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SECURITY INFORMATION

MILITARY HYDROLOGY

RESEARCH & DEVELOPMENT BRANCH

SPECIAL STUDY S-52-1

ALLER & LEINE RIVERS

ARTIFICIAL FLOODING

POTENTIALITIES

SECURITY INFORMATION

Corps of Engineers — Dept. of Army

Washington District

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PREPARED BY
MILITARY HYDROLOGY R & D BRANCH
ENGINEERING DIVISION
WASHINGTON DISTRICT CORPS OF ENGINEERS
WASHINGTON, D. C.
AUGUST 1952

SPECIAL STUDY S-52-1

ALLER AND LEINE RIVERS

ARTIFICIAL FLOODING POTENTIALITIES

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SPECIAL STUDY S-52-1

ALLER AND LEINE RIVERS

ARTIFICIAL FLOODING POTENTIALITIES

SECTION I
INTRODUCTION

1-01 ASSIGNMENT.

This special study was assigned to the Military Hydrology Research and Development Branch, Engineering Division, Washington District by letter from Office, Chief of Engineers, ENGWE, to the Division Engineer, North Atlantic Division; subject "Military Hydrology R & D Project No. 8-72-12-001: Special Assignments," dated 27 May 1952.

1-02 PURPOSE AND SCOPE.

a. This report presents information regarding the hydraulic effects and nature of artificial flooding potentialities in the Aller and Leine River basin. It consists largely of a compilation and consolidation of information presented in various intelligence documents and technical publications, with certain supplementary analyses and discussions. Additional studies are needed to adequately cover the subject for general military requirements.

b. The report is designed to furnish basic data and results of analyses needed to answer questions concerning:

(1) Normal and extreme stages and surface velocities at key stations on the Aller and Leine Rivers.

(2) Stream characteristics including gradients, depths and widths of channel and flood plain of the Aller and Leine Rivers.

(3) Data concerning locations and zero elevations of gaging stations.

(4) Data concerning location and dimensions of navigation structures, reservoirs, and bridges.

(5) The extent of flooding possible by means of erection of temporary dams.

(6) The magnitude and duration of flood waves or flow variation created by breaching or regulated discharge from the valley dams and navigation dams and the effect on bridging, crossing, and navigation on the Aller and Leine Rivers.

1-03 ARRANGEMENT.

This report is subdivided as follows:

Section I Introduction
Section II Drainage Basin Characteristics and Developments
Section III Hydrologic Characteristics
Section IV Artificial Flood Potentialities
Section V Effect on Military Operations

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Exhibit A Description of Bridges and Dams, Aller and Leine Rivers

Exhibit B Description of Watercourse and Control Structures

1-04 DEFINITION OF TERMS.

a. Equivalent English-Metric Terms. Both the English and metric systems are used in this report. Conversion factors are presented for reference in Table 1.

b. Hydrologic Terms and Abbreviations. The following abbreviations are used in this report: m for meters, km for kilometers, l for liters, km^2 for square kilometers, m^3 for cubic meters, m/s for meters per second, and m^3/s for cubic meters per second. Abbreviations applicable to stage and discharge are defined in Table 2.

1-05 REFERENCES.

All references cited in this report are listed in the bibliography following Section V of the text.

SECTION II
DRAINAGE BASIN CHARACTERISTICS AND DEVELOPMENTS

2-01 GENERAL.

a. The Aller and Leine Rivers lie in the Weser River Basin which is located in the Province of Hannover in the northwest part of Germany. Both streams have their headwaters in the Upper Harz Mountain Region. The Leine River is a 279-km long tributary of the Aller River, and the latter is a 263-km long tributary of the Weser River. A general map is shown on Plate 1, and detailed descriptions are contained in Exhibits A and B and in References 1 to 5, listed in the bibliography.

b. This report is confined to consideration of the main stem of the Aller River, the portion of the Leine River below the confluence of the Rhume River and those reaches of the Rhume, Oder and Soese*Rivers below the Oder and Soese Dams.

2-02 TOPOGRAPHY.

The general topography of the Aller and Leine River basins is indicated on the Physiographic Diagram shown as Plate 2. The Leine River emerges from the mountainous Upper Harz region onto the North German Plain near Hannover, while the Aller River flows westerly through the northern foothills of the Mid-German Highlands. Reference is made to the document listed in the Bibliography as Reference 14 for detailed topographic information.

2-03 GEOLOGY.

The river bed of the Aller and Leine Rivers is mostly sand with some gravel. Rock outcrops occur in the lower reaches of the Aller River near Westen and Verden, and in the Leine River near Neustadt. The river valley floors are mostly alluvial clay with extensive sand dunes along the Aller River below Celle. A detailed description of the geologic conditions is contained in References 1, 2, and 14.

2-04 DRAINAGE AREAS.

The drainage area of the Aller River and its tributaries comprises 15,594 km^2 of the 45,548 km^2 drainage area of the Weser River system. Drainage areas at key gaging stations of the Aller River system are included in Tables 3 and 4. The areas drained by the Aller River and its major tributaries are as follows:

River	Drainage Area (km^2)
Oker (tributary of Aller R.)	1,902
Innerste (tributary of Leine R.)	1,235
Leine (tributary of Aller R.)	6,532
Aller	15,594

*Also spelled as Söse

2-05 GRADIENTS AND PROFILES.

a. Gradients are indicated on the stream bottom and water surface profiles, Plates 3 to 7, inclusive. Following are average gradients:

River	Reach	Average gradient per 10,000
Oder	Oder Dam-Rhume R.	122
Soese	Soese Dam-Rhume R.	49
Rhume	Oder R.-Leine R.	15
Leine	Rhume R.-Hannover	6.7
	Hannover-Aller R.	2.7
Aller	Weser-Elbe Canal-Oker R.	3.2
	Oker R.-Leine R.	2.6
	Leine R.-Weser R.	2.1

b. All elevations referred to in this report are in meters above "Normal Null" the zero of the German land survey datum.

c. River distances are expressed in this report as kilometers above the junction of the Aller and Weser Rivers. However, in Exhibit B and in some official German publications, distances along navigable streams are commonly shown as kilometers below the head of navigation. Both kilometrage systems are indicated on the General Map, Plate 1.

2-06 CHANNEL DEPTHS.

The depth of the streams varies non-uniformly along the course. Reference is made to Appendix A and to the stream profiles, Plates 4 to 7 for detailed depth data. A tabulation of representative average depths follows:

River	Reach	Depth at Mean Water (Meters)
Oder	Oder Dam-Rhume R.	0.5-1
Rhume	Oder R.-Leine R.	1-2
Leine	Rhume R.-Hannover	0.5-3
	Hannover-Aller R.	1.5-2
Aller	Weser-Elbe Canal-Oker R.	0.5-2
	Oker R.-Leine R.	1-2.5 (3-4 near dams)
	Leine R.-Weser R.	2-3.5

2-07 CHANNEL AND FLOOD PLAIN WIDTHS.

Widths of channel are shown in Exhibit A. The widths of valley subject to flooding can be estimated by reference to the "Forecast of Possible Inundations," Plate 8 and to the General Map, Plate 1. Following is a general indication of the channel and flood plain widths along the streams of the Aller-Leine River system:

River and Reach	Channel Width (meters)	Flood Plain Width (kilometers)
Oder River		
Oder Dam-Rhume R.	10-25	0.5-1.5
Soese River		
Soese Dam-Rhume R.	less than 10	0.5-1.5
Rhume River		
Oder River-Leine R.	10-25	0.5-3
Leine River		
Rhume River-Hannover	10-50	0.5-2.5
Hannover-Aller R.	25-50	0.5-2.5
Aller River		
Weser-Elbe Canal-Oker R.	5-20	
Oker River-Leine R.	20-50	0.5-2
Leine River-Weser R.	50-70	1-3

2-08 NAVIGATION.

a. The Leine River is navigable for 180-ton*craft as far upstream as Hannover. A branch canal, provided with locks, provides for passage of 600-ton*barges between the Leine River port of Hannover and the Mittelland Canal. Navigation locks and dams are provided on the Leine River at Herrenhausen (km 153) and Neustadt (km 110). Locations of structures are shown on the map, Plate 1 and on the profile, Plates 4 and 5. Ice drifts form above Herrenhausen Dam, interrupting navigation.

b. The Aller River is navigable upstream to Celle (km 117). Navigation is suspended for about 35 days a year because of ice or flood. The reach downstream of the Leine River confluence is designed for 350-ton*vessels at low water or 600-ton*craft at mean water stages. Upstream of the Leine River confluence, are four navigation locks: Oldau (km 102), Bannetze (km 90), Marklendorf (km 79), and Hademstorf (km 67). Those locks can accommodate barge-trains of three 200-ton*or two 300-ton*barges. Locations of structures are shown on the General Map, Plate 1 and on the profiles, Plate 7. Ice conditions occur at Verden on the Aller River for an average of 13 days annually between 11 November and 8 March.

2-09 REGULATION.

a. High-Water Regulation. Flood stages are reduced by impounding flood flows in the reservoirs of the Harz

*metric tons

Mountain Region. The Oder Reservoir has 5 mil. m^3 of its storage capacity reserved for flood protection, the Soese Reservoir up to 4.5 mil. m^3. The newly-constructed Ecker Reservoir and the incomplete Oker Reservoir each will have reserved for flood protection about 5-7 mil. m^3 capacity according to the general project plan for the area. Due to insufficient flow records subsequent to/* reservoirs, accurate appraisal cannot be furnished regarding their effect upon stream flow.

b. Low-Water Regulation. Low water stages and flow are regulated by operation of the navigation locks and dams for power generation as well as for navigation. Operation of the outlet control structures of the storage dams in the Harz Mountain Region for power generation and irrigation would influence the stage and flow, especially in the upper reaches. The small mill dams upstream of the navigation limits serve to regulate the flow and stage in those reaches where located. The water level upstream of the Aller River dams located above Celle is raised during the wintertime in order to inundate the adjacent meadows as a means of fertilization. Reference is made to Exhibit B for detailed description of regulation.

2-10 DAMS AND RESERVOIRS.

a. General. Descriptions of important dams are contained in Exhibit B and locations are indicated on the General Map, Plate 1, and on the profiles, Plates 3 to 7, inclusive.

b. Harz Mountain Reservoirs. On the headwaters of the Aller and Leine Rivers in the Harz Mountain Region are located several important large dams, "talsperren," locations of which are shown on Plate 1. In the Leine River basin are the Oder and Soese Dams. The Oder Dam (km 312) is located near Bad Lauterberg on the Oder River, which flows into the Rhume River, tributary to the Leine River near Northeim (km 264). The Soese Dam (km 301) is located north of Osterode on the Soese River, likewise tributary to the Rhume River. In the "Oberharz" area of the Aller River Basin are located the newly-completed Ecker Dam and the proposed Oker Dam, now under construction. The Ecker Dam (km 261), completed in 1943, is located on the Ecker River, a branch of the Oker River tributary to the Aller River near Mueden (km 151). The Oker Dam (km 260) is being built on the Oker River in the vicinity of the Ecker Dam. Those dams are all multiple purpose reservoirs providing storage for flood protection, water supply, power generation and flow regulation. Many towns depend upon those reservoirs for their water supply and electrical power; for example, Soese Dam provides water and electricity for Bremen, Hildesheim and fifty other towns. The locations of the Harz reservoirs are shown on the General Map, Plate 1, and the dam cross sections and elevations

/* completion of those

are shown on Plate 9. Detailed data and description is contained in Exhibit B and in References 8 to 12. The following pertinent data are presented:

	Oder Dam	Soese Dam	Ecker Dam	Oker Dam
Date built	1928/33	1929/31	1934/45	Being built
Type	Earth	Earth	Concrete	Concrete
Height (m)	62.3	57.3	62	57
Length (m)	310	500	240	400
Width at base (m)	285	252.5	43	No data
Storage capacity (mil. m^3)	30.6	25.5	13	45
Drainage area (km^2)	52	46.5	19	85
Annual power output (mil.kwh)	8	3	0.8	No data

c. Harz Mountain Ponds. In the northern part of the Harz Mountain Region near Altenau, there are located, in addition to the large valley dams, 69 smaller ponds, called "Oberharzteiche," with a total storage capacity of approximately 10.5 million m^3 and a total water surface of about 250 hectares. The largest is the "Oderteich," in operation since 1721, and located on the Oder River about 15 km upstream of the Oder Valley Dam. The "Oderteich," has a storage capacity of 1.67 million m^3 and its water surface covers about 22 hectares. Its outflow can be permitted either to enter or to bypass the Oder Dam reservoir. The "Oberharzteiche" are all interconnected by channels and flumes to form an integrated runoff storage system. The Harz ponds and channels provide storage of water for agricultural use, operation of mills, collection of run-off, drainage of mines, and are important recreational assets. Detailed description is contained in References 8 and 10.

d. Maschsee Reservoir. In connection with other phases of an extensive local protection project for the City of Hannover on the Leine River, a marshy area called the "Maschsee," was converted into an artificial lake. The water surface is about 2 m above the Leine River normal stage. The lake contains approximately 1.6 million m^3 and is fed by pumping from the river.

e. Navigation Dams. Detailed description of the important navigation dams on the Aller and Leine River is contained in Exhibits A and B and locations are indicated on the General Map, Plate 1 and on the profiles, Plates 5 and 7. Names and locations of navigation dams are listed in paragraph 2-08.

f. Mill Dams. A number of small mill dams, providing power for local electric power plants, mills and factories, are located on the streams of the Aller-Leine system above the head of navigation. Detailed descriptions of the important mill dams are contained in Exhibit B and locations are indicated on the General Map, Plate 1 and on the profiles, Plates 4 to 7, inclusive. The important mill dams are:

River	Mill Dam	River km
Aue (tributary of Leine R. at km 120.3)	Blumenau	(2.5 km upstream of Aue-Leine Junction)
Leine	"Am Schnellen Graben" (in Hannover)	159
Aller	Gifhorn	166
Aller	Diekhorst	152
Aller	Langlingen (SW of Nordberg)	140
Aller	Celle	116

2-11 LEVEES.

Levees are of minor importance along the Aller and Leine Rivers, although short local levees exist at various places. In connection with other extensive local flood protection works at Hannover, about 5 km of levees were built along the Leine and Ihme Rivers to an elevation 0.5 m above HHW (at junction of Leine and Ihme Rivers in Hannover, HHW is 53.2 m/NN). Other short levees with crowns 0.3-0.5 m above HHW, exist along the Leine River near Wilkenburg (km 165) and Bordenau (km 118). Following is a tabulation of the main levee system along the Aller River:

Place	River km	Remarks
Winsen	99.7-97.5	Winter dike, right bank
Ahlden	59.3-56.5	Left bank
	56.0-55.3	
Bierde	53.8-53.6	Right bank
	53.4-52.7	
	52.4-52.3	
Hilte	51.0-50.3	Right bank
"	44.3-22.9	Summer dike
Hulsen	24.0-21.8	Winter dike
Westen	22.3-18.7	Winter dike protecting 99 km^2 on right bank
Westen	22.5-16.9	Winter dike, left bank
Downstream of Westen	16.9- 7.5	Summer dike, left bank

2-12 CANALS.

a. Mittelland Canal. The Mittelland Canal System extends from Duisberg on the Rhine River to Magdeburg on the Elbe River. The course is shown on the General Map, Plate 1; the profile appears on

Plate 10; and standard cross sections are presented on Plate 11. The Ems-Weser portion crosses over the Leine River near Lohnde (km 136) by means of an aqueduct, while a branch descends through locks to the river near Hannover. The Oker and Aller Rivers, together with smaller streams, pass beneath the Weser-Elbe portion of the canal by means of siphons, equipped with auxiliary relief gates to permit diversion of flood waters into the canal and thence to the Elbe River. Reference is made to document listed as Reference 3 in the Bibliography for detailed description of the canal system.

2-13 BRIDGES.

Locations and clearances (wherever data are available) of major bridges across the Oker, Soese, Rhume, Leine and Aller Rivers are indicated on the profiles, Plates 3 to 7, inclusive. Tabulations of pertinent bridge data are included in Exhibit A and are contained in References 1, 2, 3, and 13 of the Bibliography. Reliable information upon post-war reconstruction subsequent to 1945 is not available.

SECTION III
HYDROLOGIC CHARACTERISTICS

3-01 GENERAL.

a. Information regarding river stage, discharge, flow duration, and current velocities pertinent to the Leine and Aller Rivers are presented in generalized graphical form insofar as practicable to facilitate application of the data to specific military problems. References should be utilized for supplementary data.

b. Most available stage and discharge records cover periods prior to completion of the Harz Mountain Valley Dams described in paragraph 2-10b. No data are available regarding the effects of those reservoirs in modification of stages and discharge, but it is considered probable that floods would be reduced and that the minimum stages and flows would be raised.

3-02 CLIMATOLOGY.

Climatological data for the region covered by the report may be found in References 3, 8, and 14. The annual rainfall in Germany decreases from about 700 mm on the North Sea coast to about 600 mm at Hannover and increases about 10 mm for each 100 meters altitude. The average annual rainfall in the Harz Mountains exceeds 1500 mm. Seasonal variation in rainfall is illustrated by the following tabulation showing the monthly percentage of the annual rainfall for a number os stations for the period of 1881 to 1910:

J	F	M	A	M	J	J	A	S	O	N	D
Harz Mountains											
8.8	8.2	8.9	5.7	6.5	7.7	10.6	8.8	7.2	8.5	8.6	10.5
Adjacent Lowlands											
6.5	5.9	7.7	6.2	8.8	10.1	13.7	10.4	8.3	8.4	6.8	7.2

3-03 STREAM GAGING STATIONS

A number of gages have been established on the Aller and Leine Rivers and their tributaries, with records being published for the more important stations in such official annual publications as the German Hydrologic Yearbooks listed as References 6 and 7. Locations of important gages are shown on the General Map, Plate 1, and on the stream profiles, Plates 3 to 7, inclusive.

3-04 RIVER STAGES.

a. Records. Data regarding the maximum, mean, and minimum stages of record at key gaging stations on the Aller, Leine, Oker and Rhume Rivers are presented in Tables 3 and 4, together with other pertinent gage information. Additional data are contained in the German Hydrologic Hearbooks, References 6 and 7.

b. Seasonal variation. The range of stages observed for each month is indicated in Tables 3 and 4. It may be observed in those tables that, average winter stages (November-April) are consistently higher than corresponding summer stages (May-October), with the maximum MHW, MW, and MNW occurring in January or February and the minimum in July through September. The monthly range between MHW and MNW follows similar trends. It is not considered that operation of the Harz Mountain reservoirs would radically alter these general seasonal trends, although the range between high and low stages would probably be reduced. The maintenance of higher wintertime stages in the Aller River near Gifhorn to inundate and thus fertilize the adjacent pastureland is described in Exhibit B.

3-05 RIVER DISCHARGES.

a. Discharge Records. Mean daily, mean and extreme monthly and yearly discharges are contained in Reference 6. A tabulation of discharge data is presented in Table 5 and discharge profiles are shown on Plate 13. Flow duration curves covering the 1936 to 1938 water years for 3 key stations are shown on Plate 12. Median flows, equalled or exceeded 50 percent of the time, taken from those curves are:

River	Station	Period of Record	Median Flow m^3/s
Aller	Westen	1936-38	70
Oker	Gross-Schwuelper	1936-38	8
Leine	Greene	1937-38	21

Operation of the Harz reservoirs would be expected to effect reduction of flood flows and increase of minimum discharge.

b. Stage discharge relation. Average stage-discharge rating curves for 8 key stations in the Aller-Leine River basin are presented on Plates 14 and 15. The curves were estimated from discharge measurements and from equivalent stage-discharge data contained in the German Hydrologic Yearbooks, listed as References 6 and 7. For use in this study, the curves were extended considerably beyond the range of observed data and are subject to revision, especially in the higher portions.

3-06 RIVER VELOCITIES.

a. General. The velocity of stream flow varies according to the conformation of the river bed, depths, obstructions, restrictions, local variation in slope, etc. Channel improvements and cutoffs, training walls and levees, operation of dams and other modifications of natural conditions appreciably affect the stream velocity. Influent rivers in flood tend to elevate the main river waters at the point of confluence according to the magnitude of the flood, thus tending to reduce the slope above and to increase it below the point of confluence. Accordingly, correlations between river stages and surface velocities at gaging stations cannot be interpreted as applicable to all points along the adjacent river sections, but only serve as general indications.

b. Surface Velocities. Insufficient basic information concerning the stream hydraulic functions (cross-sectional area, wetted perimeter, water surface slope, roughness factor) was available to permit accurate determination of stream velocities. Estimates were based on velocities observed during discharge measurements at gaging stations and recorded in Reference 7. Such velocities probably tend to be higher than velocities in the adjacent stream reaches because discharge measurements are normally made at locations of restricted sections in order to facilitate measurement. The deduced stream velocities were multiplied by 1.18 (i.e. 1/0.85) to obtain corresponding surface velocities. Surface velocity profiles for MW and MHW are shown on Plate 13. Tabulation of estimated surface velocities corresponding to statistical mean stages for the period 1926-35 follows:

Station	River km	Surface Velocity (km/hr) MHW	MW	MNW
	Aller River			
Brennackenbrueck	158	2.1	1.4	—
Celle	115	6.8	3.0	—
Ahlden	59	4.0	3.0	2.3
Westen	22	5.1	3.6	2.7
	Leine River			
Loineturm (Northeim)	269	4.2	3.6	—
Herrenhausen	152	4.1	3.8	—
Bothmer	68	—	3.1	2.5
	Rhume River			
Elvershausen	275	7.2	4.2	3.2

3-06

c. <u>Flood Wave Travel Time.</u> Examination of available flood crest times as recorded in the official German Hydrologic Yearbook, References 6 and 7, for the floods of March 1881, November 1926, January 1932, April 1936, February 1937, and January 1938 revealed considerable variation in the rate of progression of various flood waves; however, the average travel rate of those flood waves (including that of February 1946 obtained from Reference 15) are tabulated below:

Reach	River km	Average Travel Rate of Peak (km/hr)
	Aller River	
Brenneckenbrueck-Westen	158-22	3.1
	Oker River	
Ohrum-Gross Schwuelper	225-181	4.5
	Leine River	
Elvershausen(Rhume R.)-Bothmer	275-68	3.2

SECTION IV
ARTIFICIAL FLOODING POTENTIALITIES

4-01 GENERAL.

a. The term "artificial flood" as used in this report applies to any major increase in the extent of flooding, over that normally prevailing with existing developments, that is brought about by manipulation of control structures, breaching of dams or levees, or temporary damming operations designed to create flooding conditions. Applications of artificial flooding considered in this report fall into the following four general categories:

(1) Still-water barriers, created by flooding land to form water obstacles, using such means as breaching levees, diverting flow from canals, raising crests of existing dams or constructing temporary dams.

(2) Drainage obstacles or mud-flats, in which the wetness of the soil is increased to form muddy or marshy conditions that would impede military traffic, brought about by disrupting the normal drainage, destroying pumping and drainage facilities used to drain marshy or low land, or by inducing shallow inundation of flood plains or reclaimed land. Mud-flats may also be formed by draining areas normally inundated by reservoirs or ponds.

(3) Stream flow variations, in which changes in discharges, depths, velocities and widths of streams are brought about to hinder stream-crossing operations or navigation such as might be accomplished by opening and closing outlet works of water control structures.

(4) Major flood waves, created by sudden breaching of a dam to release large quantities of impounded water.

b. Many opportunities exist for effective use of each of the four general categories of artificial flooding. The potentialities are reviewed and quantitative evaluation of the effects are presented in this section.

c. Previous studies by German and Allied military staffs indicate the general nature and extent of possible artificial flooding. The document listed in the Bibliography as Reference 4, a translation of which is included in this report as Exhibit B, was prepared for the German General Staff and contains considerable information on the effects of artificial flooding. The area considered by that source as subject to flooding is indicated on the General Map, Plate 1 of this report. Reference is also made to the map overprint prepared by G-2 SHAEF (see Reference 16) presented as Plate 8 of this report, which outlines the areas considered floodable, during high water conditions, by natural or artificial means. These studies have been utilized in preparation of this report. Reference is also made to a report on the Aller System prepared by the British Army of the Rhine in 1946 (Reference 17), which was unavailable at this time. Examination of other similar reports by the same source indicates that some information on the artificial flooding possibilities of the Aller and Leine Rivers is included within the scope of that report.

4-02 STILL-WATER BARRIERS AND DRAINAGE OBSTACLES.

a. General. The studies herein reviewed in this paragraph pertain to artificial flooding produced by creation of still-water barriers and drainage obstacles along the Aller River below the Weser-Elbe Canal crossing, and along the Leine River below the Rhume River confluence. The studies were largely based on a map study, using the 1:25,000 GSGS 4414 map series, supplemented by data from References 1, 2, 4 and 16. Exact determination of elevations, contours, and boundaries from those maps was difficult; however, the results of this study are believed to offer good indications of the relative possibilities of such flooding. First-hand information should be obtained by local reconnaissance regarding ground elevations and the location, elevations and dimensions of levees, roadfills and culverts in the vicinity of specific barriers in order to accurately establish the area subject to artificial flooding.

b. Hydrologic Considerations. The effect of artificial flooding is largely contingent upon the natural hydrologic conditions prevailing at the time of the operation. The volume of water stored and available within the basin, the rate of stream flow and the river stage are important factors. Reference is made to Section III of this report for detailed description, and to the following summation of pertinent hydrologic considerations.

(1) Attention is directed to the wide range between high and low flows shown in Table 5. The following average mean natural discharges were used in this study:

River	Reach	Average mean Discharge (m^3/s)
Aller	Above Oker R.	10
"	Oker R.-Leine R.	40
"	Leine R.-Weser R.	90
Leine	Rhume R.-Aller R.	30

(2) A plentiful supplementary water supply is afforded by the 100 million m^3 storage capacity of the existing canals, reservoirs and ponds within the drainage area. Completion of the Oker Dam would add another 45 million m^3. During extended dry periods, irrigation and other demands would considerably reduce the volume of stored

water available for artificial flooding unless drastic conservation of impounded water was enforced.

(3) Considerable variation in river stage has been experienced during the past period of record, as indicated in Tables 3 and 4. Operation of the Harz reservoirs may be expected to moderate the extreme flows in the future.

c. Means of Creating Still-Water Barriers and Drainage Obstacles.

(1) The water obstacle afforded by the existing streams of the Aller-Leine basin could be increased by utilization of one or more of the following means:

(a) Creation of still-water barriers by raising crests of existing dams or by construction of temporary dams, combined with closing of culverts and other openings in levees and road fills.

(b) Inundation of lowlands along the streams by breaching dikes and levees and opening of flood gates in levees.

(c) Inundation of lowlands by closing normal drainage outlets.

(2) In order to obtain a comparative quantitative evaluation of the potential artificial flooding at various locations, analysis was arbitrarily confined to still-water barriers resulting from temporary damming to 1 m and 3 m above mean water (MW), herein designated as "low barriers" and "high barriers," respectively. In this study, it was assumed that the water surface of the pools above the temporary dams would be level, and that mean water conditions would prevail at the time of the operation. During high water conditions, greater flooding could be expected due to the increased slope of water surface upstream from the temporary dams.

d. General Effect of Still-Water Barriers.

The effects of artificial flooding created by temporary damming operations on the Aller and Leine Rivers are summarized in Tables 6 and 7, and the extent of inundation outlined on the strip maps presented on Plate 16. Serial numbers of sites correspond to those of Exhibit A. Reference is made to Exhibits A and B for data on the dimensions of dams and bridges. The flooding produced by the low barriers would be mostly confined within the stream banks, while that produced by the high barriers would flood areas about 0.2 to 2.5 km wide. Formation of continuous overbank flooding would not be practicable, except during periods of high flows. Review of the artificial flooding possibilities in specific reaches of the Aller and Leine Rivers follows.

e. Effect of Aller River Still-Water Barriers.

(1) General. The navigation and mill dams along the Aller River are built so that their crest heights may be readily increased without damage to the structure, as described in Exhibit B. For purposes of this analysis, it was assumed that the crest elevation could be increased 1 m, but that higher increases would be impracticable because of the excessive lengths of temporary damming required. Temporary damming by means of blocking of bridge openings at suitable sites was also considered as shown in Table 6 and discussed below.

(2) Source to Gifhorn (km 166). The Aller River flows through a broad marshy valley and is the basis for an extensive system of irrigation canals which could be used to form water obstacles and inundation in localized areas. Blocking of the Aller River syphon beneath the Weser-Elbe canal (See Plates 6, 10 and 16) would cause inundation over a considerable area adjacent to the canal; however, a large volume of water would be required (17.5 million m^3 for the low barrier or 57 million m^3 for the high barrier as indicated in Table 6). In the vicinity of Gifhorn, shallow artificial flooding of the Aller and Ise Depressions could be accomplished as indicated in Table 6 and further described in Exhibit B.

(3) Gifhorn to Celle (km 115). Temporary damming at Brenneckenbrueck (Site 1) and Diekhorst Sluice (Site 6) could produce a still-water barrier about 0.5 km wide and nearly 15 km long. High barriers at the other 3 sites in this reach indicated on Plate 16 would create isolated shallow inundation of an average width of 250-500 m, and average length of about 1 km as shown in Table 6.

(4) Celle to Leine R. (km 65). The four navigation dams in this reach afford excellent opportunities for formation of low barriers, each producing flooding averaging about 0.3 m deep over areas 2-4 km long and 500-1,000 meters wide (See Plate 16). Creation of high barriers at the 4 suitable bridge sites shown in Table 6 would create additional obstacles each 2-5 km long and 500-1500 m wide, averaging approximately 0.4 m deep over the adjacent lowlands. Considerable construction might be involved in blocking the large bridge openings (each over 100 m in length) to the required height; but the resulting pools would produce a nearly continuous water obstacle.

(5) Leine R. to Weser R. There are no existing dams in this reach, but the bridges at Ahlden (Site 51), Rethem (Site 57), and Verden (Site 63) would be likely locations for erection of temporary dams (See Plate 16). No significant flooding would result from low barriers, but areas 8-11 km long and 1200-2000 m wide would be flooded to an average depth of approximately 1 m by creation of high barriers, as summarized in Table 6. The size of bridge openings are large (110-375 m) and several lengthy stretches of railroad and highway embankments would have to be used as part of the barricade, thus probably involving closure of culverts and other openings.

f. Effect of Leine River Still-Water Barriers.

(1) General. The narrow valley and steep gradients in the upper reaches of the Leine River restrict the possibilities for creation of effective still-water barriers (See profiles on Plates 3 to 5). The effects of the low barriers would be mostly confined to increasing the channel depth. High barriers at the sites, indicated on Table 7 and Plate 16 would produce inundation of 300-2500 m average width, practically continuous in the lower reaches below Hannover (km 161).

(2) Rhume R. (km 264) to km 161 (South of Hannover). Artificial flooding produced by still-water barriers is insignificant in this reach, except for the 2 sites (Serial Nos. 196 and 197) shown on Plate 16, in the vicinity of Salzderhelden (km 252), where ponds 1750 m wide for a total length of 11 km could be formed. Table 7 summarizes the effects in this reach of the Leine River.

(3) Km 161 (South of Hannover) to Neustadt (km 110). Several suitable sites for still-water barriers exist in the vicinity of Hannover, where an extensive local flood protection project, including channel rectification, dikes, and creation of an artificial lake (see paragraphs 2-10d and 2-11) has been constructed. Combination of temporary damming and breaching of dikes in that locality would inundate an area about 1 km wide and extending for several kilometers above and below Hannover. A continuous water obstacle, 12 km long, 300-900 m wide and averaging approximately 0.5 m deep would be created by erecting five high temporary dams at sites 112 to 116, inclusive, shown on Plate 16. Blocking of the Neustadt highway bridge opening (site 109) to 3 m above mean water would flood a 1200 m wide area extending for 8.5 km. Reference is made to Table 7 for summary of effects.

(4) Neustadt to Aller R. junction. A practically continuous 26 km long water obstacle, averaging about 300 m wide could be produced by creation of high barriers at the 3 bridge openings designated as 102, 104, and 105 on Table 7 and Plate 16. Flooding by low barriers at those sites would be mostly confined to the stream bed and to the old meanders. A low temporary dam at the Bothmer RR bridge would create a still-water obstacle averaging 460 m wide and 1.2 m deep, extending upstream 5.6 km.

g. Water Requirements for Still-Water Barriers.

(1) The volume of water required to effect the artificial flooding on the Aller and Leine Rivers described in preceding paragraphs and shown on Plate 16 and in Tables 6 and 7, together with the estimated time of filling at the natural mean rates of flow given in paragraph 4-02b(1), are approximately as follows:

River Reach	Water Requirement (million m^3) Low Barrier	High Barrier	Natural Filling Time (Days-hours) Low Barrier	High Barrier
Aller R.				
Source-Gifhorn	21.4	57.0	25- 0	66- 0
Gifhorn-Celle	1.0	0.9	0- 8	0- 6
Celle-Leine R.	5.0	8.7	1-11	2-13
Leine R.-Weser R.	-	42.0	-	5-10
	27.5	108.6	26-19	74- 5
Leine R.				
Rhume R.-Hannover	8.7	10.5	3- 8	4- 1
Hannover-Neustadt	1.8	32.3	0-17	12-10
Neustadt-Aller R.	9.8	45.0	2-18	17- 7
	20.3	87.8	6-19	33-18

(2) Supplementary sources of water supply for still-water barriers are the reservoirs, ponds and canals located within the basin and described in paragraphs 2-10 and 2-12. A summation of available storage capacities follows:

Location	Storage Capacity (million m^3)
Oder Dam	30.6
Soese Dam	25.5
Ecker Dam	13.0
Harz Ponds (Harzteiche)	10.5
Maschsee Reservoir (Hannover)	1.6
Mittelland Canal	19.0
	100.2

Upon completion of Oker Dam, an additional 45 million m^3 capacity would be available. During extended dry periods, the volume of water stored in the reservoirs and available for discharge would be considerably reduced, as indicated by the representative 10-year reservoir hydrograph of Plate 17.

(3) The rates of discharge from the Oder, Soese and Ecker Dam outlets are discussed in detail in paragraph 4-04. The discharge rates and durations are summarized in Table 9. Those flows may be used to supplement natural flows in filling the pools behind temporary dams. The initial combined rate of discharge from the existing Oder and Soese dam outlets at full reservoir pool, is about 85 m^3/sec. In 8-10 days, those reservoirs could be emptied, providing about 50 million m^3 of released water. Studies described in paragraph 4-04 indicate that it would take about 2 days for the initial increase in flow to travel downstream to the vicinity of the Aller and Leine River confluence, plus 3 additional days for the flow there to reach the sustained maximum rate of approximately 60 m^3/s above the base flow. At that rate, the still-water barriers along the Leine River would be

filled in about 1/3 the time required by the mean natural stream discharge shown in previous subparagraph 4-02g(1). Modification of the dam outlets to increase their discharge capacity would further reduce the time required. Reference is made to paragraph 4-04 and to Table 9 for further data.

4-03 MAJOR FLOOD WAVES.

a. General.

(1) The studies in this paragraph pertain to the artificial flooding effects that might be produced by breaching of the large Harz Mountain dams.

(2) Quantitative estimates of the potential effects of major flood waves are presented for the Oder, Soese and Ecker Dams. Reference is made to paragraph 2-10b and to Exhibit B for descriptive data on those structures and to Plate 9 for sketches of the dam cross-sections and elevations.

(3) Insufficient data were available to permit detailed study of the effects of a major flood wave from the Oker Dam, which is in process of construction; however, estimates of the relative potentialities are included.

b. Hydrologic Considerations.

(1) High stages on the Aller and Leine Rivers are reduced by impounding runoff in the Harz Mountain reservoirs. Water is released to maintain navigable stages during low flow periods and for irrigation purposes as discussed in paragraphs 2-09 and 3-04. The natural discharges of the Aller and Leine Rivers normally are not disturbed by operation of the dams for power because of re-regulation pools immediately below the main dams. In study of the effect of major artificial flood waves, it was assumed that the base flow in the stream at the start of the wave corresponded to mean water conditions as tabulated in Tables 3 to 5.

(2) The peaks and durations of flood waves are greatly influenced by the initial reservoir pool level and the storage capacity of the reservoirs. In this study, it was assumed that the reservoir was at the maximum level in order to define the maximum probable limits of the flood waves. The maximum reservoir levels shown on Plates 9, 17 and 18 are attained only during the flood season. The hypothetical Oder Dam stage and storage hydrograph for the period 1908 to 1917 (Plate 17) reflects the general trends of reservoir variation prevailing for the Harz dams. The reservoir storage curve for Oder Dam is based on data in Reference 9 and is shown on Plate 18. The curve shown on the plate for Soese Dam was based on data from Exhibit B and developed by the method presented in "A Progress Report on the Disposition of Sediment in Reservoirs" by A. W. Van't Hul (See Reference 18). The Ecker Dam

storage curve was similarly developed from data given in Reference 12. The equations for the storage curves can be expressed as:

Oder Dam	S equals 3400 $H^{2.31}$
Soese Dam	S equals 3400 $H^{2.31}$
Ecker Dam	S equals 200 $H^{2.76}$

Where S equals storage in cubic meters, H equals reservoir depth in meters.

(3) During passage of a major flood wave downstream, an appreciable amount of volume is retained behind embankments and in depressions on the floodplain, and lost through evaporation, seepage, etc. For example, 39.5 percent of the volume of water discharged from the Eder Dam breach of May 1943 was lost in the passage of the flood wave to Intschede, 426.6 km below the dam (See References 19 and 20). Consequently, it was assumed in this study that for each 10 km of travel, about 1 percent of the volume within the flood wave would be lost or retained on the flood plain.

c. Means of Creating Artificial Flood Waves.

(1) Major artificial flood waves can be created on the Aller and Leine Rivers by breaching of the Oder, Soese, and Ecker Dams.

(2) The bombing of the Mohne, Sorpe, and Eder Dams by the R.A.F. in May 1943 (described in Reference 19) provided the basis for estimating the size and shape of breach. For purposes of this study, it was assumed that demolition would cause an opening similar to that produced by the Eder Dam bombing.

(3) The assumed breach approximates a parabolic shape, corresponding closely to the equation:

x^2 equals 51 y

Where x equals horizontal distance from vertical axis of the opening

y equals vertical distance above lowest point of breach opening

It was considered that the assumed breach approximates the largest feasible opening likely to be produced in the Oder, Soese and Ecker Dams. Breaching of earth dams with concrete cores like the Oder and Soese Dams would require special preparations and procedures as described in Reference 19.

(4) In order to permit comparative evaluation of artificial flood waves it was further assumed in all cases that the lowest

point of the breach was 24 m below the initial water surface (similar to conditions at the Eder Dam breach); therefore, the initial discharge would be 8500 m^3/s for breaches at all dams studied. Breach discharge hydrographs are shown on Plates 19 and 20.

(5) In view of the equalizing effect of stream conditions upon various sized flood waves as the wave progresses downstream (See Reference 20), it was considered that more precise computations of probable breach opening would be unwarranted for purposes of this report.

d. Effects of Dam Breaching Operations.

(1) General. The estimated effects of artificial flood waves produced by breaching of the Harz dams, as described above, is summarized in Table 8, and discharge hydrographs at key locations are shown on Plates 19 and 20. The artificial flood waves are designated as follows:

Artificial Flood No.	Dam Breach
1	Oder
2	Soese
3	Ecker
4	Oder + Soese
5	Oder + Soese + Ecker

(2) Artificial Flood No. 1 is the flood wave on the Oder, Rhume, Leine and Aller Rivers caused by breaching of the Oder Dam. The outflow hydrograph at the dam was computed from the storage-discharge relation and routed downstream to produce the discharge hydrographs shown on Plate 19. The peak discharge at the dam of 8500 m^3/s would be reduced to 700 m^3/s at Elvershausen (37 km below the dam) and to 275 m^3/s at Westen, 290 km downstream of the Oder damsite (See Table 8).

(3) Artificial Flood No. 2 hydrographs result from breaching of the Soese Dam and are shown on Plate 19. The peak discharge decreases from 8500 m^3/s at the dam to 795 m^3/s at Elvershausen and 270 m^3/s at Westen as shown on that plate and tabulated in Table 8.

(4) Artificial Flood No. 3 is created on the Ecker, Oker and Aller Rivers by breaching of the Ecker Dam. Discharge hydrographs at key locations appear on Plate 20 and a summation of effects is contained in Table 8. The peak discharge of 8500 m^3/s at the dam would be reduced to 260 m^3/s at the confluence of the Oker and Aller Rivers (110 km below the dam) and to 210 m^3/s at Westen (239 km below the Ecker damsite), representing an increase of about 107 m^3/s above the base flow at the latter location.

(5) Artificial Flood No. 4 is produced by synchronized breaching of the Oder and Soese Dams so that the wave crests would arrive simultaneously at the confluence of the Rhume and Soese Rivers

(km 276) (See Plate 1). Breaching of the Soese Dam would be lagged 4 hours after the Oder Dam breach to effect that coincidence of peak flows. Plate 19 shows the resulting discharge hydrographs at key locations. As shown on the discharge profile, Plate 13, and in the tabulation, Table 8, the discharge from the combined breachings would be 1475 m^3/s at Elvershausen and 420 m^3/s at Westen.

(6) Artificial Flood No. 5 results from breaching operations at the Oder, Soese and Ecker dams timed so that the combined Oder and Soese peak flow would arrive at the confluence of the Leine and Aller Rivers to combine with the Ecker dam peak flow at that point, in order to produce the maximum peak stage on the lower Aller River (See Plate 1 for locations). As may be observed from the discharge hydrographs of Plate 19, the initial peak discharge of 8500 m^3/s at each dam breach would produce a combined peak discharge of 520 m^3/s at Westen. This combined wave results from lagging of breaching operations at the Soese and Ecker Dams approximately 4 and 15 hours, respectively, after the initial Oder Dam breaching. A summary of effects is included in Table 8.

(7) Comparison of Effects of Dam Breaching Operations. Table 8 presents a summary of the effects estimated to be obtained by breaching of the Harz dams. The average width of area flooded at time of passage of the peak, considering levees along the stream as breached or overtopped, is tabulated in Table 10. The relation of the peak effects of Artificial Flood No. 4 to natural conditions of stage is shown on Plates 4, 5 and 7. Discharge and surface velocity relations are graphically presented on Plate 13. Since the artificial flood flows are considerably higher than the observed discharge, stage, and velocity measurements, the estimated values for artificial floods were extrapolated and are subject to revision. Extracts of the effects shown in Tables 8 and 10 at selected key locations are presented below for comparison:

			Artificial Flood No.				
River	Location	River km	1	2	3	4	5
(a) Height of Wave above Mean Water Profile (m)							
Rhume	Elvershausen	275	3.7	3.8	-	4.2	-
Leine	Herrenhausen	152	4.6	4.5	-	6.0	-
"	Bothmer	68	3.2	3.2	-	4.8	-
Aller	Celle	115	-	-	3.1	-	-
"	Ahlden	59	2.4	2.4	1.8	3.9	4.9
"	Westen	22	1.6	1.6	1.1	2.5	3.1
(b) Surface Velocities at peak of wave (km/hr)							
Rhume	Elvershausen	275	9	9	-	9	-
Leine	Herrenhausen	152	5	5	-	5	-
Aller	Celle	115	-	-	9	-	-
"	Westen	22	5	5	5	6	6

River	Location	River km	Artificial Flood No. 1	2	3	4	5
(c) Time of Arrival of Start of Wave (hours after initial breaching)							
Rhume	Elvershausen	275	11	9	-	12	-
Leine	Herrenhausen	152	40	33	-	37	-
Aller	Celle	115	-	-	33	-	-
"	Westen	22	74	74	61	74	74
(d) Time of Arrival of Peak of Wave (hours after initial breaching)							
Rhume	Elvershausen	275	18	14	-	18	-
Leine	Herrenhausen	152	54	49	-	53	-
Aller	Celle	115	-	-	46	-	-
"	Westen	22	95	87	80	93	93
(e) Duration of Wave above Mean Water (hours)							
Rhume	Elvershausen	275	21	19	-	24	-
Leine	Herrenhausen	152	38	38	-	41	-
Aller	Celle	115	-	-	30	-	-
"	Westen	22	56	52	45	60	60
(f) Duration of Wave above Mean High Water (hours)							
Rhume	Elvershausen	275	14	13	-	16	-
Leine	Herrenhausen	152	20	18	-	25	-
Aller	Celle	115	-	-	9	-	-
"	Westen	22	0	0	0	19	24
(g) Width of Flooded Area at Peak of Wave (km)							
Rhume	Elvershausen	275	0.8	0.8	-	0.9	-
Leine	Bordenau	121	1.4	1.4	-	1.6	-
Aller	Celle	115	-	-	0.7	-	-
"	Westen	22	2.0	2.0	2.0	3.0	3.0

(8) Effect of Oker Dam Breach. Completion of the Oker Dam, now under construction on the headwaters of the Oker River near the Ecker Dam, would provide an additional source of artificial flood waves. Sufficient data were not available to permit analysis of the effects of breaching of that dam upon artificial flooding; however, estimates based upon comparison with the effects of the Oder, Soese and Ecker Dams indicate that breaching of the Oker Dam would raise the stages on the Aller River at Westen approximately an additional 1 to 2 m when combined with the flood waves resulting from breaching of the existing valley dams.

