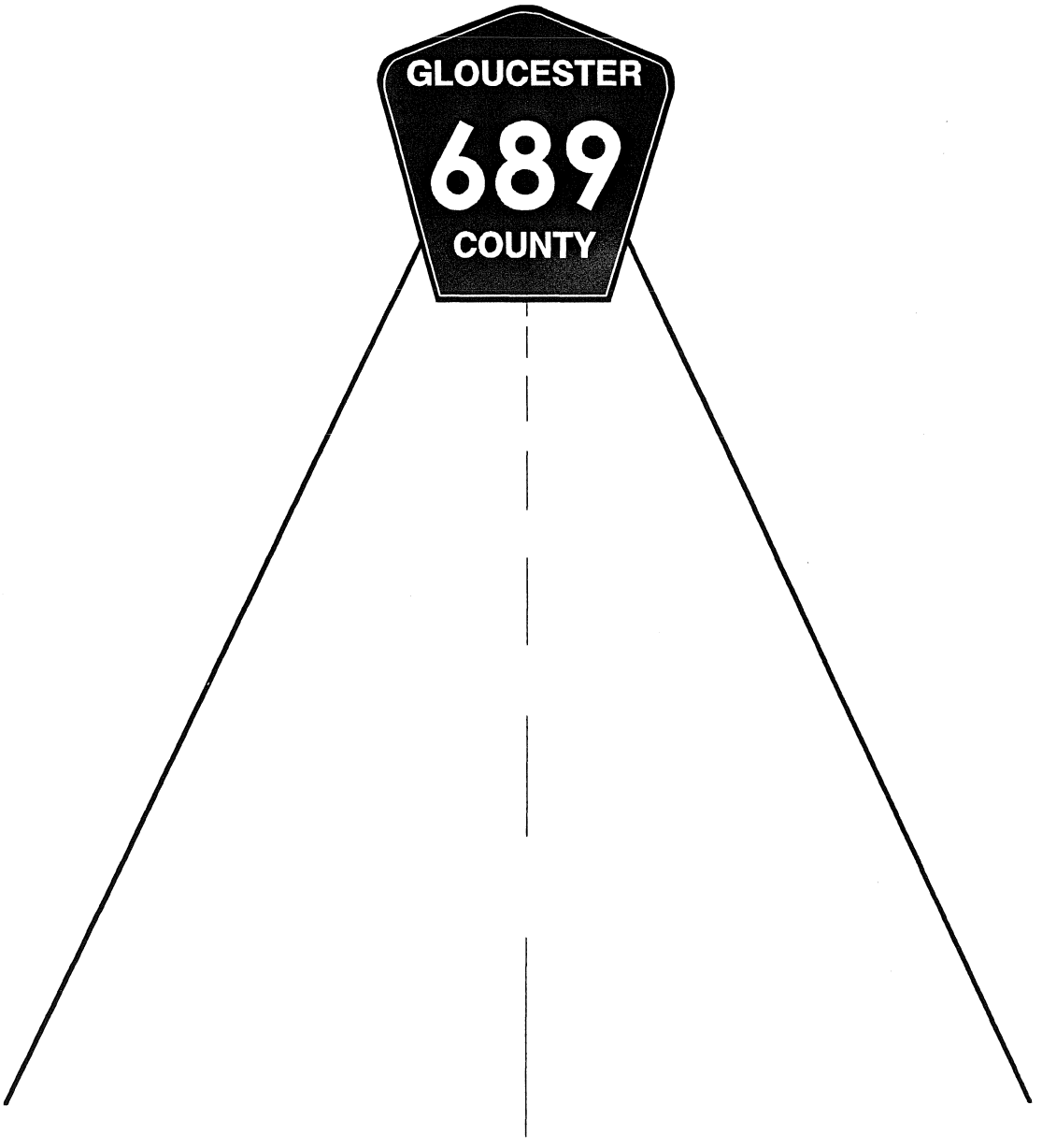
GLASSBORO-CROSS KEYS ROAD STUDY



Delaware Valley Regional
Planning Commission

October
1993

GLASSBORO-CROSS KEYS ROAD STUDY

Delaware Valley Regional Planning Commission
The Bourse Building 21 South 5th Street
Philadelphia, PA 19106

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DELAWARE VALLEY REGIONAL PLANNING COMMISSION

PUBLICATION ABSTRACT

Title	Date Published: October 1993
GLASSBORO-CROSS KEYS ROAD STUDY	Publication No. 93031

Geographic Area Covered:
The studied highway alignment traverses the Borough of Glassboro, Washington Township and Monroe Township in Gloucester County, New Jersey.

Key Words:
population and employment growth, land development, traffic counts, traffic growth, level of service analysis, traffic congestion, transportation improvements, official map

ABSTRACT

This report summarizes an examination of existing and projected future traffic volumes along Glassboro-Cross Keys Road (CR 689). Undertaken at the request of Gloucester County, the study was conducted as an investigation into the feasibility of widening the cross county artery (from the end of the proposed Cross Keys Bypass to the Delsea Drive) as a measure to increase cross county mobility.

To address the situation, three total future traffic volume scenarios were subject to traffic engineering analyses. Additionally, aerial photographs were commissioned which serve as the base for the right of way and cartway needs analysis. Review and coordination on these items with representatives of the County yielded the final set of recommendations.

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I. EXECUTIVE SUMMARY

Gloucester County requested that the Delaware Valley Regional Planning Commission (DVRPC) study the feasibility of widening Glassboro-Cross Keys Road (CR 689) *{hereinafter referred to as Cross Keys Road}*, between the Delsea Drive (NJ 47) in Glassboro and the proposed Cross Keys Bypass, as a measure to increase cross-county vehicular capacity.

The interest in widening the roadway was precipitated by the following events. First, Camden County intends to widen Cross Keys Road from Park Drive, just south of the White Horse Pike (US 30), to the Gloucester County line as a means of accommodating intense development activity occuring in the corridor. Second, in order to accommodate its own growth plans, Gloucester County is planning and designing a four lane bypass around the locality of "Cross Keys". The bypass will extend from the Black Horse Pike (NJ 42) to west of the Cross Keys intersection. Lastly, there exists the possibility of constructing an interchange between the Atlantic City Expressway and Cross Keys Road.

Multiple activities were performed as part of the work program for the Cross Keys Road Study. Traffic engineering services were rendered to provide the technical foundation for the undertaking. As such, DVRPC formulated and analyzed present and future travel characteristics and traffic demands within the corridor for three total future traffic volume scenarios. As a result of the analysis, DVRPC identified roadway and intersection improvements that were necessary to accommodate the future flows.

Next, aerial photographs of the study corridor were commissioned. Scaled enlargements (1" = 50') provided the base upon which improvement sketches, emanating from the scenario analyses, would be drawn and evaluated.

Finally, after the evaluation of the alternatives, a right of way and cartway needs analysis to support the final recommendations was undertaken and mapped on a set of the aerial photos.

This report details the activities performed in the first stage of the work program and describes the resulting set of final recommendations. The right of way and cartway needs analysis also illustrated on aerial photos of the corridor which are provided in a separate companion document.

The detailed study corridor consists of Cross Keys Road and Pitman-Downer Road (CR 658). Both are two lane, county owned and maintained facilities traversing some of the highest growth areas within Gloucester County. The study analyses focused on Cross Keys Road from the end of the proposed Cross Keys Bypass, on the east, to the Delsea Drive, on the west, a

distance of about 3.75 miles. Pitman-Downer Road was examined in detail from Cross Keys Road, on the south, to Greentree Road (CR 651), on the north, a distance of approximately 2.25 miles. Major intersections with county and state highways, within the study limits, were also examined. Based upon the analysis of existing traffic volumes (determined from traffic counts conducted in February and March of 1993), peak hour traffic operations are generally acceptable at intersections and along roadways within the study limits.

DVRPC estimated future peak hour traffic volumes for the year 2013 which account for the traffic oriented to and from 32 proposed/potential developments within the corridor, in addition to ongoing region-wide growth. Total future corridor-wide traffic growth represents annual increases of five to seven percent carried forward to the year 2013 -- a growth rate equal to that experienced within the study corridor from the mid 1980's to the early 1990's. The projected growth in traffic dictated that some level of improvement would be required to maintain mobility within the corridor.

Three scenarios of total future traffic volumes were formulated for analyses. They are summarized below.

I. DO NOTHING ALTERNATIVE - Assesses travel conditions within the corridor if no intersection or roadway improvements are provided to support growth. Most traffic will use alternate routes beyond the study area because capacity within the corridor will be insufficient to accommodate the traffic growth.

II. IMPROVE CROSS KEYS ROAD - Assesses mobility needs and impacts along Cross Keys Road (particularly as it traverses Glassboro) if unrestrained travel within the corridor is desired. Required improvements at the Delsea Drive and Cross Keys Road intersection would be very severe.

III. IMPROVE CROSS KEYS ROAD AND PITMAN-DOWNER ROAD - Assesses corridor travel conditions if cross-county/cross Glassboro capacity is provided along two facilities. Corridor mobility can be maintained through a set of feasible intersection and roadway improvements.

Ultimately, through a series of review meetings with representatives of Gloucester County's planning and engineering departments, DVRPC determined the set of improvements cited within Scenario III to be the most desirable. Enhancements were added to the improvements to integrate access needs/driveway designs of impending developments. These enhanced improvements became the final recommendations of the study which are detailed in Chapter V of this report.

II. INTRODUCTION

Gloucester County has commissioned the Delaware Valley Regional Planning Commission (DVRPC) to study the feasibility of widening Glassboro-Cross Keys Road (CR 689) *{hereinafter referred to as Cross Keys Road}*, between the Delsea Drive (NJ 47) in Glassboro and the proposed Cross Keys Bypass, as a measure to increase cross-county vehicular capacity. The interest in widening, at this particular time, was precipitated by the following events. First, Camden County intends to widen Cross Keys Road from Park Drive, just south of the White Horse Pike (US 30), to the Gloucester County line as a measure to accommodate intense development activity occuring in the corridor. Second, in order to accommodate its own growth plans, Gloucester County is planning and designing a four lane bypass around the locality of "Cross Keys". The bypass will extend from the Black Horse Pike (NJ 42) to west of the Cross Keys intersection -- formed by the junction of Cross Keys Road (CR 689), Hurffville-Cross Keys Road (CR 654) and Tuckahoe Road (CR 555). Third, and finally, there exists the possibility of constructing an interchange between the Atlantic City Expressway and Cross Keys Road.

Due to concerns of traffic impact inherent in widening Cross Keys Road as it traverses Glassboro, the County requested DVRPC to expand the investigation to include improvements to Pitman-Downer Road (CR 658) north from Cross Keys Road to Greentree Road (CR 651), as a possible alternate or relief route.

In order to complete the study a variety of activities were performed. First, traffic engineering services were rendered to provide the technical direction for the study. Study highways and intersections were field inspected as part of those services. Traffic counts were conducted. Level of traffic service analyses were performed given existing conditions of volume, geometry and control. Development activity anticipated to occur in the corridor was estimated with the cooperation and input of county and municipal representatives. Three future peak traffic volume scenarios within the study corridor were formulated (each assuming alternate levels of transportation improvement). Future level of service analyses were performed for each scenario of future traffic demand for the purpose of identifying desireable traffic improvements for the County's consideration.

Second, aerial photographs of the study corridor were commissioned and scaled enlargements (1" = 50') were prepared.

Lastly, from the traffic analyses investigating the alternate highway alignments, DVRPC mapped the necessary traffic improvements on the aerial photos of the study corridor. Roadway elements which were illustrated included existing right of way, required additional cartway/pavement area at and in between major intersections, and the additional right of way

necessary to accommodate the enhanced cross sections. The County took those cited improvements into consideration and combined them with probable operational betterments required by impending development site access needs. Those final set of improvements were then mapped on the aerials in conceptual form and serve as the recommendations of this study.

The County will use the aerials depicting the recommendations to show the project's impact on existing properties and land use.

III. EXISTING TRAFFIC CONDITIONS

The detailed study corridor consists of Cross Keys Road and Pitman-Downer Road. Both are two-lane, county owned and maintained facilities traversing some of the highest growth areas within Gloucester County. The study analyses focuses on Cross Keys Road from the end of the proposed Cross Keys Bypass, on the east, to the Delsea Drive, on the west, a distance of about 3.75 miles. Pitman-Downer Road was examined in detail from Cross Keys Road, on the south, to Greentree Road, on the north, a distance of approximately 2.25 miles. Major intersections with county and state highways, within the study limits, were also examined. Figure 1 illustrates the study area.

Study Roadways

Cross Keys Road (CR 689) is classified as an arterial highway according to the County's functional classification system. The road runs in an east-west direction and serves as the boundary line between Washington and Monroe townships. Along the study corridor, the cartway width and speed limit vary as the adjacent land uses change. Passing is generally permitted between Fries Mill Road and the Borough of Glassboro, where adjacent land use, sight distances and roadway geometry allow. Passing is prohibited along Cross Keys Road within the Borough of Glassboro.

East of Fries Mill Road (CR 655), Cross Keys Road has a 35 foot cartway with 11 foot travel lanes and six to seven foot paved shoulders. The posted speed limit along this segment is 50 miles per hour. The land use is largely wooded with scattered residential. At the signalized intersection with Fries Mill Road, Cross Keys Road widens to four lanes through the intersection.

Between Fries Mill Road and Pitman-Downer Road (CR 658), the width of the travel lanes increase to 12 feet in the eastbound direction and 13 feet in the westbound direction. The shoulder width decreases to 3 feet on either side, creating a total cartway width of 31 feet. The speed limit is posted at 50 miles per hour. The land use is a mix of low density residential and agricultural uses. At the intersection with Pitman-Downer Road, Cross Keys Road is uncontrolled while the Pitman-Downer Road approaches are stop-sign controlled.

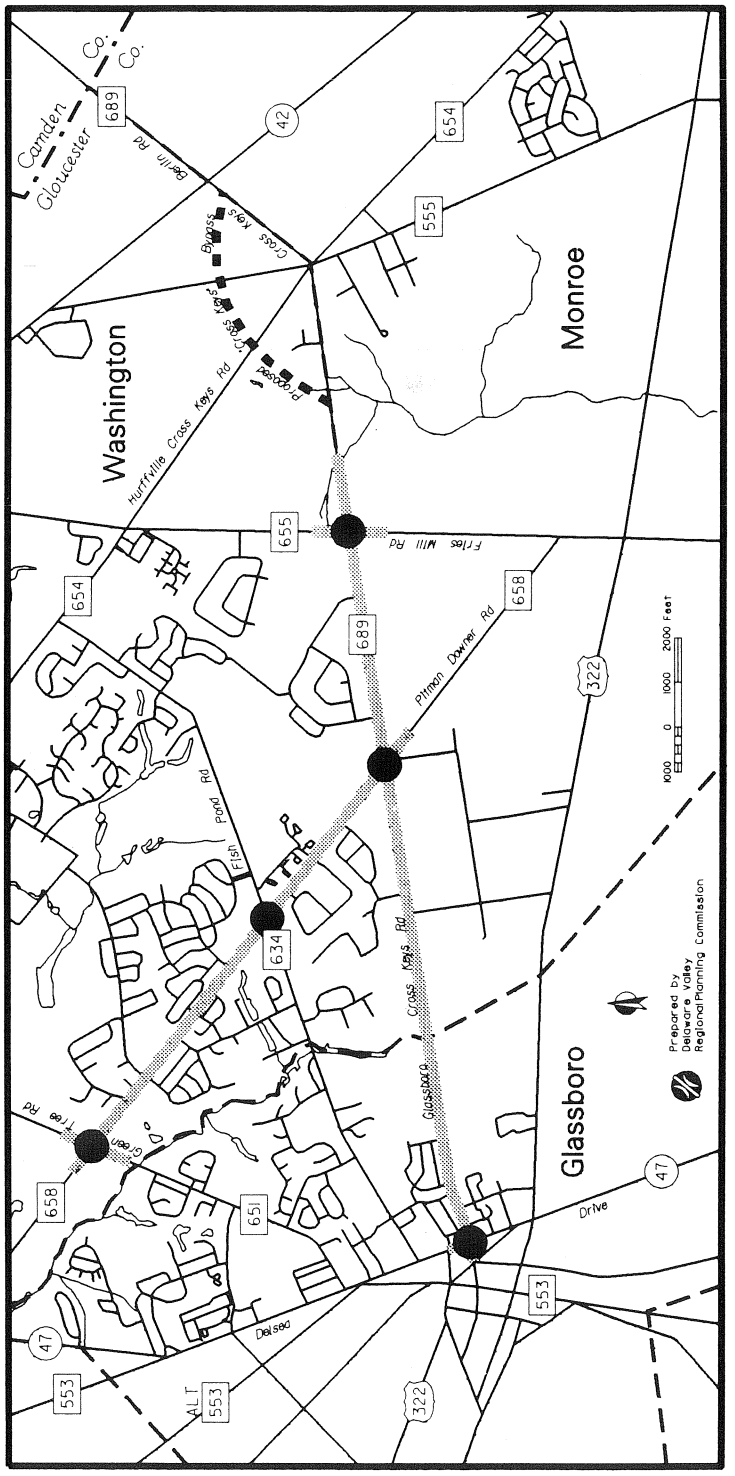
Between Pitman-Downer Road and the Delsea Drive (NJ 47), the land use along Cross Keys Road increases in density. Within the Glassboro segment, a new elementary school is under construction. In the lower density residential areas, the cartway width is 29 feet, with 12 foot travel lanes and two to three foot shoulders on each side. As the link enters the denser areas near NJ 47, travel lane width decreases to 11 feet and the shoulders become four feet in

Figure 1

STUDY AREA LOCATION MAP

Studied Highway Alignment

Studied Intersection



width. The speed limit is reduced to 25 miles per hour in Glassboro. A traffic signal regulates Cross Keys Road's intersection with the Delsea Drive. The land use immediately surrounding the intersection is devoted to commercial activity.

Pitman-Downer Road (CR 658) is classified a collector highway according to the County's functional classification system. The road extends on a north-south axis through Washington and Monroe townships. The adjacent land use is predominantly residential, with a mix of single family and multi-family dwellings. The existing cartway width is variable with noticeably wider cross sections typical along the frontages of the newer subdivisions. Passing is permitted between Cross Keys Road and Fish Pond Road. Passing is prohibited between Fish Pond Road and Greentree Road.

At its intersection with Cross Keys Road, Pitman-Downer Road has a total cartway width of 28 feet, consisting of 12 foot travel lanes and two foot shoulders on each side. The speed limit is posted at 45 miles per hour. The land use is residential on the northeast and southeast corners. An orchard is predominant on the southwest corner and a small industrial concern (Fazzio's Steel Company) is located on the northwest corner of the intersection. Along the remainder of Pitman-Downer Road's segment between Cross Keys Road and Fish Pond Road, land use is composed of single family residential units on the west side, and multi-family dwelling units on the east side.

As Pitman-Downer Road approaches Fish Pond Road (CR 634), the existing cartway becomes 27 feet across, this includes two 12 foot travel lanes and one to two foot paved shoulders. Pitman-Downer Road's approaches to the intersection are controlled by stop signs with a flashing warning device reinforcing the control. The road continues north through the intersection with an 11 foot wide northbound travel lane and a 12 foot travel lane in the southbound direction. The shoulder width becomes three feet on the east side and two feet on the west side of the road. The speed limit continues to be posted at 45 miles per hour. The segment of Pitman-Downer Road between Fish Pond Road and Greentree Road is also residential in nature. Within this segment is located the Orchard Valley Middle School. Posted speed limits are 35 miles per hour at times when children are present. As Pitman-Downer Road approaches Greentree Road (CR 651), the roadway is widened to two lanes by direction in association with traffic signalization improvements at the intersection.

Study Intersections

The five major intersections found within the study area are comprised of state and county highways. The physical and operating conditions present at those intersections are described below:

Cross Keys Road (CR 689) and Delsea Drive (NJ 47) Intersection -
This is a four legged intersection, with New Street being the western extension of Cross Keys Road. The intersection is controlled by a fixed time, two-phase traffic signal. Cross Keys Road and New Street are both about 15 feet wide and carry single lane approaches to the intersection. NJ 47 consists of a 12 feet wide left turn lane and a 13 feet wide shared through/right turn lane on both the northbound and southbound approaches. In the near future NJDOT will update this intersection's traffic signal installation. Elements of the new design include: dual left turn signal phases for the Delsea Drive approaches and traffic actuation.

Cross Keys Road (CR 689) and Pitman-Downer Road (CR 658) Intersection -
All four legs of this oblique angle intersection contain a one lane approaches to accommodate all turning movements. The approach lanes on Cross Keys Road are 12 to 13 feet wide with three foot shoulders. Pitman-Downer Road also has 12 feet wide approach lanes but the shoulders are not as clearly defined. Traffic movement along Cross Keys Road is uninterrupted while the Pitman-Downer approaches are stop sign controlled.

Cross Keys Road (CR 689) and Fries Mill Road (CR 655) Intersection -
This is a four legged intersection serving all traffic movements. Traffic control is afforded by a fully actuated, two-phase traffic signal. Each leg of the intersection consists of two travel lanes, 12 feet in width, entering and departing the intersection. Only on the northern leg of the intersection is the widening maintained at a four lane cross section. On each of the remaining legs, widening is present only within the immediate vicinity of the intersection and the roadway cross section is returned to two lanes approximately 450 feet from the center of the intersection.

Pitman-Downer Road (CR 658) and Fish Pond Road (CR 634) Intersection -
This is a four way, oblique angle intersection with one lane approaches on all legs. All traffic movements are accommodated at the intersection. Each approach and departure lane is 12 feet wide with one to two feet wide shoulders provided. The southbound approach of Pitman-Downer Road has a slight up-grade to the intersection. Fish Pond Road operates as the through street while the Pitman-Downer Road approaches are controlled by stop signs. In addition to the stop sign installation, there is also a flashing beacon at the intersection -- Pitman-Downer Road flashes red while Fish Pond Road flashes yellow.

Pitman-Downer Road (CR 658) and Greentree Road (CR 651) Intersection - This is a four legged intersection serving all traffic movements. Control is provided by a fully actuated, two phase traffic signal. Both highways are generally two lane roads which flare-out to four lanes at the intersection (two lanes approaching and two lanes departing). All approach lanes are 12 feet wide.

Existing Traffic Volumes

DVRPC collected and analyzed existing traffic volumes throughout the Cross Keys Road study area. Three types of traffic data were collected during February and March 1993: 24 hour automatic traffic counts, continuous turning movement traffic counts (conducted between 7:00 a.m. to 6:00 p.m.), and peak period turning movement traffic counts (conducted between 7:00 a.m. to 9:00 a.m., and 4:00 p.m. to 6:00 p.m.).

The raw daily traffic counts were converted into average annual daily traffic volumes (AADTs) using adjustment factors obtained from NJDOT. AADTs represent average daily traffic volumes on a road segment over the course of an entire year.

The existing AADTs are presented in Figure 2. The volumes on Cross Keys Road range from approximately 6,900 vehicles per day in the vicinity of NJ 47 to approximately 8,100 vehicles per day east of Pitman-Downer Road. The volumes on Pitman-Downer Road range from 1,800 vehicles per day south of Cross Keys Road to approximately 7,700 vehicles per day south of Greentree Road.

Manual turning movement counts were conducted at the five study intersections. The signalized intersection counts were conducted during the peak periods. The unsignalized intersection counts were conducted continuously over an 11 hour period for the purpose of conducting traffic signal warrant analyses. Existing peak travel hour traffic volumes are presented in Figure 3, for the A.M. peak hour, and Figure 4, for the P.M. peak hour. Volumes shown on the figures represent each intersection's peak traffic volume tabulated from the four highest consecutive 15-minute intervals occuring between 7:00 a.m. and 9:00 a.m., and 4:00 p.m. and 6:00 p.m..

A brief overview of the peak traffic volumes indicates that P.M. peak hour traffic volumes are typically higher than the A.M. peak volumes and that the signalized intersections serve the most traffic volume. The Cross Keys Road and NJ 47 intersection accommodates the most traffic, the Pitman-Downer and Greentree Road intersection serves the second highest demand and Cross Keys Road and Fries Mill Road carries the third highest traffic levels.

