INTEGRATED DATA SYSTEMS
— A SUMMARY REPORT —

by

Stephen N. Runkle
Research Analyst

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

Virginia Highway & Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways & Transportation and the University of Virginia)

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SUMMARY

The purpose of this report is to provide a general outline of the automated data systems work under way at the Research Council. Included is a discussion of file contents, automated procedures, and outputs provided. In addition, a time schedule for implementation of the systems under development along with target dates for future reports are provided. Recommendations regarding future work thought desirable conclude the report.

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INTRODUCTION

The need to make compatible many of the automated data systems in use by the Virginia Department of Highways and Transportation has been recognized by the author and other persons at the Virginia Highway and Transportation Research Council, as well as by the management of the Data Processing Division. The means for achieving this desired compatibility is recognized as being the selection of a common locator method to be used in each system, whether included as input information or assigned automatically by the computer on the basis of some other descriptive information. A paper milepoint system based on the graphic logs maintained by the Department's Traffic and Safety Division has been selected as the common locator method to be used for new systems.

One of the first attempts at the use of integrated data systems is the data system for planning maintenance resurfacing, skid resistance research, and pavement design evaluation as initially proposed in the report "Data System for Planning Maintenance Resurfacing" by this writer.

PURPOSE AND SCOPE

The purpose of this report is to summarize the integrated system being developed by the Data Section at the Research Council for the purposes outlined above. Included are a general flow diagram of the system and a discussion of the data involved and outputs provided. Also, the status of the major components of the system is indicated along with an estimate of the time required for completion. The report includes recommendations regarding future work deemed desirable by the author.

Additional reports by those responsible for the development of the computer software to operate the system will describe in detail the file layouts and computer programs, and will provide the information necessary to operate and maintain the system. Approximate dates for these future reports are indicated later in this report.

GENERAL SYSTEM OUTLINE

This section includes a discussion of the general outline of the system as it is now envisioned, as well as the status of various segments of the system. A following section will indicate a time schedule for completion of the system. As originally envisioned, the integrated system was to involve the use of five automated data systems either in existence, being developed, or planned. These systems were (1) the pavement data system, (2) the skid data system, (3) the dynaflect data system, (4) the accident data system, and (5) the traffic volume data system. As it is now conceived, the integrated system initially will utilize the pavement, skid, and traffic volume systems only.

The general flow diagram for the pavement, traffic volume, and skid systems is shown in Figure 1, and that for the integrated application of these systems is given in Figure 2. In each figure computer files are indicated by circles, and procedures, whether manual or computer or some combination, are indicated by rectangles, or by an output symbol when the procedure is used to produce some output. The status of the pavement, traffic volume, and skid systems will be discussed in the next three sections, and these will be followed by a section discussing the integrated applications of these systems. The final subsection within this general section deals with the timing of the system.

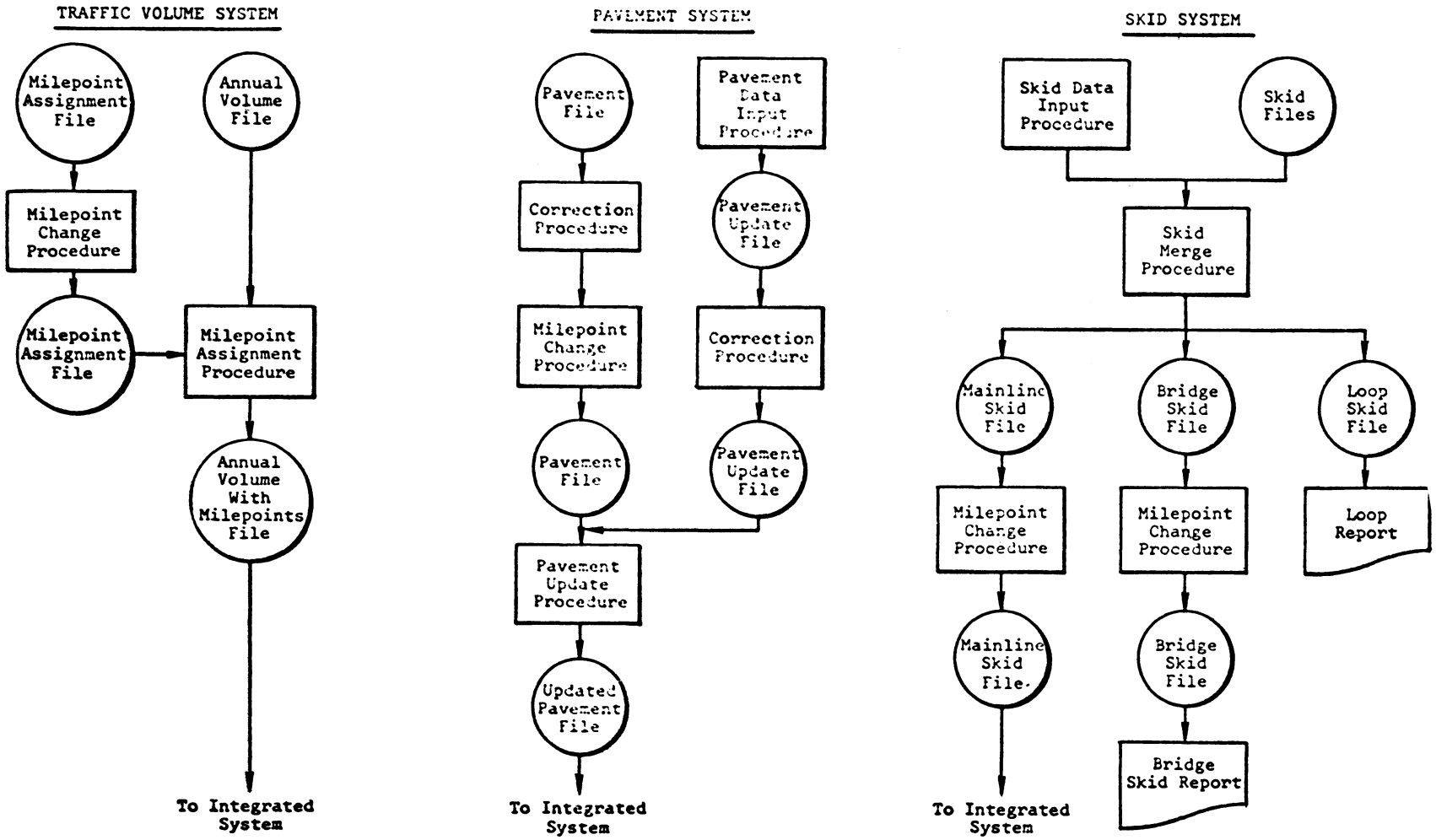

Figure 1. Flow diagrams for traffic volume, pavement, and skid systems.

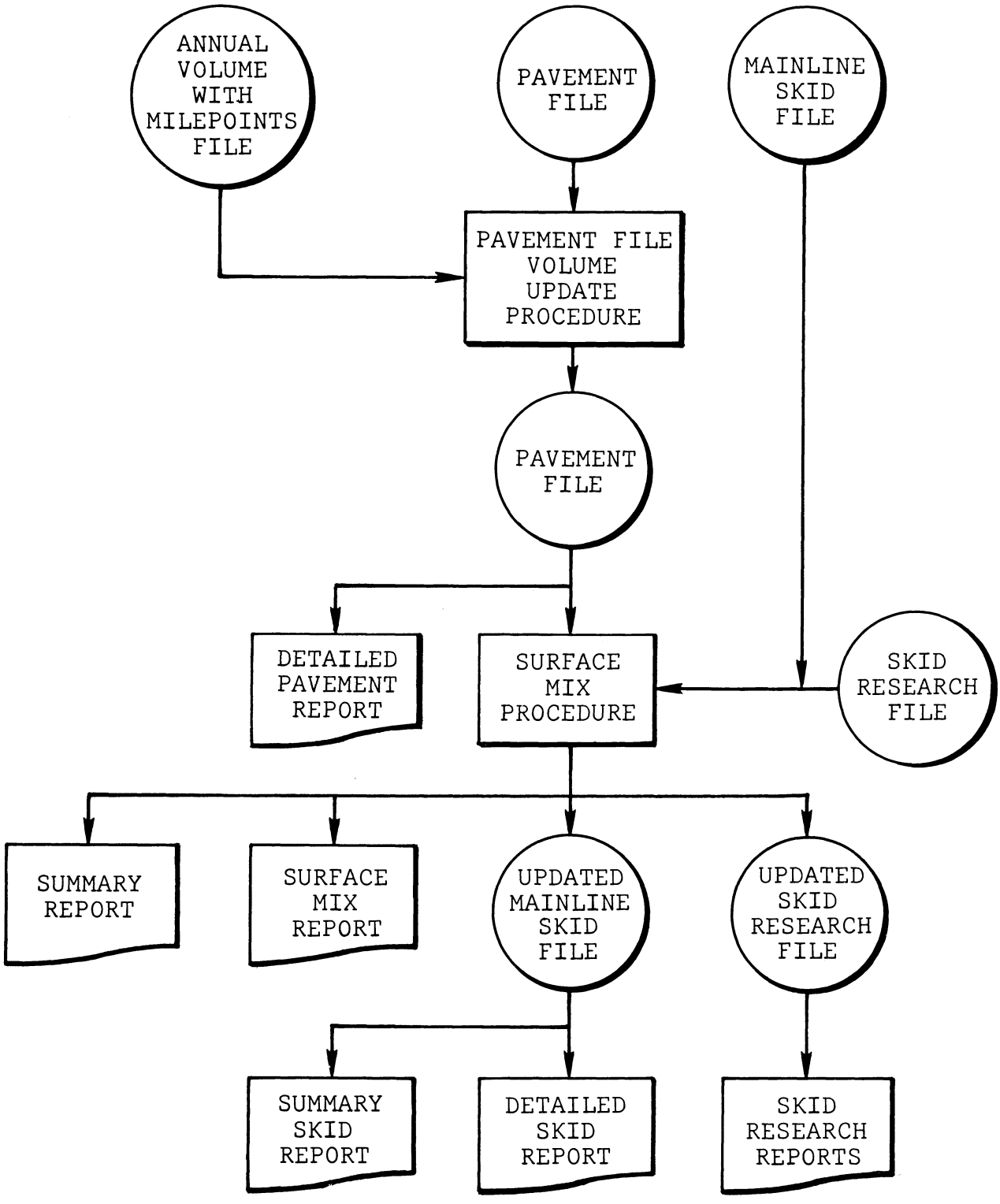

Figure 2. Flow diagram for integrated system.

