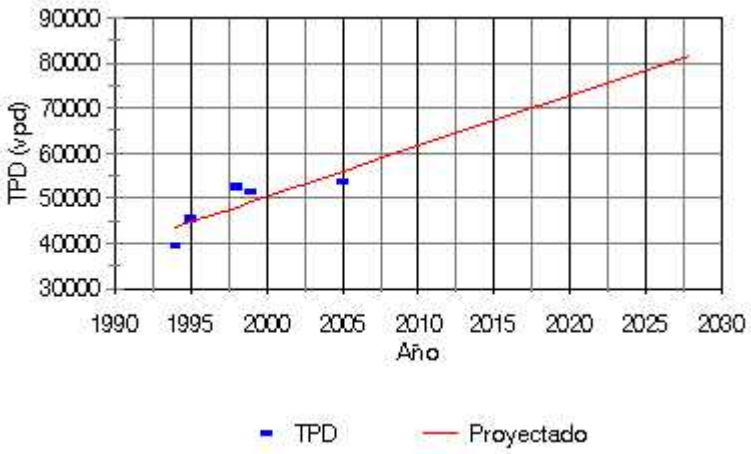
Apéndice 5. Determinación del Factor de Crecimiento del Tránsito Promedio Diario

Carretera PR-2, al norte de la Avenida Algarrobo

Año	TPD	Proyectado	Regression Output:	
1994	39390	43717	Constant	-2170945.60965722
1995	45400	44827	Std Err of Y Est	3978.58577512843
1998	52400	48159	R Squared	0.660218303595726
1999	51300	49270	No. of Observations	5
2005	53417	55934	Degrees of Freedom	3
2008		59266		
2028		81479	X Coefficient(s)	1110.66310162007
			Std Err of Coef.	460.02128482314



Ley de Interés Compuesto:

$$F = P(1+i)^n$$

$$\frac{F}{P} = (1+i)^n$$

$$1+i = \sqrt[n]{\frac{F}{P}}$$

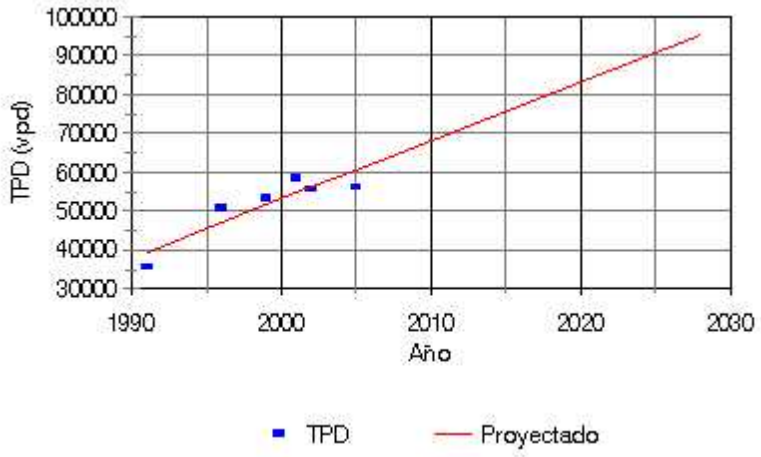
$$i = \sqrt[n]{\frac{F}{P}} - 1$$

$$i = \sqrt[34]{\frac{81479}{43717}} - 1$$

i = **1.8% anual**

Carretera PR-2, al sur de la Avenida Algarrobo

Año	TPD	Proyectado	Regression Output:	
1991	35480	39503	Constant	-2967428.99461807
1996	50600	47055	Std Err of Y Est	4148.84125208147
1999	53300	51585	R Squared	0.801649403936689
2001	58525	54606	No. of Observations	6
2002	55600	56116	Degrees of Freedom	4
2005	56007	60647		
2008		65178	X Coefficient(s)	1510.26229512327
2028		95383	Std Err of Coef.	375.618437974266



$$i = \sqrt[27]{\frac{95383}{39503}} - 1$$

i = **2.4% anual**

$$i_{prom} = \frac{1.8 + 2.4}{2} = 2.1\%$$

Se utilizó un valor de i = **2.1%** para hacer las proyecciones de flujo vehicular.

Apéndice 6. Generación, Asignación y Proyección de Viajes

GENERACIÓN DE VIAJES

Con el propósito de determinar el flujo vehicular que generará la urbanización Colinas de la Fuente se utilizó la referencia *Trip Generation* (**ITE, 2003**). Esta referencia define una serie de usos de terreno e indica el flujo vehicular que se espera que cada uso genere, basado en estudios realizados previamente.

La urbanización Colinas de la Fuente se compondrá de 447 unidades de vivienda de interés social a construirse en dos fases, una de 251 residencias y la otra de 196. Para estimar el flujo que generará este proyecto se utilizaron el uso de terreno 210 ("*Single-Family Detached Housing*") según definido por *Trip Generation* (**ITE, 2003**). El estimado de los viajes que generará el proyecto en las horas pico se realizó basado en el número de unidades de vivienda a construirse.

Tabla A6-1. Flujo Vehicular que Generará el Proyecto Propuesto

Hora Pico	Viajes Generados (veh/hr)		
	Entrando	Saliendo	Total
AM	85	240	325
PM	260	153	413

Al seguir el procedimiento definido por *Trip Generation* se obtuvo el número de viajes que generará la urbanización luego de ocupada. Los resultados se resumen en la tabla A6-1. Para la generación de viajes durante la hora pico de la mañana se utilizó la hora pico de la mañana del generador. Para la generación de

viajes durante la hora pico de la tarde se utilizó la hora pico de la calle adyacente entre 4:00 y 6:00 de la tarde. Para la mañana no se utilizó la hora pico de la calle adyacente debido a que la referencia ofrece la información si esta hora está entre 7:00 y 9:00 de la mañana, por lo que quince minutos de la hora pico se quedan fuera de este período. No hay una diferencia significativa en el origen de la información al haber utilizado la hora pico del generador por la mañana y la hora pico de la calle adyacente por la tarde ya que, generalmente, ambas horas pico coinciden (**ITE, 2003**)

DISTRIBUCIÓN DE VIAJES

Una vez determinado el flujo vehicular que generará el proyecto propuesto, se procedió a distribuir la nueva demanda de vehículos. Esta distribución se realizó basado en la proporción direccional obtenida en los conteos realizados recientemente en las cercanías del proyecto Colinas de la Fuente, durante un día laborable típico. En la figura 11 se ilustra como se distribuyeron, por la red de carreteras analizada, los viajes que se generarán.

