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AN APPROACH TO MAINTENANCE MANAGEMENT

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

AN APPROACH TO MAINTENANCE MANAGEMENT

by

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For some time we have wanted a practical means for putting a handle on the maintenance operation. With the use of the computer and application of concepts having their roots in Research Project 151, we have been developing a maintenance management program that lends itself well to our operations at both field level and at District level. We don't have all the flaws out of the program but we are continuing to refine the process as we go along.

At the heart of the operation is the foreman's assessment of his needs balanced against his ability to meet these needs. In February, each section foreman inspects all the highways in his section to determine the type maintenance activities that need to be performed to bring the highways into acceptable condition. His evaluation of the need of repairs is translated into the number of crew days of various types of maintenance activities; such as, crack pouring, edge repairs, spot level-up, squeegee seal, mowing, drainage improvement, and so forth, that would be required. For the purpose of correlation, his inspections are made using the same limits as the team performing the road rating survey. The road rating survey, incidentally, is in progress at the same time. This information is entered in a table in the appropriate column related to the work activity required. (Figure I) Where no activity is required, no entry is made. The foreman's evaluation of the number of crew days is shown in the lower left hand corner of each block, while the number of men in the crew is shown in the upper left hand corner. The large number appearing near the midpoint of the block represents the number of man-days involved. When all highways have been inspected and the man-days of work required has been determined , a tabulation is made to arrive at the total number of man-days of work that are required to be performed.

An analysis is then made of availability of field personnel to perform the work. Fixed personnel such as clerks, mechanics, the normal commitment to the signing operation and to the herbicide operation, yard and janitorial care, and so forth, can't be considered as being available for other work and are deducted from the total number of personnel in the section. (Figure II) Gross numbers of man-days available

FIGURE I

LOCATION							CREW DAYS																									
COUNTY	HIGHWAY	CONTROL	SECTION	FROM	TO	PAVEMENT SCORE	ADT	SQUEEGEE	CRACK POURING	SCAT SEAL	SPOT LEVEL	BROKEN EDGES	FILL LOW EDGES (BASE)	BLADE JOINTS	PULL EDGES	RESECTION	BEAUTIFICATION	MOWING	DRAINAGE	SHOULDERS	FENCE LINE BRUSH	FIRE BREAKS	BRIDGE CHANNELS	SIGNS	HERBICIDE	PAVEMENT MARKINGS	DRIVEWAY INSTALLATIONS	SEAL COAT	ASSIST TRAFFIC			
109	FM1426	1429	02	LP 374	MP 6.9	69	5640	6	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						
109	FM1925	1830	01	FM 2220	MP 7.4	80	1080	—	—	—	2	7	—	—	1	—	—	—	—	—	—	—	—	—	1	—						
★											3	4 1/8			3 3/8			2 3/8						3 5/8			2 1/8				
109	FM1925	1830	01	MP 7.4	MP 10.4	33	1840	—	—	—	4	28	—	—	2	28	—	6	2	—	—	—	—		1	—						
★											3	18			3 7/8	41 3/8		3 3/8	8 3/8					3 5/8			1 3/8		5 3/4		
109	FM1925	1830	01	MP 10.4	US 281	80	2800	—	—	—	—	7	—	—	1	—	—	6	—	—	—	—	—		1	3						
★												1 1/8						2 3/8						3 7/8			1 3/8				
109	FM1925	1830	02	US 281	MP 16.1	83	1540	—	—	—	2	14	—	—	2	4	1	6	2	—	—	—	—		1							
★											3	6			2 1/8	2 5/8		2 7/8	4 5/8					3 1/8			1 1/8	55			
109	FM1925	1830	02	MP 16.1	FM 493		1060	—	—	—	16	14	—	—	1	2	—	3	2	—	—	—	—		1							
★											4	2			1	1		2 1/8	1 3/8					2 5/8			2 3/8		5 1/8		

★ Total - Man Days through October, 1975

FIGURE II

ASSESSMENT OF AVAILABILITY OF FIELD PERSONNEL

Total Personnel	32
Fixed Personnel	- 8
Available Field Personnel	24
Working Days	x 247
Number of Man Days	5,928
Deduct Vacation	- 499
	5,429
Deduct 10% Contingencies	- 543
Total Man Days Available	4,886
Total Man Days Required (from work projection for year)	6,970

