Charles Rivers

APPENDIX B

STANDARD OPERATING PROCEDURE
HURRICANES AND SEVERE STORMS

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HURRICANE AND SEVERE STORMS

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SCOPE

1. GENERAL.

The Metropolitan District Commission will operate the project to satisfy the following objectives:

a. Maintain the level of the basin at about elevation 108 MDC during normal (nonflood) periods.

b. Keep the basin level below damage stage elevation 110 MDC during flood periods.

c. Serve the navigation interests of the basin.

d. Assist in the passage of anadromous fish during spawning periods.

This appendix prescribes the necessary details for the flood control operation of the Charles River Dam and appurtenant structures including sluices, pumps and navigation locks for the control of Basin levels. Climatologic, hydrologic and watershed data are included for background information. The operation of the navigation locks for boating needs and the fishway facilities are fully described in the Charles River Dam Operation and Maintainance Manual.

RESPONSIBILITIES

2. METROPOLITAN DISTRICT COMMISSION

The Metropolitan District Commission (MDC) is responsible for the operation of the flood protection works in accordance with the procedures of this appendix. The works include six pumps, one large boat lock, two small boat locks, and two flood control sluiceways. The MDC responsibilities include:

a. Complete operation of the project during flood periods in the Charles River watershed.

b. Training sufficient personnel to insure efficient and effective maintenance and operating procedures.

c. Maintaining an adequate communication system with the National Weather Service to obtain forecasts and timely advisories on storm conditions.

d. Determining phases of preparedness, mobilization or operations based on National Weather Service forecasts, Charles River stages, experienced rainfall or information obtained from the Corps of Engineers.

e. Informing the Coast Guard, Cambridge Electric Company, and the general public of the flood situation and possible curtailment of commercial and pleasure boat traffic.

f. Maintaining a log of regulation activities during flood events.

3. CORPS OF ENGINEERS

The Reservoir Control Center (RCC) of the Corps of Engineers continually monitors rainfall, runoff and weather conditions throughout New England in order to operate their system of flood control dams and hurricane barriers. This climatologic and hydrologic information is available upon request. Observers from RCC will monitor operations for several floods in order to determine whether personnel training has been adequate and whether revisions to this appendix are required.

4. NATIONAL WEATHER SERVICE (NWS)

The NWS in Boston, Massachusetts has no direct role in the operation of the project. However, it has the responsibility of issuing daily weather forecasts for public dissemination through the news media. River forecasts for the gaging station at Charles River Village are available through the NWS Northeast River Forecast Center at Bloomfield, Connecticut.

5. U. S. COAST GUARD (USCG)

In the event that operation of the flood control facilities at the project is or may be necessary, the MDC will issue special bulletins (see plate B-20) to the USCG in Boston for broadcast to mariners. As soon as practicable, following receipt of initial or revised bulletins concerning project operations, the Coast Guard will broadcast the designated bulletin to mariners and shall repeat such broadcasts at intervals appropriate to the situation until a revised bulletin has been received. It is expected that notices will be issued about 6 hours in advance of operation, however, it is recognized that for some unexpected events the project might have to be operated with only 1 to 2 hours notice.

CHARLES RIVER WATERSHED

6. GENERAL

The Charles River watershed, located in eastern Massachusetts is surrounded by the watersheds of the Mystic, Merrimack, Blackstone, Taunton and Neponset Rivers. It has a total drainage area of 309 square miles, which includes an important and highly developed portion of Metropolitan Boston and less developed but rapidly growing suburban and rural areas.

The watershed, shown on plate B-1, is hourglass in shape with a length of about 31 miles and a maximum width of about 15 miles. Elevations vary from 586 feet above mean sea level (msl), along the southwesterly rim of the watershed in Hopkinton, to about 10 feet msl, along the lower 8-1/2 miles of the Charles River. Within the drainage area there are 33 lakes and ponds having a total surface area of 2,530 acres, not including ponded areas along the river itself. The combination of moderate slopes, sandy soil, extensive swamplands, dams and lake storage, all contribute to make the upstream section of the river unusually slow in responding to heavy rains.

The Charles River rises in the Town of Hopkinton, about 25 miles southwest of the City of Boston. It meanders through extensive swamplands and passes through many heavily developed areas until it reaches the Charles River Basin, a term commonly used for that portion of the river extending from Watertown Dam to tidewater at the new Charles River Dam.

The river is nearly 80 miles long with a fall from its source to the Charles River Basin of approximately 350 feet. There are 20 dams located on the river, some of which are still used for impounding mill process water.

7. UPPER CHARLES RIVER

The upper Charles River watershed is assumed, for hydrologic purposes, to extend from the headwaters at Echo Lake in Hopkinton for approximately 66 miles to the Moody Street Dam in Waltham. This division of the watershed covers an area of about 251 square miles. The western and northern reaches of this area are moderately hilly, while the eastern and southern parts are characterized by rolling

topography with extensive swampy areas. From Echo Lake to the Medway Dam, the main river falls about 100 feet in 18 miles, an average slope of 5.5 feet per mile. From Medway Dam to South Natick Dam, the river drops about 40 feet in 20 miles and from the South Natick Dam to the Moody Street Dam in Waltham, the river falls approximately 75 feet in a distance of 30 miles.

The upper watershed is relatively flat and contains numerous swamps and natural valley storage areas resulting in sluggish characteristics. These areas modify and desynchronize floodflows from the rest of the watershed and act as natural flood control reservoirs. Most of the watershed is of a rural or suburban character; however, it is experiencing considerable pressure for more intensive development due to its proximity to metropolitan Boston and the fact that two circumferential highways have been built through the watershed in recent years.

In the interest of flood control, the Corps of Engineers instituted a plan in 1977 whereby 8,500 acres in 17 of these natural valley storage areas (shown on plate B-1) will be preserved either by acquisition or flowage easement by 1980.

8. LOWER CHARLES RIVER

a. General. The lower Charles River watershed is considered to extend from the Moody Street Dam in Waltham downstream to the new Charles River Dam.

The lower Charles River watershed (plate B-2) covers an area of approximately 56 square miles upstream of the old dam and an additional 2 square miles between the old and new dams. Muddy River, Stony Brook and Beaver Brook are the important tributaries in this reach and together they drain about 60 percent of the lower watershed. The Charles River Basin, that portion of the river between the new Charles River Dam and the Watertown Dam, has a drainage area comprised of concentrated urban and suburban development with extensive impervious areas such as roofs, parking areas and streets. These conditions result in high rates of runoff during storm periods which create the major flood threat for the basin.

b. Charles River Basin. The Charles River Basin was a tidal estuary until the construction of the old dam at Leverett Street in 1910. This dam was constructed to create a fresh water pool known as the Charles River Basin. The primary objectives of the dam were to eliminate the extensive mud flats and noxious odor at low

tide, to protect the low areas in Boston and Cambridge from high tides, and to maintain a fairly constant Basin level to stabilize the groundwater table in the adjacent areas. Marginal conduits were also constructed along both the Boston and Cambridge banks of the river to reduce the pollution in the Basin by carrying the sewage directly to the harbor.

The normal Basin elevation of 2.4 feet msl, equivalent to 108.0 feet MDC datum is lower than the mean high tide. Therefore, for a period of 4 or more hours during each tide cycle, the sluice gates cannot be used for sluicing and are closed to prevent salt water inflow from the harbor. With normal runoff or minor floods there is sufficient storage in the Basin so that closure of sluice gates during such periods results in only a minor rise in water level.

Upstream of the old dam, the Basin has a maximum width of about 2,000 feet, which gradually decreases to less than 400 feet at the Boston University Bridge. Above this location the Basin resembles a wide river with banks ranging from 300 to 500 feet apart. At the Watertown Dam, the width is reduced to 150 feet. The Basin depth generally varies from 3 feet in Watertown to a maximum of about 30 feet in the lower reaches. The shoreline is about 20 miles long, adjoining generally low areas, particularly in Back Bay and parts of Cambridge. The area-capacity curves for the Basin are shown on plate B-3.

9. MAJOR TRIBUTARIES

The Charles River, in its general northeasterly course to the ocean, is fed by a number of rivers and streams. Pertinent data on the principal tributaries are contained in table 1. The largest tributaries with drainage areas greater than 10 square miles are briefly described as follows:

a. Hopping Brook. This tributary has its source in Holliston and flows in a general southerly direction to the Charles River in Bellingham. It has a moderately hilly drainage area of 11.5 square miles and falls about 120 feet in its 8 mile length.

b. Mine Brook. The headwaters of this tributary are in southwestern Franklin. From its source this brook flows northeasterly for about 8 miles and then turns westerly to Unionville. It then travels northerly for about 4 miles to the Charles River at the northerly edge of Franklin. Mine Brook has a drainage area of 15.7 square miles, includes a number of large ponds, and has a fall of about 160 feet in its 12 mile length.

c. Mill River. The Mill River originates in Wrentham and flows in a northerly direction for about seven miles to the Charles River in Norfolk. Two relatively large bodies of water, Lake Pearl and Lake Archer, are located in the upper reaches of this river. It has a drainage area of 16.3 square miles and a fall of approximately 150 feet.

d. Stop River. This river, with a drainage area of 17.1 square miles, originates in Norfolk. It follows a winding course in a northerly direction for about 7 miles in its 100-foot fall to its confluence with the Charles River in a wide swampy area of Medfield.

TABLE 1

PERTINENT DATA
SIGNIFICANT TRIBUTARIES

Tributaries	Drainage Area (Sq. Mi.)	Location	River Mile*
Hopping Brook	11.5	Medway	64.3
Mine Brook	15.7	Franklin	63.2
Chicken Brook	7.0	Medway	62.9
Shepards Brook	5.0	Franklin	61.8
Mill River	16.3	Norfolk	57.6
Stop Brook	17.1	Medfield	51.8
Bogastow Brook	25.5	Millis	48.4
Waban Brook	16.1	Wellesley	39.4
Trout Brook	4.6	Dover	37.2
Stony Brook	23.6	Waltham	14.7
Beaver Brook	11.2	Waltham	12.2
Muddy River	21.1	Boston	2.8

*Mile 0 is assumed as intersection of centerlines of Charles River and Boston Inner Harbor Channel.

e. Bogastow Brook. Bogastow Brook, the largest tributary of the Charles River, has a drainage area of 25.5 square miles. From its source in Holliston, the brook flows southeasterly for about 9 miles and turns about 3 miles to its confluence with the Charles River in Millis. The watershed contains a number of large ponds and includes Lake Winthrop; extensive swampland in the lower reaches serves as a large storage area during flood periods.

f. Waban Brook. Waban Brook and its major tributary Fuller Brook originate in Weston and Wellesley. Nonesuch Pond, Morses Pond and Lake Waban are located within the watershed. The brook has a total fall of about 90 feet in its 6 mile length. Fuller Brook joins Waban Brook in Wellesley about 600 feet above the confluence with the Charles River. Fuller Brook has a length of approximately two miles and a fall of 20 feet. The combined drainage areas of Waban and Fuller Brooks total 16.1 square miles.

g. Stony Brook. This tributary has its source in Sandy Pond, Lincoln where it flows in a southerly direction for approximately 7 miles to its confluence with the Charles River in Waltham. Hobbs Brook and Stony Brook Reservoirs, located within the watershed, are reserved exclusively for water supply for the City of Cambridge. Stony Brook has a drainage area of 23.6 square miles and a fall of about 170 feet.

10. MOTHER BROOK DIVERSION

A unique feature of the upper Charles River watershed is that approximately one-third of the normal Charles River flow is normally diverted in Dedham(river mile 26.5, DA 198 square miles) to the Neponset River via Mother Brook. The purpose of this diversion is entirely for industrial water use and is unrelated to flood regulation. It is the result of an 1831 agreement reached between mill owners on Mother Brook and the Neponset and Charles Rivers. The flows are regulated by MDC personnel using bascule-gated dams on the Charles River and Mother Brook. Maximum non-damaging channel capacity on Mother Brook approximates 1,100 cfs.

CLIMATOLOGY

11. GENERAL

The Charles River watershed experiences the four distinct seasons that are typical of New England. The climate is changeable and is subject to frequent but generally short periods of precipitation. The area lies in the path of the prevailing westerlies and the cyclonic disturbances that cross the country from the west and southwest. It is also exposed to coastal storms that move up the Atlantic Seaboard, some of which are tropical in origin. In late summer and autumn months these storms occasionally attain hurricane intensity with high winds, heavy rainfall and abnormally high tides.

12. PRECIPITATION

The average annual precipitation of the lower Charles River watershed is about 43 inches which is rather evenly distributed throughout the year. The heaviest monthly precipitation recorded in the lower Charles was measured at Blue Hills and was just under 19 inches for the month of August 1955. The heaviest 24-hour rainfall was just under 10 inches, occurring during Hurricane "Diane," August 18-19, 1955. Table 2 lists the monthly precipitation in Boston and Blue Hills.

TABLE 2

MONTHLY PRECIPITATION
(inches)

	Boston, Massachusetts Elevation 15 feet msl (Through 1975)			Blue Hills, Massachusetts Elevation 640 feet msl (Through 1975)		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	3.57	9.54	.89	4.05	10.97	.89
February	3.39	7.08	.45	3.99	9.32	1.04
March	3.85	11.00	T	4.31	10.96	.06
April	3.57	9.14	.93	3.87	8.71	.92
May	3.24	13.38	.25	3.60	9.16	.50
June	3.20	9.13	.27	3.48	10.78	.53
July	3.15	11.69	.52	3.52	11.67	.13
August	3.60	17.09	.39	4.05	18.78	1.05
September	3.27	10.94	.21	4.01	11.04	.45
October	3.24	8.84	.06	3.75	10.84	.22
November	3.87	11.03	.59	4.30	9.29	.62
December	3.72	9.74	.66	4.33	12.60	.92
ANNUAL	41.67	67.72 (1863)	23.71 (1965)	47.26	65.51 (1972)	26.96 (1965)

13. SNOWFALL AND SNOW COVER

The mean annual snowfall over the lower watershed as shown below varies from about 42 inches at Boston to about 60 inches at the Blue Hill Observatory.

MEAN MONTHLY SNOWFALL
(inches)

	Boston	Blue Hills
	Mean	Mean
Jan.	11.8	15.5
Feb.	12.0	16.9
Mar.	7.9	11.3
Apr.	0.8	3.1
May	T	0.1
June	0	0
July	0	0
Aug.	0	0
Sep.	0	0
Oct.	T	0.2
Nov.	1.2	2.7
Dec.	7.7	10.7
ANNUAL	41.4	60.2

Snow cover reaches a maximum depth in early March with the water content often exceeding three inches. Data is not available for the water equivalency of snow in the Charles River watershed, however, mean, maximum and minimum values of water equivalency of snow cover for the adjacent Blackstone River watershed are presented in table 3.

TABLE 3

WATER EQUIVALENCY OF SNOW
BLACKSTONE RIVER WATERSHED 1965-1976*

Water Equivalent in Inches	February 1	February 15	March 1	March 15	April 1	April 15
Maximum	3.9	5.2	6.0	5.0	3.3	0.7
Mean	1.5	2.1	2.2	1.8	0.5	0
Minimum	0	0	0	0	0	0

*Based on Corps of Engineers data

14. STORMS

Southern New England has experienced storms of the following type: (a) extratropical continental storms which move across the area under the influence of the "prevailing westerlies," (b) thunderstorms produced by local convective activity or by more general frontal activity, (c) extratropical maritime storms which move northward along the Atlantic coast and (d) maritime storms of tropical origin, some which attain hurricane magnitude. The rapidly moving continental or cyclonic storms that cross the basin from the west or southwest produce frequent periods of rainfall but are not ususally severe. Continental storms are apt to be more critical when they are of the stationary frontal type which may produce appreciable rainfall over a given area on several successive days. Thunderstorms may be of the frontal type associated with continental storms or of the local type and on a small drainage basin such as the lower Charles basin, can produce high rainfall intensities. The most severe storms in the area have been of the hurricane type of tropical origin that move up the Atlantic coastline. They are most likely to occur during the summer and early autumn months.

TIDE INFORMATION

15. GENERAL

Floodwater discharges made through the old Charles River Dam were by gravity flow and dependent upon tidal levels in the Harbor. It is anticipated that the pumps in the new dam will be used in flood situations, with normal discharges being made by gravity sluicing. Therefore, tidal variations will continue to bear directly on regulation procedures.

16. NORMAL TIDES

Two high and two low tides occur each lunar day in Boston Harbor. Spring tides have a greater range than the average, and occur during new and full moon when the tidal forces of the moon and the sun act in the same direction. Normal tide data for Boston Harbor is summarized in table 4. All elevations in this manual, except as noted, are given in MDC datum which is 105.625 feet below mean sea level, National Geodetic Vertical Datum of 1929. (Formerly referred to as MSL)

TABLE 4

NORMAL TIDES - BOSTON HARBOR
(MDC Base)

	Feet
Mean Tide Range	9.5
Mean High Water	110.5
Mean Low Water	101.0
Spring Tide Range	11.0
Average Spring Tide High Water	111.3
Average Spring Tide Low Water	100.3
Maximum Observed High Water (7 February 1978)	116.0

17. INFLUENCING FACTORS

Besides the normal gravitational effects of the moon and sun, the tides are subject to meteorological influences such as changes in atmospheric pressure and strong sustained winds. A drop in barometric pressure of one inch of mercury below Standard Pressure (29.92 inches) results in approximately a one-foot rise in the tide level. In addition, it is estimated that in the Boston area the tide level is constantly rising at the rate of approximately 1.0 foot per century. It is not known whether this rate will increase or decrease in the future, and no allowance was made in design for such future uncertainties.

Many storms in the Boston area produce northeasterly winds which can sometimes cause the tide in Boston Harbor to rise 3 to 4 feet above predicted levels.

18. TIDAL FLOODING

The direction of hurricanes in southern New England is generally from the southeast so that Cape Cod and the shape of the coastline near the Boston area affords protection against extreme hurricane tides or surges. However, hurricanes are very unpredictable and have been known to change their direction, or even to make a complete loop after meeting a high pressure area. If sustained hurricane force winds were to be directed at Boston Harbor from the east or northeast at high tide, as was experienced in the February 1978 event, tide levels could be higher than any recorded thus far. However sustained hurricane force winds from the east or northeast would result from an extremely rare event.

The Great Blizzard Tide of 7 February 1978, the maximum of record in Boston Harbor, was 116.0 feet MDC which is 5.5 feet above mean high water. High water marks at the dam during construction indicate that this tide actually peaked at 116.2 feet MDC. Tide elevations 3.5 feet above mean high water occur about once a year. The tide elevation frequency curve for Boston Harbor shown on plate B-4 is based on 200 years of record, with elevations adjusted to 1970 local mean sea levels for comparison purposes. The maximum tide heights dating from 1723 are shown in table 5.

19 . DESIGN TIDE

a. Pumping. The adopted project design tide in Boston Harbor has a low of 102.5 feet and a high of 113.0 feet. The tide was used to examine the duration and maximum head against which the pumps would be likely to have to operate during a major storm. Tide cycles which have occurred during selected storms along with the design tide cycle are shown on plate B-5.

The pump discharge tube, lip elevation 116.0, would be overtopped by a recurrence of the 1978 or similar tide. Studies on reverse flow with all pumps inoperative indicate the effect on Basin elevation and salt water intrusion is minimal. Gear units are provided with a reverse ratchet arrangement to prevent windmilling under this remote reverse head condition.

b. Top of Dam. The Charles River intersects Boston Inner Harbor at nearly a right angle so that wave height at the site of the new Charles River Dam will be determined by a relatively short fetch of about 1,300 yards. Boston Harbor itself is well sheltered from ocean waves. Since the shoaling of waves begins outside the harbor entrance and continues until they reach the beach area, the higher waves will be filtered out. Because of this, the United States Naval Oceanographic Office in Washington, D.C. estimates that the average waves will be less than 3 feet if an intense storm center is located outside the harbor. Under these conditions, the wave runup on the riprap slope area of the dam would be between 1.5 and 2 feet vertical from still water elevation. With the top of the dam at elevation 118 feet MDC, the likelihood of wave wash overtopping is extremely remote. The selected top of dam elevation is 2 feet above the level of the greatest tide of record measured in Boston Harbor (See Table 4).

TABLE 5

MAXIMUM TIDE HEIGHTS
BOSTON, MASSACHUSETTS
(Commonwealth Pier)

	Observed Elevation (ft msl datum)	Adjusted* Elevation (ft msl datum)
7 Feb 1978	10.4	-
6 Feb 1978	10.1	-
14 Apr 1851	10.1	11.0
26 Dec 1909	10.0	10.6
27 Nov 1898	9.4	10.1
29 Dec 1959	9.3	9.4
18 Apr 1852	9.2	10.1
15 Dec 1839	9.2	10.2
27 Dec 1839	9.2	10.2
24 Feb 1723	9.1	10.7
19 Feb 1972	9.1	9.1
26 Mar 1830	9.0	10.0
4 Dec 1786	8.9	10.2
21 Apr 1940	8.9	9.2
26 May 1967	8.9	8.9
4 Mar 1931	8.8	9.2
30 Nov 1944	8.8	9.1
20 Jan 1961	8.8	8.9
17 Mar 1956	8.6	8.7
7 Apr 1958	8.5	8.6
7 Mar 1962	8.4	8.5
2 Dec 1974	8.4	8.4
28 Jan 1933	8.3	8.7
4 Apr 1973	8.3	8.3
22 Dec 1972	8.3	8.3
12 Nov 1947	8.2	8.4
28 Feb 1952	8.2	8.4
31 Aug 1954	8.2	8.4
2 Nov 1963	8.2	8.3
7 Feb 1974	8.2	8.2
13 Apr 1953	8.1	8.3

*Observed values after adjustment for rising sea level; adjustment made to 1970 sea level conditions.

RECENT FLOOD HISTORY

20. GENERAL

Major floods in the Charles River watershed can occur during any season of the year. Early spring rains combined with melting snow resulted in the March 1936 and March 1968 floods. Heavy rains during summer months caused the flood of July 1938 and hurricanes resulted in the September 1954 and August 1955 floods.

