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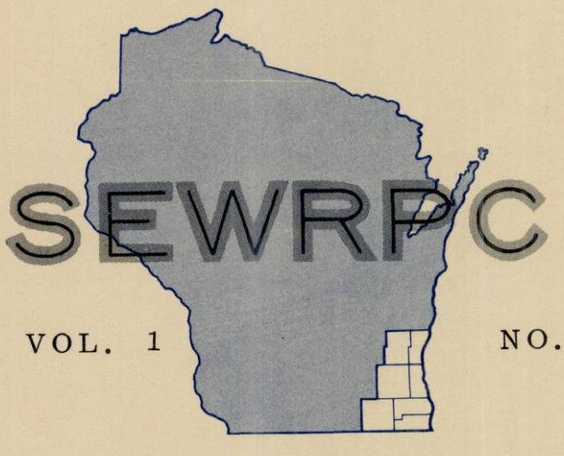
TECHNICAL RECORD



VOL. 1 NO. 6

AUGUST - SEPTEMBER

* * * * * IN THIS ISSUE * * * * *

* * CHECKING THE NETWORK DESCRIPTION FOR ARTERIAL HIGHWAY AND TRANSIT NETWORKS * A STUDY OF THE WATER QUALITY AND FLOW OF STREAMS IN SOUTHEASTERN WISCONSIN * * * * * EXPANDING THE ORIGIN - DESTINATION SAMPLE * * * *

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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THE TECHNICAL RECORD

Volume one Number six

August 1964 - September 1964

TABLE OF CONTENTS

The preparation of this publication was financed in part through a joint planning grant from the State Highway Commission of Wisconsin, the U. S. Department of Commerce, Bureau of Public Roads and the Housing and Home Finance Agency, under the provisions of the Federal Aid Highway Legislation, and Section 701 of the Housing Act of 1954, as amended.

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A BACKWARD GLANCE

by Kurt W. Bauer, Executive Director

GREENDALE--GARDEN CITY IN WISCONSIN

The concept of the "Garden City" was probably first articulated by Ebenezer Howard, an Englishman who lived from 1850 to 1928. His objective was to combine the civilizing influences of the city and the healthful and recreative qualities of the country in one complete urban unit of limited size. To achieve this, he proposed to develop the countryside around the larger central cities with a number of new towns each surrounded by its own permanent agricultural "greenbelt." Howard's concept of the garden city was based upon the following objectives with respect to urban development:

1. Planned dispersal of urban populations, such planned dispersal to be achieved by providing an urban standard of municipal services to a migration of a cross-section of city people into the countryside.

2. An urban unit of limited size, making it possible to locate residences conveniently near work, shops, meeting places, and the open countryside.

3. Ample space and a pleasant, agreeable and healthful environment; an urban plan open enough for homes, each with their own lawns and gardens, schools with ample grounds, pleasant parks and parkways.

4. A close and permanent town and countryside relationship achieved through the reservation of a large area around the urban unit for permanent agricultural use, giving the farmer a nearby market and cultural center and the townspeople a "country situation."

5. Complete preplanning of the town including the framework of streets, land use, the design and setting of buildings and landscaping.

6. Neighborhoods; the urban unit to be divided into parts, "each to some extent a developmental and social entity."

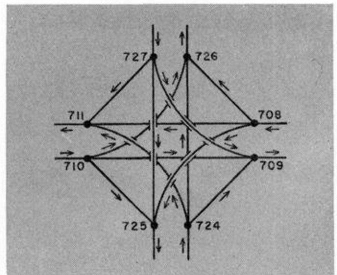
7. Unified land ownership; "the whole site including the agricultural zone to be under quasi-public or trust ownership, making possible developmental control through leasehold covenants and securing the social element in land value for the community."

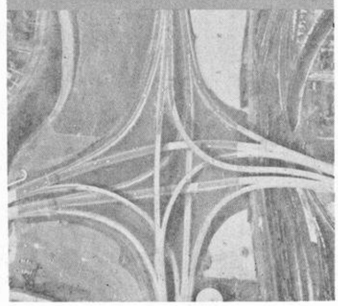
Continued on page 8

CHECKING THE NETWORK DESCRIPTION FOR ARTERIAL HIGHWAY AND TRANSIT NETWORKS

by Richard B. Sheridan, Chief Transportation Planner

INTRODUCTION





Background Review

Previous Technical Record articles[1] have described the delineation of the arterial street and highway network and the transit network, and the inventory of the physical facilities represented by the network components. After inventory data were reduced to punched cards, it was necessary to connect or assemble the component parts represented by the punched card data into a numerical description of the complete regional arterial street and highway system and the complete regional transit system. These numerical network descriptions can then be used to calculate minimum time paths between traffic analysis zones, which are used, in turn, in the assignment of interzonal trips. Trips determined from the 1963 survey data will first be assigned to the existing networks as a check of the accuracy of the data. Calculated future trips will be later assigned to planned networks. In each such assignment, traffic volumes will be accumulated by electronic computer on the network links comprising the interzonal minimum time paths to determine capacity deficiencies and verify the overall feasibility of the planned networks.

Purpose of Checking

Before using a network description for traffic assignment by computer, it is necessary to find and eliminate any errors in the link data and in the link connections at nodes. The available computer programs for building a network description include tests, or checks, for incorrect or questionable link data, thus providing an excellent edit of the link data at the time the network description is formulated.

In addition to these edits, however, it is desirable to test how well the network description represents the real transportation system. One convenient method of doing this is to calculate, for a few carefully selected zones, the minimum time paths to other zones. These minimum time paths are read from numeric tabulations printed by the computer and are plotted manually by connecting colored lines on prints of the network maps. Examination of the resulting traces

[1] "Arterial Network and Traffic Analysis Zones," Technical Record; SEWRPC; Vol. 1 – No. 2, "Rail and Transit Inventory and Design of the Transit Network," Technical Record; SEWRPC; Vol. 1 – No. 3, and "Inventory of the Arterial Network," Technical Record, SEWRPC; Vol. 1 – No. 5.

reveals major discrepancies which may have occurred in the network description due to faulty link data. Such traces may also be inspected to see whether they represent the routes people actually use in making trips between certain points of origin and destination.

Conversion of Link Inventory to Link Data Cards

In order to use the computer program for building a network description, and subsequently, to calculate minimum time paths and to assign zone-to-zone trips to these minimum time paths, it is necessary to prepare a data card containing prescribed information for each link in the following format:

Column	Data
1	Jurisdiction (optional). Used by the SEWRPC to designate freeways and expressways.
3- 6, 8-11	Node numbers. For one-way links this must be in order from node of entry to node of exit.
16-17	Link length, in miles and tenths with a decimal point assumed between columns 16 and 17.
20	S, indicating speed data to follow. (T may be used to indicate time as was done in the Transit Network.)
28-29	Speed in mph (or running time in tenths of minutes).
35	For two-way links only, same as column 20.
43-44	For two-way links only, same as columns 28 and 29, but in opposite direction. SEWRPC has thus far used the same speed in both directions.
56-60	Capacity.
61-66	Counted volume.
72	4 (identifies card as Link Data Card).
NOTE:	Columns 73-80 are available for any identification data, but are not read into the computer. SEWRPC uses the following identification:
73	H for Arterial Highway Network; T for Transit.
74, 75	Year of network.
76, 77	Network number for identification.
78-80	Card layout identification number for data processing control.

This format was used for both the arterial highway network and for the transit network. Since these networks have inventory data in different formats, it was necessary to develop a routine to convert from each inventory format to the specified link data format. For the arterial highway network, this included calculating link capacity from certain link characteristics with a given table of capacity multipliers.[2] An IBM 1401 computer was used to make the calculation and punch the link data cards. For the transit network, no link capacity was used since transit within the Region does not approach the capacity of the arterial street and highway system to carry it, nor is it likely to do so.

USE OF LINK DATA

Building a Network Description

The link data cards are used as input to Program 6 "Build Network Description" of the U. S. Bureau of Public Roads (BPR) program library. This program connects within its memory all links at their nodes, treating them all as one-way links. Program 6, which does not store link capacity or volume, has a limitation in that not more than four links may provide exit (outbound movement) from a node. The network description is written in binary numbers on magnetic tape. Program 12 converts this binary number information to decimal numbers, and writes the decimal number network description on another magnetic tape from which it can be printed. This printed record sets forth for each node the links that are connected, their distance, time, and speed.[3] As noted, both Program 6 and Program 12 have edit checks included. Edit messages are printed out when link data is inconsistent with the programmed edit checks. Generally, it is found that some of these edit messages do not represent real errors, but all should be carefully examined. For example, a link of zero length will have zero travel time. This is valid. But when Program 12 recomputes speed from distance and time, the quotient is undefined and an edit message is printed. Checks must be made for duplicate links, links whose time or distance exceed maximum values previously designated on a parameter card, more than four links at a node, links whose speed is outside a range specified on the "speed limit" card, nodes having no links outbound, and other such contingencies.

Building Minimum Time Path Trees

Program 1 "Build Trees" utilizes the Moore algorithm for finding the minimum path through a network. It creates a table which contains for each node only the minimum time and corresponding back node. By tracing from one back node or zone centroid to the next back node until the "home node" is reached, the trace of the minimum path from any designated node to all other nodes or zone centroids may be drawn onto a network map. The appearance of such a tracing of many branching paths led to its being called a "tree." The binary "tree" table produced by Program 1 is converted to decimal numbers, for printing, by Program 11, "Format Trees." It shows the home node at the top of each page and lists each node in the network with its minimum path time from the home node and its back node.

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[2] These capacity multipliers will be described in a future issue of the Technical Record.

[3] Speed is calculated from the distance and time in the binary record. Rounding may sometimes cause this printed speed to differ from the speed on the link data card input to Program 6.

A newer program, Program 50, finds the sequence of nodes from one back node to the next and lists these across the page. This program, which has a destructive trace option, has proven to be convenient in providing data for plotting trees in the selected high numbered zones. This destructive trace option, which has a computer time comparable to that of Program 11, does not list all of a trace; but merely lists that part of a trace from a loading node to a point in the network that has been used as a part of a previously listed trace of the same tree.

CHECKING ROUTE SELECTION

Selection of Trees for Plotting Minimum Path

It is usually expedient to plot trees emanating from the central business districts and from zones at or near the geographic center and corners of the network. By doing this, traces may be drawn representing routes from "downtown" to surrounding areas and also showing routes all the way across the network in directions that are generally oblique to each other. If links are incorrectly or poorly described so that calculated paths are not realistic ones, this procedure offers a high probability of detecting such discrepancies.