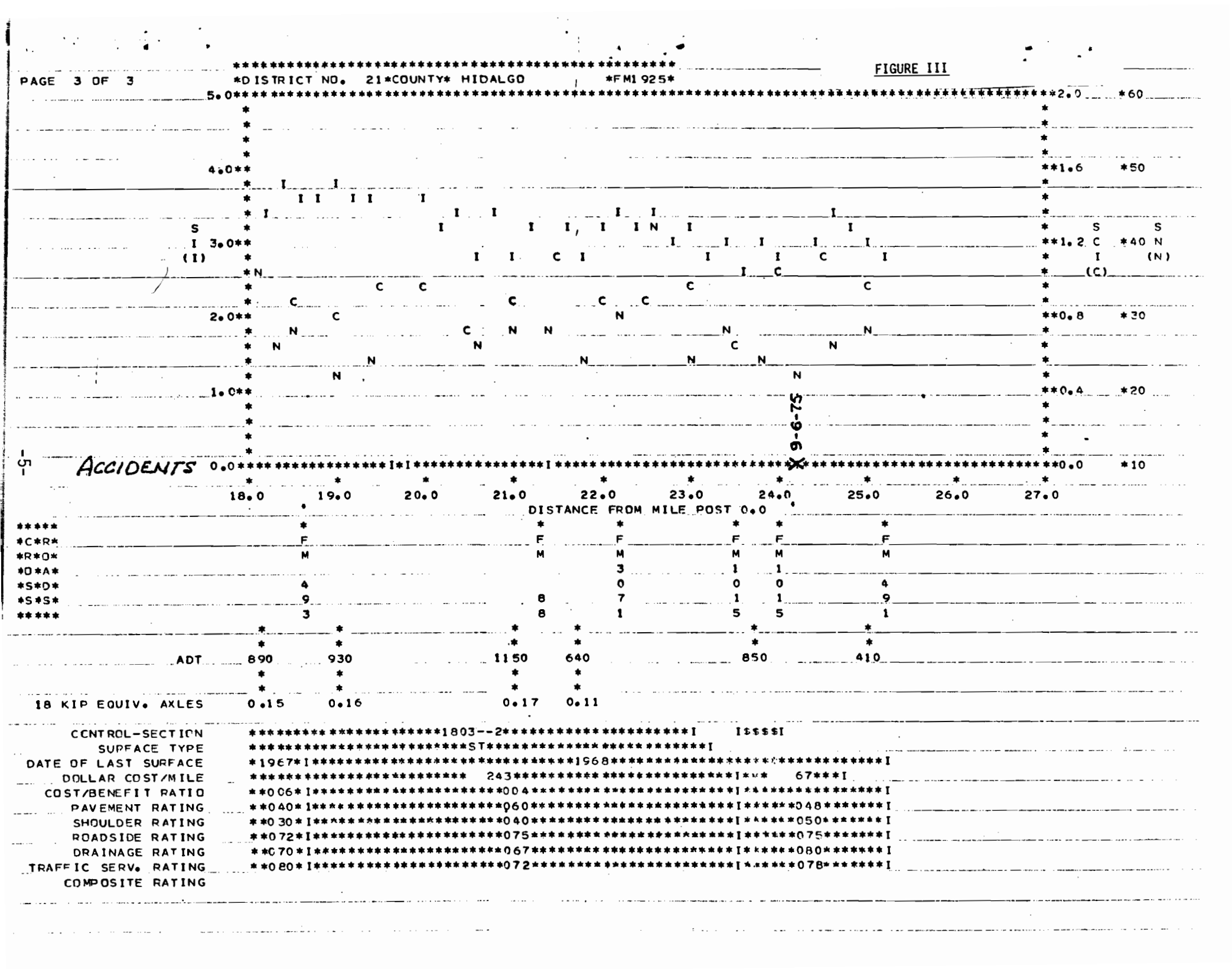
from field personnel may then be determined by multiplying the number of people in the section who can work in the field by the number of work days. Vacation must be deducted; and, once it is taken out, an additional 10% deduction is made for contingencies. The net figure is the number of man-days of field effort that can be applied to needed work. This year in my section we had a total requirement of 6970 man-days of work, but I can field only 4886 man-days when my contingency allowance has been deducted. This means as I schedule work I have to establish priorities for the highways on which my section will expend its effort in order to get the most run for the money.

