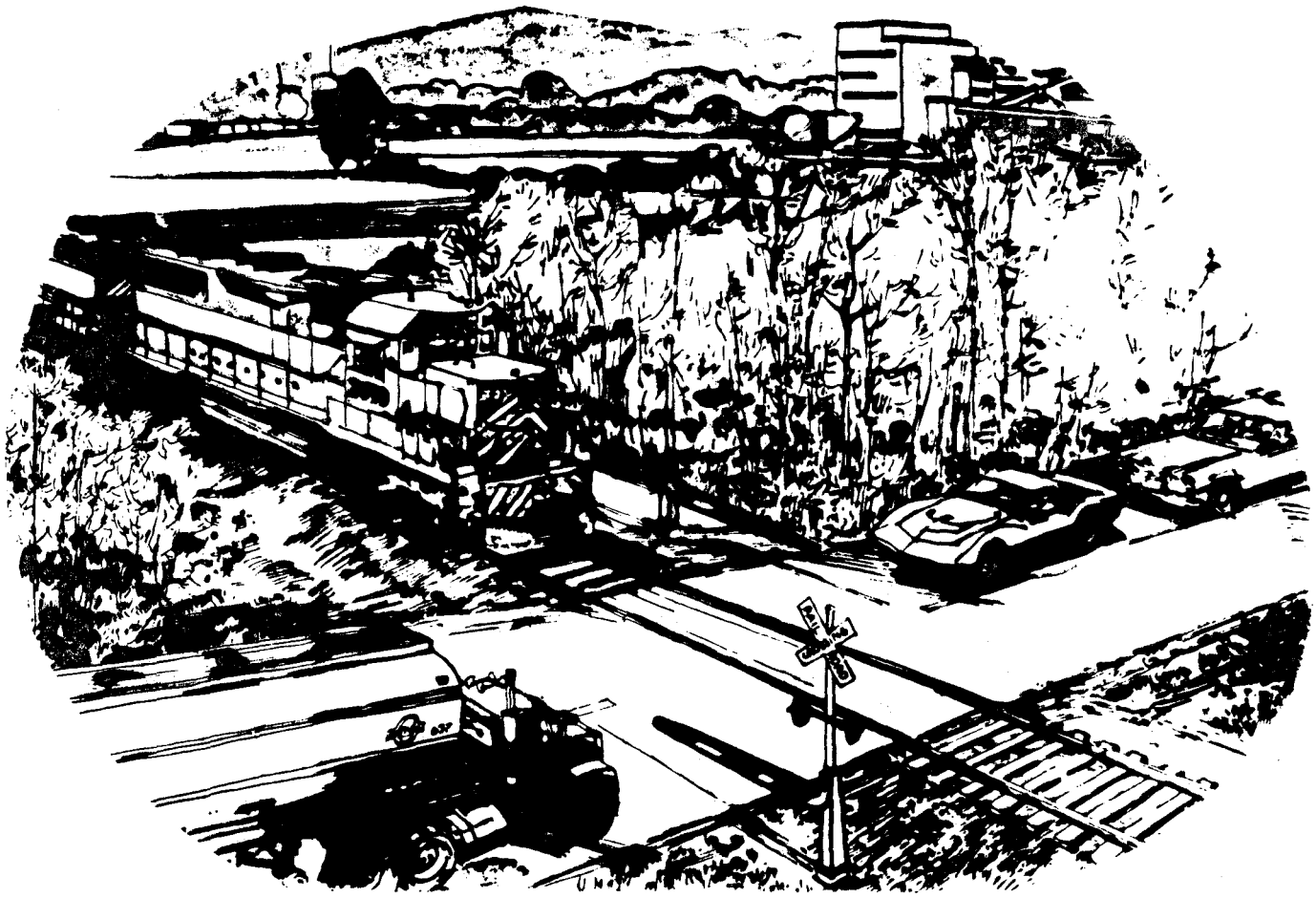


VEHICLE DELAY TIMES AT RAILROAD CROSSINGS

Prepared By:
Planning and Research Division
SEPTEMBER 1977

SUMMARY

The increased demand in recent years for low-sulphur coal has stimulated heavy production in Western coal fields. This, in turn, has generated an increasing amount of rail traffic across Iowa. The coal moves in 100-car unit trains made up of 100-ton hopper cars. As these trains move across the Chicago and Northwestern and the Burlington Northern Railroads, they add to the existing problem of vehicle delays at railroad crossings. There are 289 grade crossings on the Chicago and Northwestern, and 215 grade crossings on the Burlington Northern Railroad. Each train causes vehicle delays across the state totalling approximately eleven hours.

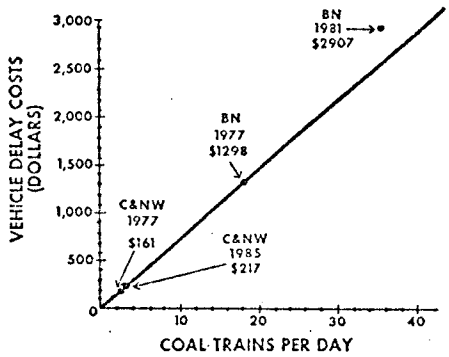
The Planning and Research Division conducted this study to assess the time and cost impact of these additional trains on highway vehicles that must stop and wait while the various railroad crossings across the state are blocked by the unit train movements.

Cost factors accounted for the highway vehicle are: fuel and oil consumption, depreciation, maintenance, and driver and passenger time loss. Costs were computed on the basis of the time each vehicle is delayed by a passing train. Delay times include factors for a safety delay (when the gates or signals are activated), the time the train blocks the crossing, and the time it takes to disperse traffic once the train has cleared the crossing.

It was determined that each train crossing Iowa incurs costs to highway vehicle users in the neighborhood of $70 to $72.

As shown on the following chart (based on the total delay cost per train in 1977 for the Burlington Northern Railroad - $72.11 per movement across Iowa), the cost climbs rapidly as the number of trains increases.

VEHICLE DELAY COSTS AT RAILROAD CROSSINGS



By superimposing the current and future delay costs for the two railroads on the chart, it can be seen that the Chicago and Northwestern Railroad delay costs are greatly overshadowed ($161 in 1977 and $217 per day in 1985) by the Burlington Northern's current delay cost of $1298, and 1981 cost of $2907 per day. This is because the Chicago and Northwestern Railroad is expected to increase unit coal train movements by less than one train per day over the next few years, while the Burlington Northern is expected to increase unit train movements by 18 trains per day (100% increase) by 1981.

The total cost of vehicle delays by the additional unit coal train movements is summarized in the following table.

TOTAL DELAY COSTS

BURLINGTON NORTHERN				CHICAGO NORTHWESTERN			
PER TRAIN	DAILY	ANNUAL (1977)	ANNUAL (1981)	PER TRAIN	DAILY	ANNUAL (1977)	ANNUAL (1985)
$72	$1300	$474,000	$1,061,000	$70	$160	$59,000	$78,000

$1,061,000
$ 78,000
$1,139,000

The $1,139,000 annual total shown in the table, while not completely mathematically correct because of differing terminal years, clearly indicates that in the period 1981-1985, highway vehicle delay costs at railroad crossings, caused by the unit coal trains will be over $1 million annually.

Introduction

The study included determination of the total amount of time that vehicles are delayed at railroad crossings and the associated costs to motorists. Data in this report includes: the amount of time each type of crossing is blocked by a unit train (Table 1); the number of grade crossings on each railroad studied (Table 2); the total vehicle delay per train at each type of crossing (Table 3); the accumulated vehicle delay for one train crossing the state on each railroad (Table 4); vehicle cost per train per crossing (Table 5); and accumulated vehicle cost for each unit train across the state (Table 6).

The following major assumptions were made to determine the times and costs for the study:

a) Each unit coal train consists of 100 cars and is a total of 5414 feet long.

b) Rural and municipal train speeds are 45 and 30 miles per hour respectively.

c) The average daily highway traffic is assumed to be split 75% from 6:00 A.M. to 6:00 P.M. and 25% from 6:00 P.M. to 6:00 A.M.

d) Train traffic is assumed to be spread evenly over 24 hours.

I. Accumulated vehicle delay times

It was assumed for the purpose of this study that when a train approaches a highway crossing with an automatic signal, the signal is activated 20 seconds prior to the train's arrival and remains active for 5 seconds after the train's departure. At non-signalized crossings it was assumed that cars would begin to stop 10 seconds before the train arrives. Various times were assigned to each type of crossing for the traffic to clear the

crossing after the train passed. These times were based on the traffic speed and the number of vehicles delayed at the crossing. Table 1 shows the total time that each type of crossing is blocked.

Table 1

Amount of Time Each Crossing is Blocked*
(in minutes per train per crossing)

Average Daily Highway Traffic	Signalized Crossings		Non-Signalized Crossings	
	Train Speed		Train Speed	
	45 MPH	30 MPH	45 MPH	30 MPH
0-99	1.78	2.47	1.53	2.22
100-999	1.83	2.52	1.58	2.27
1000-2499	1.83	2.53	1.58	2.28
2500-3999	1.85	2.55	1.60	2.30
4000+	1.92	2.63	1.67	2.38

*Includes the time the train is across the road, the safety delay and the time for the line of traffic to clear the crossing.

Table 2 shows the total number of crossings in each traffic group on each railroad.

Table 2

Number of Grade Crossings

Average Daily Highway Traffic	Burlington Northern				Total Crossings
	Signalized Crossings		Non-Signalized Crossings		
	Train Speed		Train Speed		
	45 MPH	30 MPH	45 MPH	30 MPH	
0-99	5	3	87	5	100
100-999	1	23	14	24	62
1000-2499	1	17	0	4	22
2500-3999	0	5	0	7	12
4000+	0	13	0	6	19
Total	7	61	101	46	215

Table 2 (Cont'd)

Average Daily Highway Traffic	Chicago & Northwestern				Total Crossings
	Signalized Crossings		Non-Signalized Crossings		
	Train Speed		Train Speed		
	45 MPH	30 MPH	45 MPH	30 MPH	
0-99	10	2	97	7	116
100-999	12	60	25	26	123
1000-2499	1	23	1	5	30
2500-3999	0	6	0	3	9
4000+	0	11	0	0	11
Total	23	102	123	41	289

Table 3 shows the total amount of time that vehicles are delayed at each type of crossing. The values in Table 3 were derived by multiplying the total amount of time the crossing is closed (from Table 1) times the traffic volume in vehicles per minute. That number is then multiplied by the average amount of time that each vehicle is delayed. Separate figures are derived for day and night traffic volumes. For example, the total vehicle delay for a non-signalized rural crossing during the day in the traffic range of 2500-3999 vehicles per day is calculated as follows:

> 1.6 minutes (total delay time) x 3.385 vehicles per minute x 0.931 minutes (average delay) = 5.04 vehicle minutes

Table 3

Total Delay per Train per Crossing
(in vehicle minutes)

Average Daily Highway Traffic	Signalized Crossings				Non-Signalized Crossings			
	Train Speed				Train Speed			
	45 MPH		30 MPH		45 MPH		30 MPH	
	Day	Night	Day	Night	Day	Night	Day	Night
0-99	0.17	0.06	0.32	0.11	0.12	0.04	0.26	0.09
100-999	1.83	0.64	2.88	1.22	1.43	0.48	2.43	0.98
1000-2499	3.90	1.85	7.02	3.01	3.03	1.52	5.93	2.53
2500-3999	6.61	2.82	12.10	4.89	5.04	2.17	9.96	4.02
4000+	16.32	6.04	30.13	10.88	12.45	4.67	24.78	9.02

The total delay time for a train crossing the state was derived by multiplying the total delay from Table 3 for each class of crossing times the number of crossings in the class from Table 2 and accumulating the products. The accumulated total delay time for one train is shown for each rail line in Table 4.

Table 4

Total Delay per Train Across Iowa
(in vehicle minutes)

Average Daily Highway Traffic	Burlington Northern				Total Vehicle Minutes
	Signalized Crossings		Non-Signalized Crossings		
	Train Speed		Train Speed		
	45 MPH	30 MPH	45 MPH	30 MPH	
0-99	0.58	0.65	6.96	0.88	9.07
100-999	1.24	47.15	13.37	40.92	102.68
1000-2499	2.88	85.26	0	14.92	103.06
2500-3999	0	42.48	0	48.93	91.41
4000+	0	266.57	0	101.40	367.97
Total	4.70	442.11	20.33	207.05	674.19

Average Daily Highway Traffic	Chicago & Northwestern				Total Vehicle Minutes
	Signalized Crossings		Non-Signalized Crossings		
	Train Speed		Train Speed		
	45 MPH	30 MPH	45 MPH	30 MPH	
0-99	1.15	0.43	7.76	1.23	10.57
100-999	14.82	123.00	23.88	44.33	206.03
1000-2499	2.88	115.35	2.28	21.15	141.66
2500-3999	0	50.97	0	20.97	71.94
4000+	0	225.56	0	0	225.56
Total	18.85	515.31	33.92	87.68	655.76

II. Accumulated vehicle delay cost

The costs to motorists resulting from delays at grade crossings were derived from unit costs cited in Economic Analysis for Highways by Robley Winfrey, a widely used reference work. These costs were updated to reflect 1976 prices. The cost formula includes factors for fuel and oil consumption, depreciation, maintenance, and driver and passenger time for cars and trucks. The total cost per stop includes the cost to decelerate and accelerate and the cost to idle

while waiting for the train to pass. Total cost for each type of crossing for day and night traffic volumes is shown in Table 5.

Table 5

Total Vehicle Cost per Train per Crossing

Average Daily Highway Traffic	Signalized Crossings				Non-Signalized Crossings			
	Train Speed				Train Speed			
	45 MPH		30 MPH		45 MPH		30 MPH	
	Day	Night	Day	Night	Day	Night	Day	Night
0-99	$0.025	$0.009	$0.035	$0.012	$0.019	$0.006	$0.028	$0.009
100-999	0.202	0.070	0.303	0.128	0.159	0.053	0.256	0.103
1000-2999	0.447	0.205	0.744	0.317	0.352	0.169	0.630	0.267
2500-3999	0.768	0.276	1.257	0.516	0.595	0.248	1.060	0.426
4000+	1.903	0.695	3.202	1.154	1.479	0.545	2.641	0.958

Table 6 shows the accumulated vehicle costs for one train across Iowa.

Table 6

Total Vehicle Cost per Train Across Iowa

Average Daily Highway Traffic	Burlington Northern				Total Delay Costs
	Signalized Crossings		Non-Signalized Crossings		
	Train Speed		Train Speed		
	45 MPH	30 MPH	45 MPH	30 MPH	
0-99	$0.09	$0.07	$1.09	$0.09	$ 1.34
100-999	0.14	4.96	1.48	4.31	10.89
1000-2499	0.33	9.02	0	1.79	11.14
2500-3999	0	4.43	0	5.20	9.63
4000+	0	28.31	0	10.80	39.11
Total	$0.56	$46.79	$2.57	$22.19	$72.11

Average Daily Highway Traffic	Chicago & Northwestern				Total Delay Costs
	Signalized Crossings		Non-Signalized Crossings		
	Train Speed		Train Speed		
	45 MPH	30 MPH	45 MPH	30 MPH	
0-99	$0.17	$0.05	$1.21	$0.13	$1.56
100-999	1.63	12.93	2.65	4.67	21.88
1000-2499	0.33	12.20	0.26	2.24	15.03
2500-3999	0	5.32	0	2.23	7.55
4000+	0	23.96	0	0	23.96
Total	$2.13	$54.46	$4.12	$9.27	$69.98

III. Total annual delay cost

The annual delay cost resulting from unit coal train operations was derived by multiplying the cost per train from Table 5 by the estimated number of trains per year. Total costs for 1977 are: Burlington Northern (18 train movements per day) - $474,000 per year; Chicago and Northwestern (70 train movements per month) - $59,000 per year.

It is estimated that the number of unit train movements on the Burlington Northern will grow to 36 per day by 1981. The Chicago and Northwestern unit train traffic growth is estimated at seven percent by 1985. Estimated annual vehicle delay costs in 1976 dollars are: Burlington Northern Crossings - $1,061,000 by 1981; Chicago and Northwestern Crossings - $78,000 by 1985.

RAILROAD MAP OF IOWA

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OFFICE OF TRANSPORTATION INVENTORY
PHONE (515) 296-1289
IN COOPERATION WITH
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

SCALE IN MILES
0 2 4 6 0 8 16 24

1975

LEGEND

Chicago, Rock Island & Pacific R.R. Co.	CRIP
Chicago, Milwaukee, St. Paul & Pacific R.R.	CMSTPAP
Chicago & Northwestrn Transportation Co.	CNW
Illinois Central Gulf R.R.	ICG
Burlington Northern R.R.	BN
Davenport, Rock Island & Northwestern Ry.	DRINW
Atchison, Topeka & Santa Fe Ry. Co.	ATASF
Norfolk & Western Ry. Co.	NRW
Union Pacific R.R.	UP
Cedar Rapids & Iowa City Ry. Co.	CRAIC
Des Moines & Central Iowa Ry. Co.	DMACI
Central Iowa Transportation Coop.	CITC
Iowa Terminal Ry. Co.	IT
Waterloo R.R. Co.	WA
Interchange points	★

RAILROAD OPERATION AS OF JANUARY 1, 1975