Some of the more common errors detected from this procedure are:

1. Decimal shifts: e.g., a link of length 5.0 miles is entered as 0.5 miles.

2. Incorrect node number: If the number of another node is erroneously entered, such as by transposing a digit, an unwanted connection may result. This is commonly called a "tunnel" by some practitioners and "bridge" by others, since when the path is drawn, it appears to connect a trace across an area where no true links exist. The path distortions resulting from this error are usually gross.

3. The trace may be a possible one, but simply not the known best route, or the one usually driven by people. This is usually caused by a sum of link times along the calculated path that is only a little different from that along the preferred path. A difference of 0.1 minutes is the smallest difference recognized. To correct such route selection some of the link times must be slightly adjusted so as to cause the accumulated running time to be smaller for the path actually used. Other trees utilizing this link in a different direction, however, must not be ignored when doing this. It is usually desirable to make several small changes so as not to distort the minimum path in another direction.

   Very short links pose special problems due to rounding, since it requires a relatively large change in speed along a link of length 0.1 miles to effect a time change of 0.1 minutes.

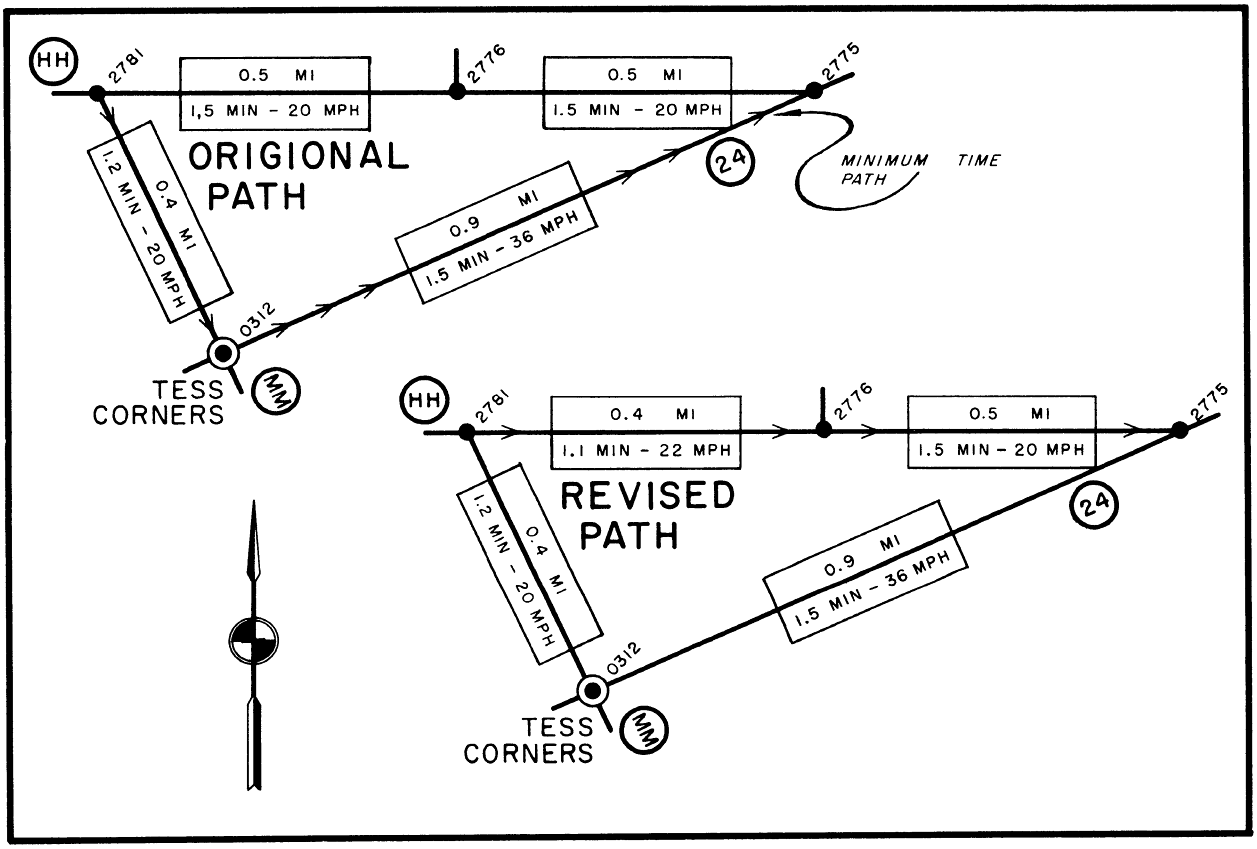
Illustrative Example

To illustrate the process described above, it may be helpful to examine an actual trace obtained.

Node 0396, the loading node for zone 396, is at the center of the City of Waukesha. The minimum path "tree" from this node was selected to be built and plotted for checking. The trace obtained along Waukesha County Trunk Highway "HH," north of Tess Corners, appeared unrealistic. Going east on "HH" (see Figure 1) it turned south on CTH "MM." It seems unlikely that any real driver, proceeding east on "HH" to its intersection with STH 24, would travel such a route.

Figure 1

EXAMPLE OF LINK DESCRIPTION ADJUSTMENT ON THE ARTERIAL NETWORK



Upon investigation of the link data, it was found that links 2781-2776 and 2776-2775 were each entered at length 0.5 miles, speed 20 mph. A further check of the measurements revealed that each of these links was actually 0.45 miles long, with a total length of 0.9 miles. The original link descriptions were not considered wrong, since link lengths were rounded up to the nearest tenth mile and running speeds were generally entered in multiples of 5 mph. However, as may be seen, the cumulative effect was erroneous. Since link lengths are recorded only to tenths of miles, it was decided to change 2781-2776 to 0.4 miles to obtain a more realistic total along "HH." At the same time, its speed was raised to 22 mph, providing a better representation of the transition from the longer, higher speed link to the west and to the average speed to the next link to the east where stop time is included. These changes reduce the link time to 1.1 minutes, making path time along "HH" from node 2781 to nodes 2776 and 2775 less than that via Tess Corners from node 2781 to nodes 2312 and 2775.

Update Program

The technique for making these changes in the network description is a simple one. Update cards are keypunched following the same general format as for the initial link data cards. The corrected or "add" cards are in the same format as the original link data cards. The "delete" cards, however, have one node in columns 3-6, as before, and the second node, in the direction of travel, in columns 50-53 instead of columns 8-11. If an S or T is punched in Column 3, it is read by the computer as a two-way deletion. A combination delete and add, utilizing all the fields, is a "change" card. A modified version of Program 6 is used to accomplish network update. The binary network tape previously produced is read into the computer, along with the update card data. The indicated changes are made in core; and the updated binary network description is written on an output tape, where it is available for subsequent use by Program 12, "Print Network Description," or Program 1, "Build Trees."

LINK CAPACITY

Network Description with Capacity and Volume Record

Another BPR computer program is available which builds a network description containing for each link, its traffic capacity and volume. It also produces a "historical" record of a sequence of traffic assignment iterations, showing at each iteration the volume assigned. This is Program 60, "Build Capacity Restraint Binary Historical Record." Program 61, "Apply Capacity Restraint to Network Description," is used following Program 60 to compare link volume with the given capacity and to apply an adjusting ratio to each link travel time, so that the network description is modified for the next iteration. This procedure is "capacity restrained" assignment.

A limitation of Program 60 is that it cannot update the binary tape on which it has written the network description. Network updates can be made, but this must be done by reading into the computer all the original link data card records followed by the update card data. Therefore, it does not permit the considerable economy obtained by means of Program 6, "Update Network Description," when editing and checking a network description.

It is intended to utilize Program 6 throughout the editing phase of developing the highway network and for assignment to the transit network, on which no capacity restrained assignments seem warranted. After obtaining a free (unrestrained) traffic assignment on the arterial highway network and making any needed network updates which this might reveal, it is then intended to make a capacity restrained assignment using Programs 60, 61, and 63. (Program 63 converts the binary results to decimal numbers in format for printing.)

Updating Inventory Cards

As changes in link data are made in the update procedure, including the addition and deletion of links and changing of link speed or distance, these changes are noted in the listing of link inventory cards. When all network updating for a particular network is completed, a corrected deck of link inventory cards will be prepared incorporating all the changes that have been made in descriptive link data. This will include not only the changes determined from computer edit of link data cards and from plotting selected trees, but also the changes in capacity values determined after review of link capacities by state and local highway and traffic engineers in the Region.

These revised link inventory cards will then be processed by a program, similar to that described earlier, which converts inventory data to link data, thus producing another complete deck of link data cards with all revisions included. This is judged to be a "cleaner" method, in the sense of being less prone to error, than to remove cards for all revised links from the original link data deck, make necessary changes, and replace the cards.

Final Three-Way Check of Arterial Network Description

To double-check the above procedure, the network description produced by Program 60 from the new link data cards will be checked against the network description obtained by Program 6 through a series of updates and against the arterial network map. This will be done by three people, each with one of the network descriptions (map included) going through the network, link by link, until all links are accounted for and cross-checked. (In the SEWRPC highway network, there are about 2,600 nodes and about 4,500 links.)

Cost and Time Duration

The checking procedure described in this article was accomplished in the SEWRPC study for a cost of approximately $6,000 in salaries of transportation planning personnel, approximately $2,000 in drafting and reproduction costs for producing and revising network maps, and approximately $800 in computer time. These salary costs include the man-hours spent in preparing control cards for computer runs, plotting selected trees, analyzing these plots, and reviewing the plans and procedures with local officials and with members of the Technical Coordinating and Advisory Committee.

Nine months elapsed between the time the first network description was built and the time the O & D survey data was ready, in summary form, for the first traffic assignment of O & D trip data. During this time, the arterial highway network was revised five times. The reasons for these updates include 1) the edit messages printed by the computer when it built a network description from data cards, 2) the needed improvements in minimum path selection that were identified from plotting selected trees, and 3) additions and changes to the system recommended by the SEWRPC staff and the Technical Coordinating and Advisory Committee. During this same interval, the transit network was revised three times. The revisions were based almost entirely on edit messages from the computer and on the detection of needed improvements in the minimum time paths.

It is expected that the need for further minor revision of both networks will become apparent after analysis of the assignment to the networks of O & D survey trips.

