Chapter 10

Pilot Project

10.1 Introduction

Implementation of one or more of the recommended traffic improvement measures during the study was envisaged as a pilot project. The purposes of the pilot project were to:

- demonstrate the effect of the recommended measures; and
- reflect the results of the implementation to the measures to be recommended.

Pilot projects are also beneficial to the counterpart agencies, as they can learn more about technical and management aspects of the measures through their actual implementation.

Several candidate projects covering different aspects of the traffic problems in Chiang Mai were conceived. Table 10-1 summarizes the candidate projects.

Table 10-1 Candidate Pilot Projects Considered

	Project	Contents	Candidate Location
1	New signal installation	Installation of new signal	Wat Chet Yod
2	Improvement of existing signal	Review of signal phase and timing	Several locations identified by the team
3	Geometric improvement	Modification of intersection geometry and layout	Several locations identified by the team
4	Transit/pedestrian mall	Conversion of road section to transit/pedestrian mall on a trial basis	Chang Khlan Road
5	Traffic improvement at school area	Various measures to ease congestion around school	Kaew Nawarat Road Charoen Prathet Road,
6	Traffic safety campaign	Promotion of the use of seat belt and helmet	City wide

Source: This study

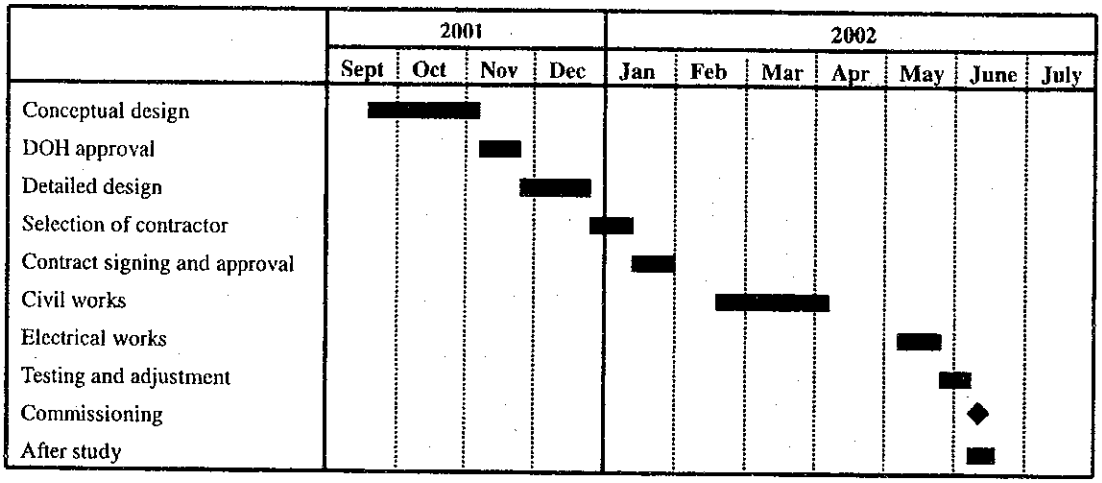
Criteria developed for the selection of a pilot project to be implemented, were as follows:

- consistency with policy and plans of Chiang Mai Police and Chiang Mai Municipality;
- traffic and pedestrian volume affected;
- size/ratio of expected benefits in terms of congestion alleviation and traffic safety improvement;
- time needed for implementation; and
- time required for implementation.

Chiang Mai needs more traffic signals, and are urgently required at some locations. One such location was Wat Chet Yod intersection, where many accidents have happened. In addition, the traffic volume at this intersection is high and large benefits were expected from signalization. As the scope of work is clear and the number of agencies, among which coordination is required, is limited, implementation was considered to be relatively easy. For these reasons, installation of a new signal at Wat Chet Yod intersection was selected as a pilot project.

The pilot project was implemented according to the schedule shown in Table 10-2 below.

Table 10-2 Implementation Schedule of Pilot Project



Source: This study

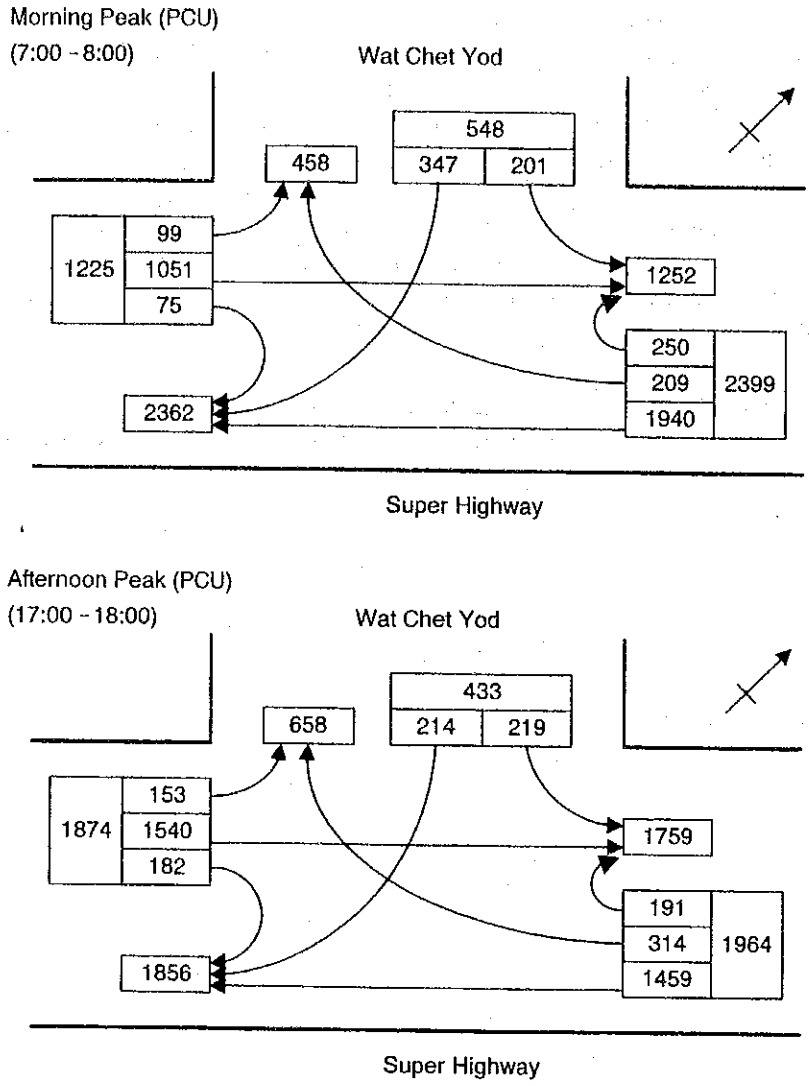
10.2 Traffic Situation and Problems of the Site

Wat Chet Yod intersection is a T-shaped intersection where Super Highway (4-lane divided road with wide shoulder) intersects a local collector road of 10 meter width. The elevation of the collector road is lower than that of Super Highway and the grade of approach is about 10%, causing slow discharge. Another collector road, which used to be a continuation of Wat Chet Yod, is located about 80 m from the intersection. A right/U-turn lane of 30 m long is provided along Super Highway for both directions. No traffic signal was installed there.

Super Highway is an arterial road and carries more than 1,000 PCU each direction per hour throughout the day. The peak hour volume reaches 2,400 PCU at the northeast approach in the morning and 1,900 PCU at the southwest approach in the afternoon. On the other hand, the hourly traffic volume from the side street is low at a level of 250 to 500 PCU per hour throughout the day. It is noted that 65-75 % of the traffic from the side street is motorcycle and 60 -70% of them cross Super Highway to make a right turn, thus creating an unsafe situation. The peak hour traffic (PCU) is shown in Figure 10-1.

Dangerous merging maneuvers between U-turn traffic and high-speed traffic on Super Highway were often observed, and large vehicles were unable to make a U-turn without backing up. The nearest U-turn point was about 700 meters southwest and 1200 meters east of the intersection along Super Highway. Traffic police were deployed in this intersection during peak hours. According to the interview survey conducted at the site for vehicle drivers and motorcycle riders, alarmingly more than half of the respondents (51%) said they have been involved in accidents there. All 63 motorcycle riders said that a traffic signal is needed at the intersection. Another interview survey for shop owners at nearby buildings revealed that all 16 interviewed tenants have seen or been involved in accidents.

Wat Chet Yod was an extremely dangerous intersection in the study area. Hospital data shows that 106 persons were involved in casualty accidents at this location in one year.



Source: Surveyed by Study Team on 20 August, 2001 Monday

Figure 10-1 Peak Hour Traffic (PCU) in Wat ChetYod Intersection

10.3 Required Geometric Improvements

The intersection had a poor geometry. Wat Chet Yod approach was 10 meter wide but became 30 meter wide at the intersection. Vehicles, particularly motorcycles, tended to take any course inside the intersection, as there was no control or guide. Because of excessive width, right turn vehicles from Super Highway sometimes entered Wat Chet Yod road on the right side of vehicles waiting on Wat Chet Yod approach instead of their left. This often caused confusion to the traffic flow. Another deficiency was the steep uphill approach from Wat Chet Yod, which slowed down the start-up speed of vehicles entering the intersection, subjecting them to a hazardous situation from the high-speed traffic on Super Highway.

The geometric improvement was designed to correct these shortcomings and at the same time channel vehicles for orderly movement. The main points of geometric improvement are:

- construction of corner islands and median on Wat Chet Yod approach at right angle to Super Highway;
- extension of median on the east side of Super Highway;
- construction of sidewalk on the south side of Super Highway for 50 meters; and
- improvement of vertical alignment and pavement overlay on Wat Chet Yod approach.

Pavement markings were renewed based on the new intersection layout. A pedestrian crossing, stop line, directional arrow, solid and broken lane line, broken give way line, etc. were provided. A zebra zone was drawn inside the intersection to guide U-turning traffic on Super Highway and right turning traffic from Wat Chet Yod. The improvement design is shown in Figure 10-2 to 10-8.

10.4 Installation of Traffic Signal with Advanced Technology

Both safety and efficiency was considered in the design of signals. The design basically follows DOH standards but some enhancements were also introduced. Features of signal design are summarized below.

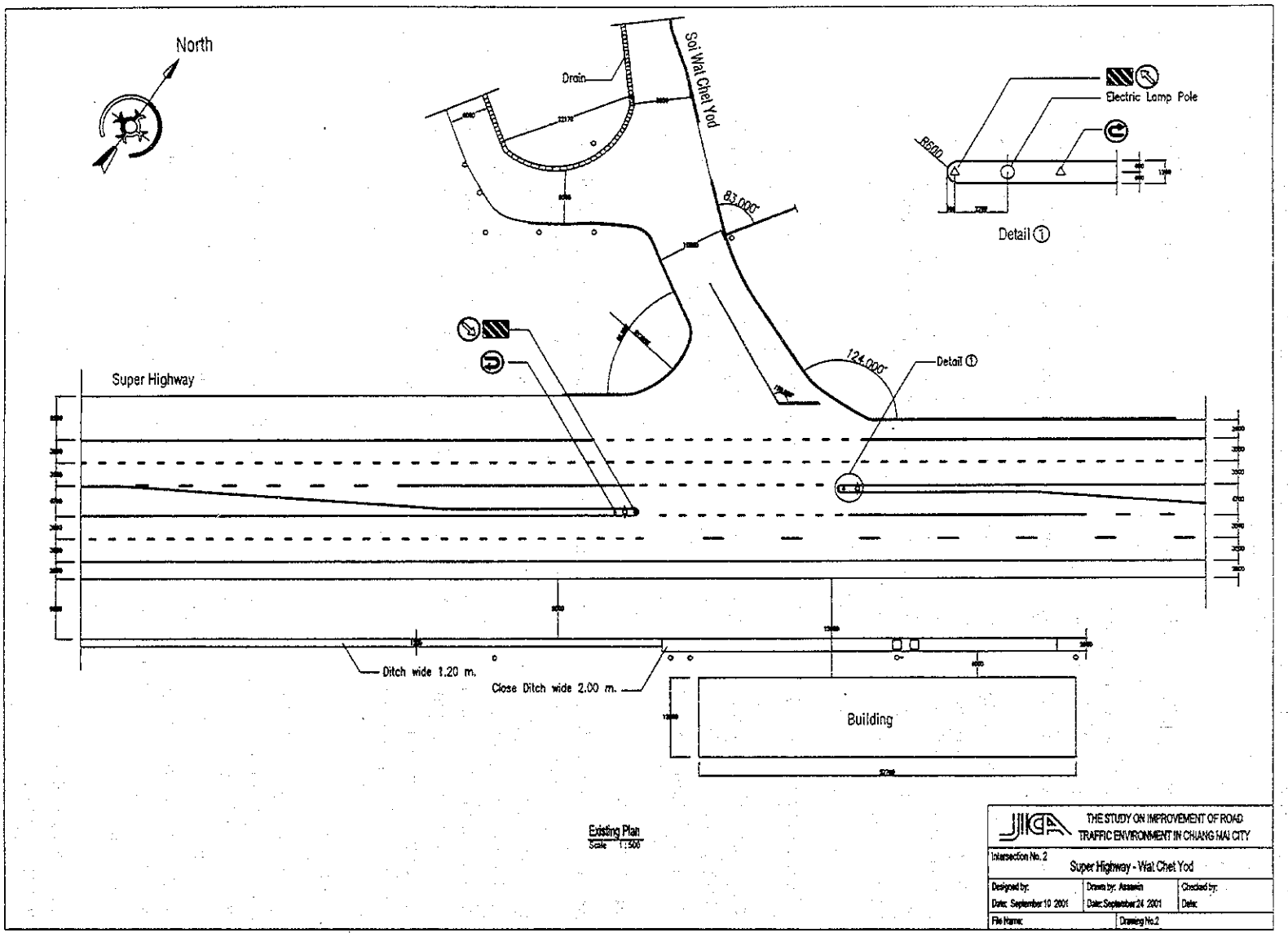
(1) Local controller

A microprocessor based local controller with very high reliability was installed. The nominal MTBF (meantime between failures) is 50,000 hours, while the actual record exceeds 200,000 hours. The controller operates in an isolated mode and signal timing will be selected based on the time-of-day (TOD control) and day of the week. In addition, vehicle and pedestrian actuation is adopted for efficient signal operation. The nearest two intersections where traffic signal of ATC system is installed is Super Highway -Huay Kaew intersection and Super Highway -Chotana Intersection. They are 850 meters and 1.3 Kilometers away so that isolated operation was not a problem.