Records of floods before the turn of the century are meager. From available information the greatest flood prior to 1900 occurred in February of 1886 when an estimated peak flow of 3,280 cfs was experienced at Waltham. Other notable floods occurred in 1807 and 1818.

Five floods of major proportions have occurred in the watershed in recent years: March 1936, July 1938, September 1954, August 1955 and March 1968. A brief description of each follows:

a. March 1936 Flood. This flood, marked by two distinct peaks spaced about six days apart (13th and 19th), resulted from a combination of runoff from melting snow and heavy rainfall from two major storms over the watershed. Rainfall amounts for the combined storms ranged from 4.5 inches in the lower watershed to more than 7 inches in the upper areas. On the Charles River at Charles River Village, a peak discharge of 3,170 cfs was computed. The March 1936 flood produced a maximum Basin elevation of 109.3 feet, 1.3 feet above normal.

b. July 1938 Flood. During a seven-day period from 18 to 24 July, torrential rains fell throughout the Charles River watershed resulting in near record flood levels along the mainstem. In the upper portion of the watershed at Milford, 12.3 inches of rain was recorded, while rainfall amounts in the lower watershed ranged from 4.0 inches at Boston to 9.2 inches at Brookline. A peak discharge of 3,110 cfs was recorded at the Charles River Village gage. The July 1938 flood resulted in the Basin level rising to approximately one foot above normal.

c. September 1954 Flood. Hurricane "Carol" on 11-12 September 1954 produced the third highest stage in the Basin with an elevation of 110.55 feet. A total rainfall of 6.32 inches was measured at Boston, while the maximum tide reached 112.0 feet.

d. August 1955 Flood. This flood, the greatest of record on the Charles River, resulted from intense rainfall accompanying hurricane "Diane" falling on a watershed saturated one week earlier by "Connie". Hurricane "Connie" 11-15 August, caused rainfall varying from 4 to 6 inches over southern New England and ended a period of drought. A week later, on 17-20 August, "Diane" brought intense rainfall up to 20 inches over portions of Massachusetts. Rainfall totals for "Diane" at Boston and Chestnut Hill were 12.5 and 13 inches, respectively. This storm also caused higher than normal tides in Boston Harbor which combined with the record local runoff to produce a record Basin elevation of 112.5 feet, 4.5 feet above the normal level. Peak discharge at the Charles River Village gage was 3,200 cfs or about the same as the 1938 flood. The isohetal map for "Diane" is shown on plate B-6.

e. March 1968 Flood. Heavy rainfall occurring over southern New England on 17-18 March combining with about one inch of runoff from melting snow resulted in the second largest flood of record in the lower reaches of the Charles River watershed. The highest amounts of precipitation fell in the Blue Hills area with 7.7 inches. The Charles River Basin rose to 110.85 feet, 2.85 feet above normal and inundated sections of Storrow Drive. This was the second highest Basin level exceeded only by the 4.5-foot rise in August 1955. Peak discharge at the Charles River Village gage was the same as the 1955 flood, 3,220 cfs. Flood photos of the Storrow Drive area are shown on plates B-24 and B-25.

21. ANALYSIS OF FLOODING

The floods of record in the watershed have been analyzed to determine the development of the floods and tributary components contributing to the crests. Basic data for this analysis include Basin elevations and discharges at the old Charles River Dam, upper watershed discharges at stream gage stations, and nearby precipitation records.

a. Lower Charles River Watershed. The critical flood problem occurred in the Charles River Basin and surrounding low areas in Cambridge and Back Bay section of Boston where storm runoff from the small, highly developed portion of the lower watershed flowed into the Basin faster than it could be discharged by gravity flow through the sluices of the old dam. The resulting flooding developed within a few hours after the beginning of heavy rainfall. Because the Basin level was about 2.5 feet below mean high water in the harbor, the runoff from past storms had to be stored from 4 to 6 hours during each high tide cycle when gravity discharge was not possible. This storage was easily accomplished during normal runoff and minor flood periods, but runoff from major storms combined with the inadequate sluicing capability and urban expansion and encroachments, to produce progressively

higher uncontrolled basin elevations. Through 1946 the Basin had never reached a level of 110.0 feet, but since then it has exceeded this value on five occasions, with a peak level of 112.5 on 19 August 1955.

The progressive rise in flood stages in the Basin was attributed to:

(1) The extensive urban development in the lower watershed with the resultant increase in impervious area.

(2) Extension and enlargement of storm drainage systems.

(3) Reduction in natural storage areas by filling in of swamps, meadows and basin areas.

High water profiles on the Charles River were determined from field surveys after floods of March 1936 and August 1955. Water surface profiles of the lower Charles River watershed for these floods are shown on plate B-7.

b. Upper Charles River Watershed. Peak flows at the Waltham gage occur approximately 4 days after termination of heavy rainfall. Natural valley storage along the main stem of the Charles River and its tributaries, particularly in the 20-mile reach extending from the Medway Dam to the South Natick Dam, is extremely beneficial in the natural control of floods on the Charles River. During the August 1955 storm, the maximum peak inflow to the reach was estimated to be at least 8,000 cfs occurring on 20 August. The storage reach reduced and delayed the peak outflow to 2,800 cfs at the South Natick Dam on the 23rd. Maximum floodflows, in terms of cubic feet per second per square mile (csm) are low in the Charles River when compared with adjacent river basins such as the Blackstone. The peak discharge at the Waltham gage was only 11 csm in 1955 compared with 121 csm on the nearby Blackstone River at Northbridge, Mass.

After major floods, it takes three to four weeks for the riverflow in the upper watershed to return to normal. In August 1955, about 54,000 acre-feet of natural storage was released after the peak discharge, most of this coming from the water stored in the wetlands and lakes. This is equivalent to about 4.5 inches of runoff from the drainage area of 227 square miles at the Waltham gage.

The contributions from the lower and upper watersheds to the peak rate of Basin inflow for recent events are shown in table 6.

TABLE 6

CHARLES RIVER BASIN
COMPARISON OF RECENT FLOOD PEAKS

Item	1954 CFS	1954 %	1955 CFS	1955 %	1962 CFS	1962 %	1968 CFS	1968 %	Proj. Des. Flood CFS	Proj. Des. Flood %
Peak Inflow to Basin(1)	9,600	-	13,400	-	6,000	-	4,800	-	15,500	-
Upper Watershed(2)	900	9	1,300	10	600	10	1,800	38	2,100	13
Lower Watershed	8,700	91	12,100	90	5,400	90	3,000	62	13,400	87

(1) Estimated
(2) USGS gaging station at Waltham

22. FREQUENCY OF CHARLES RIVER BASIN FLOODING

Since completion of the MDC Dam in 1910 there have been numerous events in which the Basin level has crested above its normal elevation of 108.0 feet. A chronological list of highest levels are shown in the following tabulation.

Year	Basin Elevation Feet msl	Basin Elevation Feet MDC
1911	3.48	109.10
1924	3.95	109.57
1931	4.20	109.82
1932	4.26	109.88
1938	4.15	109.77
1947	4.68	110.30
1949	4.44	110.06
1954	4.93	110.55
1955	6.88	112.50
1962	4.02	109.64
1968	5.23	110.85

23. PROJECT DESIGN FLOOD

The Project Design Flood (PDF) as developed in the Metropolitan District Commission "Report Upon Charles River Basin Control," dated October 1956 is based upon the inflow to the Basin experienced during hurricane "Diane" (13,400 cfs) which was increased to 15,500 cfs to allow for greater areas of impervious surfaces. The phenomenal storm produced by "Diane" resulted in record precipitation at stations with more than 100 years of observation. Following is a tabulation of the incremental precipitation at Cambridge for 19 August.

Time (hours)	Precipitation 19 August 1955/PDF (inches)
0000	0.0
0300	0.18
0600	2.18
0900	4.33
1200	0.62
1500	0.56
1800	0.24
TOTAL	8.11

Under PDF conditions peak inflow is coincident with a tide of 113.0 feet. With the Basin prelowered to 107.0 feet and pumping and sluicing operations performed as outlined in this appendix, the stage would rise to a peak elevation of 109.9 feet. As shown on plate B-8, gravity discharge would not be possible for almost 5.5 hours, and from the time when gravity discharge could be utilized together with pumping about 3.5 hours would be required to draw the basin down to 107.0.

24. RUNOFF

The U. S. Geological Survey has published records for five continuous stream gaging stations in the watershed; their locations are shown on plate B-1, and the records are summarized in table 7. In addition, published information is available for about 55 miscellaneous or partial record stations.

TABLE 7

STREAMFLOW RECORDS

Location Of Gaging Station	Drainage Area	Period of Record	Discharge (cfs) Mean*	Instantaneous Maximum*	Minimum Daily*
Charles River at Millis	86	1974-present	131	670	12.0
Charles River at Charles River Village	184	1937-present	296	3,220	0.9
Mother Brook at Dedham	-	1931-present	80	1,040	0
Charles River at Wellesley	211	1959-present	264	2,410	1.0
Charles River at Waltham	227**	1931-present	290	2,670	12.0

*Thru water year 1974
**Excludes 23.6 square miles drained by Stoney Brook, from which flow is diverted for municipal supply of Cambridge.

DESCRIPTION OF OPERATIONAL ELEMENTS

25. GENERAL

The new dam is located at the site of the Warren Avenue Bridge between the Charlestown and the North End sections of Boston. The location shown on plate B-9, is approximately 2,250 feet downstream of the old dam, and approximately 30 acres have been added to the surface area of the Basin.

The new facility is approximately 560 feet in length, of which 160 feet is earth and rock embankment while the remaining 400 feet consists of a pumping station, navigation facilities, and a combination sluiceway fishway structure. The top of dam and top of locks elevation is at 118.0 feet. Detailed plans of each specific element are included in Appendix G.

26. PUMPING STATION

The pumping station equipment consists of six propeller pumps each driven by 2,700 hp diesel engines. The units are about 27 feet high and 12 feet in diameter. The bottom of the suction bell is at elevation 89 feet and the discharge cone at elevation 116 feet. Each pump has a discharge capacity of about 1,400 cfs against a 9-foot head, or a total of 8,400 cfs. A single pump discharge curve is shown on plate B-10. The fuel consumption rate at design discharge is about 150 gallons per hour per pump. There are 40,000 gallons of diesel fuel available in two storage tanks. The minimum forebay elevation at which the pumps will function is 98.5 feet.

27. SLUICEWAYS

Two sluices, each 8 feet wide by 10 feet high are utilized to control Basin levels during normal runoff. One sluice with invert elevation 95.5 is located near the fishway while the other with invert elevation 87.0 is located near the pumping station to draw off any brackish water. Both sluice outlets are at elevation 87.0. Rating curves are shown on plate B-11 while plate B-12 shows the gravity discharge with gates fully open during a mean low tide cycle.

It has been calculated that when the Basin is at elevation 108.0 feet the daily outflow through the fully open sluices would average about 1,000 cfs with normal tide conditions in the harbor. Comparison of this average outflow rate indicates that greater inflow might occur 8 percent of the time, or approximately 29 days in a year. During high tides the use of one pump would reduce the occurrence of such a

surplus inflow to about 4 percent of the time, or approximately 15 days in any one year. Use of a second pump for extra outflow capacity during high tide would be required less than 2 percent of the time or about 7 days in any one year. Because the pumps have to be tested on a regular basis, the use of one or two pumps for storms of intermediate magnitude could be advantageous and should be considered by the operator. The two sluice gates are considered adequate for storms of small magnitude when accompanied by normal tide fluctuations. For intermediate or major events the use of the large and small boat locks should also be considered for sluicing at low tides.

28. NAVIGATION LOCKS

One large and two small boat locks serve the navigational interests of the Basin. The large lock is 300 feet long and 40 feet wide, with upstream and downstream sill elevations of 91.0 and 86.0 feet, respectively, and floor elevation 84.0 feet. Each of the two small locks are 200 feet long, 25 feet wide with upstream and downstream sill elevations of 100.0 and 94.0 feet, respectively, and floor elevation at 92.0. Sector type gates are used because of their ability to operate under reversed heads thereby permitting the use of the boat locks for gravity sluicing of floodflows.

For major storms, the additional sluicing capacity offered by the navigation locks is mandatory. Plates B-13 and B-14 provide rating curves for the large and small locks.

29. FISHWAY

a. General. The fishway is designed to provide passage for anadromous fish from Boston Harbor upstream through the barrier formed by the Charles River Dam. There are approximately 10 species of fish which may be found migrating up the Charles River, with the principal anadromous species being shad, alewives and blue-back herring. Further information on spawning and migration times, temperature requirements, water criteria for anadromous fish, life history and how to identify, is detailed in Appendix F. The Basin level is maintained at approximately 108 feet, while tidal fluctuations have a normal range of 9.5 feet, between 101.0 and 110.5 feet, with a spring tide range of 11.0 feet. Since the tide rises above the Basin level, the vertical slot ladder elevation extends above high tide. During the migratory season the fishway will be operated on a 24-hour basis.

b. Description of Fishway Elements. The fishway ladder has 29 pools connected by vertical slots, which provide fish passage from an entrance on the downstream face of the dam to either (a) a false weir with an exit chute to the Basin at the upstream face, or (b) an exit channel connecting pool 17 of the ladder to the Basin. Additional information and operational instructions are included in Part III, Division 4. Plates showing fishway details are included in Appendix G.

30. OLD DAM

The old Charles River Dam is an earth fill structure connecting Boston and Cambridge along Leverett Street, one of the most heavily traveled roads in the metropolis. The dam has a top elevation of 121.0 feet and is about 1,200 feet long. An important feature of the dam is the navigation lock which is 45 feet wide, about 21 feet deep at its upstream sill and about 500 feet long. This lock is to remain fully open at all times to facilitate the passage of both boating and storm runoff. The hydraulic facilities also include 8 sluiceways which are controlled by individual gates, each 7.5 x 10 feet. These gates, with invert elevations at 97.75 feet will be kept fully opened at all times for the passage of flood flows. It is therefore imperative that normal maintenance and inspection of all sluicing facilities in the old dam be made at least once every two years. It is not mandatory that the lock and sluice gates be kept in position. They may be removed at the descretion of the MDC as long as there is some method, such as stoplogs, to dewater the sluiceways and lock for inspection. A general plan of the Leverett Street Dam is shown on plate B-15

GAGES

31. GENERAL

There are five gages which presently measure water levels at selected locations along the Charles River. This information is automatically telemetered from the gages to recorders at the new Charles River Dam. This data is extremely useful in regulating pumps, gates and sluiceways at the facility during normal and flood control operations. The water level gages are located at:

a. The downstream (harbor) and upstream (forebay) sides of the new dam at the south side of small lock no. 1.

b. The Basin wall of the MDC's First Street Drawbridge in Cambridge (Basin).

c. Downstream of the Moody Street Dam in Waltham.

d. Downstream of the Silk Mill Dam in Wellesley.

Refer to the Charles River watershed map on plate B-1 for these locations.

32. CHARLES RIVER DAM GAGES

a. Harbor. A float level is housed within a stilling well incorporated in the south side of small lock no. 1 and continually transmits the tide levels in the harbor to a recorder in the control room.

b. Forebay. An identical device is located in the upstream end of small lock no. 1 which records the water levels on the forebay side. Both gages measure relative to MDC datum.

33. FIRST STREET DRAWBRIDGE GAGE (BASIN)

A manometer-type water level indicator, located on the south wall of the MDC's First Street Drawbridge on the left bank of the Basin about 3,000 feet upstream of the old dam, measures the water level in the Basin. Calibrated to MDC datum, the water level is continually transmitted from a control unit in the drawbridge operating room by phone line to a recorder in the control at the new dam.

This gage reading is an important indicator of the regulation necessary at the new dam to prevent or minimize flood damages in the highly developed areas adjacent to the Charles River Basin. It is located this far upstream to minimize the effects of drawdown during major flood operations.

Due to hydraulic constrictions through the lock and sluices of the old dam and also through the B & M railroad bridge which cause high channel velocities and corresponding head losses, Basin elevations could be a foot or more higher than forebay levels at the new dam if significant flood discharges were occuring. The following tabulation presents computed forebay levels with various discharges, assuming a constant Basin level at 107.5 feet.

Discharge (cfs)	Forebay Elev.
0	107.5
2,000	107.4
4,000	107.2
6,000	106.9
8,400	106.4
10,000	105.9

34. WALTHAM DAM GAGE

The Charles River gage at Waltham is maintained by the U.S. Geological Survey. It is located on the right bank 800 feet downstream from the Moody Street Dam and reflects runoff from an area of 251 square miles. River levels are continually transmitted by phone line to a recorder in the control room at the new dam. The stage-discharge rating table is shown on plate B-16. This gage provides information on the flows that can be anticipated from the upper watershed.

35. WELLESLEY GAGE

The Wellesley gage, also maintained by the USGS, is located on the left bank of the Charles River 50 feet upstream from State Highway 9 immediately upstream of the Metropolitan Circular Dam and about 1,000 feet downstream from Silk Mill Dam. Streamflow data from this 211 square mile drainage area is telemetered to a recorder at the new dam. A stage-discharge rating table is shown on plate B-17. Although

this gage is not directly used in the regulation of the Charles River Dam, it is utilized by the MDC as a guide for the operation of the bascule gate at the Silk Mill Dam.

36. PRECIPITATION GAGE

Situated near the recorder panel in the control room is a precipitation gage-recorder. A funnel device mounted on the roof collects rain and a heated conduit, in case of freezing weather, carries it to a collector bucket. A dial display reflects the total precipitation to the nearest 0.1 inch. Since high peak inflows to the Charles River Basin could be experienced shortly after the start of heavy rainfall, it is necessary to closely monitor the rainfall during storm periods. Experienced precipitation is one criteria by which initial flood control discharges are made. These discharges can later be modified in response to fluctuations in Basin levels.

OPERATIONAL CONSIDERATIONS

37. GENERAL

There are numerous items that must be considered and weighed in prescribing regulation procedures for the flood control features of the project. The principal considerations are:

a. The forecasting problem, and subsequent effect of the storm on riverflow and tide conditions. Also included is the option of pre-lowering the Basin prior to a hurricane.

b. The time needed by personnel to mobilize and to operate the pumps.

c. The establishment of lines of communication with the Coast Guard and other boating interests concerning the effects of flood regulations at the project on navigation.

38. FORECASTING

The Charles River Basin can experience flood producing storms at any time of the year. It is not yet possible for the National Weather Service to predict with a high degree of accuracy whether the track of a storm or hurricane, still several hundred miles away, will either hit or miss the greater Boston area. Thus, it is necessary in operating the project to assume that every storm threatening the area will pass close enough to require mobilization of personnel.

The antecedent conditions in the watershed will bear directly on the inflow quantities for a given amount of precipitation. Ground that has been saturated by snowmelt, as in the March 1936 flood, or previous precipitation, as in the August 1955 flood, will be able to absorb only minimal amounts of additional precipitation. Therefore, a high percentage will be runoff to the natural drainage system.

The decision to pre-lower the Basin in anticipation of a hurricane or tropical storm should be based upon the following considerations:

a. The National Weather Service has issued a hurricane "Warning" for the greater Boston area.

b. Forecasts for heavy intense rainfall associated with a tropical storm in the next 6 hours.

Consideration must be given to recovery of the Basin should the anticipated rainfall not materialize. Stage readings from the Waltham gage would indicate the runoff from the upper watershed into the Basin and would give the operator an idea of the approximate time required to return the Basin to normal elevation 108. The following tabulation provides a guide:

Total Basin Inflow (cfs)	Days Required to Refill Basin from 107 to 108
25	14
50	7
100	3.5
200	1.7
400	1-

39. MOBILIZATION

The actual time required to mobilize personnel and activate the pumping station for a flood is dependent on many factors and presently can only be estimated. To provide sufficient time to overcome unforeseeable personnel and mechanical difficulties, mobilization and staffing should be considered when:

a. The National Weather Service declares a "Hurricane Watch," which generally provides 12 hours or more advance notice for most hurricanes. It may be possible to reduce the preparatory time in the future with more operating experience and meteorological knowledge of hurricanes, but under present conditions it is considered prudent to provide ample time for contingencies.

b. The National Weather Service forecasts intense rainfall in the greater Boston area within the next six hours.

c. The Basin stage reaches 108.5 feet with conditions indicating it will continue to rise (i.e., upstream gage readings and rainfall are conducive to higher Basin stages) and gravity sluicing is inadequate or not possible because of Harbor levels.

It should again be noted that tide levels have a direct bearing on the discharge capabilities of the project. Abnormally high tides will severely limit gravity sluicing, thereby increasing reliance on the pumping facility.

40. NOTIFICATION

The U. S. Coast Guard should be advised of pumping and/or sluicing operations in order that boat traffic be alerted to possible turbulence in the project area and in the downstream navigation channel. It is estimated that interference with commercial vessel traffic will begin when the velocity through the old lock exceeds one foot per second, and with pleasure craft when the velocity through the old lock exceeds two feet per second. These conditions occur when total discharges at the new dam exceed 1,500 cfs and 3,000 cfs, respectively. Communications with Cambridge Electric Company will insure that the fuel needs of the power facility are known and taken into consideration. Warning lights must be displayed in the areas of both the new and old dams where high velocities present hazard to navigation. Consideration should also be given to notifying the MDC harbor patrol for they may wish to station one of their craft in the Basin during a severe storm. A telephone directory is provided on plate B-23 for easy reference.

OPERATION

41. GENERAL

The successful operation of the new Charles River Dam is dependent upon a knowledge of the runoff factors influencing the Basin stages and discharge capabilities of the flood control facilities. To minimize flooding of the highly developed areas adjacent to the Basin, levels must be kept low enough to allow stormwater discharge.

The optimum Basin level is elevation 108 feet, although it is expected that normal levels will vary between 107.5 and 108.5. Significant damages start at approximately elevation 110 feet, and increase dramatically at higher stages. When levels fall to elevation 106.5 feet or lower, industrial intakes cease to function properly, the most critical one is at the Cambridge Electric Company.

Upper watershed inflows and lower watershed runoff are additional variables bearing directly on stages in the Basin. The total inflow is determined by the Basin rate of rise as measured at the gage at the old lock.