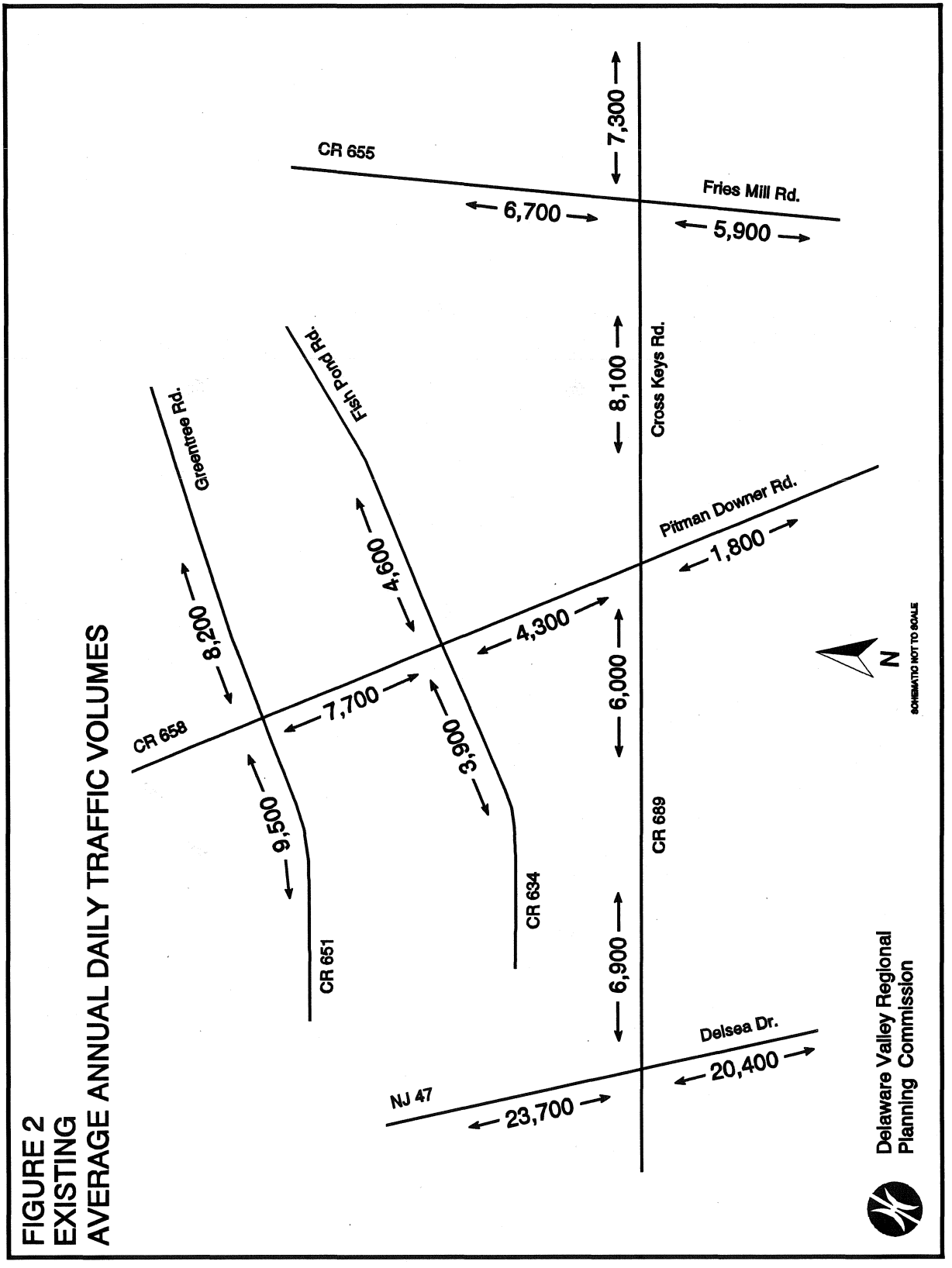


FIGURE 2
EXISTING
AVERAGE ANNUAL DAILY TRAFFIC VOLUMES
CR 655
Fries Mill Rd.
7,300
6,700
5,900
Cross Keys Rd.
8,100
Fish Pond Rd.
Greentree Rd.
4,600
8,200
Pitman Downer Rd.
1,800
4,300
CR 658
7,700
6,000
3,900
9,500
CR 634
CR 689
CR 651
6,900
Delsea Dr.
20,400
NJ 47
23,700
N
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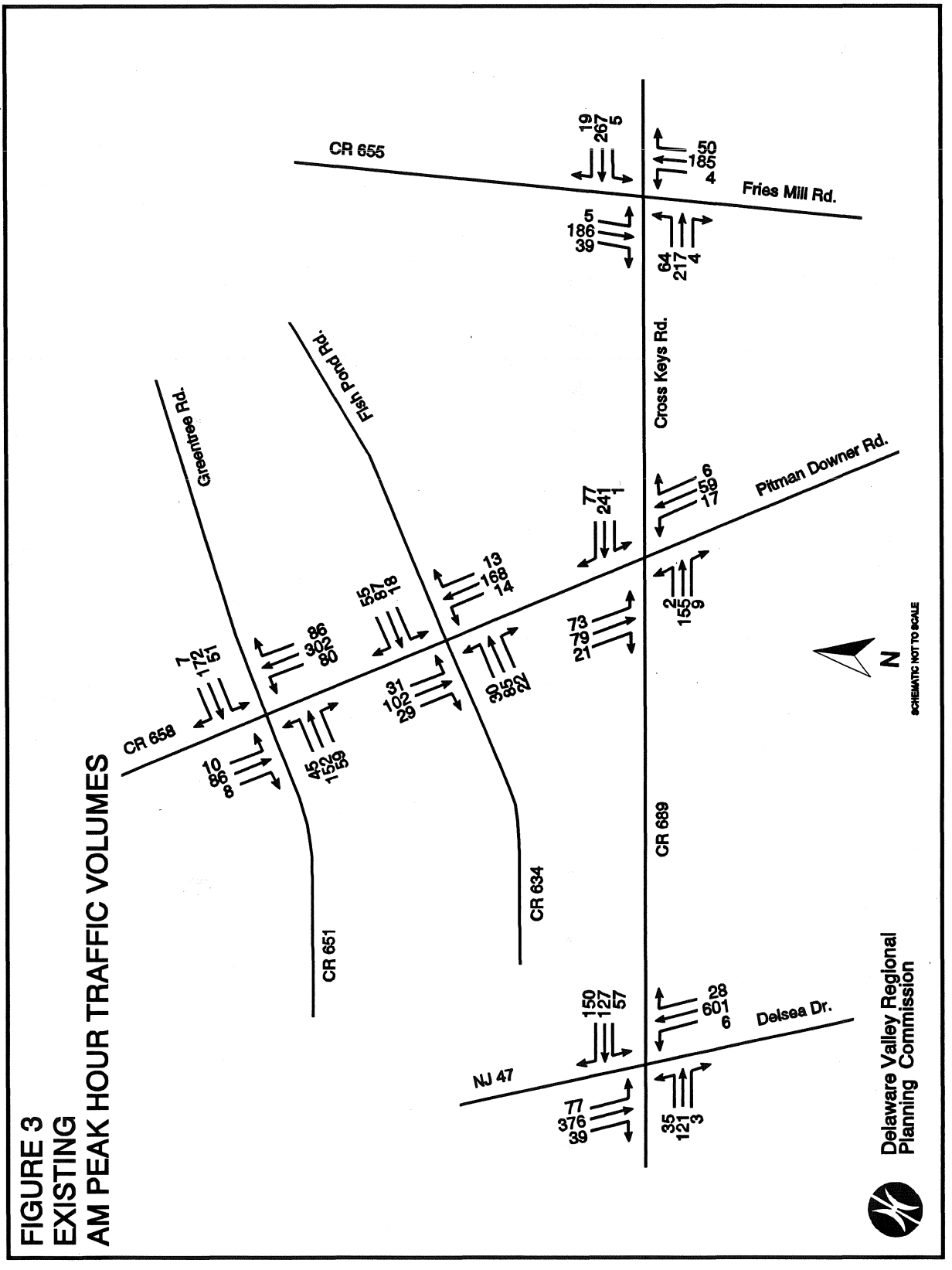
FIGURE 3
EXISTING
AM PEAK HOUR TRAFFIC VOLUMES
CR 655
Fries Mill Rd.
Cross Keys Rd.
Pitman Downer Rd.
Greentree Rd.
Fish Pond Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
N
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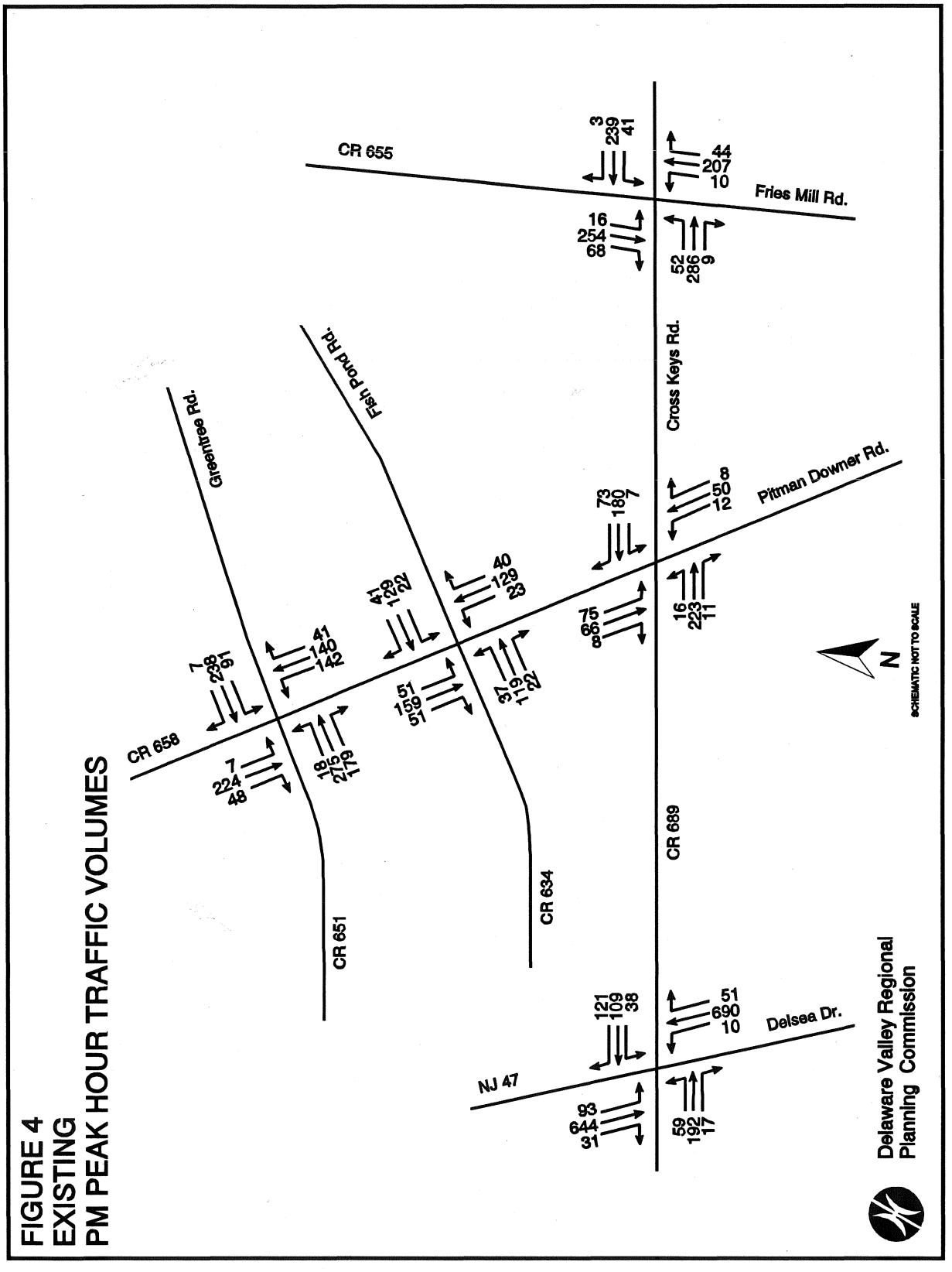

FIGURE 4
EXISTING
PM PEAK HOUR TRAFFIC VOLUMES

Traffic Signal Warrant Analyses

According to New Jersey statues, when evaluating locations for the installation of traffic signals, the Manual on Uniform Traffic Control Devices (MUTCD) must be used. This manual sets forth a series of eleven warrants based on traffic/pedestrian levels, accident histories or combinations thereof that must be met before an intersection is legally eligible for signal installation.

Within the conduct of this study, four warrants were evaluated at the two unsignalized intersections -- Cross Keys Road and Pitman-Downer Road, and Fish Pond Road and Pitman-Downer Road. An analysis of the following warrants was prepared:

Warrant 1	the Minimum Vehicular Volume warrant;
Warrant 2	the Interruption of Continuous Traffic Volume warrant;
Warrant 9	the Four Hour Volume warrant, and;
Warrant 11	the Peak Hour Volume warrant.

Warrant 1 - Minimum Vehicular Volume -

The minimum vehicular volume warrant is intended for application where the volume of intersecting traffic is the primary reason for consideration of signal installation. The warrant is satisfied when, for any eight hours of an average day, the following volume exists at an intersection with one lane approaches: 350 vehicles per hour on the major street (total both approaches) and 105 vehicles per hour on the higher volume minor street approach.

At the Cross Keys Road and Pitman-Downer Road intersection, volumes for five hours surpassed the minimum levels specified. At the Fish Pond Road and Pitman-Downer intersection only one hourly volume exceeded the minimum standard (see Table 1).

TABLE 1: Traffic Signal Warrant Analyses - Warrants 1 and 2 - Existing Conditions

CROSS KEYS ROAD AND PITMAN-DOWNER ROAD INTERSECTION

Time	Major Street (Cross Keys)	Minor Street (Pitman-Downer)	Warrants Met
7:00 - 8:00 AM	459	162	#1
8:00 - 9:00	392	135	#1
9:00 - 10:00	338	95	none
10:00 - 11:00	319	73	none
11:00 - 12:00 PM	309	87	none
12:00 - 1:00	357	91	none
1:00 - 2:00	335	80	none
2:00 - 3:00	367	94	none
3:00 - 4:00	402	126	#1
4:00 - 5:00	510	149	#1
5:00 - 6:00	450	160	#1

FISH POND ROAD AND PITMAN-DOWNER ROAD INTERSECTION

Time	Major Street (Fish Pond)	Minor Street (Pitman-Downer)	Warrants Met
7:00 - 8:00 AM	295	197	none
8:00 - 9:00	243	170	none
9:00 - 10:00	191	128	none
10:00 - 11:00	214	107	none
11:00 - 12:00 PM	242	101	none
12:00 - 1:00	274	129	none
1:00 - 2:00	241	125	none
2:00 - 3:00	269	154	none
3:00 - 4:00	299	210	none
4:00 - 5:00	348	261	none
5:00 - 6:00	369	217	#1

VOLUME REQUIREMENTS

WARRANT 1	350	105
WARRANT 2	525	53

Warrant 2 - Interruption of Continuous Traffic -
The interruption of continuous traffic warrant applies to operating conditions where the traffic volume on a major street is so heavy that traffic on a minor intersecting street may suffer excessive delay or hazard in entering or crossing the major street. The warrant is satisfied when, for any eight hours of an average day, the following volume exists at an intersection with one lane approaches: 525 vehicles per hour on the major road (total both approaches) and 53 vehicles per hour on the higher volume minor street approach.

None of the volumes at either intersection met the minimum requirements for this warrant (see Table 1).

Warrant 9 - Four Hour Volumes -
The four hour volume warrant is satisfied when, for any four hours of an average day, the points that represent the vehicles per hour on both approaches of the major street and the corresponding vehicles per hour on the highest volume minor street approach fall above the curve on the graph in Figures 5 and 6. The curve on the graph represents minimum vehicular volumes that must be met for an intersection with one lane approaches.

The intersection of Cross Keys Road and Pitman-Downer Road has three hours per day when the minimum volume is exceeded (see Figure 5). The Fish Pond Road and Pitman-Downer Road intersection also exceeds the minimum warrant thresholds for three of the four required hours (see Figure 6).

Warrant 11 - Peak Hour Volume -
The peak hour volume warrant is intended for application when traffic conditions are such that for one hour of the day minor street traffic may suffer undo delay in entering or crossing the major street. This warrant is satisfied when, for any hour of an average day, the plotted points representing the vehicles per hour on both approaches of the major street and the corresponding vehicles per hour on the higher volume minor street approach all fall above the curve in Figures 7 and 8. The curve on the graph represents minimum vehicular volumes that must be met for an intersection with one lane approaches.

The volumes for AM and PM peak hours at both intersections fall below the minimum requirements for this warrant as can be seen in Figure 7 for the intersection of Cross Keys Road and Pitman-Downer Road and Figure 8 for the intersection of Fish Pond Road and Pitman-Downer Road.

