TRAFFIC AND CAPACITY NEEDS
FOR
POTOMAC RIVER CROSSINGS

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PART I
OF
REPORT ON
TRAFFIC VOLUMES AND CAPACITY REQUIREMENTS
FOR
POTOMAC RIVER BRIDGES AND THE INNER TRAFFIC LOOP

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Chapter 1

INTRODUCTION

The Potomac River traverses the Washington Metropolitan area in a meandering course. Below the Great and Little Falls it becomes a broad waterway affected by tidal waters. Washington is located at the head of tidewater navigation; above the city the Potomac is a mere stream, below it rapidly transforms into an arm of Chesapeake Bay.

While not dominant economic assets in the city's development, the Potomac and Anacostia Rivers have greatly influenced the patterns of development, and planning of the metropolitan area. Because of Washington's role as a "capital city", the banks of the Potomac have been devoted principally to park and recreational rather than commercial purposes.

The river has never been a formidable barrier to the development of Greater Washington. Bridges have spanned the Potomac since the earlier periods of development and have largely overcome the barrier affects of the river. Figure 1 shows how the present and proposed Potomac River Crossings relate to the land development and highway patterns in the Washington area.

Increased federal employment and extended use of the automobile have been instrumental in the expansion and decentralization of Washington in the last quarter century. Strong interplay has occurred between the population and settlement changes in the metropolitan area, the available Potomac River Crossings, and trans-river trips. Decentralization has accentuated the need for effective interchange of movements across the Potomac.

POPULATION FACTORS

The Washington metropolitan area encompasses the District of Columbia, portions of Prince Georges and Montgomery Counties in Maryland, Arlington and Fairfax Counties in Virginia, and several incorporated communities.

Metropolitan Washington is growing -- in the decade between 1940 and 1950 its population increased over 50 per cent, growing to 1,464,292 persons. Since 1940, a significant portion of the land in the metropolitan area has been urbanized. Population trends are shown in Table I.

The expansion of Washington into adjoining areas has diminished the dominance of the central city. In 1940 the central city contained 69 per cent of the total population; by 1950 this value reduced to 55 per cent. Between 1940 and 1950 populations increased over 200 per cent in Fairfax and Arlington Counties, Virginia, and Prince Georges County, Maryland. Population in Montgomery County increased 96 per cent; in Alexandria, the oldest community in Virginia, population grew 84 per cent.

The automobile has developed Arlington into a dormitory community of Washington. It has doubled its population more than four times since 1900. Its 1953 population is estimated at 155,500, giving it a population density exceeding 7,000 persons per square mile.

Over half of the population increase in the Virginia area from 1950 to 1953 took place in Fairfax County. Growth can be expected to continue in this area because of the availability of attractive vacant lands to absorb the centrifugal growth of the metropolitan area

TABLE I

POPULATION TRENDS IN WASHINGTON METROPOLITAN AREA

Census Area	1900	1910	1920	1930	1940	1950	1953	Estimated 1970
Virginia								
Alexandria	14,528	15,329	18,060	24,150	33,520	61,790	75,000	103,000
Arlington County	6,430	10,321	16,040	26,615	57,040	135,450	156,000	165,000
Fairfax County	18,580	20,536	29,943	25,264	40,929	98,557	121,000	293,000
Falls Church	(Included in Fairfax County Until 1948)					7,535	8,200	9,000
TOTAL	39,538	46,186	56,043	76,029	131,489	303,532	367,200	570,000
District of Columbia	278,720	331,070	437,570	486,870	663,090	802,180	819,500	710,000
Maryland								
Montgomery County	30,451	32,089	34,921	49,200	83,910	164,400	212,600	304,000
Prince Georges County	29,898	36,147	43,347	60,100	84,490	194,180	278,700	416,000
TOTAL	60,349	68,236	78,268	109,300	168,400	358,580	491,300	720,000
Total, Washington Metropolitan Area	378,607	445,492	571,881	672,199	962,979	1,464,292	1,678,000	2,000,000
Central City as Percent of Metropolitan Area	73.5	74.4	76.5	72.5	68.8	54.7	48.8	35.5

Future Trends. Based on available population data, there were 1,678,000 persons living in the metropolitan area in the spring of 1953, an increase of about 15 per cent over 1950. It is anticipated that by 1970 there will be at least 2,000,000 persons in Metropolitan Washington; see Figure 2. A slight reduction in the number of persons residing within the District of Columbia can be expected by that year. This loss will be due in part to the greater attraction of suburbs. However, it can be largely attributed to the need for additional school and playground sites, dispersal of Federal employment centers, and construction of a major highway net which will require much land for right-of-ways.

Present and anticipated future population distributions are shown in Figure 3 for the various origin-destination areas in surrounding district. The large increases in the peripheral suburban areas are readily apparent.

LAND USE TRENDS

Washington is the seat of our Federal Government. The governmental character of the National Capital Region[1] is reflected in the relatively large amount of land in public use, the major portion of which is federally owned. Other occupied land is largely devoted to residential and public use. There is only a scattering of heavy industrial development, found principally along the waterfront and along railroad lines.

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[1] Regional Aspects of the Comprehensive Plan. A portion of the Comprehensive Plan for the National Capital and Its Environs. National Capital Park and Planning Commission. Mimeograph No. 6, June, 1950.

Areas of most intense development include the District of Columbia (only about 5 per cent is vacant), older parts of Alexandria, most of Arlington County, Falls Church, and Vienna, in Virginia; a small sector of Prince Georges County along Baltimore Boulevard (U. S. Route 1), and the southernmost extremity of Montgomery County, Maryland. Accordingly, future residential expansion must mainly occur in the three larger counties -- Fairfax, Prince Georges, and Montgomery -- beyond present urban limits.

The central business district of Washington is centrally positioned within the National Capital Region. Including most governmental and private offices and the principle retail shopping areas, it is the major attractor of persons from throughout the metropolitan area. Residential development in the District is relatively dense, particularly in the old city. A sizable amount of the high density residential districts are within walking distance of employment centers. Low density residential areas are found in the outskirts of the city. Areas of public and semi-public ownership generally relate well to the land use and land form patterns outlined in plans for the District.

Through zoning, a relatively efficient utilization of land within the metropolitan region has been achieved. Zoning has been instrumental in maintaining the character of many residential areas. The advantages of zoning are likely extended to adjoining residential communities in the metropolitan area.

Decentralization of population has been accompanied by a corresponding shift in retail shopping and service facilities which appears to be the most evident change in the existing regional land use pattern. Encouraged by the freedom of the automobile, such changes can be expected to continue.

Within the District of Columbia, much attention is being given to the elimination of blighted areas, and non-conforming land uses. The Southwest Redevelopment Area and similar projects may be effected in future years. These, and other new developments, will provide positive density control.

In Virginia, future increase in residential use is expected to take place in the Bailey's Crossroad district, at Annandale, and in the vicinity of Falls Church. In Alexandria, recent annexations have greatly increased the amount of land available for new development. Present trends indicate that most of the vacant property will be used for high density housing.

TRAFFIC CONSIDERATIONS

Key trafficways converge on Washington. The concentration of traffic volumes in the central business district are graphically depicted in Figure 4; the Potomac River Crossings constitute the main corridors for travel between the District and southern and western destinations, as well as for commuters between the central city and the Metropolitan Area in Virginia.

Transportation in the Metropolitan area is oriented strongly towards the use of private passenger vehicles; virtually all the recent suburban growth as been predicated on the automobile. Automobile registrations have increased rapidly in the region as shown in Figure 5.

Growths in trans-river corssings have far outpaced the increases in population and vehicle registration. Since 1940 the total river crossings have more than doubled! This is readily evident from Table II which summarizes bridge crossings in recent years. In 1924, approximately 12,000 vehicles per day crossed the Potomac River on the Highway Bridge; today over 100,000 vehicles utilize the bridge daily. This corresponds to an increase of over 700 per cent.

TABLE II

TRAFFIC GROWTHS
POTOMAC RIVER BRIDGES

Year	Chain Bridge	Key Bridge	Memorial Bridge	Highway Bridge
1940	4,638	30,189	32,288	38,512
1941	4,819	32,639	39,885	43,989
1942	4,447	29,062	37,673	38,024
1943	3,251	21,241	27,348	36,028
1944	3,356	21,928	28,166	36,889
1945	3,653	23,871	33,091	42,535
1946	5,534	30,603	40,288	52,806
1947	5,670	31,356	42,760	55,054
1948	6,996	32,930	46,723	60,000
1949	8,164	35,971	51,437	66,051
1950	8,939	43,946	52,211	77,094
1951	10,757	45,537	51,278	92,087
1952	11,641	46,122	52,854	97,664
1953	13,111	46,052	53,295	100,428
1954*	15,000	47,000	55,000	107,000

*Typical Days

It is interesting to note, too, that traffic crossing the Potomac River has been increasing twice as rapidly as movements across the central business district cordon. Typical comparative growths are shown in Table III.