Stormwater runoff from the lower watershed into the Basin must be considered to maintain levels within allowable limits. The volume of inflows resulting from runoff is highly variable and dependent upon many factors; duration and intensity of precipitation and antecedent conditions in the watershed (i.e., relative wetness or dryness of the ground, temperature, presence of snow, etc.). As the many highly urbanized areas in the lower watershed are relatively impervious to runoff, peak inflows occur within 2 or 3 hours following intense rainfall. As shown in table 6, the lower 58 square mile watershed contributes up to about 90 percent of the peak inflow to the Basin. For this reason, a recording precipitation gage is included in order that immediate regulation adjustments may be considered to minimize the impact of intense rainfall and resulting runoff from the lower watershed. However, considerable experience and judgment is necessary in such use of precipitation data by itself.

There are three areas which require sandbag closure if the tide elevation of Boston Harbor is expected to exceed elevation 115 MDC during coastal storms or hurricanes. Refer to plate B-26 for these locations. Generally it is not considered necessary to sandbag these openings during the preparation for a coastal storm unless the storm is unusually severe. Closure should be initiated several hours prior to expected high tide to insure sufficient time to seal the openings to the top of embankment (118 ft MDC).

Sandbags should be available for immediate use if needed. Plate XIV-2 in the main text illustrates the method for increasing sandbag height and presents an approximation of the number of sacks required for the various heights. Plate XIV-3 shows pictures of model sack dike or topping.

42. NON-FLOOD PERIOD

During non-flood periods, the storage between 107.5 and 109 will be utilized to store the interior runoff during the high tide cycle. When the Harbor level falls below the Basin level, both sluices will be operated to maintain the desired elevation. The lower sluice will be opened initially to withdraw the heavier salt water which may be present.

43. FLOOD PERIOD - HURRICANE

a. Phases. Mobilization of personnel and operational functions are related to the position and movement of the hurricane. These operational functions have been divided into "phases" to assure a clear delineation of actions to be taken as the storm approaches and affects the greater Boston area. These phases are outlined on the following pages.

Phase	Designation	Determination
1	Alert	Storm north of 30° latitude, west of 65° longitude
2	Watch	NWS issues Hurricane "Watch"
3	Warning	NWS issues Hurricane "Warning"
4	Operation	More than one inch of rainfall and still raining at dam or Basin level reaching 107.5
5	Cessation	Basin elevation returns to normal

b. Instructions. This section contains the instructions for operations during hurricanes. Standard operating procedures are summarized on plate B-18.

(1) Phase 1 - Alert. Hurricane located north of 30° latitude and west of 65° longitude. The MDC will alert all personnel connected with the operation of the project and will arrange to receive continuous Weather Service advisories. Position and movement of storm will be plotted on a hurricane plotting chart.

(2) Phase 2 - Watch. This phase commences when the National Weather Service announces a hurricane "watch" for southern New England.

(a) All personnel concerned with the operation of the project will be mobilized.

(b) Check all fuel levels to insure sufficient supplies for pump operation. Check materials such as log and report forms, emergency supplies, etc.

(c) All recording charts will be checked to insure that the time scale is accurate, and water levels correspond with tile gage readings.

(d) The Cambridge Electric Company will be advised that navigation through the project may be curtailed because of possible flood control operations.

(e) Consider notification of MDC harbor patrol.

(f) Start all diesel oil and water heating elements.

(3) Phase 3 - Warning. This phase will commence when the National Weather Service announces a hurricane "Warning" for southern New England.

(a) The pumping facilities will be continually staffed.

(b) Pre-lower Basin level to 107 feet by discharging through the two sluiceways and/or using two pumps.

(c) Initiate 30-minute recordings of rainfall, Basin elevations, and Harbor elevation on the reporting log (plate B-19).

(d) Plot observed Basin and Harbor elevations. This will enable the operator to determine when gravity sluicing can be accomplished, if necessary.

(e) The Coast Guard will be notified that navigation through the locks might be curtailed because of possible flood control operation. Refer to plate B-20 for various bulletins issued to the Coast Guard.

(f) Personnel at the sewage pump station will be notified that flood facilities at the dam may be operated due to storm conditions.

Should the hurricane slow down, stagnate offshore, or change course and not produce abnormal rainfall to initiate Phase 4, personnel will remain in Phase 3 and be prepared to resume operations as necessary.

(4) Phase 4 - Operation. This phase will commence when one inch of rain has been experienced at the dam and precipitation is continuing or Basin level rising to 107.5. During this phase, regulation procedures will be based on rainfall, Basin levels, and concurrent harbor levels. Due to the time required to bring the pumps up to full capacity (900 RPM/15 MIN.) it will be necessary to always have a pump idling, in addition to those required to discharge floodflows, once the operation phase has been initiated. When sluicing through the

locks, the downstream sector gates will always be used to control flows. The curved surface facing the direction of flow is hydraulically more efficient and will not catch debris.

(a) Begin 15 minute monitoring and logging of rainfall, basin elevation and harbor elevation.

(b) If Harbor elevation is higher than Basin elevation use the following schedule as a guide for starting pumps when basin level is rising:

Total Rainfall (inches)	OR	Basin Elevation (ft)	Pump Started
1.0		107.5	1
1.5		107.7	2
2.0		107.9	3
2.5		108.1	4
3.0		108.3	5
3.5		108.5	6

All pumps started will be left in operation until the heavy precipitation has ceased and the Basin has receeded to elevation 107.0. At that time three pumps, or all that have been started if three or less will be stopped and the storage between 107 and 109 will be utilized until tide conditions permit sluicing. After this action the Basin should begin to rise slowly, however, if it continues to fall, cease all pumping. All pumps will be activated if the Basin rises above 109. When the Harbor levels fall below Basin levels, then both sluices will be immediately opened and the instructions given in section (c) of this phase will be implemented.

(c) If Basin level is higher than Harbor level, use the following schedule as guide for initiating actions when the Basin is rising.

Total Rainfall (inches)	OR	Basin Elevation	Action
1.0		107.5	Open Both Sluices
1.5		107.7	Start Pump 1
2.0		107.9	Start Pump 2
2.5		108.1	Start Pump 3
3.0		108.3	Start Pump 4
3.5		108.5	Start Pump 5
4.0		108.7	Start Pump 6
		109.5	Open Large Lock

If the Basin continues to rise after the previous actions have been taken and reaches 110.0 then releases will be initiated through both small boat locks. It should be emphasized that this would result from an extremely rare event, occurring after more than 10 inches of rainfall in 18 hours.

All actions initiated will be continued until the heavy precipitatation has ceased and the Basin has receeded to 107.0. At that time, all pumps will be stopped, the sluiceways will remain open and the locks will be operated to keep the Basin between 107.0 and 107.5. If the Basin rises to 109.5 while sluicing, all pumps will be started. If the Harbor rises above the Basin, immediately close both sluices, and boat locks, and implement the instructions in section (b) of this phase.

(d) Once any action has been initiated in Phase 4, it should not be terminated until the Basin has been drawn down to 107.0. At that time the actions will be terminated as defined in paragraphs (b) or (c) of this phase and the storage between 107 and 109 will be utilized for storing runoff during high tide cycles.

(e) MDC will issue bulletin to USCG that flood control facilities are being operated. This may mean curtailment of boat passage depending on the total discharges being made and the turbulence and velocities that are created in and near the project area.

(5) Phase 5 - Cessation. The heavy rainfall has ceased, inflows to the Basin have receded and the Basin elevation has returned to normal. It must be emphasized that should heavy precipitation begin again or the Basin elevation begin to rise again then the regulation procedures could revert to Phase 4.

(a) If the hurricane moves away and is no longer a threat to the watershed, personnel will be demobilized. However, if it appears that additional rainfall might occur, continued staffing of the project may be necessary.

(b) Because hurricanes may stall off the coast or return on a threatening path toward southern New England, it might be necessary to revert back to either a "Watch" or "Warning" phase.

(c) MDC will notify the USCG that flood control activities have been discontinued.

44. FLOOD PERIOD - SEVERE STORM

a. Phases. The project will also be operated for storms that could produce significant runoff from moderate to heavy rainfall or associated with snowmelt. The phases for operation are outlined below:

Phase	Designation	Determination
1	Alert	NWS locates a storm that poses a potential flood threat to southern New England.
2	Warning	Storm approaching the area and NWS forecasts heavy rainfall to affect greater Boston within 6 hours.
3	Operation	Two inches of rain within 3 hours, or Basin rises to 108.5.
4	Cessation	Heavy Rainfall stopped and Basin elevation returned to normal.

b. Instructions. This section contains the instructions during operations for severe storms. Standard operating procedures are summarized on plate B-18.

(1) Phase 1 - Alert. National Weather Service locates a storm that poses a potential heavy rainfall flood threat to the watershed. The MDC will alert all personnel connected with the operation of the project, consider notification of MDC harbor patrol, closely follow weather reports on the movement and possible intensification of the storm, and start all diesel oil and water heating elements.

(2) Phase 2 - Warning. Severe storm approaching the area and the NWS forecasts heavy rainfall to occur within 6 hours in the Boston area.

(a) The pumping station will be staffed.

(b) Begin 30-minute monitoring and recording of rainfall, Basin level, and Harbor level.

(c) MDC will notify the Cambridge Electric Company of the possible curtailment of navigation due to project flood control operation.

(d) Plot Basin and Harbor elevations. This will enable the operator to judge when gravity sluicing can be accomplished, if necessary.

(e) All recording charts will be checked to insure that the time scale is accurate and water levels correspond with Harbor and forebay tile gage readings.

(f) Check all fuel levels to insure sufficient fuel supplies for pump operations. Check materials such as log and report forms, emergency supplies, et.

(g) The MDC will notify the USCG that navigation through the boat locks might be curtailed because of possible flood control operation.

(h) Notify MDC personnel at the sewage pump station that flood control facilities at the project may be operated within the next few hours.

Should the storm slow down, stagnate offshore, or pass without producing sufficient rainfall to initiate the operation phase, the MDC will remain in the warning phase and be prepared to resume

operations if necessary. When the storm poses no further flood threat to the Basin, the cessation phase can be initiated.

(3) Phase 3 - Operation. This phase will be initiated for either of the following: two inches of rainfall at the project within any 3-hour period and rainfall continuing, Basin level reaching 108.5 feet. During this phase, operations will be based on precipitation, Basin elevation, and harbor elevation. Due to the time required to bring the pumps up to full capacity (900 RPM/15 min.) it will be necessary to always have a pump idling, in addition to those required to discharge flood flows, once the operation phase has been initiated. When sluicing through the locks, the downstream sector gates will always be used to control flows. The curved surface facing the direction of flow is hydraulically more efficient and will not catch debris.

(a) Begin 15-minute reading, recording, and plotting of rainfall, Basin elevation and harbor elevation.

(b) If harbor level is higher than Basin level use the following schedule as a guide for starting pumps when the Basin is rising:

Total Rainfall (inches)	OR	Basin Elevation	Pumps Started
2.0		108.5	1
2.5		108.7	2
3.0		108.9	3
3.5		109.1	4
4.0		109.3	5
4.5		109.5	6

All pumps started will be left in operation until the heavy precipitation has ceased and the Basin has receeded to 107.0. At that time three pumps, or all that have been started if three or less, will be stopped and the storage between 107 and 109 will be utilized until tide

levels permit gravity sluicing. After this action, the Basin should begin to rise slowly, however, if it continues to fall, cease all pumping. All pumps will be started if the Basin rises above 109. When harbor drops below the Basin elevation, then both sluices will be immediately opened and the instructions given in section (c) of this phase will be implemented.

(c) If Basin levels is higher than Harbor level, use the following schedule as a guide for initiating actions when the Basin is rising.

Total Rainfall (inches)	OR	Basin Elevation	Action
2.0		108.5	Open both sluices
2.5		108.7	Start Pump 1
3.0		108.9	Start Pump 2
3.5		109.1	Start Pump 3
4.0		109.3	Start Pump 4
4.5		109.5	Start Pump 5
5.0		109.6	Start Pump 6
		109.7	Open large boat lock

If the Basin continues to rise after the above actions have been taken and reaches 110.0, then releases through both small boat locks will be initiated.

All actions initiated will be continued until the heavy precipitation has ceased and the Basin has receeded to 107.0. At that time all pumps will be stopped, the sluiceways will remain open and the locks will be operated to keep the Basin between 107.0 and 107.5. If the Basin rises to 109.5 while sluicing, all pumps will be started. If during the operation, the Harbor rises above the Basin, immediately close the sluices and boat locks, and implement the instructions in section (b) of this phase.

(d) MDC will issue bulletin to USCG that flood control facilities are being operated. This may mean curtailment of boat passage depending on the total discharges being made and the turbulence and velocities that are created in and near the project area.

(e) Once any action has been initiated in Phase 3, it should not be terminated until the Basin has been drawn down to 107.0. At that time the actions will be terminated as defined in paragraphs (b) or (c) of this phase and the storage between 107 and 109 will be utilized for storing runoff during high tide cycles.

(4) Phase 4 - Cessation. The heavy rainfall has ceased, inflows to the Basin have receded and the Basin elevation has returned to normal. It must be emphasized that should heavy precipitation begin again or the Basin elevation begin to rise again then the regulation procedures could revert to Phase 3.

(a) If the storm moves away and is no longer a threat to the watershed, personnel will be demobilized. However, if it appears that additional rainfall might occur, continued staffing of the project may be necessary.

(b) MDC will notify the USCG that flood control activities have been discontinued.

45. REPORTS

Prior to and during any flood operation, pertinent information will be entered on a reporting log or on suggested forms as shown on plate B-19. The report will include: times of sluice gate opening and closing, pump operations, Basin, Forebay, and Harbor elevations, rainfall amounts, use of navigation locks, and other information, observations or comments that would be helpful in describing the entire operation. Copies of this report will be forwarded to the Reservoir Control Center at the New England Division, Corps of Engineers within 48 hours after the operation so that RCC can determine the efficiency of communication and reporting networks and the applicability of regulation guides. In addition, this information will be used to compute benefits and also analysed to insure that precedents are not set that could adversely affect flood regulation procedures in future years. The normal maintenance and semiannual inspection reports will be forwarded to the Division Engineer as required by Part II, Division 4 of this "Operations and Maintenance Manual."

46. EXAMPLES OF OPERATIONS

In order to aid MDC personnel in the operation of project flood control facilities during flood events, two historical floods, August 1955 and March 1968, have been analyzed under the previously described regulation criteria. Plates B-21 and B-22 graphically present what would happen during a recurrence of both flood events.

PERTINENT DATA
CHARLES RIVER DAM

LOCATION: Charles River, Boston, Massachusetts, 2,250 feet downstream from old dam.

DRAINAGE AREA: Total watershed - 309 square miles; Lower watershed - 58 square miles; Upper watershed - 251 square miles

PROJECT USE: Flood Control, Recreation, Navigation

BASIN STORAGE:

	Elevation Ft msl	Elevation MDC	Area Acre	Capacity* Acre Feet	Capacity* Millions Gallons
Old River Channel	-16+	90+	0	0	0
Normal Basin	2.35	108	704	10,540	3,430
Start Damage	4.35	110	751	11,980	3,900
Top of Dam	12.35	118	-	-	---

* Volumes estimated.

DAM:

Type	Rolled earth fill, rock slope protection, sheet piling, seepage Barrier
Total length (feet)**	560
Embankment length (feet)	160
Top Elevation (MDC)	118.0
Maximum Height (feet)	36.0

** Includes 400 feet for pump house and locks.

PUMP STATION:

Pumps	6 @ 1,400 cfs = 8,400 cfs against 9 ft. static head
Intake sill elevation (MDC)	82.5
Outlet sill elevation (MDC)	116.0

SLUICES:

Low Sluice	
Size (feet)	8 X 10
Intake sill elevation (MDC)	87.0
Outlet sill elevation (MDC)	87.0
Length (feet)	144' - 10"
High Sluice	
Size (feet)	8 X 10
Intake sill elevation (MDC)	95.5
Outlet sill elevation (MDC)	87.0
Length (feet)	144' - 10"

NAVIGATION LOCKS:

Large	One
Length (feet)	300
Width (feet),	40
Basin sill elevation (MDC)	91.0
Harbor sill elevation (MDC)	86.0
Small	Two
Length (feet)	200
Width (feet)	25
Basin sill elevation (MDC)	100.0
Harbor sill elevation (MDC)	94.0

FISHWAY: Provides for passage of anadromous fish, such as shad, alewives, smelt.

TIDE DATA (MDC BASE):

Highest of record - February 7, 1978	116.0
Mean high water	110.5
Mean low water	101.0
Design tide elevation, high	113.0

FLOOD DATA:

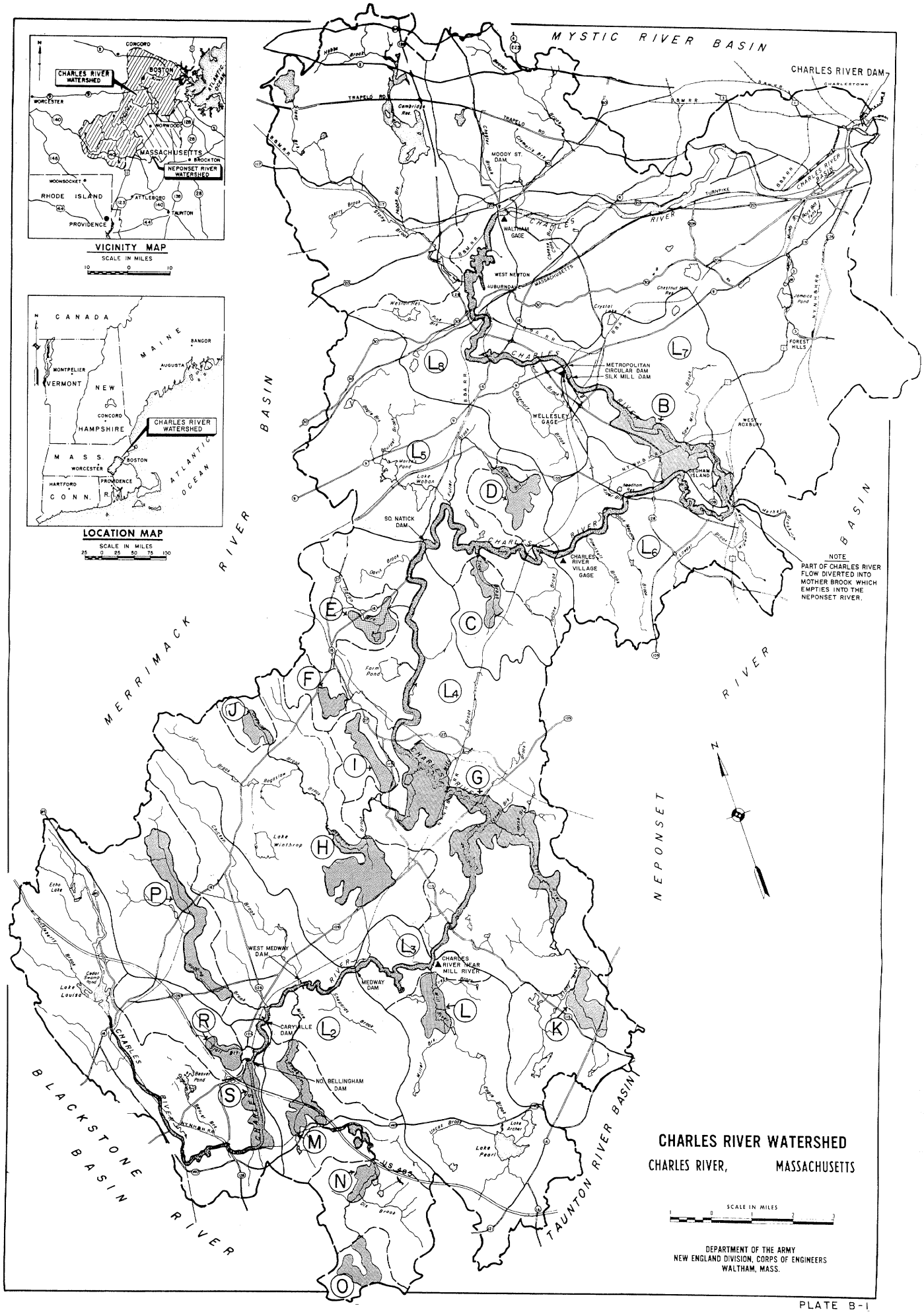
Storm	Experienced Conditions Inflow (cfs)	Experienced Conditions Basin Elev. (MDC)	Modified by New Dam Outflow (cfs)	Modified by New Dam Basin Elev. (MDC)
August 1955	13,400	112.5	12,100	109.9
March 1968	4,800	110.8	10,100	109.4
Project Design	15,500	-	18,000	109.9

PROJECT COST:

$39,977,000	(Fed)
7,255,000	(Non-Fed)
$47,232,000	(Total)