(2) Detector

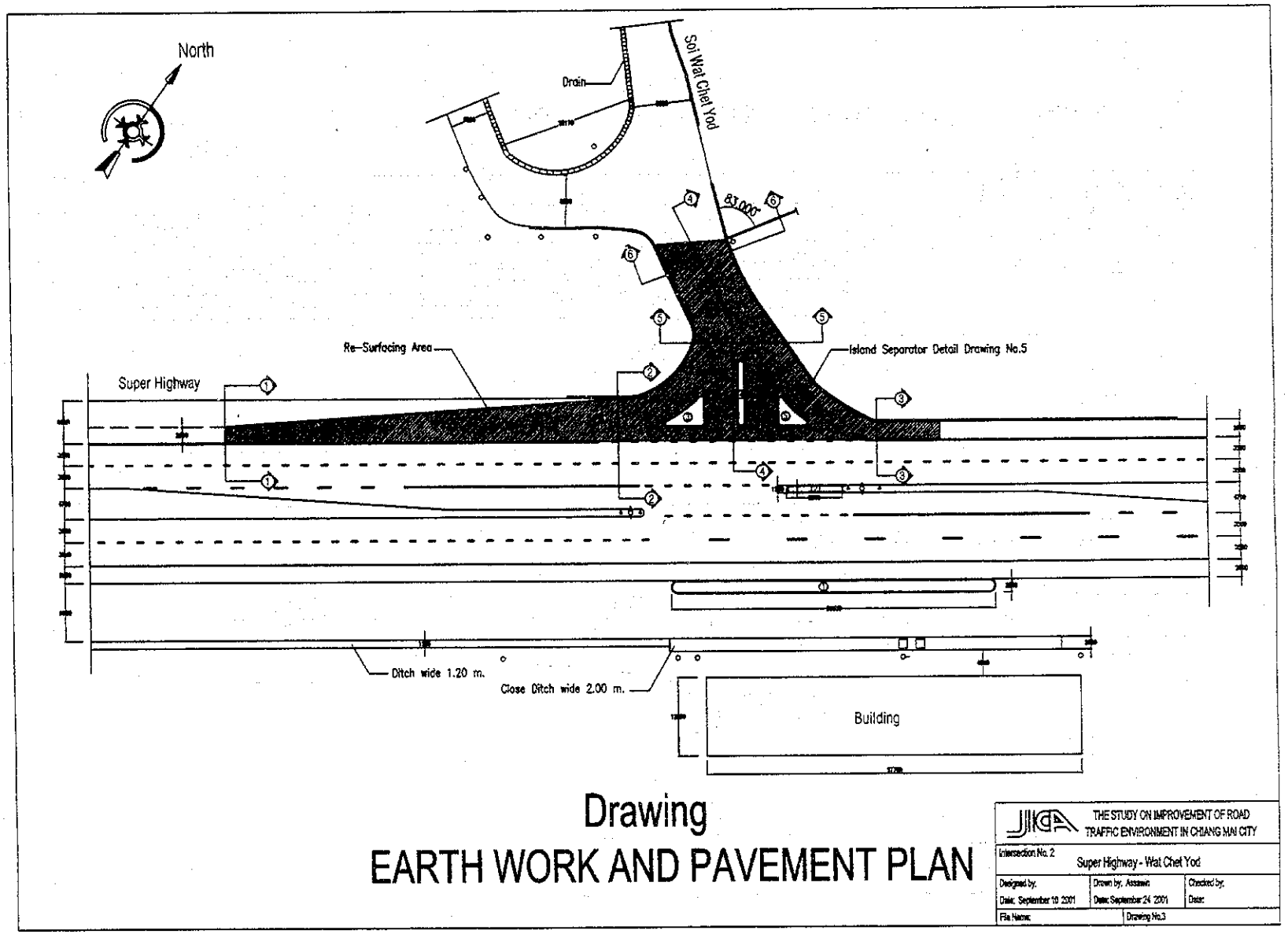
Several different types of vehicle detectors were proposed. An ultrasonic vehicle detector was used for detection of vehicles and motorcycles at three locations. The advantage of an ultrasonic detector is that, unlike the inductive loop detector, it doesn't receive any physical force on its sensor so the device is not susceptible to damage and is therefore highly reliable. Adjustment of its sensing zone and relocation of detector are also easy. These detectors were used to detect the vehicles on Super Highway and right and U-turn vehicles.

To detect a group of motorcycles, a Doppler type ultrasonic detector was employed. Although this type of detector can detect motorcycles it can only detect moving objects. As it cannot detect the presence of motorcycles, it is installed several meters