TABLE III

COMPARATIVE GROWTHS

	Central Business District Cordon		Potomac River	
	Vehicles	Index 1953= 1.00	Vehicles	Index 1953 = 1.00
1947	635,195	0.84	135,000	0.64
1953	752,141	1.00	211,000	1.00
1970 (Ant. Normal Growth)	940,000	1.25	313,000*	1.48

*Source - Highway Transportation in the Washington Metropolitan Area of Virginia.

PREVIOUS STUDIES

The need for additional traffic capacity across the Potomac River has been recognized for some time. Earlier studies, such as the Origin-Destination Survey of Central Crossings, August 1948, developed by the District Department of Highways in cooperation with the Public Roads Administration, gave primary consideration to improving the old Highway (14th Street) Bridge. These studies became crystallized in the 1945 Congressional Hearings[2], and resulted in the construction of an additional structure at this location.

The Metropolitan Area Origin Destination Survey of 1948 has provided a factual basis for analyzing and evaluating the highway needs

[2]Hearings before the Bridge Subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Seventy-Ninth Congress, First Session in H.R. 541, 1945.

of the Metropolitan Area.[3] The survey was undertaken as a cooperative project of the Board of Commissioners for the District of Columbia, the State of Maryland and the Commonwealth of Virginia acting through the Advisory Committee of the Washington Metropolitan Area. It developed basic information about the magnitude and distribution of travel desires.

In 1952, the Advisory Committee of the Washington Metropolitan Area Transportation Study submitted a detailed program of Highway improvements for the area.[4] Recommendations were based on the detailed traffic studies, and on cost estimates.

The 1948 origin-destination data have been utilized in recent analyses of Potomac River Crossings. In June 1952, A Report on Future Bridge Crossings of the Potomac River, Washington, D. C. by Harland Bartholomew and Associates was prepared for the National Capitol Park and Planning Commission, emphasizing planning aspects relevant to new river crossings. The report recommended the construction of an Inner Ring Route, and further study of Intermediate, and Outer Ring Routes, including the Alexandria and Nebraska Avenue Bridges and the Southwest Freeway. The report further recommended against construction of an "E" Street Bridge because of terminal difficulties at the District end.

A Report on Potomac River Bridges, Washington D. C., submitted to the Board of Commissioners, District of Columbia by Modjeski and Masters with Lloyd B. Reid, Traffic Consultant, July 1952, recommended the

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[3] See Washington Metropolitan Area Transportation Study, Volumes 1-4, Regional Highway Planning Committee, 1952.

[4] A Recommended Highway Improvement Program for the Washington Metropolitan Area, Regional Highway Planning Committee, 1952.

construction of a central river crossing at "E" Street followed promptly with the construction of an Alexandria crossing and later with the Nebraska Avenue Bridge or "such other crossings as may be further upstream".

Both the National Capital Planning Commission and the District of Columbia Highway Department have conducted further studies of river crossing needs.

In August 1954, the President of the United States signed H.R.1980, a bill authorizing the construction of two bridges over the Potomac River, one from a point at or near Jones Point, Virginia, and the other from the vicinity of Constitution Avenue in the District of Columbia to the Virginia side. The President suggested that the Secretary of Interior be authorized to approve all plans for the Constitution Avenue Bridge and for its approach roads at both ends. In November 1954, the Fine Arts Commission opposed the construction of the Constitution Avenue Bridge on the basis that it would detract from the beautiful setting of the Lincoln Memorial. A tunnel was recommended by that body.

PURPOSE AND SCOPE

This report on traffic and capacity requirements for Potomac River Crossing is a part of a more comprehensive report authorized in June 1954 by the National Capitol Planning Commission. It reviews factors affecting present traffic operations on the Potomac River crossings, and determines future requirements based on anticipated traffic and land use patterns.

Specifically, it is the purpose of this part of the overall report to make certain traffic analyses, findings, conclusions, and

recommendations with respect to plans for a Potomac River Bridge in the vicinity of Roaches Run and an upper central area crossing of the Potomac River. The report determines volume characteristics of 24-hour and peak-hour traffic data, relative to the location of existing and proposed free bridges. It indicates the optimum useful and economic traffic capacity which would be desirable to develop over the Roaches Run and Highway Bridges, and over the upper central area Potomac River Bridges. Capacity needs of integrated highway approach systems serving these bridges have also been determined.

Chapter II

BASIC DATA

ORIGIN - DESTINATION STUDIES

A principal source of information used in all studies made in the Washington area since 1950 is the 1948 home-interview origin-destination survey. During the 5-year period immediately following the survey, population in the metropolitan area increased by more than 50%. A careful zone by zone review of population changes and automobile ownership increases was made for 1953 conditions and the patterns of internal travel brought up to date for that year. Factors which entered into up-dating the 1948 survey included trip frequencies, travel distances, and intensity of transit use. Special adjustments were applied to key traffic generators, such as business areas and governmental centers. Zones of origin and destination used in the study are indicated in Figure 6 and include a series of zones beyond the original limits of the metropolitan area.

In order to anticipate 1970 river crossings, the 1953 origin-destination volumes have been projected to 1970 values. This has been accomplished on the basis of detailed estimates of population distribution, vehicle ownership, and considerations of travel time, trip frequency, and competing modes of travel.

SPECIAL STUDIES

Current traffic volume statistics for bridge and arterial highways within the studied area were obtained from the various governmental agencies responsible for traffic control, regulation and planning in

the metropolitan area. In addition special vehicular volume counts were made at key locations.

Studies were also made of the quality of traffic operation on each of the bridges and their approach road systems, with emphasis on morning and evening rush hours when the greatest traffic demands occur. From these studies it was possible to identify and evaluate the restrictive features which curtail operational efficiency. Capacities on bridges and approaches were thus established for use in appraising each of the Potomac River crossings.

Speed and delay runs were conducted during both peak and off-peak traffic conditions, so that the efficiency and fluidity of the principal streets and highways which serve bridge traffic could be determined. These studies serve the dual purpose of identifying those conditions which impede traffic flow and of establishing the relative ease of access to each bridge from any place in the metropolitan area.

Preliminary reconnaissance surveys were made to inspect possible bridge sites along the Potomac River and to determine the feasibility of construction at each. Reconnaissance evaluations included consideration of existing land uses which would be affected by new bridge locations, plus evaluation of terminal street and highway connections at either ends of each structure.

DEVELOPMENT OF PRESENT AND FUTURE TRAVEL DESIRES

Major transriver trip desires for 1953 are graphically depicted in Figure 7. In 1953 approximately 211,000 vehicles crossed the Potomac River daily. The Washington central business district was

found to attract about 30 percent of the total crossing movement. The heavily populated district to the north of downtown Washington generates another 14 percent of the total transriver trips. About three-fourths of all 1953 crossings had origins or destinations within the District of Columbia.

The centroid of all transriver trip desires, based on the origin-destination study was found to be about an eighth of a mile to the south of the Memorial Bridge, in approximate alignment with the central axis of the Mall. It is evident that the greatest pull is to the north of the Mall on the Washington side; hence, it follows that the centroidal trip desire line has a northeast to southwest orientation. This centroid can be expected to shift to the north of its present location as the settlement and trip generating potentials of Fairfax County increase.

The principal through trip movements are between U.S. Route 1 in Maryland and the Shirley Highway, U.S. Routes 29-211, and U.S. Route 50. U.S. Route 240 in Maryland is a secondary generator of through trips. The recent completion of the Baltimore-Washington Parkway will likely modify the through trip distributions.

The trends in total Potomac River crossings are shown in Figure 8. It is expected that by 1970 there will be approximately 313,000 vehicles crossing the Potomac River daily. This value represents a 48 percent increase over the 1953 movement of 211,000 trips.

The types of trips crossing the river in 1970, and 1953 are given in Table IV. It is anticipated that the through trips will be slightly more important part of the overall traffic pattern

in 1970 than they are in 1953.

TABLE IV

PASSENGER CAR AND TRUCK TRIPS
CROSSING THE POTOMAC RIVER*

Type Trip	1953 Number	1953 Per Cent	1970 Number	1970 Per Cent
Virginia Zones	194,000	91.9	284,000	90.7
External to Washington	9,000	4.3	16,000	5.1
Through	8,000	3.8	13,000	4.2
	211,000	100.0	313,000	100.0

INCREASE 1970:1953 = 48 per cent

* Source: Highway Transportation in the Washington Metropolitan Area of Virginia.