Summary

The arterial highway network description and the transit network description, which are essential tools for traffic assignment, were extensively checked to see that they accurately represent the corresponding "real world" systems. This was accomplished by edit routines in the standard BPR computer programs which were utilized by plotting selected minimum path trees and examining these for validity, and by review of the Technical Coordinating and Advisory Committee.

* * * * * * *

(Backward Glance continued from page ii)

Certain of these "garden city" objectives were adopted in the planning of many American "new towns", including Riverside, Illinois; Garden City, Long Island; Baldwin Hills Village, Los Angeles; and Kohler, Wisconsin. But the preplanned American communities which perhaps came closest to fulfilling the English garden city concept were the "greenbelt towns" planned and developed during the great depression. Three such greenbelt towns were developed: Greenbelt, Maryland; Green Hills, Ohio; and Greendale, Wisconsin. A fourth such greenbelt town, Green Brook, New Jersey, was planned but never developed.

The Great Depression and the Greenbelt Towns

The great economic depression of the 1930's raised the question as to whether the nation could ever hope to provide full-time, gainful employment to everyone within the labor force who needed and sought such employment. This question, in turn, gave rise to the concept of resettling a portion of the urban labor force in satellite communities around the larger central cities in which good low-cost housing and subsistence garden plots could be provided to low and medium income families. The Resettlement Administration of the U. S. Department of Agriculture was assigned the task of planning and developing four model resettlement communities on an experimental basis, and decided to apply the "garden city" concept. The purposes of this planning experiment were threefold:

1. To demonstrate in practice the soundness of planning and developing a community according to certain of the garden city principles.

2. To provide good housing at reasonable rents for low and moderate income families.

3. To provide jobs to the unemployed labor force which would result in lasting economic and social benefits to the community in which the work was undertaken.

A 3411 acre tract was selected in Milwaukee County for one of these greenbelt towns. The site chosen lay astride the Root River in the then gently rolling farmlands of the Towns of Greenfield and Franklin, approximately 8 1/2 miles southwesterly of the central business district of the City of Milwaukee. The community was to be known as Greendale.

Continued on page 17

A STUDY OF THE WATER QUALITY AND FLOW OF STREAMS IN SOUTHEASTERN WISCONSIN

by Roy W. Ryling, Hydrologist

INTRODUCTION

The SEWRPC planning program places much emphasis on the natural resource base of the Region, both as it affects and is, in turn, affected by the selection and use of land for residential, commercial, industrial and recreational purposes. The chemical quality of the streams within the Region, their condition of pollution and their flow, must be taken into account when land use regional plans are prepared. Any meaningful assessment of the possible effects of urban development on the surface water resources of the Region requires definite information about the quality and quantity of the water in the Region's major streams. A study of the water quality and flow of streams in southeastern Wisconsin is, therefore, an important part of the natural resource base studies being undertaken as an integral part of the SEWRPC regional land use-transportation study.

The importance of stream water quality to regional development stems from the limitations that are imposed on water use by the natural mineralogic composition of stream water and by the organic and inorganic pollutants that are introduced into the streams by man from domestic, municipal, agricultural, commercial and industrial uses. These limitations restrict the use to which water can be put, depending upon the mineral concentration, and the type and quantity of pollutants that are present. The economic, aesthetic and recreational potential of any area is, therefore, closely dependent upon water quality.

Purpose of the Study

The purpose of the regional water quality and streamflow study is to provide definitive knowledge essential to planning land and water development and management on a regional scale. Specific objectives of the study are:

1. to determine the present condition of stream water quality (chemical and bacteriological) in relation to existing major sources of stream pollution.

2. to determine the effect of water quality on various water uses and concommitant effects on land use patterns.

3. to predict future water quality in the Region's watersheds under alternative long-range regional development plans.

The findings of the study will be presented as a technical report that includes tables, graphs, and maps relating to current conditions of stream water quality and flow, and showing predicted future conditions under the several alternative long-range regional development plans.

Scope of the Study

The major categories of work necessary to fulfill the purpose and objectives of the study include:

1. The establishment of 87 stream sampling stations distributed over the 12 major drainage basins within the Region as listed below:

Drainage Basin	Number of Sampling Stations
Des Plaines River	3
Fox River	28
Kinnickinnic River	1
Menomonee River	12
Minor streams draining into Lake Michigan	3
Milwaukee River	12
Oak Creek	2
Pike River	4
Rock River	13
Root River	6
Sauk Creek	2
Sheboygan River	1

2. The compilation of a photographic record of each sampling station to provide detailed information on its situation and land marks.

3. A transit and tape field survey of each stream sampling station to record bridge or culvert dimensions (all stations are at locations where streams are crossed by bridges or flow through culverts), stream cross section and the angle of bridge traverse across the stream. This information is necessary for the determination of streamflow and provides a map record of the sampling station.

4. The establishment of a bench mark for stream stage measurement at each sampling station. From this information it is possible to evaluate the general conditions of streamflow at the time of each monthly sampling.

5. The collection of stream samples on a monthly basis at the 87 sampling stations. Data derived from the analyses of these samples provide the basic information regarding the chemical and bacteriological quality of the streams.

6. The measurement of streamflow during seasonal periods of high and low flow. Data derived from measurement of the streamflow, supplemented by long term flow records of permanent, continuous recording flow gages, provide the basic information regarding the quantity of water flowing through the main streams and major tributaries of the stream systems of the drainage basins.

7. The collection of existing water quality and streamflow data from Federal, state, municipal and certain private sources. Data derived from these sources will form a necessary and extremely valuable supplement to the data collected by the SEWRPC.

8. The selection and application of standards of water quality for various water uses in order to permit mapping water quality in a meaningful manner.

9. Correlation of present stream quality and flow to present sources of pollution and centers of population. This information is necessary for forecasting future conditions of stream quality in relation to the alternative land use-transportation plans.

Cooperating Agencies

The agencies most familiar with water quality and stream pollution problems within the Region are the Wisconsin State Board of Health, the State Committee on Water Pollution, and the Public Health Service of the U. S. Department of Health, Education and Welfare. These agencies have made their experience freely available to the SEWRPC and have made significant recommendations regarding the technical aspects of the water quality study. The State Committee on Water Pollution is providing the SEWRPC with invaluable laboratory services in running the laboratory determinations of biochemical oxygen demand (BOD) and of coliform count. The U. S. Department of Health, Education and Welfare has contributed to the study by providing the SEWRPC on a loan basis with analytical instruments, chemical reagents, analytical glassware and streamflow measuring equipment including such items as a Price current meter, a bridge crane, a pygmy current meter, and miscellaneous supporting equipment. Indeed, without the cooperation of these state and Federal agencies, the SEWRPC water quality study would not have been possible.

Duration of the Study

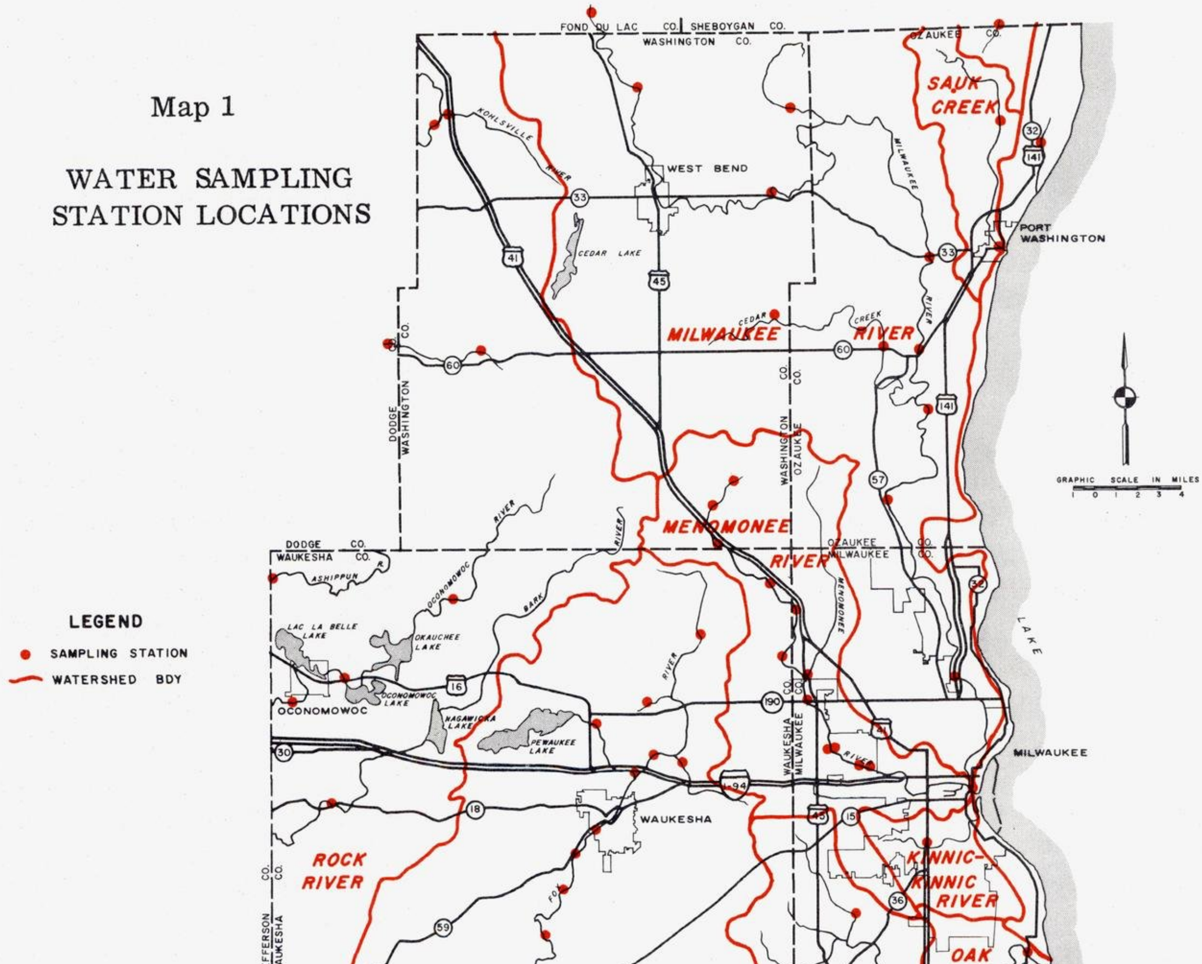
The water quality study commenced on December 2, 1963, when the staffing of the project was completed. The stream sampling program was started on January 20, 1964, at which time all the necessary equipment for the study had been gathered, and the study design completed. The sampling program is scheduled for completion on March 1, 1965.