(9) Effect of Breaching of Navigation Dams. Breaching of the navigation and mill dams on the Aller and Leine Rivers would create artificial flood waves of short duration and small amplitude. The low heights and small storage capacities of those dams are factors limiting the resulting waves. Because of lack of essential data, detailed study was not made; however, it is indicated by German sources (Exhibit B) that demolition of the navigation dams would produce flood waves 1 to 3 m high, depending upon the difference in the upstream and downstream water surface at the particular dam. Locations of navigation structures are shown on the General Map, Plate 1 and on the profiles, Plates 3-7, and descriptive data are contained in paragraphs 2-08 and 2-10, and in Exhibits A & B.

4-04 STREAM FLOW VARIATIONS.

a. General.

(1) The studies in this paragraph pertain to the artificial flooding effects that might be produced by release of water from the outlets of the Oder, Soese, and Ecker valley dams.

(2) Included are quantative estimates of the potential effects of detrimental flow variation produced by operation of the existing outlets and by modification of the outlet structures to increase the discharge capacity.

(3) Reference is made to paragraph 2-10b and Exhibit B for general descriptions of the structures, to Plate 1 for locations, to Plate 9 for sketches of the dams, and to documents listed as References 8 to 12, inclusive, in the Bibliography of this report for detailed descriptions and drawings of the dams and their outlet structures.

(4) Flow variations may be repeated to produce cyclic effects, dependent upon the replenishment of the depleted storage in the reservoirs.

b. Hydrologic Considerations.

(1) Reference is made to paragraph 4-03b for discussion of the influence of natural stream discharge and initial reservoir pool level on artificial flooding.

(2) The average time required for complete filling of the Oder and Soese reservoirs is stated in Exhibit B to be 6 months and 9 months, respectively.

c. Means of Creating Detrimental Flow Variations. Detrimental flow variations may be produced downstream from the Oder, Soese and Ecker Dams by one of the following three methods:

(1) Type A, operation of the existing controlled outlets for sustained or cyclic discharge.

(2) Type B, modification of the outlets to increase discharge capacity, accomplished by temporary by-passing, alteration or dismantling of restrictions, machinery or other outlet appurterances without causing permanent or serious disruption of normal reservoir functions.

(3) Type C, major modification of the outlet structures to increase discharge capacity accomplished by permanent removal of restrictions or such modification as to seriously hinder the normal functions of the reservoir.

d. Oder Dam Outlet Discharges.

(1) Type A. The existing main outlets of Oder Dam can discharge 42.7 m^3/s when the reservoir is full and 37.5 m^3/s when one-half full, as stated in Exhibit B. Simultaneous opening of outlets and turbines would increase the discharge capacity, at full pool, to 50 m^3/s for 8 to 10 days (See page 1 of Leine River tabulation in Exhibit B).

(2) Type B. Based on information in References 9 and 10, it was estimated that removal or by-passing of the turbines and the relief outlet would increase the discharge capacity to about 165 m^3/s at full pool. Discharges above 100 m^3/s could be sustained for about 2 days.

(3) Type C. Under full pool conditions, it was estimated that sudden release of water over the spillway by demolition or rapid operation of the 13 spillway gates, combined with discharge though the Type B modified outlets, would result in an initial peak flow of approximately 445 m^3/s. However, the rate of flow would reduce rapidly to about 160 m^3/s in 8 hours, as the reservoir level dropped to the spillway crest elevation.

e. Soese Dam Outlet Discharges.

(1) Type A. The discharge capacity of the existing outlets is stated in Exhibit B to be 36 m^3/s under maximum pool conditions, and 31 m^3/s when the reservoir is one-half full.

(2) Type B. Based on information in References 9 and 10, it is estimated that removal or by-passing of the existing turbines and water supply discharge pipe would increase the initial rate of discharge to about 55 m^3/s, which would drop to about 25 m^3/s in 5 days as the reservoir level was lowered to the elevation of the main intakes.

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(3) Type C. Discharge capacity of the Soese Dam outlets could be greatly increased by removal of the 6 m long concrete plug located approximately midway in the 3 m diameter outlet tunnel beneath the axis of the dam. Downstream from this restriction, water for water supply and power is carried through a 1.25 m diameter pipe built inside the 120 m long portion of the large tunnel. This pipe line, together with the turbine and pump machinery, would have to be removed in order to effect maximum increase of discharge capacity. Available data contained in References 9, 10, and 11 is not adequate to permit firm evaluation of the possibilities of such modification. Making these outlet modifications would permit increase of initial discharge under full pool conditions to about 280 m^3/s, but the flow would diminish to about 150 m^3/s in 30 hours when the reservoir level drops to the elevation of the intakes.

f. Ecker Dam Outlet Discharges.

(1) Type A. Information is lacking regarding the normal discharge capacity of the Ecker Dam outlets and turbines.

(2) Type B. Based upon information in Reference 12, it was estimated that by opening or by-passing the discharge pipe lines at the downstream exit of the dam, the discharge capacity would be increased to an estimated 30 m^3/s under initial full pool conditions and would be sustained above 20 m^3/s for about 5 days.

(3) Type C. Dismantling of the outlet pipes and removal of the regulating discharge valve installations would permit a discharge rate estimated to be 165 m^3/s under initial full pool conditions and dropping to about 90 m^3/s within 24 hours. Subsequent to this time, the pool level would have receded below the elevation of the main intakes and the discharge would recede from about 25 m^3/s to zero discharge in about 2 days.

g. Oker Dam Outlet Discharges.

No information is available concerning the probable discharge capacity of the incompleted Oker Dam.

h. Effects of Detrimental Flow Variations.

(1) General. The effects of the detrimental flow variations produced by release of discharge from the outlets of the Odor, Soese, and Ecker Dams is summarized in Tables 9 and 10. Reference is made to Plates 21 and 22 which present discharge hydrographs at key locations. For identification purposes, the resulting flow variations are designated herein as follows:

Artificial Flood No.	Location of Initial Discharge
Type A - Existing outlets	
6	Oder Dam
7	Soese Dam
Type B - Minor modification of outlets	
8	Oder Dam
9	Soese Dam
10	Ecker Dam
Type C - Major modification of outlets	
11	Oder Dam
12	Soese Dam
13	Ecker Dam
14	Oder + Soese Dams
15	Oder + Soese + Ecker Dams

(2) Effects of Discharge from existing outlets (Type A).

(a) General. Release of discharge through the existing outlets (designated as Type A discharges in paragraph 4-04c) could produce moderate flow variation of 8-10 days duration if outlets are allowed to remain open. Pertinent data relative to the effects are contained in Tables 9 and 10.

(b) Artificial Flood No. 6 is designated as the flow variation on the Oder, Rhume, Leine and Aller Rivers below Oder Dam resulting from sustained discharge under initial full pool conditions from the existing outlets of that reservoir. As described in paragraph 4-04d(1) and on page 1 of the Leine River table included in Exhibit B, approximately 50 m^3/s can be released for a period of 8-10 days by opening the bottom sluices and operating the turbines. The resulting discharge at Westen (km 22) would be 139 m^3/s, an increase of 36 m^3/s over the MW base flow at that location as summarized in Table 9.

(c) Artificial Flood No. 7 corresponds to the flow variation below Soese Dam resulting from sustained discharge from the existing outlets of that dam. As discussed in paragraph 4-04e(1) and in the table included in Exhibit B, approximately 36 m^3/s can be released under maximum pool conditions. The duration of discharge would be 8-10 days. As shown in Table 9, the resulting discharge at Westen would be 128 m^3/s, an increase of 25 m^3/s above the base flow at MW at that location.

(d) Comparison of Effects of Discharge from Existing Outlets (Type A). Only slight reduction in the amplitude, accompanied by slight increase in the duration of the flow variation, would be evidenced during its progress downstream as may be observed in Table 9. The resulting inundation along the stream would be negligible as indicated in Table 10. A summary of effects at selected locations, extracted from Table 9, is shown for comparison.

Location	River km	Artificial Flood No. 6	7
	Height of crest above mean water profile (m)		
Elvershausen	275	0.6	0.5
Herrenhausen	152	1.1	0.9
Westen	22	0.4	0.3
	Surface velocities (km/hr)		
Elvershausen	275	6	6
Herrenhausen	152	3	3
Westen	22	3	3
	Time of start of rise after initial discharge (hrs.)		
Elvershausen	275	12	10
Herrenhausen	152	41	38
Westen	22	69	66
	Time of peak after initial discharge (hrs.)		
Elvershausen	275	40	45
Herrenhausen	152	84	90
Westen	22	129	135
	Duration of stages above MW (hrs.)		
Elvershausen	275	210	210
Herrenhausen	152	270	270
Westen	22	340	340

(3) Effects of Minor Modifications of Outlets (Type B).

(a) General. Release of discharge through the outlets, with minor (Type B) modifications described in paragraphs 4-04c to 4-04f, would produce flow variations with peaks ranging from about 0.3 to 2.5 meters above mean water. Pertinent data are summarized in Tables 9 and 10.

(b) Artificial Flood No. 8 is the flow variation on the Oder, Rhume, Leine and Aller Rivers resulting from sustained discharge under initial*/pool conditions from the outlets of Oder Dam, modified as described in paragraph 4-04d(2). The peak discharge of 165 m^3/s at Oder Dam would result in an increase of 120 m^3/s over the base flow at Westen (See Table 9).

(c) Artificial Flood No. 9 is the flow variation downstream from Soese Dam created by sustained discharge under initial full pool conditions from the modified outlets of that dam, as described in paragraph 4-04e(2). The peak discharge at the dam of 55 m^3/s would not be appreciably reduced during its progress downstream. An increase of 40 m^3/s over the base flow at Westen would result as shown in Table 9.

*/full

4-04h(3)

(d) Artificial Flood No. 10 is the flow variation below Ecker Dam resulting from sustained discharge under initial pool conditions from the Ecker Dam outlets, modified as described in paragraph 4-04f(2). As may be observed in Table 9, the peak discharge of 30 m^3/s at the dam would result in an increase of 20 m^3/s over the base flow at Weston.

(e) Comparison of effects of minor modifications of Outlets (Type B). The effects of flow variation resulting from sustained discharge from the outlets (with minor Type B modifications) are summarized in Tables 9 and 10. The flooding would be confined generally within the stream banks, except for Artificial Flood No. 8, which would cause overbank flooding ranging in width from 0.2 to 1.7 km at various locations as shown in Table 10. Extracts of effects from Table 9 are shown below for comparison:

Location	River km	Artificial Flood No. 8	9	10
Height of crest above mean water profile (m)				
Elvershausen	275	2.2	0.8	-
Herrenhausen	152	2.7	1.3	-
Celle	115	-	-	0.6
Westen	22	1.3	0.5	0.3
Surface Velocity (km/hr.)				
Elvershausen	275	8	6	-
Herrenhausen	152	4	4	-
Celle	115	-	-	3
Westen	22	5	4	4
Time of start of rise after initial discharge (hrs.)				
Elvershausen	275	8	6	-
Herrenhausen	152	25	23	-
Celle	115	-	-	26
Westen	22	55	46	55
Time of peak after initial discharge (hrs.)				
Elvershausen	275	30	48	-
Herrenhausen	152	69	95	-
Celle	115	-	-	71
Westen	22	121	138	106
Duration of stage above MW (hrs.)				
Elvershausen	275	76	190	-
Herrenhausen	152	100	250	-
Celle	115	-	-	145
Westen	22	112	330	160

(4) Effects of Major Modifications of Outlets (Type C).

(a) General. The effects of flow variations resulting from sustained discharge from the outlets of Oder, Soese and Ecker Dams, as a result of Type C major modifications described in paragraphs 4-04c-f are summarized in Tables 9 and 10. Plates 21 and 22 show discharge hydrographs at key locations. Attention is directed to the influence of the comparatively large base flows upon the resulting discharge hydrographs.

(b) Artificial Flood No. 11 is the flow variation resulting from sustained discharge from the Oder Dam outlets modified as described in paragraph 4-04d(3). The sharp peak release of 445 m^3/s would be reduced to 218 m^3/s at Westen, an increase of about 115 m^3/s over the base flow at that location. Plate 21 shows the discharge hydrographs.

(c) Artificial Flood No. 12 is the flow variation resulting from operation of the modified Soese Dam outlets as described in paragraph 4-04e(3). The peak discharge at the dam of 282 m^3/s would result in an increase of 160 m^3/s over the base flow at Westen, effecting a peak flow of 263 m^3/s at that location as shown on Plate 21.

(d) Artificial Flood No. 13 is the result of discharge from the Ecker Dam outlets with Type C modifications as described in paragraph 4-04f(3). The peak flow at Westen of 193 m^3/s represents an increase of approximately 90 m^3/s above the base flow at that location, and is the result of the initial 165 m^3/s peak discharge from the dam outlets. Hydrographs at other key locations are shown on Plate 22.

(e) Artificial Flood No. 14 results from the combined discharge of the Type C modified outlets of Oder and Soese Dams, timing initial operation of the outlets so that the peak flows would arrive simultaneously at Elvershausen to produce maximum peak flows in the stream below that point. This combination could be effected by delaying the initial operation at the Oder Dam 5 hours later than initial discharge at the Soese Dam. The peak discharge of 445 m^3/s from the Oder outlets so combined with the peak discharge of 282 m^3/s from Soese Dam would produce a peak flow of 418 m^3/s at the point of junction of flow and would result in a peak of 318 m^3/s at Westen, an increase of 215 m^3/s over the base flow at that location. See Plate 21 for discharge hydrographs at key locations, Plates 4, 5 and 7 for water surface profile, Plate 13 for discharge profile, and Tables 9 and 10 for summary of effects.

(f) Artificial Flood No. 15 is the flow variation in the Aller River below the confluence of the Leine River resulting from the combined discharge of the type C modified outlets of the Oder, Soese and Ecker Dams. In order to produce maximum peak flow, the initial operation of the outlets at Oder and Ecker Dams were lagged

5 and 27 hours, respectively, after the initial operation at Soese Dam. The resulting peak discharge at Westen would be approximately 365 m^3/s, an increase of 262 m^3/s over the base flow at that location as shown in Table 9. Discharge hydrographs at Ahlden and Westen are shown on Plate 21.

(g) Comparison of Effects of Major Modifications of Outlets (Type C). The effects of flow variations induced by Type C major modifications of the outlet structures are summarized in Tables 9 and 10, extracts from which are shown below for purposes of comparison:

Location	River km	Artificial Flood No. 11	12	13	14	15
Height of crest above mean water profile (m)						
Elvershausen	275	2.3	2.6	-	3.2	-
Herrenhausen	152	2.7	3.4	-	4.3	-
Celle	115	-	-	1.9	-	-
Westen	22	1.2	1.5	1.0	1.9	2.2
Surface Velocity (km/hr.)						
Elvershausen	275	8	8	-	9	-
Herrenhausen	152	4	4	-	4	-
Celle	115	-	-	4	-	-
Westen	22	5	5	4	5	6
Time of start of rise after initial discharge (hrs.)						
Elvershausen	275	4	4	-	4	-
Herrenhausen	152	27	26	-	25	-
Celle	115	-	-	20	-	-
Westen	22	57	61	48	59	64
Time of peak after initial discharge (hrs.)						
Elvershausen	275	16	21	-	20	-
Herrenhausen	152	69	59	-	60	-
Celle	115	-	-	50	-	-
Westen	22	115	103	76	104	104
Duration of stages above MHW (hrs.)						
Elvershausen	275	52	32	-	58	-
Herrenhausen	152	18	30	-	51	-
Celle	115	-	-	0	-	-
Westen	22	0	0	0	0	32
Duration of stages above MW (hrs.)						
Elvershausen	275	76	52	-	84	-
Herrenhausen	152	97	73	-	105	-
Celle	115	-	-	60	-	-
Westen	22	105	80	78	118	130
Width of Flooding at Peak of Rise (km)						
Elvershausen	275	0.8	0.8	-	0.8	-
Bordenau (Leine R.)	121	0.3	0.3	-	0.6	-
Celle	115	-	-	0.3	-	-
Westen	22	0.7	0.5	0.5	1.4	2.0

4-04h

(5) Effects of Discharge from Oker Dam and Harzteiche.

(a) Detrimental flow variations might be produced by discharges from the Oker Dam, now under construction. No data are presently available to permit evaluation of the magnitude and duration of such discharges; however, it can be estimated that the resulting peak flows would be of similar magnitude to those from the other existing Harz Dams and that the duration of flow would be somewhat longer due to the larger storage capacity (45 million m^3) proposed for that new reservoir.

(b) The scattered location and small individual capacity of the 69 "Harzteiche," the Harz Mountain Ponds described in paragraph 2-10c, together with the long, small channels leading to the main streams, minimize the potential effect of discharges from those ponds to produce detrimental stream variations in the main streams of the basin.

(6) Effects of Discharge from the navigation dams. Opening of the outlets of the navigation and mill dams on the Aller and Leine Rivers would result in an undetermined amount of flow variation. The small storage capacity and the low head between the upper and lower pool elevations limit the magnitude and duration of discharge. Reference is made to Exhibit B for discussion and tabulation of the potential effects.

4-05 ARTIFICIAL FLOODING POTENTIALITIES OF CANALS.

a. Reference is made to paragraph 2-12 and to the document listed as Reference 3 in the Bibliography for detailed description of the canals.

b. Demolition of the Mittelland Canal (Ems-Weser and Weser-Elbe Canals) at the Leine River Aqueduct and at the Oker River and Aller River syphons would empty the water stored in the canals, (approximately 19 million m^3) into those streams, provided that the canal safety gates were raised (See Plate 10). The rates of flow would be too slow to create effective artificial flooding; however, the volume of released water could be utilised to supplement other sources of supply for still-water barriers described in paragraph 4-02. A total of approximately 13 million m^3 could be discharged at those three locations in 48 hours. The estimated rates of discharge are indicated in the following tabulation:

Hours After Breaching	Rate of Discharge (m^3/s) Leine R.	Oker R.	Aller R.
1	85	100	95
3	55	65	65
6	40	50	50
12	30	30	30
24	15	15	15
48	5	5	5

4-06 SUMMARY.

The artificial flooding potentialities of the Aller and Leine River basin described in preceding paragraphs 4-01 to 4-05 are herein summarized.

a. Temporary damming operations at suitable existing damsites and bridge openings would create flooding extending 1 to 11 km upstream from those locations with average widths of overbank flooding ranging from 0.1 to 2.5 km and depths of 0.03 to 2 m. The extent and locations of flooded areas are shown on Plate 16 and results summarized in Tables 6 and 7. Associated breaching of levees would be necessary in most cases. Except during high water periods, overbank inundation would not present a continuous water obstacle. Temporary dams with heights less than approximately 3 m above mean water would not effect appreciable overbank flooding. Reference is made to paragraph 4-02 for detailed discussion.

b. Breaching of the Oder, Soese, and Ecker Dams (plus the Oker Dam when completed) would create major artificial flood waves with amplitudes of approximately 4-6 m in the upper reaches and 2-5 m in the lower reaches of the Aller and Leine Rivers downstream of those structures as discussed in paragraph 4-03. Locations appear on Plate 1 and sketches of the dams on Plate 9. The start of the waves produced by breaching of the Oder or Soese Dam would arrive at Westen (km 22 above the mouth of the Aller River) in about 75 hours and the peak in about 95 hours. Waves caused by breaching of the Ecker Dam would take approximately 15 hours less time to travel to Westen. Surface velocities at the peak of the wave would range from approximately 9 km/hr in the upper reaches to about 5 km/hr in the lower reaches of the Aller and Leine Rivers. The average rate of rise of stage would be about 0.6 m/hr near the dams and 0.2 m/hr in the lower reaches of those rivers. Stages would remain above normal for 15 to 20 hours immediately below the breached dams and for 45-60 hours farther downstream. Effects are summarized in Tables 8 and 10, discharge hydrographs are shown on Plates 19 and 20; and stage, discharge, and velocity profiles are shown for a representative flood wave on Plates 4, 5, 7 and 13. The effects can be intensified by synchronized breaching of the dams to produce either increased height, longer duration or repetition of flood waves.

c. Detrimental flow variations ranging in amplitude from 0.3 to 3 m might be produced along the Aller and Leine Rivers by manipulation of the controlled outlets of the Oder, Soese, and Ecker Dams (and of the Oker Dam upon its completion). Locations of the dams are shown on Plate 1. As discussed in paragraph 4-04, modification of the outlets to increase their discharge capacity would be necessary in order to produce the higher flow variations summarized in Tables 9 and 10. River stages could be maintained higher than normal for 40 to 200 hours immediately downstream from the dam and for 80 to 350 hours in the lower reaches of the Aller and Leine Rivers, by means of sustained discharge from the dam outlets. Average surface velocities of as high as 8 km/hr could be produced in the upper reaches during the passage of the peak of the rises. In the lower reaches, the average surface velocity would not exceed 4 km/hr. The relation of the peak discharges and surface velocities of a representative flow variation to natural conditions can be observed on Plate 13. The relative peak stages are plotted on the profiles of Plates 4, 5 and 7. The resulting overbank flooding, tabulated in Table 10, would be mostly confined to the areas included within the loops of the old river meanders and would be of short duration. In most cases, levees would also have to be breached in order to cause significant inundation along the streams.

d. The approximately 100 million m^3 maximum storage capacity of the existing reservoirs, ponds and canals could be utilized as a source of supply for the still-water barriers shown on Plate 16. A combined rate of discharge as high as approximately 100 m^3/s could be sustained for about 10 days under initial/pool conditions. It would take about 2 days for the initial flow to travel downstream to the lower reaches and about 3 additional days before the flow would rise to near the sustained maximum rate. Reference is made to paragraph 4-02g for detailed discussion.

e. Completion of the Oker Dam would add 45 million m^3 of storage capacity, and would permit increase of flood wave heights of 1 to 2 m by synchronized breaching in combination with the other dams. Breaching or discharge operations at the 69 smaller ponds (Harzteiche) would exert insignificant effects upon stage and velocity in the main streams of the basin (See paragraph 4-04h(5)).

f. The elevation of a reservoir pool at the time of breaching or regulated discharge operations would have direct influence upon the rate of discharge. For example, the discharge rate of 8500 m^3/s resulting from breaching of the Oder Dam at full reservoir (elevation 381.10 m/NN) would be reduced to 4200 m^3/s at elevation 377.3 m/NN, the lower limit of flood control storage (shown on Plate 17); and the effect downstream would be reduced accordingly.

g. Breaching or sudden release of discharge from the navigation locks and dams on the Aller and Leine Rivers would cause rises in downstream stages of 1-3 meters and corresponding reduction in upstream water surface. Locations of dams are shown on Plates 1 to 7 and descriptions are contained in Exhibit B. Synchronized demolition or operation would make possible either cyclic variation, increased duration or increased height of resulting stream stages. The duration of waves or flow variations would not exceed about 12 hours, due to the low height and small storage capacity of the navigation dams. Inundation of lowlands, unprotected by levees, would result but extent and duration of flooding would be slight. See Exhibit B for detailed discussion.

*/full

h. The amount of flooding to be expected as a result of breaching or regulated discharge from the large Hart Mountain Dams largely depends upon the base flow, i.e., the flow of water existing in the streams prior to passage of the flood wave. See Tables 3 to 5 for tabulation of natural statistical stages and discharges, and Plate 12 for expected frequency of occurrence of natural flows. The studies presented in this report were based upon an assumed base flow corresponding to mean water conditions. The stage to be expected at a key station during an artificial flood for any other condition of base flow may be determined by reference to Plates 14 and 15 and Tables 8 and 9. Add the difference in base flows between that indicated in Table 8 or 9 and the flow for the given initial stage (See Plates 14 or 15) to the peak discharge shown in those tables. Having thus determined the new peak discharge, determine the corresponding stage from the rating curve on Plate 14 or 15 for the station under consideration.

SECTION V
EFFECT ON MILITARY OPERATIONS

5-01 GENERAL.

The purpose of this section is to assist military planning personnel in estimating the relative value and effect of artificial floods on associated military factors such as bridging, ferrying, and trafficability. The effects of artificial floods on military operations may vary greatly, depending on hydrologic conditions, type of equipment involved, and the tactical and logistical situation. The effects presented in this section are opinions based largely upon discussions of the military effects of artificial flooding on the Aller and Leine Rivers given in Exhibit B, a military geography document published by the German General Staff. See paragraph 4-06 for summarized discussion of hydraulic effects of artificial flooding.

5-02 EFFECT OF STILL-WATER BARRIERS AND DRAINAGE OBSTACLES.

a. Reference is made to paragraph 4-02 for discussion of the hydraulic features associated with formation and augmentation of water obstacles by means of temporary damming operations or by disruption of normal drainage.

b. Bridging and ferrying operations within the backwater reaches upstream from the temporary dams would be hindered by reason of the resulting greater width and depth of crossing, indicated in Tables 8 and 9 and on Plate 16. Approach trafficability would be decreased by the shallow overbank flooding, and the increased stream depths would hinder fording of the upper reaches of the river. Since the resulting increased water obstacle would not be continuous along the streams (as illustrated on Plate 16), still-water barriers must be combined with other natural obstacles and with tactical operations in order to channelize military action.

c. Continuous military support of the temporary dam installations would be necessary to prevent their destruction by enemy air or ground action. Destruction of a temporary dam would release a flood wave of short duration that would hinder crossing operations below the structure and which might cause progressive failure of other downstream structures.

d. Maneuverability and trafficability in the area up to 2 km from the Aller and Leine riverbank would be hindered by blocking of the numerous drain ditches and culverts which drain the low-lying pasture land adjacent to the rivers.

5-03 EFFECT OF MAJOR FLOOD WAVES.

a. Reference is made to paragraph 4-03 for discussion of the hydraulic features associated with creation of major flood waves by means of breaching of the storage dams and navigation dams located on the Aller and Leine Rivers and their tributaries.

b. Breaching of the Oder, Soese, or Ecker Dams would create artificial flood waves that would destroy or endanger bridges and dams along the streams for an undetermined distance below the breached dam. Insufficient data are available regarding the structural features of existing bridges and dams to permit estimate of the degree of destruction.

c. Breaching of one or more of the large Harz dams or destruction of the navigation dams would produce temporary flood conditions which could interfere with stream crossing operations and endanger equipage and floating bridges along the Aller and Leine Rivers. See Tables 8 and 10 for summary of resulting flood conditions. Except in the immediate vicinity of the breached dam, the time required for travel of the flood wave (as shown in Table 8) would probably be sufficiently long to permit safeguarding measures to be undertaken.

d. Destruction of the large Harz dams would seriously disrupt the municipal water supply and electrical power supply of Bremen, Hildesheim and other important industrial and urban areas.

e. Destruction of the navigation dams on the Aller and Leine Rivers would disrupt waterborne traffic to Hannover and other industrial centers, and would disrupt power supply for a number of mills and factories, as described in Exhibit B.

5-04 EFFECT OF FLOW VARIATIONS.

a. Reference is made to paragraph 4-04 for discussion of the possible detrimental flow variations that could be created on the Aller and Leine Rivers by means of regulated discharge from the Harz dams and the navigation dams. The resulting flow conditions are summarized in Tables 9 and 10.

b. Combined or cyclic release of water from the outlets of the Oder, Soese, or Ecker Dams, especially if the outlets are modified to increase the discharge capacity, would produce appreciable flow variations along the Aller and Leine Rivers that would endanger existing structures and floating bridging for considerable distances downstream. The large storage capacities of the reservoirs permit extended durations or multiple repetitions of flow variations. The several days travel time required for a release from the dams to be fully effective on the Leine River below Hannover or below Celle on the Aller River (as shown in Table 9) would permit protective measures to be undertaken.

c. Deliberate demolition of the Harz dams and the navigation locks and dams would prevent their use by the enemy in producing detrimental flow variation during a later critical period.

5-05 EFFECTS RELATED TO OTHER BASINS.

Artificial flooding along the Aller or Leine Rivers could be coordinated with similar operations on other river basins to create simultaneous or progressive water obstacles affecting military action. Reference is made to reports on studies of artificial flooding possibilities on the Rhine, Danube, Weser, and Ems Rivers listed as References 20 to 24, inclusive, in the Bibliography of this report.

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TABLES

1. Equivalent English-Metric Terms
2. Hydrologic Terms and Abbreviations
3. Summary of Gage Data, Aller and Oker Rivers
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5. Discharge Data, Aller River Basin
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TABLE I
EQUIVALENT ENGLISH-METRIC TERMS

To reduce A to B, multiply A by F. To reduce B to A, multiply B by G.

Unit A	Factor F	Factor G	Unit B
Miles	1.60935	.62137	Kilometers
Meters	3.2808	.30480	Feet
"	39.370	.025400	Inches
Square Miles	2.590	.3861	Square Kilometers
" "	259.000	.0038610	Hectares
Hectares	2.47104	.40469	Acres
Acres	4046.9	.00024710	Square Meters
Cubic Meters	35.3145	.028317	Cubic Feet
Cubic Feet	28.317	.035314	Liters
Acre-feet	43560.	.000022957	Cubic Feet
"	1233.5	.00081071	Cubic Meters
Cubic Feet per second	1.9835	.50417	Acre-feet per 24 hours
" Meters per "	35.3145	.028317	Cubic-feet per second
Miles per hour	1.60935	.62137	Kilometers per hour
" " "	1.4667	.68182	Feet per second
Meters per second	3.2808	.30480	" " "
" " "	2.2369	.44704	Miles per hour
Feet per second	1.097	.99113	Kilometers per hour
Tons (metric)	1.102	.9072	Tons (short)
" (long)	1.016	.9842	" (metric)
" (metric)	2205.	.0004536	Pounds (avoirdupois)
" (metric)	1000.	.001	Kilograms

TABLE 2
HYDROLOGIC TERMS AND ABBREVIATIONS
(In conformance with German practice)

Non-Tidal Stage	High-Tide Stage	Low-Tide Stage	Rate of Discharge (m^3/sec)	Discharge per Unit Area (1/sec-km^2)	Definition
HHW	HHThw	HHTnw	HHQ	HHq	Highest value ever known or observed
HW	HThw	HTnw	HQ	Hq	Highest value observed during a stated period of time
MHW	MHThw	MHTnw	MHQ	MHq	The mean high value during a stated period, derived by averaging the highest values of each unit time element (i.e. MHW 1926/35 is average of the 10 yearly peak stages)
MW	MThw	MTnw	MQ	Mq	The mean (arithmetical average) of all observations during a stated time period
MNW	MNThw	MNTnw	MNQ	MNq	The mean low value during a stated period, derived by averaging the lowest values of each unit time element (MNW 1926/35 is the average of the 10 yearly lowest stages)
NW	NThw	NTnw	NQ	Nq	Lowest value observed during a stated period of time
NNW	NNThw	NNTnw	NNQ	NNq	Lowest value ever known or observed

TABLE 3
SUMMARY OF GAGE DATA - ALLER AND OKER RIVERS

Gage	GSGS Map Series 4416/4414	"Nord de Guerre" Grid	Km. above Mouth of Aller	Drainage Area Sq. Km.	Gage Zero m/NN	Item*	Date or Period of Record	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Year
Brenneckenbrueck	M5/3528	X8535	158	1645	47.57	HHW	Mar 1881													269
(Aller R.)						HW	1926-35													250
						MHW	"	145	163	188	171	173	162	117	110	117	94	94	111	222
(7 km. upstream of						MW	"	104	108	141	126	114	110	71	73	69	59	66	75	93
Oker R. junction)						MNW	"	73	73	96	81	69	65	43	49	28	34	46	50	25
						NW	"													8
						NNW	Jul 1934													8
Celle	M4/3326	X5950	115	4494	31.82	HHW	Feb 1946													528
(Aller R.)						HW	1926-35													495
						MHW	"	264	270	322	286	277	273	222	202	199	182	179	206	382
(1 km. upstream of						MW	"	196	199	245	228	210	213	167	153	153	145	143	157	184
Fuhse R. junction)						MNW	"	154	156	186	180	161	162	132	120	108	109	116	127	101
						NW	"													80
						NNW	Sep 1936													53
Ahlden	M4/3223	X2464	59	14122	18.96	HHW	Mar 1881													468
(Aller R.)						HW	1926-35													434
						MHW	"	282	312	348	331	315	325	262	231	226	207	187	236	384
(6 km. downstream of						MW	"	217	231	279	273	250	256	199	173	169	155	145	165	209
Leine R. junction)						MNW	"	169	166	212	211	198	191	157	133	114	116	119	122	100
						NW														58
						NNW	July and Oct 1934													58
Westen	M3/3121	X0573	22	15221	10.59	HHW	Mar 1881													553
(Aller R.)						HW	1926-35													522
						MHW	"	338	368	407	381	372	367	310	280	277	252	240	282	454
						MW	"	271	285	336	322	301	303	252	228	225	210	202	220	263
						MNW	"	224	226	267	267	253	243	216	194	179	179	179	183	163
						NW	"													112
						NNW	July 1934													112
Gross-Schwuelper	M5/3628	X8321	181	1763	57.77	HHW	Nov 1926													341
(Oker R.)						HW	1926-35													341
						MHW	"	188	192	222	192	182	199	154	133	137	130	117	163	279
						MW	"	108	103	138	126	115	133	90	75	83	78	54	78	99
						MNW	"	61	54	74	72	69	78	51	39	33	36	36	37	24
						NW														6
						NNW	July 1934													6

River Stage in Centimeters above Gage Zero (columns Nov. through Year)

*See Table 2 for definition of symbols

TABLE 4

SUMMARY OF GAGE DATA - LEINE AND RHUME RIVERS

Gage	GSGS Map Series 4416 / 4414	"Nord de Guerre" Grid	Km. above Mouth of Aller	Drainage Area Sq. Km.	Gage Zero m/NN	Item*	Date or Period of Record	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Year
Northeim (Leineturm)	Q4 / 4226	C5447	269	984	113.69	HHW	Feb 1909													286
(Leine R.)						HW	1926-35													265
						MHW	"	92	77	124	86	64	78	47	28	58	28	18	43	184
(4 km. upstream of						MW	"	27	28	50	45	33	38	21	13	16	12	9	13	25
Rhume R. junction)						MNW	"	10	10	22	23	18	15	11	5	2	2	3	3	-2
						NW	"													-20
						NNW	Jul 1883													-30
Greene	P4 / 4125	C5264	241	2898	94.92	HHW	Feb 1946													721
(Leine R.)						HW	1926-35													679
						MHW	1926-35	401	387	452	398	374	370	305	275	321	300	242	353	563
						MW	"	295	299	325	306	304	288	259	241	252	246	231	254	275
						MNW	"	258	246	268	257	265	248	238	223	224	226	225	226	212
						NW														180
						NNW	Sep 1911													172
Herrenhausen	N4 / 3624	X3322	152	5355	44.15	HHW	Feb 1946													670
(Leine R.)						HW	1931-35													536
						MHW	"	264	206	340	325	275	311	217	212	209	147	178	236	422
						MW	"	159	130	205	205	169	191	140	114	114	94	95	104	143
						MNW	"	66	83	88	109	92	86	65	73	52	56	59	53	37
						NW	"													
						NNW	Jun 1929													15
Basse	N4 / 3423	X2041	98	6155	28.51	HHW	May 1881[1]													670[1]
(Leine R.)						HW	1926-35													634
						MHW	"	305	314	291	324	307	328	241	207	239	217	183	244	470
						MW	"	205	207	272	250	226	241	182	157	169	155	142	159	197
						MNW	"	153	142	181	184	172	168	152	131	122	123	122	116	104
						NW	"													72
						NNW	Oct 1934													72
Elvershausen	Q4 / 4226	C6247	275	1115	125.51	HHW	Jan 1932													348
(Rhume R.)						HW	1926-35													348
						MHW	"	130	124	169	142	106	119	93	89	104	106	84	135	246
(13 km. upstream of						MW	"	83	79	91	86	81	86	72	65	70	69	64	75	77
Leine R. junction)						MNW	"	66	61	66	66	67	70	62	56	55	55	55	58	51
& 1 km downstream of						NW	"													45
Soese R. junction)						NNW	Oct 1921													35

River Stage in Centimeters above Gage Zero (columns Nov. through Year)

*See Table 2 for definition of symbols

[1]Feb 1946 Flood stage probably higher, but records not available

TABLE 5
DISCHARGE DATA — ALLER RIVER BASIN
1926-1935

Gage	Km above mouth of Aller	Drainage Area km^2	HHQ / HHq	HQ / Hq	MHQ / MHq	MQ / Mq	MNQ / MNq	NQ / Nq	NNQ / NNq
			Discharge in cubic meters per second / Discharge per unit area in liters per sec. per sq. kil.						
Aller River									
BRENNECKENBRUECK	158	1,645	80* / 48.5 Mar. 1881	54* / 32.8	34(1) / 20.7	8(1) / 4.86	2(1) / 1.22	—	—
CELLE	115	4,494	—	—	—	28* / 6.2	6* / 1.3	—	—
AHLDEN	59	14,122	—	—	215* / 15.2	87* / 6.15	33* / 2.34	17* / 1.2	—
WESTEN	22	15,221	1600(2) / 105(Est) Mar. 1881	430* / 28.2	318(1) / 20.9	92(1) / 6.04	42(1) / 2.76	23* / 1.5	21(2) / 1.38(Est)
Leine River									
GREENE	241	2,898	500* / 172 Feb. 1946	455* / 157	220* / 76	28* / 9.7	14* / 4.8	7* / 2.3	6.40 / 2.21
HERRENHAUSEN	152	5,355	—	—	125* / 23.3	32* / 6.0	—	—	—
Rhume River									
ELVERHAUSEN	275	1,115	230* / 206 Jan. 1932	230* / 206	96* / 86	13* / 12	4* / 3.6	—	—

(1) Flow at MHW, MW, MNW from Jahrbuch fuer die Gewaesserkunde des Deutschen Reichs, 1938.
(2) Mean and extreme discharge (Q) tabulation in 1938 Jahrbuch.
* Flow at mean and extreme stages of tables 3 & 4, obtained by application of discharge rating curves from Plates 13 & 14.

TABLE 6
ALLER RIVER
INUNDATION EFFECT OF STILLWATER BARRIERS

Serial No.	Km above mouth of Aller	Map GSGS Series 4416/4414	"Nord de Guerre" Grid	Location and Description *	Low Stillwater Barrier (1m/MW) Pond Elev m/NN	Length km	Aver. Width m	Aver. Depth m	Pond Area km^2	Vol. 10^6 x m^3	High Stillwater Barrier (3m/MW) Pond Elev m/NN	Length km	Aver. Width m	Avor. Depth m	Pond Area km^2	Vol. 10^6 x m^3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	200.1-191	No significant flooding														
	191.4	N5/3531	131327	Crossing under Weser Elbe Canal Siphon crossing and High-water inlet to Canal	57.5			0.5	35 Flooding along South Side of Canal	17.5	58.75			1.0	57	57
	189.1	N5/3531	114312	Vorsfelde Rd. Br. 3 spans Total opening 25 m Stream width 10 m	57.0 Flooding along North side of Canal	8	800	0.3	6.4	1.9	58.75 Site unsuitable for high barrier					
	189-183	No significant flooding														
	182.7	N5/3530	043322	N.W. Fallersleben Rd. Br. 3 spans Total opening 20.5 m Stream width 7 m												
	166.1[1]	N5/3529	9136[1]	Gifhorn Sluice	52.38 Available increase of crest of weir is 20 cm Flooding of meadows along both Aller and Ise Rivers			0.5[2]	4[2]	2	Site unsuitable for high barrier					
1	161.8	N5/3528	855349	Bremneckenbrueck Rd. Br. 3 spans Total opening 31 m Stream width 20 m	"Mil-Geo" mentions a provisional dam placed at this point to form a pool back to Gifhorn. Approximate width of 500 m[1]											

[1] Estimated location; contradictory data given in Exhibit B.
[2] See Exhibit B
* See Exhibit A for details

TABLE 6
ALLER RIVER
(Continued)

Serial No.	Km above mouth of Aller	Map GSGS Series 4416/4414	"Nord de Guerre" Grid	Location and Description*	Low Stillwater Barrier (1m/MW) Pond Elev m/NN	Length km	Aver. Width m	Aver. Depth m	Pond Area km^2	Vol. $10^6 x$ m^3	High Stillwater Barrier (3m/MW) Pond Elev m/NN	Length km	Aver. Width m	Aver. Depth m	Pond Area km^2	Vol. $10^6 x$ m^3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
6	151.7	N5/3428	788398	Diekhorst Sluice	49.75 Pool extends beyond Breaneckenbrueck Rd. Br.	12.8	300	0.3	3.8	1.1	Site unsuitable for high barrier					
	151-147	No significant flooding														
9	147.5	N4/3427	760411	N of Flettmar RR Br. 2 spans Total opening 68 m Stream width 20 m	By damming to 46.5 (3m/MW) and breaching levee on left bank, water would be diverted overland to Fuhse R. depression. However, no stillwater barrier would be formed.											
10	143.7	N4/3427	737434	Langlingen Rd. Br. 7 spans Total opening 47 m Stream width 29 m	43.5	No significant flooding					45 Breaching of left bank levee also necessary	1	250	0.2	0.25	0.05
11	139.6	N4/3427	712442	Nordberg Weir	Increase of dam height would involve excessively long dam due to flat low-lying land in vicinity of site.											
12	138.1	N4/3427	703454	E. of Offensen Rd. Br. 2 spans Total opening 60.4 m Stream width 25 m	No significant flooding						43.75	1.3	500	1	0.6	0.6
13	133.7	N4/3427	680465	N.W. of Offensen Weir	Site unsuitable (See Serial No. 11)											
14	131.4	N4/3427	666460	Weinhausen Rd. Br. 4 spans Total opening 71 m Stream width 30 m	39.75 No significant flooding						41.80 Possible additional flooding may extend farther on right bank reaching upstream to the Offensen weir	1	400	0.5	0.4	0.2
	131-102	No significant flooding														

* See Exhibit A for details

TABLE 6
ALLER RIVER
(Continued

Serial No.	Km above mouth of Aller	Map GSGS Series 4416/4414	"Nord de Guerre" Grid	Location and Description*	Low Stillwater Barrier (1m/MW) Pond Elev m/NN	Length km	Aver. Width m	Aver. Depth m	Pond Area km²	Vol. 10⁶x m³	High Stillwater Barrier (3m/MW) Pond Elev m/NN	Length km	Aver. Width m	Aver. Depth m	Pond Area km²	Vol. 10⁶x m³
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
30-31	102.3	N4/3425	491536 489538	Oldau Lock and Dam Height of movable crest 1 m	33.75 Can be accomplished by operation of movable crest	3	700	0.5	2	1.0	Limit of mechanical rise is 1 m; location at lock and dam on separate channels would create difficulties for higher barriers					
32	98.4	N4/3325	471555	Winsen Rd. Br. 5 spans Total opening 108.1 m Stream width 32 m	30.75 No significant flooding						32.50	2	500	0.3	1	0.3
34-35	90.4	N4/3324	418560 415560	Bannetze Dam and Lock Height of movable crest 1 m	30.60 Can be accomplished by operation of movable crest	4	500	0.3	2	0.6	Not considered Limit of mechanical rise is 1 m Lock and dam on separate channels					
38	84.8	N4/3324	381547	Jeversen Rd. Br. Multi-span Total opening 75 m Stream width 40 m	29.1	4	1000	0.5	4	2.0	31.1	5	1500	0.5	7	3.5
40-41	78.8	N4/3324	333557 334558	Marklendorf Dam and Lock Height of movable crest 1 m	27.7 Can be accomplished by operation of movable crest	4	800	0.2	3	0.6	Limit of mechanical rise is 1 m; dam and lock on separate channels					
42	71.9	N4/3323	300576	Essel Highway Br. 3 spans Total opening 124 m Stream width 45 m	25.1 No significant flooding						27.1	3	1000	0.2	3.5	0.7
43	70.1	N4/3323	288582	Essel RR Br. 3 spans Total opening 116 m Stream width 45 m	25.2	2	500	0.2	1	0.2	27.2 Pool must hold along 2 km of rail line on left bank	5	1200	0.7	6	4.2

* See Exhibit A for details

TABLE 6
ALLER RIVER
(Continued)

					Low Stillwater Barrier (1m/MW)						High Stillwater Barrier (3m/MW)					
Serial No.	Km above mouth of Aller	Map GSGS Series 4416 / 4414	"Nord de Guerre" Grid	Location and Description*	Pond Elev m/NN	Length km	Aver. Width m	Aver. Depth m	Pond Area m^2	Vol. 10^6x m^3	Pond Elev m/NN	Length km	Aver. Width m	Aver. Depth m	Pond Area m^2	Vol. 10^6x m^3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
45-46	67.1	N4 / 3223	270590 268590	Hademstorf Lock and Dam Height of movable crest 1 m	25.0	3	1000	0.2	3	0.6	Limit of mechanical rise 1 m					
					Difficult to hold left bank over to Leine						Dam and lock on separate channels					
51	58.6	N4 / 3223	240644	Ahlden Rd. Br. 5 spans Total opening 119.4 m Stream width 56 m	22.2 No significant flooding						24.2	11	1500	1.0	17	17
											Flooding back to Essel RR Br.					
57	35.2	N4 / 3222	115669	Rethem Rd. Br. 7 spans Total opening 110 m Stream width 55-69 m	17.5 No significant flooding						19.5	8.5	2000	1.0	17	17
63	6.4	M3 / 3021	013801	Verden RR Br. 21 spans Total opening 375 m Stream width 57 m	11.5 No significant flooding						13.5	8	1200	0.8	10	8

* See Exhibit A for details

CONFIDENTIAL
SECURITY INFORMATION

TABLE 7
LEINE RIVER
INUNDATION EFFECT OF STILLWATER BARRIERS

Serial No.	Km above mouth of Aller	GSGS map series 4416/4414	"Nord de Guerre" Grid	Location and Description*	Low stillwater barrier (1m/MW) Pond level m/NN	Length km	Aver. width m	Aver. depth m	Pond area km²	Vol. 10⁶x m³	High stillwater barrier (3m/MW) Pond level m/NN	Length km	Aver. width m	Aver. depth m	Pond area km²	Vol. 10⁶x m³	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
197	254.0	P4-Q4/4225	503577	Salzderhelden Rd. Br. 7 spans Total opening 49 m Stream width 45 m	106.6	5	1750	1	8.7	8.7	108.7 Site unsuitable for high barrier						No suitable ~~sites above~~ Salzderhelden
196	251.8	P4/4125	503589	Salzderhelden RR Br. 10 spans Total opening 130 m Stream width 25 m	105.5	No significant flooding					107.5	6	1750	1	10.5	10.5	
	252-161	No significant flooding potentialities															
149	161.0	N4/3624	369183	Hannover RR Br. 2 spans Total opening 52.5 m Stream width 36 m		No significant flooding					53.75 Must hold along 2 km of RR embankment. May be necessary to block bridge over Ihme at 359192	2.5	2500	1	6.3	6.3	
119	147.9	N4/3624	315239	Herrenhausen RR Br. 3 spans Total opening 109.6 m Stream width 25.9 m	47.5	4.9 Similar bridge over dried-cut arm may also have to be blocked	560	0.6	2.8	1.7	50	5.7	860	2	4.3	8.3	
	148-137	No significant flooding															
116	136.8	N4/3523	264245	Seelze Rd. Br. 1 span Total opening 41.2 m Stream width 27.5 m	43.2	No flooding					45.0	1.3	640	0.5	0.8	0.4	
115	136.2	N4/3523	259246	Lohnde Aqueduct 3 spans Total opening 76 m Stream width 23 m	42.9	No flooding					45.0	3.0	320	0.5	0.9	0.5	Carries Weser Elbe Canal over Leine R.