At this point, the value of the pavement rating scores, strength determinations in the pavement and supporting structure from the dynaflect, Mays Ride Meter data, ADT, skid data, accident data, 18 Kip axle loads, and cost per mile expenditures in the last fiscal year readily available from our plot routine (Figure III) become evident for this data must be considered as we decide where to work. Extremely poor quality of ride (creating problems in vehicle control) would be a factor in deciding where I would perform spot level-up. Accident data is of prime importance as I consider planting headlight screening, correcting sections of smooth textured pavement with seal coats - we use skid data to verify these, etc. Weak highways (with surface curvature indices of 0.8 and higher) subjected to frequent repetitions of heavy axle loads would have to be considered as front-runners for attention in all maintenance activities when there is no hope for reconstruction of these sections within the reasonably near future. As the low priority sections of highways are dropped from consideration, the work listed to be performed on them is red-lined.

Right now we must make these determinations manually. We are hoping to have a computer program next year that will sort this information for us and provide a weighted appraisal of priorities for us to start with. Regardless of which method, manual or computer, is used to determine initial priorities, in the final analysis, the foreman is required to apply experience and judgment factors to arrive at a decision regarding how a highway will perform if distress conditions are not tended to.

It appears now that our level of maintenance for Controlled Access Highways will be about 72. The level of maintenance for U.S. and State Highways will be about 68 or 69 and the level of maintenance for Farm to Market Highways will be about 65. How close we can come to these levels depends a great part on weather.

FIGURE III


*DISTRICT NO. 21*COUNTY* HIDALGO *FM1925*
5.0
4.0
3.0
2.0
1.0
0.0
2.0
1.6
1.2
0.8
0.4
0.0
60
50
40
30
20
10
S
I
(I)
N
C
S
S
I
(N)
(C)
ACCIDENTS
57-6-9
18.0
19.0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
DISTANCE FROM MILE POST 0.0
*****
*C*R*
*R*O*
*O*A*
*S*D*
*S*S*
*****
F M 4 9 3
F M 8 8
F M 0 7 1
F M 1 5
F M 0 1
F M 0 1
F M 4 9 1
ADT 890 930 1150 640 850 410
18 KIP EQUIV. AXLES 0.15 0.16 0.17 0.11
CONTROL-SECTION 1803--2
SURFACE TYPE ST
DATE OF LAST SURFACE 1967 1968
DOLLAR COST/MILE 243 67
COST/BENEFIT RATIO 006 004
PAVEMENT RATING 040 060 048
SHOULDER RATING 030 040 050
ROADSIDE RATING 072 075 075
DRAINAGE RATING 070 067 080
TRAFFIC SERV. RATING 080 072 078
COMPOSITE RATING

We have had to examine our operations as we've never had to do before, as we make our projections. It isn't just enough to keep the men busy, but they have to be busy about the right things and at the time of year to get the maximum results from the effort expended. This has resulted in changes in crew organizations as we improve our efficiency and field more crews without increasing the number of personnel involved. One of my neighbors, for example, after he found out he had a large deficit in the available work force capability compared to the work that he needed to do, changed his crack pouring operation on highways with paved shoulders to first cut one man off of the crew and then later on modified his coning procedures and removed a second man. This was done without decreasing the safety of the operation. His production rate, which had been excellent, remained just as high as it had been with the other two men on the job. He then honed down another crew to relieve a man from its operation without appreciably affecting the performance of that crew. He was then able to field a three-man crew to perform another maintenance function; one that he had not counted on being able to get. This increased the productivity of his section with no increase in personnel.

In my case, a close analysis of the needs that would have to be met has resulted in changing my crew formation, also. (Crack pouring. I was able to drop two men from seven to five and still maintain my production.)

Since we know how much material is used each day in the various types of operations performed and by knowing when the operations will be performed, we can schedule ordering materials to have enough on hand to do the job, but not have an excessive amount of material in stock beyond that which is needed. A spinoff from our scheduling operation is that as we do our budgetary work, we look ahead at our needs for the coming year and can make projections for personnel needed, equipment usage, and materials required based on what we see in front of us instead of looking back over our shoulders at what we did last year.

As we look for ways to improve the performance of our crews, we find that we need to refine our cost data so that we can have easily acquired unit costs on various operations. (We know our unit costs now but they have been worked up by hand and this ties up our office men.) When this is known, our performance can be compared with that of other sections in the district and through comparing notes, visiting with other foremen who can do the job cheaper, we can come up with a better

way to do the job. As long as there is no way to compare performance of similar sections in the district, it is just a matter of opinion as to who is doing the best job on a particular maintenance activity in the most economical manner.

We need an expanded function code capability so that in the case of surfacing operations, spot level-up, edge repairs, crack pouring, squeegee seal - to name a few - can be easily cost-evaluated. These activities are now all lumped in Function 200. We don't anticipate any insurmountable problems with the crew leaders in getting the charges made to the right function code. These men have been at this work for a long time; they understand the differences between the various work operations and only a little training will be needed in order for them to become accustomed to new function codes. We feel that anyone who can't get it put together to make the charges properly shouldn't be a crew leader, so we have no problem at that point.