Total Potomac River crossings generated by zones of origin or destination in 1970 and in 1953 are compared in Figure 9. The greatest growths in transriver crossings are experienced in Fairfax County, which is expected to develop the greatest population increases.

Principal transriver trip desires for 1970 are depicted in Figure 10. In general, the flow patterns are similar to those experienced in 1953.

Chapter III

COMPREHENSIVE PLANNING PROPOSALS

GENERAL CONSIDERATIONS

The planning of traffic and transportation facilities must be related to the general planning of land use and occupancy. Accordingly, it is essential that origin-destination data and other information which form the basis for most traffic studies be integrated with many other planning considerations in devising a sound and workable traffic plan for the Washington Metropolitan area. Studies for the location and design of new bridges and highways must anticipate the future distribution of populations and their souces of employment. Plans for the regulation of future land use and land occupancy should evolve in conjunction with the realistic extension of transportation facilities to integrate travel and movement of goods in the whole area.

Past developments of comprehensive plans have found certain principles and concepts of transportation planning especially useful and effective. Such concepts are not static. In the field of urban traffic they are presently in a state of change. It is important, therefore, to consider the possible changes in basic concepts which might gain wide-spread acceptance in future years.

Hence, conventional traffic analyses and traffic planning concepts have been augumented with considerations of land use and occupancy which affect recommendations on bridge location and construction priorities.

General aims of the National Capital Planning Commission's comprehensive plan include the creation of satisfying healthful living conditions through the best possible arrangement of uses of land; the encouragement of a stable attractive, central business area; the

restoration of livability to conservation and blighted residential areas; the achievement of orderly development on urban fringe and outlying sections where the land is still vacant; and the efficient movement of persons and goods within the metropolitan area.

It is evident that the National Capital city must represent a symbol of the aspirations and accomplishments of the nations. Hence, an aesthetic central area is an important planning aim. The overall plans have been based on factual information and are reviewed in light of objective values which are subject to change. Any aesthetic considerations must be integrated on a sound basis into the comprehensive plan which is founded on facts.

LAND USES AND GENERATORS IN THE CENTRAL CITY

Much attention in recent years has been given to the correct future development of metropolitan Washington, with especial emphasis placed on the central city area. The future pattern of land use within the central business district, particularly the spatial relationships between structures and open space, is difficult to predict. Only through vigorous official planning is the commercial district likely to develop the unity and stability which would enhance and complement adjacent governmental centers.

The governmental center itself is due for a re-appraisal. The removal from the governmental area of temporary office buildings erected during the war is a primary planning objective. At present more than 40,000 government workers are housed in these buildings. The re-housing of these workers must be made an important consideration in planning and should be integrated with plans for the dispersion of governmental functions. Dispersed development is desirable not only from a security or military standpoint, but also as a means of reducing the concentration, and hence

congestion in the central area. Such plans would impose a practical ceiling on the amount of federal employment in the central area and thus tend to stabilize it, even though there might be some new construction of federal buildings in the area. Figure 11 shows the present distribution of federal employment in central Washington; it should be noted that approximately one-third of all federal employees are currently housed in temporary buildings.

The need for reducing urban vulnerability is becoming apparent in both private and official quarters. The Atomic Energy Commissions' recommendation of a 30 mile radius dispersal distance appears to be receiving increased acceptance as the daily minimum dispersal for all federal Executive Branch agencies.

Trends in non-governmental developments which are taking place at the present time are also of import. Washington is becoming the headquarters for an ever-increasing number of business and professional associations. Private construction of office facilities has provided a great deal of new office space within the past ten years, much of it near the central business district in blocks located between the business center and the more expensive residential areas to the northwest.

The demands for new office space by business and professional organizations is focused on the downtown area. A considerable volume of retail sales is now transacted in outlying shopping centers, some of which offer a wide variety of goods and a range of prices comparable to those in the downtown area. Trade is attracted to outlying centers by their proximity to potential customers and the availability of parking space.

A basic support for the future of the central area, however, is the fact that it is, and will remain, central. It is almost inconceivable

that any suburb will ever be as readily accessible to the central business district from the entire metropolitan area.

LOCATION OF CENTRAL BUSINESS DISTRICT

The focus of the central business district in downtown Washington lies between the White House and the Union Station. The main shopping district with its department stores and specialty shops extends from 7th to 15th streets northwest and from Pennsylvania Avenue to "H" Street. As previously indicated, office buildings and a "quality" retail development are spreading to the northwest; these growths have been stimulated by their proximity to high income residential areas. Some similar new development is also taking place at the eastern perimeter of the area.

The central business district is located in the approximate center of the Washington Metropolitan Area. The governmental buildings adjacent to it are the largest centers of employment in the city; thus the downtown shopping district is well situated to serve a high proportion of the areas' wage earners. The governmental buildings and the White House also attract large numbers of tourists and other visitors, many of whom are drawn to the shopping center. There is every reason to believe that the central business district will continue to increase in importance as the metropolitan area grows even though the retail activity in this district appears to be becoming less stable. The increase in importance of the area will come from increases in activities other than retail trade.

The distribution of Virginia trips in the "Zero Sector" of Washington, which encompasses the central business district are shown graphically in Figure 12 for both 1953 and 1970. District 05 in which

the downtown sector is located is the primary attractor and generate a third of all trips between Virginia commuters and the center of the city. Table V shows the present and distribution of transriver trips in downtown Washington. The 1970 values assume some redevelopment in the southwest areas of the city (including district 03) and the elimination of temporary governmental buildings (district 08). By 1970, it is estimated that district 05 will generate an even higher proportion of all downtown travel than at present.

TABLE V

DISTRIBUTION OF VIRGINIA TRIPS TO ZERO SECTOR
OF
CENTRAL BUSINESS DISTRICT

Sector	Year	
	1953*	1970**
01	5.4	5.9
02	2.7	2.2
03	7.7	10.8
04	2.8	3.1
05	33.0	37.1
06	9.1	10.2
071-075	16.8	18.8
076-079	7.0	7.4
08	10.6	0.2
09	4.9	4.3
	100.0	100.0

*Based on 1948 O-D Survey.

**Assumes elimination of temporary government buildings & effectuation of Southwest Redevelopment Project.

CIRCULATION SYSTEM -- THOROUGHFARE PLANS

The primary thoroughfare systems of major metropolitan areas have traditionally developed in a random piecemeal manner as the communities grew in size. When the communities were small, the primary systems consisted simply of the major streets. As the urban areas expanded, the relative importance of specialized major and minor streets became evident and a larger variety of thoroughfares were developed. Primary thoroughfares in the modern metropolis should consist of a system of express highways designed to limited access standards with separation of intersections and crossings and control of abutting access. They may include parkway features to enhance their attractiveness to the road user. These freeway type facilities should be supplented with adequate secondary roads together forming a comprehensive continuous road net.

A number of plans and programs have been set forth for the development of a major thoroughfare system for metropolitan Washington. Some studies have been quite comprehensive and have attempted to establish an integrated network of roads and bridges which would serve the entire area. The most comprehensive of these studies are those of the National Capital Park and Planning Commission, first published in 1950, and now in process of revision, and the "Recommended Highway Improvement Program" prepared by the Regional Highway Planning Committee in 1952 as an outgrowth of the 1948 origin-destination study. Both have been supplemented in part by studies of highway needs at specific locations.

The Proposed Regional Thoroughfare Plan of the National Capital Planning Commission is shown in Figure 13. Utilizing the existing elements of a comprehensive system, the plan develops an extensive system of radial and circumferential thoroughfares, of which express

highways and parkways are the key elements. Three "ring roads" serve to intercept radial traffic --an inner loop around the central business district of Washington, an intermediate loop, and an outer ring road in Maryland and Virginia. The plan calls for four new bridges across the Potomac River to provide the transriver links in the pattern.

Improvements indicated in the program of the Regional Highway Committee of Washington have been designed to increase the capacity of the street system in downtown Washington and in congested suburban centers, of important radials, and of crosstown and cross-county routes. It also recommends the eventual construction of an outer-circumferential highway about the Washington area and corrective treatments for principal trafficways in the Metropolitan area. Typical routes which are to be improved or extended include Canal Road, Rock Creek Parkway, Lee Highway and the George Washington Memorial Parkway.

The authorized construction of a Constitution Avenue bridge, approved in a recent resolution by the National Capital Planning Commission, is an immediate step in the overall plan for highway facilities and Potomac River crossings. Other components of the overall plan include the widening of Key Bridge, the development of the Inner Loop and Southwest Freeway and the construction of a Roache's Run Bridge. Recently Fairfax County presented its master plan proposing five new radial freeways and an outer circumferential.

It is evident that integration be effected of the various proposals, programs, and plans is necessary in order to complete a well-rounded highway and street system. Continuity of capacity and fluidity are requisite.