* See Exhibit A for details

CONFIDENTIAL
SECURITY INFORMATION

TABLE 7
LEINE RIVER
(Continued)

Serial No.	Km above mouth of Aller	GSGS map series 4416/4414	"Nord de Guerre" Grid	Location and Description*	Low stillwater barrier (1m/MW) Pond level m/NN	Length km	Aver. width m	Aver. depth m	Pond area km^2	Vol. $10^6 x$ m^3	High stillwater barrier (3m/MW) Pond level m/NN	Length km	Aver. width m	Aver. depth m	Pond area km^2	Vol. $10^6 x$ m^3	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
114	134.4	N4/3523	259246	Lohnde Rd. Br. 1 span Total opening 22.8 m Stream width 26 m.	42.5	0.8	400	0.4	0.3	0.1	Site unsuitable for high barrier						
113	129.3	N4/3523	219260	Bielefeld-Hannover Autobahn Br. 8 span Total opening 250 m Stream width 25 m	No significant flooding						45.0	6.7	920	1.4	6.2	8.7	
112	127.3	N4/3523	201270	Ricklingen Rd. Br. 1 span Total opening 42.7 m Stream width 30 m	No significant flooding						42.5 May require artificial barrier on right bank	2.0	290	1.0	0.5	0.5	
127-110	No significant flooding																
109	109.7	N4/3422	176356	Neustadt Rd. Br. 3 spans Total opening 57 m Stream width 30 m	No significant flooding						37.5 May require blocking bridge over left channel (Serial 110)*	8.5	1200	0.75	10.2	7.6	
110-99	No significant flooding																
105	98.1	N4/3423	201415	Basse Rd. Br. 8 spans Total opening 46 m Stream width 37 m	No significant flooding						35.0	7.1	320	1.5	2.3	3.5	

* See Exhibit A for details

TABLE 7
LEINE RIVER
(Continued)

Serial No.	Km above mouth of Aller	GSGS map series 4416/4414	"Nord de Guerre" Grid	Location and Description*	Low stillwater barrier (1m/MW) Pond level m/NN	Length km	Aver. width m	Aver. depth m	Pond area km²	Vol. 10⁶x m³	High stillwater barrier (3m/MW) Pond level m/NN	Length km	Aver. width m	Aver. depth m	Pond area km²	Vol. 10⁶x m³	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
104	88.6	N4/3423	252451	Helstorf Rd. Br. 1 span Total opening 51 m Stream width 40 m	30 Confined mostly within channel	9.5	230	0.3	2.2	0.66	31.25	9.5	340	0.9	3.2	2.9	
	88-80	No significant flooding															
102	79.2	N4/3323	250511	Niedernstockern Rd. Br. 6 spans Total opening 56 m Stream width 40 m	27.5	0.4	100	.03	.04	0.01	30.0	9.4	2030	2	19.3	38.6	
	79-66	No significant flooding															
100	66.2	N4/3323	258583	Bothmer RR Br. 5 spans Total opening 110 m Stream width 50 m	25.0	5.6	460	1.2	2.6	3.1	27.5 Site unsuitable for high barrier						

*See Exhibit A for details

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SECURITY INFORMATION

TABLE 8
SUMMARY OF EFFECTS OF ARTIFICIAL FLOOD WAVES

…VER	LOCATION	RIVER Km.	ARTIFICIAL FLOOD NO. *	RIVER DISCHARGE: PEAK of WAVE m³/s	RIVER DISCHARGE: BASE FLOW m³/s	RIVER STAGE: PEAK of WAVE m+NN	RIVER STAGE: MHW m+NN	RIVER STAGE: MW m+NN	TIME of ARRIVAL: START of WAVE hrs. *	TIME of ARRIVAL: PEAK of WAVE hrs *	DURATION of WAVE: above MHW hrs	DURATION of WAVE: above MW hrs	SURFACE VELOCITY of PEAK Km/hr
				1	2	3	4	5	6	7	8	9	10
	AT DAM: (ODER)	(312)	1	8500	-	-	-	-	0	0	-	15	-
	(SOESE) or (SÖSE)	(301)	2	8600	-	-	-	-	0	0	-	17	-
	(ECKER)	(261)	3	8500	-	-	-	-	0	0	-	19	-
	(ODER + SÖSE)		4	-	-	-	-	-	-	-	-	-	-
	(ODER + SÖSE + ECKER)		5	-	-	-	-	-	-	-	-	-	-
…HUME	ELVERHAUSEN	275	1	700	13	130.0	128.0	126.3	11	18	14	21	9
	Zero Gage = 125.51m+NN		2	795	↓	130.1	↓	↓	9	14	13	19	9
			3	-		-			-	-	-	-	-
			4	1475		130.5			12	18	16	24	9
			5	-		-			-	-	-	-	-
…EINE	GREENE	241	1	547	27	102.3	100.5	97.6	-	-	-	-	-
	Zero Gage = 94.92 m+NN		2	577	↓	102.4	↓	↓	-	-	-	-	-
			3	-		-			-	-	-	-	-
			4	950		103.7			-	-	-	-	-
			5	-		-			-	-	-	-	-
…EINE	HERRENHAUSEN	182	1	360	32	50.2	48.3	45.6	40	54	20	38	5
	Zero Gage = 44.15m+NN		2	350	↓	50.1	↓	↓	33	49	18	36	5
			3	-		-			-	-	-	-	-
			4	650		51.6			37	53	25	41	5
			5	-		-			-	-	-	-	-
…EINE	BOTHMER	68	1	275	50	26.5	25.0	23.3	60	81	22	50	4
	Zero Gage = 22.77m+NN		2	270	↓	26.5	↓	↓	55	77	21	44	4
			3	-		-			-	-	-	-	-
			4	447		28.1			59	81	30	52	5
			5	-		-			-	-	-	-	-

* NOTE: TIME AFTER INITIAL BREACHING OPERATION
FLOOD NO. 4 - INITIAL BREACH AT ODER DAM; SOESE BREACHING 4 HOURS LATER
FLOOD NO. 5 - SAME AS ABOVE; ECKER BREACHING 15 HOURS AFTER ODER

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TABLE 9
SUMMARY OF EFFECTS OF FLOW VARIATION

River	Location	River Km.	Type of Flow	Artifical Flood №	River Discharge: Peak of Rise m³/s	River Discharge: Base Flow (at MW) m³/s	River Stage: Peak of Rise m+NN	River Stage: MHW m+NN	River Stage: MW m+NN	Time of Arrival: Start of Rise hrs *	Time of Arrival: Peak of Rise hrs *	Duration of Rise: above MHW hrs *	Duration of Rise: above MW hrs *	Surface Velocity at Peak Km/hr
					1	2	3	4	5	6	7	8	9	10
	AT DAM (Oder)	312	A	6	50					0	0		200	
	(Soese) or (Söse)	301		7	36					0	0		200	
	(Oder)		B	8	165					0	0		70	
	(Söse)			9	55					0	0		180	
	(Ecker)	261		10	30					0	0		142	
	(Oder)		C	11	445					0	0		60	
	(Söse)			12	282					0	0		40	
	(Ecker)			13	165					0	0		77	
	Oder+Söse)			14	-	-	-	-	-	-	-	-	-	-
	(Oder+Söse+Ecker)			15	-	-	-	-	-	-	-	-	-	-
Leine	ELVERHAUSEN	275	A	6	49	13	126.9	128.0	126.3	12	40	0	210	6
	Gage Zero = 125.51m+NN			7	38		126.8			10	45	0	210	6
			B	8	145		128.5			8	30	42	76	8
				9	53		127.1			6	48	0	190	6
				10	-		-			-	-	-	-	-
			C	11	165		128.6			4	16	52	76	8
				12	220		128.9			4	21	32	51	8
				13	-		-			-	-	-	-	-
				14	418		129.5			4	20	58	84	9
				15	-		-			-	-	-	-	-
Leine	GREENE	241	A	6	63	27	98.6	100.5	97.6	-	-	-	-	-
	Gage Zero = 94.93 m+NN			7	52		98.4			-	-	-	-	-
			B	8	162		100.0			-	-	-	-	-
				9	68		98.7			-	-	-	-	-
				10	-		-			-	-	-	-	-
			C	11	162		100.0			-	-	-	-	-
				12	234		100.6			-	-	-	-	-
				13	-		-			-	-	-	-	-
				14	397		101.6			-	-	-	-	-
				15	-		-			-	-	-	-	-

* NOTE: TIME AFTER INITIAL DISCHARGE AT DAM

FLOOD № 14 INITIAL DISCHARGE AT SOESE DAM, ODER DISCHARGE BEGUN 5 HOURS LATER.

FLOOD № 15 SAME AS ABOVE, ECKER DISCHARGE BEGUN 27 HOURS AFTER SOESE.

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SECURITY INFORMATION

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SECURITY INFORMATION

TABLE 9
SUMMARY OF EFFECTS OF FLOW VARIATION

River	Location	River Km.	Type of Flow	Artificial Flood Nº	River Discharge: Peak of Rise	River Discharge: Base Flow (or MW)	River Stage: Peak of Rise	River Stage: MHW	River Stage: MW	Time of Arrival: Start of Rise	Time of Arrival: Peak of Rise	Duration of Rise: above MHW	Duration of Rise: above MW	Surface Velocity at Peak
					m³/s	m³/s	m+NN	m+NN	m+NN	hrs *	hrs *	hrs *	hrs *	Km/hr
					1	2	3	4	5	6	7	8	9	10
Leine	HERRENHAUSEN	152	A	6	68	32	46.7	48.3	45.6	41	84	0	270	3
	Gage Zero 44.15m+NN			7	57		46.5			38	90	0	270	3
			B	8	148		48.3			25	69	24	100	4
				9	73		46.9			23	95	0	250	4
				10	-		-			-	-	-	-	-
			C	11	141		48.3			27	69	18	97	4
				12	205		49.0			26	59	30	73	4
				13	-					-	-	-	-	-
				14	313		49.9			25	60	51	105	4
				15	-					-	-	-	-	-
Leine	BOTHMER	68	A	6	86	50	24.1	25.0	23.3	59	113	0	310	3
	Gage Zero=22.77m+NN			7	75		23.9			56	119	0	310	3
			B	8	148		25.0			50	105	24	106	4
				9	90		24.2			39	123	0	300	3
				10	-		-			-	-	-	-	-
			C	11	145		25.0			52	99	0	102	4
				12	185		25.5			53	87	24	74	4
				13	-		-			-	-	-	-	-
				14	279		26.5			47	89	52	109	4
				15	-		-				-	-	-	-

* NOTE: TIME AFTER INITIAL DISCHARGE AT DAM

FLOOD Nº 14 INITIAL DISCHARGE AT SOESE DAM, ODER DISCHARGE BEGUN 5 HOURS LATER.

FLOOD Nº 15 SAME AS ABOVE, ECKER DISCHARGE BEGUN 27 HOURS AFTER SOESE.

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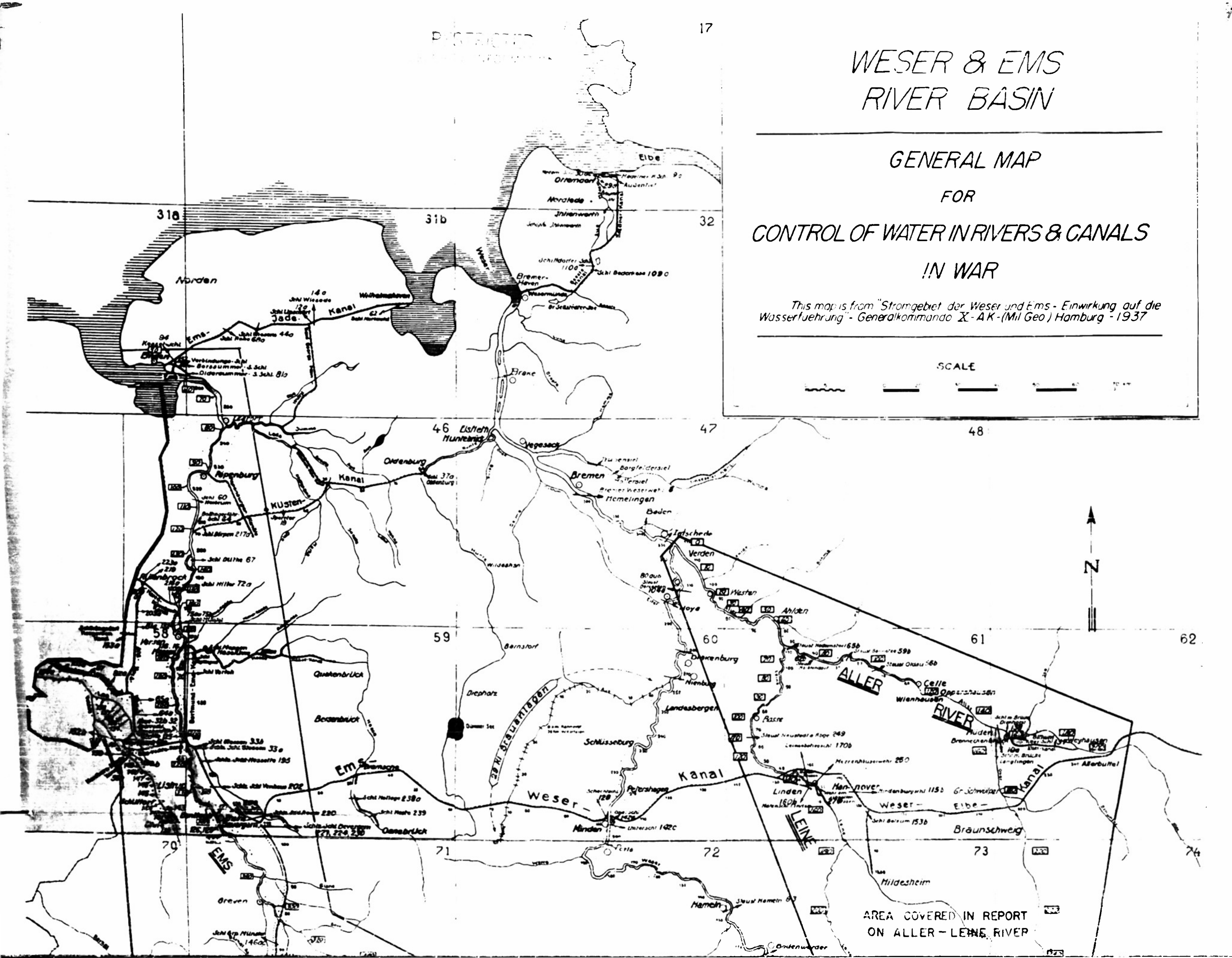
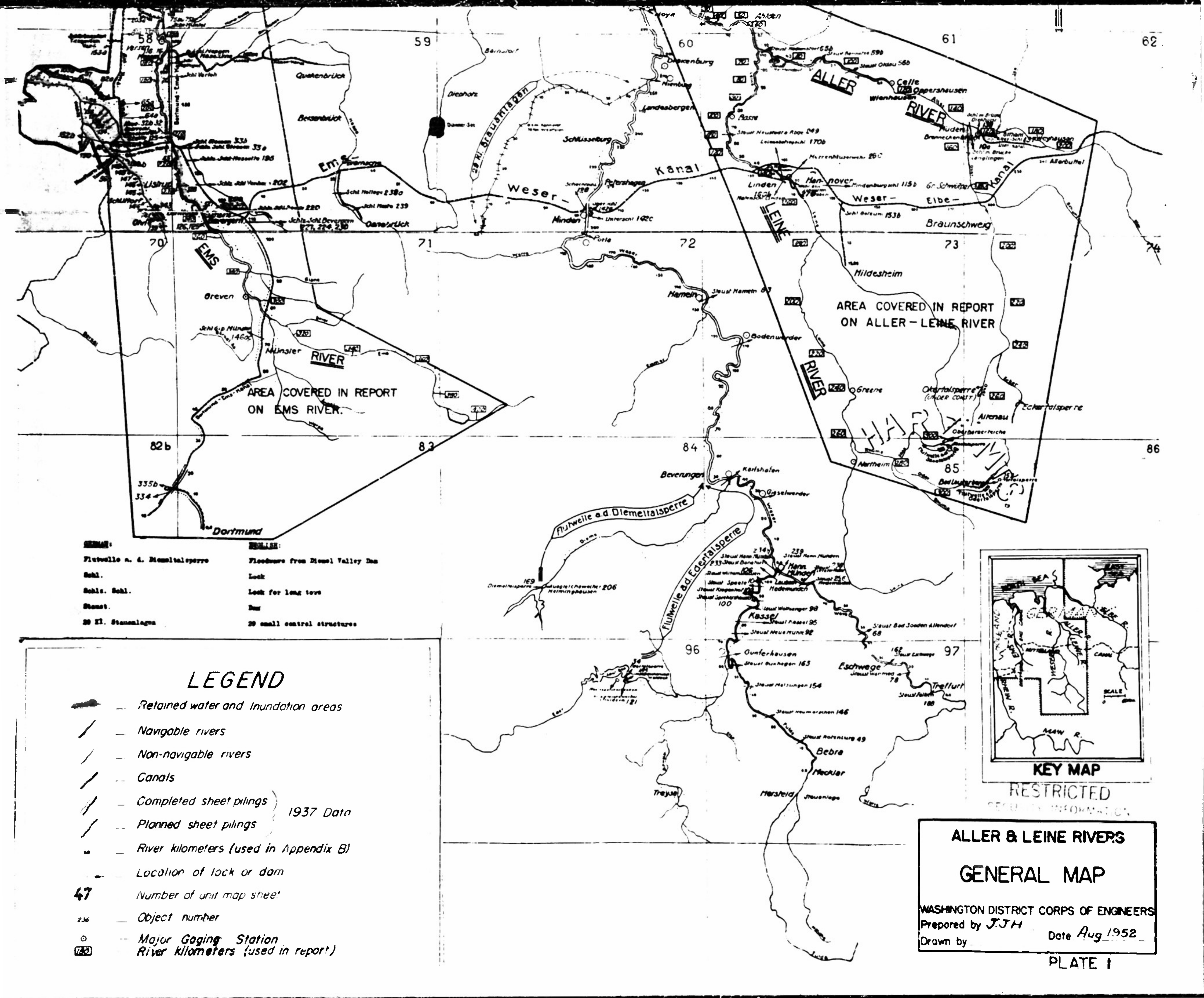
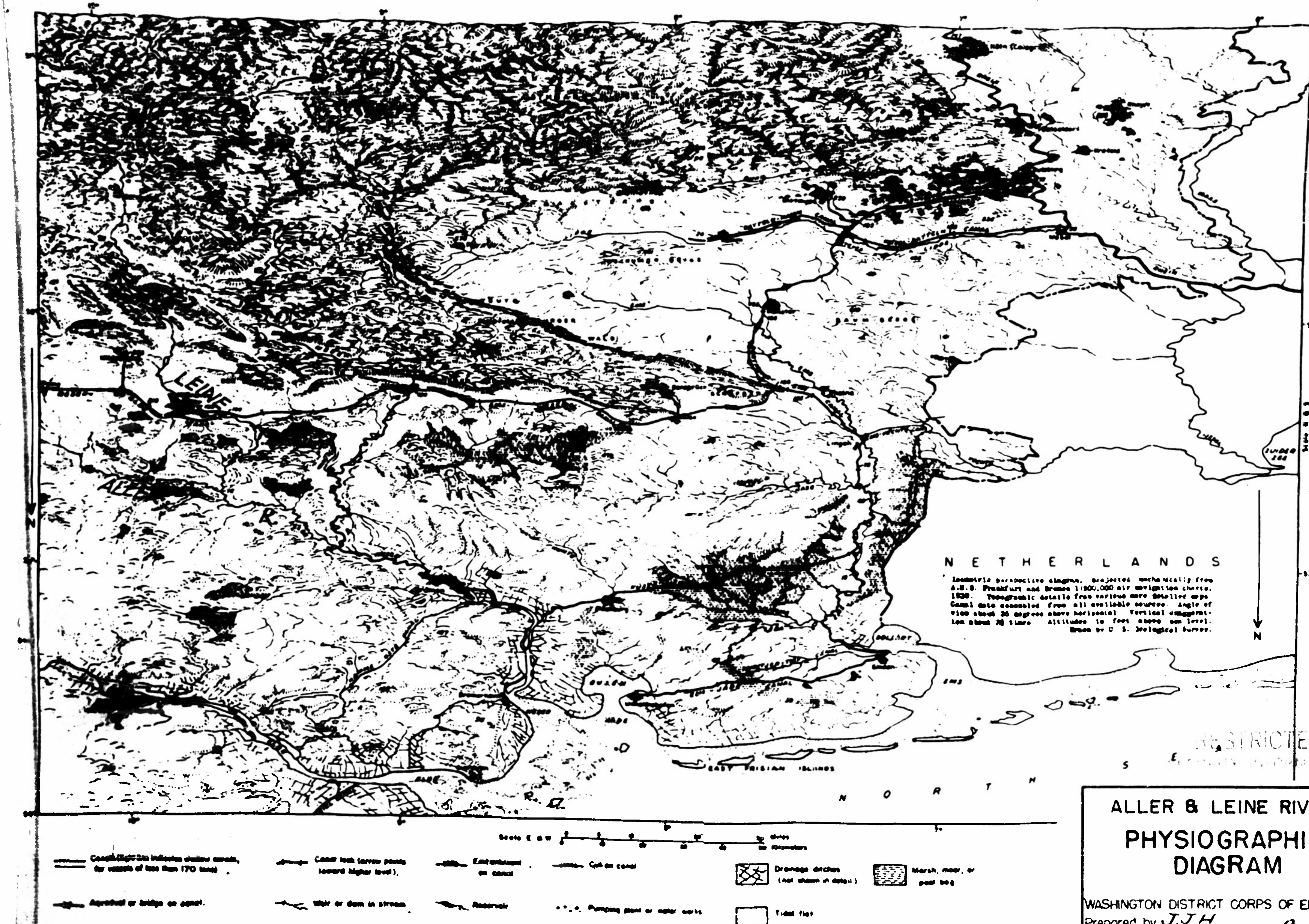

17
WESER & EMS
RIVER BASIN
GENERAL MAP
FOR
CONTROL OF WATER IN RIVERS & CANALS
IN WAR
This map is from "Stromgebiet der Weser und Ems - Einwirkung auf die Wasserfuehrung" - Generalkommando X - AK - (Mil Geo) Hamburg - 1937
SCALE
N
318
31b
32
46
47
48
58
59
60
61
62
70
71
72
73
74
Elbe
Norden
Wilhelmshaven
Jade
Kanal
Ems-
Bremerhaven
Brake
Elsfleth
Hunte
Oldenburg
Kanal
Küsten-
Vegesack
Bremen
Hemelingen
Verden
Westen
Ahlden
Hoya
Celle
ALLER
RIVER
Nienburg
Landesbergen
Schlüsselburg
Petershagen
Minden
Weser
Kanal
Linden
Hannover
Weser -
Elbe -
Braunschweig
LEINE
Hildesheim
Hameln
Quakenbrück
Bersenbrück
Diepholz
Dümmer See
Bernstorf
Wildeshausen
Ems
Osnabrück
EMS
Greven
Papenburg
Lingen
AREA COVERED IN REPORT
ON ALLER - LEINE RIVER



AREA COVERED IN REPORT ON ALLER – LEINE RIVER
AREA COVERED IN REPORT ON EMS RIVER.
ALLER RIVER
LEINE RIVER
EMS RIVER
Weser – Elbe – Kanal
Ems – Weser – Kanal
Celle
Hannover
Linden
Hildesheim
Braunschweig
Minden
Hameln
Bodenwerder
Greene
Northeim
Karlshafen
Beverungen
Kassel
Eschwege
Treffurt
Bebra
Hersfeld
Nienburg
Schlüsselburg
Landesbergen
Petershagen
Porta
Oppershausen
Wienhausen
Huden
Allerbuttel
Greven
Münster
Dortmund
Quakenbrück
Bersenbrück
Diepholz
Osnabrück
Ahlden
Hoya
Altenau
Oderteisperre
Eckertalsperre
HARZ
Flutwelle a.d. Diemeltalsperre
Flutwelle a.d. Edertalsperre
Gunterhausen
Hedemünden
Hann. Münden
Diemeltalsperre
Treysa
58
59
60
61
62
70
71
72
73
74
82b
83
84
85
86
96
97
GERMAN:
Flutwelle a. d. Diemeltalsperre
Schl.
Schls. Schl.
Stauat.
20 Kl. Stauanlagen
ENGLISH:
Floodwave from Diemel Valley Dam
Lock
Lock for long tows
Dam
20 small control structures
LEGEND
— Retained water and inundation areas
— Navigable rivers
— Non-navigable rivers
— Canals
— Completed sheet pilings
— Planned sheet pilings
1937 Data
— River kilometers (used in Appendix B)
Location of lock or dam
47 Number of unit map sheet
236 — Object number
— Major Gaging Station
River kilometers (used in report)
KEY MAP
NORTH SEA
GERMANY
EMS R.
WESER R.
ALLER R.
LEINE R.
ELBE R.
RHINE R.
MAIN R.
HOLLAND
SCALE
RESTRICTED
SECURITY INFORMATION
ALLER & LEINE RIVERS
GENERAL MAP
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by J.J.H.
Drawn by
Date Aug 1952
PLATE I



RESTRICTED

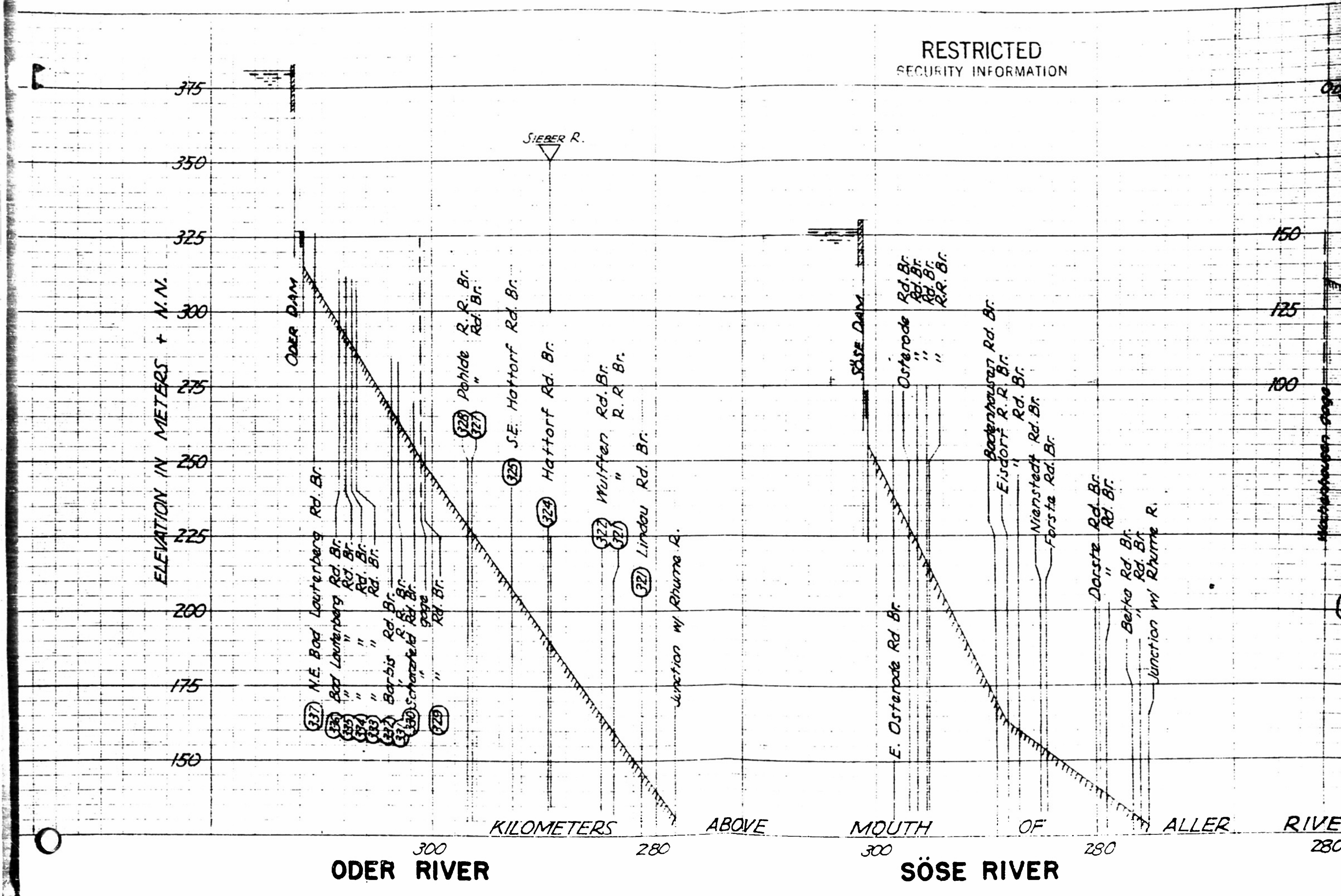
ALLER & LEINE RIVERS
PHYSIOGRAPHIC
DIAGRAM

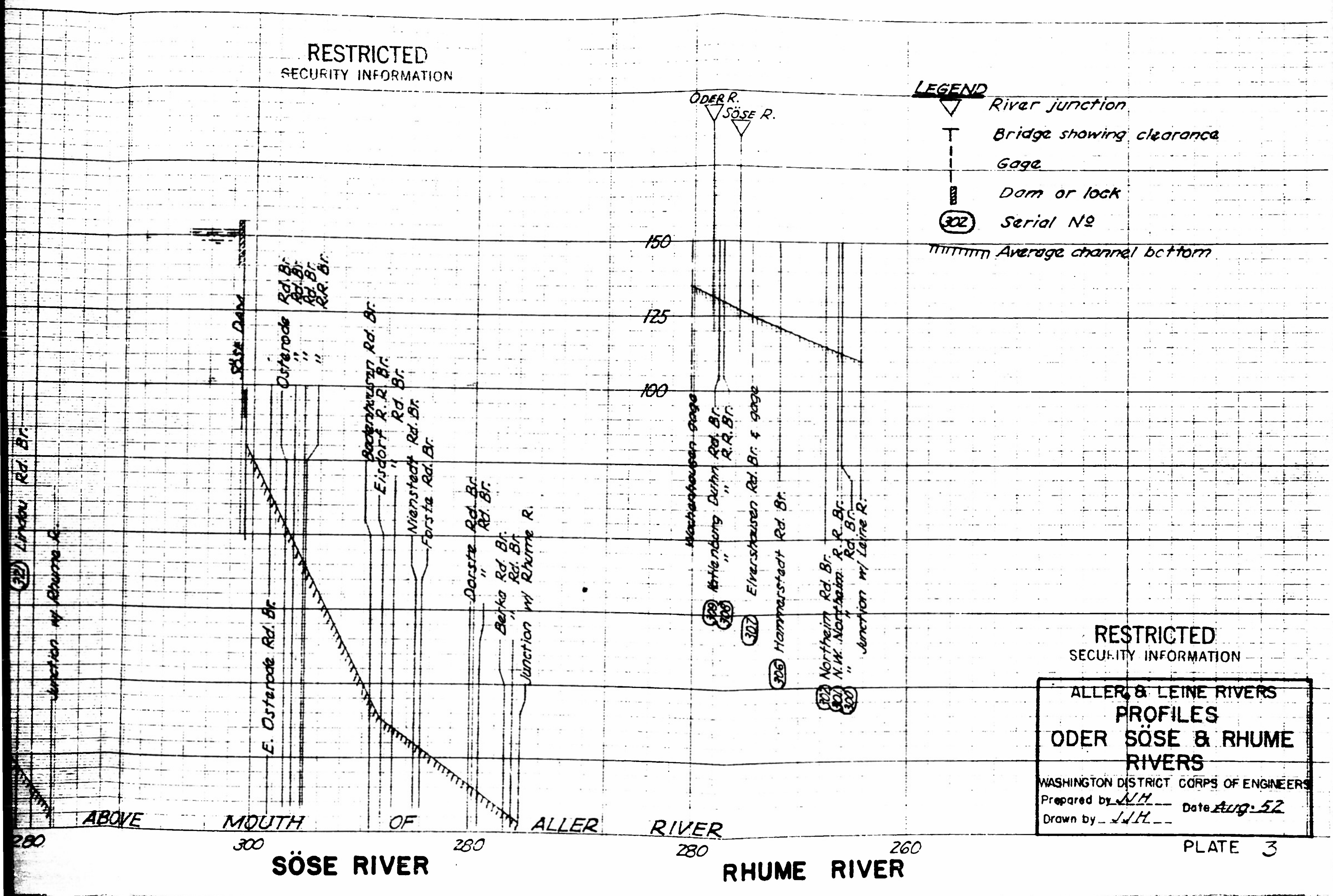
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by J.J.H.
Date Aug. 1952
Drawn by ________

REPRODUCED FROM "NAVIGABLE WATERWAYS OF GERMANY"
S.E.S. 128, O.C.E., U.S.A., AUGUST, 1944.

PLATE 2

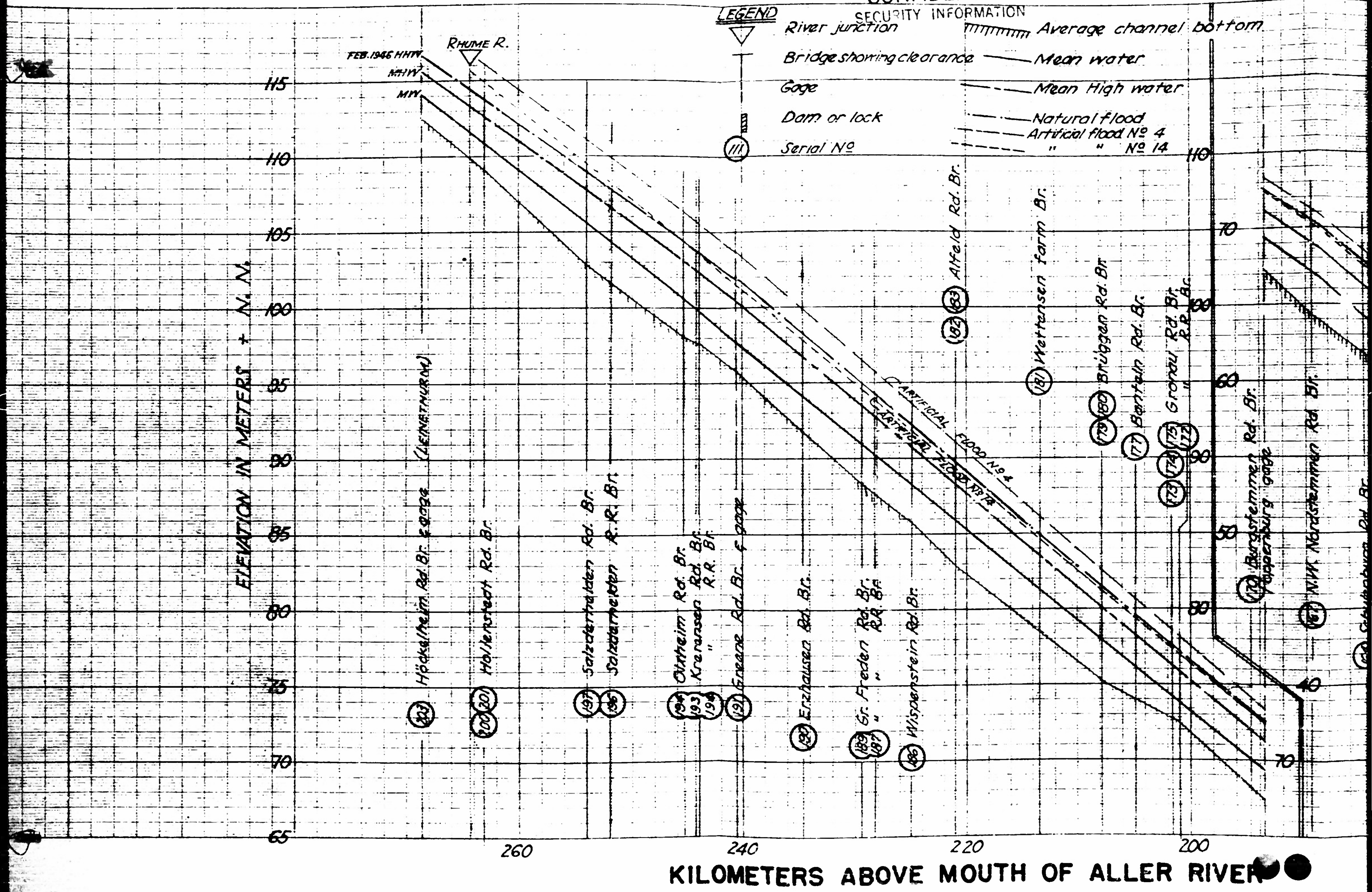
RESTRICTED
SECURITY INFORMATION

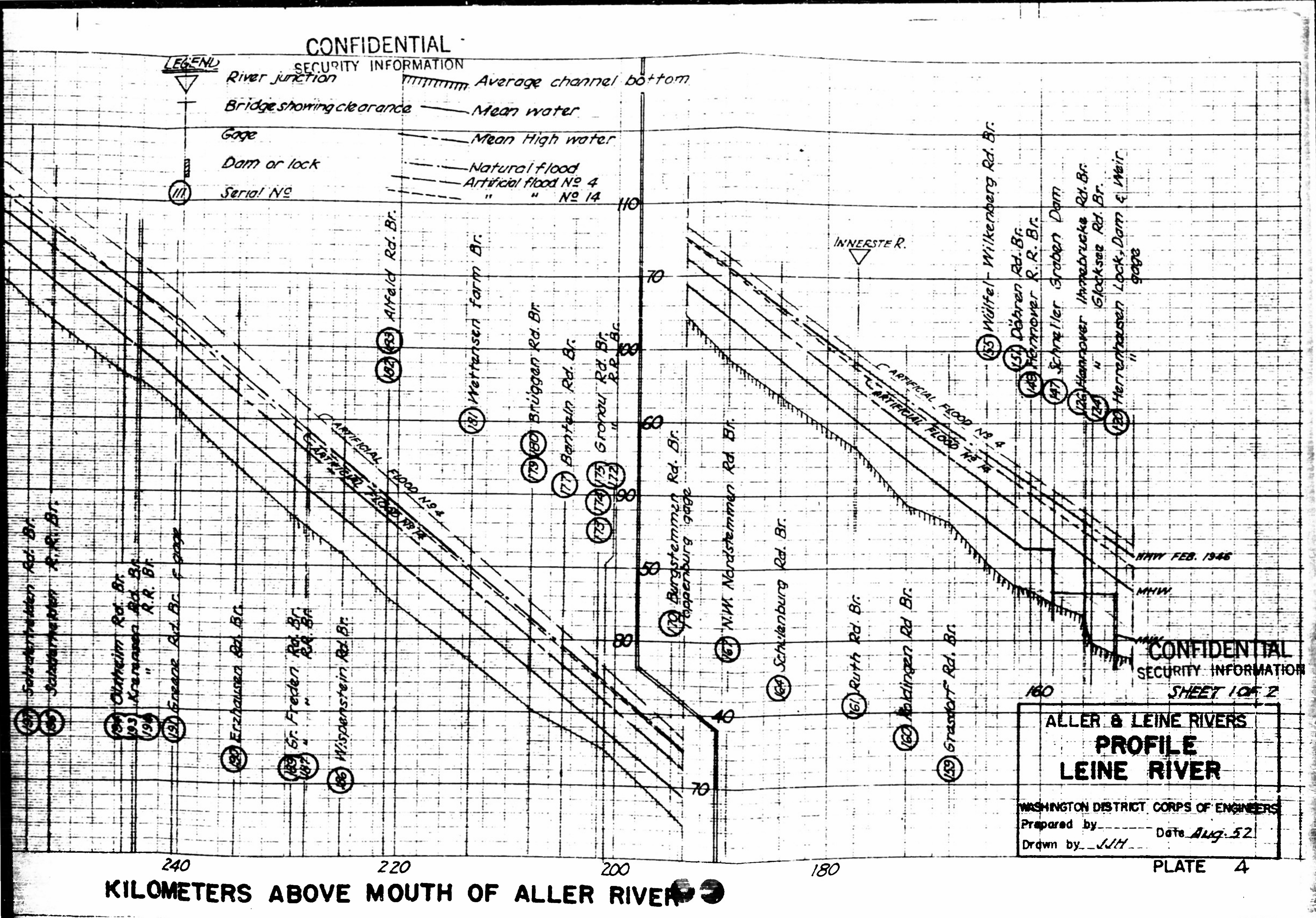




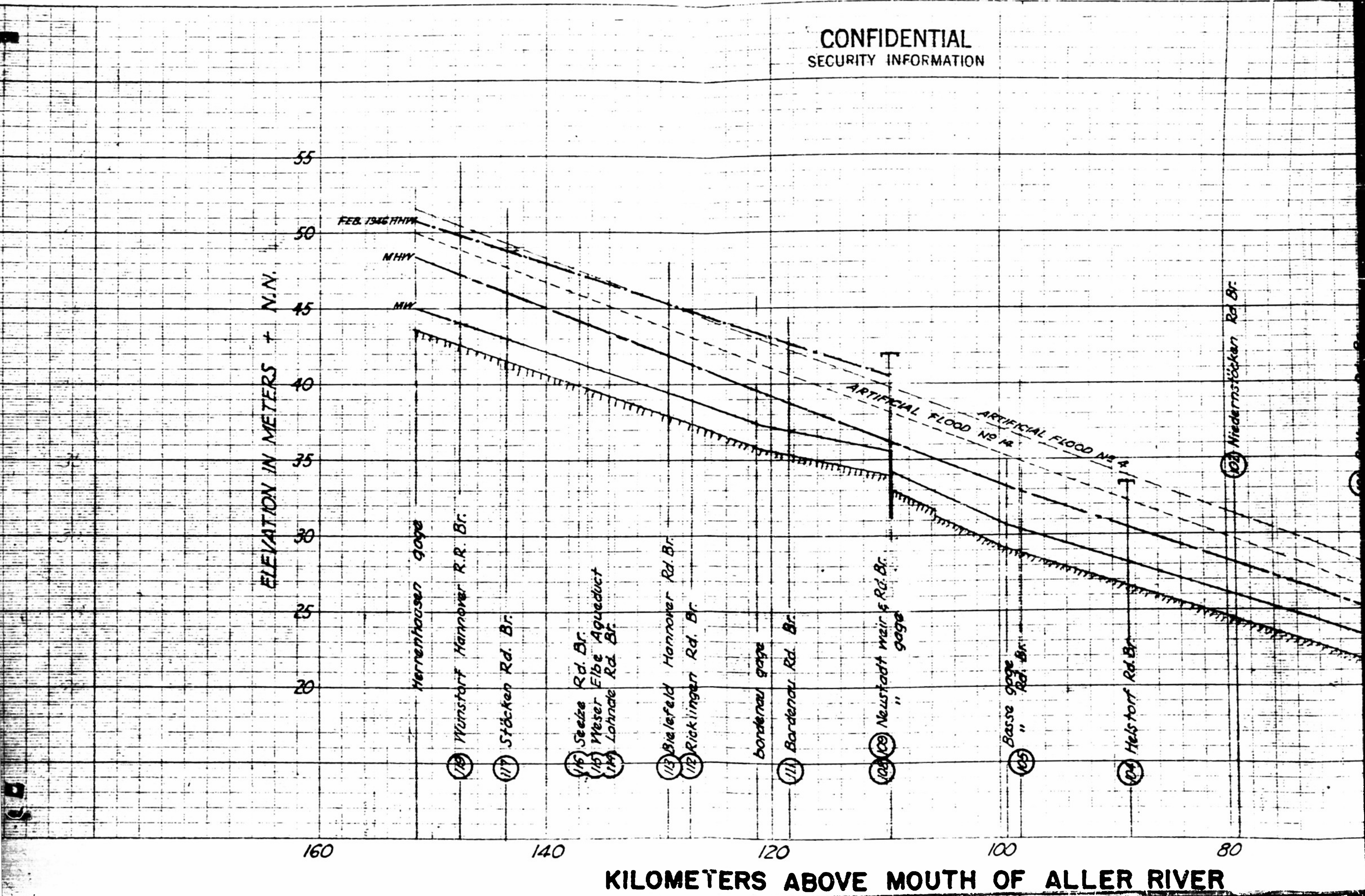
RESTRICTED
SECURITY INFORMATION
LEGEND
River junction
Bridge showing clearance
Gage
Dam or lock
302 Serial No
Average channel bottom
ODER R.
SÖSE R.
150
125
100
Söse Dam
Osterode Rd. Br.
" Rd. Br.
" Rd. Br.
" R.R. Br.
E. Osterode Rd. Br.
Eisdorf R.R. Br.
" Rd. Br.
Nienstedt Rd. Br.
Forsta Rd. Br.
Dorste Rd. Br.
" Rd. Br.
Berka Rd. Br.
" Rd. Br.
Junction w/ Rhume R.
Lindau Rd. Br.
Junction w/ Rhume R.
Wachenhausen gage
Katlenburg Duhm Rd. Br.
" R.R. Br.
Elvershausen Rd. Br. & gage
Hammenstedt Rd. Br.
Northeim Rd. Br.
N.W. Northeim R. R. Br.
" Rd. Br.
Junction w/ Leine R.
310
309
308
307
306
303
302
301
300
ABOVE MOUTH OF ALLER RIVER
280
300
280
280
260
SÖSE RIVER
RHUME RIVER
RESTRICTED
SECURITY INFORMATION
ALLER & LEINE RIVERS
PROFILES
ODER SÖSE & RHUME RIVERS
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JJH Date Aug. 52
Drawn by JJH
PLATE 3