Pavement System

Pavement File and Pavement Update File

Each record in the pavement file refers to a physical section of roadway within which each of the items of data contained in the record as shown in Table 1 remains constant. As indicated by the locational data system in Table 1, a pavement section can include all lanes of a highway, all lanes in a given direction, or a single lane in a given direction. Thus, if information as shown in Table 1 is different for directions, or even for lanes, then separate pavement records will exist showing the correct information.

The pavement file is being maintained by the Data Systems and Analysis Section on the CDC 6400 computer at the University of Virginia's Center for Academic Computing. Presently, the information shown in Table 1 under locational data, additional descriptive data with the exception of design 18 Kip volume, and surface materials and construction data are contained or being placed on the file for the interstate, arterial, and primary systems. For much of the primary system aggregate data are not readily available and thus are not in the file. Since the inception of the field data collection in 1972, all data just mentioned plus subsurface materials and construction data (except for traffic volume information and reason for resurfacing) for subsurface layers have been included as regular input to the system. It should be mentioned that the subsurface layer information shown in Table 1 includes former surface layers when they become part of the subsurface.

Work is now under way to modify the pavement file so as to allow for all the data items shown in Table 1, including volume data, and to place the file on the IBM 370 computer used by the Virginia Department of Highways and Transportation. While space will be available in each file record for reason for resurfacing, the actual submission of these data as yet has not begun.

The comments made above about the pavement file are true for the pavement update file. Obviously, the pavement update file will never contain actual traffic volume information since these data are entered into the system at a later point as indicated in Figure 1.

TABLE 1

Items of Data in Pavement File Record

Locational Data	Additional Descriptive Data	Surface Materials and Construction Data	Subsurface Materials and Construction, Data For Each Layer	Traffic Volume Data
District	Project Number(s)	Mix Type Completion Date (month & year)	Mix Type	Accumulated Volume since Previous Resurfacing for:
Residency	Schedule Number	Special Feature	Depth	18 Kip
County	Highway System	For Bituminous Plant Mixes Asphalt Type	Percent Cement/Lime/Asphalt	2 Axle Vehicles 3 " " 5 " "
Route Number	Highway Type	Application PSY Average Design Asphalt Content	Year of Completion	
City (Business Routes only)	New Construction Code	For Portland Cement Mixes: Curing Method		AVD - Latest Year
Beginning Milepoint		Texturing Method Bags per Cubic Yard	Actual Accumulated 18 Kip Volume	
Ending Milepoint	Specification Year	Cement Source Construction Method	Reason for Resurfacing	
Direction	Design 18 Kip Volume based on constructed cross section	Thickness Joint Spacing		
Lane		Joint Material For Bituminous Surface Treatments:		
Beginning Description		Asphalt Type Asphalt, GSY		
Ending Description		Stone, PSY For each Aggregate:		
		Size Geologic Type		
		Source Percent		

Pavement Data Input Procedure

Since 1972, input of all data shown in Table 1 except the traffic volume data, reason for resurfacing, and design 18 Kip volumes have been submitted from the field on coded forms as described in the report entitled "Pavement Data System Code Manual" (revised September 1974). The responsibility for monitoring the field submission of data for maintenance resurfacing (including ensuring that all data have been submitted), and for revising the code manual as necessary has been transferred to the Maintenance Division. Data for new construction are channeled through the Construction Division. Some thought is being given to the possibility of modifying the field submission of data and effectively eliminating the requirement to have the field personnel code input forms. Instead, precoded forms would be sent to the field for submission when work was completed with corrections noted where necessary. This system of inputing data will be dependent on automating to some extent the schedule preparation procedure and will be discussed again under recommendations. Once submitted, new pavement data are keypunched, and an annual pavement update file created. At present, the forms are sent from the Maintenance and Construction Divisions to the Data Processing Division. The forms are then sent to the Data Section at the Research Council for keypunching and preparation of the update file. Obviously, when the system is transferred to the Data Processing Division the keypunching and preparation of the update file will be handled by that Division.

An edit program for the purpose of editing new pavement data and building the pavement update file has been developed and utilized on the CDC 6400 computer system. At present, this program is being modified for use on the IBM 370 system consistent with the pavement file modifications discussed earlier.

One critical aspect of the pavement data input procedure is the verification that beginning and ending milepoint locations shown for each section are correct when the sections are on routes where milepoint changes have occurred because of relocation of a portion of the route, dual dividing a two lane route, or for some other reason. A milepoint change procedure for adjusting milepoint information in the pavement data base for routes where milepoint changes have occurred will be discussed later. However, the pavement system as it now operates assumes new pavement data reflect correct, new milepoint locations.

Presently, the verification that new pavement information has new milepoint information where milepoint changes have occurred is handled by the Data Section. This verification is accomplished in part by evaluating updated graphic log sheets supplied by the

Traffic and Safety Division and determining routes where milepoint changes have occurred. New pavement data for these routes are then reviewed to verify the milepoint data. However, this process is often complicated since new pavement data may be received before the updated graphic log sheets due principally to the fact that updated graphic log sheets are sent out semi-annually. Additionally, work is required to develop an orderly method of ensuring correct milepoints for new pavement data where milepoint changes have occurred before implementing this segment of the pavement data input procedure.

Because of the milepoint change problem, only new pavement data having a completion date prior to January 1 will be included in each year's pavement update procedure. This will be discussed further under system timing.

Correction Procedure

The pavement data correction procedure is utilized to make corrections to any item (or group of items) of a pavement file record as shown in Table 1. It is used on the pavement update file prior to the updating procedure, and can be utilized at any time on the pavement data base. A flow chart depicting the correction procedure is shown in Figure 3. The edit program is the same program discussed above under pavement data input procedure. The correction program has been developed and utilized on the CDC 6400 computer, and, as with the edit program, is now being converted for use on the IBM 370.

While it is not presently being done and thus not shown in Figure 3, it may be recommended that listings of the pavement update file be provided the Maintenance and Construction Divisions prior to correcting the update file. Corrections to the file could thus be made on the basis of a review of these listings.

Milepoint Change Procedure

The milepoint change procedure is utilized to change milepoint information in the pavement data base when milepoints change along a highway due to some physical change in the highway such as a relocation. For example, suppose a curve was straightened as illustrated in Figure 4, where the original length of the road through a county was 16 miles. The relocation resulted in a decrease of one mile in the total length with milepoint locations up to 6.0 being identical after the relocation, milepoint locations between 6.0 and 7.0 describing the new section, and milepoint locations beginning at 8.0 for the old route now being reduced by 1.0. In addition to the illustration in Figure 4, milepoint changes may occur as existing two lane facilities are made four lane facilities as well as in other circumstances.

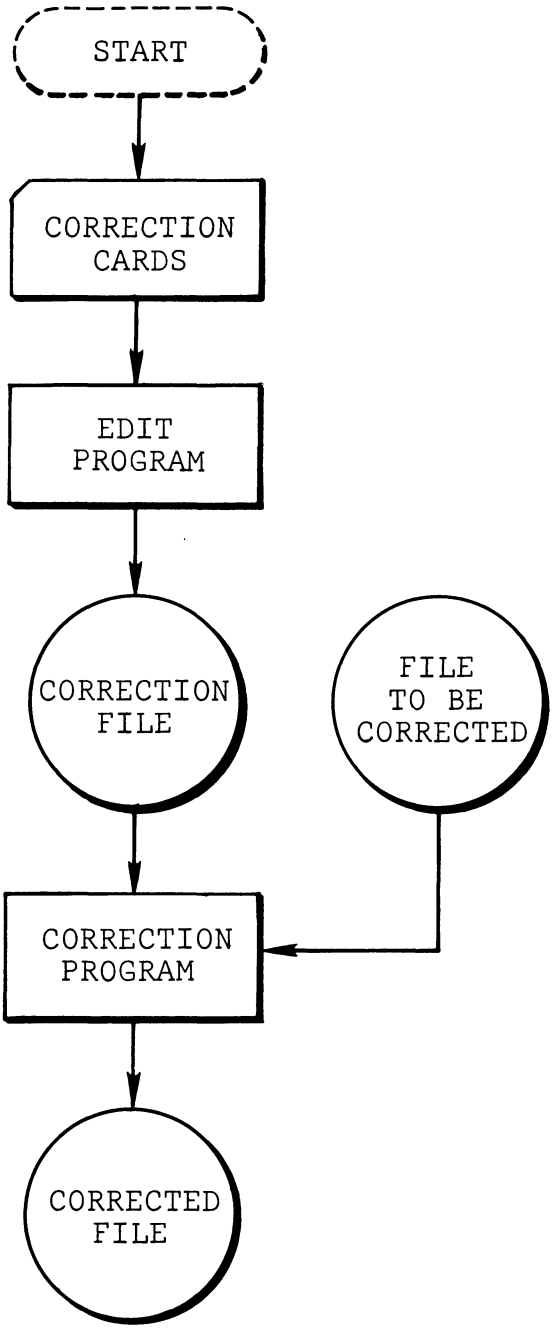

Figure 3. Flow diagram of correction procedure.

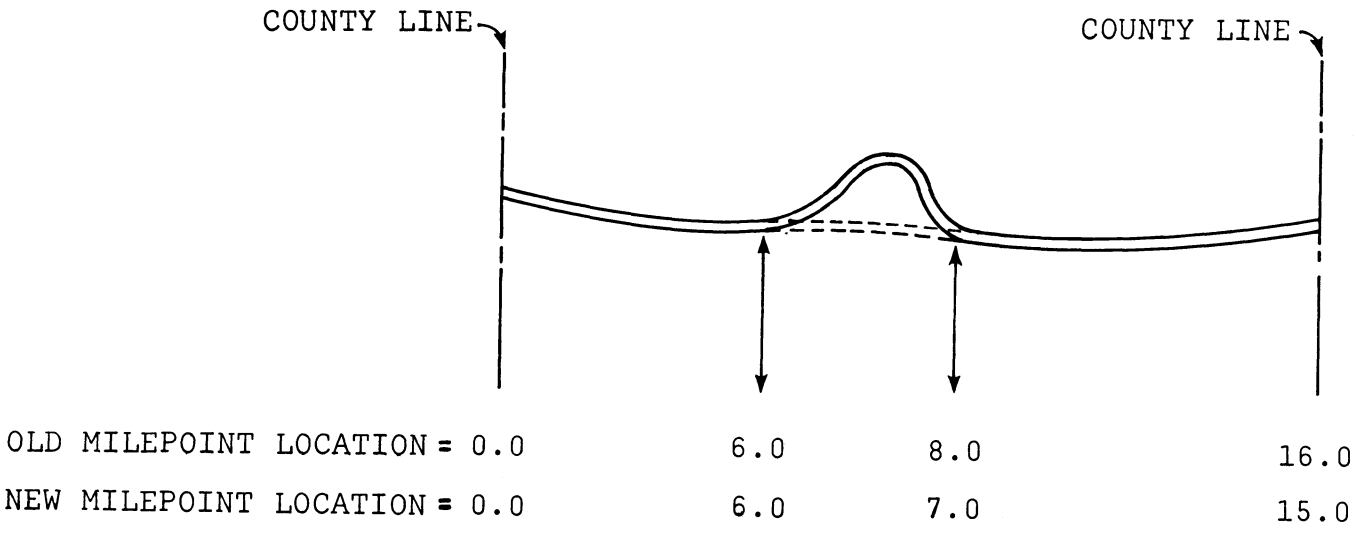

Figure 4. Illustration of milepoint changes due to relocation.

