5451

ORIGINAL.

SUPPLEMENTAL 5451

Form 504
Rev. Dec. 1933

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
R. S. PATTON, DIRECTOR

DESCRIPTIVE REPORT

Air-Photo Topographic ~~Hydrographic~~ } Sheet No. T-5451

State New York & New Jersey.

LOCALITY

Hudson River,

George Washington Bridge.

1936

CHIEF OF PARTY

J.C.Partington - Jr. H. & G. Engr.
~~R.C.Bolstad - Jr. H. & G. Engr.~~

U. S. GOVERNMENT PRINTING OFFICE: 1934

5451

SUPPLEMENTAL 5451

applied to Chart 747 – Mar 15, 1937 L.M.Z.
Applied to Chart 746 – Mar 17, 1937 L.M.Z.
Corr'ns. to Mar. 14, 1939 applied to 746. Z.M.A. 3/15/39
" " Aug. 15 " " " " " 9/9/39

Form 537a
Ed. Nov. 1929

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY

REG. NO.

TOPOGRAPHIC TITLE SHEET

The Topographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

Field No. 83 T5451

REGISTER NO. T-5451.

State New York and New Jersey.

General locality Hudson River.

Locality George Washington Bridge.

Scale 1: 5,000 Date of ~~survey~~ photographs - Nov. 25, 1934 & May 16, 1935., 19

Date of Compilation -

Vessel Air Photo Compilation Party.

Reviewed and recommended for approval - J. C. Partington

Chief of party J.C.Partington.

Surveyed by See STATISTICS SHEET, page 2 of this report.

Inked by See STATISTICS SHEET, page 2 of this report.

Heights in feet above - - - - - to ground to tops of trees

Contour, Approximate contour, Form line interval - - - feet

Instructions dated March 14th., 19 34

Remarks: Compiled on a scale of 1:5,000 and printed by photo-lithography.

1213-3
281-3

Datum station:

Palisades (N.J.) 1898, 1933 — Lat. 40° 51′ 08.″153

Long. 73° 57′ 40.″409

Plane Coordinates, Long Island:

$x = 2,010,727.37$

$y = 228,340.60$

New Jersey:

$x = 2,195,160.84$

$y = 736,203.10$

* STATISTICS *

on

COMPILATION, FIELD NO. 83 , REGISTER NO. T-5451.

Photographs, No.	Date	Time	Approx. Tide (below M.H.W.
V325 - V327 (876A-8)	Nov. 25, 1934	10:54 A.M.	At HW. @ G.Wash. Br.
V357 - V360 (876A-8)	Nov. 25, 1934	1:15 P.M.	At HW. @ G.Wash. Br.
V328 - V332 (876A-8)	Nov. 25, 1934	11:01 A.M.	At HW. @ Wash. Br.
V515 - V517 (876A-8)	May 16, 1935	3:30 P.M.	3 ft. @ G.Wash. Br.

	BY	Date From	To
SCALE FACTOR (1.000)	R.C.Bolstad	(Previously determined	
PROJECTION	W.E.Hackett	12/21/34	
PROJECTION CHECKED	J.P.O'Donnell	12/21/34	
CONTROL PLOTTED	W.E.Hackett	12/26/34	
CONTROL CHECKED	R.H.Peckworth	12/27/34	
TOPOGRAPHY TRANSFERRED	J.Rippstein	1/3/35	1/5/35
TOPOGRAPHY CHECKED	W.E.Hackett	1/5/35	
SMOOTH RADIAL LINE PLOT	R.C.Bolstad F.M.Overby (Intermittent)	1/6/35	6/8/35
RADIAL LINE PLOT CHECKED	J.P.O'Donnell	6/ /35	
DETAIL INKED	J.C.Partington (part) J.C. Partington ~~Robert H. Young~~	1/29/36 ~~6/1/36~~	2/5/36 ~~6/25/36~~
PRELIMINARY REVIEW OF SHEET	R.C.Bolstad (plot only) J.C.Partington J.C. Partington	4/29/36 ~~6/26/36~~	5/2/36 ~~6/27/36~~

AREA OF DETAIL INKED 3.6 Sq. Statute Miles (Land Area).

AREA OF DETAIL INKED .01 Sq. Statute Miles (Shoals in Water Area).

LENGTH OF SHORELINE (More than 200 m. from nearest opposite shore) 3.7 Statute Miles.

LENGTH OF SHORELINE (Rivers, sloughs, etc., less than 200 m. wide) 1.9 Statute Miles.

LENGTH OF STREETS, TRAILS, RAILROADS, etc. 141.7 Statute Miles.

DATUM North American 1927.

STATION ~~Highbridge (N.Y.) 1898; r 33~~ Latitude 40°-50'-32.7/9"=1011.1 m.
Longitude 73°-55'-58.9/6"=1381.6 m.

See opposite page

(Adjusted computations)

COMPILER'S REPORT

for

AIR PHOTO TOPOGRAPHIC SHEET, FIELD NO. 83.

GENERAL INFORMATION.

The Air-photo Field Inspection Report for METROPOLITAN NEW YORK attached to the descriptive report for compilation sheet, register number T-5458, furnished the necessary information for the compilation of this sheet. Additional information was furnished by Mr. J. Rippstein, who performed the field inspection, and by Mr. F. M. Overby, draftsman, who made several trips in the field to clear up questionable points and to assist in supplementing the control in weak areas.

This sheet was compiled from single lens photographs (see STATISTICS SHEET, page 2, for numbers, date, etc.) taken by the U. S. Army Air Corp at Mitchell Field, L.I., N.Y. The plane was piloted by Lieut. Cullen at an altitude close to 15,000 feet; the photographer was Sergeant Cates. The photographs were taken with a special camera (called "K-7C"by Army and "K-7A" by Fairchild Co.) recently developed by the Fairchild Camera Corporation, 62-10 Woodside Ave., Woodside, New York City, with the cooperation of the Air Corp. It was equipped with a 24 inch cone (f.l. = 60 cm.) which placed the original negatives on a scale closely approximating 1:7,500. One set of contact prints were furnished the field inspecting party for their use, and the original negatives were forwarded to the Coast Survey Office, D.C., where enlarged office prints to a scale of 1:5,000 were made. These office prints were used directly in the process of compiling this sheet. Inasmuch as these photographs were among the first to be taken with this new type camera difficulties were encountered in obtaining well defined photographs free from tilt. Mechanical difficulties experienced at this high altitude engaged the photographer's attention to such extent at times as to result in reduced over-lap and tilted photographs. To counteract this handicap and to strengthen the photo plot is was necessary for the compiling party to place supplementary control (see following paragraph) in the required areas. Also because of the above difficulty, and because of party shut-down due to lack of funds, this compilation has been worked on intermittently. See note regarding accuracy on page 11.

CONTROL.

(a) Sources.

Control for the compilation of this sheet was obtained from the following sources:-

(1) Triangulation, 1932, Lieut. Woodworth. Field positions on a N.A.Datum were used after correcting proper amount to convert to N.A. 1927 Datum. Comparisons were made between stations common to the two datums and following corrections used:- Lat. minus 12.0 meters, Long. plus 3.5 meters. The main scheme stations were available on N.A. 1927 datum (final office adjusted).

(2) Triangulation, 1930, Lieut. C.A.Egner. Field positions on N.A. datum were used after correcting as follows to convert to N.A. 1927 datum: Lat. minus 12.0 meters, Long. plus 3.0 meters.

(3) The U.S.E.D. stations as listed in the paragraph LIST OF RECOVERABLE OBJECTS were used as supplementary control for the radial plot. They were plotted on an aluminum sheet (at 5,000 scale) from the U.S.E. coordinate values, and transferred to the celluloid compilation sheet by means of adjusting to the common stations (i.e., coordinate positions of triangulation

Within limits of [illegible]

Note: The differences in position of the U.S.E. stations noted on the opposite page are within the probable error of the photo plot and are not significant.

B.G.J.

stations on the aluminum sheet fitted to their respective geographical positions on the celluloid sheet.). The transferred position of the U.S.E. station was not accepted unless it adherred strictly to the photo plot as there is sufficient other control to definately establish the plot.

(4) Three-point theodolite position "BRONX COURT 1935" (with check angle) - resultant check of 0.094 meter.) (See form 524 for position). Established by R.C.Bolstad in 1935 to supplement the plot.

(5) The stations "Tank","Chy.", "Cupola (Jewish Home)" and "Br. stack" were used as supplementary control for the photo plot. The positions of these stations on the celluloid compilation sheet were established graphically by means of cuts obtained by theodolite from "Bronx Court 1935" and sextant angles obtained from triangulation station "Highbridge 1885, 1932-33" (See Hor. Angle Record book for angles at "Bronx Court", following page gives sextant angles obtained at "Highbridge".)

(6) A taped-theodolite traverse up Melrose Ave. and 161st. Street between triangulation station "Spire (Immaculate Ch.) 1932" and a point radially plotted in the vicinity of "Bronx Court", (See paragraph Methods) as shown on page 6, furnished definate control for establishing a strong junction with compilation T-5089 which joins on the east.

(b) Errors.

No error in the position of any of the above control established by this bureau was discovered. However, the following U.S.E. station discrepancies were discovered in conducting the photo plot:

⊙ East High (U.S.E.) - new position as determined by the photo plot and shown on this sheet, lies about ½ meter north of the U.S.E. position. 7

⊙ Station 26 (U.S.E.) - new position as determined by the photo plot and shown on this sheet, lies about 1 meter N.E. of the U.S.E. position.

⊙ Water (U.S.E.) - new position as determined by the photo plot and shown on this sheet, lies about 1 meter north of the U.S.E. position.

⊙ Granite (U.S.E.) - new position as determined by the photo plot and shown on this sheet, lies about 1½ meters N.E. of U.S.E. position.

⊙ West 139th. Street (U.S.E.) - new position as determined by the photo plot and shown on this sheet, lies about 2 meters distant on azimuth 255°(from north) from the U.S.E. position.

There are adequate field measurements for the location of these stations of the photographs and they appear to be spotted correctly. Because of the large amount of control, including supplemental, the plotted position (radial position) should be well established within certain plottable limits of error.

See opposite page

COMPILATION.

(a) Method.

The usual radial line method of plotting was used in the compilation of this sheet.

The U.S.E. stations were used as supplementary control, as explained in the paragraph Sources.

On the S.E. corner of this compilation a junction is established with compilation T-5089 which is on a 1-10,000 scale. As compilation T-5089 was found to disagree with the photo plot of this sheet it was decided that additional supplementary control would be necessary to definately establish a correct junction. Therefore the control, items

T 5089 has not been published and will be corrected to join this compilation.

SEXTANT ANGLES TAKEN AT TRIANGULATION STATION "HIGHBRIDGE 1885".

Cupola(Jew. Home)to Chy.

1°- 33' - 30"
- 34' - 00"
- 33' - 30"
- 33' - 40"

1°- 33' - 40" Mean.

Cupola(Jew.Home) to Br.Stack.

59°-47'-20"
-47'-50"
-47'-40"
-47'-40"
-47'-40"

59°-47'-38" Mean.

Cupola(Jew.Home) to Tank.

79°-45'-40"
-45'-30"
-45'-40"

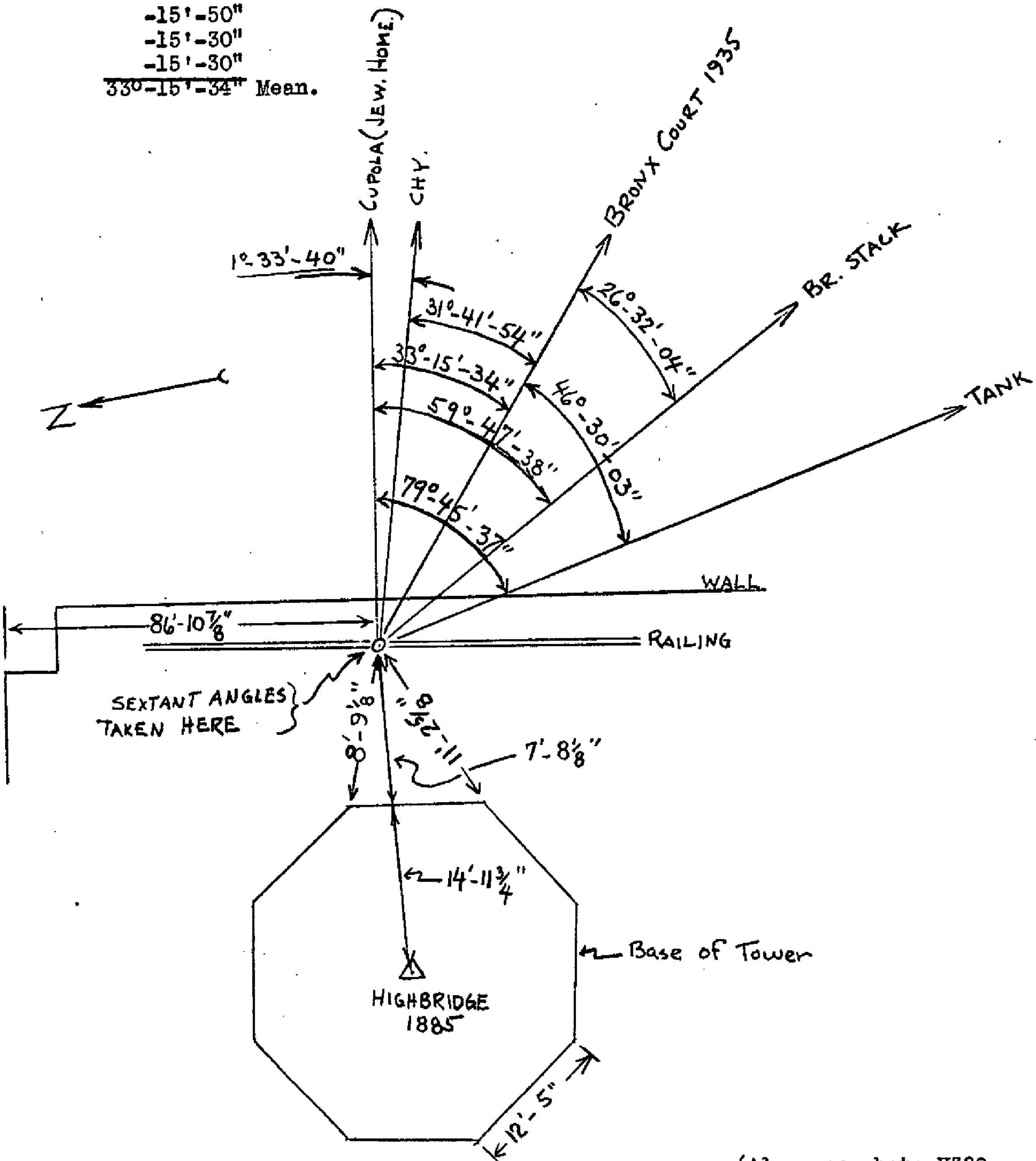
79°-45'-37" Mean.

Cupola(Jew.Home) to Bronx Court 1935.

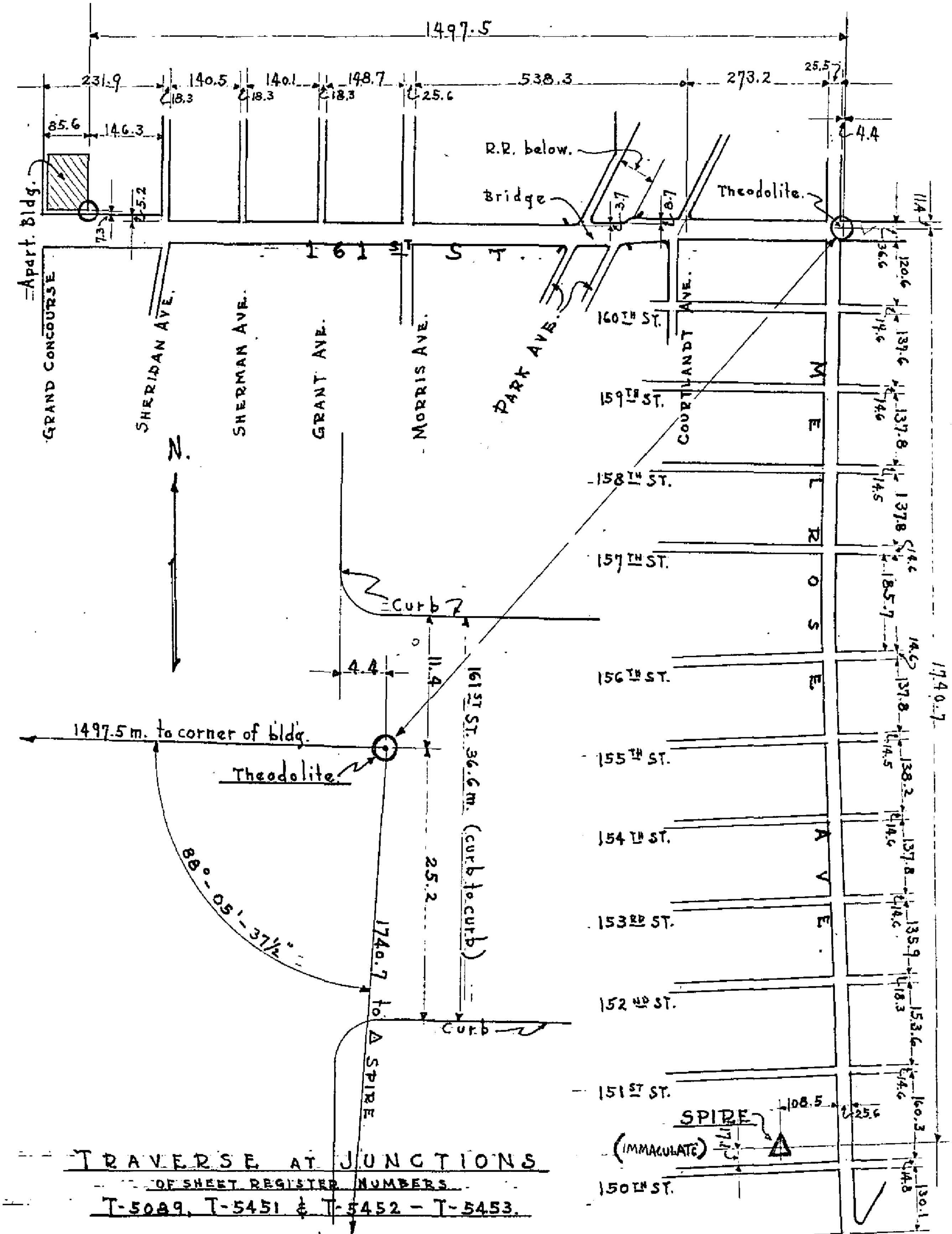
33°-15'-20"
-15'-40"
-15'-50"
-15'-30"
-15'-30"

33°-15'-34" Mean.