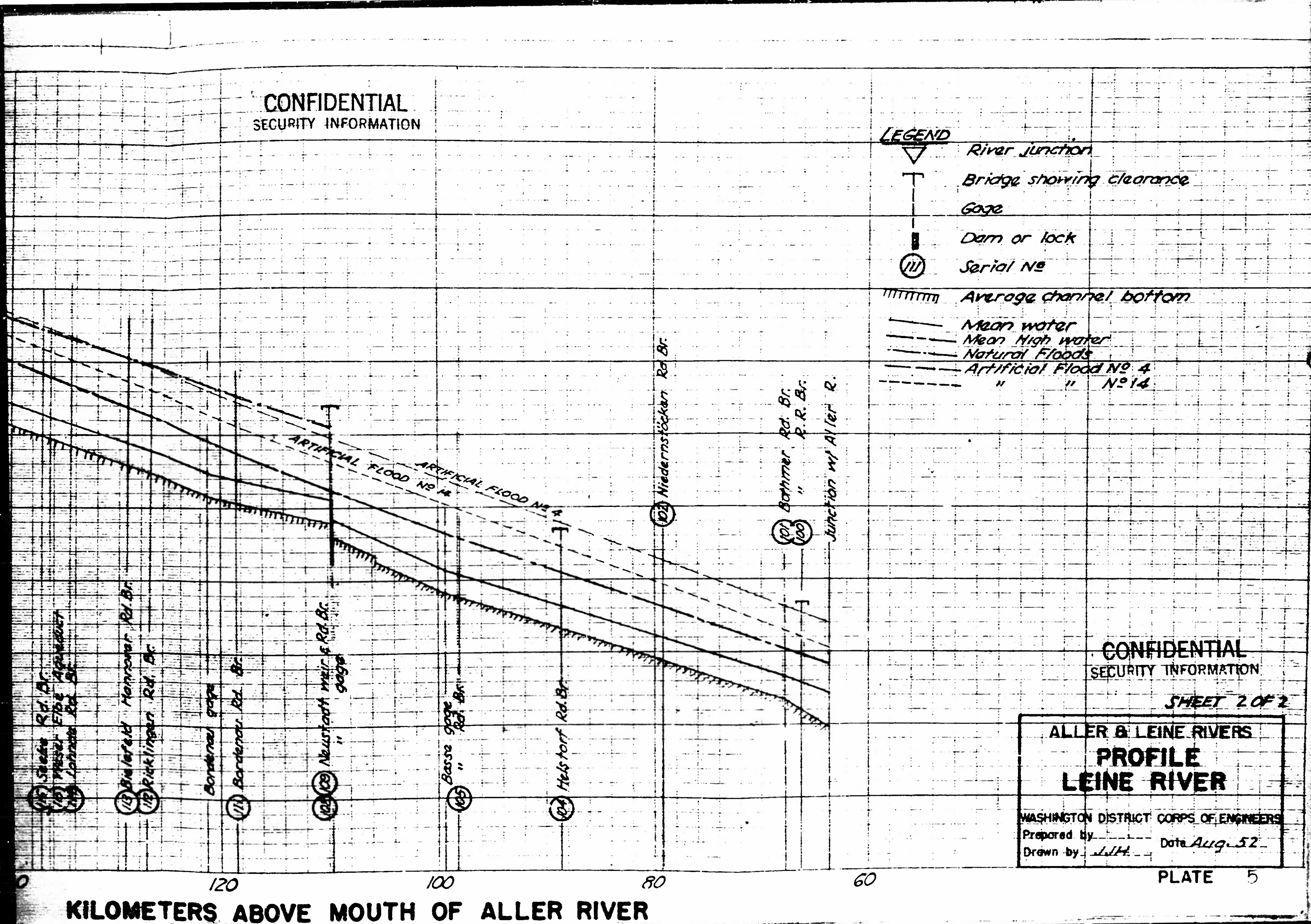
CONFIDENTIAL
SECURITY INFORMATION




CONFIDENTIAL
SECURITY INFORMATION
LEGEND
River junction
Bridge showing clearance
Gage
Dam or lock
Serial Nº
Average channel bottom
Mean water
Mean High water
Natural flood
Artificial flood Nº 4
" " Nº 14
INNERSTE R.
ARTIFICIAL FLOOD Nº 4
ARTIFICIAL FLOOD Nº 14
Alfeld Rd. Br.
Wettensen farm Br.
Brüggen Rd. Br.
Banteln Rd. Br.
Gronau Rd. Br.
R.R. Br.
Burgstemmen Rd. Br.
Poppenburg gage
N.W. Nordstemmen Rd. Br.
Schulenburg Rd. Br.
Ruth Rd. Br.
Koldingen Rd. Br.
Grasdorf Rd. Br.
Wülfel-Wilkenberg Rd. Br.
Döhren Rd. Br.
Hannover R.R. Br.
Schneller Graben Dam
Hannover Ihmebrucke Rd. Br.
Glocksee Rd. Br.
Herrenhausen Lock, Dam & Weir gage
Erzhausen Rd. Br.
Gr. Freden Rd. Br.
R.R. Br.
Wispenstein Rd. Br.
Greene Rd. Br. & gage
R.R. Br.
HHW FEB. 1946
MHW
MW
110
100
90
80
70
60
50
40
240
220
200
180
160
CONFIDENTIAL
SECURITY INFORMATION
SHEET 1 OF 2
ALLER & LEINE RIVERS
PROFILE
LEINE RIVER
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Date Aug. 52
Drawn by JJH
PLATE 4
KILOMETERS ABOVE MOUTH OF ALLER RIVER

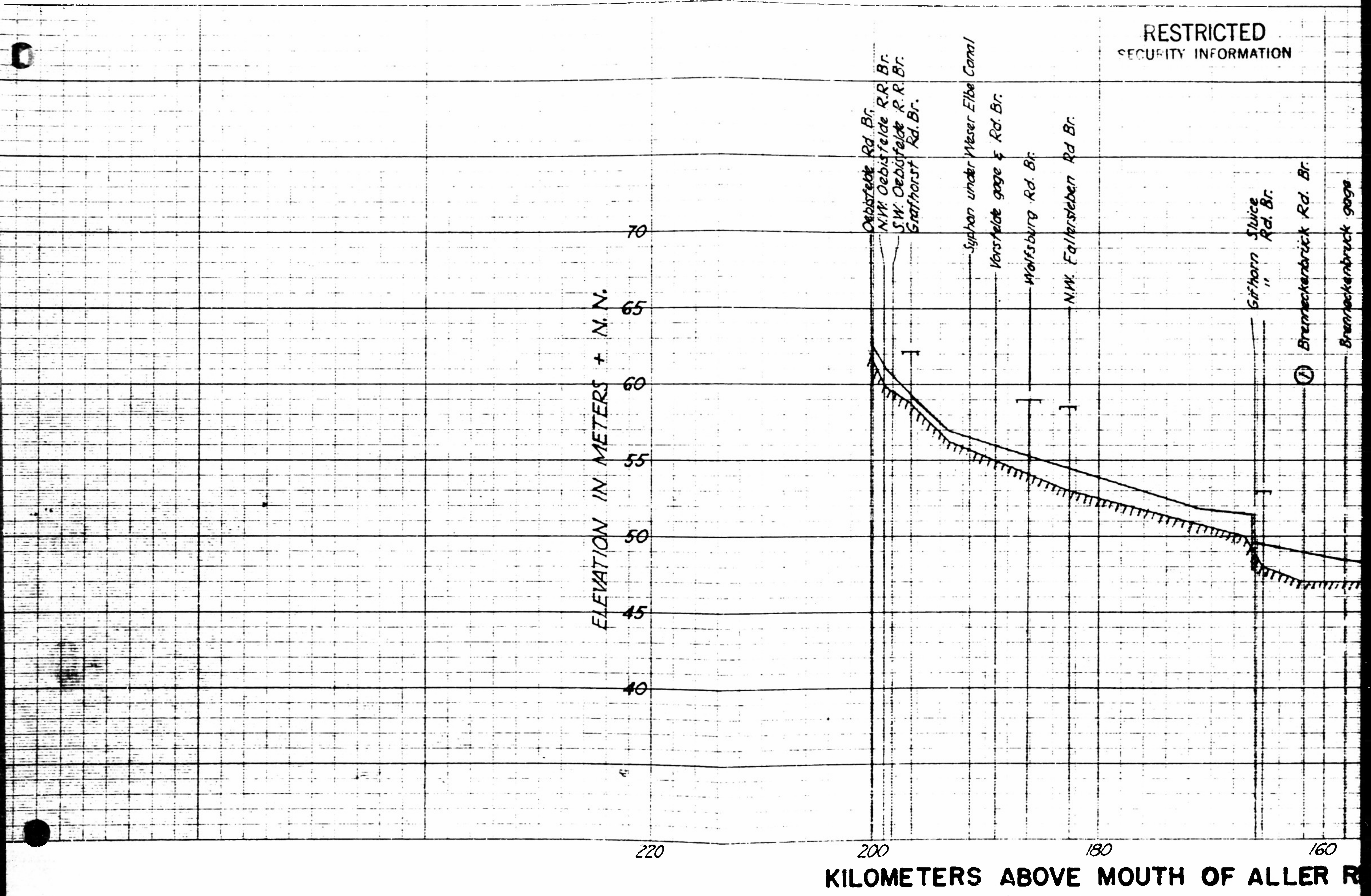
CONFIDENTIAL
SECURITY INFORMATION



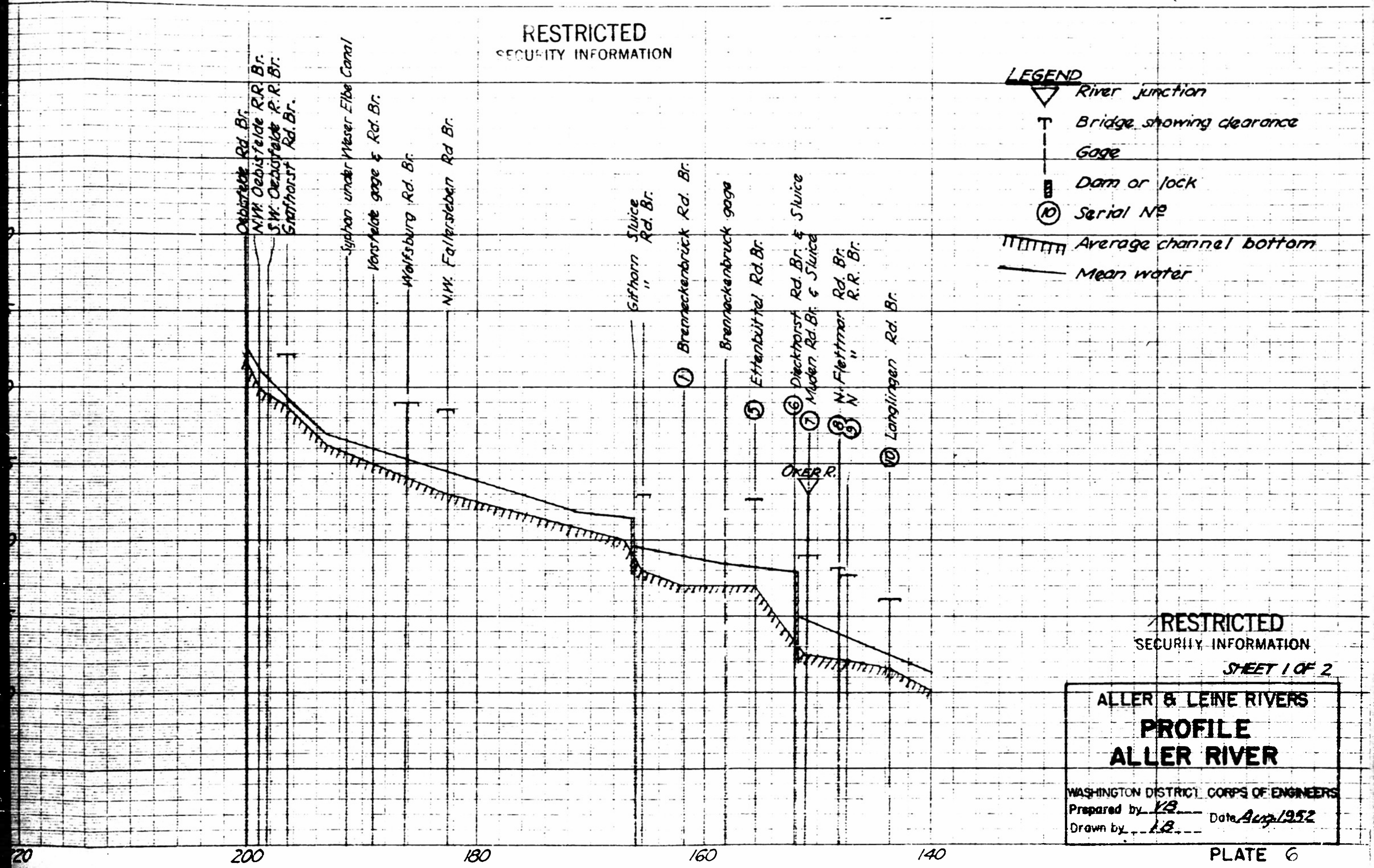


CONFIDENTIAL
SECURITY INFORMATION
LEGEND
River junction
Bridge showing clearance
Gage
Dam or lock
Serial №
Average channel bottom
Mean water
Mean High water
Natural Floods
Artificial Flood № 4
" " № 14
ARTIFICIAL FLOOD № 14
ARTIFICIAL FLOOD № 4
Bielefeld Hannover Rd. Br.
Ricklingen Rd. Br.
Bordenau gage
Bordenau Rd. Br.
Neustadt weir & Rd. Br.
" gage
Basse gage
" Rd. Br.
Helstorf Rd. Br.
Niedernstöcken Rd. Br.
Bothmer Rd. Br.
" R. R. Br.
Junction w/ Aller R.
120
100
80
60
KILOMETERS ABOVE MOUTH OF ALLER RIVER
CONFIDENTIAL
SECURITY INFORMATION
SHEET 2 OF 2
ALLER & LEINE RIVERS
PROFILE
LEINE RIVER
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Drawn by J.H.
Date Aug. 52
PLATE 5

RESTRICTED
SECURITY INFORMATION



RESTRICTED
SECURITY INFORMATION



RESTRICTED
SECURITY INFORMATION

SHEET 1 OF 2

ALLER & LEINE RIVERS
PROFILE
ALLER RIVER

WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by VB Date Aug. 1952
Drawn by LB

PLATE 6

KILOMETERS ABOVE MOUTH OF ALLER RIVER

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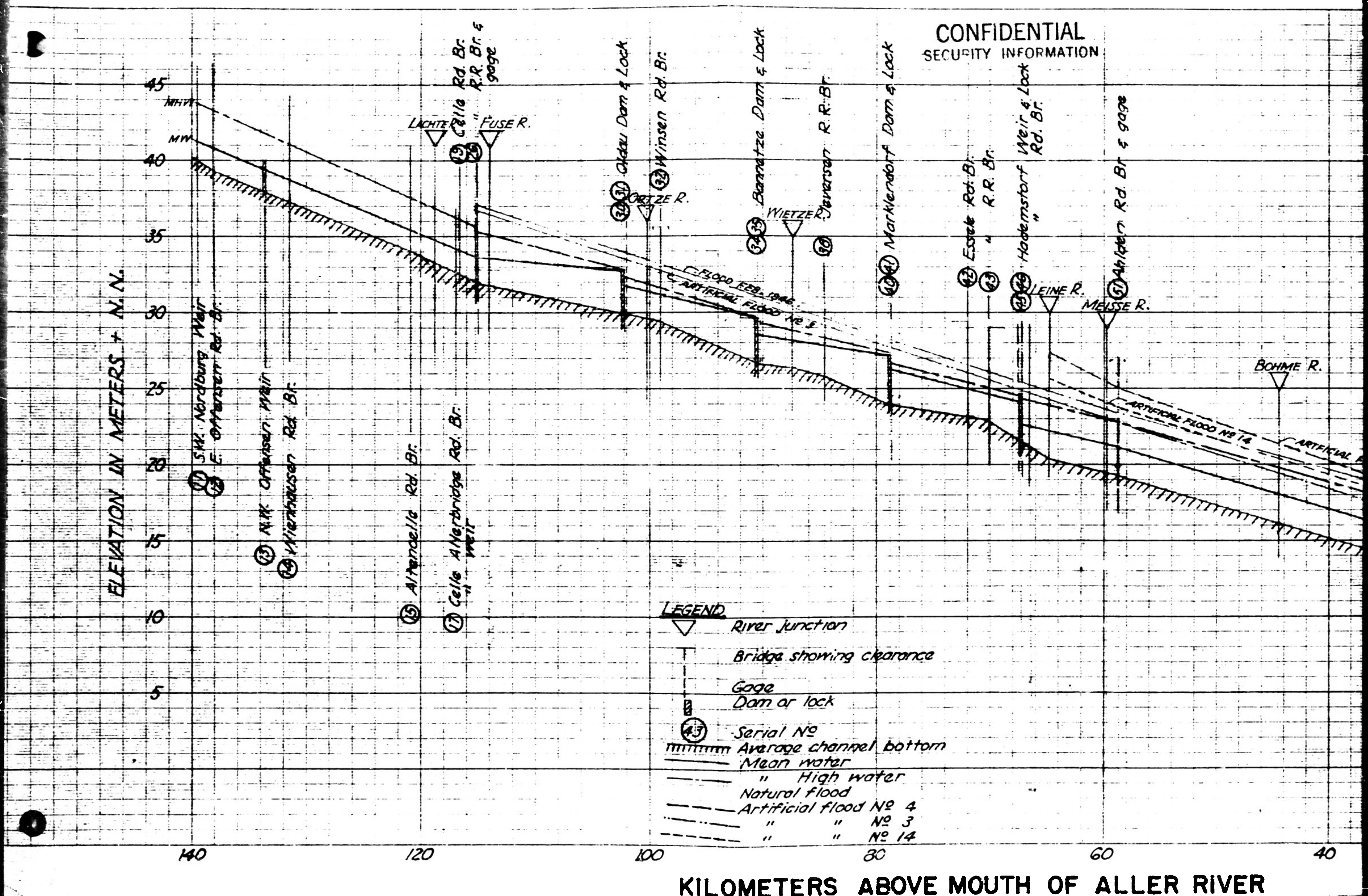
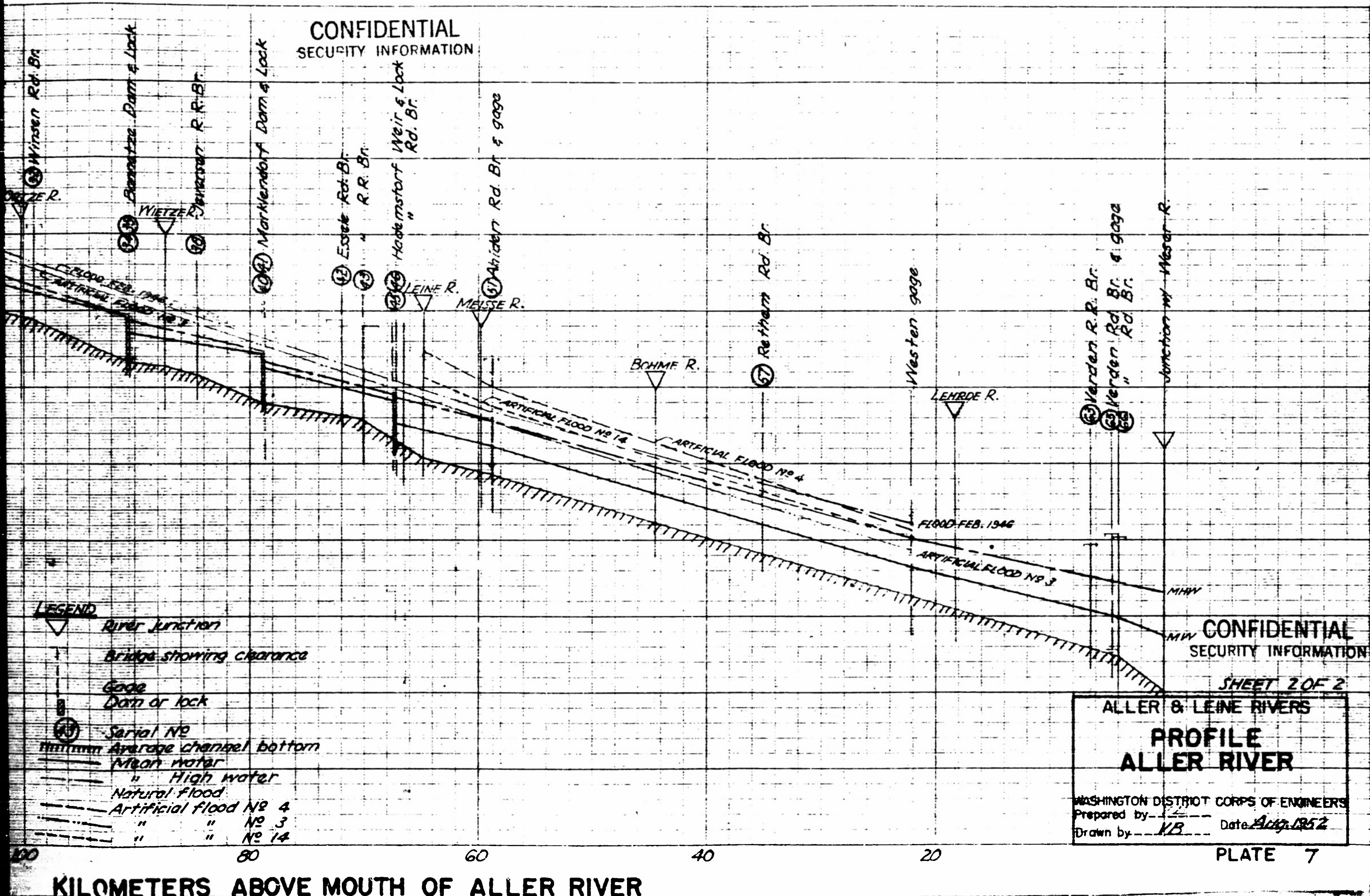
SECURITY INFORMATION





CONFIDENTIAL
SECURITY INFORMATION

SHEET 2 OF 2

ALLER & LEINE RIVERS

PROFILE
ALLER RIVER

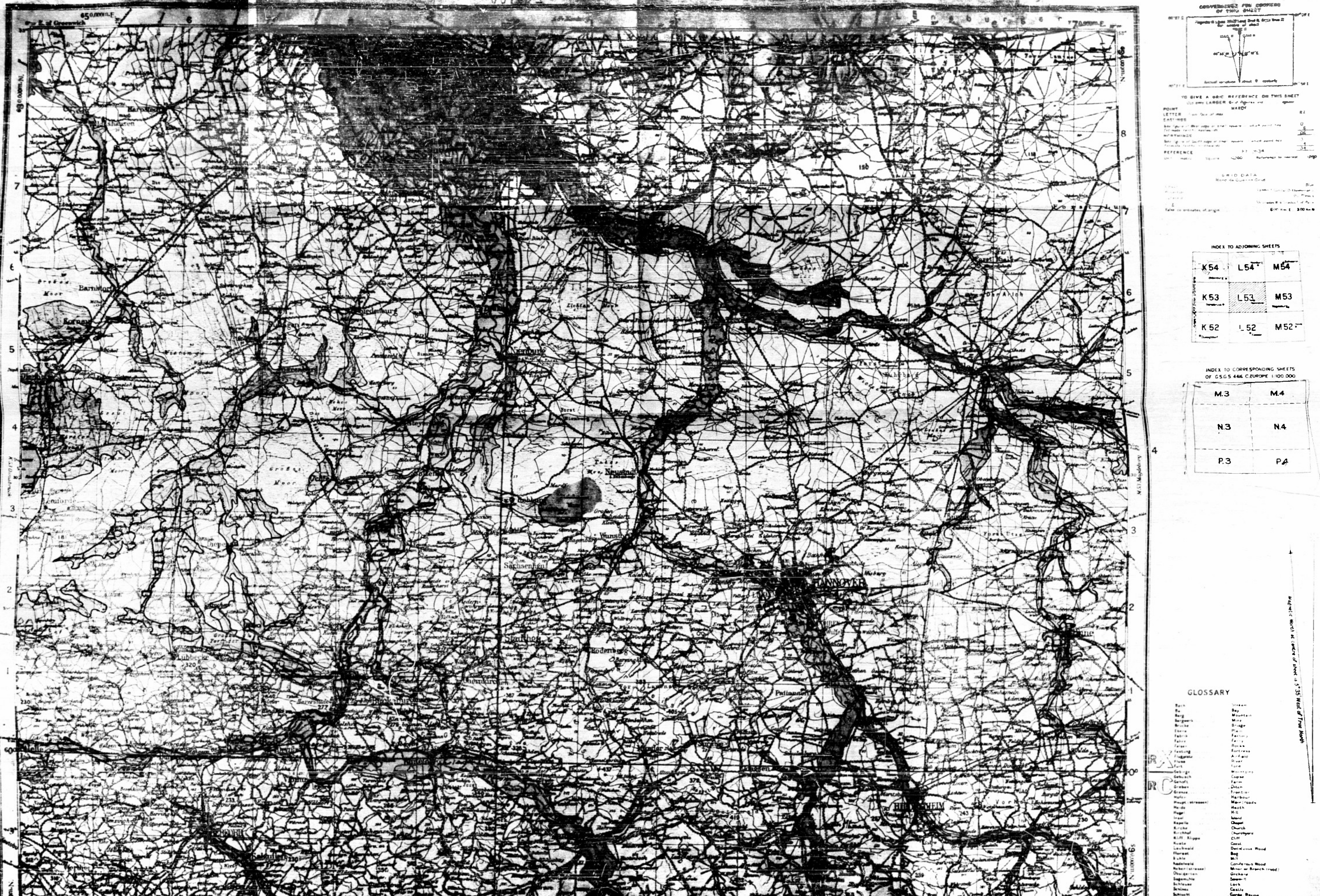
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Drawn by VB
Date Aug. 1952

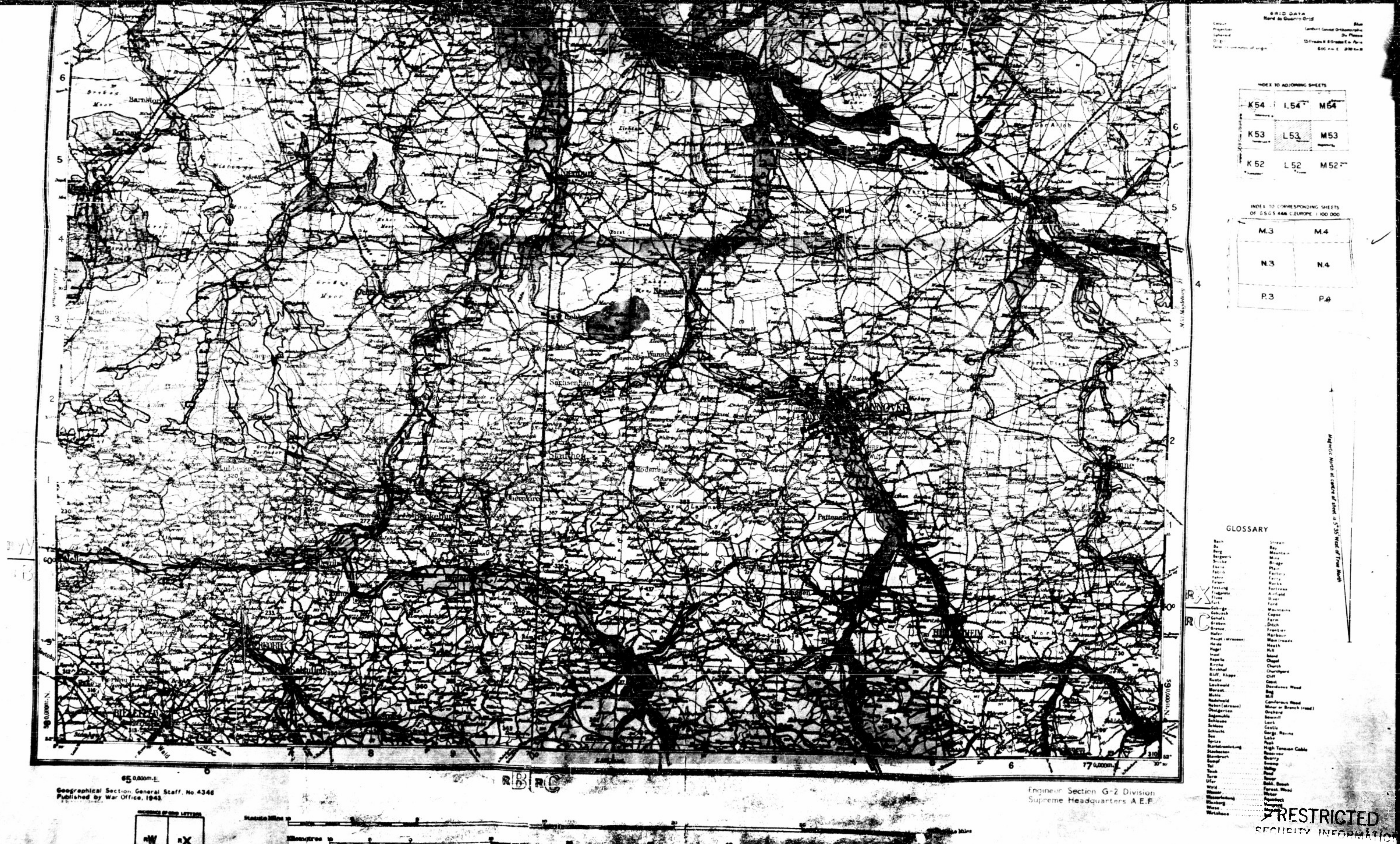
PLATE 7

RESTRICTED

GERMANY

SHEET L.53





ALLER & LEINE RIVERS

FORECAST OF POSSIBLE INUNDATION

WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by J.J.H.

Date Aug. 1952

Drawn by ________

PLATE 8

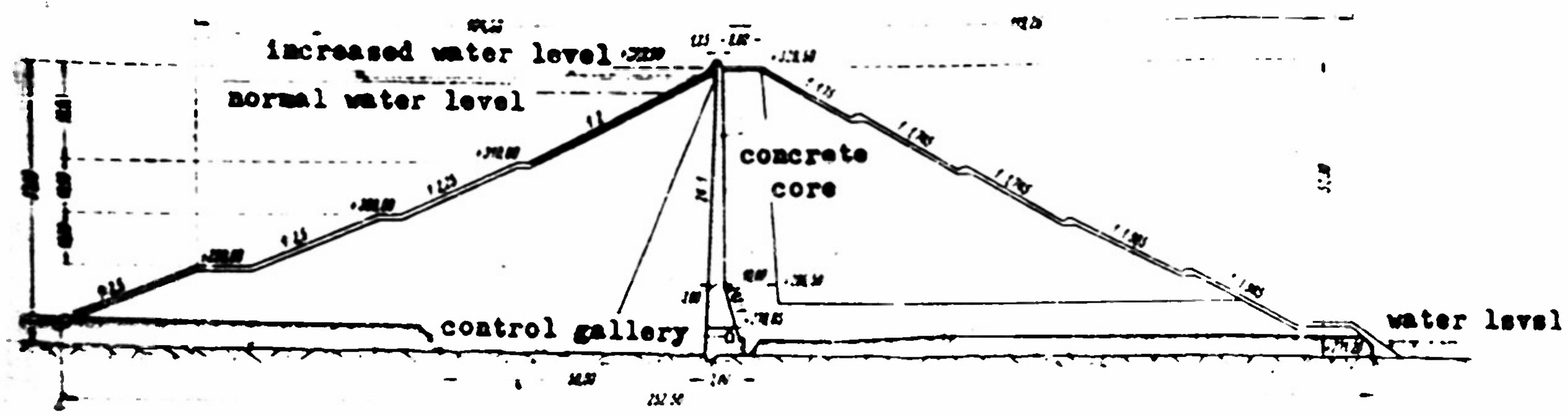


Fig. I: Soese Dam - Cross section of main dam

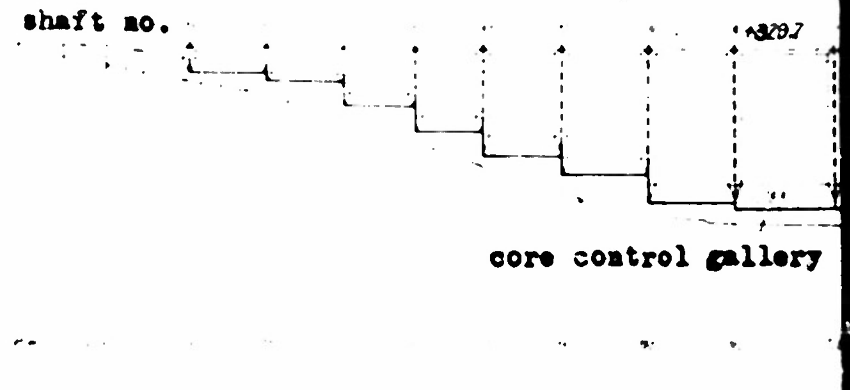


Fig. II Soese Dam - Section thru

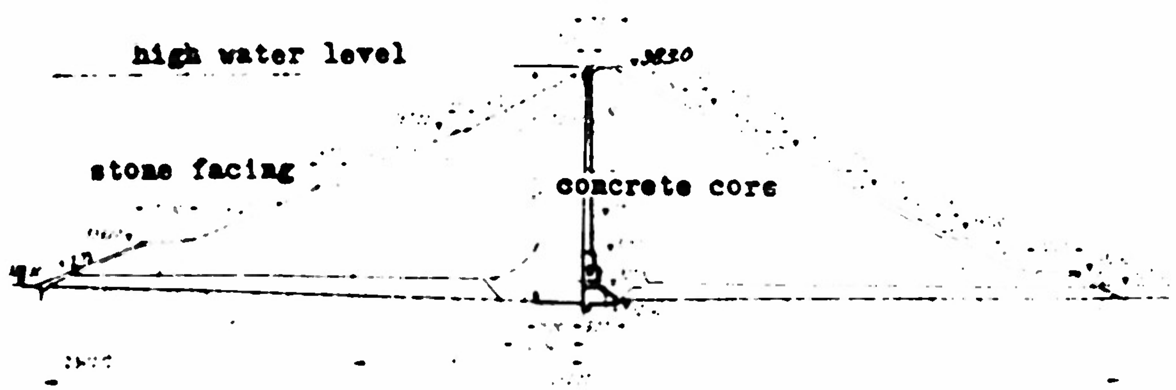


Fig III Oder dam - Hartz: Cross section of main dam

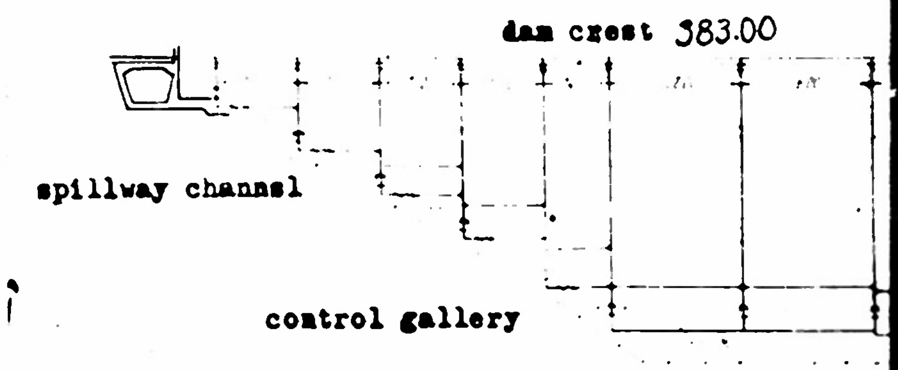


Fig. IV Oder Dam - Hartz: Cross sectio

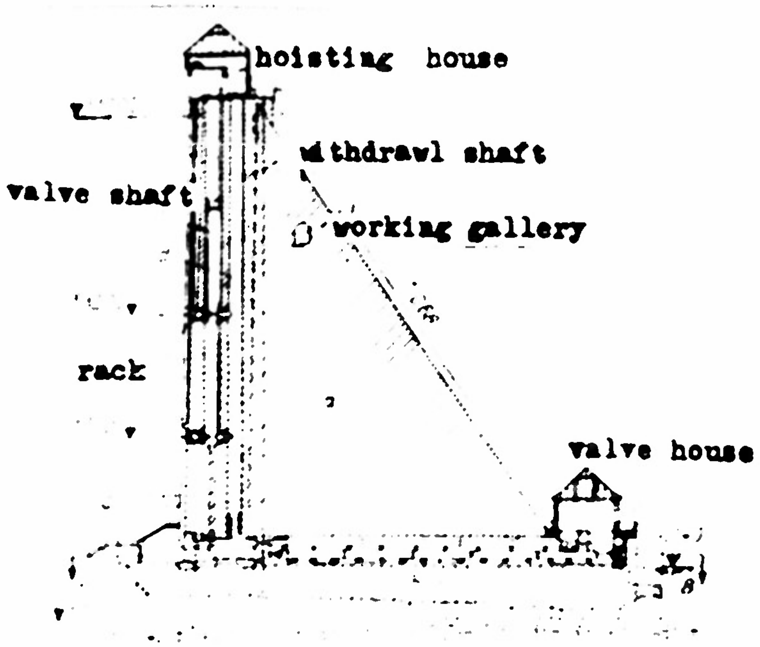
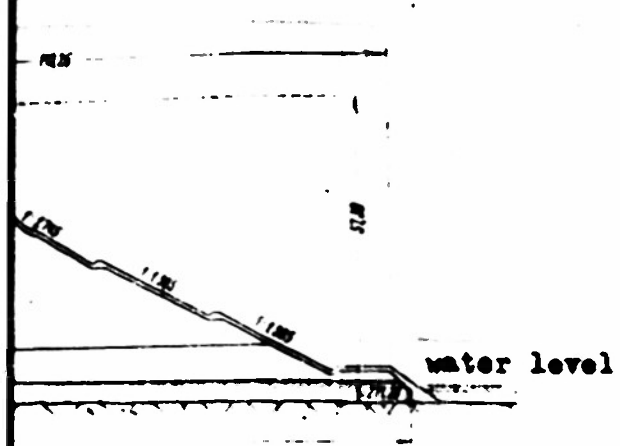


Fig. V Ecker Dam: Cross section

Ref:
Fig I "Bautechnik", Dec. 1936, p 756
Fig II "Bautechnik", Dec. 1936, p 752
Fig III "V D I", Aug. 1936, p 1064
Fig IV "Bautechnik", Dec. 1936 p 753
Fig V "V D I", Feb. 1948 ; p 38



ain dam

ion of main dam

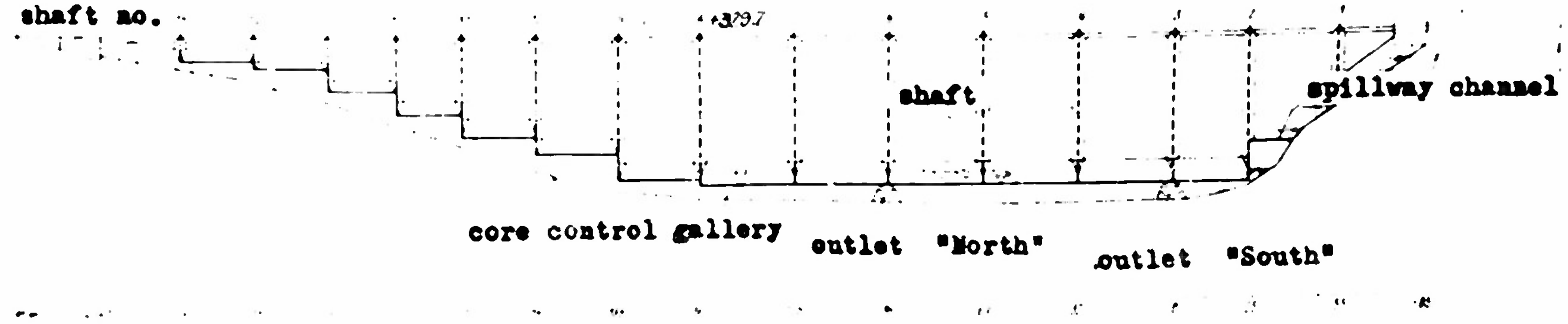


Fig. II Soese Dam - Section thru concrete core from downstream

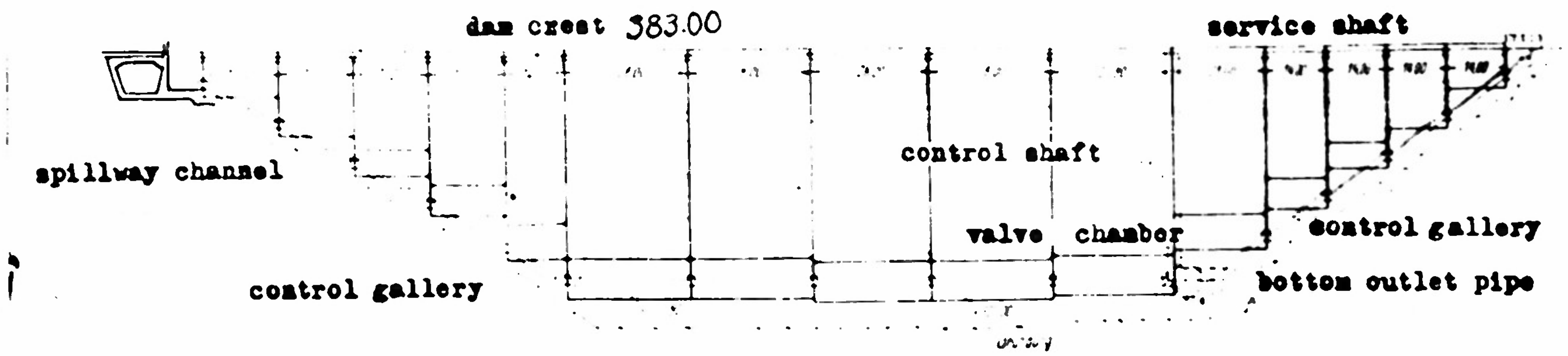


Fig. IV Oder Dam - Hartz: Cross section thru concrete core from downstream.