The specific needs of this study require that an estimate be made of 1970 traffic demands in the Washington Metropolitan Area. The time required to travel between origin and destination -- from home to work, from work to shopping, etc. -- is a basic element in the generation of travel by either automobile or bus. It is necessary, therefore, to anticipate the degree to which an express highway network will have been completed to serve the metropolitan area by 1970, and to estimate the time required to travel on it from one zone to another.

Existing elements of a comprehensive highway plan are shown in Figure 14. Typical of the expressways are the Baltimore-Washington Parkway, the Washington-Annapolis Expressway, Suitland Parkway, Shirley Highway and the Pentagon network. The Rock Creek and Potomac Parkway, the Mount Vernon Memorial Boulevard and the George Washington Memorial Parkway have partial expressway characteristics. The Kenilworth Avenue improvement and the East Capitol Street Bridge are now under contract. Further sections of the Washington-Annapolis Expressway and the Washington National Pike are now scheduled for early construction.

The several major thoroughfare plans for the Washington area have been carefully studied and the portions of them which appear to be most likely of realization by 1970 are shown in Figure 15. It is this system of expressways which forms the basis for the 1970 estimates of traffic interchange in the Washington area. This system includes the extension of the Washington Memorial Parkway, the Inner and Outer Circumferential and the Fort Drive Link in the Intermediate Circumferential.

POSSIBLE EFFECTS OF PROPOSED FEDERAL HIGHWAY LEGISLATION ON ROUTE PLANNING

The possibilities of legislative action in the immediate future which might modify the scope of anticipated construction programs cannot be overlooked. There are strong indications that Congress is preparing to enact highway legislation which will greatly increase the tempo of highway construction in and around large metropolitan areas, particularly those routes designated as part of the National Interregional Highway System. If the tentative proposals thus far announced were to be enacted, even in part, it is clear that funds for new highway construction would be available in much larger amounts than those the present plans are based on.

If an accelerated program of highway construction takes place in the Washington Metropolitan area and the highways anticipated for 1970 are built before that date, traffic volumes will undoubtedly increase more rapidly than the forecasts made here indicate.

Chapter IV

POTOMAC RIVER BRIDGES

Increased river crossings demands are a reflection of the suburbanization of Virginia, and of the development of traffic generators, such as the Pentagon, on the Virginia side. River crossings have more than doubled in the last 15 years; at present (1954) there are 224,000 transriver trips. By 1970, based on normal growths, it has been shown that total crossings will approach 320,000 daily.

EXISTING BRIDGES

Analysis of traffic characteristics and operations of existing bridges is a prerequisite to the determination of future bridge needs. Accordingly, performance of the four vehicular bridges currently spanning the Potomac River -- Highway Bridge, Memorial Bridge, Key Bridge, and Chain Bridge -- have been studied. General characteristics of these bridges are summarized in Table VI.

HIGHWAY BRIDGE

The Highway Bridge is the principal and most direct connector between Central Washington and Alexandria. The original Highway Bridge, with its 40 foot roadway was erected in 1903. In 1927, when crossings totaled 12,000 daily, the street railway tracks were removed and the bridge resurfaced. The bridge roadway carried two lanes of traffic in each direction prior to 1950 when a companion Highway Bridge with a fifty foot roadway was placed in operation to the south of the original structure. The new bridge provides four lanes of traffic inbound, while the old bridge carries three outbound lanes.

On a typical 1954 weekday the Highway Bridge carried 107,000 vehicles. Hourly traffic variations for the Bridge are indicated in Figure 16.

for typical 1953 and 1954 days. Peak directional volumes were found to approximate 5400 vehicles per hour--inbound during the morning rush period and outbound during the evening rush. Effects of Virginia employment centers (viz. the Pentagon) are evident from the pronounced secondary "counter rush" peak values.

Table VI

PHYSICAL CHARACTERISTICS: POTOMAC RIVER BRIDGES

Bridge	Year Open to Traffic	Pavement Width	Lanes	Type Span
Highway - Old	1903	40	3	Movable
New	1950	50	4	Movable
Memorial	1932	60	6	Movable
Key	1924	50	4	Fixed
Chain	1938	30	2	Fixed

A detailed traffic flow diagram for the Highway Bridge, and its Washington approaches (14th Street and connectors) is presented in Figure 17. for a typical morning rush hour. The dispersion of bridge traffic to Maine Avenue, D Streets, Independence Avenue and 15th Street is readily apparent. Only about 15 per cent of the total inbound bridge traffic crosses Constitution Avenue northbound on 14th Street.

Maximum lane capacity of the Highway Bridge was determined to be about 1800 vehicles per hour. Present peak traffic volumes equal this value. The practical lane capacity for the bridge was found to be 1500 vehicles per hour. In Virginia, the Highway Bridge has limited access connections with the Mount Vernon and Shirley Memorial Highways, U. S. Route 1 and the Pentagon Road net. The capacity of these roads is

sufficient to accommodate all Virginia-bound traffic.

In Washington, except for a devious turnoff to Fifteenth Street, the four inbound lanes must converge to three before reaching the off ramp at Maine Avenue. This restrictive cross section prevents full utilization of the inbound roadway. The effective inbound bridge capacity is reduced to three lanes, and backups of traffic into Virginia frequently results. It should also be noted that Fourteenth Street (three lanes each way) is saturated during periods of maximum bridge traffic. Traffic signals at "C" Street and Independence Avenue impede the steady flow inbound. Insufficient bridge capacity during peak hours often causes traffic backups across the Mall on Fourteenth Street.

MEMORIAL BRIDGE

The Arlington Memorial Bridge was opened to traffic in 1932. It is centered upon an axis connecting the Lincoln Memorial in Washington with the Memorial entrance to Arlington National Cemetery, and the Lee Mansion. The structure is 90 feet wide, and consists of two fifteen foot walks and six ten foot vehicular lanes. Trucks are prohibited on the bridge. The Virginia terminus was modernized in 1941 by construction of a traffic circle at the entrance to the Arlington National Cemetery. The bridge connects major parkways and roadways on the Virginia side with Constitution Avenue, Independence Avenue, 23rd Street, and the extension of Rock Creek and Potomac Parkway on the Washington side of the river.

Fifty-five thousand vehicles use the Memorial Bridge on a typical weekday. Peak directional volumes amount to about 4,400 vehicles per hour, inbound towards Washington in the morning and outbound to Virginia in the evening. Typical hourly traffic variations are shown in Figure 18 and pinpoint the preponderance of peak hour flows. Bridge capacity

values are also indicated.

The traffic flow patterns on Memorial Bridge and its environs are depicted in Figure 19 for a typical peak morning rush hour. The intermingling of bridge and other movements are readily apparent. Over 30 per cent of all inbound bridge traffic travels north on 23rd Street. Bridge traffic on Constitution Avenue at 14th Street is only about 15 per cent of the total inbound crossings.

The Memorial Bridge, in terms of lane densities, is the lightest travelled bridge even though its maximum per lane flows of 1500 vehicles per hour exceed optimum capacity value. Short turning radii on the traffic circles at both ends of the Memorial Bridge, particularly at the Lincoln Memorial, restrict speed and develop critical weaving conflicts.

KEY BRIDGE

The Francis Scott Key Bridge, Georgetown was completed in 1924 replacing an old iron bridge constructed in 1888. The Bridge has a 50 foot roadway, with a double streetcar track in the center. There are two moving lanes of traffic in each direction of travel. The bridge connects with the Whitehurst Freeway and "M" Street on the District side of the Potomac River. In Virginia a traffic circle connects Lee Highway (U.S. 29-211) and local streets to the bridge. The local streets serve as connectors to Wilson Boulevard.

The Key Bridge currently carries 47,000 vehicles. Hourly traffic variations as related to bridge capacities are indicated in Figure 20. Peak directional flows approach 2,700 vehicles per hour.

The traffic flow patterns on the Washington approach of the bridge are graphically depicted in Figure 21 for a typical 1954 morning peak hour. Approximately 80 per cent of all inbound movements are destined

to the east. The greater number of these vehicles utilize the Whitehurst Freeway.

Capacity restrictions on both the Washington and Virginia approaches prevent the Key Bridge from developing a possible lane capacity in excess of about 1,400 vehicles per lane. As shown in Figure 20 this saturation capacity is frequently equalled. Traffic back-ups onto the bridge in the morning hour from the eastern terminum of the Whitehurst Freeway often impede bridge traffic flows. Similarly the signalized operations at "M" Street cannot efficiently accommodate the approaching steady flows. In the evening rush period westbound Freeway traffic backs up across the outbound ramp from the signalized intersection at Canal Road. Similarly, the traffic circle at Virginia and nearby traffic signal operations decrease possible bridge capacities. Some capacity restrictions results from street railway operation on the bridge roadway. They appear to be relatively minor when compared to the bridge approach conditions.