A flow chart for the milepoint change procedure is shown in Figure 5. As with the other programs discussed thus far, the programs indicated in Figure 5 have been utilized on the CDC 6400 computer and are now being modified for use on the IBM 370 computer. The modification also will ensure that the same programs as currently used to make milepoint changes to the pavement file can be utilized for milepoint changes to the skid and milepoint assignment file. The procedure allows for three basic commands to be carried out by the milepoint change program. These are: (1) a delete command that allows for the deletion of a section of highway between stated milepoints as for the removed curved section between milepoints 6.0 and 8.0 in Figure 4; (2) a retain command that allows for changes to descriptive information on a record as may be required when milepoints change as a result of dual dividing a two lane road (for instance, the lane-direction of an existing record would change if a two lane road was dual divided); and (3) a modify command that allows for adjustments to milepoint data of a stated amount on all sections between defined milepoints (the 1.0 reduction between milepoints 8.0 and 16.0 in Figure 4 is an example).

Presently, the command data utilized in the milepoint change program to make milepoint changes are obtained from updated graphic log sheets as submitted by the Traffic and Safety Division. This work, which is handled now by the Data Section, involves a review of each graphic log update for a route to determine if a milepoint change has occurred, and if one has to determine the correct

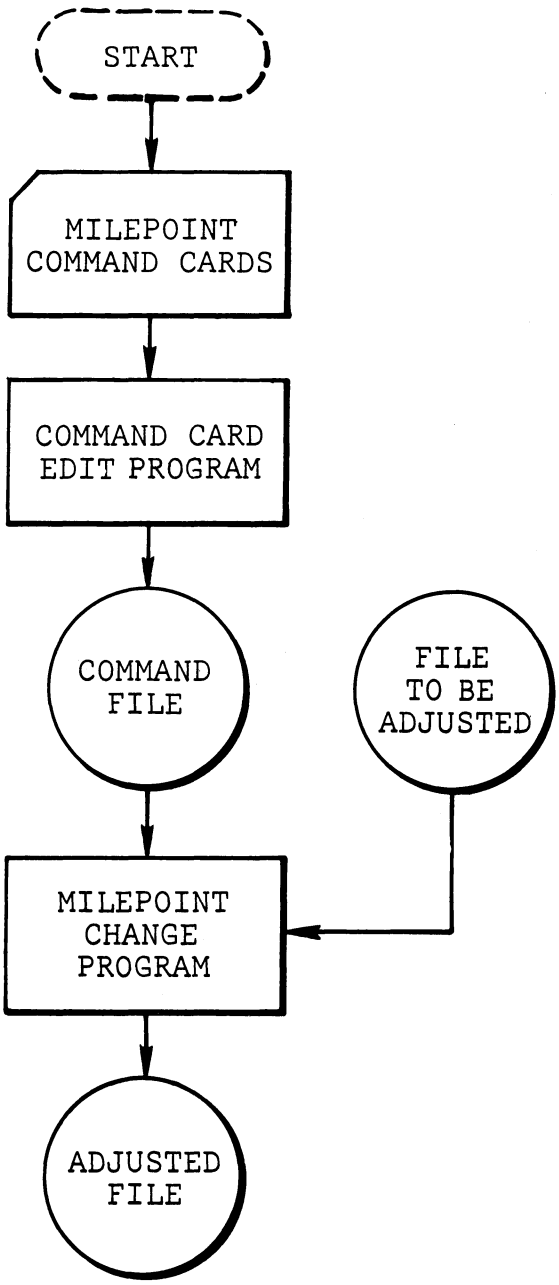

Figure 5. Flow diagram of milepoint change procedure.

milepoint change commands for input. As was indicated earlier, the same procedure is followed in verifying milepoints for new pavement data. This is a function which must be implemented in an operating division before the pavement system is totally implemented.

Pavement Update Procedure

The pavement update procedure is utilized to update the existing pavement data. A general flow chart for this procedure is shown in Figure 6. The pavement update program and milepoint program shown in Figure 6 have been developed and utilized on the CDC 6400 computer to maintain the pavement data base, and are presently being modified for use on the IBM 370 computer.

The update program automatically changes information in the data base to make it consistent with new records. For instance, suppose a route had four existing pavement sections as shown in Figure 7. If a new surface was placed from milepoint 2.5 to 5.0, then section 2 would be subdivided in two sections of milepoint 1.5 to 2.5 and 2.5 to 3.2. Since a pavement section could contain data down to the subbase one can imagine how complex the update procedure must be to allow for all possible changes to the data base. Another common modification required is the lane and direction data in the data base for an existing two lane road when it is dual divided.

As part of the final modification of this program, a routine will be added to compute the design 18 Kip traffic volume based on the constructed cross section. Also, the volume data shown in the last column of Table 1 will be included in the new pavement record during the pavement file volume update procedure.

As indicated in a previous section, the update procedure retains certain information about the existing surface and makes it part of the subsurface data for the new pavement section. This information is shown in column 4 of Table 1.

The milepoint program produces a listing showing gaps and/or overlaps with regard to milepoint termini on pavement sections due to the update program. Any errors detected on this output are corrected through the correction procedure previously discussed. Obviously, when no further errors are detected the update is completed.

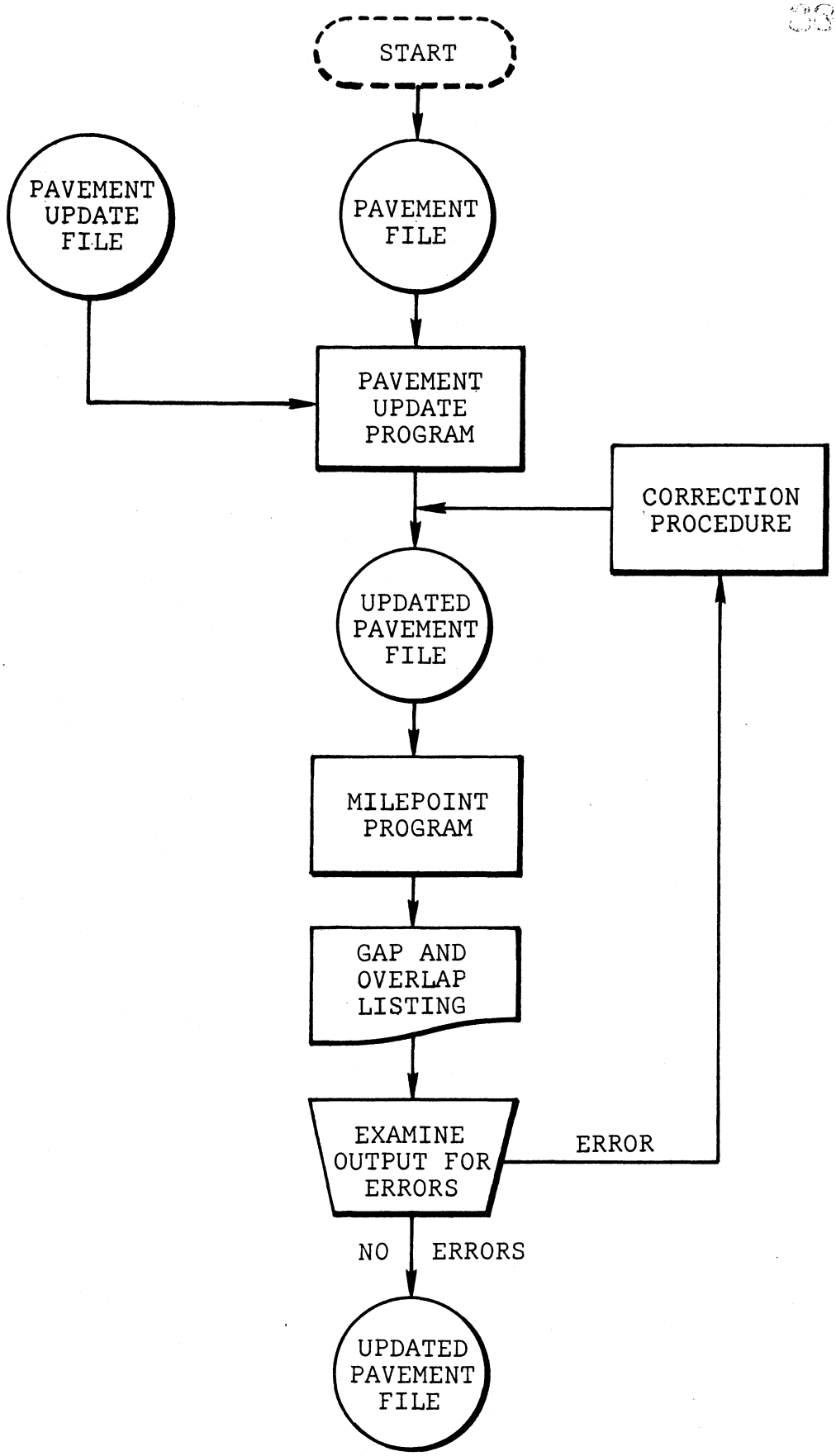

Figure 6. Flow diagram of pavement update procedure.

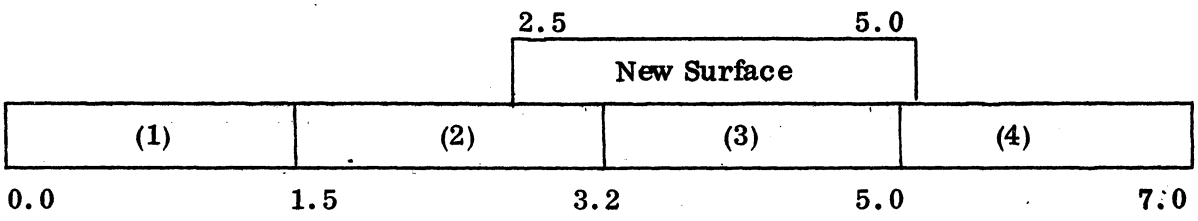

Figure 7. Example of pavement update data.