ve house

ion

Ref:
- Fig I "Bautechnik", Dec. 1936, p 756
- Fig II "Bautechnik", Dec. 1936, p 752
- Fig III "V D I ", Aug. 1936, p 1064
- Fig IV "Bautechnik", Dec. 1936 p 753
- Fig V "V D I", Feb. 1948 ; p 38

ALLER & LEINE RIVERS

SKETCHES

VALLEY DAMS

WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by J.B. Date Aug. 1952

Drawn by

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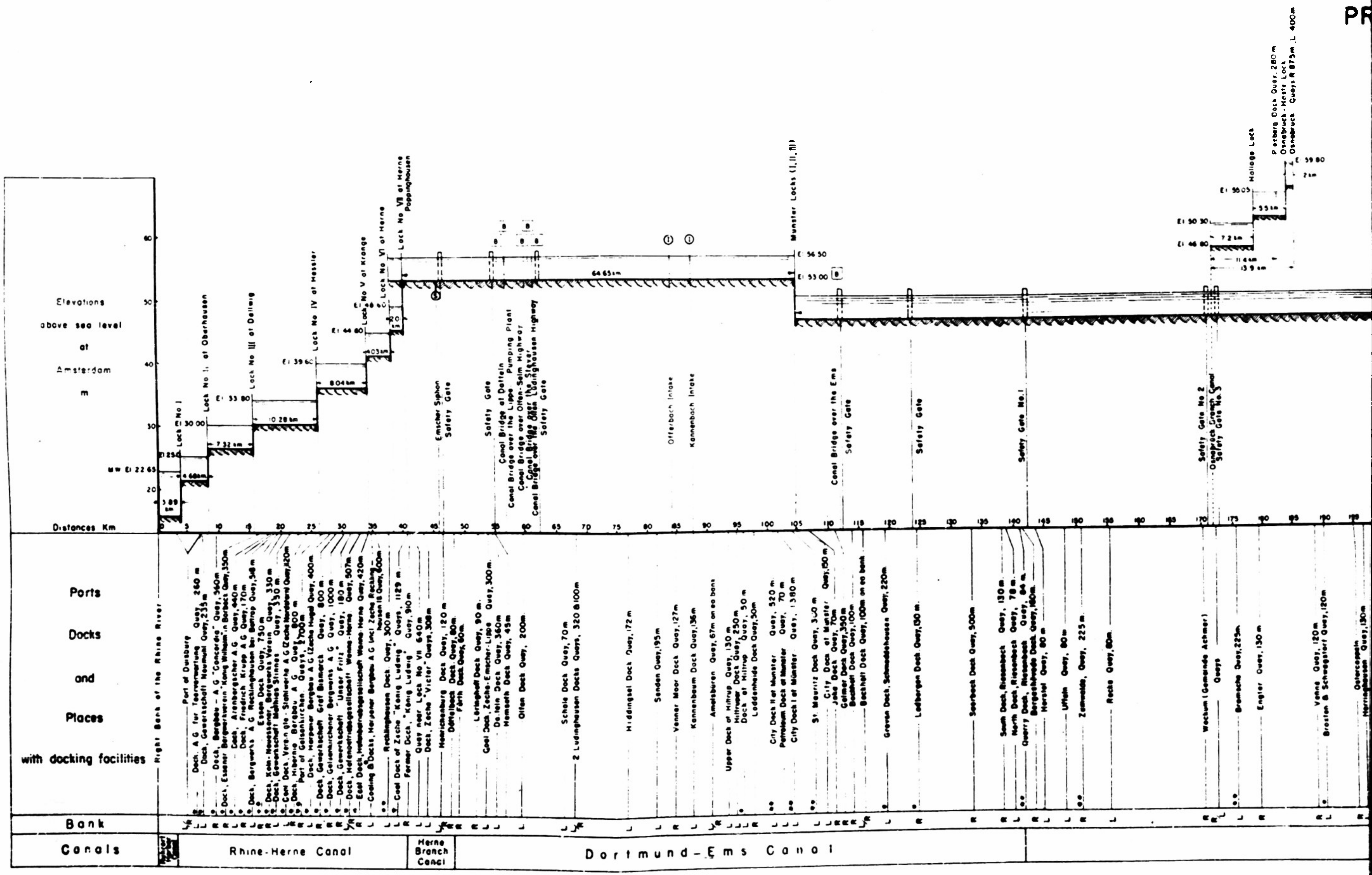


ICTED
FORMATION

PROFILE OF THE MITTELLAND CANAL

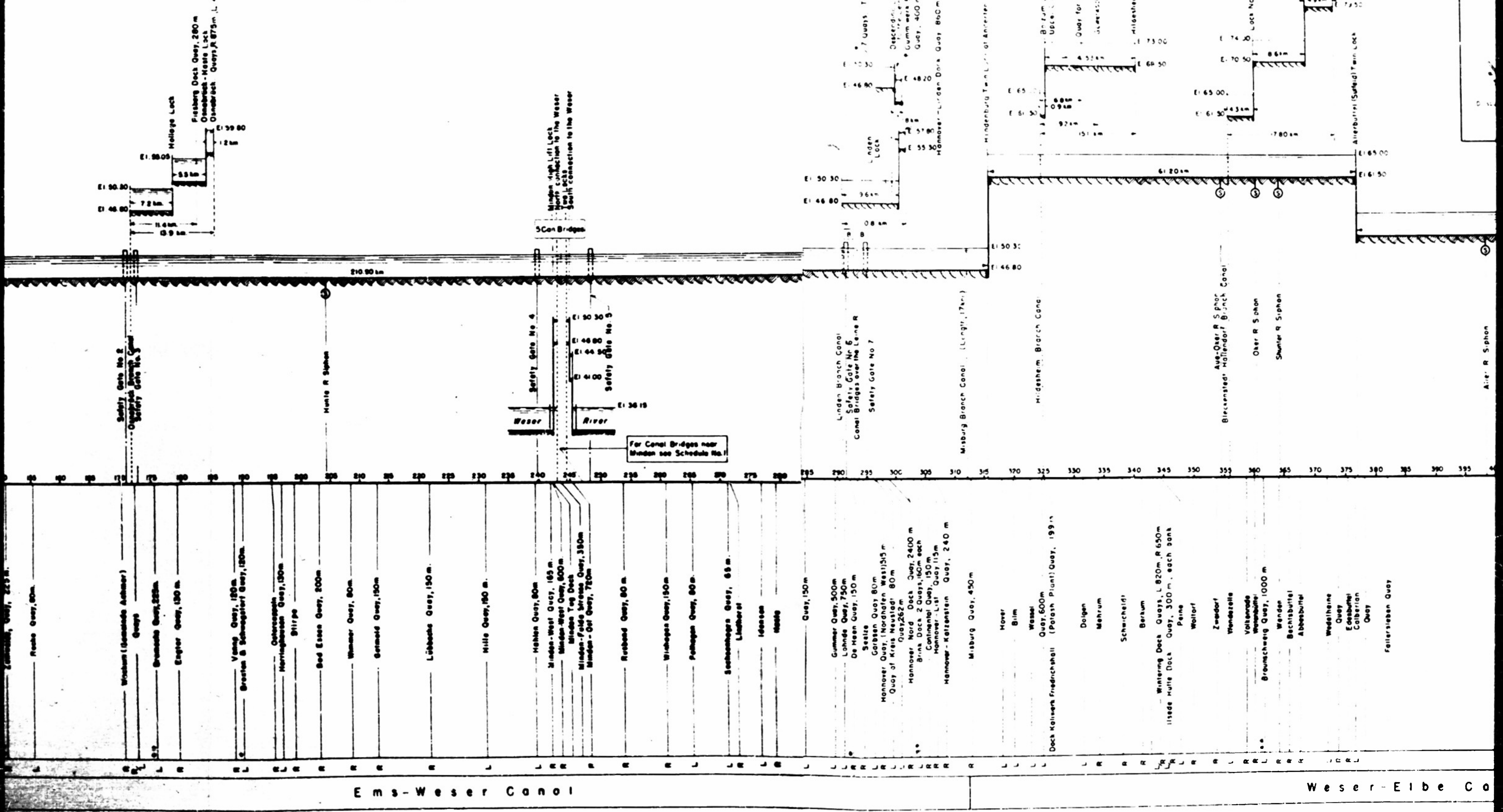
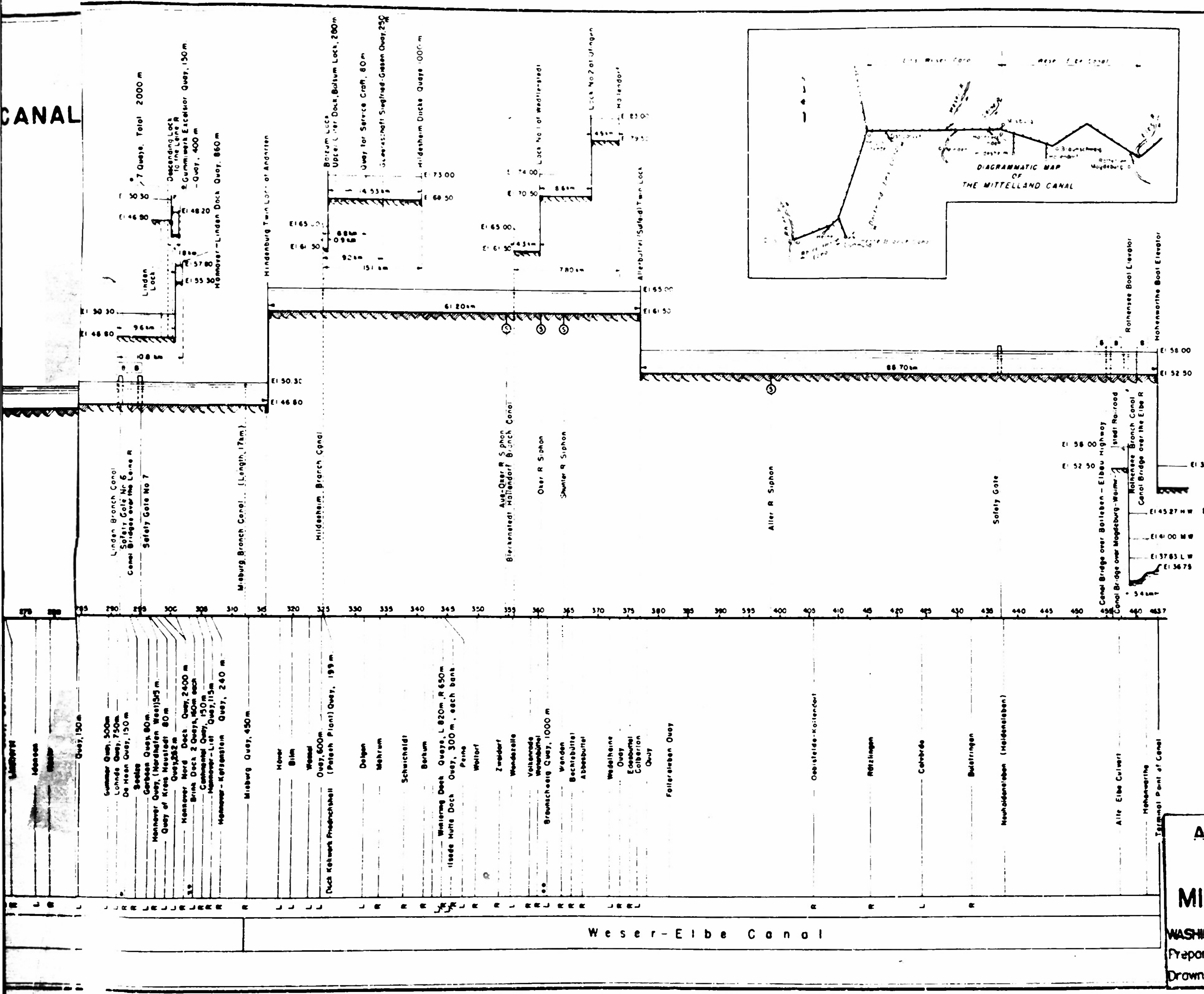


FIG 15-4

Reproduced from "NAVIGABLE WATER-WAYS OF GERMANY" S.E.S. 128, O.C.E. U.S.A., August, 1944.



SCHEDULE NO. 1
Canal Bridges near Minden

km Point	Canal Bridges
243.7	Canal Bridge over Werftstrasse
243.8	Canal Bridge over the Wesel
244.3	Canal Bridge over Friedrich Wilhelm Strasse
246.3	Canal Bridge over Dankersen-Hesenkamp Road
247.1	Canal Bridge over Dankersen Common Road

RESTRICTED
SECURITY INFORMATION

ALLER & LEINE RIVERS
PROFILE
MITTELLAND CANAL

WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by J.I.H. Date Aug 1952
Drawn by ________

PLATE 10

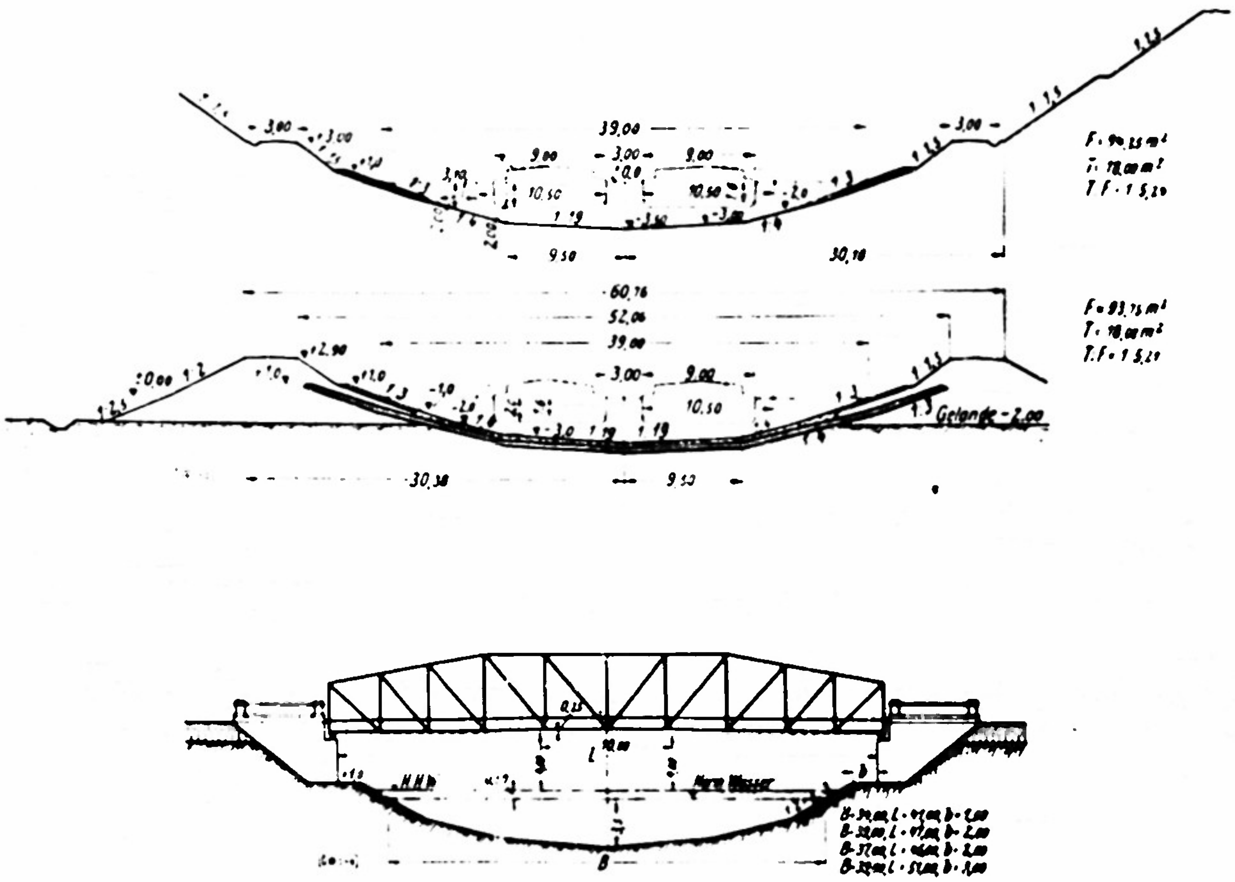


Fig. 15-7
Standard Cross Sections of the Mittelland Canal in Cuts, on Embankments, and Under Bridges

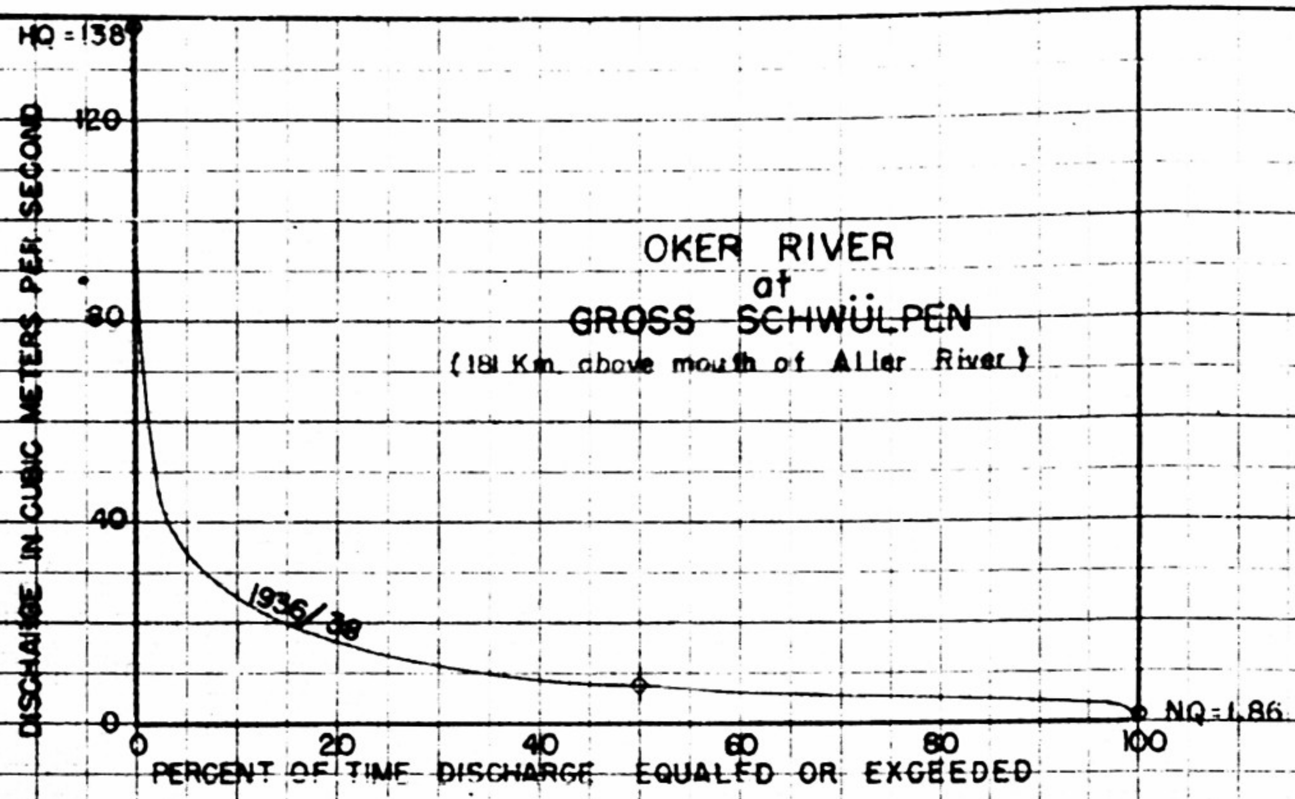
F - Wet cross section of canal prism
T - Wet cross section of boat
B - Canal width at the surface, at regulation water level
b - Berm
L - Horizontal clearance between abutments

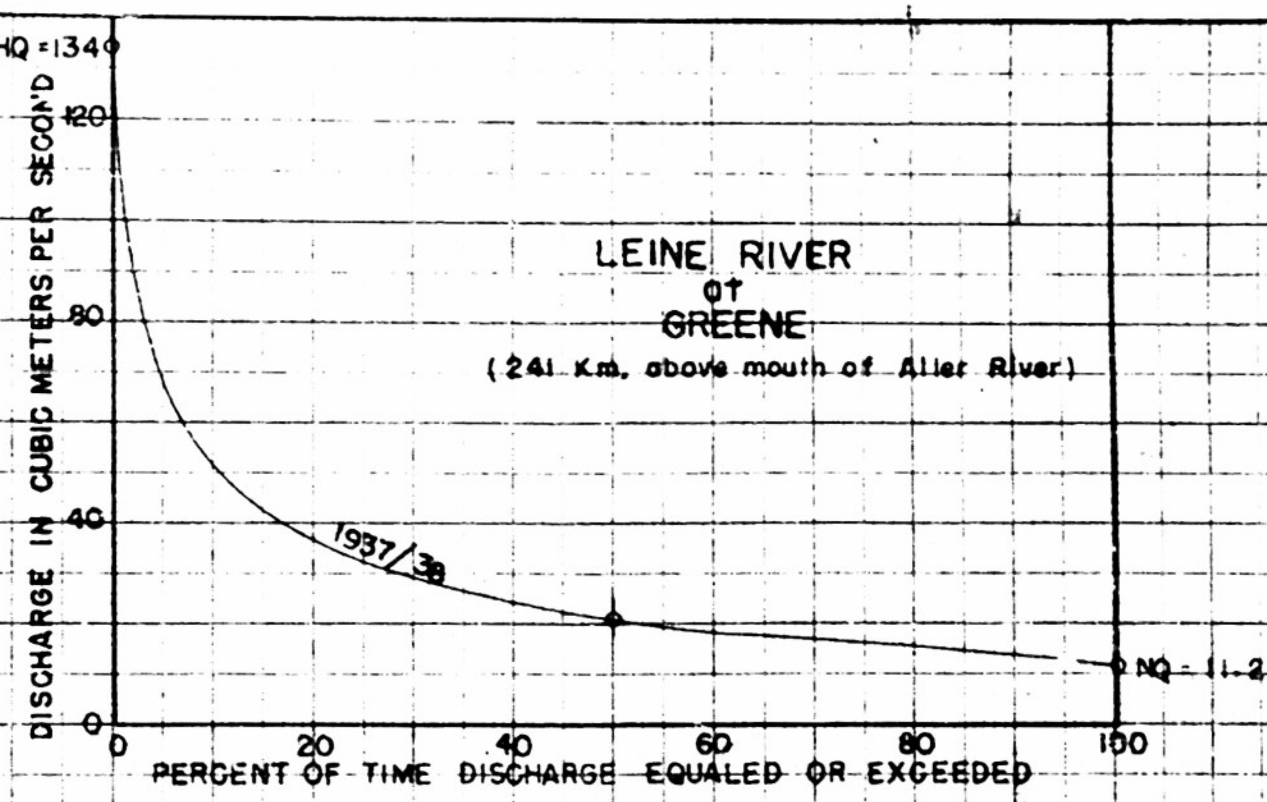
On newly constructed German canals the ratio T:F is kept within the limits of 1:4 or 1:5.

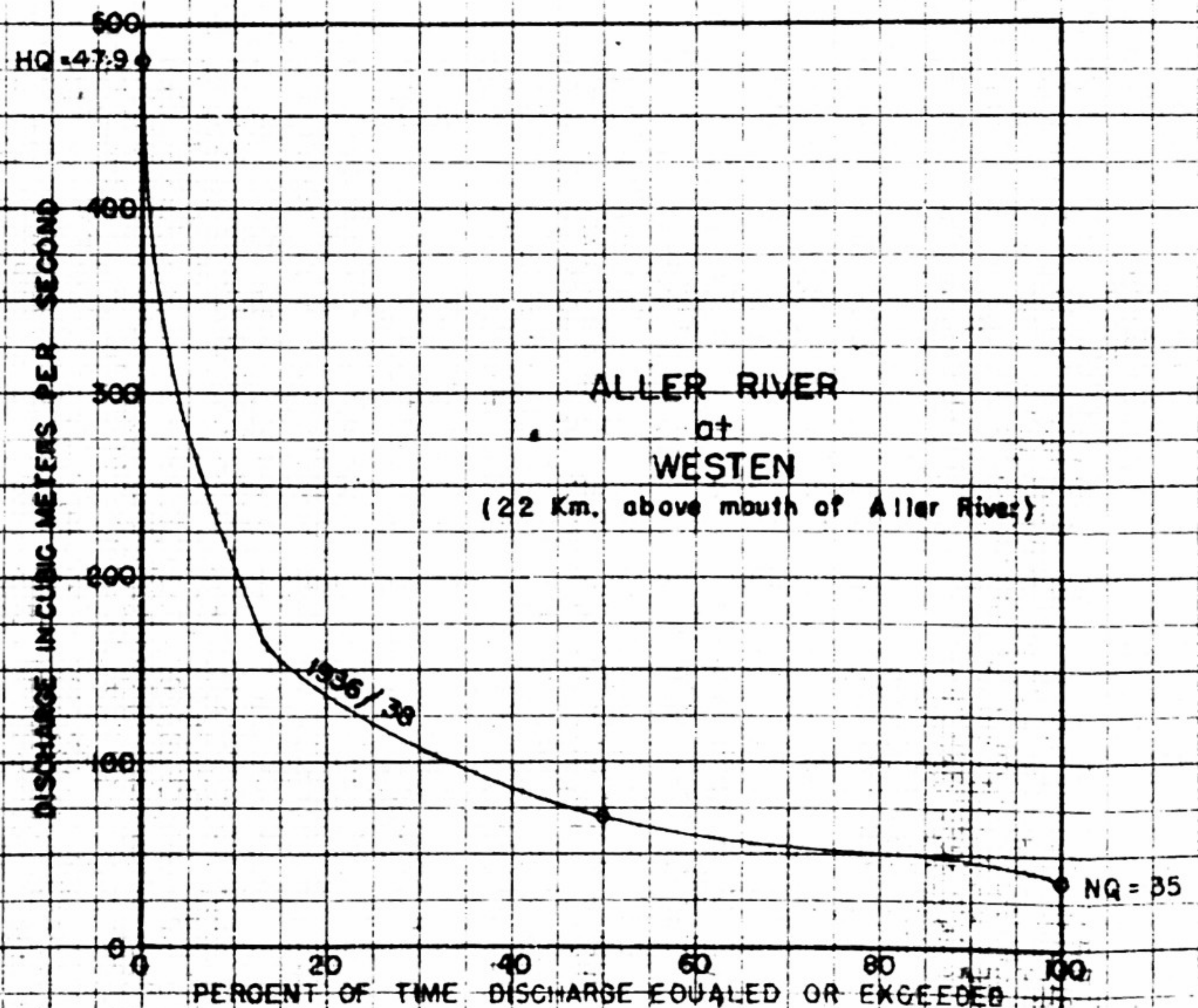
REPRODUCED FROM "NAVIGABLE WATERWAYS OF GERMANY" S.E.S. 128, O.C.E., U.S.A., AUGUST, 1944.

ALLER & LEINE RIVERS
CROSS SECTIONS
MITTELLAND CANAL
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by J.J.H. Date Aug 1952
Drawn by

PLATE 11







SOURCE: Jahrbuch für die Gewässerkunde des Deutschen Reichs, Abflussjahr 1938

ALLER & LEINE RIVERS

FLOW DURATION CURVES

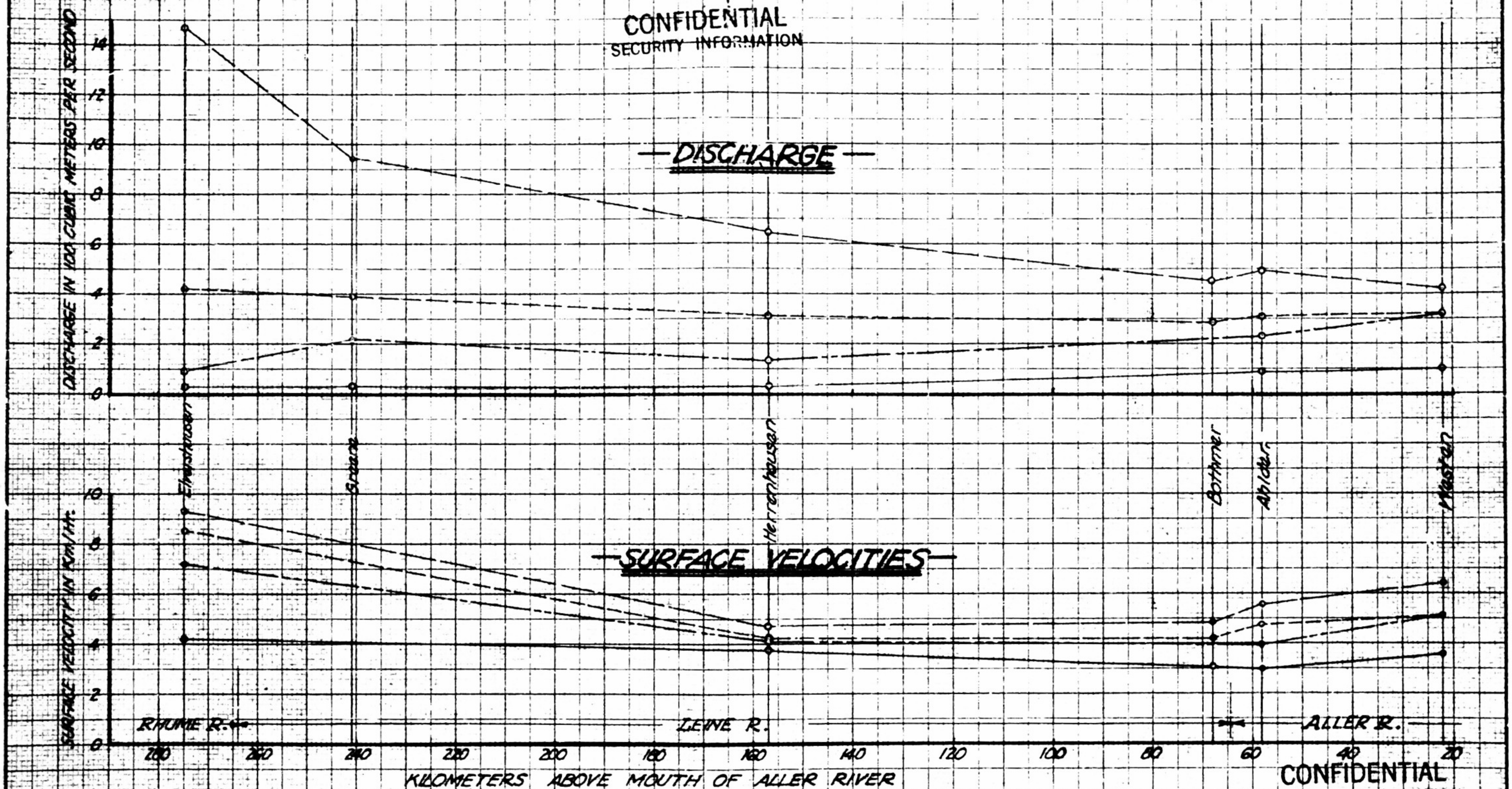
WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by EBB Date Aug 4, 1952

Drawn by J.J.H.

PLATE 12

CONFIDENTIAL
SECURITY INFORMATION



CONFIDENTIAL
SECURITY INFORMATION

LEGEND

- Combined Söse & Oder breaches - Artificial Flood No. 4
- Combined Söse & Oder flow variation - Artifical Flood No. 14
- MHW
- MW
- o Computed value

ALLER & LEINE RIVERS

DISCHARGE & VELOCITY PROFILES

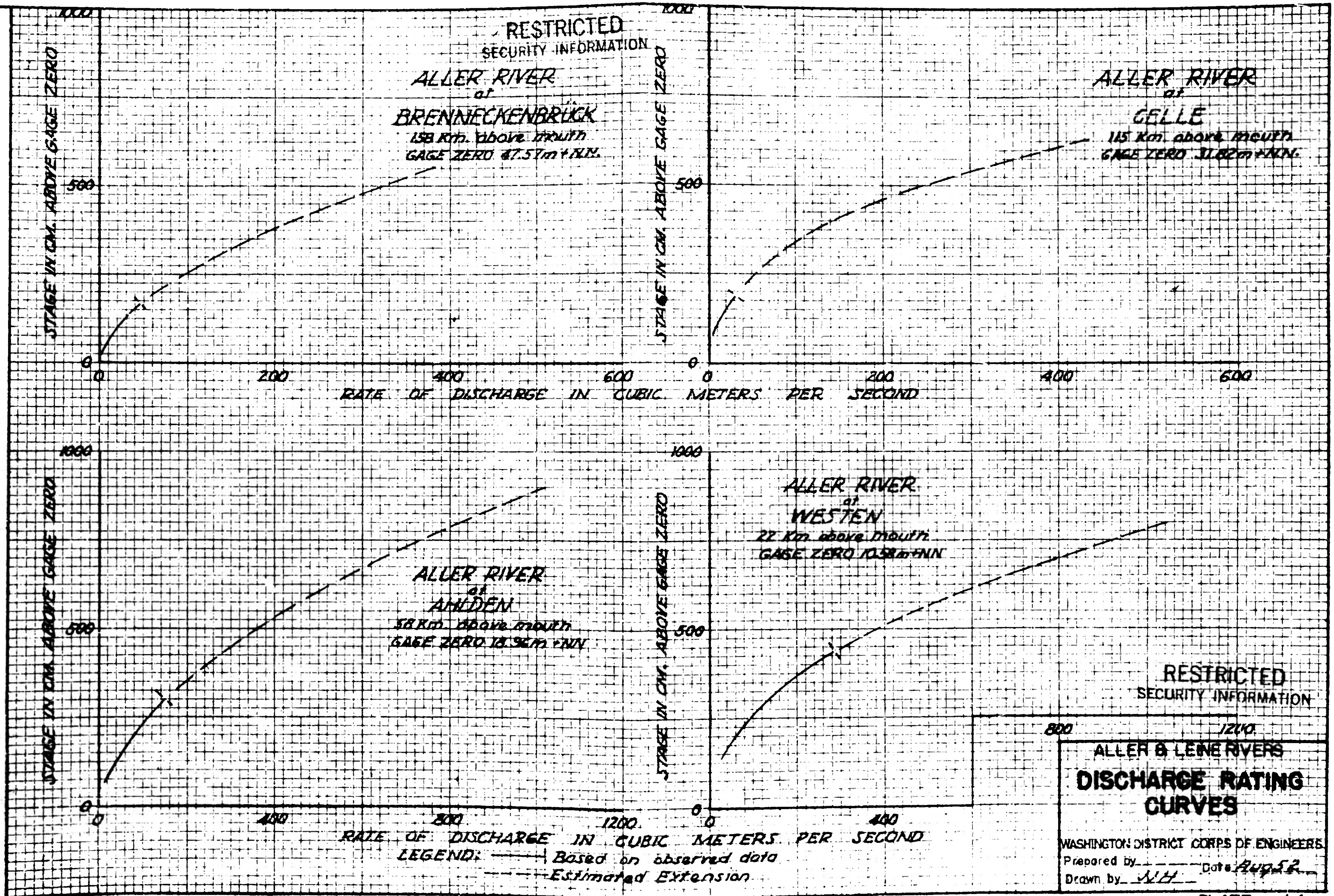
WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by VB Date Aug 53

Drawn by VB

PLATE 13

RESTRICTED
SECURITY INFORMATION



RESTRICTED
SECURITY INFORMATION

ALLER & LEINE RIVERS

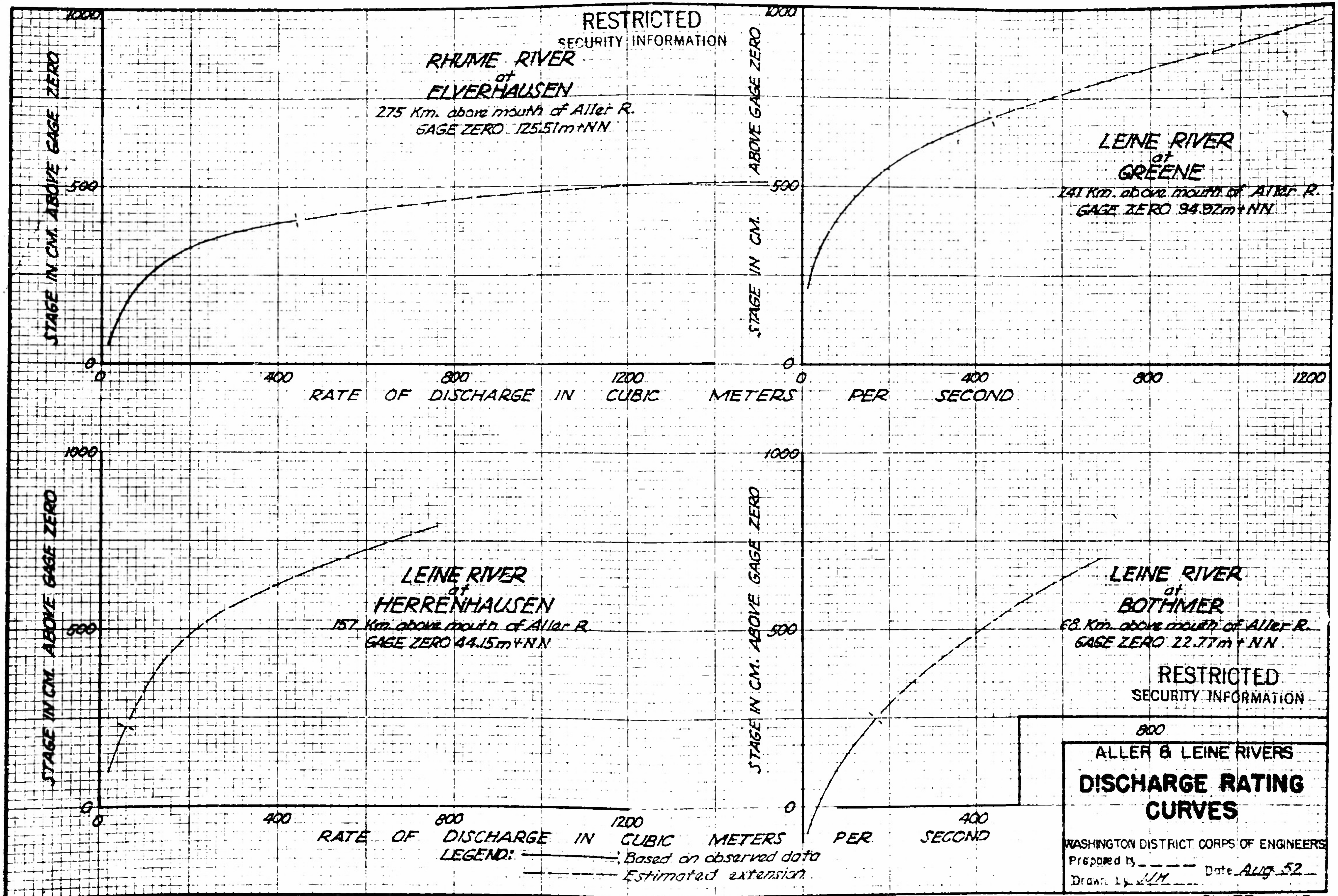
DISCHARGE RATING CURVES

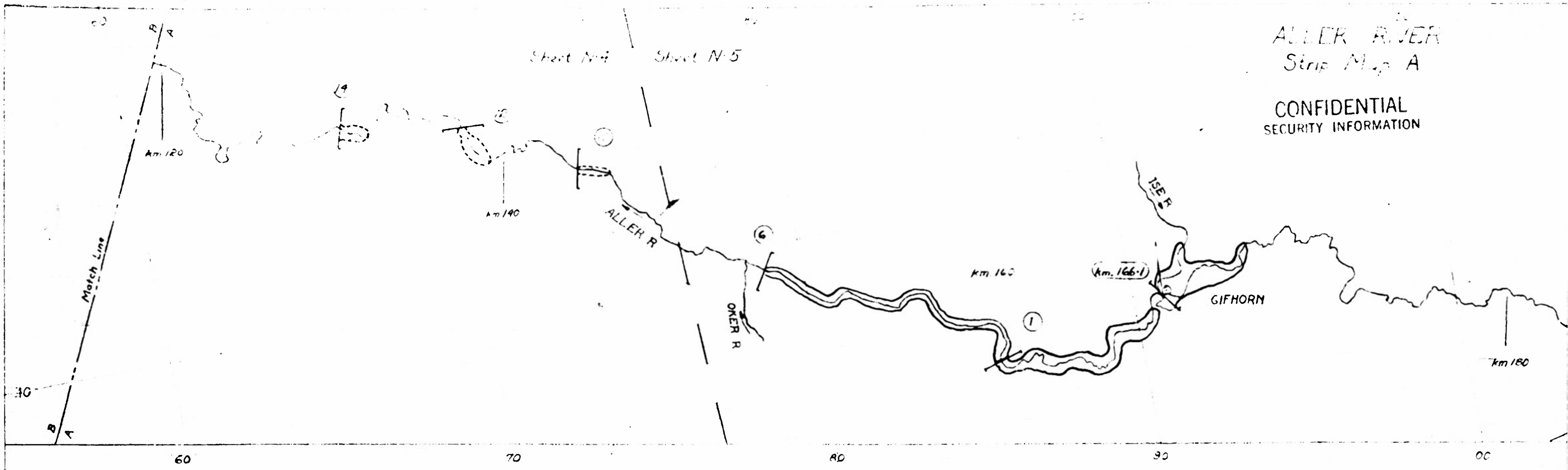
WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by ______ Date Aug 52

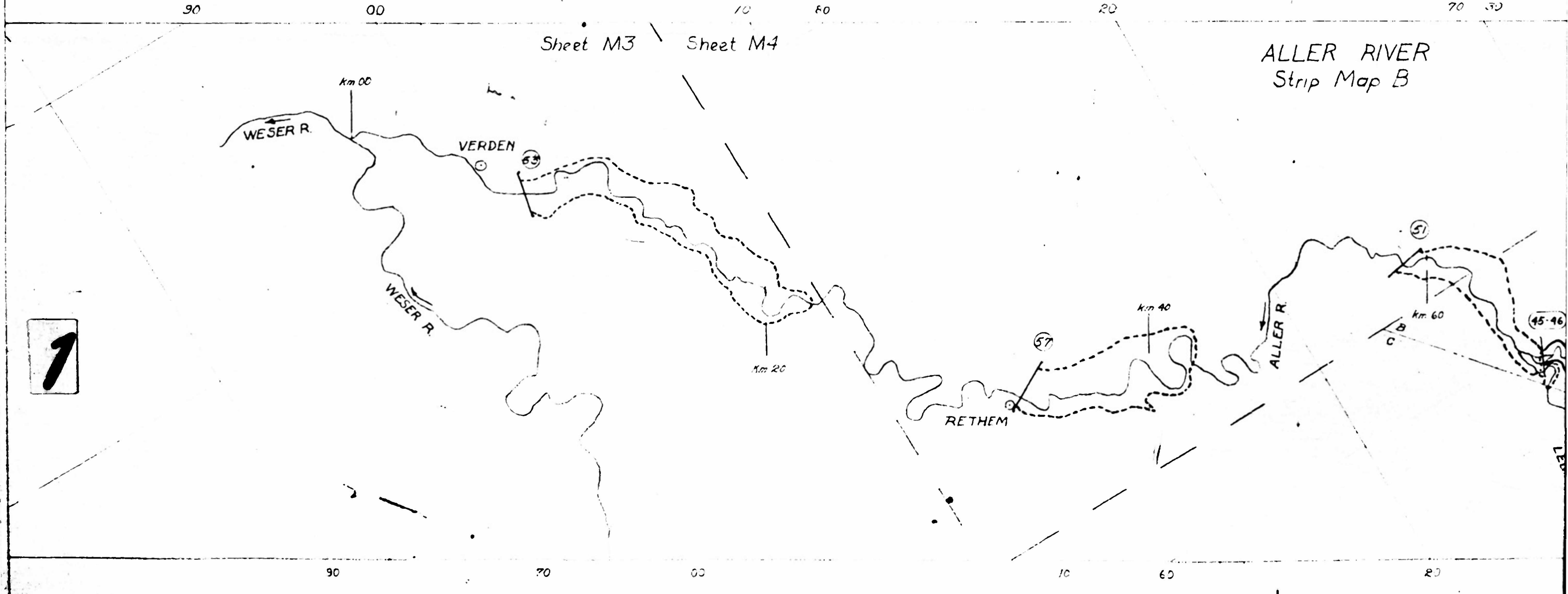
Drawn by NH

PLATE 14


RESTRICTED
SECURITY INFORMATION
RHUME RIVER
at
ELVERHAUSEN
275 Km. above mouth of Aller R.
GAGE ZERO 125.51m+NN
LEINE RIVER
at
GREENE
241 Km. above mouth of Aller R.
GAGE ZERO 94.92m+NN
STAGE IN CM. ABOVE GAGE ZERO
0
500
1000
400
800
1200
RATE OF DISCHARGE IN CUBIC METERS PER SECOND
LEINE RIVER
at
HERRENHAUSEN
157 Km. above mouth of Aller R.
GAGE ZERO 44.15m+NN
LEINE RIVER
at
BOTHMER
68 Km. above mouth of Aller R.
GAGE ZERO 22.77m+NN
RESTRICTED
SECURITY INFORMATION
LEGEND:
Based on observed data
Estimated extension
ALLER & LEINE RIVERS
DISCHARGE RATING CURVES
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Drawn by UH
Date Aug 52



