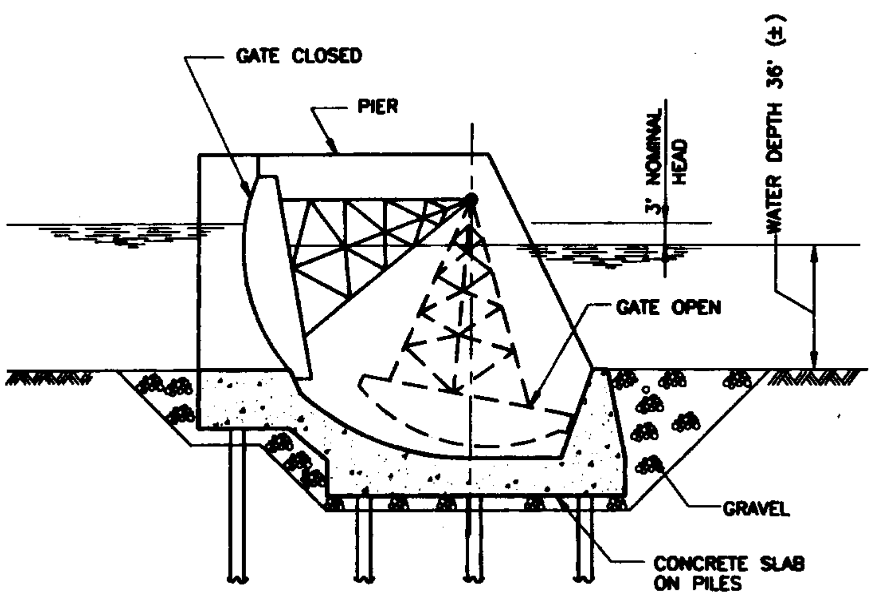


Figure 4-6. Variation on the Thames Barrier type, with buoyant gates. Source: M.J. Abrahams and A. Matlin.

The report notes that there is potential for silt and debris accumulation to interfere with lock operations. The method for silt and debris removal would have to be developed in the project design process.

From the standpoint of interference with river traffic, the piers in the river in this design present more of an obstacle than the buoyant slabs but less than the passive tiered tide gates.

[4] M.J. Abrahams and A. Matlin, ibid. p. 111, 112.

4.2 Navigation locks

In each of the tide gate designs described above, navigation locks would be provided to allow vessels to pass through the structure when the locks are closed. The locks proposed with the midtown passive tiered tide gates would be a ship lock 80 feet wide and 1,000 feet long, and a boat lock 25 feet wide and 325 feet long. At the Lawrence Point site, the suggested dimensions for the ship lock are: 115 feet wide, 750 feet long, and 35 feet deep; for the barge lock: 70 feet wide, 400 feet long, and 18 feet deep.

4.2.1 Corps of Engineers lock designs

Standard practice of the Corps of Engineers for designing navigation locks is described in two engineering manuals.[5,6] Lock design is seen as a multidisciplinary activity consisting of four topics:[7]

- Navigation system studies concerning the interdependency of waterway, vessel, and commodity characteristics
- Navigation transit time studies concerning the problem of expeditiously moving vessels through the locks
- Chamber alternative studies concerned with the optimum dimensions and number of chambers based on economic and physical factors, and
- Geotechnical and structural studies to identify chamber location and type of structure.

For the design of deep-draft navigation projects, a "design ship" is characterized. By international practice, it may not be the largest ship to use the facility, for large ships are often accorded the greatest attention and are subject to special rules of operation.[8] More than one design ship may be necessary. By Corps practice, the design ship is chosen as the maximum or near the maximum size ship in the range of ship sizes from the vessel fleet.[9]

By Corps standards, the following factors should be considered during economic, capacity, and design studies for lock configuration:[10]

- Visibility
- Ease of approach
- Few lockage restrictions, such as double lockages
- Provisions for prompt lockage
- Adequate approach channel with low velocities

---

[5] U.S. Army Corps of Engineers. Planning and design of navigation locks. EM1110-2-2602. 30 September 1995.
[6] U.S. Army Corps of Engineers. Hydraulic design of navigation locks. EM 1110-2-1604. 30 June 1995.
[7] EM 1110-2-1604, p. 2-1.
[8] Approach channels: a guide to design. Final report of the Joint PIANC-IAPH Working Group II-30 in cooperation with IMPA and IALA. June 1997. p. 11.
[9] EM 1110-2-1613, p. 3-12.
[10] EM 1110-2-2602, p. 3-3.

- Elimination of crosscurrents that would tend to draw vessels away from the lock entrance
- Duplicate gates or closure to prevent downtime due to emergency and accident
- Elimination of lockage in congested areas
- Adequate horizontal and vertical navigational clearances for bridges at or near locks
- Adequate mooring facilities and maneuvering areas.

4.2.1.1 Lock sizes

Standard Corps lock sizes are either 84 or 110 feet in width and 600, 800, or 1,200 feet in length.[11] Most of the locks built in the United State since 1950 are 84 by 600 feet, 110 by 600 feet, or 110 by 1,200 feet, although a number of locks of other sizes have been built.[12] Locks having usable lengths of 400 feet or less are considered "recreational locks", although they may also be used by limited small-tow and special commercial vessels.[13] Recreational traffic also uses locks designed for either shallow-draft (barge) or deep-draft (large ship) traffic.[14]

The majority of Corps lock chambers are for commercial tows with drafts of 14 feet or less, 9 feet being the most common. Lower sill submergence values for oceangoing ships built by the Corps are shown in Table 4-1.[15]

Table 4-1. Lower sill submergence values for locks built by the Corps for deep-draft ships

Navigation system	*Lock name*	*Normal lower sill submergence (ft)*
Gulf Intracoastal Waterway	Inner Harbor	31
Lake Washington Ship Canal	Chittendon (large)	29
	Chittendon (small)	16
St. Marys River, South Canal	MacArthur	31
	Poe	32
St. Marys River, North Canal	Davis	23.1
	Sabin	23.1

Corps navigation locks are classified by the height of the lift as shown in Table 4-2.[16]

Table 4-2. Classification of Corps of Engineers navigation locks by lift

Range of maximum design lift (ft to ft)	*Project classification*	*Percent of Corps locks*
0 to 10	Very low lift	25%
10 to 30/40	Low lift	60%
30/40 to 100	High lift	15%
100 to __ (undefined)	Very high lift	(1 lock of 107-ft lift)

[11] EM 1110-2-2602, p. 3-7.
[12] EM 1110-2-1604, p. 2-5.
[13] EM 1110-2-1604, p. 2-6.
[14] EM 1110-2-1604, p. 2-3.
[15] EM 1110-2-1604, p. 2-5.
[16] EM1110-2-1604, Table 1-1.

For very low lift locks, end filling-and-emptying systems are considered suitable. Each of the three general types (gate, valve(s)-in-gate, and loop culvert) can normally provide satisfactory chamber conditions. The choice of type is influenced by economic, operational, and layout factors.

The sector gate (Figure 4-7) has been used exclusively for Corps very-low-lift designs since 1950. Sector gates can be opened or closed under a head because the total hydrostatic force on the cylindrical surface of the gate is always aimed at the hinge. They can be designed to withstand head from either direction and are very useful at a tidal lock or at any situation where reversal of head occurs.[17]

Figure 4-7. Sector gates under construction. Vermilion Lock, Gulf Intracoastal Waterway, with design lift of 3 feet. Sector gates have been used exclusively for very-low-lift locks by the Corps since 1950. Source: U.S. Army Corps of Engineers, EM 1110-2-1604, p. 2-10.

[17] EM 1110-2-2602, p. 7-2.

The maximum lift required for East River locks is determined by the maximum difference between high and low water. This difference is highest at Willets Point, nominally 6 feet, although it may be higher depending upon meteorological conditions. For lifts approaching 10 feet, the Corps recommends for conservative design using the practice for low lift, rather than very low lift, locks.

For low lift locks, the best suited filling-and-emptying system are wall culverts with side ports. The auxiliary system using lateral manifolds is suitable for low-lift projects requiring one culvert lock operation.

Concerns in the hydraulic design of the filling system are the turbulence of water initially rushing in and "overtravel" at the end of the filling cycle causing the water level in the lock to exceed the desired level.

4.2.2 Lock transit time

Transit time, the time required for tows to transit the locks, is defined by the Corps as the total time required for a tow to move into a lock from a waiting point, be raised or lowered, and then proceed out of the lock to a position where it will not interfere with any other tow that needs to transit the lock. Transit time includes:

- Time required for a tow to move from an arrival point to the lock chamber
- Time to enter the lock chamber
- Time to close the gates
- Time to fill or empty the locks
- Time to open the gates
- Time for the tow to exit from the chamber
- Time required for the tow to reach a clearance point so that another tow moving in the opposite direction can start toward the lock, and
- Time required for break down, locking through, and reassembling a tow that is too large for the lock chamber.

Operation time is defined by the Corps as the time required to fill or empty the chamber to the value used for project authorization. Decreased operation time reduces total transit time unless surges and currents in the approaches adversely affect entry and exit conditions. By means of model and prototype tests and design studies, filling-an-emptying systems have been developed that achieve operation times near 8 minutes. Operation time in existing systems may vary between 8 and 10 minutes for low-lift and 8 and 12 minutes for high-lift projects.[18]

For a single lockage at modern locks, operation time constitutes about 25 to 40 percent of total transit time.[19] Thus, total transit time for low-lift locks may vary between 20 and 40 minutes. This does not include the time that may be spent in a waiting queue.

4.3 Twin tide gates without locks

[18] EM 1110-2-1604, p. 2-4.
[19] Ibid.

As an alternative to constructing one or more locks alongside the tide gates, river traffic can be passed through by placing a second set of tide gates some distance downriver and using the river itself as a lock. In the narrow passage between Lawrence Point and Hell Gate, for example, tide gates could be placed as much as a mile apart. As a vessel moved from one gate to the next, the gate could close behind him, the water level could equalize while the vessel is moving to the next gate, where it would then exit the "lock".

If a vessel were moving at 4 knots, the minimum speed for ships to maintain rudder control,[20] it would take 15 minutes to go one mile from one set of locks to the next. If the water level could equalize in that time, the vessel could pass out the other end with virtually no delay whatsoever. The concept of a tide gate system with no traffic delays was particularly appealing to the East River Subcommittee of the Harbor Operations Committee.

Even if this ideal situation could not always be achieved, however, there would be other advantages to twin tide gates:

- The "lock" would have enormous capacity, capable of accommodating a few tugs-and-barges and many recreational vessels.
- There would never be a requirement to break down and reassemble a tow that is too large for the chamber
- Vessels reaching the open side would require no time to move from the arrival point to the lock chamber. (On average, this would be half the vessels. If lock operations were regularly scheduled, however – say, on the half hour – vessels could time their arrivals to enter an open gate directly.)
- There would be no queuing delays as one vessel waited for others before it to transit the lock one at a time. The maximum waiting time would be twice the lock operation time.

Alternatively, if the river were separated into two parallel channels, as shown in Figure 4-8, the maximum waiting time would be only the lock operation time. The question is: can the water level be equalized quickly enough in a section of the river of this length for the scheme to work?

Unfortunately, it is not possible to answer this question precisely within the scope of this work. In Engineer Manual EM 1110-2-1604, *Hydraulic design of navigation locks* (p. 5-5), the Corps provides a formula for calculating lock filling time.[21] Making some

---

[20] EM 1110-2-1613, p. 3-12.

[21]

$$T - Kt_v = \frac{2\,A_L\,[(H + d_f)^{1/2} - d_f^{\,1/2}]}{nA_cC_L\,(2g)^{1/2}}$$

where

T = lock filling (or emptying) time

K = overall valve coefficient (a measure of the efficiency of the valve, typically 0.4 to 0.6)

t_v = valve opening time

A_L = lock chamber surface area in ft^2

H = initial head (i.e., lift) in ft

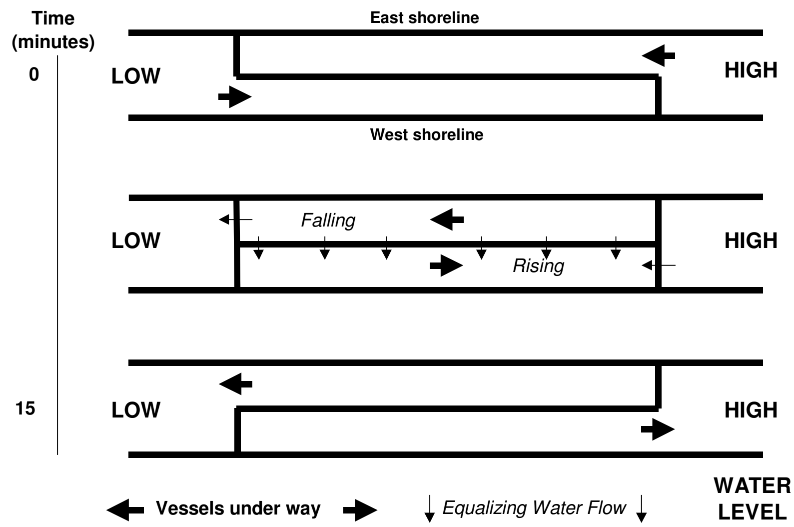


Figure 4-8. Operation of twin tide gates with parallel channels.

assumptions as to "valve opening time," "chamber surface area," and "culvert area of the valves," one can calculate that water level would equalize in one mile of river length in 10 to 12 minutes. (With two parallel channels, it would be less.) However, this formula is clearly intended to estimate the filling time in locks of conventional design, not for a length of river. Its application to our problem therefore needs modification.

The constraint on rapid filling of conventional locks is termed "chamber performance" by the Corps.[22] Acceptable performance is normally studied by means of filling and emptying operations in small-scale physical models. Typical concerns are as follows:

- *Surface currents and turbulence*. Acceptable performance requires that surface turbulence hazardous to small vessels be identified and to the extent possible eliminated
- *Drift of free tows*. The movement of unmoored vessels (from the traffic mix) must be acceptable to navigation and lock operations and not be hazardous to either vessels or structure.

With a head of 6 feet or less in the East River, the tide gates would be classified by the Corps as "very low lift," for which in conventional locks end filling-and-emptying systems are suitable.

---

d_f = overshoot in ft (estimated to be ~ 0.5 ft)
n = number of valves used, one or two
A = culvert area at the valves in ft^2
C_L = overall lock coefficient (a measure of the efficiency of the design typically ranges from 0.5 to 0.9)
g = acceleration due to gravity = 32 ft s^{-2}

[22] EM 1110-2-1604, p. 2-4.

5 TRAFFIC DELAYS VS. TIME SAVED

With the minute-by-minute traffic data compiled in our traffic observations, it is possible to estimate the traffic delays that would be experienced with the two configurations of tide gates and locks: (1) conventional locks accompanying one set of tide gates, and (2) twin tide gates without conventional locks. These delays can then be compared with the time savings that would result from transiting the East River in slack water when the tide gates are closed. We can only assume the duration of lock operation time, as discussed in Section 4, but with this assumption we can calculate the time vessels must wait to pass through the locks. The waiting time depends upon the frequency with which vessels arrive at the locks and the lock operation time.

5.1 Observed arrival rates

The mean arrival rates of recreational boats and commercial vessels, excluding ferries and sightseeing boats, in our observations of river traffic are shown in Table 5-1. A 10-minute interval was selected to match arrival rates with an assumed lock operation time of 10 minutes.

Table 5-1. Mean number of vessels arriving in one direction in a 10-minute interval.

Recreational vessels

Location	*Winter weekend*		*Summer weekend*		*Winter weekday*		*Summer weekday*	
	N/E	S/W	N/E	S/W	N/E	S/W	N/E	S/W
College Point	20 March 1999		5 September 1998		17 March 1999		18 August 1999	
	0.122	0.053	2.480	1.769	0.064	0.053	0.706	0.817
Lawrence Point	13 March 1999		5 September 1998		18 March 1999		18 August 1999	
	---	---	1.713	1.278	0.068	0.063	0.553	0.628
			4 July 1999					
			1.661	2.332				
Midtown	14 March 1999		5 September 1999		19 March 1999		18 August 1999	
	---	---	1.388	1.198	---	---	0.643	0.750

Commercial vessels

Location	*Winter weekend*		*Summer weekend*		*Winter weekday*		*Summer weekday*	
	N/E	S/W	N/E	S/W	N/E	S/W	N/E	S/W
College Point	20 March 1999		5 September 1998		17 March 1999		18 August 1999	
	0.051	0.072	0.058	0.143	0.111	0.136	0.190	0.138
Lawrence Point	13 March 1999		5 September 1998		18 March 1999		18 August 1999	
	0.140	0.148	0.097	0.253	0.197	0.187	0.143	0.098
Midtown	14 March 1999		5 September 1999		19 March 1999		18 August 1999	
	0.159	0.232	0.197	0.171	0.113	0.157	0.381	0.222

Notes: An oil spill just south of the midtown site on 5 September 1998 may distort the data on that date.
N/E to north or east; S/W to south or west.
Blanks indicate insufficient data in sample.

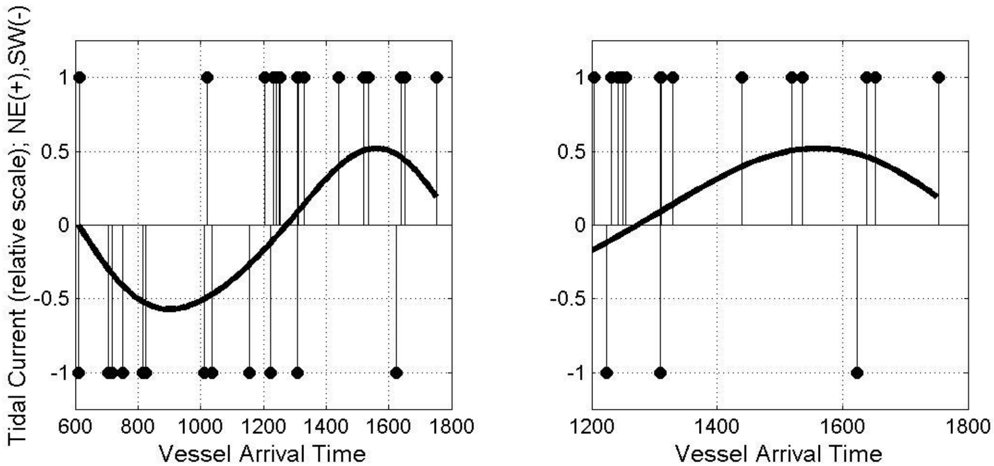


Figure 5-1. Comparison of directions of commercial vessels and tidal current, 13 and 18 March 1999.

To estimate traffic delays, we need to know the distribution of intervals between successive arrivals at the barrier as well as the amount of traffic. In our observations of river traffic, we noted the time of passage of vessels to the nearest minute, classifying it as commercial or recreational, winter or summer, weekday or weekend, and moving in a north/east or south/west direction. We did not record the direction of the current at the time. However, that can be determined from tidal records.

As examples of the commercial traffic with which we are primarily concerned, the timing and direction of vessel arrivals (vertical lines) are shown in Figure 5-1 superimposed on the tidal cycle (continuous curve). With the exception of one passage in each direction, all the vessels are either traveling with the current or within a window of slack water as the tide turns lasting about one hour and twenty minutes. The latter illustrates the tug-and-barge practice of passing through Hell Gate within this brief window of time, as described below in Section 7. Thus, although we did not explicitly note tidal direction in our observations, noting the direction of traffic amounts to essentially the same thing. No further analysis of arrival rates in relation to tidal phase was therefore needed.

With tide gates in place, there would be still water in the river half the time. The distribution of arrivals of traffic throughout the day would undoubtedly be quite different when the passage of slow vessels is not limited to a brief period of time. As a test of the delays that might be experienced, however, we assume that the present pattern of arrivals continues. Any relaxation of the present restrictions would reduce congestion on the river, and therefore also reduce traffic delays from those calculated below.

5.2 Queuing theory

Mean arrival rates are used to estimate the delays that would be experienced by the observed traffic if it were necessary to pass through navigation locks. Queuing theory is used to make these estimates. It calculates the number of vessels in a queue that might develop for river traffic arriving at a tide gate, and the associated waiting times. The two controlling parameters in basic queuing theory models are the *vessel arrival rates* and the *lock operation time*.

Queuing theory addresses the general problem of 'requests' (in this case individual vessels) coming in which have to be answered by a 'service' (in this case passage through the tide gate). In classical queuing theory it is assumed that the requests may be described as a Poisson process. A Poisson process is characterized by the single parameter λ. For intervals described by this distribution, λ represents the mean (expected value) rate of requests, and $1/\lambda$ represents the mean (expected value in a probability sense) interval between requests,. For traffic represented by a Poisson process, the probability of exactly N requests occurring within a time interval t would then be:

$$h(N)=\exp(-\lambda t)*(\lambda t)^N/N!.$$

Below we consider the implications of two relatively simply queuing models that apply to the two gate-and-lock configurations. For the theory to apply in both cases, it is necessary to assume that the arrival rate is a Poisson distribution.

In a Poisson process, arrivals are independent of each other and “evenly distributed” over time (no "rush hours"). As we have seen, there presently are rush hours during the brief period of time when there is slack water at Hell Gate. Are we then justified is using this theory? We can examine the actual distribution of arrivals to find out.

The comparison is illustrated in Figure 5-2 for *recreational* traffic. The bar chart shows the actual arrival data by 10-minute intervals. The continuous line shows the theoretical Poisson distribution with the same arrival rate. If the actual arrival rates were truly random, the two distributions would overlap. If there are “rush hours” the actual distribution would diverge in both directions. There would be more cases with vessels bunched at higher arrival rates, and therefore also more cases with very low or zero arrival rates. This is clearly the case in the upper right part of Figure 5-2 which shows the eastbound traffic at College Point on Labor Day weekend, the highest rate we observed. This can be explained by the fact that recreational vessels, particularly those that are slow-moving, take advantage of the tidal currents.

The lower part of Figure 5-2 shows the data for eastbound traffic at College Point in winter, among the lightest recreational traffic we observed. In this case, the fit to a Poisson distribution is much better.

Similarly, the fit of *commercial* traffic to a Poisson distribution shown in Figure 5-3 for typical arrival rates is very good, despite the clustering of traffic when the tide turns. With the introduction of tide gates, we would expect that the arrival rates would become more random. When the gates are closed, it would not be necessary to schedule by the direction of the tide or the brief opportunity to pass Hell Gate at slack water. Waiting times calculated on the assumption of a Poisson distribution of arrival rates should therefore be quite accurate.

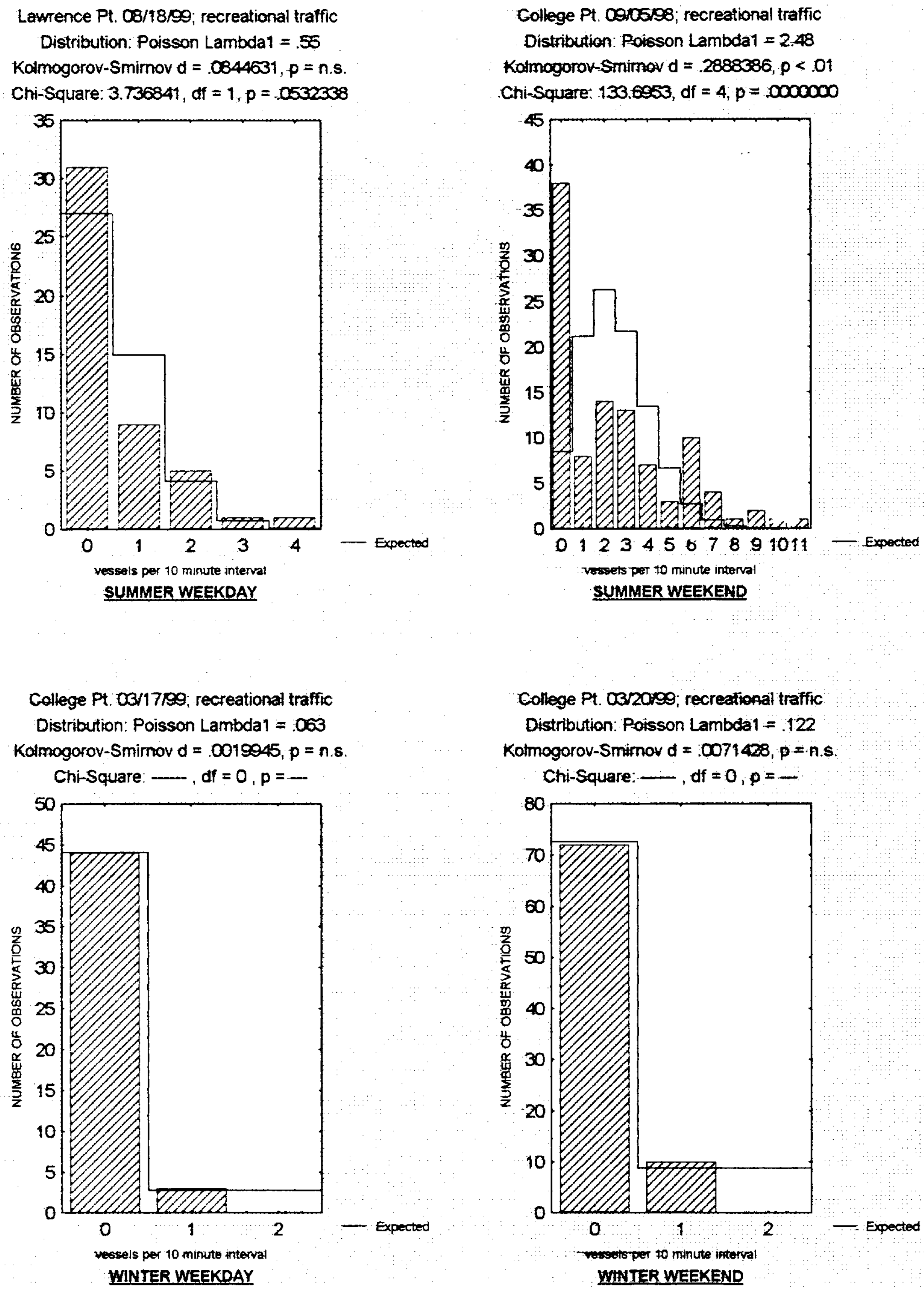


Figure 5-2. Observed arrival rate distributions and Poisson fits for recreational traffic.

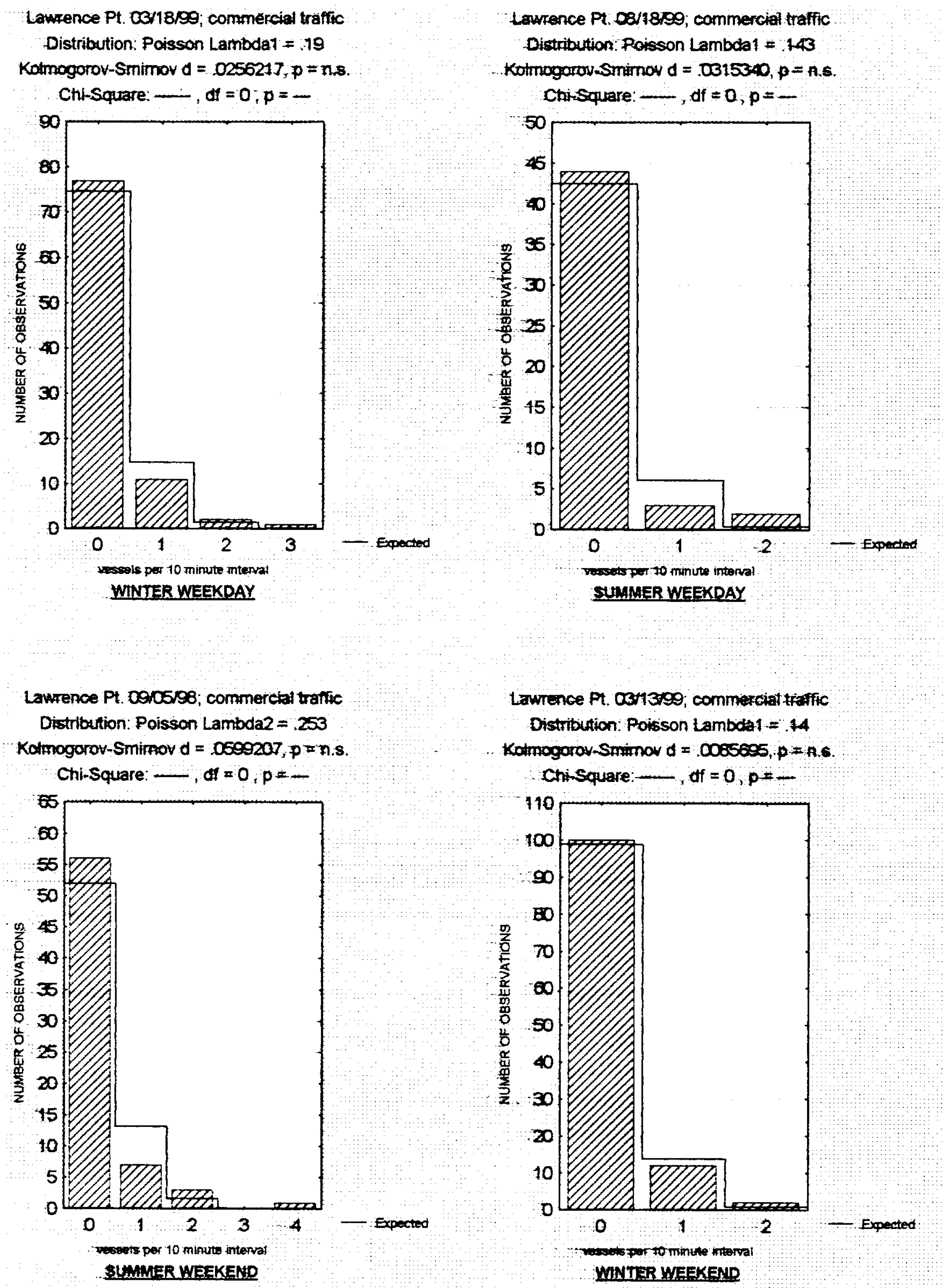


Figure 5-3. Observed arrival rate distributions and Poisson fits for commercial traffic.