CHAIN BRIDGE

The Chain Bridge, located upstream and farthest removed from central Washington, was first built in 1797. The present bridge has been in operation since 1938 and superceded five earlier structures.

The Chain Bridge has a thirty foot wide roadway; one lane of traffic moves in each direction. In Virginia the bridge connects with Globe Road, Military Road, and Route 123. It connects with Canal Road in the District south of the river. There are 15,000 Potomac River crossings over the bridge on a typical 1954 day.

Hourly traffic variations for the Chain Bridge, and bridge capacities are shown in Figure 22. Flows are relatively minor when compared to the loadings on the other river crossings. Movements during the peak hour exhibit pronounced directional tendencies. Peak hour directional

volume approximate 1500 vehicles.

The sharp curvature on the Washington side of the bridge, and the intersection of Route 123 and Glebe Road on the Virginia side of the Potomac River with its restricted sight distance reduce the possible bridge capacity to about 1,500 vehicles per lane per hour. This value is reached during peak hours.

GENERAL TRAFFIC CHARACTERISTICS OF EXISTING BRIDGES

The existing Potomac River Bridges must also be analyzed as a system of river crossings. The location and general accessibility of each bridge as related to desire lines of travel and the traffic attractiveness or capacity of the bridge, will determine the proportion of transriver trips that will use any given facility.

The distribution of the present transriver crossings are summarized in Table VII. Almost half of the 224,000 daily crossings, and about 40 per cent of the total peak hour directional movement of 14,000 vehicles use the Highway Bridge. There is relatively equal usage throughout the day of the Memorial and Chain Bridges, with a somewhat heavier share of the total peak hour crossings on the Memorial Bridge.

TABLE VII

RELATIVE UTILIZATION
POTOMAC RIVER BRIDGES

1954

Bridge	Daily Traffic Vehicles	% of Total Crossings	Peak Hour Inbound Vehicles	Peak Hour Inbound % of Total	Peak Hour Outbound Vehicles	Peak Hour Outbound % of Total
Highway	107,000	47.8	5,400	38.8	5,350	38.4
Memorial	55,000	24.5	4,230	30.4	4,420	31.7
Key	47,000	21.0	2,660	19.3	2,670	19.2
Chain	15,000	6.7	1,600	11.5	1,490	10.7
TOTAL	224,000	100.0	13,890	100.0	13,930	100.0

The traffic composition of vehicles crossing the Potomac River are summarized in Table VIII.

TABLE VIII

TRAFFIC COMPOSITION
POTOMAC RIVER BRIDGES

Per Cent of Totals

Type Vehicle	Highway Bridge		Memorial Bridge		Key Bridge		Chain Bridge	
	1948	1953	1948	1953	1948	1953	1948	1954
	%		%		%		%	
Passenger Vehicles	84.6	87.8	97.2	97.4	83.7	87.0	90.8	93.2
Single Unit Trucks	9.4	7.8	0.4	0.5	12.1	10.6	8.7	6.3
Combination Trucks	3.2	2.9	0.0	0.0	1.8	0.8	0.3	0.3
Buses	2.8	1.5	2.4	2.1	2.4	1.6	0.2	0.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Equivalent Passenger Vehicles	106	105	100	101	106	104	103	102

Passenger cars comprise over 85 per cent of the total movement across all bridges.

Peak hour directional movements are compared with the total daily river crossings for each of the existing bridges in Table IX. Inbound trips in the morning peak hour and outbound trips in the evening peak hour each constitute over 6 per cent of the total daily crossings. Peak hour traffic ranges from 5 per cent of the total daily movements across the Highway Bridge to 10 per cent of the total daily Chain Bridge traffic.

TABLE IX

PEAK HOUR TRAFFIC CHARACTERISTICS

POTOMAC RIVER BRIDGES

1954

Bridge	Daily Traffic	Peak Hour Inbound Vehicles	% of Daily Total	Vehicles	% of Daily Total
Highway	107,000	5,400	5.0	5,350	5.0
Memorial	55,000	4,230	7.7	4,420	8.0
Key	47,000	2,660	5.6	2,670	5.6
Chain	15,000	1,600	10.6	1,490	9.9
TOTAL	224,000	13,890	6.2	13,930	6.2

Peak hour traffic is slightly more concentrated on the bridges than on the adjacent street net in the District. As shown in Table X evening peak hour traffic leaving the inner cordon area of central Washington represents about 5 per cent of the total daily movements. In evaluating all peak hour traffic flows it must be remembered that 15 and 30 minute peaks within the hour often have greater intensities than the indicated hourly values.

By relating the traffic demands placed on a facility to the available capacity, its adequacy can be determined. Accordingly, capacity values for the existing bridges and their approaches were calculated.* Consideration was given to the number and efficiency of moving lanes, nature and extent

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* The following capacity criteria in accord with the Highway Capacity Manual were employed: maximum, possible, or saturation capacity represents the greatest sustained hourly loading that a facility can accommodate under prevalent conditions of operations. Optimum or practical capacity represents the maximum desired loading.

TABLE X

PEAK HOUR TRAFFIC IN CENTRAL WASHINGTON
AS PERCENT OF TOTAL ADT-1953

	A.M. Rush Hour		P.M. Rush Hour	
	Inbound	Outbound	Inbound	Outbound
South Side Inner Cordon	4.5%	4.8%	4.1%	4.7%
West Side Inner Cordon	5.6	4.3	3.2	6.7
North Side Inner Cordon	4.9	3.4	2.9	5.0
East Side Inner Cordon	4.7	3.7	2.9	5.0
Entire Cordon Area*	5.0%	3.8%	3.2%	5.2%

*Cordon extends south of Constitution, West of 21st, North of L Street, east of Third Street

TABLE XI
PRESENT BRIDGE CAPACITIES

BRIDGE:	HIGHWAY*		MEMORIAL		CHAIN*		KEY*		TOTAL*	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
Possible Capacity* Bridge & Approaches	5,400	5,400	4,800	4,800	1,600	1,500	2,900	2,700	14,700	14,400
Possible Capacity Bridge Only	7,200	5,400	4,800	4,800	1,800	1,800	3,400	3,400	17,200	15,400
Practical Capacity Bridge and Approaches	4,500	4,500	3,900	3,900	1,300	1,300	2,400	2,400	12,100	12,100
Peak Hour Loading 1954	5,400	5,350	4,230	4,420	1,600	1,490	2,660	2,670	13,890	13,930

*Commercial vehicles would reduce these capacities slightly.

of interferences, vehicular headways, and related operational factors which influence capacities.

Present bridge and approach capacities are summarized in Table XI. The minor variances between inbound and outbound capacities result from the critical approach conditions. The combined present possible directional capacity of the four bridges and their approaches approximates 14,500 vehicles per hour. The maximum optimum directional loading is about 12,000 vehicles per hour for the bridges and approaches. Present total peak hour directional loadings approximate 14,000 vehicles.

The potential capacities of the bridges, if restrictive approach conditions were eliminated, are also indicated. The most marked capacity increase is that of the inbound span of the Highway Bridge. Full utilization of all four lanes would increase present capacities about a third.

Trends in inbound peak hour Potomac River Bridge traffic are compared with available capacities in Figure 23. It is significant to note that the practical capacities of all bridge systems have been exceeded in recent years.

Trends in outbound peak hour Potomac River Bridge traffic, as related to capacities are shown in Figure 24. The patterns of growth are similar to those for inbound traffic.

Approximate daily capacities have also been determined from the present (1954) relationships between peak hour directional loadings and average daily flows. These capacity values have been superimposed over the trends of average daily traffic crossing the Potomac River on existing bridges and are graphically summarized in Figure 25. The need for additional bridge capacity is evident!

The traffic sufficiencies for the existing Potomac River bridges and their approaches are indicated in Table XII. Peak hour volumes are expressed as a per cent of available capacities. It is readily apparent that the practical capacities of all four bridges are exceeded during peak traffic hours. Possible or saturation capacity values are reached during both peaks on the Highway Bridge, and are approached on all the other structures. The Memorial Bridge appears to be the least overloaded.

The sufficiency of the Potomac River Crossings is summarized in Table XIII. The seriousness of the bridge problem, and the need for additional river crossings, is evident. At the present time the directional peak hour traffic exceeds the combined "practical capacity" of all bridges. The peak hour loads are within 95 per cent of the possible capacity of the combined bridges. Peak hour congestion involving river crossings can be expected to reach the "breaking point" - complete saturation - in approximately one year.

FUTURE BRIDGE NEEDS

It has been previously indicated that, based on normal growth trends, there will be about 313,000 vehicles. This value represents an increase of approximately 40 per cent over present crossings. If attractive and fully adequate systems of approach roads can be provided, the desired crossings can be expected to approach 375,000 daily.