PROYECCIÓN DEL TRANSITO

Para proyectar los conteos de flujo vehicular actuales hacia el futuro, se supuso que el volumen vehicular en el área de análisis crecerá a una razón similar al promedio del valor al que ha crecido en los últimos años en la carretera PR-2, a ambos lados de la avenida Algarrobo. Se obtuvieron datos históricos del flujo

vehicular en el sector, recopilados por el Departamento de Transportación y Obras Públicas (**ELA, 2005**) (**ELA, 1999**) (**ELA, 1994**) (**ELA, 1991**) y por esta oficina (**Pérez Berenguer y Asociados, 2002**). Con esos datos y los tomados en este estudio se desarrollaron ecuaciones de regresión lineal para determinar la curva que mejor se les ajusta. Los resultados se detallan en el Apéndice 5. Utilizando la ley de interés compuesto y el factor de crecimiento anual obtenido, se proyectaron los datos actuales al año 2008. En la figura A6-1 se ilustran los datos de flujo vehicular proyectados a dicho año. Estos datos proyectados se sumaron a los generados y distribuidos en la red analizada (figura 11) para obtener los viajes que la utilizarán en el año 2008 durante las horas pico (figura 12). Con la ley de interés compuesto y el factor de crecimiento anual obtenido se proyectaron esos datos al año 2028 para obtener el flujo durante las horas pico y se redistribuyeron de acuerdo a las condiciones futuras de la red vial. Estos últimos datos aparecen en la figura 13.

DISTRIBUCIÓN DE VIAJES PARA EL AÑO 2028

Debido a que se supuso que la red vial analizada habrá experimentado grandes cambios para el año 2028, hubo que modificar la distribución de viajes que se realizó para obtener los datos utilizados para el análisis operacional correspondiente al año 2008. Para la situación a largo plazo se supuso, de acuerdo al Plan Vial de Mayagüez, que existirán carreteras que actualmente no

existen, por lo que hubo que manejar la información de cierta manera que se tomaran estas nuevas vías en consideración. La vía que más afectó la distribución de viajes para el año 2028 fue la avenida Algarrobo, la que actualmente no llega hasta la finca donde se propone el proyecto ni continúa hacia el oeste en su intersección con la carretera PR-2, características que sí tendrá a largo plazo. Por ese motivo se manejó la información en las dos intersecciones analizadas tomando en cuenta esta nueva vía, lo que se detalla en las próximas secciones.

INTERSECCIÓN DE LA CALLE PRINCIPAL PERIFERAL NORTE (CAMINO CUBA) Y LA AVENIDA ALGARROBO

La distribución de viajes en esta facilidad, para el escenario a largo plazo, se realizó de acuerdo a los siguentes pasos:

1) Se estimó que entre las urbanizaciones Alturas de Mayagüez y Alturas de Algarrobo existen 500 residencias, que en los condominios de Alturas de Mayagüez existen 180 unidades de vivienda y que en los "walk-ups" aledaños (Westernlake Village y otro complejo existente en la intersección de la avenida Algarrobo y el camino Algarrobo) existen 150 unidades de vivienda. Estos estimados se basan en las visitas realizadas al área.
2) Se buscó en *Trip Generation* los usos de terreno que más se asemejaran a los condominios y a los "Walk-Ups". Estos fueron los usos 221 (*Low-Rise Apartment*) y 223 (*Mid-Rise Apartment*).

El uso de terreno 221 se refiere a unidades de vivienda localizadas en edificios de uno o dos niveles mientras que el uso de terreno 223 se refiere a apartamentos en edificios de entre tres y diez niveles. Esta información se utilizó para los "walk-ups" y condominios, respectivamente. En ambos casos la hora pico del generador típicamente coincide con la hora pico de la calle adyacente. Con esta información se obtuvieron datos relacionados a la cantidad de viajes que debe generar actualmente el área residencial descrita en el paso 1. La información obtenida se resume en la tabla A6-2.

Tabla A6-2. Viajes que Genera el Área Residencial Ubicada a lo Largo de la Avenida Algarrobo

Uso de Terreno	Hora Pico AM		Hora Pico PM	
	Entrando	Saliendo	Entrando	Saliendo
210	94	268	287	169
221	16	65	62	34
223	20	49	44	31
Total	130	382	393	234

3) Se restaron los viajes generados en el paso 2 a los datos del año 2008, ya que no se espera que se construyan nuevos proyectos de vivienda a lo largo de la actual avenida Algarrobo desde el presente hasta ese año. La resta se hizo distribuyendo los viajes generados de acuerdo a las proporciones actuales obtenidas en los conteos y restándolos a los movimientos correspondientes. Se supuso que los

residentes del área indicada entran o salen de la misma solamente a través de la avenida Algarrobo o del camino Algarrobo aun cuando existen otros dos caminos para entrar o salir del lugar, estos son Pitillo y Cristo de los Milagros. Esta suposición se hizo para obtener el escenario más crítico posible ya que se supuso que todos los viajes que salen del área descrita hacia el este transitan frente a la finca donde se propone Colinas de la Fuente, cuando esto no es así, quiere decir que, para el análisis se supuso que por el camino Cuba transitarán más vehículos provenientes del área descrita de los que, con toda probabilidad, lo harán. La distribución de los viajes generados se resume en la tabla A6-3.

Tabla A6-3. Distribución de los Viajes que Genera el Área Residencial Ubicada a lo Largo de la Avenida Algarrobo

Movimiento	Hora Pico AM	Hora Pico PM
Intersección Carretera PR-2 y Avenida Algarrobo		
E-N	60	61
N-E	24	107
E-S	159	112
S-E	56	159
Camino Algarrobo		
Saliendo de Alturas	163	61
Entrando a Alturas	50	127

Una vez se restaron los datos que aparecen en la tabla A6-3 de los que realizarán los diferentes movimientos en el año 2008, se determinó la cantidad de viajes que utilizaría la

intersección de la calle principal Periferal Norte (camino Cuba) y la avenida Algarrobo, si esta existiese. Para esto se supuso que los viajes que genere el área residencial indicada y transiten hacia o desde el este no utilizarían el camino Algarrobo para comunicarse con la calle principal Periferal Norte, si no que utilizarían la avenida Algarrobo a estos fines, por lo que harán los movimientos S-E o E-S en la intersección indicada. También se supuso que los ejes centrales de la avenida Algarrobo y de la calle de acceso a la urbanización Colinas de la Fuente estarían alineados. Los resultados obtenidos se resumen en la tabla A6-4.