5.3 Delay with conventional locks

Large commercial vessels arriving at a single conventional lock will queue up and pass through one at a time. Assuming a Poisson distribution for vessel arrivals and a lock operation time that is exponentially distributed, the average waiting time, E, spent in the queue is:[1]

$$E = \lambda / [1-\lambda]$$

where E is nondimensionalized by expressing it as a fraction of the mean service time. Figure 5-4 shows that E increases monotonically as a function of arrival rate λ in one direction. E becomes unbounded as the total arrival rate approaches the mean service time. In other words, the waiting queue would become infinitely long if the mean number of vessels arriving in the lock operation time equals one or more.

The observed data listed in Table 5-1 are shown on the curve in Figure 5-4; commercial arrivals as diamonds, and recreational arrivals as circles. Except for summer weekday data at the midtown location, which is based on a very brief period of observation, the arrival rates for commercial vessels are 0.25 or less per ten minutes. By the above equation, the waiting time is thus less than one-third the lock operation time. With one lock, the lock would have serve both directions, and the total operation time would be 20 minutes. Thus, the average queuing wait would be less than 7 minutes. With two parallel locks operating in opposite directions, the lock operation time would be 10 minutes, and the average queuing wait would be less than 5 minutes. To this wait in the queue must be added the lock operation time of 10 minutes. Thus, the time from arriving at the lock to leaving it, exclusive of maneuvering time, is 15 to 17 minutes.

If heavy summer recreational traffic were similarly limited to one vessel at a time, the waiting time would become prohibitively long. Actually, smaller recreational vessels would enter and leave the lock in groups, as they do on the Shinnecock Canal. Many boaters would simply change plans to avoid the locks. To minimize interference with heavy recreational traffic, the locks could be left open on summer weekends.

Note that this analysis takes into account only waiting time and lock operation time. There are several other elements of lock transit time listed in Section 4.2.2 that are not included, namely:

- Time required for a tow to move from an arrival point to the lock chamber
- Time to enter the lock chamber
- Time to exit the lock chamber
- Time required for the tow to reach a clearance point so that another tow moving in the opposite direction can start down toward the lock, and
- Time required for break down, locking through, and reassembling a tow that is too large for the chamber.

---

[1] M.K. Starr and D.W. Miller. 1982. Executive Decisions and Operations Research, Prentice-Hall, New York, pp. 348-364.

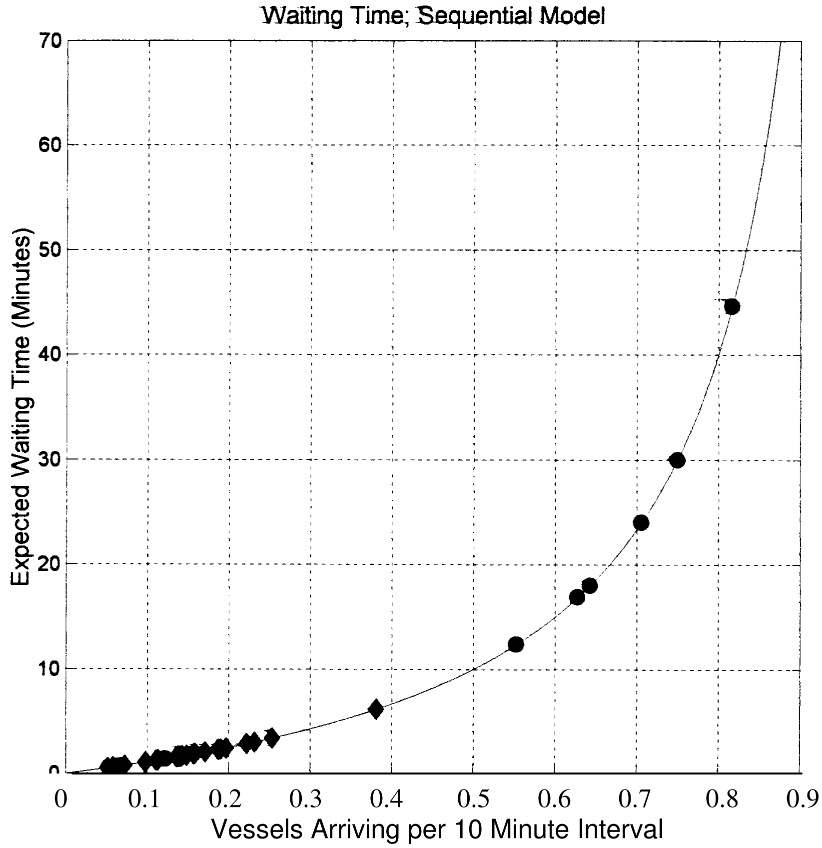


Figure 5-4. Expected time in a queue waiting to enter a conventional lock. Diamonds show daily samples of commercial traffic; circles recreational traffic. Note: Model assumes no change in vessel arrivals due to the presence of tide gates.

5.4 Delay with twin sets of tide gates

The second alternative is the use of two sets of tide gates spaced some distance apart along the river, for example, between Lawrence Point and Hell Gate, dispensing with conventional navigation locks, as described in Section 4.3. For a single channel, the delay time model in this case is a two-terminal shuttle model[2] in which the shuttle (in our case the tide gate enclosure) has unlimited capacity. The overall average waiting time, E_S, can be derived in terms of λ_1 and λ_2, the arrival rates in both directions:

$$E_S = [\lambda_1(1-\gamma_1) + \lambda_2(1-\gamma_2)]/[\lambda_1 + \lambda_2]$$

where $(1-\gamma_i)$ is the expected wait time for river traffic arriving at terminal *i* in units of shuttle operation time (in our case lock operation time). For a shuttle which responds immediately to a traffic request, $(1-\gamma_i)$ can be expressed in terms of λ_1 and λ_2. In Fig. 5-5 isolines for the overall average waiting time E_S are presented as a function of λ_1 and λ_2 for this model.

---

[2] A. Barnett 1973. On operating a shuttle. **Networks**, 3:305-313

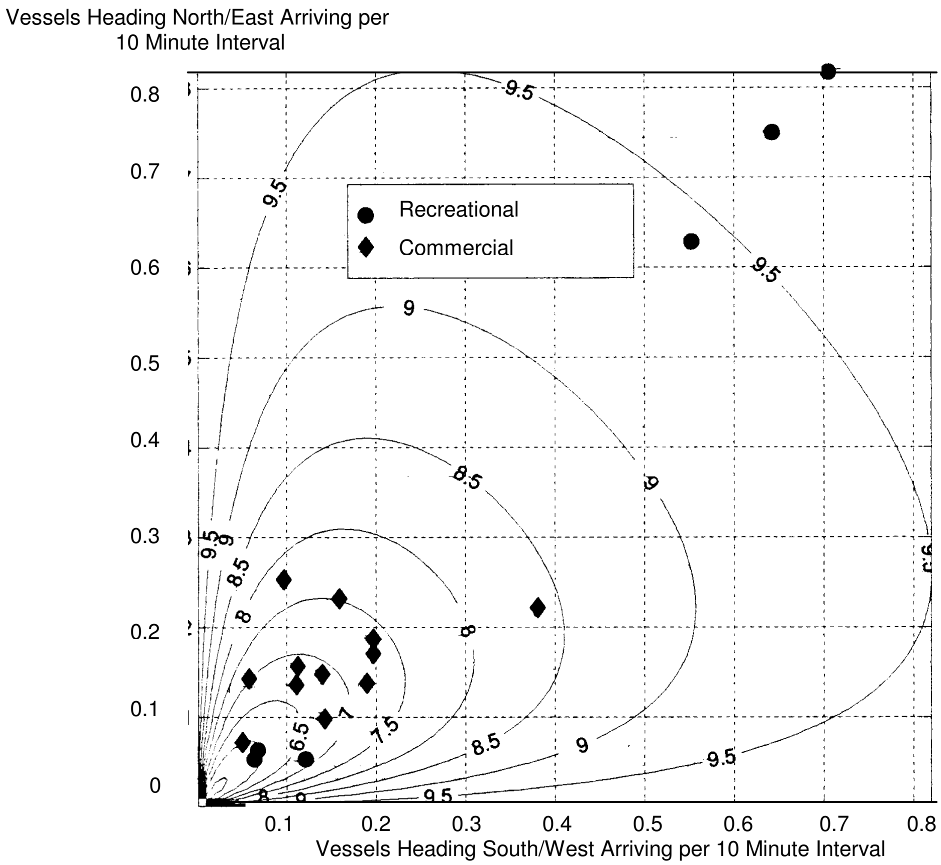


Figure 5-5. Expected waiting time using twin tide gates, assumed to have unlimited capacity for vessels waiting for lock operation. Diamonds show daily samples of commercial traffic; circles recreational traffic. Waiting times are in minutes. Note: Model assumes no change in vessel arrivals due to the presence of tide gates.

Figure 5-5 indicates that as the vessel arrival rate approaches the lock operation time, the average waiting time approaches and is bounded by the lock operation time. In other words, with the assumed unlimited capacity of the "lock chamber" there is no queue waiting for more than the next operation of the lock. On the other hand, the model gives no credit for travel along the river during the lock operation time.

With one exception, the samples of commercial traffic indicated by diamonds wait less than 8 minutes. (The exception is one point with a waiting time of about 8.4 minutes, based on a very short sample observation period at the midtown site on 18 August 1999.) Again, the "lock" operation time of 10 minutes must be added to calculate the delay.

In this case, any number of recreational vessels are assumed to be accommodated within the river enclosure, and as the number increases their expected waiting time approaches the 10-minute operation time. The observed daily samples of recreational traffic are again represented in the figure by circles.

This model does not include:

- Time to enter the lock chamber (for those vessels approaching the closed side; the others enter directly)

- Time to exit the chamber
- Time required for the tow to reach a clearance point so that another tow moving in the opposite direction can start toward the lock.

With the whole river to maneuver in, presumably there would be no need to break down, lock through, and reassemble a tow that is too large for the "chamber."

In both these models, it is assumed that the lock is operated in response to the arrival of a vessel or to serve a waiting queue. Other modes of operation would alter the results, and may be preferable. For example, with traffic heavier in one direction than the other, an idle lock might return to the busy side rather than waiting for an arrival on the slow side.[3] Or, even simpler, the locks may operate at scheduled times, such as on the quarter or half hour, so that vessels could plan their arrival time to an open lock.

5.5 Travel time saved in slack water

To determine the net effect of the presence of closed tide gates on the time it takes a vessel to transit the East River, the lock delays described above can be compared to the time savings that would result from traveling in slack water. A vessel making a round trip on the East River in slack water would take less time than it would with the tidal current flowing in one direction. That is, a vessel going against the current would lose more time than it would gain going with the current, simply because it would spend more time going against the current than traveling with it. Over time, the comings and goings of a vessel would average out to such a round trip.

The time a vessel would take to make a round trip in slack water can be calculated simply by dividing the distance by the vessel speed. To estimate the time it would take in actual East River currents, a simulation model was developed as described in detail in Appendix A8.

The data on river currents was taken from the last set of tidal current charts for the East River published by the government.[4] Current velocities are shown hourly at thirteen locations along the river under normal weather conditions; strong winds can modify these velocities considerably. The published velocities are for the time of spring tides, when currents are stronger than average and the tidal range is from 5.6 to 6.0 feet. The correction factor for other tidal ranges goes from 0.7 for a tidal range of 2.4 to 2.9 feet, to 1.1 for a tidal range of 6.1 to 6.6 feet.

It was necessary to develop the simulation model so that the ground speed of the vessel could be calculated by interpolating between locations at brief time intervals; one-minute intervals were used. In other words, at one-minute intervals the ground speed was recalculated for that time and location.

---

[3] E. Ignall and P. Kolesar. Operating characteristics of a simple shuttle under local dispatching rules. Operations Research, November-December 1972, pp. 1077-1088.
[4] Coast and Geodetic Survey, ESSA. Tidal current charts, New York Harbor, 7th edition. 1956.

A range of vessel speeds from 5 to 30 knots was assumed. Regardless of its speed, each vessel was assumed to depart so at to pass through Hell Gate, a midpoint in the trip, at the time of maximum tidal current there. The total transit time was calculated traveling both with and against the current. The total round trip times are shown in Figure A8-6 where they are compared with the time for a round trip in slack water, and the time for a round trip traveling with the current each way. Example results are shown in Table 5-2.

Table 5-2. Estimate of time saved on the East River with slack water

Vessel speed (knots)	*Duration of round trip in the current (minutes)*	*Duration of round trip in slack water (minutes)*	*Time saved in slack water (minutes)*
5	431	327	104
6	337	273	64
8	233	204	29
10	178	164	14
12	144	136	8
15	113	109	4

Thus, for a 5-knot vessel, traveling in slack water would save about an hour and three-quarters. For a 6-knot vessel, about an hour. For an 8-knot vessel, about half an hour. For a 10 knot vessel, about one-quarter hour. For faster vessels, the time savings are not appreciable.

Of course, operating a vessel so that it always traveled in the direction of the tidal current would be best of all, but time and tide wait for no man.

5.6 Comparison of lock delays with time saved in slack water

As mentioned in Section 4.2.2, the Corps of Engineers reports that the operation time of low-lift navigation locks is 8 to 10 minutes, and operation time constitutes about 25 to 40 percent of total transit time. Thus, the traffic delay due to lock operation may vary between 20 and 40 minutes, disregarding the time that may be spent waiting in a queue. Assuming a lock operation time of 10 minutes, our estimates above of the average time spent by commercial vessels waiting in a queue are on the order of 5 to 8 minutes.

On balance, it appears that these lock delays are substantially offset for slow vessels by the time saved traveling in slack water when the gates are closed. With time savings of about half an hour for 8-knot vessels, it’s a wash. For the 6-knot speed typical of tugs with loaded barges, the advantage of traveling in slack water may indeed result in a net time saving.

The larger advantage to operators of slow-moving vessels from closed tide gates may be the greater freedom it affords in scheduling operations through Hell Gate at least half the time instead of only in an hour-and-a-half window when the tide reverses.

6 PERMITTING CRITERIA

For the East River tide gates to be built, the builder must receive a permit from the U.S. Army Corps of Engineers. To obtain this permit, it is necessary to satisfy the criteria, not only of the Corps, but of the New York State Coastal Management Program (CMP). To meet the requirement of consistency with the New York State CMP, it is necessary to comply with the New York City Waterfront Revitalization Program. For each of these, a set of criteria exist that must be satisfied. Moreover, since the environmental changes due to tide gates would extend to New Jersey and Connecticut, those states too would have the opportunity to judge the consistency with their coastal management programs, as well as affected communities on Long Island Sound and the Hudson River.

Under New York State legislation, New York City is also authorized to adopt a Harbor Management Plan which would authorize the city to regulate in-water structural uses of the harbor. Finally, the upper East River may come to be affected by the Long Island Sound CMP which would be administered by the Long Island Sound Coastal Advisory Commission.

The details of these requirements are presented in Appendices 1 and 3. In this section we summarize the main criteria.

Since the tide gates are not themselves a “bridge,” that is, a structure that carries railroad or highway traffic over a navigable waterway, the U.S. Coast Guard does not have primary jurisdiction over them. The Coast Guard participates in the Corps of Engineers regulatory program on aids to navigation and shipping safety fairways and anchorage areas.

6.1 Regulations of the U.S. Army Corps of Engineers

Until 1968, the primary thrust of the Corps’ regulatory program was the protection of navigation. As a result of several new laws and judicial decisions, however, the program has evolved to one involving the consideration of the full public interest by balancing the favorable impacts against the detrimental impacts. This is known as the “public interest review.”

As is stated in the public notice that is part of the review process:

> The decision whether to issue a permit will be based on an evaluation of the probable impact including cumulative impacts of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefit which may reasonably be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposal will be considered including the cumulative effects thereof; among those are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land

use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, *water quality*, energy needs, safety, food and fiber production, mineral needs, consideration of property ownership and, in general, the needs and welfare of the people.

The benefits that reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of this general balancing process.

The specific weight of each factor is determined by its importance and relevance to the particular proposal. Accordingly, how important a factor is and how much consideration it deserves will vary with each proposal. However, full consideration and appropriate weight will be given to all comments, including those of federal, state, and local agencies, and other experts on matters within their expertise.

6.2 New York State Coastal Management Program

The Coastal Zone Management Act (CZM Act) of 1972 establishes a process for the development of state coastal zone management programs. It provides states the opportunity to adopt a Coastal Management Program (CMP). States that develop an approved CMP gain effective regulatory control of their coastal areas through the requirement for federal consistency with the CMP.

The federal consistency, or "reverse preemption," requirement allows states to better control the activities of all state agencies and "relevant federal agencies" that are active in coastal areas. Federal consistency is the CZM Act requirement that federal actions that are reasonably likely to affect any land use or water use or natural resource of the coastal zone be consistent with enforceable policies of a coastal state's federally approved coastal management program.

The term "enforceable policies" means State policies that are legally binding through constitutional provisions, laws, regulations, land use plans, ordinances, or judicial or administrative decisions, by which a State exerts control over private and public land and water uses and natural resources in the coastal zone. The policies were developed to provide clear and explicit statements of federal and state policy in the coastal area that are to be used in government decision-making. New York's 44 CMP policies are contained in the state's Coastal Management Program and Final Environmental Impact Statement.

Comparatively few of the 44 CMP policies would seem to apply to East River tide gates. Eight of those that may are listed here. In Appendix C, all 44 are listed, and the "explanations" of these eight are reported.

7. Significant coastal fish and wildlife habitats will be protected, preserved, and where practical, restored so as to maintain their viability as habitats.

11. Buildings and other structures will be sited in the coastal area so as to minimize damage to property and the endangering of human lives caused by flooding and erosion.
18. To safeguard the vital economic, social and environmental interests of the state and its citizens, proposed major actions in the coastal area must give full consideration to those interests, and to the safeguards which the state has established to protect valuable coastal resource areas.
19. Protect, maintain, and increase the level and types of access to public water-related recreation resources and facilities.
20. Access to the publicly owned foreshore and to lands immediately adjacent to the foreshore or the water's edge that are publicly owned shall be provided, and it shall be provided in a manner compatible with adjoining uses.
22. Development, when located adjacent to the shore, will provide for water-related recreation, whenever such use is compatible with reasonably anticipated demand for such activities, and is compatible with the primary purpose of the development.
31. State coastal area policies and management objectives of approved local waterfront revitalization programs will be considered while reviewing coastal water classifications and while modifying water quality standards; however, those waters already overburdened with contaminants will be recognized as being a development constraint.
44. Preserve and protect tidal and freshwater wetlands and preserve the benefits derived from these areas.

6.3 New York City Waterfront Revitalization Program

New York provides coastal municipalities with the opportunity to adopt and implement refinements of state coastal policies through Local Waterfront Revitalization Programs. LWRPs refine and supplement New York State's CMP by defining area-specific needs and objectives at the municipal level, based on local circumstances and needs.

The *New York City Waterfront Revitalization Program* is the city's principal coast zone management tool. It establishes the city's policies for development and use of the waterfront and provides the framework for evaluating the consistency of all discretionary actions in the coastal zone with those policies. The guiding principle of the NYCWRP is to maximize the benefits derived from economic development, environmental preservation, and public use of the waterfront, while minimizing the conflicts among these objectives.

The present NYCWRP states ten policies as follows:
1. Support and facilitate commercial and residential redevelopment in areas well-suited to such development.
2. Support water-dependent and industrial uses in New York City coastal areas that are well suited to their continued operation.
3. Promote use of New York City's waterways for commercial and recreational boating and water-dependent transportation centers.

4. Protect and restore the quality and function of ecological systems within the New York City coastal area.
5. Protect and improve water quality in the New York City coastal area.
6. Minimize loss of life, structures and natural resources caused by flooding and erosion.
7. Minimize environmental degradation from solid waste and hazardous substances.
8. Provide public access to and along New York City's coastal waters.
9. Protect scenic resources that contribute to the visual quality of the New York City coastal area.
10. Protect, preserve and enhance resources significant to the historical, archaeological, and cultural legacy of the New York City coastal area.

Each of these policies is elaborated in the plan.

A feature of the NYCWRP is the recognition of two types of coastal areas with special characteristics:

- Significant Maritime and Industrial Areas (SMIAs)
- Special Natural Waterfront Areas (SNWAs)

As noted in Section 3, the College Point site abuts two of the three SNWAs. The three SNWAs have particular natural habitat features that should be considered in connection with any waterfront activity. Activities proposed within the SNWAs that do not directly foster the goals for these areas may still be found "consistent," but would be analyzed to ensure that the special characteristics of these areas are not substantially impeded or destroyed.

Policy 4 (above) is the primary policy to be considered in SNWAs. This policy is elaborated in the NYCWRP under the following headings:

4.1 Protect and restore the ecological quality and component habitats and resources.
4.2 Protect and restore tidal and freshwater wetlands.
4.3 Protect vulnerable plant, fish and wildlife species, and rare ecological communities. Design and develop land and water uses to maximize their integration or compatibility with the identified ecological community.
4.4 Maintain and protect living aquatic resources.

Under Policy 6, within SNWAs, protection of the natural shoreline and non-structural measures have priority over other erosion and flood control methods.

6.4 Other coastal management programs

Other affected communities in New York State with Local Waterfront Revitalization Programs would also have the opportunity to judge the consistency of these effects on their LWRPs. On Long Island Sound, these communities include the Town of Mamaroneck and Village of Larchmont (joint program), the Village of Port Chester, and City of Rye in Westchester County; and the Village of Lloyd Harbor and others to the east on Long Island. In addition, there are eighteen state-approved programs covering the Hudson River to the federal dam at Troy, some of which may be affected.

Moreover, the consistency provisions of the Coastal Zone Management Act require that all federal agency activities be consistent with the Coastal Management Plan not only of the state in which they take place, but of other affected states. New Jersey and Connecticut would therefore have the opportunity to review any certification by New York State for consistency with their CMPs.[1]

6.5 Mandate for a New York City Harbor Management Plan

In response to the conflicts that have resulted from recreational boating on coastal resources and uses in harbors, the New York State legislature amended the WRCRA in 1992 to allow local governments to develop and adopt Harbor Management Plans (HMP). Under the WRCRA, a municipality that wishes to adopt a LWRP must also include a HMP, or at least address the possibility of establishing a HMP. If a HMP is not appropriate for a particular area, then the requirement may be waived.

Local governments that had a Local Waterfront Revitalization Plan in effect prior to the 1992 amendment of the WRCRA, such as New York City, are not required to adopt a Harbor Management Plan. However, in 1991 New York City published a *New York/New Jersey Harbor Estuary Water Use Management Study* which addresses much of the same issues. The study aimed to assess the then current level of activity on the waterways, project future levels and patterns of activity, and identify ways of reducing the potential for conflict among the various vessel types using the waterways.

Since New York City may in the future adopt a HMP, its mandate bears noting. The HMP amendments provide direct regulatory authority to local governments that adopt a harbor management plan to regulate in-water structural uses. Section 922 of WRCRA provides the following:

> In order to implement a comprehensive harbor management plan the local legislative body of a city, town, or village may adopt, amend and enforce local laws and ordinances to regulate the construction, size and location of wharves, docks, moorings, piers, jetties, platforms, breakwaters or other structures and uses in waters within or bounding the municipality… to a distance of fifteen hundred feet from shore.

Further, New York regulations state “the Legislature … recognizes the significant role New York’s cities, towns and villages are capable of taking in the regulation and management of activities in and over the State’s navigable waters and underwater lands if granted clear authority to regulate these areas. Accordingly, the Legislature has provided for the development and approval of local government HMPs and the local laws or ordinances necessary to implement these plans.” Factors that municipalities should consider when enacting HMPs include commercial and recreational needs, habitat protection, water-dependent uses, aesthetic values, and public interests.

[1] Steven Resler, New York State Department of State, personal communication, 5 October 1999.

6.6 Long Island Sound Coastal Advisory Commission

The Long Island Sound Coastal Advisory Commission, the latest addition to the WRCRA, was established in 1995 as a result of the state's efforts to address regional issues in Long Island Sound with a Long Island Sound CMP, in part on the recommendation of the Governor's Task Force on Coastal Resources. The Long Island Sound CMP was established to act as the overall regional plan for Long Island Sound's coastal environment. The commission was created to address the problems of the Sound, including water quality degradation, decreasing biological diversity, stress on beaches and shellfish beds, loss of open space, and an increasingly difficult business climate. The seventeen-member commission will be responsible for implementing the Long Island Sound Coastal Management Program. The Long Island Sound CMP was completed as a regional effort and has not yet been approved by the federal government. The commission will also be responsible for assisting other local government agencies that have jurisdiction over the Sound and for coordinating their actions.

7 VIEWS OF THE MARITIME COMMUNITY

We had four meetings with members of the New York maritime community. Two were held at U.S. Coast Guard headquarters on Staten Island. The first was a meeting with Captain Larry Brooks, Deputy Commander, Coast Guard Activities New York, and his staff. The second, suggested by Captain Brooks, was with the East River Subcommittee of the Harbor Safety, Navigation and Operations Committee (the "Harbor Ops Committee"), which is chaired by the Coast Guard. At the second meeting, we met representatives of the Sandy Hook Pilots Association and the tug-and-barge community. Follow-up meetings were held with Reinauer Transportation Company and Moran Towing Corporation.

At all these meetings, we received informed and constructive responses. Although there was clearly concern about a project that would obstruct the East River up to half the time, those we spoke to were helpful in suggesting how that might be done with the least interference to navigation.

An important finding is that the treacherous tidal currents in Hell Gate limit the amount of time that slow-moving vessels, like tugs and barges, can pass through. Tug and barge operators must therefore schedule their operations by the tide, having the opportunity to pass through Hell Gate only twice a day during the hour-and-a-half window when the tide is reversing.

Captain Peterson of Reinauer Transportation Company described how tugs and barges navigate the East River. While waiting for favorable conditions to pass through the East River, tugs hold off Bay Ridge near Governors Island, and near Whitestone Bridge in upper East River. There is a 40-minute window during which loaded barges can pass through Hell Gate, although this is sometimes stretched to 2 hours. Tugs that miss the Hell Gate window must loiter for several hours at a cost to the customer of $300 to $500 per hour. There is often a group of tugs waiting near the United Nations building jockeying for position to go through Hell Gate first. They are in radio contact with each other, but may not behave as they indicate.

Thus, at least some members of the tug-and-barge community will be receptive to the argument that tide gates will give them greater leeway in scheduling operations and possibly net savings in operating time. However, there is concern that there will be eddies at the entrance to the Harlem River with tide gates in operation unless it is closed off.

Further details of these meetings and the lists of those attending are given in Appendices 5 and 6. Some of the comments that we received follow:

- It would be better to have the gates at one end of the East River or the other. There must be a safe place to stage from. Vessels will queue up and need elbow room near the locks. Suitable staging areas would be below Governors Island, and between the Whitestone and Throgs Neck bridges.

- A large vessel cannot stop in the East River. It loses control. There is a rock bottom where anchors do not hold or will hang up. Extra tugs would be needed.
- East River has a “controlled depth” of 35 feet. New barges have a 32 foot draft..
- The range of cruising speed for a vessel in the East River is 8 to 12 knots. For a tanker it is 8 knots.
- Tugs without barges travel at 7 to 8 knots. Tanker barges travel 4 knots loaded and light, and tankers 4 knots loaded and 5 knots light.
- Tugs use a short hawser through Hell Gate; they do not push barges.
- A fast ferry, *Sassacus*, transports gamblers from NYC to New London; it needs to average 30 knots to make a profit. Fast ferry operators may therefore oppose the idea of tide gates.
- Any piers in the river present a problem for vessels passing through when the gates are open.
- Structures in the river would require “protection cells”, i.e., dolphins.
- There will be concern about the risk of damage in using locks.
- The group prefers the idea of using the whole river as a lock (with two tide gates spaced some distance apart along the river) if it would reduce traffic delays rather than one tide gate with conventional locks.
- The commercial community will want to know the cost of using locks.
- Tidal current charts for the East River were rescinded in 1991. However, they have not been replaced.
- New York Harbor now has two stations (at The Battery and Bergen Point) that report tidal currents in real time which vessel operators can reach. These are used instead of tidal current tables. This is part of the Vessel Traffic Service (VTS) which can be reached in three ways: telephone, direct dial, and the Web.
- NOAA will provide a tide gauge at no charge if local authorities pay for its operations and maintenance.
- A traffic control system for maritime use similar to air traffic control is 25 years away.
- The largest vessel ever piloted in the East River by the senior East River pilot was 950 feet in length with 156 foot beam. This operated only east of the Lawrence Point.
- There is a problem with large vessels being stopped near La Guardia field, possibly interfering with flight paths.
- New York Police Department uses Wards Island as their base and will be concerned with the location of tide gates.
- New York City (not Houston) is the largest oil port in the USA.
- Consideration should be given to whether the gates can be designed to stop oil spills while allowing an underflow of water. Oil spills are a special concern in the vicinity of La Guardia Field.