Sextant held level.
By- F.M.Overby.



(Also see photo V329
(876A-8))



TRAVERSE AT JUNCTIONS
OF SHEET REGISTER NUMBERS
T-5089, T-5451 & T-5452 - T-5453.

LAT. 40°-48.9' to 40°-49.6'
LONG. 73°-54.8' to 73°-55.3'

Scale = Approx. 1:5000
All measurements are to curb lines.

P.M.O. 6/22/35.

4, 5, and 6, mentioned in previous paragraph Sources, was established.

Bronx Court 1935 was established by one set of 6 D & R, with theodolite #232, on triangulation stations as follows: N. Tower (Eldorado); Flagpole (C.C.N.Y.); Highbridge; and Morris H.S.F.P.. While this station may be within the limits of triangulation it has been called a recoverable topographic station and the computed position and description given on form 524 submitted with this report.

Stations "Tank", "Chy.","Cupola (Jewish Home)" and"Br. Stack"(falls on sheet T-5453) were plotted on the celluloid compilation sheets with the steel protractor from angles determined at "Bronx Court 1935" and "Highbridge 1885" (See paragraph Sources.) The intersecting cuts have been left on the back of the celluloid compilation sheet (in red) to show the strength of intersection determining the position. These red lines should be erased before the compilation is photo-lithographed. As these stations were not actually visited at the site no descriptions have been submitted on form 524. However the name is descriptive and they have been plotted (or spotted) on the photographs and can easily be recovered for future surveys if need be.

The taped-theodolite traverse (item 6, paragraph Sources)(Also see page 6) was plotted on the celluloid compilation sheet graphically. At the north terminus of the traverse a tie-in was obtained to a radial point (corner of apartment building - shown by double blue square on back of compilation sheet). As this radial point is well established by sufficient radial intersections in an area adjacent to "Bronx Court" it furnished a good tie-in point which could not have been obtained at "Bronx Court" due to changes in elevation, between this point and "Bronx Court", of the street level; also the offset measurements at "Bronx Court" would have been difficult to obtain. No plottable error of closure was discovered in graphically laying out the traverse. This traverse aids in the junctions of compilations T-5089, T-5451, & T-5453.

(b) Adjustments of Plot.

Due to insufficient overlap and some tilted photographs in certain areas it was necessary to adjust the plot. Radial points along the Hudson River between lat. 40°-49.5', and lat. 40°-50.2' have only two cuts. The shoreline points, being at the same level, it was found upon proportioning between the adjacent triangulation stations (Post, F.P. Boat Club, Shire, & Mile), that these intersections were correct.

As difficulty was experienced with the photographs in the area bounded by latitudes 40°-49.7' to 40°-50.1', longitudes 73°-54.9' to 73°-55.5' an adjustment of the plot was necessary in order to hold to all the control, including the special tape-theodolite traverse run for the special purpose of adjusting this difficulty. It appears that there may be some distortion of the photographs in this area as an adjustment was required all along Melrose Ave.

(c) Additional Note- Method.

Amsterdam Ave., being a straight street (established as such by N.Y. City Surveys) was tied-in to triangulation stations at intervals and plotted on the compilation sheets. Field measurements were taken at triangulation stations George Washington H.S., Highbridge, and F.P.(C.C.N.Y.) on this sheet; additional tie-ins were made on the sheets to the south. The compilation sheets were joined and the centerline of Amsterdam Ave. drawn in. The field measurements were consistent and showed no plottable errors as the centerline of this avenue passed directly through the arc of the distance from the control station as laid off on the celluloid compilation sheets. The width of the street (curb to curb) was then plotted on the compilations from the field measurements. This information served as additional control in establishing a strong photo plot.

(d) Interpretation.

No attempt has been made to show the street railway systems in the streets. Only the trackage passing over the open areas has been shown.

The double full line was used to show first class roads and streets (curb to curb), the double dased line to indicate second class roads, poor motor roads, walks in park areas, and the single dashed line to indicate trails and paths.

Interpretation of the George Washington Bridge approaches has been aided by the Port of New York Authority Data, enclosed herein on pages 8x and 8y.

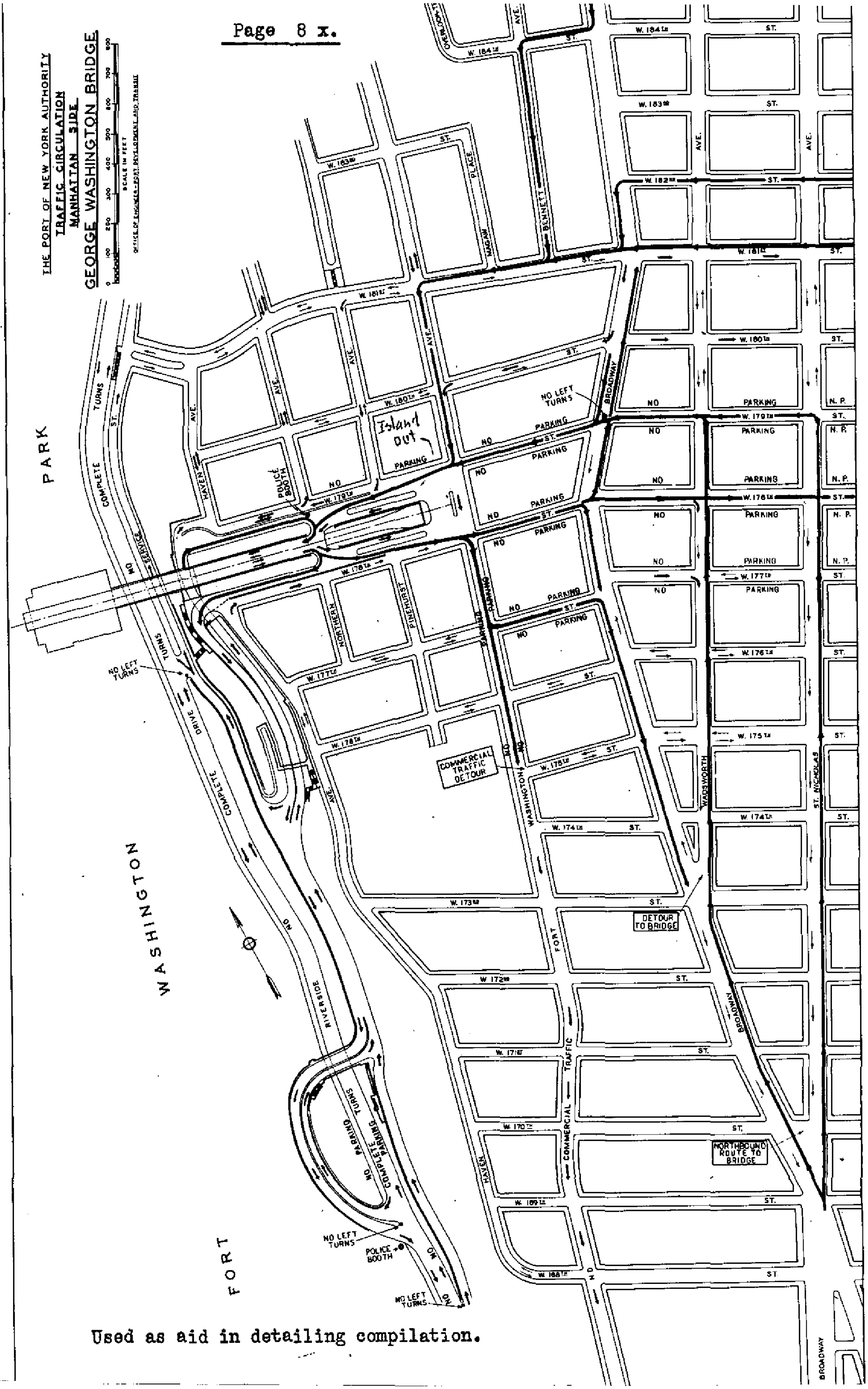
No information on the railroad track layouts in this vicinity was available and it is quite possible that some tracks have been omitted, particularly in the railroad yards and sidings.

Only two photographs of the shoreline and near shoreline detail north of the George Washington Bridge, New York side, could be used. Radial points were difficult to locate due to shadows and the detail north of the George Washington Bridge (New York side), and east to Riverside Drive is doubtful.

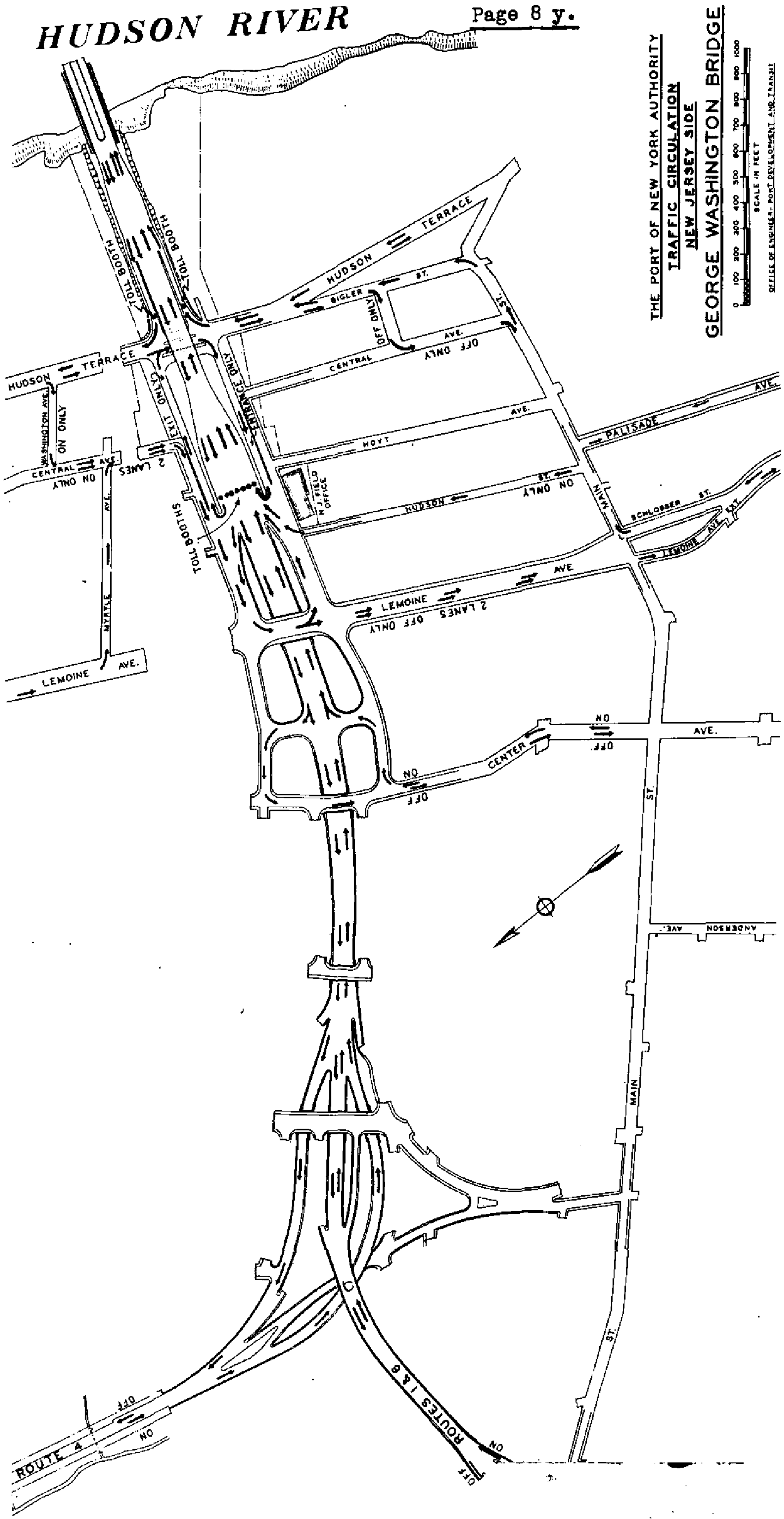
The usual graphic symbols were used as approved by the Board of Surveys and Maps (1932) and no difficulty, other than that mentioned in the preceeding paragraph, was experienced in interpreting the photographical detail.

This detail has been checked with the 1930 topographic surveys and no errors of importance for charting were found.
BGG

Page 8 x.



Used as aid in detailing compilation.


HUDSON RIVER
THE PORT OF NEW YORK AUTHORITY
TRAFFIC CIRCULATION
NEW JERSEY SIDE
GEORGE WASHINGTON BRIDGE
SCALE IN FEET
OFFICE OF ENGINEER - PORT DEVELOPMENT AND TRANSIT
TOLL BOOTH
TOLL BOOTHS
HUDSON TERRACE
BIGLER ST.
OFF ONLY
CENTRAL AVE.
ENTRANCE ONLY
EXIT ONLY
ON ONLY
WASHINGTON AVE.
2 LANES
HOYT AVE.
PALISADE AVE.
N.J. FIELD OFFICE
HUDSON ST.
MAIN ST.
SCHLOSSER ST.
LEMOINE AVE. EXT.
LEMOINE AVE.
2 LANES OFF ONLY
MYRTLE AVE.
CENTER AVE.
ANDERSON AVE.
ROUTE 4
ROUTES 1 & 9
ON
OFF

Note The red lights discussed on the opposite page are obstruction lights. They are not Air Beacons. The present chart 746, edition of May 1935, last print 36-7/7, shows one inch obstruction light on each tower as plotted from N.M. 48, 1929.

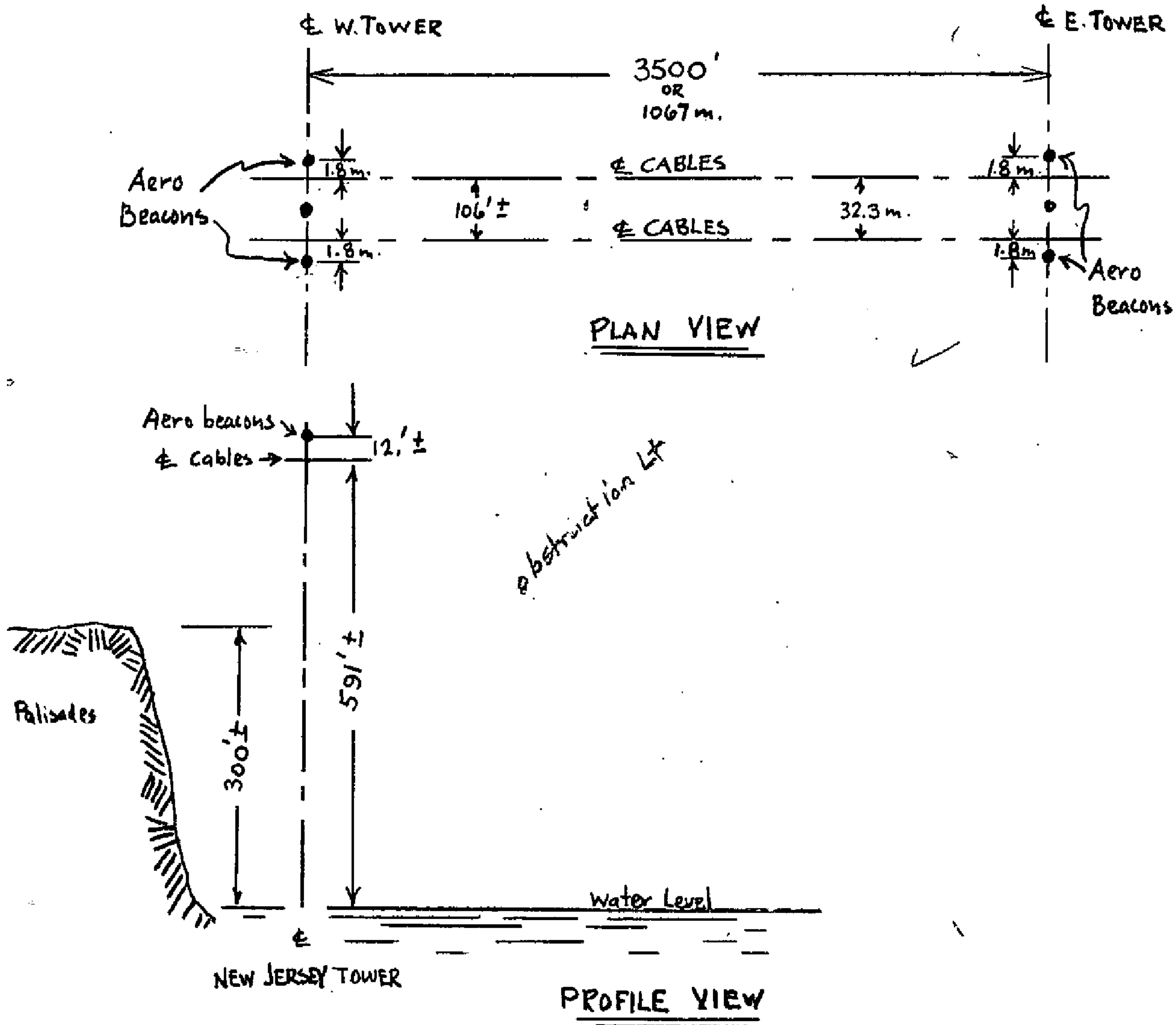
In the absence of field verification the obstruction lights as noted on the opposite page have not been plotted on this compilation.

