REPORT DOCUMENTATION PAGE	1. Report No. MN/RD - 91/01	2.	3. Recipient's Accession No.

4. Title and Subtitle

Detour Management Study

5. Report Date January, 1991

6.

7. Author(s)
Joint Mn/DOT - County Engineers Task Force and Technical Advisors

8. Performing Organization Rept. No. 9LRR671

9. Performing Organization Name and Address
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10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
Minnesota Local Research Board
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Maplewood, MN 55109

13. Type of Report & Period Covered Final Report 1985 - 1991

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

A simple and fair method for reimbursing local government units for use of their roads as detours by Mn/Dot was agreed upon by a task force consisting of Mn/DOT and county engineers. Nine different detours were evaluated by three methods of payment. The methods of payment are described in detail and the theoretical amount of payment for each detour is given. The actual amount expended for each detour under current practices is also given.

17. Document Analysis a.Descriptors

Detours
Gas Tax
Equivalent Overlay
Deflection
FWD (Falling Weight Deflectometer)
Condition Rating
Pavement Serviceability Rating

b.Identifiers/Open-Ended Terms

c.COSATI Field/Group

18. Availability Statement No restrictions. This document is available through the National Technical Information Services, Springfield, VA 22161	19. Security Class (This Report) Unclassified	21. No. of Pages 45
	20. Security Class (This Page) Unclassified	22. Price

DETOUR MANAGEMENT STUDY
FINAL REPORT

INVESTIGATION NO. 671

By
Joint Task Force
Mn/DOT and County Engineers

January, 1991

Prepared for the
MINNESOTA LOCAL ROAD RESEARCH BOARD
MATERIALS AND RESEARCH LABORATORY
1400 GERVAIS AVENUE
MAPLEWOOD, MINNESOTA 55109

EXECUTIVE SUMMARY

This report is a summary of the steps leading to the recommendation of a method to pay other local government agencies, mainly counties, for use of their roads as detours by Mn/DOT.

The search for a simple, uniform and fair method goes back at least to 1985 when the assistant district engineers (A.D.E.s) formed a task force. This group was unable to reach a solution satisfactory to the county engineers. The task force was reformed in 1990 comprised of 4 members from Mn/DOT and 4 county engineers.

Three different methods of payment for detours were devised and evaluated on nine different detours in 1990. The amounts that would have been paid for each of these proposed methods for each detour were compiled along with the actual Mn/DOT expenditures.

The task force recommended the following:

1. Selection of a detour route should involve some analysis to determine the road carrying capacity of the route(s).

2. The gas tax method should be used to compute the reimbursement due the local road authority.

3. Mn/DOT should provide ordinary maintenance during the detour period.

4. Any Mn/DOT expenditure over and above ordinary maintenance such as overlays would be credited.

5. The local road authority has the option of doing an "equivalent overlay method" analysis at their expense. Any amount over twice the gas tax computation would be added to the gas tax value.

6. The vehicle for providing reimbursement would be via an agreement executed through the C.O. Agreements Unit.

7. For emergency of short term detours, all the preceding recommendations apply except no agreement or payment is necessary for reimbursements less than $500.

1990 DETOUR MANAGEMENT STUDY

FINAL REPORT

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1990 DETOUR MANAGEMENT STUDY

INTRODUCTION:

Minnesota Statute 161.25 provides for the use of any public street or highway, as necessary, for a detour or haul road by Commissioner's Order designating it as a temporary trunk highway. The statute further requires Mn/DOT to maintain the same as a temporary trunk highway during its use and, prior to revoking the designation, the Commissioner shall "restore such streets or highways to as good condition as they were prior to the designation".

In the distant past, administration was accomplished by a review, before and after, by appropriate officials of both jurisdictions and based on the presence or absence of visible damage, restoration work was ordered as mutually agreed to. Recently, agreement between Mn/DOT and local road authorities on restorative measures has become increasingly difficult. Some likely contributing factors are:

1. Continual increase in traffic volumes and increased allowable loadings on trucks.

2. Railroad abandonments have placed additional demand on highways.

3. Increase in detour usage caused by recent large construction programs.

4. Increased awareness by local road authorities of invisible damage, or road life used up, by detoured traffic. This has been more clearly focused by new pavement management techniques utilizing N.D.T. (non-destructive testing) methods.

5. Apparent lack of uniformity and objective basis for restoration efforts from one authority to the next.

Concern for uniformity and satisfactory restoration practices led the A.D.E.'s to form a task group for the purpose of studying the problem in 1985. This was at the direction of the District Engineers.

HISTORICAL REVIEW OF PAST EFFORTS:

In response to concerns from various user groups and at the request of the District Engineers, the A.D.E.'s implemented a pilot study in 1986. This study focused on detours only. Six detours were studied, using four alternate restoration concepts as follows:

1. Weight management (% life used)
2. Weight management (additional structure required)
3. Gas tax generated
4. Rental rate

The task force, chaired by Dick Klobuchar, selected the gas tax generated concept as the best restoration method. This recommendation, after getting approval from the A.D.E. group, was presented to the OMT group in February, 1988. OMT then requested a review by the County Engineers, who through their executive committee assigned it to a group of County Engineers for their study. The group, working with the A.D.E. Task Force, was unable to agree on a process. The study was resumed in 1990.

1990 DETOUR MANAGEMENT STUDY

A new effort to find a mutually agreeable restoration process for detours was initiated in early 1990. The membership of the task force is as follows:

Art Hill, A.D.E. (D-4)
Jim Swanson, A.D.E. (D-7)
Bruce Larson, A.M.E. (D-1)
Ken Wasnie, D.M.E. (D-3)
Dave Everds, Dakota County Engineer
Wayne Fingalson, Wright County Engineer
Mike Sheehan, Olmstead County Engineer
Pete Boomgarden, Redwood County Engineer

Expert Technical Advisors:

George Cochran, Research Engineer
Gerry Rohrbach, Pavement Engineer
Roger Olson, Research
Loren Hill, Pavement Management Engineer

It was agreed to study as many 1990 actual detours as possible, using a variety of methods to determine restoration values. The objective of the study was to develop and select a process for computing detour restoration values that would best meet the following criteria:

1. Provide uniform application and results

2. Be simple to apply, requiring a minimum of engineering input.

3. Produce a fair restoration settlement for all parties.

Three alternate methods of computing restoration values were chosen for the study as follows:

1. Gas tax collected

2. Equivalent overlay

3. Condition rating

See Appendix for complete explanation and formulas.

The three alternate methods for computing reimbursement/restoration values were applied to nine actual detours used for 1990 Mn/DOT construction projects. Total length of the detours equaled 94.8 miles and were located in five different districts involving 15 different local road authorities. (See Appendix for complete detailed listing.)