8 COMBINED SEWER OUTFALL CONSIDERATIONS

Wastewater flowing through New York City sewers normally goes to a wastewater treatment plant before being released into the rivers. However, when storm water fills the sewers with more water than the treatment plants can handle, a combined sewer outfall (CSO) regulator automatically sends the untreated wastewater directly to the receiving waters. These regulators are mostly located within 2 or 3 feet of local mean sea level, and are within the normal tidal range. When they are below sea level, CSO tide gates associated with the regulators prevent the outside waters from backing up into the sewers.

(Note the distinction between CSO tide gates, relatively small units that are part of the CSO regulators, and the East River tide gates that are the main subject of this report.)

Associated with the six wastewater treatment plants that empty into the East River are CSO regulators at approximately 220 locations. Almost all of these CSOs empty into the East River; a few into the Harlem River.

The operation of the East River tide gates would lead to a rise of 0.8 feet in high water on their west/south side, according to recent results of the Systemwide Eutrophication Model (SWEM)[1]. With the East River tide gates located in the vicinity of the Whitestone Bridge, this rise in high water decreases to 0.2 feet at Gowanus. The concern is that this rise in sea level may interfere with the normal operation of the CSO regulators due to the greater hydrostatic pressure on CSO tide gates from the higher receiving waters.

The tidal elevations of the weirs at the 220 regulator locations are shown as a histogram in Figure 8-1 with intervals of 0.8 feet. By 2010, 52 percent of the regulators will be below mean sea level. If all experienced a rise in sea level of 0.8 feet, this would increase to 67 percent. A maximum tidal range of 9.6 feet is shown for reference. For all but a handful of the regulators, the elevations lie within the 2010 tidal range. Three are permanently submerged; with a 0.8 foot rise in sea level, this increases to five.

Thus, even with an increase of as much as 0.8 feet due to the operation of East River tide gates, under most conditions the tidal elevations to which regulator tide gates would be subjected are within the range to which they are routinely exposed already. An increase of 0.8 feet above extreme high tides could contribute to more frequent and extensive sewer surcharge and flooding. This potential would need to be examined on a regulator-by-regulator basis. However, the higher tidal elevations associated with operation of East River tide gates would not necessarily have to increase extreme high tide elevations. The East River tide gates could simply be left open during tidal extremes in order to avoid exacerbating high tide conditions that might contribute to flooding. Or, as discussed in Section 10, East River tide gates may possibly be used to reduce general flooding that results from storm surges in Long Island Sound.

A detailed analysis of the effect of East River tide gates on CSOs is given in Appendix 4.

[1] J. St. John and R.L. Miller. East River tidal barrier: solution to water quality problems in the NY/NJ Harbor? Hudson River Foundation Tuesday Seminars, April 6, 1999.

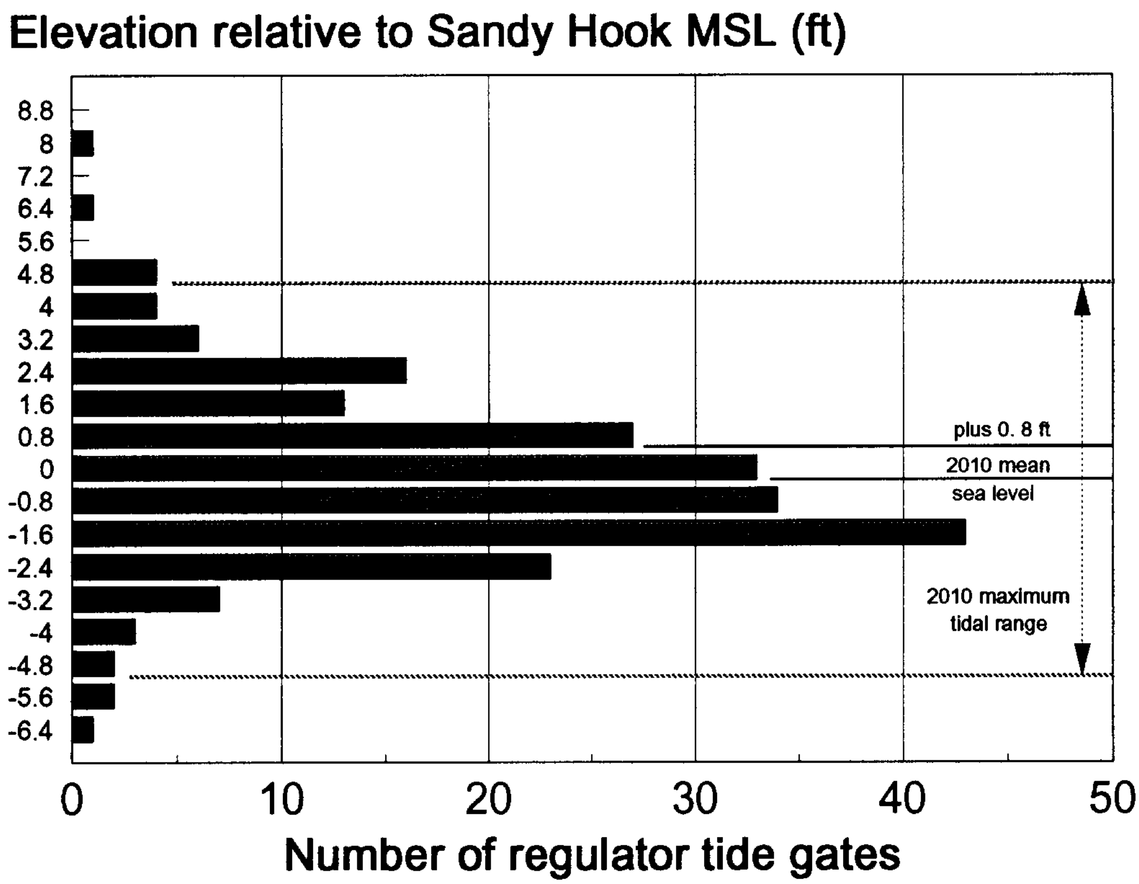


Figure 8-1. Histogram of the elevation of CSO regulator tide gates relative to mean sea level. With a few exceptions, these are within the maximum tidal range, with or without East River tide gates in operation.

9 NATIONAL OCEAN SERVICE TIDAL CURRENT DATA

The National Ocean Service, National Oceanic and Atmospheric Agency, U.S. Department of Commerce, was contacted to determine the implications of East River tide gate operations on tidal current charts and other information that they publish. The correspondence is contained in Appendix 7.

The area that would be affected by the operation of the tide gates would include western Long Island Sound, East River, Harlem River, Upper New York Harbor, and the lower Hudson River estuary. Both water level and tidal currents could change significantly over this area. As a result, the full suite of NOAA chart products, tidal datums, and tide and current predictions could become obsolete. The tide and tidal current reference system would have to be re-established through new surveys after completion of the construction.

The National Ocean Service (NOS) has a Physical Oceanographic Real-Time System (PORTS) in operation in this area. PORTS is a network of real-time reporting current meters, tide stations and meteorological stations. The PORTS will have to be expanded to include observations of real-time water levels and currents for the navigation community. NOAA will soon be linking an operational nowcast/forecast hydrodynamic model into the system for water level and current prediction. The hydrodynamic model will have to be re-run to forecast effects of the tide gates on model outputs and will have to be recalibrated and verified for operational purposes after completion of the tide gates.

In response, we have noted that the indicated necessary actions would be within the normal operating parameters of NOAA, and the necessary surveys and analysis could be accomplished through an intense local study.

NOS notes that storm surges in the New York City area have been close to catastrophic elevation levels, and comments that the effects of tide gates on possibly increasing storm surge levels needs to be modeled to evaluate the need to modify some infrastructure such as air intakes to tunnels. In response, we have pointed out that the use of East River tide gates during the “nor'easter” storms common to this area could actually reduce the impacts of storm surge on New York City, as we discuss in Section 10.

10 OTHER USES OF EAST RIVER TIDE GATES

The presence of tide gates in the East River could have benefits other than the major improvement in water quality that would occur. In this section, we discuss two of them: preventing flooding in New York City and containing oil spills in the East River.

10.1 Flood control

Coastal flooding has occurred frequently in New York City and its environs in recent decades. The metropolitan area is near the top of the national list of flood insurance claims filed every year; many places in the region are flooded in major storms. A Category 3 hurricane (winds up to 130 mph with a storm surge elevation of 24 feet) would flood most of the streets of downtown Manhattan. The subway system, sections of which are already being pumped out 24 hours per day, is particularly at risk, especially PATH near the Hudson River and the IRT division in downtown Manhattan. Other waterfront infrastructure, such as airports (particularly La Guardia Airport), roads, bridge access roads, railroads, electric power plants, oil refineries and tank farms, solid waste transfer stations, sewage treatment plants, and combined sewer outfalls would be affected.[1,2]

While hurricanes are infrequent, New York City regularly suffers from flooding in "nor'easters," typical winter storms with the wind driving from the northeast for three days or more. Severe flooding from a nor'easter occurred most recently in December 1992. With a continuing rise in sea level, such flooding is likely to worsen. If projections of the effects of climate change in the New York area are correct, the rate of sea level rise will accelerate and more severe storms will become more frequent.[3]

In both cases, coastal flooding is due to storm surges. The orientation of Long Island Sound makes it a natural funnel for strong northeast winds which drive surface waters into the western Sound and the upper East River.

An allied, but separate consequence arising from the same storm can be a general rise in sea level along the eastern seaboard. This results both from a drop in atmospheric pressure which allows sea level to rise (inverse barometer effect) plus an onshore piling up of ocean water due to the Ekman effect. The Ekman effect, due to the rotation of the earth, moves surface waters on open coasts to the right of the wind. In the case of a northeast wind blowing parallel to the south shore of Long Island, the Ekman effect will pile up water along the Atlantic coast. The combined rise in sea level, due to both the

---

[1] R. Zimmerman. Global warming, infrastructure, and land use in the metropolitan New York area: prevention and response. In D. Hill (ed.), The Baked Apple? Metropolitan New York in the Greenhouse. Volume 790, Annals of the New York Academy of Sciences, 1996. Johns Hopkins University Press. p. 57ff.

[2] U.S. Army Corps of Engineers, FEMA, National Weather Service, and NY/NJ/CT State Emergency Management. Metro New York Hurricane Transportation Study, Interim Technical Report. November 1995.

[3] J. Bloomfield, M. Smith and N. Thompson. Hot nights in the city: global warming, sea-level rise and the New York metropolitan region. Environmental Defense Fund. 1999.

pressure drop and the coastal Ekman transport, is transmitted into New York Harbor principally through The Narrows. The rise will also be transmitted into Long Island Sound through The Race at its eastern connection to Block Island Sound and the Atlantic Ocean.

Thus, during prolonged, slow moving northeast storms, sea level will rise both in New York Harbor and western Long Island Sound, but usually much more in western Long Island Sound due to the funneling effect described above.[4,5]

Much of this flooding could be ameliorated during northeast storms by keeping the tide gates shut during both flooding and ebbing tide in the East River (flow directed from western Long Island Sound to New York Harbor). This would have the effect of blocking that component of storm surge originating in western Long Island Sound from flowing into New York Harbor and all points east (south) of the tide gates. Calculations by Wilson *et al*.[6] show that water level from a storm surge in western Long Island Sound is unlikely to increase significantly as a consequence of blocking the surge from discharging into New York Harbor via the East River.

To protect, say, La Guardia Airport from flooding (which has occurred several times in living memory including November 1950 and December 1992), the College Point location is the only one of the proposed tide gate location that would be effective since it is located east of La Guardia Airport.

Numerical simulations of storm surge under a variety of storm scenarios need to be undertaken, but it is submitted that suitably designed and operated tide gates in the appropriate location could prove effective in protecting the infrastructure of low-lying coastal areas of New York City. The Thames Barrier, currently in use across the Thames River in England, has been proven effective in protecting the city of London from North Sea storm surges.

10.2 Oil spill containment

The East River is at risk from oil spills. As described in Section 2, by weight petroleum products account for three-quarters of the shipments on the river. Oil pipelines cross the river at the Midtown location and in Newtown Creek. Oil deliveries are made to numerous locations in Newtown Creek, to several electric power plants, including one adjacent to the Lawrence Point site, and to oil depots, including those in Steinway Creek in Queens and the Port Morris section of The Bronx.

Precautions to limit the damage from oil spills are illustrated for one section of the East River in Figure 10-1. Booms are in place prior to any oil spill at two locations in Flushing

---

[4] R.E. Wilson, K-C. Wong, and R. Filadelfo. Low frequency variability in the East River tidal strait. Journal of Geophysical Research **90**: 954-960, 1985.
[5] R. Filadelfo and R.E. Wilson. Residual Eulerian currents in the upper and lower East River tidal strait. Journal of Geophysical Research 96: 15, 217 – 15, 226. 1991.
[6] R.E. Wilson et al., *ibid*.

Bay, one near La Guardia Field, and at Pugsley Creek and Westchester Creek in The Bronx. Second priority areas are designated at Powell's Cover near the College Point site, and at the mouth of the Bronx River. Present precautionary or exclusionary techniques are regarded as ineffective in the open river near Big and Little Brother Islands, just north of the Lawrence Point site. Particularly in this central part of the East River, from Lawrence Point to the Midtown site, oil spills would spread rapidly due to the fast tidal currents.

Tide gates across the East River could prevent a major spill from spreading up or downstream from its source if they are kept closed. With the Thames River design, the gates could be rotated to the upshot position, allowing the river to flow freely but blocking the spread of oil on the surface.

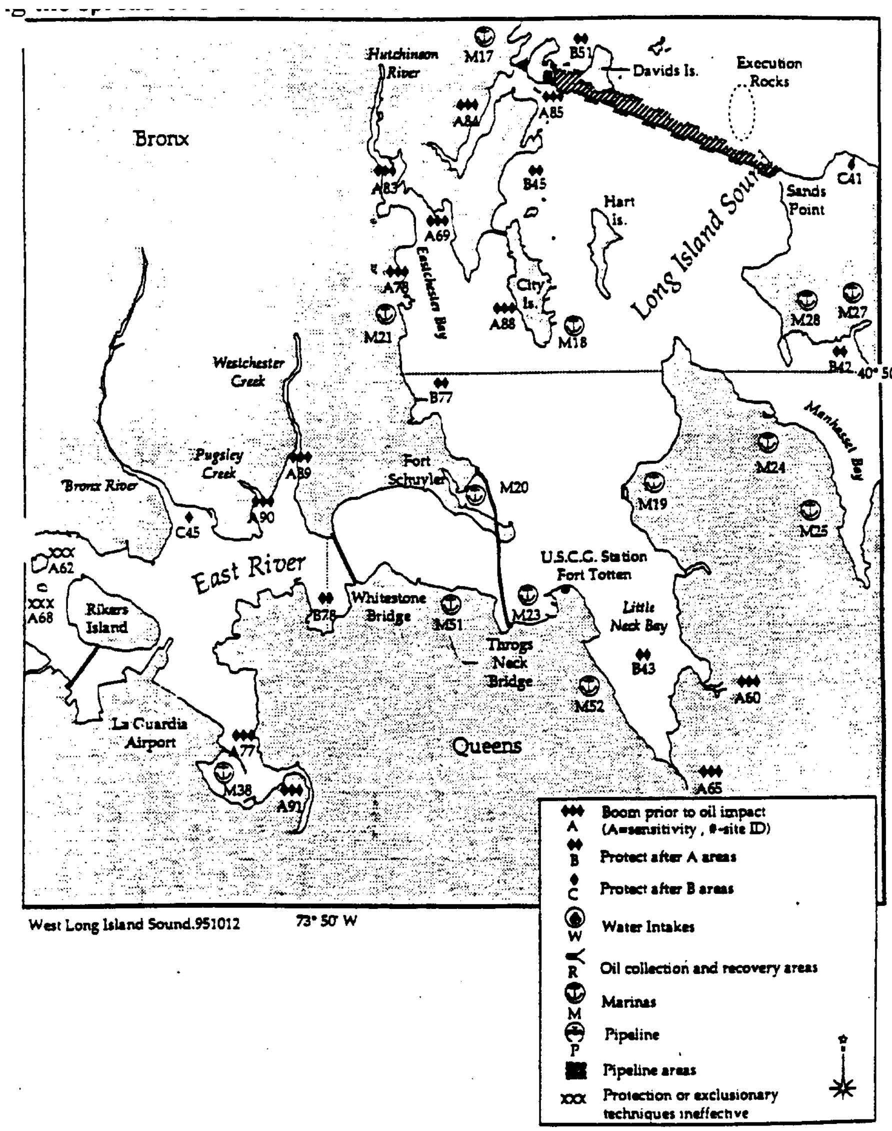


Figure 10-1. Locations of oil spill protection facilities in the upper East River. Source: Edwin Levine, Office of Response and Restoration, NOAA/SSC, National Oceanic and Atmospheric Administration.

Appendix 1. Regulations of the U.S. Army Corps of Engineers

Task: Meet with representatives of the New York District, U.S. Army Corps of Engineers, to obtain criteria and data that would be used in judging whether East River tide gates would be permitted. Also, obtain information to prepare a time-line on the permitting process for these gates.

Malcolm Bowman and Douglas Hill met to discuss East River tide gates on 16 December 1998 with Col. William H. Pearce, District Engineer, New York District, U.S. Army Corps of Engineers, and members of his staff: Lt. Col. Joseph Muscarella, James Haggerty, and Robert Will.

Under various Federal laws, the Department of the Army is authorized to issue permits controlling certain activities in navigable waters of the United States. These activities specifically include:

- Dams or dikes
- Other structures or work including excavation, dredging, and/or disposal activities
- Activities that alter or modify the course, condition, location, or capacity of a navigable water of the United States.

Until 1968, the primary thrust of the Corps' regulatory program was the protection of navigation. As a result of several new laws and judicial decisions, the program has evolved to one involving the consideration of the full public interest by balancing the favorable impacts against the detrimental impacts. This is known as the "public interest review."

Section 9 of the Rivers and Harbor Act of 1899 prohibits the construction of any dam or dike across any navigable waterway of the United States in the absence of Congressional consent and approval of the plans by the Chief of Engineers and the Secretary of the Army. Where the navigable portions of the waterbody lie wholly within the limits of a single state, the structure may be built under authority of that state if the location and plans are approved by the Chief of Engineers and the Secretary of the Army. The instrument of authorization is designated a permit.

The East River is presumably an *interstate* waterbody, however, since it carries interstate commerce.

The regulatory program of the Corps of Engineers is defined in the Code of Federal Regulations (33 CFR Parts 320 through 330). Those aspects of the regulations that are most relevant to East River tide gates are excerpted below.

General Regulatory Policies (Part 320)

General policies for evaluating permit applications consist of a public interest review in which the benefits that reasonably may be expected to accrue from the proposal are balanced against its reasonably foreseeable detriments, as discussed in Section 6. The criteria listed there include navigation and water quality.

The following general criteria will be considered in the evaluation of every application:
- The relative extent of the public and private need for the proposed structure
- Where there are unresolved conflicts as to resource use, the practicability of using reasonable alternative locations and methods to accomplish the objective of the proposed structure or work
- The extent and permanence of the beneficial and/or detrimental effects which the proposed structure or work is likely to have on the public and private uses to which the area is suited.

For the factors that seem relevant to East River tide gates, the Corps regulations include the following information:

(b) *Effect on wetlands*. The unnecessary alteration or destruction of wetlands should be discouraged as contrary to the public interest. Wetlands considered to perform functions important to the public interest include:
- Wetlands that serve significant natural biological functions, including food chain production, general habitat and nesting, spawning, rearing and resting sites for aquatic and land species
- Wetlands set aside for the study of aquatic environment or as sanctuaries or refuges
- Wetlands the destruction or alteration of which would affect detrimentally natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, current patterns, or other environmental characteristics
- Wetlands that are significant in shielding other areas from wave action, erosion, or storm damage
- Wetlands that serve as valuable storage areas for storm and flood waters
- Wetlands which are ground water discharge areas that maintain minimum baseflows important to aquatic resources and those that are prime natural recharge areas
- Wetland that serve significant water purification functions, and
- Wetlands that are unique in nature and scarce in quantity to the region or local area.

No permit will be granted that involves the alteration of wetlands identified as important by these criteria.

(c) *Fish and wildlife*. In accordance with the Fish and Wildlife Coordination Act, the district engineer will consult with the Regional Director, U.S. Fish and Wildlife Service, the Regional Director, National Marine Fisheries Service, and the head of agency for fish and wildlife for the state in which the work is to be performed, with a view to the conservation of wildlife resources by prevention of their direct and indirect loss and damage due to the proposed activity.

(d) *Water quality*. Applications for permits for activities that may adversely affect the quality of waters of the United States will be evaluated for compliance with applicable effluent limitations and water quality standards. The evaluation should include both point and non-point sources of pollution. It should be noted, however, that the Clean Water Act assigns responsibility for control of non-point sources of pollution to the states. Certification of compliance with applicable effluent limitations and water quality standards required under provisions of the section 401 of the Clean Water Act will be considered conclusive with respect to water quality considerations unless the Regional Administrator, Environmental Protection Agency, advises of other water quality aspects to be taken into consideration.

(e) *Historic, cultural, scenic and recreational values*. Full evaluation of the public interest requires that due consideration be given to the effect that the proposed structure may have on values such as those associated with wild and scenic rivers, historic properties and National Landmarks, National Rivers, National Wilderness Areas, National Seashores, National Recreational Areas, National Lakeshores, National Parks, National Monuments, estuarine and marine sanctuaries, archaeological resources, including Indian religious and cultural sites, and other such areas as may be established under federal and state law for similar and related purposes.

(f) *Effects on limits of the territorial sea*.

(g) *Consideration of property ownership*. Authorization of work or structures by the Department of the Army does not convey a property right, nor authorize any injury to property or invasion of other rights. An inherent aspect of property ownership is a right to reasonable private use. However, this right is subject to the rights and interests of the public in the navigable and other waters of the United States, including federal navigation servitude and federal regulation for environmental protection.

(h) *Activities affecting coastal zones*. No permit will be issued to a non-federal applicant until certification has been provided that the proposed activity complies with the coastal zone management program and the appropriate state agency has concurred with the certification or has waived its right to do so. However, a permit may be issued to a non-federal applicant if the Secretary of Commerce, on his own initiative or upon appeal by the applicant, finds that the proposed activity is consistent with the objectives of the Coastal Zone Management Act of 1972 or is otherwise necessary in the interest of national security.

(i) *Activities in marine sanctuaries*.

(j) *Other Federal, state, or local requirements*. Processing of an application for a Department of the Army permit normal will proceed *concurrently* with the processing of other required Federal, state, and/or local authorizations or certifications. The primary responsibility for determining zoning and land use matters rests with state, local and tribal governments. The district engineer will normally accept decisions by such governments on those matters unless there are significant issues of overriding national importance. In the absence of overriding national factors of the public interest, a permit will generally be issued following receipt of a favorable state determination provided the concerns, policies, goals, and requirements as expressed in 33 CFR Parts 320-324, and the applicable statutes have been considered and followed: e.g., the National Environmental Policy Act, the Fish and Wildlife Coordination Act, the Historical and Archaeological Preservation Act, the National Historic Preservation Act, the Endangered Species Act, the Coastal Zone Management Act, the Marine Protection, Research and Sanctuaries Act, the Clean Water Act, the Archaeological Resources Act, ad American Indian Religious Freedom Act.

Where general permits to avoid duplication are not practical, district engineers shall develop joint procedures with those local, state, and other Federal agencies having ongoing permit programs for activities also regulated by the Department of the Army. In such cases, applications for Department of the Army permits may be processed jointly with the state or other federal applications to an independent conclusion and decision by the district engineer and the appropriate Federal or state agency.

(k) *Safety of impoundment structures*. To insure that all impoundment structures are designed for safety, non-Federal applicants may be required to demonstrate that the structures comply with established state dam safety criteria or have been designed by qualified persons and, in appropriate cases, have been independently reviewed by similarly qualified persons.

(m) *Water supply and conservation*.

(n) *Energy conservation and development*.

(o) *Navigation*. Protection in navigation in all navigable waters of the United States continues to be a primary concern of the federal government. District engineers should protect navigational and anchorage interests in connection with the NPDES program by recommending to EPA or to the state, if the program has been delegated, that a permit be denied unless appropriate conditions can be included to avoid any substantial impairment of navigation and anchorage.

(p) *Environmental benefits*. Some activities that require Department of the Army permits result in beneficial effects to the quality of the environment. The district engineer will weigh these benefits as well as environmental detriments along with other factors of the public interest.

(q) *Economics*. When private enterprise makes application for a permit, the district engineer may in appropriate cases make an independent review of the need for the project from the perspective of the overall public interest.

(r) *Mitigation*. Consideration of mitigation will occur throughout the permit application review process and includes avoiding, minimizing, rectifying, reducing, or compensating for resource losses.

Permits for Dams and Dikes in Navigable Waters of the United State (Part 321)

In addition to the general policies of 33 CFR Part 320 and the procedures of 33 CFR Part 325, there are special policies, practices and procedures to be followed by the Corps of Engineers for reviewing permits to authorize construction of a dam or dike in a navigable water of the United States. This is required by section 9 of the Rivers and Harbors Act of 1899 (33 U.S.C. 401). Such dams or dikes also require Department of the Army permits under section 404 of the Clean Water Act (33 U.S.C. 1344 and 33 CFR Part 323).

The term "dike or dam" means any impoundment structure that completely spans a navigable water of the United States and that may obstruct interstate waterborne commerce. The term does not include a weir.

The Assistant Secretary of the Army (Civil Works) will decide whether Department of the Army authorization for a dam or dike in an *interstate* navigable water of the United States will be issued, since this authority has not been delegated to the Chief of Engineers. The conditions to be imposed in any instrument of authorization will be recommended by the district engineer when forwarding the report to the Assistant Secretary of the Army (Civil Works), through the Chief of Engineers.

District engineers are authorized to decide whether Department of the Army authorization for a dam or dike in an *intrastate* navigable water of the United States will be issued.

Processing a Department of the Army application under section 9 will not be completed until the approval of the United State Congress has been obtained if the navigable waterway of the United States is an *interstate* waterbody, or until the approval of the appropriate state legislature has been obtained if the navigable water of the United States is an *intrastate* waterbody (i.e., the navigable portion of the navigable water is solely within the boundaries of one state).

(Note: A waterbody may be entirely within a state, yet still be capable of carrying interstate commerce.)

Permits for Structures or Work in or Affecting Navigable Waters of the U.S. (Part 322)

Certain other structures or work in or affecting navigable waters of the United States are also regulated under other authorities. Such structures include, without restriction, any pier, boat dock, boat ramp, wharf, dolphin, weir, boom, breakwater, bulkhead, revetment, riprap, jetty, artificial island, permanent mooring structure, power transmission line, permanently moored floating vessel, piling, aid to navigation, or any other obstacle or obstruction.

Processing of Department of the Army Permits (Part 325)

Arranged in the basic timing sequence used by the Corps of Engineers, the processing of applications for Department of the Army permits is as follows:

Pre-application consultation for major applications. The district staff of the Corps of Engineers regulatory program shall be available to advise potential applicants of studies or other information foreseeably required for later federal action. Potential applicants may contact the district engineer or the regulatory staff to request pre-application consultation. Upon receipt of such request, the district engineer will assure the conduct of an orderly process which may involve other staff elements and affected agencies (Federal, state or local) and the public. This early process should be brief but thorough so that the potential applicant may begin to assess the viability of some of the more obvious potential alternatives in the application. Whenever a potential applicant indicates the intent to submit an application for work which may require the preparation of an environment document, a single point of contact shall be designated within the regulatory staff to effectively coordinate the process. Effort devoted to this process should be commensurate with the likelihood of a permit application actually being submitted to the Corps.

Application form. Applicants must use the standard application form (ENG Form 4345, OMB Approval No. OMB 49-R0420).

Content of the application. The application must include a complete description of the proposed activity including

- Necessary drawings, sketches, or plans sufficient for public notice (detailed engineering plans and specifications are not required)
- Location, purpose, and need for the proposed activity
- Scheduling of the activity
- Names and addresses of adjoining property owners
- Location and dimensions of adjacent structures
- List of authorizations required by other federal, interstate, state, or local agencies, including all approvals received or denials already made.