A new Air Beacon has recently been placed on the East Bridge Tower according to information in the Section of Airway Mapping. This Beacon was erected after the photographs were taken and no precise position is available for plotting it on this compilation.

B.G.J. 10/9/36

(e) Information from Other Sources.

Members of this compilation party who reside in the Bronx and are familiar with this area have called attention to the aero beacons located on the towers of the George Washington Bridge. During the several trips made across the bridge by the chief of party (R.C.Bolstad) during the day time no sign of these beacons was observed. It is reported that each beacon consists of a fixed red light. The following data was obtained from the Port of New York Authority, the constructors of the bridge.



It is suggested that this information be verified by field examination before it is shown on the chart. The present chart shows only one beacon on each tower. No beacons have been shown on the compilation sheet because of the uncertainty.

On the west tower is shown a triangulation station "Face" which was previously located by theodolite from a measured base; it has been described on form 525 and forwarded to the Washington office. It was used to aid in controlling the photo-plot. See opposite page

(f) Names.

All geographical names shown on this compilation have been listed on the special forms included in the back of this report.

Bridge rebuilt 1931 and listed in
Engineer Bridge book for 1935
as 1 span, M.L.W. clearance 105 ft.
= M.H.W. clearance of 100 ft. as compared
to 93 ft given by coast pilot.

LIST OF RECOVERABLE OBJECTS.

The following tabulation lists all recoverable objects shown on this compilation with a small ($2\frac{1}{2}$ mm. diam.) black circle. When followed by (d) they have been described on Form 524 and are submitted with this report.

NAME		LATITUDE			LONGITUDE		METHOD OF DETERMINATION
Flagpole (Hudson Villa) (d)	40°	50'	1673.5 m.	73°	57'	1166.0 m.	A.P.T.
Sta. # 28 New (U.S.E.) (d)		51	197.0		57	857.0	A.P.T.
Granite (U.S.E.) (d)		50	1431.0		55	925.5	A.P.T.
Water (U.S.E.) (d)		50	1347.0		55	1121.0	A.P.T.
Station 26 (U.S.E.) (d)		50	958.0		55	932.5	A.P.T.
East High (U.S.E.) (d)		50	990.5		55	1138.5	A.P.T.
Tri. Sta. #27 (new)(U.S.E.) (d)		50	1001.0		55	1290.0	A.P.T.
Station 31 (U.S.E.) (d)		50	185.0		56	222.0	A.P.T.
Cupola 225 Ft.		51	351.0		56	485.5	A.P.T.
Stone Tower		50	1432.5		55	1133.5	A.P.T.
Square Tower		50	1447.5		55	1210.0	A.P.T.
Tower (resembling lighthouse)		49	1720.0		55	1287.0	A.P.T.
Tank (steel)		49	1805.5		56	440.0	S-T
Chy (brick stack 90 Ft.)		50	227.0		55	292.0	S-T
Cupola (Jewish Home)		49	1695.5		54	1070.0	S-T
Bronx Court 1935 (d)		49	1093.1		55	643.9	T

Legend:- A.P.T. denotes location by air-photo topography (radial plot)
S-T denotes location by sextant and theodolite cut(see page 7)
T denotes location by 3 pt. theodolite fix (see page 7)

BRIDGES.

The bridge data shown on the overlay for the George Washington Bridge over the Hudson River, was obtained from the publication page 178 of "List of Bridges Over the Navigable Waters of the United States" by the U.S.E.D. From the same publication, page 168, information was obtained for the bridges over the Harlem River. These data were checked with that given in the publication "United States Coast Pilot,Atlantic Coast, Section B, 1933". The two publications were found to agree except for the data on the Harlem River's "High Bridge". (The U.S.Engineers publication gives the width of channel as 44 feet and the vertical clearance above H.W. as 100.8 feet.) The Coast Pilot gives the width of channel as "unobstructed", and the vertical clearance as 93 feet at the center of span and 77 feet at the ends.

The information given in the Coast Pilot has been shown on the overlay. No field measurements were taken to clear up this discrepancy.

Pamphlets giving information in regard to the new George Washington Bridge over the Hudson River are included on page 12 of this report.

JUNCTIONS.

This sheet joins compilation T-5448 (1: 5000 scale) on the New Jersey side and the junction is satisfactory. It also joins compilation T-5278 (1: 10000 scale) on the New Jersey side and this junction id satisfactory.

On the New York side this compilation joins compilations T-5452 and T-5453 (1: 5000 scales) to the southward and compilation T-5089 (1: 10000) to the eastward. These junctions are satisfactory.

Note Because of scale differences and tilt and the resulting adjustments of the plot and of detail traced between intersected points the accuracy given on the opposite page is high. A better estimate is 0.5 to 0.8 mm for intersected points and 0.5 to 1.2 mm for other detail B.J.J.

COMPARISON WITH OTHER SURVEYS.

This compilation has been compared with Sheet 4568 - COMPILATION OF AERIAL PHOTOGRAPHS taken in 1930. The comparison shows differences of as much as 6 meters in the location of roads on this sheet and the photo-lithographic print of Sheet 4568. There are some smaller differences in the shore line probably due to changes since 1930. Two small docks just north of the New Jersey pier of the George Washington Bridge are shown on Sheet 4568. These docks cannot be seen on the photographs of this compilation (T-5451) on account of shadows and they have not been shown on this sheet.

The location of detail has been checked on this compilation (T-5451) in this area and is believed to be correctly shown. It is recommended that this compilation be accepted in preference to Sheet 4568 because of additional control and perhaps better photographs.

This compilation has been compared with Sheet 4567 - COMPILATION OF AERIAL PHOTOGRAPHS taken in 1930. The two sheets agree very well in the location of streets and where the shoreline is of a permanent nature. There are differences in the high water line along the east shore of the Hudson River between latitude 40° 49' 30" and the George Washington Bridge. These differences are due mainly to filling in and cutting away and to building and tearing down of docks. Notes on the field inspection photos indicate that this shore line is subject to considerable change.

There are some small changes in the shore line along the east bank of the Harlem River due mainly to filling in and cutting away of the shore and to change in docks.

Since this compilation (T-5451) is more rigidly controlled it is recommended that it be accepted in preference to Sheet 4567. The shore line on T-5451 also shows the ground as it is at the present time.

NAMES.

The names shown on the overlay sheet are listed on Form M 234 in the back of this report. For additional names of streets etc. consult charts 274, 746; compilations Nos. 4567 and 4568; and the New York City Map, Board of Estimate and Apportionment.

RECOMMENDATIONS FOR FURTHER SURVEYS.

This sheet is believed to have a probable error of not greater than 2 meters in position for well defined detail of importance for charting, and not more than 4 meters for other detail. It is understood the widths of railroad tracks, roads, and similar detail may be slightly exaggerated in order to keep the detail clear when the sheet is reproduced.

See opposite page.

To the best of my knowledge and belief this sheet is complete in all details of importance for charting, within the accuracy specified above and with the one exception reported under "Interpretation", and no additional surveys are required.

Submitted by

Approved:
J.C. Partington
Chief of Party.

Robert H. Young
Draftsman

GEORGE WASHINGTON BRIDGE

Over the Hudson River
at 179th Street, New York City
and Fort Lee, New Jersey

Owned and Operated by
The Port of New York Authority
111 Eighth Avenue
New York City

George Washington Bridge

The George Washington Bridge over the Hudson River, connecting 179th Street, New York City, and Fort Lee, New Jersey, is the longest suspension span in the world. It took four and one-half years to construct at a cost of about $60,000,000 and was completed in the initial stage and opened to traffic on October 25, 1931. At present the bridge is a single deck structure consisting of four roadway lanes and two pedestrian sidewalks. Additional roadway lanes and a lower deck, intended for rapid transit service, can be added to meet future requirements.

The bridge affords a convenient and direct route for motorists traveling between New York City, Long Island or New England, and northern New Jersey and Pennsylvania, or that portion of New York State west of the Hudson River.

The approaches are so constructed as to avoid grade crossings and left turns against traffic moving in the opposite direction, thus permitting safe and uninterrupted traffic movement. In New York City, direct connections are offered with Riverside Drive, Fort Washington Avenue and Broadway. In Fort Lee direct connections are made with New Jersey State Highway Route Nos. 1, 4 and 6; with United States Highway Route 9W, and the excellent Bergen County highways.

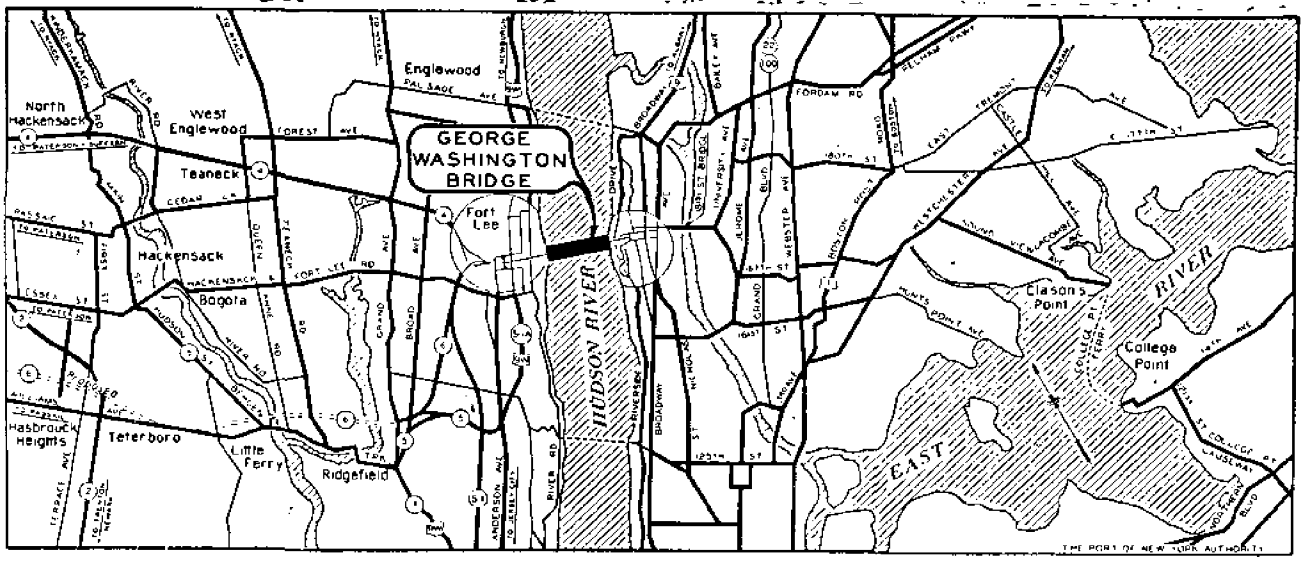
Authorization to construct and operate the George Washington Bridge was given by the States of New York and New Jersey to The Port of New York Authority, which is an interstate agency created under treaty between the two states with the consent of Congress.

The bridge was financed by the sale of Port of New York Authority bonds, secured by revenue from tolls received from the operation of the bridge. The States of New York and New Jersey aided the financing by advancing a sum of $10,000,000. This will be repaid with interest.

The George Washington Bridge is one of the outstanding points around New York, and visitors, pedestrians as well as motorists, find the magnificent view from the bridge of the Hudson River valley, with its historic Palisades on one side and the Manhattan skyline on the other, most interesting.

Principal Data

Length of river span	3,500 feet
Length of main bridge between anchorages	4,760 feet
Length of bridge and approaches	10,500 feet
Width of main structure, overall	120 feet
Height of towers above water	600 feet
Traffic Capacity:—In initial stage, four vehicular lanes	
In ultimate stage, eight vehicular lanes on upper deck and four rapid transit tracks on lower deck	
Height of roadway above river	250 feet
Clearance beneath lower deck, at center	213 feet
Number of cables	4
Diameter of each cable	36 inches
Number of wires in each cable	26,474
Diameter of each wire	0:196 inch
Strength of wire	225,000 lbs. per sq. inch
Quantity of steelwork in towers	43,070 tons
Quantity of cable wire	28,300 tons
Total steel in main bridge, initial stage	103,000 tons
Total masonry in main bridge, initial stage	170,000 cu. yds.
Rock excavation through Palisades	300,000 cu. yds.


GEORGE
WASHINGTON
BRIDGE
Englewood
North
Hackensack
West
Englewood
Teaneck
Fort
Lee
Hackensack
Bogota
Hasbrouck
Heights
Teterboro
Little
Ferry
Ridgefield
HUDSON RIVER
EAST
RIVER
Clason's
Point
College
Point
FORDAM RD
THE PORT OF NEW YORK AUTHORITY

THE HUDSON RIVER BRIDGE

Between

FORT LEE, NEW JERSEY

and

MANHATTAN, NEW YORK

The Port of New York Authority
80-90 Eighth Avenue
New York City

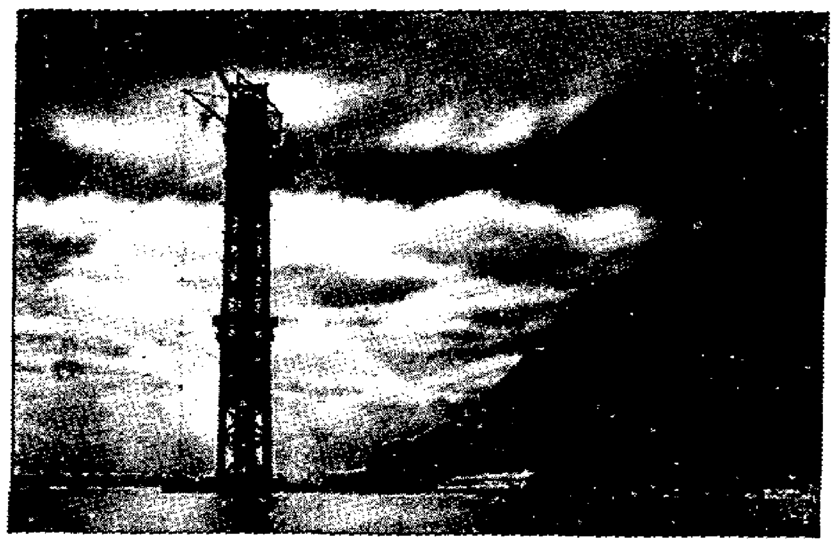
PRINCIPAL DATA

Length of main span		3500 feet
Length between anchorages		4760 feet
Width of main structure, overall		120 feet
Height of towers above water		635 feet
Number of cables		4
Diameter of each cable		36 inches
Number of wires in each cable		26,474
Diameter of each wire		0.196 inches
Specified strength of wire, min.		220,000 lbs. per sq. in.
Weight of cable wire		28,450 tons
Deck structure—upper deck for vehicular roadway and sidewalks—lower deck for rapid transit		
Vehicular traffic lanes		8
Height of roadway above river		250 feet
Clearance beneath lower deck, at New York tower		195 feet
Clearance beneath lower deck, at center		213 feet
Steelwork—	TONS	
Silicon steel in towers	23,600	
Carbon steel in towers	16,600	
Total steel work in towers		40,200 tons
Total structural steelwork in main bridge without lower deck		73,000 tons
Foundations on solid dock, at water level for New York tower, and at depth of 35 to 75 feet for New Jersey tower constructed in open cofferdams		
Masonry in New Jersey tower foundation		37,500 cu. yds.
Rock excavation for New Jersey anchorage and approach		300,000 cu. yds.
Masonry in New York anchorage		165,000 cu. yds.