Tabla A6-4. Distribución de los Viajes Resultantes en la Futura Intersección de la Calle Principal Periferal Norte y la Avenida Algarrobo

Movimiento	Hora Pico AM	Hora Pico PM
N-O	103	91
N-E	137	62
O-N	49	105
O-E	215	70
S-E	163	61
E-N	36	155
E-O	233	67
E-S	50	127

4) Para ambas horas pico, se redistribuyeron los viajes que generará el proyecto propuesto (movimientos N-O, N-E, O-N y E-N de la tabla A6-4) de acuerdo a la proporción de viajes que se ilustra en la tabla A6-4. Para la proporción se tomó en

consideración su origen y su destino y no el movimiento realizado (por ejemplo, se tomó en consideración que en el paso anterior 50 viajes, de todos los viajes que se ilustran en la tabla A6-4, tienen como destino el sur durante la hora pico de la mañana. Utilizando la proporción que represente 50 viajes a la suma de los que tienen como destino al sur, oeste y este se obtuvieron los viajes que saldrían del proyecto propuesto y seguirían por la avenida Algarrobo).

5) De forma similar a la descrita en el paso 4 se distribuyeron los movimientos O-E y S-E, de forma que se obtuvieron los viajes que realizarían los movimientos O-S y S-O.

6) Se utilizó el PHF determinado para el año 2008. Para los movimientos relacionados a la avenida Algarrobo, se utilizó el PHF que tienen los movimientos con origen similar, si corresponden a la calle principal Periferal Norte (origen o destino), o se calculó un promedio ponderado, si corresponden a la urbanización Colinas de la Fuente.

7) Los resultados obtenidos luego del paso 5 se proyectaron al año 2028, utilizando el factor de crecimiento anual calculado en este estudio y la ley de interés compuesto, para obtener los datos utilizados en el análisis operacional de esta intersección, para el escenario a largo plazo. Los resultados obtenidos se ilustran en la figura 13.

INTERSECCIÓN DE LA CARRETERA PR-2 Y LA AVENIDA ALGARROBO

La distribución de viajes en esta facilidad, para el escenario a largo plazo, se realizó de acuerdo a los siguientes pasos:

1) Debido a que la avenida Algarrobo se extenderá hasta la carretera PR-64, al sur de la comunidad El Maní, se obtuvieron datos históricos de TPD de la Autoridad de Carreteras y Transportación. Se obtuvo que 10300 vehículos transitaban diariamente para el 2001 por la mencionada carretera, al sur de la comunidad El Maní y al sur de la futura avenida Algarrobo mientras que para el 2002, 11600 vehículos lo hacían por la misma carretera, al norte de la mencionada comunidad. Estos datos se llevaron al año 2000, utilizando el factor de crecimiento anual calculado en este estudio y la ley de interés compuesto. También se supuso que la distribución direccional de este transito era 50/50.
2) Se supuso que el transito por los puntos indicados de la carretera PR-64 durante las horas pico era un 10% del TPD y se supuso que, a estas horas, la distribución direccional era similar a la de la carretera PR-2, al norte de la avenida Algarrobo. También se supuso que las horas pico en la carretera PR-64 son similares a las que se registran en la intersección de la carretera PR-2 y la avenida Algarrobo.
3) Se calculó la diferencia, por dirección, en los datos de tránsito que se detallan en el paso 2. De esta manera se

obtuvo la cantidad de vehículos que tienen como origen o destino a la comunidad El Maní. Se supuso que el resto de los vehículos utilizarían la avenida Algarrobo, de esta existir, entre las carreteras PR-2 y PR-64. Esto es un supuesto conservador ya que gran parte del tránsito que no esté relacionado a la comunidad El Maní continuará utilizando la actual carretera PR-64 aun cuando exista el tramo mencionado de la avenida Algarrobo.

4) Se proyectó al año 2005 el tránsito asignado al tramo indicado de la avenida Algarrobo, utilizando el factor de crecimiento anual calculado en este estudio y la ley de interés compuesto.

5) Para ambas horas pico, se distribuyó el tránsito del nuevo tramo de la avenida Algarrobo, en su intersección con la carretera PR-2 utilizando la proporción de acuerdo a los orígenes y los destinos de los viajes, de manera similar a los pasos 4 y 5 de la sección anterior. Se supuso que los viajes que realizarán el movimiento N-O serán usuarios nuevos de la intersección, que actualmente realizan ese mismo movimiento en la intersección de las carreteras PR-2 y PR-64. Un supuesto similar se realizó para los viajes del movimiento S-O ya que estos provendrían de la intersección de las carreteras PR-2 y PR-102. Los viajes para el movimiento E-O se le restaron, proporcionalmente, a los viajes que realizan los movimientos E-S y E-N.

6) El PHF para los nuevos movimientos se calculó utilizando el promedio ponderado de los PHF actuales de acuerdo a su origen.

7) Utilizando el factor de crecimiento anual calculado en este estudio y la ley de interés compuesto, se proyectaron al año 2028 los valores obtenidos en el paso 5 y se utilizaron para el análisis operacional correspondiente a ese escenario. Los resultados se ilustran en la figura 13.