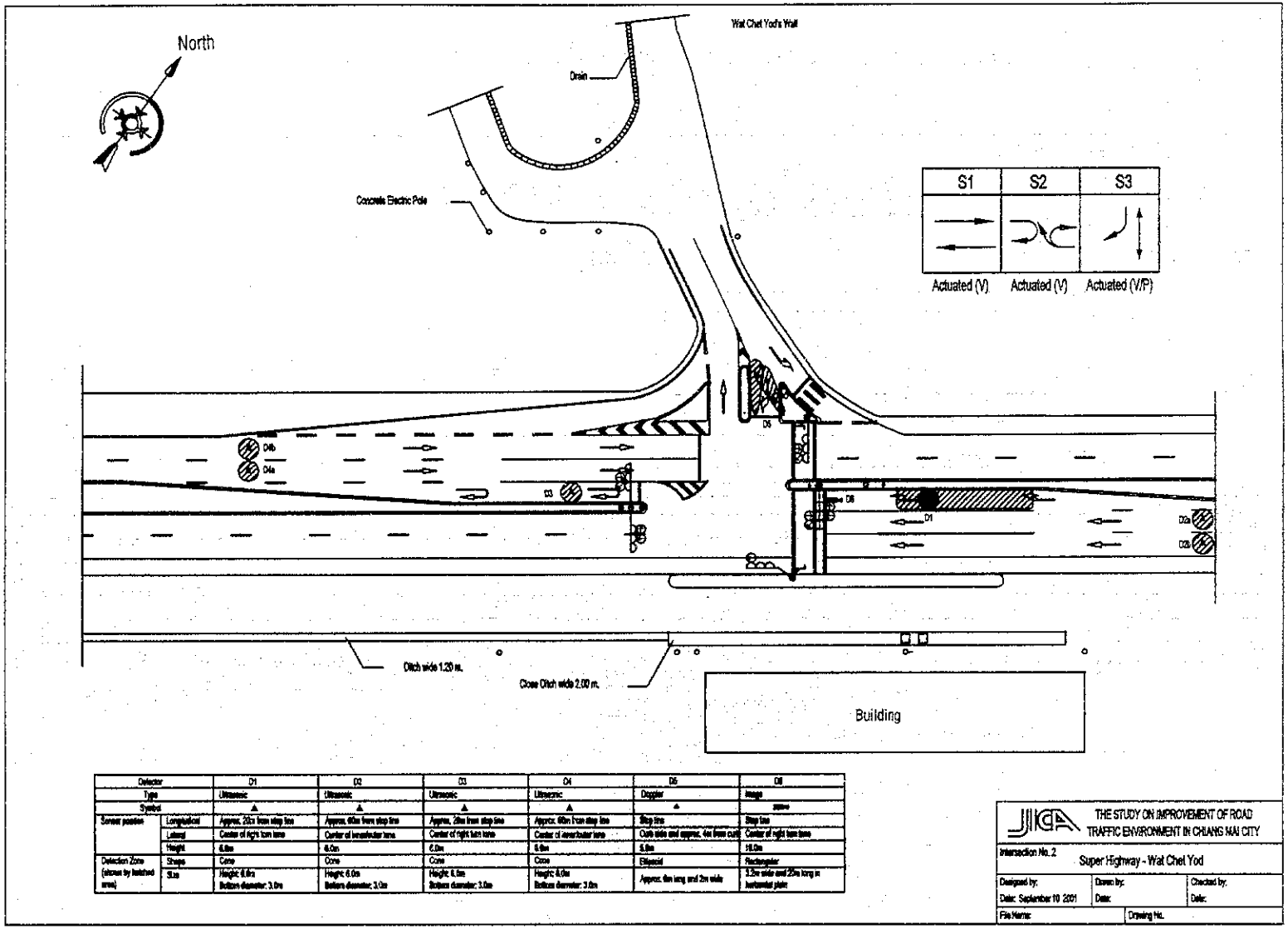
Source: This study

Figure 10-2 Existing Condition in Wat Chet Yod Intersection



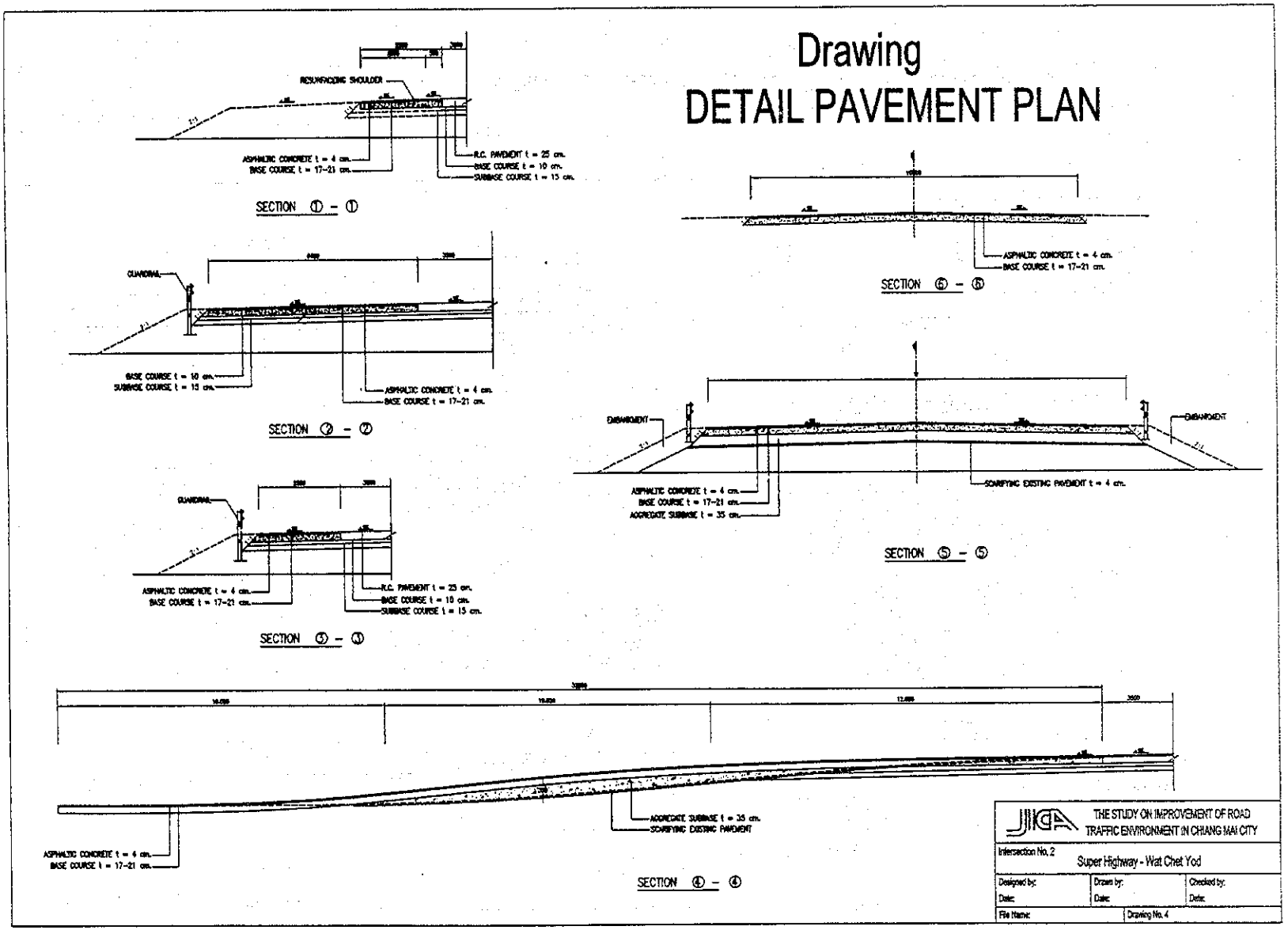
Source: This study

Figure 10-3 Geometric Improvement Proposed for Wat Chet Yod Intersection



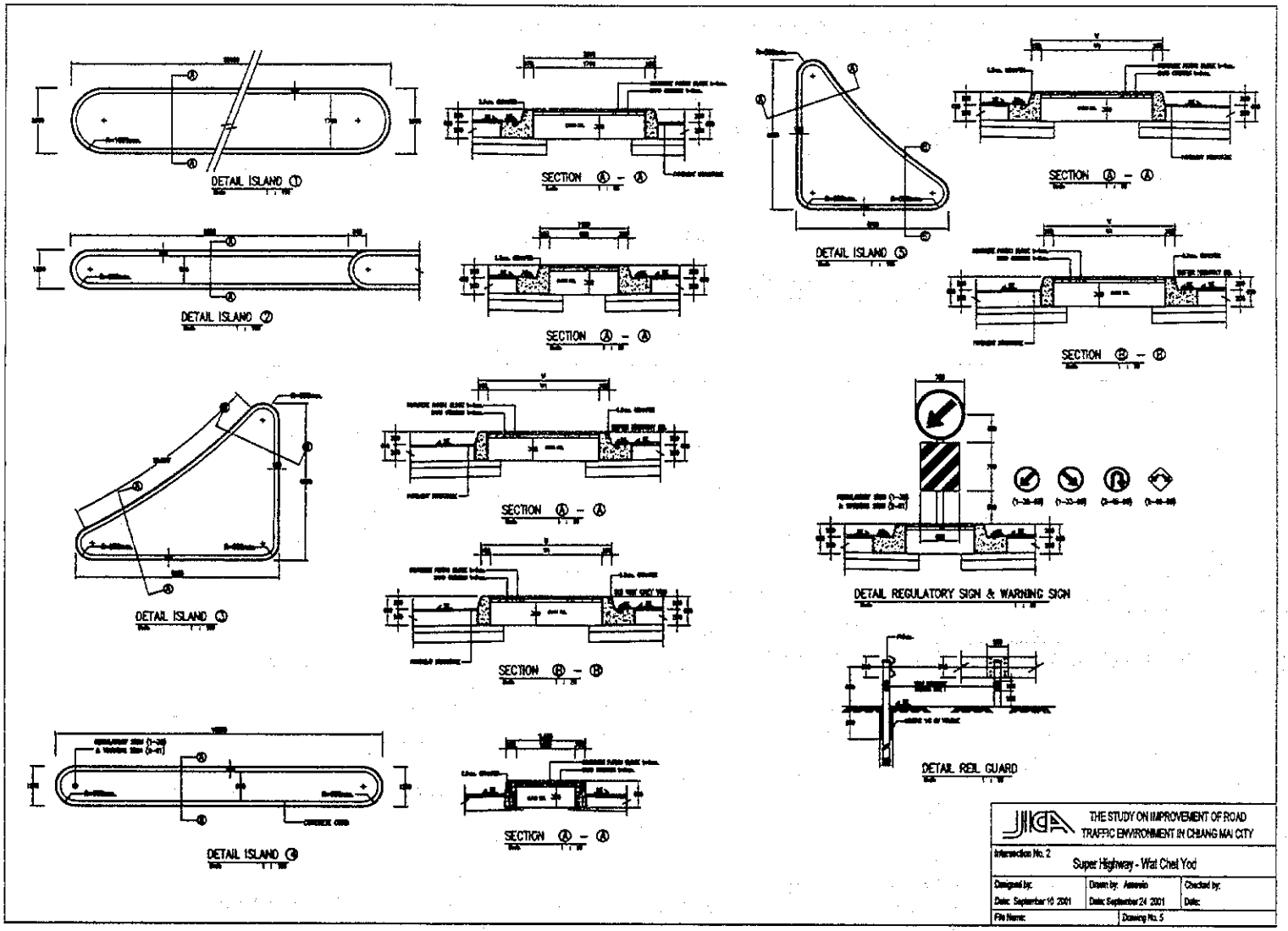
Source: This study

Figure 10-4 Signal Installation Proposed for Wat Chet Yod Intersection



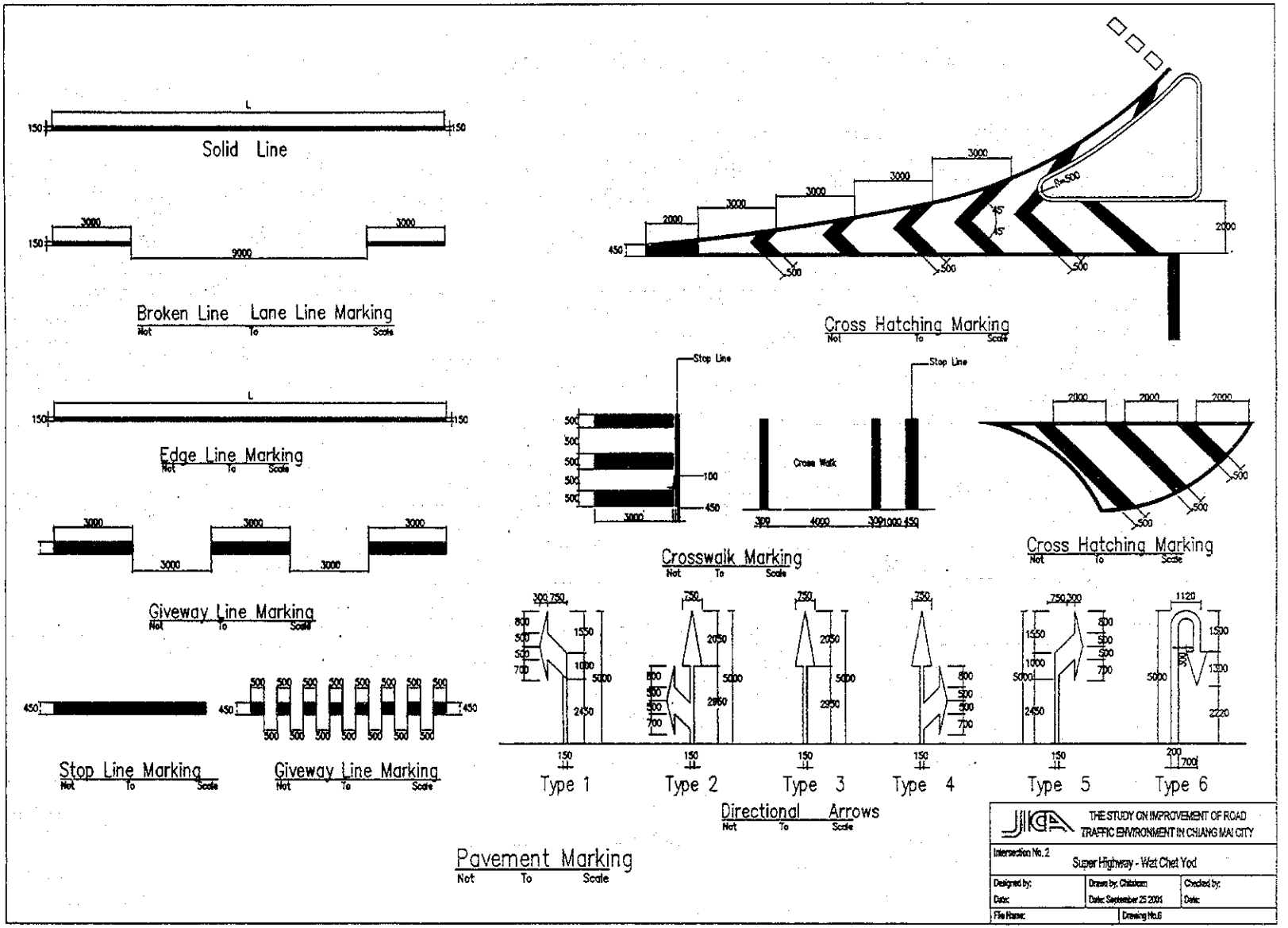
Source: This study

Figure 10-5Sectional Design (1) for Wat Chet Yod Intersection



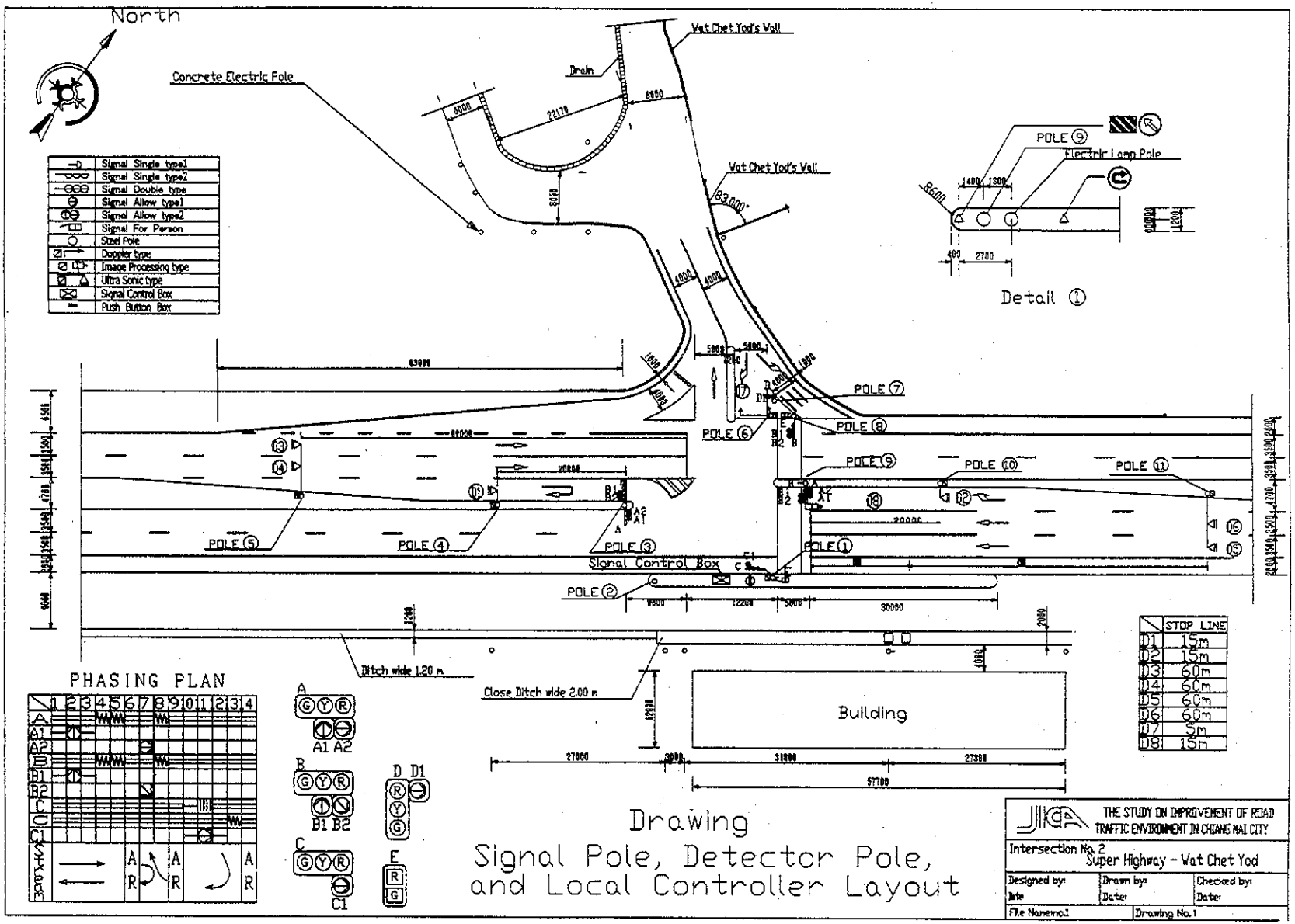
Source: This study

Figure 10-6 Sectional design (2) for Wat Chet Yod Intersection



Source: This study

Figure 10-7 Pavement Marking Improvement for Wat Chet Yod Intersection



Source: This study

Figure 10-8 Signal Equipments for Wat Chet Yod Intersection

before the stop line. Also as an experiment, an image type vehicle detector was proposed. This detector was proposed to detect cars and motorcycle on the right turn lane on Super Highway.

(3) Lantern

A signal head using LED (light emitting diode) was installed. In addition to the uniform brightness of the lens, an LED type signal head has the advantage of a much longer life expectancy (up to 10 times compared with incandescent) and lower power consumption (up to 80% less against incandescent).

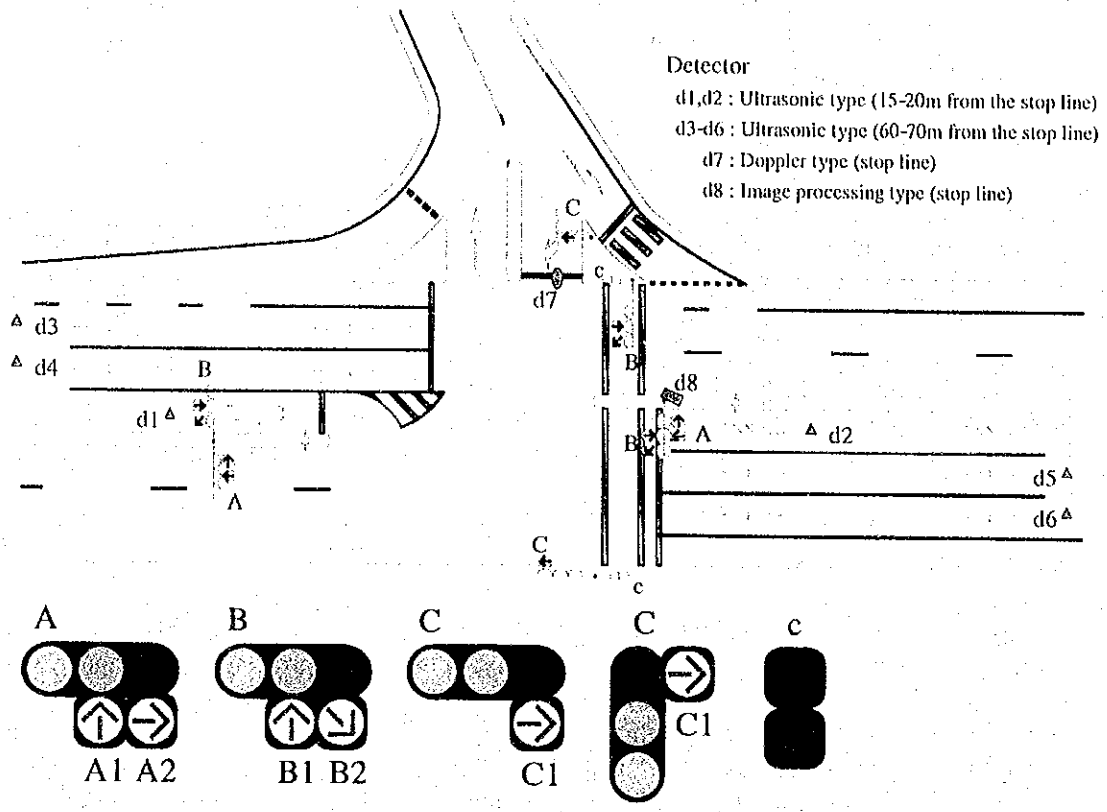
The primary/secondary signal layout was employed for all movements. The primary signal was installed on the near side of the intersection at stop line, while the secondary signal was installed at the far side of intersection. An overhang pole with a long arm was used.