Traffic Volume System

Volume File, Milepoint Assignment File, Volume with Milepoint File

The traffic volume data used in the integrated system will be obtained from the annual volume file produced by the Data Processing Division for the latest year's volume data. Details about the contents in this file can be obtained from the Data Processing Division or the Traffic and Safety Division, which is responsible for the input of the volume data. The problem with utilizing this file is that milepoint information is not contained in the file. Thus, in order to utilize these data milepoint information must be appended to each volume section. This will be accomplished through the use of a milepoint assignment file and volume with milepoint file.

As yet, the precise contents for the milepoint assignment file and volume with milepoint file have not been decided. However, it is known that the milepoint assignment file record will contain traffic section identification with associated beginning and ending milepoints, and that the volume with milepoint file will contain descriptive information such as route, county, traffic section, and beginning and ending milepoints as well as average vehicles daily for automobiles, two-axle trucks, two-axle six wheel trucks, three-axle trucks, trailer trucks, and buses.

Milepoint Change Procedure

The milepoint change procedure used to correct milepoint information will be the same as discussed above for the pavement system. However, in this case the application will be much simpler in that only milepoint data for traffic sections will be changed, and not direction-lane designations. This is true since traffic sections pertain to the entire highway rather than just a given lane or direction.

Milepoint Assignment Procedure

As with the file contents as discussed above, the exact procedure to assign milepoint information to the annual volume file has not yet been determined. However, it is envisioned that this will likely be in the form of a single program which will not require a major effort to develop.

Skid System

Mainline, Bridge and Loop Skid Files

The mainline skid file contains skid data for the mainline traveling lanes of the highway system and, thus, excludes ramps and service roads. As the name implies, the bridge file contains data collected on bridge decks when the deck is different from the adjacent pavement surface. The loop file contains skid data from several selected sites which have been tested at various dates, and which will continue to be tested as part of the survey skid program. These data are used to ensure data accuracy over time.

A record in each of the three files contains the items of data shown in Table 2. Data type indicates if the data are mainline, bridge, or loop data, and thus allows for the division of the data into three files. Of the items shown in Table 2, air temperature, surface temperature, pavement condition, and time since last rain are collected only for loop skid tests. In addition, time is indicated only for the collection of loop data.

At present, the skid files are maintained by the Data Systems and Analysis Section at the Research Council on the IBM 370 computer. However, as of the writing of this report work is under way to transfer the responsibility for maintenance of the files to the Data Processing Division. All data in the files have been collected by the skid trailer operated by the Materials Division since June 1974. To date all data have been collected on the interstate system. While just data from the single skid trailer have thus far been placed in the data files, the file formats allow for data from the Research Council's skid trailer and car as well as new skid trailers.

TABLE 2

Items of Data in Skid File Record

District
Residency
County
Route Number
City/Town/County
Test Vehicle
Test Wheel
Calibration
Operators
Date of Test
Time of Test
Weather Condition
Air Temperature
Surface Temperature
Tread Depth
Direction
Lane
Date Type
Milepoint
Speed
Skid Number
Pavement Condition
Time Since Last Rain

Skid Data Input Procedure

The report entitled "Test Procedure and Data Input Techniques for Skid Testing" describes basic skid testing methodology and coding techniques for the input of skid data. The procedure allows for the complete manual coding of input data, or the manual coding of descriptive data only with skid number, speed, and milepoint being automatically obtained and printed on paper tape. The recent installation of the paper tape printer has led to some slight modifications being necessary in the input procedures. Presently, data are submitted to the Materials Division where they are reviewed and sent to the Data Section for keypunching for input to the skid data bases. Ultimately, the Data Processing Division will assume this function currently handled by the Data Section.

Prior to the complete implementation of the skid system the Data Processing Division is exploring the possibility of utilizing magnetic cassettes for the automatic retention of all skid test data at the time of the testing, thus eliminating the need for keypunching. The use of these cassettes may require further minor modifications in the input procedures, but these modifications will be handled by the Data Processing Division and those responsible for the survey skid testing program.

Skid Merge Procedure

A flow diagram for the skid merge procedure as it now exists is shown in Figure 8. The edit program checks the new skid data and creates a temporary file. When errors are detected by the edit program the correction program is utilized to make the necessary corrections to the temporary file. The merge program is then utilized to merge the new skid data with the existing data bases for mainline skid data, loop skid data, and bridge skid data. Thus, the entry of new skid data does not involve the removal of any data from the data bases. This type of update is done later through the surface mix procedure shown in Figure 2 for the integrated system. In addition to the programs shown in Figure 8, a separate correction program has been developed for the purpose of making corrections to any of the three data bases as may be required.

As indicated above, some slight modifications in data input coding are necessary with the installation of the paper tape printer, and additional modifications may be necessary if it is decided to install the magnetic cassette unit. These modifications have made it necessary to write a separate program to format the input data so as to make them acceptable to the edit program shown in Figure 8. The development of this program is now in progress.

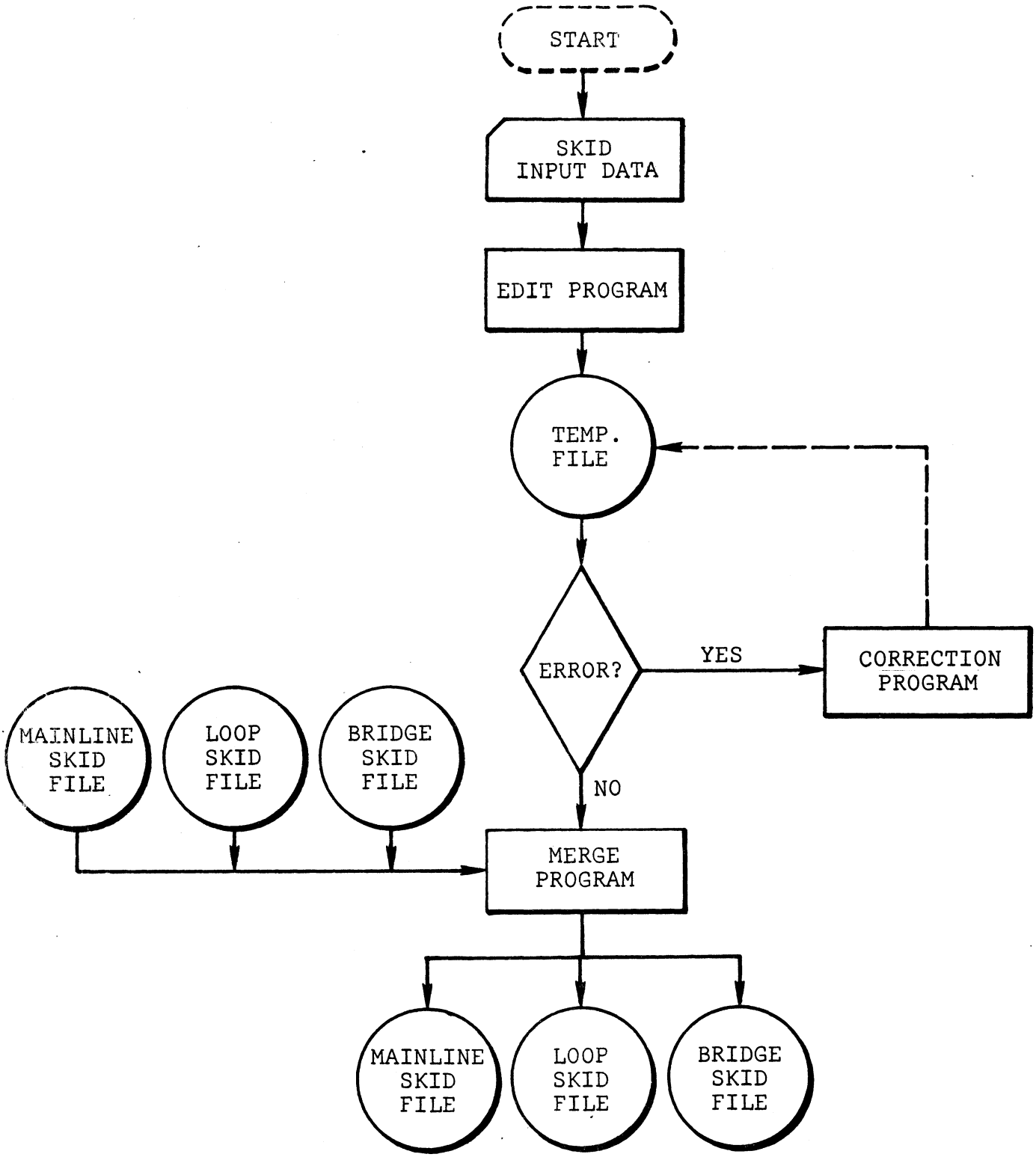

Figure 8. Flow diagram of skid merge procedure.

All of the programs shown in Figure 8 have been developed for use on the IBM computer, and, in fact, have been utilized on that machine via the Research Council's Data 100 Batch Terminal to maintain the skid system.

Milepoint Change Procedure

As with the traffic volume system, the milepoint change procedure used to modify milepoint data in the mainline and bridge skid files will be the same as discussed for the pavement system. As with the pavement system, at times it will require the modification of data items other than milepoint. In particular, it will be required to change the lane/direction data when highway type changes. Since loop skid data are obtained for specified test sections which remain the same, milepoint data here would be meaningless, and the milepoint change procedure will not be necessary with the loop skid file.

One further comment should be made regarding an assumption relative to using the milepoint change procedure on the mainline and bridge skid files. One item of data supplied with milepoint change command will be the effective date of the change (revision date shown on graphic log). In making milepoint changes to the skid files, it will be assumed that data collected before that date were on the basis of old milepoints, and these will be changed. Milepoints for data collected after that date will not be changed. The skid crew will thus have to record milepoint data on the basis of this assumption.

Loop Report

As indicated previously, loop skid data are those collected on a repeated basis from several selected sites used to ensure data accuracy over time. Some consideration has been given to adjusting survey data on the basis of loop results, but to date this procedure has not been implemented. The purpose of the loop report is then to indicate data trends with time for each of the loop sites.