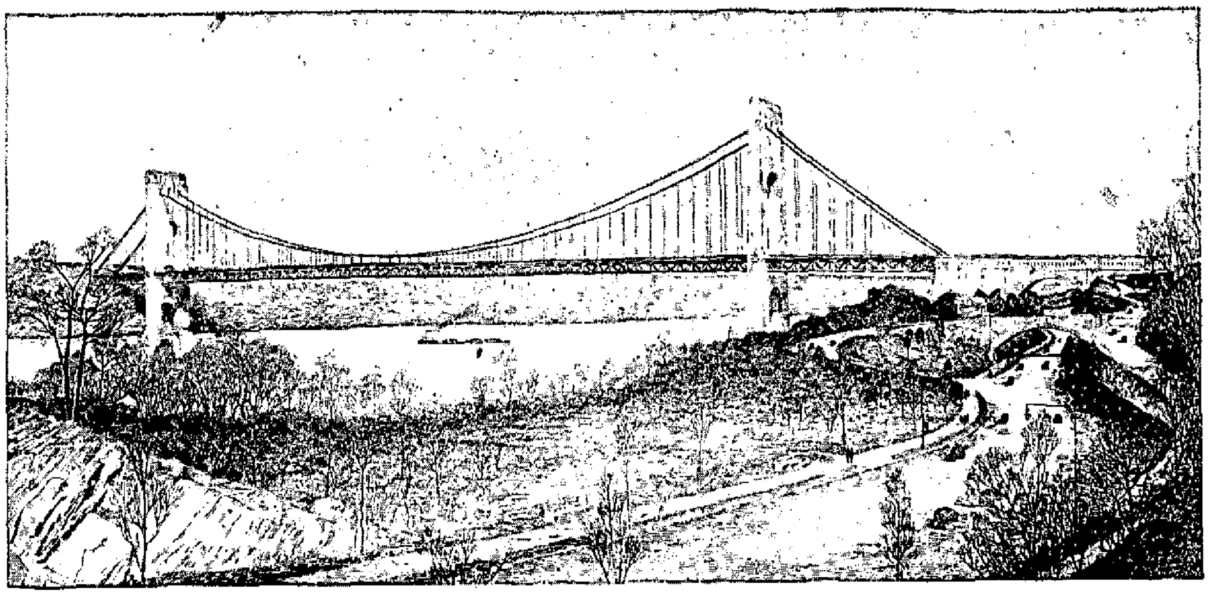
The monies advanced by the two States will be repaid to them, with interest.

In order to secure the advantages of low initial cost, early opening to traffic, and flexibility in adapting the ultimate facilities to future traffic requirements, the bridge will be opened to traffic in an initial stage of construction which will include only part of the facilities for which the structure is designed. In this initial stage, the upper deck will be constructed for two sidewalks and four lanes of vehicular traffic. When needed, four additional vehicular lanes can be added on the upper deck and a lower deck can be provided for four rapid transit tracks.

Construction of the bridge was started in May, 1927, and the initial stage of construction is to be completed and the roadway opened to traffic early in 1932. The cost for completion of the initial stage is estimated to be $60,000,000.



TOWER ERECTION, MAY, 1929



THE HUDSON RIVER BRIDGE

CONTRACTORS

SILAS B. MASON CO., INC.

New Jersey Tower Foundations

Two masonry and concrete piers containing 36,000 cu. yds. of concrete, constructed in the dry in cofferdams to reach bed rock from 40 to 80 feet below river surface.

FOLEY BROTHERS, INC.

New Jersey Anchorage and Approach Excavation

Excavation of 220,000 cu. yds. of trap rock for the New Jersey Approach and the two inclined shafts in which the bridge cables are anchored.

ARTHUR McMULLEN COMPANY

New York Anchorage and Tower Foundation

The base for the New York tower involves 9,700 cu. yds. of concrete. The first portion of the New York Anchorage involves 107,000 cu. yds. of concrete and the placing of 2,500 tons of structural steel.

McCLINTIC-MARSHALL COMPANY

Towers and Floor Steel

Fabrication and erection of the two structural steel towers 600 feet high. Each contains over 40,000 tons of steel. The fabrication and erection of the floor involves 11,000 tons of steelwork.

JOHN A. ROEBLING'S SONS COMPANY

Cables and Anchorage Steelwork

Fabrication of the structural steel in both anchorages and its erection in the New Jersey Anchorage; the manufacture and spinning of 30,000 tons, or 110,000 miles, of wire in the cables; and, the manufacture and erection of about 1,300 tons, or 35 miles, of the three-inch diameter suspender ropes.

KLOSK CONTRACTING COMPANY

Demolition of Buildings—New York Approach

The complete demolition of all buildings covering four blocks on the site of the approach between 178th and 179th Streets, Manhattan, west of Fort Washington Avenue.

CORNELL CONTRACTING CORPORATION

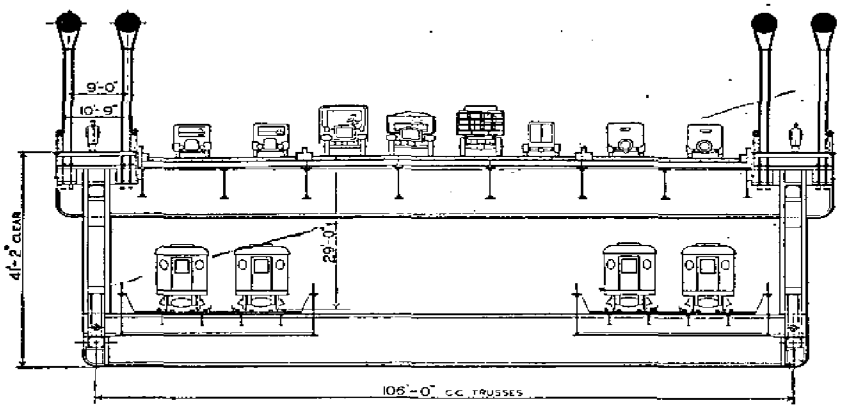
Main Approach Ramp, and Vehicular Tunnell in West 178th Street—New York Approach

The construction of a 200 foot arch, a viaduct structure 800 feet long, and a vehicular tunnel 2,500 feet long—from the anchorage in Fort Washington Park to Amsterdam Avenue.

GEORGE M. BREWSTER & SON, INC.

New Jersey Approach Excavation

Excavating of 80,000 cubic yards of trap rock for the New Jersey Approach and miscellaneous foundation and masonry work.



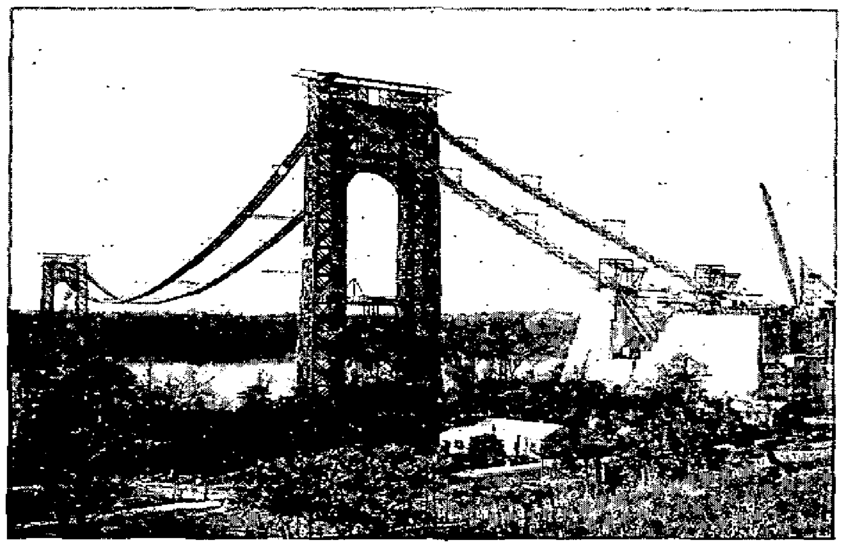
TYPICAL CROSS SECTION

The Hudson River Bridge, like all other interstate bridges built and being built by The Port of New York Authority, has been authorized by Legislative Acts of the States of New York and New Jersey and approved by Congress. The legislation committing the project to the Port Authority recognizes the fact that the bridge, although it is to be paid for out of tolls, is for the benefit of the people of the two states and that the Port Authority performs a governmental function in undertaking its construction, maintenance and operation.

The States of New York and New Jersey agreed to advance to the Port Authority a total of $10,000,000, in five equal annual installments, to meet part of the construction cost. For completing the financing, the Port Authority issued fifty million dollars, Port of New York Authority, New York-New Jersey Interstate Bridge Gold Bonds, of which twenty millions were sold December 9, 1926, and thirty millions November 1, 1929. The bonds are secured by a first lien on the revenues to be derived from operation of the bridge.

THE HUDSON RIVER BRIDGE

THE Hudson River Bridge, between Fort Lee, New Jersey, and Fort Washington, Manhattan, New York City, is located on a line parallel to, and between, 178th and 179th Streets in New York City. It will form an important link in the highways planned for comprehensive development of transportation facilities at the Port of New York, and it will also provide a vital connection in the national highway routes. It will provide direct and expeditious access from northern New Jersey and the portions of New York State west of the Hudson River to New York City. It will serve traffic between New England and the Atlantic seaboard, affording a route which will avoid the more congested sections of New York City. In conjunction with the Washington Bridge across the Harlem River and the proposed Tri-borough Bridge across the East River, it will establish a new highway between Long Island and New Jersey.



CABLE CONSTRUCTION ON HUDSON RIVER BRIDGE

THE PORT OF NEW YORK AUTHORITY

COMMISSIONERS

New York	*New Jersey*
John F. Galvin, *Chairman*	Frank C. Ferguson, *Vice-Chairman*
Howard S. Cullman	Schuyler N. Rice
John F. Murray	William C. Heppenheimer
George R. Dyer	Joseph G. Wright
John J. Pulleyn	George deB. Keim
A. J. Shamberg	Ira R. Crouse

EXECUTIVE DEPARTMENT

John E. Ramsey, *General Manager*
Billings Wilson, *Assistant General Manager*
John J. Mulcahy, *Assistant General Manager*
L. J. Keefe, *Secretary*
H. S. Quigel, *Real Estate Agent*
E. Tracy Lanterman, *General Claim Agent*
Marion Rodgers, *Auditor*
William Leary, *Treasurer*

LEGAL DEPARTMENT

Julius Henry Cohen, *General Counsel*
Leander I. Shelley, *Attorney*
T. J. W. Geraty, *Attorney* — F. B. Wettig, *Attorney*
A. J. Tobin, *Real Estate Attorney*

DEPARTMENT OF ENGINEERING

O. H. Ammann, *Chief Engineer*

Edw. W. Stearns, *Assistant Chief Engineer*	J. C. Evans, *Terminal Engineer*
Allston Dana, *Engineer of Design*	Montgomery B. Case, *Engineer of Construction*

Consulting Engineers

William H. Burr	Leon S. Moisseiff
Daniel E. Moran	Lewis Buckley Stillwell
Joseph B. Strauss	Ole Singstad

Cass Gilbert, *Architect*

Prof. Charles P. Berkey, *Consulting Goelogist*

	Remarks	Decisions
1	* Shown as "Fort Lee" Coytesville is on next sheet north	
2	* Not named below the George Washington Bridge	
3		
4		
5		
6		
7		
8		
9		
10		
11		
12	* Shown as "Railroad Station" only	
13		
14	* Shown as "Manhattan Field"	
15		
16	* Shown as "Spuyten Duyvil Creek"	
17		
18		
19	* Shown as 181st Street Bridge	
20		
21	° Shown as N.Y.C. and H.R.R. * Shown as N.Y.C.R.R. only	
22	° Shown only as N.Y.C.R.R.	
23		
24		
25		
26		
27		

GEOGRAPHIC NAMES

Survey No. T-5451

Air Photo Compilation

Name on Survey	A On Chart No. 214	B On previous ... No. 4586 4587 (Photo Compilation)	C On U. S. quadrangle Maps	D From local information (Field Inspection Party)	E On ... (N.Y.C. Map Board of Estimate and Apportionment)	F	G P. O. Guide or Map	H Rand McNally Atlas	K U. S. Light List (Chart 746)	
Coytesville		*			x					1
Fort Lee		*			x				x	2
Main Street		x								3
Mackay Drive		x								4
Hudson Terrace		x								5
Palisade Interstate Park					x					6
George Washington Bridge		x		x	x				x	7
Fort Washington Park		x			x				x	8
Riverside Drive	x	x			x				x	9
Sedwick Avenue	x	x			x					10
Haven Avenue		x			x					11
Sedwick Ave. R.R. Station		*		x						12
Broadway	x	x			x				x	13
Old Manhattan Field	*				x					14
W. 173rd Street	x	x			x					15
Harlem River	*			x	x					16
W. 184th Street	x	x			x					17
Hudson River	x	x		x	x					18
Washington Bridge	x	*			x					19
Harlem River Driveway	x	x			x					20
N.Y.C.R.R. Hudson River Division	°	*		x	*					21
N.Y.C.R.R. Putnam Division	°	°		x	°					22
W. 145th Street	x				x				x	23
Colonial Park				X	x					24
High Bridge	x				x					25
Boscobel Avenue	x	x			x					26
		(next sheet)								27

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Remarks	Decisions
* Shown as High Bridge Park.	
* Shown as Trinity Church Cemetery.	

GEOGRAPHIC NAMES (Sheet #2)

Survey No. T-5451

Air Photo Compilation

Name on Survey	A On Chart No. 274	B On previous survey No. 4567 4868	C On U. S. quadrangle Maps (Photo Compilation)	D From local information (Field Inspection Party)	E O. (N.Y.C. Map Board of Estimate and Apportionment)	F P. O. Guide or Map	G Rand McNally Atlas	H U. S. Light List	K Chart 746	
Highbridge Park		*			x					1
Macombs Dam Park	x				x					2
Polo Grounds				x	x					3
Amsterdam Avenue	x	x		x	x					4
Trinity Cemetery				*	x					5
Macombs Place	x				x					6
8th Avenue	x			x	x					7
Yankee Stadium	x			x	x					8
Joyce Kilmer Park				x	x					9
										10
										11
										12
										13
										14
										15
										16
										17
										18
										19
										20
										21
										22
										23
										24
										25
										26
										27

Names underlined in red approved by K.T.A on 10/5/36

M 234

REVIEW OF AIR PHOTO COMPILATION T-5451
Scale 1:5,000

Contemporary Surveys

There are no recent planetable or hydrographic surveys in this area.

Comparison with Previous Topographic Surveys

1. Changes due to construction since the date of the older topographic surveys in this area have been so numerous that detailed discussion is unnecessary. This compilation is complete and adequate to supersede the sections of the following surveys which it covers, except for the contours shown on the old sheets as indicated below:

T- 16	(1854),	1:10,000	- Shows few hachures
T- 485	(1856),	"	- Shows few contours
T- 609	(1857),	"	- Shows detail contous of Palisades on Jersey side
T- 658	(1857),	"	- Shows detailed contours on New York side
T-1743,			
T-1743a	(1886),	"	- Show very few contours along the shore
T-3151	(1911),	"	

2. T-4554 (1930), 1:5,000 - This is a shoreline survey showing a small amount of adjacent detail. There have been a number of changes in waterfront detail, the important items of which are listed under the following paragraphs, "Comparison with the Charts". The George Washington Bridge piers are shown as 635 feet high on T-4554 whereas the descriptive booklet attached on page 12 of this report gives an elevation of 600 feet.

This compilation is complete and adequate to supersede the section of T-4554 which it covers.

3. T-4567 and T-4568 (1930), 1:5,000 - Air photo compilations: This compilation overlaps and supersedes the lower sections of both T-4567 and T-4568. At the next printing the lower sections of T-4567 and T-4568 will be deleted to a line of junction on the copies printed for sale. Comparison of this compilation with T-4567 and T-4568 is discussed on page 11 of this report. The differences of location of streets amounting to as much as 1.5 mm. in places is due to errors in adjusting scale differences and to lack of control on T-4567 and T-4568.

Comparison with the Charts

1. Chart 746 - This compilation shows numerous corrections to waterfront detail, all of which have been checked against the photos in this office.

No new landmarks have been recommended by this compilation. All landmarks within this area on present chart 746 are shown on the compilation.

2. Chart 274 - This compilation shows numerous small corrections to the shoreline detail in Harlem River. The line of old barges shown on chart 274 on the east shore just above Washington Bridge have been removed. The sunken wreck shown on chart 274 near the east shore above Washington Bridge projects partly above water and is so shown on this compilation. The lower one of 4 docks shown on chart 274 on the east shore at lat. 40° 49.8' is gone except for piling remains shown on this compilation.

No new landmarks have been recommended by this compilation. All landmarks shown on the present chart in this area are on the compilation.

General

1. This is a hand drawn projection and a number of the lines are slightly bowed 0.1 to 0.3 mm, due to drafting errors in inking. Small errors in the projection are troublesome in applying the state rectangular coordinate systems. In this case, the grids can be applied with a maximum error of about 0.2 mm. The use of machine drawn projections will greatly facilitate the application of the coordinate systems.

2. Grid intersections computed by Division of Geodesy and filed at the back of this report. Positions plotted by HWS and checked by F.R.G. . Grids inked on the projection ruling machine.

3. Examination of the field photos showed the omission of two wrecks and a few minor waterfront details which have been added in this office.

Sleiter

B.G. Jones

Nov. 10, 1936.

B. G. JONES

REVIEW OF AIR PHOTO COMPILATION NO. T 5451

Chief of Party: J. C. Partington Compiled by: See Statistics Sheet.

Project: HT 175 Instructions dated: Mar. 14, 1934.

1. The charts of this area have been examined and topographic information necessary to bring the charts up to date is shown on this compilation. (Par. 16a, b,c,d,e,g and i; 26; and 64)

2. Change in position, or non-existence of wharfs, lights, and other topographic detail of particular importance to navigation which affect the chart, is discussed in the descriptive report. (Par. 26; and 66 g,n)

3. Ground surveys by plane table, sextant, or theodolite have been used to supplement the photographic plot where necessary to obtain complete information, and all such surveys are discussed in the descriptive report. (Par. 65; and 66 d,e)

4. Blue-prints and maps from other sources which were transmitted by the field party contain sufficient control for their application to the charts. (Par. 28)
Maps on pages 8 x and 8 y of Descriptive Report used to aid in detailing sheet only.