To effectively meet peak hour demands and to accommodate reasonable trip requirements, the minimum lane requirements will be fourteen additional lanes within the next 16 years. This assumes that the new bridges will be located so as to permit direct and effective travel between motorists' principal points of origins and destinations and that all lanes will be

TABLE XII

TRAFFIC SUFFICIENCIES

POTOMAC RIVER BRIDGES*

	PEAK HOUR VOLUME AS PERCENT OF AVAILABLE CAPACITY			
	INBOUND		OUTBOUND	
	A	B	A	B
Highway Bridge	120	100	119	100
Memorial Bridge	108	88	114	93
Key Bridge	111	92	112	99
Chain Bridge	122	100	114	99

A- Practical Capacity B- Possible Capacity

* As affected by restrictive approach conditions.

TABLE XIII

PRESENT TRAFFIC SUFFICIENCY
POTOMAC RIVER BRIDGES

	Inbound	Outbound
Total Volume-Typical 1954 Day Peak Hourly Flow	13,890	13,930
Practical Capacity	12,100	12,100
Sufficiency	114	114
Possible Capacity	14,700	14,400
Sufficiency	94	96

*Volume as per cent of capacity

utilized. It is evident that their locations will have to conform with natural travel patterns. The new bridges will have to be located so that their capacity can be served by approach roads on each side of the river. Approach road nets must be carefully integrated with bridge plans. Inadequate approach highways, or required circuitous travel will greatly reduce the practical effectiveness of a bridge. Improper locations can mean, therefore, that more lane capacities will be required.

ACCEPTED PROPOSED BRIDGES ON OUTER CIRCUMFERENTIAL

Comprehensive plans for new Potomac River Bridge crossings should give cognizance to both capacity and access needs. Bridges should be constructed not only to eliminate capacity deficiencies, but also at those locations where they will become integral links of primary regional trafficways. A balanced system of Potomac River crossings should contain both central and peripheral bridges.

Highway as well as planning officials have already agreed on the construction of the Jones Point and Cabin John Bridges as part of the Greater Washington outer circumferential route. This is an accepted condition in this report.

Jones Point Bridge

The location for a river crossing at Alexandria has been one of the Regional proposals of the Comprehensive Plan. Bill H.R. 1980, signed by the President, authorized the Jones Point Bridge. The Jones Point crossing site is located south of the central district of Alexandria. Tentative plans reveal that a four-lane bridge would meet traffic demands. In Virginia the bridge would have interchange with the Mount Vernon Memorial Highway, Jefferson Davis Highway and Telegraph Road, and via an extension with the Shirley Highway. If the proposed Potomac River expressway is developed it would likely provide access to the bridge. In Maryland the bridge would have interchange with the proposed George Washington Memorial Parkway, Indian Head Road, and eventually be extended eastward as part of the Outer Circumferential.

The bridge would provide a valuable traffic service, by affording a much needed by-pass of central Washington. It would permit direct routing between southwestern portions of the Metropolitan area and

southeastern Washington, and eliminate virtually all the reverse movements currently negotiated over the Highway and South Capitol Street Bridges. Similarly, the connection to the Shirley Highway would attract traffic which would otherwise be required to traverse the Pentagon Road net. It would encourage suburbanization and would provide a "dispersed development" crossing of the Potomac River.

Cabin John Bridge

The Cabin John Bridge would span the Potomac in the vicinity of Cabin John Park about 8 miles northwest of central Washington. It would have contact with Route 193 in Virginia, and MacArthur Boulevard in Maryland. The bridge would be an integral link in the outer circumferential. It would tap new areas, and stimulate their development.

Preliminary traffic studies indicated that there are insufficient traffic potentials to justify its construction at the present time. In light of the recent plans by Maryland to expedite the construction of the outer circumferential, it is reasonable to expect substantial increases in the bridge's future traffic potentials. Accordingly, it is desirable that rights-of-way be reserved at the present time for the bridge approaches in both Virginia and Maryland.

NEW PROPOSED RIVER CROSSINGS CONSIDERED

Highway and planning agencies recognize the need for the construction of new intermediate and central Potomac River Crossings. Three general locations have been considered:

(1) a downstream central location in the vicinity of Roaches Run or Hains Point:

(2) a midstream central location in the vicinity of Constitution Avenue and "E" Street; and,

(3) an upstream intermediate crossing between the Key and Chain Bridges.

Tentative locations and alternates of the Roaches Run and Constitution Avenue River Crossings are shown in Figure 26.

Roaches Run

The planned Roaches Run Crossing would be located in the vicinity of Roaches Run approximately 800 feet down stream of the railroad bridge; and would be a six-lane facility. The bridge would connect directly with the Southwest Freeway leg of the lower loop, and 12th Streets in Washington and have interchange with Mount Vernon Memorial Highway and the Pentagon road network on the Virginia side via high type connectors.

By development of the Four Mile Run Expressway between the bridge and the Shirley Highway much trans-river traffic could be intercepted before reaching the Pentagon road net and conveyed directly to the bridge. The Four Mile Run Expressway integrates well into the planned Intermediate Circumferential in the Virginia Metropolitan area. The contemplated Potomac River Expressway to Alexandria can be readily tied into the bridge.

Advantages. Attractive interchanges can readily be provided in both approaches to the bridge. The facility can be expected to provide substantial relief to the heaviest travelled Highway Bridge. It can advantageously serve densely populated sectors of the Metropolitan area; about two thirds of the Virginia Metropolitan area currently live south of Arlington Boulevard. It is readily possible to integrate the bridge approach roads with the Southwest Freeway and Southwest Redevelopment Plans. Opportunities exist for providing off-street parking areas in proximity of bridge approaches. It should be noted

that these plans would increase the traffic attractibility of the southwest portions of central Washington. Via the Southwest Freeway Bridge traffic would have free flowing access to the South Capitol Street as well as to the Third Street leg of the Inner Loop Expressway. The bridge would provide all-weather express access to the National Airport. It provides direct access to the central shopping district via Twelfth Street.

Disadvantages. Increased north-south traffic flows on surface streets tributary to the bridge can be expected to develop need for additional capacity at intersections along Constitution Avenue. The anticipated north-south flows and required capacity will be developed fully in Part II of this report.

Constitution Avenue Bridge

The proposed Constitution Avenue Bridge is located about 1200 feet north of the Arlington Memorial Bridge. It connects with George Washington Parkway, Arlington Boulevard and the Jefferson Davis Highway on the Virginia side in a series of high capacity type interchanges. On the Washington side the bridge would have complete interchange with the west leg of the Inner Belt Expressway and would have a direct connection to Constitution Avenue. Twenty-third Street would be carried over Constitution Avenue thereby increasing the capacity of both roadways. Integrated with the new bridge are new Mall roads which would serve with Memorial Bridge traffic, and reduce existing weaving maneuvers. An attractive contact between the Belt expressway and a widened "E" Street Mall roadway would be provided. Plans call for the widening of Constitution Avenue to 12th Street.

Advantages. The bridge provides a direct central crossing for Arlington Boulevard, Washington Memorial Parkway, and Lee Highway traffic approaching from the west and north. The bridge would attract vehicles currently using Memorial and Key bridges relieving capacity problems on these facilities. It provides attractive access to the west central area, in anticipation of the present development trends of this district, (shifts of office buildings, etc.).

Disadvantages. Converging traffic from Virginia Avenue onto Constitution east of the bridge is likely to develop capacity problems on the street, even with widening.

To separate Memorial and Constitution Avenue Bridge traffic, the Mall has been converted into a through trafficway to Ninth Street; the increased traffic movements on the Mall roadways are contrary to the previous concepts as to the function of the roadways. The bridge will not substantially relieve the traffic loadings on the Highway Bridge. The attractive interchange provided with Arlington Boulevard will likely develop increased traffic loads on the Virginia thoroughfare. Arlington Boulevard is currently saturated during peak traffic hours. Normal increases in local Virginia traffic alone will tax the capacities to be provided by the planned widening. The additive bridge traffic would aggravate this condition and restrict operations on the roadway. To repeat, present trans-river traffic combined with the rapidly growing intra-Virginia traffic would absorb the capacity of this important new expressway as rapidly as it is provided.

The Commission of Fine Arts has clearly set forth the impact of the structure on central area esthetics. In the opinion of the Commission, the bridge to be erected over the Potomac River between

the Memorial Bridge and Theodore Roosevelt Island would seriously affect the beauty of these memorials. The Mall terminating in the Memorial Bridge and the wide expanse of the river, with the wooded island given to the Nation as a memorial to Theodore Roosevelt, provide a setting of incomparable beauty for the Lincoln Memorial and form perhaps the finest civic landscape in America. Many official and civic bodies feel that it is of the utmost importance that this landscape should not be marred by another bridge at this point.