We have three computer management programs; two of them are produced through the Mark IV process and one being developed now will be produced through our remote terminal. These give us valuable guidance as we look back at the expenditures we have made and keep an eye on our operations. (Figure IV)

The first report - Maintenance Foreman Expenditure by Function - developed by the San Angelo District, provides an overall picture to each section foreman of his expenditures by function code and for each type of highway as well as a breakdown showing the charges to salary and labor, equipment rental, and stock. This allows the foreman a one page "look in" on the overall operation. Should there be something that he questions, he can zero in on the troublesome area using the next report to be shown. (Figure V)

This report is real handy to pick off improper charges and it only takes a few minutes to scan all of the report in a maintenance section - perhaps 30 minutes each month is all that's needed for a quick checkout of how the money is being spent. Anything unusual is quickly spotted. You get a pretty good feel for the percentage of charges for each function that would be made to S & L, equipment rental, and materials, after just a little work with this report. We have had this report for two months now. This is why we need an expanded Code #, it helps in picking out the proper charges. Sweeping is also charged to Function 200. As a matter of interest when we were developing percentages for function 200, we found some sections of highways badly out of balance. Investigation showed costs due to bleeding control.

FIGURE IV

NOV 13, 1975 — MAINTENANCE FOREMAN EXPENDITURES BY FUNCTION — PAGE 3

MAINT SECT 02

FUNC	IH HWY	US&STATE HWY	FM HWY	OTHER HWY	HWY TOTAL	SAL&LAB	EQ MENT	MATERIAL	JV TOTAL	SECTION TOTAL
100	.00	.00	1,802.70	.00	1,802.70	657.34	474.50	670.81	1,802.70	1,802.70
200	.00	3,493.10	6,713.09	1,076.28	11,282.47	7,197.94	2,230.00	1,854.53	11,282.47	11,282.47
211	.00	.00	297.68	.00	297.68	297.68	.00	.00	297.68	297.68
400	.00	581.16	3,237.45	.00	3,818.61	1,661.99	2,149.56	7.06	3,818.61	3,818.61
500	.00	1,205.80	4,353.91	117.93	5,677.64	3,640.46	1,831.10	206.08	5,677.64	5,677.64
510	.00	8,198.97	2,606.93	291.54	11,097.44	6,867.14	3,919.00	311.30	11,097.44	11,097.44
520	.00	292.41	116.75	.00	409.16	341.08	42.56	25.52	409.16	409.16
530	.00	146.34	.00	.00	146.34	80.62	64.40	1.32	146.34	146.34
700	.00	.00	28.41	.00	28.41	24.81	3.60	.00	28.41	28.41
710	.00	188.18	258.87	.00	447.05	425.63	21.42	.00	447.05	447.05
720	.00	412.45	647.65	34.86	1,095.16	669.82	102.42	322.92	1,095.16	1,095.16
730	.00	2,647.24	1,845.22	303.68	4,796.14	1,662.72	330.88	2,802.54	4,796.14	4,796.14
740	.00	1,421.52	233.73	77.58	1,732.83	1,159.59	429.56	143.68	1,732.83	1,732.83
900	.00	.00	.00	7,612.75	7,612.75	5,710.77	843.86	1,058.12	7,612.75	7,612.75
	.00	18,587.17	22,142.59	9,514.62	50,244.38	30,397.64	12,442.86	7,403.88	50,244.38	50,244.38