5. Differences between this compilation and contemporary photo compilations 4567 & 4568 ~~plane table and hydrographic surveys~~ have been examined ~~and rectified~~ in the field before forwarding the compilations to the office and are discussed in the descriptive report.

6. The control and adjustment of the photo plot are discussed in the descriptive report. Unusual or large adjustments are discussed in detail and limits of the area affected are stated. (Par. 12b; ~~44~~; and 66 c,h,i)

7. High water line on marshy and mangrove coast is clear and adequate for chart compilation. (Par. 16a, 43, and 44)

NOTE: Strike out paragraphs, words or phrases not applicable and modify those requiring it. Paragraph numbers refer to those in the Topographic Manual. Refer also to the pamphlet "Notes on the Compilation of Planimetric Line Maps from Five Lens Air Photographs."

M-67

8. The representation of low water lines, reefs, coral reefs and rocks, and legends pertaining to them is satisfactory. (Par. 36, 37, 38, 39, 40, 41)

9. Recoverable objects have been located and described on Form 524 in accordance with circular 30, 1933, circular letter of March 3, 1933, and circular 31, 1934. (Par. 29, 30, and 57)

10. A list of landmarks was furnished on Form 567 and instructions in the Director's letter of July 16, 1934, Landmarks for Charts, complied with. (Par. 16d, e; and 60)

11. All bridges shown on the compilation are accompanied by a note stating whether fixed or draw, clearance, and width of draw if a draw bridge. Additional information of importance to navigation is given in the descriptive report. (Par. 16c)

12. Geographic names are shown on the overlay tracing. The accepted local usage of new names has been determined and they are listed in the report, together with a general statement as to source of information and a specific statement when advisable. Complete discussion of place names differing from the charts and from the U. S. G. S. Quadrangles is given in the descriptive report, together with reasons for recommendations made. (Par. 64, and 66k)

13. The geographic datum of the compilation is N.A. 1927 and the reference station is correctly noted.

14. Junctions with adjoining compilations have been examined and are in agreement. (Par. 66j)

15. The drafting is satisfactory and particular attention has been given the following:

   1. Standard symbols authorized by the Board of Surveys and Maps have been used throughout except as noted in the report.

   2. The degrees and minutes of Latitude and Longitude are correctly marked.

3. All station points are exactly marked by fine black dots. ✓

4. Closely spaced lines are drawn sharp and clear for printing. ✓

5. Topographic symbols for similar features are of uniform weight. ✓

6. All drawing has been retouched where partially rubbed off. ✓

7. Buildings are drawn with clear straight lines and square corners where such is the case on the ground. ✓

(Par. 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 48)

16. No additional surveying is recommended at this time. ✓

17. Remarks:

18. Examined and approved;

J. C. Partington
Chief of Party

19. Remarks after review in office:

Reviewed in office by:
H. W. Schleiter

B. G. Jones

Examined and approved:

C. K. Green
Chief, Section of Field Records

Fred. L. Peacock
Chief, Section of Field Work

L. O. Colbert
Chief, Division of Charts

G. Rude
Chief, Division of Hydrography and Topography.

Plane coordinates on Lambert projection

1898, 1933

State *Long Island* Station △ *Palisades (N.J.)*

ϕ = 40° 51′ 08.″153 λ = 73° 57′ 40.″409

Tabular difference of R for 1″ of ϕ = 101.20350

	For machine computation	
R (for min. of ϕ)		24235032.18
Cor. for sec. of ϕ		− 825.11
R		24,234,207.07
θ (for min. of λ)		+ 0° 01′ 57.″73478
Cor. for sec. of λ		− 26.43080
θ		1 31.30398
θ''		91.″30398
log θ''		1.96048970
S for θ		4.68557485
log sin θ	sin θ	
log R		7.38442881
log x′		4.03049336
x′	R sin θ	+ 10,727.37
		2,000,000.00
x		2,010,727.37

	For machine computation	
y′ (for min. of ϕ)		227,513.12
Cor. for sec. of ϕ		+ 825.11
y′		228,338.23
y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 2.37 ✓
y		228,340.60
$\frac{\theta}{2}$		° ′ ″
log θ''		1.96049
colog 2		9.69897000
S for $\frac{\theta}{2}$		4.68557
log sin $\frac{\theta}{2}$	sin $\frac{\theta}{2}$	6.34503
	R sin $\frac{\theta}{2}$	
log $\sin^2 \frac{\theta}{2}$	R $\sin^2 \frac{\theta}{2}$	2.69006
log R		7.38442
log 2		0.30103000
log y″		0.37551

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

(R 340)

Geodetic positions from Lambert coordinates

State *Long Island* Station {2,020,000 / 220,000}

x	2,020,000.00	R_b+A	24,462,545.30
C	2	y	220,000
x' (= x−C)	20,000.00	R_b+A − y	24,242,545.30
	4.30103000 7.38457822		
tan θ	6.91645178	R	
θ	5.31442503 " 0.18436774		
	2.41524455 "	y	220,000.00
$\frac{\theta}{\ell}$ (= Δλ)	260.1624	y''	− 8.25
		y'	219,991.75
λ (central mer.)	74° 00' 00".0000		
− Δλ	+ 4 20.1624	φ (by interpolation)	40° 49' 45".6805
λ	73 55 39.8376		~~967.40~~
	461.08		(883.42)

(945.02)
1406.1

1850.82

Station {2,008,000 / 230,000}

x	2,008,000.00	R_b+A	24,462,545.30
C	2	y	230,000
x' (= x−C)	8,000.00	R_b+A − y	24,232,545.30
	3.90308999 7.38439903		
tan θ	6.51869096	R	
θ	5.31442512 " 0.18436774		
	2.01748382	y	230,000.00
$\frac{\theta}{\ell}$ (= Δλ)	104.1079	y''	− ~~13.21~~ 1.32
		y'	229,9~~86.79~~ 98.68
λ (central mer.)	74° 00' 00".0000		
− Δλ	1 44.1079	φ (by interpolation)	40° 51' 24".5600
λ	73 58 15.8921		1515.20
	744.42		(335.62)

(660.87)
1405.3

1150.82

$\tan\theta = \frac{x - C}{R_b + A - y}$

$\Delta\lambda = \frac{\theta}{\ell}$

$\lambda = \lambda$ (central mer.) − $\Delta\lambda$

$R = (R_b + A - y) \sec\theta$

$y'' = 2R \sin^2 \frac{\theta}{2}$

$y' = y - y''$

C is constant added to x' in computation of coordinates

R_b is map radius of lowest parallel

A is value of y' for R_b; in most cases it is zero

φ is interpolated from table of y'

(M-28)

Geodetic positions from Lambert coordinates

State Long Island Station { 2,008,000 / 220,000 }

x	2,008,000.00	$R_b + A$	24,462,545.30
C	2	y	220 —
x' (= x − C)	8,000.00	$R_b + A - y$	24,242,545.30
	3.90308999 7.38457822		
tan θ	6.51851177	R	
θ	5.31442512 " 0.18436774		
	2.01730463 50	y	220,000.00
$\frac{\theta}{\ell}$ (= Δλ)	104.064	y''	− 1.32
		y'	219,998.68
λ (central mer.)	74° 00' 00.0000"		
− Δλ	1 44.0650	φ (by interpolation)	40° 49' 45.7489"
λ	73 58 15.9350		971.61 (879.20)
	746.87 (659.23) 1406.1		1850.81

Station { 2,014,000 / 225,000 }

x	2,014,000.00	$R_b + A$	24,462,545.30
C	2	y	225,000.00
x' (= x − C)	14,000.00	$R_b + A - y$	24,237,545.30
	4.14612804 7.38448863		
tan θ	6.76163941	R	
θ	5.31442508 " 0.18436774		
	2.26043223	y	225,000.00
$\frac{\theta}{\ell}$ (= Δλ)	182.1513	y''	− 4.04
		y'	224,995.96
λ (central mer.)	74° 00' 00.0000"		
− Δλ	3 02.1513	φ (by interpolation)	40° 50' 35.1277"
λ	73 56 57.8487		316.34 (1534.48) 1850.82
	1304.80 (100.80) 1405.6		

$\tan\theta = \frac{x - C}{R_b + A - y}$

$\Delta\lambda = \frac{\theta}{\ell}$

$\lambda = \lambda$ (central mer.) $- \Delta\lambda$

$R = (R_b + A - y) \sec\theta$

$y'' = 2R \sin^2 \frac{\theta}{2}$

$y' = y - y''$

C is constant added to x' in computation of coordinates

R_b is map radius of lowest parallel

A is value of y' for R_b; in most cases it is zero

φ is interpolated from table of y'

(M-28)

Geodetic positions from Lambert coordinates

State Long Island Station {2,020,000 / 230,000

x	2,020,000.00	R_b+A	24,462,545.30
C	2	y	230
x' (= x−C)	20,000.00	R_b+A-y	24,232,545.30
	4.30103000 7.38439903		
tan θ	6.91663097	R	
θ	5.31442503 "		
	0.18436774		
	2.41542374	y	230,000.00
$\frac{\theta}{\ell}$ (= Δλ)	260.2698	y''	− 8.25
		y'	229,991.75
λ (central mer.)	74° 00′ 00″.0000		
− Δλ	4 20.2698	φ (by interpolation)	40° 51′ 24″.4915
λ	73 55 39.7302		1510.98
	′ ′ 455.82 (949.48)		(339.84)

1405.3 1850.82

Station

x		R_b+A	
C		y	
x' (= x−C)		R_b+A-y	
tan θ		R	
θ	° ′ ″		
	″	y	
$\frac{\theta}{\ell}$ (= Δλ)		y''	−
		y'	
λ (central mer.)	° ′ ″		
− Δλ		φ (by interpolation)	° ′ ″
λ			

$$\tan\theta = \frac{x - C}{R_b + A - y}$$

$$\Delta\lambda = \frac{\theta}{\ell}$$

$$\lambda = \lambda(\text{central mer.}) - \Delta\lambda$$

$$R = (R_b + A - y)\sec\theta$$

$$y'' = 2R\sin^2\frac{\theta}{2}$$

$$y' = y - y''$$

C is constant added to x' in computation of coordinates

R_b is map radius of lowest parallel

A is value of y' for R_b; in most cases it is zero

φ is interpolated from table of y'

(M-28)

Form No. 743
DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Ed, May 1935

GEODETIC POSITIONS FROM TRANSVERSE MERCATOR COORDINATES

STATE New Jersey STATION

x	2,194,000.00	$\log S_g$	5.28779551
K	2,000,000.00	$\log (1200/3937)$	9.4840158 3
x' $(=x-K)$	+ 194,000.00	$\log (1/R)$	1086
$x'^3/(6\rho_o^2)_g$	− 2.78	$\log S_m$	4.77182220 +
S_g	+ 193,997.22	cor. arc to sine	− 620
		$\log S_1$	4.77181600
$3 \log x'$	15.86340519	$\log A$	8.50909066
$\log 1/(6\rho_o^2)_g$	4.5810213	$\log \sec \phi$	0.12128173
$\log x'^3/(6\rho_o^2)_g$	0.4444265	$\log \Delta\lambda_1$	3.40219439
		cor. sine to arc	+ 1085
$\log S_m^2$	9.5436 4440	$\log \Delta\lambda$	3.40220524
$\log C$	1.3414 35	$\Delta\lambda$	+ 2524.6736″
$\log \Delta\phi$	0.8850 79		
y	738,000.00		
ϕ' (by interpolation)	40° 51′ 33.6745″	λ (central mer.)	74° 40′ ″
$\Delta\phi$	− 7.6750	$\Delta\lambda$	42 04.6736
ϕ	40 51 25.9995	λ	73 57 55.3264
	1604.01 (246.81) 1850.82		1186.38 (218.92) 1405.3

Explanation of form:

$x'=x-K$

$S_g=x'-\frac{x'^3}{(6\rho_o^2)_g}$

$S_m=\frac{1}{R}\left(\frac{1200}{3937}\right)S_g$

R=scale reduction factor

ϕ' is interpolated from table of y

$\Delta\phi=C\,S_m^2$

$\phi=\phi'-\Delta\phi$

$\Delta\lambda_1=S_1 A \sec\phi$

$\log S_1=\log S_m-$cor. arc to sine

$\log \Delta\lambda=\log \Delta\lambda_1+$cor. arc to sine

$\lambda=\lambda$ (central mer.)$-\Delta\lambda$

U. S. GOVERNMENT PRINTING OFFICE 11—11521

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form No. 744
Ed. May 1935

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New Jersey Station

λ (Central meridian) 74° 40′

φ 40° 51′ 25.9995″ λ 73° 57′ 55.3264″

Δλ (Central meridian−λ) + 42′ 04.6736″

Δλ (in sec.) + 2524.6736″

log Δλ	3.402 20 524	log S_m^2	9.5436 44 40
Cor. arc to sine	− 1 085	log C*	1.3414 ~~03~~ 35
log $\Delta\lambda_1$	3.402 19 439	log Δφ	0.8850 ~~47~~ 79
log cos φ	9.878 71 827		
colog A	1.490 90 334	φ	40° 51′ 25.9995″
log S_1	4.771 81 600	Δφ	+ 7.67~~44~~ 50
Cor. sine to arc	+ 620	φ′	40 51 33.67~~39~~ 45
log S_m	4.77182220		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.20150
log R	− 1086		
log S_g	5.28779551	y (for minutes of φ′)	734,592.09
log S_g^3	15.86338653	y (for seconds of φ′)	+ 3,407.91
log $(1/6\rho_o^2)_g$	4.5810213	y	738,000.00
log $(S_g^3/6\rho_o^2)_g$	0.4444078		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	193,997.22	log Δλ	
$(S_g^3/6\rho_o^2)_g$	2.78	log $\Delta\alpha_1$	
x′	+ 194,000.00		
	500,000.00	log $(\Delta\lambda)^3$	
x	694,000.00	log F	
		log b	
		$\Delta\alpha_1$ ″	
		b	
		Δα ″	
		Δα ° ′ ″	

*Take out C first for φ and correct for approximate φ′.

$x = 500{,}000.00 + x'$

$x' = S_g + \left(\frac{S_g^3}{6\rho_o^2}\right)_g$

$S_g = \frac{3937}{1200} S_m R$

$\log S_m = \log S_1 +$ cor. sine to arc

$S_1 = \frac{\Delta\lambda_1 \cos\phi}{A}$

$\log \Delta\lambda_1 = \log \Delta\lambda -$ cor. arc to sine

$\phi' = \phi + \Delta\phi$

$\Delta\phi = C\, S_m^2$

$\Delta\alpha = \Delta\lambda \sin \frac{\phi + \phi'}{2} + F(\Delta\lambda)^3$

S_m = distance in meters from point to central meridian

S_1 = distance in meters from point to central meridian reduced to sine

S_g = grid distance in feet from point to central meridian

R = scale reduction factor

Values of y in minutes and tabular difference for 1 second, scale reduction factors, colog A, and log C are given in auxiliary tables.

Form No. 743
DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Ed. May 1935

GEODETIC POSITIONS FROM TRANSVERSE MERCATOR COORDINATES

STATE New Jersey STATION

x	2,190,000.00	$\log S_g$	5.27874763
K	2,000,000.00	$\log (1200/3937)$	9.48401583
x' $(=x-K)$	+190,000.00	$\log (1/R)$	1086
$x'^3/(6\rho_o^2)_g$	− 2.61	$\log S_m$	4.76277432
S_g	+189,997.39	cor. arc to sine	− 595
		$\log S_1$	4.76276837
$3 \log x'$	15.8362 6080	$\log A$	8.50909666
$\log 1/(6\rho_o^2)_g$	4.5810 213	$\log \sec \phi$	0.12128230
$\log x'^3/(6\rho_o^2)_g$	0.4172 821	$\log \Delta\lambda_1$	3.39314733
		cor. sine to arc	+ 1040
$\log S_m^2$	9.525 54 864	$\log \Delta\lambda$	3.39315773
$\log C$	1.341 43 5	$\Delta\lambda$	2472.6220″
$\log \Delta\phi$	0.866 98 4		
y	738,000.00		
ϕ' (by interpolation)	40° 51′ 33.6745″	λ (central mer.)	74° 40′ 00.0000″
$\Delta\phi$	− 7.3618	$\Delta\lambda$	41 12.6220
ϕ	40 51 26.3127	λ	73 58 47.3780
	1623.34		814.07
	(227.48)		(591.23)
	1850.82		1405.3

Explanation of form:

$x'=x-K$

$S_g=x'-\frac{x'^3}{(6\rho_o^2)_g}$

$S_m=\frac{1}{R}\left(\frac{1200}{3937}\right)S_g$

R=scale reduction factor

ϕ' is interpolated from table of y

$\Delta\phi=C\,S_m^2$

$\phi=\phi'-\Delta\phi$

$\Delta\lambda_1=S_1 A \sec\phi$

$\log S_1=\log S_m-$cor. arc to sine

$\log \Delta\lambda=\log \Delta\lambda_1+$cor. arc to sine

$\lambda=\lambda$ (central mer.)$-\Delta\lambda$

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form No. 744
Ed. May 1935

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New Jersey Station

λ (Central meridian) 74° 40′

φ 40° 51′ 26.3127″ λ 73° 58′ 47.3780″

Δλ (Central meridian—λ) + 41′ 12.6220″

Δλ (in sec.) + 2472.6220″

log Δλ	3.393 15 773	log S_m^2	9.52554 862
Cor. arc to sine	− 1 041	log C*	1.34146 4 (corr. 3 5)
log $Δλ_1$	3.393 14 732	log Δφ	0.86695 3 (corr. 8 4)
log cos φ	9.878 21 770		
colog A	1.490 90 334	φ	40° 51′ 26.3127″
log S_1	4.762 76 836	Δφ	+ 7.3613 (corr. 8)
Cor. sine to arc	+ 595	φ′	40 51 33.6740 (corr. 5)
log S_m	4.76277431		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.20150
log R	− 1086		
log S_g	5.27874762	y (for minutes of φ′)	734,592.09
log S_g^3	15.83624286	y (for seconds of φ′)	+ 3,407.91
log $(1/6\rho_o^2)_g$	4.5810213	y	738,000.00
log $(S_g^3/6\rho_o^2)_g$	0.4172642		
S_g	189,997.384	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	2.614	log Δλ	
x′	+ 190,000.00	log $Δα_1$	
	500,000.00	log $(Δλ)^3$	
x	690,000.00	log F	
		log b	
		$Δα_1$ ″	
		b	
		Δα ″	
		Δα ° ′ ″	

*Take out C first for φ and correct for approximate φ′.

$$x=500{,}000.00+x'$$

$$x'=S_g+\left(\frac{S_g^3}{6\rho_0^2}\right)_g$$

$$S_g=\frac{3937}{1200}\,S_mR$$

$$\log S_m=\log S_1+\text{cor. sine to arc}$$

$$S_1=\frac{\Delta\lambda_1\cos\phi}{A}$$

$$\log \Delta\lambda_1=\log \Delta\lambda-\text{cor. arc to sine}$$

$$\phi'=\phi+\Delta\phi$$

$$\Delta\phi=C\,S_m^2$$

$$\Delta\alpha=\Delta\lambda\sin\frac{\phi+\phi'}{2}+F(\Delta\lambda)^3$$

S_m=distance in meters from point to central meridian

S_1=distance in meters from point to central meridian reduced to sine

S_g=grid distance in feet from point to central meridian

R =scale reduction factor

Values of y in minutes and tabular difference for 1 second, scale reduction factors, colog A, and log C are given in auxiliary tables.