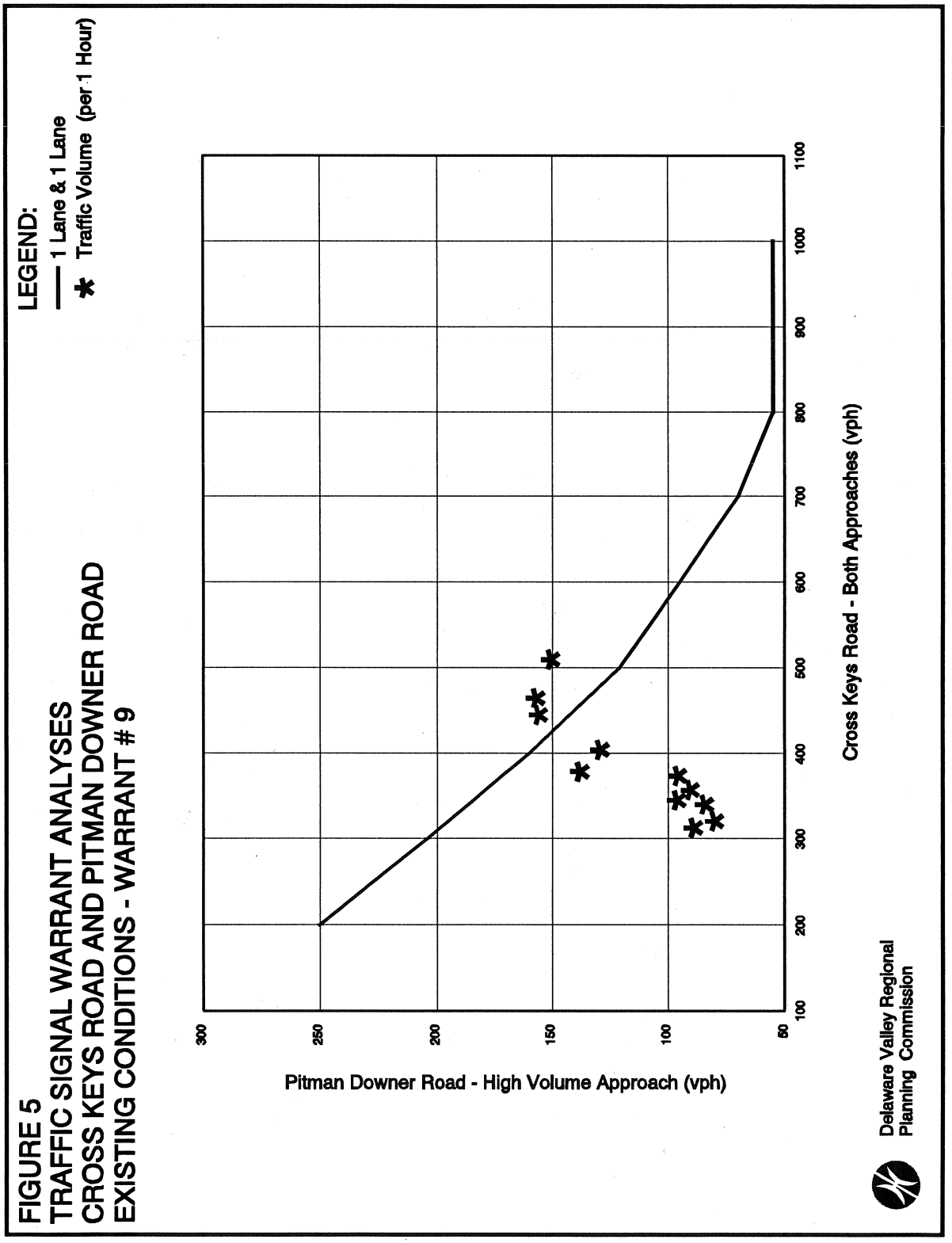
FIGURE 5
TRAFFIC SIGNAL WARRANT ANALYSES
CROSS KEYS ROAD AND PITMAN DOWNER ROAD
EXISTING CONDITIONS - WARRANT # 9
LEGEND:
1 Lane & 1 Lane
Traffic Volume (per 1 Hour)
300
250
200
150
100
50
100
200
300
400
500
600
700
800
900
1000
1100
Pitman Downer Road - High Volume Approach (vph)
Cross Keys Road - Both Approaches (vph)
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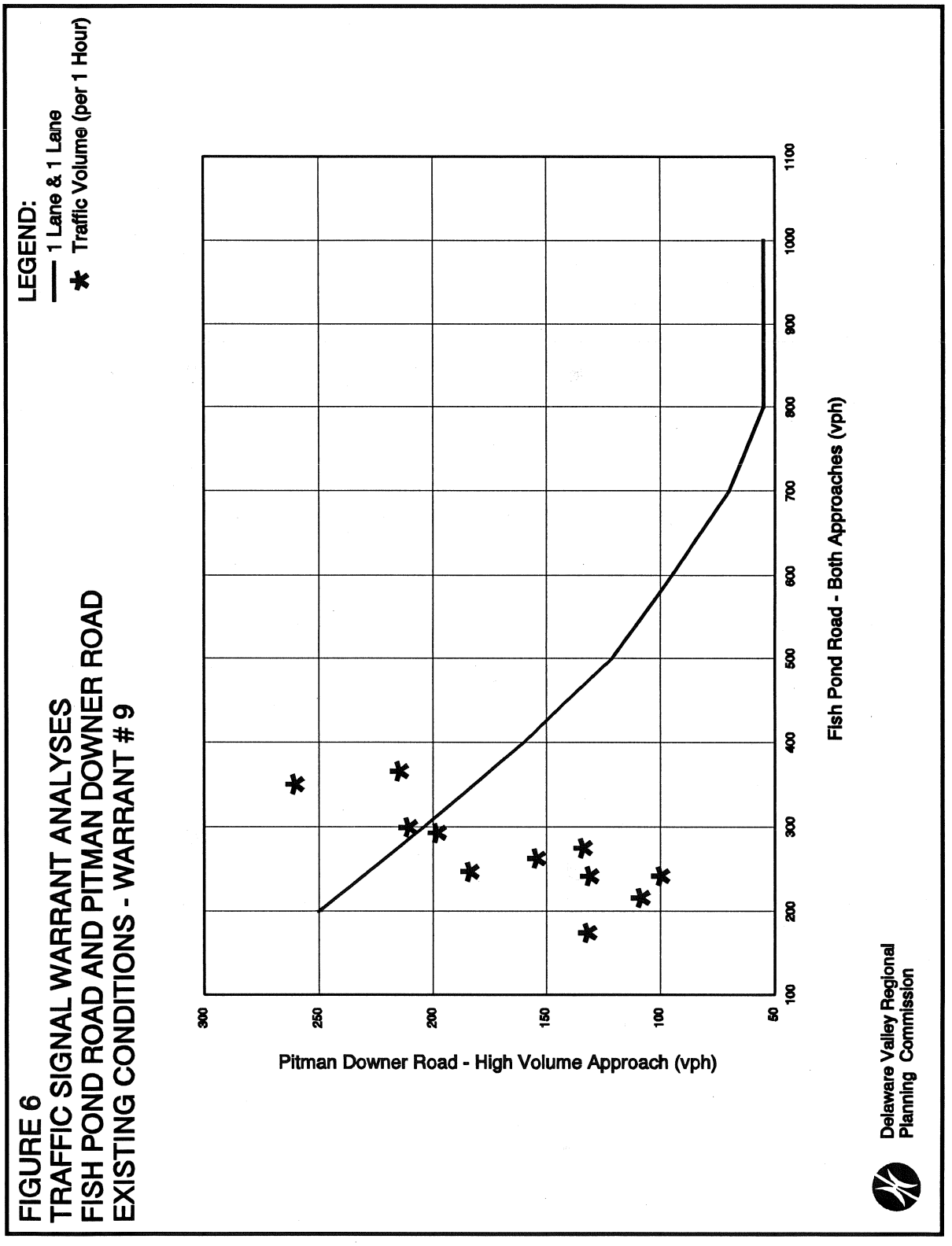
FIGURE 6
TRAFFIC SIGNAL WARRANT ANALYSES
FISH POND ROAD AND PITMAN DOWNER ROAD
EXISTING CONDITIONS - WARRANT # 9
LEGEND:
1 Lane & 1 Lane
Traffic Volume (per 1 Hour)
Pitman Downer Road - High Volume Approach (vph)
300
250
200
150
100
50
Fish Pond Road - Both Approaches (vph)
100
200
300
400
500
600
700
800
900
1000
1100
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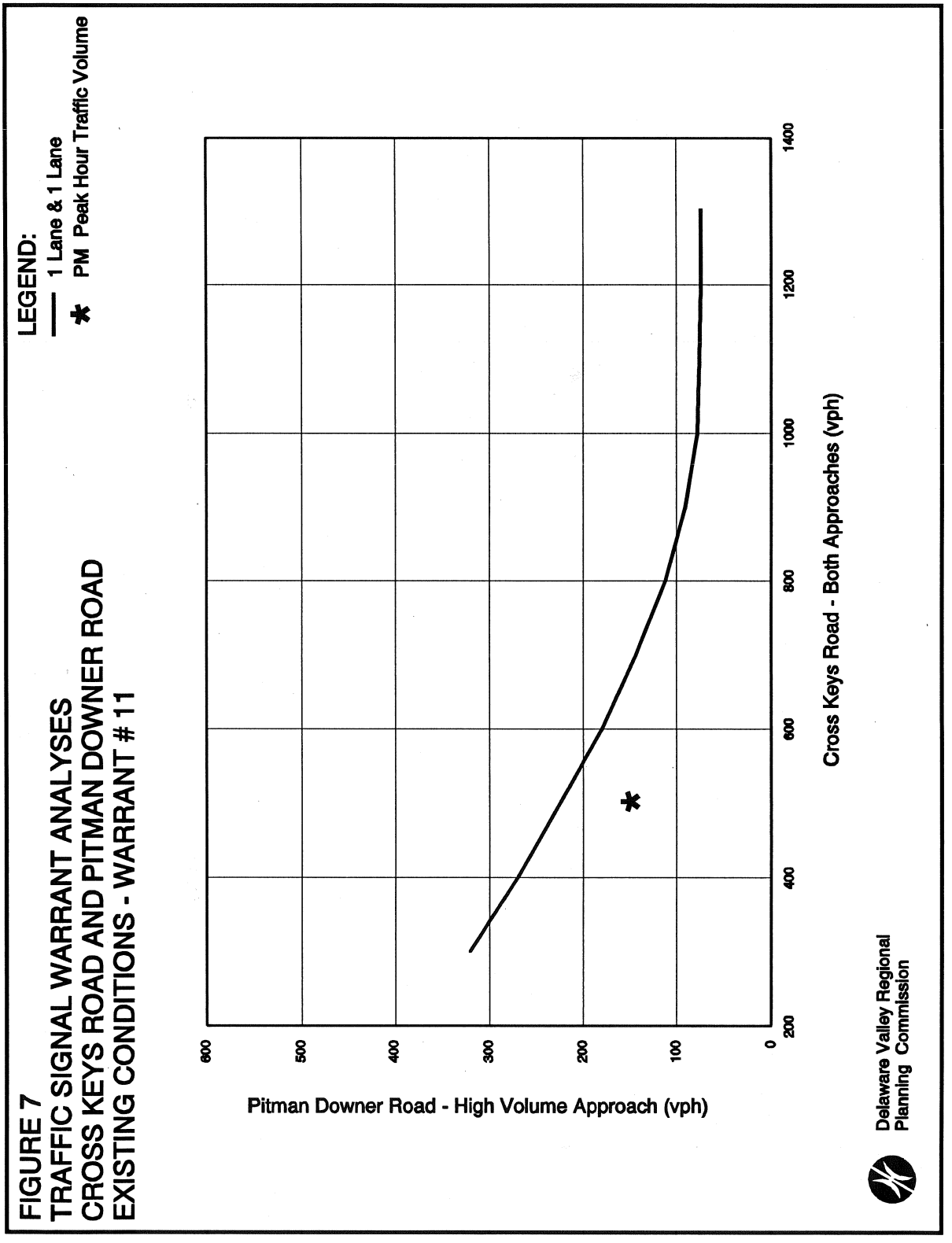
FIGURE 7
TRAFFIC SIGNAL WARRANT ANALYSES
CROSS KEYS ROAD AND PITMAN DOWNER ROAD
EXISTING CONDITIONS - WARRANT # 11
LEGEND:
1 Lane & 1 Lane
PM Peak Hour Traffic Volume
600
500
400
300
200
100
0
200
400
600
800
1000
1200
1400
Pitman Downer Road - High Volume Approach (vph)
Cross Keys Road - Both Approaches (vph)
Delaware Valley Regional
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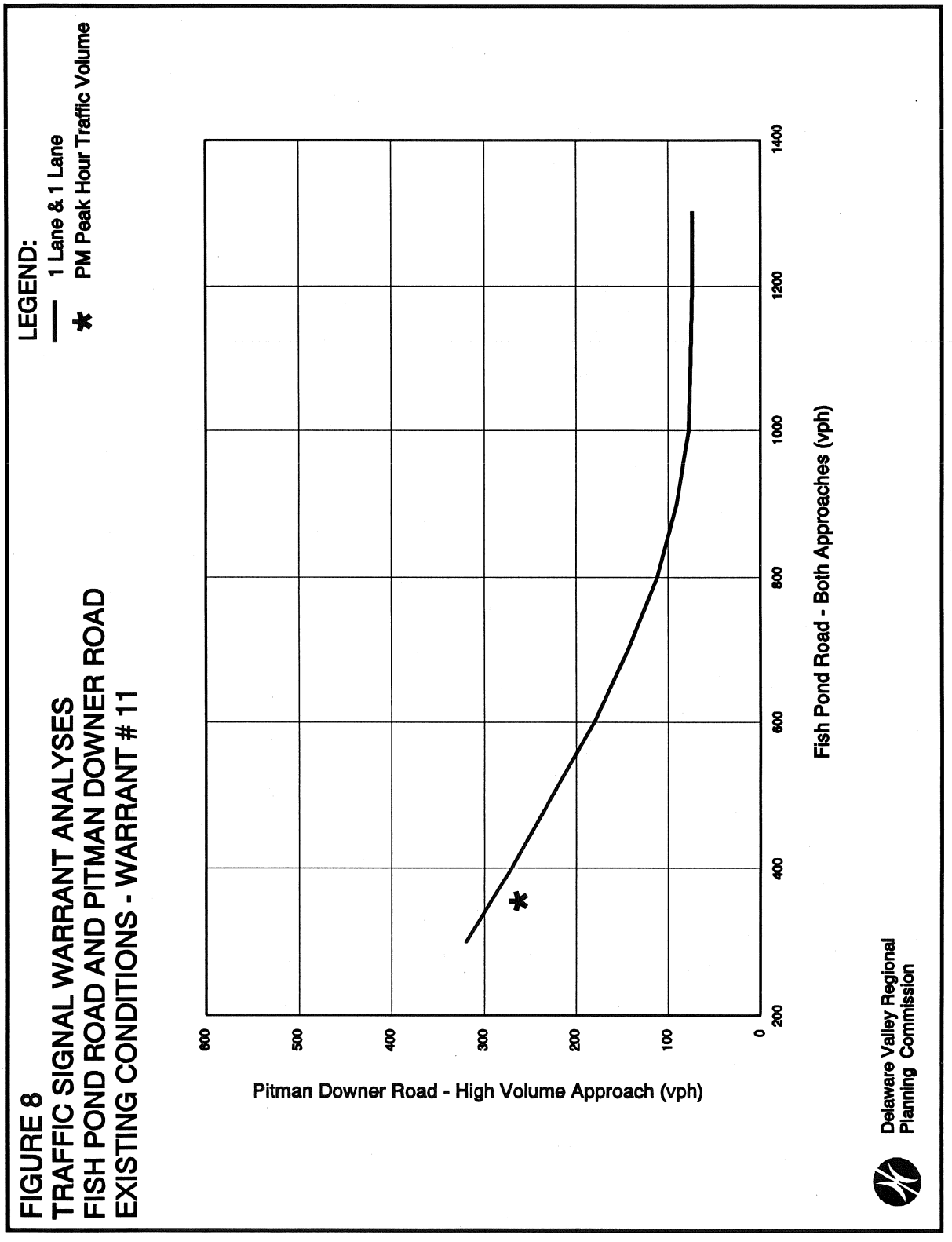


FIGURE 8
TRAFFIC SIGNAL WARRANT ANALYSES
FISH POND ROAD AND PITMAN DOWNER ROAD
EXISTING CONDITIONS - WARRANT # 11
LEGEND:
1 Lane & 1 Lane
PM Peak Hour Traffic Volume
600
500
400
300
200
100
0
200
400
600
800
1000
1200
1400
Pitman Downer Road - High Volume Approach (vph)
Fish Pond Road - Both Approaches (vph)
Delaware Valley Regional
Planning Commission

In summary of the traffic signal warrant analyses, the intersections of Cross Keys Road and Pitman-Downer Road, and Fish Pond Road and Pitman-Downer Road do not presently meet the minimum traffic volume requirements necessary to justify the installation of a traffic signal.

Existing Level of Traffic Service

Level of service analysis is a procedure which relates traffic operations to motorist's perception of same in terms of -- speed, travel time, traffic interruptions, freedom to maneuver, comfort, and convenience. Level of service analyses were performed at key intersections and roadway segments within the study area given existing peak hour traffic volumes and existing conditions of roadway and intersection geometry and control. The analyses were performed using the methodology and procedures of the Highway Capacity Manual (Special Report 209, Transportation Research Board, Washington, D.C., 1985). It should be noted that since the various system components (e.g., intersections -- signalized or stop sign controlled, and roadway -- two lane or multilane, etc.) are measured differently, the letter designations for level of service are not necessarily comparable to one another for different facilities.

At intersections, level of service reflects the freedom to maneuver through conflicting traffic volumes and/or the ability to clear a traffic signal. Level of service at signalized intersections is measured in terms of average stopped delays encountered by vehicles traversing the intersection. Delays in these cases are influenced by the length of the signal cycle, the amount of green time apportionned to an approach as well as the vehicular demand on the approach. Table 2 gives a description of each level of service and its delay range. It is important to note that delay (i.e., level of service) is not related to capacity in a direct manner. Thus, the designation of level of service F does not automatically imply the approach is overloaded. Long cycle length and/or poor progression through adjacent traffic signals can also result in excessive delays.

Level of service analyses were completed for the study area's three signalized intersections. All three intersections operate at an acceptable level of service in both peak travel hours. The results are illustrated on Figure 9. A summary of the findings, on an intersection-by-intersection basis, follows.

TABLE 2: Level of Service Criteria - Signalized Intersections

LEVEL OF SERVICE A - Very low delay, good progression; most vehicles do not stop at intersection. Average stopped delays equal 5.0 seconds or less per vehicle.

LEVEL OF SERVICE B - Generally good signal progression and/or short cycle length; more vehicles stop at intersection than level of service 'A'. The average stopped delay range is between 5.1 to 15.0 seconds per vehicle.

LEVEL OF SERVICE C - Fair progression and/or longer cycle length; significant number of vehicles stop at intersection. The delay range averages 15.1 to 25.0 seconds per vehicle.

LEVEL OF SERVICE D - Congestion becomes noticeable, many vehicles stop at signal, individual cycle failures. Longer delays from unfavorable progression and longer cycle lengths. Delay range is between 25.1 to 40.0 seconds per vehicle.

LEVEL OF SERVICE E - Considered limit of acceptable delay, indicative of poor progression, long cycle lengths. Frequent individual cycle failures. Delay range equals 40.1 to 60.0 seconds per vehicle.

LEVEL OF SERVICE F - Unacceptable delay, indication of oversaturation (i.e., arrival flow exceeds capacity). Average delay exceeds 60.0 seconds per vehicle.

Source: Highway Capacity Manual, Transportation Research Board, Special Report 209, 1985

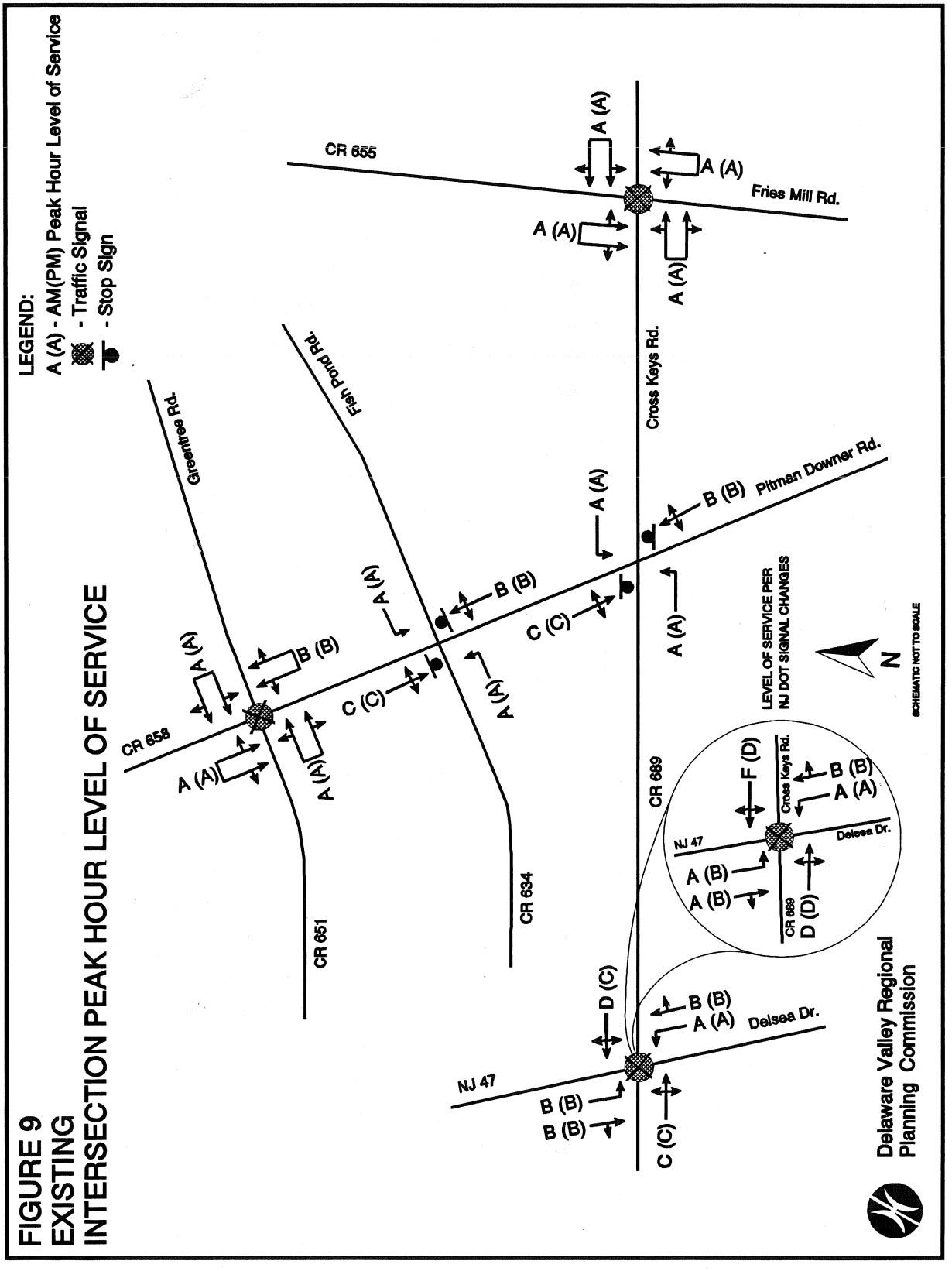


FIGURE 9
EXISTING
INTERSECTION PEAK HOUR LEVEL OF SERVICE
LEGEND:
A (A) - AM(PM) Peak Hour Level of Service
- Traffic Signal
- Stop Sign
CR 655
Fries Mill Rd.
Cross Keys Rd.
Greentree Rd.
Fish Pond Rd.
Pitman Downer Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
LEVEL OF SERVICE PER
NJ DOT SIGNAL CHANGES
SCHEMATIC NOT TO SCALE
N
Delaware Valley Regional
Planning Commission

Cross Keys Road and Delsea Drive Intersection -
This intersection operates reasonably well in both peak periods. All approaches operate at level of service D or better in the A.M. peak and level of service C or better in the P.M. peak hour. Overall the intersection provides level B conditions in both the A.M. and P.M. peaks. Observations of actual traffic operations during the course of the traffic counts generally support the findings of the level of service analyses. One notation should be made -- from time to time traffic backups emanating from the adjacent NJ 47 and US 322 WEST intersection reached Cross Keys Road limiting the ability of the Cross Keys Road intersection to process traffic. On-site observations indicate the lack of a functioning interconnect between the two signalized intersections.

It should also be noted that NJDOT is proposing to update the intersection's traffic signal design in the near future, including actuated and interconnected operation with exclusive left-turn signal phases on the Delsea Drive approaches. The specific nature of the changes will alter the timing at the intersection and as a consequence traffic operating conditions. The inset on Figure 9 displays the expected results of the impending change. Overall intersection traffic operating conditions are estimated to drop to level of service C during the peak travel hours. Similarly, individual traffic movements will change most substantially on the Cross Keys Road approaches. As shown on the inset on Figure 9, a level of service F will result on the westbound Cross Keys Road approach in the A.M. peak hour.

A desireable complement to the signal change would be the provision of separate right-turn lanes on the eastbound approach and (particularly) on the westbound approach. This improvement would make more efficient use of available green time at the intersection and would yield level C or better conditions on the side street approaches during both peaks.

Cross Keys Road and Fries Mill Road Intersection -
The overall intersection operates at level of service A in both the AM and PM peak hours. Similiarly individual traffic movements throughout the intersection operate at level A.

Pitman-Downer Road and Greentree Road Intersection -
The overall intersection operates at level of service A during both peak hours. Only the northbound approach operates at level B. All others operate at level of service A.

Level of service criteria for unsignalized intersections (e.g., stop sign controlled side streets approaching uninterrupted major highway segments) are measured in terms of reserve capacity. Reserve capacity is related to qualitative delay ranges (see Table 3).

The analysis focuses on minor street traffic approaching a stop or yield sign and left-turns from the major street. The potential capacity of the critical traffic movement is based upon two factors: 1) distribution of gaps in the cross traffic stream, and; 2) driver judgement in selecting gaps through which to execute the desired maneuvers. Reserve capacity represents the difference between the approach volume and potential capacity.

Level of service analyses were prepared given existing conditions of peak volume, geometry and control at the two unsignalized study intersections. Immediately following is a summary of the findings of that analysis. The results of the unsignalized intersection analyses are also illustrated on Figure 9.

Cross Keys Road and Pitman-Downer Road Intersection -
Both Pitman-Downer Road approaches, which are controlled by stop signs, operate satisfactorily in both peak hours (level of service C or better). Left turns from Cross Keys Road operate at level of service A.

Pitman-Downer Road and Fish Pond Road Intersection -
Both Pitman-Downer Road approaches, which are controlled by stop signs, operate satisfactorily in both peak hours (level C or better). Left turns from Fish Pond Road operate at LOS A.

For roadway segments, assuming uninterrupted flow conditions, levels of service relate to the driver's ability to choose travel speed and/or to pass slower vehicles. Two lane highways operate under uninterrupted flow conditions when the distance between traffic signals or stop signs exceeds two miles. (When the roadway segment is less than two miles in length, generally the intersection where flow is interrupted, is the primary determinant of level of service.) When uninterrupted flow conditions occur, the level of service for a two lane highway is measured in terms of average travel speed or the volume to capacity ratio (v/c ratio). The capacity of a highway is a function of a number of factors including: lane and shoulder widths, percentage of "no passing zones", truck percentage, directional split in traffic flow, and roadway grade. A subjective description of each level of service is given in Table 4. It is important to note that because of the complex relationship between travel speed, percent "no passing zones", roadway grade and level of service, it is not possible to simply list a v/c ratio for each level of service. Service flows at each service level are expressed for ideal conditions. Any deviation from these conditions (for example a lane width of less than 12 feet) will reduce the service flow volume.

TABLE 3: Level of Service Criteria - Unsignalized Intersections

LEVEL OF SERVICE A - Little or no delay. Reserve capacities equal 4000 or more passenger cars per hour.

LEVEL OF SERVICE B - Short traffic delays. Reserve capacities between 300 to 399 passenger cars per hour.

LEVEL OF SERVICE C - Average traffic delays. Reserve capacities between 200 to 299 passenger cars per hour.

LEVEL OF SERVICE D - Long traffic delays. Reserve capacities between 100 to 199 passenger cars per hour.

LEVEL OF SERVICE E - Very long traffic delays. Reserve capacities between 0 and 99 passenger cars per hour.

LEVEL OF SERVICE F - Extreme traffic delays. Reserve capacities less than 0. When demand volume exceeds the capacity of the lane queuing may result causing congestion and affecting other traffic movements in the intersection.

Source: Highway Capacity Manual, Transportation Research Board, Special Report 209, 1985

TABLE 4: Level of Service Criteria - Two Lane Highways

LEVEL OF SERVICE A - Average speeds at or above speed limit. Passing demand is well below passing capacity; almost no platoons of three or more vehicles are observed. A maximum flow rate of 420 vehicles per hour, total in both directions, may be achieved under ideal conditions.

LEVEL OF SERVICE B - In order to maintain desired speeds, the demand for passing becomes significant and approximately equals passing capacity at the lower boundary of LOS 'B'. The number of platoons forming in the traffic stream begins to increase dramatically. Service flow rates of 750 vehicles per hour, total in both directions, can be achieved under ideal conditions.

LEVEL OF SERVICE C - Noticeable increase in platoon formation, platoon size, and frequency of passing impediment. At higher volume levels, chaining of platoons and significant reductions in passing capacity begin to occur. While traffic flow is stable, it is becoming susceptible to congestion due to turning traffic and slow-moving vehicles. A service flow rate of up to 1,200 vehicles per hour, total in both directions, can be accommodated under ideal conditions.

LEVEL OF SERVICE D - Unstable flow is approached, passing becomes extremely difficult as a consequence of increasing traffic volume. The availability of passing areas within the segment has little influence on passing. Turning vehicles and/or roadside distractions cause major shock waves in the traffic stream. This is the highest flow rate that can be maintained for any length of time without a high probability of a breakdown. A service flow rate of up to 1,800 vehicles per hour, total in both directions, can be accommodated under ideal conditions.

LEVEL OF SERVICE E - Passing is virtually impossible and platooning becomes intense when slower vehicles or other interruptions are encountered. The highest volume attainable under LOS 'E' is by definition the capacity of the highway. Under ideal conditions, capacity is 2,800 vehicles per hour total in both directions. For other conditions, capacity is lower.

LEVEL OF SERVICE F - Represents heavily congested flow with traffic demand exceeding capacity. Frequently, perturbations in traffic flow as level 'E' is approached cause a rapid transition to level of service 'F'.

Source: Highway Capacity Manual, Transportation Research Board, Special Report 209, 1985

A level of service analysis for two lane highways was conducted on eight links within the study area highway network. The results of this analysis, illustrated on Figure 10 and summarized below, indicate that generally acceptable operating conditions exist along all of the study highways.

Cross Keys Road -
Two lane, two-way flow conditions are generally at level C during the A.M. peak travel hour and level of service D during the P.M. peak between the east leg of the Fries Mill Road intersection and NJ 47.

Pitman-Downer Road -
Two lane, two-way flow conditions during the peak travel hours are level of service C between Cross Keys Road and Fish Pond Road and on the leg on the north side of Greentree Road. Between Fish Pond and Greentree Roads roadway operating conditions are at level of service D.

Greentree Road -
Uninterrupted flow conditions along the eastern leg of the Pitman-Downer intersection are LOS C during the morning and evening peak travel hours. On the western leg of the same intersection, LOS C conditions exist during the A.M. peak and LOS D conditions exist during the P.M. peak.