(4) Phase design

The vehicle detectors actuate every stage so that if there is few traffic, the stage moves to the next stage early, and if there are many vehicles, it prolongs the stage by a predetermined increment. The minimum and maximum time is also predetermined according to the time of day. For the pedestrians to cross Super Highway, push button actuated pedestrian signal was employed. If there is no pedestrian the pedestrian signal stays in red and length of the second stage is less than 20 seconds. If any pedestrian pushes the button, the pedestrian signal turns green for them to be able to cross the Highway safely. The time was estimated at 20 to 30 seconds. Vehicles from the Northwest could make a right turn to the Highway at the same time.

Phase plans are considered under explained conditions and are shown in Table 10-3. In plan 3, at stage 2, U-turn will end earlier than right turn. That is at the later part of stage 2, the vehicles going straight from right to left can go straight and this period may become waste time. In plan 2, at stage 3 right turns might be cleared up and there may be waste green for right turn split. On the other hand in plan 1 those cause of waste time was overcame because the continuity of stages are considered and the most efficient phase plan.

The adopted signal phase with a pedestrian consideration is shown in Figure 10-10. Vehicle actuation is employed at all stages while pedestrian actuation is used at the second stage. Pedestrian actuation enables safe pedestrian crossing by indicating pedestrian green long enough for pedestrian to cross. Efficient signal operation is maintained by suppressing the pedestrian green when there is no pedestrian demand.



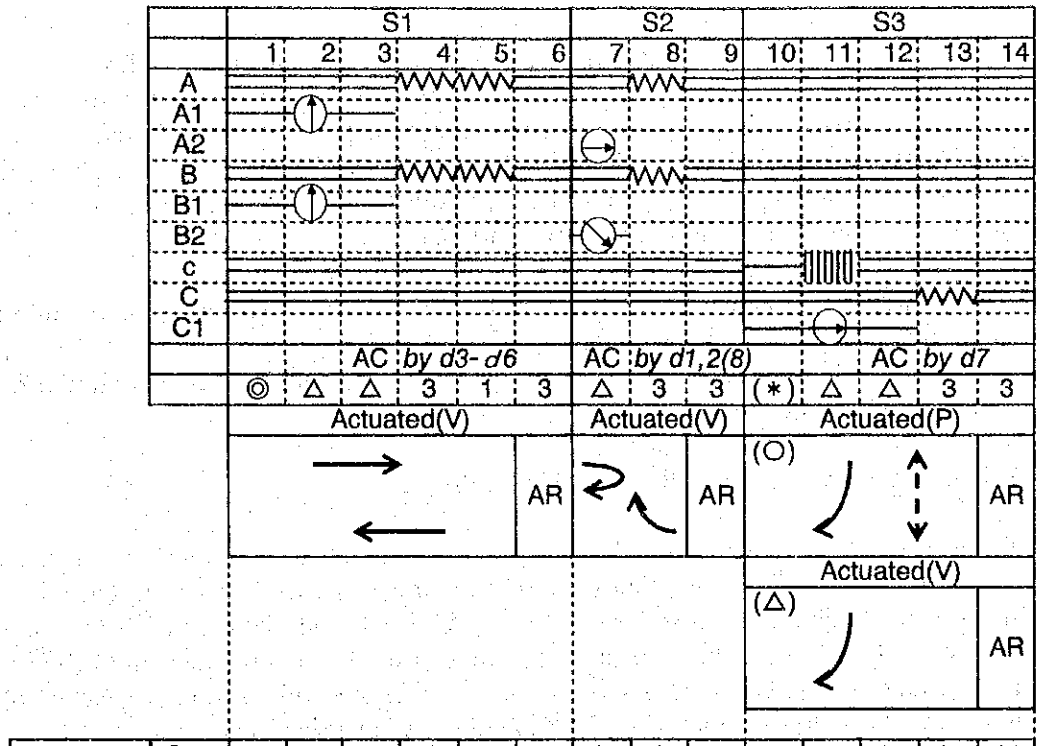
Source: This study

Figure 10-9 Location of Controller and Detector

Table 10-3 Phase Plans

Stage	1		2		3		4	
Plan 1		AR		AR		AR		AR
Plan 2		AR		AR		AR		AR
Plan 3		AR		AR		AR		

Source: This study



Time	Step	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Cycle	Green			Y		Ar	G	Y	Ar	Green			Y	Ar
00:00-07:00	122	36	1	20	3	1	3	13	3	3	7	20	6	3	3
07:00-09:00	142	48	1	20	3	1	3	14	3	3	7	20	13	3	3
09:00-16:00	122	36	1	20	3	1	3	13	3	3	7	20	6	3	3
16:00-19:00	162	62	1	20	3	1	3	26	3	3	7	20	7	3	3
19:00-24:00	122	36	1	20	3	1	3	13	3	3	7	20	6	3	3
											3	2			
											3	2			
											3	2			
											3	2			
											3	2			

00:00-07:00	Min./Max. Green	5	35	
07:00-09:00	Min./Max. Green	5	35	
09:00-16:00	Min./Max. Green	5	35	
16:00-19:00	Min./Max. Green	5	35	
19:00-24:00	Min./Max. Green	5	35	
		(-15,+15)		

5	33	
5	34	
5	33	
5	46	
5	33	
(-21,+20)		

3	16
3	23
3	16
3	17
3	16
(-10,+10)	

Protective Green Time	
◎	8sec-110sec
O	6sec-110sec
△	0sec-110sec

Source: This study

Figure 10-10 Wat Chet Yod Intersection Phase Diagram

10.5 Evaluation Methodology

A signal installed at Wat Chet Yod intersection is more for enhancing traffic safety than management of traffic congestion. However, signalization would also increase the intersection capacity as a by-product. The evaluation of the project, therefore, focuses on the safety improvement, as it is difficult to collect sufficient accident data to allow statistical comparison for the given short period after implementation. Instead, the following surveys were conducted for evaluation:

- Observation of vehicle and pedestrian movements at the intersection and counting of the number of dangerous incidents.
- Interview survey for vehicle drivers, motorcycle riders and shop owner similar to the ones already conducted.

(1) Traffic Studies for the Evaluation of Pilot Project

A Pilot Project for intersection improvement at Wat Chet Yod was proposed and conducted as Phase 2 for the "Study on Improvement of Road Traffic Environment in Chiang Mai City", based on the results of the Phase 1 study conducted between July-September, 2001. This Pilot Project is to demonstrate the effectiveness in traffic safety improvement at the selected intersection. Works for this Pilot Project involves improvements to the geometric design, pavements, markings and other traffic safety devices of the intersection; and the installation of a traffic signal system using both ultrasonic and VIP (video image processing) vehicle detectors. The Pilot Project was completed by June, 2002.

(2) Objectives and Types of Traffic Surveys Conducted

The main objective of conducting the surveys for the Pilot Project is to obtain data for evaluating the 'before' and 'after' effects of the intersection improvement effort. The WCY intersection was a non-signalized junction with serious vehicular conflicts between the various traffic streams. The location has been witnessing a large number of traffic accidents.

Intersection Turning Movement Survey (ITM)

This survey was also conducted in the Phase 1 study in August, 2001. This survey was again conducted for 14 hours for two purposes. One is to compare and ensure that traffic behavior at the junction has not changed since 2001. Secondly, the survey is to provide up-to-date traffic data signal timing plan.

Running Time Survey (RTS)

The Pilot Project is expected to improve traffic flow and reduce the probability of traffic accidents. As an indicator of improved traffic flow, average travel time of vehicles passing through the junction is expected to reduce. Hence travel time shall be measured before and after the improvement works. A RTS (running time survey) was thus

conducted for this purpose.

Queue Length Survey (QLS)

The Pilot Project is expected to reduce queue at the junction. Queue length by direction was measured in the Phase 1 study at WCY. QLS was also conducted after the installation of the signal to evaluate the effect on the reduction of queue.

Observation of Conflicted Traffic Survey (OCT)

Reduction of traffic accidents will only become clear after a reasonable time period has elapsed, such as one year or two years in ascertaining the decrease in accidents at the location. As an immediate measure on probability of accident occurrence, the number of conflicts (near miss) between vehicles at the Pilot Project site is expected to decrease considerably with traffic being controlled by signals. Thus the type and number of conflicts were measured on site.

Interview Survey of Vehicle Users (ISU)

Since the Pilot Project is a physically visible improvement to the junction, road users were to be interviewed on their perception on the level of safety before and after the improvements.

Table 10-4 Summary of Types of Traffic Survey and Purposes

No.	Type of Survey	Objectives	Remarks
1	Traffic turning movement survey	To obtain up-to-date traffic data for signal timing plan and to ascertain traffic demand remains unchanged at the project location	Similar in vehicle classes and for 14 hours
2	Running time survey	To measure average running time through the junction before and after the improvements	Travel time measured between pairs of pre-determined points
3.	Queue length survey	To measure queue length after the improvement and compared to those obtained in 2001.	
4.	Observation of conflicted traffic survey	To measure number and types of conflicts (near miss) between vehicles	Criteria set up to determine conflicts such sudden change of lanes, stopping, and accident.
5	Interview survey on vehicle users survey	To obtain users perception of improved traffic safety levels	

Source: This study

(3) Traffic Survey Execution

The Pilot Project thus involved basically two major works, earthworks for intersection improvement and installation of traffic signals system. The above traffic surveys were therefore to be conducted at three possible time slots:

a) Before the earthwork,
b) After the earthwork, (intersection improvement works) and
c) After start operation of signal system.

Similar Intersection Turning Movement Survey (ITM) and Queue length Survey (QLS) were conducted in August 2001, the survey result of which can be used as indicative of condition 'Before the earthwork' of the pilot project. However, an Intersection Turning Movement Survey (ITM) was conducted in January 2002 to ascertain that traffic demand has not changed in any significantly way since 2001.

Running Time Survey (RTS) and Observation of Conflicted Traffic Survey (OCT) were not conducted in Phase 1 study. In this Pilot Project study, these two surveys will have to be conducted at all the three time slots.

The Interview Survey of Vehicle Users (ISU) shall be conducted after the earthwork and after the start operation of the signal system.

Table 10-5 Summary of Type of Traffic Survey and Timings

No.	Type of survey	Before Earthwork	After Earthwork	After signal operation	Survey Duration/sample size
1	ITM	●	●	●	Vehicles: 14 hours Pedestrians:.6 hours
2	QLS	*	●	●	14 hours
3	RTS	●	●	●	6 hours
4	OCT	●	●	●	6 hours
5	ISU	*	●	●	6 hours / 250 samples

Notes: *= results of surveys in Aug are to be used. ● = surveys to be conducted in Pilot Project.
Source: This study

10.6 Results of Traffic Surveys

(1) Intersection Turning Movement Survey (ITM)

The "before earthwork" survey was conducted in January 17th 2002, on a Thursday, "After earthwork" survey was conducted in March 14th 2002, on a Thursday, and "after signal operation" survey was conducted in June 7th and 10th 2002, on a Friday and Monday. The survey method was slightly different from that used in 2001. Instead of manual count by enumerators, video recording of the intersection was taken from 6 am to 8 pm and classified counts were done in the laboratory. Volumes were recorded by every 15 minutes. The classification of vehicles for this survey is similar to the previous survey, as follows:

1. Cars and Pickups (incl. 4 wheel drives/jeep/van)
2. Motorcycles
3. Minibuses

4. Buses and Coaches
5. Small trucks (2 axles)
6. Medium and Large trucks (three axles and above, bulldozers, trailers, etc)
7. Others (Tuk-tuk, tricycles, etc)

Total Traffic Volume in PCU

Table 10-6 below shows the results of the ITM survey at WCY compared to results obtained in August 2001. As shown in this table, there are no significant differences of traffic demand by approach and by direction. The total PCU volume for the 14 hours survey period has increased marginally from 45,610 to 46,245 PCU or 1.4% only. It is an effect of summer holidays for school students that the volumes in March survey went down below 40,000.