If the activity involves dredging in navigable waters of the United States, the applicant must include a description of the type, composition and quantity of the material to be dredged, the method of dredging, and the site and plans for disposal of the dredged material. If the activity involves the construction of an impoundment structure, the applicant may be required to demonstrate that the structure complies with established state dam safety criteria or that the structure has been designed and reviewed by qualified persons, as described above.

An application will be determined to be complete when sufficient information is received to issue a public notice. Additional information may required that the district engineer deems essential to make a public interest determination. A $10 fee will be charged for permit applications when the proposed work is non-commercial in nature.

Processing of applications

(1) Within 15 calendar days of receipt of an application the district engineer will determine either that the application is complete and issue a public notice, or that it is incomplete and notify the applicant of the information necessary for a complete application.

(2) The comment period should not be more than 30 days or less than 15 days from the date of the notice. The district engineer may extend the comment period up to an additional 30 days if warranted.

The district engineer will consider all comments received in response to the public notice. If the district engineer determines, based on the comments received, that he must have the views of the applicant on a particular issue to make a public interest determination, the applicant will be given the opportunity to furnish his views. At the earliest practicable time, other substantive comments will be furnished to the applicant. The district engineer may also offer Corps regulatory staff to be present at meetings between applicants and objectors, where appropriate, to provide information on the process, to mediate differences, or to gather information to aid the decision process. The district engineer should not delay processing of the application unless the applicant requests a reasonable delay, normally not to exceed 30 days, to provide additional information or comments.

(3) District engineers will generally decide on all applications not later than 60 days after receipt of the complete application. Certain laws (e.g., the Clean Water Act, the CZM Act, the National Environmental Policy Act, the National Historic Preservation Act, the Preservation of Historical and Archaeological Data Act, the Endangered Species Act, the Wild and Scenic Rivers Act, and the Marine Protection, Research and Sanctuaries Act) require procedures such as state and other federal agency certifications, public hearings, environmental impact statements, consultation, special studies, and testing which may prevent district engineers from being able to decide certain applications within 60 days.

A decision will be made as to whether the permit application will require either an environmental assessment or an environmental impact statement unless it is included within a categorical exclusion. The applicant will be given a reasonable time, not to exceed 30 days to respond to requests of the district engineer.

(4) The district engineer will also evaluate the application to determine the need for a public hearing.

(5) After all of the above actions have been completed, the district engineer will determine whether or not the permit should be issued. He shall prepare a statement of findings (SOF) or, where an environmental impact statement has been prepared, a record of decision (ROD), on all permit decisions. The SOF or ROD shall include the district engineer's views on the probable effect of the proposed work on the public interest. If a permit is warranted, the district engineer will determine the special conditions, if any, and

duration which should be incorporated into the permit. The district engineer will take final action, or forward the application with all pertinent comments, records, and studies, including the final EIS or environmental assessment, through channels to the official authorized to make the final decision.

(6) If the final decision is to deny the permit, the applicant will be advised in writing of the reason(s) for denial.

Procedures for particular types of permit situation

(1) *Section 401 Water Quality Certification*

If the district engineer determines that water quality certification for the proposed activity is necessary under the provisions of section 401 of the Clean Water Act, he shall so notify the applicant and obtain from him or the certifying agency a copy of such certification. The public notices for such activity will serve as notification to the Administrator of the Environmental Protection Agency. If the EPA determines that the proposed discharge may affect the quality of the waters of *any state other* than the state in which the discharge will originate, it will so notify such other state, the district engineer, and the applicant. If EPA determines another state's waters will be affected, such state has 60 days from the receipt of EPA's notice to determine if the proposed discharge will affect the quality of its waters so as to violate any water quality requirement in such state, to notify EPA and the district engineer in writing of its objection to permit issuance, and to request a public hearing. If such occurs, the district engineer will hold a public hearing in the objecting state. The issues to be considered at the public hearing will be limited to the water quality impacts. Based upon the recommendations of the objecting state, EPA, and any additional evidence presented at the hearing, the district engineer will condition the permit, if issued, in such a manner as may be necessary to insure compliance with the applicable water quality requirements. If the imposition of conditions cannot, in the district engineer's opinion, insure such compliance, he will deny the permit.

(2) *Coastal Zone Management Consistency*

If the applicant is a federal agency, and the application involves a federal activity in or affecting the coastal zone, the district engineer shall forward to the agency of the state responsible for reviewing the consistency of federal activities. The federal agency applicant shall be responsible for complying with the Coastal Zone Management Act's directive for ensuring that federal agency activities are undertaken in a manner that is consistent, to the maximum extent practicable, with approved CZM Programs.

If the applicant is not a federal agency and the application involves an activity affecting the coastal zone, the district engineer shall obtain from the applicant a certification that his proposed activity complies with and will be conducted in a manner that is consistent with the approved state CZM Program. If the state agency objects to the certification or issues a decision indicating that the proposed activity requires further review, the district engineer shall not issue the permit until the state concurs with the certification statement or the Secretary of Commerce determines that the proposed activity is consistent with the purposes of the CZM Act or is necessary in the interest of national security. If the state agency fails to concur or object to a certification statement with six months of its receipt, state agency concurrence shall be conclusively presumed.

Joint procedures. Division and district engineers are authorized and encouraged to develop joint procedures with states and other federal agencies with ongoing permit programs for activities also regulated by the Department of the Army. Such procedures may be substituted for those described above.

Appendix 2. Limits on Required Channel Depths

Task. Establish whether a drop in low-water tidal elevations would be limited by required channel depths to accommodate navigation.

The design and rationale for the hydraulic design of deep-draft navigation projects undertaken by the U.S. Army Corps of Engineers are described in Regulation ER 1110-2-1404, *Engineering and Design, Hydraulic Design of Deep-draft Navigation Projects*. The initial step in the hydraulic design process is to develop a hydraulic design plan. The study plan proceeds on the basis of alternative design fleets represented by a "design vessel."

Selecting the design vessel representative of a design fleet is the joint responsibility of engineering and planning disciplines. The project geometries for channels, turning basins, and anchorages (depths, widths, and alignments) are based on the selected design vessel.[1] Selection of the design ship and project design depth is determined jointly by an economic analysis of the expected project benefits compared with project costs. Generally, several alternative channel depth design levels are developed, since depth is often one of the major cost determining parameters.[2]

The required channel depth ("authorized project depth") is based on the draft of the loaded design vessel plus "squat,"[3] sinkage in fresh water, effect of wind and wave action, and safety and efficiency clearance. Additional depth may be required because of the location of the vessel saltwater intake and to provide for advanced maintenance and dredging tolerance, but these latter two factors are not included in the authorized project depth.[4]

The design vessel is usually the largest ship of the major commodity movers expected to use the project improvements on a frequent and continuing basis.[5] It may not be the largest ship to use the channel, for large ships are often accorded the greatest attention and are subject to special rules of operation when arriving at or leaving port and may not therefore pose the greatest threat to safety.[6]

The design vessel or vessels are selected on the basis of economic studies of the types and sizes of the ship fleet expected to use the proposed navigation channel over the project life. Projections of ship fleet data are usually needed to account for expected ship

---

[1] U.S. Army Corps of Engineers. Engineering and design: hydraulic design of deep-draft navigation projects. ER 1110-2-1404. 31 January 1996. p. 2.

[2] U.S. Army Corps of Engineers. Hydraulic design of deep-draft navigation projects. Engineer Manual EM 1110-2-1613. 8 January 1994. p. 6-1.

[3] A ship in motion will be lowered vertically below the still water surface because of the increased velocity past the ship causing the pressure on the ship hull to be decreased. This "squat" is greatly increased in shallow, restricted water.

[4] ER 1110-2-1404, p. 3.

[5] EM 1110-2-1613. 8 January 1994. p. 2-3.

[6] Approach channels: a guide to design. Final report of the joint Working Group PIANC and IAPH, in cooperation with IMPA and IALA, Supplement to Bulletin No. 95. Permanent International Associaton of Navigation Congresses & International Association of Ports and Harbors, June 1997. p. 11.

construction trends.[7] Extremes of weather, rate tidal or discharge events, and other limiting (though seldom encountered) conditions are not normally part of the design conditions.[8]

By far the most common commercial traffic through the upper East River consists of tugs and barges. Tugs may vary in length from 50 to 200 feet with drafts of 6 to 20 feet. Barges generally vary in length from 100 to 400 feet with drafts of 6 to 30 feet,[9] but new barges on the East River are reported to have drafts of 32 feet.

A clearance of at least two feet is normally provided between the bottom of a ship and the design channel bottom to avoid damage to ship hull, propellers, and rudders from bottom irregularities and debris. When the bottom of the channel is hard consisting of rock, consolidated sand, or clay, the clearance should be increased to at least three feet.

Advance maintenance dredging consists of dredging deeper than the channel design depth so as to provide for the accumulation and storage of sediment. Generally, depth increments of 2 or 3 feet are normal advance maintenance allowances. In addition to advanced maintenance dredging, an additional one to three feet below the selected dredging depth is generally provided because of the inability to dredge at a uniform depth with fluctuating water surface.[10] Because there will be no tidal currents up to half the time with East River tide gates, more sediment may settle out than at present thus requiring additional dredging.

The majority of canal lock chambers built by the Corps are for commercial tows with drafts equal to or less than 14 feet, 9 feet being the most common. A sample of the depth of the sills of locks built by the Corps other than those designated as "deep draft" is shown in the following table:[11]

Table A2-1. Lower sill submergence values for some Corps of Engineers ship locks

Navigation System	Lock Name	Normal Lower Sill Submergence (feet)
Gulf Intracoastal Waterway	Inner Harbor	31
Lake Washington Ship Canal	Chittendon (large)	29
	Chittendon (small)	16
St. Marys River, South Canal	MacArthur	31
	Poe	32
St. Marys River, North Canal	Davis	23.1
	Sabin	23.1

[7] EM 1110-2-1613, p. 3-12.
[8] Ibid. p. 3-19.
[9] New York City Department of City Planning, Waterfront and Open Space Division, and New Jersey Department of Environmental Protection, Division of Coastal Resources. New York/New Jersey Harbor Estuary Water Use Management Study. February 1991. p. A3.1.
[10] EM 1110-2-1613. p. 6-15.
[11] U.S. Army Corps of Engineers. Hydraulic design of navigation locks. EM 1110-2-1604. 30 June 1995. p. 2-5.

The "controlling depth" of the East River at mean low water is 40 feet from the Upper New York Bay to Wallabout Channel; the balance of the waterway ranges from 20 to 35 feet. The "project depth" is 40 feet to the former Brooklyn Navy Yard, and 35 feet above the Brooklyn Navy Yard.[12]

At a few locations just south of Roosevelt Island, nautical charts show the maximum depth at low water in the main channel of the East River is as little as 33 to 35 feet, and at Lawrence Point it is 36 feet. Elsewhere in the upper East River, the depth is greater, reaching109 feet opposite Willets Point.[13]

This report does not include a geologic survey of bottom conditions at the three candidate sites. However, these conditions have been described for the Lawrence Point location:

> The water depth at mean low water is about 36 feet over most of the river width (of approximately 1,500 feet), with the exception of a narrow (approximately 100- to 150-foot wide) trench 70 to 75 feet deep. This trench, apparently a geological fault or highly decomposed zone in the rock, is located closer to the Queens side and is parallel to the shore… The general geology of the proposed site is fill and glacial deposits overlying bedrock. The overburden consists of manmade miscellaneous fill on top of possibly glacial lake deposits and glacial moraine deposits. Below the glacial moraine, bedrock is typically decomposed from the surface of the top-of-rock to a variable depth depending upon the degree of weathering. The top-of-rock elevation may vary from 40 to 80 feet below the ground surface.[14]

The HydroQual SWEM model indicates that operation of the East River tide gates would lower minimum low water by 0.5 feet just east of the tide gates at Willets Point, declining to 0.3 feet in the Long Island Sound at Stamford. On the west side of the tide gates, there would be no change in minimum low water. This half foot or less can be compared to the safety margins described above as a 3-foot clearance to a rock bottom, 2 or 3 feet for advance maintenance dredging, plus one to 3 feet to allow for a fluctuating water surface.

The major commodity moving through the East River is petroleum products carried in tankers and barges, so possible grounding is a particularly serious issue. If these vessels are indeed loaded to a depth of 30 to 32 feet, a drop in the low-water tidal elevation of even half a foot would reduce what would seem to be an already marginal clearance at the two locations where the depth is 33 to 36 feet: midtown and Lawrence Point.

However, it appears that the minimum channel depth to accommodate East River traffic would be established by the sill depth chosen for the tide gate and lock structures. By Corps procedures, this would be determined by a cost-benefit comparison of alternative

---

[12] U.S. Army Corps of Engineers, Water Resources Support Center. Waterborne commerce of the United States, Calendar Year 1997, Part 1, Waterways and Harbors, Atlantic Coast. p. 46.
[13] Embassy's Waterproof Chart of New York Harbor and Approaches no. 8.1, updated 12 February 1997.
[14] M.J. Abrahams and A. Matlin. East River tidal barrage. In D. Hill (ed.) The East River tidal barrage: a symposium on a multipurpose addition to New York City's infrastructure. Volume 742. Annals of the New York Academy of Sciences. New York. 1994. p. 107.

depths, requiring a detailed study of the depths needed for existing and anticipated vessels. This type of analysis would take into consideration the drop of one-half foot in low-water tidal elevation on the eastern side of the tide gates.

Appendix 3. Coastal Zone Management Program of New York State

Task: Contact the New York Department of State to identify any restrictions on the East River tide gates required to comply with the Coastal Zone Management Program of the State.

The Coastal Zone Management Act (CZM Act) of 1972 establishes a process for the development of state coastal zone management programs. It encourages states to implement a Coastal Management Program (CMP) by offering two incentives. First, it offers states that develop approved CMPs effective regulatory control of their coastal areas through federal consistency with the CMP. Second, it provides for federally funded development and administrative grants.

The federal consistency, or "reverse preemption," requirement allows states to better control the activities of all state agencies and "relevant federal agencies" that are active in coastal areas. Federal consistency is the CZM Act requirement that federal actions that are reasonably likely to affect any land use or water use or natural resource of the coastal zone be consistent with enforceable policies of a coastal state's federally approved coastal management program.

The term "enforceable policies" means State policies that are legally binding through constitutional provisions, laws, regulations, land use plans, ordinances, or judicial or administrative decisions, by which a State exerts control over private and public land and water uses and natural resources in the coastal zone. The policies were developed to provide clear and explicit statements of federal and state policy in the coastal area that are to be used in government decision-making. New York's 44 CMP policies are contained in the state's Coastal Management Program and Final Environmental Impact Statement. The objective is that federal agencies and applicants for federal approvals and funding consider and comply with state CMPs.

In order for a state to gain federal approval, its program must, among other things, contain the following elements:

- a definition of what shall constitute permissible land uses and water uses within the coastal zone that have a direct and significant impact on the coastal waters
- an inventory and designation of areas of particular concern within the coastal zone
- an identification of means by which the state proposes to exert control over land and water uses, including a list of relevant state constitutional provisions, laws, regulations, and judicial decisions
- broad guidelines on priorities of uses in particular areas
- a description of the organizational structure proposed to implement the management program, including the responsibilities and interrelationships of local, areawide, state, regional, and interstate agencies in the management process
- a planning process for assessing the effects of, and studying and evaluating ways to control, or lessen the impact of, shoreline erosion, and to restore areas adversely affected by such erosion.

In addition, the state must follow all rules and regulations issued under the CZM Act and seek full participation of all relevant Federal and state agencies. A state must also ensure that it has sought input from public and private groups and individuals in developing its coastal program.

In 1990, Congress passed the Coastal Zone Act Reauthorizing Amendments (CZARA) to deal with modern problems in the coastal zone. Realizing the "clear link between coastal water quality and land use activities along the shore," Congress aimed CZARA at controlling land uses that significantly affect coastal area, specifically nonpoint source pollution. CZARA requires states with approved CMPs to develop federally approved Coastal Nonpoint Pollution Control Programs.

New York Waterfront Revitalization and Coastal Resources Act

Pursuant to the CZM Act, the New York State Legislature passed the Waterfront Revitalization and Coastal Resources Act (Article 42 of the Executive Law, the "Waterfront Act") (WRCRA) in 1981. In accordance with the CZM Act's mandate, and to encourage economic growth while preserving coastal area, New York has developed coastal policies to which all state and federal agencies must adhere (see below). These policies are derived from the legislative declarations of policy of the WRCRA, and other state and federal laws.

New York's coastal management program pursues these major objectives: (1) to encourage and oversee the development of Local Waterfront Revitalization Programs (LWRPs) as components of the CMP, (2) to ensure state and federal consistency with the CMP or LWRPs, and (3) to advance New York's coastal policies.

Local Waterfront Revitalization Programs

New York provides coastal municipalities with the opportunity to adopt and implement refinements of state coastal policies through Local Waterfront Revitalization Programs. LWRPs refine and supplement New York State's CMP by defining area-specific needs and objectives at the municipal level, based on local circumstances and needs.

WRCRA provides that a LWRP shall be consistent with the general goals of the state's coastal management program. Therefore, each LWRP must address the 44 coastal policies contained the state's Coastal Management Program. In each LWRP, each of the applicable 44 state policies are either incorporated into the local waterfront revitalization program, refined to reflect local circumstances, or determined to be inapplicable to the coastal area in the municipality.

Direct LWRP regulatory authority is through state and local laws and in federal regulatory authority, and local, state and federal consistency provisions. The legal authority to implement its policies is derived from a municipality's comprehensive planning and zoning power delegated by the state through the town, village, or general city laws. Once a LWRP is adopted by a municipality and approved by the state and federal governments, it effectively becomes a comprehensive plan for the coastal area of the municipality that the municipality, state and federal government must comply with.

WRCRA provides numerous incentives to local governments to establish LWRPs. Perhaps the most pronounced incentive is the consistency requirement of both the WRCRA and the CZM Act. Briefly stated, once a program is adopted by a municipality and approved by the state, and the federal government concurs with the state's approval, *it sets the standard to which all coastal activities of local, state and federal agencies must adhere*.

Consistency Requirements

The precise procedures that federal agencies must follow to establish consistency with New York's coastal management policies depends upon whether proposed actions are directly undertaken by the federal agency or whether the agency is involved in some other way. However, the New York State Department of State ultimately determines whether a federal agency's funding, direct, or permitted activity would be consistent with the CMP.

State agency actions must be consistent with the state's coastal policies in the WRCRA or an approved LWRP as set forth in the WRCRA and its corresponding rules and regulations. Under New York State law, all state agencies must certify to the consistency of their actions with the policies set forth in the Executive Law, Article 42. However, according to the findings of an Administrative Law Judge, consistency with coastal policies is an area clearly within the primary expertise of the Department of State. State agencies, while not necessarily bound by DOS's determination, would ordinarily defer to the DOS in matters of coastal policy consistency when DOS is itself directly involved in federal agency decision-making.

If a state agency action will be contrary to the state's coastal policies or an approved LWRP, the agency may not undertake the action unless it can find that it would meet all of the following WRCRA consistency requirements:

- No reasonable alternative exist which would permit the action to be taken in a manner that would not substantially hinder the achievement of such policy or purpose
- The action taken will minimize all adverse effects on such policies to the maximum extent practicable
- *The action will result in an overriding regional or statewide public benefit.*

The New York State Department of Environmental Conservation is responsible for management and protection of natural resources and environmental quality. The DEC regulates activities that may have a negative impact on wetlands and water quality. Activities such as draining, filling or building structures within a wetland or its adjacent buffer area may be undertaken only if DEC has granted a permit. In granting a permit, DEC is empowered to place conditions and restrictions on an activity which can include mitigation measures.

New York City Waterfront Revitalization Program

The *New York City Waterfront Revitalization Program* is the city's principal coast zone management tool. It establishes the city's policies for development and use of the waterfront and provides the framework for evaluating the consistency of all discretionary actions in the coastal zone with those policies. The guiding principle of the NYCWRP is to maximize the benefits derived from economic development, environmental preservation, and public use of the waterfront, while minimizing the conflicts among these objectives.

New York City's original Waterfront Revitalization Program adopted in 1982 incorporated the 44 state policies, added 12 local policies, and delineated a coastal zone to which the policies would apply. The present NYCWRP replaces the 56 city and state policies by ten policies as follows:

> Policy 1: Support and facilitate commercial and residential redevelopment in areas well-suited to such development.
> Policy 2: Support water-dependent and industrial uses in New York City coastal areas that are well suited to their continued operation.
> Policy 3: Promote use of New York City's waterways for commercial and recreational boating and water-dependent transportation centers.
> Policy 4: Protect and restore the quality and function of ecological systems within the New York City coastal area.
> Policy 5: Protect and improve water quality in the New York City coastal area.
> Policy 6: Minimize loss of life, structures and natural resources caused by flooding and erosion.
> Policy 7: Minimize environmental degradation from solid waste and hazardous substances.
> Policy 8: Provide public access to and along New York City's coastal waters.
> Policy 9: Protect scenic resources that contribute to the visual quality of the New York City coastal area.
> Policy 10: Protect, preserve and enhance resources significant to the historical, archaeological, and cultural legacy of the New York City coastal area.

Each of these policies is elaborated in the 1997 plan.

A feature of the NYCWRP is the recognition of two types of coastal areas with special characteristics:
- Significant Maritime and Industrial Areas (SMIAs)
- Special Natural Waterfront Areas (SNWAs)

The six identified SMIAs are particularly well-suited for maritime and industrial development. The three SNWAs have particular natural habitat features that should be considered in connection with any waterfront activity. Activities proposed within the SMIAs and SNWAs that do not directly foster the goals for these areas may be found "consistent," but would be analyzed to ensure that the special characteristics of these areas are not substantially impeded or destroyed.

In the upper East River are found two such areas: the East River-Long Island Sound SNWA and the South Bronx SMIA, as shown in Figures A3-1 and A3-2. The East River-Long Island Sound SNWA contains “special natural waterfront areas” on Flushing Bay, Powell’s Cove (adjacent to College Point), and Little Neck Bay in Queens. In The Bronx, there are several such area fronting on Long Island Sound and Eastchester Bay, and on the East River extending from Ferry Point Park westward to the mouth of the Bronx River. The west side of the mouth of the Bronx River bounds the South Bronx SMIA which extends along the East River to Bronx Kill and the Harlem River.

Policy 4 (above) is the primary policy to be considered in SNWAs. This policy is elaborated in the NYCWRP under the following headings:

> 4.1 Protect and restore the ecological quality and component habitats and resources.
> 4.2 Protect and restore tidal and freshwater wetlands.
> 4.3 Protect vulnerable plant, fish and wildlife species, and rare ecological communities. Design and develop land and water uses to maximize their integration or compatibility with the identified ecological community.
> 4.4 Maintain and protect living aquatic resources.

Under Policy 6, within SNWAs, protection of the natural shoreline and non-structural measures have priority over other erosion and flood control methods.

Comprehensive Harbor Management Plans

In response to the conflicts that have resulted from recreational boating on coastal resources and uses in harbors, the New York State legislature amended the WRCRA in 1992 to allow local governments to develop and adopt Harbor Management Plans (HMP). Under the WRCRA, a municipality that wishes to adopt a LWRP must also include a HMP, or at least address the possibility of establishing a HMP. If a HMP is not appropriate for a particular area, then the requirement may be waived.

The HMP amendments provide direct regulatory authority to local governments that adopt a harbor management plan to regulate in-water structural uses. Section 922 of WRCRA provides the following:

> In order to implement a comprehensive harbor management plan the local legislative body of a city, town, or village may adopt, amend and enforce local laws and ordinances to regulate the construction, size and location of wharves, docks, moorings, piers, jetties, platforms, breakwaters or other structures and uses in waters within or bounding the municipality… to a distance of fifteen hundred feet from shore.

Further, New York regulations state “the Legislature … recognizes the significant role New York’s cities, towns and villages are capable of taking in the regulation and management of activities in and over the State’s navigable waters and underwater lands if

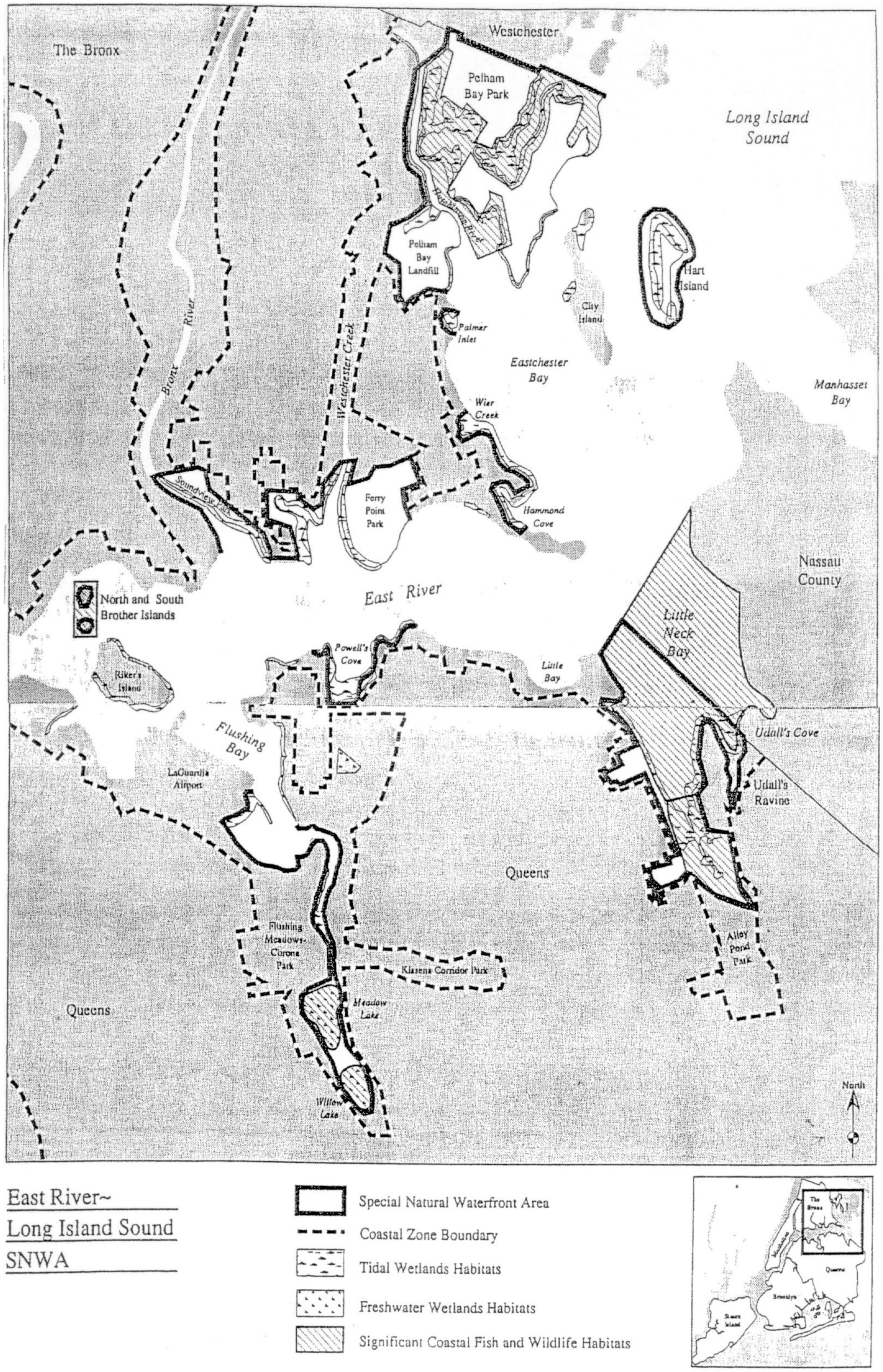


Figure A3-1. East River – Long Island Sound Special Natural Waterfront Areas. Source: New York City Department of City Planning, NYC DCP 97-12.