FIELD OPERATIONS

Field operations started with the inspection of potential sampling station sites to determine their suitability for stream sampling and streamflow measurement. These sites had to be easily accessible the year around; and for this reason, highway bridges and road culverts were chosen as sites. An adequate dispersal of sampling sites over all major streams had to be achieved in keeping with the regional approach to the water quality study. Sufficient density of sampling control had to be achieved, however, in areas of known or anticipated heavy pollution. As a result of office and field investigations, 87 sampling sites were finally selected and established as stream sampling stations. Forty-seven of these stations are used also for the measurement of streamflow. Map 1 shows the location of the sampling stations within the 12 drainage basins of the Southeastern Wisconsin Region.

Map 1

WATER SAMPLING STATION LOCATIONS



Identifying the Stations

A photograph was taken of each sampling station at the time the sites were originally inspected. This photographic record is a part of a card file maintained on each sampling station which includes data on the specific location of the stations referred to the U. S. Public Land Survey system.

A permanent identification code was assigned to each sampling station within each drainage basin. The codes consist of a two-letter prefix representing the drainage basin and of a number representing the particular sampling station within the basin. The sequence of these numbers are in accordance with standard U. S. Geological Survey usage. These station numbers were painted on the respective bridge abutments and culverts in an inconspicuous location so that the stations could be readily identified at a later date. Bridges traversing a stream in a general east-west direction had the sampling station number painted on the west abutment under the bridge deck on the downstream side of the bridge. Bridges traversing a stream in a general north-south direction had the sampling station number painted on the north abutment under the bridge deck on the downstream side of the bridge. Where culverts are involved a similar system of locating the sampling station number is used. Culverts that are traversed by roads having a general north-south direction are marked on the downstream side toward the north end.

Stream Cross Sections

A two-man survey crew was placed in the field during the early months of the field operations. Each sampling site was surveyed to determine the dimensions of the bridge or culvert waterway openings to measure the stream cross sections, and to determine the angle at which the bridges traversed the streams. These data were then summarized in the form of location sketches of the sampling station areas and in the form of bridge and stream cross-section drawings.

Water Sampling Procedures

The actual water quality sampling was begun on January 20 after all the necessary equipment for water analyses and streamflow measurement had been assembled. The sampling program, which is still in progress, consists of collecting three water samples each month at each of the 87 stations, and a fourth sample at certain selected stations where additional data on the chemical quality of water is needed. Two samples are submitted to the State Board of Health for determination of biochemical oxygen demand and of coliform count. A third sample is collected and prepared in the field under standard procedures for dissolved oxygen determination. This sample and a fourth sample for chemical analysis are retained by the SEWRPC for analytical determinations. The chemical analyses performed by the SEWRPC include silica, iron, manganese, calcium, magnesium, sodium (calculated), bicarbonate, carbonate, sulfate, chloride, nitrite, nitrate, detergents, dissolved solids (calculated), hardness, noncarbonate hardness, calcium hardness, magnesium hardness, alkalinity "P," alkalinity "M," specific conductance at 25^{o}C., pH, color and turbidity. Figure 1 shows the form used by the SEWRPC in recording the chemical analyses and computed streamflow measurements. Also included on the form are spaces for recording the biochemical and bacteriological parameters determined by the Wisconsin State Board of Health.

Figure 1

FORM USED TO RECORD CHEMICAL, BIOCHEMICAL AND BACTERIOLOGICAL ANALYSES AND COMPUTED STREAM FLOW DATA

Form T4-15 6/64
SEWRPC Regional Land Use-Transportation Study

WATER QUALITY STUDY

CHEMICAL WATER ANALYSIS

Drainage basin:________ Sampling station number: ________
Station description:________
Station location:____ 1/4 ____ 1/4 ____ 1/4 sec. ____, T. ____ N., R.____ E.
Date of sampling:________ 196. Day of sampling:________
Water temperature at time of sampling:________ °C (______ °F)

Silicia (SiO_2)	______.______
Iron (Fe)	______.______
Manganese (Mn)	______.______
Calcium (Ca)	______.______
Magnesium (Mg)	______.______
Sodium (Na), calculated	______.______
Bicarbonate (HCO_3)	______.______
Carbonate (CO_3)	______.______
Sulfate (SO_4)	______.______
Chloride (Cl)	______.______
Nitrite (NO_2)	______.______
Nitrate (NO_3)	______.______
Detergents	______.______
Dissolved solids, calculated	______.______
Hardness as $CaCO_3$	______.______
Noncarbonate hardness as $CaCO_3$	______.______
Calcium hardness as $CaCO_3$	______.______
Magnesium hardness as $CaCO_3$	______.______
Alkalinity "P" as $CaCO_3$	______.______
Alkalinity "M" as $CaCO_3$	______.______
Specific conductance at 25°C	______.______
pH	______.______
Color	______.______
Turbidity	______.______

All determinations are expressed in parts per million except specific conductance and pH.

BIOCHEMICAL AND BACTERIOLOGICAL WATER ANALYSES

Biochemical oxygen demand (BOD)	______.______
Dissolved oxygen (DO)	______.______
Membrane filter coliform count (MFCC/100ml)	______.______

STREAM STAGE AND STREAM FLOW MEASUREMENTS

Stream stage ____.____ feet below measuring point that is located ________
________. Date and time of measurement: ____ 196, at ________ a.m./p.m.
Stream flow:________ cfs on ____ 196, at ____ a.m./p.m.Cross sectional area of stream:________ sq. ft. Average stream velocity:____ft/sec.

3/4 ORIGIONAL SIZE

The original plans regarding streamflow measurement involved making monthly flow measurements at selected stations within the Region, with a much larger number of flow measurements being made during periods of high and low flow. However, as the field work progressed, it was decided that streamflow measurements would instead be made extensively during the months of high and low flow. To supplement this streamflow data, stream stage measurements are made monthly at the 87 sampling stations at the time of stream sampling. This program of stream stage measurement was started in June, 1964, and will continue through February, 1965.

Streamflow measurements are made by means of a pygmy current meter and a small Price current meter following standard procedures set forth in the U. S. Geological Survey Water Supply Paper 888, "Stream-gaging Procedure." Data are obtained also from permanent U. S. Geological Survey stream gaging stations and from the SEWRPC flood gaging stations located on the Fox, Milwaukee, and Root Rivers and on Oak Creek.

LABORATORY PROCEDURES

A discussion of the analytical procedures used in determining the chemical and bacteriological parameters will be presented in a technical report which will serve as a documentation of procedures that will facilitate evaluation of the analytical results and permit duplication of procedures for future water quality studies. The analytical procedures to be discussed will pertain to all parameters listed on the form in Figure 1 and in addition to chromium, fluoride, phosphate, cyanide, and oil which will be determined by the State Board of Health for certain samples collected during periods of low flow.

ESTABLISHMENT OF WATER QUALITY STANDARDS

Numerical expressions of the chemical and bacteriological qualities of water are not meaningful for planning purposes unless related to quality standards for the various water uses. The establishment of water quality standards is a particularly difficult task in that either no standards at all, or no uniform standards, have been established relating water quality to the many water uses. The present study of water quality by the SEWRPC deals with 32 quality parameters relative to 10 principal water uses. Recommendations will be made as to the level of water quality suitable for the following water uses in terms of the pertinent parameters determined from the field sampling:

1. Public water supply.

2. Agriculture other than irrigation.

3. Preservation of fish and wildlife.

4. Recreational use.

5. Industrial.

6. Irrigation.

7. Aesthetic.

8. Waste water assimilation.

9. Drainage and navigation.

10. Cooling.

MAPPING OF STREAM WATER QUALITY

The establishment of suitability standards for the quality parameters relative to the major water uses tested above will permit the mapping of water quality within a drainage basin in terms of suitability relative to use. Without such standards, water quality can be mapped only in terms of arbitrary ranges of concentration that would lack significance to land use planning.

Each stream which was surveyed will be mapped along its reaches on the basis of existing water quality according to its suitability for the water use categories listed above. Possible changes in the mapped use pattern as a result of further urbanization will be explored. The ability of each reach to absorb additional waste loadings due to continued urbanization without a deterioration of water quality will be determined, and recommendations will be made on suitable land use patterns on the basis of present and probable future water quality conditions. Recommendations will also be made on possible ways of improving existing levels of water quality.

SUMMARY

Land and water arc closely inter-related resources, and urban development is heavily dependent upon surface water resources for the dilution of treated sewage wastes, for the recharge of ground water tables, for recreational purposes, and in some cases, for water supply. As urbanization increases, waste outlets along the stream networks become more numerous and carry greater volumes of stronger and more complex wastes. Unless development is adjusted to the waste assimilation capacities of the natural streams, the multi-purpose utility of these streams will be destroyed and severe environmental problems created.

The purpose and intent of the SEWRPC water quality study are focused on the problem of estimating the impact that alternative land use plans will have on stream quality and flow. Describing present conditions of stream pollution relative to current major sources of pollutants and evaluating these relationships in terms of future land use requirements is the essential function of the study of water quality and streamflow.

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(Backward Glance continued from page 8)

The actual town site utilized approximately 5 percent of the total tract, the remainder being reserved as an agricultural greenbelt encircling the "urban" development. This agricultural greenbelt was intended to:

1. Limit the growth of Greendale itself.
2. Clearly define the Greendale boundaries so as to preserve its identity.
3. Prevent encroachment by unplanned communities expanding in a southwesterly direction from the Milwaukee core.
4. Provide a country setting for Greendale.

The original plan called for a development density of about 15 persons per gross acre (31 persons per net residential acre), with 572 dwelling units being provided to house a total planned population of 2500 on the 170-acre town site. The plan included provision for a variety of housing types ranging from single family dwellings to six-family rowhouses, and for a carefully designed functional street pattern which separated arterial from service streets; and, to a considerable extent, separated pedestrian ways from both. The plan provided for a shopping area, school and community building, administration building, fire and police building, and public works building, all conveniently grouped in a community center. Water and sewage purification plants and a central heating plant were provided as well as entirely underground electric power and communication systems.