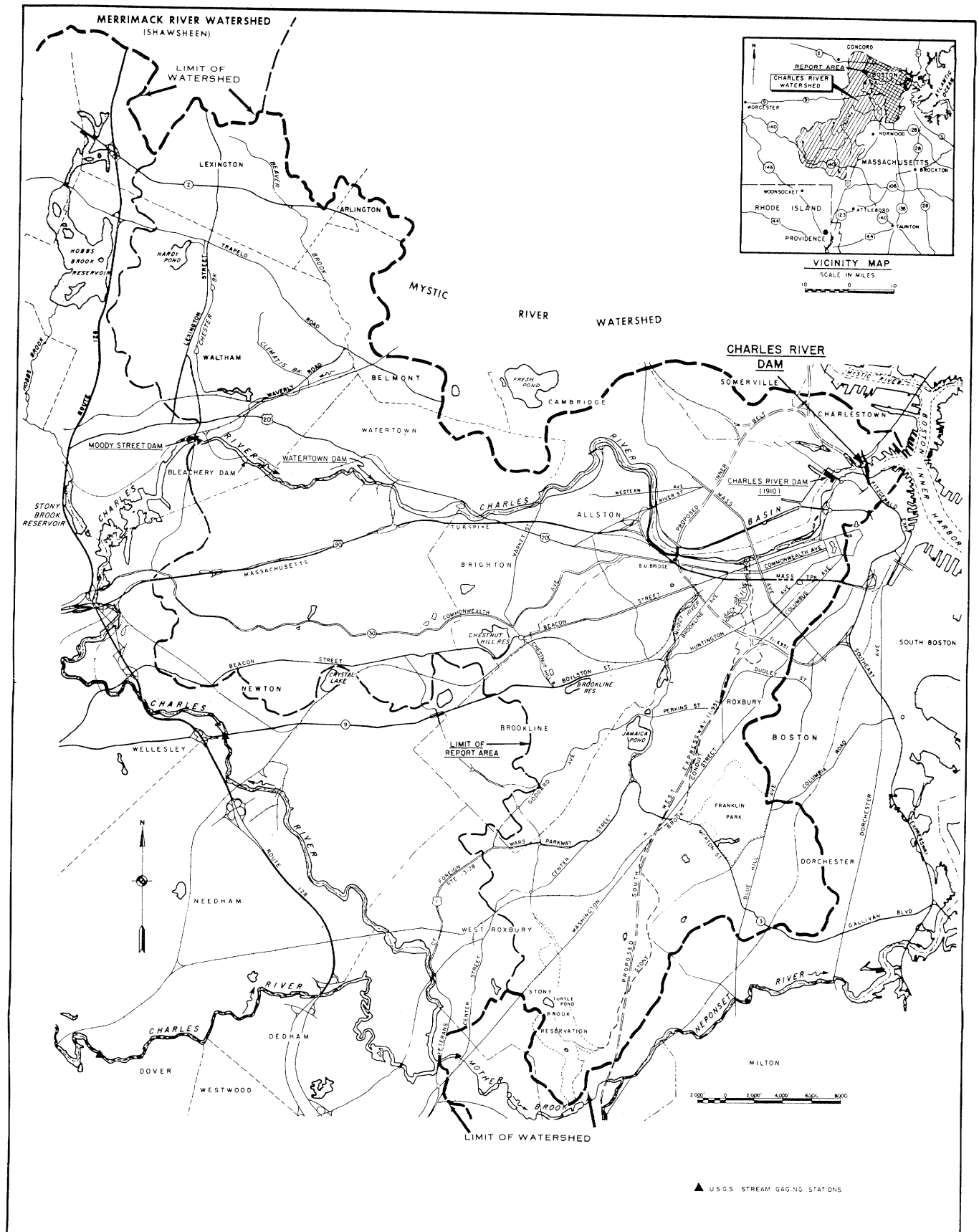
DATE OF COMPLETION: May 1978

MAINTAINED BY: Metropolitan District Commission of Boston



MYSTIC RIVER BASIN
CHARLES RIVER DAM
CHARLESTOWN
TRAPELO RD.
MOODY ST. DAM
WALTHAM GAGE
WEST NEWTON
AUBURNDALE
CHARLES RIVER
CHARLES RIVER BASIN
TURNPIKE
METROPOLITAN CIRCULAR DAM
SILK MILL DAM
WELLESLEY GAGE
WEST ROXBURY
FOREST HILLS
GEDHAM ISLAND
SO. NATICK DAM
CHARLES RIVER VILLAGE GAGE
NOTE
PART OF CHARLES RIVER FLOW DIVERTED INTO MOTHER BROOK WHICH EMPTIES INTO THE NEPONSET RIVER.
MERRIMACK RIVER BASIN
NEPONSET RIVER BASIN
BLACKSTONE RIVER BASIN
TAUNTON RIVER BASIN
WEST MEDWAY DAM
MEDWAY DAM
CHARLES RIVER NEAR MILL RIVER
CARYVILLE DAM
NO. BELLINGHAM DAM
Lake Winthrop
Lake Louisa
Lake Pearl
Lake Archer
Farm Pond
Lake Waban
Echo Lake
Cedar Swamp Pond
Beaver Pond
US 495
CHARLES RIVER WATERSHED
CHARLES RIVER, MASSACHUSETTS
SCALE IN MILES
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
VICINITY MAP
SCALE IN MILES
CONCORD
BOSTON
WORCESTER
NORWOOD
MASSACHUSETTS
BROCKTON
NEPONSET RIVER WATERSHED
WOONSOCKET
RHODE ISLAND
ATTLEBORO
TAUNTON
PROVIDENCE
LOCATION MAP
SCALE IN MILES
CANADA
MAINE
BANGOR
AUGUSTA
MONTPELIER
VERMONT
NEW HAMPSHIRE
CONCORD
MASS.
WORCESTER
BOSTON
HARTFORD
CONN.
PROVIDENCE
ATLANTIC OCEAN

PLATE B-1



WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER LOCKS AND DAM

CHARLES RIVER BASIN — MASSACHUSETTS

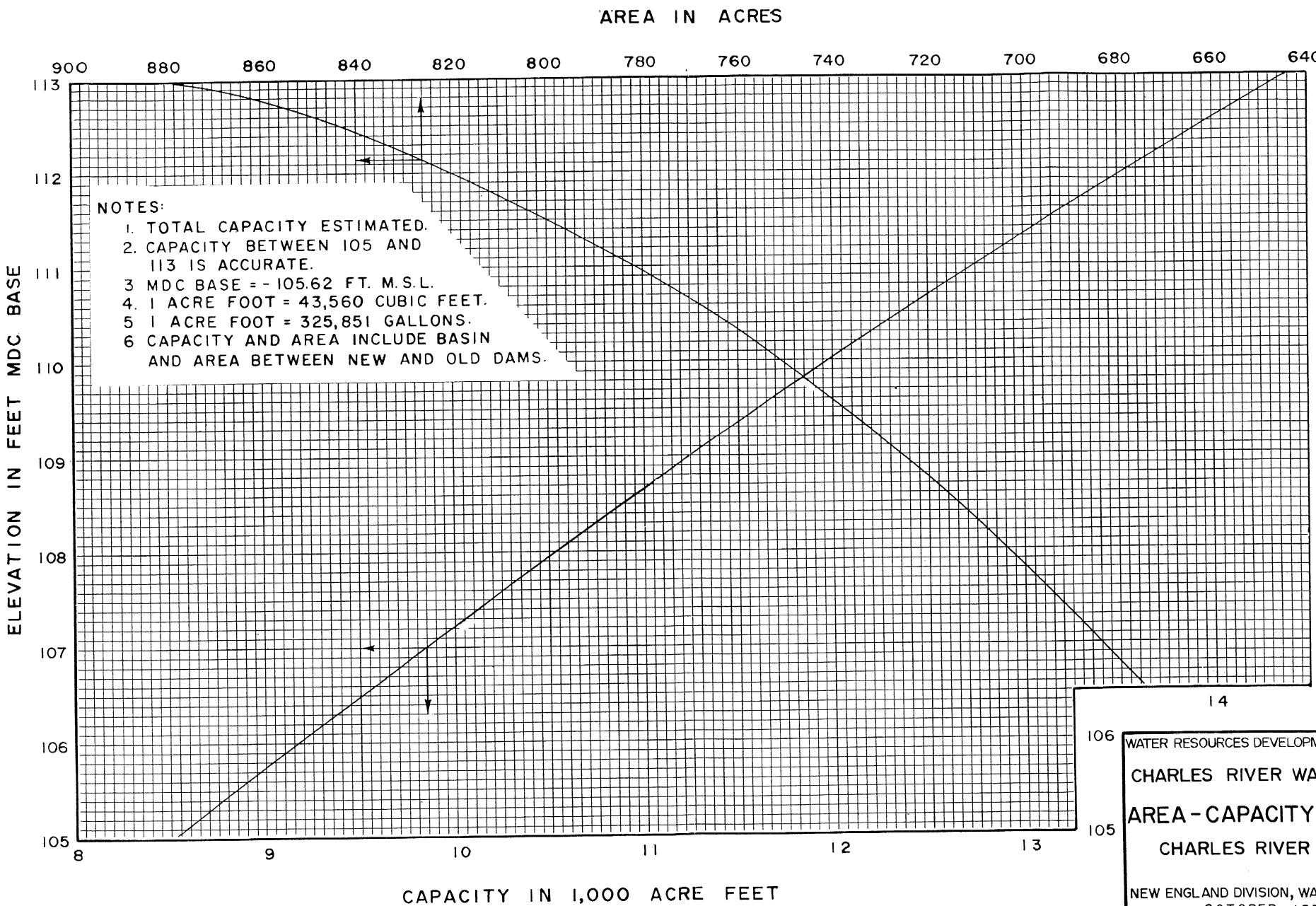
LOWER CHARLES RIVER

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION

CORPS OF ENGINEERS — WALTHAM, MASS.

PLATE B-2



WATER RESOURCES DEVELOPMENT PROJECT

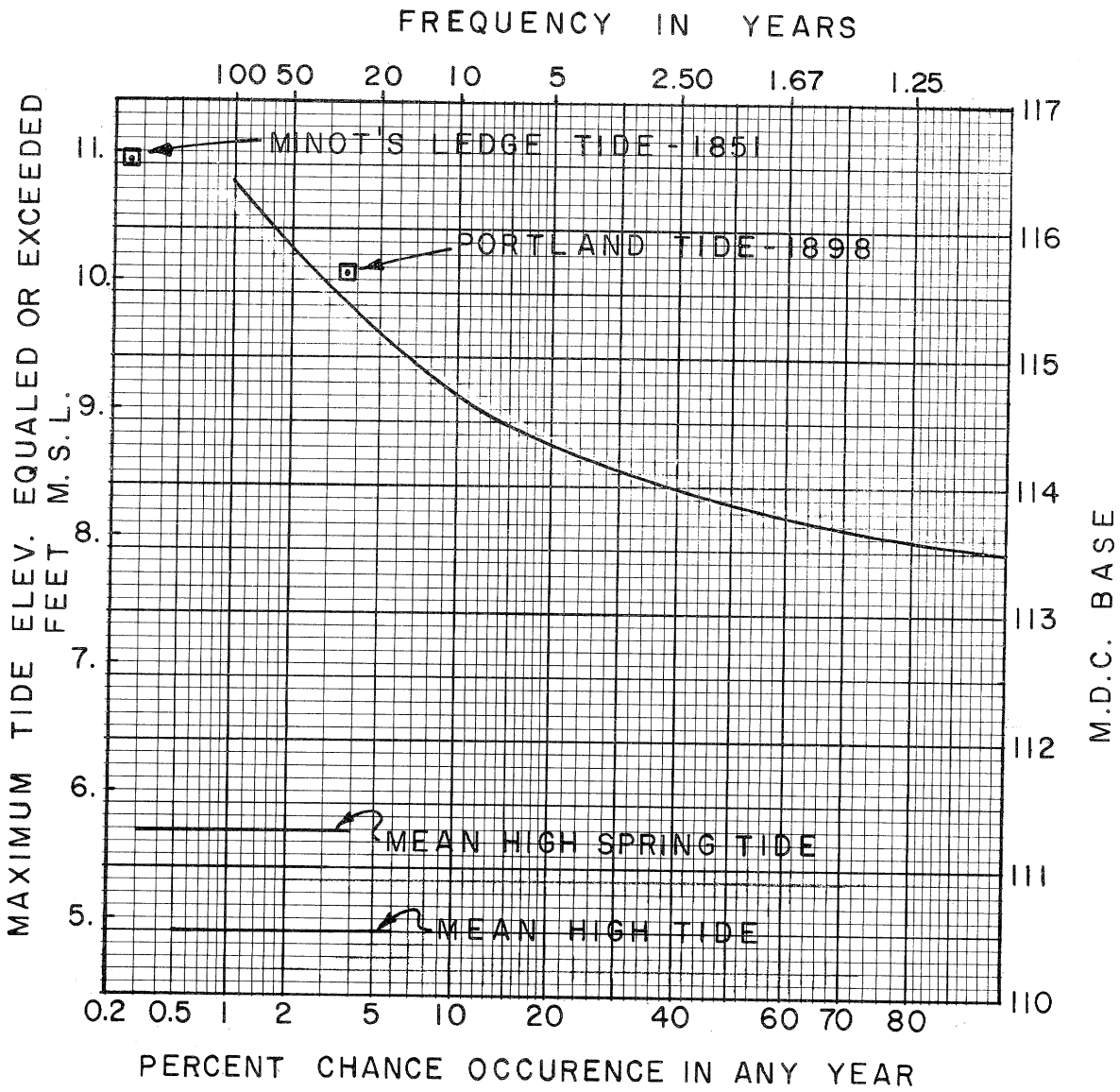
CHARLES RIVER WATERSHED

AREA - CAPACITY CURVES

CHARLES RIVER BASIN

NEW ENGLAND DIVISION, WALTHAM, MASS.
OCTOBER 1977

PLATE B-3



NOTE

ELEVATIONS ADJUSTED TO 1970 LEVELS

WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER WATERSHED
TIDAL FREQUENCY CURVE

BOSTON HARBOR

NEW ENGLAND DIVISION, WALTHAM, MASS.
OCTOBER 1977

PLATE B-4

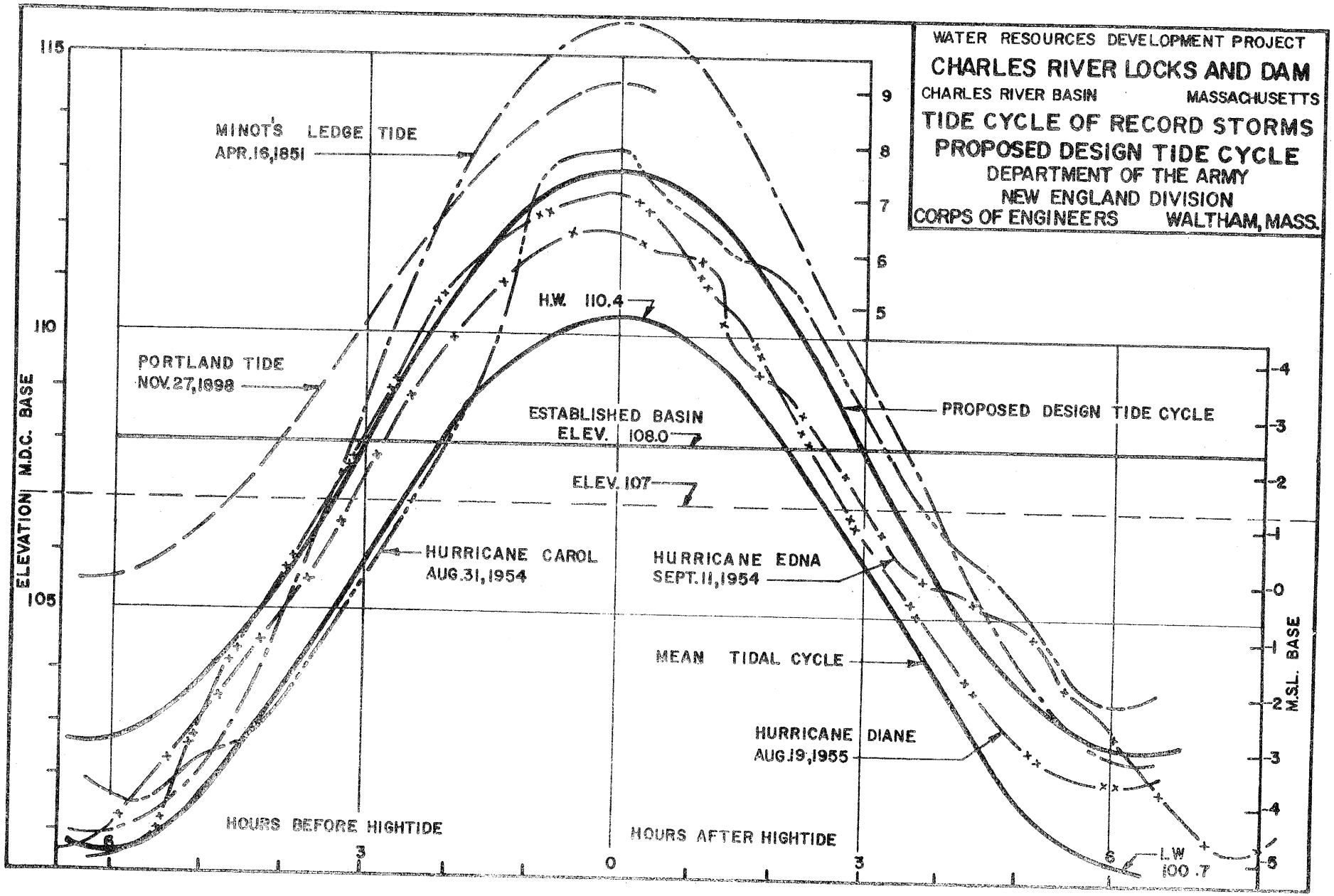

WATER RESOURCES DEVELOPMENT PROJECT
CHARLES RIVER LOCKS AND DAM
CHARLES RIVER BASIN
MASSACHUSETTS
TIDE CYCLE OF RECORD STORMS
PROPOSED DESIGN TIDE CYCLE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
MINOT'S LEDGE TIDE
APR. 16, 1851
PORTLAND TIDE
NOV. 27, 1898
H.W. 110.4
ESTABLISHED BASIN
ELEV. 108.0
ELEV. 107
PROPOSED DESIGN TIDE CYCLE
HURRICANE CAROL
AUG. 31, 1954
HURRICANE EDNA
SEPT. 11, 1954
MEAN TIDAL CYCLE
HURRICANE DIANE
AUG. 19, 1955
L.W.
100.7
HOURS BEFORE HIGHTIDE
HOURS AFTER HIGHTIDE
ELEVATION M.D.C. BASE
M.S.L. BASE
115
110
105
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
3
0
3
6

PLATE B-5

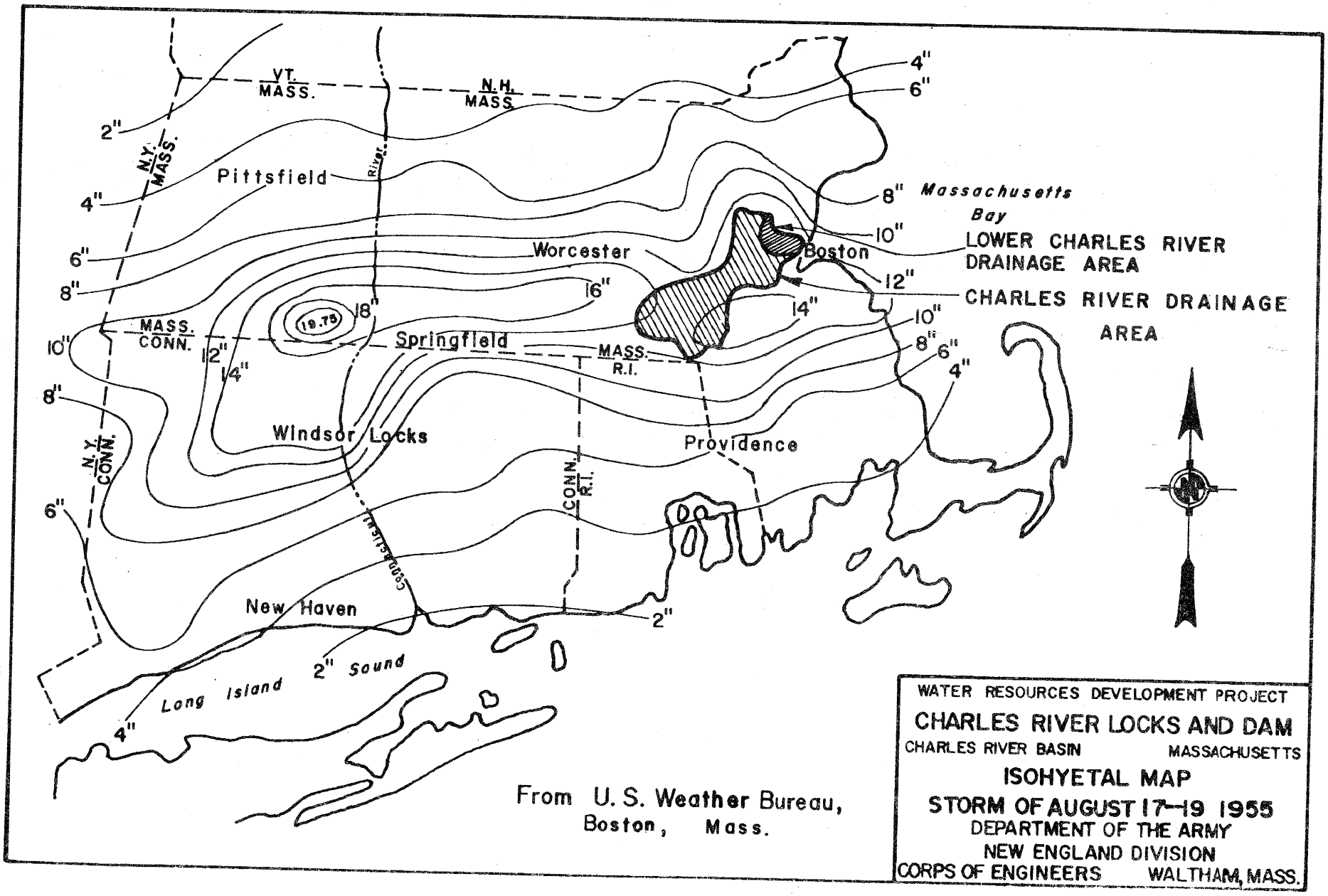
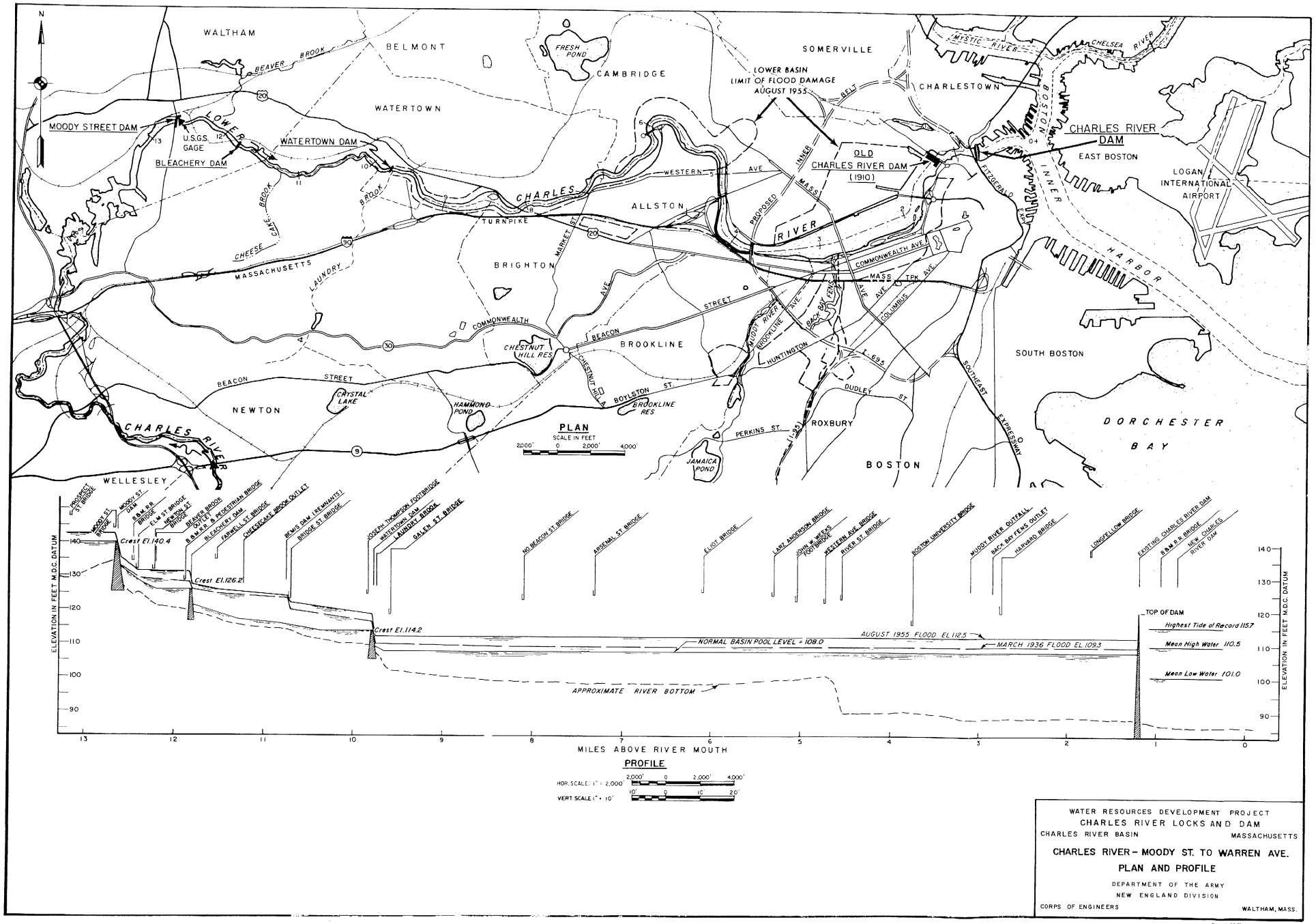