Strip Map A
CONFIDENTIAL
SECURITY INFORMATION
Sheet N-4
Sheet N-5
Match Line
km 120
km 140
ALLER R
6
OKER R
km 160
1
km 166.1
ISE R
GIFHORN
km 180
60
70
80
90
00

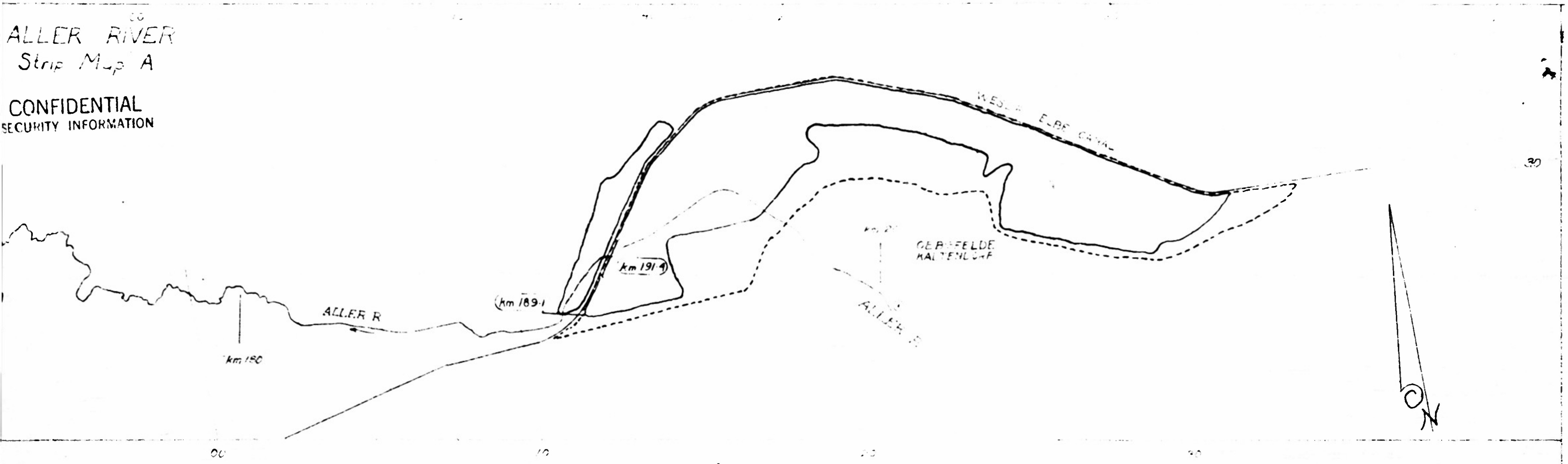


90
00
80
20
70
Sheet M3
Sheet M4
ALLER RIVER
Strip Map B
km 00
WESER R.
VERDEN
63
WESER R.
km 20
RETHEM
57
km 40
ALLER R.
51
km 60
45-46
B
C
90
70
00
10
60
20

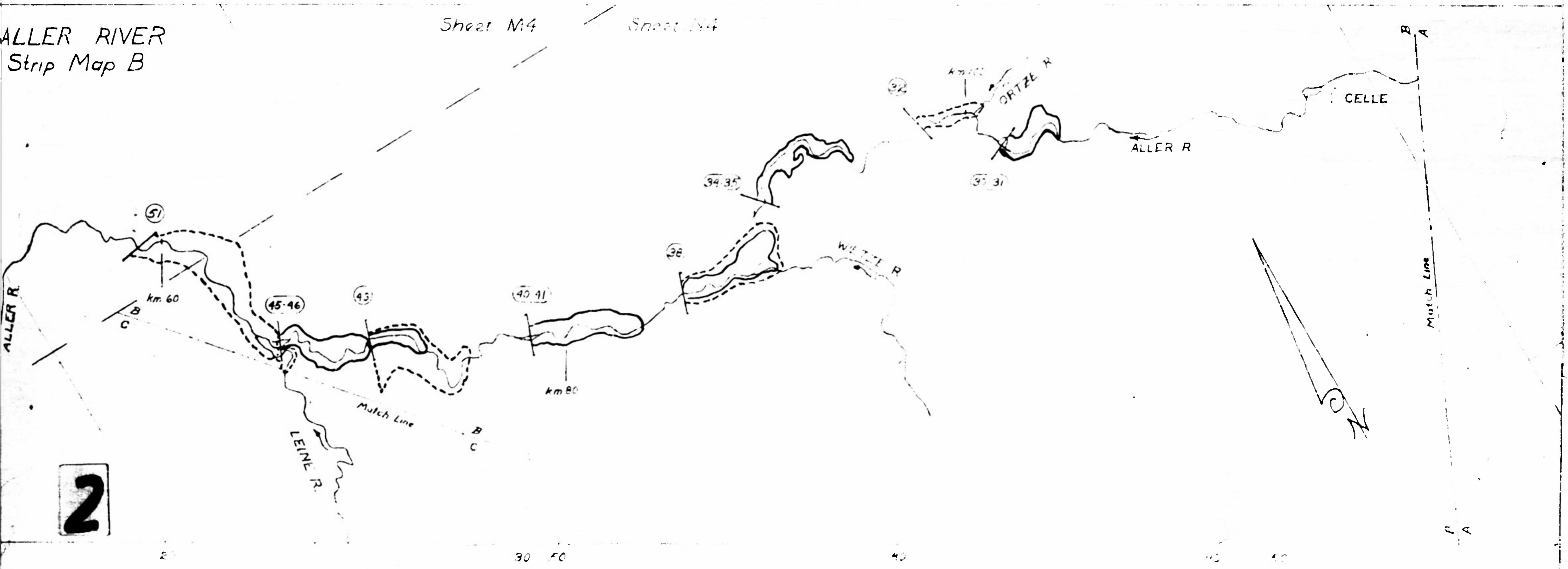
1

ALLER RIVER
Strip Map A

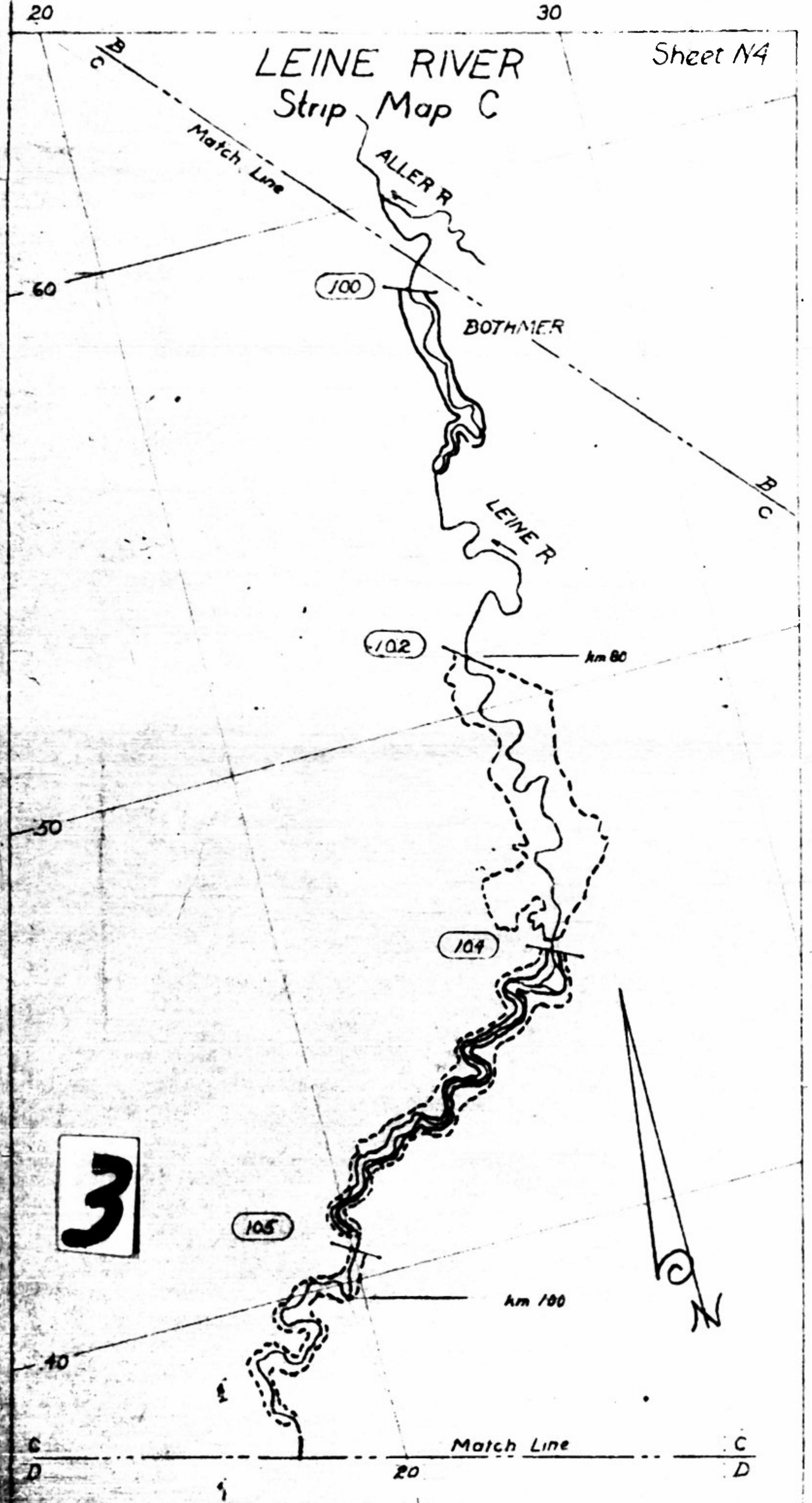
CONFIDENTIAL
SECURITY INFORMATION

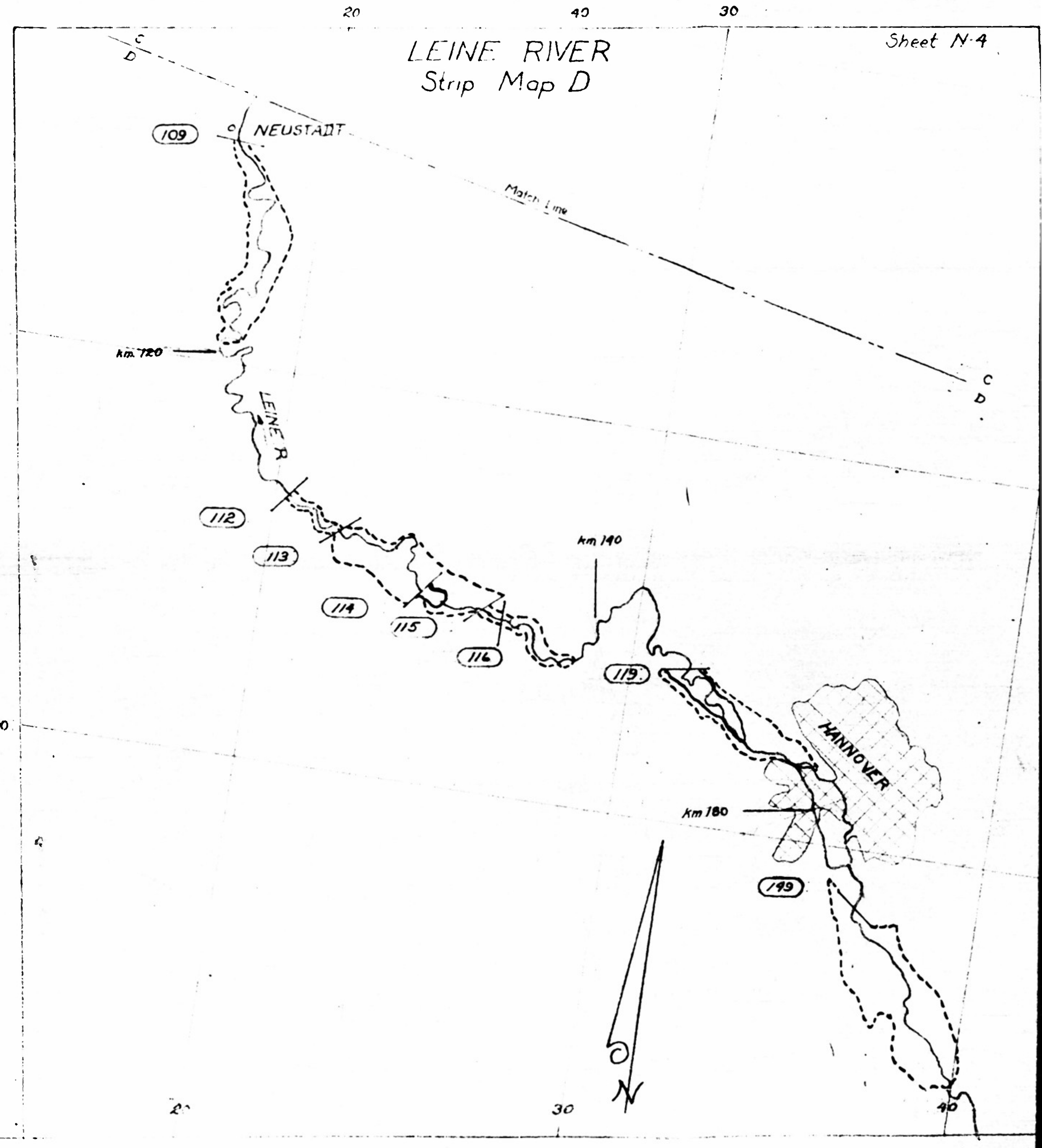


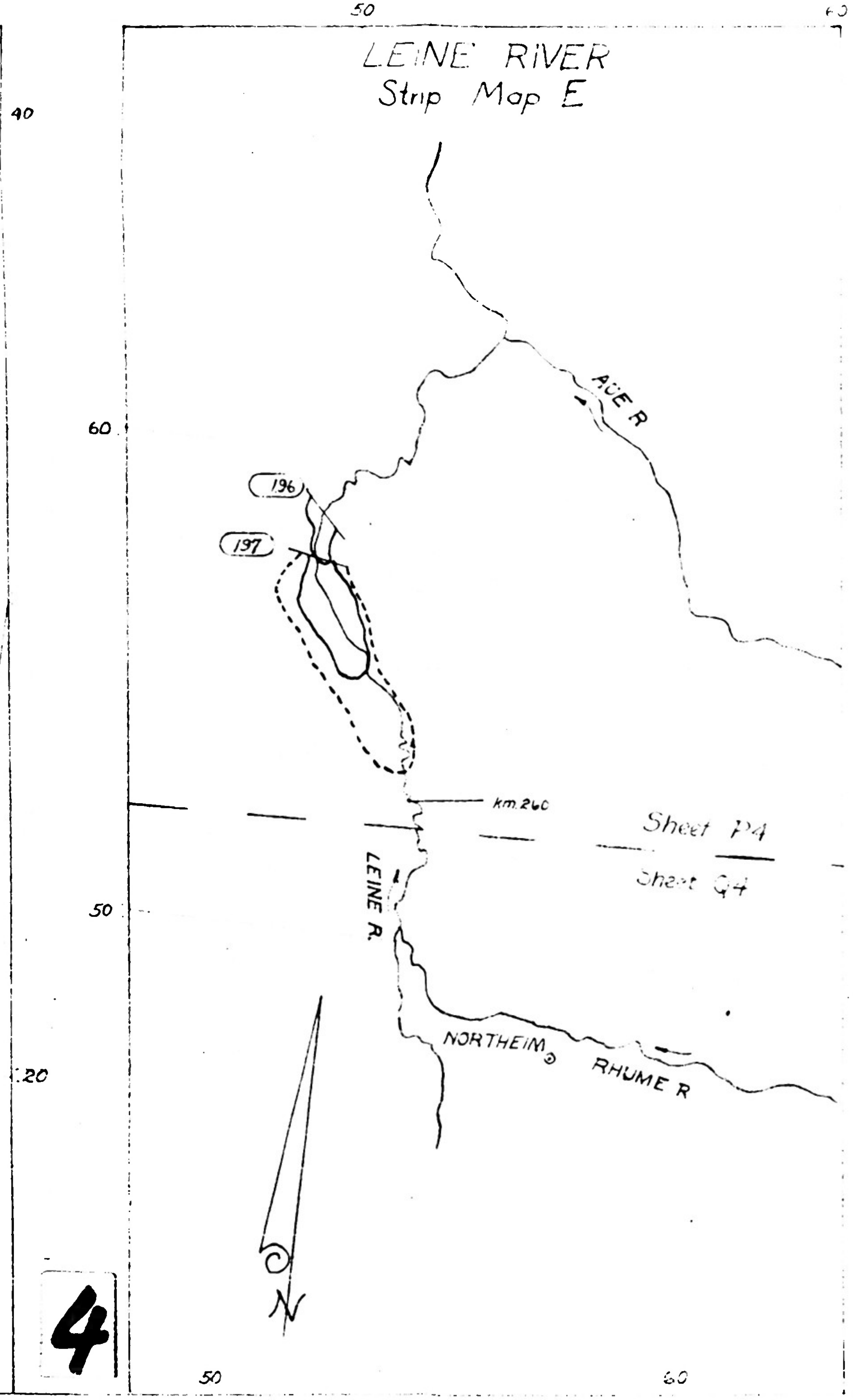
ALLER RIVER
Strip Map B

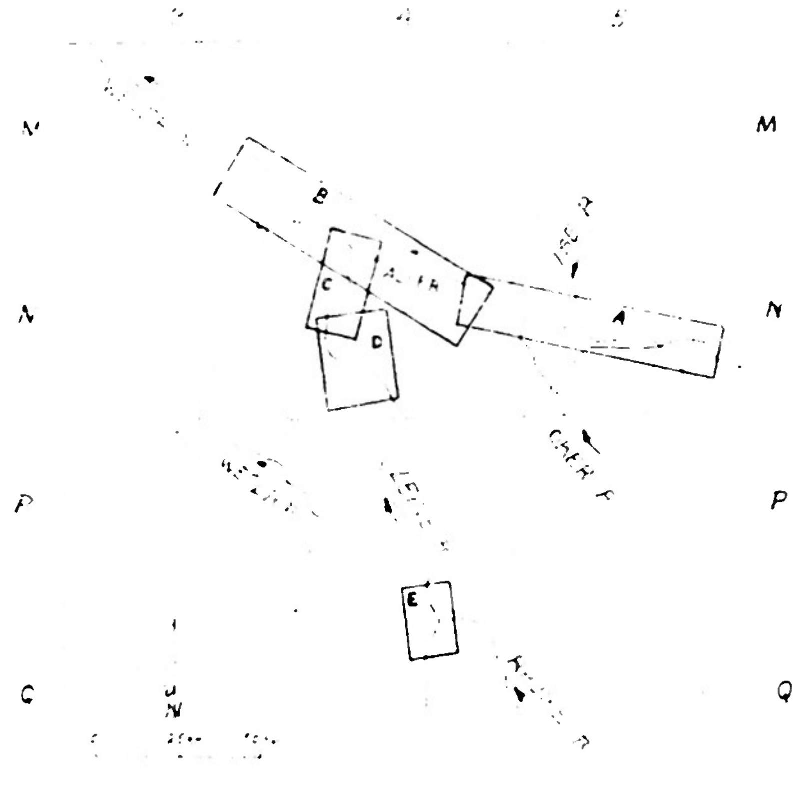


2


LEINE RIVER
Strip Map C
Sheet N4
Match Line
ALLER R
100
BOTHMER
LEINE R
102
km 80
104
105
km 100
Match Line
3
N


LEINE RIVER
Strip Map D
Sheet N·4
109
NEUSTADT
Match Line
km 120
LEINE R
112
113
114
115
116
km 140
119
HANNOVER
km 180
149
N





KEY MAP

LEGEND

Sheet Line GSGS 4416 Map Series (1:100 000)

Match Line for Strip Maps

"Nord de Guerre" Grid Lines

Temporary Dam Location

Low Barrier Inundation (1m + MW)

High Barrier Inundation (3m + MW)

Site Serial (Table 6 & 7)

0 5 km 10 km

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SECURITY INFORMATION

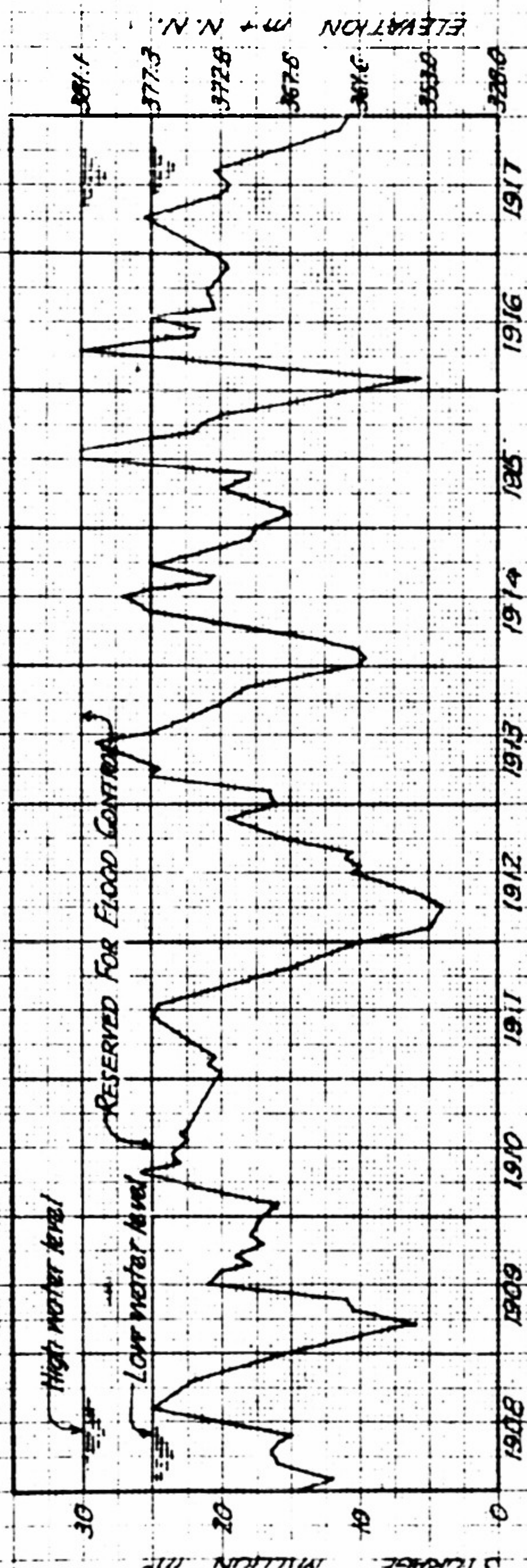
ALLER & LEINE RIVERS

INUNDATION BY STILLWATER BARRIERS

WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by ______ Date ______
Drawn by ______

PLATE 16



OPERATION PLAN - ODER DAM

NOTE: Estimated Oder Reservoir stage & storage for 1908 - 1917 conditions and with proposed operation plan if Oder Dam had been in full operation during that period.

SOURCE: "Die neuen Talsperrendämme im Harz" by Prof. Collorio, Die Bautechnik, Jahrgang 15 Heft 15, 2 April 1937.

ALLER & LEINE RIVERS

ODER RESERVOIR STAGE HYDROGRAPH

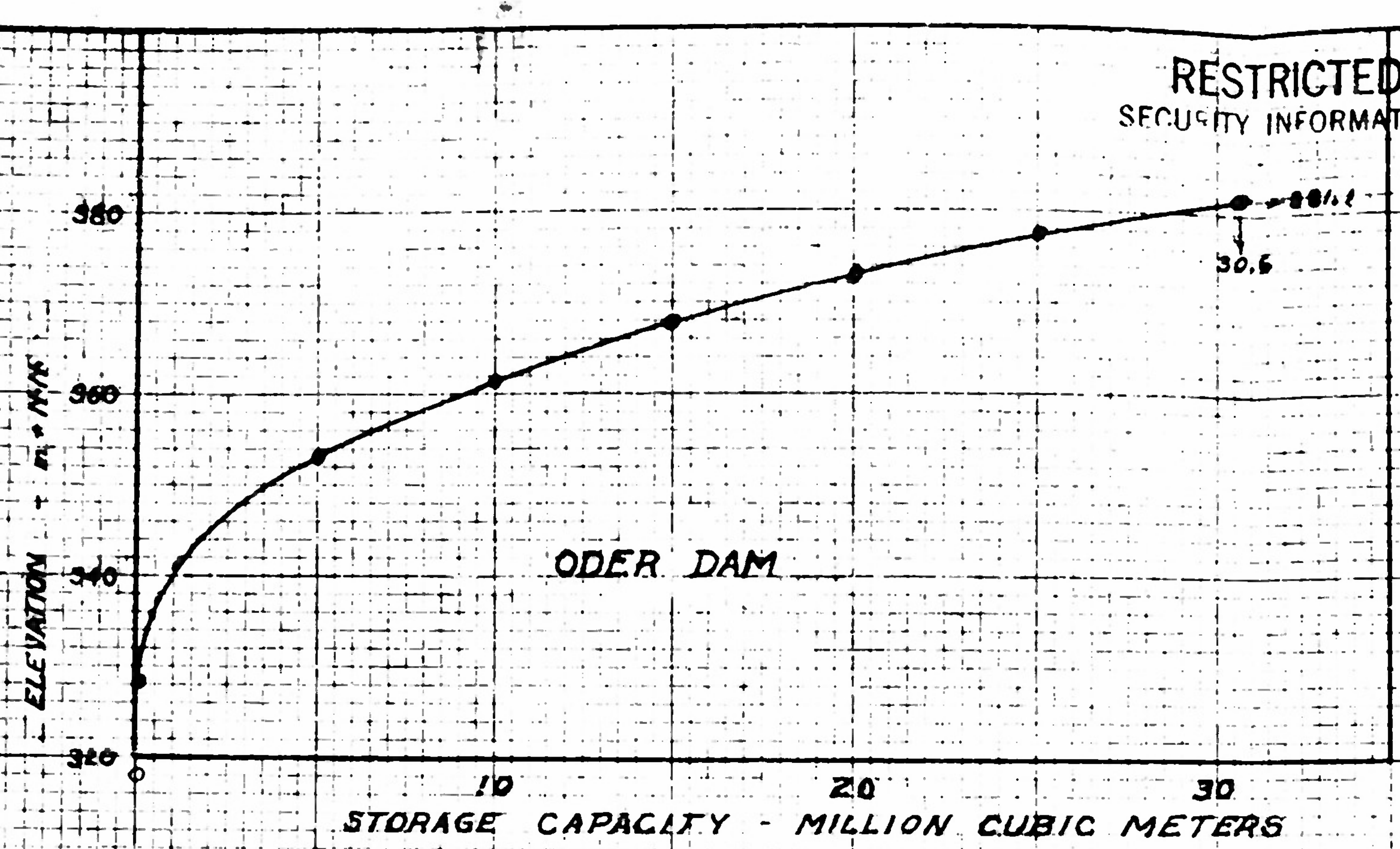
WASHINGTON DISTRICT CORPS OF ENGINEERS

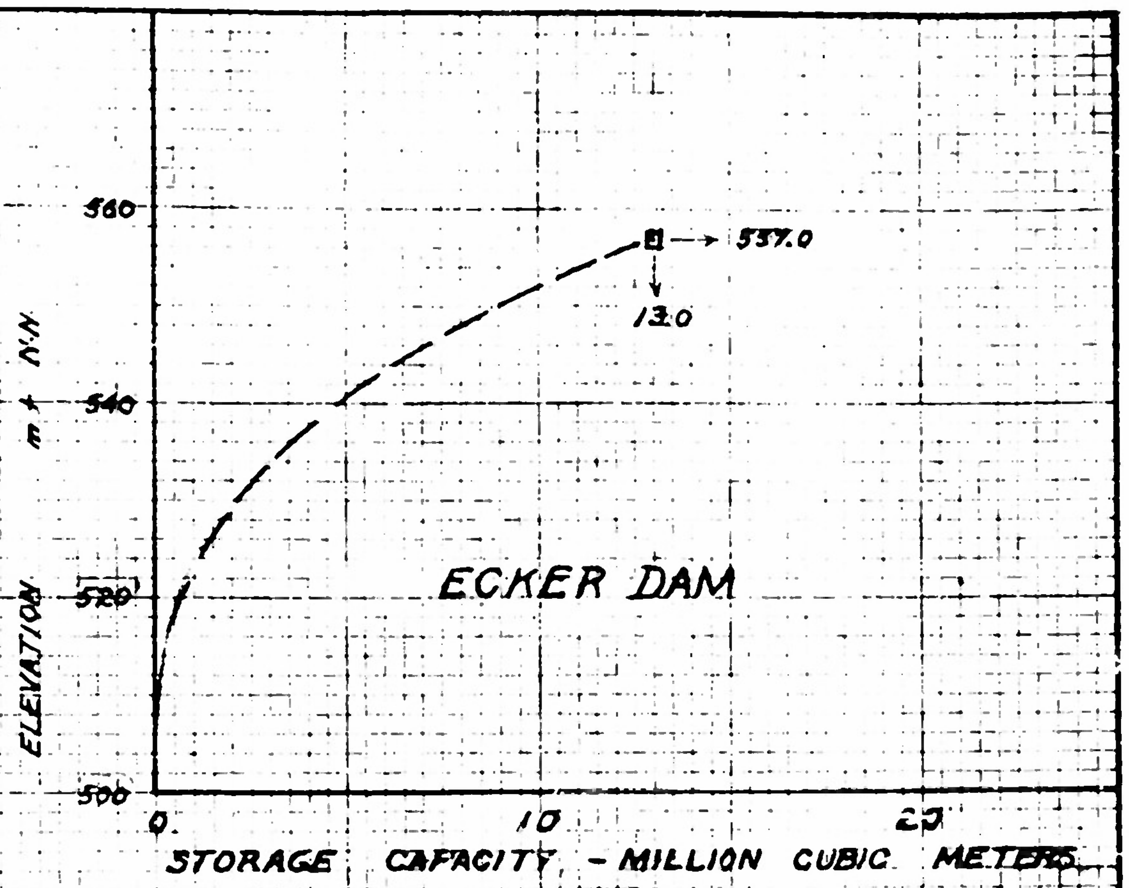
Prepared by F.B.B.

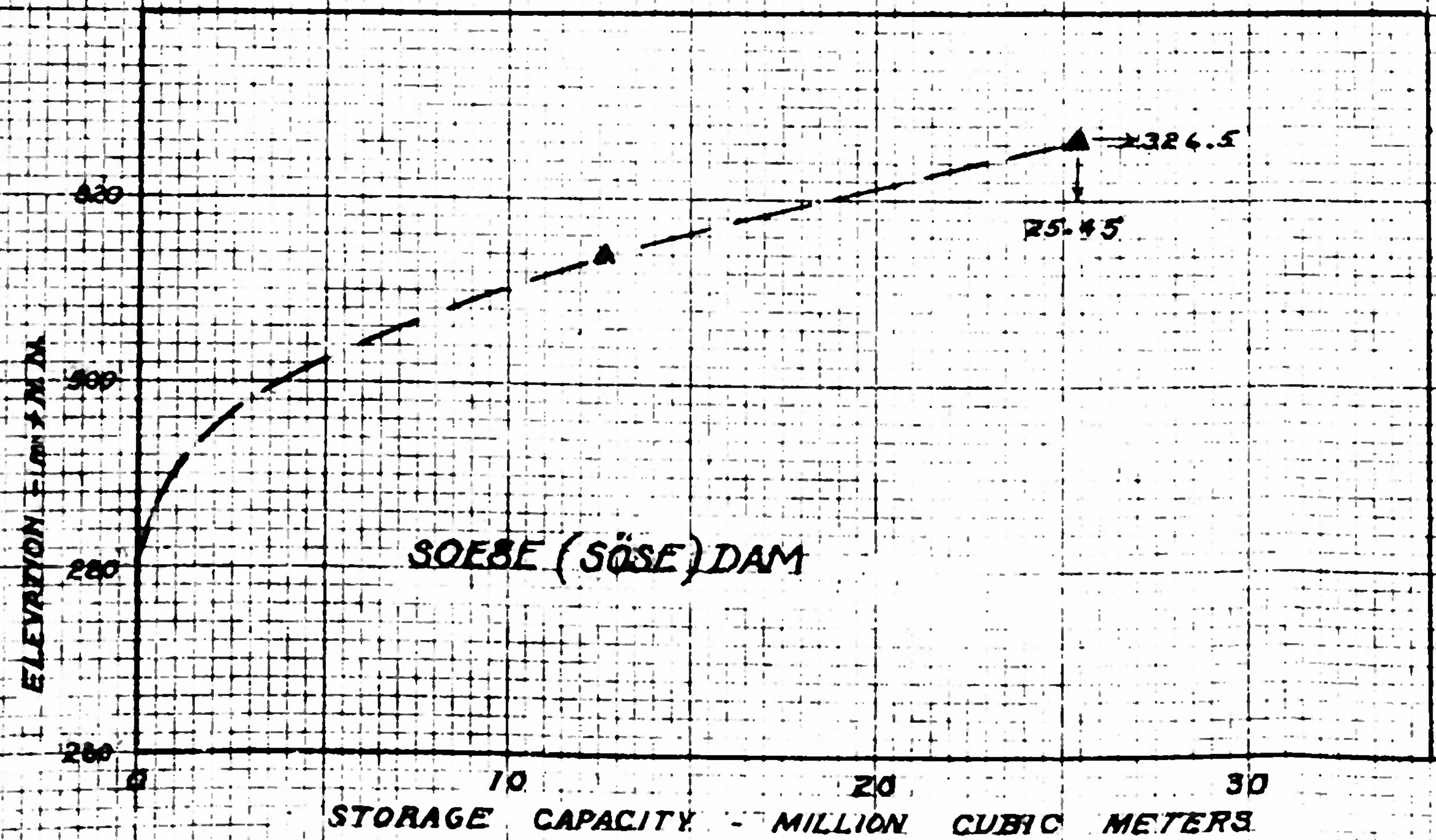
Drawn by J.B.K. Date Aug. 52

PLATE 17

RESTRICTED
SECURITY INFORMATION







Note: Estimated storage curves based on points from cited sources

- ⊙ From Ref. 9
- △ From Exhibit B
- ⊡ From Ref. 12

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SECURITY INFORMATION

ALLER & LEINE RIVERS

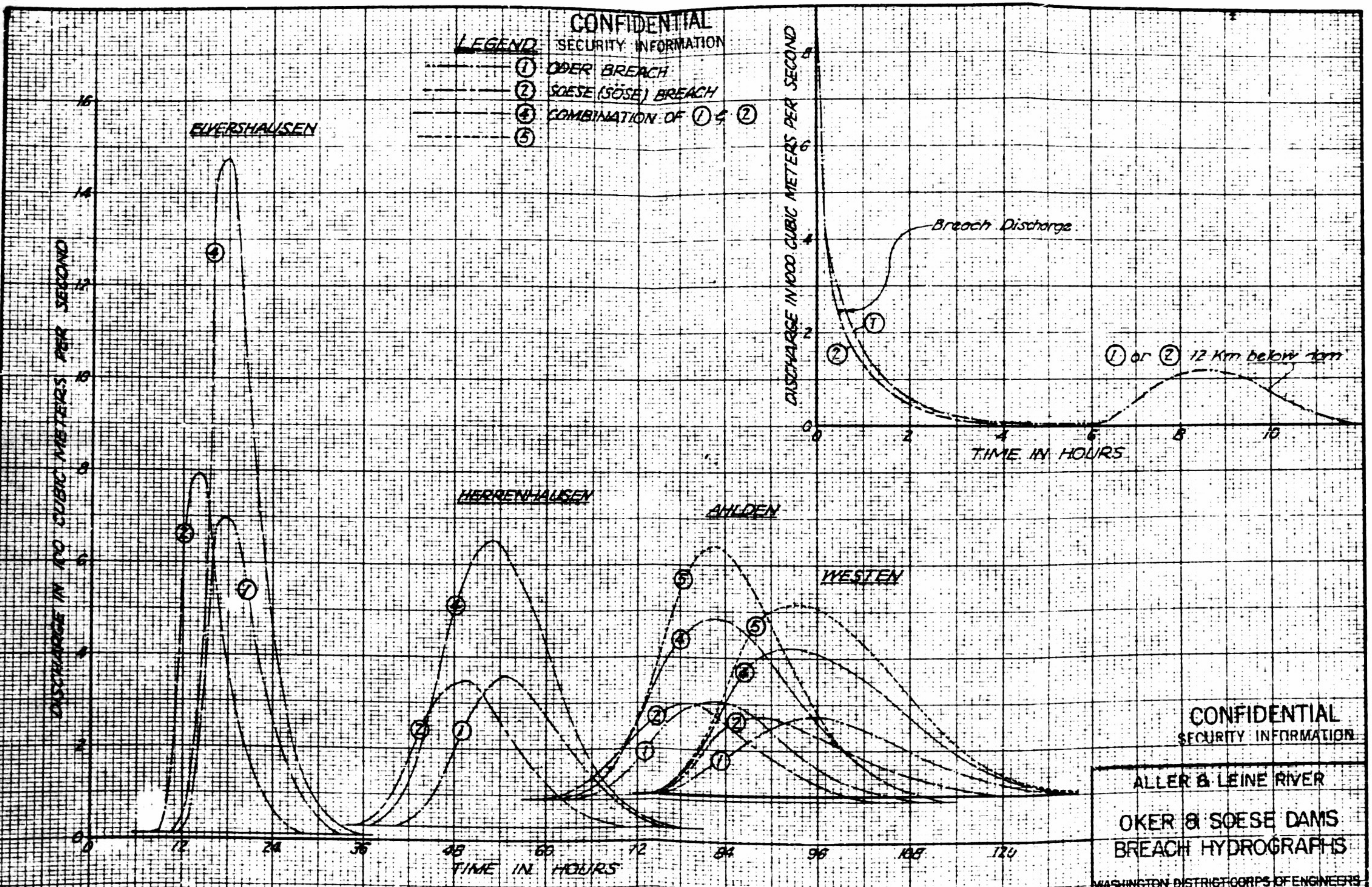
VALLEY DAMS STORAGE CURVES

WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by FBA
Drawn by FBB
Date Aug. '52

PLATE 18

CONFIDENTIAL
SECURITY INFORMATION



CONFIDENTIAL
SECURITY INFORMATION

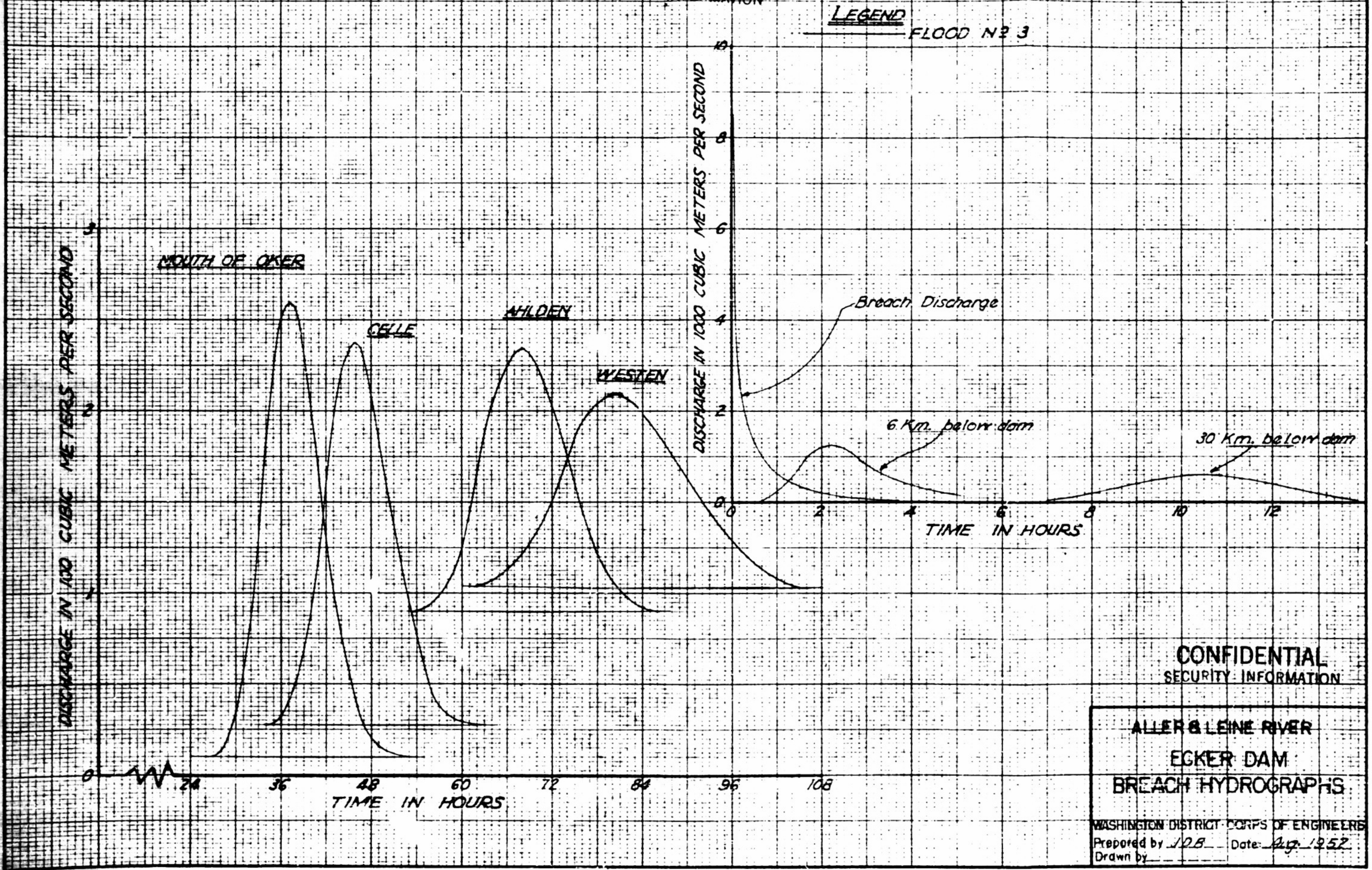
ALLER & LEINE RIVER

OKER & SOESE DAMS
BREACH HYDROGRAPHS

WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JDB Date Aug. 1952
Drawn by