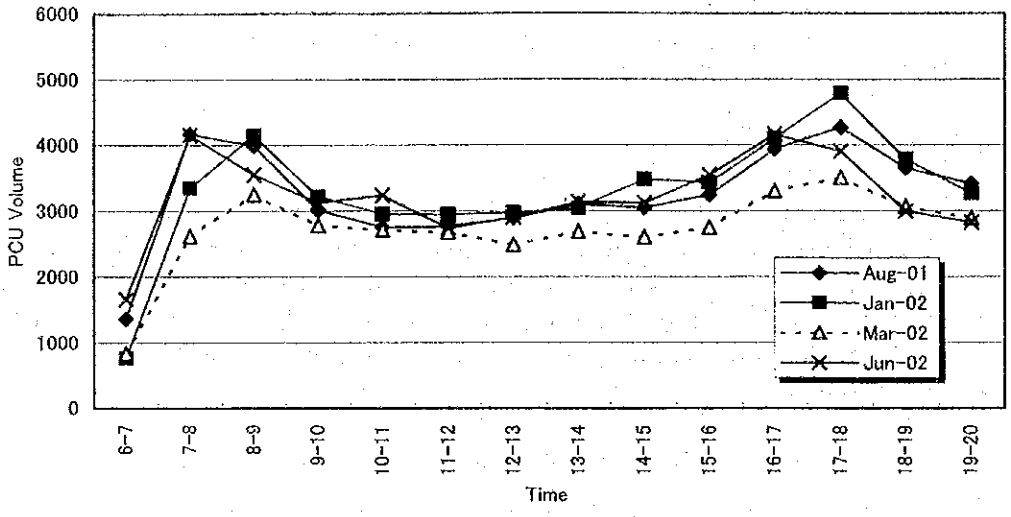
Table 10-6 Summary of ITM Survey Results at WCY

Approach	Direction	PCU Volumes			
		August, 2001	January, 2002	March, 2002	June, 2002
From North East (From Kuang Sing)	Through	17,903	18,018	15,769	17,943
	Right Turn	5,090	2,914	2,017	2,439
	U-Turn		2,240	1,096	2,021
From South-West (From Rimkham)	Through	14,904	15,298	12,725	15,076
	Left Turn	1,325	1,374	1,172	1,459
	U-Turn	1,699	1,830	1,685	1,839
From Soi Wat Chet Yod	Right Turn	2,565	2,444	1,955	2,307
	Left Turn	2,063	2,126	1,741	1,973
All Approaches	Total 14 hours	45,610	46,245	38,159	49,054

Source: This study

Hourly Distribution Pattern of 14 Hours Traffic Volume

In terms of hourly distribution of traffic within the 14 hours, the pattern displays a small seasonal change in pattern. Compared to August and June, the January and March pattern show a slightly later morning peak and no significant difference in evening peak traffic. This is due to the fact that January and March are the winter months in Chiang Mai, and as day light comes late, people generally leave home slightly later (Figure 10-11).



Source: This study

Figure 10-11 Hourly Distribution of Traffic Pattern at WCY

Table 10-7 Comparison of Peak Hour Traffic

Survey Time	Peak Hours	Traffic Volume (PCU)	Share to Total 14 Hours Traffic
August 2001	07 -08 hrs	4,172	9.1%
	17 -18 hrs	4,272	9.4 %
January 2002	08 -09 hrs	4,149	9.0 %
	17 -18 hrs	4,790	10.4%
March 2002	08 -09 hrs	2,619	6.9%
	17 -18 hrs	3,503	9.2%
June 2002	07 -08 hrs	4,157	9.2%
	16 -17 hrs	4,162	9.2%

Source: This study

The morning and evening peak hour traffic volumes from the surveys are almost identical except in the March survey. Although there are some increases and decreases in total 14 hour traffic volume and peak hour traffic volumes, these are considered to be within seasonal fluctuation.

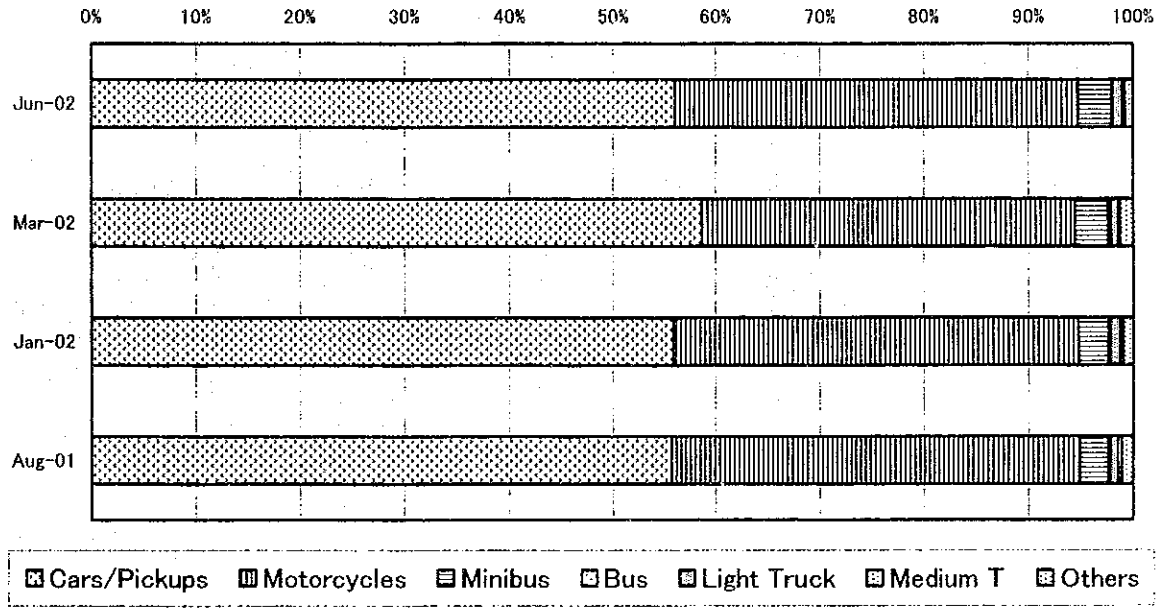
Traffic Composition Variation

Table 10-8 and Figure 10-12 show the comparison of traffic composition at WCY intersection between August 2001, January, March, and June 2002. As the results show, there are no significant differences of traffic composition between the four survey periods.

Table 10-8 Comparison of Traffic Composition

Survey Dates	Cars, Pickups &Vans	Motorcycles	Minibus	Bus &Coach	Light Truck	Medium &Heavy Truck	Others	Total (vehicles)
Total Aug 01	33,186	23,225	1,673	93	492	240	627	59,536
% share	55.7%	39.0%	2.8%	0.2%	0.8%	0.4%	1.1%	100.0%
Total Jan 02	33,619	23,257	1,723	149	610	155	619	60,132
% share	55.9%	38.7%	2.9%	0.2%	1.0%	0.3%	1.0%	100.0%
Total Mar 02	28,500	17,300	1,533	151	387	61	632	48,564
% share	58.7%	35.6%	3.2%	0.3%	0.8%	0.1%	1.3%	100.0%
Total Jun 02	33,334	22,927	1,948	70	554	152	453	59,438
% share	56.1%	38.6%	3.3%	0.1%	0.9%	0.3%	0.8%	100.0%

Source: This study



Source: This study

Figure 10-12 Comparison of Traffic Composition at WCY Intersection

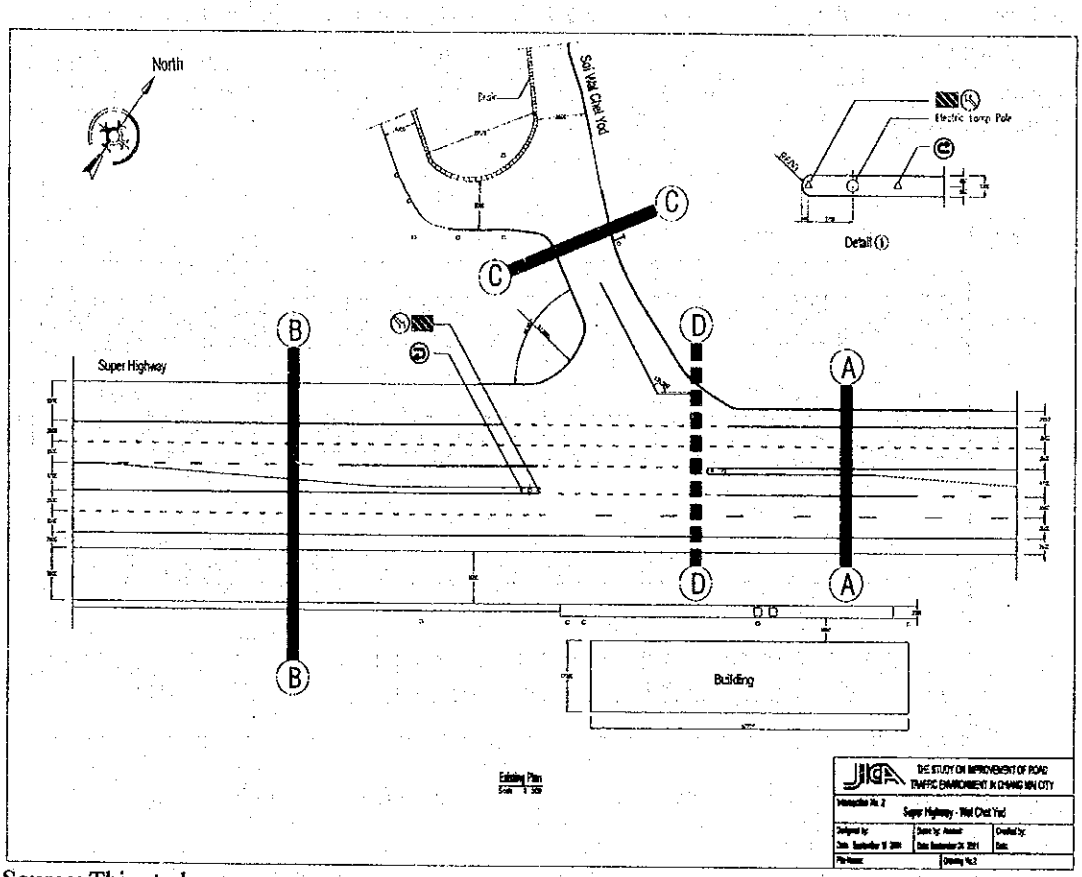
(2) Running Time Survey

Running time surveys were conducted by observation on site on the same day with other traffic surveys, i.e. 17th January, 14th March and 10th June, 2002. Markers were set up and enumerators were stationed on a higher ground (on the third floor of a nearby building) in order to be able to observe the movement of vehicles between the marked points. (See Figure 10-13; AA, BB, CC and DD).

The running time in seconds between a pair of points (A-A (U-turns), A-B, A-C, B-A, B-B (U-turns), and C-B) was recorded using stopwatches. These running times were

then recorded on survey sheets by vehicle types. (see Figure 10-13) The vehicles are classified into following 7 categories.

i. Cars
ii. Pickups and Vans
iii. Motorcycles
iv. Trucks
v. Buses
vi. Pedestrians
vii. Minibuses/Tuktuks/Bikes



Source: This study

Figure 10-13 Designated Survey Points for RTS at WCY Junction

The minimum and maximum travel time as well as the mean travel times by vehicle type are computed for the 6 hours of survey. Assuming that this minimum running time is the time taken by vehicles passing through the junction without any obstructions, such as under the condition where there is a signal control and these vehicles arriving at the junction during the green phase, and there is no queue. Therefore, the difference in running time between the mean and the minimum would represent the average time loss due to various obstructions experienced by vehicles passing through the junction.
The results of the running time survey are shown in Tables 10-9, 10-10, and 10-11.

Table 10-9 Running Times by Vehicle Type (Before Earthworks in January, 2002)

Direction	Vehicle Type	Min. in V Type (sec)	Max. in V Type (sec)	Mean in V Type (sec)	Mean Total Loss (sec)	Max. Total Loss (sec)	No. of Sample
A - A (U Turns)	Car	12	102	30	18	90	40
	Pickup	14	88	37	23	74	50
	M/C	11	107	24	13	96	37
B - B (U Turns)	Car	12	144	37	25	132	27
	Pickup	13	116	30	17	103	40
	M/C	12	55	25	13	43	23
A - B (Straight)	Car	4	57	8	4	53	49
	Pickup	4	37	9	5	33	49
	M/C	4	20	10	6	16	48
B - A (Straight)	Car	4	48	9	5	44	225
	Pickup	4	112	8	4	108	227
	M/C	2	42	10	8	40	152
A - C (R Turns)	Car	11	61	27	16	50	42
	Pickup	12	139	41	29	127	35
	M/C	5	130	27	22	125	50
C - B (R Turns)	Car	14	164	55	41	150	52
	Pickup	14	146	47	33	132	62
	M/C	14	120	43	29	106	81

Note: Data with samples less than 5 not shown:
Source: This study

Table 10-10 Running Times by Vehicle Type (After Earthworks in March, 2002)

Direction	Vehicle Type	Min. in V Type (sec)	Max. in V Type (sec)	Mean in V Type (sec)	Mean Total Loss (sec)	Max. Total Loss (sec)	No. of Sample
A - A (U Turns)	Car	17	106	48	31	89	45
	Pickup	14	126	41	27	112	55
	M/C	15	65	32	17	50	11
B - B (U Turns)	Car	8	90	38	30	82	21
	Pickup	14	90	40	26	76	25
	M/C	15	80	32	17	65	31
A - B (Straight)	Car	3	14	7	4	11	75
	Pickup	4	13	7	3	9	73
	M/C	5	18	8	3	13	72
B - A (Straight)	Car	3	75	9	6	72	193
	Pickup	4	31	7	3	27	213
	M/C	5	21	9	4	16	161
A - C (R Turns)	Car	13	252	51	38	239	55
	Pickup	12	133	45	33	121	53
	M/C	12	222	30	18	210	67
C - B (R Turns)	Car	9	128	53	44	119	42
	Pickup	11	137	51	40	126	44
	M/C	10	123	39	29	113	93

Note: Data with samples less than 5 not shown:
Source: This study

Table 10-11 Running Times by Vehicle Type (After Signalization in June, 2002)

Direction	Vehicle Type	Min. in V Type (sec)	Max. in V Type (sec)	Mean in V Type (sec)	Mean Total Loss (sec)	Max. Total Loss (sec)	No. of Sample
A - A (U Turns)	Car	16	147	71	55	131	16
	Pickup	16	159	83	67	143	22
	M/C	16	127	67	51	111	14
B - B (U Turns)	Car	29	51	40	11	22	6
	Pickup	17	89	45	28	72	13
	M/C	12	120	36	24	108	21
A – B (Straight)	Car	5	109	27	22	104	42
	Pickup	6	97	20	14	91	39
	M/C	4	77	22	18	73	35
B – A (Straight)	Car	4	97	26	22	93	54
	Pickup	4	88	21	17	84	56
	M/C	5	81	25	20	76	78
A - C (R Turns)	Car	10	152	78	68	142	28
	Pickup	17	132	73	56	115	26
	M/C	13	131	80	67	118	30
C – B (R Turns)	Car	9	128	53	44	119	42
	Pickup	11	137	51	40	126	44
	M/C	10	123	39	29	113	93

Note: Data with samples less than 5 not shown:
Source: This study

As the summary of these results shows, comparisons of Mean Time Loss and Maximum Time Loss are shown in Table 10-12 and Table 10-13 by chronological order. The straight traffic (A-B and B-A) had the right of way all the time even after the earthworks so that time loss did not increase much, or rather decreased. After the signalization, however, mean loss and maximum loss increased 200 to 550 % from the losses before the earthworks. Although the losses increased, maximum time loss is shorter than 100 sec. and this time is within the cycle time of the signal. That is, within a cycle all cars that have arrived at the intersection can be cleared and no queue occurs. This can also be observed from the queue length survey.