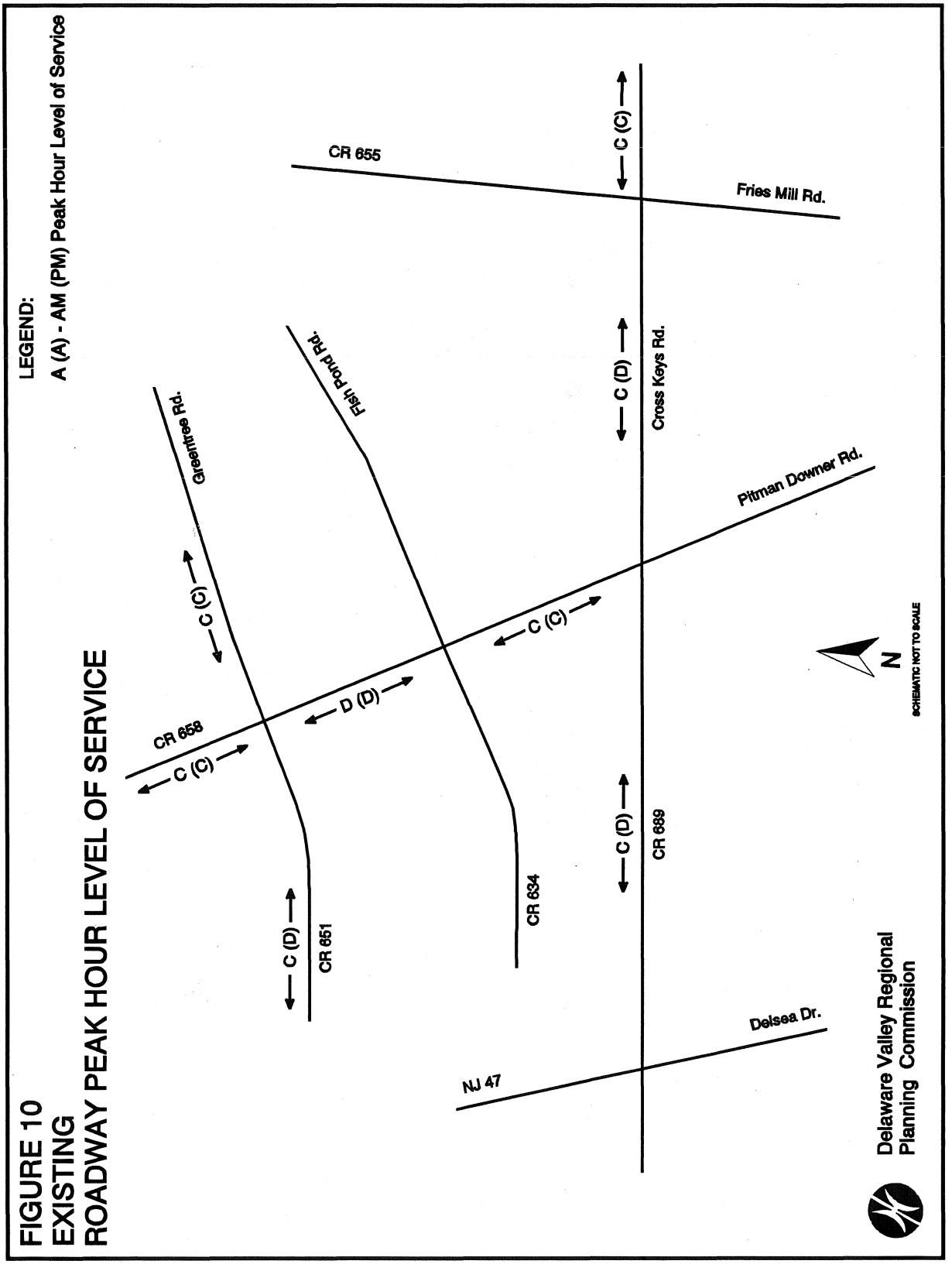


FIGURE 10
EXISTING
ROADWAY PEAK HOUR LEVEL OF SERVICE
LEGEND:
A (A) - AM (PM) Peak Hour Level of Service
CR 655
Fries Mill Rd.
C (C)
C (D)
Cross Keys Rd.
Greentree Rd.
Fish Pond Rd.
Pitman Downer Rd.
C (C)
D (D)
CR 658
C (C)
C (D)
CR 651
CR 634
C (D)
CR 689
Delsea Dr.
NJ 47
N
SCHEMATIC NOT TO SCALE
Delaware Valley Regional
Planning Commission

IV. FUTURE TRAFFIC CONDITIONS

In order to estimate the transportation needs of the study area in the design year (year 2013), the following steps were taken. First, future traffic demands were carefully estimated. This process included estimating volume associated with identifiable developments within the study area and background traffic growth resulting from ongoing regional development from outside the study limits. Second, sensitivity analyses were performed to identify the network necessary to serve projected traffic demands.

Future Land Development

Projected land development expected to occupy the general area surrounding the study highway network was identified by Gloucester County and DVRPC staff through a series of meetings held with personnel from the Borough of Glassboro, Washington Township and Monroe Township. Descriptions and locations of likely developments were based upon the local's knowledge of pending or imminent development applications and land use plans/zoning allowances within the individual jurisdiction.

From those meetings a total of 32 developments, including: one elementary school; 2,566 residential units; 1,183,000 square feet of office space; 711,000 square feet of light industrial/warehouse space, and; 980,000 square feet of retail space were identified to be likely candidates within the study's planning horizon. Figure 11 displays the general location of each development. (A description of each development is shown on Table 5 which is presented and more fully described in the following section).

Future Traffic Volumes

Estimates of future peak hour traffic volume were prepared to assess traffic conditions within the corridor for a study horizon of 20 years. Two components of new future traffic volume were estimated: background growth applied to through traffic, and study area development oriented traffic.

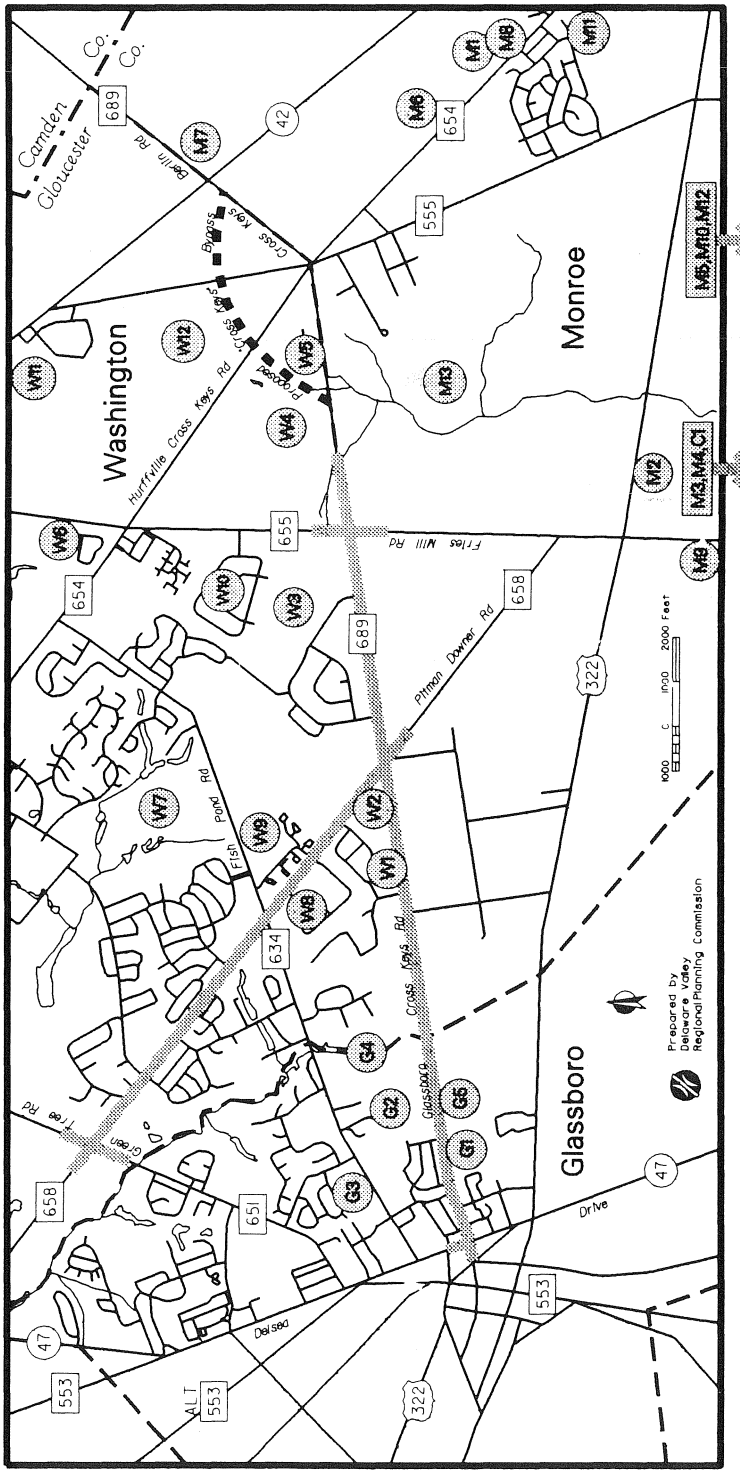
Background traffic growth occurs as a consequence of ongoing regional development. Based upon projected changes in population and employment between 1990 and the year 2020, for this portion of the region, it is estimated that through travel within the immediate area will increase at 1.37 percent per year. Therefore existing through peak hour traffic volumes were factored upward by 31 percent to account for area-wide traffic growth anticipated through the year 2013.

Figure 11

STUDY AREA LAND DEVELOPMENT

W8 Approximate Location of Proposed / Potential Development Site (see Table 5 for development descriptions)

Studied Highway Alignment



Development expected to take place within the corridor will also generate new travel demand upon the study area highways. Descriptions of pending or anticipated development applications, were provided by township and borough personnel expressly for the conduct of this study. Estimates of associated vehicular trip activity were formulated by applying trip generation rates and/or formulas (obtained primarily from: Trip Generation, 5th edition, Institute of Transportation Engineers, January 1991) to the future development scenario described by the local officials. Table 5 summarizes the trip generation. It should be noted that the trips shown in Table 5 are the volume of new trips[1] expected to be added to the surrounding roadways between now and the year 2013.

As a summary of Table 5, it is estimated that 84,530 total new vehicular trips will be added throughout the study corridor over the course of a typical weekday. During the A.M. peak hour 5,629 total trips are anticipated to be drawn to/from the study area. In the P.M. peak travel hour, when the strongest effects of retail shopping traffic are felt, 8,059 new vehicular trips will be generated within the study area.

The directional distribution of development traffic was determined giving due consideration to: traffic data obtained from other traffic studies performed within the general study area; the patterns of existing peak hour traffic volume, and; the dispersion of employment and population anticipated in twenty years. Immediately following is a summary of the directional distribution of development traffic volume used in the analysis.

	to/from the:			
	North	East	South	West
Residential	45%	20%	15%	20%
Retail (new)	50%	10%	25%	15%
Office/Industrial	40%	25%	15%	20%

[2] Trips have been generated for only those portions of ongoing developments which are not presently constructed or occupied. Only new trips generated to/from retail developments which would impact surrounding public roadway systems are included (passby trips -- which will have their highest impact at proposed driveway locations are assumed to come from the volume of traffic which will be on surrounding roadways by 2013). Trips emanating to/from developments which contain complementary uses have been discounted for the trip internalization effects of multi-use sites.

TABLE 5: New Trips Generated by Future Development within Cross Keys Road Study Corridor

Map Code	Development Description (ITE Code)	Average Weekday TOTAL	AM Peak Hour IN	AM Peak Hour OUT	AM Peak Hour TOTAL	PM Peak Hour IN	PM Peak Hour OUT	PM Peak Hour TOTAL
BOROUGH OF GLASSBORO								
G1	ELEMENTARY SCHOOL: 87,700 square feet (520)	940	144	96	240	9	14	23
G2	ROLLING GREENS: 179 Single Family (210)	1,760	35	99	134	119	64	183
G3	HARPER'S ORCHARD: 34 Single Family (210)	380	8	24	32	27	14	41
G4	OBERST LAKE: 75 Single Family (210) {see also Washington Twp}	770	15	45	60	52	29	81
G5	UNDEVELOPED TRACT: 90 Single Family (210)	940	19	55	74	64	34	98
Sbttl	**GLASSBORO**	**4,790**	**221**	**319**	**540**	**271**	**155**	**426**
WASHINGTON TOWNSHIP								
G4	OBERST LAKE: 27 Single Family (210) {see also Glassboro}	280	6	16	22	19	10	29
W1	BONNAIRE: 110 Single Family (210) {34 units remaining},	370	8	21	29	25	14	39
	Shopping Center -- 185,000 square feet (820) {35% passby traffic}	6,750	96	56	152	316	316	632
W2	FAZZIO STEEL EXPANSION: 11,000 square feet (120)	40	9	1	10	6	12	18
W3	ORCHARDVIEW: 93 Single Family (210) {74 units remaining}	780	16	45	61	53	28	81
W4	ACKERMAN TRACT: 178 Single Family (210)	1,760	35	98	133	118	64	182
W5	WHISPERING OAKS: 17 Single Family (210)	200	5	12	17	14	8	22

TABLE 5: New Trips Generated by Future Development within Cross Keys Road Study Corridor

Map Code	Development Description (ITE Code)	Average Weekday TOTAL	AM Peak Hour IN	AM Peak Hour OUT	AM Peak Hour TOTAL	PM Peak Hour IN	PM Peak Hour OUT	PM Peak Hour TOTAL
W6	OFFICE COMPLEX: 8,000 square feet (710)	210	24	3	27	5	24	29
W7	FRED SMITH TRACT: 149 Single Family (210)	1,490	30	84	114	101	54	155
W8	PLUMTREE: 54 Single Family (210) {27 units remaining}	300	6	18	24	20	11	31
W9	CUTLER TRACT: 31 Single Family (210)	350	8	21	29	24	14	38
W10	DEAUX MARE: 116 Single Family (210) {22 units remaining}	260	5	15	20	18	9	27
W11	RETAIL DEVELOPMENT: Sam's Club -- 150,000 square feet (source: NJDOT data)	6,450	66	34	100	275	275	550
W12	AMERICAN CONTINENTAL PROPERTIES: Office Space -- 875,000 square feet (710), Shopping Center -- 375,000 square feet (820)	7,230	892	113	1,005	156	648	804
	{28% passby traffic}	10,480	161	94	255	549	549	1,098
					-- NOTE: trips reduced to account for interaction between uses --			
Sbttl	**WASHINGTON TWP**	**36,950**	**1,367**	**631**	**1,998**	**1,699**	**2,036**	**3,735**
MONROE TOWNSHIP								
M1	FOX HOLLOW II: 80 Townhouses (230)	540	7	36	43	34	18	52
M2	HUNTERS WOODS: 395 Single Family (210)	3,660	69	196	265	242	131	373
M3	TALL OAKS: 126 Single Family (210)	1,280	26	73	99	86	47	133

TABLE 5: New Trips Generated by Future Development within Cross Keys Road Study Corridor

Map Code	Development Description (ITE Code)	Average Weekday TOTAL	AM Peak Hour IN	AM Peak Hour OUT	AM Peak Hour TOTAL	PM Peak Hour IN	PM Peak Hour OUT	PM Peak Hour TOTAL
M4	DESCHLER FARMS: 136 Single Family (210) {see also C1}	1,270	24	69	93	84	45	129
M5	SAGEWOOD ESTATES: 132 Single Family (210)	1,330	27	76	103	90	49	139
M6	THE CLOISTERS: 90 Townhouses (230)	600	8	39	47	38	19	57
M7	K-MART/BUILDER'S SQUARE: K-Mart, 135,000 square feet (815) Builder's Square, 135,000 square feet (812) Total	13,590	237	117	354	452	452	904
M8	MONROE TWP. INVESTMENT GRP.: 107 Townhouses (230)	690	9	45	54	44	22	66
M9	DUCK POND ACRES: 39 Single Family (210)	430	10	26	36	30	16	46
M10	ADDISON BRADLEY: 20 Single Family (210)	230	5	15	20	16	9	25
M11	UNNAMED RESIDENTIAL DEVELOPMENT: 19 Single Family (210)	220	5	14	19	16	8	24
M12	SIGMUND SOMMER: 265 Single Family (210)	2,530	49	139	188	169	91	260
M13	MONROE TWP. PLANNED BUSINESS PARK: 1,000,000 square feet (770), {typically -- 20%-30% office/commercial 70%-80% light industry/warehouse}	14,370	1,377	243	1,620	326	1,154	1,480
Sbttl	**MONROE TWP**	**40,740**	**1,853**	**1,088**	**2,941**	**1,627**	**2,061**	**3,688**

TABLE 5: New Trips Generated by Future Development within Cross Keys Road Study Corridor

Map Code	Development Description (ITE Code)	Average Weekday TOTAL	AM Peak Hour IN	AM Peak Hour OUT	AM Peak Hour TOTAL	PM Peak Hour IN	PM Peak Hour OUT	PM Peak Hour TOTAL
CLAYTON BOROUGH								
C1	DESCHLER FARMS: 220 Single Family (210) {see also M4}	**2,050**	**39**	**111**	**150**	**137**	**73**	**210**
GRANDTOTAL								
	CROSS KEYS ROAD CORRIDOR	**84,530**	**3,480**	**2,149**	**5,629**	**3,734**	**4,325**	**8,059**

The routes that development traffic will travel to access the respective development will depend upon: the location of the development site; the network of roadways serving the site and the quantity and quality of the transportation network serving the study area.

The locations of the developments were determined through meetings with township personnel as was already described. It has been assumed for the purposes of this study that vehicular access would take place via the immediately surrounding highway(s) to each development site. Vehicle circulation to/from the corridor on the east will be enhanced as a result of the provision of the Cross Keys Bypass and Cross Keys Road's widened cross section into Camden County. Lastly, no interchange between the Atlantic City Expressway and Cross Keys Road has been assumed in this study. While Gloucester and Camden counties are actively pursuing and expect to realize this improvement, it is expected that the interchange would provide its greatest benefits at the extreme eastern limits of the study corridor and within Winslow and Gloucester townships in Camden County. As such the interchange improvement poses no significant changes to the projections, analyses and findings of this study.

The traffic assignment process follows the trip generation and trip distribution steps. As part of that process the development traffic is "loaded" onto the study highway network guided by the distribution percentages (trip assignment = trip generation x trip distribution). Total future peak hour traffic volumes were then calculated by summing existing peak hour traffic volumes plus background traffic growth peak hour volumes plus peak hour traffic assignments oriented to/from the 32 developments listed in Table 5.

Three total future peak hour traffic volume scenarios were prepared for complete traffic analysis[2]. Each future scenario assumes differing levels of improvement to the study area roadway and intersection system. In response, traffic demand varies in its ability to "fit" within the network. The process was iterative and has in its basis -- capacity analyses of existing and future traffic volumes, as well as consideration of feasible alternate travel routes within the enlarged study area. Descriptions of the three future traffic volume scenarios are presented below.

SCENARIO I - DO NOTHING ALTERNATIVE :

A capacity restrained assignment which assumes no changes to the study area roadway geometry or methods of intersection control (excluding the NJDOT

[3] A fourth traffic volume scenario was also prepared which estimates future volume on the study area highways resulting from all future developments except development #M13 in Table 5. This scenario, entitled the "Probable Build" scenario, is more fully described in the APPENDIX to this report.

traffic signal changes anticipated at the Delsea Drive and Cross Keys Road intersection). As a consequence of the constrained nature of the Cross Keys and Delsea Drive intersection, travellers oriented to/from the west will primarily use Cross Keys Road to Fries Mill Road northbound to Hurffville-Cross Keys Road northbound to Greentree Road westbound (to either -- Delsea Drive southbound to US 322 westbound, or; Dalton Drive/Heston Road/Bowe Boulevard westbound to US 322 westbound on the far side of the Rowan College campus). A secondary alternate also includes Cross Keys Road westbound to Pitman-Downer Road northbound to Greentree Road westbound.

Traffic volumes developed under the premises of this scenario are shown on Figure 12 and Figure 13. This scenario clearly shows that corridor-wide traffic volume will disperse widely across the study corridor making maximum use of the capacity available along Greentree Road and Fries Mill Road in addition to Cross Keys Road and Pitman-Downer Road.

Traffic volumes shown for the Pitman-Downer Road intersections with Cross Keys Road and Fish Pond Road are of sufficient levels to warrant traffic signals under the peak hour volume warrant criteria. This analysis has excluded these improvements as a means of illustrating the anticipated worst impact of growth upon the corridor's highways. Traffic signals alone may provide more orderly and safer traffic movement at the two locations but may not improve the efficiency of the location(s).

SCENARIO II - IMPROVE CROSS KEYS ROAD :

An unrestrained traffic assignment reflecting the implementation of ideal improvements to Cross Keys Road -- most noteably at the Delsea Drive intersection. Under this scenario, it is assumed that traffic loads the highway net in the most logical and direct fashion available. There are no internal or external "bottlenecks" to be avoided through the use of less direct paths.

Figure 14 and Figure 15 illustrate the peak hour traffic projections assuming the unrestrained traffic volume assignment. Inspection of this alternative's traffic volumes, indicate that the highest travel demands will be along Cross Keys Road.