Thus far, loop data have been output using the detailed skid output which will be discussed later under the integrated system. However, this type of output requires manual manipulation of the data contained in the output before the output is particularly meaningful. A loop output has been designed as shown in Figure 9 to meet user needs, but the program to produce the output has not been developed. When developed, the program will produce the loop output for each survey skid testing trailer in use if and when additional trailers are obtained. Also, the program will allow

LOOP DATA — SITE XXXX
TEST VEHICLE #X
INITIAL DATE XX-XX-XX

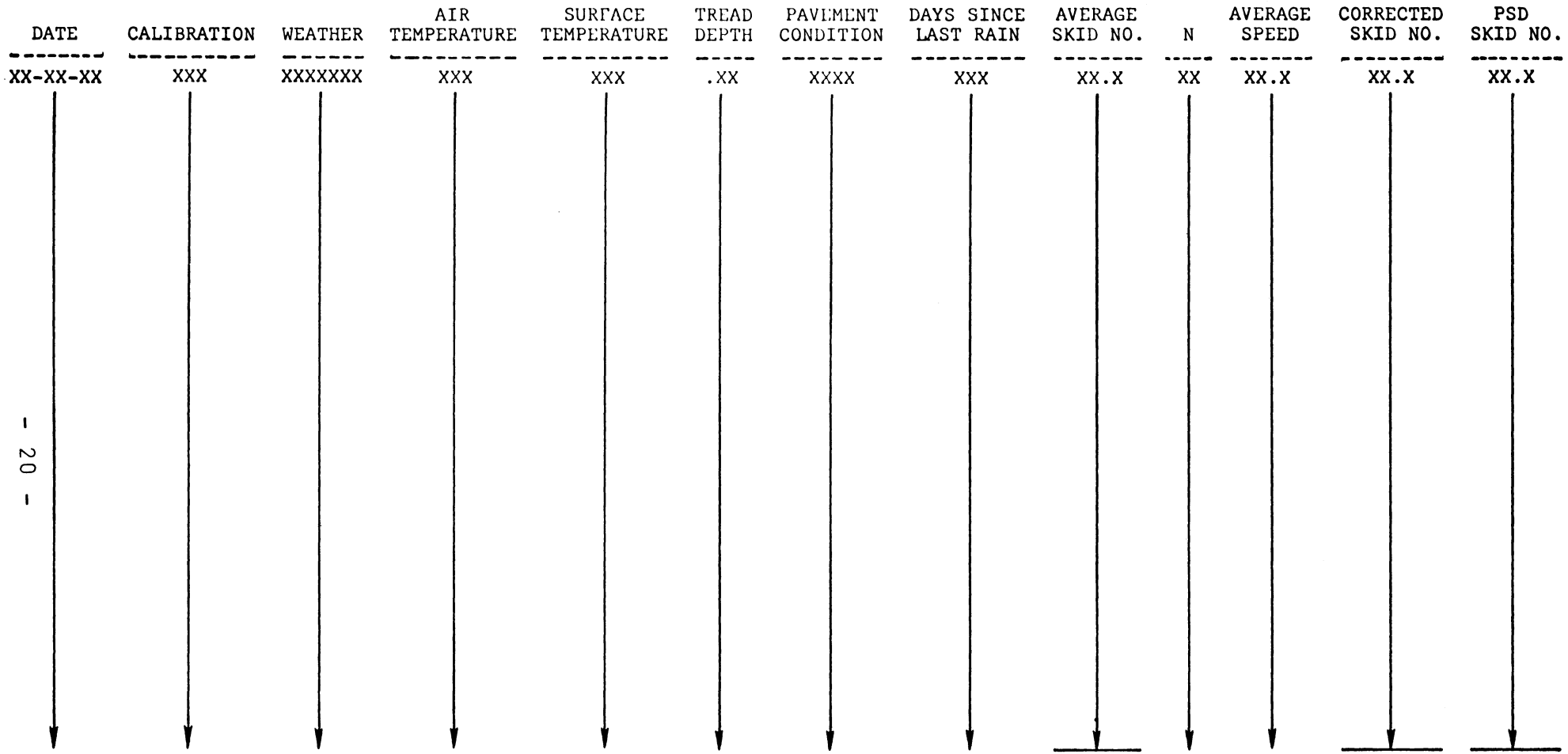

Figure 9. Example of loop output.

for an initial date to be specified so that data obtained prior to that date will not be shown on the output or included in the analysis presented as part of the output.

It is planned that the output as shown in Figure 9 will be obtained each time new skid data are added to the loop skid file. The output will be submitted to the skid crew stationed in the Lynchburg District, John Bassett in the Materials Division, and to the author at the Research Council. The item of most interest in the output is the corrected skid number value. Inspection of the individual values will show if data in any specific time period are unreasonable. The average and standard deviation values will indicate what range of variability one might expect. The descriptive type of data such as air temperature are included to allow for analyses to be made to determine what effect, if any, these data may have on the level of skid resistance in normal testing conditions. This output will also be used to determine what seasonal trends may exist in the level of skid resistance.

Bridge Skid Reports

It is not planned that any special outputs be developed within the scope of this project to handle skid data outputs for data obtained on bridges. Instead, the detailed skid output to be discussed later can be used to provide output from the bridge file. This is an area where some additional work will be required to provide the most meaningful type of output.

Integrated System

The contents of the three files shown at the top of Figure 2 have been discussed above. The only additional file presently planned is the skid research file.

Skid Research File

The intended purpose of the skid research file is to provide a data base for skid resistance studies which will contain the necessary traffic volume data, surface mix data, and skid data, but which will not contain most of the irrelevant data in the files already discussed. By eliminating the large amount of unnecessary data items, various skid studies can be completed with a minimum amount of data processing.

No definite decisions have been made regarding what the precise record contents for this file will be. However, it is envisioned that each record will include at least an average corrected trailer skid number, the sample size that average is based on, the average speed the results were obtained at, the standard deviation associated with the average, a predicted stopping distance skid number, the surface mix type the average was obtained on, aggregate data pertaining to the surface mix, and an accumulated traffic volume (or perhaps volumes for various classes of vehicles) on the surface mix at the time the skid tests were run. It is not envisioned that locational and descriptive information contained in the pavement and skid files will be included.

Pavement File Volume Update Procedure

The pavement file volume update procedure will be used to update the traffic volume data contained in each pavement file record as shown in the last column of Table 1. Thus, each year that the surface mix remains the same the accumulated figures for 18 Kip, 2-axle vehicles, 3-axle vehicles, and 5-axle vehicles will be adjusted upward by the volume accumulated for each of these classifications during the previous year. The method of determining 18 Kip volumes from the annual traffic volume classifications is described in a report by Vaswani and Thacker.* Obviously, the average vehicles daily figure (AVD) will be changed to reflect the latest year's data.

To date, no work has been done on the pavement file volume update procedure. The major work required will be the development of the program to access the annual volume with milepoints file, and apply the volume information in this file to the pavement file.

Detailed Pavement Report Procedure

The program for preparing the detailed pavement report has been completed and utilized on the CDC 6400 computer. The conversion of this program for use on the IBM 370 remains to be done.

An example of the detailed output for one pavement section is shown in Figure 10. The top two portions of the output pertain to descriptive information about the section and detailed materials information for the surface mix while the bottom portion indicates the cross section design. Notice that the program provides for the design accumulated 18 Kip volume, actual accumulated 18 Kip volume, and reason for resurfacing even though these items are not presently in the system.

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*Vaswani, N. K. and D. E. Thacker, "Estimation of 18-Kip Equivalent on Primary and Interstate Road Systems in Virginia," Virginia Highway Research Council, VHRC 71-R34, Charlottesville, Virginia, May 1972.

SECTION LOCATION AND DESCRIPTIVE INFORMATION

SYSTEM	ARTERIAL	BEGINNING MILE	6.20 .328 MI E NEW RR	PROJECT NUMBER 0211-069-
DISTRICT	STAUNTON	ENDING MILE	10.97 0.32 MI E INT 644	101,C501
RESIDENCY	LURAY	LENGTH	4.77 MILES	
COUNTY	PAGE			
		SURFACE MIX TYPE	S-5	
ROUTE	211	SPECIAL FEATURE	LIMESTONE BLEND-BITM. CONC.	
		COMPLETION DATE	JULY 1972	SCHEDULE NUMBER
DIRECTION/LANE	ALL LANES	AGE	2 YEARS AND 9 MONTHS	SPEC. YEAR 1966
HIGHWAY TYPE	FOUR LANE DIVIDED - PARTIAL CONTROL OF ACCESS			NEW CONSTRUCTION

SURFACE MIX MATERIALS AND CONSTRUCTION DATA

BITUMINOUS MIXES

ASPHALT TYPE	AP-3
APPLICATION, PSY	165
AVG. DESIGN AC	6.30
CHANGE IN AC	NO

AGGREGATE INFORMATION

SIZE	TYPE	PERCENT	SOURCE
8	GRAVEL	55	RIVERTON LIME AND STONE LURAY, VA.
10	GRAVEL	25	RIVERTON LIME AND STONE LURAY, VA.
10	LIMESTONE	20	RIVERTON LIME AND STONE LURAY, VA.

CROSS SECTION AND PERFORMANCE DATA - BEGINNING WITH PRESENT SURFACE

YEAR	MIX TYPE	DEPTH	PERCENT CEMENT/ LIME/ASPHALT	DESIGN ACCUMULATED 18 KIP VOL.	ACTUAL ACCUMULATED 18 KIP VOL.	REMAINING ACCUMULATED 18 KIP VOL.	REASON FOR RESURFACING
1972	S-5	1.6	6.30				
1972	B-3	3.0	4.40				
1972	SUBBASE MATERIAL - STONE SIZE 21A	6.0					
1972	SELECT MATERIAL - TYPE III	8.0					
1972	SUBGRADE-NATIVE-UNSTABILIZED						

Figure 10. Virginia Department of Highways — pavement information, April 1, 1975.

This output is currently distributed to the district materials engineers and the Maintenance Division with the intended use being for general references. A summary output designed to aid in planning maintenance resurfacing is discussed later. To minimize the amount of output, consideration is being given to sending to the district materials engineers and the Maintenance Division only the detailed output for those portions of the roadway where new construction or resurfacing has occurred and have them include these new sheets in their copies of the complete detailed output where appropriate. In effect, this would mean the actual accumulated 18 Kip volume figure would be up-to-date only for the output sections submitted each year. In fact, it is the author's opinion that the distribution of the detailed output as just discussed may be eliminated with a central copy being maintained in the Central Office as one now is at the Research Council.