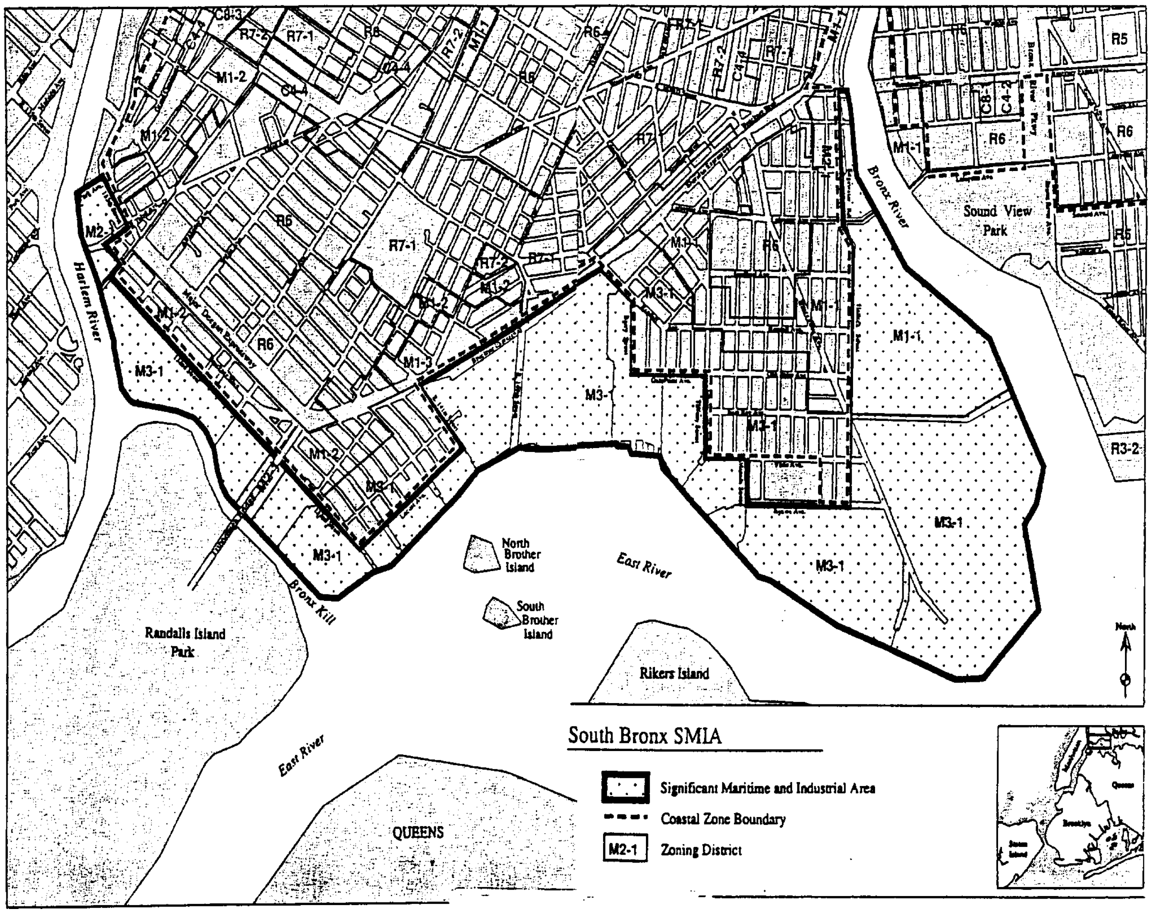


Figure A3-2. South Bronx Significant Maritime and Industrial Area. Source: New York City Department of City Planning, NYC DCP 97-12.

granted clear authority to regulate these areas. Accordingly, the Legislature has provided for the development and approval of local government HMPs and the local laws or ordinances necessary to implement these plans." Factors that municipalities should consider when enacting HMPs include commercial and recreational needs, habitat protection, water-dependent uses, aesthetic values, and public interests.

Local governments that had a Local Waterfront Revitalization Plan in effect prior to the 1992 amendment of the WRCRA, such as New York City, are not required to adopt a Harbor Management Plan. However, in 1991 a *New York/New Jersey Harbor Estuary Water Use Management Study* was published which addresses much of the same issues. The study aimed to assess the then current level of activity on the waterways, project future levels and patterns of activity, and identify ways of reducing the potential for conflict among the various vessel types using the waterways.

Long Island Sound Coastal Advisory Commission

The Long Island Sound Coastal Advisory Commission, the latest addition to the WRCRA, was established in 1995 as a result of the state's efforts to address regional issues in Long Island Sound and a Long Island Sound CMP, in part on the recommendation of the Governor's Task Force on Coastal Resources. The Long Island Sound CMP was established to act as the overall regional plan for Long Island Sound's coastal environment. The commission was created to address the problems of the sound, including water quality degradation, decreasing biological diversity, stress on beaches and shellfish beds, loss of open space, and an increasingly difficult business climate. The seventeen-member commission will be responsible for implementing the Long Island Sound Coastal Management Program. The Long Island Sound CMP was completed as a regional effort and has not yet been approved by the federal government. The commission will also be responsible for assisting other local government agencies that have jurisdiction over the sound and coordinating their actions.

New York State Coastal Management Program Policies

The 44 New York State Coastal Management Program Policies, excerpted from the *State of New York Coastal Management Program and Final Environmental Impact Statement*, Section 6, August 1982, together with explanations of the policies, constitute a 41-page document. Although comparatively few would seem to apply to East River tide gates, all 44 are listed here. For some of those that may be applicable to East River tide gates (Policies 7, 11, 18, 19, 20, 22, 31, and 44), the policy explanations are also reported or excerpted in context.

Development Policies

1. Restore, vitalize, and redevelop deteriorated and underutilized waterfront areas for commercial, industrial, cultural, recreational, and other compatible uses.
2. Facilitate the siting of water-dependent uses and facilities on or adjacent to coastal waters.

3. Further develop the state’s major ports of Albany, Buffalo, New York, Ogdensburg, and Oswego as centers of commerce and industry, and encourage the siting, in these port areas, including those under the jurisdiction of state public authorities, of land use and development which is essential to, or in support of, the waterborne transportation of cargo and people.
4. Strengthen the economic base of smaller harbor areas by encouraging the development and enhancement of those traditional uses and activities which have provided such areas with their unique maritime identity.
5. Encourage the location of development in areas where public services and facilities essential to such development are adequate.
6. Expedite permit procedures in order to facilitate the siting of development activities at suitable locations.

Fish and Wildlife Policies

7. Significant coastal fish and wildlife habitats will be protected, preserved, and where practical, restored so as to maintain their viability as habitats.

<u>Explanation of Policy No. 7</u>

Habitat protection is recognized as fundamental to assuring the survival of fish and wildlife populations. Certain habitats are particularly critical to the maintenance of a given population and, therefor, merit special protection. Such habitats exhibit one or more of the following characteristics:

- are essential to the survival of a large portion of a particular fish or wildlife population (e.g., feeding grounds, nursery areas)
- support populations of rare and endangered species
- are found at a very low frequency within a coastal region
- support fish and wildlife populations having significant commercial and/or recreational value, and
- would be difficult or impossible to replace.

In order to protect and preserve a significant habitat, land and water uses or development shall not be undertaken if such actions destroy or significantly impair the viability of an area as a habitat. When the action significantly reduces a vital resource (e.g., food, shelter, living space) or changes environmental conditions (e.g., temperature, substrate, salinity) beyond the tolerance range of an organism, then the action would be considered to “significantly impair” the habitat. Indicators of a significantly impaired habitat may include: reduced carrying capacity, changes in community structure (food chain relationships, species diversity), reduced productivity and/or increased incidence of disease and mortality…

The range of physical, biological and chemical parameters which should be considered include, but are not limited to, the following:

- Physical parameters, such as living space, circulation, flushing rates, tidal amplitude, turbidity, water temperature, depth, (including loss of littoral zone), morphology, substrate type, vegetation, structure, erosion and sedimentation rates
- Biological parameters, such as community structure, food chain relationships, species diversity, predator/prey relationships, population size, mortality rates, reproductive rate, behavioral patterns and migratory patterns, and
- Chemical parameters, such as dissolved oxygen, carbon dioxide, acidity, dissolved solids, nutrients, organics, salinity and pollutants (heavy metals, toxic and hazardous materials).

When a proposed action is likely to alter any of the biological, physical or chemical parameters as described in the narrative beyond the tolerance range of the organisms occupying the habitat, the viability of that habitat has been significantly impaired or destroyed. Such action, therefore, would be inconsistent with the above policy.

In cooperation with the State's Coastal Management Program, the Department of Environmental Conservation has developed a rating system incorporating these five parameters (*The Development and Evaluation of a System for Rating Fish and Wildlife Habitats in the Coastal Zone of New York State*, Final Report, January 1981, 15pp.).

To further aid Federal and State agencies in determining the consistency of a proposed action with this policy, a narrative will be prepared for each significant habitat that will (1) identify the location of the habitat; (2) describe the community of organisms that utilize the habitat; (3) identify the biological, physical and chemical parameters that should be considered when addressing the potential impacts of a project on the habitat; (4) identify generic activities that would most likely create significant impacts on the habitat; and (5) provide the quantitative basis used to rate the habitat. Prior to formal designation of significant fish and wildlife habitats, copies of the individual habitat narratives plus copies of habitat maps and completed rating forms will be provided to Federal and State agencies and the public for the review and comment.

8. Protect fish and wildlife resources in the coastal area from the introduction of hazardous wastes and other pollutants which bio-accumulate in the food chain or which cause significant sublethal or lethal effect on those resources.
9. Expand recreational use of fish and wildlife resources in coastal areas by increasing access to existing resources, supplementing existing stocks, and developing new resources.
10. Further develop commercial finfish, shellfish, and crustacean resources in the coastal area by encouraging the construction of new, or improvement of existing on-shore commercial fishing facilities, increasing marketing of the state's seafood products, maintaining adequate stocks, and expanding aquaculture facilities.

Flooding and Erosion Hazards Policies

11. Buildings and other structures will be sited in the coastal area so as to minimize damage to property and the endangering of human lives caused by flooding and erosion.

Explanation of Policy No. 11

…The only new structure allowed in coastal erosion hazard areas is a moveable structure defined in Section 505.3(u) of the regulations for ECL, Article 34. Prior to its construction, an erosion hazard areas permit must be approved for the structure…

12. Activities or development in the coastal area will be undertaken so as to minimize damage to natural resources and property from flooding and erosion by protecting natural protective features including beaches, dunes, barrier islands and bluffs.
13. The construction or reconstruction of erosion protection structures shall be undertaken only if they have a reasonable probability of controlling erosion for at least thirty years as demonstrated in design and construction standards and/or assured maintenance or replacement programs.
14. Activities and development, including the construction or reconstruction of erosion protection structures, shall be undertaken so that there will be no measurable increase in development, or at other locations.
15. Mining, excavation or dredging in coastal waters shall not significantly interfere with the natural coastal processes which supply beach materials to land adjacent to such waters and shall be undertaken in a manner which will not cause an increase in erosion of such land.
16. Public funds shall only be used for erosion protective structures where necessary to protect human life, and new development which requires a location within or adjacent to an erosion hazard area to be able to function, or existing development: and only where the public benefits outweigh the long term monetary and other costs including the potential for increasing erosion and adverse effects on natural protective features.
17. Non-structural measures to minimize damage to natural resources and property from flooding and erosion shall be used whenever possible.

General Policy

18. To safeguard the vital economic, social and environmental interests of the state and its citizens, proposed major actions in the coastal area must give full consideration to those interests, and to the safeguards which the state has established to protect valuable coastal resource areas.

Explanation of Policy No. 18

Proposed major actions may be undertaken in the coastal area if they will not significantly impair valuable coastal waters and resources, thus frustrating the achievement of the purposes of the safeguards that the State has established to protect those waters and resources. Proposed actions must take into account the social, cultural, economic, and environmental interests of the State and their citizens in such matters that would affect natural resources, water levels and flows, shoreline damage, hydroelectric power generation, and recreation.

Public Access Policies

19. Protect, maintain, and increase the level and types of access to public water-related recreation resources and facilities.

<u>Explanation of Policy No. 19</u>

This policy calls for achieving balance among the following factors: the level of access to a resource or facility, the capacity of a resource or facility, and the protection of natural resources. The imbalance among these factors is the most significant in the State's urban areas…

The following guidelines will be used in determining the consistency of a proposed action with this policy:

- The existing access from adjacent or proximate public lands or facilities to public water-related recreation resources and facilities shall not be reduced, nor shall the possibility of increasing access in the future from adjacent or proximate public lands or facilities to public water-related recreation be eliminated, unless in the latter case estimates of future use of these resources and facilities are too low to justify maintaining or providing increased public access.
- Any proposed project to increase public access to public water-related recreation resources and facilities shall be analyzed according to the following factors: (a) The level of access to be provided should be in accord with estimated public use. If not, the proposed level of access to be provided shall be deemed inconsistent with the policy. (b) The level of access to be provided shall not cause a degree of use which would exceed the physical capability of the resource or facility. If this were determined to be the case, the proposed level of access to be provided shall be deemed inconsistent with the policy.
- The State will not undertake or fund any project which increases access to a water-related resource or facility that is not open to all members of the public.
- In their plans and programs for increasing public access to public water-related resources and facilities, State agencies shall give priority in the following order to projects located: within the boundaries of the Federal-Aid Metropolitan Urban Area and served by public transportation; within the boundaries of the Federal-Aid Metropolitan Urban Area but not served by public transportation; outside the defined Urban Area boundary and served by public transportation; and outside the defined Urban Area boundary but not served by public transportation.

20. Access to the publicly owned foreshore and to lands immediately adjacent to the foreshore or the water's edge that are publicly owned shall be provided, and it shall be provided in a manner compatible with adjoining uses.

<u>Explanation of Policy No. 20</u>

In coastal areas where there are little or no recreational facilities providing specific water-related recreational activities, access to the publicly owned lands of the coast at large should be provided for numerous activities and pursuits which require only minimal facilities for their enjoyment. Such access would provide for walking along a beach or a city waterfront or to a vantage point from which to view the seashore. Similar activities requiring access would include bicycling, birdwatching, photography, nature study, beachcombing, fishing and hunting…

Recreation Policies

21. Water-dependent and water-enhanced recreation will be encouraged and facilitated and will be given priority over non-water-related uses along the coast.
22. Development, when located adjacent to the shore, will provide for water-related recreation, whenever such use is compatible with reasonably anticipated demand for such activities, and is compatible with the primary purpose of the development.

<u>Explanation of Policy No. 22</u>

Many developments present practical opportunities for providing recreational facilities as an additional use of the site or facility. Therefore, whenever developments are located adjacent to the shore, they should, to the fullest extent permitted by existing law, provide for some form of water-related recreation use unless there are compelling reasons why any form of such recreation would not be compatible with the development, or a reasonable demand for public use cannot be foreseen…

In determining whether compelling reasons exist which would make inadvisable recreation as a multiple use, safety considerations should reflect a recognition that some risk is acceptable in the use of recreation facilities…

Historic and Scenic Resources Policies

23. Protect, enhance and restore structures, districts, areas or sites that are of significance in the history, architecture, archaeology or culture of the state, its communities, or the nation.
24. Prevent impairment of scenic resources of statewide significance.
25. Protect, restore or enhance natural and man-made resources which are not identified as being of statewide significance, but which contribute to the overall scenic quality of the coastal area.

Agricultural Lands Policy

26. Conserve and protect agricultural lands in the state's coastal area.

Energy and Ice Management Policies

27. Decision on the siting and construction of major energy facilities in the coastal area will be based on public energy needs, compatibility of such facilities with the environment, and the facility's need for a shorefront location.

28. Ice management practices shall not interfere with the production of hydroelectric power, damage significant fish and wildlife and their habitats, or increase shoreline erosion of flooding.
29. Encourage the development of energy resources on the outer continental shelf, in Lake Erie and in other water bodies, and ensure the environmental safety of such activities.

Water and Air Resources

30. Municipal, industrial, and commercial discharge of pollutants, including but not limited to, toxic and hazardous substances, into coastal waters will conform to state and national water quality standards.
31. State coastal area policies and management objectives of approved local waterfront revitalization programs will be considered while reviewing coastal water classifications and while modifying water quality standards; however, those waters already overburdened with contaminants will be recognized as being a development constraint.

Explanation of Policy No. 31

Pursuant to the Federal Clean Water Act of 1977 (PL 95-217) the State has classified its coastal and other waters in accordance with considerations of best usage in the interest of the public and has adopted water quality standards for each class of waters. These classifications and standards may be reviewed at least every three years for possible revision or amendment. Local Waterfront Revitalization Programs and State coastal management policies shall be factored into the review process for coastal waters. However, such consideration shall not affect any water pollution control requirement established by he State pursuant to the Federal Clean Water Act.

The State has identified certain stream segments as being either “water quality limiting” or “effluent limiting.” Waters not meeting State standards and which would not be expected to meet these standards even after applying “best practicable treatment” to effluent discharges are classified as “water quality limiting.” Those segments meeting standards or those expected to meet them after application of “best practicable treatment” are classified as “effluent limiting,” and all new waste discharges must receive “best practicable treatment.” However, along stream segments classified as “water quality limiting,” waste treatment beyond “best practicable treatment” would be required, and costs of applying such additional treatment may be prohibitive for new development.

32. Encourage the use of alternative or innovative sanitary waste systems in small communities where the costs of conventional facilities are unreasonably high, given the size of the existing tax base of these communities.
33. Best management practices will be used to ensure the control of stormwater runoff and combined sewer overflows draining into coastal waters.
34. Discharge of waste materials into coastal waters from vessels subject to state jurisdiction will be limited so as to protect significant fish and wildlife habitats, recreational areas and water supply areas.

35. Dredging and dredge spoil disposal in coastal waters will be undertaken in a manner that meets existing state dredging permit requirements, and protects significant fish and wildlife habitats, scenic resources, natural protective features, important agricultural lands, and wetlands.
36. Activities related to the shipment and storage of petroleum and other hazardous materials will be conducted in a manner that will prevent or at least minimize spills into coastal waters; all practicable efforts will be undertaken to expedite the cleanup of such discharges; and restitution for damages will be required when these spills occur.
37. Best management practices will be utilized to minimize the non-point discharge of excess nutrients, organics and eroded soils into coastal waters.
38. The quality and quantity of surface water and groundwater supplies will be conserved and protected, particularly where such waters constitute the primary or sole source of water supply.
39. The transport, storage, treatment and disposal of solid wastes, particularly hazardous wastes, with coastal areas will be conducted in such a manner so as to protect groundwater and surface water supplies, significant fish and wildlife habitats, recreation areas, important agricultural land, and scenic resources.
40. Effluent discharge from major steam electric generating and industrial facilities into coastal waters will not be unduly injurious to fish and wildlife and shall conform to state water quality standards.
41. Land use or development in the coastal area will not cause national or state air quality standards to be violated.
42. Coastal management policies will be considered if the state reclassifies land areas pursuant to the prevention of significant deterioration regulations of the Federal Clean Air Act.
43. Land use or development in the coastal area must not cause the generation of significant amounts of acid rain precursor: nitrates and sulfates.
44. Preserve and protect tidal and freshwater wetlands and preserve the benefits derived from these areas.

<u>Explanation of Policy No. 44</u>

Tidal wetlands include the following ecological zones: coastal fresh marsh; intertidal marsh; coastal shoals, bars and flats; littoral zone; high marsh or salt meadow; and formerly connected tidal wetlands. These tidal wetland areas are officially delineated on the Department of Environmental Conservation’s Tidal Wetlands Inventory Map.

Freshwater wetlands include marshes, swamps, bogs, and flats supporting aquatic and semi-aquatic vegetation and other wetlands so defined in the NYS Freshwater Wetlands Act and the NYS Protection of Waters Act.

The befits derived from the preservation of freshwater wetlands include but are not limited to:

- habitat for wildlife and fish, including a substantial portion of the State’s commercial fin and shellfish varieties; and contribution to associated aquatic food chains
- erosion, flood and storm control

- natural pollution treatment
- groundwater protection
- recreational opportunities
- educational and scientific opportunities, and
- aesthetic open space in many otherwise densely developed areas.

References

Coastal Management Program, Department of State, New York State. Consistency review: coastal management program policies. Excerpted from the State of New York Coastal Management Program and Final Environmental Impact Statement, Section 6, August 1982. June 1992.

Giuliani, Rudolph W. and Joseph B. Rose. The new waterfront revitalization program: a proposed 197a plan. NYC DCP 97-12. New York City Department of City Planning. May 1997.

Koch, Edward I. and Herbert Sturz. Coastal zone boundary of New York City: waterfront revitalization program task 4.4. New York City Department of City Planning. June 30, 1986.

New York City Department of City Planning, Waterfront and Open Space Division, and New Jersey Department of Environmental Protection, Division of Coastal Resources. New York/New Jersey Harbor Estuary Water Use Management Study. Funded by U.S. Department of Commerce, National Oceanic and Atmospheric Administration. February 1991.

Resler, Steven C. Supervisor of Consistency Review and Analysis, New York State Department of State, prefiled testimony (undated).

Sokol, Matthew A. Coastal zone management in New York. Pace University School of Law. Spring 1998.

Appendix 4. Effect on East River Combined Sewer Outfalls

Task: Contact the New York City Department of Environmental Protection to determine the elevations and operations of the tide gates/regulator assemblies on combined sewer outfalls in the East River. Review with the NYC DEP and determine whether tide gate/regulator operations will limit the permissible rise in the level of high water in the East River.

Combined sewer outfalls (CSO) serve as a safety valve on the combined sewer system. Under normal conditions the flow of wastewater through the combined sewers goes entirely to wastewater treatment plants. With heavy rain, however, the amount of the water flow may exceed the capacity of the wastewater treatment plants. Under these circumstances, the regulators automatically redirect the wastewater to an outfall where it enters the receiving waters directly without treatment.

The receiving waters are prevented from backing up into the sewer by tide gates that are part of the regulator assembly. (We will refer to these as regulator tide gates to distinguish them from the East River tide gates. See Figure A4-1.) Wastewater continues to flow to the treatment plant through an interceptor sewer. With heavy rain, however, the flow to the interceptor is automatically limited by the regulator, and the upstream water pressure forces open the regulator tide gates to allow the overflow to go directly to the receiving waters.

Higher tides offer more resistance to combined sewer overflows at regulator tide gates than do lower tide elevations. Peak wastewater flows are thus backed up to higher levels during high tide conditions than they are at low tide, increasing the extent of sewer surcharging and the potential for street and service connection flooding. Extreme increases in tidal elevations could potentially interfere with regulator tide gate operations, backing up storm flows in the sewer system still further than they are under usual high tide conditions.

Operation of the East River tide gates to control the river flows would affect the tidal elevations in their general vicinity. The results of the Systemwide Eutrophication Model (SWEM) indicate a maximum increase of 0.8 feet in maximum high water on the west side of the tide gates when they are closed. This diminishes to 0.2 feet at Gowanus, assuming that the tide gates are constructed in the vicinity of the Whitestone Bridge. On the east side of the East River tide gates, maximum high water is 0.2 feet lower than before.[1] Therefore, the concern with sea level rise is focused close to the west side of the East River tide gates.

The New York City regulated interceptor system is shown in Figure A4-2. Combined sewer outfalls located on the East River are connected with six wastewater treatment plants: Wards Island, Hunts Point, Tallman Island, Bowery Bay, Newtown Creek, and Red Hook.

---

[1] John St. John and Robin L. Miller, HydroQual, Inc. East River tidal barrier: solution to water quality problems in the NY/NJ Harbor? Hudson River Foundation Tuesday Seminars, April 6, 1999.

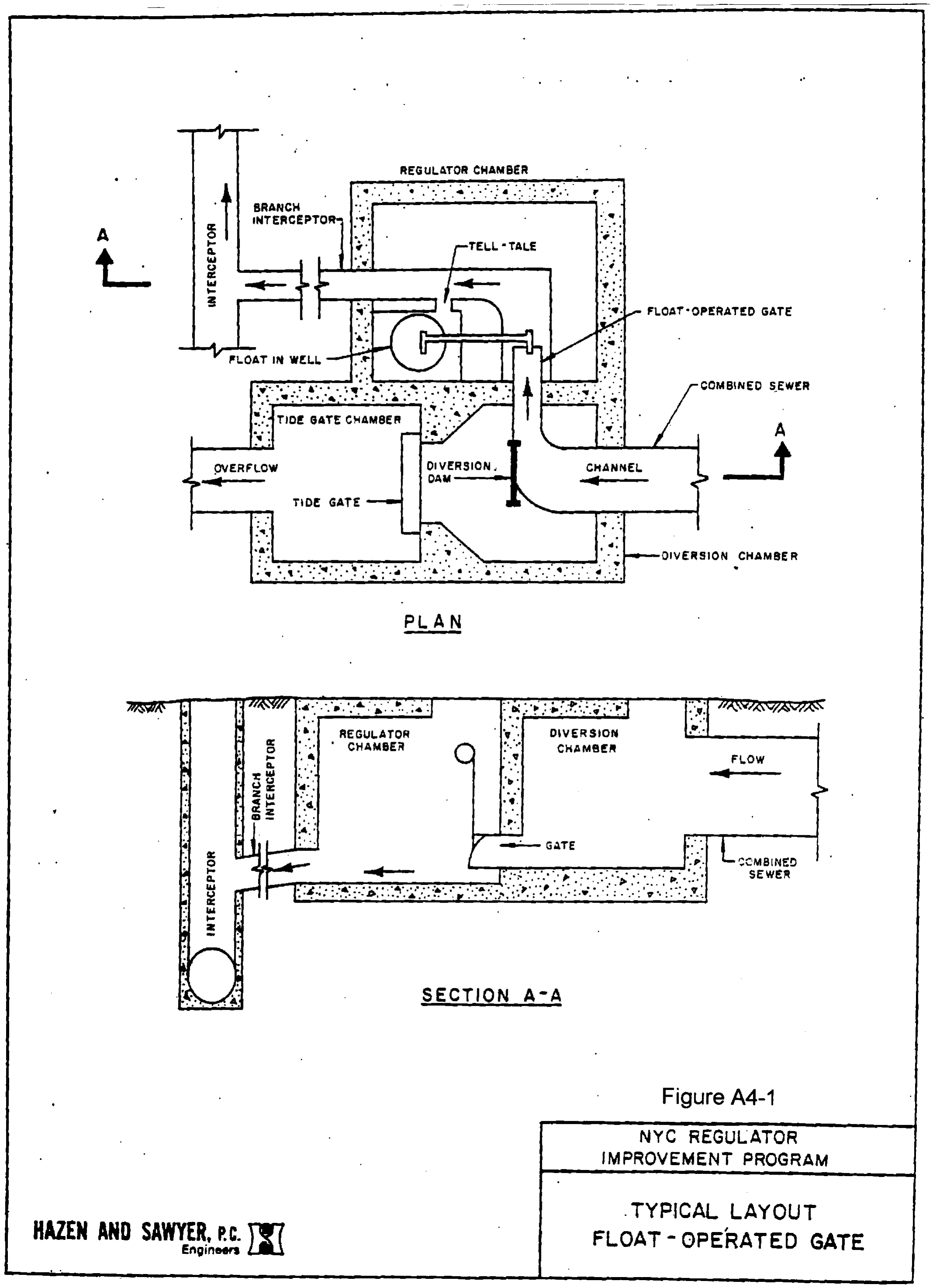


Figure A4-1. Typical layout of a float-operated gate for a combined sewer outfall regulator. Source: Hazen and Sawyer, P.C.

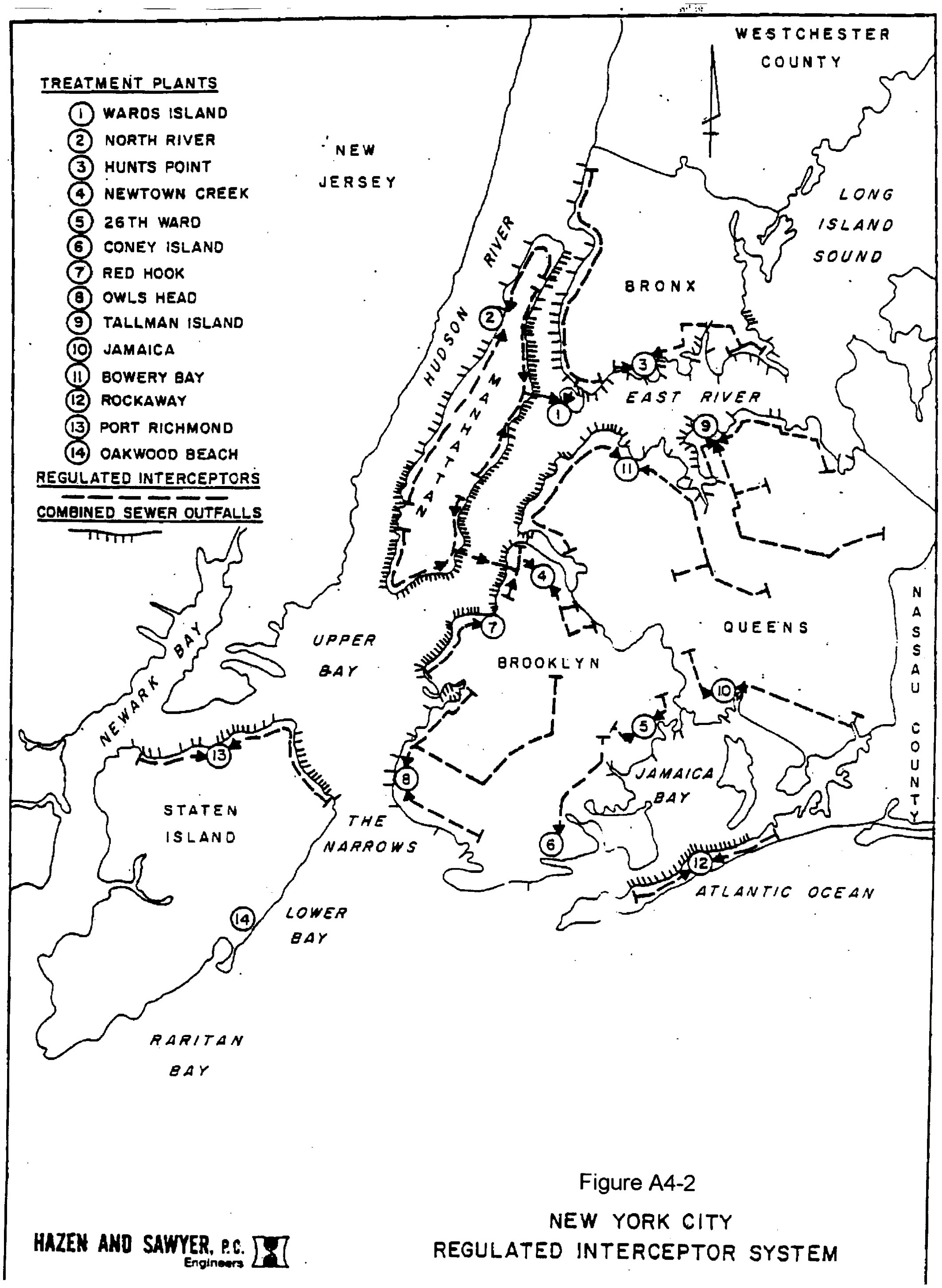


Figure A4-2. New York City regulated interceptor system. Source: Hazen and Sawyer, P.C.

Information on the combined sewer regulators and tide gates was obtained from a task report prepared as part of NYCDEP's Regulator Improvement Program. The report lists the elevations of the weirs in the regulators through which the wastewater normally flows.[2] The elevations for the 220 CSO regulator locations on the East River are shown in the Figures A4-3 to A4-5. The weir elevations relative to sea level have been extrapolated to the year 2010 from the 1985 data to account for an assumed continuation in the rise in sea level in the East River of 0.0012 feet per year experienced from 1950 to 1993. It can be seen that the great majority of these weir elevations are within 2½ feet of mean sea level, above or below. The year 2010 is taken as a year in which tide gates might go into operation. Sea level can be expected to continue to rise thereafter, of course.

In order to place the maximum predicted increase of 0.8 feet in high water in some perspective, we note that the mean tidal range at Hell Gate is 5.1 feet and at Willets Point 7.1 feet. The variability that actually occurs is illustrated for Willets Point in Figure A4-6. The figure shows the sea level record for a 1.5 month period during the spring of 1997 partitioned into the semidiurnal fluctuations associated with the astronomical tide (lower figure) and the subtidal fluctuations associated with meteorological fluctuation which are superposed on the astronomical variation (upper figure).

The amplitude of the semidiurnal fluctuations (plotted relative to local mean tide level) exhibits marked fortnightly and monthly variations associated with the beating of the three major semidiurnal constituents. The amplitude varies from a minimum of 0.8 meters (tidal range of 5.25 feet) to a maximum of approximately 1.5 meters (tidal range of 9.8 feet). The subtidal fluctuations which are superposed on the astronomical fluctuations have maximum amplitudes of approximately 0.8 meters (2.6 feet). These fluctuations tend to be most intense in spring and fall.

The tidal elevations of the weirs at the 220 regulator locations are shown as a histogram in Figure 8-1 with intervals of 0.8 feet. By 2010, 52 percent of the regulators will be below mean sea level. If all experienced a rise in sea level of 0.8 feet, this would increase to 67 percent. A maximum tidal range of 9.6 feet is shown for reference. For all but a handful of the regulators, the elevations lie within the 2010 tidal range. Three are permanently submerged; with a 0.8 foot rise in sea level, this increases to five.

In summary, even with an increase of as much as 0.8 feet upon construction of East River tide gates, under most conditions the tidal elevations to which regulator tide gates would be subjected are within the range to which they are routinely exposed already. An increase of 0.8 feet above extreme high tides could contribute to more frequent and extensive sewer surcharge and flooding. This potential would need to be examined on a regulator-by-regulator basis. However, the higher tidal elevations associated with operation of East River tide gates would not necessarily have to increase extreme high tide elevations. The East River tide gates could simply be left open during tidal extremes in order to avoid exacerbating high tide conditions that might contribute to flooding.

[2] Hazen and Sawyer, P.C. New York City regulator improvement program, Task 1.2, regulator and outfall tables. Submitted to New York City Department of Environmental Protection. April 1985. Appendix A.

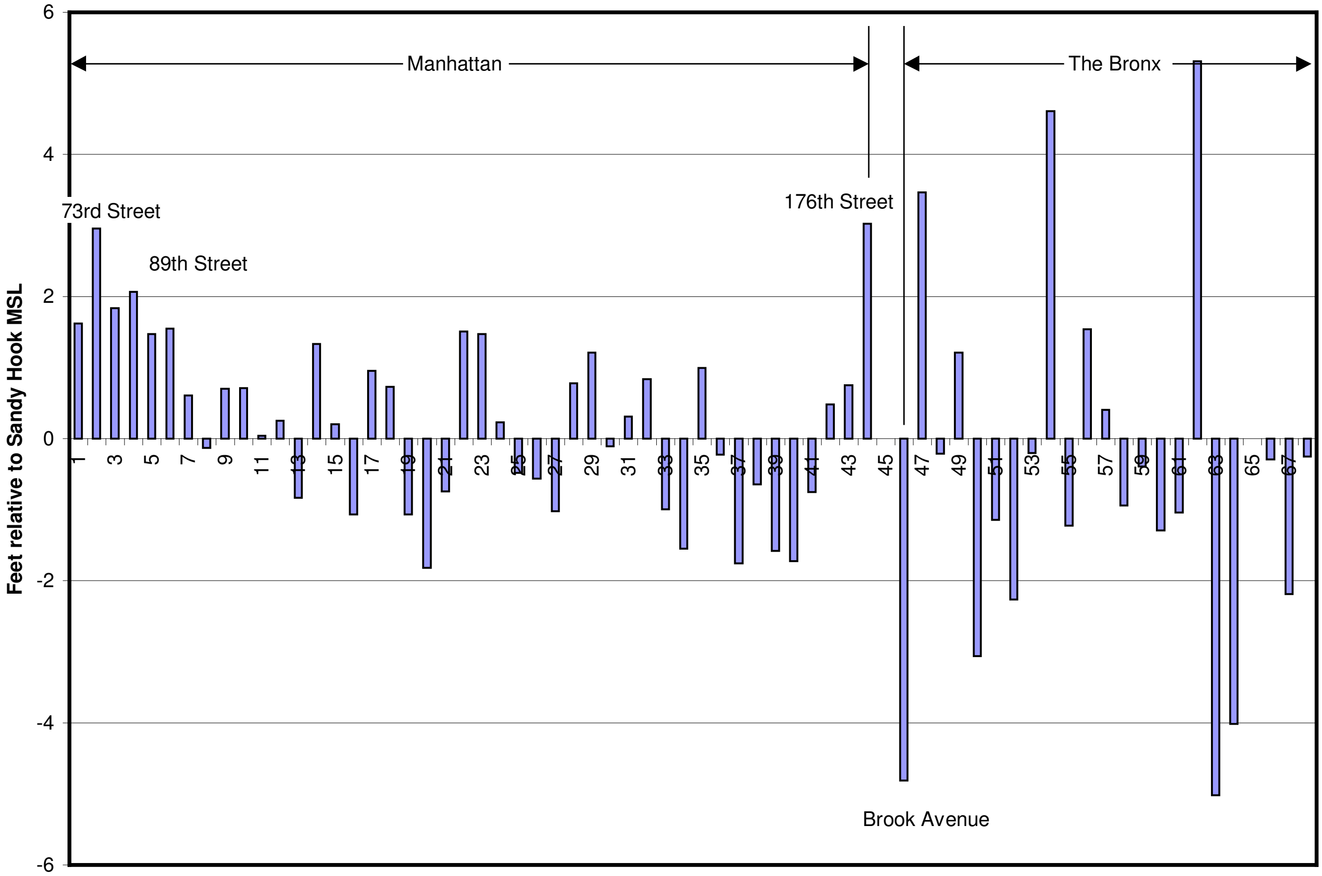


Figure A4-3. Weir elevations in 2010 for Wards Island CSO system. Source: Hazen and Sawyer, P.C.

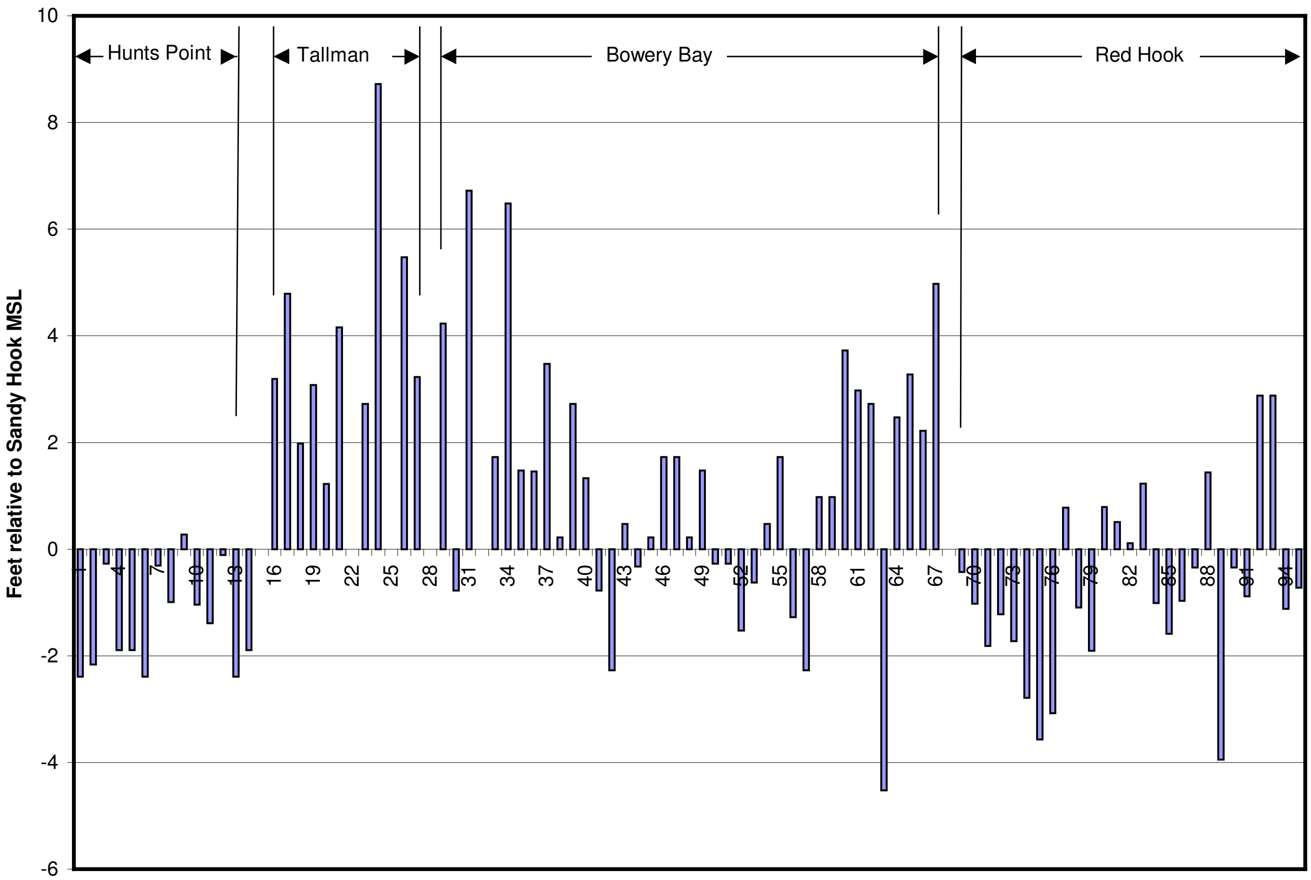


Figure A4-4. Weir elevations in 2010 for the Hunts Point, Tallman Island, Bowery Bay and Red Hook CSO systems. Source: Hazen and Sawyer, P.C.

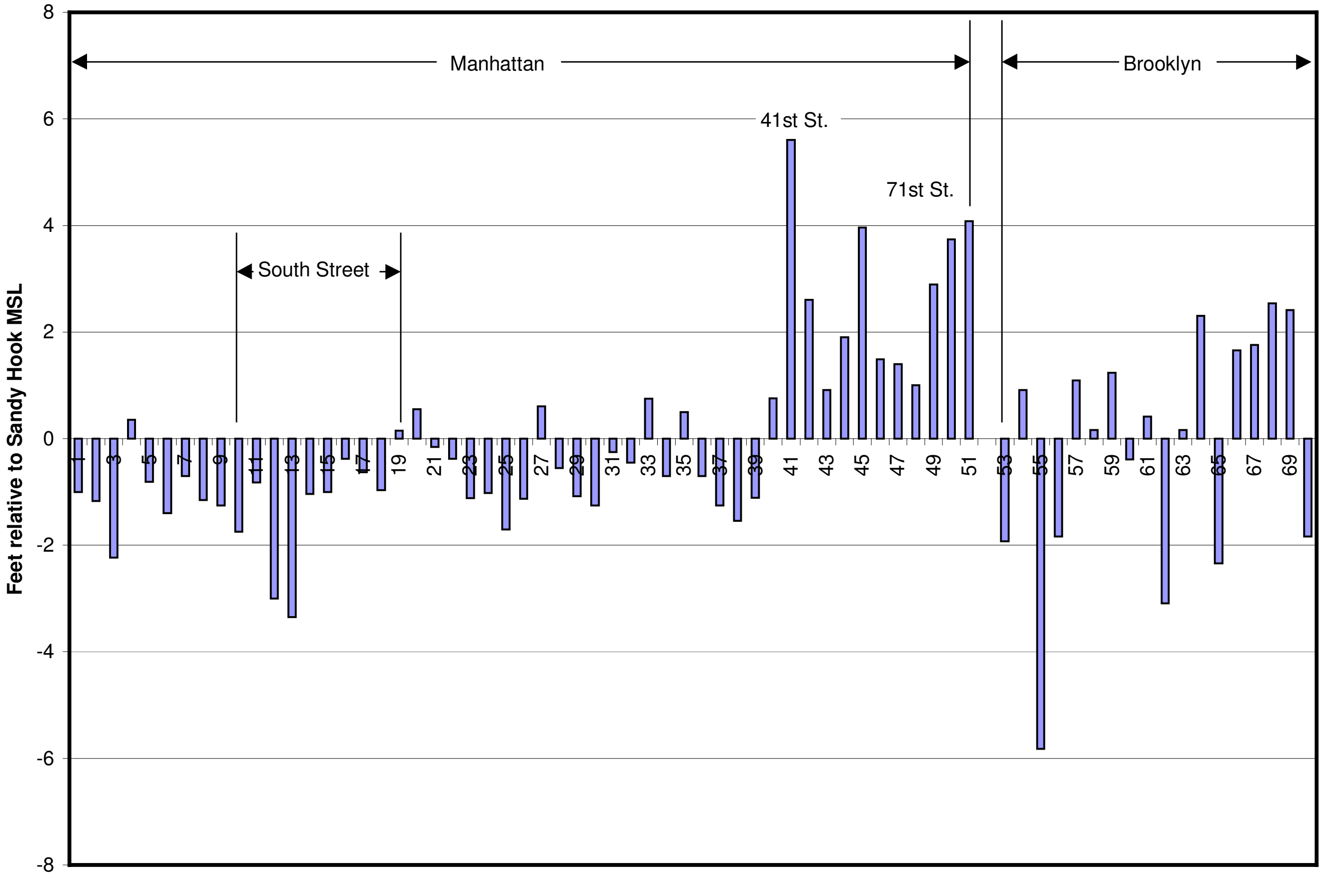


Figure A4-5. Weir elevations in 2010 for Newtown Creek CSO system.

Source: Hazen and Sawyer, P.C.

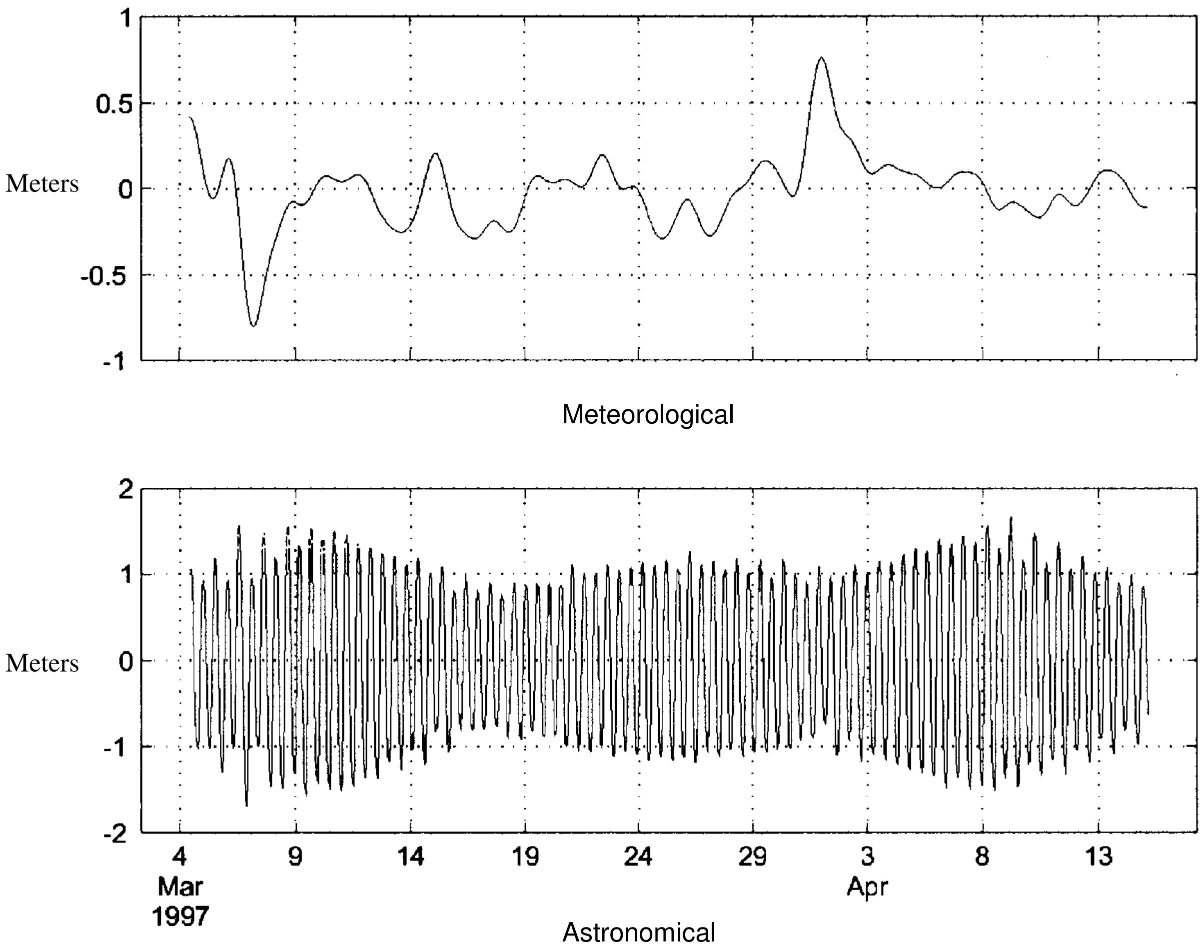


Figure A4-6. Meteorological and astronomical contributions to tide at Willets Point, New York.

Appendix 5. Meetings with U.S. Coast Guard

Task: Meet with the U.S. Coast Guard to determine if tide gates might be construed as a "bridge," which would require USCG authorization and any other restrictions they might apply. Also, if USCG is authorized to review the tide gates, obtain information to prepare a schedule for USCG reviews and approvals.

Douglas Hill and Robert Wilson met with Captain Larry Brooks, Deputy Commander, Coast Guard Activities New York, and five members of his staff on 27 January 1999. On his recommendation, a second meeting was held with the East River Subcommittee of the Harbor Safety, Navigation and Operations Committee (the "Harbor Ops Committee) which is chaired by the Coast Guard, at which two Coast Guard officers were present. These were LCDR Brian Krenzien, then Branch Chief of the Vessel Traffic Service (VTS), and CDR Daniel R. Croce, Senior Investigating Officer, Investigations and Analysis Branch. (See Appendix 6.)

The authority of the Secretary of the Army and Chief of Engineers with respect to bridges and causeways was transferred to the Secretary of Transportation under the Department of Transportation Act of October 15, 1966. This authority of the Secretary of Transportation is administered through the U.S. Coast Guard.

As defined in the U.S. Code:

> The term "bridge" means a lawful bridge over navigable waters of the United States, including approaches, fenders, and appurtenances thereto, which is used and operated for the purpose of carrying railroad traffic, or both railroad and highway traffic, or if a State, county, municipality, or other political subdivision is the owner or joint owner thereof, which is used and operated for the purpose of carrying highway traffic. (33 USC Sec. 511)

Although the piers that might be constructed for East River tide gates conceivably could also serve as the foundation for a bridge, the tide gates themselves are clearly not a means of carrying traffic over a navigable waterway. However, as a party concerned with navigation, aids to navigation, oil spills and other matters, the Coast Guard will have an interest in East River tide gates.

These concerns are evident in the discussion of public comments and changes accompanying the *Issuance of the final regulatory program of the U.S. Corps of Engineers* on January 12, 1987.

> The U.S. Coast Guard was particularly concerned that these rules be more specific with regard to information and criteria that will be used to ensure navigation safety and the prevention of navigation obstructions. Section 204 of the National Fishing Enhancement Act requires that the Department of Commerce consult the U.S. Coast Guard in the development of the National Artificial Reef Plan regarding the criteria to be established in the plan. One of the standards with

> which the criteria must be consistent is the prevention of unreasonable obstructions to navigation. In addition, the district engineer shall consult with any governmental agency or interested party, as appropriate, in issuing permits for artificial reefs. This includes pre-application consultation with the U.S. Coast Guard, and placing conditions in permits recommended by the U.S. Coast Guard to ensure navigational safety… The U.S. Coast Guard requested that they be provided copies of permit applications for artificial reefs, and that a permittee be required to notify the Coast Guard District Commander when reef construction begins and when it is completed so timely information can be included in notices to mariners… Two weeks advance notice is a reasonable period of time both for construction scheduling and for government notification to mariners.

Specific references to Coast Guard participation in the Corps of Engineers regulatory program are as follows:

> *Aids to navigation*: The placing of fixed and floating aids to navigation in a navigable water of the United States is within the purview of Section 10 of the Rivers and Harbors Act of 1899, which prohibits the unauthorized obstruction or alteration of an navigable waters of the United States. These aids are of particular interest to the U.S. Coast Guard because of its control of marking, lighting and standardization of such navigation aids. A Section 10 nationwide permit has been issued for such aids provided they are approved by, and installed in accordance with the requirements of the Coast Guard. Navigation aids or danger markings must be installed as required by the Coast Guard.
>
> *Shipping safety fairways and anchorage areas*. Department of the Army permits are required for structures located within shipping safety fairways and anchorage areas which are established by the U.S. Coast Guard.
>
> In the processing of Department of the Army permits, public notices are distributed to the District Commander, U.S. Coast Guard, among others.

At the meeting with Captain Brooks and his staff, the following points were made:

- Commercial navigation interests in New York waters are considered at monthly meetings of the Harbor Safety, Navigation & Operations Committee (“Harbor Ops Committee”), which is chaired by the Coast Guard. Two key people are Linda O’Leary, Towboat & Harbor Carriers Conference, and Capt.Andrew McGovern, Sandy Hook Pilots Association; also Interport Pilot, Inc. (Linda O”Leary subsequently also referred us to Capt. McGovern. The meeting with the newly formed East River Subcommittee of the Harbor Ops Committee, which included members of the Sandy Hook Pilots Association, is described in Appendix 6.)
- The commercial community will want to know the cost of using locks.
- New York Police Department uses Wards Island as their base and will be concerned with the location of tide gates.

- Vessels navigate Hell Gate in the 1½-hour window of slack tide. Tugs use a short hawser through Hell Gate; they do not push barges.
- There will be concern about the risk of damage in using locks.
- A fast ferry, *Sassacus*, transports gamblers from NYC to New London; it needs to average 30 knots to make a profit. Fast ferry operators will vehemently oppose the idea of tide gates.
- Tugs travel at 6 knots or less with a tow; 10 knots otherwise.
- There are five recreational marinas near La Guardia Field that should be consulted.
- It would be better to have the gates at one end of the East River or the other; you can't stop a big ship once it enters the East River. There must be a safe place to stage from. Vessels will queue up and need elbow room near the locks. Suitable areas would be below the Governors Island area, and between the Whitestone and Throgs Neck bridges.
- New York Harbor now has two stations (at The Battery and Bergen Point) that report tidal currents in real time which vessel operators can reach. These are used instead of tidal current tables. This is part of the Vessel Traffic Service (VTS) which can be reached in three ways: telephone, direct dial, and the Web.
- New York City is the source of home heating oil for New England, and there is heavy barge traffic through the East River in winter.
- Consideration should be given to whether the gates can be designed to stop oil spills while allowing an underflow of water. Oil spills are a special concern in the vicinity of La Guardia Field. (Edwin Levine, Scientific Support Coordinator, NOAA).

Appendix 6. Meetings with Maritime Community

Task 5: Identify typical operators of vessels using the East River. Contact these operators to obtain their manner of scheduling trips, schedules, and views on the possible impacts on operations of the presence of piers in the river and from changes in tide and current patterns due to tide gates.

Operators of vessels using the East River were contacted through a meeting of the East River Subcommittee of the Harbor Safety, Navigation & Operations Committee, and two follow-up visits to tug-and-barge companies.

The Operations Committee provided information on navigating the East River and commented on their concerns with possible East River tide gates. At a second meeting, the tug-and-barge operator who had been present at the Operations Committee meeting said that he agreed that the benefit of loaded barges being able to transit the East River at least half the time more than offsets the delays of locking through closed tide gates. At a third meeting, a tug-and-barge operator who was new to the concept stressed the difficulties introduced by an obstacle in the river, and claimed to see no need for additional flexibility in scheduling.

East River Subcommittee Meeting

Those present at the East River Subcommittee of the Harbor Safety, Navigation & Operations Committee, which was held on 22 April 1999, were:

Capt. Andrew McGovern	President	Sandy Hook Pilots Association
Capt. J.H. Olthius	Training Director	Sandy Hook Pilots Association
Capt. Henry Mahlmann	East River Pilot	Sandy Hook Pilots Association
Capt. Ken Peterson		Reinauer Transportation Co. (tug and barge company)
William O. Gray	President	Gray Marine Company
Frank Santangelo		Corps of Engineers
Kevin Harte		American Waterways Ops
LCDR B. Krenzien, USCG	(then) Branch Chief	Vessel Traffic Service
CDR D.R. Croce, USCG	Investigating Officer	Investigations & Analysis Branch

An important fact is that the treacherous tidal currents in Hell Gate limit the amount of time that slow-moving vessels, like tugs and barges, can pass through. Tug and barge operators must therefore schedule their operations by the tide, having the opportunity to pass through Hell Gate only twice a day during the hour-and-a-half window when the tide is reversing.

A principal concern expressed by the pilots was the likelihood of eddy currents at the entrance to the Harlem River with tide gates in operation.

In addition, the following points were made:

- There will be an increase in flow through The Race at the eastern end of Long Island Sound to compensate for blocking the flood tide in the East River.
- A large vessel cannot stop in the East River. It loses control. There is a rock bottom where anchors do not hold or will hang up. Extra tugs would be needed.
- There is a problem with large vessels being stopped near La Guardia field, possibly interfering with flight paths.
- Tidal current charts for the East River were rescinded in 1991. However, they have not been replaced.
- Regarding the size of the opening needed for ships to pass through a canal, the Suez Canal provides a guide. "Wetted area", i.e., the beam times the draft cannot be more than one-quarter of the cross-section of the waterway. There, however, the bottom and sides are sand, not hard surface, which makes a stranding easier to remedy.
- The Suez and Panama Canals have established anchorages at both ends and in the middle to handle stopped vessels
- East River has a "controlled depth" of 35 feet. New barges have a 32 foot draft..
- New York City (not Houston) is the largest oil port in the USA.
- The largest vessel ever piloted by Captain Hank Mahlmann in the East River was 950 feet in length with 156 foot beam. This operated only east of the Lawrence Point.
- The largest tank barges are owned by Bouchard, located in Hicksville, LI.
- A traffic control system for maritime use similar to air traffic control is 25 years away.
- The group prefers the idea of using the whole river as a lock (with two tide gates spaced some distance apart along the river) if it would reduce traffic delays rather than one tide gate with conventional locks.
- Any piers in the river present a problem for vessels passing through when the gates are open.
- Structures in the river would require "protection cells", i.e., dolphins.
- The range of cruising speed for a vessel in the East River is 8 to 12 knots.
- NOAA will provide a tide gauge at no charge is local authorities pay for its operations and maintenance.

Reinauer Transportation Company

One of the subsequent meeting was held on 13 October 2000 with Captain Ken Peterson of Reinauer Transportation Company, who attended the Operations Committee meeting. He said that he agreed with our conclusion that the benefit of loaded barges being able to transit the East River at least half the time more than offsets the delays of locking through closed tide gates.

Captain Peterson described how tugs and barges navigate the East River. While waiting for favorable conditions to pass through the East River, tugs hold off Bay Ridge near Governors Island, and near Whitestone Bridge (Eastchester) in upper East River.