VT.
MASS.
N.H.
MASS.
N.Y.
MASS.
Pittsfield
River
Worcester
Boston
Massachusetts Bay
LOWER CHARLES RIVER DRAINAGE AREA
CHARLES RIVER DRAINAGE AREA
MASS.
CONN.
Springfield
MASS.
R.I.
Windsor Locks
Providence
N.Y.
CONN.
CONN.
R.I.
Connecticut
New Haven
Long Island Sound
2"
4"
6"
8"
10"
12"
14"
16"
18"
19.75
From U. S. Weather Bureau, Boston, Mass.
WATER RESOURCES DEVELOPMENT PROJECT
CHARLES RIVER LOCKS AND DAM
CHARLES RIVER BASIN MASSACHUSETTS
ISOHYETAL MAP
STORM OF AUGUST 17-19 1955
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS WALTHAM, MASS.

PLATE B-6

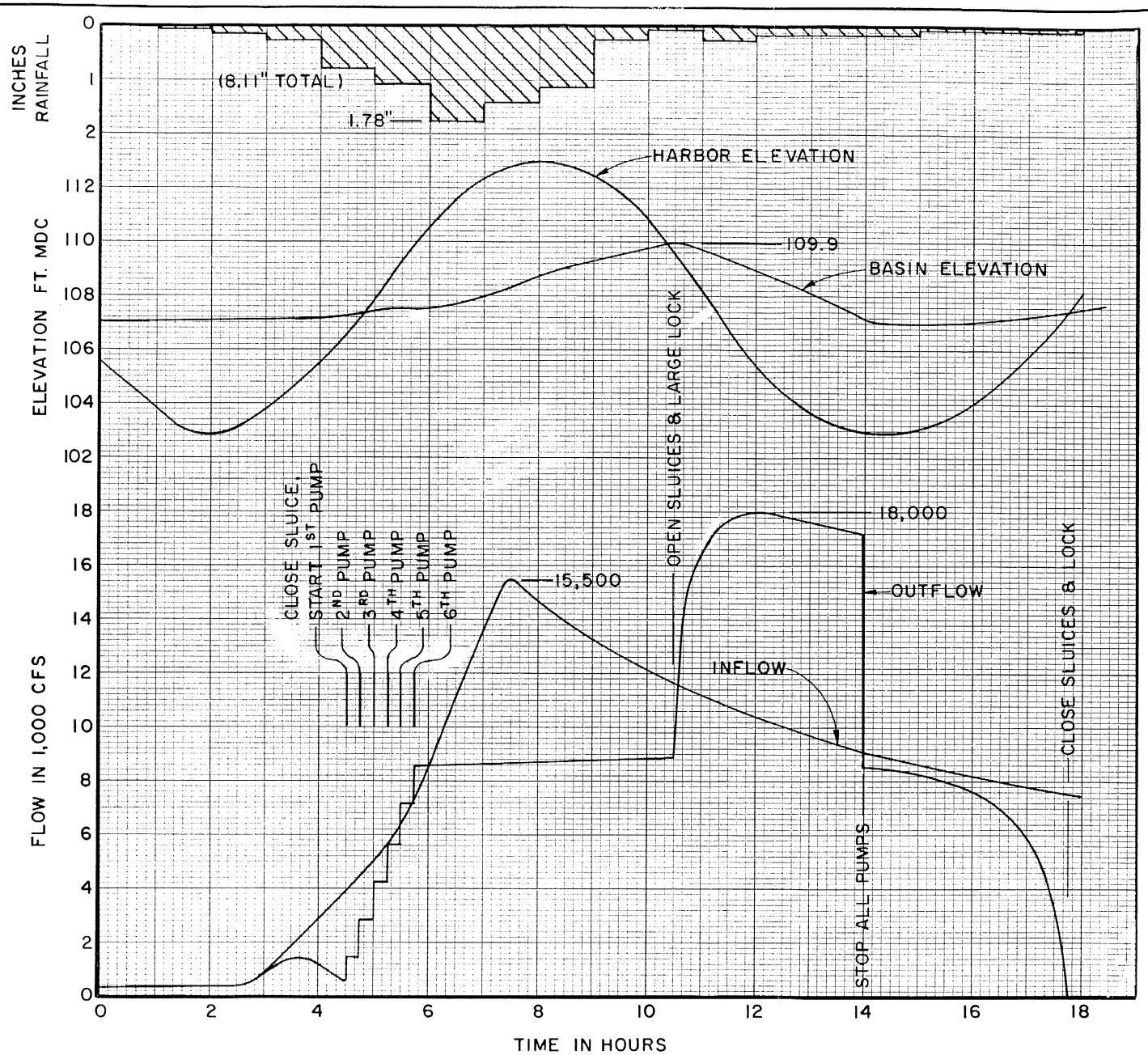


WATER RESOURCES DEVELOPMENT PROJECT
CHARLES RIVER LOCKS AND DAM
CHARLES RIVER BASIN MASSACHUSETTS

CHARLES RIVER – MOODY ST. TO WARREN AVE.
PLAN AND PROFILE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS WALTHAM, MASS.

PLATE B-7



WATER RESOURCES DEVELOPMENT PROJECT

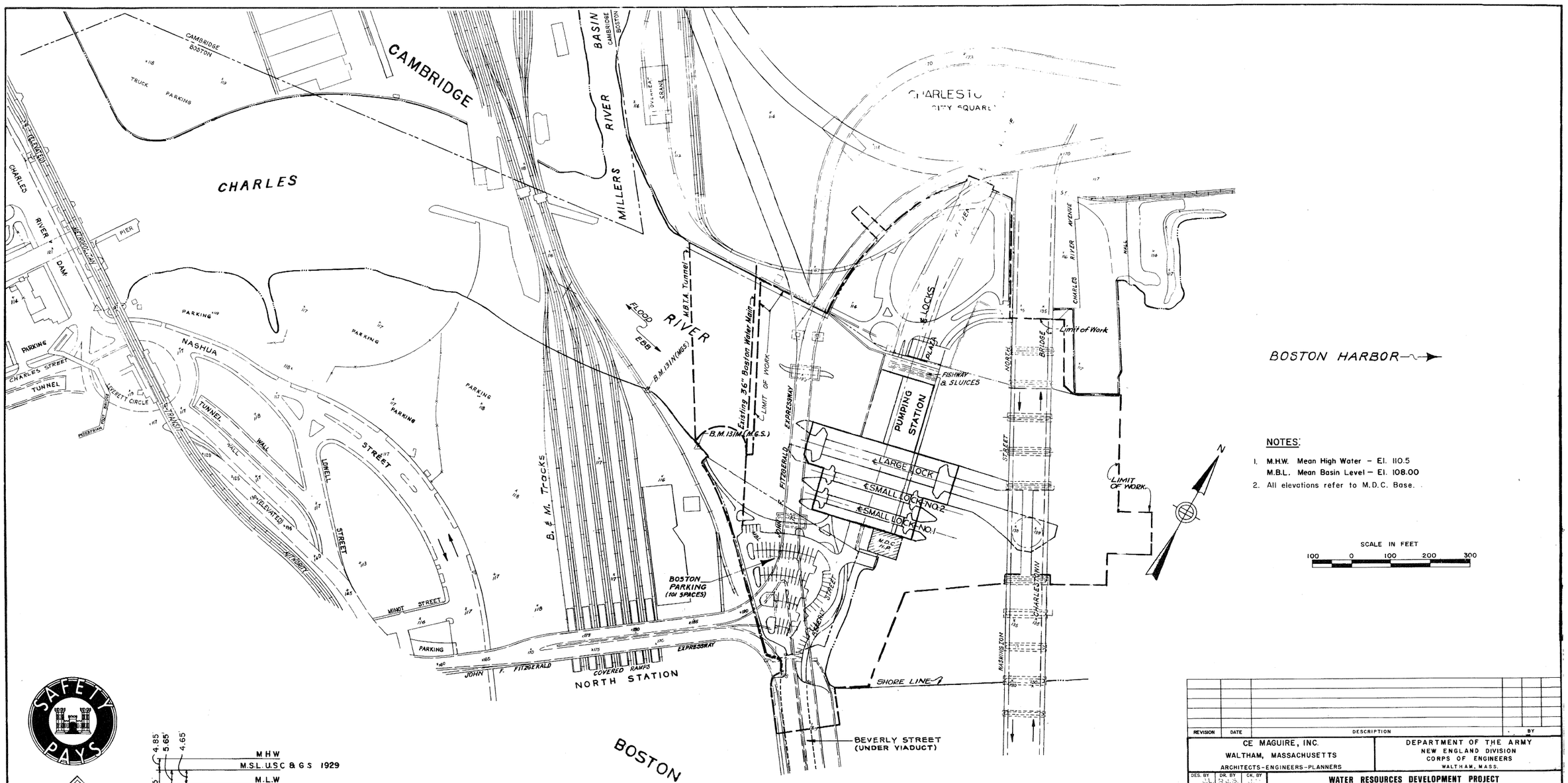
CHARLES RIVER WATERSHED

PROJECT DESIGN FLOOD

EXAMPLE OPERATION

NEW ENGLAND DIVISION, WALTHAM, MASS.
OCTOBER 1977

PLATE B-8



NOTES:

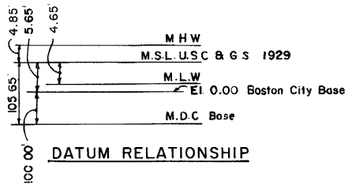
1. M.H.W. Mean High Water – El. 110.5
   M.B.L. Mean Basin Level – El. 108.00
2. All elevations refer to M.D.C. Base.

SCALE IN FEET

100 0 100 200 300

SAFETY PAYS

VALUE ENGINEERING PAYS DIVIDENDS



DATUM RELATIONSHIP

REVISION	DATE	DESCRIPTION	BY

CE MAGUIRE, INC.
WALTHAM, MASSACHUSETTS
ARCHITECTS-ENGINEERS-PLANNERS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.L. DR. BY S.J.S. CK. BY
SUBMITTED
ARCHITECT-ENGINEER
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, TECH. ENG. BRANCH
APPROVAL RECOMMENDED
CHIEF, PROJECT BRANCH

WATER RESOURCES DEVELOPMENT PROJECT

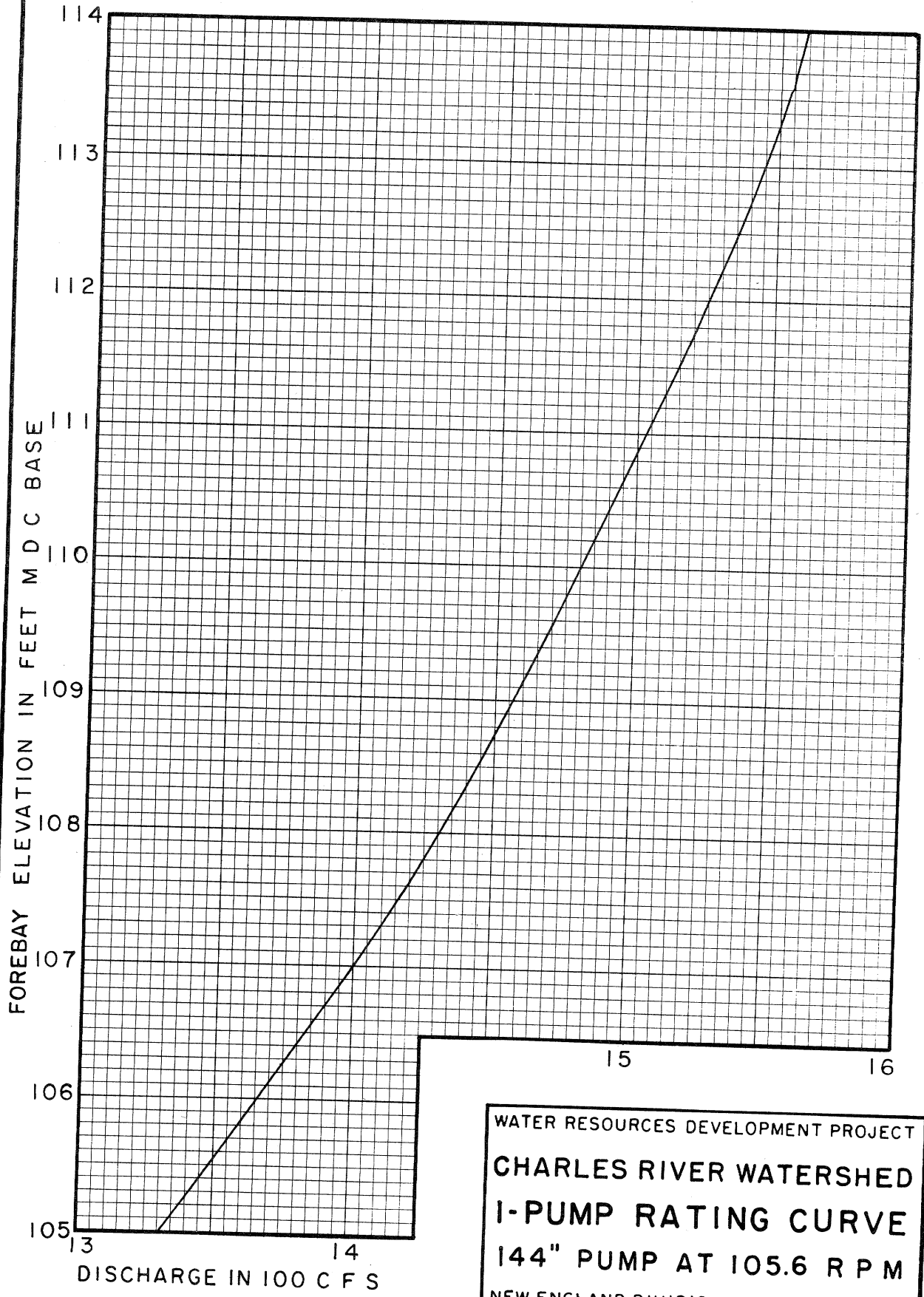
CHARLES RIVER DAM

GENERAL PLAN

CHARLES RIVER BASIN MASSACHUSETTS

APPROVED
CHIEF, ENGINEERING DIVISION

SCALE: 1"=100'
DATE: NOV. 1973
SPEC. NO. DACW 33-74-B-0017
DWG. NO. CHA-2
SHEET 3



WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER WATERSHED

1-PUMP RATING CURVE

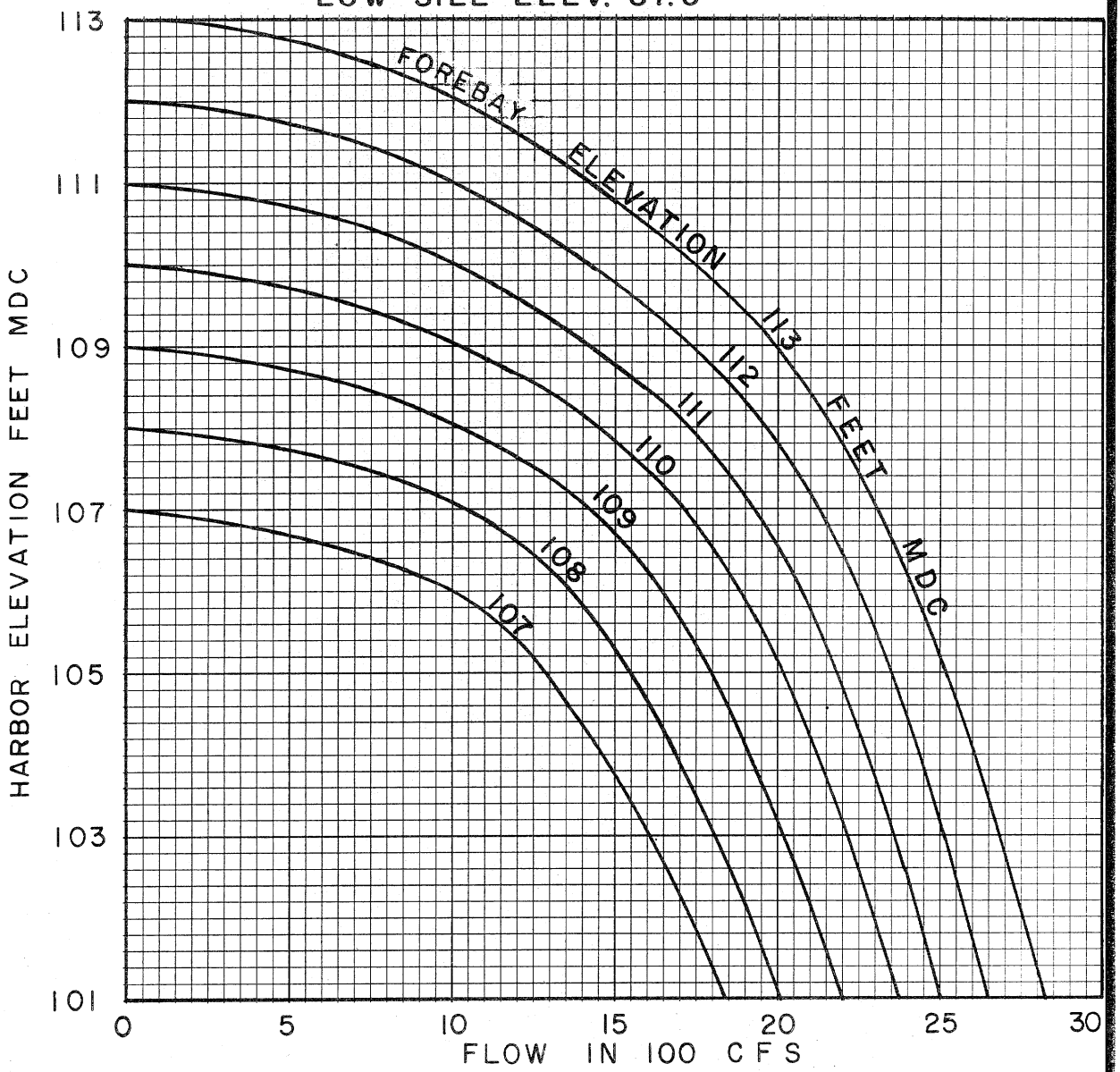
144" PUMP AT 105.6 R P M

NEW ENGLAND DIVISION, WALTHAM, MASS.
OCTOBER 1977

PLATE B-10

NOTES:

1. RATING IS FOR BOTH SLUICES OPENED FULL.
2. TWO SLUICES AT 8' X 10'.
3. HIGH SILL ELEV. 95.5'
   LOW SILL ELEV. 87.0'



WATER RESOURCES DEVELOPMENT PROJECT

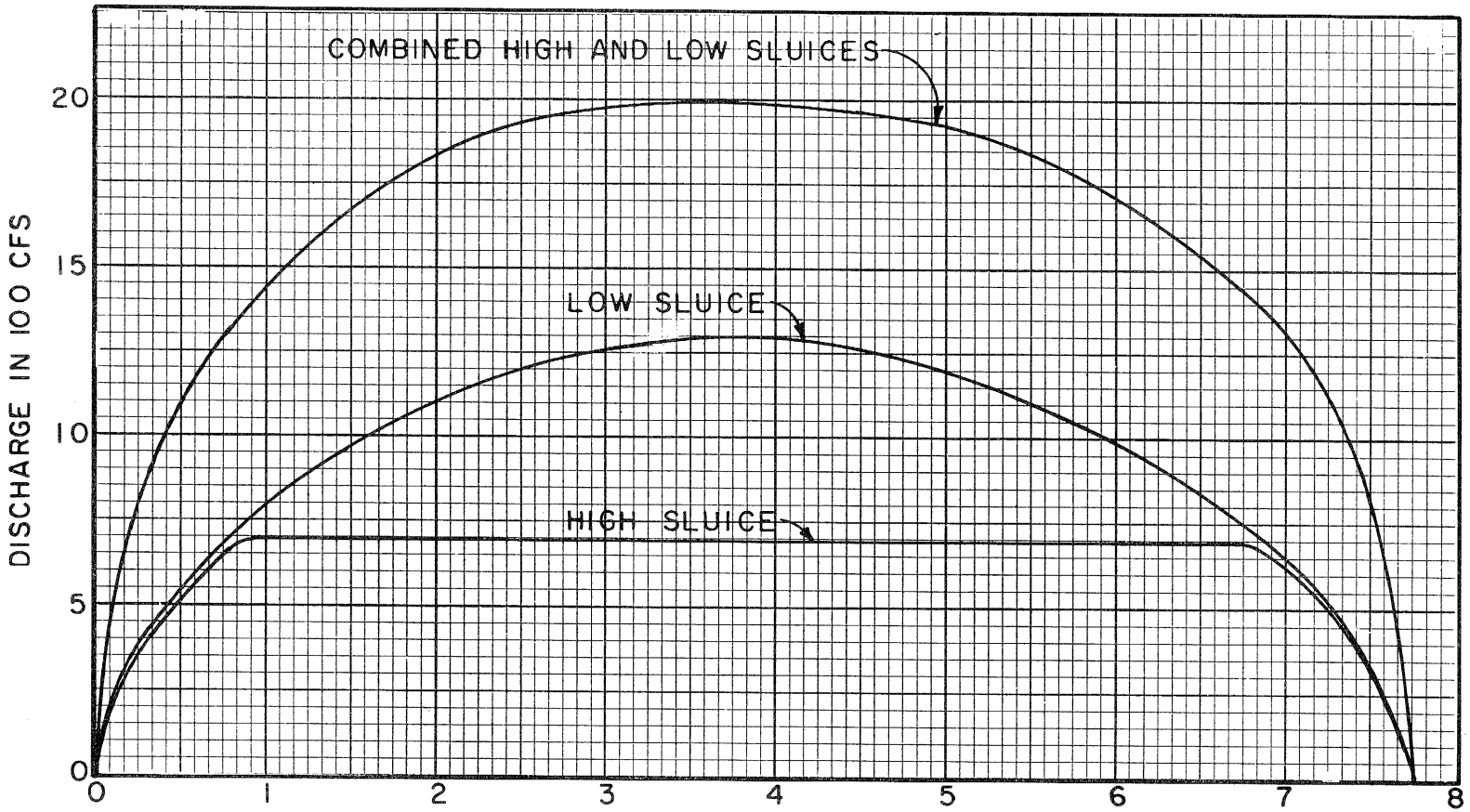
CHARLES RIVER WATERSHED

OUTLET RATING CURVES

HIGH & LOW SLUICES

NEW ENGLAND DIVISION, WALTHAM, MASS.
OCTOBER 1977

PLATE B-11



TIME IN HOURS AFTER FALLING HARBOR ELEVATION RECEDES BELOW 108

NOTE: SLUICES FULLY OPENED

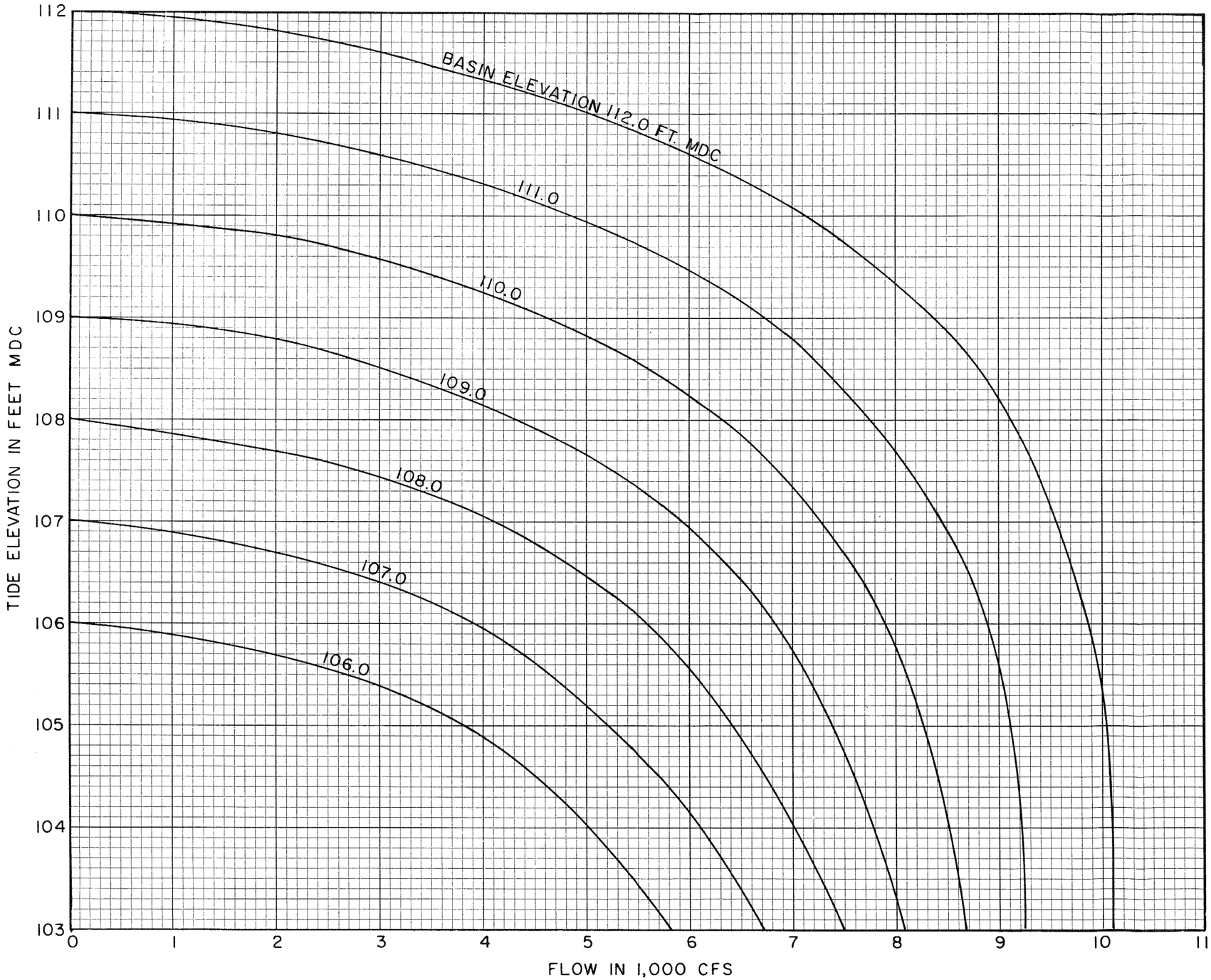
WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER WATERSHED

SLUICEWAY DISCHARGE DURING MEAN TIDE CYCLE

NEW ENGLAND DIVISION, WALTHAM, MASS.
OCTOBER 1977

PLATE B-12



NOTES:

1. BASIN ELEVATION IS TAKEN UPSTREAM OF OLD DAM.
2. LOCK IS FULLY OPEN.

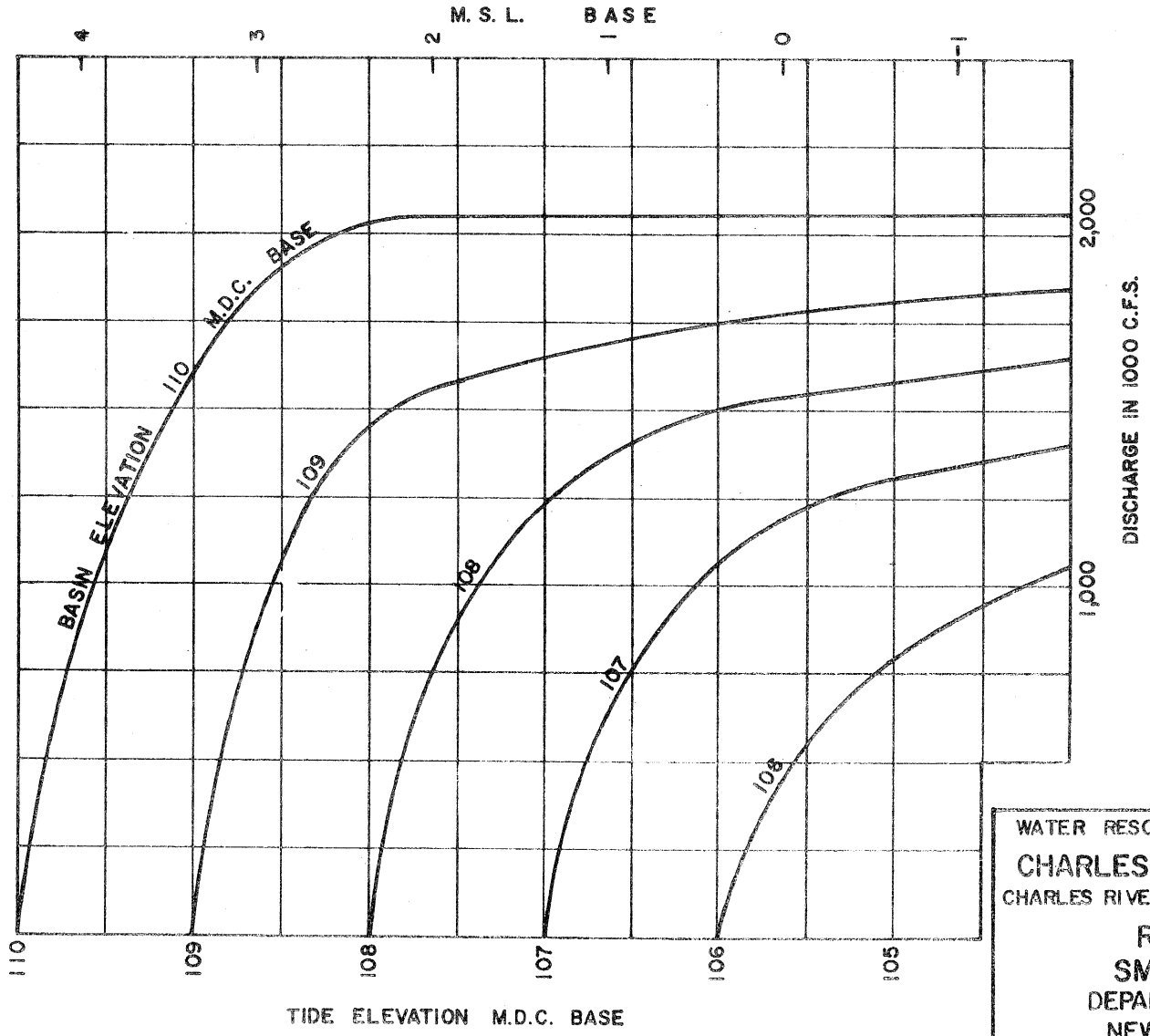
WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER WATERSHED

OUTLET RATING CURVES

LARGE BOAT LOCK

NEW ENGLAND DIVISION, WALTHAM, MASS.
OCTOBER 1977



PROPOSED SMALL BOAT LOCK 25' WIDE.

WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER LOCKS AND DAM

CHARLES RIVER BASIN MASSACHUSETTS

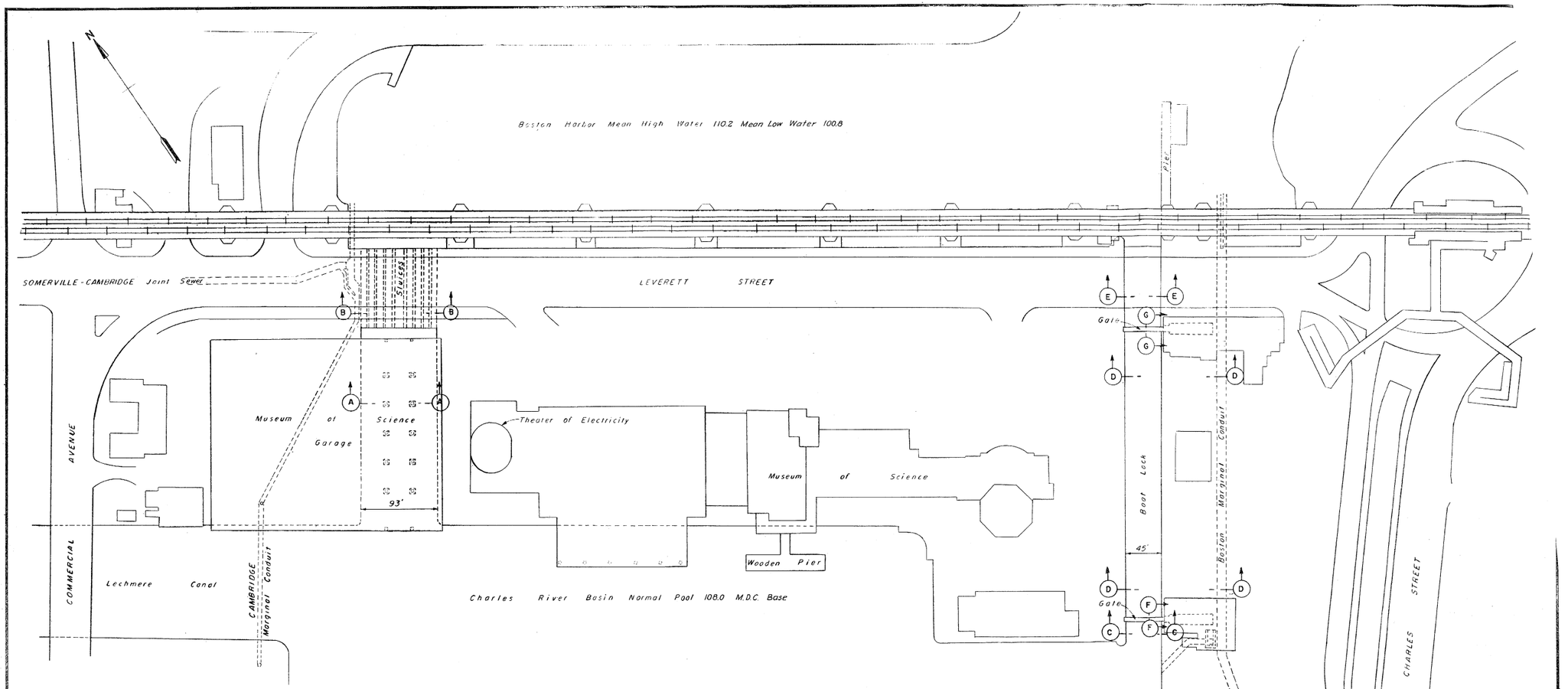
RATING CURVES

SMALL BOAT LOCK

DEPARTMENT OF THE ARMY

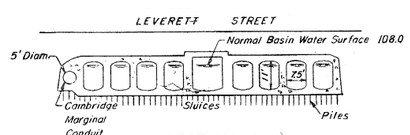
NEW ENGLAND DIVISION

CORPS OF ENGINEERS WALTHAM, MASS.



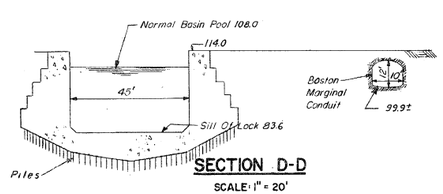
PLAN

SCALE: 1" = 50'



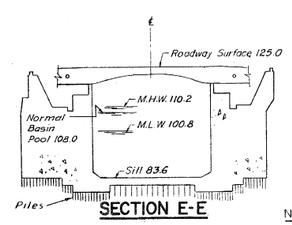
SECTION B-B

SCALE: 1" = 20'



SECTION D-D

SCALE: 1" = 20'



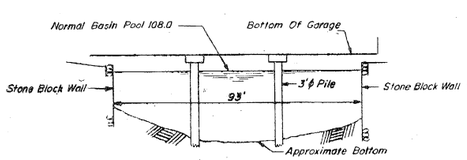
SECTION E-E

LEVERETT STREET LIFT BRIDGE

SCALE: 1" = 20'

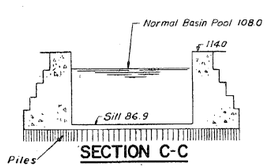
NOTES:

Elevations M.D.C. Datum
M.D.C. Datum is 105.65' Below M.S.L.
Boston City Datum is 5.65' Below M.S.L.



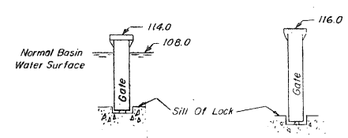
SECTION A-A

SCALE: 1" = 20'



SECTION C-C

SCALE: 1" = 20'



SECTION F-F

UPSTREAM GATE

SCALE: 1" = 20'

SECTION G-G

DOWNSTREAM GATE

SCALE: 1" = 20'

GRAPHIC SCALES

1" = 50' 50' 0 50' 100'

1" = 20' 20' 0 20' 40'

WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER LOCKS AND DAM

CHARLES RIVER BASIN MASSACHUSETTS

OLD CHARLES RIVER DAM

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION

CORPS OF ENGINEERS WALTHAM, MASS.

(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 01104100

Table No. 28

Begin 671001 (YR. MO. D. HR.)

Rating table for Charles River at Waltham, Mass.

from 1 Oct 1967 *to* _____, *from* _____ *to* _____, *from* _____ *to* _____

Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs
0.00			2.00	350	45	4.00	1640	80	.00			.00			.00			.00		
.10			.10	395	50	.10	1720	80	.10			.10			.10			.10		
.20			.20	445	50	.20	1800	90	.20			.20			.20			.20		
.30			.30	495	50	.30	1890	90	.30			.30			.30			.30		
.40			.40	545	55	.40	1980	90	.40			.40			.40			.40		
.50			.50	600	55	.50	2070	90	.50			.50			.50			.50		
.60	14	9	.60	655	55	.60	2160	90	.60			.60			.60			.60		
.70	23	11	.70	710	60	.70	2250	90	.70			.70			.70			.70		
.80	34	13	.80	770	60	.80	2340	90	.80			.80			.80			.80		
.90	47	15	.90	830	65	.90	2430	90	.90			.90			.90			.90		
1.00	62	17	3.00	895	65	5.00	2520	100	.00			.00			.00			.00		
.10	79	20	.10	960	70	.10	2620	100	.10			.10			.10			.10		
.20	99	22	.20	1030	70	.20	2720	100	.20			.20			.20			.20		
.30	121	25	.30	1100	70	.30	2820	100	.30			.30			.30			.30		
.40	146	27	.40	1170	75	.40	2920	100	.40			.40			.40			.40		
.50	173	30	.50	1245	75	.50	3020	100	.50			.50			.50			.50		
.60	203	33	.60	1320	80	.60			.60			.60			.60			.60		
.70	236	36	.70	1400	80	.70			.70			.70			.70			.70		
.80	272	38	.80	1480	80	.80			.80			.80			.80			.80		
.90	310	40	.90	1560	80	.90			.90			.90			.90			.90		

This table is applicable for open-channel conditions. It is based on 10 discharge measurements made during 1968(458-460,463-468),1969(469),

is identical with rating 27 above 1.5 ~~feet~~ _____ well defined between _____ cfs and _____ cfs.

Comp. by RAG date 11-7-68

Ckd. by LAS date 11-27-68

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—249-705

9-210
(Rev. 2-67)

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Table No. 0 6

Begin 7 2 1 0 1 3 (YR. MO. D. HR.)

Rating table for Charles River at Wellesley, Mass.

from 13 Oct 1972 *to* ....., *from* ..... *to* ....., *from* ..... *to* .....

Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs
2 .00			4 .00	500	60	6 .00	2190	110	.00			.00			.00			.00		
.10			.10	560	65	.10	2300	110	.10			.10			.10			.10		
.20			.20	625	65	.20	2410	110	.20			.20			.20			.20		
.30			.30	690	70	.30	2520	110	.30			.30			.30			.30		
.40			.40	760	75	.40			.40			.40			.40			.40		
.50			.50	835	75	.50			.50			.50			.50			.50		
.60			.60	910	80	.60			.60			.60			.60			.60		
.70	15.5	14	.70	990	80	.70			.70			.70			.70			.70		
.80	29.5	18.5	.80	1070	80	.80			.80			.80			.80			.80		
.90	48	23	.90	1150	80	.90			.90			.90			.90			.90		
3 .00	71	28	5 .00	1230	90	.00			.00			.00			.00			.00		
.10	99	32	.10	1320	90	.10			.10			.10			.10			.10		
.20	131	36	.20	1410	90	.20			.20			.20			.20			.20		
.30	167	40	.30	1500	90	.30			.30			.30			.30			.30		
.40	207	43	.40	1590	90	.40			.40			.40			.40			.40		
.50	250	45	.50	1680	100	.50			.50			.50			.50			.50		
.60	295	47	.60	1780	100	.60			.60			.60			.60			.60		
.70	342	50	.70	1880	100	.70			.70			.70			.70			.70		
.80	392	53	.80	1980	100	.80			.80			.80			.80			.80		
.90	445	55	.90	2080	110	.90			.90			.90			.90			.90		

This table is applicable for open-channel conditions. It is based on 10 discharge measurements made during 1973 (141-198), 1974 (199,150), is identical with rating 5 above 3.7 feet and is well defined between ..... cfs and ..... cfs.