The detailed output is also intended for use in the evaluation of the effectiveness of pavement designs. For this purpose it should be distributed to the Research Council and Materials Division, but again it is not necessary to distribute complete copies. Instead, only sections having complete cross sectional information should be distributed, but updated outputs should be provided for these sections each year.

Surface Mix Procedure

The surface mix procedure is intended for three main purposes: (1) to update the mainline skid file; (2) to update the skid research file; and (3) to produce surface mix reports. A flow diagram for this procedure is shown in Figure 11. As it is now envisioned a single program probably will accomplish everything shown in Figure 11, but the diagram as presented indicates the major functions to be performed and thus serves as a good basis of discussion.

The surface mix program is utilized to determine directional surface mix sections from the pavement file by combining all pavement sections in a given direction having the identical surface mix with respect to mix type, aggregate data, rate of application, and date placed. This program has been developed and utilized to produce surface mix reports which will be discussed later. The only further development required, other than making it operational on the IBM 370 computer, is a routine to deterime traffic volume data for each surface mix section as shown in the last column of Table 1 except for the 18 Kip volume.

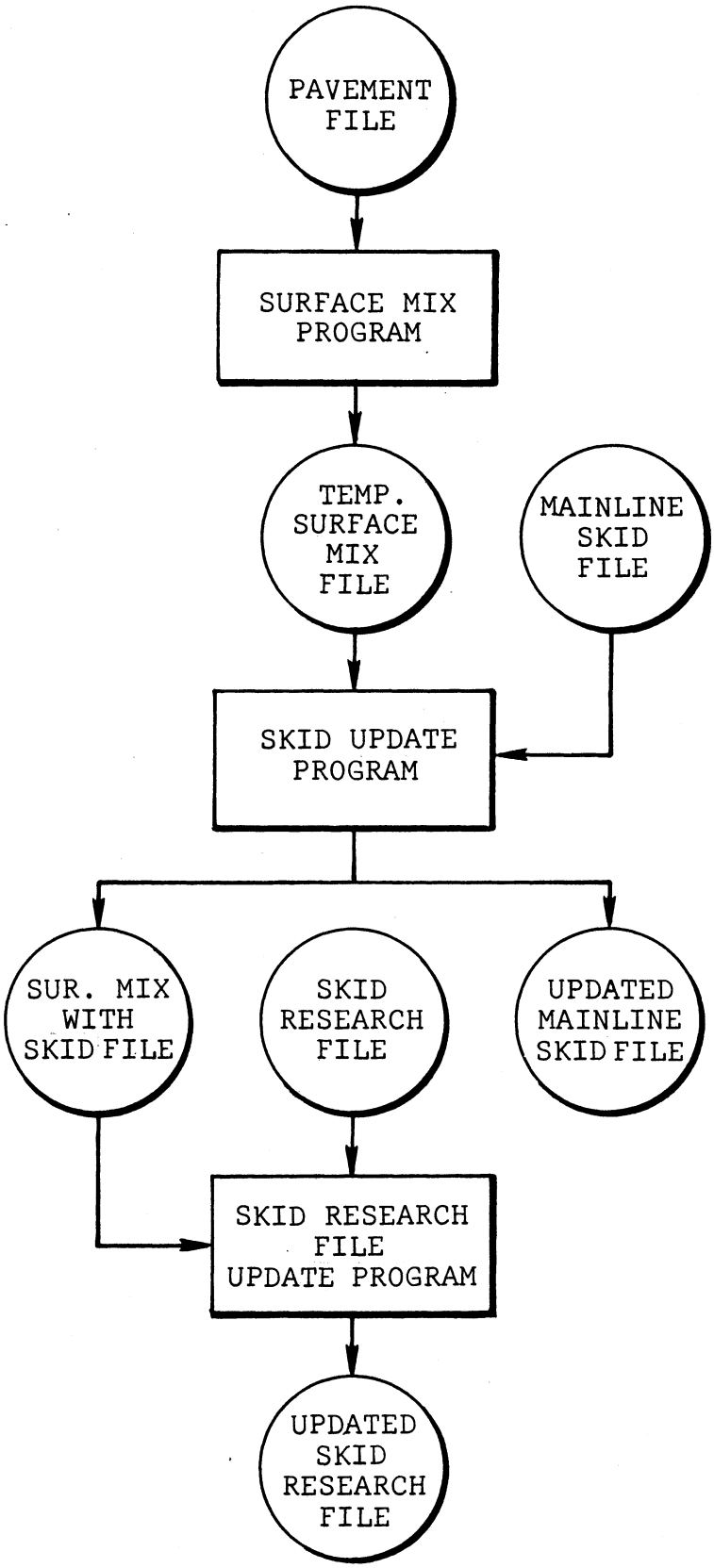

Figure 11. Flow diagram of surface mix procedure.

The skid update program, which remains to be developed, is intended to update the mainline skid file, and include average skid data for each of the surface mix sections on which skid data have been collected. Although the programming has not yet been done, the methodology will be to ascertain the milepoint termini and date placed for each surface mix section, and then to determine various skid information by date tested for each lane within the section. Since this skid information will be used to update the skid research file at least the data items indicated earlier to be in that file will be determined for each lane of the surface mix section. Also, as will be indicated again under system timing, only that skid data collected prior to January 1 will be considered because of possible milepoint change problems. The skid information for each lane will be retained in the surface mix record. In this process, skid data having a date of test preceding the resurfacing date will be deleted from the mainline skid file so that only skid data pertaining to current surfaces will be retained.

The skid research file update program, as yet not developed, is intended to add summary skid and mix information now contained in the surface mix file to the skid research file. Only information relating to skid data collected since the previous update will be added. Thus, the process will be dependent on the data associated with each skid test.

Surface Mix Reports

As indicated in the previous section, one of the purposes of the surface mix procedure is to produce surface mix reports. The detailed report discussed earlier presented data on the basis of pavement sections which are identical for the entire cross section, or as much of the cross section as is contained in the data base. Thus, often the same surface mix is broken into several pavement sections. For many purposes, including planning maintenance resurfacing and the evaluation of skid information, it makes more sense to present data in terms of a surface mix.

Figure 12 presents an example of the surface mix output. The program to produce this output has been developed but must be converted to the IBM 370 computer. This particular example is for Interstate Route 64 in Alleghany County. Note that the output is broken down by direction and that many of the section termini are the same for both directions. Other than the descriptive information the rate of application, mix type, and date of placement for the surface mix are indicated. Also shown as part of the mix information are special characteristics such as sprinkel mix, and, under date, the date the previous surface was

SURFACE MIX SECTION DIRECTION REPORT FOR THE STAUNTON DISTRICT APRIL 1, 1975

ROUTE I 64 RESIDENCY OF LEXINGTON COUNTY OF ALLEGHANY SYSTEM - INTERSTATE

DIRECTION E	DIRECTION W	MILE POINT	M-P DESCRIPTION	LENGTH	HIGHWAY TYPE	RATE/MIX TYPE	DATE	SKID #/DATE	TRAFFIC ADV-
I		.00	WEST VIRGINIA LINE	6.90	FOUR-LANE	SLURRY A	1971		
I		TO 6.90	0.38 MI W INT 661						
I		6.90	0.38 MI W INT 661	7.72	FOUR-LANE	100# S-5	1967		
I		TO 14.62	.01 M W WCL COVINGT						
I		14.62	0.01 MI W WCL COVIN	2.40	FOUR-LANE	100# S-5	1966		
I		TO 17.02	0.46 MI E INT 60WBL						
I		17.02	0.46 MI E INT 220	3.37	FOUR-LANE	110# MS-5	1972		
I		TO 20.39	1.23 MI W INT 696			SPRINKLE MIX	(64)		
I		20.39	1.23 MI W INT 696	3.38	FOUR-LANE	I-3	1964		
I		TO 23.77	2.15 MI E INT 696						
I		23.77	2.15 MI E INT 696	4.39	FOUR-LANE	MS-5	1972		
I		TO 28.16	INT 60 END I064						
	I	.00	WEST VIRGINIA LINE	6.90	FOUR-LANE	SLURRY A	1971		
	I	TO 6.90	0.38 MI W INT 661						
	I	6.90	0.38 MI W INT 661	7.72	FOUR-LANE	100# S-5	1967		
	I	TO 14.62	.01 M W WCL COVINGT						
	I	14.62	.01 MI W WCL COVING	2.40	FOUR-LANE	100# S-5	1966		
	I	TO 17.02	0.46 MI E INT 60WBL						
	I	17.02	0.46 MI E INT 220	3.03	FOUR-LANE	110# MS-5	1972		
	I	TO 20.05	1.57 MI W INT 696			SPRINKLE MIX	(64)		
	I	20.05	1.57 MI W INT 696	3.72	FOUR-LANE	I-3	1963		
	I	TO 23.77	2.15 MI E INT 696						
	I	23.77	2.15 MI E INT 696	4.39	FOUR-LANE	MS-5	1972		
	I	TO 28.16	INT 60 END I064						

Figure 12. Maintenance planning summary report for the Staunton District. District totals — April 1, 1975.

placed is shown in parentheses when it is known. Since the integrated system has not been completed no skid or volume data are shown even though the output allows for their inclusion. Plans are to show the predicted average stopping distance car skid number and the sample size the average is based on for each lane in each direction, along with the date the tests were made. The average daily vehicles for the latest year will be shown under the traffic column.

The surface mix report is distributed to the resident engineers, the assistant district engineers in charge of maintenance, the Maintenance Division (2 copies), the survey skid crew, and the Research Council. In addition to providing a complete output, plans are to ultimately include a procedure in the report generating program to mark sections likely in need of attention because of age and/or low skid resistance. A long-range possibility that has been considered is to also indicate an accumulated 18 Kip volume figure and a prediction of remaining life until the next resurfacing based on this figure. Also, another future possibility is a prediction of when the skid resistance may reach a dangerously low level.

The program to produce the listing has been developed and now needs modification for the IBM 370 computer.

Summary Report

In addition to the surface mix report just discussed a summary report is produced showing the lane mileage by age for bituminous concrete mixes, surface treatments, slurry seals, and portland cement concrete. This program has also been developed, but it too must be converted to the IBM 370 computer.