The entire plan was admirable adjusted to the topography of its site. To conserve the natural beauty of the site, the plan provided for an integrated network of greenways connecting the various parts of the community to each other and to the surrounding agricultural belt. About 29 percent of the developed area of the town site was set aside in the plan for park and open space purposes, and carefully related to such natural features as the Root River. No industrial development was provided for in the original plan, a major departure from the garden city concept.

The plan for Greendale was completed in December, 1935; and construction was begun in May, 1936. By July, 1937, the 360 residential buildings provided in the plan were ready for occupancy as were the shopping area and public service buildings. The buildings, while diverse in form and placement, possessed architectural unity and the finished town possessed a charm and liveability which few other communities approach. Rents were low, no effort being made to meet capital recovery costs, but adequate to provide for operation and maintenance. By 1938, all of the residential units were being rented directly from the Federal

Continued on page 18

(Backward Glance continued from page 17)

Government, and the Greendale project became a living reality. The community became a village in 1938 and adopted the manager form of government. Since the Federal Government owned the entire area, the village government was supported by negotiated federal payments in lieu of taxes.


The townsite of Greendale as originally planned is shown shortly after completion of construction in the photo at left. Note the contrast between the village and its surrounding rural greenbelt, an early and excellent application of the "cluster development" concept to urban development. The photo at right shows the townsite of Greendale today. Note the new planned developments surrounding the original townsite.

The Greendale experiment flourished under the aegis of the Federal Government from 1839 to 1952 when lack of interest at the national level in continuing the greenbelt experiment, coupled with criticism of the experiment by some as a socialistic venture, caused the Federal Government to dispose of Greendale.

<u>Maintaining the Concept Under Private Development</u>

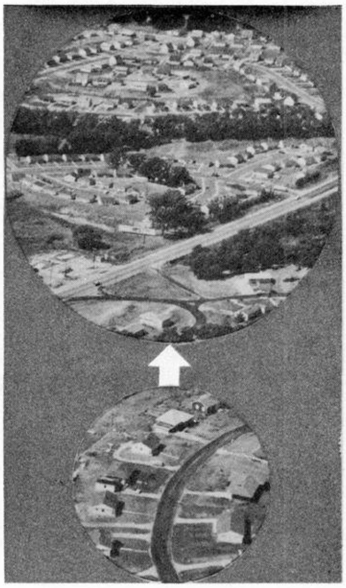
Several schemes were considered for the disposition of Greendale, including one which involved financing by and attachment to the central city of Milwaukee. It was finally decided, however, to sell the existing houses to individual purchasers giving first options to current tenants. Disposition of the shopping area, administration and public service buildings, and the vacant greenbelt land presented problems. Alarmed at the interest shown by several large national real estate speculators, three large Milwaukee corporations decided to join forces and purchase the greenbelt lands and community buildings. These corporations--the Allis Chalmers Manufacturing Company, the Kearney and Trecker Corporation, and the Boston Store--formed the Milwaukee Community Development Corporation (MCDC) with the expressed intention of conserving the improved property, and of sponsoring the planned extension of the original town site in as much harmony with the original garden city concepts as the economics of private enterprise would permit.

Continued on page 32

EXPANDING THE ORIGIN-DESTINATION SAMPLE

by Richard B. Sheridan, Chief Transportation Planner, and
Wade G. Fox, Cartography and Design Supervisor

BACKGROUND



Review of Origin-Destination Surveys

Data on travel characteristics in the Region, essential to the preparation of sound long-range transportation plans, were collected by sampling travel on average weekdays in May and June of 1963 in several component origin-destination surveys. Each of these surveys has been described in detail in previous issues of the Technical Record:

The home interview survey,[1] conducted in the more highly urbanized areas of the Region, obtained data on personal travel and on household characteristics, through personal interviews with occupants of an approximately 3 percent sample of all housing units in the greater Milwaukee urbanized area, and of an approximately 10 percent sample in the greater Racine and Kenosha urbanized areas.

The truck and taxi survey,[2] conducted in the same areas as the home interview survey, obtained data on truck and taxi movements through personal interviews with registered owners, dispatchers, or drivers of these vehicles. An approximately 8 percent sample of all such vehicles was obtained in the greater Milwaukee urbanized area, and an approximately 25 percent sample in the greater Racine and Kenosha urbanized areas.

The postal questionnaire surveys,[3] conducted in the remainder of the Region lying outside of the home interview survey areas, obtained data on personal travel and on truck and taxi movements through mailed questionnaires. Although the postal questionnaire survey area covered about 75 percent of the Region, this area housed only 15 percent of the regional population. Questionnaires were mailed to all households and to all truck and taxi owners within the postal questionnaire survey area. The sampling rate obtained was a function of the rate of

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[1] "Home Interview Sample Selection – Part I," Technical Record, SEWRPC; Vol. 1 – No. 1, and "Conducting the Home Interview Survey," Technical Record, SEWRPC; Vol. 1 – No. 2.

[2] "Truck and Taxi Survey Sample Selection," Technical Record, SEWRPC; Vol. 1 – No. 1, and "Conducting the Truck and Taxi Survey," Technical Record, SEWRPC; Vol. 1 – No. 3.

[3] "Conducting the Household Postal Questionnaire Survey," Technical Record, SEWRPC; Vol. 1 – No. 2, and "Conducting the Truck and Taxi Postal Questionnaire Survey," Technical Record, SEWRPC; Vol. 1 – No. 3.

the return. An overall sampling rate of about 17 percent was realized for the household questionnaires and of about 19 percent for the truck and taxi questionnaires.

The external (roadside) survey,[4] conducted at the boundary of the seven-county planning Region on the 32 highways having the highest traffic volumes, obtained data on vehicle movement through personal interviews with the drivers at the roadside. At low volume stations nearly all vehicles were halted and their drivers interviewed; at high volume stations as many vehicles were stopped for interviews as could be processed without seriously impeding traffic flow. The total number of vehicles crossing the cordon line at each station was counted and recorded by hour, by direction, and by vehicle type, so that the sample obtained could be expanded to represent the observed hourly totals passing the station.

The procedures followed to expand the sample data obtained in each of the five origin-destination surveys are the subject of this article.

Definitions

The expansion of sample data may be defined as the process of multiplying each sampled trip or household characteristic by an appropriate expansion factor, so that the products of each sampled characteristic times its expansion factor can be summed by zone or other areal unit to represent the corresponding characteristic of the statistical universe or population from which the sample was drawn.

In the course of developing the expansion procedures, the following terminology was evolved:

The term basic expansion factor was applied to the factor determined by dividing the total number of units in a given areal unit, i.e., the statistical universe, by the number of like units in the area which were drawn for sampling. It should be noted that this determination is independent of the method used in drawing the sample. The term adjustment factor was applied to the factors used to modify the basic expansion factors so that the fully expanded data would be equal to the statistical universe in each expansion area. The requirements for adjustment factors were different for each component survey, and therefore, the adjustment factors are herein described separately for each component survey.

The term final trip factor was applied to the product of the basic expansion factor and the appropriate trip adjustment factor(s).

The term final household factor was applied to the product of the basic expansion factor and appropriate household adjustment factor.

The calculation of expansion factors to be applied to the sample data generally followed the methods recommended in the USBPR Manual of Procedure for Home Interview Traffic Study. It was found convenient, however, to compute most final expansion factors in two or more steps, and these will be described for each component survey.

[4] "Conducting the External Survey," Technical Record, SEWRPC; Vol. 1 – No. 3.

THE HOME INTERVIEW SURVEY

As explained in an earlier Technical Record article, the home interview samples were drawn both from the residential account records of a public utility company and from a list compiled from directories of special group living quarters, such as those found in institutions, dormitories, and convents. Before the samples were drawn, it was believed that these two sources would account for all housing units in the survey area. After the samples were drawn, however, it became apparent through comparisons with U. S. Census of Housing data that the sampling obtained was actually smaller than expected and that an undersampling condition existed.

Subsequent re-examination of the utility account records revealed that certain housing units were included in what hitherto had been considered as purely commercial accounts. The majority of such housing units found in commercial accounts consisted of those in which two or more households in a single structure were served by a common meter. A supplementary sample was then drawn from those commercial accounts which could be identified as possible multifamily residences. This was accomplished through a screening of approximately 80,000 commercial account records. The number of housing units added to both the original sample and sample universe by this means was substantial. Because time limitations during the conduct of the field survey did not permit a complete examination of each commercial account record, however, it was believed that all housing units in the survey universe still had not been accounted for, and that some commercial accounts containing housing units had been misinterpreted during the rapid screening process.