Comp. by BAG date 1-7-74

Ckd. by WAG date 2-1-74

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—249-760

PLATE B-17

CORPS OF ENGINEERS A B C D E F G H U. S. ARMY

STANDARD OPERATING PROCEDURES

CHARLES RIVER DAM

BOSTON, MASSACHUSETTS

HURRICANES

PHASE 1 ALERT

CONDITIONS	PROCEDURAL DUTIES
1. NATIONAL WEATHER SERVICE ANNOUNCES THAT A HURRICANE IS LOCATED NORTH OF 30° LATITUDE AND WEST OF 65° LONGITUDE.	1. ALERT PERSONNEL FOR POSSIBLE STAFFING. 2. MONITOR WEATHER SERVICE ADVISORIES. 3. PLOT POSITION AND MOVEMENT OF HURRICANE.

PHASE 2 WATCH

CONDITIONS	PROCEDURAL DUTIES
1. N.W.S. ANNOUNCES A HURRICANE "WATCH" FOR SOUTHERN NEW ENGLAND COAST.	1. MOBILIZE NECESSARY PERSONNEL FOR OPERATION. 2. CHECK FUEL LEVELS AND OTHER SUPPLIES. 3. CHECK ALL RECORDING CHARTS. 4. NOTIFY CAMBRIDGE ELECTRIC OF POSSIBLE NAVIGATION CURTAILMENT. 5. CONSIDER NOTIFICATION OF MDC HARBOR PATROL. 6. START ALL DIESEL OIL AND WATER HEATING ELEMENTS

PHASE 3 WARNING

CONDITIONS	OPERATIONS
1. N.W.S. ANNOUNCES A HURRICANE "WARNING" FOR SOUTHERN NEW ENGLAND.	1. STAFF PROJECT FACILITIES ON 24 HOUR BASIS. 2. PRELOWER BASIN TO 107. 3. INITIATE 30-MINUTE RECORDINGS OF RAINFALL AND BASIN AND HARBOR ELEVATIONS. 4. INITIATE PLOTTING OF OBSERVED BASIN AND HARBOR ELEVATIONS. 5. NOTIFY U.S.C.G. OF POSSIBLE FLOOD CONTROL OPERATIONS (PLATE B-20) 6. NOTIFY PERSONNEL AT SEWAGE PUMP STATION OF POSSIBLE OPERATION.

PHASE 4 OPERATION

CONDITIONS	OPERATIONS
1. ONE INCH OF PRECIPITATION HAS BEEN EXPERIENCED AT THE PROJECT AND RAINFALL IS CONTINUING OR BASIN LEVEL RISING TO 107.5 FEET.	1. INITIATE 15-MINUTE MONITORING AND LOGGING OF RAINFALL, BASIN, ELEVATION AND HARBOR ELEVATION. 2. IF HARBOR ELEVATION IS HIGHER THAN BASIN ELEVATION, USE THE SCHEDULE ON PAGE B-35 OF THIS APPENDIX AS A REGULATION GUIDE. 3. IF BASIN ELEVATION IS HIGHER THAN HARBOR ELEVATION, USE THE SCHEDULE ON PAGE B-36 OF THIS APPENDIX AS A REGULATION GUIDE. 4. ISSUE ADVISORY TO U.S.C.G. (PLATE B-20) 5. UTILIZE STORAGE BETWEEN 107 AND 109 TO MINIMIZE USE OF PUMPS.

PHASE 5 CESSATION

CONDITIONS	OPERATIONS
1. BASIN ELEVATION RETURNS TO NORMAL AND DOES NOT RISE ABOVE 108.5 FEET DURING HIGH TIDE CYCLE.	1. DEMOBILIZE PERSONNEL IF HURRICANE NO LONGER POSES THREAT TO SOUTHERN NEW ENGLAND COAST. 2. ISSUE ADVISORY TO U.S.C.G., PROJECT FACILITIES NO LONGER IN OPERATION (PLATE B-20) 3. NORMAL DUTY PERSONNEL WILL CONTINUE TO MONITOR POSITION AND COURSE OF HURRICANE IN THE EVENT THAT IT RETURNS TO THE AREA.

SEVERE STORMS

PHASE 1 ALERT

CONDITIONS	PROCEDURAL DUTIES
1. N.W.S. LOCATES A STORM THAT POSES A POTENTIAL FLOOD THREAT TO SOUTHERN NEW ENGLAND.	1. ALERT PERSONNEL FOR POSSIBLE STAFFING. 2. MONITOR WEATHER SERVICE ADVISORIES. 3. CONSIDER NOTIFICATION OF MDC HARBOR PATROL. 4. START ALL DIESEL OIL AND WATER HEATING ELEMENTS.

PHASE 2 WARNING

CONDITIONS	OPERATIONS
1. N.W.S. FORECASTS HEAVY RAINFALL TO OCCUR WITHIN 6 HOURS IN THE BOSTON AREA.	1. MOBILIZE PERSONNEL AND STAFF PUMPING STATION ON 24 HOUR BASIS. 2. INITIATE 30-MINUTE RECORDING OF RAINFALL AND BASIN AND HARBOR ELEVATION. 3. NOTIFY CAMBRIDGE ELECTRIC OF POSSIBLE OPERATION. 4. INITIATE PLOTTING OF BASIN AND HARBOR ELEVATIONS. 5. CHECK ALL RECORDING CHARTS. 6. CHECK FUEL LEVELS AND OTHER SUPPLIES. 7. NOTIFY U.S.C.G. OF POSSIBLE OPERATION (PLATE B-20) 8. NOTIFY PERSONNEL AT SEWAGE PUMP STATION OF POSSIBLE OPERATION

PHASE 3 OPERATION

CONDITIONS	OPERATIONS
1. TWO INCHES OF RAINFALL HAVE BEEN EXPERIENCED AT THE PROJECT WITHIN 3 HOURS AND IS CONTINUING AND 2. BASIN ELEVATION REACHES 108.5 FT. AND IS RISING.	1. INITIATE 15-MINUTE MONITORING AND LOGGING OF RAINFALL, BASIN AND HARBOR ELEVATIONS. 2. IF HARBOR ELEVATION IS HIGHER THAN BASIN ELEVATION, USE THE SCHEDULE ON PAGE B-39 OF THIS APPENDIX AS A REGULATION GUIDE. 3. IF BASIN ELEVATION IS HIGHER THAN HARBOR ELEVATION, USE THE SCHEDULE ON PAGE B-40 OF THIS APPENDIX AS A REGULATION GUIDE. 4. ISSUE ADVISORY TO U.S.C.G. (PLATE B-20) 5. UTILIZE STORAGE BETWEEN 107 AND 109 TO MINIMIZE USE OF PUMPS.

PHASE 4 CESSATION

CONDITIONS	OPERATIONS
1. BASIN ELEVATION RETURNS TO NORMAL AND DOES NOT RISE ABOVE 108.5 FT. DURING HIGH TIDE CYCLE.	1. DEMOBILIZE PERSONNEL IF STORM NO LONGER POSES THREAT TO SOUTHERN NEW ENGLAND. 2. ISSUE ADVISORY TO U.S.C.G., PROJECT FACILITIES NO LONGER IN OPERATION (PLATE B-20)

NOTES:

1. DURING OPERATION PHASES ALWAYS HAVE A PUMP IDLING IN ADDITION TO THOSE REQUIRED TO DISCHARGE FLOOD FLOWS.
2. WHEN SLUICING THROUGH THE NAVIGATION LOCKS, ALWAYS USE THE DOWNSTREAM SECTOR GATES TO CONTROL FLOWS.
3. IF THE TIDE ELEVATION IS EXPECTED TO EXCEED 115 FEET, PLACE SANDBAGS AT THE THREE LOCATIONS SHOWN ON PLATE B-26.

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
CHARLES RIVER WATERSHED
CHARLES RIVER DAM
STANDARD OPERATING PROCEDURES
HURRICANES AND SEVERE STORMS

APPROVED DATE OCT. 1977
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

REPORT LOG - CHARLES RIVER DAM - STORM OF _____

SHEET ___ OF ___

DATE TIME	PRECIPITATION		BASIN ELEVATION		HARBOR	WALTHAM GAGE		WELLESLEY GAGE		CHARLES R. VILLAGE		SLUICES		LOCKS			PUMPS						INSTRUCTIONS AND / OR REMARKS
	TOTAL (INCHES)	INCREMENT (INCHES)	OLD DAM (FT. MDC.)	NEW DAM (FT. MDC.)	ELEVATION (FT. MDC.)	STAGE (FT.)	DISCHARGE (CFS)	STAGE (FT.)	DISCHARGE (CFS)	STAGE (FT.)	DISCHARGE (CFS)	HIGH	LOW	LARGE	SMALL #1	SMALL #2	#1	#2	#3	#4	#5	#6	

CHARLES RIVER DAM
BULLETINS CONCERNING OPERATION
OF PROJECT FLOOD CONTROL FACILITIES

1. WARNING BULLETIN

THE METROPOLITAN DISTRICT COMMISSION ADVISES THAT BASED ON THE PRESENT WEATHER FORECASTS, IT MAY BE NECESSARY TO OPERATE THE FLOOD CONTROL FACILITIES AT THE CHARLES RIVER DAM AND THIS MIGHT CURTAIL BOAT TRAFFIC THROUGH THE LOCKS. MARINERS SHOULD BE ALERT FOR FURTHER ADVISORIES.

2. OPERATIONS BULLETIN

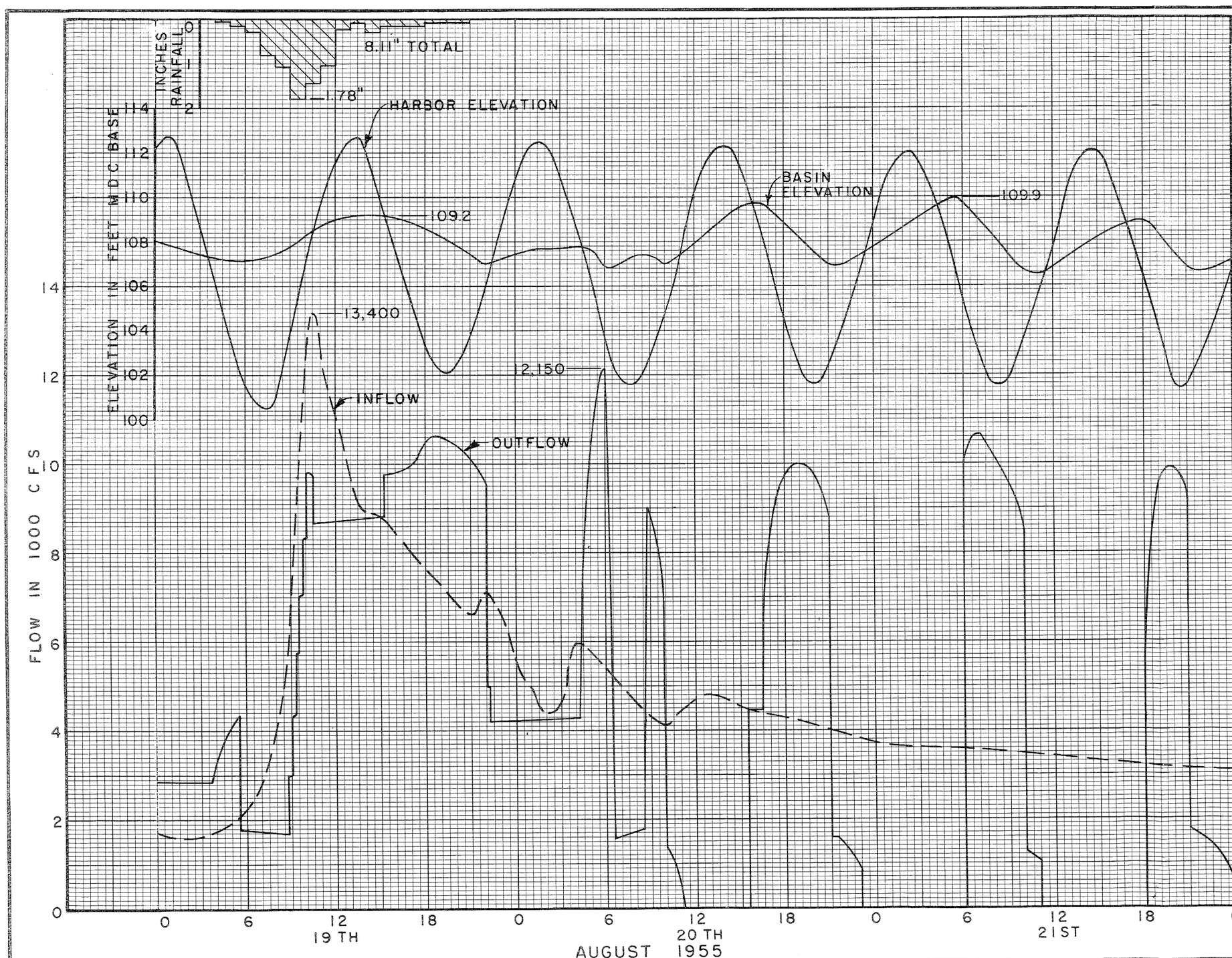
THE METROPOLITAN DISTRICT COMMISSION ADVISES THAT THE FLOOD CONTROL FACILITIES AT THE CHARLES RIVER DAM ARE BEING OPERATED AND WILL REMAIN IN OPERATION UNTIL THE CHARLES RIVER FLOOD FLOWS HAVE RECEDED. NAVIGATION THROUGH THE BOAT LOCKS (IS OR IS NOT) AVAILABLE AT THIS TIME. MARINERS WILL BE ADVISED AS SOON AS PROJECT FLOOD CONTROL ACTIVITIES HAVE CEASED.

3. CESSATION BULLETIN

THE METROPOLITAN DISTRICT COMMISSION ADVISES THAT THE OPERATION OF THE FLOOD CONTROL FACILITIES OF THE CHARLES RIVER DAM HAVE CEASED AND THAT TRAFFIC MAY BE RESUMED. HOWEVER, FLOOD CONTROL ACTIVITIES COULD BE REACTIVATED DUE TO INTENSE RAINFALL. MARINERS SHOULD BE ALERT FOR FURTHER ADVISORIES.

4. NONOPERATION BULLETIN

THE METROPOLITAN DISTRICT COMMISSION ADVISES THAT IT HAS NOT BEEN NECESSARY TO OPERATE THE FLOOD CONTROL FACILITIES AT THE CHARLES RIVER DAM. HOWEVER, SHOULD INTENSE RAINFALL BEGIN THEN PROJECT FACILITIES COULD BE ACTIVATED. MARINERS SHOULD BE ALERT FOR FURTHER ADVISORIES.



ACTIONS

19th

0000 - START 2 PUMPS
0330 - OPEN SLUICES
0530 - STOP 2 PUMPS
0845 - START 6 PUMPS IN 15 MINUTE INCREMENTS
1000 - ALL PUMPS STARTED
1030 - CLOSE SLUICES
1515 - OPEN SLUICES
2200 - STOP 3 PUMPS
2215 - CLOSE SLUICES

20th

0415 - OPEN LARGE LOCK AND SLUICES
0600 - STOP LAST 3 PUMPS
0615 - CLOSE LARGE LOCK
0830 - OPEN LARGE LOCK
0945 - CLOSE LARGE LOCK
1100 - CLOSE SLUICES
1530 - START 3 PUMPS
1630 - STOP 3 PUMPS; OPEN LARGE LOCK & SLUICES
2100 - CLOSE LARGE LOCK
2300 - CLOSE SLUICES

21st

0600 - OPEN LARGE LOCK AND SLUICES
1000 - CLOSE LARGE LOCK
1100 - CLOSE SLUICES
1800 - OPEN LARGE LOCK AND SLUICES
2100 - CLOSE LARGE LOCK
2400 - CLOSE SLUICES

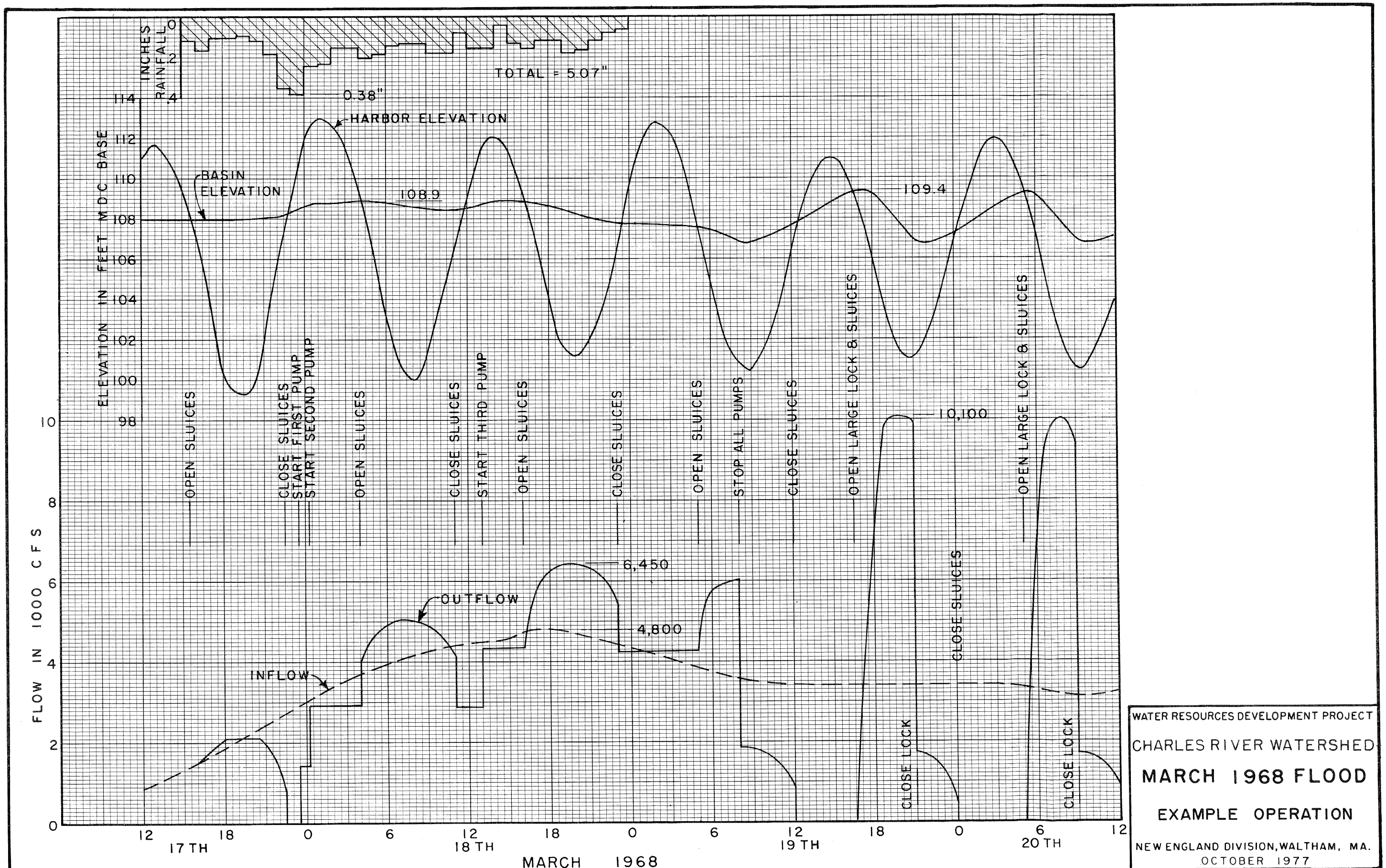
WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER WATERSHED

AUGUST 1955 FLOOD

EXAMPLE OPERATION

NEW ENGLAND DIVISION, WALTHAM, MA.
OCTOBER 1977



WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER WATERSHED

MARCH 1968 FLOOD

EXAMPLE OPERATION

NEW ENGLAND DIVISION, WALTHAM, MA.
OCTOBER 1977

PLATE B-22

KEY PERSONNEL
TELEPHONE DIRECTORY

1. Metropolitan District Commission

	Work(1)	Home
Thomas Mooney	523-1793	643-0086
Clayton Stokes	727-0059	1-851-2749
William Bleiler	666-3337	1-283-3590
Paul McGuiggan	523-1793	
New Dam	727-0488, 0489	
Old Dam	727-0064	

2. City (Department of Public Works)

Boston	725-4960
Cambridge	876-6800
Watertown	924-1585
Newton	244-0180

3. U.S. Coast Guard

Chief, Aids to Navigation	223-3632 (duty hours) 223-3644 (non-duty hours)

4. Corps of Engineers

a. RCC, Office hours(2) 894-2400, ext. 627, 628, 629 or 630
b. RCC, Non-office hours(3) 894-2414 or 2415
c. Operations Division, Office hours 894-2400, ext. 478 or 306
d. Home Numbers - RCC Personnel

Saul Cooper, Hull, Mass.	925-0984
Joseph Finegan, Peabody, Mass.	535-0586
Richard Doherty, Wakefield, Mass.	245-7892

5. National Weather Service

a. District Forecaster, Boston, Mass.	223-3110
b. River Forecast Center, Bloomfield, Conn.	203-244-2014 or 2178

6. Other: Cambridge Electric Company

Chief Engineer	864-3110, ext. 280, 283 or 285
Emergency calls after hours	876-0474

(1) Staffed 24 hours.
(2) Monday through Friday, 0800 to 1630 hours.
(3) Nights, holidays and weekends when switchboard is unmanned.