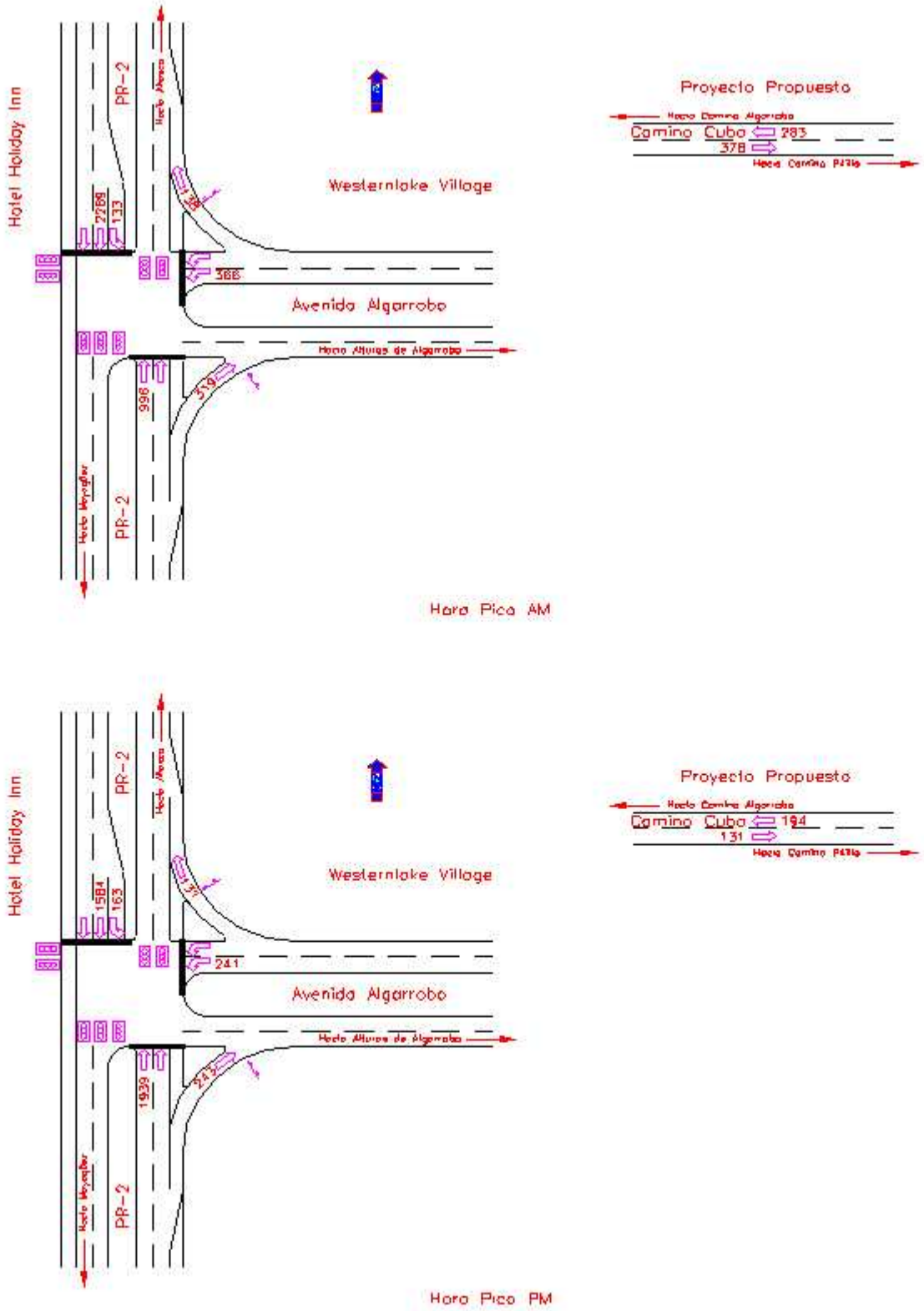


Figura A6-1. Viajes actuales durante ambas horas pico de un día laborable típico, proyectados al año 2008

Apéndice 7. Justificaciones para la Evaluación de la Instalación de Sistemas de Semáforos (ATSSA/ITE/AASHTO, 2003)

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.

The investigation of the need for a traffic control signal shall include an analysis of the applicable factors contained in the following traffic signal warrants and other factors related to existing operation and safety at the study location:

Warrant 1, Eight-Hour Vehicular Volume.
Warrant 2, Four-Hour Vehicular Volume.
Warrant 3, Peak Hour.
Warrant 4, Pedestrian Volume.
Warrant 5, School Crossing.
Warrant 6, Coordinated Signal System.
Warrant 7, Crash Experience.
Warrant 8, Roadway Network.

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Support:

Sections 8D.07 and 10D.05 contain information regarding the use of traffic control signals instead of gates and/or flashing light signals at highway-railroad grade crossings and highway-light rail transit grade crossings, respectively.

Guidance:

A traffic control signal should not be installed unless one or more of the factors described in this Chapter are met.

A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.

A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.

The study should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the above signal warrants.

Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics dictate whether an approach should be considered as one lane or two lanes. For example, for an approach with one lane for through and right-turning traffic plus a left-turn lane, engineering judgment could indicate that it should be considered a one-lane approach if the traffic using the left-turn lane is minor. In such a case, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.

Similar engineering judgment and rationale should be applied to a street approach with one lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turn traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.

At a location that is under development or construction and where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into stop-and-go operation to determine if the signal is justified. If not justified, the signal should be taken out of stop-and-go operation or removed.

For signal warrant analysis, a location with a wide median, even if the median width is greater than 9 m (30 ft), should be considered as one intersection.

Option:

At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" volume.

For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support:

When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option:

Engineering study data may include the following:

A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.
C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B above and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.
E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.
F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.
G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.

The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods specified in Item B of the preceding paragraph:

A. Vehicle-hours of stopped time delay determined separately for each approach.
B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
E. Queue length on stop-controlled approaches.

Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume

Support:

The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then the criteria for Warrant 1 is satisfied and Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then the criteria for Warrant 1 is satisfied and the combination of Conditions A and B is not needed.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1.....	1.....	500	400	350	280	150	120	105	84
2 or more...	1.....	600	480	420	336	150	120	105	84
2 or more...	2 or more...	600	480	420	336	200	160	140	112
1.....	2 or more....	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1.....	1.....	750	600	525	420	75	60	53	42
2 or more...	1.....	900	720	630	504	75	60	53	42
2 or more...	2 or more...	900	720	630	504	100	80	70	56
1.....	2 or more....	750	600	525	420	100	80	70	56

[a] Basic minimum hourly volume.
[b] Used for combination of Conditions A and B after adequate trial of other remedial measures.
[c] May be used when the major-street speed exceeds 70 km/h or exceeds 40 mph or in an isolated community with a population of less than 10,000.
[d] May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 70 km/h or exceeds 40 mph or in an isolated community with a population of less than 10,000.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:

A. The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or

B. The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100 percent columns.

Guidance:

The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:

A. The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and

B. The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.03 Warrant 2, Four-Hour Vehicular Volume

Support:

The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-2 may be used in place of Figure 4C-1.