There is a 40-minute window during which loaded barges can pass through Hell Gate, although this is sometimes stretched to 2 hours. Tugs that miss the Hell Gate window must loiter for several hours at a cost to the customer of $300 to $500 per hour. There is often a group of tugs waiting near the United Nations building jockeying for position to go through Hell Gate first. They are in radio contact with each other, but may not behave as they indicate.

Light barges can go through Hell Gate at any stage of the tide.

Tugs without barges travel 7 to 8 knots. Tanker barges travel 4 knots loaded & light, and tankers 4 knots loaded and 5 knots light.

Captain Peterson reiterated his preference for the Italian floating tide gate type and double tide gates, rather than gates with locks. If they are located in the channel near Randalls Island, he is concerned with the possible conflict with docking at the Wards Island wastewater treatment plant.

Reinauer Transportation Company has a fleet of 17 tugs and 27 barges in New York City which principally carry light oil. Reinauer is getting a new 600-foot barge, and operates 485-foot barges with tugs that are 90 to 100 feet long. They also have a fleet in Boston, and they operate from Yorktown, VA, to Maine.

Moran Towing Company

A third meeting was held with Captain Igor Loch and others on 1 February 2001 at Moran Towing Corporation Those at Moran had not been previously introduced to the concept of tide gates.

Captain Loch stressed the importance of any obstruction in the river. Tugs propel barges in one of three ways: with a long line, a short line, or alongside. Maneuvering a barge through locks would require changing from towing on a short line to towing alongside. This maneuvering might require two tugboats instead of one. Any such additional handling would be time-consuming and undesirable.

He then introduced us to the person responsible for scheduling operations. A major part of their work is towing fuel barges to make deliveries to Long Island Sound ports on Long Island and in Connecticut. The scheduler did not think that being restricted to passing through Hell Gate only at slack tide was a handicap, because it timed deliveries to Long Island Sound ports under desirable tidal conditions. The additional opportunities that might exist with greater flexibility in scheduling did not seem to impress him.

Moran Towing is the largest towing company on the U.S. East Coast. Its operations include harbor ship docking services, transportation of dry and liquid bulk products on both a contract and spot basis, as well as specialty and offshore towing. Moran owns and operates 54 tugboats and 14 tank and bulk barges.

Appendix 7. Implications for National Ocean Service, NOAA

Task: Determine the implications of tide gate operations on tidal-current charts and other information published by the National Ocean Service, NOAA.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Silver Spring, Maryland 20910

August 30, 1999

Dr. Douglas Hill
15 Anthony Court
Huntington, NY 11743-1327

Dear Dr. Hill:

Thank you for the opportunity to review the material regarding the proposed East River tide gate project. Mr. Richard Barazotto, Director, Center for Operational Oceanographic Products and Services (CO-OPS), has asked me to respond to your request. We have responded with some very general projected impacts on NOAA's tide and tidal current products. Specific impacts must await the detailed design of the structure and the analysis of new measurements. All of NOAA's suite of nautical chart products would also be affected and more specific comments could be obtained from the Office of Coast Survey of the National Ocean Service.

In general, if the tide gates were built, the NOAA tide and tidal current products would be significantly impacted over a fairly large geographic area, depending on the specific location and extent of the proposed structure. The models contained in the reference material you provided show this geographic area to generally be from western Long Island Sound, to Upper New York harbor, including the Harlem River and the lower Hudson River estuary up to the Harlem River Entrance. The models predict that the tidal characteristics, both for water level and currents, could change significantly over this area. As a result, the full suite of NOAA chart products, tidal datums, and tide and tidal current predictions could become obsolete. The tide and tidal current reference system would have to be re-established through new surveys after the completion of construction.

1) Tidal Datum Elevations: The range of tide and time of tide is modeled to change on each side of the tide gate, with the amount decreasing with increasing distance from the location

   - The reference system for tidal datums is a 19-year national tidal datum epoch period (NTDE). NTDE values based on direct observation are available at NOAA tide stations at Willets Point, Sandy Hook, and the Battery. These reference datums will become obsolete and will be updated only through new measurements after the tide gate is in place. The reference datums will be sufficiently accurate only after several years of new measurement and will be updated frequently until the new 19-year period is obtained.

- Present NOAA tidal datum and tidal prediction products contain information from approximately 100 subordinate (short-term) locations in the area. Each of these locations would also have to be re-occupied with new observational series to update tidal datums on local bench marks and to update values in Table 2. of the NOS tide table products. Information from any location would have to be dropped from public issuance until re-occupation.

- The references appear to only address modeled changes to the tidal heights (high water or low water depending on which side of the tide gate). However, there would also be a resulting undetermined amount of change in local relative mean sea level on which the tide "rides". That is, sea level as measured by tide stations, relative to the local land, would also change due to the tide gate.

- NOAA Nautical Chart Datum is Mean Lower Low Water (MLLW), a tidal datum. MLLW elevations relative to the land would change due to the tide gate, and the NOAA nautical charts would be obsolete for an undetermined local area. NOAA would have to issue updated charts or appropriate notices to reflect changes in the depth soundings. The actual change would not be known until new measurements are analyzed after the tide gate is completed and in operation.

2) Tidal Current Products:

NOAA has three tidal current reference stations in the project area that would have to be re-occupied for several months to re-establish the proper reference for approximately 75 subordinate current meter stations found in Table 2. of the NOS Tidal Current Predictions. Each of these subordinate stations would also have to be re-occupied to update the values or dropped.

3) PORTS:

The National Ocean Service has a Physical Oceanographic Real-Time System (PORTS) in operation in the project area. PORTS is a network of real-time reporting current meters, tide stations and meteorological stations. The tidal datum and tidal current references used in this real-time system will be obsolete as soon as the tide gate is in place. It will be extremely important to the navigation community to keep the PORTS system operational before, during, and after the construction of the tide gate. The PORTS will have to be expanded to include observations of real-time water levels and currents for the navigation community on both sides of the tide gate. NOAA will soon be linking an operational nowcast/forecast hydrodynamic model into the system for water level and current prediction. The hydrodynamic model will have to be re-run to forecast effects of the tide gate on model outputs and will have to be re-calibrated and verified for operational purposes after completion of the tide gate.

4) Storm Surge:

The tide gate is modeled to elevate the high tides in the East River and Northern New York Harbor significantly, even without taking into consideration of any effects of potential elevated sea levels. Storm surges will be higher when riding the higher tides. Observed storm surge elevations relative to the land in the New York City area have been close to catastrophic elevation levels for some engineering infrastructures such as intakes to tunnels, etc... The effects of the tide gate on potentially increasing the storm surge levels needs to be modeled very precisely to evaluate the need to re-engineer these structures to prevent negative impacts.

The above is a very cursory review of potential impacts on NOAA's oceanographic products and services and chart products due to construction of the tide gate. The impacts are considered significant, requiring an intense observational program and new data analyses to re-establish reference systems and to update information required for the full suite of products and services that NOAA provides to the marine community in the project area. Please do not hesitate to contact me at 301-713-2981 ext. 139 or via e-mail at Stephen.Gill@noaa.gov with further questions.

Sincerely,

Stephen K. Gill, Technical Director
Center for Operational
Oceanographic Products and
Services

cc:

CO-OPS:
Richard Barazotto
Mike Szabados
Bill Stoney

Office of Coast Survey:
Dr. Bruce parker

marine sciences research center
STATE UNIVERSITY OF NEW YORK, STONY BROOK, N.Y. 11794-5000 (516) 632-8701
FAX (516) 632-8820

October 6, 1999

Mr. Stephen K. Gill, Technical Director
Center for Operational Oceanographic
Products and Services, National Ocean Service
NOAA
United States Department of Commerce
Silver Spring, Md 20910

Dear Mr. Gill:

Thank you for your thoughtful letter of 30 August 1999 regarding impacts of the proposed East River tide gates on navigation in New York Harbor, in particular the general projected impacts on NOAA's tide and tidal current products.

Professor Robert Wilson and I have carefully read the points you made on Tidal Datum Elevations, Tidal Current Products, PORTS (Physical Oceanographic Real-Time System), and Storm Surge.

We concur with the points you raise. It appears that the indicated necessary actions would be within the normal operating parameters of NOAA, and the necessary surveys and analysis could be accomplished through a local, intense study.

Regarding storm surge, we agree that "the effects of the tide gate on potentially increasing the storm surge levels needs to be modeled very precisely to evaluate the need to re-engineer these structures to prevent negative impacts". However, as detailed in our study, it is worth mentioning that we expect that appropriate management of the tide gates during nor' easterly storms could actually *reduce* the impacts of storm surge on New York City. For example, if the gates were constructed east of La Guardia airport, and held shut during the storm, the runways could be protected against being inundated during nor-easter wind-induced setup in Long Island Sound. A second point to mention is that modern computer numerical hydrodynamic models are now able to provide realistic, accurate predictions of tides, currents and storm surge. Such predictions increasingly are useful in designing surveys to re-establish new datums, current patterns, and tidal predictions.

Thank you again for your detailed response.

Sincerely,

Malcolm J. Bowman
Professor of Physical Oceanography

Appendix 8. Time Saved by Vessels in Still Water

Slow moving vessels, such as tugs with barges, are now limited in the time periods when they can transit the East River for two reasons. First, moving at 5 or 6 knots when loaded or 10 to 12 knots when light, they must take into account tidal currents that reach 3.8 knots at Hell Gate and 4.6 knots alongside Roosevelt Island. Second, treacherous eddies at the twist in the river that is Hell Gate prevent vessels from passing through except for periods of about 1½ hours when the tide is changing. These vessels are therefore scheduled by the tide, not by the time of day.

With tide gates closed in the East River, the water will be essentially still during the period when there would otherwise be tidal currents flowing up the river. This would enable these slow vessels to operate freely more than half the time. With the tide gates closed, it would be necessary for them to pass through locks which would of course create delays. However, these delays will be offset by time savings that result from traveling in still water. Traveling up and down the river in still water will take less time than a round trip with a current flowing.

The latter point may need an explanation. Traveling with the current, a vessel moves that much faster. Traveling against the current, its speed is diminished by the same amount. In covering the same distance, however, a vessel spends more time bucking the current than riding with it. As a result, a vessel making a round trip – with the current one way and against it the other – takes more time than a vessel making the same round trip in still water. Thus, vessels making regular round trips up and down the river would on average save time in still water. This appendix reports an estimate of the time that would be saved in still water.

Tidal current speeds have been reported by the Coast and Geodetic Survey at twelve locations in the East River at hourly intervals during the tidal cycle, as illustrated in Figure A8-1 for conditions four hours after low water at The Battery.[1] In order to estimate their effect on a vessel transiting the river, it is necessary to interpolate between the locations on the river and between the hourly intervals. A program was developed to make this interpolation. Using the interpolated data, the effect of the tidal current on the speed of vessels going up and downstream was calculated at one-minute intervals during its passage between Willets Point at the northeast end of the river and The Battery at the southeast end.

Calculations were made for vessel speeds between 5 and 30 knots. In each calculation, the time of departure from Willets Point was assumed to be such that the vessel, regardless of its speed, passed Hell Gate 5 hours after low water at The Battery, when the current speed at Hell Gate is at its maximum (3.8 knots). The tidal currents are reported for spring tides – that is, near the time of new or full moon when the currents are stronger than average – under normal weather conditions. These results therefore represent the

---

[1] U.S. Department of Commerce, Coast and Geodetic Survey. Tidal current charts, New York Harbor, 7th edition, 1956. This report was rescinded in 1991, but it is the most recent publication showing these currents.

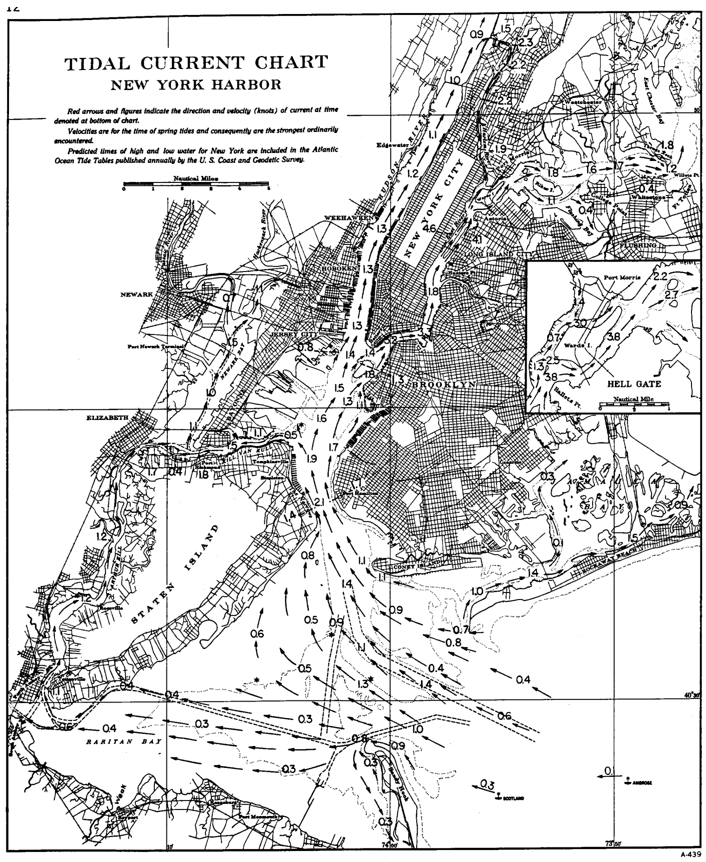


Figure A8-1. Tidal currents 4 hours after low water at The Battery. Source: U.S. Department of Commerce, Coast and Geodetic Survey. Tidal current charts, New York Harbor, 1956.

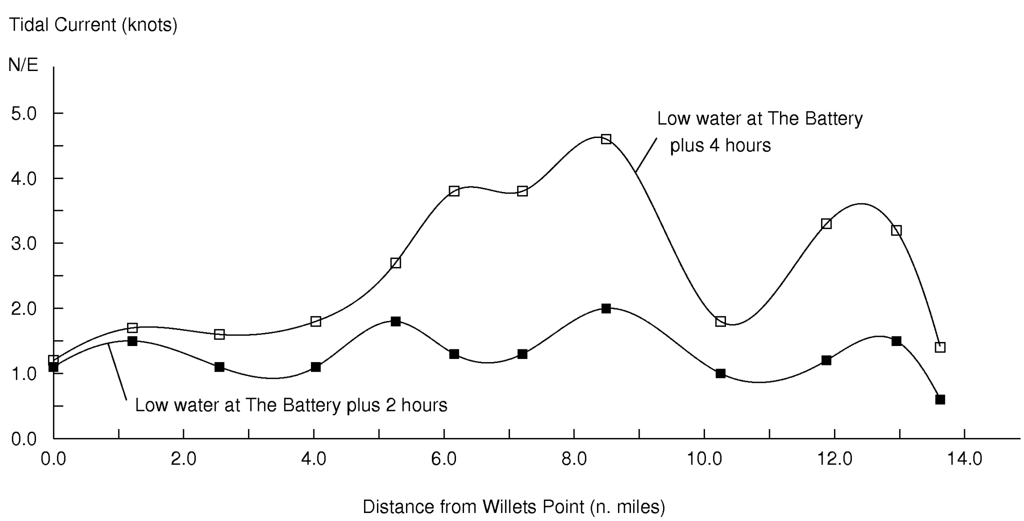


Figure A8-2. Interpolated tidal current velocities along the East River 2 hours and 4 hours after low water at The Battery.

maximum effects of tidal currents, disregarding weather conditions. At neap tides, the currents may be as much as 30 percent lower.

Examples of the current velocities at points along the East River are shown on the chart in Figure A8-1 and the graph in Figure A8-2. In the latter figure, the curves are sections along the river through the interpolation surface that was calculated to represent the tidal velocities. In Figure A8-3, sections of the interpolation surface at different times along points in the river are illustrated. (The curves are not smooth sine curves because the tidal velocities are reported only to two significant figures.) The complete interpolation surface is shown in Figure A8-4.

Using this interpolation surface, the ground speed of a vessel to transit the river with and against the current was calculated. Figure A8-5 compares the time required for a one-way transit of the East River with the current, against the current, and in still water. The fact that more time is lost against the current than is gained with the current is clear. For example, a vessel traveling at 5 knots with the current gains about 53 minutes compared to still water, but loses about 160 minutes against the current.

On average, vessels scheduled by the time of day ("by the clock") instead of by the tide will travel with the tide half the time and against it the other half. The extra time it takes because of the tidal current can therefore be calculated by the time for a round trip with and against the current, compared to the same trip in still water. This is shown in Figure A8-5 to be about 105 minutes for a 5-knot vessel. Of course, if the vessel could always take advantage of a favorable tide both up and down the river ("scheduled by the tide"), that would require the least time. However, it seems unlikely that this could be accomplished much of the time.

The percentage of time saved by operations in still water is shown in Figure A8-6 compared to operations scheduled by the clock. The savings for a 5-knot vessel as calculated for the previous figures is 24 percent; for a 10-knot vessel 8 percent.

Tidal Current Velocity Simulation Model

Data interpolation and graphics were developed by Jeffrey D. Hill on the Linux operating system by Linus Torvalds et al. (for information see http://www.linus.org or ftp://sunsite.unc.edu/pub/Linux or ftp://tsx-11.mit.edu/pub/linux) using the XFree86 version (http://www.xfree86.org) of the X window system from the X Consortium (http://www.x.org) and software tools from the Free Software Foundation, including EMACS, bash, and Ghostview (http://www.gnu.org), the C compiler EGCS (http://www.cygnus.com/egcs), and the PostScript interpreter Aladdin Ghostscript (ftp://ftp.cs.wisc.edu/pub/ghost). The three-dimensional surface plot was developed using Gnuplot by Thomas Williams, Colin Kelley et al. available from the Free Software Foundation or with the Linux distribution.

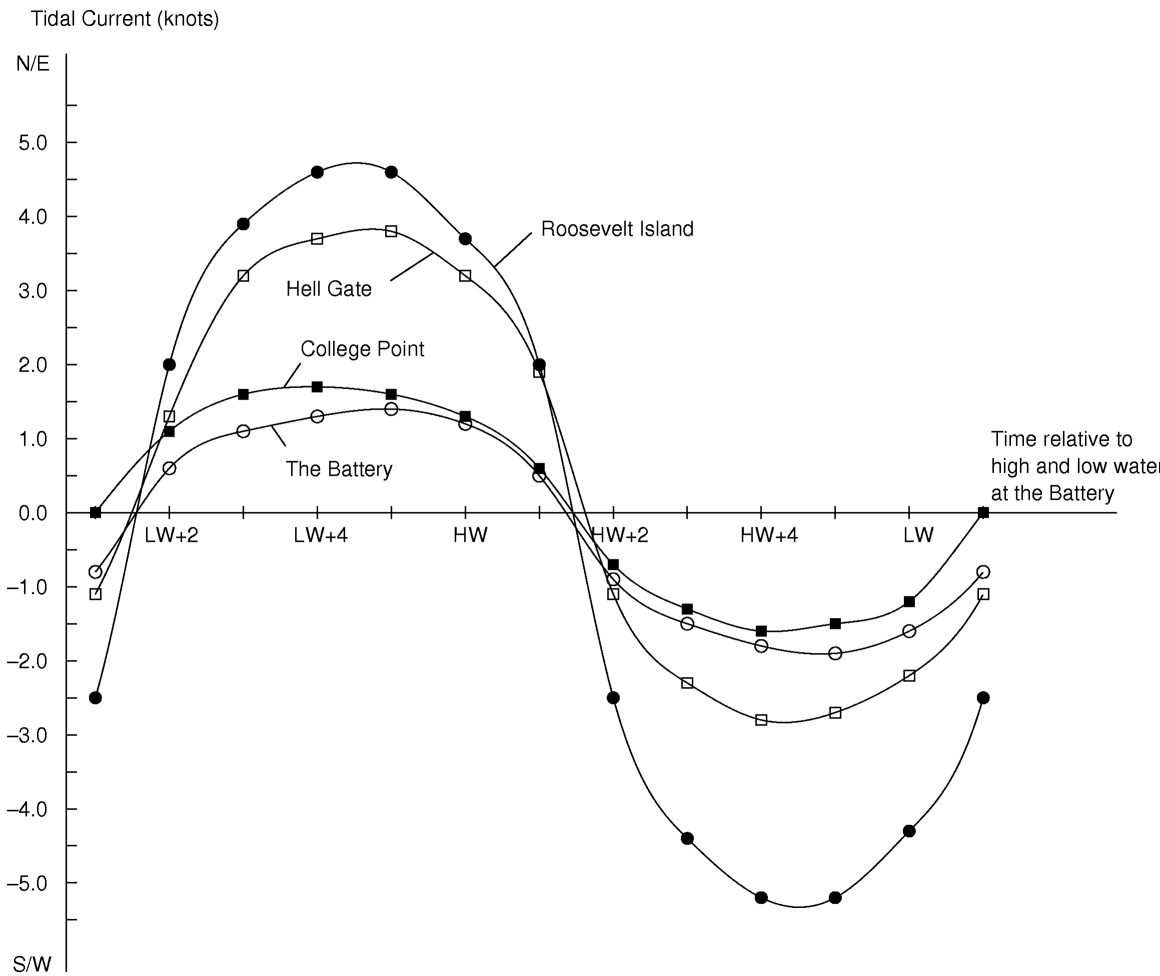


Figure A8-3. Interpolated tidal current velocities during the tidal cycle at 4 points on the East River.

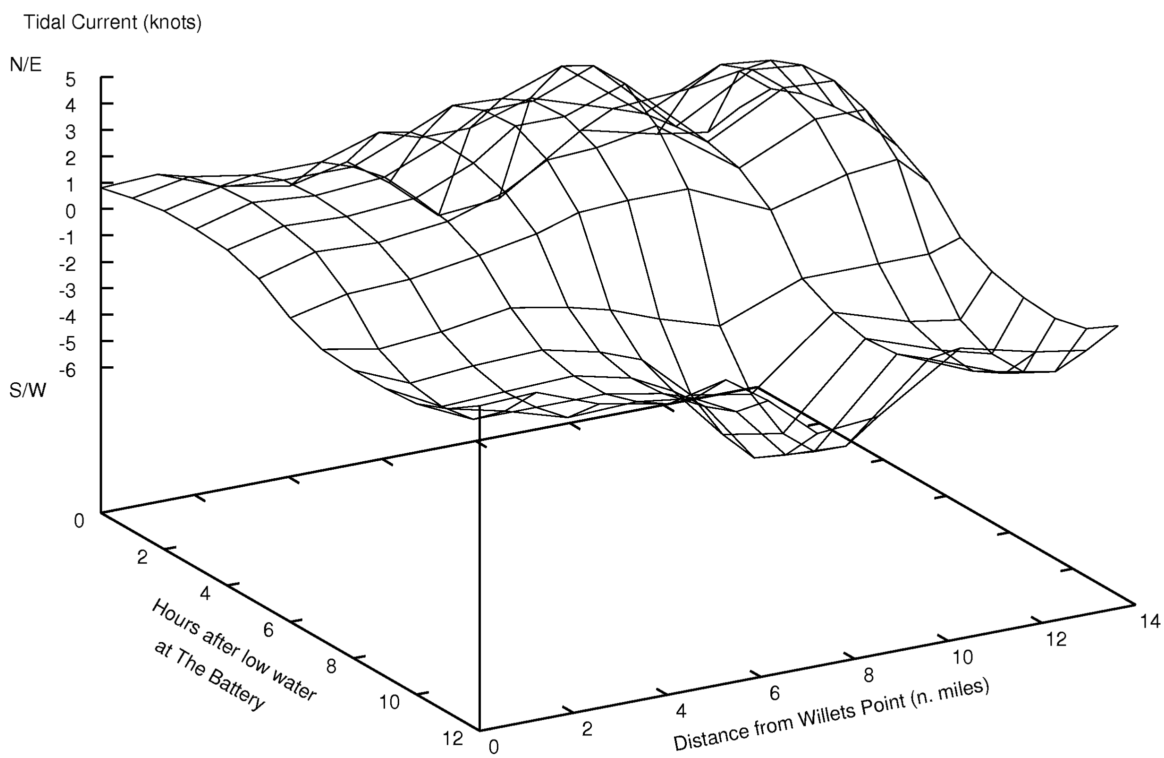


Figure A8-4. Interpolation surface of tidal current velocities in the East River.

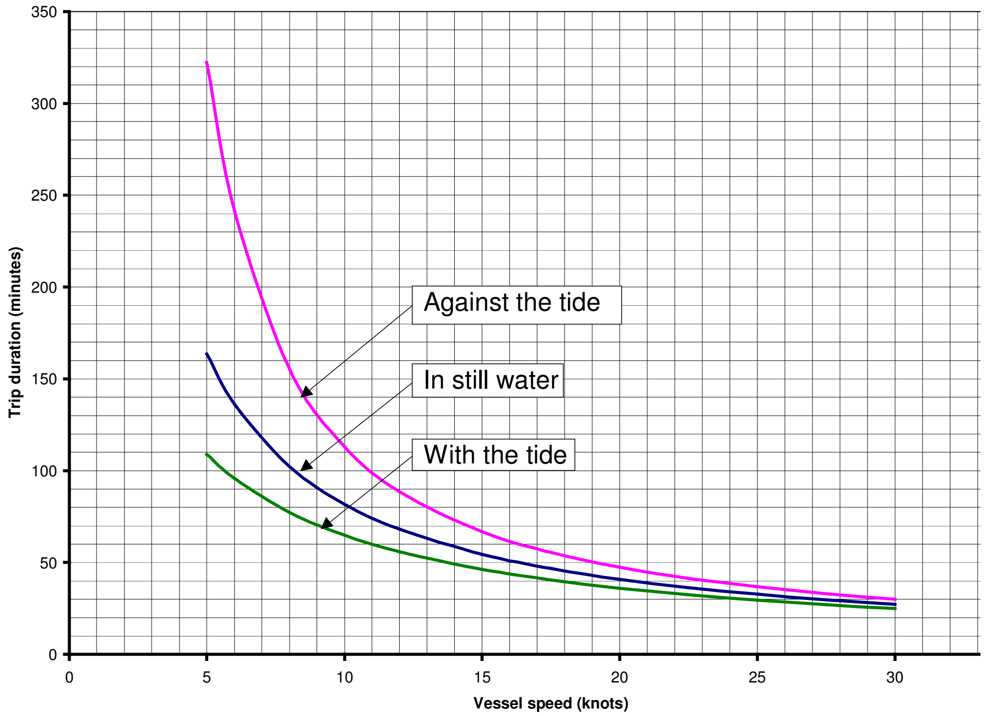


Figure A8-5. Duration of one-way transit of the East River.

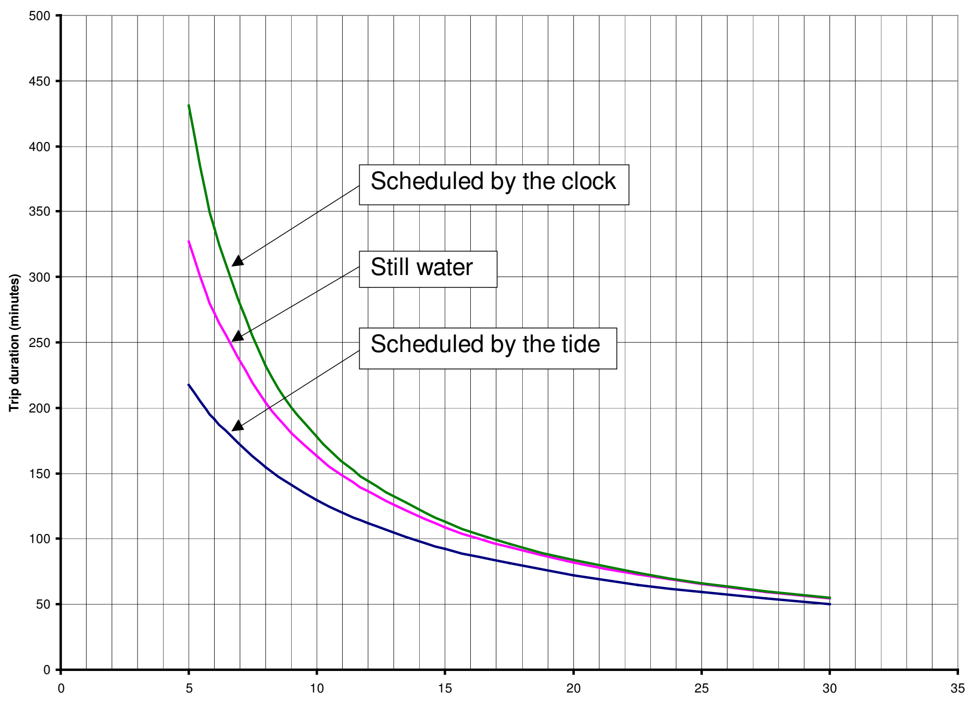


Figure A8-6. Duration of a round trip on the East River.