For A-A U-turns, loss time increased up to 300 % from the original loss time. All queues, however, cleared within a signal cycle. For right turns (A-C and C-B), the loss time also increased. In particular, the increase in loss time from Soi to B direction (C-B), cannot be seen.

As a whole, the delay time caused by the signal installation is within the signal cycle and has not caused any additional queues at the junction. On the other hand, traffic conflicts have decreased dramatically and the number of casualties and traffic accidents may also decrease.

Table 10-12 Mean Time Loss Comparison by Vehicle Type

Direction	Vehicle Type	Jan. 2002	Mar. 2002		May 2002	
		(sec)	(sec)	Change (%)	(sec)	Change (%)
A -A (U-turns)	Car	18	31	172	55	306
	Pickup	23	27	117	67	291
	M/C	13	17	131	51	392
B -B (U-turns)	Car	25	30	120	—	—
	Pickup	17	26	153	—	—
	M/C	13	17	131	24	185
A -B (Straight)	Car	4	4	100	22	550
	Pickup	5	3	60	14	280
	M/C	6	3	50	18	300
B -A (Straight)	Car	5	6	120	22	440
	Pickup	4	3	75	17	425
	M/C	8	4	50	20	250
A -C (R-turn)	Car	16	38	238	68	425
	Pickup	29	33	114	56	193
	M/C	22	18	82	67	305
C -B (R-turn)	Car	41	44	107	44	107
	Pickup	33	40	121	40	121
	M/C	29	29	100	29	100

Source: This study

Table 10-13 Maximum Time Loss Comparison by Vehicle Type

Direction	Vehicle Type	Jan. 2002	Mar. 2002		May 2002	
		(sec)	(sec)	Change (%)	(sec)	Change (%)
A -A (U-turns)	Car	90	89	99	131	146
	Pickup	74	112	151	143	193
	M/C	96	50	52	111	116
B -B (U-turns)	Car	132	82	62	—	—
	Pickup	103	76	74	—	—
	M/C	43	65	151	108	251
A -B (Straight)	Car	53	11	21	104	196
	Pickup	33	9	27	91	276
	M/C	16	13	81	73	456
B -A (Straight)	Car	44	72	164	93	211
	Pickup	108	27	25	84	78
	M/C	40	16	40	76	190
A -C (R-turn)	Car	50	239	478	142	284
	Pickup	127	121	95	115	91
	M/C	125	210	168	118	94
C -B (R-turn)	Car	150	119	79	119	79
	Pickup	132	126	95	126	95
	M/C	106	113	107	113	107

Source: This study

For B-B U-turns of cars and pickups, enough data could not be obtained and the comparisons were not performed.

For traffic movement D -D (pedestrian crossing), only three samples were recorded. An average of 69 seconds is found for the crossing.

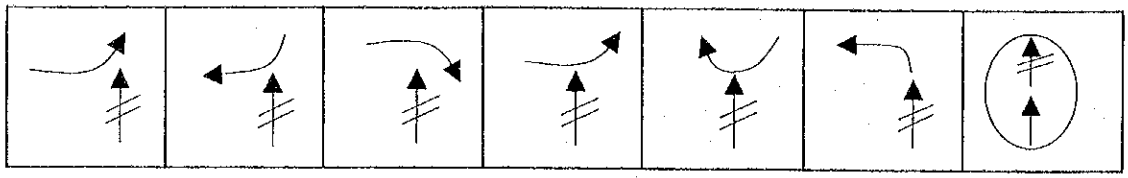
(3) Observation of Conflicted Traffic Survey (OCT)

For this survey, the major types of conflicts are first identified. As the visual determination of possible conflicts can sometimes be subjective, the survey has to specifically use certain obvious discernable actions by two possible conflicted vehicles to determine a conflict. Survey enumerators are therefore told to observe traffic conflicts based on the following criteria:

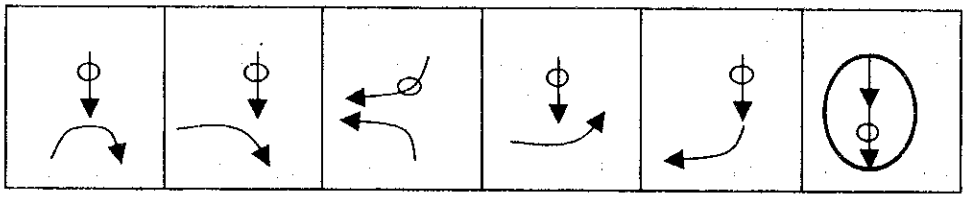
- there is a sudden change of lane by any or both vehicles, in an effort to avoid a possible collision,
- there is a sudden braking by any or both vehicles in an effort to avoid a possible collision.

It is felt that honking or flashing of headlights are merely defensive actions by drivers to warn other drivers ahead within when approaching the junction. Such actions are not counted as conflicted traffic events.

The major types of conflicts are identified by the following diagrams.



Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
Thru from SW conflict with LT traffic from minor road	Thru from SW conflict with RT traffic from NE	Thru from SW conflict with RT traffic from minor road	Thru from SW conflict with cross traffic from minor road	Thru from SW conflict with U-turn traffic from NE	Thru from SW conflict with traffic from right hand lane turning left	Secondary conflict of Thru traffic from SW



Type 8	Type 9	Type 10	Type 11	Type 12	Type 13
Thru from NE conflict with U-turn traffic from SW	Thru from NE conflict with RT traffic from minor road	RT from NE conflict with LT traffic from SW	Thru from NE conflict with cross traffic from minor road	Thru from NE conflict with RT turn traffic from NE	Secondary Conflict of thru traffic from NE

Source: This study

Figure 10-14 Types of Traffic Conflicts for the OCT Survey

OCT surveys were conducted three times, i.e. on January 17, 2002 before the construction, on March 14, 2002 just after the geometric improvement of the intersection was completed, and on June 10 after the traffic signal began operation. For each survey the data was recorded from 6:30 to 9:30 during the morning peak hours and from 15:30 to 18:30 during the evening peak hours.

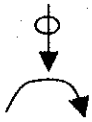
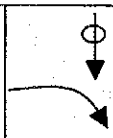
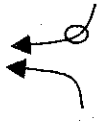
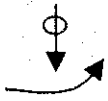
Table 10-14 shows the summary result of the surveys. The total number of conflicts decreased in accordance with the progress of the improvement. Before the improvement, the total number of conflicts was 1175. That is, 196 conflicts occurred for every hour, or every 3.3 minutes a conflict occurred. By the geometric improvement, the total number of conflicts decreased to 446 or became 38%. After the traffic signal started the operation, the total number of conflicts became 88. This result shows that the chance of traffic accidents at the Wat Chet Yod intersection will be dramatically decreased.

In Table 10-14, the proportion of each type of conflict is also shown. Before improvement most of the conflicts occurred when making a right turn or U-turn (Type 2,3,5,8, and 9). (See Figure 10-15 and Figure 10-16.) By only the geometric

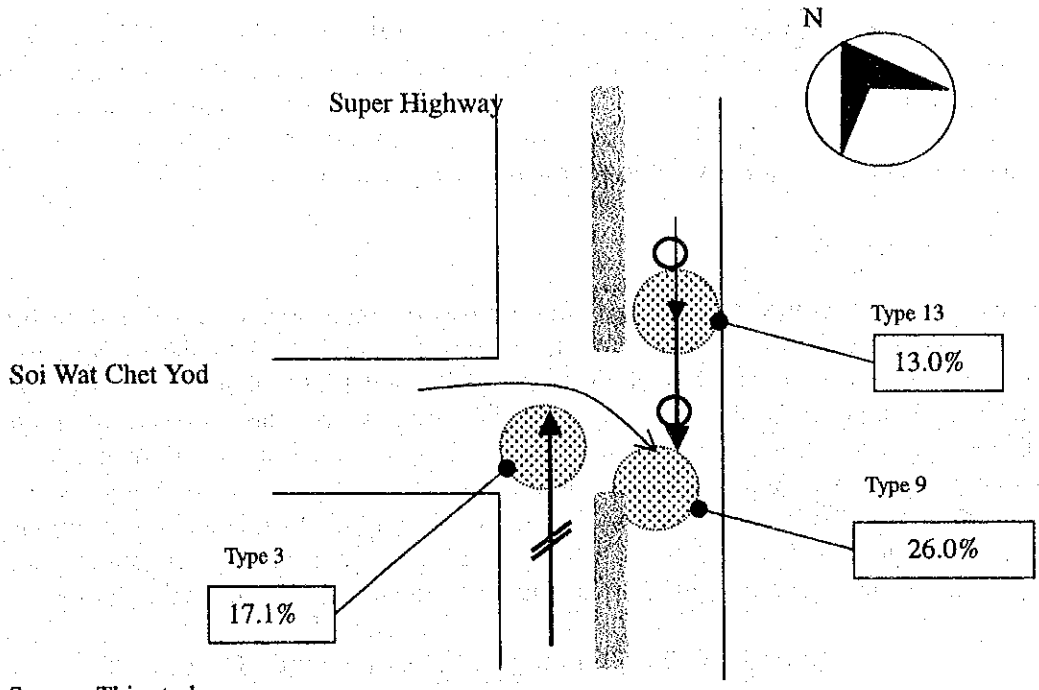
improvement, the number of conflicts decreased but still occurred when making a right turn or U-turn. On the other hand, after the traffic signal started an operation, although the absolute number is small, the conflicts occur mainly by secondary effects (Type 7 and 13). That is, if the car running in front of another car stops by the signal suddenly, the car behind almost collides with the front car. The other conflict after signal operation is conflict between the car making a left turn from Soi Wat Chet Yod and the straight going car from SW of Super Highway. These conflicts are not inherent problems of the signal installation and will be solved when drivers get used to the signalized intersection at Wat Chet Yod. Incidentally, the survey was conducted 8 days after the traffic signal commenced operation.

Table 10-14 Traffic conflicts by the type

Type of conflict								
Day	1	2	3	4	5	6	7	
Jan 17, '02	25	109	201	3	90	1	50	
	2.1%	9.3%	17.1%	0.3%	7.7%	0.1%	4.3%	
Mar 14, '02	2	93	77	1	18	0	25	
	0.4%	20.9%	17.3%	0.2%	4.0%	0.0%	5.6%	
Jun 10, '02	2	2	0	21	2	0	31	
	2.3%	2.3%	0.0%	23.9%	2.3%	0.0%	35.2%	

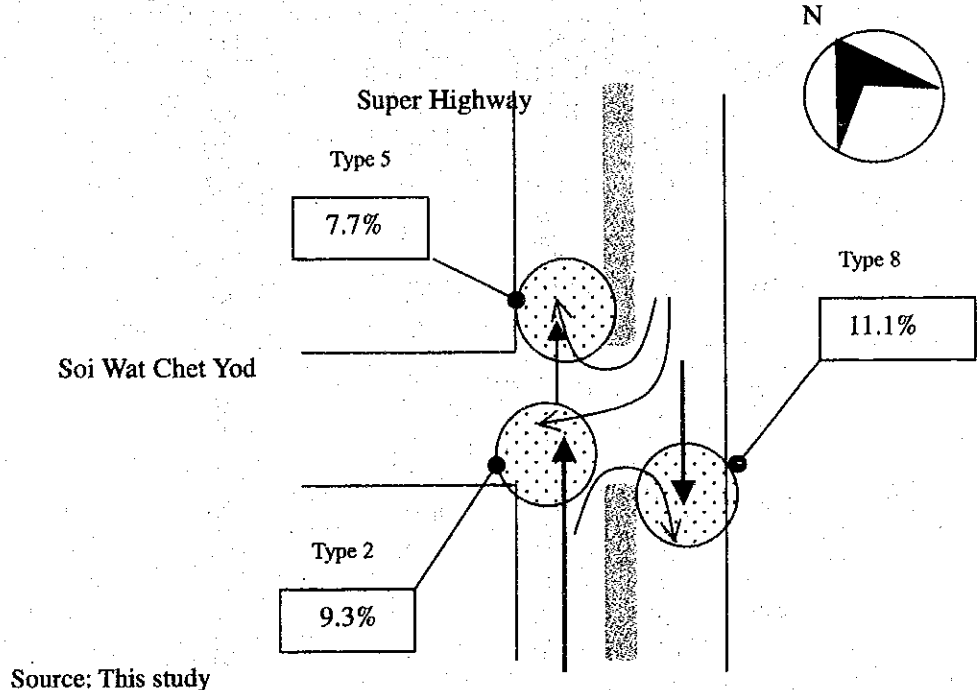
Type of conflict							Others	Total
Day	8	9	10	11	12	13		
Jan 17, '02	130	306	23	31	53	153	0	1175
	11.1%	26.0%	2.0%	2.6%	4.5%	13.0%	0.0%	100.0%
Mar 14, '02	76	83	0	6	31	34	0	446
	17.0%	18.6%	0.0%	1.3%	7.0%	7.6%	0.0%	100.0%
Jun 10, '02	3	2	5	0	0	16	4	88
	3.4%	2.3%	5.7%	0.0%	0.0%	18.2%	4.5%	100.0%

For each day, upper row is number of conflicts and lower row is 5 share of the conflict
The conflicts between 17:00 and 18:30 could not be observed because of heavy rain and for the comparison the data between 15:30 and 17:00 were added twice.
Source: This study



Source: This study

Figure 10-15 Percent Share of 3 Major Conflicts at WCY Junction



Source: This study

Figure 10-16 Other Major Conflicted Traffic Movements in WCY Junction

Before improvement, motorcycles were involved in 391 conflicts out of 1175 (33.3%). Motorcycles were involved in 191 cases out of 446 conflicts (42.8%) after geometric improvement and in 39 cases out of 70 conflicts (42.3%) after signal operation. The reason why the rate did not decrease after signal installation can be assumed that motorcyclists have a tendency not to follow traffic signals and signs

(4) Queue Length Survey

A queue length survey was conducted after earthworks on March 14, 2002 and on June 10, 2002 after the traffic signal came into operation. For both days the surveys were conducted three times a day, 7:30-8:30, 13:00-14:00, and 17:30-18:30. At the survey in March, queue lengths for the three approaches (in meters from the intersection) and the clock hour in hour-minute-second were recorded at the times when the queue length became maximum, when the queue became zero, and when queue length started increasing. At the survey in June, the queue length and the clock hour in hour-minute-second were recorded at the times when the green signal started, when the queue became zero, when the red signal started, and when the queue started accumulating.