Basic Expansion Factor

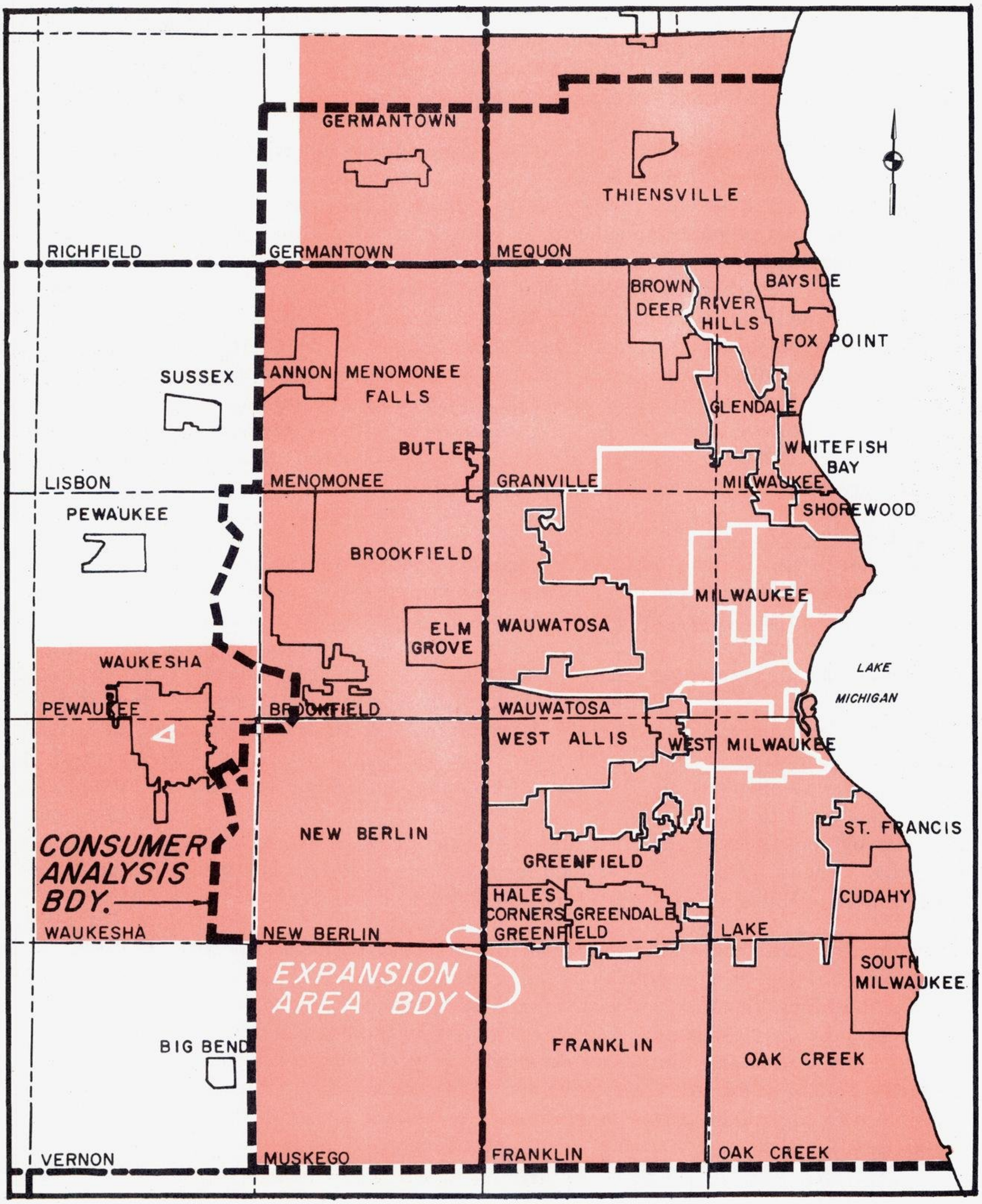
It was, therefore, decided that basic expansion factors for the home interview survey data should be derived from an accurate determination of the total 1963 housing units for sub-areas of the home interview survey area made from sources other than the utility account records. Each of these new totals would then be divided by the actual number of samples selected from within the same sub-area to determine the basic expansion factor. After examination of several sources, it was determined that the best source available for accurately determining the statistical universe of housing units in the Milwaukee area was the Milwaukee Journal 41st Consumer Analysis-1964. This report was prepared by The Journal Company in association with the Advertising Research Foundation, Inc. This report summarized the total number of existing housing units by census tract and civil division in the greater Milwaukee area as shown on Figure 1. These totals were derived for the "Consumer Analysis" by adding the net gain in housing units since April, 1960, to the 1960 census figures.[5]

The number of existing housing units in the cities of Kenosha, Racine and Waukesha, not covered by the "Consumer Analysis," was determined by updating the census data utilizing building permit records furnished by the cities. In areas outside of the cities not covered by the "Consumer Analysis" but within the home interview area, the number of existing housing units was determined by counting residential structures on SEWRPC 1:4800 scale aerial photographs. Such photo interpretation was, of course, possible only in predominantly single family residence areas.

[5] Since the updating of the census dwelling unit count was based on the number of building and demolition permits issued, it was assumed that dwelling units for which permits were issued during or after January, 1963, would not be constructed or demolished before the start of the home interview survey.

Figure 1

MILWAUKEE HOME INTERVIEW SURVEY
EXPANSION AREAS



Once the number of existing housing units had been determined from the sources described, basic expansion factors for home interview samples were calculated for each expansion area by dividing the number of existing housing units by the number of home interview samples selected from the same expansion area. In determining these basic expansion areas, contiguous census tracts were grouped into 19 areas containing similar housing characteristics to better obtain a statistically significant sample.

Basic expansion factors ranged between 10.00 and 10.41 in the Racine-Kenosha home interview area, and, except for 18 census tracts, ranged between 30.51 and 33.37 in the Milwaukee home interview area. Seventeen of the undersampled tracts were located in or near the core of the City of Milwaukee and one was located in the center of the City of Waukesha. These census tracts, which contained a large number of housing units on commercial meters, were also grouped into contiguous areas for the purpose of calculating their basic expansion factors. Expansion areas for the Milwaukee home interview survey area are also shown on Figure 1.

The basic expansion factor calculated for each expansion area was listed and subsequently gang punched into the household survey cards representing interviews from those areas. (Gang punching is the automatic copying of punched information from a master card into one or more detailed cards that follow it.) Using these survey cards and factors, a summary tabulation was prepared listing the total housing units by census tract in the City of Milwaukee, and by civil division in the remainder of the home interview area as determined from the expanded survey data. The estimate of total housing units thus obtained was checked against the source data to verify that all expansion factors had been assigned properly. In all cases the expansion factor was found to be correct and no further adjustment was required.

Trip and Household Adjustment Factors

Since only completed interviews can be used to represent the travel, housing (except vacant units) and household characteristics of the home interview area residents, it was necessary to modify the basic expansion factor of these completed interviews to represent the total sample of completed interviews plus non-interviews. Based on the final disposition code assigned each non-interview, two such adjustment factors were necessary; one a household (and housing) adjustment factor and the other, a trip adjustment factor. Following are the ten final disposition codes that were used to rate each of the sample households and the formulae for calculating the two adjustment factors.

Final Disposition Code	Definition
Code 0	Completed interview
Trips Possible in Region	
Code 1	Refused
Code 2	No one at home
Code 3	Other (similar to codes 1 and 2)

Trips Not Possible in Region

Code 4 . . . . Vacant

Code 5 . . . . Residents out of the Region on travel day

Code 6 . . . . Other (including quarantined homes and the like, but not including vacant units)

Interview Not Possible (Sampling errors--not used for expansion process)

Code 7 . . . . Demolished dwelling unit

Code 8 . . . . Commercial use only

Code 9 . . . . Other sampling errors

The following household adjustment factor formula was then derived:

$$HAF = \frac{\text{Sum of the interviews listed under codes 0, 1, 2, 3, 5, 6}}{\text{Sum of the interviews listed under code 0}}$$

where HAF = household adjustment factor.

The following trip adjustment factor formula was also derived:

$$TAF = \frac{\text{Sum of the interviews listed under codes 0, 1, 2, 3}}{\text{Sum of the interviews listed under code 0}}$$

where TAF = trip adjustment factor.

Samples whose final disposition code was 4, vacant, did not require an adjustment factor, and vacant dwelling units were properly represented by only the basic expansion factor.

The trip and household adjustment factors were calculated for sampled housing units within each traffic analysis zone and district. These areal units were considered to be the best geographic bases for computing adjustment factors because the delineation of the traffic analysis zones and subsequent district boundaries, was based upon a grouping of areas of similar urban characteristics. It was concluded, therefore, that the completed interviews in a zone or a district would best represent the non-interviews in the same areal unit. A summary tabulation was prepared showing the number of samples assigned each type of final disposition code (0 thru 6) by zone and totaled by district. At each level (zone and district) the trip and household formula was applied to calculate the appropriate adjustment factors. After review and evaluation of the zone and district summary, it was decided that, except for downtown Milwaukee, adjustment factors should be applied at traffic analysis zone level. In downtown Milwaukee, due to the small size of zones and few households per zone, it was decided that adjustment factors should be applied at the traffic analysis district level.

The trip and household adjustment factor calculated for each zone or district was then entered into the appropriate household survey punch cards. With the addition of these two adjustment factors, each completed interview address summary card had three factors recorded on it: the basic expansion factor, the household adjustment factor, and the trip adjustment factor. All basic expansion factors were calculated to hundredths and rounded to tenths before they were punched into the survey cards. Adjustment factors were calculated to hundredths and punched as such. When the final trip factor and household factor (basic factor x adjustment factor) were calculated, the results were rounded to tenths, and when these factors are accumulated for summary tables of trips between zones, the totals will be rounded to the nearest whole number.

Checking the Expansion Factors

A preliminary check of the household adjustment factor was accomplished by comparing population and automobile registration by civil division, as determined from the expanded interview sample, with similar data from the "Consumer Analysis," the 1960 census of population and the Wisconsin Motor Vehicle Department (MVD) records. Population by civil division was compared with 1960 census totals, to see that the expanded counts neither fell below the 1960 census totals nor exceeded them greatly. The 1963 automobile registration figures by civil division were obtained from the MVD, but these figures included business-owned passenger cars and taxis, and excluded Federal vehicles. Therefore, only a generalized comparison of automobile ownership could be made. Since more confidence was placed in the expanded count of housing units by civil division, as derived from the "Consumer Analysis" information, the ratios of autos per household and persons per household were calculated from the expanded sample for each civil division and compared with census data. No significant discrepancies were revealed by any of these checks.

After these checks of the sample expansion factors were completed, the final trip and household factors were entered into the internal trip and household history survey cards. This was completed in two steps; first, all trip cards were sorted and matched, by sample numbers, with their respective interview address summary card and the final trip factor transferred by gang punching. When this was completed, the household history survey cards were matched by sample number with their respective interview address summary cards, and the final household factor was gang punched in each household history card.

TRUCK AND TAXI SURVEY

Samples for the truck and taxi survey were drawn from the Wisconsin Motor Vehicle Department (MVD) vehicle registration file and a special list of all taxis and Federal trucks operating within the Region. The former contained all private and municipal truck registrations but did not contain taxis and Federal trucks. A list of these vehicles was compiled by contacting Federal agencies, taxi companies, and municipal clerks. A sample of 1 in 12 taxis and trucks was then drawn from the MVD file and the SEWRPC list in the Milwaukee area, and of 1 in 4 in the Racine-Kenosha area.

Basic Expansion Factor

Since no better estimate of the total number of taxis and Federal trucks was available than the list compiled by the SEWRPC, the basic expansion factor used for these samples was simply the reciprocal of the sampling rate used, i.e., 12 or 4.

The basic expansion factor for other trucks garaged in the home interview survey area was determined by civil division or group of civil divisions. The number of samples obtained from each civil division expansion area was divided into the number of trucks garaged in the same area, as reported by the MVD. These factors were calculated for two categories of trucks, light trucks (net weight 8,000 pounds or less and all farm trucks) and heavy trucks (net weight more than 8,000 pounds). The light and heavy truck categories were identifiable from the license number of each truck sampled.