Funds Authorized Maint. Sec 02 — 481,834.58

Funds Spent Thru Sep. 1975 — 61,932.99

Funds Spent Month Of Oct. 1975 — 50,244.38

Total Funds Spent Fiscal Year — 112,177.37

% Funds Expended — 23.28 %

Time Expended Fiscal Year — 2 Months = 16.66 %

FIGURE V

MAINT SECT 02

	CO. NO.	HWY KIND	HWY NO.	CLASS	MILEAGE	FUNC	SAL&LAB	EQ RENT	MATERIAL	JV TOTAL
FUNCTION TOTAL	031	FM	0506	11	17.91	200	24.81	30.00	.00	54.81
FUNCTION TOTAL	031	FM	0506	11	17.91	500	198.46	119.64	.00	318.10
FUNCTION TOTAL	031	FM	0506	11	17.91	720	37.21	5.58	2.98	45.77
FUNCTION TOTAL	031	FM	0506	11	17.91	730	86.83	27.44	61.60	175.87
FUNCTION TOTAL	031	FM	0506	11	17.91	740	18.25	15.00	.00	33.25
CLASS TOTAL	031	FM	0506	11	17.91		365.56	197.66	64.58	627.80
HWY KIND TOTAL	031	FM	0506				365.56	197.66	64.58	627.80
FUNCTION TOTAL	031	FM	0733	11	3.22	730	24.81	5.40	20.00	50.21
CLASS TOTAL	031	FM	0733	11	3.22		24.81	5.40	20.00	50.21
HWY KIND TOTAL	031	FM	0733				24.81	5.40	20.00	50.21
FUNCTION TOTAL	031	FM	0800	11	5.35	730	24.81	16.20	54.10	95.11
CLASS TOTAL	031	FM	0800	11	5.35		24.81	16.20	54.10	95.11
HWY KIND TOTAL	031	FM	0800				24.81	16.20	54.10	95.11
FUNCTION TOTAL	031	FM	2556	11	16.94	400	24.81	48.00	.00	72.81
FUNCTION TOTAL	031	FM	2556	11	16.94	500	446.52	202.10	44.88	693.50
FUNCTION TOTAL	031	FM	2556	11	16.94	510	49.61	45.00	.00	94.61
FUNCTION TOTAL	031	FM	2556	11	16.94	720	130.44	14.04	85.46	229.94
FUNCTION TOTAL	031	FM	2556	11	16.94	740	18.25	15.00	13.44	46.69
CLASS TOTAL	031	FM	2556	11	16.94		675.63	324.14	143.78	1,143.55
HWY KIND TOTAL	031	FM	2556				675.63	324.14	143.78	1,143.55
FUNCTION TOTAL	031	FM	2629	11	.37	730	.00	.00	25.00	25.00
CLASS TOTAL	031	FM	2629	11	.37		.00	.00	25.00	25.00
HWY KIND TOTAL	031	FM	2629				.00	.00	25.00	25.00
FUNCTION TOTAL	031	LO	0374	11	5.12	200	310.09	96.40	11.77	418.26
FUNCTION TOTAL	031	LO	0374	11	5.12	500	49.62	17.52	.00	67.14
FUNCTION TOTAL	031	LO	0374	11	5.12	510	49.61	37.50	.00	87.11
FUNCTION TOTAL	031	LO	0374	11	5.12	730	37.21	13.40	54.81	105.42
FUNCTION TOTAL	031	LO	0374	11	5.12	740	42.56	35.00	.00	77.56
CLASS TOTAL	031	LO	0374	11	5.12		489.11	199.82	66.58	755.51
HWY KIND TOTAL	031	LO	0374				489.11	199.82	66.58	755.51
FUNCTION TOTAL	031	LO	0448	11	3.11	510	62.02	47.80	.00	109.82
CLASS TOTAL	031	LO	0448	11	3.11		62.02	47.80	.00	109.82
HWY KIND TOTAL	031	LO	0448				62.02	47.80	.00	109.82

This is another case of a maintenance activity now lumped in Function 200 that needs special identification. Costs incurred here are frequently hair-raising when compared to costs of the original seal coat.

The third report is to be run on our remote terminal at the district headquarters and provides a monthly update on our progress toward completion of the estimated work. The only input to this program is from the foreman and in order for him to stay abreast of the progress being made, he needs to do a good job of record keeping. Since work scheduling is very important - it is necessary that we watch our updates to see how we are progressing. If we see that we are getting more work done than we had anticipated, it will be necessary to make a mid-course correction to get us back on target, reassess our priorities and pick up some work to be done that has been red-lined or cut out earlier; or, if our progress is slower than anticipated, we may have to red-line some work that we thought we could get done. Starting at mid-point of the projection year we will also be incorporating the 10% contingency allowance into our work scheduling as we see that it's not being used.

We plan to do this on pro-rated basis. In other words, one-sixth of the 10% will be incorporated into the seventh month after we find that it is not needed in the first half year. We are not sure that the 10% contingency allowance is enough but until we gain some experience in this work we will not know. This is our first trial at work projection and it seems to be working out satisfactorily. The gripes come from the foremen who are newest on the job and don't have enough experience to feel confident in their estimates of time required to get a particular job done. All of us are gaining considerable experience in this category since most of us never had to establish and try to meet conditions of a work schedule.

Acknowledgement should be given to the efforts of Dr. Jon Epps of T.T.I., who has worked on this program with us from the beginning; and Dr. Harry Jones, who has been active in the computer program development. Also, we have had excellent cooperation from D-18.