PLATE 19

CONFIDENTIAL
SECURITY INFORMATION

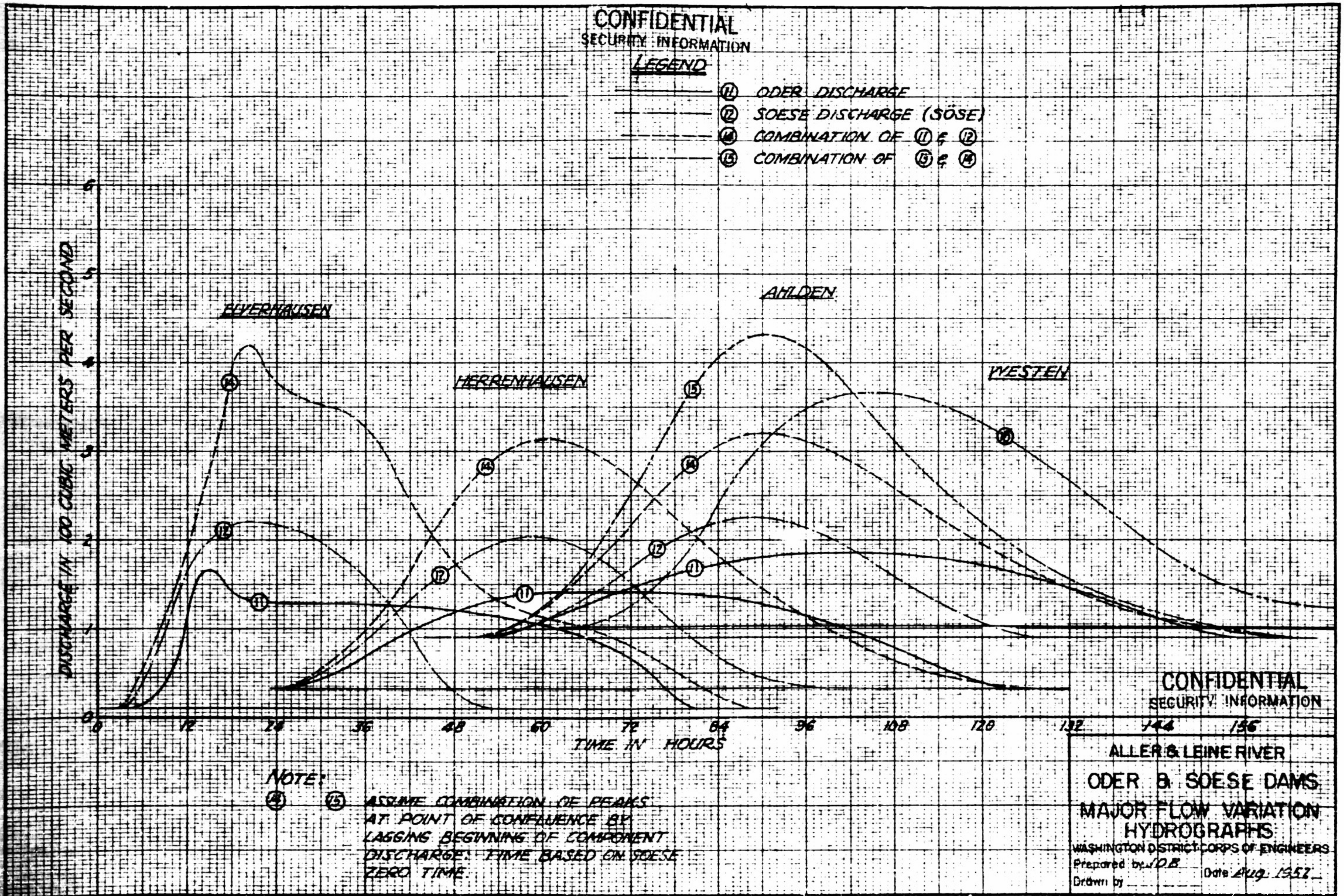


CONFIDENTIAL
SECURITY INFORMATION

ALLER & LEINE RIVER
EGKER DAM
BREACH HYDROGRAPHS

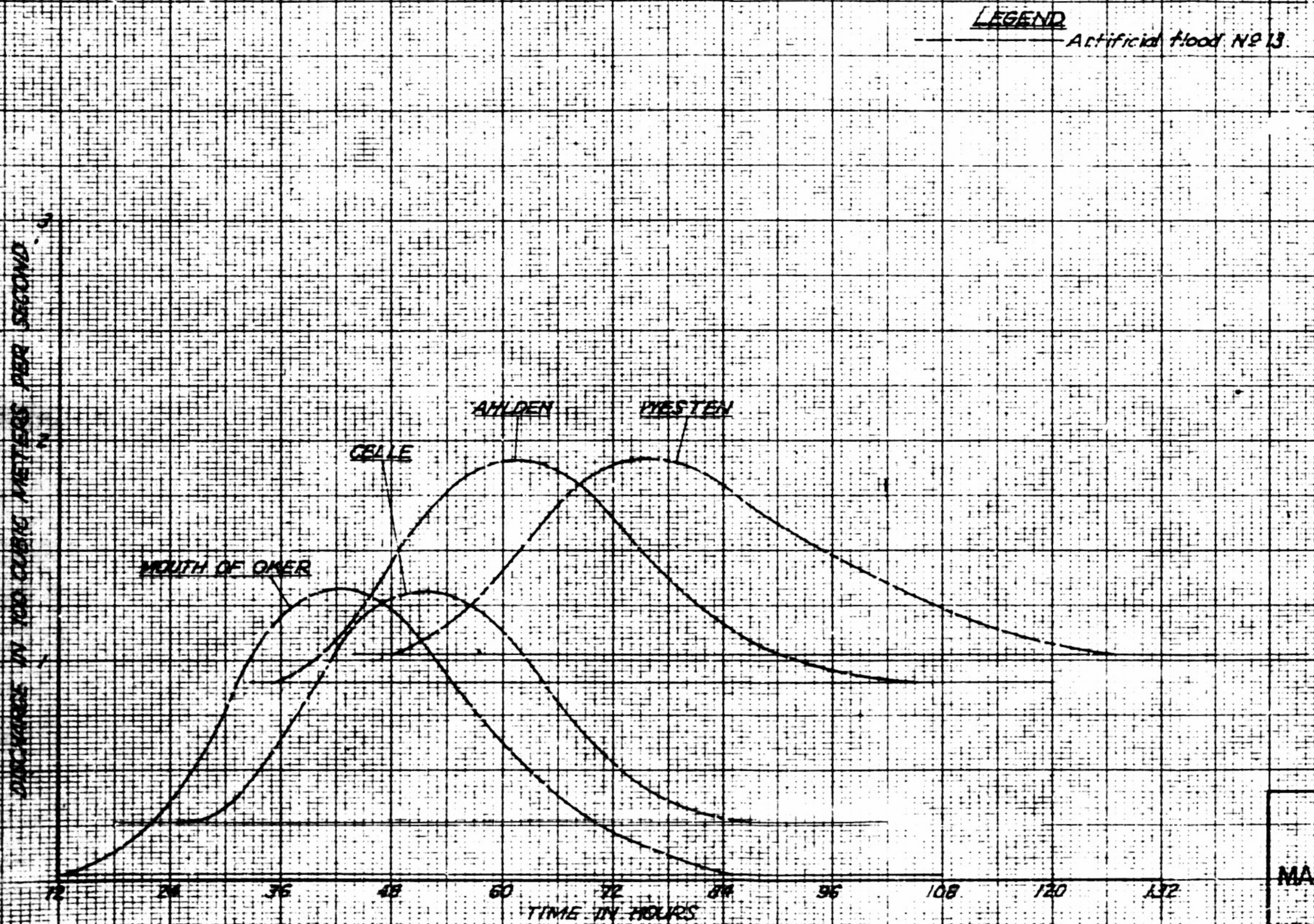
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JOB Date: Aug. 1952
Drawn by

PLATE



CONFIDENTIAL
SECURITY INFORMATION
LEGEND
⑪ ODER DISCHARGE
⑫ SOESE DISCHARGE (SÖSE)
⑭ COMBINATION OF ⑪ & ⑫
⑮ COMBINATION OF ⑮ & ⑭
DISCHARGE IN 100 CUBIC METERS PER SECOND
BEVERHAUSEN
HERRENHAUSEN
AHLDEN
WESTEN
TIME IN HOURS
0 12 24 36 48 60 72 84 96 108 120 132 144 156
CONFIDENTIAL
SECURITY INFORMATION
NOTE:
⑭ ⑮ ASSUME COMBINATION OF PEAKS AT POINT OF CONFLUENCE BY LAGGING BEGINNING OF COMPONENT DISCHARGE. TIME BASED ON SOESE ZERO TIME.
ALLER & LEINE RIVER
ODER & SOESE DAMS
MAJOR FLOW VARIATION HYDROGRAPHS
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by J.O.B. Date Aug. 1952
Drawn by

CONFIDENTIAL
SECURITY INFORMATION



CONFIDENTIAL
SECURITY INFORMATION

ALLER & LEINE RIVERS
ECKER DAM
MAJOR FLOW VARIATION
HYDROGRAPHS
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JDB Date Aug 1952
Drawn by

PLATE 22

EXHIBIT A

DESCRIPTION OF BRIDGES AND DAMS*

	Page
Notes	1
Aller River	2
Leine River	10
Rhume River	25
Oder River	27

*Abstracted and Reproduced from "Report on River Aller, First Edition," Part II; and "Report on River Leine, First Edition," Part II. G.S.I. (R.E.) Main Hq. 21 Army Group, March 1945.

Description of Bridges, Locks, Dams, etc.

NOTES.

1. Accuracy. The majority of constructional details and measurements have been taken from documentary sources and unless otherwise stated have been checked and supplemented from air photos. Measurements of river widths refer to normal water levels.

2. Crossings not shown on GSGS 4416 A note "Not marked on map" has been included in the remarks column wherever a road or railway bridge exists which does NOT appear on the current edition of the sheet concerned in the GSGS 4416 series. It has not been thought necessary to do so in the case of farm bridges, footbridges and other construction.

3. Abbreviations.

L. W.	Low water.
M. W.	Mean low water
M. H. W.	Mean high water
H. W	High water
H. N. W.	Highest navigable water
m.	metre
N. N.	Normal Null (German land survey datum)

4. Load classification of bridges The load classification of bridges, as given in this schedule is almost entirely taken from official German ratings by conversion according to the following table:-

GERMAN CLASS.	MEANING	BRITISH EQUIVALENT.
(a) Road Bridges.		
I	2 - axled vehicles up to 24 (metric) tons singly and slowly.	class 40 or over.
II	" " " up to 16 tons.	class 24
III	" " " up to 7 tons.	" 12
IV	" " " less than 7 tons	Under class 12.

(b) Railway bridges

N.	max. axle load 25 tons.
E.	" 25 "
G.	" 20 "
H.	" 18 "
J.	" 16 "
K.	" less than 16 tons.

Where the German sources give only a civil rating in tons, usually in the case of weak bridges, this has been recorded in the schedule as e.g. "5 tons". This civil figure is the heaviest safe load in metric tons for 2 axled vehicles without intervals and gives a guide to the strength of the bridge until the military classification can be ascertained. It will be noted that "Class 40" in this schedule includes bridges of greater capacity.

REPORT ON R. ALLER. Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial.	Type.	Location & Name.	Map ref 1/100,000	Constructional details.	Overall length.	Width Road	Width Sidewalks	Width Overall	Load class	River width	Depth LW	Depth HW	Remarks.
1.	Road bridge	South of [illegible] R.I. 188	Sheet 16 855349	Two span reinf. conc. beam & slab bridge spans 45ft each. This bridge replaces one at original site immediately down-stream. New section of rd has been built across the valley to eliminate bends on original course.	100	20		32		65	1½	6½	
2	Road bridge	SW of [illegible]	858356	Single span inreinf. conc. rd bridge	60	10		14		45			NOT marked on map.
3	Farm bridge	East of ETTENBUTTEL	858371	Farm bridge, probably timber. Unmetalled approaches.	60	8		10		45			
4	Farm bridge	East of ETTENBUTTEL	835375	Farm bridge, probably timber. Poorly metalled approach track on right bank, none on left bank.	45	7		9		33			
5	Road bridge	ETTENBUTTEL	816376	Single span steel girder through truss with curved top chord type on reinforced concrete abutments. Clear span 131 ft. [illegible] embanked across valley. Reinf. conc. slab flood span of 46 ft clear span, roadway 15 ft with 2 sidewalks each of 1½ft is 50 yds from main bridge on right bank.	164	20	One of 1.	25	Est. 40	47	2½	4	
◆ 6	Road bridge	DIEKHORST	783393	Two span stone arch bridge with sluices and two flood bridges of T - girder construction masonry abutments. Main br. 2 spans each [illegible] Flood br. each 33 ft [illegible]	Main br 30. Flood br 92 each	[illegible] 16	Main br Two of 1½ Flood br s One of 3	1[illegible] 2[illegible]	[illegible]	20	[illegible]	6½	? small rd br. over sluice immediately upstream of this br. ◆
7	Road bridge	MUDEN	782398	Eight span wooden br. with three wooden middle piers flanked on each side by two masonry piers and masonry abutments. 2 clear spans each 18.7 ft. 4 " " " 19 ft 2 " " " 20.6 ft.	174	12	One of 2½	20	? 9	82	3	8	
8	Road bridge	North of FLETTMAR	Sheet 14 764407	Eight span timber bridge on timber trestle piers. Footbridge 200 yds downstream.	167	10		12	Total load 3 tons	98	3	8	

◆ NOT checked from air cover.

REPORT ON R. ALLER — Description of bridges, dams, etc. — ALL MEASUREMENTS IN FEET.

Serial	Type.	Location & Name.	Map ref 1/100,000	Constructional details.	Overall length	Width Road	Width Sidewalks	Width Overall	Load class	River Width	Depth LW	Depth HW	Remarks.
9	Railway Bridge	North of FLETTMAR	760411	2 span single track bridge. Main river span 149ft through type steel truss with curved top chord. Left bank floodspan of 69 ft parallel truss.	223			1	Max. axle load 20 tons	55	2½ to 3	5	
10	Road bridge	LANGLINGEN	737434	Seven span timber bridge with six river piers 7 clear spans of 24 ft.	154	11		14	Total load 6 tons	95	2½		
11	Farm bridge & weir.	SW of [illegible]	712442	Multispan timber farm bridge over weir. Side-stream joins immediately upstream & restricts left bank approach.	85	8		10		75			
12	Road bridge	East of OFFENSEN	703454	Two span steel through truss, bridge on masonry piers and abutments. Spans each 80 ft.	197	19	Two of 1½		40	[illegible]	3 to 4	5 to 6	
13	Weir & Farm bridge	NW of OFFENSEN	680465	Masonry weir with ? timber road bridge over top.	93	8		11		71			
14	Road bridge	WIENHAUSEN	666460	4 span deck type reinf. conc. bridge with [illegible] approaches. River span 65 ft, 2 left bank, 1 right bank flood span each 33 ft. Original 9 span timber bridge at 666461 (shown on map) has been removed.	232	22		32		55			NOT [illegible]
15	Road bridge	ALTENCELLE	621444	Eight span timber bridge on timber abutments & piers. 8 clear spans each 27.8 ft.	230	11	One of 2		9	114	3 to 4	5 to 6	
16	Foot-bridge	CELLE	594504	Narrow ? wooden footbridge.	218			5		200			
17	Road bridge	CELLE R.S.3.	589505	3 span steel bowstring girder bridge on masonry piers and abutments. 2 clear spans each 41 ft. 1 " span of 78 ft.	177	20	Cycle track 14, 2 foot-walks canti-levered beyond bowstring trusses each 10	60	24	164	5 to 6½	about 10	
18	Dam & mill	CELLE	539505	Dam over right channel with 2 mill buildings, projecting 100 ft from right bank.						230			

REPORT ON R. ALLER Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial.	Type	Location & Name.	Map ref 1/100,000	Constructional details.	Overall length.	Width Road	Width Sidewalks.	Width Overall.	Load class.	River Width	Depth LW	Depth HW	Remarks.
19	Road Br. over left channel.	CELLE "SCHUTZEN-HAUSBRUCKE"	587504	Four span, steel girder with concrete filling between girders, concrete piers & abutments. Roadway 2in asphalt surfacing. Spans each 14.7 ft.	103	18	One of 10		40	98	3	5 to 6½	NOT a though route
20	Mill, dam & foot-bridge (over left channel)	CELLE	586503	Left channel in 2 streams round small island. Left stream passes under mill buildings, right stream over weir, with footbridge immediately above downstream junction of the 2 streams.						Right stream 80 at weir 25 at footbridge Left stream 10 - 15			
21	Foot-bridge (over left channel)	CELLE	585503	7 Multispan light steel girder footbridge Serial 20 immediately upstream.	160			6		160			
22	Foot-bridge (over left channel)	CELLE	585503	Light foot bridge, probably steel girder.	45			4		40			
23	Railway bridge (over left channel)	CELLE	583503	2 span single track electrically operated lift bridge. Line leads to harbour area only. One river lift span 1 right bank flood span of 48 ft. CELLE harbour on right bank immediately down-stream.	120	Single track		13		50	4	6	
24	Railway bridge (over right channel)	CELLE	580505	Single track steel girder railway bridge linking harbour to main line 53ft through truss river span. 2 plate girder flood spans each 26 ft masonry piers and abutments.	110	Single track		12	Max axle load less than 16 tons.	40	3½	5½	
25	Foot-bridge	CELLE	578499	Seven span lattice steel girder on steelwork piers and masonry abutments. 6 clear spans each 41 ft 1 " span of 83 ft. Immediately upstream of serial 26.	330	7½		9		65		5	Vertical clearance at HHW 15 ft.
26	Railway bridge	CELLE	578499	3 single track railway bridges side by side. Each 7 spans. Plate girder & reinf. conc. T-girders on masonry piers and abutments. One central span flanked by 3 flood spans each side. Spans 1 X 55 ft, 4 X 42 ft, 2 X 40 ft.	341	3 single track	Two of 2½	40		85	4	6	Vertical clearance at HHW 14 & ft.

REPORT ON R. ALLER. Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial.	Type.	Location & Name.	Map ref 1/100,000	Constructional details.	Overall length.	Widths. Road.	Widths. Sidewalks.	Widths. Overall.	Load class	River width	Depth LW	Depth HW	Remarks.
27	Foot-bridge	West of CELLE	563503	Small Multispan timber footbridge.	75			5		65			
28	Ferry	BOYE	551515	1 small boat for 12 passengers						75	3		
29	Vehicle ? ferry	OLDAU	491535	Reported vehicle ferry. Underwater cable type length 43 ft; Breath 13 ft; Draught 2 ft (loaded). Capacity 60 passengers or 13 horses or 1 lurry. Also another small boat ferry for 10 passengers.						147		6½	No boat visible on air photos 13 Sep 44. Unmetalled approaches
30	Lock & foot-bridge (over left channel)	OLDAU	489538	Masonry lock with footbridge over lock gates. Lock:- length 540 ft; width 48 ft.	55			3		48		12	
31	Footbridge dam & power house (over right channel)	OLDAU	491536	Dam with power house on left bank and foot-bridge. Dam has 4 double sluices & a 49 ft lift gate for use in flood.	236			5		Above 195 below 170			
32	Road bridge	Winsen	471555	Single steel girder through truss with curved top chord river span and 1 right bank & 3 left bank reinf. conc. flood spans. Masonry piers & abutments. Main span 140 ft. Flood spans each 47 ft.	354	19	Two of 3 each	30	40	105		6½	Vertical clearance at HW 13 ft HW = 33.23m + NN See photographs.
33	? vehicle ferry	West of WINSEN	445564	Reported underwater cable ferry. Length 19ft Breath 9.8ft; Draught 0.6ft (loaded). Capacity 20 passengers or 3 horses. No approach roads, but tracks lead to site. Small boat visible.					Total load 3 tons	115	Max 7 Min 4 dependent on operation of dam.		
34	Lock & foot-bridge (over right channel)	BANNETZE	415560	Masonry lock. Length 540 ft width 48 ft with footwalk over lock gates.	60			3		48		Max. 10 Min. at MLW 3	Dependent on operation of dam.

* NOT checked from air cover

REPORT ON R. ALLER. Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial.	Type.	Location & Name.	Map ref 1/100,000	Constructional details.	Overall length.	Widths Road	Widths Sidewalks.	Widths Overall.	Load class	River width	Depth LW	Depth HW.	Remarks.
35.	Dam & footbridge (over left channel)	[illegible]	418560	Dam with footbridge. Dam has 5 double sluices and a needle weir.	148					138			
36.	Vehicle Ferry	[illegible]	406544	Underwater cable type length 46 ft breath 16 ft. draught 1.3 ft (loaded). Capacity 80 passengers or 20 horses or 1 lorry. Also a further small boat capable of carrying 6 passengers.					Total load. 10 tons.	105	6	7	
37.	Vehicle ferry	NE of JEVERSEN	366545	Underwater cable type. Length 40ft; breath 13ft; Capacity 60 passengers or 18 horses or 1 lorry. Also a further small boat, capacity 4 passengers.					Total Load 7½ tons	147	6	7 Min. 5	Dependent on operation of dam (serial 41.)
38.	Light rly br. 7 rd. br. with Rd br. under construction.	North of JEVERSEN	381547	(a) Multi-span steel girder light rly and 7 rd bridge on masonry abutments.	250	10		12		140			NOT marked on map
				(b) Immediately downstream of (a) main road br. under construction, multi-span 7 reinf. concrete beam. Approaches embanked but not finished. Light rly leads to quarry on right bank downstream, crossing main rd under constr. 100 yds from br on right bank.	250			30		140			
39.	Vehicle ferry	North of MARKLENDORF	338558	Underwater cable ferry length 43 ft breath 13ft draught 2 ft (loaded) Capacity 60 passengers or 21 horses, or 1 lorry. Also a further small boat for 6 passengers. The top of the dyke is 5ft above mean water level.						215		10	
40.	Footwalk over lock (over right channel)	North of MARKLENDORF	334558	Masonry lock with footwalk over each pair of gates. Lock length 540 ft width 48 ft				3		40		9	
41.	Dam & power-house (over left channel)	North of MARKLENDORF	333557	Masonry dam with power station on left bank Foot bridge over all. Dam has 7 sluices and a 49 ft wide lift gate.	142			6		270			

NOTE: Work has not been started on proposed autobahn across valley of R. ALLER.

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SECURITY INFORMATION

REPORT ON R. ALLER. Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial.	Type.	Location & Name.	Map ref 1/100,000.	Constructional details.	Overall length.	Width Road	Width Sidewalks.	Width Overall.	Load class.	River width.	Depth LW	Depth HW	Remarks.
42	Road bridge	North of [illegible].	300576	Single span steel girder through truss with curved top chord on masonry abutments. Clear span 140 ft. Five flood spans, reinforced concrete slab, one left bank, four right bank each of 47 ft.	407	17	One of 3		40	140		9	Vertical clearance at HW 13 ft. See photographs.
43	Rly br	North of [illegible].	[illegible]	3 span steel girder through truss with curved top chord single trunk bridge on masonry piers and abutments. 3 clear spans each 119 ft. Trunk embanked across old meander on right bank.	380	Single track.	One of 2½	11	Max axle load 25 tons	131 to 147	4	6	Vertical clearance at HW 13 ft.
44	Vehicle ferry (over left channel)	[illegible]	[illegible]	Underwater cable type. Square-ended steel boat length 42 ft, breadth 13 ft, draught 2 ft (loaded) Capacity - 60 passengers or 20 horses or 1 lorry Crest of dyke 6 ft above normal water level.					Total load 7½ tons.	121		10	
45	Lock & foot-bridge (over left channel)	[illegible]	268590	Masonry lock. length 540 ft, width 48 ft. Foot walk over lock gates.						48			
				R. LEINE confluent immediately downstream.									
46	Dam & footbridge (over right channel)	[illegible]	270590	Concrete weir with light steel girder footbridge Dam has 2 double sluices and a needle weir. Disused ferry site 100 yds downstream.	174		3			150		Max 9 Min 4	Dependent on operation of dam.
47	Road bridge (over right channel)	[illegible]	270595	6 span timber trestle and steel girder road bridge.	155	12		16		100			NOT [illegible] route.
48	Vehicle ferry (over right channel)	EICKELOH	260600	Underwater cable type. Square ended steel boat. Length 40ft; breath 14 ft. draught 2 ft (loaded) Capacity 70 passengers or 16 horses or 1 lorry Also another small boat capacity 8 passengers. Approaches probably unmetalled.						137	1.6	5.0	
49	Ferry	EICKELOH	256607	Underwater cable ferry 43 ft long by 13 ft wide, draught 2 ft. Capacity 50 passengers or 16 horses or 1 lorry. Also 1 rowboat for 7 persons. Approach ramps both banks.						92	3	6½	

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SECURITY INFORMATION

REPORT ON R. ALLER. Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial.	Type.	Location & Name.	Map ref 1/100,000 Sht M.4.	Constructional details.	Overall length.	Width. Road	Width. Sidewalks	Width. Overall	Load class.	River width.	Depth LW	Depth HW.	Remarks.
50	Vehicle ferry	HUDEMUHLEN	254635	Underwater cable type. Square ended wooden boat. Length 42 ft. breath 13 ft. draught 2 ft (loaded). Capacity - 60 passengers or 20 horses or 1 lorry. Also another boat capacity 10 passengers.					Total load 5 tons	170	5	12	
51	Road bridge	AHLDEN	240644	Single span, steel girder, curved top chord over river. Two reinf. conc. flood spans each side, clear spans 1 X 140 ft. 2 X 47ft 2 X 47.2 ft. Roads treelined. 3 span reinf. conc. deck type bridge over waterfilled original arm at 230643. Overall length 220ft.	390	20	Two of 1½		40	183	8	12	Vertical clearance at HW 13 ft.
52	Vehicle ferry	EILTE	188645	Underwater cable type. Square ended steel boat. Length 50ft; breath 17ft; draught 2.6ft (loaded). Capacity - 100 passengers or 30 horses or 1 lorry. Also another smaller boat capacity 15 passengers. Metalled ramps and approach roads on both banks.						167	5	8½	
53	?Vehicle ferry	West of EILTE	178548	Reported underwater cable type. Square ended wooden boat. length 41 ft. breath 13 ft. draught 2 ft (loaded). Capacity - 50 passengers or 16 horses or 1 lorry. Also another smaller boat capacity 7 passengers.						170	5½	9	No boat visible on air photo of 13 Sep. 44.
54	Vehicle ferry	SE of BOSSE	172642	Underwater cable type. Square ended steel boat. length 39 ft. breath 10.8 ft draught 1.3 ft. Capacity 100 passengers or 13 horses or 1 lorry. Unmetalled right bank approaches.						180 to 226	4½	8	
55	? passenger ferry	BOSSE	167651	Small boat for 5 passengers.						180 to 226	4½	8	No boat visible on air photos 13 Sep 44.
56	? passenger ferry	BOSSE	164650	Small boat for 5 passengers.						180 to 226	4½	8	No boat visible on air photos 13 Sep 44.
57	Road bridge	RETHEM R.S. 235.	115669	Four span, steel girder, curved top chord, over river with three reinf. conc. flood spans. length of spans main br 4 X 1?? ft length of flood spans 2 X 51.5ft (left bank) 1 X 50 ft (right bank).	341	20	Two of 3	28	40	180 to 226	4½	8	Vertical clearance at HW 13 ft. See photographs.

REPORT ON R. ALLER . Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial	Type	Location & Name	Map ref 1/100,000	Constructional details	Overall length	Width Road	Width Sidewalks	Width Overall	Load class	River width	Depth LW	Depth HW	Remarks
* 58	Passenger ferry	HULSEN	085688	One rowing boat; capacity 5 passengers.						197	4½	[illegible]	
* 59	Vehicle ferry	WESTEN	Sheet M 3. 061729	Underwater cable type ferry. Square ended wooden boat. length 43 ft, breath 11.4ft capacity 50 passengers or 10 horses or 1 lorry						197	4½	8	
60	Passenger ferry	BARNSTEDT	050761	One rowing boat; capacity 4 passengers.						197	4½	8	
61	Vehicle ferry	BARNSTEDT	049764	Underwater cable ferry square ended wooden boat. Length 41 ft breath 13 ft. Capacity 50 persons or 10 horses or 1 lorry. Right bank poorly metalled approaches.					Total load 7½ tons	197	4½	[illegible]	
62	Vehicle ferry	EITZE	037799	Underwater cable ferry Boat 48 ft long by 16 ft wide. Draught 12 inches. Capacity 50 persons or 10 horses or 2 lorries. Also rowboat ferry for 8 persons. Unmetalled approaches.					Total load [illegible] tons.	200	5	[illegible]	
63	Railway bridge	VERDEN	013801	21 Span double track masonry & concrete arch rly viaduct. 8 central river spans of 46 ft each. 7 right bank and 6 left bank flood spans of 39 ft each separated by short stretch of embankment from central set of spans. Additional 6 span flood bridge on left bank at 013794.	1230	Double track		26	[illegible] axle load 35 tons.	177 (495 at highest high water)	5	1[illegible]	Vertical [illegible] [illegible] of [illegible] reported [illegible] at [illegible] [illegible] -line.
64	Passenger ferry	VERDEN	007805	Passenger cable ferry capacity 10 persons.						200	5	[illegible]	
65	Road bridge	VERDEN R.S.215 (original route)	003815	2 span steel girder through truss bridge with curved top chord on masonry & conc. pier & masonry abutments. Spans of 115ft each 3 span lattice girder flood bridge 100 yds from main bridge on left bank over side arm which dries out in summer. Spans 104 ft each.	630	Main bridge 16; Flood bridge 13	Two of 5; Two of 4	32; 25		200	5	[illegible]	Vertical clearance at [illegible] 16 ft. Bridge reported to be in [illegible] condition.
66	Road bridge	VERDEN R.S.215 (VERDEN by-pass)	002820	3 span deck type steel cantilever girder bridge on conc. piers & abutments. Main river span of 130 ft, side spans of 80 ft each. Similar bridge over side arm. Additional 39 ft flood span at 000820 - Small harbour immediately downstream on right bank.	760	20	Two of 5	30	40	200	5	11	Mine chambers exist (4 cavities in each pier). See photographs.

* NOT checked from Air Cover. Confluence with R. WESER at 975844 . Width at confluence 140 ft.

REPORT ON R. [illegible] Description of bridges, dams, etc. ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name.	Map Ref 1/100,000 Sheet K [illegible]	Constructional details.	Overall Length	Width Road	Width Sidewalks	Width Overall	Load class	River width	Depth LW	Depth HW	REMARKS
100	Railway Br	[illegible]	258583	Five span single track railway Bridge on masonry abutments. Two main river spans, steel through truss with curved top chord, clear spans 102 ft. Three right bank flood spans, probably masonry arch, each of 30 ft.	360	Single track		15	Max axle load 18 tons	164	3	5½	
101	Road Br	[illegible] R.R.214	258571	Eight span steel girder and timber Bridge on timber piers and concrete abutments. One electric steel Bascule span of 35 ft, 7 fixed spans 27 ft each.	235	20		24	40	118 to 142	3	5½	
102	Road Br	[illegible]-STOCKUM	250511	Five span steel and timber Bridge on timber piers. Central double leaf steel Bascule span of 36 ft. Two other river spans and two flood spans each of 34 ft. Immediate approaches tree lined.	182	22 (14 on Bascule span)		25	Total load 6 tons	130	2½	5½	
103	Vehicle Ferry	[illegible]	255-65	Underwater cable ferry 46 ft long by 14 ft wide. Capacity 40 persons. Small rowboat also visible on air photos of 13 Sep 44					Total load 4½	130	2½	5½	Bridge shown on map does not exist.
104	Road Br	[illegible]	258451	158 ft single span steel through truss Bridge with curved top chord on masonry abutments. Embanked approaches. Clearance above highest navigable water 11½ ft	162	16	Two of 1½	21	24 estimated	130	2½	5½	
* 105	Road Br	[illegible]	301415	Eight span timber Bridge on timber piers. Main river span of 25 ft with Bascule section two spans of 20 ft, five spans of 16 ft.	152	11½			12	118 to 140	2½	5½	NOT marked on map.
106	? Passenger Ferry	[illegible]	185389	Reported passenger ferry for eight persons						130	1½	4½	No boat visible 13 Sep 44

[illegible] 1735. River flows in two channels right (Main stream) 90 ft average width, left stream 30 – 40 ft average width. The two channels are joined by a lock downstream (the left channel continuing separately through mill Serial 107 for 300 [illegible]). There is a Weir at the upstream end of the right stream.

* NOT checked against air cover.

REPORT ON R. LEINE — Description of bridges, dams, etc. — ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name	Map Ref 1/100,000 Sheet N 4	Constructional details.	Overall length	Width: Road	Width: Sidewalks	Width: Overall	Load Class	River Width	Depth LW	Depth HW	REMARKS.
[illegible]	Mill (over left channel)	NEUSTADT	175359	Mill bldgs and probably farm bridge over left stream downstream of lock.						35			
108	Lock (over left channel)	NEUSTADT	175357	Masonry lock, effective dimensions 130 ft x 12 ft Immediately downstream of Serial 109.						12			
109	Road Br (over right channel)	NEUSTADT R.S.6	175356	Three span masonry arch Bridge with reinforced concrete strengthening; Masonry piers and abutments. Spans 47 ft each. 150 yds tree lined embankment on left bank leads to Serial 110. Clearance at HW 21 ft	116	20	Two of 5	35	40	100 to 110	5	8	In Series with Serial 110
110	Road Br (over left	NEUSTADT R.S.6	175356	Two span masonry arch bridge with concrete strengthening. Masonry piers and abutments Spans 35 ft ea ch. 150 yds treelined embankment on right bank leads to Serial 109 Clearance at HW 14 ft.	86	20	Two of 5	35	40	50	2	5	In series with Serial 109
111	Road Br	BORDENAU	182310	Four span concrete arch deck type road bridge Spans from right to left - 2 of 54 ft, 1 of 82 ft and 1 of 54 ft. Headroom above highest navigable water is 11½ ft over a breadth of 26 ft.	310	15	Two of 1½	22	24 estimated	100 to 115	2	5	
112	Road Br	RICKLINGEN	201270	140 ft single span steel through truss with curved top chord. Treelined and embanked approaches.	150	16	Two of 1½	22	24 esti-	100 to 115	2	5	
113	Road Br	RICKLINGEN BIELEFELD - HANNOVER Autobahn	219260	Eight span reinforced concrete deck arch autobahn bridge. Concrete piers and abutments Rd embanked across valley. Spans 3 x 108 ft, 1 x 106 ft, 1 x 104 ft, 1 x 101 ft, 1 x 99 ft, 1 x 96 ft.	820	Twin roadways prob 25 each.	One of 6½	74	40	80			
114	Road Br	LOHNDE	243247	75 ft Single span reinforced concrete arch bridge Headroom above highest navigable level is 10 ft.	120	14	One of 5	22		85	2	4½	

REPORT OF R. LEINE — Description of bridges, dams, etc. — ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name	Map Ref 1/100000 Sheet N 4	Constructional details.	Overall Length	Width Road	Width Sidewalks	Width Overall	Load Class	River Width	Depth LW	Depth HW	REMARKS.
115	A queduct	LOHNDE	289266	Three span steel plate girder aquaduct carrying EMS - WESER - ELBE Canal. Central span 90 ft: side spans 70 ft each. Headroom above highest navigable water is 10 ft over a width of 26 ft.	250		Two tow-paths of 9	Canal 81		75	2	4½	
116	Road B r.	SEELZE	264245	130 ft single span steel through truss with curved top chord on masonry abutments. Headroom above highest navigable level 11½ ft.	135	13	One of 6	23	24 esti-mated	90	2	4½	
117	Road Br.	STOCKEN	302257	Three span bridge ? reinforced concrete. Spans 45 ft each	160	18		22		65			
118	Pipeline Bridge	HANNOVER	315239	Single span steel arch pipeline bridge. Serial 119 immediately upstream.	125			6		60			
119	Railway Bridge	HANNOVER	315239	Three span 4 track deck type parallel steel truss Bridge on masonry piers and abutments. Spans of 110 ft each. Similar bridge over dried out arm of river at 310235 with spans of 78 ft each. Head room of main bridge above highest navigable water is 12 ft.	360	4 track	6½ ft footwalk on up-stream side.	61	Reported max axle load less than 16 tons	85	4½	5	
			From 333225 to 308230 R. LEINE is in two channels, the right channel being approach to lock. Average width of right channel is 45 ft and left channel is 90 ft.										
120	Lock dam and Road Br (over right channel)	HANNOVER	333223	Right channel is split by small island, with lock in left branch and dam in right branch. Lock is 140 ft x 17 ft. Right branch is 35 ft wide at upstream end and 85 ft at downstream end. At upstream end of right branch there is a ? diamond dam with footbridges at downstream end there is another dam with several sluices. Road bridge passes across downstream side of lock and lower dam.	150	9		11		130 immediately downstream			In series with Serial 121

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REPORT O N R. LEINE Description of bridges, dams, etc. ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name	Map Ref 1/100,000 Sheet N 4	Construction details.	Overall length	Width: Road	Width: Sidewalk	Width: Overall	Load Class	River Width	Depth LW	Depth HW	Remarks.
121	Dam & Foot-bridge (over left channel)	HANNOVER	333222	Left channel is split into two branches by small island 65 ft maximum width, and is dammed in both branches. Bridge passes over dam and sluice gates on both branches. Left channel is separated from LEINE Branch Canal for 800 yds, from 326225 to 334221, by spit of land 80 - 130 ft wide. River and canal are confluent 200 yds upstream of dam. Bridge over right branch steel girder deck type 7 or 8 span; over left branch steel girder 3 span.	180 (right) 100 (left)	10		12		175 right 90 left			Is series with Serial 120.
122	Farm Br. (over left channel)	HANNOVER	336218	Multi span farm bridge probably steel and timber leading to small island only, over left channel.	140			6		130			NOT a through route.
123	Road Br.	HANNOVER	345219	? Five span steel girder road bridge	290	11		16		225			Not marked on map.
				From 365194 to 347219 R. LEINE is in two channels. The right channel (known also as the MUHLENLEINE) is of 65 ft average width, the left channel is from 100 - 200 ft wide. The left channel is confluent with the R. IHME at 359193 and is called the IHME till it reunites with the LEINE proper at 347219. The R. IHME is less than 30 ft average width above the point where it is confluent with R. LEINE at 359193.									
124	Road Br. (over R. IHME)	HANNOVER "GLOCKSEE" Bridge.	350215	118 ft single span steel through truss bridge Cantilevered sidewalks.	120	28	Two of 10	64	40	125 (190 at the side in flood)	5 to 8	11 to 13	
125	Railway Br. (over R. IHME)	HANNOVER	350214	Three span steel girder rly Bridge (leads to gasworks only) Main river span 123 ft, two side spans each 44 ft.	220	Single Track		15		125			
126	Road Br. (over R. IHME)	HANNOVER "IHMEBRUCKE"	353209	Two span steel plate girder with masonry-faced concrete pier. Spans 70 ft each.	148	45	Two of 13	75	40	130	5 to 8	11 to 13	

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REPORT ON R. LEINE — Description of bridges, dams, etc. — ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name	Map Ref 1/100,000 Sheet N 4	Constructional details.	Overall length	Width: Road	Width: Sidewalk	Width: Overall	Load class	River width	Depth LW	Depth HW	REMARKS
127	Road Br. (over R. LEINE)	HANNOVER	356203	Three span steel plate girder bridge at 74° skew on concrete granite-faced piers and abutments. Roadway is reinforced concrete with clinker brick surfacing laid in sand. Main span of 158 ft, side spans of 70 ft each. Bridge slightly damaged Oct 44 but repaired Mar 45	300	39	Two cycle tracks of 6½. Two cantilevered sidewalks of 16	85		115			MW 48.40 + NN HHW 52.68 + NN. Not marked on map.
128	Road Br (over R. LEINE)	HANNOVER	356201	Three span steel plate girder bridge on concrete stone-faced piers and abutments. Roadway is reinforced concrete with clinker brick surfacing laid in sand. Main span of 144 ft, side spans of 70 ft each. Right bank span upstream sidewalk damaged by bombing on photos of 9 Mar 45, roadway unaffected	285	29½	Two cycle tracks of 5½. Two cantilevered footwalks of 12.	66		95			MW 48.80 + NN HHW 52.07 + NN. Not marked on map
129	Light Railway Br (over R. LEINE)	HANNOVER	349219	? Two span skew light rly bridge. Detail obscured by trees. Rly leads to LEINE HAFEN only.	110	Single track		13		65			
130	Road Br. (over R. LEINE)	HANNOVER "HANISCH" Bridge	349220	Single span steel girder bridge.	55	15		25		65			Not marked on map.
131	Road Br. (over R. LEINE)	HANNOVER "KOENIGSWORTHERSTRASSE" Bridge.	353217	80 ft single span masonry arch skew bridge	100	35		66		60			
132	Road Br. (over R. LEINE)	HANNOVER	353215	? Single span masonry arch bridge. Detail obscured by shadow.	? 70	? 10		? 13		? 50			
133	Road Br. (over R. LEINE)	HANNOVER	357216	Single span masonry arch bridge.	75	22		35		65			
134	Road Br. (over R. LEINE)	HANNOVER "GOETHE" Bridge.	358216	60 ft single span masonry arch bridge	109	40		50	40	56	6½	10	

REPORT ON R. LEINE Description of bridges, dams, etc. ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name	Map Ref 1/100,000 Sheet N 4	Constructional details.	Overall length	Width			Load Class	River Width	Depth LW	Depth HW	REMARKS.
						Road	Sidewalk	Overall					
135	Road Br (over R. LEINE)	HANNOVER	359215	Three span masonry arch bridge. May have been damaged by bombing and temporarily shored up. Spans of 25 ft each.	85	11		21		70			
			From 359214 to 362209 R. LEINE flows in two branches round island.										
136	Road Br. (over R. LEINE right channel)	HANNOVER	360213	Single span deck type box girder bridge.	65	10		19		65			In series with Serial 137.
137	Road Br. (over R. LEINE left channel)	HANNOVER	360213	Single span steel girder bridge.	37	9		13		32			In series with serial 136.
138	Road Br. (over R. LEINE right channel)	HANNOVER	360212	Single span masonry arch bridge.	33	22		30		33			In series with serial 139
139	Road Br. (over R. LEINE left channel)	HANNOVER	359212	Single span masonry arch bridge.	45	10		32		40			In series with serial 138.
140	Road Br. (over R. LEINE right channel)	HANNOVER	361211	Single span bridge probably masonry arch	45	17		24		41			
141	Road Br. (over R. LEINE left channel)	HANNOVER "WATERLOO" Bridge.	360211	34 ft Single span steel plate girder bridge. Mill bldgs (now demolished by bombing) span channel immediately downstream. River makes dog-leg turn under bridge on which two roads meet.	[illegible]	120		100	40	34	6½	10	In series with Serial 142.
142	Road Br. (over R. LEINE right channel)	HANNOVER "FRIEDERIKE" Bridge.	361210	49 ft Single span steel plate girder bridge. Bldg built out over downstream side. River makes dog-leg turn under bridge on which two rds meet.	54	130		165	40	49	6½	10	In series with Serial 141

REPORT ON R. LEINE Description of bridges, dams, etc. ALL MEASUREMENT IN FEET.

Serial	Type	Location & Area	Map Ref 1/100,000 Sheet 144	Constructional details.	Overall length	Width: Roads	Width: Sidewalks	Width: Overall	Load Class	River Width	Depth LW	Depth HW	REMARKS.
143	Road Br. (over R. LEINE)	HANNOVER	362208	Single span steel girder bridge. Approaches possibly unmetalled.	82	9		15		53			
144	Road Br. (over R. LEINE)	HANNOVER	363204	Single s pan dock type steel girder bridge. Approaches possibly unmetalled.	85	17		22		55			
145	Road Br. (over R. LEINE)	HANNOVER	364203	Single span skew bridge reinforced concrete or steel plate girder.	170	20		59		82			
146	Foot Br. (over R. LEINE)	HANNOVER	365195	Single span through steel truss footbridge.	80	8		12		65			
147	Dam foot bridge power station.	HANNOVER	364195	Three sector dam with steel footbridge over. Short channel leads to power house on left bank. Sectors 32 ft each. Dam is on the "SCHNELLE GRABEN" which forms the left branch of R. LEINE and links it to the R IHME.	112	4		6		100			
148	Road Br.	HANNOVER	366153	114 ft single span steel through truss bridge with curved top chord. Formerly through route but rd now closed by MASCHSEE lake on right bank.	126	11		14		100	10	13	
149	Railway Br.	HANNOVER	369183	Two parallel double track rly bridges, steel through truss and steel plate girder constr on masonry pier and concrete abutments. Main river span of 115 ft. Left bank flood span of 48 ft.	172	Two of double track each	One of 2½ [illegible]	26 each	Max axle load 20 tons	110	64		
150	Light foot Br.	NORTH OF DOHREN	377175	Light footbridge, probably steel girder single span	170	6		8		85			

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REPORT ON R. LEINE Description of bridges, dams, etc. ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name	Map Ref 1/100,000 Sheet N 4	Constructional details	Overall length	Width			Load Class	River Width	Depth LW	Depth HW	REMARKS.
						Roads	Sidewalks	Overall					
151	Road Br.	DOHREN	380173	Four span steel girder deck type. Steel piers, concrete abutments. Spans 41 feet each.	164	20 with two 4 ft cycle tracks	Two of 6½	41		95			
				Immediately upstream river flows in two channels round island covered by factory Bldgs with mill on right channel between Serials 151 and 152.									
152	Road Br. (over right channel)	DOHREN	381170	Two span road bridge over right channel, built in centre on small island. Spans 50 ft each. Probably masonry arch construction.	170	18		28		Two Channels of 50 ft ea ch.			
153	Railway Br. (over right channel)	DOHREN	381170	Single track steel girder bridge.	70	Single track		15		60			
154	Railway Br. (over left channel)	DOHREN	379169	125 Ft single span single track skew through steel girder rly bridge.	150	Single track		15		50			Track leads to factory only.
155	Road Br.	WULFEL "WILKENBURG" Br.	383161	Six span steel girder on reinforced concrete piers. Spans, two of 30 ft, two of 24 ft, two of 18 ft	145	23		27	12	115	6	10	
156	? Light railway Br.	LAATZEN	390154	? Two span light rly bridge. Track may have been removed.	170	Single tra ck		10		90			
157	Road Br.	LAATZEN	395149	Road bridge probably two span steel girder	150	8		11		85			
158	Road Br.	GRASDORF	406139	130 Ft. single span masonry arch bridge. 20 ft side spans at each end. Masonry piers and abutments. Embanked approaches. Possibly intended as replacement for Serial 159 Cover unsuitable for interpretation of approach roads.	140	15	Two of 2	20	12	115	3½	7	Not marked on Map.