Since the MVD did not separate municipal vehicles by type, the above procedure could not be followed for municipal truck samples. A review of the original source data revealed that, of the municipal vehicles that were included, an adequate sample had been obtained; therefore, a basic expansion factor of 12 was assigned the municipal truck samples in the Milwaukee area, and a basic expansion factor of 4 in the Racine-Kenosha area.

The basic expansion factors calculated as described above were entered into the appropriate truck and taxi survey punch cards.

Trip Adjustment Factor

The trip adjustment factor for the truck and taxi samples was determined in a manner similar to that followed for the trip adjustment factor for the home interview samples. Each sample was assigned a final disposition code identifying it as a completed interview or one of ten non-interview types. The trip adjustment factor was determined from the relationship between the number of completed interviews and the number of non-interviews representing trucks or taxis that could have made a trip in the Region on the assigned travel day. Listed below are the eleven final disposition codes that were used to rate each of the truck and taxi samples, along with the formula for calculating the trip adjustment factor.

Final Disposition Code	Definition
X	Completed interview
Trips Possible in Region	
1	Refusal
2	No one home
3	Cannot locate

4 . . . . Travel date past due

5 . . . . Other (similar to 1 thru 4)

Trips Not Possible in Region

6 . . . . Moved out of the Region

7 . . . . Junked--no replacement

8 . . . . Out of Region on travel date

9 . . . . Permanently assigned out of Region

0 . . . . Other (similar to 6, 7 or 9)

$$TAF = \frac{\text{Sum of the interviews listed under codes X, 1, 2, 3, 4, 5}}{\text{Sum of the interviews listed under code X}}$$

where TAF = trip adjustment factor.

The trip adjustment factor, calculated by the above formula, was punched into the survey card for each completed truck and taxi interview. The same expansion areas used to develop the basic expansion factor (civil divisions) were also used for the trip adjustment factor.

To determine the final trip factor for the completed interviews, the basic expansion factor was multiplied by the trip adjustment factor. Basic expansion factors were calculated to hundredths and rounded to tenths before being punched into the survey cards. Trip adjustment factors were calculated to thousandths and rounded to hundredths before being punched into the completed interview survey cards; final trip factors were rounded to tenths.

HOUSEHOLD POSTAL QUESTIONNAIRE SURVEY

Using utility company records as the address source, postal questionnaires were mailed to all permanent residences of the Region outside the personal interview area. The basis of geographic control for the questionnaires was the post office service area. The basic expansion factor was calculated by dividing the number of questionnaires mailed to a post office service area by the number of usable questionnaires returned from the same post office service area. The factors derived were entered into the appropriate household survey punch cards. These survey cards were then sorted by civil division, and the basic expansion factor in each household survey card accumulated on a summary tabulation.

Housing Unit Adjustment Factor

A preliminary total of 1963 occupied housing units for each civil division, obtained by applying the basic expansion factor to the sample returns, was compared with occupied housing unit totals for each civil division, obtained by updating 1960 census of housing data to 1963 by means of building permit records.[6] It was determined from this preliminary analysis that an adjustment factor was necessary to obtain a correct total of occupied housing units in each civil division. The civil division housing unit adjustment factor was determined by dividing the expanded occupied housing unit count into the updated census count of occupied housing units. The quotient derived was entered into the appropriate household survey cards.

To verify the accuracy of the housing unit adjustment factor, and to evaluate the population count, a detailed listing by civil division was prepared. The housing unit count was determined by the accumulation of the product of the basic expansion factor and the housing unit adjustment factor for each survey card. In addition, the product of this calculation was also multiplied by the number of persons living at each sampled household, and the second product summed to arrive at a population estimate for each civil division in the postal questionnaire survey area. The housing unit count for each civil division was checked against the source data to verify the accuracy of the expansion. The results of this occupied housing unit check were considered satisfactory; and therefore, the housing unit adjustment factors were considered adequate. The product of the basic expansion factor and housing unit adjustment factor was the <u>final occupied housing unit factor</u>.

Household Characteristic Adjustment Factor

The preliminary check of expanded population figures against 1960 census figures was not considered satisfactory. Since reliable 1963 population figures were not available, the 1960 ratio of persons per occupied housing unit was compared to the 1963 ratio as derived from the postal survey. This comparison indicated a need for a household characteristic adjustment factor in some localities. In almost all such cases, the number of persons per occupied housing unit was higher for the postal questionnaire survey than for the 1960 census. A comparison of the proportion of one and two person households, as reported in the postal survey, against those reported in the census, was made for selected areas. On the basis of this comparison, it was concluded that one-person and two-person households were not adequately represented in the returned questionnaires. The household characteristic adjustment factor was calculated to correct the population count so that the number of persons per household would be compatible with the number determined in the 1960 census. The adjustment factors calculated were entered into the appropriate punch cards, and another summary tabulation was prepared to verify that the number of persons per household had been brought in line with the 1960 rates. In addition, automobile ownership per household as derived from the postal survey was compared with the ownership determined in the 1960 census. The number of autos owned per civil division determined from the expanded sample was also checked against counts provided by the MVD. In each of these checks, the household characteristic adjustment factor was found to be adequate; therefore,

[6] Source: Metropolitan Builders Association.

the product of the final occupied housing unit factor and the household characteristic adjustment factor was designated as the final household characteristic and trip factor.

Checking the Expansion Factors

An independent check was made in the rural areas of the number of occupied housing units in each traffic analysis zone. In such areas, it was possible to obtain a reliable estimate of the number of housing units in each zone from a residential structure count made on SEWRPC 1:4800 scale aerial photographs taken in March, 1963. The number of these units that were occupied was estimated by applying the occupancy rate determined from 1960 census data. The number of occupied housing units (households), thus estimated, compared favorably with the expanded postal area samples, and no further adjustments were deemed necessary.

The end results of the factoring process for the household postal questionnaire survey were two final factors--the occupied housing unit factor and the household characteristics and trip factor. Both of these factors were punched into the household survey card. The trip factor was subsequently transferred to the trip cards by matching sample numbers and gang punching the factor from each household survey card into its corresponding trip cards.

TRUCK AND TAXI POSTAL QUESTIONNAIRE SURVEY

All owners or operators of trucks and taxis in the postal questionnaire survey area, registered with the MVD or listed by the SEWRPC, were mailed postal questionnaires. It was originally intended that all the usable questionnaires returned would be expanded by civil division. Upon review of the returns, however, it was found that a bias would develop if this procedure was followed because many of the truck and taxi respondents were owners of fleets of vehicles, and either returned all or none of the questionnaires. This uneven return would serve to bias both trip reporting and number of vehicles by type. For example, the trip pattern of dump trucks might, on the basis of a biased return, be expanded beyond its true configuration while that of milk delivery trucks might be entirely missing. In order to minimize the effects of such a bias, ownerships were divided into two categories:

1. Owners of four or more trucks and all taxi owners were designated as multitruck/taxi operators, and

2. All other vehicle owners were designated as individual truck operators.

The source lists of names and addresses which were used to mail out the postal questionnaires were reviewed and separated into the two categories described above. Returned questionnaires were then matched and similarly divided. Multitruck/taxi operators who were not represented by a return questionnaire were contacted again by telephone and asked to submit travel data on a randomly selected 1 in 3 sample of their trucks or taxis.

Expansion Factors

To arrive at the basic expansion factor for each multitruck/taxi operator's vehicle, the number of his trucks or taxis operating in the survey area was divided by the number of completed questionnaires returned. The factor thus calculated was coded on the questionnaire and entered into punch cards along with the vehicle and trip data.

To account for the relatively few multitruck/taxi operators who did not respond after repeated contacts, some of the basic expansion factors used for the multitruck/taxi operators' samples were further adjusted to represent the nonrespondents. This was accomplished by matching the business-industry, and vehicle type where possible, of the owners within each civil division. The result of these calculations was a final expansion factor for multitruck/taxi operators.

The final expansion factor for the remainder of the trucks (individual truck operators) was developed on a civil division basis. No adjustment factor was needed. The total number of questionnaires mailed out to a civil division, minus the multitruck operators' vehicles, was divided by the number of questionnaires returned from the same civil division minus multitruck questionnaires returned. The result of each of these calculations was coded on the appropriate questionnaires and entered into punch cards along with the vehicle and trip data.

To check the number of trucks by expansion area, the expanded samples were summed by civil division and compared with MVD registration data. In a few civil divisions, the final expansion factors of the individual truck operators required corrections. In most cases, no further adjustment was considered necessary.

EXTERNAL (ROADSIDE INTERVIEW) SURVEY

As reported in a previous issue of the Technical Record, 27 of the 32 roadside interview stations were operated on a 14-hour basis (6 a.m. to 8 p.m.); the remaining five stations, located on the highest volume arterials, were operated on a 24-hour basis. Basic expansion factors were calculated at the time the interview schedules were edited. The editor selected the appropriate number of samples for coding, following the procedure described in the previously cited issues of the Technical Record. The basic expansion factors were calculated by dividing the number of external survey samples into the manual classification counts at each interview station for the directional hourly count of each vehicle type. The quotient was rounded to the nearest whole number by the editors. It was originally planned that the stations operated over a 14-hour period would be factored to represent 24-hour values after the accuracy checks were made. Upon checking the sum of the basic expansion factors by vehicle type over the entire interview period (14-hour day period or 10-hour night period) at each station versus similar totals by vehicle type determined from the classification counts, discrepancies were found for some vehicle types. These discrepancies were the results of the rounding procedures followed when calculating the basic expansion factor. This meant that an hour-of-interview adjustment factor, by vehicle type, was required for both the 14-hour and 24-hour stations in addition to the previously anticipated factor to expand the 14-hour counts to represent the 24-hour counts.

The hour-of-interview adjustment factor, required to more accurately represent total vehicles passing a station, by type, during the hours of interviewing, was calculated by dividing the classification counts for the interview period by the sum of the basic factors. This was computed for each vehicle type at each station.

The 24-hour adjustment factor, which was required to expand the data from 14-hour stations to represent 24-hour trip movement, was computed by dividing the 14-hour sum of basic factors into the 24-hour classification count[7] for each vehicle type at each station. Data from the five stations where interviews were obtained during all 24 hours did not require this 24-hour adjustment factor. However, to avoid special handling of data cards for interviews at these stations, the hour-of-interview adjustment factor was also entered in the card column designated for the 24-hour factor. Therefore, in all external survey data cards, the basic factor can be multiplied by the adjustment factor in one field to obtain the hour-of-interview total and by the adjustment factor in another field to obtain the 24-hour total.