1990 STUDY RESULTS

The following table compares the results of three alternate analysis methods, as well as the actual dollars spent on restoration by the individual districts.

RESULTS 1990 DETOUR MANAGEMENT STUDY

Detour No.	District	Detour T.H.	Gas Tax Method	Equivalent Overlay Method	Condition Rating Method	*Actual District Cost
1	3	169	$11,809	0	0	$ 51,800
2	3	25	$ 2,602	0	0	$ 5,500
3	4	106	$ 2,460	$4,362	0	$26,000
4	6	19	$15,298	$48,395	0	$21,500
5	6	60	$25,969	$86,542	0	$68,000
6	7	60	$42,653	$ 4,993	0	$36,000
7	7	14	$ 6,679	0	$74	$10,000
8	8	7	$19,233	$16,847	0	$12,300
9	8	7	$17,112	$36,574	0	$14,800
		TOTALS	$143,815	$197,713	$74	$245,900

*Actual district cost includes maintenance costs, overlay costs and/or rental costs.

DISCUSSION OF RESULTS:

Most noteworthy observations:

- The standard Mn/DOT Condition Rating procedure, which is the basis for Mn/DOT's current official restoration policy, was almost completely insensitive to any detour damage.

- Administration of the equivalent overlay and condition rating methods was the most difficult and time consuming.

- Most districts are currently using some form of detour reimbursement analysis other than the official Mn/DOT process. A number of these look at the gas tax value.

RECOMMENDATIONS:

1. Selection of a detour route should involve some analysis to determine the load carrying capacity of the candidate route(s) to insure the selected route is suitable for the proposed detour traffic.

2. The gas tax method, as detailed in the Appendix of the 1990 Detour Report, should be used to compute the reimbursement due the local road authority. All mileage should be included (i.e. bituminous, concrete, gravel).

3. Mn/DOT should, in addition to No. ~~1~~ 2, provide any necessary signing, striping, bituminous patching and ordinary maintenance on the roadway or shoulder during the detour period. Bituminous patching is defined as any work, including continuous full-width overlays, less than 100 feet in length.

4. Any Mn/DOT expenditure over and above those outlined in No. ~~2~~ 3, such as overlays, would be credited against any reimbursement due the local road authority.

5. The local road authority has the option of doing an "equivalent overlay method" analysis at their expense. Testing and analysis to be done by Mn/DOT approved firm. Any value computed by said analysis in excess of twice the gas tax computation would be included, along with the gas tax formula value, as final payment to the local road authority. The equivalent overlay procedure to be used is as detailed in the Appendix of the 1990 Detour Report.

6. The vehicle for providing reimbursement of the gas tax value and any additional value, if required, as computed by the equivalent overlay formula, should be via an agreement executed through the C.O. Agreements Unit, prior to the establishment of the detour. The agreement would be binding on both parties and should in most instances, dramatically reduce the amount of engineering time required.

7. For emergency or short term detours, all the preceding recommendations apply except no agreement or payment is necessary for reimbursements less than $500.

CONCLUSIONS:

The primary goal of the task group was to develop a process that would provide simplicity, uniformity and a fair settlement for both parties. The recommended procedure seems to provide all those ingredients. For the majority of detours, the administration is very simple and repeatable, requiring much less engineering than the present process.

Implementation of the recommended procedure would appear to only require processing of a standardized agreement and should be possible for 1991 detours.

Future consideration should be given to developing a new process for haul roads.

ACKNOWLEDGEMENTS:

The task group wishes to extend its appreciation to the following for their valuable assistance and input into this study:

George Cochran, Research Engineer
Gerry Rohrbach, Pavement Engineer
Roger Olson, Research Engineer
Loren Hill, Pavement Management Engineer
Dave Bullock, Research
Jerry Teig, Research
Fred Maurer, Pavement Management
Art Bolland, D.M.E. (D-8)
Steve Oakey, D.M.E. (D-7)
Bud Wyborny, D.M.E. (D-4)
Joe Meade, D.M.E. (D-6)

APPENDIX

DEPARTMENT OF TRANSPORTATION
Office of Materials
& Research

STATE OF MINNESOTA
OFFICE MEMORANDUM

Date: November 16, 1990

DRAFT

To : Art Hill, A.D.E., D-4, Chair
Jim Swanson, A.D.E., D-7
Bruce Larson, A.M.E., D-1
Ken Wasnie, D.M.E., D-3
Dave Everds, Dakota County Engineer
Wayne Fingalson, Wright County Engineer
Mike Sheehan, Olmsted County Engineer
Pete Boomgarden, Redwood County Engineer

From: George R. Cochran, Manager
Physical Research

Phone: 779-5525

Subject: Detour Study

Attached for your study is a summary of the analysis of data accumulated from the 1990 Detour Study. Three methods were applied to nine detours in five districts. The three methods are described in the attached report of March 9, 1990.

The Gas Tax traffic was supplied by the various District Materials Engineers. Payout was calculated by Physical Research as per the March 9, 1990 report.

The FWD tests and calculated payouts were performed by Physical Research as described in the above mentioned report.

The before and after Structural Ratings were performed by the various District Materials personnel with assistance from the Pavement Management Unit who also performed the before and after Pavement Serviceability ride ratings. Physical Research calculated the payout again as described in the above report.

The proposed payouts are tabulated on the attached computer sheets. In summary, the total potential payouts are as follows:

Total Mileage: 94.768

Gas Tax: $143,814

FWD (Equivalent Overlay Method) $197,712

Condition Rating: $73

Comments:

<u>Gas Tax</u> - This method was extremely easy to calculate. It may, however, require a change in legislation.

In a macro sense, the gas tax method is essentially a benchmark method, as it is the gas tax which fuels pavement improvements statewide. All detours receive potential payment under this method.

<u>FWD</u> - This method is quite complicated to apply and to calculate. The FWD approach pays out most to weak roads and none to strong roads. There is a certain rationale to this result, although it could be argued that it penalizes those with overdesigned roads and rewards those with underdesigned roads, even though this may be more a function of local geology than design.

It should also be noted that if a Safety Factor of two were not applied to the Design ESALs in this method, the payout would have been $60,322.

<u>Condition Rating</u> - This method requires before and after surveys.

The Condition Rating system seemed insensitive to detour traffic. This may be due to little or no visible damage or a certain lack of precision in the method. Also note that one detour in D-4 was overlayed before the after rating was taken.

Final Note:
The committee will have to struggle with the basic philosophical difference betwen the various methods. They should not be unaware of the differences in the efforts required to apply the different methods. Ultimately, the application process must move out of Research into Operations with help as needed from Materials. Whatever method selected, if any, must be applied uniformly. The Committee must also recognize that any approach selected will be imperfect but it is important to make a real start in resolving this issue regardless of which method is selected.

Finally, I would like to thank the various MN/DOT personnel involved in this effort.

If you have any questions, please contact me.

cc: A. Bolland
D. Bullock
D. Carlson
L. Hill
P. Hughes
F. Maurer
J. Meade
S. Oakey
R. Olson
G. Rohrbach
R. Sullivan
G. Teig
K. Wasnie
S. Wyborny

DETOUR MANAGEMENT STUDY
GAS TAX METHOD

		DETOUR	ADT TWO WAY	DURATION DAYS	MILES NDT FOOTMETER	COST/ SEGMENT	TOTAL MILES	TOTAL COST
District 3	1	T.H. 169						
		CSAH 5	1550	147	7.529	6724.69		
		AITKIN 3			5.692	5083.94	13.221	$11,808.63
	2	T.H. 25						
		SHERBURNE 53	1915	88	2.921	1929.61		
		BECKER TOWNSHIP			1.018	672.49	3.939	$2,602.10
District 4	3	T.H. 106						
		OTTERTAIL 142	770	114	1.995	686.47		
		OTTERTAIL 135			3.023	1040.21		
		OTTERTAIL 52			2.130	732.93	7.148	$2,459.61
District 6	4	T.H. 19						
		RICE 46	2900	102	5.085	5896.24		
		RICE 86			5.200	6029.59		
		RICE 3			2.908	3371.93	13.193	$15,297.76
	5	T.H. 60						
		WILLOW ST	2625	137	1.125	1585.95		
		RICE 19			12.966	18278.56		
		GOODHUE 12			4.330	6104.13	18.4	$25,968.64
District 7	6	T.H. 60						
		16TH ST	5260	148	0.402	1226.76		
		COTTONWOOD 13			9.744	29735.20		
		COTTONWOOD 1			3.831	11690.84	14.0	$42,652.79
	7	T.H. 14						
		NICOLLET 23	3600	85	4.943	5929.23		
		BLUE EARTH 42			0.625	749.70	5.568	$6,678.93

DETOUR MANAGEMENT STUDY
GAS TAX METHOD

		DETOUR	ADT TWO WAY	DURATION DAYS	MILES NDT FOOTMETER	COST/ SEGMENT	TOTAL MILES	TOTAL COST
District 8	8	T.H. 7						
		MEEKER 14	2650	136	3.874	5473.06		
		MEEKER 12			5.065	7155.67		
		RENVILLE 7			4.675	6604.69	13.614	$19,233.42
	9	T.H. 7						
		MCLEOD 7	7600	101	1.628	4898.64		
		MCLEOD 79			3.055	9192.47		
		MCLEOD 4			1.004	3021.03	5.687	$17,112.14
						GRAND TOTAL		$143,814.01

DETOUR MANAGEMENT STUDY
EQUIVALENT OVERLAY METHOD

DISTRICT THREE

TH 169 DETOUR
5/9/90

*CR 5 NBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
7.529	ave	23.5	33.8	1,230,097	127	14,079	1,201,940	1400	147	5,447	(1,196,493)	-9.51	NO PAYMENT
	sd	2.8											

*CR 3 WBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
5.692	ave	31.1	38.3	820,120	434	53,792	712,535	1400	147	5,447	(707,088)	-5.23	NO PAYMENT
	sd	0.9											

TH 25 DETOUR
5/17/90

*CSAH 53 NBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
2.921	ave	47.3	70.2	114,689	249	30,848	52,993	2300	88	5,357	(47,636)	-1.42	NO PAYMENT
	sd	6.6											

*TOWNSHIP ROAD EBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
1.018	ave	39.8	58.4	208,028	60	7,442	193,144	2300	88	5,357	(187,787)	-6.15	NO PAYMENT
	sd	5.3											

DETOUR MANAGEMENT STUDY
EQUIVALENT OVERLAY METHOD
DISTRICT FOUR

TH 106 DETOUR
5/10/90

*CR 142 WBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
1.995	ave	64.3	88.0	54,962	551	60,927	(66,892)	770	114	2,323	2,323	0.11	$4,361.54
	sd	5.8											

*CR 135 SBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
3.023	ave	46.0	63.8	156,437	91	10,022	136,392	770	114	2,323	(134,069)	-5.14	NO PAYMENT
	sd	4.5											

*CR 52 EBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
2.13	ave	39.2	61.2	178,852	500	55,283	68,287	770	114	2,323	(65,964)	-1.21	NO PAYMENT
	sd	6.8											

DETOUR MANAGEMENT STUDY
EQUIVALENT OVERLAY METHOD

DISTRICT SIX

TH 19 DETOUR
5/02/90

*COUNTY ROAD 46

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
5.085	ave	28.3	42.0	609,854	1066	117,863	374,129	2900	102	7,829	(366,300)	-2.42	NO PAYMENT
	sd	3.9											

*COUNTY ROAD 86

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
5.2	ave	44.0	80.5	73,441	538	59,484	(45,527)	2900	102	7,829	7,829	0.27	$27,814.23
	sd	12.7											

*COUNTY ROAD 3

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
2.908	ave	56.1	88.2	54,587	611	67,559	(80,532)	2900	102	7,829	7,829	0.35	$20,580.91
	sd	10.0											

TH 60 DETOUR
5/23/90

*CSAH 45 (WILLOW ST)

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
1.125	ave	15.4	23.9	3,779,580	2500	276,413	3,226,754	2625	137	9,518	(3,217,236)	-5.03	NO PAYMENT
	sd	2.6											

*CSAH 19

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
12.996	ave	42.1	75.6	90,309	584	64,581	(38,854)	2625	137	9,518	9,518	0.26	$68,766.45
	sd	11.5											

*CSAH 12

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
4.33	ave	38.5	69.6	117,736	624	68,965	(20,194)	2625	137	9,518	9,518	0.21	$17,775.64
	sd	10.8											

DETOUR MANAGEMENT STUDY
EQUIVALENT OVERLAY METHOD
DISTRICT SEVEN

TH 60 DETOUR
5/15/90

*16th ST

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
0.402	ave	46.7	79.1	77,705	580	64,128	(50,550)	5260	148	20,603	20,603	0.62	$4,992.72
	sd	10.7											

*LAKEVIEW AVE (Gravel)
0.000 = CL 16TH ST
0.250 = CL CSAH 13

*CSAH 13 EBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
9.744	ave	48.8	67.4	131,175	300	33,192	64,791	5260	148	20,603	(44,187)	-1.08	NO PAYMENT
	sd	4.6											

*CSAH 1 NBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
3.831	ave	34.5	52.0	303,393	685	75,751	151,890	5260	148	20,603	(131,287)	-1.50	NO PAYMENT
	sd	5.2											

TH 14 DETOUR
5/17/90

*CSAH 23 SBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
5.568	ave	31.7	50.6	331,801	934	103,266	125,269	3600	85	8,099	(117,170)	-1.15	NO PAYMENT
	sd	6.0											

DETOUR MANAGEMENT STUDY
EQUIVALENT OVERLAY METHOD

DISTRICT EIGHT

TH 7 DETOUR (WEST)

5/11/90

*CSAH 14 WBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
3.874	ave	22.0	39.1	765,700	432	47,764	670,172	2650	136	9,538	(660,633)	-5.24	NO PAYMENT
	sd	5.9											

*CSAH 12 WBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
5.065	ave	41.0	78.6	79,571	340	37,603	4,365	2650	136	9,538	5,173	0.17	$16,846.68
	sd	13.3											

*CSAH 7 WBL

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
4.675	ave	29.6	47.3	414,891	187	20,666	373,559	2650	136	9,538	(364,020)	-5.54	NO PAYMENT
	sd	5.5											

TH 7 DETOUR (EAST)

5/24/90

*CSAH 7

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
1.628	ave	37.7	70.0	115,748	1661	183,642	(251,536)	7600	101	20,315	20,315	0.43	$13,901.90
	sd	11.3											

*CR 79 EB

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
3.055	ave	19.7	29.7	1,880,215	406	44,868	1,790,479	7600	101	20,315	(1,770,164)	-7.49	NO PAYMENT
	sd	2.9											

*CSAH 4 SB

LENGTH		BB80	BBS	CAPACITY ESALs	ADT	DESIGN ESALs	EXCESS ESALs	TH ADT	DURATION DAYS	DETOUR ESALs	OVERLAY ESALs	OVERLAY THICKNESS	COST
1.004	ave	53.6	98.6	38,072	315	34,828	(31,584)	7600	101	20,315	20,315	1.13	$22,671.99
	sd	15.7											

GRAND TOTAL $197,712.06

DETOUR MANAGMENT STUDY
CONDITION RATING METHOD

DISTRICT	PSR NITAL	PSR FINAL	SR NITAL	SR FINAL	CR NITAL	CR FINAL	DELTA CR	COST/ SEGMENT	MILES	COST/ DETOUR
DISTRICT 3										
USTH 169										
CSAH 5	3.6	3.6	4.0	4.0	3.8	3.8	0.00	NO PAYMENT	7.529	
AITKIN 3	3.6	3.6	3.7	3.9	3.7	3.8	-0.10	NO PAYMENT	5.692	NO PAYMENT
MNTH 25										
SHERBURNE 53	3.5	3.4	3.3	3.4	3.4	3.4	0.00	NO PAYMENT	2.638	NO PAYMENT
DISTRICT 4										
MNTH 106										
OTTERTAIL 142	3.4	3.5	3.7	3.7	3.5	3.6	-0.05	NO PAYMENT	1.995	
OTTERTAIL 135	3.0	3.1	3.9	3.9	3.5	3.5	-0.05	NO PAYMENT	3.023	
OTTERTAIL 52	2.5	3.1	3.0	3.5	2.7	3.3	-0.55	NO PAYMENT	2.130	NO PAYMENT
DISTRICT 6										
MNTH 19										
RICE 86*										
RICE 46	3.1	2.7	2.6	3.0	2.9	2.9	0.00	NO PAYMENT	4.914	
RICE 3	2.8	2.8	3.1	3.0	3.0	2.9	0.05	NO PAYMENT	2.908	NO PAYMENT
USTH 60										
RICE 45	2.6	2.7	3.2	3.1	2.9	2.9	0.00	NO PAYMENT	1.125	
RICE 19	3.0	3.0	3.6	3.5	3.3	3.3	0.05	NO PAYMENT	12.966	
GOODHUE 12	3.3	3.3	3.9	3.8	3.6	3.6	0.05	NO PAYMENT	4.330	NO PAYMENT

*DETOUR WAS DETOURED DUE TO BRIDGE WASHOUT

DETOUR MANAGMENT STUDY
CONDITION RATING METHOD

DISTRICT	PSR NITAL	PSR FINAL	SR NITAL	SR FINAL	CR NITAL	CR FINAL	DELTA CR	COST/ SEGMENT	MILES	COST/ DETOUR
DISTRICT 7										
USTH 60										
COTTONWOOD 13	3.5	3.7	3.4	3.2	3.5	3.5	0.00	NO PAYMENT	10.396	
COTTONWOOD 1	3.3	3.3	3.6	3.6	3.5	3.5	0.00	NO PAYMENT	3.831	NO PAYMENT
USTH 14										
BLUE EARTH 42	3.2	2.9	3.6	3.6	3.4	3.3	0.15	$73.53	0.063	
NICOLLET 23	3.6	3.8	3.9	3.9	3.8	3.9	-0.10	NO PAYMENT	4.943	73.53
DISTRICT 8										
MNTH 7										
MCLEOD 14	3.8	3.7	3.9	3.9	3.9	3.8	0.05	NO PAYMENT	3.874	
MEEKER 12	3.5	3.4	3.3	3.6	3.4	3.5	-0.10	NO PAYMENT	5.065	
RENVILLE 7	3.0	3.0	2.8	2.7	2.9	2.9	0.05	NO PAYMENT	4.675	NO PAYMENT
MNTH 7										
MCLEOD 7	2.8	2.7	3.8	3.9	3.3	3.3	-0.00	NO PAYMENT	1.628	
MCLEOD 79	2.9	3.2	3.2	3.1	3.1	3.2	-0.10	NO PAYMENT	3.055	
MCLEOD 4	3.0	3.1	1.7	1.6	2.4	2.4	0.00	NO PAYMENT	1.004	NO PAYMENT
								GRAND TOTAL		$73.53

DETOUR MANAGEMENT STUDY

DETOUR NUMBER	DISTRICT	DETOUR	GAS TAX COST	OVERLAY COST	CONDITION RATING COST	ACTUAL DISTRICT COST *
1	3	T.H. 169	$11,808.63	$0.00	$0.00	$51,800.00
2	3	T.H. 25	$2,602.10	$0.00	$0.00	$5,500.00
3	4	T.H. 106	$2,459.61	$4,361.54	$0.00	$26,000.00
4	6	T.H. 19	$15,297.76	$48,395.14	$0.00	$21,500.00
5	6	T.H. 60	$25,968.64	$86,542.09	$0.00	$68,000.00
6	7	T.H. 60	$42,652.79	$4,992.72	$0.00	$36,000.00
7	7	T.H. 14	$6,678.93	$0.00	$73.53	$10,000.00
8	8	T.H. 7	$19,233.42	$16,846.68	$0.00	$12,300.00
9	8	T.H. 7	$17,112.14	$36,573.89	$0.00	$14,800.00
			$143,814.02	$197,712.06	$73.53	$245,900.00

* Consists of maintenance costs, overlay costs and/or rental costs

APPENDIX A

DEFINITIONS OF ABBREVIATIONS

<u>BB80</u> BENKLEMAN BEAM READING CORRECTED
TO 80 DEGREES F
DEFLECTION VARIES WITH TEMPERATURE

<u>BBSPRING</u> BENKLEMAN BEAM READING CORRECTED
FOR SEASON TO REFLECT HIGHEST
READING IN SPRING

<u>CR</u> CONDITION RATING, AVERAGE OF SR AND PSR

<u>ESAL</u> EQUIVALENT STANDARD AXLE LOAD
(9 TON AXLE)

<u>FWD</u> MACHINE WHICH MEASURES DEFLECTION
USING A FALLING WEIGHT

<u>PSR</u> PRESENT SERVICEABILITY RATING, RIDE AS
MEASURED BY SOUTH DAKOTA PROFILOMETER

<u>SR</u> STRUCTURAL RATING, RATING OF PAVEMENT
SURFACE BY COUNTING PAVEMENT DEFECTS

STEPS TO CALCULATE GAS TAX INCOME

1. DETERMINE TRAFFIC ON DETOURED ROAD FROM LATEST TRAFFIC MAP

2. CALCULATE INCOME
   INCOME = ADT (DETOURED ROAD) * FACTOR * LENGTH (MILES) * DURATION (DAYS)

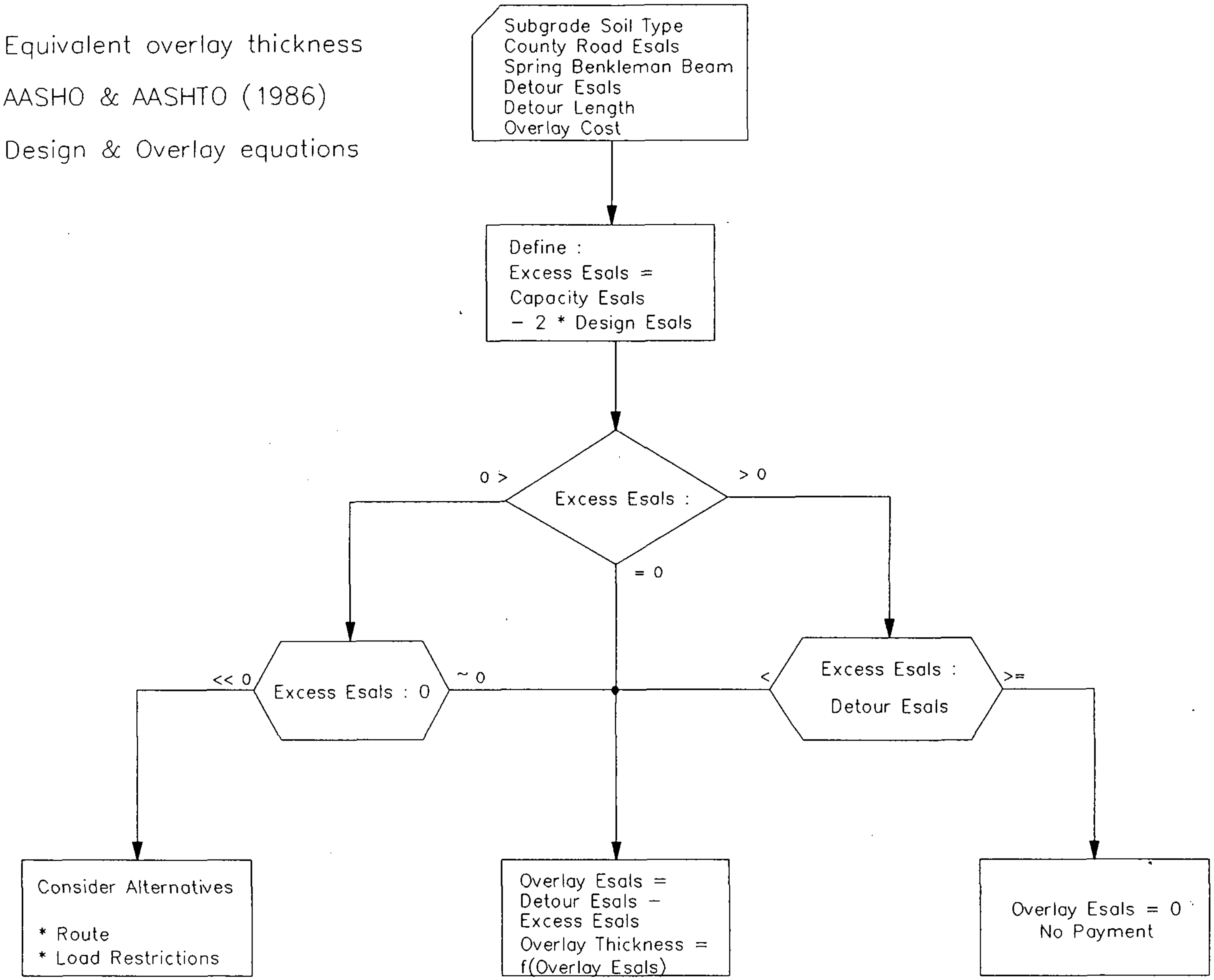
STEPS TO CALCULATE EQUIVALENT OVERLAY INCOME

1. CONVERT FWD READINGS TO BBs
   (1.05 * FWD @ 9 KIPS + 5.0)
2. CONVERT BBs TO BB80s
   TABLE 1, INV 603
3. COMPUTE STANDARD DEVIATION FOR SEGMENT
4. ADD TWO S.D.s TO BB80
5. MAKE SEASONAL CORRECTION TO GET BBSPRING
   TABLE 2 REVISED, INV 603
6. CALCULATE DAILY ESALs FOR STATE AND COUNTY ROADS USING DAILY ADT AND FACTOR FROM TABLE
   STATE 0.0529324 COUNTY 0.0214228
7. CALCULATE CAPACITY ESALs FROM AASHO EQUATION
   $LOG(ESALS) = 11.06 - 3.25 * LOG(BBS)$
8. USE DAILY COUNTY ESALs TO CALCULATE DESIGN ESALs
   $DESIGN\ ESALs = DAILY\ ESALS * 365 * 1.035^{19}$
9. DETOUR ESALs = DAILY STATE ESALs * DAYS DETOURED
10. CALCULATE EXCESS ESALs
    EXCESS ESALs = CAPACITY ESALs − 2 * DESIGN ESALs
11. CALCULATE OVERLAY ESALs
    OVERLAY ESALs = DETOUR ESALs − EXCESS ESALs
12. CALCULATE OVERLAY COST USING 11% REDUCTION IN DEFLECTION PER INCH OF OVERLAY (INV 630) AND $20,000 PER INCH PER MILE OF OVERLAY

Equivalent overlay thickness

AASHO & AASHTO (1986)

Design & Overlay equations



4.

STEPS TO CALCULATE CONDITION RATING INCOME

1. GET BEFORE AND AFTER PSR AND SR
2. DETERMINE CR

   CR = (PSR + SR) / 2
3. CALCULATE INCOME

   INCOME = (DELTA CR-0.1) / 1.7 * 2 * $20,000 * LENGTH (MILES)

APPENDIX B

DETOUR ROUTE ANALYSIS

AND

COMPENSATION METHODS

DRAFT COPY

Revised
January 11, 1991

MINNESOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH LABORATORY
PHYSICAL RESEARCH SECTION
1400 GERVAIS AVENUE
MAPLEWOOD, MN 55109

In the process of selecting methods for detour analysis and compensation, it is necessary to maintain the criteria of simplicity of application and a minimum expenditure of man hours.

While many simplifying assumptions may render a more detailed mechanistic analysis invalid, they can be considered useful within the limits of this analysis.

Three methods of analysis were selected for final consideration. It was felt that the justification for these preserved the initial selection criteria.

The first method selected was the Gas Tax method. It maintains the application simplicity while still providing reseasonable compensation. It has been selected virtually in the same format as presented by the ADE Committee, with the exception that 100 percent of the detour traffic is assumed to be using the detour route, rather than the 75 percent assumed initially. The justification for this is that the traffic is assumed to go somewhere else in the system. Without extensive traffic counts this assumption seems reasonable and some of the detour traffic not using the designated route may be using another county road, for example.

The second method selected was the equivalent overlay method, which is quite similiar to the Mn/DOT overlay method. The concept of excess esals may be a controversial point in this method, but, this is negotiable.

Finally the method of condition rating is presented. It was selected because it is believed to be a more direct measure of actual damage incurred by the roadway during the detour period.

In considering the manhour requirements and responsibilities, the Gas Tax method is the simplest to apply. It would be completed by the District Materials Office.

The Equivalent Overlay and the Condition Rating method each require considerably more effort to complete. The Equivalent Overlay method, being similiar to the Mn/DOT overlay method, requires Deflections being taken on the detour route. This can be done by a Mn/DOT Central Lab crew or a consultant with FWD or Roadrater capabilities. The remaining computations would be done by the District Materials Office or possibly the consultant.

The Condition Rating method assumes a given overlay will restore a pavement from a terminal condition to an as new condition. Before and after Condition Ratings are required. The structural rating is accomplished by the District Materials Office, while the ride portion is done by the Pavement Management Office.The remaining computations would be done by the District Materials Office.

No one analysis method is recommended over the others. It is hoped that usage and acceptance will yield the most appropiate method. However, it is recommended that deflections still be used as a screening device to establish roadway load handling capabilities.

A detailed description of the three methods is provided on the following pages. Much of this material has been presented before, but is included here for consolidation.

GAS TAX METHOD

All gas tax income raised by any road authority is generated by traffic using some specific road segment.

When traffic that normally uses one road segment is detoured to a road segment owned by another jurisdiction, the income generated by this traffic is made available to the owner or jurisdiction of the accepting roadway.

Computation of the gas tax generated by detoured traffic involves applying the gas tax paid per mile by the detoured traffic to the total vehicle miles traveled over the length and duration of the detour.

The following assumptions are made in computing gas tax income:

1) An average miles per gallon should be used for the entire fleet of detoured vehicles to eliminate the need to determine percentage of various vehicle types. Average fleet m.p.g of 17.5 is recommended by the Office of Highway Programs.

2) The current State Gas Tax is 20 cents per gallon.

3) It is assumed that the constitutional provision which limits the State's portion of the gas tax income to 62% will not be changed.

4) Of the 14 cents per gallon Federal gas tax, 8 cents is available for use on highways (1 cent is designated for Transit Programs and 5.0 cents is used for non-highway purposes), but only 7.2 cents per gallon is used on highways on the Federal Aid System. Various non-system roads use 0.8 cents.

5) Assume that Minnesota is neither a donor nor recipient and that it receives 100% of the Federal Gas Taxes generated in the State.

Approximately 35% of both State and Federal Gas Tax Incomes are available for roadbed improvements on non-interstate segments and assignable to another jurisdiction if such a segment is detoured.

METHODOLOGY

State Gas Tax	S_t	0.20
State's portion		0.62
percent available for roadbed improvement	F_s	0.35
net State Gas Tax		$0.62 * S_t * F_s$

Federal Gas Tax	F_t	0.14
available for highways		$F_t - 0.06$
percent available for highways on Federal Aid System		0.90
percent available for roadbed improvement	F_f	0.35
net Federal Gas Tax		$0.9 * (F_t - 0.06) * F_f$

Combined Tax factor T = net State Gax Tax + net Federal Gas Tax

$$= 0.62 * S_t * F_s + 0.90 * (F_t - 0.06) * F_f$$

$$= 0.62 * 0.20 * 0.35 + 0.90 * 0.08 * 0.35$$

$$= 0.0434 + 0.0252$$

$$= 0.0686$$

Gas Tax Income generated by Detour

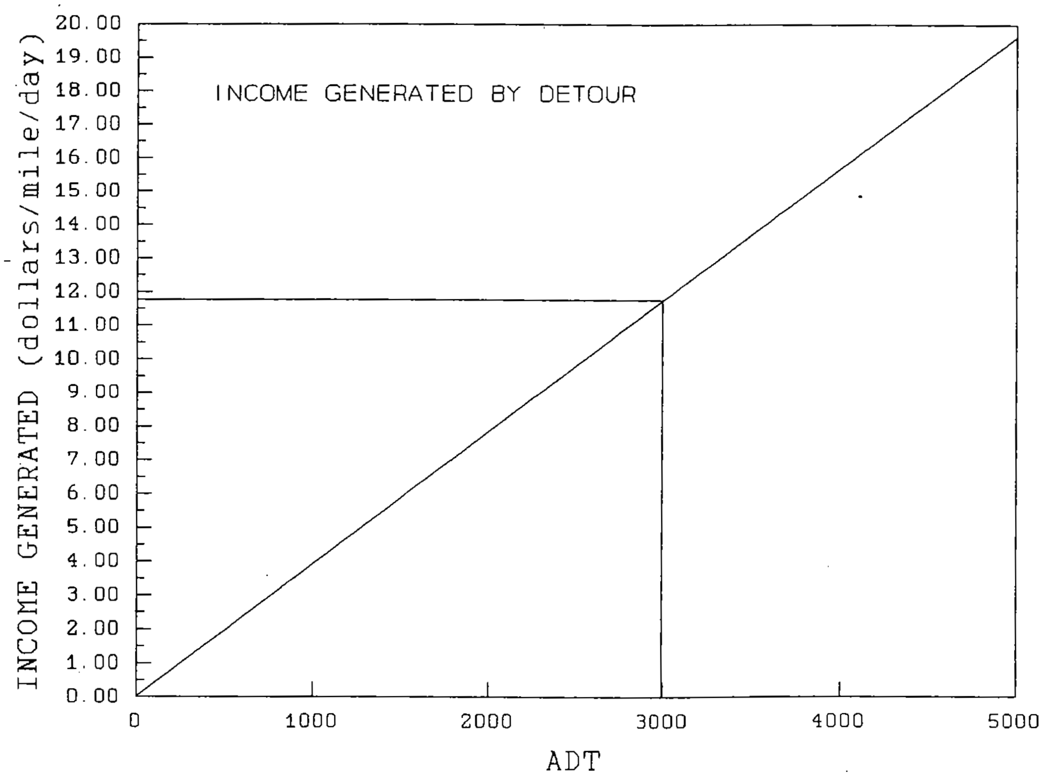
$$I = \frac{ADT * Length\ (mi) * Time\ (days)}{mpg\ (fleetwide)} * Combined\ Tax\ Factor$$

$$I = \frac{ADT * Length\ (mi) * Time\ (days)}{mpg\ (fleetwide)} * 0.0686$$

$$I = \frac{ADT * Length\ (mi) * Time\ (days)}{17.5\ mpg} * 0.0686$$

$$I = ADT * Length\ (mi) * Time(days) * \frac{0.0686}{17.5\ mpg}$$

$$= 0.00392 * ADT * Length\ (mi) * Time\ (days)$$



EXAMPLE:

CR 45 MORRISON/CROW WING COUNTIES (1986) (GAS TAX @ $0.17)

GAS TAX METHOD

MILE	ADT	GAS TAX INCOME
1.0	225	19.96
2.0	225	19.96
3.0	215	19.07
4.0	215	19.07
5.0	270	23.95
6.0	280	24.84
7.0	310	27.50
8.0	310	27.50
9.0	390	34.59
10.0	420	37.25
11.0	530	47.01
12.0	530	47.01
13.0	570	50.56
14.0	720	63.86
15.0	810	71.85
16.0	900	79.83
17.0	900	79.83
SUMMARY	460	$693.63

EQUIVALENT OVERLAY METHOD

Roadway Life Capacity

Roadway life capacity (Capacity ESALs) is defined as the number of equivalent standard axle loads that a particular pavement can accomodate during its functional lifetime.

The AASHO Road Test results yielded a correlation of spring deflection to functional roadway life. Investigation 183 found this AASHO correlation to be applicable to Minnesota pavements. At the present, this equation is used to predict pavement life.

$$\text{LOG(ESALS)} = 11.06 - 3.25 * \text{LOG(BBS)}$$

where BBS = Spring Benkleman Beam Deflection in mils.

Design Life

The design life capacity (Design ESALs) of a pavement is calculated as outlined in Section 7-5.03.01 of the Mn/DOT Road Design Manual.

$$\text{Present Daily N18} = \sum \left[\frac{\text{ADT}}{2} * \begin{matrix}\text{Assumed} \\ \text{Distribution} \\ \text{Factor by} \\ \text{Vehicle type} \\ \text{(Tab 7-5.03B)}\end{matrix} * \begin{matrix}\text{Average} \\ \text{N18 Factor by} \\ \text{Vehicle Type} \\ \text{(Tab 7-5.03D)}\end{matrix} \right]$$

$$\text{One-way Design Lane ESALS} = 365 * \text{Present Daily N18} * \begin{matrix}\text{Time-Growth} \\ \text{Factor} \\ \text{(Tab 7-5.03E)}\end{matrix}$$

where, for expediency, the ADT is the 2-way ADT as taken off a current county traffic flow map. The Present Daily N18 is calculated following the procedure outlined in Table 7-5.03F. The time-growth factor is obtained from Table 7-5.03E assuming an annual growth factor in present daily N18 of 3.5% and a design period of 20 years, as suggested in Section 7-5.03.01.

Overlay Design

The present Mn/DOT overlay design procedure utilizes the assumption that, an inch of bituminous overlay will result in an average reduction of 11% in the deflection of a pavement (INV 630). The overlay design procedure uses this to reduce the allowable benkleman beam deflection to give the road a desired load rating.

This procedure can be modified, so that an overlay could be designed, that when added to the original structure would give a Spring Benkleman Beam Deflection that would be the same as that of a pavement that would have a Design Life equal to the original design traffic plus that of the added detour traffic.

$$\text{Log(ESALs)} = 11.06 - 3.25\ \text{Log(BBS)}$$

$$\text{Log(ESALs}^*) = 11.06 - 3.25\ \text{Log(BBS}^*)$$

where, ESALs = Roadway Life

ESALs* = Roadway Life + Detour Traffic

$$\text{Log(BBS)} = \frac{11.06 - \text{Log(ESALs)}}{3.25}$$

$$\text{Log(BBS}^*) = \frac{11.06 - \text{Log(ESALs}^*)}{3.25}$$

$$\text{BBS} = 10 \wedge \left[\frac{11.06 - \text{Log(ESALs)}}{3.25}\right]$$

$$\text{BBS}^* = 10 \wedge \left[\frac{11.06 - \text{Log(ESALs}^*)}{3.25}\right]$$

This would be the deflection of the structure needed to accommodate the addition of the detour traffic.

$$\frac{\text{BBS}^*}{\text{BBS}} = 10 \wedge \left[\frac{\text{Log(ESALs)} - \text{Log(ESALs}^*)}{3.25}\right]$$

This then represents the ratio of the deflection of the new structure to that of the original structure.

$$= 10 \wedge \left[\frac{\text{Log} \dfrac{(\text{ESALs})}{(\text{ESALs}^*)}}{3.25} \right]$$

$$= \left[\frac{\text{ESALs}}{\text{ESALs}^*} \right]^{(1/3.25)}$$

Assuming an inch of bituminous overlay will yield an 11% reduction in the measured BBS, we can calculate the required overlay thickness to give the equivalent reduction necessary to accomodate the added detour traffic.

$$\frac{\text{BBS}^*}{\text{BBS}} = (1-n)^x$$

$$\left[\frac{\text{ESALs}}{\text{ESALs}^*} \right]^{(1/3.25)} = (1-n)^x$$

$$X = \frac{\text{Log} \left[\dfrac{(\text{ESALs})}{(\text{ESALs}^*)} \right]}{3.25 \text{ Log}(1-n)}$$

where x = the equivalent overlay in inches
n = the reduction per inch, in this case, .11

Equivalent Overlay

If it can be assumed that additional structure will yield additional life, then an overlay can be designed such that a particular pavement will have a predicted capacity that will accommodate the original design traffic plus that imposed upon it by a detour.

Excess ESALS

Utilizing minimum design standards a structure may have a capacity beyond that of the traffic for which it was designed. To compensate for this, the concept of excess esals is proposed.

The Roadway Life Capacity (Capacity ESALs) is determined by the AASHO design equation.

The predicted traffic for which the actual roadway was designed is given a safety factor of 2, to account for errors of traffic prediction.

The Excess ESALs are then the difference in the determined capacity and the traffic for which the roadway was designed.

Excess ESALs = Capacity ESALs - 2 * Design ESALs

Case 1. Excess ESALs < 0

Consider:
Overlay ESALs = Detour ESALs if Excess ESALs ~ 0
Alternatives if Excess ESALs << 0.

Case 2. Excess ESALs = 0

Overlay ESALs = Detour ESALs

Case 3. Excess ESALs > 0

a. Excess ESALs < Detour ESALs

Overlay ESALs = Detour ESALs - Excess ESALS

b. Excess ESALs = Detour ESALs

Overlay ESALs = 0
: no payment

c. Excess ESALS > Detour ESALs

Overlay ESALs = 0
: no payment

The overlay is designed for overlay ESALs and payment, in any case, is the cost of the computed overlay.

EXAMPLE:

CR 45 MORRISON/CROW WING COUNTIES (1986)

EQUIVALENT OVERLAY METHOD

MILE	DETOUR ESALs	ADT	SBB	CAPACITY ESALS	DESIGN ESALS	EXCESS ESALS	
1.0	7238	225	41.4	637895	27908	582080	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
2.0	7238	225	35.3	1070860	27908	1015045	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
3.0	7238	215	41.7	623101	26667	569766	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
4.0	7238	215	41.0	658344	26667	605009	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
5.0	7238	270	34.6	1142887	33489	1075908	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
6.0	7238	280	36.6	952109	34730	882650	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
7.0	7238	310	44.6	500798	38451	423897	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
8.0	7238	310	47.4	410885	38451	333984	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
9.0	7238	390	43.8	531141	48373	434394	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
10.0	7238	420	38.4	814561	52094	710373	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
11.0	7238	530	45.1	482977	65738	351501	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
12.0	7238	530	55.3	248968	65738	117492	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
13.0	7238	570	57.5	221819	70700	80419	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
14.0	7238	720	58.3	209690	89305	31081	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
15.0	7238	810	59.2	199506	100468	(1430)	Cost of Overlay * Less Than $100/mile
16.0	7238	900	53.9	270606	111631	47344	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
17.0	7238	900	51.4	315770	111631	92508	NO PAYMENT : EXCESS ESALS > DETOUR ESALS
SUMMARY		460	46.2	446595	57056	332484	

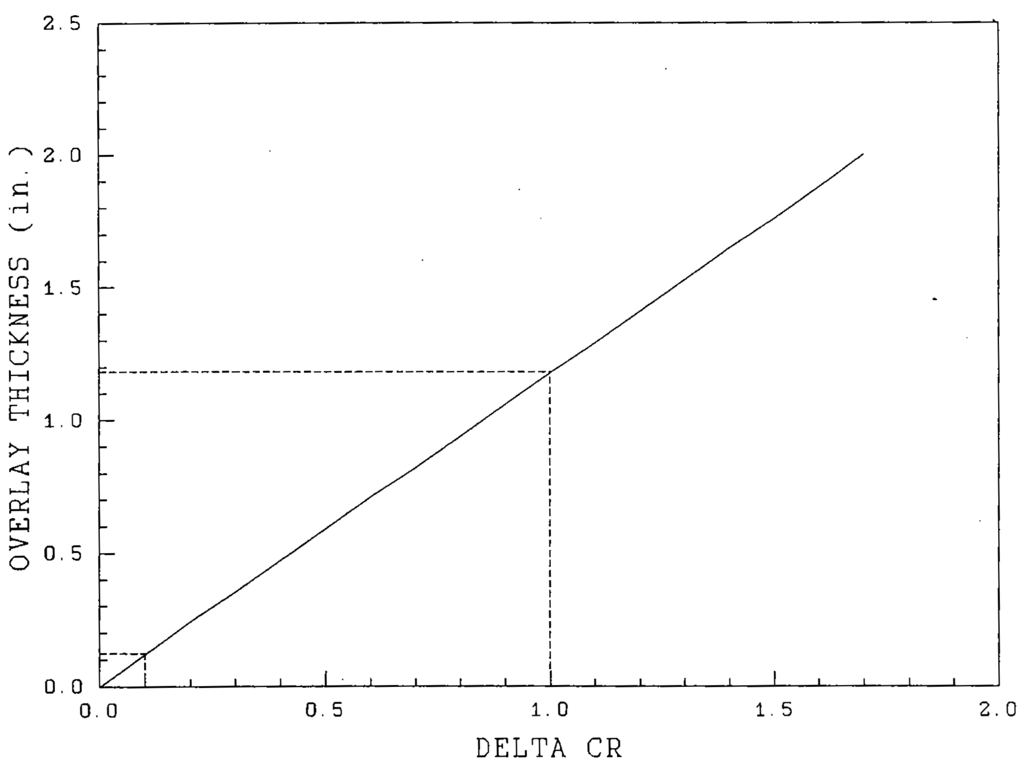
STANDARD OVERLAY THICKNESS

In attempting to arrive at a method of compensation for the condition rating method of detour route evaluation, it could be assumed that a given overlay thickness will restore the roadway to its original condition. If it is further assumed that this relationship is linear, then the amount of overlay needed will be directly proportional to the change in condition rating.

It is recocognized that a typical road loses, on the average, 0.1 Condition Rating points per year (1.7/17 years).

Assuming an overlay thickness of 2 inches would restore a pavement with a condition rating of 2.5 to a condition rating of 4.2, the following relationship can be drawn.

2 in. Standard Overlay



$$\text{overlay thickness} = \frac{\text{delta CR} - .1}{\text{CRo} - \text{CRt}} * 2.0 \text{ inches}$$

where CRo = 4.2, condition rating when new

CRt = 2.5, terminal condition rating

Assuming an overlay cost of $20,000 per inch per mile

ex: light
Delta CR = 0.1
Overlay Thickness = 0 in.
Payment = 0

ex: moderate
Delta CR = 1.0
Overlay Thickness = 1.06 in.
Payment = $21,200 per mile