An example of the summary output is shown in Figure 13. The output as shown for the Staunton District is produced for each district and for each residency. The output is interpreted as follows. The age 1 refers to summation of lane miles of a surface mix less than or equal to one year. The age 2 refers to surfaces greater than one year old, but less than or equal to two years. Thus, in the output shown in Figure 13, 436.4 miles of bituminous concrete surfaces were greater than seven years old, but less than or equal to eight years old. As shown, the age is listed up to 13 years, with the final category being over 13 years old. Obviously, the surfaces in this final category could be any age greater than 13 years. The percentage of type for each age is simply the lane mileage for that age divided by the total lane mileage, or, for example, 164.5 divided by 2772.3 for age 1 for bituminous concrete. The accumulated total and percentage are

	AGE OF SURFACE IN YEARS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	OVER 13	NOT KNOWN	TOTAL
BITUMINUS CONCRETE																
LANE MILEAGE	164.5	222.8	233.9	267.6	227.0	174.0	174.6	436.4	185.6	259.4	125.2	83.2	73.1	144.4	.0	2772.3
PERCENT OF TYPE	5.9	8.0	8.4	9.6	8.1	6.2	6.2	15.7	6.6	9.3	4.5	3.0	2.6	5.2	.0	100.0
ACCUMULATED TOTAL	164.5	387.3	621.3	889.0	1116.1	1290.1	1464.7	1901.1	2086.8	2346.2	2471.4	2554.6	2627.8	2772.3	.0	2772.3
ACCUMULATED %	5.9	13.9	22.4	32.0	40.2	46.5	52.8	68.5	75.2	84.6	89.1	92.1	94.7	100.0	.0	100.0
SURFACE TREATMENT																
LANE MILEAGE	5.3	.0	41.5	.0	.0	16.0	34.6	.0	.0	.0	.0	.0	.0	.0	.0	97.7
PERCENT OF TYPE	5.4	.0	42.5	.0	.0	16.4	35.4	.0	.0	.0	.0	.0	.0	.0	.0	100.0
ACCUMULATED TOTAL	5.3	5.3	46.9	46.9	46.9	63.0	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	.0	97.7
ACCUMULATED %	5.4	5.4	48.0	48.0	48.0	64.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	.0	100.0
SLURRY SEALS																
LANE MILEAGE	158.7	52.9	89.4	27.6	5.6	16.0	34.6	.0	.0	.0	.0	.0	.0	.0	.0	385.1
PERCENT OF TYPE	41.2	13.7	23.2	7.1	1.4	4.1	8.9	.0	.0	.0	.0	.0	.0	.0	.0	100.0
ACCUMULATED TOTAL	158.7	211.7	301.1	328.7	334.4	350.4	385.1	385.1	385.1	385.1	385.1	385.1	385.1	385.1	.0	385.1
ACCUMULATED %	41.2	54.9	78.1	85.3	86.8	91.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	.0	100.0
MIX TYPE UNKNOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	26.2	26.2
BITUMINOUS TOTALS	323.2	275.8	323.4	295.2	232.7	190.0	209.2	436.4	185.6	259.4	125.2	83.2	73.1	144.4	26.2	3183.7

Figure 13. Surface mix section direction report for the Staunton District April 1, 1975.

determined by addition for each age in ascending order. The lane mileage of 26.2 at the junction of the mix type unknown row and age not known column is the total lane mileage for which mix type and age both are unknown. Had there been some mixes for which the age was unknown the lane mileage would have appeared for the appropriate mix type in the age not known column. If age was known, but mix type wasn't, the lane mileage would appear in the mix type unknown row under the appropriate age.

This report is distributed to the assistant district engineers in charge of maintenance, the Maintenance Division, and the Research Council, with the intended purpose being long-range maintenance resurfacing planning.

Detailed Skid Report

The program to produce the detailed test output has been completed and is operational on the IBM 370 computer. This output can be provided at any point in time from the mainline skid file, and certainly not only where it is indicated in the general flow diagram for the integrated system. It is shown where it is because at this point the mainline skid file has been updated in the sense that data not pertaining to existing surfaces have been deleted from the file.

An example of the detailed skid output is shown in Figure 14. Included is descriptive information showing where each test was run, the date it was run, and the speed at which it was run. The actual skid number obtained for each test is shown along with the skid number corrected to a test speed of 40 mph and the predicted 40 mph stopping distance skid number. The methodology for obtaining the corrected skid number and predicted stopping distance skid number is explained in the report by S. N. Runkle entitled "Evaluation of the New Virginia Department of Highways & Transportation Skid Testing Trailer."

The user of the program to produce the detailed output has the option of specifying the county, route, beginning milepoint, ending milepoint, and the oldest month and year of skid data to be included in the output. Thus, someone may specify that a detailed skid output be provided for Route I-64 in Albemarle County between milepoints 3.50 and 6.50 for data obtained since January 1, 1975, and output would be provided for all lanes meeting these requirements. In this way someone who knows the average skid number for a surface mix section from the surface mix report can obtain detailed skid data as may be desired when the average is fairly low and resurfacing due to slipperiness is being considered. It is envisioned that the principal use of the detailed skid report will be for requests of the type just discussed.

DISTRICT CULPEPER
RESIDENCY FAIRFAX
COUNTY FAIRFAX
ROUTE I 95

LANE	MILE POST	DATE	TEST SPEED	ACTUAL SN	CORR SN	PCSN
NBL1	.10	10-09-74	40.0	41	41	52
	.30		40.0	42	42	53
	.50		40.0	42	42	53
	.70		40.0	43	43	53
	1.00		41.0	40	41	51
	1.20		38.0	43	42	52
	1.40		39.0	41	40	51
	1.50	10-08-74	40.0	44	44	54
	1.60		39.0	45	44	54
	1.80		39.0	45	44	54
	2.00		39.0	45	44	54
	2.20		40.0	41	41	52
	2.40		40.0	43	43	53
	2.80		40.0	42	42	53
	3.00		42.0	40	41	52
	3.30		41.0	42	43	53
	3.60		40.0	43	43	53
	3.80		40.0	44	44	54
	4.00		39.0	46	45	55
	4.20		40.0	45	45	55
	4.40		38.0	46	45	55
	4.60		40.0	42	42	53
	4.80		40.0	45	45	55
	5.00		40.0	43	43	53
	5.20		40.0	47	47	56
	5.40		40.0	41	41	52
	5.60		40.0	46	46	56
	5.80		40.0	44	44	54
	6.00		40.0	43	43	53
	6.20		40.0	44	44	54
	6.40		40.0	42	42	53
	6.60		40.0	41	41	52
	6.80		40.0	44	44	54
	7.00		38.0	40	39	50
	7.20		40.0	45	45	55
	7.30		40.0	40	40	51
	7.40		40.0	41	41	52
	7.60	10-01-74	40.0	46	46	56
	7.80		40.0	46	46	56
	8.00		40.0	46	46	56
	8.20		40.0	46	46	56
	8.60		40.0	49	49	58
	8.80		40.0	45	45	55
	9.00		40.0	51	51	59
	9.20		40.0	48	48	57
	9.50		40.0	43	43	53
	9.60		40.0	47	47	56
	9.80		40.0	46	46	56

Figure 14. Example of detailed skid report.

At present there is no routine distribution of the detailed skid report other than by request.

Summary Skid Report

The summary skid program was originally developed prior to the inception of the pavement system as a means of presenting skid data in a summarized form. Since skid data ultimately will be summarized on the basis of surface mix sections this output will probably be of limited value in the future.

The computer program to produce the summary skid report also has been completed and is operational on the IBM 370 computer. Also, as with the detailed skid report, the summary report can be produced as desired and not just as indicated in Figure 2. The same input specifications exist for the summary program as for the detailed program so that output can be specified for segments of routes if so desired, but it is not envisioned the output will be used in this way as the detailed output may.

An example of the summary output is shown in Figure 15, where it is indicated that the data are summarized by mile. The corrected to 40 mph average skid number and predicted 40 mph stopping distance skid number are presented for each lane in a given direction along with the sample size (n) and standard deviation of the corrected skid numbers. As with the detailed output, the summary skid output is distributed by request only.

It should be mentioned that in the future the summary program (unless modified) may produce output averaging data obtained at various dates. Thus, one would have to carefully select the beginning date to avoid averaging skid data obtained on different dates.

Skid Research Report

Thus far no work has been done on the design of reports for skid research purposes. However, a working plan is being written for work which will utilize pavement, volume and skid data to determine the effects of accumulated traffic volumes on skid resistance for various mixes and aggregates in Virginia. As part of this project, the specifications for skid research outputs will be developed.

DISTRICT CULPEPER
RESIDENCY FAIRFAX
COUNTY FAIRFAX
ROUTE I 95
SUMMARY INFORMATION BEGINNING 10-74

	NBL-1					NBL-2					NBL-3				
MILE	AVG COR SN	AVG SPEED	N	STD DEV SN	PCSN	AVG COR SN	AVG SPEED	N	STD DEV SN	PCSN	AVG COR SN	AVG SPEED	N	STD DEV SN	PCSN
0- 1	42	40.0	4	.8	53	48	40.0	4	2.1	57	42	40.0	2	1.4	53
1- 2	43	39.3	6	1.9	53	47	40.0	6	.9	56	45	39.6	5	2.9	54
2- 3	43	39.8	4	1.4	53	46	39.3	4	.4	56	48	39.0	4	.8	57
3- 4	43	40.8	4	1.2	53	45	40.5	4	1.2	54	48	40.0	4	.5	57
4- 5	44	39.4	5	1.4	54	46	40.0	5	.4	56	48	40.0	5	1.3	57
5- 6	44	40.0	5	2.4	54	46	40.6	5	1.2	56	49	40.2	5	.7	58
6- 7	43	40.0	5	1.3	53	46	39.0	5	1.1	55	49	40.0	5	1.3	58
7- 8	43	39.7	6	3.2	53	47	39.7	6	3.3	56	50	40.0	6	2.0	58
8- 9	47	40.0	4	1.7	56	52	40.0	4	1.9	60	49	40.0	1		58
9-10	47	40.0	5	2.9	56	49	40.0	5	4.1	58	48	40.0	1		57
10-11	47	40.0	6	3.7	56	45	40.0	6	1.3	55	46	40.0	6	3.0	55
11-12	48	40.0	5	3.5	57	45	40.0	5	1.5	55	43	40.0	4	2.6	53
12-13	47	40.0	5	3.4	57	44	40.0	5	3.3	54	44	40.0	5	3.2	54
13-14	44	40.0	5	1.5	54	45	40.0	5	1.1	55	46	40.0	5	1.7	55
14-15	43	40.0	3	1.0	53	46	40.0	3	2.0	56	43	40.0	4		53

Figure 15. Example of summary skid output.