Section 4C.04 Warrant 3, Peak Hour

Support:

The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

Standard:

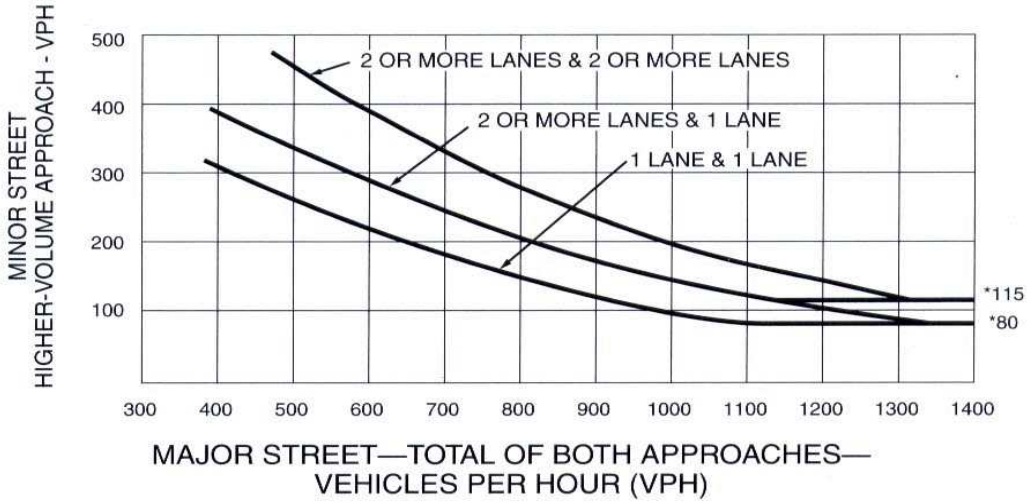
This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:

A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach; or 5 vehicle-hours for a two-lane approach, and

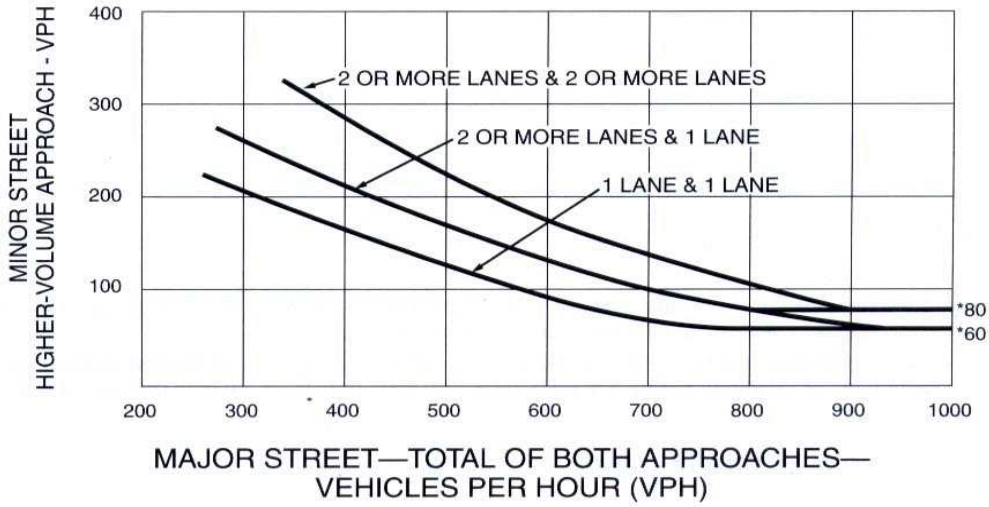
Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h OR ABOVE 40 mph ON MAJOR STREET)



*Note: 80 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor-street approach with one lane.

2. **The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes, and**
3. **The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.**

B. **The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.**

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-4 may be used in place of Figure 4C-3 to satisfy the criteria in the second category of the Standard.

Section 4C.05 Warrant 4, Pedestrian Volume

Support:

The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Standard:

The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that both of the following criteria are met:

A. **The pedestrian volume crossing the major street at an intersection or midblock location during an average day is 100 or more for each of any 4 hours or 190 or more during any 1 hour; and**
B. **There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular traffic.**

The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads conforming to requirements set forth in Chapter 4E.

Guidance:

If this warrant is met and a traffic control signal is justified by an engineering study, then:

A. If at an intersection, the traffic control signal should be traffic-actuated and should include pedestrian detectors.
B. If at a nonintersection crossing, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 30 m (100 ft) in advance of and at least 6.1 m (20 ft) beyond the crosswalk, and the installation should include suitable standard signs and pavement markings.
C. Furthermore, if installed within a signal system, the traffic control signal should be coordinated.

Option:

The criterion for the pedestrian volume crossing the major roadway may be reduced as much as 50 percent if the average crossing speed of pedestrians is less than 1.2 m/sec (4 ft/sec).

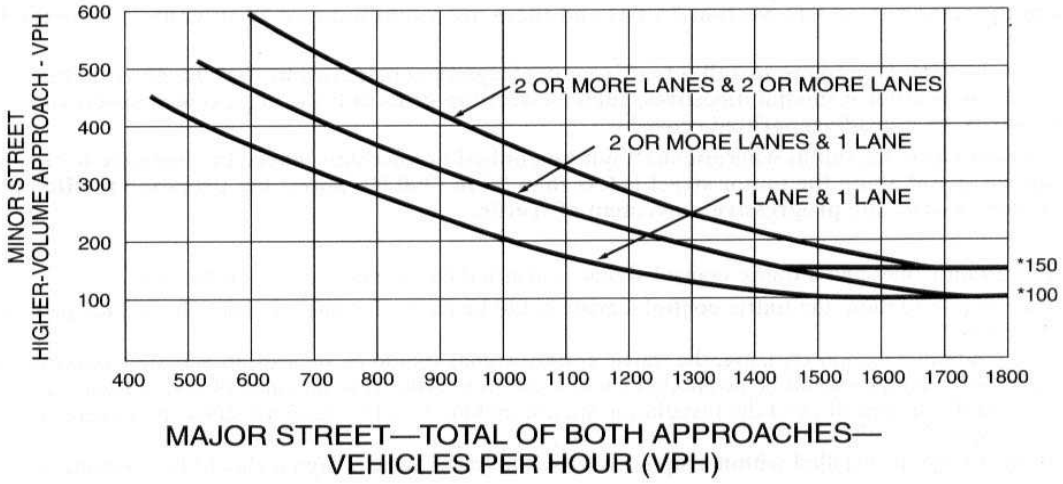
A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street, even if the rate of gap occurrence is less than one per minute.

Section 4C.06 Warrant 5, School Crossing

Support:

The School Crossing signal warrant is intended for application where the fact that school children cross the major street is the principal reason to consider installing a traffic control signal.

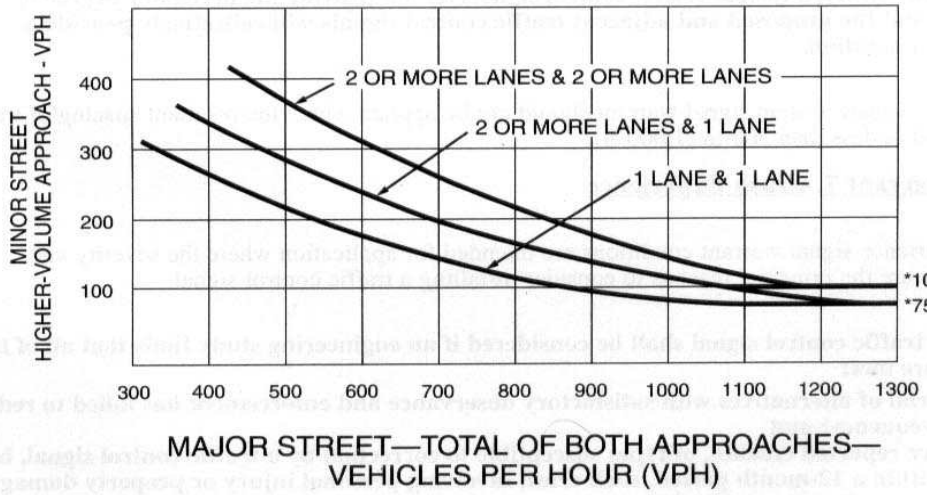
Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h OR ABOVE 40 mph ON MAJOR STREET)



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Standard:

The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the children are using the crossing is less than the number of minutes in the same period (see Section 7A.03) and there are a minimum of 20 students during the highest crossing hour.

Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Guidance:

If this warrant is met and a traffic control signal is justified by an engineering study, then:

A. If at an intersection, the traffic control signal should be traffic-actuated and should include pedestrian detectors.
B. If at a nonintersection crossing, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 30 m (100 ft) in advance of and at least 6.1 m (20 ft) beyond the crosswalk, and the installation should include suitable standard signs and pavement markings.
C. Furthermore, if installed within a signal system, the traffic control signal should be coordinated.

Section 4C.07 Warrant 6, Coordinated Signal System

Support:

Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that one of the following criteria is met:

A. On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.
B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

Guidance:

The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 300 m (1,000 ft).

Section 4C.08 Warrant 7, Crash Experience

Support:

The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:

A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and
B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and
C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not

less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.09 Warrant 8, Roadway Network

Support:

Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:

A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or

B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a nonnormal business day (Saturday or Sunday).

A major route as used in this signal warrant shall have one or more of the following characteristics:

A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow; or

B. It includes rural or suburban highways outside, entering, or traversing a City; or

C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

Apéndice 8. Curriculum Vitæ del consultor

José Luis Pérez Berenguer, M.S.C.E., P.E., P.T.O.E.
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Mayagüez, Puerto Rico 00681-6512
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CURRICULUM VITÆ

EDUCATION:

JANUARY 1992 TO MAY 1994
Master of Science in Civil Engineering, Pavement Design and Transportation. University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico. GPA: 3.70

AUGUST 1986 TO DECEMBER 1991
Bachelor of Science in Civil Engineering. University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico. Cum Laude

PROFESSIONAL LICENSES AND CERTIFICATIONS:

Professional Engineer - License 12673 P.E.

Professional Transportation Operations Engineer - Certificate Number 840

Certified Worksite Traffic Supervisor - Certification 54159

RESEARCH PROJECTS:

JULY 1998 TO FEBRUARY 1999
Análisis del Diseño de los Accesos, Facilidades de Transferencia Intermodal, Estacionamientos y "Kiss and Ride" en las Estaciones del Tren Urbano. Research supervisor of the undergraduate student Joel A. Martínez Vega for the UPR/MIT Tren Urbano Internship Program - coordinated by the Civil Infrastructure Research Center. Poster and presentation

JULY 1997 TO MAY 1998
Analisis de los Planes de Mantenimiento de Tránsito a Implementarse Durante la Construcción del Tren Urbano. Research supervisor of the undergraduate student Jorge L. Ramos Ortiz for the UPR/MIT Tren Urbano Internship Program - coordinated by the Civil Infrastructure Research Center. Written report, poster and presentation

SEPTEMBER 1996 TO MAY 1998
El Impacto Futuro en el Patrón de Flujo Vehicular en las Intersecciones Adyacentes al Corredor del Tren Urbano. Research supervisor of the undergraduate student Diego Torres for the UPR/MIT Tren Urbano Internship Program - coordinated by the Civil Infrastructure Research Center. Written report, poster and presentation

MARCH 1996 TO FEBRUARY 1998
Measurement and Analysis of Pavement Condition and Improvement of Existing Roughness Mathematical Models Applied to the Puerto Rico Highway Network. Principal Investigator, supported by the Puerto Rico Department of Transportation and Public Works - coordinated by the Civil Infrastructure Research Center. Written report poster and presentation

JUNE 1996 TO AUGUST 1996
Medidas y Análisis de Rugosidad en el Pavimento en la Red de Carreteras de Puerto Rico. Research supervisor of the undergraduate student Jorge L. Ramos Ortiz, sponsored by the Puerto Rico Alliance for Minority Participation. Written report, poster and presentation

AUGUST 1995 TO MAY 1996
Análisis Operacional de un Sistema de Transportación sobre Rieles; Plan de Servicio Propuesto para el Tren Urbano. Research supervisor of the graduate student Ginger M. Rossy Robles for the UPR/MIT Tren Urbano Internship Program - coordinated by the Civil Infrastructure Research Center. Written report and presentation

MAY 1992 TO MAY 1994
Develop of the thesis ***Análisis de datos de Rugosidad y Desarrollo de Modelos para Estimar la Tendencia del Deterioro de Pavimentos.*** Requirement to obtain a Master Degree in Pavement Design and Transportation Engineering Area. University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico. Written report and oral exam

PAPERS:

SEPTEMBER 1996
Replicabilidad de Medidas de Rugosidad del Pavimento Utilizando el equipo ARAN. Published. IX Congreso Panamericano de Ingeniería de Tránsito y Transportes, La Habana, Cuba

JULY 1996
Analysis of Roughness Measurements for Delineating Homogeneous Units for Pavement Management Application. Co-author, submitted for consideration to the Transportation Research Board 76th Annual Meeting

JUNE 1994
Un Nuevo Enfoque en el Análisis de Datos de Rugosidad para un Sistema de Gerencia de Pavimentos. Published. VIII Congreso Panamericano de Ingenería de Tránsito y Transportes, Ciudad de Mexico, Mexico

PRESENTATIONS:

DECEMBER 2, 1996 TO DECEMBER 6, 1996
Replicabilidad de Medidas de Rugosidad del Pavimento Utilizando el equipo ARAN. IX Congreso Panamericano de Ingeniería de Tránsito y Transportes, Capitolio Nacional, La Habana, Cuba

OCTOBER 24, 1996
Measurement and Analysis of Pavement Condition and Improvement of Existing Roughness Mathematical Models Applied to the Puerto Rico Highway Network. Civil Engineering Department, University of Puerto Rico - Mayagüez Campus. Sponsored by the Civil Infrastructure Research Center

APRIL 1994
Análisis de datos de Rugosidad y Desarrollo de Modelos para Estimar la Tendencia del Deterioro de Pavimentos. 29th ACS Junior Technical Meeting, University of Puerto Rico - Mayagüez Campus. Sponsored by Puerto Rico Alliance for Minority Participation.

WORK EXPERIENCE:

JULY 1994 TO PRESENT
Pérez Berenguer y Asociados; Principal, Transportation and Civil Engineer

AUGUST 1994 TO DECEMBER 1998
University of Puerto Rico - Mayagüez Campus, Department of Civil Engineering; Professor of the following courses in the Transportation and Civil Engineering Department:

Highway Location and Curve Design
Highway Engineering
Undergraduate Research
Seminar of Civil Engineering

OCTOBER 1992
Traffic Study in Lomas Verdes Ave. and Ramírez de Arellano Ave. at Guaynabo, Puerto Rico. Dr. Sergio L. González Quevedo - Consultant; Technical support

JANUARY 1992 TO MAY 1992
University of Puerto Rico - Mayagüez Campus; Teacher Assistant of Dr. José F. Lluch García, Construction Management Course

MARCH 1991 TO JANUARY 1992
Office for the Improvement of the Public Schools, Department of Education, Commonwealth of Puerto Rico; Engineer's Assistant, Field Inspector

DECEMBER 1990 TO JANUARY 1991
Office for the Improvement of the Public Schools, Department of Education, Commonwealth of Puerto Rico; Engineer's Assistant, Field Inspector

AUGUST 1990 TO DECEMBER 1990
University of Puerto Rico - Mayagüez Campus; Assistant of Dr. Milton R. Martínez Delgado (R.I.P.) in the development of Structural Analysis Computer Programs

GRADUATE COURSES TAKEN:

Analysis and Design of Public Transportation Systems
Urban Transportation Planning
Traffic Engineering I
Pavement Design
Advanced Engineering Economics
Bituminous Mix Design and Construction Techniques I
Bituminous Mix Design and Construction Techniques II
Pavement Management
Applied Soil Mechanics
Operations Research
Geosynthetics in Civil Engineering

Design of Intelligent Traffic-Control Systems

CONTINUING EDUCATION COURSES TAKEN

AUGUST 2005 TO PRESENT
Legal Aspects I - Vidal Rodríguez Amaro, J.D., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

JUNE 2005 TO JULY 2005
Summer Surveying Camp - Ernesto Arroyo Mora, M.S.C.E., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

JANUARY 2005 TO MAY 2005
Industrial Organization and Management - Fethi Calisir, PhD, University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

AUGUST 2004 TO DECEMBER 2004
Theory of Map Projection - Evi de la Rosa Ricciardi, M.S.C.E., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

SEPTEMBER 24, 2004
The Process of Forced Expropriation: Important Aspects for Engineers and Land Surveyors - Johnny Colón Díaz, P.E., Polytechnic University of Puerto Rico, San Juan, Puerto Rico

JANUARY 2004 TO MAY 2003
Physical Geodesy - Julio C. Ríos, M.S.L.S., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

AUGUST 2003 TO DECEMBER 2003
Adjustment Computations I - Julio C. Ríos, M.S.L.S., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

JANUARY 2003 TO MAY 2003
Geodetic Astronomy - Julio C. Ríos, M.S.L.S., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

AUGUST 2002 TO DECEMBER 2002
Special Surveys - José L. Flores Malavé, M.S.L.S., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

JANUARY 2002 TO MAY 2002
Topographic Drawing - José L. Flores Malavé, M.S.L.S., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

AUGUST 2001 TO DECEMBER 2001
Astronomy I - Leszekan Nowakowski, Ph.D., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

OCTOBER 13, 2001
Professional Traffic Operations Engineer Certification Exam Refresher Course - Benjamín Colucci Ríos, Ph.D., Institute of Engineers and Surveyors of Puerto Rico, San Juan, Puerto Rico

JULY 31, 2001
Addressing Lead-Based Paint Hazards During Renovation, Remodeling and Rehabilitation in Federally Owned and Assisted Housing -Benjamín Cintrón, Quantech - Fort Buchanan, Guaynabo, Puerto Rico. Sponsored by HUD

JANUARY 2001 TO MAY 2001
Photogrammetry I - José L. Flores Malavé, M.S.L.S., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

AUGUST 2000 TO DECEMBER 2000
Elements of Optics and Photography in Surveying and Photogrammetry - Linda L. Vélez Rodríguez, B.S.C.E., M.S.L.S., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

JANUARY 2000 TO MAY 2000
Geodesy I - José L. Flores Malavé, M.S.L.S., University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

JULY 14-16, 1998
Worksite Traffic Supervisor Training Course - James A. Brandon, Jr., P.E., American Traffic Safety Services Association. PGA Mariott Hotel, Palm Beach Gardens, Florida

JULY 1998
Public Transportation in Boston - Nigel Wilson, Ph.D. and Kenneth Kruckemeyer, Ph.D., MIT. Massachussetts Institute of Technology, Cambridge, Massachussetts