Table 10-15 The Summary of Queue Length Survey

	Approach	Time zone	Max. Queue (in meters)	Period of Queue (in seconds)
March Survey	NE	7:30 -8:30	90	118
		13:00 -14:00	40	123
		17:30 -18:30	70	384
	SW	7:30 -8:30	30	19
		13:00 -14:00	20	103
		17:30 -18:30	35	244
	NW	7:30 -8:30	60	151
		13:00 -14:00	25	64
		17:30 -18:30	20	44
June Survey	NE	7:30 -8:30	313	118
		13:00 -14:00	130	88
		17:30 -18:30	190	125
	SW	7:30 -8:30	175	130
		13:00 -14:00	110	96
		17:30 -18:30	283	150
	NW	7:30 -8:30	45	175
		13:00 -14:00	45	96
		17:30 -18:30	35	161

Source: This study

The longest queue observed was 313 m from NE to SW on Super Highway during the morning peak period. This queue disappeared in 118 sec. The queue started accumulating during the red split and became maximum at the beginning of the green split. The queue, however, disappeared before the next red split started 67 sec. later. Similarly, other queues occurred and disappeared within the signal cycle. This means that the installation of a traffic signal at Wat Chet Yod does not increase the queues and from the result of the conflict survey, it can be said that the safety of the drivers and pedestrians has increased significantly.

(5) Interview Survey of Vehicle Users

An interview survey was conducted on site on different days from the other surveys, i.e. September 11, 2001 for preliminary survey, March 15, 2002 for intermediate survey and June 7, 2002 for final survey.

Questionnaire for each occasion is slightly different. Those are;

(a) Preliminary survey (Sept. 11, 2001)
- Q1 How often do you pass this intersection?
- Q2 Is it easy to make turn at this intersection?
- Q3 Do you often feel dangerous at this intersection?
- Q4 Have you ever seen, caused, or involved in an accident at this intersection?
- Q5 Do you think tat a traffic signal is necessary at this intersection?

(b) Intermediate survey (Mar. 15, 2002)
- Q1 Have you ever involved in any accidents at this location?
- Q2 Do you feel now it is easier to make turnings at this junction, compared to before the improvement?
- Q3 Do you feel safe now when using this junction, compared to before the improvement?
- Q4 Do you think traffic signals is needed here to improve safety?

(c) Final survey (Jun. 7, 2002)
- Q1 Do you feel easier now than before when there is no signal to make a turning at this junction?
- Q2 Do you feel safer now than before when there is no signal to make a turning at this junction?
- Q3 This signal adopts different lamp layout. Can you understand signal indication easily?
- Q4 Do you have any problems with the new signal?

Answers are summarized as shown in Table 10-16, 17, 18 19, 20, and 21.

Table 10-16 Summary of Interview Survey by Traffic Direction
(September 2001, before civil work)

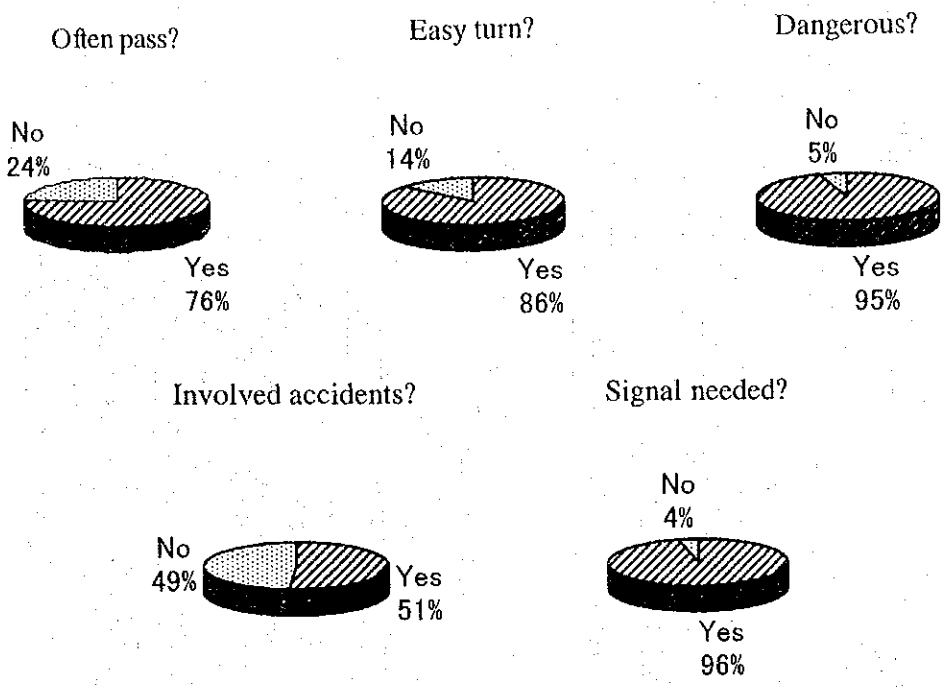
		NE			SW			Soi			Total		
		Yes	No	Not sure	Yes	No	Not sure	Yes	No	Not sure	Yes	No	Not sure
Q1	Often pass?	57	23	0	23	6	0	27	4	0	107	33	0
		71.3%	28.8%	0.0%	79.3%	20.7%	0.0%	87.1%	12.9%	0.0%	76.4%	23.6%	0.0%
Q2	Easy turn?	68	12	0	25	4	0	28	3	0	121	19	0
		85.0%	15.0%	0.0%	86.2%	13.8%	0.0%	90.3%	9.7%	0.0%	86.4%	13.6%	0.0%
Q3	Dangerous?	76	4	0	26	3	0	31	0	0	133	7	0
		95.0%	5.0%	0.0%	89.7%	10.3%	0.0%	100%	0.0%	0.0%	95.0%	5.0%	0.0%
Q4	Involved accident?	34	46	0	15	14	0	23	8	0	72	68	0
		42.5%	57.5%	0.0%	51.7%	48.3%	0.0%	74.2%	25.8%	0.0%	51.4%	48.6%	0.0%
Q5	Signal needed?	77	3	0	29	0	0	29	2	0	135	5	0
		96.3%	3.8%	0.0%	100%	0.0%	0.0%	93.5%	6.5%	0.0%	96.4%	3.6%	0.0%

Source: This study

Table 10-17 Summary of Interview Survey by Vehicle Type
(September 2001, before civil work)

		Passenger car			Motorcycle			Total		
		Yes	No	Not sure	Yes	No	Not sure	Yes	No	Not sure
Q1	Often pass?	59	18	0	48	15	0	107	33	0
		76.6%	23.4%	0.0%	76.2%	23.8%	0.0%	76.4%	23.6%	0.0%
Q2	Easy turn?	67	10	0	54	9	0	121	19	0
		87.0%	13.0%	0.0%	85.7%	14.3%	0.0%	86.4%	13.6%	0.0%
Q3	Dangerous?	72	5	0	61	2	0	133	7	0
		93.5%	6.5%	0.0%	96.8%	3.2%	0.0%	95.0%	5.0%	0.0%
Q4	Involved accident?	38	39	0	34	29	0	72	68	0
		49.4%	50.6%	0.0%	54.0%	46.0%	0.0%	51.4%	48.6%	0.0%
Q5	Signal needed?	72	5	0	63	0	0	135	5	0
		93.5%	6.5%	0.0%	100%	0.0%	0.0%	96.4%	3.6%	0.0%

Source: This study



Source: This study

Figure 10-17 Summary of Interview Survey (September 2001, before civil work)

Table 10-18 Summary of Interview Survey by Traffic Direction
(March 2002, after civil work)

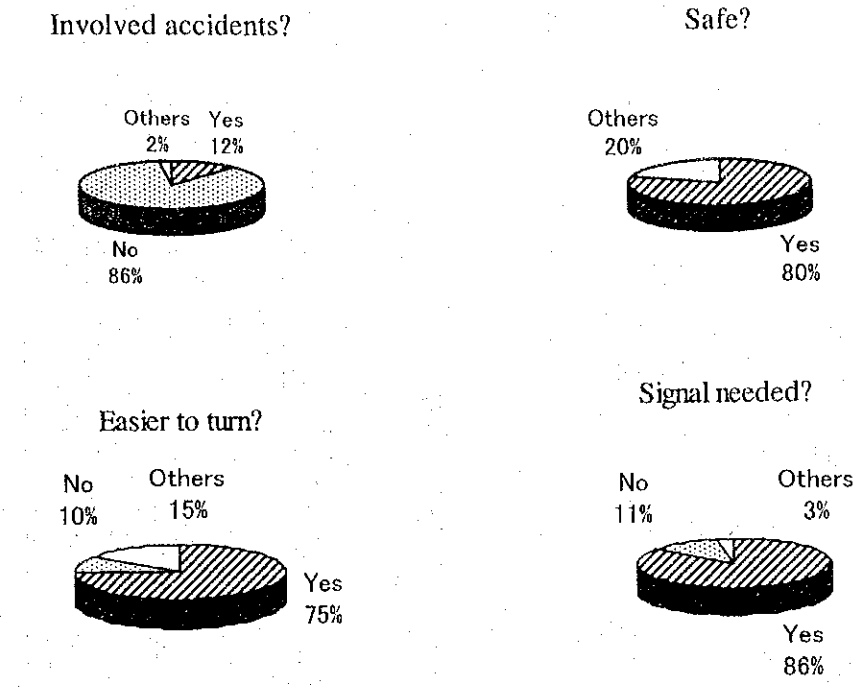
	NE				SW				Soi				Total			
	Yes	No	Same	Not sure	Yes	No	Same	Not sure	Yes	No	Same	Not sure	Yes	No	Same	Not sure
Q1 Involved accident?	19	135	0	3	19	114	0	5	7	79	0	1	45	328	0	9
	12.1%	86.0%	0.0%	1.9%	13.8%	82.6%	0.0%	3.6%	8.0%	90.8%	0.0%	1.1%	8.0%	90.8%	0.0%	1.1%
Q2 Easier to turn?	119	10	15	13	104	14	12	8	65	14	3	5	288	38	30	26
	75.8%	6.4%	9.6%	8.3%	75.4%	10.1%	8.7%	5.8%	74.7%	16.1%	3.4%	5.7%	75.4%	9.9%	7.9%	6.8%
Q3 Safer?	125	0	20	12	112	0	17	9	68	0	13	6	305	0	50	27
	79.6%	0.0%	12.7%	7.6%	81.2%	0.0%	12.3%	6.5%	78.2%	0.0%	14.9%	6.9%	79.8%	0.0%	13.1%	7.1%
Q4 Signal needed?	139	16	0	2	110	21	0	7	79	6	0	2	328	43	0	11
	88.5%	10.2%	0.0%	1.3%	79.7%	15.2%	0.0%	5.1%	90.8%	6.9%	0.0%	2.3%	85.9%	11.3%	0.0%	2.9%

Source: This study

Table 10-19 Summary of Interview Survey by Vehicle Type
(March 2002, after civil work)

	Passenger car				Motorcycle				Total			
	Yes	No	Same	Not sure	Yes	No	Same	Not sure	Yes	No	Same	Not sure
Q1 Involved accident?	38	223	0	5	7	105	0	4	45	328	0	9
	14.3%	83.8%	0.0%	1.9%	6.0%	90.5%	0.0%	3.4%	11.8%	85.9%	0.0%	2.4%
Q2 Easier to turn?	195	25	22	24	93	13	8	2	288	38	30	26
	73.3%	9.4%	8.3%	9.0%	80.2%	11.2%	6.9%	1.7%	75.4%	9.9%	7.9%	6.8%
Q3 Safer?	209	0	34	23	96	0	16	4	305	0	50	27
	78.6%	0.0%	12.8%	8.6%	82.8%	0.0%	13.8%	3.4%	79.8%	0.0%	13.1%	7.1%
Q4 Signal needed?	226	30	0	10	102	13	0	1	328	43	0	11
	85.0%	11.3%	0.0%	3.8%	87.9%	11.2%	0.0%	0.9%	85.9%	11.3%	0.0%	2.9%