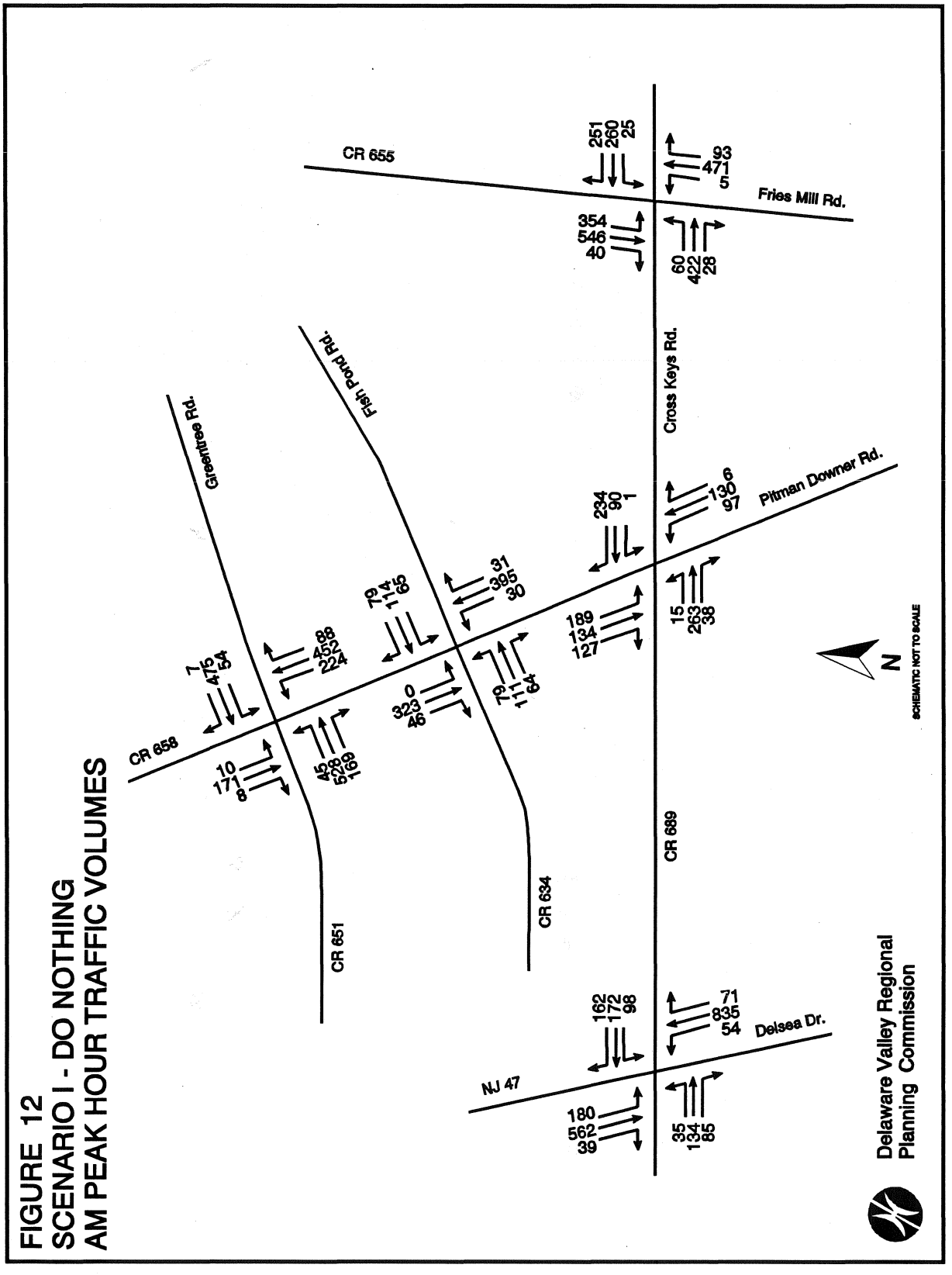


FIGURE 12
SCENARIO I - DO NOTHING
AM PEAK HOUR TRAFFIC VOLUMES

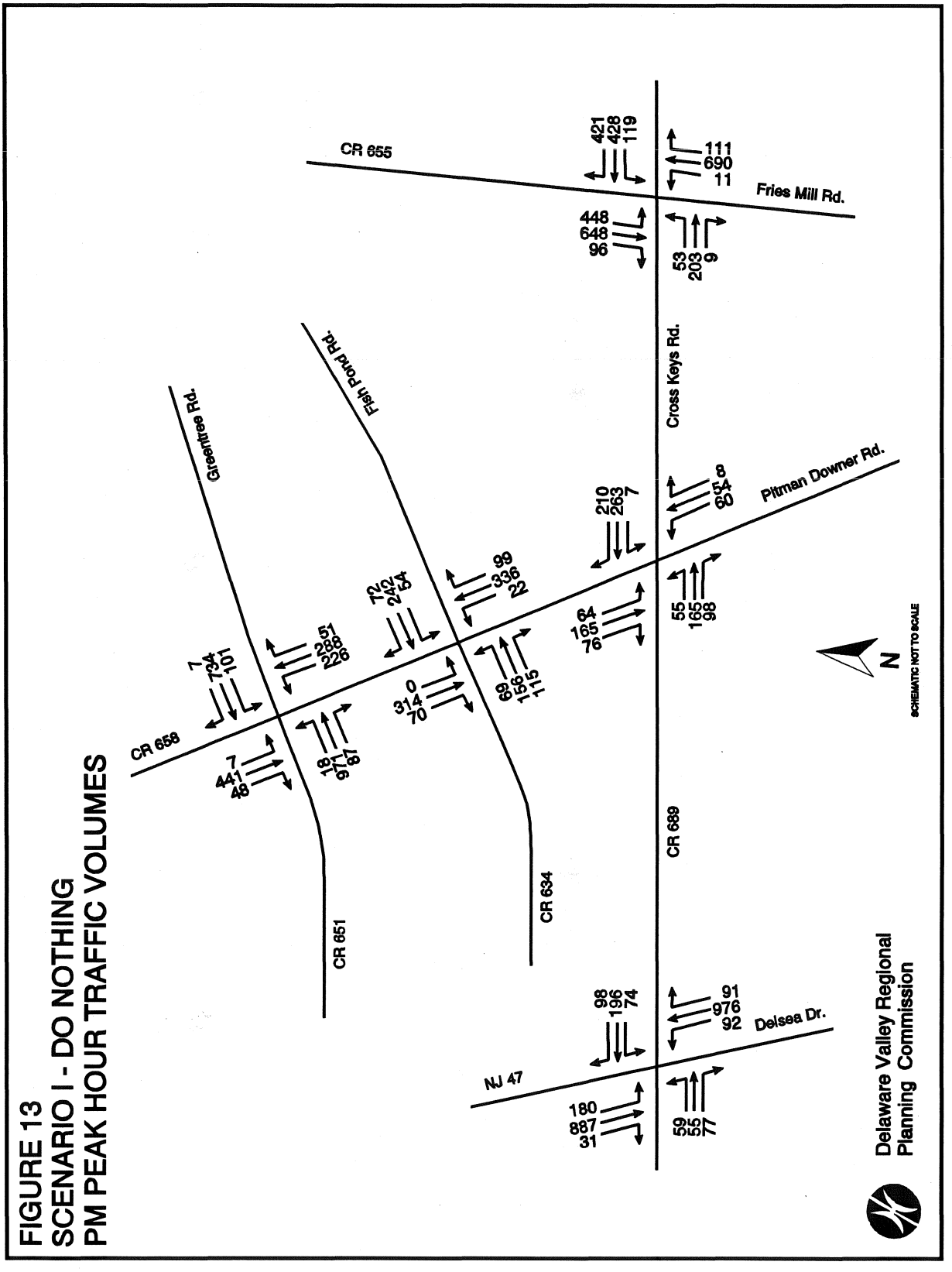


FIGURE 13
SCENARIO I - DO NOTHING
PM PEAK HOUR TRAFFIC VOLUMES
CR 655
Fries Mill Rd.
421
428
119
111
690
11
448
648
96
53
203
9
Cross Keys Rd.
Fish Pond Rd.
Greentree Rd.
Pitman Downer Rd.
210
263
7
8
54
60
99
336
22
242
54
64
165
76
55
165
98
257
288
226
7
734
101
0
314
70
89
156
115
CR 658
7
441
48
18
97
18
CR 651
CR 634
CR 689
N
SCHEMATIC NOT TO SCALE
98
196
74
91
976
92
Delsea Dr.
NJ 47
180
887
31
59
55
77
Delaware Valley Regional
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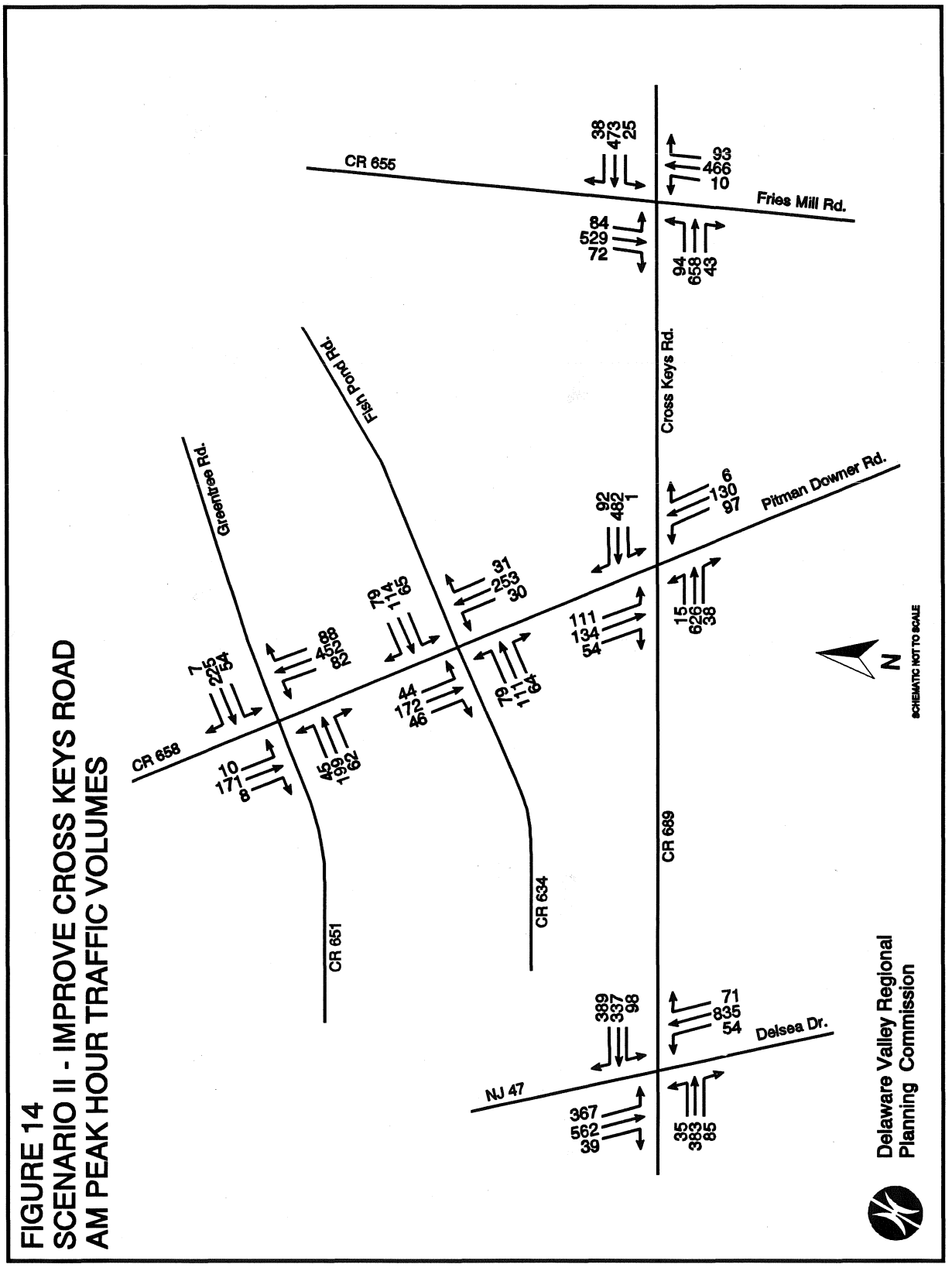
FIGURE 14
SCENARIO II - IMPROVE CROSS KEYS ROAD
AM PEAK HOUR TRAFFIC VOLUMES
CR 655
Fries Mill Rd.
Cross Keys Rd.
Greentree Rd.
Fish Pond Rd.
Pitman Downer Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
N
SCHEMATIC NOT TO SCALE
Delaware Valley Regional
Planning Commission

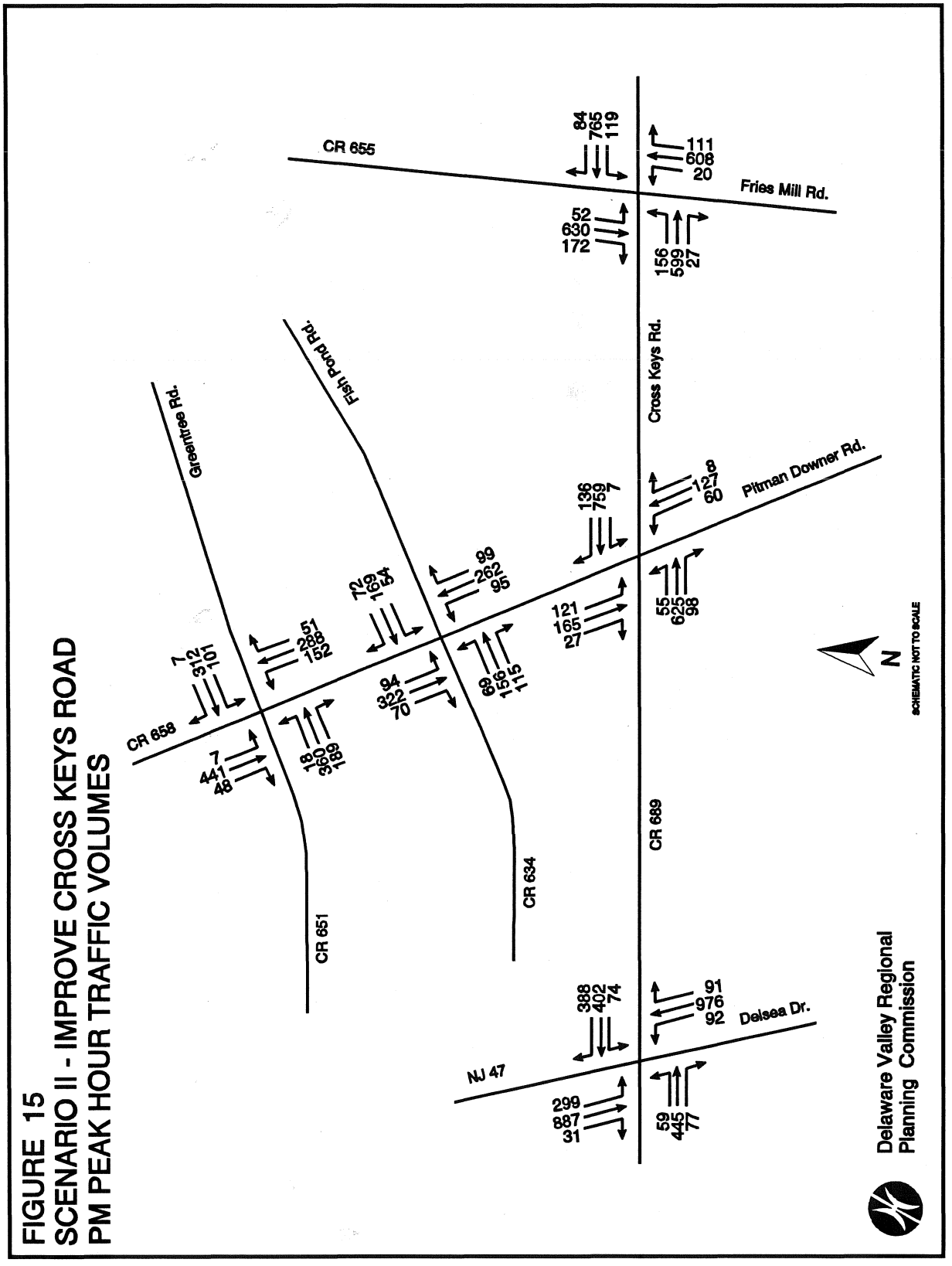
FIGURE 15
SCENARIO II - IMPROVE CROSS KEYS ROAD
PM PEAK HOUR TRAFFIC VOLUMES
CR 655
Fries Mill Rd.
Cross Keys Rd.
Pitman Downer Rd.
Greentree Rd.
Fish Pond Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
N
SCHEMATIC NOT TO SCALE
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Analysis of Scenario II's peak hour volumes indicates that traffic signals will be warranted at the Pitman-Downer Road and Cross Keys Road intersection and at the Pitman-Downer Road and Fish Pond Road intersection. Figures 16 and 17 document that analysis.

SCENARIO III - IMPROVE CROSS KEYS ROAD AND PITMAN-DOWNER ROAD :

A second capacity restrained travel assignment was prepared. Scenario III assumes a minimal level of investment toward traffic improvements are realistic at the Delsea Drive and Cross Keys Road intersection. In place of the ideal improvements, selected reasonable transportation improvements which spread the travel demand between Cross Keys Road and Pitman-Downer Road are assumed to be implemented. Given these assumptions, a significant share of the future traffic volume travelling the corridor can be contained to the immediate alignments of Cross Keys Road and Pitman-Downer Road.

Figure 18 and Figure 19 illustrate the set of traffic volumes estimated for this Scenario.

Analysis of the Scenario III peak hour volumes also indicates that traffic signals will be warranted at the Pitman-Downer Road and Cross Keys Road intersection and at the Pitman-Downer Road and Fish Pond Road intersection. Figures 20 and 21 document that analysis.

Table 6 presents a comparison of projected volumes served by selected facilities within each scenario. Under the "Do Nothing Alternative" (Scenario I), the greatest volume impacts are anticipated along the northern alignments of Greentree and Fries Mill Roads. Where full improvement to only Cross Keys Road is modelled (Scenario II), the largest traffic increases are confined to Cross Keys Road. Where the set of traffic improvements address Cross Keys Road as well as Pitman-Downer Road (Scenario III), east-west volume will be spread between Cross Keys Road and Greentree Road by means of Pitman-Downer Road. Review of area-wide traffic growth suggests that projected volumes, regardless of the scenario, reflect increases over existing peak volumes on the order of five to seven percent per year[3].

[4] Actual traffic growth trends within the study corridor from the mid 1980's to the early 1990's indicate that annual traffic growth was averaging about five percent per year based upon historical traffic count data contained within traffic impact reports performed in the area.

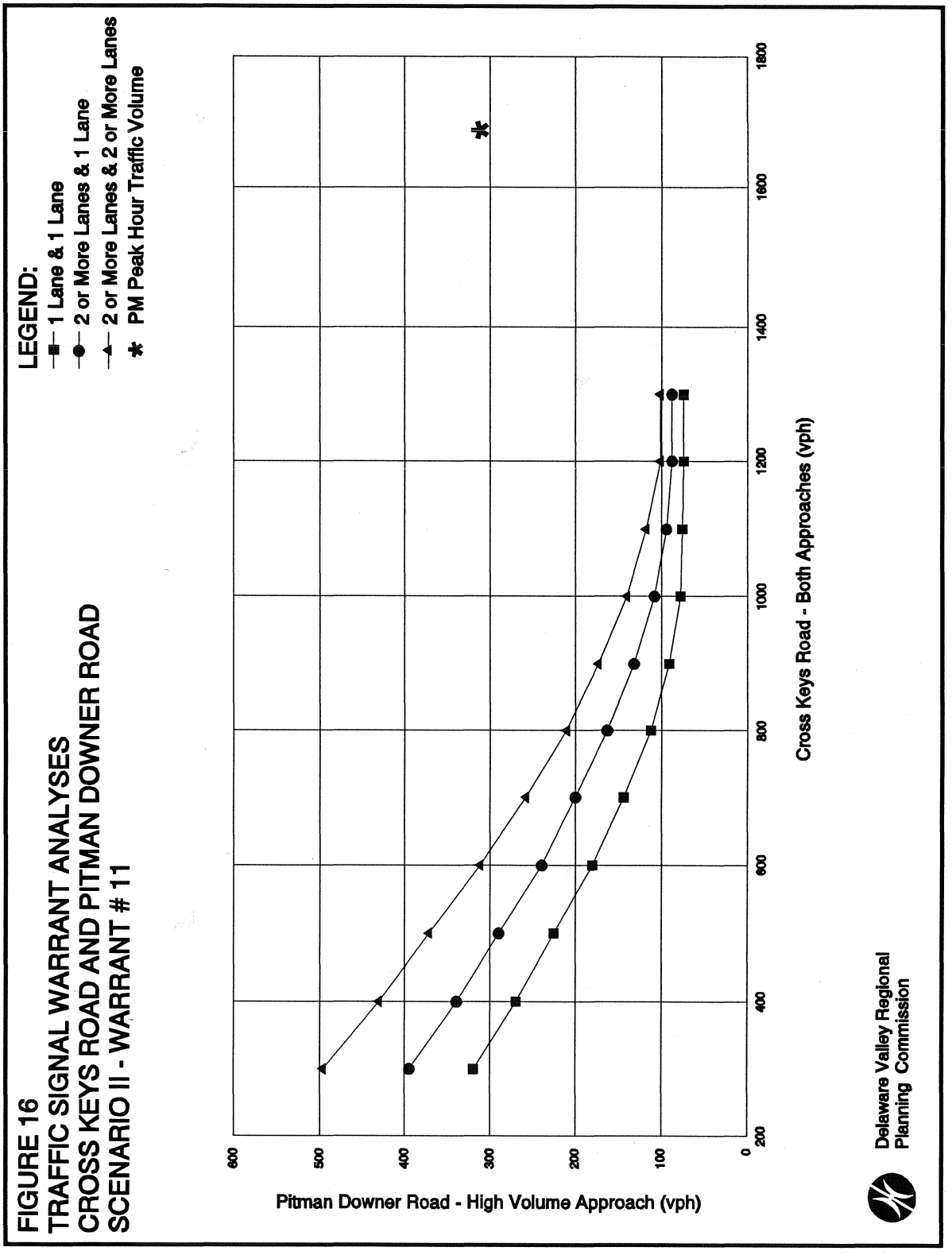
FIGURE 16
TRAFFIC SIGNAL WARRANT ANALYSES
CROSS KEYS ROAD AND PITMAN DOWNER ROAD
SCENARIO II - WARRANT # 11
LEGEND:
1 Lane & 1 Lane
2 or More Lanes & 1 Lane
2 or More Lanes & 2 or More Lanes
PM Peak Hour Traffic Volume
Pitman Downer Road - High Volume Approach (vph)
600
500
400
300
200
100
0
200
400
600
800
1000
1200
1400
1600
1800
Cross Keys Road - Both Approaches (vph)
Delaware Valley Regional
Planning Commission

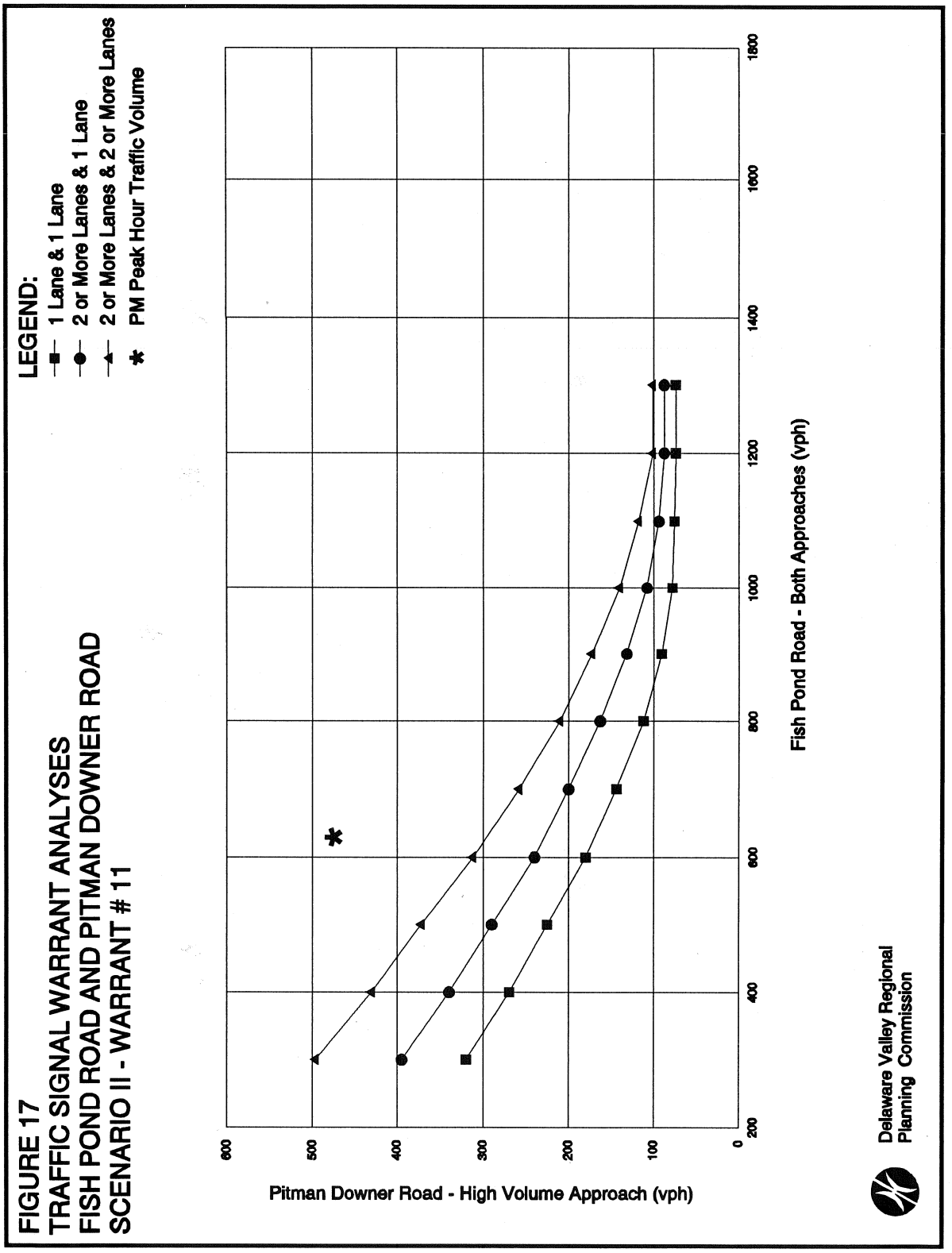
FIGURE 17
TRAFFIC SIGNAL WARRANT ANALYSES
FISH POND ROAD AND PITMAN DOWNER ROAD
SCENARIO II - WARRANT # 11
LEGEND:
1 Lane & 1 Lane
2 or More Lanes & 1 Lane
2 or More Lanes & 2 or More Lanes
PM Peak Hour Traffic Volume
Pitman Downer Road - High Volume Approach (vph)
600
500
400
300
200
100
0
Fish Pond Road - Both Approaches (vph)
200
400
600
800
1000
1200
1400
1600
1800
Delaware Valley Regional
Planning Commission