Final Trip Factors

Using the basic expansion factor and the two types of adjustment factors, hour-of-interview adjustment factor and the 24-hour adjustment factor, two kinds of final trip factors were derived as follows. The hour-of-interview adjustment factor was multiplied by the basic expansion factor; the product was the final trip factor for each hour of the 14-hour day interview period or 10-hour night interview period. These factors were used for cordon line and screen line accuracy checks. The product of the 24-hour adjustment factor and the basic expansion factor was the final trip factor for a 24-hour period. These factors will be used to represent average weekday trips in subsequent traffic assignment and travel analysis.

As part of the calculation of the final trip factors, it was necessary to introduce a half-factor for "through" trips.[8] Since such trips were sampled twice, once each at station of entrance and at station of exit, their expansion factor calculated by the above procedure must be halved. This adjustment was made before the final trip factors were punched into the survey cards.

The end result of the procedure described above was an hour-of-interview final trip factor and a 24-hour final trip factor punched into each external survey trip data card.

ACCURACY CHECKS

When all trip cards contained the final trip factors, the data was subjected to several accuracy checks which will be described in greater detail in a future issue of the Technical Record. Internal-external trips of residents, which were sampled both by roadside interviews and by the other surveys, were independently compiled from each of these sources and the results compared. Duplicate sampling was then eliminated. Trips having origins and destinations on opposite sides of selected screen lines were compared with the number of vehicles counted at all crossings of these screen lines. Population and auto ownership per civil division were checked as described in this

[7] At 12 light volume stations, classification counts were not made for the hours 9 p.m. to 5 a.m. For these stations 24-hour classification counts were estimated by multiplying the 16-hour classification counts by the ratio of 24-hour machine count volume divided by 16-hour machine count volume.

[8] Through trips are those trips reported at an external interview station whose trip origin and destination were both outside the external cordon line.

article. Only after such checks were the data considered ready for compilation into tables of trips between zones. This compilation, and its analysis, will also be described in a future issue of the Technical Record.

CONCLUSION

The discussion in this article of the difficulties encountered in the development of expansion factors for samples drawn from electric utility records may appear to deprecate the usefulness of such records in an origin and destination study. Such an implication would be unfortunate for it is neither intended nor warranted. Quite to the contrary, it is considered that electric utility records properly organized provide an excellent universe from which to draw samples in a large scale study.

In this study, time limitations between access to the records and the starting dates of the field surveys precluded a thorough examination of the organizational structure of the commercial accounts in the records. If such an examination had been made, it is believed that a more detached representation of the Region's housing units would have been obtained. It should be noted that even without this examination the areas in which substantial discrepancies were found amounted to only a very small portion of the large survey area.

The use of an independent source for a determination of total 1963 housing units for subareas of the Region was necessary in this study because of the obvious discrepancies in housing unit counts in the home interview data. It is suggested, however, that such a check would probably prove useful in any case.

Precise records of the costs involved in the development of expansion factors of the component surveys were not kept, but it is estimated that $3,000 closely approximates the actual costs of labor and data processing equipment required.

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In 1953, MCDC purchased all of the vacant greenbelt land, 2300 acres, together with the shopping area and community buildings, ending Federal ownership and interest in Greendale. MCDC engaged a permanent planning staff headed by Mr. L. A. Riegel and retained Mr. Elbert Peets, one of the original greenbelt town planners, to prepare an overall plan for the continued development of the village as well as to administer development policies in cooperation with the Village Plan Commission.

The new plan for Greendale evolved by the MCDC staff, unlike that for many suburbs in the metropolitan area, attempts to provide a socially and economically balanced community by allocating land to both high and low cost single and multifamily residence use. Three single family residence districts are provided by the new plan with minimum net lot areas per dwelling unit of 7140, 8400 and 30,000 square feet. Homes range in price from $15,000 to $40,000 including

Continued on page 33

(Backward Glance continued from page 32)

lots. Multiple family residence areas call for a minimum net lot area per dwelling unit of 2,000 square feet. The multiple family residence areas are, however, carefully interspersed among the single family areas to achieve an overall gross development of about 10 persons per acre, somewhat lower than the overall gross density of the original town site of approximately 15 persons per acre.

In addition, the new plan allocates land to light industrial as well as to commercial use, a significant departure from the original plan. To date, a large research laboratory, a plastics molding plant, and a half million dollar addition to the original shopping center have been completed under the new plan.

The new plan provides a street pattern which, like that of the original plan, is based upon a functional street classification system. Four types of streets are provided:

1. Regional trafficways which range from 90 to 200 feet in right-of-way width and are fully controlled as to access.
2. Village trafficways which range from 80 to 100 feet wide in right-of-way and also are fully controlled as to access. No lots front on these streets, and generally no utilities are installed in these streets.
3. Collector streets which feed to village trafficways and are all 60 feet wide in right-of-way.
4. Land access streets which range from 40 to 50 feet wide in right-of-way and which are generally designed as loop streets.

Street layouts are carefully adjusted to the topography, and final locations are based upon fine grading studies. Planting screens are provided along all regional and village trafficways making them, in effect, parkways.

The new plan allocates approximately 1,000 acres or 38 percent of the total area of the village to park and parkway purposes, and it sets aside another 135 acres for school and church sites. Park areas are located to preserve such points of natural beauty as streams and watercourses, stands of fine trees, or high points offering exceptional vistas.

Perhaps the most noteworthy thing about the new plan, however, is the manner in which it is being implemented. Whenever MCDC and the Village Plan Commission decide that an integrated area (modified neighborhood unit) is ready for development, a development contract is negotiated with a local builder. The decision as to development times is based upon such community consideration

Continued on page 34

(Backward Glance continued from page 33)
as school, utility, fire and police protection requirements and capacities as well as on consideration of real estate market factors. In the development contract MCDC agrees to sell the land for a stipulated price; the purchaser agrees to subdivide and improve the site and erect a home on every lot within three years, all within the framework of the general plan and under MCDC supervision and control. MCDC reserves the right to approve all site improvements, all building plans, and all building costs and sale prices. Site improvements required include sanitary sewers, storm sewers and water mains, all sized according to a general system plan; service laterals from the mains to the lot lines; concrete curb and gutter, concrete walks, and an intermediate type of bituminous pavement. In addition, deed restrictions are required for each integrated area regulating such matters as the size of front, side, and rear yards; minor lot and building sizes; location size and type of fences; and architectural control over all new construction.

Development under the new plan has been rapid, with the village population increasing from 2750 in 1957, to 6843 in 1960, to about 9800 in 1963. Even during periods when residential construction declined generally in the metropolitan area, Greendale's development activity continued to rise indicating that the distinctive characteristics of the village are attractive to the public. The success of the continued planned development of Greendale lies, in part, in the fact that one corporate body controls the undeveloped land surrounding the village and that this body has chosen to exercise this control with enlightened self-interest. The manner in which the physical development of a community can be shaped to a plan through such control makes such usual plan implementation devices as zoning, official mapping and subdivision control seem crude by comparison.

A typical street scene in the original townsite of Greendale as it appears today is shown in the above photo. After 25 years, the area is even more attractive and desirable as a residential area than at the time of its construction.

Continued on page 35

(Backward Glance continued from page 34)

New development has been placed in both time and space for the best interests of the community. Entire integrated areas are completely developed over a short period of time, thereby providing the community with a maximum tax base and avoiding troublesome pockets of vacant land. Growth is orderly following the logical extension of existing utilities, and the rate of development is geared to school and other community service capacities as well as market demand. Each potential development is studied in light of the community plan, and a degree of control is exercised over site improvements and architectural treatment difficult to achieve through the usual subdivision control ordinance. Finally, positive means are provided, through the deed restrictions, of maintaining the desirable physical characteristics of the community regardless of future changes in the form or attitude of government.

The new plan for Greendale does not provide for the retention of a permanent agricultural greenbelt around the village. It does, however, provide for an approximation of such a greenbelt through the reservation of county parkland (Root River Parkway) along the southern and western boundaries of the village.

In both its original and current planning and development, the Village of Greendale represents an interesting planning experiment which has benefited its citizens with far ranging economic benefits, aesthetic architectural and park-like surroundings, and a very pleasant community environment in which to live. As such, it warrants further study by planners and public officials.

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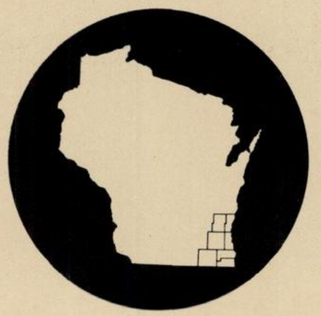
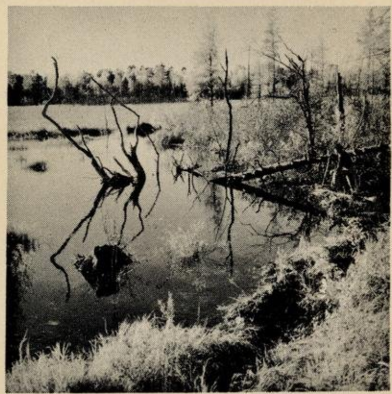
THIS IS SOUTHEASTERN WISCONSIN

Important vital statistics on the Region and percent of totals for the State of Wisconsin.

Land and Water Area (sq. mi.)	2,688	5%
Population (1960)	1,573,620	40%
Resident Employment (1960)	612,723	42%
Resident Unemployment (1960)	24,174	41%
Resident Labor Force (1960)	636,897	42%
Resident Man'f. Employment (1960)	253,292	52%
Resident Non-Man'f. Employment (1960)	359,431	37%
Disposable Personal Income (1960)	$3,572,000,000	46%
Retail Establishments (1958)	15,780	33%
Retail Sales (1960)	$2,045,000,000	42%
Property Value (1960)	$8,726,000,000	46%
Total Shared Tax (1960)	$62,777,000	54%
Total State Aids (1960)	$35,474,000	26%
Total Property Tax Levy	$239,380,000	50%
Total Long Term Public Debt	$378,592,000	55%
Total Highway (miles) (1960)	8,740.45	8.9%
Value of Mineral & Non-Metal Production (1961)	$15,494,487	20.08%
Total Vehicle Registration (1962-1963)	633,540	36.8%
Auto Vehicle Registration (1962-1963)	551,188	40%
Truck Registration (1962-1963)	55,950	23%
State Parks & Forest Areas (acres) (1963)	12,546	3.02%





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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION