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HAMILTON BOULEVARD SAFETY PROJECT EVALUATION

SIOUX CITY, IOWA

Hamilton Boulevard Safety Project Evaluation

In 1973, the Sioux City Transportation Engineering Department conducted a study to determine the need for improvements to reduce accidents and congestion on Hamilton Blvd. Hamilton Blvd. is the major north/south arterial serving the north side of Sioux City and, in 1973, carried 12,000 vehicles per day.

The safety study showed that over a three year period, ending December 1972, motorists experienced a total of 186 accidents at the intersection of W. 19th and Hamilton and between W. 28th St. and Stone Park Blvd. Over half of these accidents involved left turning vehicles. Traffic accidents were expected to increase further after the opening of a new section of the route which would connect Interstate 29 with the northern sections of Hamilton Blvd.

As a result of the safety study, the City approved a federal funding agreement for the reconstruction project along Hamilton Blvd. Work on the project began in 1976 and included construction projects from 18th St. north past the Sunset Plaza Shopping Center to Stone Park Blvd.

The improvements included street widening, paving, resurfacing of the roadway and bridge construction. Medians were constructed along part of the route and left turn bays were provided at major intersections. Access to the shopping center was restricted to two locations and traffic signal control was provided at the shopping center entrances. Other traffic signals were upgraded and street lighting was improved.

The new traffic signals were interconnected to provide a coordinated signal timing system. The system provides different timing plans for inbound and outbound peak periods of traffic flow as well as off-peak periods of balanced traffic flow. Two way progression is provided in all timing plans.

The project was constructed as a Federal Aid Urban Systems project with the local share 30% and the federal share 70%. Total cost was $2.6 million. Construction was completed in the spring of 1978.

Project Benefits: Although extensive before and after evaluation studies were not preplanned, an analysis of available data was undertaken after project completion.

Accident Reduction: Accident information, for equivalent 8 month periods before and after project construction, was compiled as shown below:

	Before (Feb.'75 to Oct.'75) ADT=15,000	After (Feb.'78 to Oct.'78) ADT=19,000
Total Accidents	47	20
Property Damage Expense	$51,585	$32,070
Personal Injuries	27	13
Fatalities	0	0
Accident Rate*	3,480	1,170

*Accidents per 1 million vehicle miles traveled.

The before and after figures indicated reductions in most areas of accident statistics. (There were no fatal accidents for either period.) The percentage of reductions is shown below:

Total Accidents	- Reduced by 57.4%
Property Damage	- Reduced by 37.8%
Personal Injuries	- Reduced by 51.9%
Fatalities	- N/A
Accident Rate	- Reduced by 66%

These figures represent significant accident reductions in the project area on Hamilton Blvd. despite a 27 percent increase in traffic volume on the street between 1975 and 1978.

Travel Time and Stop Reduction: The following figures represent comparisons of travel time and number of stops before and after coordination of the new fully actuated signals along Hamilton Blvd. between W.19th St. and Stone Park Blvd.

Travel Time
(seconds)

	Before	After	Reduction
Overall Average	213	175	18%

Number of Stops

	Before	After	Reduction
Average	2.3	1.4	39%

These figures indicate significant reductions in travel time and the number of stops required to traverse the street.

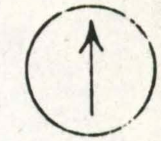
Cost/Benefit Analysis (see attachments): In order to determine if the expenditure of 2.3 million dollars was a wise investment, a cost benefit ratio was calculated. Dollar savings to the road user from reductions in accidents, delays and fuel consumption indicated a cost benefit ratio of 3.08, an estimated savings of $3.08 to the user for every $1.00 in public funds invested.

Other Benefits: In addition to the previously mentioned benefits, there are other non-measureable benefits such as community pride, encouragement of economic growth, better access to commercial areas, improved transit access and aesthetic improvements.

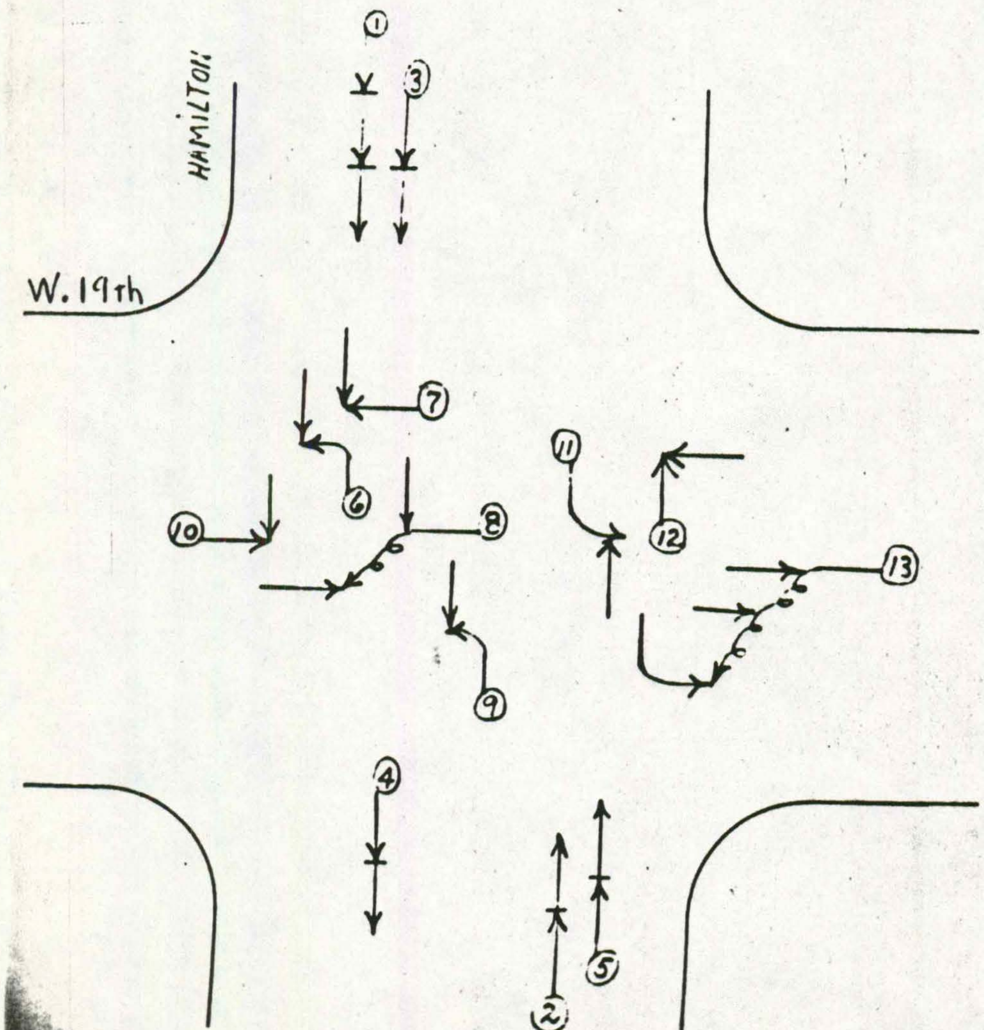
Conclusion: It is our finding that the Hamilton Blvd. Improvement Project was a justified expenditure which resulted in many benefits to the citizens of Sioux City.

Note: This evaluation study was based on limited data and was not intended to be a statistically significant analysis of before and after conditions. The annual value of travel time and fuel savings was based on an assumption that delays before reconstruction were a least as long as delays after reconstruction. The purpose of the evaluation study was to provide the City with an indication of benefits resulting from the improvement project.

W. 19TH & HAMILTON

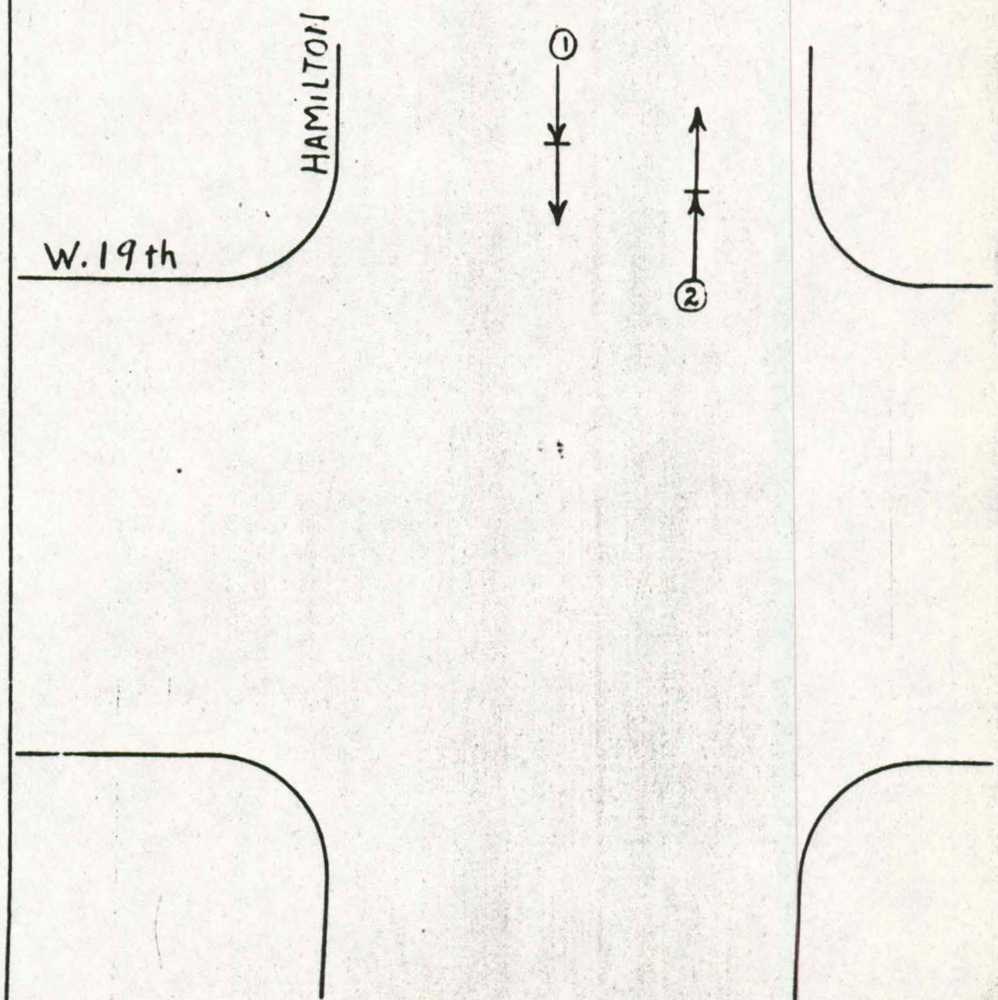


BEFORE FEB.'75 TO OCT.'75



13 ACCIDENTS

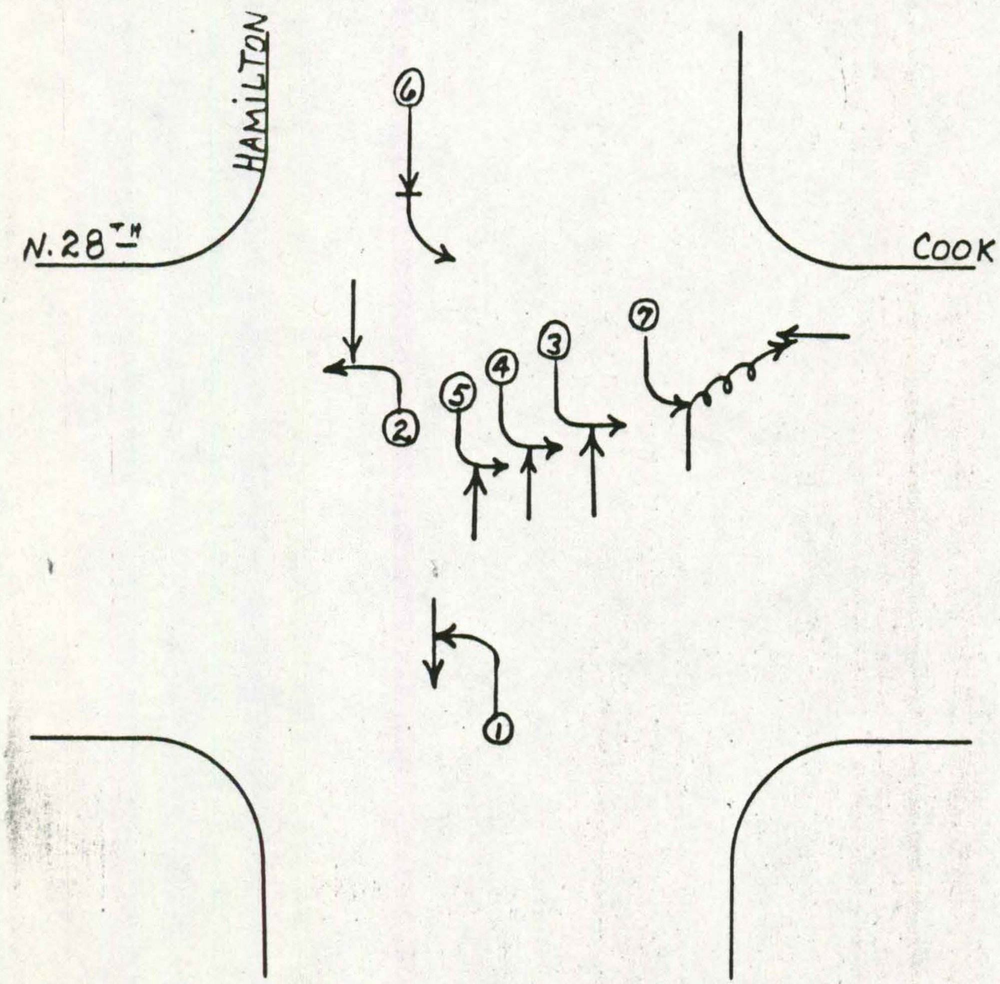
AFTER FEB.'78 TO OCT.'78



2 ACCIDENTS

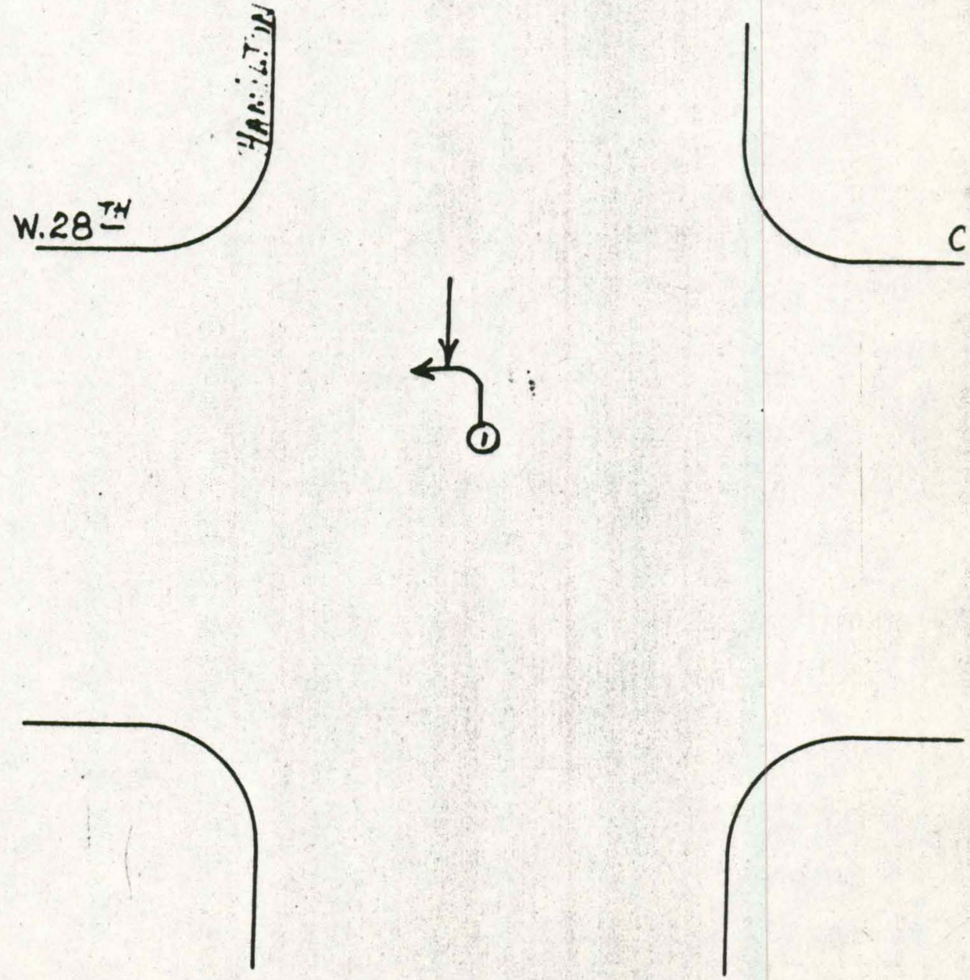
W. 28TH & HAMILTON BLVD.

BEFORE FEB. '75 TO OCT. '75



7 ACCIDENTS

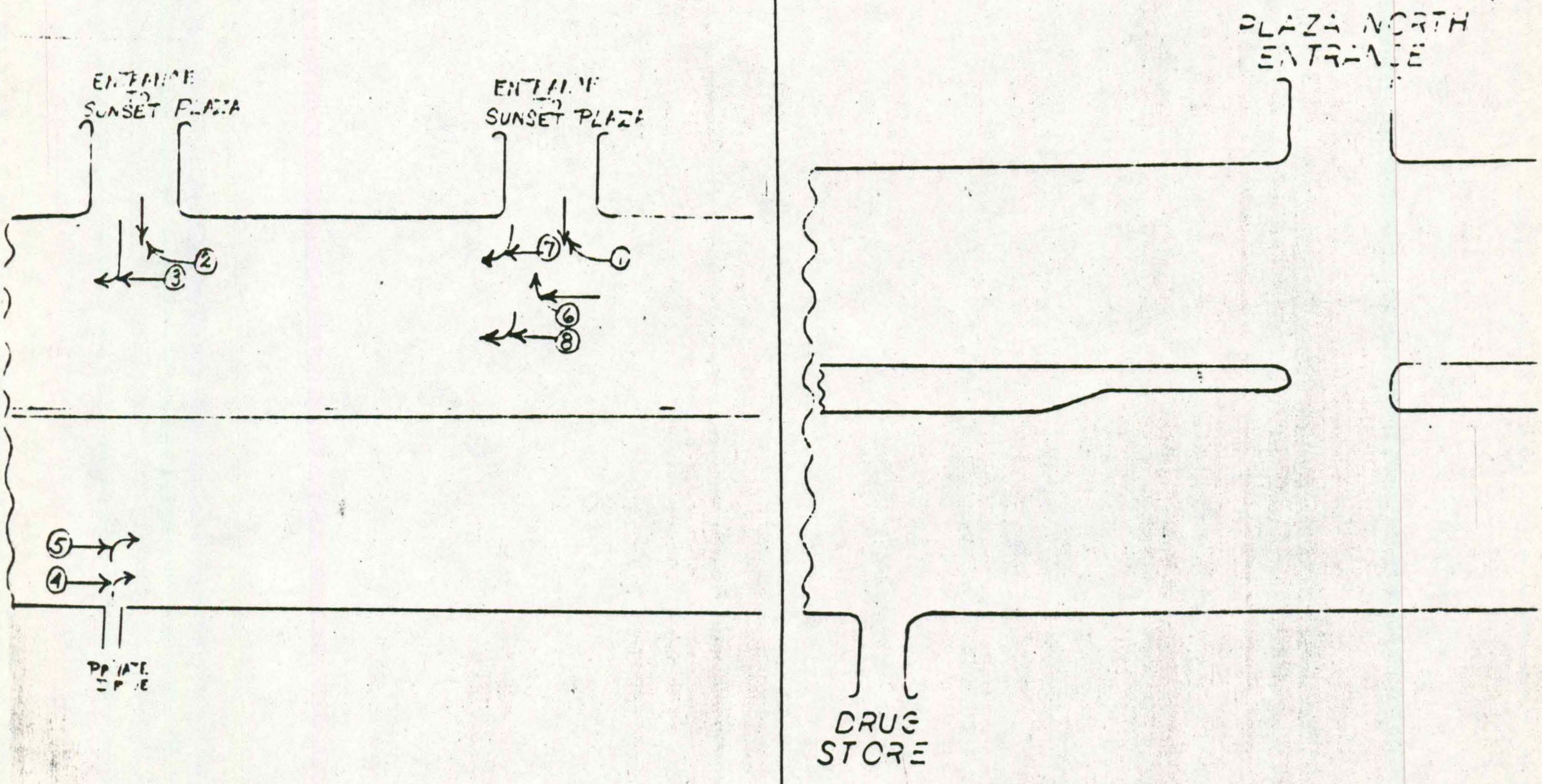
AFTER FEB. '78 TO OCT. '78



1 ACCIDENT

HAMILTON BLVD. & SUNSET NORTH

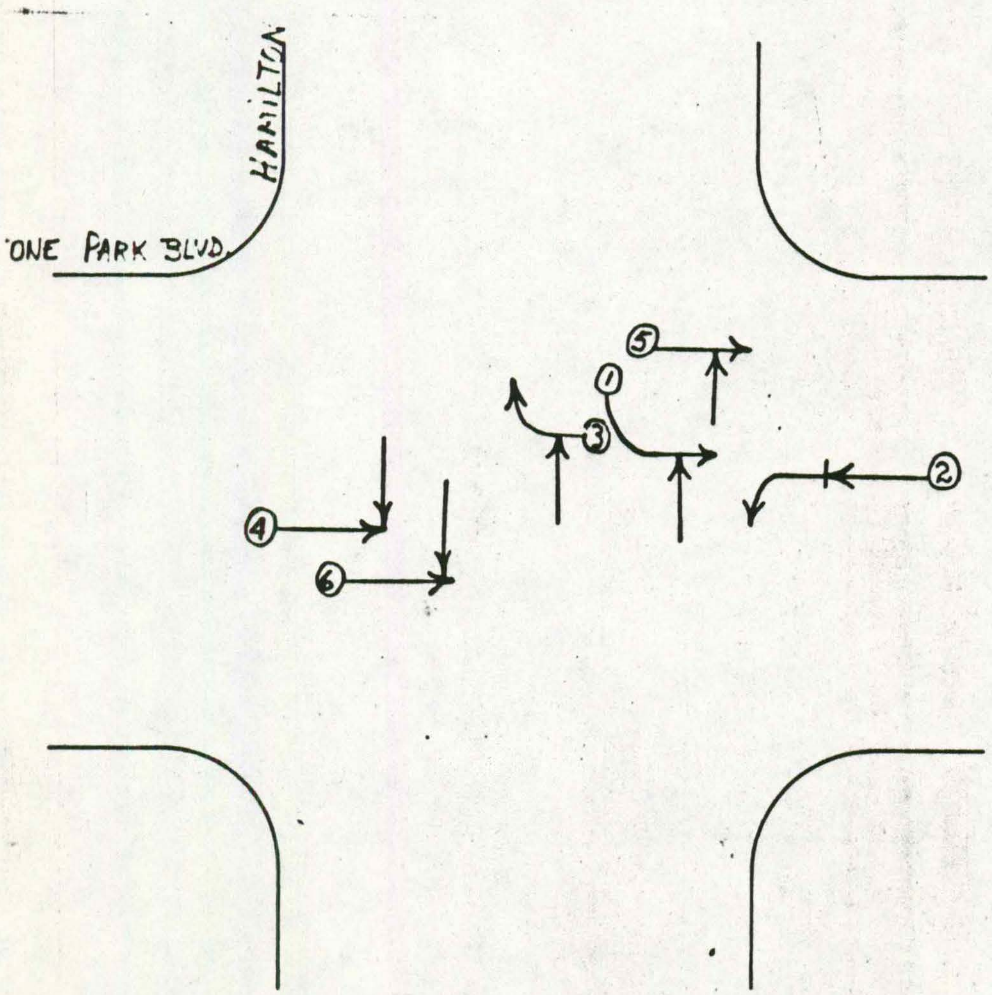
BEFORE FEB.'75 TO OCT.'75 | AFTER FEB.'78 TO OCT.'78



8 ACCIDENTS | 0 ACCIDENTS

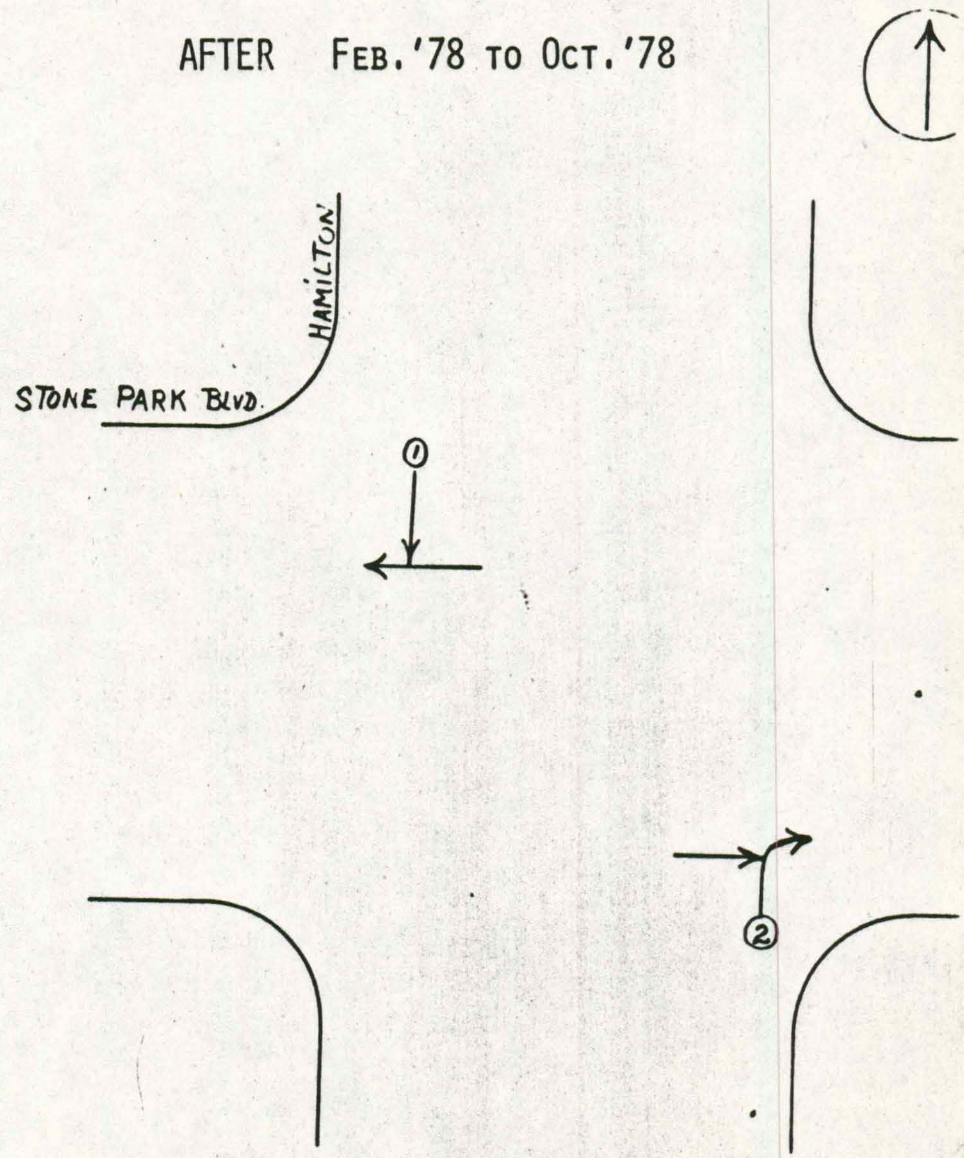
STONE PARK BLVD. & HAMILTON BLVD.

BEFORE Feb.'75 to Oct.'75



6 ACCIDENTS

AFTER Feb.'78 to Oct.'78



2 ACCIDENTS

EVALUATION OF

HAMILTON BLVD. IMPROVEMENT PROJECT

No. Accidents Before and After Construction

Location	Feb. '75 to Oct. '75 ADT = 15,000	Feb. '78 to Oct. '78 ADT = 19,000
1800 Block	4	1
W. 19th Street	13	2
1900 Block	2	0
W. 29th Street	0	0
2000 Block	0	3
W. 21st Street	0	0
2100 Block	1	1
W. 22nd Street	0	0
2200 Block	1	0
W. 23rd Street	1	0
2300 Block	1	2
W. 24th Street	1	2
2400 Block	0	0
W.25th Street	0	1
2500 Block	0	0
W. 26th Street	0	0
2600 Block	1	0
W. 27th Street	0	1
2700 Block	0	0
W. 28th Street	7	1
Sunset Plaza (South)	1	3
Sunset Plaza (North)	8	1
Stone Park Blvd.	6	2

HAMILTON BLVD. IMPROVEMENT PROJECT

57% REDUCTION IN ACCIDENTS

27% INCREASE IN VOLUME

Hamilton Boulevard Improvement Project

STATISTICAL ANALYSIS OF ACCIDENT REDUCTION

$$\text{Accident Rate*} = \frac{(\#\ \text{Accidents})\ (10^6)}{(\#\ \text{Days})\ (\text{ADT})\ (\text{Miles})}$$

$$\text{Accident Rate (Before)} = \frac{47{,}000{,}000}{(243)\ (15{,}000)\ (1)} = 12.9$$

$$\text{Accident Rate (After)} = \frac{20{,}000{,}000}{(243)\ (19{,}000)\ (1)} = 4.3$$

$$\text{Per Cent Accident Reduction} = 100 \left[\frac{(\text{Accident Rate Before})\ (\text{Accident Rate After})}{(\text{Accident Rate Before})}\right]$$

$$\text{Per Cent Accident Reduction} = 100 \left[\frac{12.9 - 4.3}{12.9}\right] = 67\%^{**}$$

* Accidents per million vehicle miles

** Significant at 99% Level of Confidence

HAMILTON BLVD. IMPROVEMENT PROJECT
ANNUAL ACCIDENT COST REDUCTION

	COST BEFORE	COST AFTER	COST REDUCTION
PROPERTY DAMAGE ACCIDENTS 8 MOS. ACTUAL COST	$51,585	$32,070	$19,515
PERSONAL INJURY ACCIDENTS 8 MOS. @ $3,185 EA.	85,995	41,405	44,590
ALL ACCIDENTS	$137,580	$73,475	$64,105

ACCIDENT COST REDUCTION 8 MOS. = $64,105

$$\text{ANNUAL ACCIDENT COST REDUCTION} = \frac{\$64,105}{8} \times 12 = \$96,158$$

EVALUATION OF HAMILTON NORTH SYSTEM

BEFORE AND AFTER SIGNAL COORDINATION

ADT = 19,000

	Average Travel Time (Seconds)		
	Before	After	%Decrease
Northbound			
A.M. Peak	192	184	4%
Midday	195	156	20%
P.M. Peak	210	161	23%
Southbound			
A.M. Peak	192	170	11%
Midday	239	190	21%
P.M. Peak	246	191	22%
Overall Average	213	175	18%

	Average No. Stops		
	Before	After	%Decrease
Northbound			
A.M. Peak	1.7	1.5	12%
Midday	1.9	1.3	32%
P.M. Peak	2.3	0.7	70%
Southbound			
A.M. Peak	1.8	0.9	50%
Midday	3.0	2.2	27%
P.M. Peak	3.0	1.8	40%
Overall Average	2.3	1.4	39%

HAMILTON BLVD. IMPROVEMENT PROJECT
BEFORE AND AFTER SIGNAL COORDINATION

18% DECREASE IN TRAVEL TIME

39% REDUCTION IN NO. STOPS

HAMILTON BLVD. IMPROVEMENT PROJECT

SIGNAL COORDINATION

ANNUAL VEHICLE TIME SAVINGS

AVERAGE TIME SAVINGS - PEAK HOURS
(STUDY DATA) = 38 SECONDS PER VEHICLE

AVERAGE TIME SAVINGS - OFF PEAK HOURS
(ESTIMATED) = 19 SECONDS PER VEHICLE

$$\frac{38 \text{ SEC./VEHICLE}}{3600 \text{ SEC./HOUR}} \times \frac{7,372 \text{ VEHICLES}}{\text{DAY}} \times \frac{250 \text{ DAYS}}{\text{YEAR}} = 19,454 \text{ HOURS}$$

$$\frac{19 \text{ SEC./VEHICLE}}{3600 \text{ SEC./HOUR}} \times \frac{11,626 \text{ VEHICLES}}{\text{DAY}} \times \frac{250 \text{ DAYS}}{\text{YEAR}} = 15,440 \text{ HOURS}$$

$$\frac{19 \text{ SEC./VEHICLE}}{3600 \text{ SEC./HOUR}} \times \frac{19,000 \text{ VEHICLES}}{\text{DAY}} \times \frac{115 \text{ DAYS}}{\text{YEAR}} = 11,532 \text{ HOURS}$$

TOTAL HOURS SAVED = 46,426

FIRST YEAR SAVINGS = 46,426 HOURS X $5.76/HOUR* = $267,414

ASSUME TRAFFIC GROWTH @ 4% YEAR FOR 20 YEARS.
(GROWTH FACTOR = 1.59555)

AVERAGE ANNUAL SAVINGS = $267,414 X 1.59555 = $426,672

* The value of time used was based on the findings of a study performed by Stanford Research Institute in 1967 which established $2.82 per person per hour as the value of travel time. The 1967 per person value of time was adjusted using the cost of living index. The value of time per vehicle hours was then developed by multiplying the value of time per person per hour by the average vehicle occupancy - assumed to be 1.2 persons (1977 Report, JHK and Associates).

ANNUAL FUEL SAVINGS

AFTER SIGNAL COORDINATION

IDLE TIME PER STOP
(STUDY DATA AVERAGE) = 15 SECONDS

ASSUME .6 GALLONS PER HOUR IDLE TIME.

AVERAGE NO. STOPS PER VEHICLE

BEFORE	AFTER
2.3	1.4

AVERAGE NO. STOPS PER VEHICLE SAVED = .9

$$\frac{.9 \text{ STOPS}}{\text{VEHICLE}} \times \frac{15 \text{ SEC./STOP}}{3600 \text{ SEC./HOUR}} \times \frac{19{,}000 \text{ VEHICLES}}{\text{DAY}} \times \frac{365 \text{ DAYS}}{\text{YEAR}} = \frac{26{,}006 \text{ HOURS}}{\text{YEAR}}$$

$$\text{FUEL SAVED} = \frac{.6 \text{ GALLONS}}{\text{HOUR}} \times \frac{26{,}006 \text{ HOURS}}{\text{YEAR}} = 15{,}606 \text{ GALLONS/YEAR}$$

$$\text{ANNUAL FUEL SAVINGS} = \frac{15{,}606 \text{ GALLONS}}{\text{YEAR}} \times 70¢\text{/GALLON} = \$10{,}924$$

Hamilton Blvd. Improvement Project
COST/BENEFIT ANALYSIS

Project Costs		Annual Costs	
Bridge	$394,000	80 years @ 5% =	$20,106
Other Construction	1,906,000	20 years @ 5% =	152,942
Total Cost	$2,300,000	Annual Cost	$173,048

Benefits

Annual Vehicle Time Savings	$426,672
Annual Accident Cost Reduction	96,158
Annual Fuel Savings	10,924
Total Annual Benefits	$533,754

$$\text{COST/BENEFIT RATIO} = \frac{\$533,754}{\$173,048} = 3.08$$

$3.08 RETURN FOR EACH DOLLAR INVESTED

As specific improvements are more clearly identified and designed, and more precise cost estimates can be prepared, it may be necessary to make adjustments in the budget estimates.

SCHEDULING

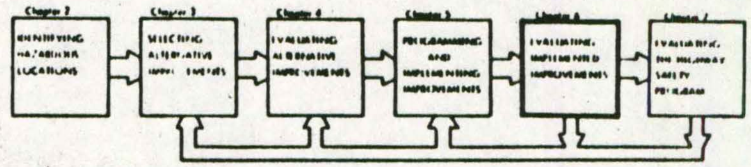
Effective scheduling of individual projects is essential to accomplishing any highway improvement program--including implementing of safety improvements. It would be unrealistic to propose an annual program requiring considerable more funds than will be available--and it would be equally unrealistic to suggest a program larger than can be accomplished with available manpower.

Consideration must be given to time and manpower requirements for:

- Detailed planning and design
- Contracting formalities
- Obtaining special equipment and/or materials
- Constructing and/or installing improvements.

For some improvements, the requirements will be minimal. A simple work order may be sufficient to authorize the work, materials and equipment may be available in stock, and a few days work by agency crews may finish the job. But other improvements may require considerable lead time before implementation, with commitment of significant amounts of engineering, administrative and construction manpower.

Some agencies, with large numbers of projects under way, utilize various forms of computerized critical path scheduling techniques. At the other extreme, a simple bar graph can be used to document the schedule of development and implementation of each of a series of proposed improvements. In any case, it is essential that a realistic schedule be established with target dates for accomplishment of the various phases of project development.



Chapter Six

EVALUATING IMPLEMENTED IMPROVEMENTS

One of the principal weaknesses of past experience with highway safety programs has been lack of adequate follow-up and evaluation of the actual results of implemented improvements.

Accident prediction is not yet a precise art. Even the best of approaches usually involves some assumptions--and certainly there are many complex contributory factors which we do not understand. There is documentation of safety improvements that have failed to produce predicted benefits. Sometimes unexpected side effects of an improvement have actually worsened the situation.

We do not know all the answers--and until we increase our storehouse of knowledge on what really happens after implementing various safety improvements we cannot have complete confidence in our future judgments and actions. Orderly systems and procedures for regular evaluation of all implemented improvements are essential to effective management of highway safety programs.

DATA REQUIREMENTS

In previous chapters, emphasis was placed on the need for good documentation on all steps taken for identifying hazardous locations, selecting and evaluating alternative improvements, prescribing and implementing a particular improvement and predicting results. This information will be needed by the analyst when evaluating after-implementation results.

Specifically, the analyst will want to know:

- What type of improvement was installed?
- Where was it installed?
- When was it installed?
- Which agency installed the improvement?
- What was the implementation cost?
- What was the prior accident data?
- How was the problem diagnosed?
- Why was this improvement selected?
- What results were predicted?

Figure 7 illustrates a typical project file documentation. Figure 8 is an example summary form used by one agency as data documentation for computer input.

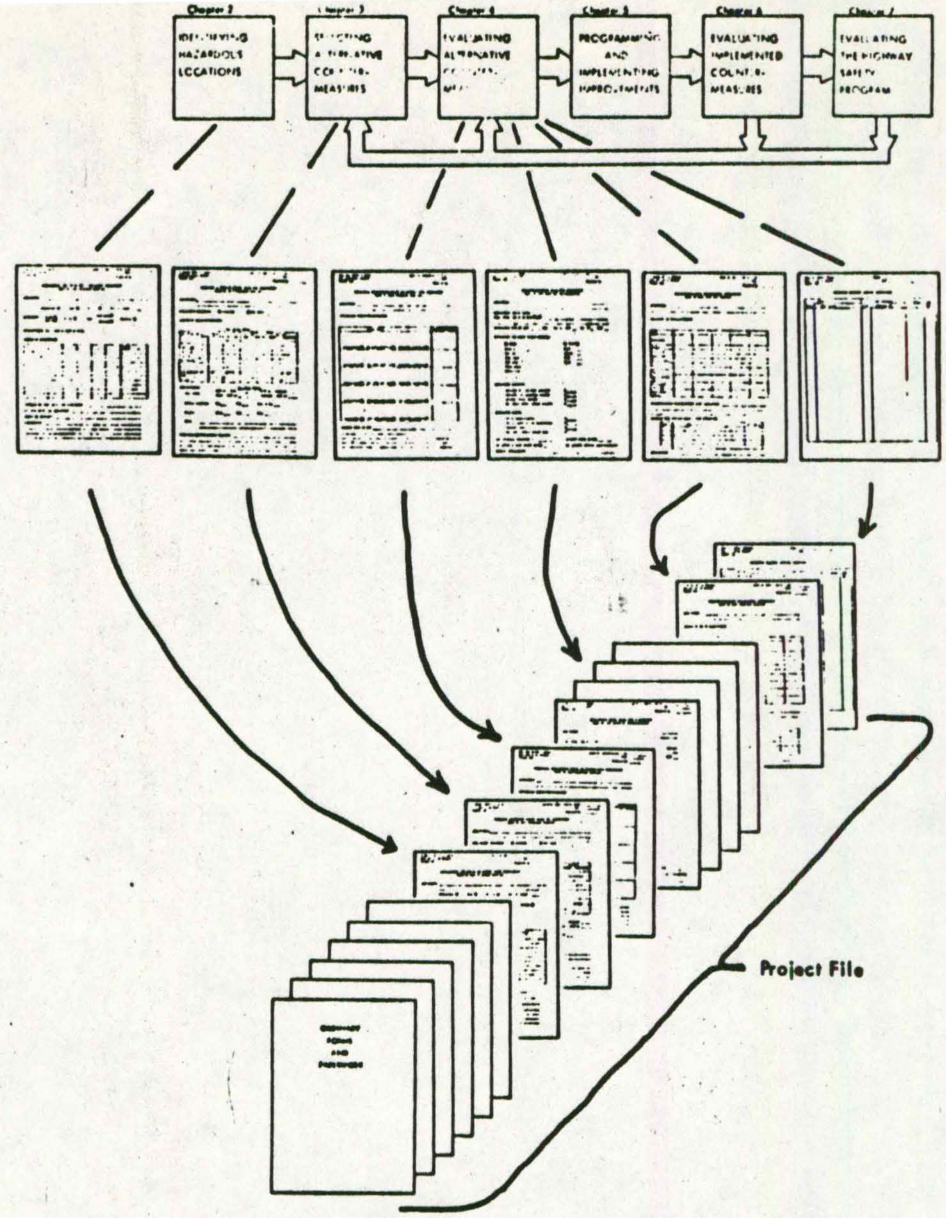


Figure 7. Basic Documentation of the Process

COUNTERMEASURE NUMBER (Assigned by Traffic & Safety)

COUNTERMEASURE LOCATION OR AREA OF INFLUENCE

Type of Location at [illegible] Countermeasure Applied

1–State Highway   4–Vehicle Design   7–Drivers   0–Others
2–City Street   5–Emergency Facilities   8–Schools
3–County Road   6–Courts   9–

Specific Location or Area of Influence (Select Corresponding Method of Describing Location for Codes 1–3 above)

(1) State Highway Number

From Milepoint

To Milepoint

(2) City Number

Highway Number (For State Highways in Urban Areas – City Code 18)

From Node or At Node for Intersection

Milepoint of Node – For Highways

To Node

Milepoint of Node – For Highways

(3) County Number

Township

Range

From Node or At Node for Intersection

To Node

(4)

Location: Statewide–1, City–2, County–3 in Column 7
City Number or County Number in Columns 8–10.

DIRECTION OF TRAVEL FOR WHICH COUNTERMEASURE IS APPLICABLE

Roadway Section – Both Directions – 1
One Direction – 2

If for one direction, indicate direction of travel

Intersection – All Approaches – 1
Specific Approaches – 2

If for Specific Approaches, indicate direction of
Approaches – N-1, NE-2, E-3, SE-4, S-5, SW-6, W-7, NW-8

TIME LIMITS

Last day in before period or day before field program began

Month

Day

Year

First day of after period or first day that countermeasure is fully operational

Month

Day

Year

Last day that countermeasure was operational

Month

Day

Year

TYPE OF COUNTERMEASURE

RESPONSIBLE AGENCY

COST OF IMPROVEMENT Round to $100's

ESTIMATED PERCENT REDUCTION IN ACCIDENTS

Figure 8. Data Documentation for Computer Input

BASIS FOR COMPARISON

The purpose of implementing an improvement is to effect a significant accident reduction. Several techniques have been employed for evaluating results:

- Before and After Analysis: This analysis compares accident experience at a particular location before and after improvement implementation. To obtain statistically reliable data for evaluating a type of improvement, the before and after accident experiences at several locations may be grouped together.
- Parallel or Control Group Analysis: This analysis compares accident experience at the improved location with accident experience at similar locations not receiving improvements. Comparisons are made with the experience at these "control group" locations during the "after" period or with the trend in experience from "before" to "after."
- Performance Standard Analysis: This analysis compares improvement performance with standard performance for that improvement--and is applicable only when performance standards have been established.

Before and after analyses have been used more extensively than the other techniques, probably because of the difficulty of finding truly similar control locations. The before and after analysis is described in this manual. The other two methods are discussed in the NCHRP 17-2A Research Report.

EVALUATION PROCEDURES

Before and after studies may be conducted at a single location or at several locations with similar characteristics where the same improvement has been implemented. A regular program should be established for reviewing all implemented improvements every three months during the first year, and annually thereafter.

The basic data needed are:

- The improvement documentation--location, time, etc.
- Accident data--how many, what types, how severe.
- Traffic volumes.
- Any significant changes in the physical environment (other than the improvement) which may influence accident records--illumination, skid resistance, etc.

Before and after comparisons normally will be made in terms of accident rates-accidents per million vehicles or per million vehicle miles. The basis for measurement will be percent reduction of accident rate. Comparisons also may be made in terms of numbers of accidents, but adjustments must be made for both time periods and changes in traffic volumes for meaningful results.

Before and after data should reflect comparable time periods, preferably at least twelve months. When less than twelve months data are available following implementation, the before data should be selected from the same months as the after data. For example, if after data are based on a period from October to March, the before data should be based on experience for the same months of the preceding year--or for the average of those months for several preceding years.

After the time period has been identified and the basic data selected, the first step is to calculate the accident rates before and after--using the respective data on numbers of accidents and traffic volumes.

For intersections or spots:

$$\text{Accidents per million vehicles} = \frac{(\text{No. of accidents})\ (10^6)}{(\text{No. of days})\ (\text{ADT})}$$

For sections:

$$\text{Accidents per million vehicle miles} = \frac{(\text{No. of accidents})\ (10^6)}{(\text{No. of days})\ (\text{ADT})\ (\text{Section Length})}$$

For each location, or for each group of locations with similar characteristics and improvements, the change in accident experience is calculated and identified as:

$$\text{Percent Accident Reduction} = 100 \left[\frac{(\text{Accident rate before}) - (\text{accident rate after})}{(\text{Accident rate before})} \right]$$

The procedures shown above should then be repeated to identify changes in accident experience by types of accidents and severity of accidents. This will permit evaluation of the overall effect of the improvement. For example, the total accident rate may not have been materially reduced, but a significant decrease in severity of accidents will result in measurable overall benefits. On the other hand, a reduction in accident rate may produce little benefit if, for some unforeseen circumstance, the severity of accidents shows a marked increase.

The original premise was that each improvement was economically justified. Using the actual findings on reduction of accidents by types and severity, along with updated data on accident costs and the costs of implementing improvements, we can now determine whether we made wise decisions. And more important, the findings will help us make better decisions next year.

SIGNIFICANCE OF RESULTS

Before we jump to a conclusion about the merits of a particular improvement, and its effectiveness in reducing accidents, we need to back-off and take a second look at our data to determine how much confidence we have in the findings.

There is a certain degree of chance in all happenings. Just because a coin comes up heads 7 times out of 10 flips, we would not have much confidence in predicting 70 heads out of 100 flips. We are reasonably sure it is going to even out about 50-50 in the long run. But if it happened that heads came up 70 out of the next 100 times the results would start to be significant--we would begin to believe the coin was unbalanced, or that something other than mere chance was controlling the happening.

The same thing applies to accident data. We would have little confidence in predicting great changes on the basis of one week's experience, or a month--or probably even three months. The more experience we observe, the greater will be our confidence.

Suppose two locations had the accident experience shown below for periods of one year before and one year after implementation of an improvement.

Location	Before Accidents	After Accidents	% Reduction
A	50	40	20%
B	5	4	20%

Even though both locations experienced the same percent reduction during the same period, we would have a great deal more confidence in the findings at location A than at location B.

A simple test can be employed to determine whether the results at a particular location (or group of locations) are truly statistically significant. The test assumes that the distribution of accidents at a location has the general characteristics of a Poisson distribution. This distribution is illustrated graphically by the curves in Figure 18, and relates the total number of accidents in the data period preceding the improvement to the percent reduction of accidents following implementation of the improvement.

The curves in Figure 9 are designed to assure a 95% level of confidence that the indicated accident reduction was significant. This means there is only a 5% probability

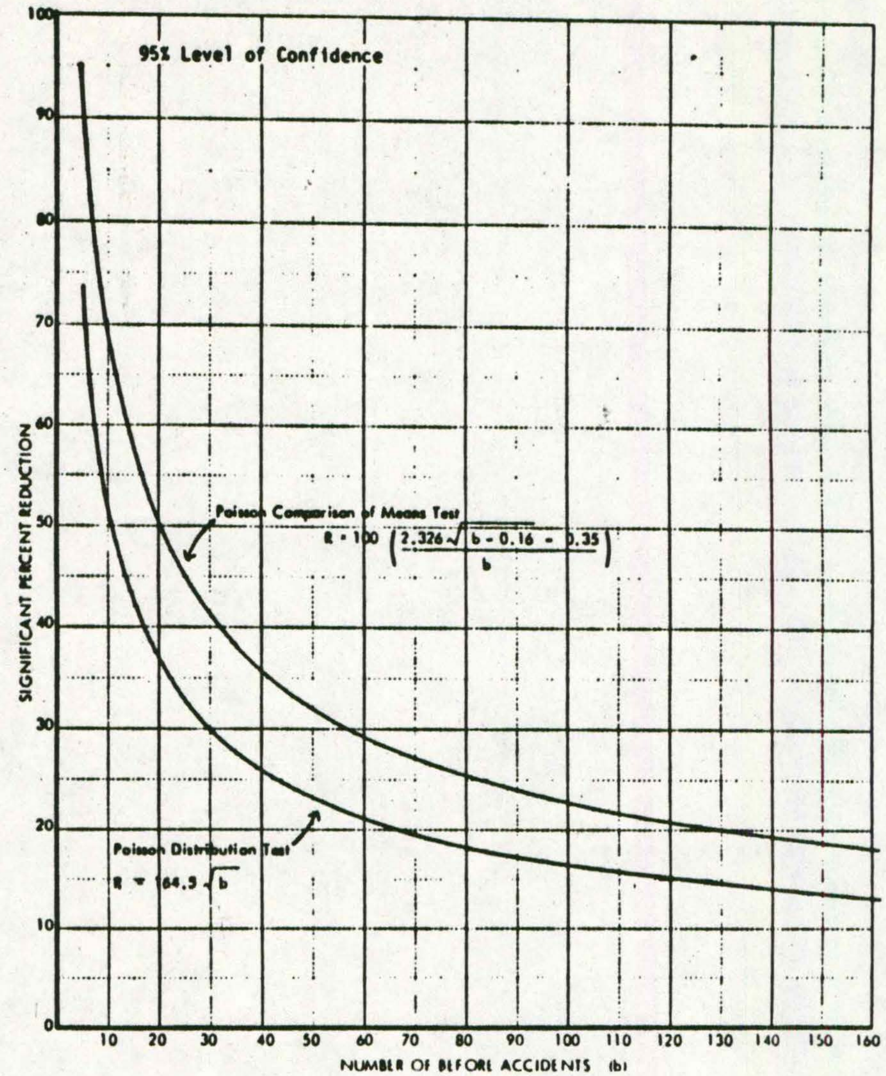


Figure 9. Poisson Tests For Significance

that the reduction occurred merely by chance. A 95% level of confidence is considered generally acceptable. Similar curves for other levels of confidence are shown in the Research Report for NCHRP 17-2A.

The lower of the two curves reflects a liberal test of significance--the upper curve a more conservative test. Testing of results at a particular location involves the following steps:

1. Identify the number of accidents in the data time period before implementation (the time should be comparable to the after-implementation data time period).
2. Compute the percent accident reduction at the location (see instructions in previous section).
3. Adjust, if necessary, the number of before accidents:
   If the before time period is longer than the after time period (this is the usual case), adjust the number of before accidents, B', to reflect differences in traffic volumes and time periods:

   $$B' = B \frac{\text{(After ADT) (Days in after period)}}{\text{(Before ADT) (Days in before period)}}$$

   For intersections, use the sum of the ADT on each of the legs and divide by 2 to obtain average ADT.
   If the traffic volume changes during the before or after period, multiply each ADT by the number of days it was applicable.
   If the after time period is longer than the before time period, the number of before accidents, b, need not be adjusted.
4. Refer to the curves in Figure 17 and locate the point of intersection of the number of accidents and the percent reduction.
5. If the intersection point is below the bottom curve, we are not sufficiently confident that the improvement actually caused that amount of accident reduction. The data are not considered significant as bases for future judgments.
6. If the intersection point is above the top curve, we are 95% certain that the accident reduction was attributable to the improvement. Data from these locations should be reliable for updating our standards, guides and criteria for future planning.

7. If the intersection point falls between the two curves, the significance of the results is uncertain. Continue to collect data from the location for an additional period of time and then re-evaluate the improvement.

EXAMPLE EVALUATION

Raised pavement markers were installed with existing lane lines on a four-mile hazardous section of freeway. The following data were obtained for two years before and one year following the installation of the improvements.

		Accidents	Traffic Volume (ADT)
Before:	1971	48	52,000
	1972	46	55,000
	(Average)	(47)	(53,500)
After:	1973	33	58,500

The evaluation steps are:

1. Accident Rate Before $= \dfrac{(47)(10^6)}{(365)(53,500)(4.0)}$

   $= 0.602$ accidents/million vehicle miles

2. Accident Rate After $= \dfrac{(33)(10^6)}{(365)(58,500)(4.0)}$

   $= 0.386$ accidents/million vehicle miles

3. Percent Reduction $= 100\left[\dfrac{(0.602) - (0.386)}{(0.602)}\right] = 100\left[\dfrac{0.216}{0.602}\right]$

   $= 35.9\%$

4. Check the Poisson distribution curves to determine the significant percent reduction for 95% confidence with 47 accidents.

   Lower curve (liberal test) = 24% reduction

   Upper curve (conservative test) = 32% reduction

Because the actual reduction of accident rate (35.9%) exceeds the minimum requirements for both tests, the results are considered significant.

5. If data are available, conduct similar evaluations and testing of significance by types of accidents and severity of accidents.

Documentation

There is need for careful documentation of each step of the evaluation of implemented improvements. This information will be essential for evaluation of the overall program and for refinement of data for future forecasts--as described in the following chapter.

Specifically, the documentation should include:

- Before and After Periods -- What was the before period? The after period? This information will be useful to compare the results of a given type of improvement at similar locations.
- After Accident History -- How many accidents have occurred at this location since improvement implementation? What type? This information will be useful in measuring and analyzing the results of the improvement.
- Improvement Results--What were the results of the improvement? Was this a significant decrease? If not, why? Was the magnitude of the decrease as expected? If not, why? This information will be useful in refining the selection of applicable improvements and the prediction of accident reduction benefits.

With relatively small numbers of evaluations, the documentation can be prepared manually and filed with other improvement documents. In larger agencies, much of the evaluation and documentation is performed with computer programs. Table 10 is an example computer printout of a before and after analysis.

APPENDIX J
ADDITIONAL GRAPHS FOR TESTING ACCIDENT REDUCTION SIGNIFICANCE

The Users' Manual contains a graph for testing significant accident reduction at a 95% level of confidence (the recommended level). Figures J-1, J-2 and J-3 are graphs for testing significant accident reduction at 80%, 90% and 99% levels of confidence, respectively.

To use these graphs:

1. Select the level of confidence and the test to be used.

2. Find the number of before accidents on the abscissa.

3. Project vertically from this point to the appropriate test curve.

4. From this point on the test curve, plot horizontally to the ordinate.

5. Read the ordinate. If the actual percent reduction is equal to or exceeds the value read from the ordinate, the reduction is considered statistically significant at the given level of confidence.

J-1

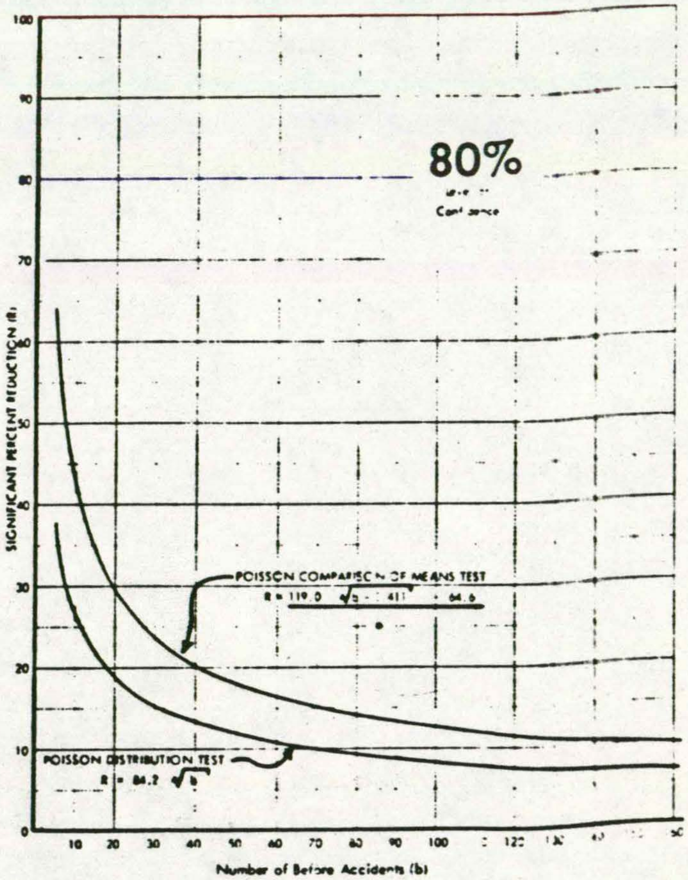


Figure J-1. Poisson Tests for Significance at 80% Level of Confidence

J-2

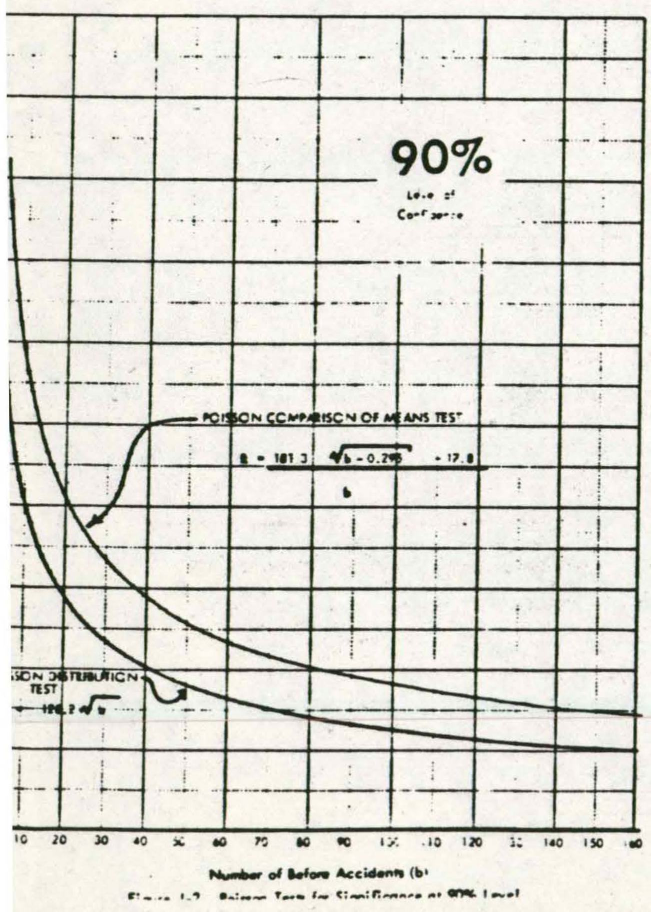


Figure J-2. Poisson Tests for Significance at 90% Level