U. S. GOVERNMENT PRINTING OFFICE 11—11525

Form No. 743
DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Ed. May 1935

GEODETIC POSITIONS FROM TRANSVERSE MERCATOR COORDINATES

STATE New Jersey STATION ✓

x	2,190,000.00	log S_g	5.27874763
K	2,000,000.00	log (1200/3937)	9.48401583
x' $(=x-K)$	+ 190,000.00	log $(1/R)$	1086
$x'^3/(6\rho_o^2)_g$	− 2.61	log S_m	4.76277432
S_g	+ 189,997.39	cor. arc to sine	− 595
		log S_1	4.76276837
3 log x'	15.8362 6080	log A	8.50909693
log $1/(6\rho_o^2)_g$	4.5810 213	log sec ϕ	0.12121034
log $x'^3/(6\rho_o^2)_g$	0.4172 821	log $\Delta\lambda_1$	3.39307564
		cor. sine to arc	+ 1040
log S_m^2	9.525 54 864	log $\Delta\lambda$	3.39308604
log C	1.341 26 8	$\Delta\lambda$	2472.2139″
log $\Delta\phi$	0.866 81 7		
y	734,000.00		
ϕ' (by interpolation)	40° 50′ 54.1494″	λ (central mer.)	74° 40′ 00.0000″
$\Delta\phi$	− 7.3590	$\Delta\lambda$	41 12.2139
ϕ	40 50 46.7904	λ	73 58 47.7861
	1035.86 (814.96) 1850.82		833.34 572.26 1405.6

Explanation of form:

$x'=x-K$

$S_g=x'-\frac{x'^3}{(6\rho_o^2)_g}$

$S_m=\frac{1}{R}\left(\frac{1200}{3937}\right)S_g$

R=scale reduction factor

ϕ' is interpolated from table of y

$\Delta\phi=C\,S_m^2$

$\phi=\phi'-\Delta\phi$

$\Delta\lambda_1=S_1A\sec\phi$

$\log S_1=\log S_m-$cor. arc to sine

$\log\Delta\lambda=\log\Delta\lambda_1+$cor. arc to sine

$\lambda=\lambda$ (central mer.)$-\Delta\lambda$

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form No. 744
Ed, May 1935

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New Jersey Station ______

λ (Central meridian) 74° 40′

φ 40° 50′ 46.7904″

λ 73° 58′ 47.7861″

Δλ (Central meridian − λ) + 41′ 12.2139″

Δλ (in sec.) + 2472.2139″

log Δλ	3.393 04 604	log S_m^2	9.525 54 864
Cor. arc to sine	− 1 040	log C*	1.341 268
log $\Delta\lambda_1$	3.393 67 564	log Δφ	0.466 517
log cos φ	9.878 78 966		
colog A	1.490 90 307	φ	40° 50′ 46.7904″
log S_1	4.762 76 837	Δφ	+ 7.3590
Cor. sine to arc	+ 595	φ′	40 50 54.1494
log S_m	4.7627743 2		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.20117
log R	− 1086		
log S_g	5.27874763	y (for minutes of φ′)	728,520.02
log S_g^3	15.83624289	y (for seconds of φ′)	+ 5,479.98
log $(1/6\rho_o^2)_g$	4.5810213	y	734,000.00
log $(S_g^3/6\rho_o^2)_g$	0.4172642		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	189997.39	log Δλ	
$(S_g^3/6\rho_o^2)_g$	2.61	log $\Delta\alpha_1$	
x′	+ 190,000.00		
	500,000.00	log $(\Delta\lambda)^3$	
x	690,000.00	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

*Take out C first for φ and correct for approximate φ′.

$x = 500,000.00 + x'$

$x' = S_g + \left(\frac{S_g^3}{6\rho_o^2}\right)_g$

$S_g = \frac{3937}{1200} S_m R$

$\log S_m = \log S_1 +$ cor. sine to arc

$S_1 = \frac{\Delta\lambda_1 \cos \phi}{A}$

$\log \Delta\lambda_1 = \log \Delta\lambda -$ cor. arc to sine

$\phi' = \phi + \Delta\phi$

$\Delta\phi = C\, S_m^2$

$\Delta\alpha = \Delta\lambda \sin \frac{\phi + \phi'}{2} + F(\Delta\lambda)^3$

S_m = distance in meters from point to central meridian

S_1 = distance in meters from point to central meridian reduced to sine

S_g = grid distance in feet from point to central meridian

R = scale reduction factor

Values of y in minutes and tabular difference for 1 second, scale reduction factors, colog A, and log C are given in auxiliary tables.

U. S. GOVERNMENT PRINTING OFFICE 11—11525

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 24A
Rev. Oct., 1932

LIST OF DIRECTIONS

Station Bronx Court State N. Y.

Chief of party R.C. Bolstad Date Computed by

Observer Instrument Checked by

U. S. GOVERNMENT PRINTING OFFICE: 1933 11—9503

OBSERVED STATION	Observed direction	Eccentric reduction	Sea level reduction*	Corrected direction with zero initial	Adjusted direction*
	° ′ ″	′ ″	″	° ′ ″	′ ″
N Tower (Eldorado)	0 00 00.00			0 00 00.00	
Flagpole (CCNY)	30 53 28.9				
Highbridge	116 27 54.8				
Morris High School	227 25 00.1				

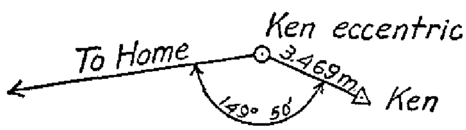
* These columns are for office use and should be left blank in the field.

Station: Ken — *State:* Maryland

Chief of party: C. V. H. — *Date:* 1917 — *Computed by:* O. P. S.

Observer: C. V. H. — *Instrument:* No. 168 — *Checked by:* W. F. R.

OBSERVED STATION	Observed direction	Eccentric reduction	Sea level reduction	Corrected direction with zero initial	Adjusted direction
	° ′ ″	′ ″	″	° ′ ″	′ ″
Chevy	0 00 00.00	− 7.31		0 00 00.00	
Tank west of △ Dulce	29 03 37.0	−1 09.8		29 02 34.5	
Ken (center), 3.469 meters	176 42				
Forest Glen standpipe	313 24 53.0	+3 01.2		313 28 01.5	
Home	326 31 30.21	+ 31.93		326 32 09.45	
Bureau of Standards, wireless pole	352 17 20.8	+ 5.7		352 17 33.8	
Reno	357 28 48.63	− 1.16		357 28 54.78	
Reference mark, 16.32 m	358 31 20				



This form, with the first three and fifth columns properly filled out and checked, must be furnished by field parties. *To be acceptable it must contain every direction observed at the station.*

It should be used for observations with both repeating and direction theodolites.

The directions at only one station should be placed on a page.

If a repeating theodolite is used, do not abstract the angles in tertiary triangulation. The local adjustment corrections (to close horizon only) are to be written in the Horizontal Angle Record, and the List of Directions is to be made from that record directly.

Choose as an initial for Form 24A some station involved in the local adjustment, and preferably one which has been used as an initial for a round of directions on objects not in the main scheme. Use but one initial at a station. Call the direction of the initial 0° 00′ 00.″ 00, and by applying the corrected angles to this, fill in opposite each station its direction reckoned *clockwise* around the whole circumference regardless of the direction of graduation of the instrument. The clockwise reckoning is necessary for uniformity and to make the directions comparable with azimuths.

If a station has been occupied eccentrically, reduce to the center and enter in this form, in ink, the resulting corrections to the observed directions in the column provided for them. If an eccentric reduction is necessary, but not made in the field, leave the column blank. If the station was occupied centrally, and no eccentric reduction is required, put dashes in the column to show that no corrections are necessary.

Directions in the main scheme should be entered to hundredths of seconds in first-order triangulation; otherwise to tenths only. Points observed upon but once, direct and reverse, should be carried to tenths in first-order and second-order triangulation, and to even seconds only in third-order triangulation. In general, but two uncertain figures should be given.

It is recommended that the following simple plan of observing be used with a repeating instrument: Measure each single angle in the scheme at each station and the outside angle necessary to close the horizon. *Measure no sum angles.* Follow each measurement of every angle immediately by a measurement of its explement. Six repetitions are to constitute a measurement. The local adjustment will consist simply of the distribution of the error of closure of the horizon.

11—9503

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
Form 665
Ed. Dec. 1929

TRIANGLE COMPUTATION USING TWO SIDES AND INCLUDED ANGLE

$\left[\frac{a}{b} = \tan(45° + \phi)\right.$ (Call longer side a): $\tan \frac{1}{2}(A_p - B_p) = \tan\phi \tan \frac{1}{2}(A_p + B_p)$: $\left. c = \frac{a \sin C_p}{\sin A_p}\right]$*

	° ′ ″				
C_s	74 23 10.2	Log a	3.835 710	Log m	
Sph. excess / 3		Log b	3.470 540	Log sin C_s	
C_p	74 23 10.2	Log tan $(45+\phi)$	0 365 170	Log a	
$\frac{1}{2} C_p$	37 11 35.1	$(45° + \phi)$	66° 40′ 01.345″	Log b	
$90° - \frac{1}{2}C_p = \frac{1}{2}(A_p + B_p)$	52 48 24.9	ϕ	21 40 01.345	Log sph. ex.	
$\frac{1}{2}(A_p - B_p)$	27 38 00.4	Log tan ϕ	9.599 0990	Sph. excess	
Sum $= A_p$	80 26 25.3	Log tan $\frac{1}{2}(A_p + B_p)$	0.119 8435		
Diff $= B_p$	25 10 24.5	Log tan $\frac{1}{2}(A_p - B_p)$	9.718 9425		
C_p	74 23 10.2			(Sketch)	

Log a	3.835710
Log sin C_p	9.9836703
Colog sin A_p	0.006 0732
Log c	3.825453

CHECK COMPUTATION

No.	STATION	SPHERICAL ANGLE	SPHERICAL EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
	2-3				3.825 453
C	1 Morris High School	74 23 10.2			0.016 3297
A	2 High bridge	80 26 25.3			9.993 9268
B	3 N. Tower (Eldorado	25 10 24.5			9.628 7570
	1-3				3.835710
	1-2				3.470 540
	2-3				
	1				
	2				
	3				
	1-3				
	1-2				

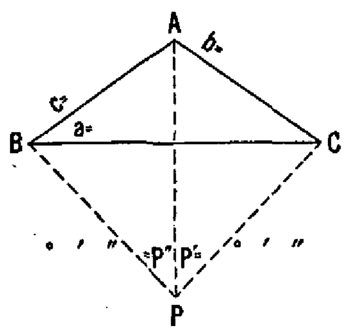
*The subscripts s and p on this form refer to spherical and plane angles respectively.

U. S. GOVERNMENT PRINTING OFFICE: 1948 11—11142

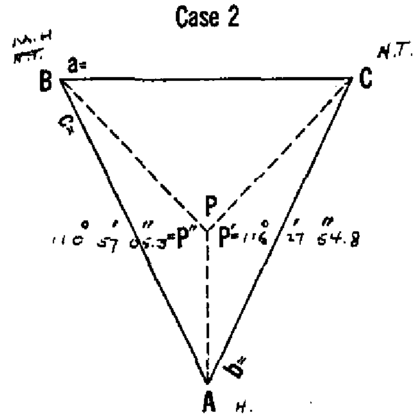
DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 655
Ed. Sept., 1929

COMPUTATION OF THREE-POINT PROBLEM

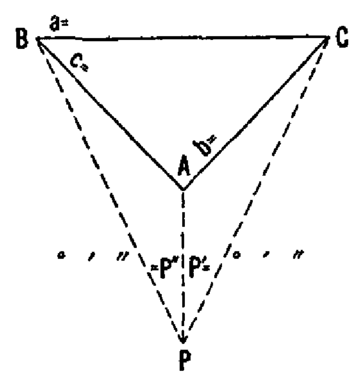
Case 1



Case 2



Case 3



Cases 1 and 2

P′	116 27 54.8
P″	110 57 05.3
A	80 26 25.3
Sum	307 51 25.4
½ Sum	153 55 42.7
S=180°−½ sum=	26 04 17.3
Log c =	3.470 540
Log sin P′ =	9.951 9225
Colog b =	6.174 547
Colog sin P″ =	0.029 7072
Sum=log tan Z=	9.6267167
Z=	22 56 46.3
Z+45°=	67 56 46.3
Log cot (Z+45°) =	9.607 5829
Log tan S=	9.689 5554
Sum=log tan ε=	9.297 1383 (sign +)
ε	11 12 41.8
S	26 04 17.3

Case 3

P′	
P″	
Sum	
A	
A−sum	
S=½ (A−sum)=	

(Tan ε+)		(Tan ε−)	
S+ε=angle ABP	37 16 59.1	S−ε=angle ABP	
S−ε=angle ACP	14 51 35.5	S+ε=angle ACP	

BPA		APC		PCB	
ABP		PCA		CBP	
PAB		CAP		BPC	

(For explanation of this form see Special Publication No. 138, pages 191 and 192, or Special Publication No. 145, pages 98–100)

U. S. GOVERNMENT PRINTING OFFICE: 1929
11—9912

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

COMPUTATION OF TRIANGLES

11—9121

State: ....

U. S. GOVERNMENT PRINTING OFFICE: 1929

NO.	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
	2-3						3.825 453
	1 Bronx Court	116 27 54.8					0.048 0776
	2 N Tower	14 51 35.5					9.409 0124
	3 Highbridge	(48 40 29.7)					9.875 6267
	1-3						3.282 543
	1-2						3.749 157
	2-3						3.470 540
	1 Bronx Court	110 57 05.3					0.029 7072
	2 Highbridge	(31 45 55.6)					9.721 3514
	3 Morris High Sch.	37 16 59.1					9.782 2960
	1-3						3.221 599
	1-2						3.282 543
	2-3						3.835 710
	1 Bronx Court	132 34 59.9					0.132 9486
	2 Morris High School	37 06 11.1					9.780 4980
	3 N. Tower	10 18 49.0					9.252 9402
	1-3						3.749 157
	1-2						3.221 599
	2-3						
	1						
	2						
	3						
	1-3						
	1-2						

Do not write in this margin

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 27
Ed. April, 1929

POSITION COMPUTATION, THIRD-ORDER TRIANGULATION

			°	′	″
α	2	to 3			
2d ∠		&	+		
α	2	to 1	51	13	13.0
Δα			−	02	28.8
			180	00	00.0
α′	1	to 2	231	10	44.27

FIRST ANGLE OF TRIANGLE

	°	′	″			°	′	″
φ	40	49	37.021	2 M.H.S	λ	73	54	~~67.645~~ 16.427
Δφ	−	02	19.154		Δλ		03	47.766
φ′	40	47	17.867	1	λ′	73	58	04.193

	Logarithms		Values in seconds
s	3.835710		
Cos α	9.796802	-2	
B	8.510790	0	
h	2.143302	1st term	+139.0920 ″
s^2	7.671142		
Sin²α	9.78370		
C	1.34069		
	8.79581	2d term	+.0625
h²	4.2866		
D	2.3877		−0.0005
	6.6743	3d term	+0.0005
	6.1214	−Δφ	+139.1545

2.1433
8.4551
6.7198

	Logarithms	Values in seconds
½(φ+φ′)	40 48 27.44	
s	3.835710	
Sin α	9.891849	+4
A′	8.509098	+4
Sec φ′	0.120830	+4
Δλ	2.357488	+227.7655 ″
Sin ½(φ+φ′)	9.815260	
−Δα	2.172748	+148.85

			°	′	″
α	3	to 2			
3d ∠		&	−		
α	3	to 1			
Δα					
			180	00	00.0
α′	1	to 3			

	°	′	″			°	′	″
φ				3	λ			
Δφ					Δλ			
φ′				1	λ′			

	Logarithms		Values in seconds
s			
Cos α			
B			
h		1st term	″
s^2			
Sin²α			
C			
		2d term	+
h²			
D			
		3d term	+
		−Δφ	

	Logarithms	Values in seconds
½(φ+φ′)		
s		
Sin α		
A′		
Sec φ′		
Δλ		″
Sin ½(φ+φ′)		
−Δα		

40 50 32.779 — Highbridge (1927) 73 55 58.976
33.168 NA 58.826
− 0.389 +0.150

40 49 37.021 Morris H.S (1927) 73 54 16.427
37.408 (NA) 16.271
−0.387 +0.156

−0.387
−0.389
−0.388

+0.150
+0.156
+0.153

40 49 35.823 Bronx Count 73 55 27.332
−.388 +0.153
35.435 (1927-reduced) 27.485
35.435 computed 0.481
.000 .004

23.432
.004
.093728

Check in position = 0.094 m

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 662
Rev. April, 1931

INVERSE POSITION COMPUTATION

$$s_1 \sin\left(\alpha+\frac{\Delta\alpha}{2}\right)=\frac{\Delta\lambda_1 \cos\phi_m}{A_m}$$

$$s_1 \cos\left(\alpha+\frac{\Delta\alpha}{2}\right)=\frac{-\Delta\phi_1 \cos\frac{\Delta\lambda}{2}}{B_m}$$

$$-\Delta\alpha=\Delta\lambda \sin\phi_m \sec\frac{\Delta\phi}{2}+F(\Delta\lambda)^3$$

in which log $\Delta\lambda_1$=log $(\lambda'-\lambda)$ − correction for arc to sin*; log $\Delta\phi_1$=log $(\phi'-\phi)$ − correction for arc to sin*; and log s=log s_1+ correction for arc to sin*.