The Commission of Fine Arts states that if a crossing must be provided at this location that it should be a tunnel. This type facility would be very costly and would, because of grade, preclude contact with the Inner Loop. All traffic would tend to be unduly concentrated on Constitution Avenue. Extensive approach roadways would be required.

E Street Bridge.

Early plans for a central crossing also considered a bridge connecting Arlington Boulevard with E Street in the vicinity of the E Street Inner Loop interchange. This bridge would, in general, have the same connections in Virginia as would be provided in the Constitution Avenue Bridge.

Some objections to this bridge have arisen because it traverses the bird sanctuary on Theodore Roosevelt Island. Land acquisition costs on the District side are relatively high. The Washington approach develops an improved street as the proper east-west distributor. Traffic would be routed through the White House area into Pennsylvania Avenue in the most congested part of town.

Three Sisters.

The proposed Three Sisters Bridges would span the Potomac River over the Three Sisters Island. It would connect with Canal Road, MacArthur Boulevard, Foxhall Road and the planned Glover Archbold Parkway on the Washington side. On the Virginia side it would connect with the existing Washington Memorial Parkway, and its planned extension in a "bulb" type interchange. The proposed Falls Church Expressway would be linked with the existing spur of the Washington Parkway to Lee Boulevard. The proposed Whitehaven Parkway in Washington about a mile to the north of the bridge would serve as a major east-west distributor.

Advantages. The Three Sisters bridge would strategically "intercept" Washington bound traffic from northwestern Virginia areas which would otherwise use Key, Central, or Memorial Bridges. That is, the "traffic shed" of the Three Sisters Bridge includes many of the fastest growing areas in the Metropolitan region. This will occur to an even greater extent when the Falls Church Expressway is completed. The bridge would permit direct and efficient trans-river movements to northwest Washington from all of Metropolitan Virginia. This is a function which none of the existing bridges provides. The planned intermediate circumferential could easily utilize the bridge. Possibilities exist for connecting the bridge with the Inner Loop.

Disadvantages. For the Three Sisters Bridge to offer maximum traffic service to trans-river crossings it should have a limited access connection via the Whitehaven Parkway to the Inner Loop. This necessitates an extension of the Whitehaven Parkway, through several blocks of relatively expensive residences and buildings, to

connect with the Inner Loop at about Florida and Connecticut Avenues. The bridge will not serve traffic traveling to and from central Washington as efficiently as a more central crossing. Unless Canal Road is developed to expressway standards and the present bottlenecks of the Whitehurst Freeway at its eastern terminus are removed, Three Sisters Bridge traffic will tend to overload these roadways during peak inbound periods.

Nebraska Avenue

The Nebraska Avenue crossing of the Potomac River is located about midway between the Three Sisters and the Chain Bridges. The facility would be almost entirely an intermediate crossing and would not develop the traffic potentials of the Three Sisters. Field studies indicate that it would be difficult to provide attractive and economical connections on the Virginia side.

TRAFFIC POTENTIALS OF POTOMAC RIVER CROSSINGS

The present trans-river crossing desires were related to the transportation services afforded by the available road net of Metropolitan Washington. The amount of traffic potential to any bridge depends on the relative time and distance savings, and the quality of flow over the given facility as compared with competing routes, and its relation to vehicle origins and destinations. Motorists can be expected to seek out the easiest route from their origins to their destinations. The diversion factors that have been empolyed give due cognizance to that component of traffic which is potential to several alternate facilities. Origin-destination characteristics of central Washington were analyzed in detail.

Assignments of 1954 average daily traffic volume to the existing bridges are summarized in Table XIV. The actual traffic flows on the existing bridges are also indicated. In general, there is a reasonable correspondence between the actual and assigned crossings. It should be noted that the traffic assigned to the Key Bridge is considerably lighter than the volumes recorded on the facility. This crossing appears unattractive when trip desires are considered, chiefly because of its indirect approach connections and its poor orientation. The present loadings are to a considerable extent resultant from the extreme traffic pressures on more direct crossings and their approaches. In this regard the Key Bridge is used as an alternate route for the Memorial Bridge.

The desire traffic loadings on each bridge are shown graphically in Figure 27. Trip desires to the zero sector are also indicated. It is interesting to note that over 35 per cent of all trips assigned to

the Memorial and Highway bridges are between Virginia and downtown Washington.

TABLE XIV

PRESENT TRAFFIC DISTRIBUTION

TYPICAL 1954 DAY

Bridge	Effective Lane	Approx. Daily Practical Capacity*	Actual Count Daily Traffic	% Of Total Crossings	Assigned Daily Traffic	Of Total Crossings
Highway	6	90,000	107,000	47.8%	109,000	48.7%
Memorial	6	50,000	55,000	24.5	69,000	30.8
Key	4	43,000	47,000	21.0	32,000	14.3
Chain	2	12,000	15,000	6.7	14,000	6.2
TOTAL			224,000	100.0	224,000	100.0

* Capacities are based on the relation of existing peak hour directional volumes to total daily traffic. It can be assumed that this value does not fully represent the approach demand on the peak hour; this value would probably be less, say 85,000.

Present trans-river crossings projected to 1970 approximate 313,000 vehicles daily. As new bridges and approach road systems are placed into operation they will generate new traffic trips. This generated traffic is additive to normal projected volumes. Accordingly, the total anticipated 1970 trans-river crossings, assuming the development of new Potomac River bridges has been estimated at 375,000 trips daily. This value is used in subsequent traffic assignments.

TABLE 15

ANTICIPATED 1970 TRAFFIC DISTRIBUTION

OF

POTOMAC RIVER CROSSINGS

Based on Trip Desires

BRIDGE	CENTRAL CROSSING AND OUTER CROSSINGS		THREE SISTERS CROSSING AND OUTER CROSSINGS	
	Daily Traffic	Percent of Total Crossings	Daily Traffic	Percent of Total Crossings
Jones Point	28,000	7.5	28,000	7.5
Roaches Run	49,000	13.1	50,000	13.3
Highway	89,000	23.7	92,000	24.5
Memorial	51,000	13.5	72,500*	19.3
Central	90,000*	24.0	-	-
Key	41,700	11.2	17,200	4.6
Three Sisters	-	-	96,000*	25.6
Chain	17,000	4.5	11,500	3.1
Cabin John	9,300	2.5	7,800	2.1
TOTAL	375,000	100.0	375,000	100.0

*Exceeds the practical capacity of bridge. Traffic would distribute to Key and other bridges where excess capacity is available.

Anticipated 1970 traffic volumes have been assigned to existing and proposed bridges. Assignments were predicated on the completion of certain highway improvements, delineated in Figure 15. They have assumed the planned Outer Potomac Crossings at Cabin John and Jones Point, and an intermediate new crossing at Roaches Run. With these bridges in place, anticipated loadings were determined for the entire system of Potomac River crossings assuming (1) a central bridge and (2) a Three Sisters Bridge. Traffic values are indicated in Table XV. The Three Sisters location was considered preferential to the Nebraska Avenue site because it can be more readily integrated into overall highway plans.

A study of this table shows that the maximum percentage of traffic on any one bridge is about half the present percentage. A more equitable overall distribution of traffic attained. Over 85 per cent of all transriver crossings would use central or intermediate bridges; only 15 percent of the total traffic is potential to Jones Point, Chain and Cabin John Bridges.

Traffic demands would be served best by either the Central or Three Sisters Bridge. Either crossing would attract about one-quarter of the total transriver trip demands. Either facility would divert appreciable volumes from existing adjacent bridges. The Roaches Run Bridge would substantially reduce overall loadings on the Highway Bridge.

The Central crossing attracts considerable more traffic than the Memorial Bridge because of its ability to "intercept" transriver trips approaching from western and northern Virginia areas. It affords relief to Memorial and Key Bridges. Similarly the Three Sisters crossing attracts significantly greater volumes than Key Bridge because of more direct roadway connection. It provides greatest relief to Key and Chain

TABLE 16

ANTICIPATED 1970 TRAFFIC DISTRIBUTION

OF

POTOMAC RIVER BRIDGE CROSSINGS

Based on Trip Desires as Related to Bridge Capacities

Bridge	Lanes	Approx. Daily Practical Capacity*	Central Crossings and Outer Crossings Daily Traffic	% of total Crossings	Three Sisters Crossings and Outer Crossings Daily Traffic	% of total Crossings
Jones Point	4	50,000	28,000	7.5%	28,000	7.5%
Roaches Run	6	75,000	51,000	13.6	52,000	13.9
Highway	8	100,000	89,000	23.7	93,000	24.8
Memorial	6	60,000	54,000	14.4	60,000	16.0
Central	6	75,000	75,000	20.0	-	-
Key	6	75,000	51,700	13.8	46,300	12.3
Three Sisters	6	75,000	-	-	75,000	20.0
Chain	2	20,000	17,000	4.5	12,900	3.4
Cabin John	4	50,000	9,300	2.5	7,800	2.1
TOTAL			375,000	100.0	375,000	100.0

* Assumes that peak hourly directional movements will be 6 per cent of total daily crossings.
For Memorial and Chain Bridges, a 7 per cent value has been used.

bridges, although it diverts traffic from Memorial Bridge as well.