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REPORT ON R. LEINE Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial	Type	Location & Name	Map ref 1/100,000 Sheet N 4	Construction details.	Overall length	Width			Load class	River width	Depth LW	Depth HW	REMARKS.
						Road	Sidewalk	Overall					
159	Road Br	GRASDORF	407135	Five span bridge, possibly timber and steel girder Spans 30 ft each.	150	10		14		120			
160	Road Br	KOLDINGEN	412107	Three span brick arch bridge. Main span 65 ft, side spans 58 ft each. Bridge also carries tramway.	215	16	Two of 3½	25	40	150	7½	10½	
			Sheet P 4	R. INNERSTE right bank tributary confluent at 428077. Width at confluence 55 ft.									
161	Road Br	RUTHE	423074	3 Span reinforced concrete beam and slab bridge. Piers 5 ft thick. Piers and abutments masonry with granite facing. Spans 85 ft each.	305	20	5 and 6½	34	40	90	3	6	
162	Farm Br	SCHLIEKUM	426063	Six span timber ~~farm bridge~~. Spans - 5 of 22 ft, 1 of 21 ft. Round timber of 35 cm. diameter.	135	11		13	Total load 4 tons	89	3	6½	
♦ 163	Farm Br	JEINSEN	416043	Seven span timber and steel girder bridge. Spans - 15½; 18; 20; 2 x 21; 23; 24 ft.	148	10½			Total load 4 tons	[illegible]	3	6½	
♦ 164	Road Br	SCHULENBURG	405022	Three span sandstone arch bridge. Main span 48 ft side spans 38 ft each.	140	18½			40	110	3½	6½	
♦ 165	Road Br	SCHULENBURG	405021										Leads to Serial 167.
♦ 166	Mill and ? light Rly Br.	SCHULENBURG	403019	On right channel. Dam on left channel at 402016									
♦ 167	Road Br	NW of NORDSTEMMEN	392990	Six span reinforced concrete arch bridge. Two main river spans each of 48 ft with side spans of 36 ft and 24 ft on each side. Site is overlooked by steep wooded hill rising to 175 m + NW on which stands SCHLOSS MARIENBURG.	255	12½	Two of 3½	23	40	56	7	9	
168	Farm Br	WULFINGEN	389975	? Timber farm bridge probably several spans	75	8		10		65			

♦ Not checked against air cover.

REPORT ON R. [illegible] Description of bridges, dams, etc. ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name	Map Ref 1/100,000. Sheet P 4	Constructional details	Overall length	Width			Load Class	River Width	Depth LW	Depth HW	Remarks
						Road	Sidewalk	Overall					
169	Railway Br	[illegible]	[illegible]	[illegible] steel through truss single track bridge on common piers and abutments. Five spans Two of 62 ft each, three of 77 ft each.	375	Two single track	Two of 2	30	Max axle load 20 & 25	[illegible]	3	[illegible]	
170	Road Br	[illegible] R.S.I.	391964	100 ft single span steel through truss bridge on masonry abutments. [illegible] [illegible]. 100 yds from site on left bank is the [illegible] reinforced concrete flood bridge with spans, one of 41 ft, two of 32 ft, 12[illegible] ft overall length. Class 40. Road 30 ft wide with sidewalks of 5 ft and 6 ft.	115	13	Two of 4	[illegible]	40	[illegible]	4	6½	
171	? Passenger Ferry	[illegible]	387328	Bridge shown on map does not exist. Possibly a [illegible] ferry site.						65			
• 172	Railway Br.	GRONAU	[illegible]	[illegible] span steel lattice girder single track bridge on masonry piers and abutments. River span of 152 ft. Flood span of 7[illegible] ft each.		Single track			Max axle load 16 tons	100	2½	[illegible]	
				From 395896 to 392[illegible]85 river is in two channels. The east [illegible] is called the "[illegible]" and has a weir at its upstream end.									
• 173	Road Br (over left channel)	GRONAU	395895	84 ft. single span steel through truss with curved top chord.		15	3 and 5		24				[illegible] with Serial 174.
• 174	Road Br (over right channel)	GRONAU	396895	82 ft. single span steel through truss with curved top chord. 11½ ft clearance above HW.	100	15	3 and 5		24	57 to 82	3	8	In series with Serial 173.
175	? Road Br & Mill (over right channel)	GRONAU	400891										

• Not checked against air cover.

REP GRP ON R. LEINE — Description of bridges, dams, etc. — ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name	Map Ref 1/100,000 Sheet P 4	Constructional details.	Overall length	Width Road	Width Sidewalk	Width Overall	Load Class	River Width	Depth LW	Depth HW	REMARKS.
176	Farm Br	BANTELN	390878	Three span ? steel girder and timber farm bridge Spans 30 ft each. Left bank approach track embanked across water-filled old meander at 388879	105	6		9		80			
				River in two channels from 390873 to 390865. Weir round small island at upstream end of right channel with footbridge to island. Both channels are 50 - 60 ft average width.									
177	Road Br (over left channel)	BANTELN	389872	Single span masonry arch bridge with mill buildings on downstream side.	65	14		18		25 under br and mill 50 upstream.			Not a through route. Bridge shown on map over right channel at 390871 does not exist.
178	Farm Br.	NORTH OF BRUGGEN	392860	? Three span timber bridge. Waterfilled meander on right bank.	65	6		9		52			
				River in two channels from 396847 to 399843, both 55 ft average width. Weir at upstream end of left channel.									
179	Road Br (over left channel)	BRUGGEN	399845	Three span steel girder bridge on timber piers with concrete base. Masonry abutments. Spans of 32, 29 and 25 feet. Height of bridge above river bed is 20 feet. Two flood spans on left bank as follows.	105	18		20	24	53	6	2	In series with Serial 180.
				(a) At 394845 78 ft single span steel through truss with curved top chord.		15	Two of 4	25	24				
				(b) At 395845 Three span masonry arch bridge - spans of 36 ft and two of 13 ft each.	62			25	24				
180	Road Br. (over right channel)	BRUGGEN	400846	35 Feet single span reinforced concrete beam and slab bridge on concrete abutments.	48	21	Two of 4	30	40	35			In series with Serial 179

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REPORT ON R. LEINE Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial	Type	Location & Name.	Map Ref 1/100,000 Sheet P 4	Constructional details.	Overall length	Width			Load Class	River Width	Depth LW	Depth HW	Remarks
						Road	Sidewalk	Overall					
181	Farm Br.	WETTENSEN	422814	Five span timber trestle bridge with steel girder roadbearers and timber decking 3 inches thick. Spans - 1 of 23 ft, 2 of 26 ft and two of 11½ ft. Vertical clearance 12 ft. River in two channels from 428793 to 434782. Left channel 50 - 60 ft, right channel 25 - 30 ft average width. 95 ft wide weir at upstream end of left channel.	103	10		11½	Less than 12	70	4	8	
182	Road Br (over right channel)	ALFELD	434733	Probable single span masonry arch. (site obscured by shadow) Mill bridge on right bank 250 yds downstream	40	13		21		25			Not a through route. Not marked on map
183	Road Br	ALFELD	434782	Three span steel plate girder bridge with reinforced concrete decking on piers 6 ft thick. Main river span 130 ft, side spans 56 ft each. 100 yds from site on left bank is 80 ft reinforced concrete beam flood span, 100 ft overall length. Class 40. Width of roadway 23 ft and sidewalks of 8 and 10 ft. Overall [illegible] ft.	265	23	Two of 7½	40	40	80	7	10	
184	Footbridge	ALFELD	437778	Timber footbridge probably 2 or 3 spans	60			5		20			
185	Farm Br.	SOUTH of ALFELD	437771	Multi span steel girder and timber farm bridge	105	8		11		60			
186	Road Br	WISPENSTEIN	457753	Two span steel girder bridge with 4 inch thick timber decking. Masonry abutments. Spans of 35 ft each. Minimum height above water is 10 feet.	75	12½		14	Total load 24 tons	50	6	8½	
187	Railway Br.	GR. FREDEN	470734	Two parallel five span steel plate girder single track bridges on common piers and abutments. Three spans of 69 feet each, two spans of 57 feet each.	330	Two single tracks		18	Max axle load 25 tons.	60	[illegible]	[illegible]	
188	Road Br	GR. FREDEN	479733	Single span parallel truss steel girder bridge. Right bank approaches appear in poor condition. Level crossing at 481735.	75	10		14		80			Not marked on map

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REPORT ON R. LEINE — Description of bridges, dams etc. — ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name.	Map Ref 1/100,000 Sheet P 4.	Construction details.	Overall length	Width: Roads	Width: Sidewalk	Width: Overall	Load class	River width	Depth LW	Depth HW	REMARKS.
189	Road Br	GR. FREDEN	486723	174 Ft. single span steel through truss with curved top chord on masonry abutments. Right bank approaches embanked and tree lined. Vertical clearance 15 feet.	180	16	Two of 4	27	40	180	8	9	
				River in two channels from 486723 to 487720. Factory on island between the channels with sluice gates and footbridge over it at downstream end and two footbridges and two roadbridges upstream. None of these is a through route. All are on left channel which is 50 feet average width. There are no crossings over right channel which is 50 - 65 feet average width. At its upstream end are two weirs 50 feet and 85 feet wide on each side of small island.									
+ 190	Road Br.	ERZHAUSEN	518677	94 Feet single span reinforced concrete arch bridge	124	12	Two of 16 ins	-	24	82	6½	8	
				River in two channels from 522680 to 523644. 145 ft wide weir across upstream end of right channel. Right channel 50 ft, left channel 25 ft average width.									
191	Road Br	GREENE R.S.64	522846	79 Feet single span reinforced concrete arch bridge Bridge over right channel. Treelined embanked approaches. Mill bldgs. across left channel 250 yds (downstream. ... approach spans, as follows:-	110	24	Two of 5	39	40	75	3	6½	
				(a) Over left channel at 522846 single span reinforced concrete arch.	55	15		25		40			
				(b) Right bank at 524646 four span reinforced concrete beam and slab on masonry piers. Spans 12 ft each.	68	20	Two of 5	32	40				
				(c) Right bank at 525947 eight span reinforced concrete beam and slab on masonry piers. Spans 13 ft each.	138	20	Two of 5	32	40				
				(d) Right bank at [illegible]847 five span reinforced concrete beam [illegible] masonry piers. Spans 29½ ft each.	172	20	Two of [illegible]	[illegible]	[illegible]				
192	Railway Br.	KREIENSEN	39629	Four span double track masonry arch bridge. Two central spans of 41 ft each, two side spans of 15 ft each	150	Double track.		25		60	5	7	

+ Not checked against air cover.

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REPORT ON R. LEINE Description of bridges, dams, etc. ALL MEASUREMENT IN FEET.

Serial	Type	Location & Name	Map Ref 1/100,000 Sheet P 4	Constructional details	Overall length	Width: Roads	Width: Sidewalk	Width: Overall	Load Class	River Width	Depth LW	Depth HW	REMARKS
193	Road Br	[illegible]	539626	100 Feet single span reinforced concrete through arch bridge	120	17	Two of 1½	24	40	65	5½	8	
194	Road Br	OLXHEIM	525619	Six span timber bridge on timber trestle piers and masonry abutments. Spans - two of 21 ft; 20 ft, 19 ft, 14 ft, 9 ft.	104	16		20	24	79	5	8	Not marked on map.
195	Foot Br	RITTIERODE	529601	Three span timber footbridge. Weir immediately downstream with small island approached by 25 ft footbridge over narrow side arm	82	4		6		70	5	8	
				R. ILME (left bank tributary) confluent at 510597 Width at confluence 30 ft.									
196	Railway Br.	SALZDERHELDEN	503589	Four span steel girder single track bridge on masonry piers and abutments. Spans 49 ft each. Six span flood bridge 250 yds from site on left bank. Spans of 39 ft each.	225	Single track		16	Max axle load less than 16 tons.	82	2	4	
				River in two channels from 503604 to 503579. Right channel 40 - 50 ft, left channel 25 - 30 ft average width. Left channel is crossed by two farm bridges at 503581 and 503600. There are no crossings over right channel.									
197	Road Br.	SALZDERHELDEN R.B. 3	503577	Three span masonry arch bridge with centre section over upstream end of island 40 ft wide by 275 ft long. Spans of 48 ft, 20 ft and 17 ft. Flood bridge on right bank at 506577, 4 spans of 38 ft each.	160	23	4 & 6	36	40	Upstream 140 Downstream left channel 40 right channel 55	6	9	
* 198	Foot Br.	VOGELBECK	514559	Six span timber trestle footbridge. Spans 20 ft each	134	4				65 - 85	4	6½	
199	Farm Br.	EDESHEIM	523528	Four span steel girder and concrete bridge on timber piers. Spans 10 ft, 13 ft, 23 ft and 32 ft.	60	4½		Total load 2 tons		50	3	4½	

* Also checked against air cover.

REPORT 38. R. LEINE Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET.

Serial	Type	Location & Name	Map Ref 1/100,000 Sheet 84	Constructional details	Overall length	Width			Load Class	River Width	Depth LW	Depth HW	REMARKS.
						Roads	Sidewalk	Overall					
				From 532520 to 528801 river is in two main channels each 40 - 50 ft average width with minor branches 15 - 20 ft wide. R. RHUME (right bank tributary) is confluent at 530503. Width at confluence 65 ft. Weir immediately downstream of confluence.									
200	Road Br (over left channel)	HOLLENSTEDT	529513	Two span reinforced concrete steel girder bridge on concrete piers and abutments. Spans 25 ft each.	53	16	Two of 3½	23	12	50	1½	6	In series with Serial 201.
201	Road Br (over right channel)	HOLLENSTEDT	530512	Five span concrete arch bridge. Spans 51 ft each. Tree lined embanked approaches. Flood span over side stream at 531512. Steel superstructure on concrete abutments. Single span of 55 ft.	225 Flood Span 59	16 16	Two of 3 Two of 3½	26 26	12 12	50 26	1 1½	2½ 2½	In series with Serial 200.
202	Farm Br (over left channel	HOLLENSTEDT	525508	Multi span timber farm bridge. ? Footbridge upstream at 523504 (no air cover available).	60	9		12		50			Not on through route.
203	Road Br	HOCKELHEIM	542476	55 Feet single span steel girder through type bridge on masonry abutments. Footbridge immediately downstream.	60	14	Two of 4	24	40	42	2½	5	
204	Railway Br.	HILLERSE	543459	Four span double track masonry arch bridge. Spans 49 ft each.	270	Double track	Two of 1½	27		42	2½	5	
				River is two channels from 542451 to 541446. Both channels 35 - 40 ft average width. Weir at upstream end of right channel.									
205	Road Br	EAST of HILLERSE	542449	Two span timber bridge over right channel. Spans of 20 and 22 ft. also 2? ft single span over left channel with mill bldgs on left bank.	45	11		15	12	43	2½	4½	
206	Road Br	S.E. of HILLERSE	538445	Single span iron bridge on concrete abutments	50	25		32	40	37	2½	4½	
207	Foot Br	[illegible]	535434	Timber footbridge, probably 2 or 3 spans	65			6		40			

REPORT ON R. LEINE — Description of bridges, dams, etc. — ALL MEASUREMENT IN FEET — R. RHUME.

Serial	Type	Location & name	Map Ref 1/100,000 Sheet Q 4	Constructional details	Overall length	Width. Road	Width. Sidewalks	Width. Overall	Load	River	Depth	Depth	REMARKS.
				R. RHUME. Confluent with R. LEINE at 530503. Width at confluence 65 ft.									
300	Road Br	NORTHEIM	551405	Five span oak bridge. Spans of 18 ft each	90	11½		15	12	65	4	5½	
301	Railway Br	NORTHEIM	553406	Six span masonry arch double track bridge Spans 30 ft each	275	Double track		30	Max axle load 25 tons	30	2	4	
				River in two channels through NORTHEIM from 562405 to 577404. Left channel 30 ft, right channel 65 ft average width.									
302	Road Br (over right channel)	NORTHEIM R.S.3	565406	Five span masonry arch bridge. Spans 41 ft each. Ford immediately downstream	245	20	Two of 3	36	40	145	1	3½	In series with Serial 303.
303	Road Br (over left channel)	NORTHEIM R.S.3	565401	Single span skew masonry arch road bridge. Mill Bldgs immediately downstream. Footbridge across left channel downstream at 563485	90	20		36		50			In series with Serial 302.
304	Road Br (over left channel)	NORTHEIM	566401	Single span ? masonry arch bridge. Footbridge across left channel upstream at 570403	50	15		25		45			In series with Serial 302 as alternative to Serial 303.
305	Farm Br & foot Br	NORTHEIM	580404	Farmbridge and footbridge parallel and probably on common piers. Three spans each of 23 ft approx.	75	5 (farm br) 4 (foot br)		13		60			
306	Road Br	HAMMENSTEDT	605470	Three span timber trestle bridge. One span of 36 ft and two spans of 21 ft each.	37	6½		9	Total load 5 tons	60	2	4½	Not marked on map.

REPORT ON R. LEINE. Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET R. RHUME.

Serial	Type	Location & name.	Map Ref 1/100,000 Sheet Q 4	Constructional details	Overall length	Width. Road	Width. Sidewalks	Width. Overall	Load class	River width	Depth LW	Depth HW	REMARKS.
307	Road Br	ELVERSHAUSEN	6 29476	95 Ft single span steel through truss bridge. Minor bridges over mill stream on right bank and weir 250 yds upstream.	110	13	One of 2½	22	40	50	3½	4½	Bridge marked on map at 623477 does not exist.
308	Railway Br	KATLENBURG-DUHM	640455	Two three span parallel single track steel plate girder bridges on masonry piers. Spans 38 ft each	160	Two single tracks		36	Max axle load 20 tons.	30	2½	3½	
309	Road Br	KATLENBURG-DUHM R.S.241	638452	Six span timber trestle bridge with piers on masonry foundations. Spans of 20 ft each.	100	15	One of 2½	19	40	30	2	3½	
				R. ODER right tributary confluent at 637448. Width at confluence 35 ft.									
310	Road Br.	KATLENBURG-DUHM R.S.247	637447	92 Ft single span steel girder bridge. 150 Yds WEST is two span steel girder bridge. Spans 17 ft each, roadway 16 ft wide. Class 40 over left channel (mill stream) 30 ft wide, ½ to 5 ft deep.		14		20	40	30	3½	5½	
♦ 311	Road Br	WACHENHAUSEN	635435	Two span timber bridge. Spans 21 ft each.	44	11			Total load 4 tons	39	3	5	
♦ 312	Road Br	LINDAU	653420	36 Ft single span steel girder bridge. 23 Ft steel girder span over right channel (mill stream) 200 yds NORTH.	43	17	Two of 3		40	33	3½	5½	
♦ 313	Road Br	BILSHAUSEN	678400	Two span steel girder bridge. Spans 16 ft each	34	15	Two of 3		40	33	4	5½	
♦ 314	Railway Br.	GIEBOLDEHAUSEN	709304	Two span steel plate girder on masonry pier and abutments. Spans 50 ft each.		Single track			Max axle load 25 tons	33	3	4	
♦ 315	Road Br (over left channel)	GIEBOLDEHAUSEN R.S.247	719379	26 Ft single span steel girder	33	16	Two of 3		40	26	1		

♦ Not checked against air cover.

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REPORT ON R. LEINE Description of bridges, dams, etc. ALL MEASUREMENTS IN FEET R. ODER.

Serial	Type	Location & Name.	Map Ref 1/100,000 Sheet Q 4	Constructional details.	Overall length	Widths: Road	Widths: Sidewalks	Widths: Overall	Load class	River width	Depth LW	Depth HW	REMARKS.
				R. ODER Confluent with R. RHUME at 637448. Width at confluence 35 ft.									
+ 320	Road Br	LINDAU	650429	Ten span steel girder bridge on 4 timber and five masonry piers. Spans 23 ft each.	245	13			Total load 5 tons	32	1½	3	
+ 321	Railway Br.	WULFTEN	682425	Three span steel plate girder bridge on masonry piers and abutments. Spans 82 ft each.		Single track			Max axle load 25 tons.	65	1	2½	
+ 322	Road Br	WULFTEN	688428	Twelve span timber bridge. Spans 20 ft each	240	10	1 and 4		Total load 5 tons	79	1	2½	
323	Foot Br	WEST of HATTORF	713413	Timber footbridge	45			6		35			
324	Road Br	HATTORF	729413	Four span timber bridge. Two spans of 29 ft each two of 34 ft each. Footbridge and weir 250 yds and 300 yds downstream	140	11½	Two of 1½		Estimated total load 5 tons	30 (90 in flood)	1	2½	
+ 325	Road Br	SE of HATTORF	756396	102 ft single span iron bridge. Footbridge 400 yds downstream.		15	Two of 2½		40 estimated	65	1	2½	
+ 326	Road Br	POHLDE	791351	Road bridge. Detail concealed by snow.	70	14		10		35			
+ 327	Road Br.	POHLDE	791361	Five span timber trestle bridge on concrete foundations with iron girder superstructure. Spans 17 ft each. Treelined embanked right approach.	98	16	3½	22	12 estimated	30 (90 in flood)	1½	3½	
328	Railway Br.	POHLDE	794390	Two span steel through truss single tr[illegible] on masonry pier. Spans 79 ft each.	170	Single track		10	Max axle load 20 tons.	30	1	2½	

+ Not checked against air cover.

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REPORT ON R. LEINE Description of bridges, dams, etc ALL MEASUREMENTS IN FEET R. ODER.

Serial	Type	Location & Name	Map Ref 1/100,000 Sheet Q 4	Constructional details	Overall length	Width Road	Width Sidewalks	Width Overall	Load Class	River Width	Depth LW	Depth HW	REMARKS
329	Road Br	SCHARZFELD	029379	Single span masonry arch road bridge. Level crossing immediately on right bank. Footbridge 400 yds downstream.	45	14		10		? 25			Not marked on map
330	Road Br	SCHARZFELD	039395	Single span steel girder bridge. Left bank approach probably poorly metalled	75	8		12		60			Not marked on map
331	Railway Br.	BARBIS	846395	Two span twin steel plate girder single track bridges on common concrete and masonry piers and abutments. Spans 51 ft each. Weir immediately downstream. Pier on small island	125	Two single tracks	Two of 3	35	Max axle load 25 tons	40	1	2	
332	Road Br	BARBIS R.S.243	856395	72 Ft single span reinforced concrete skew bridge	85	19	6½ & 5	35	40	60	1	2	
333	Road Br	BAD LAUTERBERG	815392	? Single span reinforced concrete bridge. Possibly sluice gates underneath	100	10		17		85			Not marked on map
334	Road Br	BAD LAUTERBERG	817395	Masonry arch bridge ? single span	95	15		22		Obscured by trees			Not marked on map
335	Road Br	BAD LAUTERBERG	851391	22 Ft single span masonry arch bridge.	87	16	4 and 3½	27	40	39	2	4	
336	Road Br	BAD LAUTERBERG	844402	? Steel girder and timber bridge	100	8		10		80			Not marked on map
* 337	Road Br	NE of BAD LAUTERBERG	902415										

At 9142 R. ODER reaches lower end of [illegible]. This reservoir, completed in 1934 has a superficial area of 346 acres, with a maximum head of 172 ft and a maximum capacity of 30 million m^3.
A roadway runs along the top of the dam and across the lower end of a compensating reservoir at the foot of the main dam.
A power station on the right bank has a capacity of 6 MW.

* Not checked against air cover.

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EXHIBIT B

DESCRIPTION OF WATERCOURSE AND CONTROL STRUCTURES*

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The Aller River	1
The Leine River	7

*Abstracted and Translated from "Stromgebiet der Weser und Ems, Einwirklung auf der Wasserfuehrung" (River Basins of the Weser and Ems, Influence of Flow). Military Geography ("Mil-Geo") Training Manual H. Dv. g. 33a, General Staff of German Army, Section 9, Berlin 1937.

THE ALLER RIVER

1. Description of the Watercourse.

a. Above Celle with its Tributaries

(Ocker, Fuhse, Ise, etc.)

Discharge at	Mean Low Water m 3/s	Middle Water m 3/s	High Navigable Water m 3/s
Langlingen	6.1	15	60
Bannetze	15	32	100
Hademstorf (uncontrolled)	36	108	250
Verden	43	110	300

The velocity at MNW is up to 0.95 m/s
MW " " " 1.1 "
HschW " " 1.35 "

The Aller is not navigable above Celle. Aside from high water and two pools of 150 and 170 hectares at Grifhorn and Mueden, and without the erection of new installations, the military obstacle is hardly of importance.

Ice seldom forms.

The river bed is mostly sandy.

Fording is possible in straight reaches.

Between Bockelskamp and Celle the river spreads out; therefore, it is shallow: the remainder is irregular; concave banks are mostly steep (up to 4 m high), convex banks are mostly flat.

Between Wolfsburg and Gifhorn in the Aller Depression, the bottom is unstable and is passable for horses and motor vehicles only in the valley floor; below Gifhorn, it is mostly sandy and also passable.

Larger side canals	Length m	Width m	Depth m
1. Aller Diversion Canal, between Weyhausen and Brenneckenbrueck	19	20	1-3
2. Wienhaeusen Mill Canal, below Langlingen up to Wienhaeusen	9.4	15	1.2-1.5

b. From Celle to the Mouth at the Weser.

From Celle (River km 0.0), it is navigable. Above the Leine mouth it is canalized, below it is built for 350-ton vessels, at MW up to 600 ton.

Between Verden (River km 113.0) and the mouth, a strong increase in stream velocity may appear, when the low stage of the Weser meets the high flow of the Aller, which is often the case.

In the reverse condition (high Weser stage with small flow in the Aller), a backwash of the Weser is observed up to Verden.

Large overdepths (up to 5m) exist on the convex banks.

The width up to Celle is 5-60m, from Celle to the mouth 22-70 m.

Above Celle it is fordable nowhere.

The subgrade consists of fine sand and is therefore unstable.

The banks are sandy all the way through the foreland (Heide); steep and rocky slopes are seldom if ever found.

Valley flats are uneven across the course.

II. Peacetime Regulation and Utilization of the Flow.

a. Above Celle with the Tributaries.

(Oker, Fuhse, Ise, etc.)

The following are control structures on the Aller:

1. Above Celle

	Unit map no.	Object no.	Description	River km.
a.	62	137	Lock with a walk, above Gifhorn for power production for operating a mill	28.6
b.	62	138	Lock with a bridge, at Dieckhorst above mouth of Ise (Purpose same as 1a)	0.6

	Unit map no.	Object no.		River km.
c.	62	10b	Lock with a bridge, at Lenglingen, for power production for Weinhaousen flour and saw mills and irrigation	48.4
d.			Lock at Opperhausen, serves for irrigation of Osterbruch meadows, east of Altencelle	
e.			Domain-Fiscal Dam in Celle, for power production for the Domain-Fiscal Mill and for the city and for the paper factory at Drewsen, also it feeds the Magnus City and Castle ditch for hygienic purposes.	

All the control structures are hand operated and are without significance for the flow in the navigable reach.

2. Below Celle

The following are the most important control structures:

	Unit map no.	Object no.	Description	River km.
a.	61	56b	Dam, Oldau	14.8
b.	61	59b	" Bannetze	26.8
c.	61	62b	" Marklendorf	38.2
d.	61	65b	" Hadenstorf	49.7

Besides that stored by these control structures, there is no other water stored in the Aller watershed.

The dams serve to improve the navigation of the Aller up to Celle harbor; also the Oldau and Marklendorf Dams generate electric power.

III. Warfare Changes in the Flow.

a. Above Celle with the Tributaries.

(Oker, Fuhse, Ise, etc.)

With the help of temporary installations, the maximum winter water stage of the locks at Gifhorn and Dickhorst can be increased about 20 cm. forming flooded areas totaling from 320 to 400 hectares. If a temporary dam were erected below Brenneckenbrueck (about River km. 32 near the bridge at Map No. 62, Object No. 8), together with the dams at Gifhorn and Diokhorst, the artificial inundation of a 20 km-reach of the Aller Valley to a width of about 400 m would result, but only when the flow is sufficient, which at low stages is doubtful.

By suddenly releasing this storage a damaging wave of short duration would be generated below Mueden (River km about 49.5), which could be repeated every 2-3 days at Middle Water.

When at High Water the Aller water level lies above the surrounding land, lying so that a penetration of the left Aller dikes between Flottmar and the Celle-Gifhorn railroad dam will produce an artificial flooding of the area between Flettmar up to Kleine Eicklingen bringing about the partial discharge of High Water to the Fuhse Lowlands. This would, however, besides endangering the villages of Flettmar, Hohnebostel, Fornhavekost, Paulmannshavekost, and Sandlingen, cause great cultural damage, particularly to farmland. If the dams are wrecked or made inoperative from enemy action, the operation of flour mills and irrigation would be stopped. With longer duration, the damages of drouth should be considered, especially in the higher areas.

The tributaries of the Aller above Celle, such as Oker, Fuhse, etc., are not navigable. With the smaller dams, it is not possible to inundate large areas.

The Oberharzer Ponds (Teiche), west of Altenau, would produce a floodwave of a few hours duration if the dams were cut; however, this would have little effect, except to put the war factory "tanne" out of order.

b. <u>From Celle up to the Junction with the Weser</u>.

The normal damming can be raised by closing the weirs and making the turbines inoperative so the lowland areas along both banks will be inundated. The opening of the High Water intakes, and if necessary, by cutting the low-bank dikes above the Bannetze and Marklendorf Dams will increase the flooded area.

Both the Bannetze and Hadenstorf Dams can be raised about 40 cm, the Marklendorf Dam about 20 cm, above the peacetime level, without any special superstructure. Furthermore, all four dams can be raised about 20 cm higher by means of a superstructure. The tops of the dams are not prepared and must be specially constructed. A break in the dam producing a higher stage is not to be feared, because the foundation is strong enough.

A further inundation of the lowland, independent from the damming of the river, can be produced by damming the numerous drain ditches on both sides (obstructing the intakes to the existing conduits).

It is not possible to create an effective flood wave.

The emptying of the pools of the four dams below Celle, would cause the halting of navigation and power generation, therewith hindering the transportation of oil necessary to the war effort.

Aller River Basin (Sequence Downstream)

DESCRIPTION OF CONTROL STRUCTURES

Location River km	Sheet No.* Obj. No.	Control Structure (Name & Purpose)	Pool Data a. Backwater Extent d. Headwater Elev. b. Pool Width e. Tailwater Elev. c. Pool Depth	Lock & Dam Data a. Lock b. Dam c. Bridgeway	Operation Effects a. Full Closure b. Full Opening c. Associated Results	Remarks
1	2	3	4	5	6	7
E of Gifhorn 28.6 km (according to the "Wasserbuch")	62 137	Aller Lock Power Irrigation of Aller lowlands	a. 3 km b. 1200 m (In winter, east of Gifhorn on Aller and Ise Rivers 300 m (In winter, south of Neuhaus on Aller River. c. Maximum depth: East of Gifhorn: (In winter) 2.25 m (channel), 0.60 m (flood plain). South of Neuhaus: (In winter) 1.90 m (channel), 0.30 m (flood plain) d. 51.30 m/NN (Summer) 52.18 m/NN (Winter) e. 49.60 m/NN	b. Pile clusters. 6 movable wooden gates. Length 14.0 m. c. Roadway 2.5 m.	a. Upstream: Simultaneous operation of this lock Sandmuehlen Lock and the Cardenaps Mill and Lock would produce the winter stage of 52.18 m/NN and flood 170 hectares of the Aller and Ise lowlands 0.6 m deep. Downstream: At Brenneckenbrueck (at mouth of Aller Canal) the river bed would be dry in a short time. b. Upstream: Would return to natural flow. Downstream Rapid opening would flood the Aller River Valley from Minden to Diekhorst. After the wave recedes, the stage would be lowered to base flow. c. Damage to agriculture from long periods of closure (except during winter-15 Oct.-1 March, also by repeated overflowing of the land.	6c. By flooding, other than during the winter, the mills at Gifhorn would be shut down until the flow recedes to normal winter stages.
In Gifhorn 0.6 km above the mouth of the Ise River	62 138	Cardenaps Mill and Lock (Cardenapsmuehlenschleuse) Power Irrigation	a. 2.5 km b.-c. Widths and depths, same as above d. 51.45 m/NN (summer) 52.18 m/NN (winter) e. 49.60 m/NN	b. Masonry side walls, the rest, wood. 8 gates. Length 5 m.	a.-c. Same as above.	

* General map reference

Aller River Basin (Sequence Downstream)

DESCRIPTION OF CONTROL STRUCTURES

Location River km	Sheet No.* Obj. No.	Control Structure (Name & Purpose)	Pool Data: a. Backwater Extent b. Pool Width c. Pool Depth d. Headwater Elev. e. Tailwater Elev.	Lock & Dam Data: a. Lock b. Dam c. Bridgeway	Operation Effects: a. Full Closure b. Full Opening c. Associated Results	Remarks
1	2	3	4	5	6	7
At Langlingen 40.4 km (according to the "Wasserbuch")	62 10a	Aller Lock (Allerschleuse) Power for Diekhorst Mill Irrigation of Aller lowlands	a. 3 km b. 300-500 m (Diekhorst to Ettenbuettel) c. 2.25 m d. 47.90 m/NN e. 45.00 m/NN	b. Dam and wing-walls of masonry, 7 wooden gates with iron lifting devices. Length 3.- m. c. Roadway 3 m. Walkway 0.85 m/0.7 m	a. Upstream: At winter stage (47.90 m/NN) of the Aller and Muehlen Locks, would flood 150 hectares of Aller lowland. Downstream: For a short time the groundwater level would be lowered until the appearance of seepage from the Oker River, the mouth of which is about 700 m above the mill. b. Upstream: Same as for Aller Lock at Gifhorn. Downstream: Rapid emptying through Aller and Muehlen Locks would flood the Aller Valley from Diekhorst to Wiemhof and below Langlingen to Wienhausen. c. Agricultural damage-same as Aller Lock at Gifhorn. Flooding below Langlingen to Wienhausen could be prevented by timely opening of Aller Locks below Langlingen and at Oppershausen.	
East of Oldau 14.8 km	61 56b	Oldau Dam (Staustufe) Power Navigation	a. 14.5 km b. 17 m (km 1.0) 31 m (km 7.0) 49 m (km 14.2) c. 1.5 m (max. at km 1.0) 2 m (max. at km 7.0) 3.8 m (max. at km 14.2) d. 32.80 m/NN e. 30.01 m/NN (MNW)	a. Concrete with vitrified facing. Iron miter gate. Chamber, length 165 m, width 14.9. Gate 10 m. b. Concrete with vitrified facing. Iron weir structure. Vertical lift gate with 4 double wickets. Length 30 m. c. Walkway 1 m over both. Powerhouse: 3 turbines Total peak capacity 4[illegible] kw Total daily capacity [illegible] kwh	a. Upstream: Increase in the stage. Downstream: Temporary lowering of stage. b. Upstream: Reduction in the water level. c. Inundation of river lowlands. Vessels in Celle Harbor and Oldau shelter harbor would be grounded.	Destruction: Blocking of the operating machinery for the weir gates and lock gates, or by blasting the large gate-lifts and a pair of lock gates.

* General map reference

Aller River Basin (Sequence Downstream)

DESCRIPTION OF CONTROL STRUCTURES

Location River km	Sheet No.* Obj. No.	Control Structure (Name & Purpose)	Pool Data: a. Backwater Extent b. Pool Width c. Pool Depth d. Headwater Elev. e. Tailwater Elev.	Lock & Dam Data: a. Lock b. Dam c. Bridgeway	Operation Effects: a. Full Closure b. Full Opening c. Associated Results	Remarks
1	2	3	4	5	6	7
E of Bannetze 26.8 km	61 / 59b	Bannetze Dam (Staustufe) Navigation	a. 12 km b. 22 m (km 16) 41 m (km 23) 49 m (km 26) c. 1.5 m (max. at km 16) 2.9 m (max. at km 23) 3 m (max. at km 26) d. 29.57 m/NN e. 27.53 m/NN (MNW)	a. Concrete with vitrified facing. Iron miter gate. Same as at "Oldau Lock," river km 14.8. b. Same as at "Oldau Dam." Length 37.5 m. c. Walkway 1 m on both	a.-c. Same as "Oldau Dam."	Destruction: Same as "Oldau Dam."
NW of Marklendorf 38.2 km	61 / 62b	Marklendorf Dam (Staustufe) Power Navigation	a. 11.4 km b. 33 m (km 28.0) 49 m (km 33.5) 61 m (km 37.6) c. 1.5 m (max. at km 28.0) 2.4 m (max. at km 33.5) 3.6 m (max. at km 37.6) d. 27.2 m/NN e. 24.40 m/NN (MNW)	a. Concrete lock. Iron miter gate. Chamber, length 165 m, width 14.9 m, gate 10 m b. Concrete dam with vitrified facing. Iron weir structure. 1 lift gate and 7 double wickets.	a.-c. Same as "Oldau Dam."	Destruction: Same as "Oldau Dam."
W of Hademstorf 49.7 km	61 / 65b	Hademstorf Dam (Staustufe) Navigation	a. 11.5 km b. 33 m (km 40) 40 m (km 45) 49 m (km 49) c. 1.5 m (max. at km 40) 2 m (max. at km 45) 2.8 m (max. at km 49) d. 24.0 m/NN e. 21.56 m/NN at MNW	a. Lock same as "Marklendorf Lock" b. Concrete dam with vitrified facing. 2 double-lift wickets. Frame weir with 6 frames with 300 drop-boards.	a.-c. Same as "Oldau Dam."	Destruction: Same as "Oldau Dam."

* General map reference

THE LEINE RIVER

I. Description of the Watercourse.

Above Hannover, the Leine has 19 water-control structures which are utilized for the operation of flour mills and other industrial installations.

The Leine River below Hannover.

The current velocity varies from about 0.5 m/s at Low Water to 1.5 m/s or more at High Water.

Ice Drifts: Small ice drifts generally form above Herrenhaeusen Dam (River-km. 22.8) halting navigation.

Backwash does not exist.

Navigation is possible only at Middle Water and above (up to 150 tons at high stages) to High navigable water, except the reach of the Ihme River Branch above Herrenhausen Dam to the Hannover gas plant. This reach is accessible from the Mittelland Canal through the Leine Descending Lock (Mittelland Canal, Linden Branch Canal, Canal-km. 0.6) and is navigable for 600-ton vessels. The lower canal of the lowest Aller Lock empties into the Leine River 1.5 km. above the mouth.

The river bed is sandy with bed-load movement.

The width at water level from the mouth of the Ihme River (river-km. 16.7) to the mouth of the Leine at the Aller (river-km. 112.1) averages 25-35 m.; the bottom depth averaging from 1.4-1.9 m. at Middle Water, except at Herrenhausen Dam, where the depth is 2.5 m. at Middle Water.

The Leine River can be forded at low water stages in almost all straight reaches, except in pools formed by dams.

River cross sections are very irregular. In the concave banks of curves, they are very deep (up to 5 m).

The river banks have numerous breaks, particularly in the upper reaches where they are proportionally high.

Swampy banks, steep and rocky banks, dikes, and built-up reaches do not exist.

Old river channels, drain ditches, and side canals, likewise, do not exist.

On the Innerste River below the Harz, 18 water-control structures are located for industrial purposes, without military significance.

The Soese Dam (Unit map 85, Object 255) north of Osterode in Harz, serves for power production and drinking water for Bremen, Hildesheim and 50 other communities, and for flood control.

An opening of the sluice outlets will produce a flood wave (up to 2 m/s) which would not even entirely eliminate the fording possibilities.

By destruction and not servicing the sluice gates, high-water protection can not be maintained, so that High Water, which, like flow from the filled or destroyed dam, can destroy roads and bridges in the lower reach.

The Oder Dam (Unit map 86, Object 152) north of Bad Lauterberg, Harz, serves for power production and flood control.

An opening of the sluice outlets will produce a flood wave (1-2 m/s) which would eliminate fording possibilities and a single emptying, produced by the breaching of the dam, would cause the destruction of the village of Bad Lauterberg and the roads and bridges until the crest of the wave (length unknown) is over. Flood-control protection at Soese Dam is the same.

II. Peacetime Regulation and Utilization of the Flow.

The important dams are:

Unit Map Number		Object Number	Dam	River km.
(1)	61	250	Herrenhaeusen Sluice Dam	22.8
(2)	61	249	Fixed dam near Neustadt for flour mills and electric power. Without regulation	65.4
(3)	61	270	Dam on the "Schnellen Graben" in Hannover	20.3
(4)	61	271	Dam on the Aue at Blumenau for the electric power works Neustadt, Rberge	

Interlocking of dams 1 and 4 is not possible.

III. Warfare Changes in the Flow.

Except from the river itself, damming can not produce a serious obstacle, because the over-damming and swamping of extended reaches is not possible.

A flood wave of long duration and intensity can not be produced.

A certain river-discharge increase can be attained only below Northeim which is below the mouth of the Rhume, from the Soese and Oder Dams. The effect of such additional water is not permanent enough to change the above conditions.

By the destruction of Herrenhaeusen Dam, the water connection of the City of Hannover and other, large industrial plants would be eliminated so that special examination should be made of the federal, state, and local war industries affected.

RESTRICTED
SECURITY INFORMATION

Leine River Basin (Sequence Downstream)

DESCRIPTION OF CONTROL STRUCTURES

Location River km	Sheet No.* Obj. No.	Control Structure (Name & Purpose)	Pool Data: a. Backwater Extent b. Pool Width c. Pool Depth d. Headwater Elev. e. Tailwater Elev.	Lock & Dam Data: a. Lock b. Dam c. Bridgeway	Operation Effects: a. Full Closure b. Full Opening c. Associated Results	Remarks
1	2	3	4	5	6	7
N of Bad Lauterberg	86 / 152	Oder Dam (Odertalsperre) Flood control Power Flow regulation	1/2 full: (15.31 mil. m³) a. 3.3 km c. 37.7 m (at dam) d. 364.65 m/NN Full: (30.62 mil. m³) a. 4.5 km c. 51.15 m (at dam) d. 381.10 m/NN (Downstream equalizing reservoir, 900,000 m³)	b. Earth dam of river-gravel. Crest 383.00 m/NN. Foot 329.95 m/NN. c. Roadway 4.5 m, made to carry heavy traffic. Walkway, 1.95 plus 1.45 m.	Discharge: At 1/2 full 37.5 m³/s, completely full-42.7 m³/s. By opening the bottom outlets and starting the turbines, the discharge at full pool can be raised to 50 m³/s for 8-10 days. (Endangering bridges) Simultaneous opening of bottom outlets and turbines-discharge 200 m³/s for 2 hrs. This flow would destroy Bad Lauterberg and roads and bridges.	Power: 1 turbine, 6,000 kw. Total daily output, 36,000 kwh in 6 hrs. Power generation is greatly reduced when the pool is below 1/2 full. Refilling time: 6 months
N of Osterode, in Harz	85 / 255	Soese Dam (Soesetalsperre) flood control Drinking water Power Flow regulation	1/2 full: (12.72 mil. m³) a. 2.7 km c. 34.85 m (at dam) d. 313.95 m/NN Full: (25.45 mil. m³) a. 3 km c. 47.4 m d. 326.50 m/NN	b. Earth dam of river-gravel. Crest 326.50 m/NN. Foot 279.10 m/NN. c. Roadway 6.4 m Walkway 1.7 m	Discharge: At 1/2 full 31 m³/s, completely full-36 m³s. Refilling time: 9 months	Power: Power generation is greatly reduced when pool is below 1/2 full. Drinking water: Water supply is inadequate when pool is below 1/3 full.
In the City of Hannover 20.3 km	61 / 270	"Am Schnellen Graben" Weir				
S section of Hannover-Herrenhausen 22.8 km	61 / 256	Herrenhausen Dam (Herrenhauser Wehr) Navigation Power	a. 2.5 km b. 36 m c. 2.5 m d. 48.20 m/NN e. 45.20 m/NN	a. Solid masonry lock. Chamber, length 37 m, width 6.3 m. Gate 5.1 m. Roadway 3.5 m. b. North part-wood. South part-concrete. Length 55 plus 30 m. 2 undershot water-wheels. Roadway 3 m.	a. Upstream: Only at HW would the flow be affected. Downstream: No significant effect. b. Upstream: Leine river-bed would become dry. Downstream: Wave 2-3 m high created. Bottom land flooded and banks damaged. c. Flood damage in Hannover. Navigation shut down.	Destruction of dam would stop navigation between Hannover and the Mittelland Canal Cross-over of the Leine and Ihme Rivers.

* General map reference

RESTRICTED
SECURITY INFORMATION

Leine River Basin (Sequence Downstream)

DESCRIPTION OF CONTROL STRUCTURES

Location River km	Sheet No.* Obj. No.	Control Structure (Name & Purpose)	Pool Data: a. Backwater Extent b. Pool Width c. Pool Depth d. Headwater Elev. e. Tailwater Elev.	Lock & Dam Data: a. Lock b. Dam c. Bridgeway	Operation Effects: a. Full Closure b. Full Opening c. Associated Results	Remarks
1	2	3	4	5	6	7
In the village of Blumenau on the Aue R. (a tributary of the Leine R.)	61 271	Dam on the Aue Power (for Neustadt a Rbge electric works)				
In the city area of Neustadt a Rbge. 65.4 km (dam) 66.0 km (lock)	61 249	Neustadt Dam Flour mill operation Navigation	a. 7.5 km b. 60 m (km 65.3) 30 m (km 66.0) c. 3.2 m (km 65.3) 0.8 m (km 66.0) d. 35.66 m/NN e. 34.12 m/NN	a. Stone lock. Chamber length 44.7 m, width and gate 5.25 m. b. Overflow weir, Faschine and stone. Length 60 m		Destruction of dam would stop flour mill operation.

* General map reference