	°	′	″	NAME OF STATION		°	′	″
1. ϕ	40	50	33.168	High bridge	λ	73	55	58.826
2. ϕ'	40	49	14.170	flag pole (CCNY	λ'	73	56	53.910
$\Delta\phi$ $(=\phi'-\phi)$		−01	18.998	$\Delta\lambda$ $(=\lambda'-\lambda)$				+55.084
$\frac{\Delta\phi}{2}$			39.50	$\frac{\Delta\lambda}{2}$				
$\phi_m\left(=\phi+\frac{\Delta\phi}{2}\right)$	40	49	53.67					
$\Delta\phi$ (secs.)			−78.998″	$\Delta\lambda$ (secs.)				+55.084″

log $\Delta\phi$	1.8976161		log $\Delta\lambda$	1.7410255
cor. arc−sin	−		cor. arc−sin	−
log $\Delta\phi_1$	1.8976161		log $\Delta\lambda_1$	1.7410255
log cos $\frac{\Delta\lambda}{2}$			log cos ϕ_m	9.8788863
colog B_m	1.4892116		colog A_m	1.4909027
log $\left\{s_1 \cos\left(\alpha+\frac{\Delta\alpha}{2}\right)\right\}$	3.3868277	(opposite in sign to $\Delta\phi$)	log $\left\{s_1 \sin\left(\alpha+\frac{\Delta\alpha}{2}\right)\right\}$	3.1108145 +
			log $\left\{s_1 \cos\left(\alpha+\frac{\Delta\alpha}{2}\right)\right\}$	3.3868277 +
log $\Delta\lambda$	1.7410255	3 log $\Delta\lambda$	log tan $\left(\alpha+\frac{\Delta\alpha}{2}\right)$	9.7239868
log sin ϕ_m	9.8154699	log F	$\alpha+\frac{\Delta\alpha}{2}$	27° 54′ 28.12″
log sec $\frac{\Delta\phi}{2}$		log b	log sin $\left(\alpha+\frac{\Delta\alpha}{2}\right)$	9.6702925
log a	1.5564954		log cos $\left(\alpha+\frac{\Delta\alpha}{2}\right)$	9.9463058
a			log s_1	3.4405220
b			cor. arc−sin	+
$-\Delta\alpha$ (secs.)	+36.02″		log s	3.440522
$\frac{\Delta\alpha}{2}$	18.01″			
	+38.07			

	°	′	″
$\alpha+\frac{\Delta\alpha}{2}$	27	54	28.12
α (1 to 2)	27	54	46.13
$\Delta\alpha$			−36.02
	180		
α' (2 to 1)	207	54	10.11

*Use the table on the back of this form for correction of arc to sin.

NOTE.—For log s up to 4.52 and for $\Delta\phi$ or $\Delta\lambda$ (or both) up to 10′, omit all terms below the heavy line except those printed (in whole or in part) in heavy type or those underscored, if using logarithms to 6 decimal places. 11—9810

U. S. GOVERNMENT PRINTING OFFICE: 1931

Table of arc-sin corrections for inverse position computations

log s_1	Arc-sin correction in units of seventh decimal of logarithms	log $\Delta\phi$ or log $\Delta\lambda$	log s_1	Arc-sin correction in units of seventh decimal of logarithms	log $\Delta\phi$ or log $\Delta\lambda$	log s_1	Arc-sin correction in units of seventh decimal of logarithms	log $\Delta\phi$ or log $\Delta\lambda$
4. 177	1	2. 686	5. 223	124	3. 732	5. 525	497	4. 034
4. 327	2	2. 836	5. 234	130	3. 743	5. 530	508	4. 039
4. 415	3	2. 924	5. 243	136	3. 752	5. 534	519	4. 043
4. 478	4	2. 987	5. 253	142	3. 762	5. 539	530	4. 048
4. 526	5	3. 035	5. 260	147	3. 769	5. 543	541	4. 052
4. 566	6	3. 075	5. 269	153	3. 778	5. 548	553	4. 057
4. 599	7	3. 108	5. 279	160	3. 788	5. 553	565	4. 062
4. 628	8	3. 137	5. 287	166	3. 796	5. 557	577	4. 066
4. 654	9	3. 163	5. 294	172	3. 803	5. 561	588	4. 070
4. 677	10	3. 186	5. 303	179	3. 812	5. 566	600	4. 075
4. 697	11	3. 206	5. 311	186	3. 820	5. 570	613	4. 079
4. 716	12	3. 225	5. 318	192	3. 827	5. 575	625	4. 084
4. 734	13	3. 243	5. 326	199	3. 835	5. 579	637	4. 088
4. 750	14	3. 259	5. 334	206	3. 843	5. 583	650	4. 092
4. 765	15	3. 274	5. 341	213	3. 850	5. 587	663	4. 096
4. 779	16	3. 288	5. 349	221	3. 858	5. 591	674	4. 100
4. 792	17	3. 301	5. 356	228	3. 865	5. 595	687	4. 104
4. 804	18	3. 313	5. 363	236	3. 872	5. 600	702	4. 109
4. 827	20	3. 336	5. 369	243	3. 878	5. 604	716	4. 113
4. 857	23	3. 366	5. 376	251	3. 885	5. 608	729	4. 117
4. 876	25	3. 385	5. 383	259	3. 892	5. 612	743	4. 121
4. 892	27	3. 401	5. 390	267	3. 899	5. 616	757	4. 125
4. 915	30	3. 424	5. 396	275	3. 905	5. 620	771	4. 129
4. 936	33	3. 445	5. 403	284	3. 912	5. 624	785	4. 133
4. 955	36	3. 464	5. 409	292	3. 918	5. 628	800	4. 137
4. 972	39	3. 481	5. 415	300	3. 924	5. 632	814	4. 141
4. 988	42	3. 497	5. 422	309	3. 931	5. 636	829	4. 145
5. 003	45	3. 512	5. 428	318	3. 937	5. 640	845	4. 149
5. 017	48	3. 526	5. 434	327	3. 943	5. 644	861	4. 153
5. 035	52	3. 544	5. 440	336	3. 949	5. 648	877	4. 157
5. 051	56	3. 560	5. 446	345	3. 955	5. 652	893	4. 161
5. 062	59	3. 571	5. 451	354	3. 960	5. 656	909	4. 165
5. 076	63	3. 585	5. 457	364	3. 966	5. 660	925	4. 169
5. 090	67	3. 599	5. 462	373	3. 971	5. 663	941	4. 172
5. 102	71	3. 611	5. 468	383	3. 977	5. 667	957	4. 176
5. 114	75	3. 623	5. 473	392	3. 982	5. 671	973	4. 180
5. 128	80	3. 637	5. 479	402	3. 988	5. 674	989	4. 183
5. 139	84	3. 648	5. 484	412	3. 993	5. 678	1005	4. 187
5. 151	89	3. 660	5. 489	422	3. 998			
5. 163	94	3. 672	5. 495	433	4. 004			
5. 172	98	3. 681	5. 500	443	4. 009			
5. 183	103	3. 692	5. 505	453	4. 014			
5. 193	108	3. 702	5. 510	464	4. 019			
5. 205	114	3. 714	5. 515	474	4. 024			
5. 214	119	3. 723	5. 520	486	4. 029			

11—9810

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 662
Rev. April, 1931

INVERSE POSITION COMPUTATION

$$s_1 \sin\left(\alpha+\frac{\Delta\alpha}{2}\right)=\frac{\Delta\lambda_1 \cos\phi_m}{A_m}$$

$$s_1 \cos\left(\alpha+\frac{\Delta\alpha}{2}\right)=\frac{-\Delta\phi_1 \cos\frac{\Delta\lambda}{2}}{B_m}$$

$$-\Delta\alpha=\Delta\lambda \sin\phi_m \sec\frac{\Delta\phi}{2}+F(\Delta\lambda)^3$$

in which log $\Delta\lambda_1$=log $(\lambda'-\lambda)$−correction for arc to sin*; log $\Delta\phi_1$=log $(\phi'-\phi)$−correction for arc to sin*; and log s=log s_1+ correction for arc to sin*.

	° ′ ″	NAME OF STATION		° ′ ″
1. ϕ	40 49 37.408	Morris H. S.	λ	73 54 16.271
2. ϕ'	40 49 14.17-	Flagpole	λ'	73 56 53.91-
$\Delta\phi$ $(=\phi'-\phi)$	−23.238		$\Delta\lambda$ $(=\lambda'-\lambda)$	+02 37.639
$\frac{\Delta\phi}{2}$	11.619		$\frac{\Delta\lambda}{2}$	01 18.82
$\phi_m\left(=\phi+\frac{\Delta\phi}{2}\right)$	40 49 25.79			
$\Delta\phi$ (secs.)	23.238		$\Delta\lambda$ (secs.)	+157.639

log $\Delta\phi$	1.3661987		**log** $\Delta\lambda$	2.1976636
cor. arc−sin	−		cor. arc−sin	−
log $\Delta\phi_1$	1.3661987		log $\Delta\lambda_1$	2.1976636
log cos $\frac{\Delta\lambda}{2}$			**log cos** ϕ_m	9.8789371
colog B_m	1.4892110		**colog** A_m	1.4909025
log $\left\{s_1 \cos\left(\alpha+\frac{\Delta\alpha}{2}\right)\right\}$	2.8554097	(opposite in sign to $\Delta\phi$)	**log** $\left\{s_1 \sin\left(\alpha+\frac{\Delta\alpha}{2}\right)\right\}$	3.5675032 +
			log $\left\{s_1 \cos\left(\alpha+\frac{\Delta\alpha}{2}\right)\right\}$	2.8554097 +
log $\Delta\lambda$	2.1976636	3 log $\Delta\lambda$	**log tan** $\left(\alpha+\frac{\Delta\alpha}{2}\right)$	0.7120935 +
log sin ϕ_m	9.8154020	log F	$\alpha+\frac{\Delta\alpha}{2}$	79 (~~78~~) 01 (~~59~~) 06.29 (~~37.38~~)
log sec $\frac{\Delta\phi}{2}$		log b	**log sin** $\left(\alpha+\frac{\Delta\alpha}{2}\right)$	9.99 19487 (~~9.991 9374~~)
log a	2.0130656		**log cos** $\left(\alpha+\frac{\Delta\alpha}{2}\right)$	9.279 8802 (~~9.280 8439~~)
a	+103.06		**log** s_1	3.575 5295 (~~3.575 5658~~)
b			cor. arc−sin	+
$-\Delta\alpha$ **(secs.)**	+103.06		log s	3.575 530~~5~~ 29
$\frac{\Delta\alpha}{2}$	+51.53			
	51.53			
$\alpha+\frac{\Delta\alpha}{2}$	79 01 06.29			
α (1 to 2)	79 01 57.82	57.8		
$\Delta\alpha$	−01 43.06	43.1		
	180			
α′ (2 to 1)	259 00 14.76	14.7		

* Use the table on the back of this form for correction of arc to sin.

NOTE.—For log s up to 4.52 and for $\Delta\phi$ or $\Delta\lambda$ (or both) up to 10′, omit all terms below the heavy line except those printed (in whole or in part) in heavy type or those underscored, if using logarithms to 6 decimal places. 11—9310

U. S. GOVERNMENT PRINTING OFFICE: 1931

Table of arc-sin corrections for inverse position computations

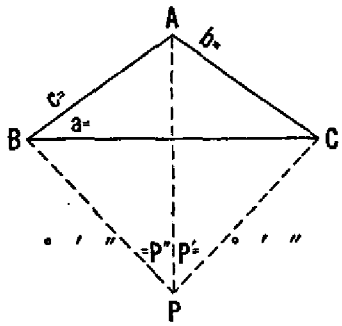
log s_1	Arc-sin correction in units of seventh decimal of logarithms	log $\Delta\phi$ or log $\Delta\lambda$	log s_1	Arc-sin correction in units of seventh decimal of logarithms	log $\Delta\phi$ or log $\Delta\lambda$	log s_1	Arc-sin correction in units of seventh decimal of logarithms	log $\Delta\phi$ or log $\Delta\lambda$
4. 177	1	2. 686	5. 223	124	3. 732	5. 525	497	4. 034
4. 327	2	2. 836	5. 234	130	3. 743	5. 530	508	4. 039
4. 415	3	2. 924	5. 243	136	3. 752	5. 534	519	4. 043
4. 478	4	2. 987	5. 253	142	3. 762	5. 539	530	4. 048
4. 526	5	3. 035	5. 260	147	3. 769	5. 543	541	4. 052
4. 566	6	3. 075	5. 269	153	3. 778	5. 548	553	4. 057
4. 599	7	3. 108	5. 279	160	3. 788	5. 553	565	4. 062
4. 628	8	3. 137	5. 287	166	3. 796	5. 557	577	4. 066
4. 654	9	3. 163	5. 294	172	3. 803	5. 561	588	4. 070
4. 677	10	3. 186	5. 303	179	3. 812	5. 566	600	4. 075
4. 697	11	3. 206	5. 311	186	3. 820	5. 570	613	4. 079
4. 716	12	3. 225	5. 318	192	3. 827	5. 575	625	4. 084
4. 734	13	3. 243	5. 326	199	3. 835	5. 579	637	4. 088
4. 750	14	3. 259	5. 334	206	3. 843	5. 583	650	4. 092
4. 765	15	3. 274	5. 341	213	3. 850	5. 587	663	4. 096
4. 779	16	3. 288	5. 349	221	3. 858	5. 591	674	4. 100
4. 792	17	3. 301	5. 356	228	3. 865	5. 595	687	4. 104
4. 804	18	3. 313	5. 363	236	3. 872	5. 600	702	4. 109
4. 827	20	3. 336	5. 369	243	3. 878	5. 604	716	4. 113
4. 857	23	3. 366	5. 376	251	3. 885	5. 608	729	4. 117
4. 876	25	3. 385	5. 383	259	3. 892	5. 612	743	4. 121
4. 892	27	3. 401	5. 390	267	3. 899	5. 616	757	4. 125
4. 915	30	3. 424	5. 396	275	3. 905	5. 620	771	4. 129
4. 936	33	3. 445	5. 403	284	3. 912	5. 624	785	4. 133
4. 955	36	3. 464	5. 409	292	3. 918	5. 628	800	4. 137
4. 972	39	3. 481	5. 415	300	3. 924	5. 632	814	4. 141
4. 988	42	3. 497	5. 422	309	3. 931	5. 636	829	4. 145
5. 003	45	3. 512	5. 428	318	3. 937	5. 640	845	4. 149
5. 017	48	3. 526	5. 434	327	3. 943	5. 644	861	4. 153
5. 035	52	3. 544	5. 440	336	3. 949	5. 648	877	4. 157
5. 051	56	3. 560	5. 446	345	3. 955	5. 652	893	4. 161
5. 062	59	3. 571	5. 451	354	3. 960	5. 656	909	4. 165
5. 076	63	3. 585	5. 457	364	3. 966	5. 660	925	4. 169
5. 090	67	3. 599	5. 462	373	3. 971	5. 663	941	4. 172
5. 102	71	3. 611	5. 468	383	3. 977	5. 667	957	4. 176
5. 114	75	3. 623	5. 473	392	3. 982	5. 671	973	4. 180
5. 128	80	3. 637	5. 479	402	3. 988	5. 674	989	4. 183
5. 139	84	3. 648	5. 484	412	3. 993	5. 678	1005	4. 187
5. 151	89	3. 660	5. 489	422	3. 998			
5. 163	94	3. 672	5. 495	433	4. 004			
5. 172	98	3. 681	5. 500	443	4. 009			
5. 183	103	3. 692	5. 505	453	4. 014			
5. 193	108	3. 702	5. 510	464	4. 019			
5. 205	114	3. 714	5. 515	474	4. 024			
5. 214	119	3. 723	5. 520	486	4. 029			