Source: This study



Source: This study

Figure 10-18 Summary of Interview Survey (March 2002, after civil work)

Table 10-20 Summary of Interview Survey by Traffic Direction
(June 2002 after signal installation)

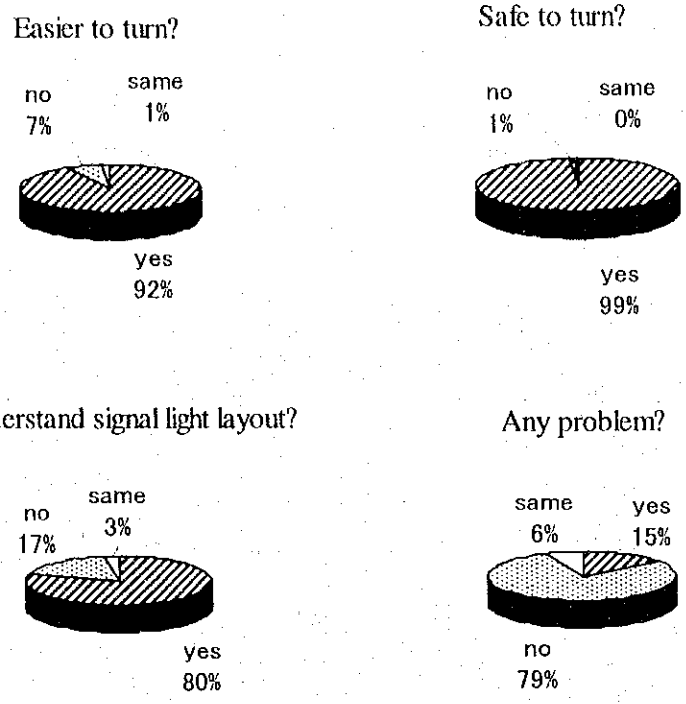
		NE			SW			Soi			Total		
		Yes	No	Same	Yes	No	Same	Yes	No	Same	Yes	No	Same
Q1	Easier to turn?	642	37	14	384	22	1	111	23	2	1137	82	17
		92.6%	5.3%	2.0%	94.3%	5.4%	0.2%	81.6%	16.9%	1.5%	92.0%	6.6%	1.4%
Q2	Safer to turn?	679	9	5	404	2	1	112	23	2	1218	12	6
		98.0%	1.3%	0.7%	99.3%	0.5%	0.2%	81.6%	16.9%	1.5%	98.5%	1.0%	0.5%
Q3	Understand signal lamp layout?	575	102	16	313	84	10	104	26	6	992	212	32
		83.0%	14.7%	2.3%	76.9%	20.6%	2.5%	76.5%	19.1%	4.4%	80.3%	17.2%	2.6%
Q4	Any problem?	123	540	31	64	325	18	4	101	30	191	966	79
		17.7%	77.8%	4.5%	15.7%	79.9%	4.4%	3.0%	74.8%	22.2%	15.5%	78.2%	6.4%

Source: This study

Table 10-21 Summary of Interview Survey by Vehicle Type
(June 2002 after signal installation)

		Passenger car			Motorcycle			Truck			Total		
		Yes	No	Same	Yes	No	Same	Yes	No	Same	Yes	No	Same
Q1	Easier to turn?	430	48	7	695	32	10	12	2	0	1137	82	17
		88.7%	9.9%	1.4%	94.3%	4.3%	1.4%	85.7%	14.3%	0.0%	92.0%	6.6%	1.4%
Q2	Safer to turn?	474	7	4	730	5	2	14	0	0	1218	12	6
		97.7%	1.4%	0.8%	99.1%	0.7%	0.3%	100%	0.0%	0.0%	98.5%	1.0%	0.5%
Q3	Understand signal lamp layout?	387	87	11	593	123	21	12	2	0	992	212	32
		79.8%	17.9%	2.3%	80.5%	16.7%	2.8%	85.7%	14.3%	0.0%	80.3%	17.2%	2.6%
Q4	Any problem?	94	341	37	96	612	42	1	13	0	191	966	79
		19.9%	72.2%	7.8%	12.8%	81.6%	5.6%	7.1%	92.9%	0.0%	15.5%	78.2%	6.4%

Source: This study



Source: This study

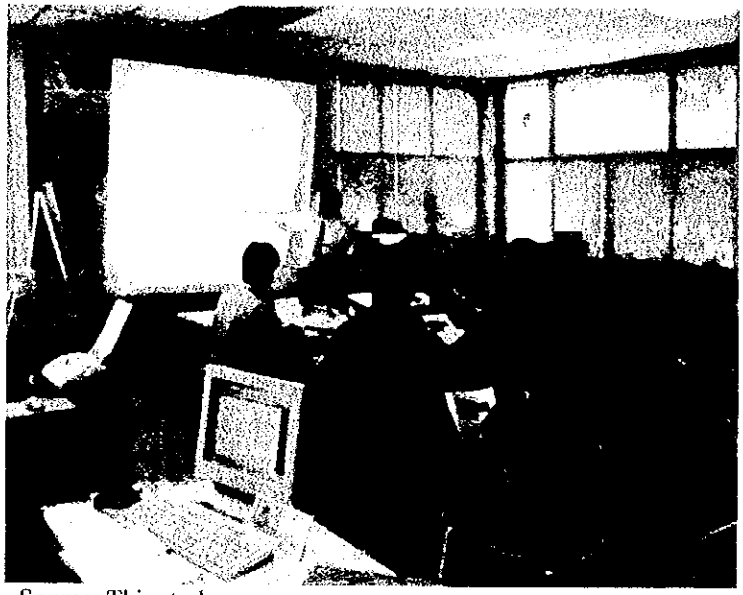
Figure 10-19 Summary of Interview Survey (June 2002 after signal installation)

In September 2001, about 50 % of the interviewed drivers and motorcyclists said that they had been involved in accidents. In March and June 2002, however, only 10 to 15 % of the drivers and motorcyclists answered that they had been involved in accidents. The reason for this difference is not clear. On the other hand, over 90 % people felt the intersection is dangerous and wanted the traffic signal.

The interview survey after signal installation revealed that over 90 % of the drivers on the Super Highway feel safer and easier to make turns at the intersection. The percentage of drivers from the Soi who feel safer and easier to make turns is about 10 % lower than the drivers on the Super Highway. The reason is that the drivers from Soi still pay attention to the traffic on the Super Highway. There are no significant differences between the types of vehicles. On the whole, the signal is appreciated in that it helps to facilitate easier and safer turns and the signal lamp layout is accepted. The features of the signal lamp layout are; all the green lamps are indicated by arrow signs, the lamps are lined horizontally, and the lanterns do not have back plates to avoid reflection from the background.

(6) Training

Operation and maintenance lectures were held on June 4 and June 5 respectively at the study team office and Wat Chet Yod intersection. For the operation lecture, 12 people from Chiang Mai Police and 2 people from DOH attended. For the maintenance lecture, 3 people from DOH, 2 people from Chiang Mai Municipality, and 2 people from Chiang Mai Police attended.



Source: This study

Figure 10-20 Operation lecture at study team Office

Source: This study

Figure 10-21 Maintenance lecture at Wat Chet Yod

10.7 Evaluation of the Pilot Project

The Pilot Project had three objectives as stated in the first section of this chapter, namely,

- Demonstration of the effectiveness of the measures implemented,
- Reflection of the lessons learnt from the Project to other measures proposed, and
- Technology transfer to counterpart agency.

(1) Effectiveness of Measures

Five kinds of surveys were conducted before, during and after the Pilot Project as summarized in Table 10-5. The intersection turning movement survey was intended to check whether there was any change in traffic volume for the three survey periods. The results showed that the traffic volume remained at the same level with slight seasonal fluctuations.

The results of the other four surveys are briefly summarized in Table 10-22. Although, the average loss time at the intersection increased, there is a significant reduction in conflicts. As to queue length, the maximum queue length became longer but discharge time remains at the same level. These data imply that the traffic flow at Wat Ched Yod became more consistent and stable. Thus, a reduction in accidents can be expected. Such expectation is supported by the results of the interview survey. Before the project, drivers felt that the intersection was dangerous. After the project, however, more than 95% of drivers feel safer at the intersection and can make a turn more easily.

Based on the survey results, the pilot project is judged highly successful in terms of safety enhancement.

Table 10-22 Summary of Survey Results

Survey	Results		
	Before	During	After
Running Time Survey	Average loss time of observed vehicles: 13.2 second	Average loss time of observed vehicles: 14.6 second	Average loss time of observed vehicles: 32.8 second
Queue Length Survey	Queue of 50 – 120 meter long observed on Super Highway and disappeared in 90 – 266 sec. On Soi, maximum 20 meter long queue appeared and disappeared in 50 – 90 sec.	Queue of 20 – 90 meter long formed on all approaches and took 20 – 380 seconds to disappear.	Queue of 110 – 310 meter long observed on Super Highway and queue of 35-45 m long formed on Soi. All queues discharged in 90-175 seconds.
Traffic Conflict Survey	A total of 1,175 conflicts observed.	A total of 446 conflicts observed during the same duration. A 62% reduction compared with "before."	A total of 88 conflicts observed, 1/13 of the "Before" situation.
Interview Survey	95.10% of respondents felt dangerous at the intersection.	79.8% of respondents felt safer at the intersection, and 75.4% said easier to make turn.	98.5% of respondents feel safer at the intersection, and 92.0% said easier to make turn.

Note: For the queue length data of before survey, the data which is conducted on August 20, 2001 is used.
Source: This Study

(2) Lessons from the Project

There are both positive and negative lessons learnt from the project.

Measures implemented are extremely effective for traffic safety

One of the reasons for the success is the well-prepared design. The Consultant spent time and exerted effort in the design of the measures taken in the Pilot Project. Base drawing was prepared by site survey and traffic volume was counted by traffic survey. Based on the intersection drawing and traffic volume data, the intersection geometry and signal were carefully designed. For future projects, it is hoped that similar efforts are exerted to achieve the intended objectives.

Drivers' behavior becomes more disciplined if intersection and signal are well designed

Before the project, the traffic condition at Wat Ched Yod intersection was chaotic. Drivers drove any path, even on the wrong side of facing traffic, and took risks to cross. The situation became orderly after the Project. It suggests that an unruly situation is sometimes created by a lack of or inadequate traffic and road facilities. Such conditions can be improved by well-designed traffic management measures.

On the other hand, there were also lessons on what could be improved.

Construction took much longer time than expected

The civil and signal works were expected to take two months to finish. In reality, however, it took more than four months, although there was one-month break due to contract renewal of the Consultant. The main reason for such delay was inefficient arrangement by the inexperienced and poorly equipped contractor and sub-contractor. It is suggested that the qualifications of contractor including sub-contractors must be checked closely before the works are contracted out.

Quality of work was not satisfactory

Several sub-standard works were found during the construction of civil works and installation of signal equipment. Materials and application technique of pavement markings was initially not satisfactory. Setting out and alignment of civil works was not accurate enough and most of the civil works lacked finishing touch. Wrong connections of signal cable wiring at the terminal box on the pole were found. These defects were eventually corrected as directed. But the Consultant had to spend more time at the site to supervise the work. It was also perceived that quality was not regarded important among the contractor's staff and workers. More consideration must be given to the quality of work.

(3) Evaluation of Traffic Signal System

Judging by the results of the traffic survey, it can be said that the traffic signal system which was installed at Wat Chet Yod works properly. The detectors installed at each approaching lane detected the end of the car cluster without fail and actuated the signal timing in accordance with traffic volume.

For the image processing detector installed on Super Highway, the count which was taken by the detector and the video image was compared. The result is shown in Table 10-23.

Table 10-23 Comparison between Actual Data and Data Counted by the Image Processing Detector

	14:20 – 15:20, June 5, 2002		20:00 – 21:00, June 3, 2002	
Case	Visually counted number	Number counted by the detector	Visually counted number	Number counted by the detector
A	26	26	57	57
B	20	29	54	53

Note: Case A is when motorcycles and vehicles exist in detecting area.
Case B is when there are one or more motorcycles in detecting area.
Source: This study

The discrepancy in the count occurred during the nighttime because the tail of the vehicle was missed due to the brightness. This can be improved to higher level adjusting the threshold level.

Although for the Doppler detectors installed at the Soi, the comparison between actual and counted numbers was not conducted because no image data was taken, they detect motorcycles as well as cars and other motor vehicles. On Super Highway, the ratio of motorcycles to cars is less than 1 (1/2 ~ 1/3). On the other hand, the ratio on Soi is greater than 1 (2 ~ 3). Consequently, if the motorcycle detectors do not work properly, many motorcycles are left behind at the Soi and long queue will occur.

The signal installed at Wat Chet Yod was an independent signal system without synchronization between upper and lower traffic signals. The vehicles on Super Highway, however, approach in cluster without any synchronization with the signal cycle at Wat Chet Yod. Although the traffic capacity is enough for the traffic demand at Wat Chet Yod and no queue appears beyond the capacity of one traffic signal cycle, if the synchronization of the cycle is achieved, more vehicles can go through these areas.

(4) Technology Transfer

The Consultant had regular weekly meetings with the counterpart agency staff during the Study to discuss various topics related to traffic management. The process of geometric and signal design at Wat Ched Yod was also explained and discussed in detail as the work progress.

Many staff from Provincial Police and Municipality eagerly attended the workshops held at the office and the site for operation and maintenance of the signal. They were generally very much interested in the signal, as it is different from those found at other intersections.

It is still not clear how much technology has been transferred to the counterpart and how much contribution has been made to enhance the traffic management skill of the counterpart agencies through these activities. It is sure, however, that the Pilot Project will play the role of a symbol for good traffic management.

In conclusion, it can be said that the Pilot Project was a success.