In assigning traffic it has been assumed that the Roaches Run and Central or Three Sisters Bridges would provide three moving lanes in each direction, while the outer bridges would be four lane facilities. Assigned loadings to the Three Sisters or Central Bridges appear to exceed optimum capacity values. There is a tendency for traffic to distribute itself in accord with available capacities. Hence, the traffic excess or overload has been re-allocated in order to determine the actual traffic volumes on each of the Potomac River crossings. Anticipated 1970 volumes based on trip desires and capacities are summarized in Table XVI. Highway and the Central or Three Sisters Bridges will carry the heaviest flows: Figure 28 graphically summarizes and compares the anticipated 1970 traffic loadings on the Potomac River Bridges.

Chapter V

RECOMMENDATIONS

Long-range plans for Potomac River Crossings can be made from the data and analyses presented. Also, other improvements essential to efficient use of the bridges are apparent.

Coincident with the improvement of existing bridges, and their approaches, and taking precedence over the construction of new crossings, it is essential that additional street capacity be provided on the Washington side of the river. Roadways are currently taxed during peak hours and cannot accommodate the additional loadings which would result from increased bridge capacity.

1. Inner Loop Expressway.

The Inner Loop Expressway distributor should be developed before any new bridge is built.

2. Improvements to Existing River Crossings and Approaches.

Capacities of existing bridges and their approaches can be readily increased. Existing bridges should be improved as follows:

Highway Bridge - A new four lane span should be constructed to replace the original Highway Bridge. The inbound bridge should be connected to Maine Avenue and the Inner Loop by a new ramp which permits full utilization of the four inbound lanes. These improvements will increase the bridge capacity about 25 per cent. The plans to depress 14th Street under Independence Avenue and the Mall are good, and will increase both north-south and east-west capacities. Long-range plans should develop north-south one way operations through the Central area. Pairing of 14th and 15th Streets as a one-way system between Thomas Circle and 14th and

Madison Drive would substantially improve operations through the downtown area and should be considered.

Memorial Bridge - By modification of the ramp connections on the Virginia side of the river, several weaving sections can be improved. Improvements on the Washington side are contingent on the development of a central crossing. The present weaving maneuvers at the Lincoln Memorial should be reduced by making the Bacon Drive a one-way eastbound roadway, and by increasing its radius at Constitution Avenue. Pending the grade separation of 23rd Street at Constitution Avenue, westbound bridge traffic should turn left at 24th Street extended and merge with bridge-bound traffic on the Loop from Ohio Drive. These improvements should increase Memorial Bridge capacities at least 10 per cent.

Key Bridge - Street railway operation on this bridge should be replaced with buses and the existing streetcar tracks removed as planned. The Bridge should be widened to provide three moving lanes in each direction, including the cantilevering of the south walk. Existing plans for south terminus are workable. Efficient interchange should be provided between Key Bridge and George Washington Memorial Parkway. Initially a one-way street system over existing right-of-way should connect Arlington Boulevard to Key Bridge with grade separations developed at Arlington and Wilson Boulevards. Long range plans should provide for a limited access north-south connector to Arlington Boulevard. On the Washington side a grade separated interchange at M Street should be constructed. 35th and 34th Streets should be developed as one way connectors through Georgetown to Wisconsin Avenue and the planned Whitehaven Parkway.

Plans to develop Canal Road as an expressway extension of the Whitehurst Freeway will eliminate the present congested operations at their intersection. The improvement of K Street as an eastern extension of the Whitehurst Freeway will eliminate the present bottleneck at the eastern terminus and permit over a 30 per cent increase of inbound freeway capacity. For maximum stability and flexibility of operations attractive connectors should be developed between the Whitehurst Freeway and the Inner Loop. The widening of Key Bridge and the improvement of its approaches should increase the crossing capacity over 15 per cent.

Chain Bridge - The planned improvement of Canal Road will improve the bridge approach on the Washington side. In Virginia, widening of the nearby intersection, including the provision of increased sight distance is desirable. About a 10 per cent increase in bridge capacity would be realized after these improvements are effected.

3. New Potomac River Crossings.

The analyses of traffic growth and origin-destination data reveals that by 1970 a minimum of 14 additional bridge lanes will be required, assuming that the lanes are all positioned in accord with drivers' desire lines of travel. Recommended improvements to the Highway and Key Bridge will provide four new lanes. New river crossings are required to provide the additional lanes.

1. New bridges must have adequate approach and distributor connections on both sides of the river. At present a flexible road net exists on the Virginia side.
2. While the acceptance of the extremity bridges, Jones Point and Cabin John, is desirable from a standpoint of regional development

and accessibility, the bridges would not divert appreciable quantities of traffic from more centrally located crossings, now or in the future. Four lane roadways would adequately accommodate traffic demands at each crossing.

3. Roaches Run must be developed as a separate facility and not merely as another bridge to return Highway Bridge traffic. It should provide six lanes.

4. A new six lane central crossing should be provided. The development of either the Constitution Avenue or Three Sisters Bridge with adequate approach connectors would afford the maximum traffic services.

   (a) Both bridges would have about the same overall traffic affects on the system of Potomac River crossings and would relieve existing crossings.

   (b) The Constitution Avenue Bridge would be better adapted for trips to or from the central area of Washington. The Three Sisters Bridge would receive its greatest usage from other than downtown oriented trips.

   (c) The Three Sisters Bridge appears to have better long range planning possibilities. It permits a north to south trans-river movement removed from the central area. Its Virginia approaches are removed from the heavy peak hour loadings in the Pentagon Road net.

   It is better suited to new highway development: the planned Falls Church expressway in Virginia, which will tap some of the fastest growing sections of the metropolitan

region would link directly into the bridge. Similarly, the bridge would attract traffic flows from areas served by the Washington Memorial Parkway extension. The bridge can and should be integrated with the intermediate circumferential route. In Washington the Glover Archbold Parkway should be extended northward at least as far as Wisconsin Avenue.

(d) For either the Constitution Avenue or Three Sisters Bridge, direct limited access connections to the Inner Loop Expressway should be provided. To achieve this for the Three Sisters Bridge the planned Whitehaven Parkway would have to be developed between the Inner Loop and the Glover Archbold Parkway.

5. Even with the proposed system of bridges, by 1970 all motorists would not be able to cross where they prefer during peak hours, although there would be sufficient total reserve capacity. In any large metropolitan area it is never possible to accommodate all trip desires, and some redistribution of traffic is necessary.

6. Anticipated traffic requirements and assignments have been predicated on optimum capacities*. Higher capacity values are currently attained on existing bridges and can be expected to develop on new facilities as pressures mount. Thus, the use of a conservative capacity criteria represents a factor of insurance insofar as future bridge requirements are concerned.

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* Practical lane capacity values approximating 1500 vehicles per steady flow lane per hour were assumed.

SCHEDULE

In programming proposed Potomac River Bridge improvements, it is evident that primary attention should be turned to central crossings and that outer bridges should be built subsequently as funds become available. The recommended scheduling of improvements follows:

Immediate Construction

1. Build the Inner Loop Expressway giving priority to the Southwest Freeway.
2. Replace the old Highway Bridge and improve the Washington approaches on the new bridge so as to develop four effective lanes in each direction.
3. Widen the Key Bridge and improve its interchange on both sides of the Potomac River.
4. Construct a central bridge crossing either at Three Sisters or at Constitution Avenue.
5. Improve approaches to Memorial Bridge.

Second Stage Construction (to be initiated by 1960)

1. Construct the Roaches Run Bridge.
2. Improve the approaches to the Chain Bridge.
3. Construct the Jones Point Bridge.

Eventual Construction (to be initiated by 1965)

1. Construct the Cabin John Bridge.

Bridge improvements must of course be integrated into the overall highway plans for the metropolitan area. In light of this, some modifications in the recommended construction sequence may be necessary.

FIGURES

The following figures will be incorporated in the report when they are reproduced:

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26. Inner Loop Expressway and Potomac River Bridges
27. Present Traffic Distribution Based on Transriver Trip Desires
28. Anticipated 1970 Traffic Distribution - Potomac River Crossings