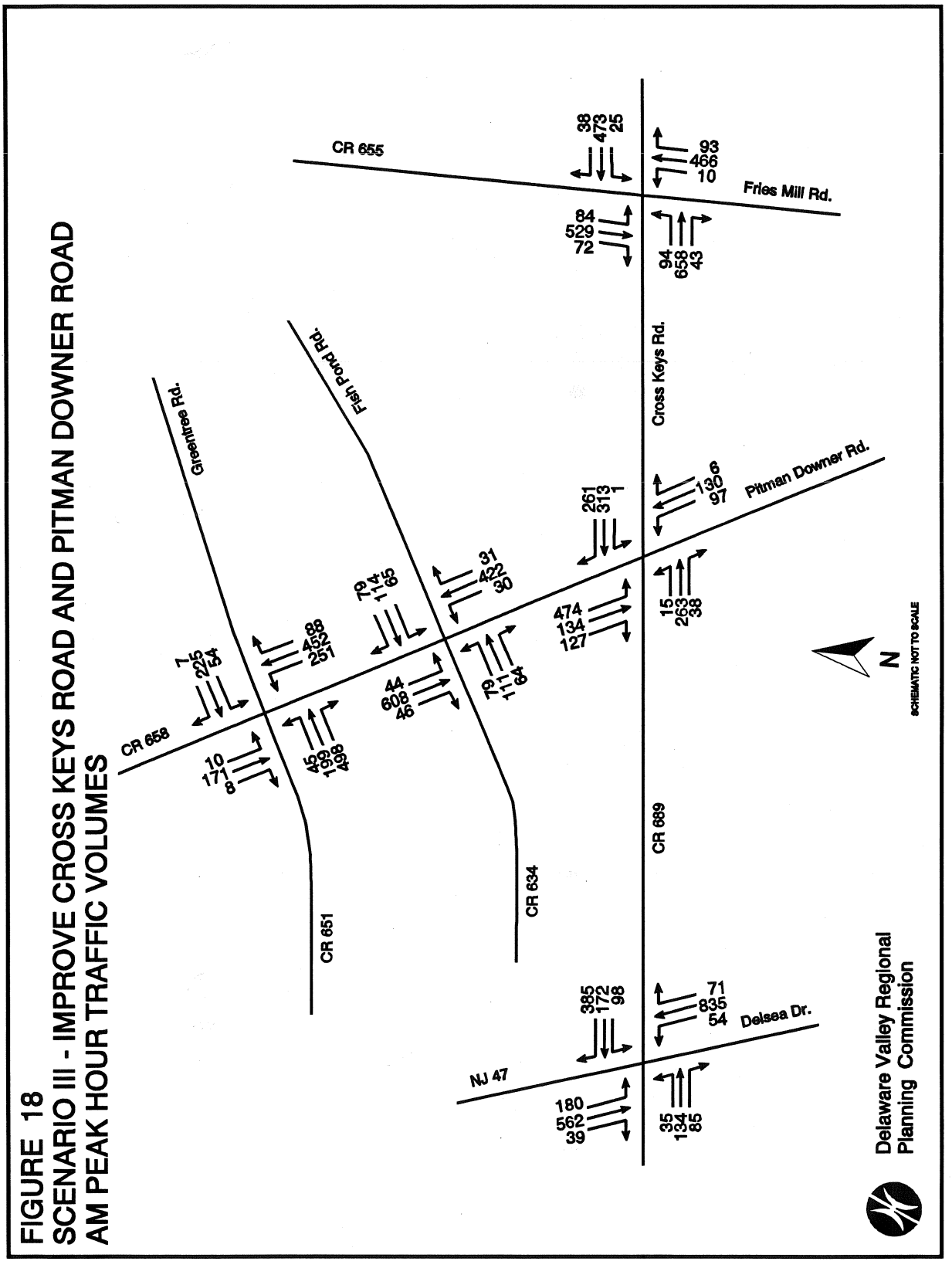
FIGURE 18
SCENARIO III - IMPROVE CROSS KEYS ROAD AND PITMAN DOWNER ROAD
AM PEAK HOUR TRAFFIC VOLUMES
CR 655
Fries Mill Rd.
Cross Keys Rd.
Greentree Rd.
Fish Pond Rd.
Pitman Downer Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
N
SCHEMATIC NOT TO SCALE
Delaware Valley Regional Planning Commission

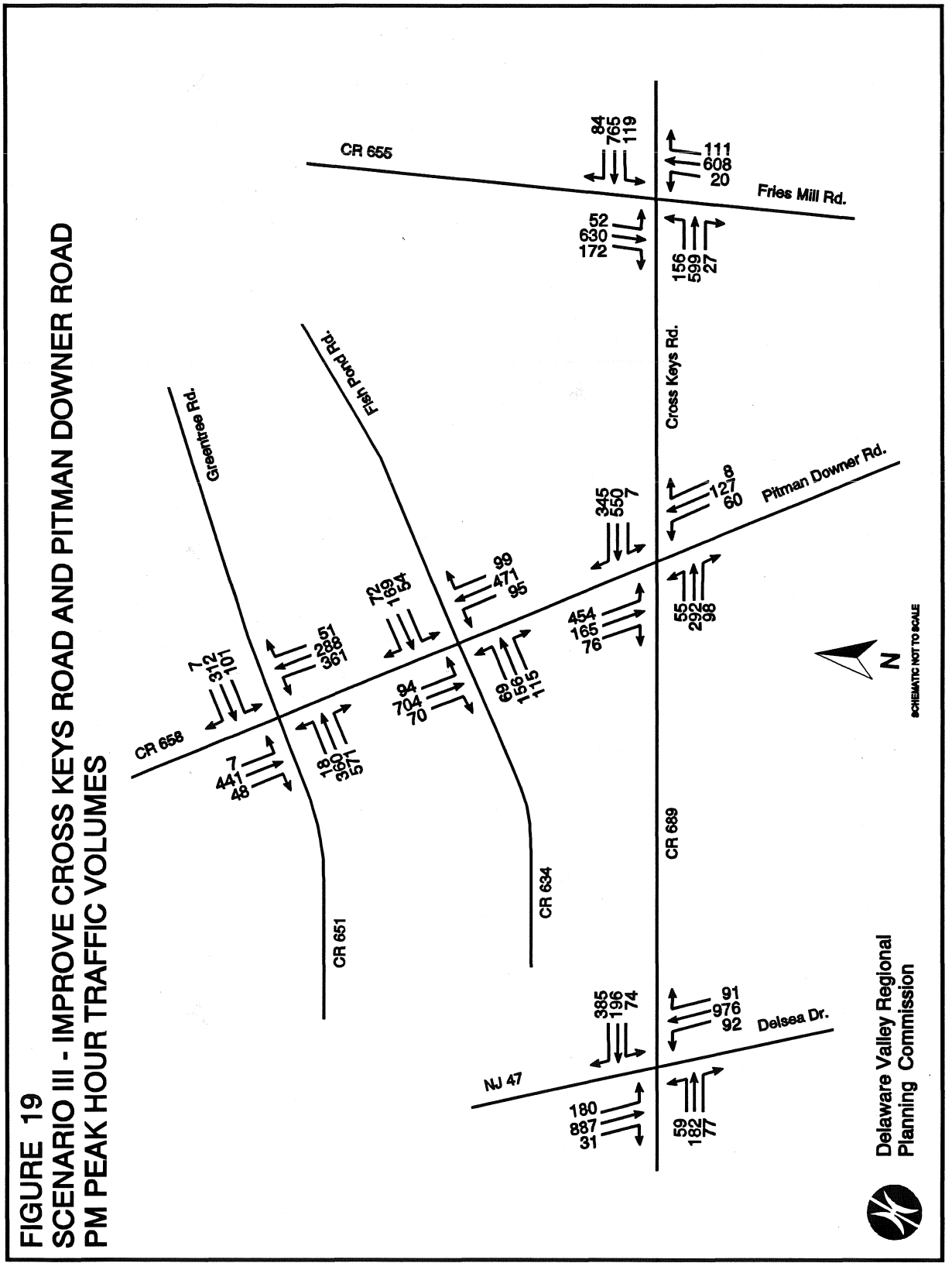
FIGURE 19
SCENARIO III - IMPROVE CROSS KEYS ROAD AND PITMAN DOWNER ROAD
PM PEAK HOUR TRAFFIC VOLUMES
CR 655
Fries Mill Rd.
Cross Keys Rd.
Greentree Rd.
Fish Pond Rd.
Pitman Downer Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
N
SCHEMATIC NOT TO SCALE
Delaware Valley Regional Planning Commission

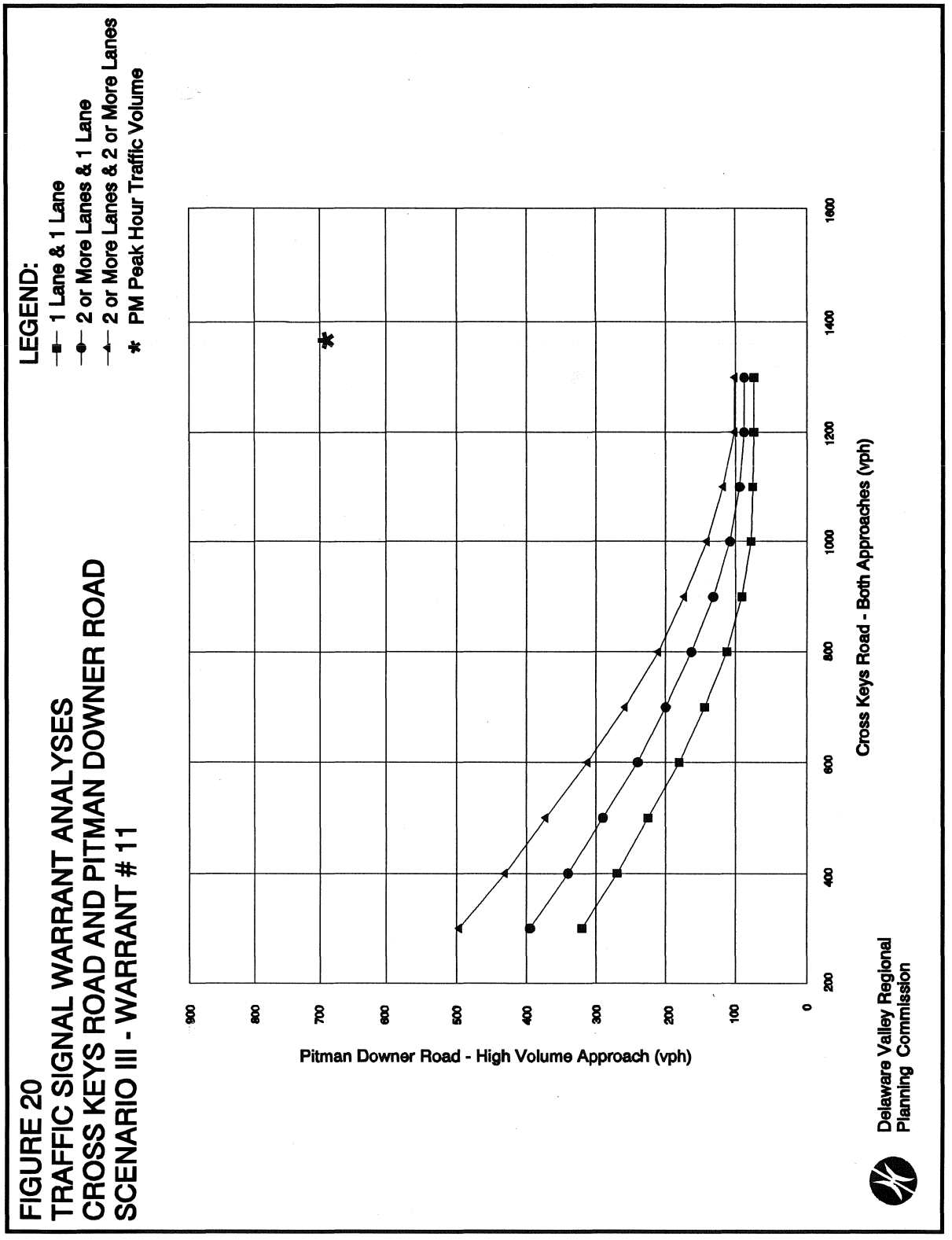
FIGURE 20
TRAFFIC SIGNAL WARRANT ANALYSES
CROSS KEYS ROAD AND PITMAN DOWNER ROAD
SCENARIO III - WARRANT # 11
LEGEND:
1 Lane & 1 Lane
2 or More Lanes & 1 Lane
2 or More Lanes & 2 or More Lanes
PM Peak Hour Traffic Volume
900
800
700
600
500
400
300
200
100
0
200
400
600
800
1000
1200
1400
1600
Pitman Downer Road - High Volume Approach (vph)
Cross Keys Road - Both Approaches (vph)
Delaware Valley Regional
Planning Commission

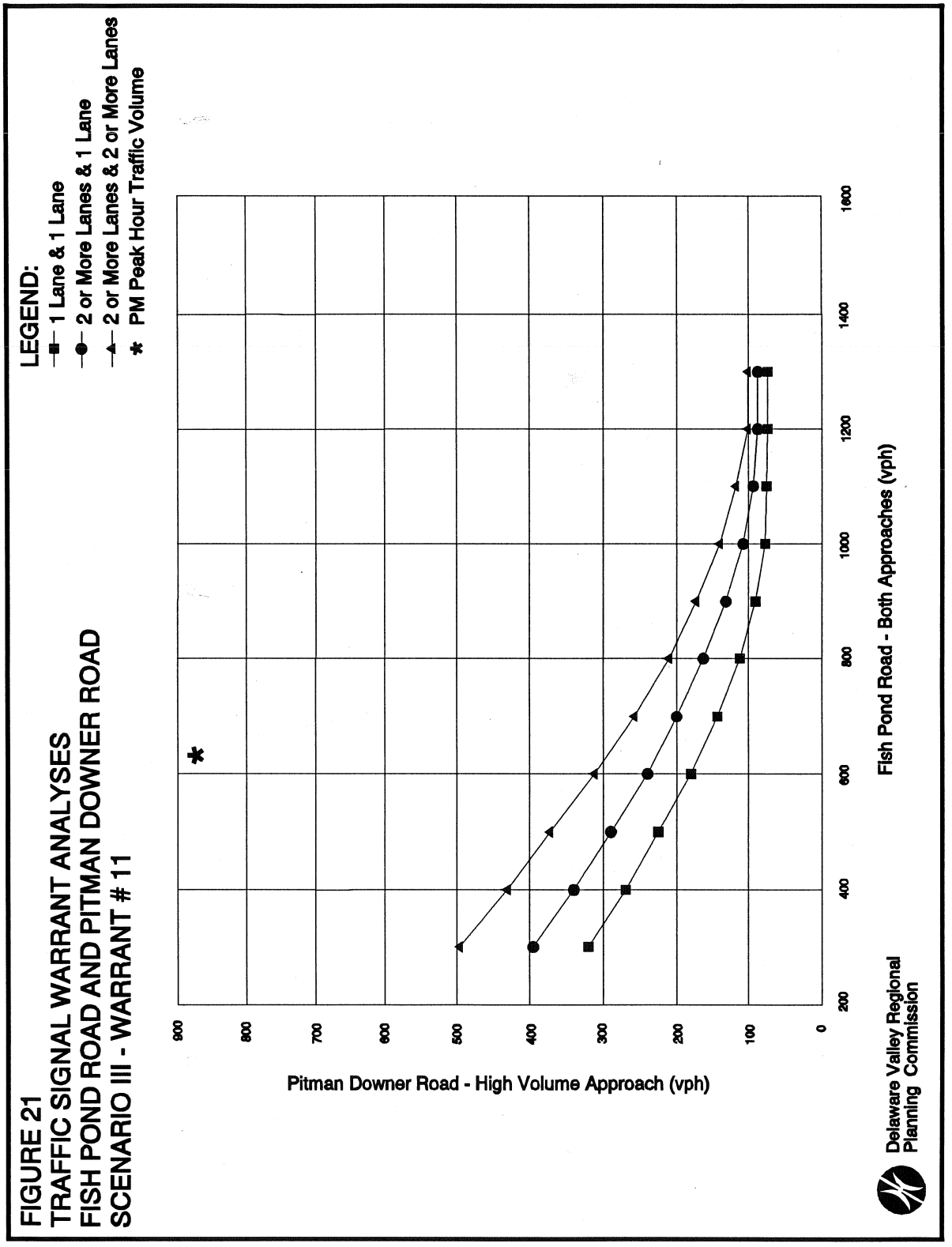
FIGURE 21
TRAFFIC SIGNAL WARRANT ANALYSES
FISH POND ROAD AND PITMAN DOWNER ROAD
SCENARIO III - WARRANT # 11
LEGEND:
1 Lane & 1 Lane
2 or More Lanes & 1 Lane
2 or More Lanes & 2 or More Lanes
PM Peak Hour Traffic Volume
900
800
700
600
500
400
300
200
100
0
200
400
600
800
1000
1200
1400
1600
Pitman Downer Road - High Volume Approach (vph)
Fish Pond Road - Both Approaches (vph)
Delaware Valley Regional Planning Commission

TABLE 6: Future PM Peak Hour Traffic Volume Comparisons

ROADWAY SEGMENT	FULL-BUILD SCENARIO (two-way traffic volumes) I Do Nothing Alternative	II Improve Cross Keys Road	III Improve Cross Keys & Pitman-Downer
CROSS KEYS ROAD east of NJ 47	694	1,699	1,108
CROSS KEYS ROAD Pitman-Downer to Fries Mill	800	1,739	1,739
CROSS KEYS ROAD east of Fries Mill	1,730	1,730	1,730
FRIES MILL north of Cross Keys	2,356	1,702	1,702
PITMAN-DOWNER ROAD Cross Keys to Fish Pond	940	947	1,538
PITMAN-DOWNER ROAD Fish Pond to Greentree	1,194	1,222	1,813
PITMAN-DOWNER ROAD north of Greentree	809	809	809
GREENTREE ROAD east of Pitman-Downer	1,871	838	838
GREENTREE ROAD west of Pitman-Downer	2,084	1,079	1,670

Future Level of Traffic Service

Level of service analyses were performed for the study intersections and roadway locations for each future traffic volume scenario. The purpose of the analyses is two-fold. First, to identify the minimum level of improvement required to accommodate peak traffic demand. Second, to illustrate the relative benefits of alternate improvement strategies (e.g., continuous widening versus localized widening).

When continuous widening is cited, the improvement converts the existing two lane highway to a four lane facility. Generally, in rural and suburban settings, multilane highway facilities have posted speed limits between 40 and 55 miles per hour and traffic signal spacings greater than two miles. According to the Highway Capacity Manual level of service associated with uninterrupted, multilane highways are measured in terms of density (passenger cars per mile per lane). Density is an indicator of the proximity of vehicles to one another and thus indicates the degree of maneuveribility available within the traffic stream. Corresponding average travel speed data, maximum service flow rates and volume/capacity ratios are provided for each level of service depending upon free-flow speeds along the facility as well as the other physical and operating characteristics of the highway.

Ideal physical and operational characteristics of multilane highways include: level terrain; 12-foot travel lanes; minimum 12-foot lateral clearances to obstructions along the side of the road; no direct points of access along the highway; a divided highway; no trucks or buses in the traffic stream, and; 60 mile per hour or greater free flow speeds. Table 7 describes the level of service characteristics and specific measurement criteria for rural and suburban multilane highways.

The findings of the level of service analysis is summarized below for each of the future volume scenarios. Also detailed, where appropriate, are the traffic related improvements underlying the analyses. The results are illustrated on Figure 22 and Figure 23 for intersections and midblock locations included within Scenario I (the Do Nothing Alternative). Figure 24 and Figure 25 illustrate the intersection and midblock level of service findingsreached in evaluating Scenario II (Improve Cross Keys Road). Figure 26 and 27 reflect intersection and midblock level of service results given Scenario III traffic volumes (Improve Cross Keys Road and Pitman-Downer Road).

TABLE 7: Level of Service Criteria - Rural and Suburban Multilane Highways

LEVEL OF SERVICE A - Completely free-flow conditions. The operation of vehicles is virtually unaffected by the precesence of other vehicles, and operations are constrained only by the geometric features of the highway and by driver preferences. Vehicles are spaced at an average of 440 feet at a maximum density of 12 passenger cars per mile per lane (pc/mi/ln). Maneuverability within the traffic stream is good. Minor disruptions to flow are easily absorbed at this level without a change in travel speed. Under ideal conditions: average travel speeds are 60 miles per hour; maximum service flow rates are 720 pc/hr/ln, and; the maximum v/c ratio is 0.33.

LEVEL OF SERVICE B - Also indicative of free-flow conditions, although the presence of other vehicles begins to be noticeable. Average travel speeds are the same as in LOS A, but drivers have slightly less freedom to maneuver. Vehicles are spaced at an average of approximately 264 feet at a maximum density of 20 pc/mi/ln. Minor disruptions are still easily absorbed at this level, although localized deterioration in level of service will be more obvious. Under ideal conditions: average travel speeds are also 60 miles per hour; maximum service flow rates are 1,200 pc/hr/ln, and; the maximum v/c ratio is 0.55.

LEVEL OF SERVICE C - The range in which the influence of traffic density on the operations becomes marked. The ability to maneuver within the traffic stream is now clearly affected by the presence of other vehicles. Average travel speeds begin to show some reduction for multilane highways with free-flow speeds over 50 miles per hour. The average spacing of vehicles is reduced to approximately189 feet at a maximum density of 28 pc/mi/ln. Minor disruptions may be expected to cause serious local deteriation in service, and queues may form behind any significant traffic disruption. Under ideal conditions: average travel speeds are 59 miles per hour; maximum service flow rates are 1,650 pc/hr/ln, and; the maximum v/c ratio is 0.75.

LEVEL OF SERVICE D - The range in which the ability to maneuver is severely restricted because of traffic congestion. Travel speed begins to be reduced by increasing volumes. The average spacing of vehicles is 155 feet at a maximum density of 34 pc/mi/ln. Only minor disruptions can be absorbed without the formation of extensive queues and the deterioration of service to LOS E and LOS F. Under ideal conditions: average travel speeds are 57 miles per hour; maximum service flow rates are 1,940 pc/hr/ln, and; the maximum v/c ratio is 0.89.

LEVEL OF SERVICE E - Represents operations at or near capacity and is quite unstable. Densities vary depending upon free-flow speed. At LOS E, vehicles are operating with the minimum spacing at which uniform flow can be maintained. Thus as the limits for the level of service are approached, disruptions cannot be damped or readily dissipated, and most disruptions will cause queues to form and service to deteriorate to LOS F. For the majority of multilane highways with free-flow speeds between 45 and 60 miles per hour, passenger-car speeds at capacity range from 40 to 55 miles per hour but are highly variable and unpredictable within that range. Under ideal conditions: average travel speeds are 55 miles per hour; maximum service flow rates are 2,200 pc/hr/ln, and; the maximum v/c ratio is 1.00.

LEVEL OF SERVICE F - Represents forced or breakdown flow. It occurs either at a point where vehicles arrive at a rate greater than the rate at which they are discharged or at a point on a planned facility where forecast demand exceeds computed capacity. Although operations at such points (and on sections immediately downstream) will appear to be at capacity, queues will form behind these breakdowns. Operations within queues are highly unstable, with vehicles experiencing brief periods of movement followed by stoppages. Average travel speeds with queues are generally less than 30 miles per hour. Note that the term "LOS F" may be used to characterize both the point of the breakdown and the operating condition within the queue. It must be remembered, however, that it is the point of breakdown that causes the queue to form and that operations within the queue are generally not related to defects along the highway segment over which the queue extends.

Source: Highway Capacity Manual, Transportation Research Board, Special Report 209, 1985

SCENARIO I - DO NOTHING ALTERNATIVE *{also see Figures 22 and 23}* :

Cross Keys Road and Delsea Drive Intersection -
This scenario assumes only that the traffic signal update committed by NJDOT (including a new traffic signal providing multi-phase, actuated and interconnected operation) will be in place at the intersection.

Individual movements will operate primarily at level of service E or level of service F during both peak hours. The intersection as an entity will operate at level D during the A.M. peak and level of service F (and beyond capacity) during the P.M. peak hour.

Cross Keys Road and Pitman-Downer Road Intersection -
Left-turns from Cross Keys Road will operate at level A. Side street movements will operate variably between level E and level F from the stop sign controlled Pitman-Downer Road approaches.

Cross Keys Road and Fries Mill Road Intersection -
Overall operations are projected to be level of service B at the signalized intersection during the A.M. peak hour, with individual turning movements operating at level C or better. During the P.M. peak, the overall intersection is projected to fail (level F) due to volume exceeding capacity on the southbound Fries Mill Road approach.

Pitman-Downer Road and Fish Pond Road Intersection -
Left-turns from Fish Pond Road will operate at level A. Stop sign regulated movements from Pitman-Downer Road will operate variably between level E and level F.

Pitman-Downer Road and Greentree Road Intersection -
Overall signalized operations are projected to be at level of service B the intersection, with individual turning movements operating at level B conditions or better.

Cross Keys Road -
Two lane, two-way flow operations along Cross Keys Road will be between level C and level of service D from the Delsea Drive to Fries Mill Road. East of Fries Mill Road, level E roadway conditions are projected if the cross section is not increased in conjunction with the bypass improvement.