11—9810

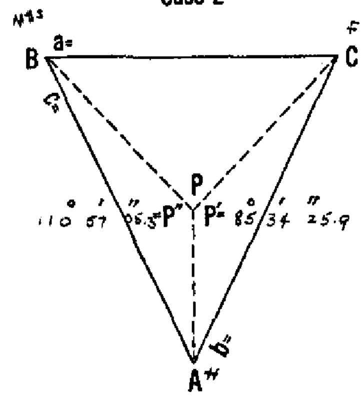
DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 655
Ed. Sept., 1929

COMPUTATION OF THREE-POINT PROBLEM

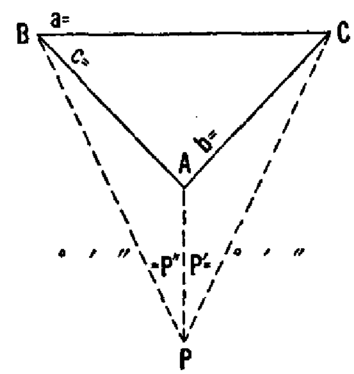
Case 1



Case 2



Case 3



Cases 1 and 2		Case 3	
P′	85 34 25.9	P′	
P″	110 57 05.3	P″	
A	82 19 33.1		
	278 51 04.3	Sum	
Sum		A	
½ Sum	139 25 32.15		
		A−sum	
S=180°−½ sum=	40 34 27.85	S=½ (A−sum)=	
Log c =	3.470559		
Log sin P′ =	9.9987029		
Colog b =	6.559478		
Colog sin P″ =	0.0297072		
Sum=log tan Z=	0.0584471		
Z=	48 50 37.79		
Z+45°=	93 50 37.79		
Log cot (Z+45°) =	8.8272938		
Log tan S=	9.9326407		
Sum=log tan ε=	8.7599345 (sign −)		
ε	3 17 34.44		
S	40 34 27.85		
(Tan ε+)	37 16 53.4	(Tan ε−)	
S+ε=angle ABP	43 52 02.3	S−ε=angle ABP	
S−ε=angle ACP		S+ε=angle ACP	

BPA		APC		PCB	
ABP		PCA		CBP	
PAB		CAP		BPC	

(For explanation of this form see Special Publication No. 138, pages 191 and 192, or Special Publication No. 145, pages 98–100)

U. S. GOVERNMENT PRINTING OFFICE: 1929
11—9912

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

COMPUTATION OF TRIANGLES

11—9121

State: ....

NO.	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
	2-3						3.470 559
	1 Flagpole (CCNY)	51 06 04.6					0.108 876 9
	2 Highbridge	82 19 33.1					9.996 092 7
	3 Morris H.S.	46 34 22.3					9.861 085 6
	1-3						3.575 529
	1-2						3.440 522
	2-3						3.440 522
	1 Bronx Court	85 34 25.9					0.001 297 1
	2 Flagpole	43 52 02.3					9.840 727 4
	3 Highbridge	(50 33 31.8)					9.887 773 3
	1-3						3.282 546
	1-2						3.329 592
	2-3						3.470 559
	1 Bronx Court	110 57 05.3					0.029 707 2
	2 Highbridge	(31 46 01.3)					9.721 370 8
	3 Morris H.S.	37 16 53.4					9.782 280 2
	1-3						3.221 637
	1-2						3.282 546
	2-3						3.575 529
	1 Bronx Court	163 28 28.8					0.546 010 5
	2 Morris H.S.	9 17 28.9					9.208 051 6
	3 Flagpole	7 14 02.3					9.100 099 8
	1-3						3.329 591 +1
	1-2						3.221 639 −2

Do not write in this margin

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 27
Ed. April, 1929

POSITION COMPUTATION, THIRD-ORDER TRIANGULATION

			°	′	″
α	2	to 3	305	35	16.3
2d ∠		&	+ 31	45	55.6
α	2	to 1	337	21	11.9
Δα				+	20.6
			180	00	00.0
α′	1	to 2	157	21	32.5 −
		First Angle of Triangle	110	57	05.3

			°	′	″
α	3	to 2	125	36	23.2
3d ∠		&	− 37	16	59.1
α	3	to 1	88	19	24.1
Δα				−	46.5
			180	00	00.0
α′	1	to 3	268	18	37.6 +1

	°	′	″			°	′	″
φ	40	50	32.779	2 Highbridge	λ	73	55	58.976
Δφ			57.345		Δλ		−	31.495
φ′	40	49	35.434 +1	1 Bronx Court	λ′	73	55	27.481

	°	′	″			°	′	″
φ	40	49	37.021	3 Morris H. S.	λ	73	54	16.427
Δφ			01.586		Δλ	+	01	11.053
φ′	40	49	35.435	1 Bronx Court	λ′	73	55	27.480

	Logarithms		Values in seconds	
s	3.282543			
Cos α	9.965153	+1		
B	8.510788	−4		
h	1.758484		1st term	+57.3435″
s²	6.56509			
Sin² α	9.17103			
C	1.34118			
	7.07730		2d term	+ 0.0012
h²	3.5170			
D	2.3878			
	5.9048		3d term	+ 0.0001
			−Δφ	+57.3448

	Logarithms	Values in seconds
½(φ+φ′)	40 50 04.1	
s	3.282543	
Sin α	9.585514 +4	
A′	8.509098 −5	
Sec φ′	0.121080 +5	
Δλ	1.498235	−31.4945″
Sin ½(φ+φ′)	9.815495	
−Δα	1.313730	−20.59

	Logarithms		Values in seconds	
s	3.221599			
Cos α	8.466255	−1		
B	8.510788	−2		
h	0.198643		1st term	+ 1.5799″
s²	6.44320			
Sin² α	9.99963			
C	1.34094			
	7.78377		2d term	+0.0061
h²	0.			
D	2.3878			
	——		3d term	+ ——
			−Δφ	+1.5860

	Logarithms	Values in seconds
½(φ+φ′)	40 49 36.2	
s	3.221599	
Sin α	9.999814 0	
A′	8.509098 −5	
Sec φ′	0.121080 +5	
Δλ	1.851581	+71.0528″
Sin ½(φ+φ′)	9.815427	
−Δα	1.667008	+46.45 +

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ON N.A. 1927 Datum

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 27
Ed. April, 1929

POSITION COMPUTATION, THIRD-ORDER TRIANGULATION

			°	′	″
α	2	to 3	305	35	13.0
2d ∠		&	+ 31	46	01.3
α	2	to 1	337	21	14.3
Δα				+	20.6
			180	00	00.0
α′	1	to 2	157	21	34.9
	First Angle of Triangle		110	57	05.3

	°	′	″			°	′	″
φ	40	50	33.168	2 High Bridge	λ	73	55	58.826
Δφ			- 57.345		Δλ		-	31.494
φ′	40	49	35.823	1 Bronx Court	λ′	73	55	27.332

	Logarithms		Values in seconds	
s	3.282546			
Cos α	9.965155	+2		
B	8.510788	-4		
h	1.758489	1st term	+57.3441	
s^2	6.56409			
$Sin^2 α$	9.17100			
C	1.34118			
	7.07627	2d term	+ 0.0012	
h^2	3.5170			
D	2.3878			
	5.9048	3d term	+ 0.0001	
		−Δφ	+57.3464	

	° ′ ″	
½(φ+φ′)	40 50 04.5	
	Logarithms	**Values in seconds**
s	3.282546	
Sin α	9.585502	+3
A′	8.509098	-5
Sec φ′	0.121081	+2
Δλ	1.498227	-31.4939
Sin ½(φ+φ′)	9.815496	
−Δα	1.313723	- 20.59

			°	′	″
α	3	to 2	125	36	20.1
3d ∠		&	- 37	16	53.4
α	3	to 1	88	19	26.7
Δα				-	46.5
			180	00	00.0
α′	1	to 3	268	18	40.2

	°	′	″			°	′	″
φ	40	49	37.408	3 Morris H.S.	λ	73	54	16.271
Δφ		-	01.585		Δλ		+	01 11.061
φ′	40	49	35.823	1 Bronx Court	λ′	73	55	27.332

	Logarithms		Values in seconds	
s	3.221637			
Cos α	8.466868	-1		
B	8.510789	-2		
h	0.198494	1st term	+1.5794	
s^2	6.44327			
$Sin^2 α$	9.99963			
C	1.34095			
	7.78385	2d term	+0.0060	
h^2	0.3970			
D	2.3878			
	27 —	3d term	+ —	
		−Δφ	+1.5854	

	° ′ ″	
½(φ+φ′)	40 49 36.6	
	Logarithms	**Values in seconds**
s	3.221637	
Sin α	9.999814	+2
A′	8.509098	-5
Sec φ′	0.121081	+2
Δλ	1.851630	+71.0608
Sin ½(φ+φ′)	9.815428	
−Δα	1.667058	+ 46.46

11—9362 U. S. GOVERNMENT PRINTING OFFICE: 1929

ON N.A. Datum.
Apply Correction.

Department of Commerce
U. S. Coast and Geodetic Survey
Form 28 B

GEOGRAPHIC POSITIONS

Accession No. of Computation:

Locality ______ *Datum* North American 1927 *State* ______

U. S. GOVERNMENT PRINTING OFFICE 11—10298

STATION	LATITUDE AND LONGITUDE ° ′ ″	SECONDS IN METERS	AZIMUTH ° ′ ″	BACK AZIMUTH ° ′ ″	TO STATION	DISTANCE: LOGARITHM (METERS)	DISTANCE: METERS	DISTANCE: FEET
Bronx	40 49 35.435	1093.1	40 53 37.6	220 51 55.1	N. Tower (Eldorado)	3.749157		
	73 55 27.481	643.9	157 21 32.4	337 21 11.9	Highbridge	3.282543		
			268 18 37.7	88 19 24.1	Morris High School	3.221599		

This station established by 3-point fix to stations given. Results of a computation using Highbridge, Morris High School and flagpole (CCNY) check the position given within 0.1 meter.

E. S. B. 5/23/35

Descriptive Report for T-5451 Supplemental

Sept. 26 ~~March 14,~~ 1939

This report covers corrections and additions shown in color on T-5451 Supplemental.

Items in red and blue were plotted from single lens air photographs taken by the Naval Air Station, D. C. early in February, 1939. Negatives are filed in this office.

Items in red were plotted prior to field inspection and were reported to the chart standards on March, 1939.

Items in blue were plotted after field inspection and were reported to the chart standards on June 7, 1939.

The eastern approach to the George Washington Bridge was under reconstruction at the time the photographs were taken but the work was not sufficiently advanced for the new details to be shown on the supplemental.

The Round Tower at lat. 40° 51.2', long. 74° 56.5' on charts 746 and 747 is gone. The field inspection note made on chart 746 (filed as B.P. 32845) is incorrect. The field inspection evidently confused the position of the former "Round Tower" with one of the lower ornamental towers on the wall just to the ~~next word.~~ westward.

The aero beacon and obstruction lights on the George Washington Bridge (shown in yellow) were spotted on the 1939 photos under the stereoscope and plotted in this office. A copy of the positions was sent to the New York office for checking. See attached correspondence. Previous information about these ~~towers~~ lights is given on page 9 of the descriptive report T-5451. Reported to standards on September 27, 1939.

B. G. Jones

B G Jones 9/27/39.

IN REPLY ADDRESS THE DIRECTOR
U. S. COAST AND GEODETIC SURVEY
AND NOT THE SIGNER OF THIS LETTER

AND REFER TO NO. 826-DRM

DEPARTMENT OF COMMERCE

U. S. COAST AND GEODETIC SURVEY

WASHINGTON

August 22, 1939.

To: Inspector,
U. S. Coast and Geodetic Survey,
620 Federal Office Building,
90 Church Street,
New York, N. Y.

From: The Director,
U. S. Coast and Geodetic Survey.

Subject: Location of air navigation lights on George Washington Bridge towers.

Enclosed is a section of air photographic survey T-5451 showing the locations of three obstruction lights and one aero beacon on the towers of the George Washington Bridge. These lights were located by air photographs without conclusive information as to whether all four lights still exist and which of the four lights is the aero beacon.

Please inquire at the office of the Port of New York Authority regarding the number and the proper designation of the lights, and their positions on the bridge towers, and advise this office as to whether the information is correctly shown on the enclosed map section.

Enclosure.

Acting Director.

80 1930R

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
FIELD STATION
ROOM 620 FEDERAL OFFICE BUILDING
90 CHURCH STREET
NEW YORK, N. Y.

REFER TO FILE NO.

Sept.23,1939.

'25 AM 10 23

To: The Director, Coast & Geodetic Survey, Washington, D.C.

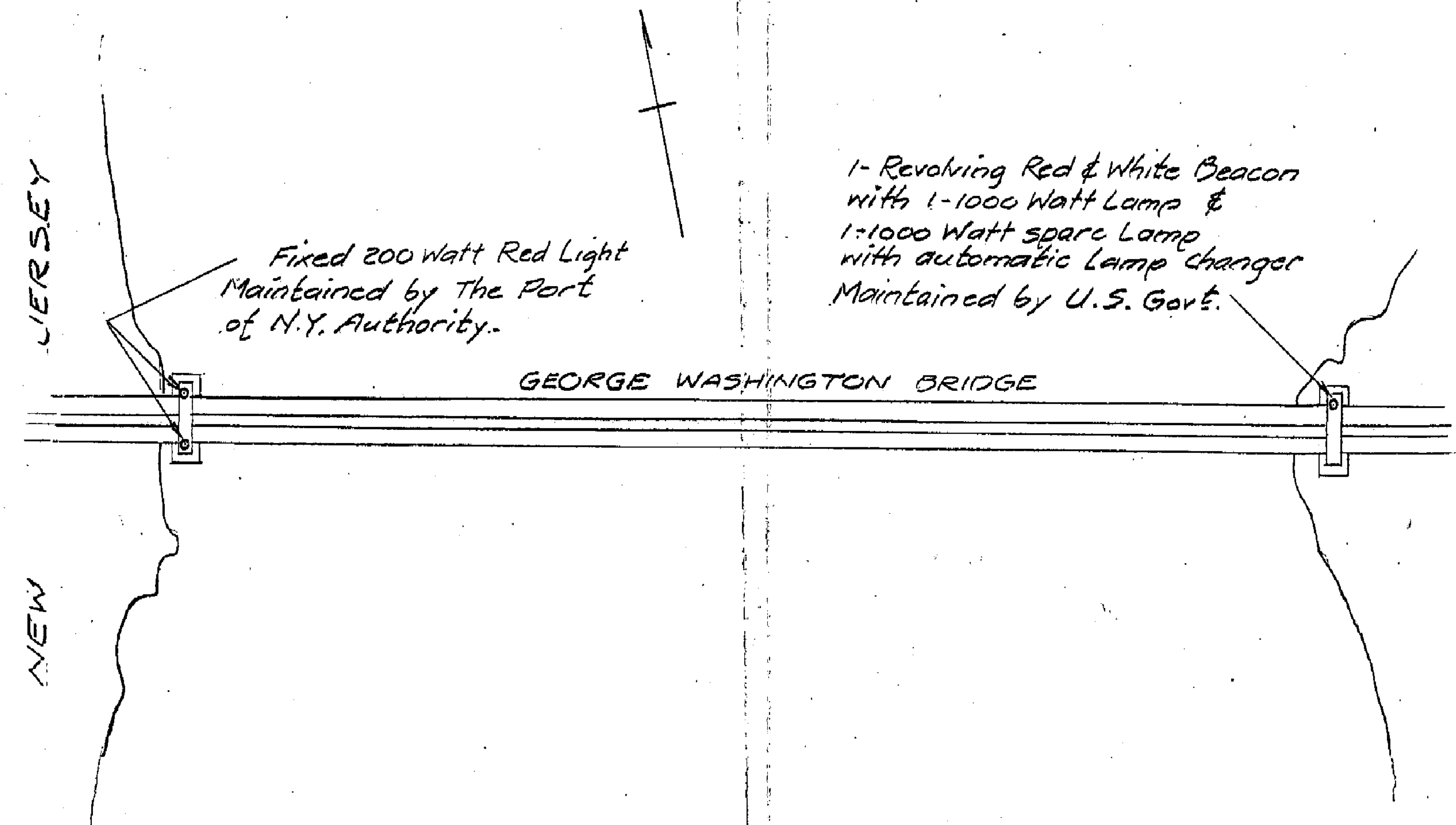
From: The Inspector, N.Y.Field Station.

Subject: Location of Air Navigation Lights on George Washington Bridge Towers.

Reference: Your letter dated August 22,1939,826DRM-- Returned herewith.

Transmitted herewith is a tracing submitted by Mr.Milligan Superintendent of Bridges, Port of New York Authority. I received the tracing this morning, but was unable to contact Mr.Milligan for the purpose of obtaining a definite statement regarding the fourth light shown on the print received from you. I was switched over to Mr.Heppemheimer, at the bridge who stated that there are two red lights on the New Jersey side, one on the north and one on the south tower and that the areo beacon was on the north towers on the New York side; that there wasn't any light on the south tower on the New York side; that it had been removed as it caused interference with the light on the north tower.

Thos.J.Maher.
Thos. J. Maher



AIR NAVIGATION LIGHTS
GEORGE WASHINGTON BRIDGE 9/21/39