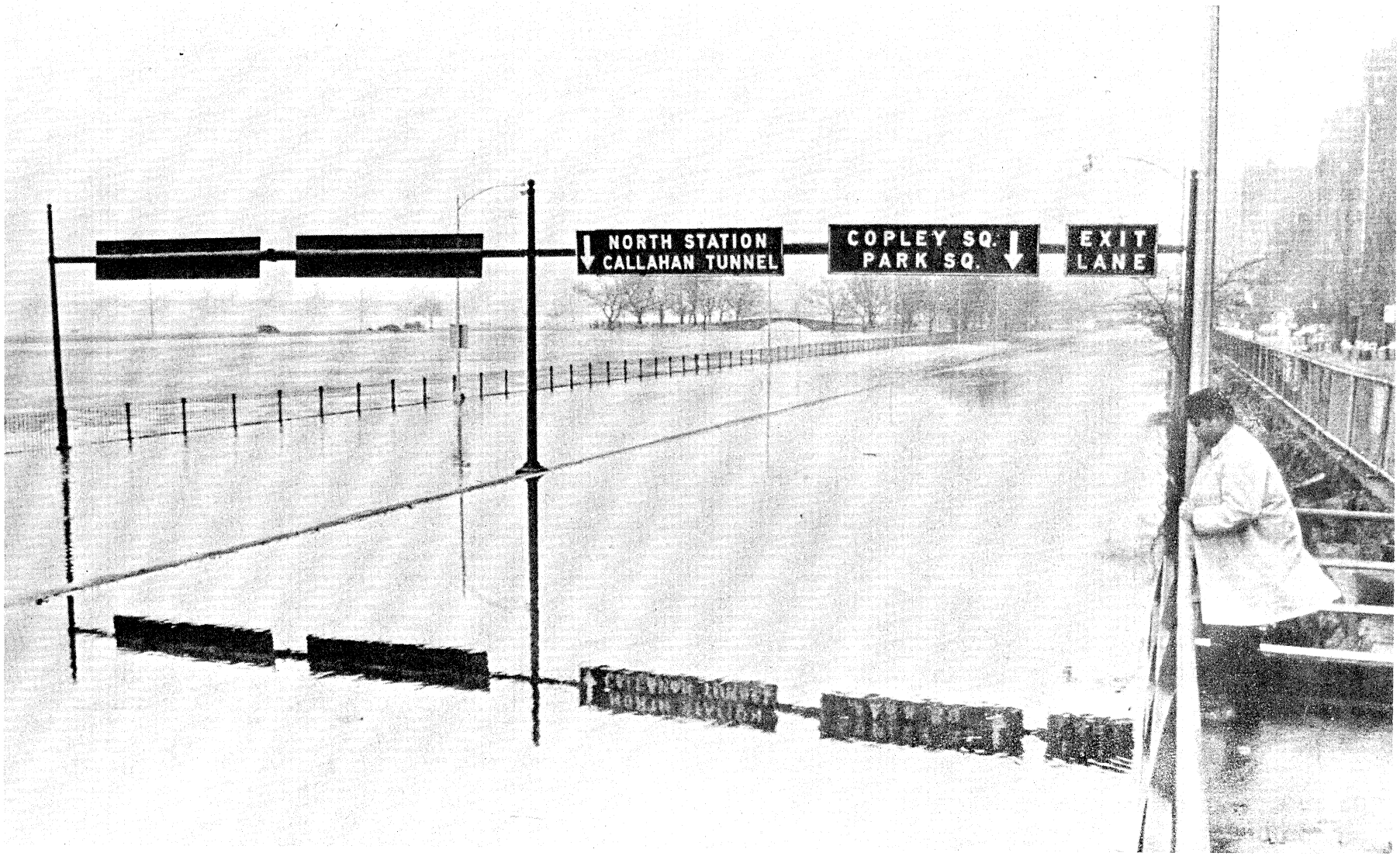
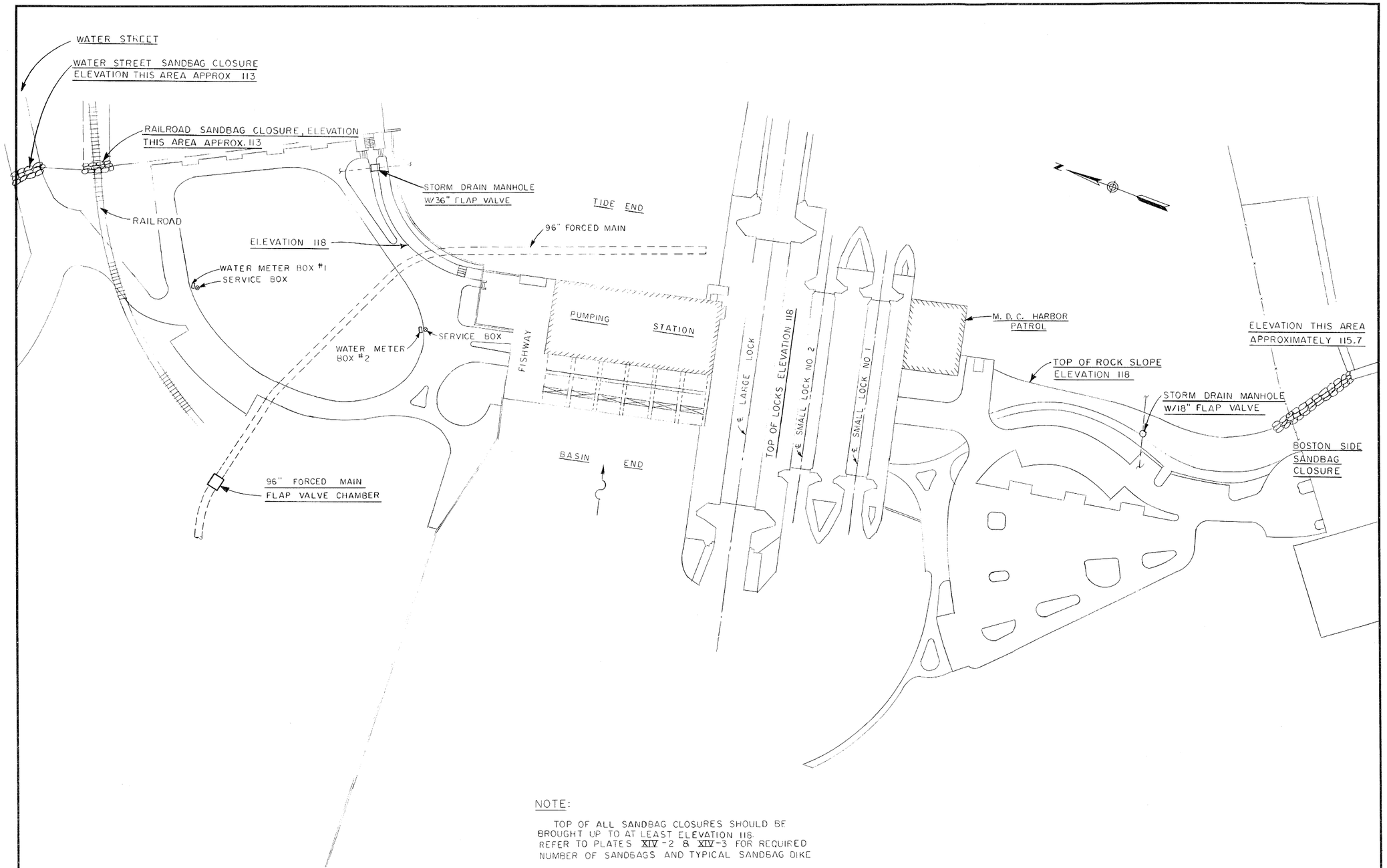


PHOTO - COURTESY OF THE BOSTON GLOBE

Storrow Drive March 1968
(Looking East)

PHOTO - COURTESY OF THE BOSTON GLOBE

Storrow Drive March 1968
(Looking East)



NOTE:

TOP OF ALL SANDBAG CLOSURES SHOULD BE BROUGHT UP TO AT LEAST ELEVATION 118. REFER TO PLATES XIV-2 & XIV-3 FOR REQUIRED NUMBER OF SANDBAGS AND TYPICAL SANDBAG DIKE

INTERIM STANDARD

OPERATING PROCEDURES

June 1978

INTERIN FLOOD CONTROL REGULATION PROCEDURES

Appendix B has been prepared with the assumption the existing Boston and Cambridge marginal conduits would be tied into the MDC's new interceptor sewer system with treatment plant and pumping station, which would discharge the treated effluent downstream of the new dam. The MDC's sewer construction work is underway, but is not scheduled for completion until 1980. Therefore, the two marginal conduits (and several other sewer overflows) will continue to discharge by gravity flow into the Charles River between the old and new dams.

During this interim period, if the MDC operated the new dam to maintain a constant river level at 108 feet, the marginal conduits would be submerged, and untreated sewage would be bypassed into the Charles River Basin. In addition, the existing tidal flushing action downstream of Msgr. O'Brien Highway would be eliminated, resulting in a probable water quality pollution problem in the new basin area. Therefore, an interim SOP has been developed that assumes the new facility will be operated only during significant flood events and during all other times:

a. The navigation gates and sluice gates will be open.

b. The forebay level between the old and new dams will fluctuate with the tide.

c. The old dam will continue to be operated for navigation purposes and maintaining the basin at about 108 feet MDC.

Operating for hurricanes will follow the same phases as delineated in paragraph 43 as Appendix B with modifications as indicated on plate B-18-1, Interim SOP for Hurricanes. Operating in this manner prevents the marginal conduits from discharging at their maximum capacity and could cause a short term water quality problem in the Basin by discharging untreated sewage through the overflows.

Operations for severe storms will follow the same phases as delineated in paragraph 44 of Appendix B with modifications as indicated on plate B-18-2, Interim SOP for Severe Storms. These procedures allow continuous sluicing through the conduits of the old facility, and also allows the existing marginal conduits to discharge by gravity flow.

INTERIM
STANDARD OPERATING PROCEDURES
CHARLES RIVER DAM
BOSTON, MASSACHUSETTS

HURRICANES

PHASE 1 ALERT

CONDITIONS	PROCEDURAL DUTIES
1. NATIONAL WEATHER SERVICE ANNOUNCES THAT A HURRICANE IS LOCATED NORTH OF 30° LATITUDE AND WEST OF 65° LONGITUDE.	1. ALERT PERSONNEL FOR POSSIBLE STAFFING. 2. MONITOR WEATHER SERVICE ADVISORIES. 3. PLOT POSITION AND MOVEMENT OF HURRICANE.

PHASE 2 WATCH

CONDITIONS	PROCEDURAL DUTIES
1. N.W.S. ANNOUNCES A HURRICANE "WATCH" FOR SOUTHERN NEW ENGLAND COAST.	1. MOBILIZE NECESSARY PERSONNEL FOR OPERATION. 2. CHECK FUEL LEVELS AND OTHER SUPPLIES. 3. CHECK ALL RECORDING CHARTS. 4. NOTIFY CAMBRIDGE ELECTRIC OF POSSIBLE NAVIGATION CURTAILMENT. 5. CONSIDER NOTIFICATION OF MDC HARBOR PATROL. 6. START ALL DIESEL OIL AND WATER HEATING ELEMENTS

PHASE 3 WARNING

CONDITIONS	OPERATIONS
1. N.W.S. ANNOUNCES A HURRICANE "WARNING" FOR SOUTHERN NEW ENGLAND.	1. STAFF PROJECT FACILITIES ON 24 HOUR BASIS. 2. PROCEED WITH "A" OR "B" — — — — — — 3. INITIATE 30-MINUTE RECORDINGS OF RAINFALL AND BASIN AND HARBOR ELEVATIONS. 4. INITIATE PLOTTING OF OBSERVED BASIN AND HARBOR ELEVATIONS. 5. NOTIFY U.S.C.G. OF POSSIBLE FLOOD CONTROL OPERATIONS (PLATE B-20) 6. NOTIFY PERSONNEL AT SEWAGE PUMP STATION OF POSSIBLE OPERATION.

PHASE 4 OPERATION

CONDITIONS	OPERATIONS
1. ONE INCH OF PRECIPITATION HAS BEEN EXPERIENCED AT THE PROJECT AND RAINFALL IS CONTINUING OR BASIN LEVEL RISING TO 107.5 FEET.	1. INITIATE 15-MINUTE MONITORING AND LOGGING OF RAINFALL, BASIN, ELEVATION AND HARBOR ELEVATION. 2. IF HARBOR ELEVATION IS HIGHER THAN BASIN ELEVATION, USE THE SCHEDULE ON PAGE B-35 OF THIS APPENDIX AS A REGULATION GUIDE. 3. IF BASIN ELEVATION IS HIGHER THAN HARBOR ELEVATION, USE THE SCHEDULE ON PAGE B-36 OF THIS APPENDIX AS A REGULATION GUIDE. 4. ISSUE ADVISORY TO U.S.C.G. (PLATE B-20) 5. UTILIZE STORAGE BETWEEN 107 AND 109 TO MINIMIZE USE OF PUMPS.

PHASE 5 CESSATION

CONDITIONS	OPERATIONS
1. BASIN ELEVATION RETURNS TO NORMAL AND DOES NOT RISE ABOVE 108.5 FEET DURING HIGH TIDE CYCLE.	1. PROCEED WITH "A" OR "B" — — — — — — 2. DEMOBILIZE PERSONNEL IF HURRICANE NO LONGER POSES THREAT TO SOUTHERN NEW ENGLAND COAST. 3. ISSUE ADVISORY TO U.S.C.G., PROJECT FACILITIES NO LONGER IN OPERATION (PLATE B-20) 4. NORMAL DUTY PERSONNEL WILL CONTINUE TO MONITOR POSITION AND COURSE OF HURRICANE IN THE EVENT THAT IT RETURNS TO THE AREA.

A. HARBOR RISES HIGHER THAN BASIN
1. CLOSE ALL NAVIGATION GATES AND SLUICE GATES AT NEW DAM.
2. ACTIVATE 2 PUMPS TO LOWER FOREBAY ELEVATION TO BASIN ELEVATION.
3. WHEN FOREBAY AND BASIN ELEVATIONS ARE SIMILAR, OPEN THE 8 SLUICE GATES AND THE BOAT LOCK GATES AT THE OLD DAM AND OPERATE PUMPS TO MAINTAIN BASIN ELEVATION AT ABOUT 107.

B. HARBOR FALLS LOWER THAN BASIN
1. CLOSE ALL NAVIGATION GATES AND SLUICE GATES AT NEW DAM.
2. OPEN ALL SLUICE GATES AT THE OLD DAM. WHEN BASIN AND FOREBAY ELEVATIONS ARE SIMILAR OPEN THE BOAT LOCK GATES AT THE OLD DAM.
3. MAINTAIN BASIN ELEVATION AT ABOUT 107 BY DISCHARGING THROUGH THE NEW SLUICE GATES AND/OR PUMPING AT THE NEW DAM.

A. HARBOR RISES HIGHER THAN BASIN
1. OPERATE PUMPS TO MAINTAIN BASIN ELEVATION AT ABOUT 108.
2. WHEN HARBOR ELEVATION AND FOREBAY ELEVATION ARE SIMILAR, STOP ALL PUMPS, CLOSE OLD LOCK GATES, OPEN ALL NEW NAVIGATION GATES AND SLUICE GATES AND OPERATE OLD SLUICE GATES TO MAINTAIN BASIN AT ABOUT 108.

B. HARBOR FALLS LOWER THAN BASIN
1. CLOSE THE LOCK GATES AND SLUICE GATES AT THE OLD DAM.
2. LOWER FOREBAY ELEVATION TO EQUAL HARBOR ELEVATION BY DISCHARGING THROUGH THE TWO NEW SLUICE GATES AND/OR USING PUMPS.
3. WHEN HARBOR AND FOREBAY ELEVATIONS ARE SIMILAR, OPEN ALL NAVIGATION GATES AND SLUICE GATES AT THE NEW DAM. OPERATE SLUICE GATES AT OLD DAM TO MAINTAIN BASIN ELEVATION AT ABOUT 108 FEET.

NOTES:
1. INTERIM PERIOD — AFTER THE PROJECT IS COMPLETED BUT PRIOR TO COMPLETION OF THE MDC'S SEWAGE TREATMENT PLANT AND PUMP STATION.
2. THE BOAT LOCK GATES IN THE OLD DAM CAN NOT BE OPERATED IF THERE IS A HEAD DIFFERENTIAL BETWEEN THE BASIN AND FOREBAY WATER LEVELS.
3. PERSONNEL FROM THE RESERVOIR CONTROL CENTER WILL OBSERVE AND CONSULT, IF REQUESTED, IN FLOOD OPERATIONS DURING THE INTERIM PERIOD.
4. DURING OPERATION PHASE ALWAYS HAVE A PUMP IDLING IN ADDITION TO THOSE REQUIRED TO DISCHARGE FLOOD FLOWS.
5. WHEN SLUICING THROUGH THE NAVIGATION LOCKS ALWAYS USE THE DOWNSTREAM SECTOR GATES TO CONTROL FLOWS.
6. IF THE TIDE ELEVATION IS EXPECTED TO EXCEED 115 FEET, PLACE SANDBAGS AT THE THREE LOCATIONS SHOWN ON PLATE B-26 AND CLOSE ALL SECTOR AND SLUICE GATES.

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
CHARLES RIVER WATERSHED
CHARLES RIVER DAM
INTERIM STANDARD OPERATING PROCEDURES FOR HURRICANES

APPROVED DATE OCT. 1977
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS A B C D E F G H U. S. ARMY

INTERIM
STANDARD OPERATING PROCEDURES
CHARLES RIVER DAM
BOSTON, MASSACHUSETTS

INSERT 'A'

1. CLOSE ALL NAVIGATION GATES AND SLUICE GATES AT NEW DAM.
2. START PUMPS, IF NECESSARY, AND DRAW DOWN FOREBAY ELEVATION TO ABOUT 101 FEET MDC.
3. OPERATE SLUICE GATES AT OLD DAM TO MAINTAIN BASIN ELEVATION AT ABOUT 108 FEET MDC.
4. OPERATE PUMPS TO MAINTAIN FOREBAY ELEVATION AT ABOUT 101 FEET MDC. (MAXIMUM DISCHARGE THROUGH THE 8 SLUICE GATES AT THE OLD DAM IS ABOUT 8000 CFS.)

NOTES:

1. THE BOAT LOCK GATES IN THE OLD DAM ARE NOT TO BE OPERATED IF THERE IS A DIFFERENTIAL BETWEEN THE BASIN AND FOREBAY WATER LEVELS.
2. INTERIM PERIOD-AFTER PROJECT IS COMPLETED BUT PRIOR TO COMPLETION OF MDC'S SEWAGE TREATMENT PLANT AND PUMP STATION.
3. RESERVOIR CONTROL CENTER PERSONNEL WILL OBSERVE AND CONSULT, IF REQUESTED, IN FLOOD OPERATIONS DURING THE INTERIM PERIOD.
4. SHOULD THE PEAK INFLOW TO THE BASIN EXCEED THE MAXIMUM DISCHARGE CAPACITY THROUGH THE OLD SLUICE GATES AND THE BASIN RISES TO 109 AND IS CONTINUING TO RISE THEN THE FOREBAY WILL BE FLOODED AS DIRECTED IN THE HURRICANE INTERIM REGULATION PROCEDURE (PLATE B-18-1) AND THE INSTRUCTIONS GIVEN IN APPENDIX B PHASE 3 SOP FOR SEVERE STORMS FOLLOWED (PLATE B-18).
5. DURING OPERATION PHASE ALWAYS HAVE A PUMP IDLING IN ADDITION TO THOSE REQUIRED TO DISCHARGE FLOOD FLOWS.
6. IF SLUICING THROUGH THE NAVIGATION LOCKS IS NECESSARY ALWAYS USE THE DOWNSTREAM SECTOR GATES TO CONTROL FLOWS.
7. IF THE TIDE ELEVATION IS EXPECTED TO EXCEED 115 FEET, PLACE SANDBAGS AT THE TWO LOCATIONS SHOWN ON PLATE B-26 AND CLOSE ALL SECTOR AND SLUICE GATES.

SEVERE STORMS

PHASE 1 ALERT

CONDITIONS	PROCEDURAL DUTIES
1. N.W.S. LOCATES A STORM THAT POSES A POTENTIAL FLOOD THREAT TO SOUTHERN NEW ENGLAND.	1. ALERT PERSONNEL FOR POSSIBLE STAFFING. 2. MONITOR WEATHER SERVICE ADVISORIES. 3. CONSIDER NOTIFICATION OF MDC HARBOR PATROL. 4. START ALL DIESEL OIL AND WATER HEATING ELEMENTS.

PHASE 2 WARNING

CONDITIONS	OPERATIONS
1. N.W.S. FORECASTS HEAVY RAINFALL TO OCCUR WITHIN 6 HOURS IN THE BOSTON AREA.	1. MOBILIZE PERSONNEL AND STAFF PUMPING STATION ON 24 HOUR BASIS. 2. INITIATE 30-MINUTE RECORDING OF RAINFALL AND BASIN AND HARBOR ELEVATION. 3. NOTIFY CAMBRIDGE ELECTRIC OF POSSIBLE OPERATION. 4. INITIATE PLOTTING OF BASIN AND HARBOR ELEVATIONS. 5. CHECK ALL RECORDING CHARTS. 6. CHECK FUEL LEVELS AND OTHER SUPPLIES. 7. NOTIFY U.S.C.G. OF POSSIBLE OPERATION (PLATE B-20) 8. NOTIFY PERSONNEL AT SEWAGE PUMP STATION OF POSSIBLE OPERATION

PHASE 3 OPERATION

CONDITIONS	OPERATIONS
1. TWO INCHES OF RAINFALL HAVE BEEN EXPERIENCED AT THE PROJECT WITHIN 3 HOURS AND IS CONTINUING OR 2. BASIN ELEVATION REACHES 108.5 FT. AND IS RISING.	1. INITIATE 15-MINUTE MONITORING AND LOGGING OF RAINFALL, BASIN AND HARBOR ELEVATIONS. 2. SEE INSERT "A" 3. ISSUE ADVISORY TO U.S.C.G. (PLATE B-20)

PHASE 4 CESSATION

CONDITIONS	OPERATIONS
1. BASIN ELEVATION RETURNS TO NORMAL AND DOES NOT RISE ABOVE 108.5 FT. DURING HIGH TIDE CYCLE.	1. STOP ALL PUMPS-WHEN HARBOR AND FOREBAY ELEVATIONS ARE SIMILAR, OPEN ALL NAVIGATION GATES AND SLUICE GATES AT THE NEW DAM. 2. DEMOBILIZE PERSONNEL IF STORM NO LONGER POSES THREAT TO EASTERN MASSACHUSETTS. 3. ISSUE ADVISORY TO U.S.C.G., PROJECT FACILITIES NO LONGER IN OPERATION (PLATE B-20)

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WATER RESOURCES DEVELOPMENT PROJECT
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