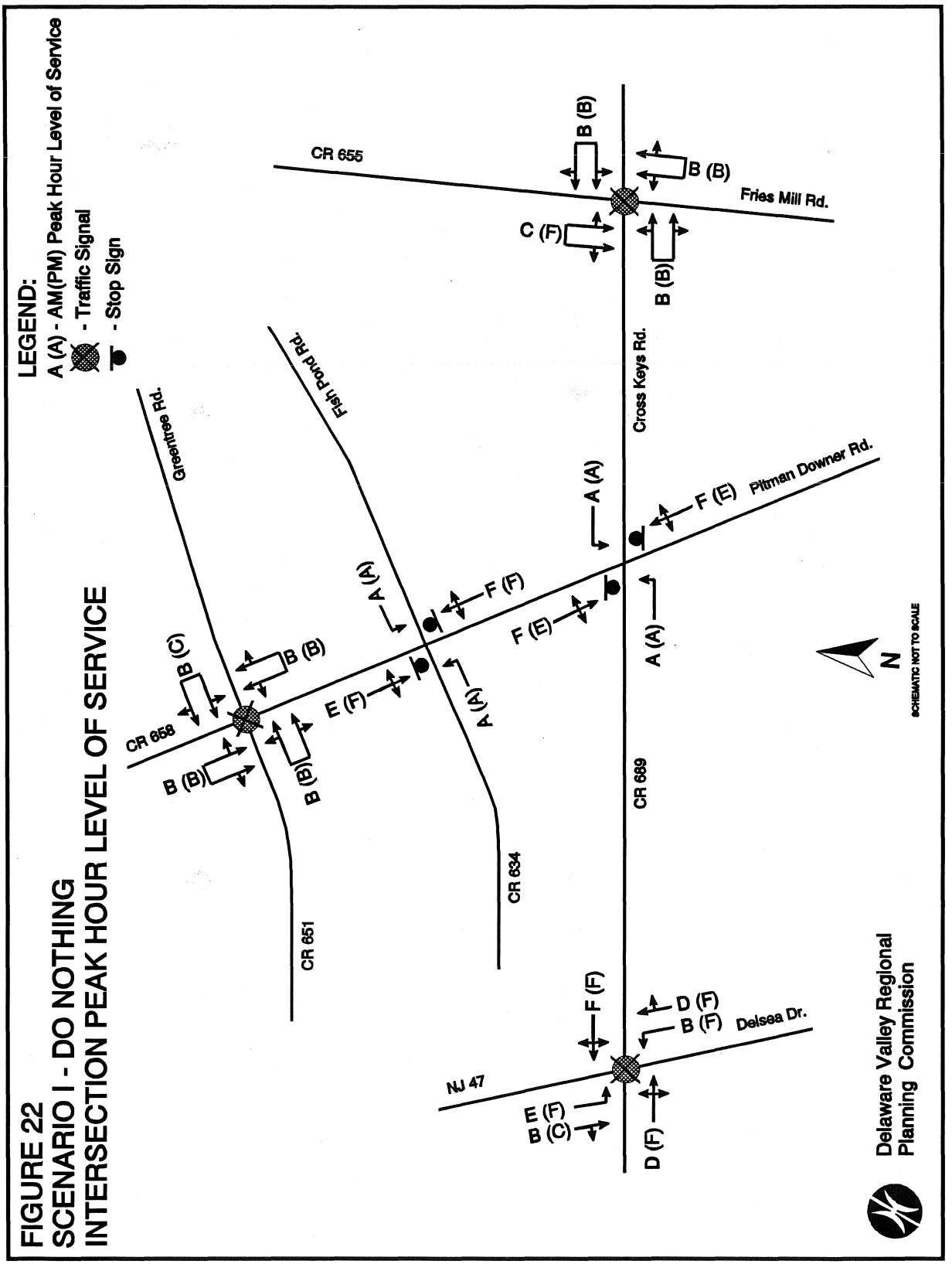
FIGURE 22
SCENARIO I - DO NOTHING
INTERSECTION PEAK HOUR LEVEL OF SERVICE
LEGEND:
A (A) - AM(PM) Peak Hour Level of Service
- Traffic Signal
- Stop Sign
CR 655
Fries Mill Rd.
Cross Keys Rd.
Greentree Rd.
Fish Pond Rd.
Pitman Downer Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
B (B)
B (C)
C (F)
A (A)
F (E)
F (F)
E (F)
D (F)
B (F)
B (C)
N
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Planning Commission

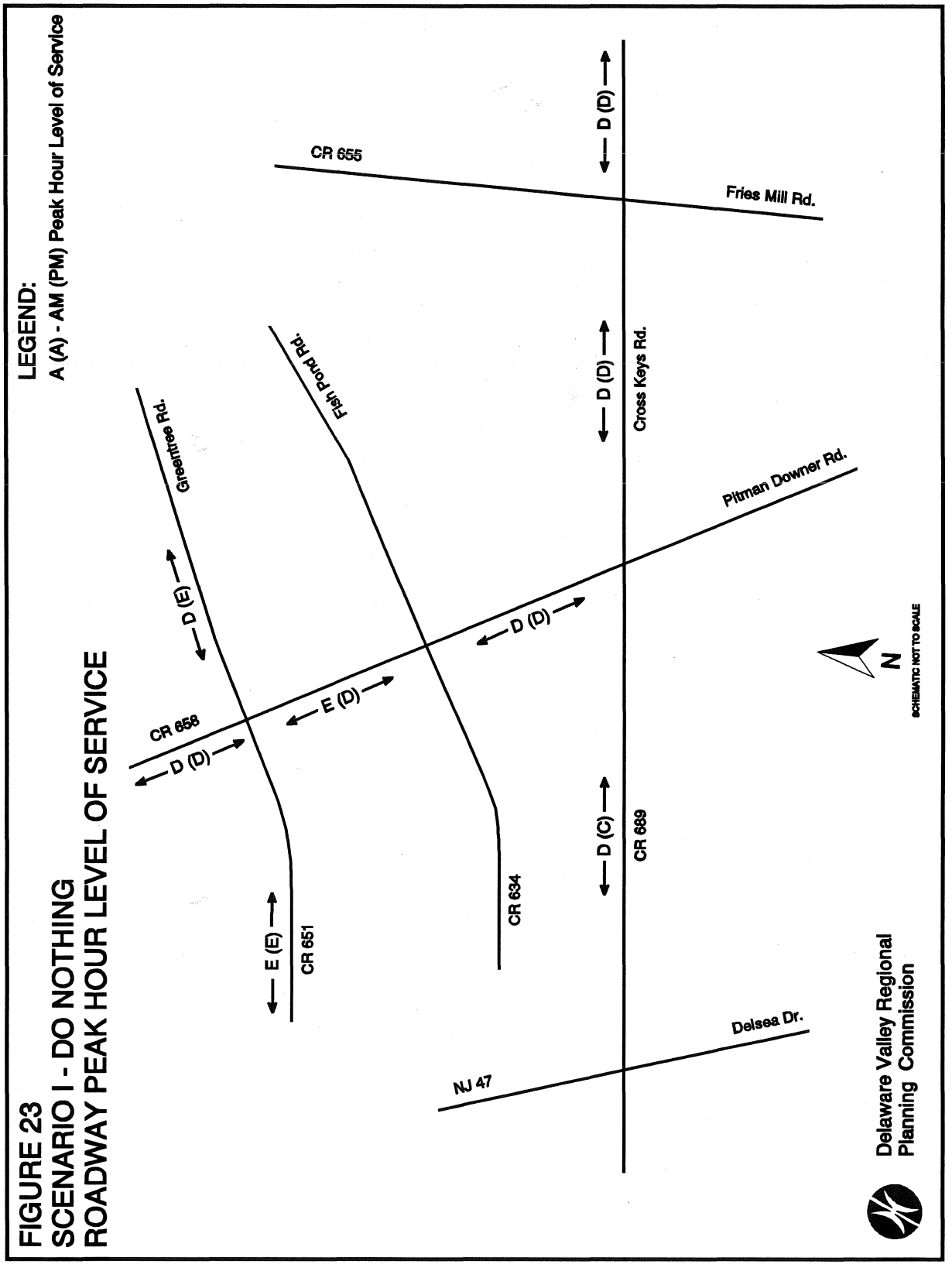
FIGURE 23
SCENARIO I - DO NOTHING
ROADWAY PEAK HOUR LEVEL OF SERVICE
LEGEND:
A (A) - AM (PM) Peak Hour Level of Service
CR 655
Fries Mill Rd.
D (D)
Greentree Rd.
Fish Pond Rd.
Cross Keys Rd.
D (D)
D (E)
Pitman Downer Rd.
CR 658
D (D)
E (D)
D (D)
E (E)
CR 651
CR 634
D (C)
CR 689
N
SCHEMATIC NOT TO SCALE
Delsea Dr.
NJ 47
Delaware Valley Regional
Planning Commission

Pitman-Downer Road -
Assuming two lane, two-way flow conditions are continued along the highway, peak traffic operations will be at level of service D between Cross Keys Road and Fish Pond Roads. To the north, between Fish Pond and Greentree Roads, operations will fluctuate between levels D and E. North of Greentree Road, level D conditions will prevail during both peak travel hours.

Greentree Road -
Assuming two lane, two-way flow conditions continue along Greentree Road, operations will vary between level D and level E during the A.M. and P.M. peak hours, respectively, on the east side of Pitman-Downer Road. On the west side of Pitman-Downer Road, level E conditions will exist during both the A.M. and P.M. peak travel hours.

SCENARIO II - IMPROVE CROSS KEYS ROAD *{also see Figures 24 and 25}* :

Cross Keys Road and Delsea Drive Intersection -
In order for the intersection to function acceptably, NJ 47 will require widening to a five lane cross section, consisting of two lanes in each direction for through traffic and a center left-turn lane (note: this cross section should be continued along Delsea Drive through the US 322 dogleg). Additionally, Cross Keys Road should be widened for separate left, through and right-turn lanes on each approach. Installation of a new traffic signal providing multi-phase, actuated and interconnected operation will also be required.

Given the aforementionned improvements, the overall intersection will operate at level of service C during the peak travel hours. Individual movements will operate at level D or better during both peak hours for all but the westbound left-turn lane. For this movement levels E and F conditions will be a consequence of the signal cycle length and signal timing as opposed to a capacity deficiency.

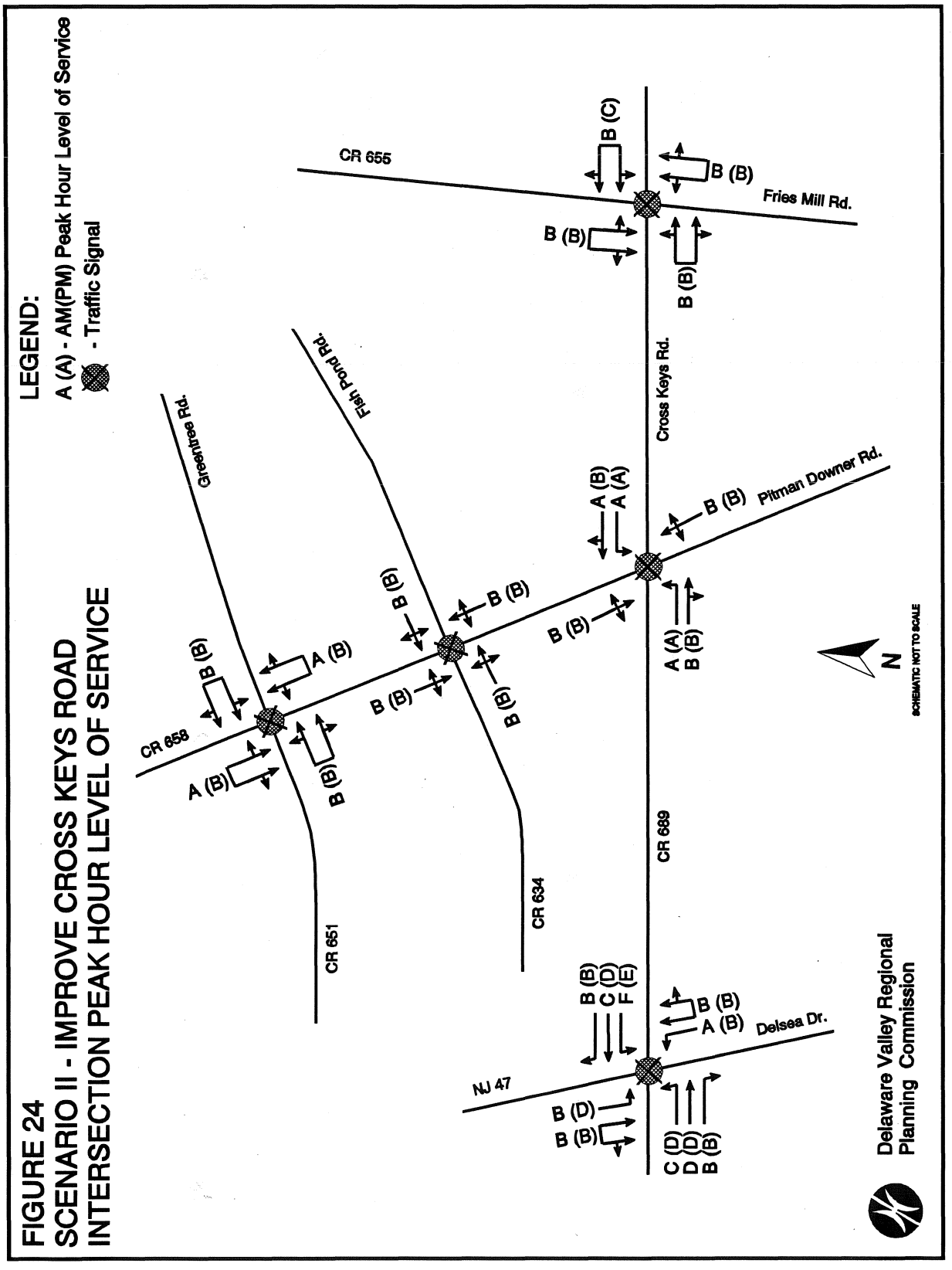
FIGURE 24
SCENARIO II - IMPROVE CROSS KEYS ROAD
INTERSECTION PEAK HOUR LEVEL OF SERVICE
LEGEND:
A (A) - AM(PM) Peak Hour Level of Service
- Traffic Signal
CR 655
Fries Mill Rd.
Cross Keys Rd.
Pitman Downer Rd.
Greentree Rd.
Fish Pond Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
N
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Delaware Valley Regional
Planning Commission

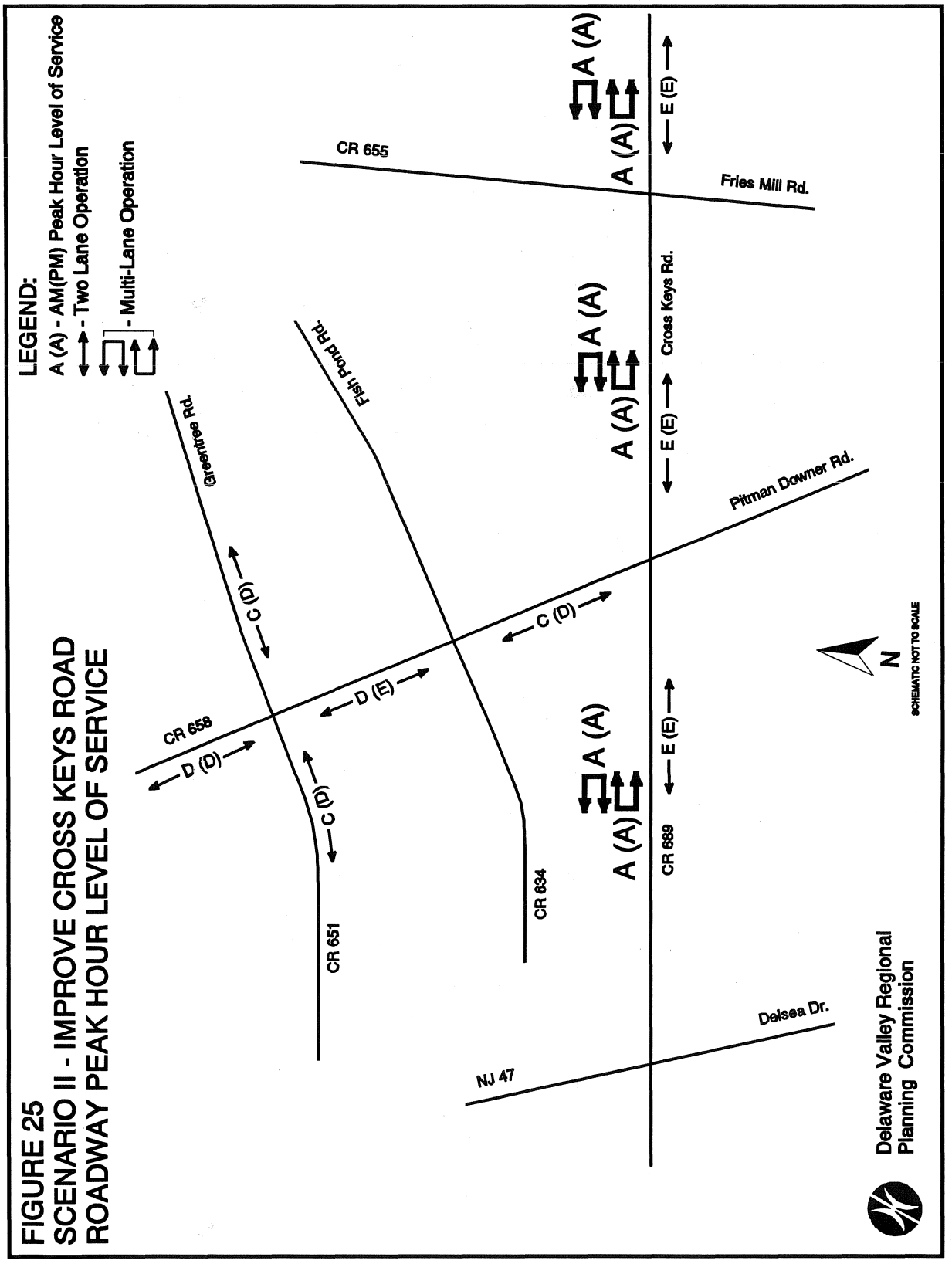
FIGURE 25
SCENARIO II - IMPROVE CROSS KEYS ROAD
ROADWAY PEAK HOUR LEVEL OF SERVICE
LEGEND:
A (A) - AM(PM) Peak Hour Level of Service
- Two Lane Operation
- Multi-Lane Operation
CR 655
Fries Mill Rd.
A (A)
A (A)
E (E)
Cross Keys Rd.
Fish Pond Rd.
Greentree Rd.
C (D)
Pitman Downer Rd.
CR 658
D (D)
D (E)
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
N
SCHEMATIC NOT TO SCALE
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Planning Commission

Cross Keys Road and Pitman-Downer Road Intersection -
A traffic signal will be warranted and should provide two-phase operation to regulate flow at the intersection. A center left-turn lane on Cross Keys Road will also be required to provide acceptable operations.

With the aforementionned improvements the overall intersection will operate at level of service B and individual traffic movements will function at level B or better conditions.

Cross Keys Road and Fries Mill Road Intersection -
No changes are required to the physical or operational elements of the intersection.

Overall operations are projected to be at level B at the intersection, while individual turning movements are expected to equal or exceed level C conditions.

Pitman-Downer Road and Fish Pond Road Intersection -
A traffic signal will be warranted. Two phase operation will be sufficient to regulate traffic flow at the intersection.

All intersection approaches will function at level B as will the overall intersection during both peak travel hours.

Pitman-Downer Road and Greentree Road Intersection -
No changes are required to the physical or operational elements of the intersection.

Overall operations are projected to be level B at the intersection, with individual turning movements operating at level B conditions or better.

Cross Keys Road -
Cross Keys Road is anticipated to operate at level E during the morning and evening peak travel hours if the cross section is maintained at two-lanes.

Widening the cross section to four continuous travel lanes (two in each direction) will yield roadway level of service A conditions during both peak hours from the Cross Keys Bypass to the Delsea Drive.

Pitman-Downer Road -
Assuming two lane, two-way flow conditions are continued along the highway, operations will vary between levels C or D between Cross Keys Road and Fish Pond, and levels D or E between Fish Pond Road and Greentree Road. North of Greentree Road, level D conditions will prevail during both peak travel hours.

Greentree Road -
Assuming two lane, two-way flow conditions continue, roadway operations along Greentree Road will vary between levels of service C and D during the future peak travel hours.

SCENARIO III - IMPROVE CROSS KEYS ROAD AND PITMAN-DOWNER ROAD *{also see Figures 26 and 27}* :

Cross Keys Road and Delsea Drive Intersection -
As discussed in the preceding "Future Traffic Volumes" section of this report a minimum level of improvement has been assumed at this intersection -- the provision of separate right-turn lanes on both Cross Keys Road approaches and installing a new traffic signal providing multi-phase, actuated and interconnected operation. These improvements are deemed both reasonable and possible and are considered valuable under present traffic volume conditions assuming the proposed changes to the traffic signal regulating the intersection proposed by NJDOT.

Further into the future these same improvements will be necessary, at a minimum, to provide some continued serviceability of the intersection[4]. Upgrading alternate routes for travel to/from the west provides the most realistic means to improve corridor mobility.

As a result of the intersection improvement (and the diversion of vehicles to alternate alignments) overall the intersection of Delsea Drive and Cross Keys Road will function at level E or F during the peak travel hours. Individual movements will operate at level of service F or better during both peak hours.

---

[5] A separate analysis of the phasing of the identified intersection improvements was also prepared. The intersection's current geometry is sufficient to serve corridor growth to 1997 (about 30% of total future corridor development potential assuming straight line growth). The addition of east/west right-turn lanes on Cross Keys Road will extend the intersection's serviceability to 1999 (about 50% of corridor development potential).