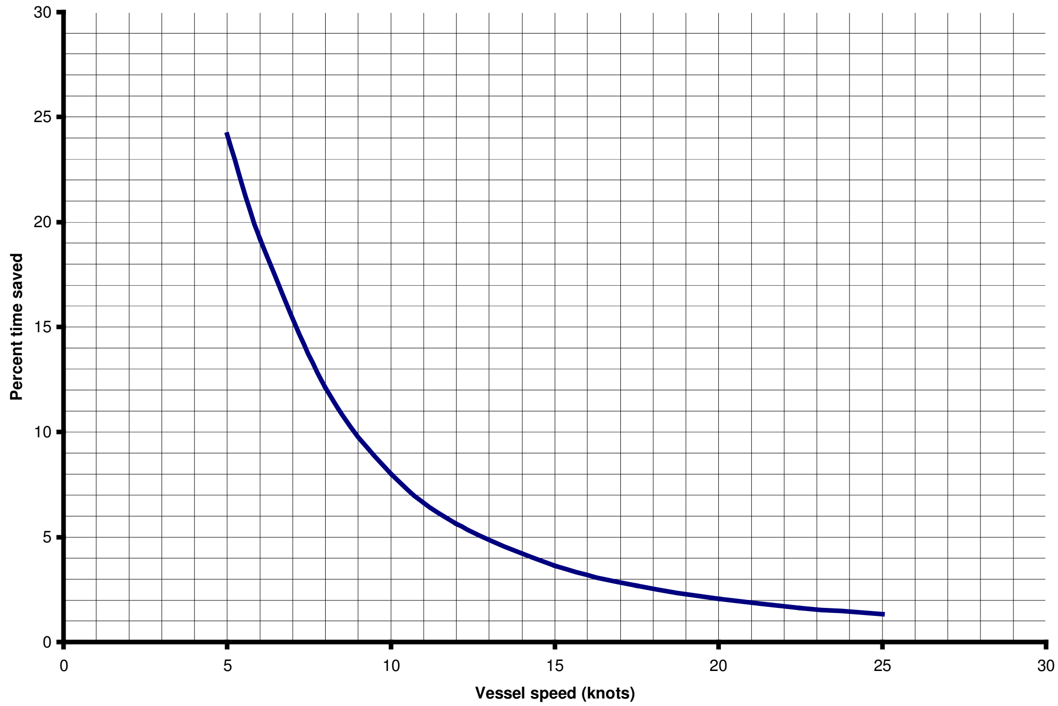
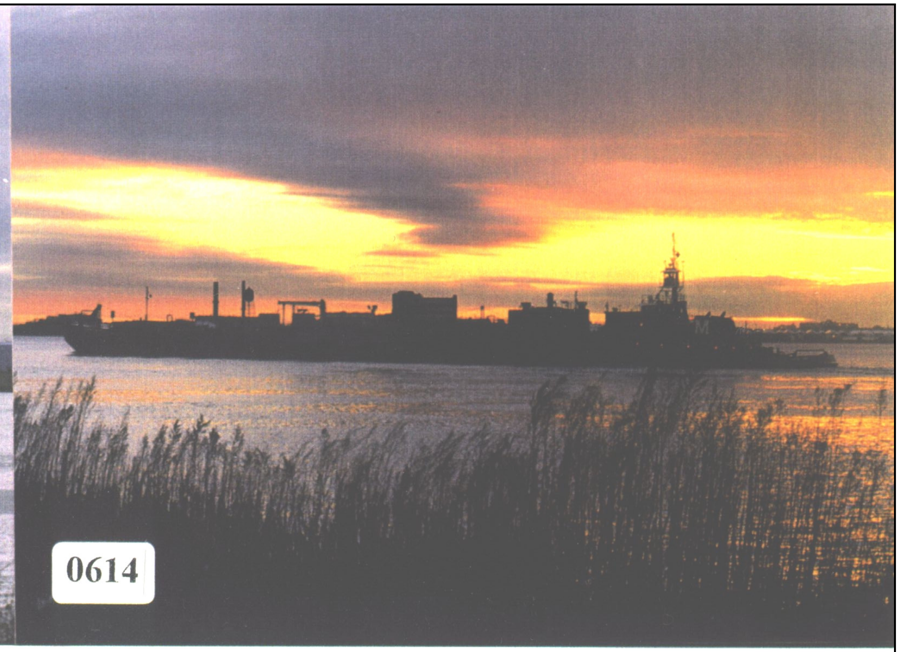


Figure A8-7. Percent time saved in still water with operations scheduled by the time of day.

Appendix 9

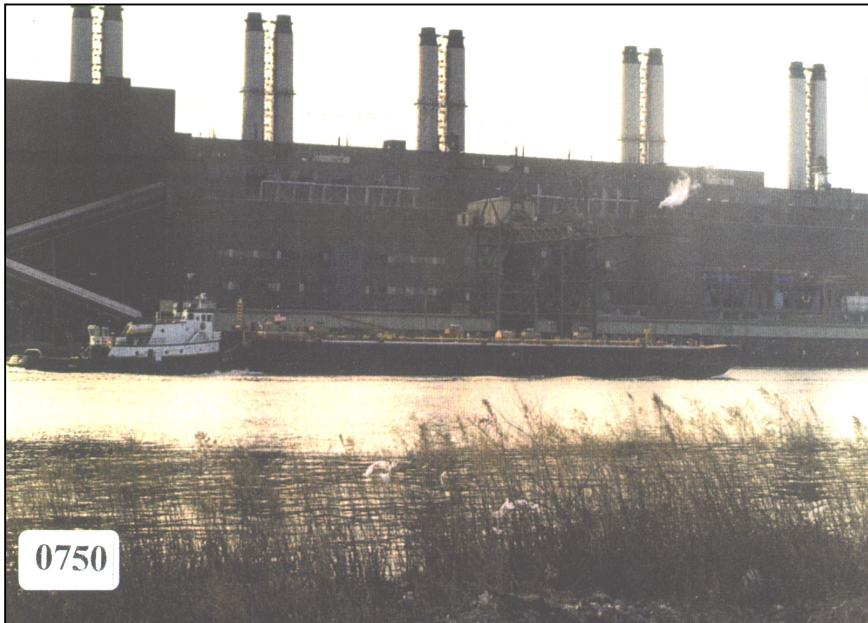
One day on the East River
13 March 1999
Lawrence Point

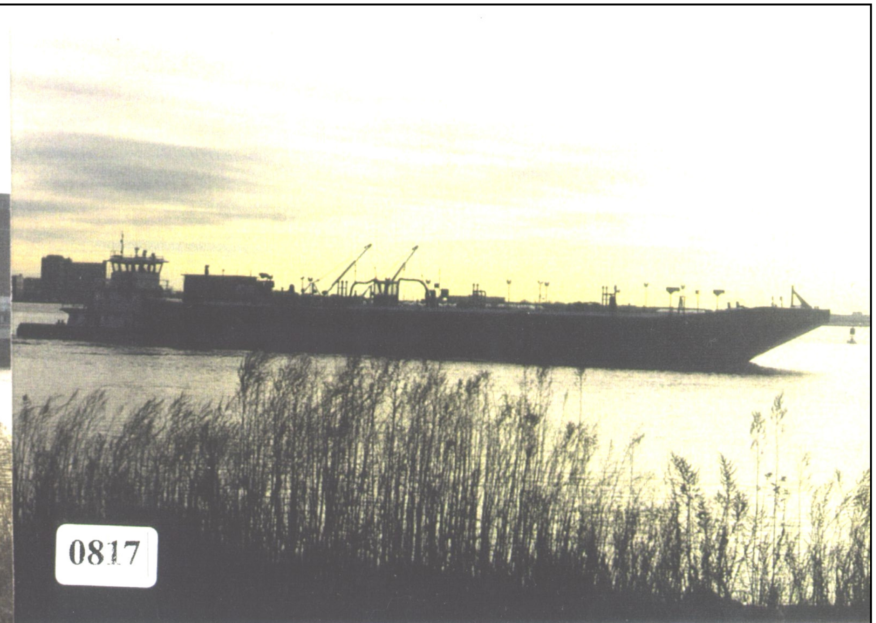

0610


0614


0707

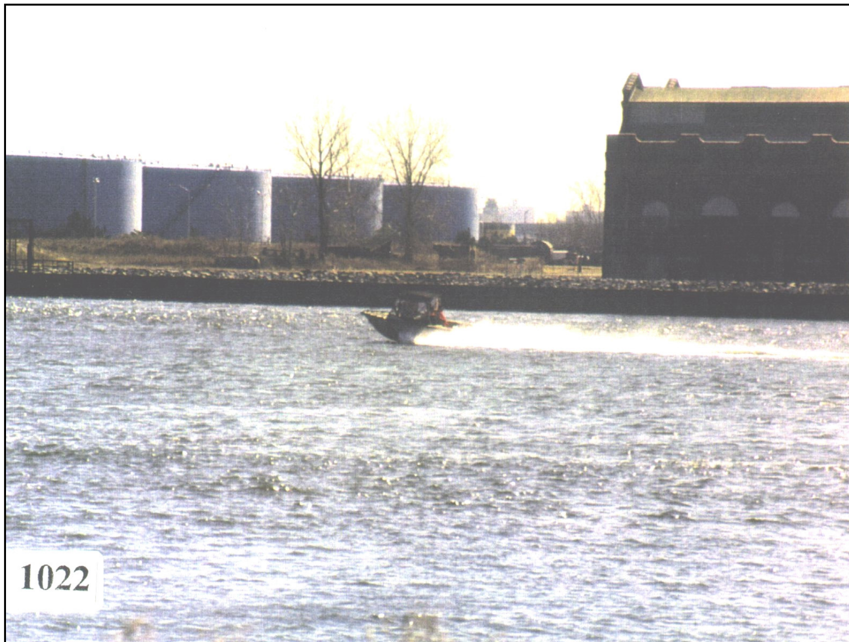

0717

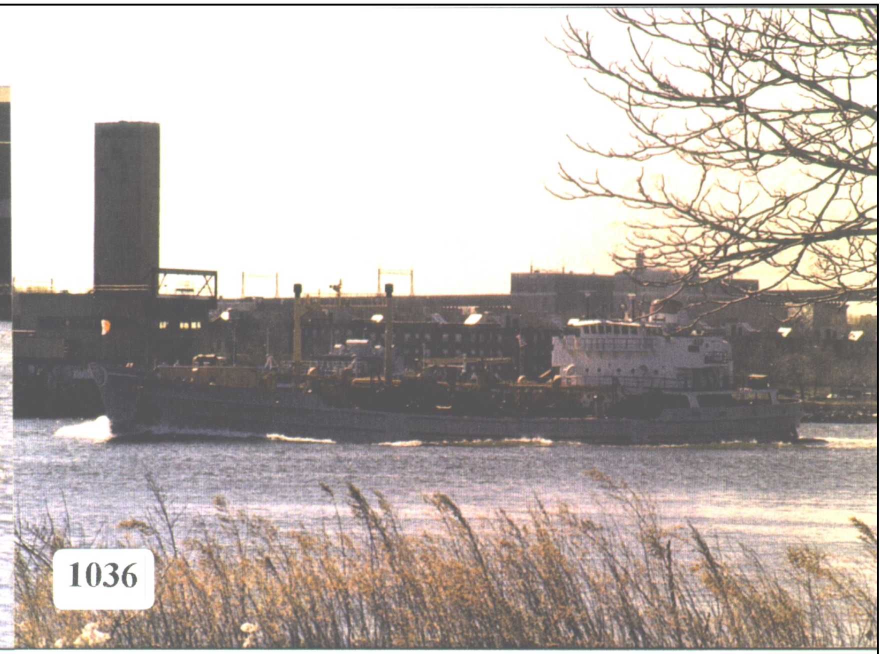

0750


0817

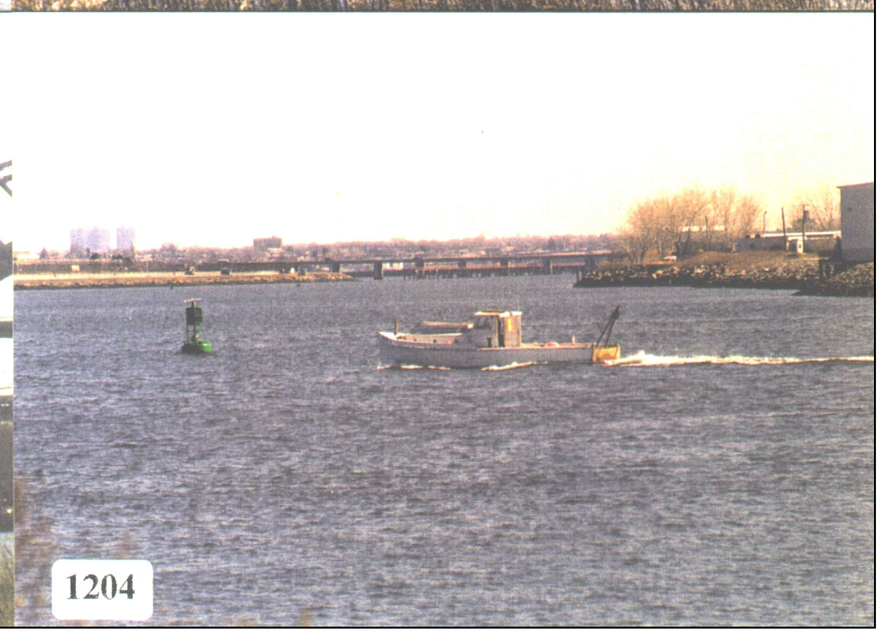

0824


1013

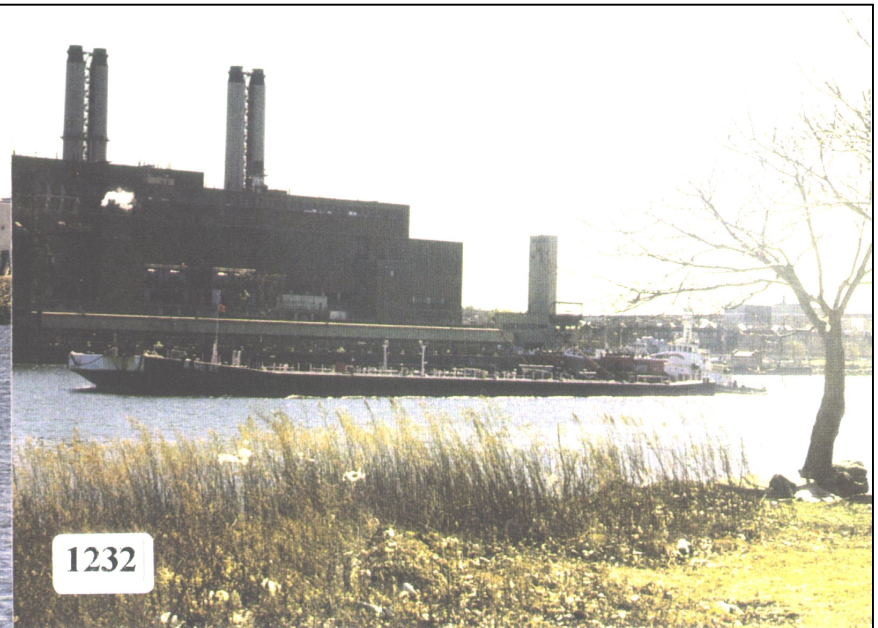

1022


1036


1157


1204


1224


1232

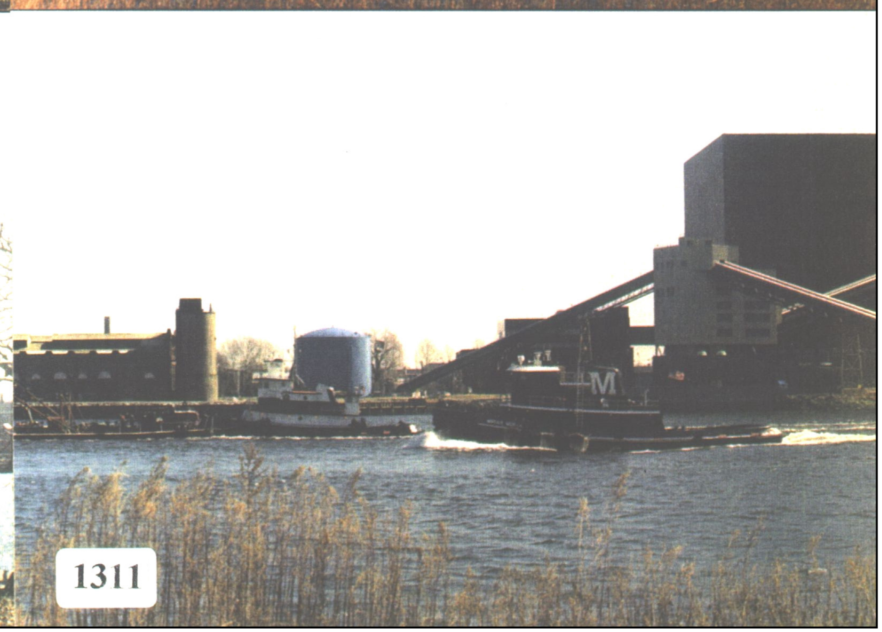

1242


1250

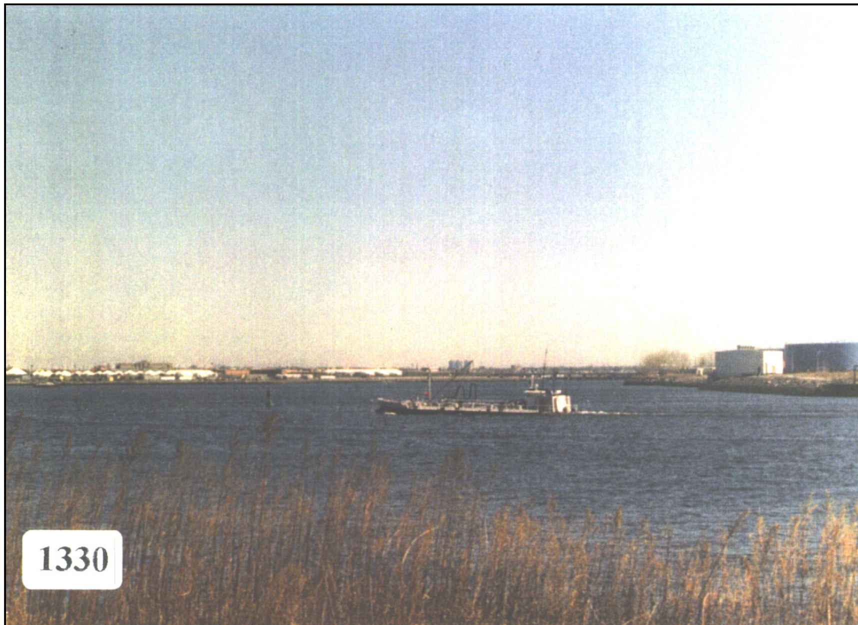
1255

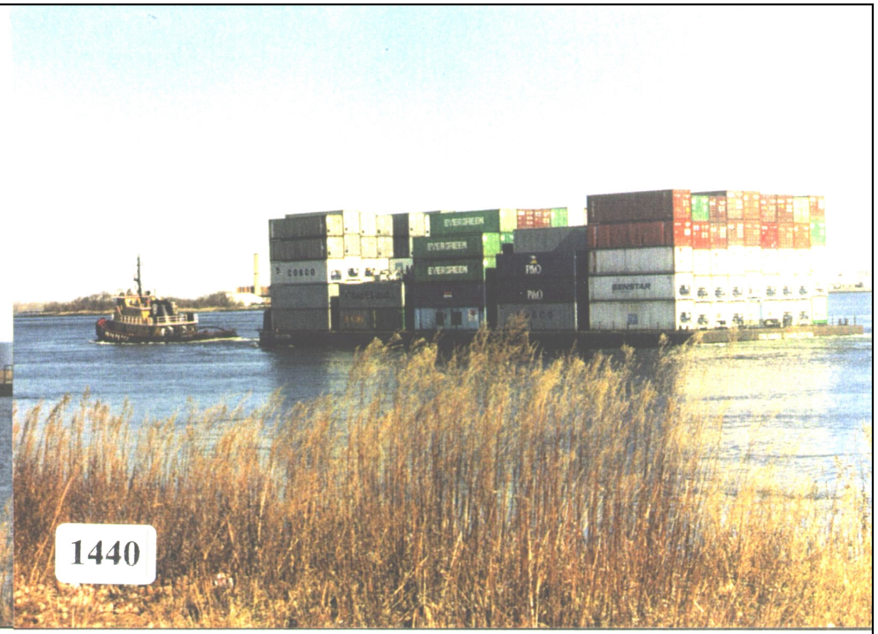
1309

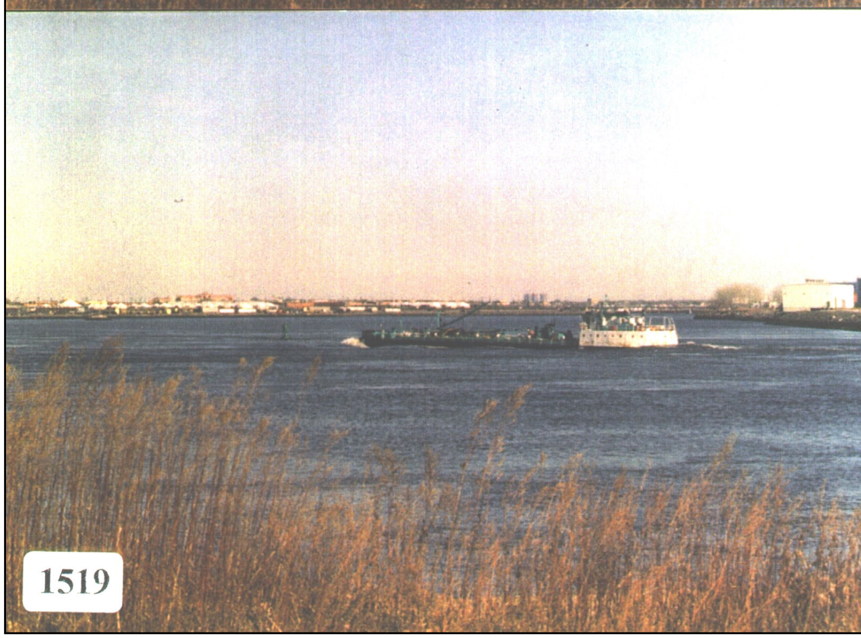
1310

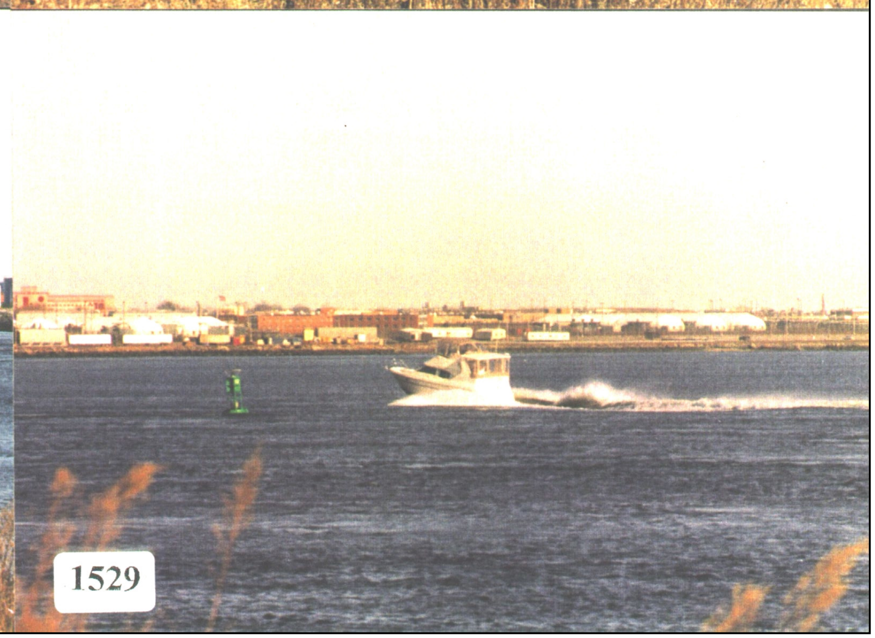


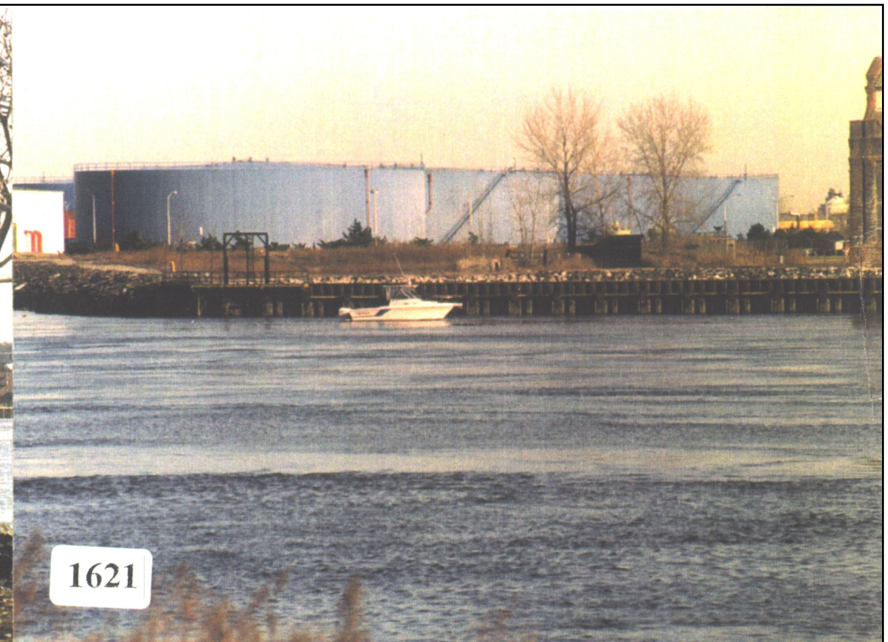
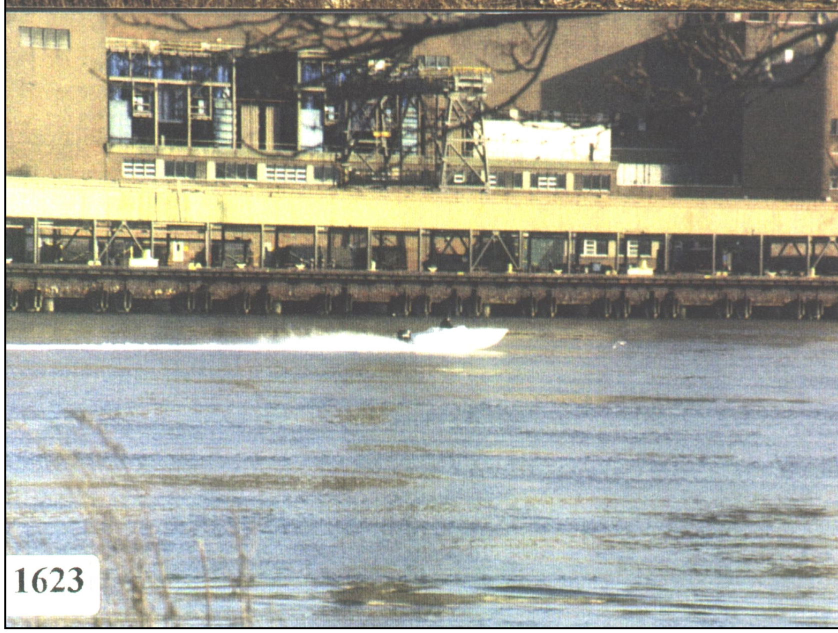
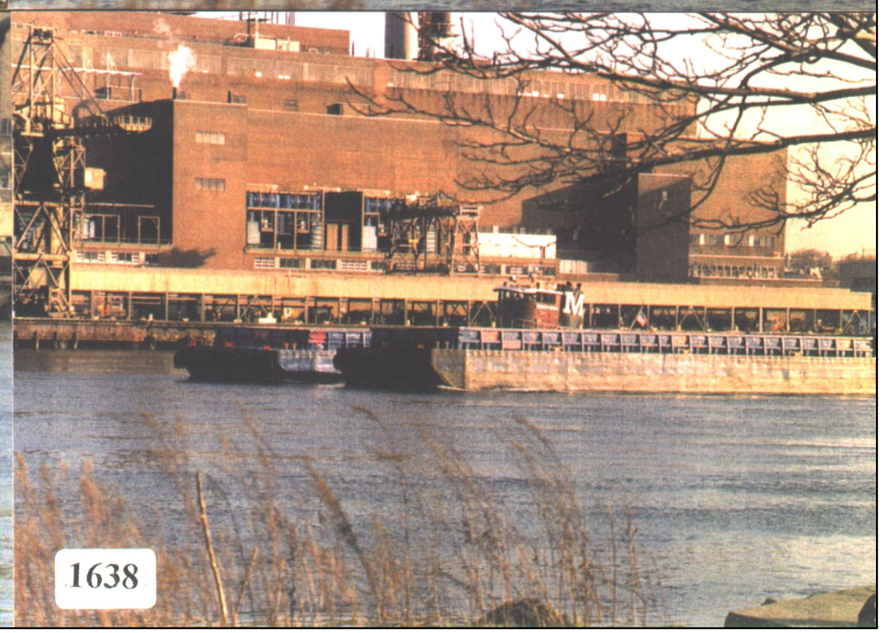
1311


1330


1440
EVERGREEN


1519


1529


1536

1621

1623

1638


1648


1653


1753


1800