System Time Frame

This section deals with the planned timing of the various activities involved in a complete update cycle for the system as discussed above. In essence, the system will be updated on an annual basis with the timing of the various activities being largely dependent on the milepoint change procedure and the date the summary and surface mix reports are desired as explained below.

As already indicated, the command data utilized in the milepoint change program to make milepoint changes are obtained from updated graphic log sheets submitted by the Traffic and Safety Division. The general procedure is to submit updated graphic log sheets semiannually with the cutoff dates for revisions being July 1 and January 1 and the submissions being completed by April 1 and October 1. For example, if a project is completed December 28, the revised graphic logs for the route in the county involved would be submitted by April 1. Since the summary and surface mix reports are desired by September 1 of each year so as to be available in planning the next year's maintenance resurfacing, the critical update activities shown in Figures 1 and 2 must be completed between April 1 and September 1.

With the above in mind the timing as indicated in Table 3 is proposed as the most reasonable. As already indicated, the revised graphic log sheets from the previous July and January would be available by April 1. Two months' time is allowed to determine where milepoint changes have occurred and complete the milepoint change procedure on the pavement data base. The correction procedure is shown indented under the milepoint change procedure to indicate that it too must be completed prior to completing the milepoint change procedure. (Actually the correction procedure can be done at any time, but is shown in the flow diagram to precede the milepoint change and update procedures.)

The pavement update procedure is scheduled for completion by July 15 each year, which obviously also requires the completion of the pavement data input procedure and corrections to the update file by this date. In effect, this schedule allows six weeks (June 1 to July 15) to review pavement updates for routes where milepoint changes have occurred and to ensure the correct milepoints are inputted. Obviously, other errors must be corrected during this time also, or prior to June 1, which certainly is possible. As previously indicated, a listing of update data may aid in making corrections.

TABLE 3

System Timing

Activity	Completion Date
Milepoint Change Procedure: Pavement File •Correction Procedure: Pavement File	June 1
Pavement Update Procedure: •Pavement Data Input Procedure •Correction Procedure: Pavement Update File	July 15
Pavement File Volume Update Procedure: •Milepoint Change Procedure: Milepoint Assignment File •Milepoint Assignment Procedure	August 1
Surface Mix Procedure: •Skid Data Input Procedure •Skid Merge Procedure •Milepoint Change Procedure: Mainline Skid File	August 15
Summary, Surface Mix and Detailed Pavement Reports:	Sept. 1
Bridge Skid Report:	As Requested.
Milepoint Change Procedure: Bridge Skid File	Preferably by June 1.
Loop Report:	Following Each Skid Merge Procedure.
Summary Skid, Detailed Skid, and Skid Research Reports:	As Requested.

Also as previously indicated, only pavement data having a completion date prior to January 1 will be included in the update file. Input received having completion dates after January 1 will be retained and included in the next year's update. This procedure is to ensure that revised graphic log sheets showing milepoint changes and pertaining to routes having pavement update sections would be received by April 1. By including pavement input data having a completion date after January 1 there would be no assurance a milepoint change would be detected. While milepoint changes occur on only a small number of routes annually it is felt this procedure is still necessary to ensure data accuracy.

The pavement volume update procedure is scheduled for August 1, which would require that the milepoint change procedure to the milepoint assignment file and the milepoint assignment procedure be completed by this date, and preferably earlier. It is anticipated that the annual volume file would be available at an early enough date to make this scheduled completion date possible.

The surface mix procedure is scheduled for completion by August 1. In this case the skid data input procedure, skid merge procedure, and the milepoint change procedure to the mainline skid file also must be completed by August 1. The skid data input procedure will be a continuous activity as testing occurs. The merge procedure should also be a fairly frequent activity with the frequency determined by the Data Processing Division (merging probably will be done at least monthly). It should be noted, as indicated earlier, that the milepoint change procedure and the surface mix procedure will not include skid data dated after January 1 of the year in question because of the necessity to ensure that milepoint changes are detected. Skid data collected after this date will be included in these procedures the following year.

The summary, surface mix, and detailed pavement reports are scheduled for completion by September 1 to allow for planning as previously discussed. This completion date should allow sufficient time for distribution of the output to the field offices and Maintenance Division by October 1 of each year.

The activities shown at the bottom of Table 3 have no specific date for completion. As indicated, most are report procedures used by request, and then can be run at any time. One must remember that for the skid files based on milepoints there is a slight chance of having skid data with incorrect milepoints for data collected during the current year of the request, but this will happen so infrequently that it is not considered a major deficiency in using the outputs. As already discussed, the incorrect milepoints that do exist will be corrected by the following year's milepoint change procedure.

It is recognized that the reports used for planning would be more beneficial if they could be made more current. However, this is totally dependent on speeding up the milepoint change procedure, which is a recommendation made later in this report but which falls under the category of future work beyond the scope of this project.

IMPLEMENTATION SCHEDULE

This section consists of a discussion of the anticipated dates for completion of the systems discussed and their implementation on the IBM 370 computer, including the shifting of responsibility for maintenance of the systems to the Data Processing Division. The dates indicated necessarily will be very tentative since they can be affected by several things. For example, the completion of the systems is dependent on the level of routine service data processing work performed by the Data Section, and implementation, to a large extent, will be dependent on the time available by the Data Processing Division.

The anticipated dates for complete implementation are as follows:

Pavement System	—	June, 1976
Traffic Volume System	—	June, 1976
Skid System	—	October, 1975
Integrated System	—	December, 1976

A summary of remaining activities to be completed for each of the procedures prior to final implementation is shown in Table 4.

In addition to this report, other reports will be written as the computer programming is completed. These will include the following:

(1) Skid system report (July 1, 1975). This report will include the documentation for the skid data input procedure, the skid merge procedure, the summary skid report procedure, and the detailed skid report procedure.

(2) Pavement system report (July 1, 1976). This short report will include the documentation required for the implementation of the pavement system.

(3) Traffic volume system report (July 1, 1976). This short report will include the documentation required to create the annual traffic volume with milepoints file.

(4) Integrated Applications Report (Jan. 1, 1977). This report will include the documentation required to complete the integrated system as outlined in Figure 2.

TABLE 4

Activities to be Completed Prior to Final Implementation

PROCEDURE	ACTIVITIES
. Pavement Data Input Procedure	. Transfer to Central Office responsibility for ensuring new pavement data have correct milepoints for routes where milepoint changes have occurred. . Modify edit program for IBM 370.
. Correction Procedure	. Modify correction program for IBM 370.
. Milepoint Change Procedure	. Transfer to Central Office responsibility for determining milepoint change commands. . Modify command card edit program for IBM 370. . Modify milepoint change program for IBM 370.
. Pavement Update Procedure	. Modify update program for IBM 370. . Transfer to Data Processing Division responsibility for reviewing gap and overlap listing and making necessary corrections.
. Milepoint Assignment Procedure	. Determine file contents of milepoint assignment and volume with milepoints file. . Develop milepoint assignment program.
. Skid Data Input Procedure	. Determine applicability of magnetic cassette and modify input codes as necessary (Data Processing Division).
. Skid Merge Procedure	. Transfer responsibility to Data Processing Division.
. Skid Loop Report Procedure	. Develop listing program.
. Bridge Skid Report Procedure	. Same as detailed skid report procedure below.
. Pavement File Volume Update Procedure	. Develop update program.
. Detailed Pavement Report Procedure	. Modify listing program for IBM 370. Finalize distribution list.
. Surface Mix Procedure	. Complete development of program or programs required for procedure. . Determine file contents for skid research file.
. Surface Mix Report Procedure	. Modify listing program for IBM 370.
. Summary Report Procedure	. Modify listing program for IBM 370.
. Detailed Skid Report Procedure and Summary Skid Report Procedure	. Transfer responsibility to Data Processing Division. . Determine if and to whom regular distribution may be required.
. Skid Research Reports Procedure	. Work in this area will be dependent on analyses performed and how the data should be presented. Thus, final implementation is not influenced.

RECOMMENDATIONS

When one considers the number of automated data systems utilized by the Virginia Department of Highways and Transportation the possibilities of integrated applications that could be offered as recommendations are almost unlimited (thus the need for compatibility of data systems is obvious). However, the recommendations contained herein deal basically with additional work that might be desirable to improve the effectiveness of the integrated system as discussed in this report.

1. Investigate ways to speed up the process of determining routes where milepoint changes have occurred and making the necessary milepoint adjustments to the various data bases. As explained in the report, this process, which is dependent on the update and distribution procedures for revised graphic log sheets, controls to a large extent the timing of the entire system. By speeding this process, more up-to-date data could be included in the annual update of the system.

2. Begin collecting as input data the reason for resurfacing. Since one of the intended purposes of the integrated system is to evaluate pavement designs, the reason for resurfacing is obviously beneficial and necessary data. This procedure would have to allow for general categories of reasons such as transverse cracking, longitudinal cracking, alligator cracking, patching, rutting, flushing, scaling, settlements, shaving, ravelling and low skid resistance, and also probably should allow for the selection of more than one reason (i.e., combination of factors). Furthermore, these reasons would be determined during the review process rather than at the completion of the resurfacing.

3. Consideration should be given to establishing a work in progress file which would contain new construction and scheduled resurfacing. Such a file would permit the determination before hand where milepoint changes will occur and thus allow for automatic milepoint adjustments as work is completed involving milepoint changes. It would also allow for schedules and pavement input forms to be automatically produced. Thus, the submission of pavement data would simply involve the submission of an already completed form with just

changes noted. The reason for resurfacing as discussed above would be an input item to this file as resurfacing requirements are determined.

This file would also allow for the automatic determination of unsubmitted forms (not completed resurfacing or new construction) at any time, and thus aid the manual review necessary to ensure that forms have been submitted.

4. Further work should be done to determine what adjustments should be made in the detailed pavement output to make it a more valuable research tool. Since this is research in nature it is recommended that this area of systems work be continued at the Research Council.

5. Modify the detailed skid output so as to allow for the average corrected skid number, the standard deviation and sample size that average is based on, and the predicted stopping distance skid number to be shown on the output for sections specified if desired.

6. Develop a deflection data system which can be used interactively with the systems as discussed in this report. Since all present deflection data are collected and used at the Research Council it is recommended that this system also be developed at the Research Council.

7. Provide listing of pavement update data to Construction and Maintenance Divisions for their review and corrections prior to pavement update procedure.

8. Investigate the possibility of utilizing the skid data bases together with accident data to determine present and potential areas of high wet pavement accident experience.

9. Continue to evaluate the desirability of the development or modification of related data systems for integrated applications. These systems would include the road inventory system, the bridge inventory system, and possibly new systems for additional roadway information.