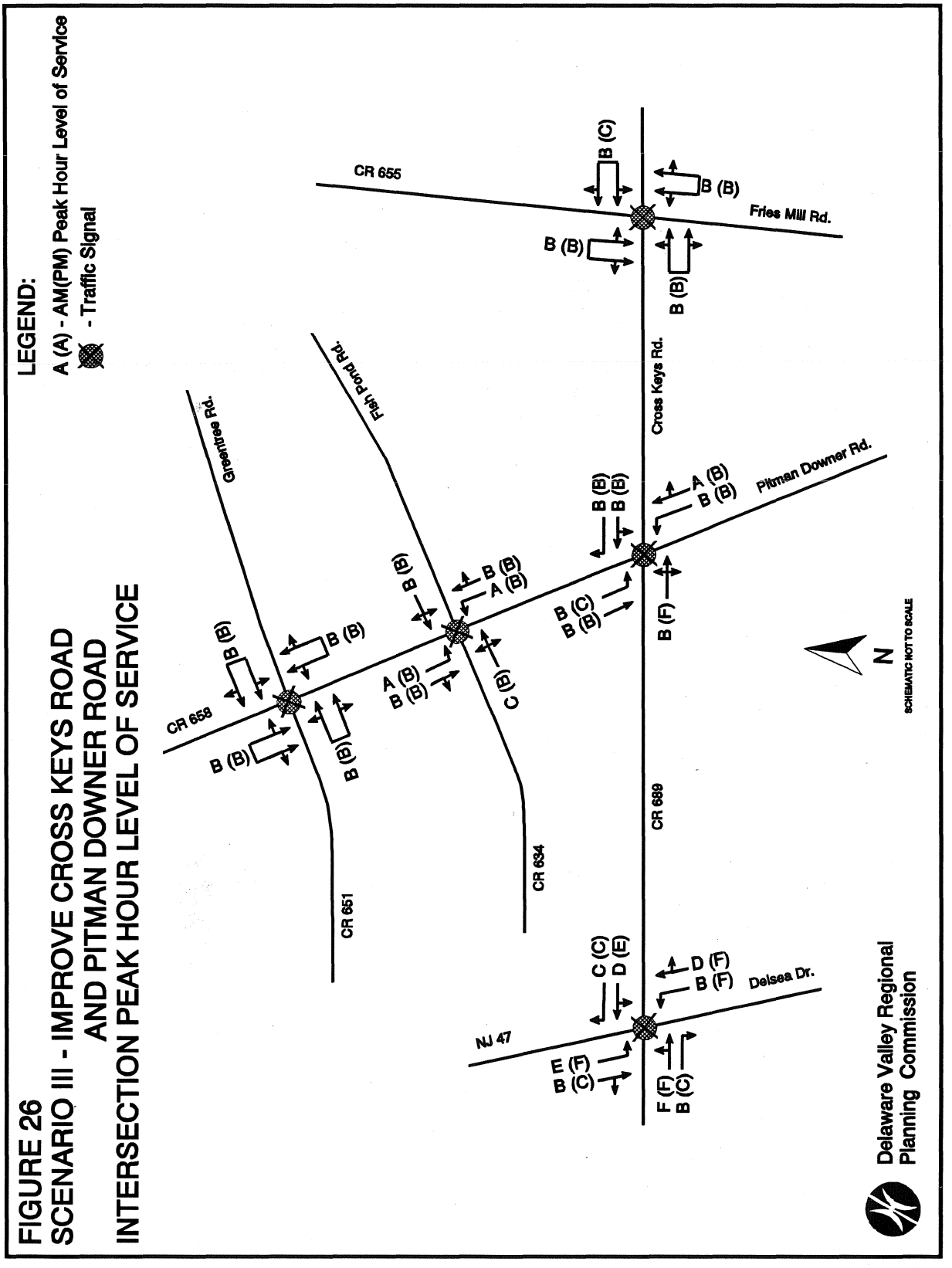
FIGURE 26
SCENARIO III - IMPROVE CROSS KEYS ROAD
AND PITMAN DOWNER ROAD
INTERSECTION PEAK HOUR LEVEL OF SERVICE
LEGEND:
A (A) - AM(PM) Peak Hour Level of Service
- Traffic Signal
CR 655
Fries Mill Rd.
Cross Keys Rd.
Greentree Rd.
Fish Pond Rd.
Pitman Downer Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
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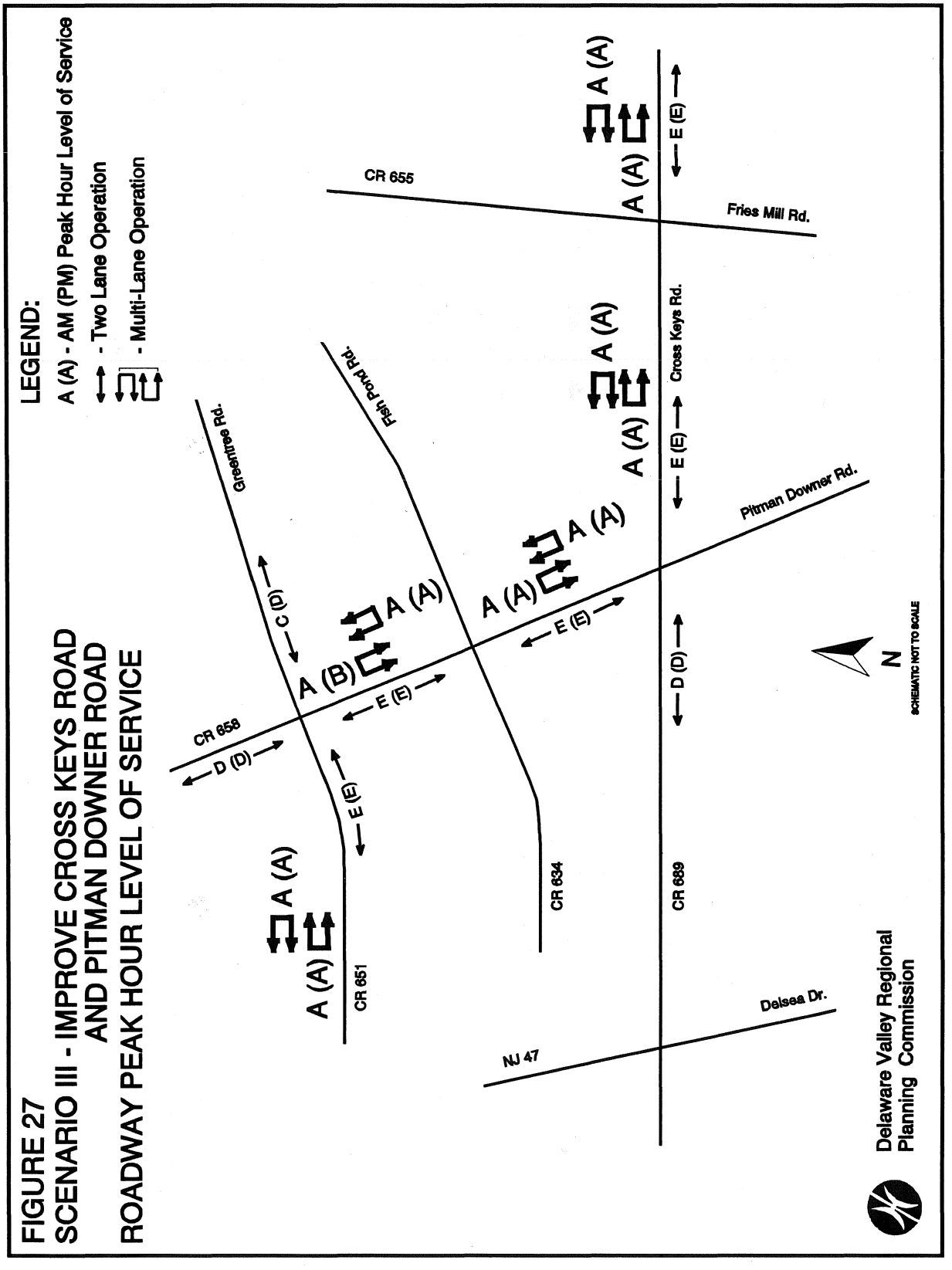
FIGURE 27
SCENARIO III - IMPROVE CROSS KEYS ROAD AND PITMAN DOWNER ROAD
ROADWAY PEAK HOUR LEVEL OF SERVICE
LEGEND:
A (A) - AM (PM) Peak Hour Level of Service
- Two Lane Operation
- Multi-Lane Operation
CR 655
Fries Mill Rd.
Greentree Rd.
Fish Pond Rd.
Cross Keys Rd.
Pitman Downer Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
A (A)
A (B)
C (D)
D (D)
E (E)
N
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The majority of movements experiencing the level E and F conditions will be as a consequence of the signal cycle length and signal timing at the intersection. A capacity deficiency will be encountered for the eastbound left-turn/straight through movement during the P.M. peak hour.

It is also concluded that some widening/improvement component address NJ 47 through the US 322 dogleg to eliminate downstream backups and blockages.

Cross Keys Road and Pitman-Downer Road Intersection -
A traffic signal will be warranted and two phases will be necessary to regulate flow at the intersection. A center left-turn lane should be added on the Pitman-Downer Road approaches and a separate right-turn lane provided on the westbound Cross Keys Road approach.

With the aforementionned improvements the overall intersection will operate at level C during the peak travel hours. Individual traffic movements will largely function at level C or better conditions. However, delays longer than one minute (level of service F conditions) will be experienced on the eastbound Cross Keys Road intersection approach during the P.M. peak hour. This latter condition may be viewed as a possible means of discouraging traffic from traversing the western limits of the corridor given the density of residential development and given the presence of the Glassboro elementary school (currently under construction) within the segment.

Measures necessary to alleviate the level F condition on the approach include providing separate left-turn lanes on the Cross Keys Road approaches in addition to the improvements listed above for the balance of the intersection.

Cross Keys Road and Fries Mill Road Intersection -
The intersection volumes presented under this scenario are identical with the preceding scenario. Therefore, the conclusions with respect to the operational analyses are also exactly the same. No changes are required to the physical or operational elements of the intersection versus present conditions.

Overall operations are projected to be level B at the intersection, while individual turning movements are expected to equal or exceed level C conditions.

Pitman-Downer Road and Fish Pond Road Intersection -
A traffic signal will be warranted providing two phase operation to regulate traffic flow at the intersection. Separate left-turn lanes will be required on the northbound and southbound Pitman-Downer Road intersection approaches. All intersection approaches will operate at level C or better.

Overall intersection operations will be at level B during both peak hours.

Pitman-Downer Road and Greentree Road Intersection -
No changes are required to the physical or operational elements of the intersection to accommodate projected Scenario III traffic volume.

Overall operations are projected to be at level of service B at the intersection, with individual turning movements operating at level B conditions or better.

Cross Keys Road -
Assuming continuance of the present cross section of two lanes along Cross Keys Road, projected peak hour traffic is anticipated to operate at level E during the morning and evening peak travel hours on the eastern links of the corridor between the Cross Keys Bypass and Pitman-Downer Road. Between Pitman-Downer and the Delsea Drive uninterrupted flow operating conditions are expected to be level D during both peaks.

Widening Cross Keys Road's cross section to four travel lanes (two lanes in each direction) will yield roadway level of service A conditions during both peak hours.

Pitman-Downer Road -
Assuming two lane, two-way flow conditions are continued along the highway, operations will be level E between Cross Keys Road and Greentree Road. North of Greentree Road, level of service D conditions will prevail during both peak travel hours.

Widening the cross section of Pitman-Downer from Cross Keys to Fish Pond, with an additional travel lane in each direction, to accommodate the projected additional volume would yield level A conditions for both directions of flow. Widening for the additional travel lane between Fish Pond Road and Greentree Road will result in level B or better uninterrupted travel conditions.

Greentree Road -

Assuming two lane, two-way flow conditions continue along Greentree Road, operations will vary between levels of service C and D on the east side of Pitman-Downer Road to level E operations on the west side of Pitman-Downer.

In order to accommodate the additional traffic volume within the corridor, widening the western segment of Greentree Road from Pitman-Downer Road to the Delsea Drive or the Dalton/Heston/Bowe alignment might be desireable. Such an undertaking would yield level A uninterrupted roadway traffic operations, at least in the vicinity of Pitman-Downer Road.

V. RECOMMENDATIONS

The preceding chapters of this report addressed a methodological approach in assessing roadway and intersection needs along Cross Keys and Pitman-Downer Road within the study limits.

Having completed that assessment with the identification of necessary traffic improvements, which at a minimum would be required to serve future study area traffic demand, the scope of the conceptual improvements were mapped on copies of the aerial photographs of the corridor. Subsequent follow-up meetings were held with representatives of Gloucester County's planning and engineering departments. The purposes of those sessions were to assess:

- The "global" impact of each of the alternate scenario's improvements;
- Conformity with Gloucester County's official map;
- Agreement with the County's current highway design standards/practices, and;
- Interrelationship of the improvements with specific access plans of impending developments.

The improvements cited in the preceding section of this report represent the minimum improvements required to support projected traffic volumes. The County, taking a longer term perspective and establishing minimum intersection configurations into account, modified that initial set of improvements. The set of selected improvements do, however, exceed those defined in the traffic analysis and generally correspond with the improvements included within Scenario III, the "Improve Cross Keys Road and Pitman-Downer Road" alternative.

The recommendations are summarized below and are illustrated in conceptual form on copies of the aerial photographs (these graphics are incorporated into a separate document as a supplement to this report).

- <u>CROSS KEYS ROAD</u>

1. Delsea Drive Intersection - Provide right-turn lanes on eastbound and westbound Cross Keys Road approaches. Install new traffic signal providing multi-phase, actuated and interconnected operation (per NJDOT project). *See sheet 1 of the aerials.*

2. Generally maintain the existing two lane roadway cross section between the Delsea Drive and the Bonnaire development frontage, west of Pitman-Downer Road. *See sheets 1 to 6 of the aerials.*

3. Provide a three lane cross section including one lane each for eastbound and westbound through travel, and a continuous two-way left-turn lane along the frontage of the Rolling Greens development. A westbound right-turn deceleration lane should be added as a complement to the above cross section in the vicinity of the proposed development's driveways. *See sheet 3 of the aerials.*

4. Provide a three lane cross section including one lane each for eastbound and westbound through travel, and a center left-turn lane along the frontage of the Bonnaire development. A westbound right-turn deceleration lane should be added in the vicinity of and as a complement to the driveways proposed to serve the development's commercial component as well as Belmont Boulevard. Continue three lane roadway cross section eastward into the western leg of the Pitman-Downer Road intersection. *See sheets 6, 7 and 8 of the aerials.*

5. Pitman-Downer Road Intersection - Provide center left-turn lanes on northbound and southbound Pitman-Downer Road approaches. Provide center left-turn lane within three lane cross section on western Cross Keys Road leg. Provide center left-turn lane within five lane cross section on eastern Cross Keys Road leg, consisting of: two eastbound departure lanes, the center left-turn lane, one westbound through travel lane and one westbound right-turn lane. Install two-phase, fully actuated traffic signal. *See sheet 8 of the aerials.*

6. Continue the five lane cross section on the east leg of the Pitman-Downer Road intersection through the Appletree Lane driveway intersection, approximately 1,100 feet east of Pitman-Downer Road to provide an eastbound left-turn lane at the intersection. *See sheets 8 and 9 of the aerials.*

7. East of Appletree Lane taper down to four lane cross section (two lanes eastbound and two lanes westbound). Carry four lanes eastward through the existing Fries Mill Road intersection and tie into the proposed Cross Keys Bypass. *See sheets 9 through 13 of the aerials.*

As a general guide the following design criteria have been incorporated into the recommendations (as illustrated on the aerials) to provide for the continued operations of Cross Keys Road.

- Proposed right of way equals 88 feet (per the official map).
- Provide 10 feet wide shoulders adjacent to four lane sections, between intersections from Pitman-Downer Road to the proposed Cross Keys Bypass (except in the Fries Mill Road intersection area -- taper back to existing geometry).

- Provide 5 feet wide shoulders in the areas to be widened to three lane cross section west of Pitman-Downer Road (e.g., along the frontages of the Rolling Greens and Bonnaire developments).
- Provide curb at reconstructed intersections (generally within 200 feet of the intersection).
- Travel lane widths are 15 feet when adjacent to curb at reconstructed intersections or 12 feet when adjacent to shoulders.

- PITMAN-DOWNER ROAD

1. Widen to provide three lane cross section (one lane northbound, a continuous two-way left-turn lane and one southbound lane) from just south of Cross Keys Road to the southern leg of the Greentree Road intersection. *See sheets 14 through 21 of the aerials.*

2. Cross Keys Road Intersection - See description above.

3. Fish Pond Road Intersection - Provide center left-turn lanes on all intersection approaches. Install two-phase, fully actuated traffic signal. *See sheet 17 of the aerials.*

4. Extend existing four lane cross section on south leg of Greentree Road intersection to increase area for storage into intersection. *See sheets 20 and 21 of the aerials.*

As a general guide the following design criteria have been incorporated into the recommendations (as illustrated on the aerials) to provide for the continued operations of Pitman-Downer Road.

- Proposed right of way equals 76 feet (per the official map).
- Provide 5 feet wide shoulders.
- Provide curb at reconstructed intersections (generally within 200 feet of the intersection).
- Travel lane widths are 15 feet when adjacent to curb at reconstructed intersections or 12 feet when adjacent to shoulders.

APPENDIX

"PROBABLE BUILD"
FUTURE TRAFFIC VOLUMES
(SCENARIO IV)

"PROBABLE BUILD" SCENARIO

As mentioned within Chapter IV of this report (FUTURE TRAFFIC CONDITIONS) a fourth future traffic volume scenario was developed for analysis of study area traffic conditions. Entitled the "Probable Build" scenario, this scenario projects future peak hour volumes in the same manner as described in the body of the report with the main differences being that Monroe Township's Planned Business Park (development #M13 in Table 5) has been omitted from the trip generation and distribution process. The assignment process for the Probable Build scenario's traffic volumes is analogous to the "Improve Cross Keys Road" scenario (Scenario II). That is, trips to/from the study area (to/from the west especially) were assigned to the study area roadways in the most direct fashion.

The purpose of preparing this traffic volume scenario was to provide a sensitivity analysis in assessing the levels of traffic volume which might be expected as a consequence of developments which are expected or likely versus those which only have the potential to be. All of the developments included in Table 5, except #M13, are in some stage of the development application, review and approval process in the respective municipality. Whether the development comes in as described is not certain, of course, but the best indication as to what may happen is already in the process and will most likely come to fruition within the planning horizon of this study (2013). The Monroe Township Planned Business Park (development #M13 in Table 5), on the other hand, is mostly speculation on the part of the township officials. Something may occur there and its scale could be very large, but the exact nature of the development or its timing are not clearly understood. As a consequence, the 1,000,000 square feet of office/warehouse space was derived to conservatively estimate future volume for the tract.

A.M. peak hour and P.M. peak hour traffic volumes were projected for the "Probable Build" alternative to show the level of traffic that can reasonably or probably be expected on the study area roadway system. Figures A-1 and A-2 illustrate these volumes.

Comparing the Probable Build scenario traffic volumes to full build total future traffic volumes per the Improve Cross Keys Road scenario (Scenario II) indicates that at the western end of the corridor -- where more constraints exist in accommodating growth -- the volume differential is not exceedingly large. It can, therefore, be concluded that the level of transportation improvements which are cited to serve potential development within the corridor are not out of scale to the traffic which might result from probable future development.

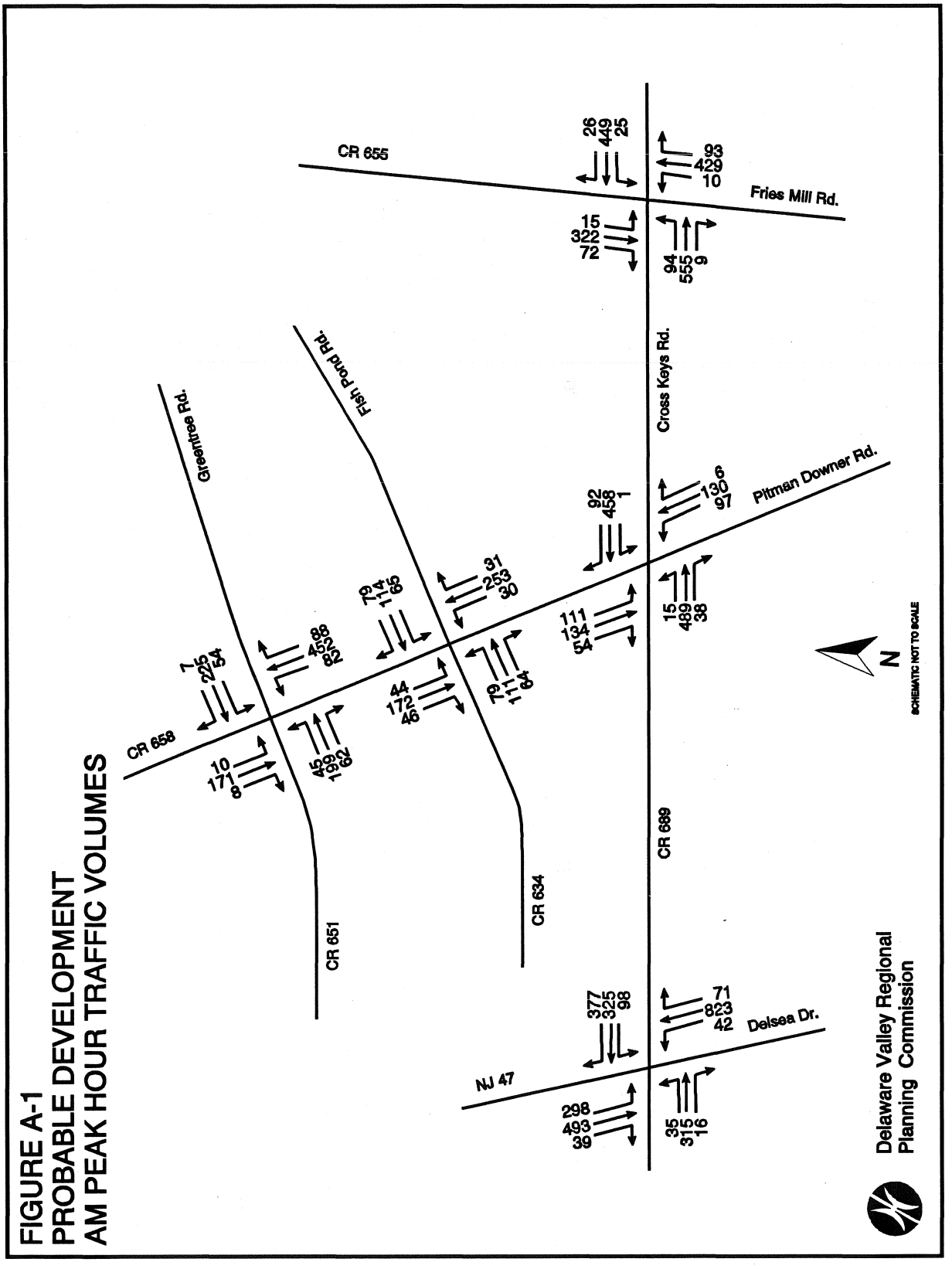
FIGURE A-1
PROBABLE DEVELOPMENT
AM PEAK HOUR TRAFFIC VOLUMES
CR 655
Fries Mill Rd.
Cross Keys Rd.
Greentree Rd.
Fish Pond Rd.
Pitman Downer Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
N
SCHEMATIC NOT TO SCALE
Delaware Valley Regional
Planning Commission

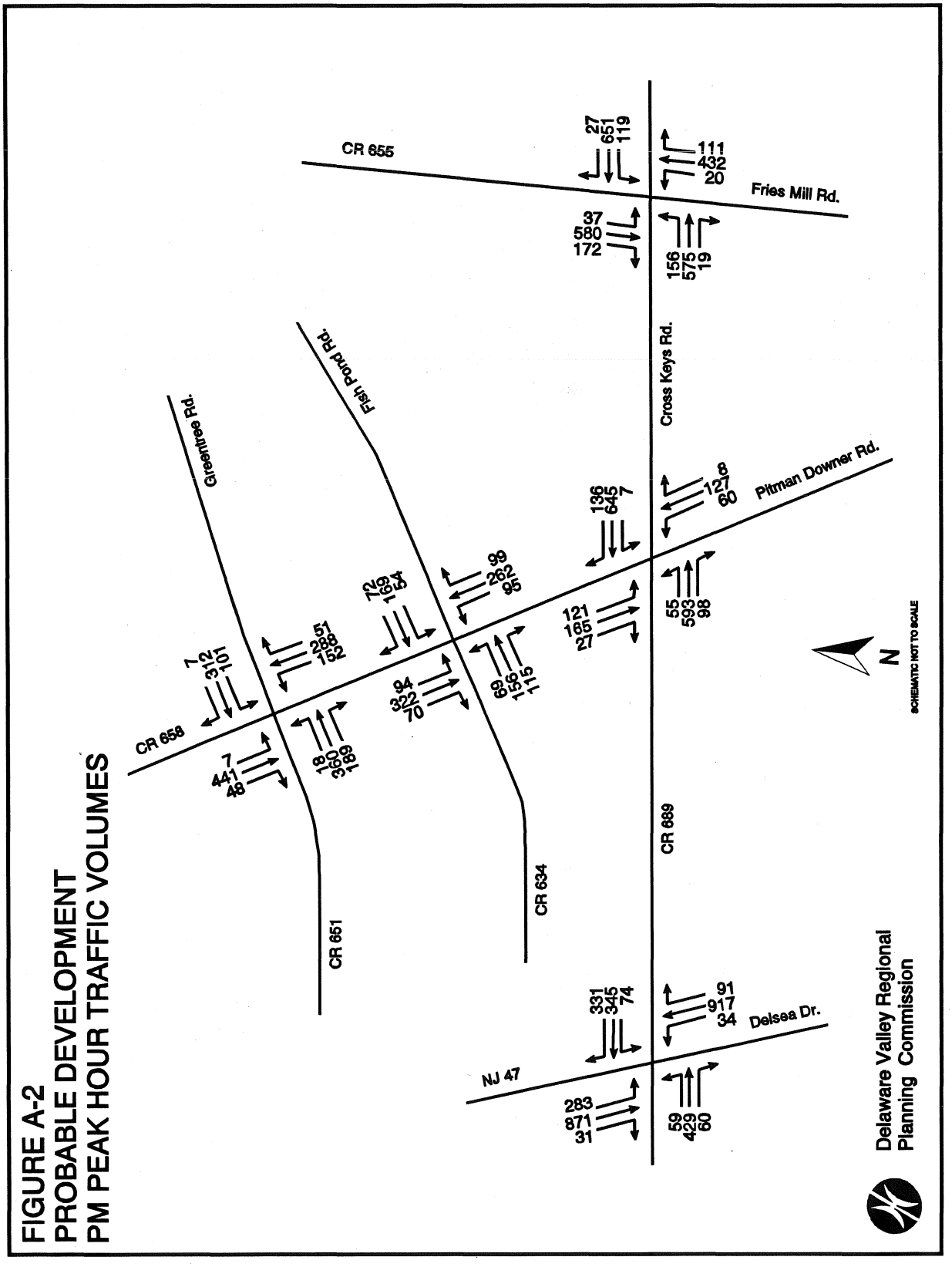
FIGURE A-2
PROBABLE DEVELOPMENT
PM PEAK HOUR TRAFFIC VOLUMES
CR 655
Fries Mill Rd.
Cross Keys Rd.
Fish Pond Rd.
Greentree Rd.
Pitman Downer Rd.
CR 658
CR 651
CR 634
CR 689
NJ 47
Delsea Dr.
N
SCHEMATIC NOT TO SCALE
Delaware Valley Regional
Planning Commission