JULY 1997
Reglamentación y Procedimientos para el Desarrollo de Terreno y Permisos de Construcción en Puerto Rico - José F. Lluch García, Ph.D., P.E., Institute of Engineers and Surveyors of Puerto Rico (CIAPR). University of Puerto Rico-Mayagüez Campus, Mayagüez, Puerto Rico

JULY 1997
Public Transportation in Boston - Nigel Wilson, Ph.D. and Kenneth Kruckemeyer, Ph.D., MIT. Massachussetts Institute of Technology, Cambridge, Massachussetts

FEBRUARY 8, 1996
Standard Drawings of the Puerto Rico Highway and Transportation Authority - Isabel Cristina Victoria Jaramillo, M.S.C.E., PRHTA - Institute of Engineers and Surveyors of Puerto Rico (CIAPR), Hato Rey, Puerto Rico

SEPTEMBER 1995 TO DECEMBER 1995
Autocad I - Surveyor José Vigo, University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

JULY 1995
Public Transportation in Boston - Nigel Wilson, Ph.D. and Kenneth Kruckemeyer, Ph.D., MIT. Massachussetts Institute of Technology, Cambridge, Massachussetts

MEMBERSHIP IN PROFESSIONAL AND COMMUNITY ORGANIZATIONS:

Institute of Engineers and Surveyors of Puerto Rico (CIAPR) - License 12673 P.E.

Institute of Civil Engineers of Puerto Rico

Member - Institute of Transportation Engineers

Associate Member - American Society of Civil Engineers

Miembro - Centro Cultural Salvador Brau, Cabo Rojo

NOVEMBER 1998 TO NOVEMBER 2000
President, Asociación de Residentes de Urbanización y Extensión La Concepción, Inc., Cabo Rojo, Puerto Rico

NOVEMBER 1994 TO DECEMBER 1998
Tren Urbano Internship Program - coordinated by the Civil Infrastructure Research Center, University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

1995 TO 1998
Member of the University of Puerto Rico evaluating committee for grant the Dwight D. Eisenhower Scholarship for Transportation Engineering studies

NOVEMBER 1994 TO OCTOBER 1997
Faculty Advisor - Institute of Transportation Engineers, Student Chapter, University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

NOVEMBER 1995 TO AUGUST 1996
Member of the Academic Affairs Committee of the Civil Engineering Department, University of Puerto Rico - Mayagüez Campus, Mayagüez, Puerto Rico

WORK DONE BY THE OFFICE IN RELATED FIELDS:

NOVEMBER 2005
Traffic Study to analyze the impact of Colinas de la Fuente housing development in the adjacent area, to be located at Cuba road, Sabanetas ward, Mayagüez, Puerto Rico, for Mr. Javier López

NOVEMBER 2005
Maintenance of Traffic Plan for the Construction of Garage Isla Verde New Sanitary Pumping Station and Off-Site Force Line, located at Los Ángeles Frontage Road, Cangrejo Arriba ward, Carolina, Puerto Rico, for Paredes Luciano Architects

NOVEMBER 2005
Traffic Study to analyze the impact of Plaza Pla shopping center in the adjacent area, to be located at the State Highway PR-445, Km. 0.2, Guatemala ward, San Sebastián, Puerto Rico, for Mr. Raul Pla

OCTOBER 2005
Traffic Count to determine the Average Daily Traffic and the Traffic during a Typical Saturday at the Frontage Road of State Highway PR-2, Km. 149.5, Sabanetas ward, Mayagüez, Puerto Rico, for Mr. Santos Vélez

OCTOBER 2005
Traffic Study to analyze the impact of Mansiones de la Sultana housing development in the adjacent area, to be located at the José Bechara road, interior, Guanajibo ward, Mayagüez, Puerto Rico, for ADI, Inc.

SEPTEMBER 17 AND OCTOBER 1st, 2005
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

AUGUST 2005
Maintenance of Traffic Plan, Pavement Markings and Permanent Signing Design for Plaza Río Canas Shopping Center, to be located at Intersection of State Highways Ramal PR-2 and PR-585/A Street, Canas Urbano ward, Ponce, Puerto Rico, for VVK Arquitectura, C.S.P.

AUGUST 2005
Evaluation of the impact in the traffic of the adjacent area (including public hearing) of Mansiones del Club Housing Development, to be located at State Highway PR-308, adjacent to Club Deportivo del Oeste, Miradero ward, Cabo Rojo, Puerto Rico, for BEFA Holding

JULY 2005
Traffic Study to analyze the impact of Mansiones de Barceloneta housing development in the adjacent area, to be located at the State Highway PR-684, Km. 17.5, Palmas Altas ward, Barceloneta, Puerto Rico, for ADI, Inc.

MAY 2003 TO JUNE 2005
Maintenance of Traffic Plans for projects to be constructed in 27 municipalities as part of the Urban Cores Improvements Program, for the Directorate of Urbanism, Department of Transportation and Public Works

MAY 2005
Access, Maintenance of Traffic Plan, Pavement Markings and Permanent Signing Design for Villas de Porta Coeli housing development, State Highway PR-2, Km. 178.0, Minillas ward, San Germán, Puerto Rico, for Urbanización Villas de Porta Coeli, Inc.

MAY 2005
Traffic Study to analyze the impact of Baldwin's View residential complex in the adjacent area, to be located at the State Highway PR-833, Km. 13.0, interior, End of Emiliano Chinea Street, Frailes ward, Guaynabo, Puerto Rico, for Baldwin Investment Corp.

APRIL 2005
Traffic Study to analyze the impact of Villas de Porta Coeli housing development in the adjacent area, to be located at the State Highway PR-2, Km. 178.0, Minillas ward, San Germán, Puerto Rico, for Urbanización Villas de Porta Coeli, Inc.

MARCH 5 AND 12, 2005
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

DECEMBER 2004
Report with the results of an evaluation of the proposed street network of the future Multeado Estrella urban development, Playa ward, Ponce, Puerto Rico, for Administración de Terrenos de Puerto Rico

DECEMBER 2004
Traffic Study to analyze the impact of Monte Sierra housing development in the adjacent area, to be located at the State Highway PR-349, Km. 1.1, Quebrada Grande ward, Mayagüez, Puerto Rico, for Urbanización Monte Sierra, Inc.

OCTOBER 2004
Traffic Study (written report and comparison to public hearings) to analyze the impact of Frailes Centro shopping center in the adjacent area, to be located at the State Highway PR-873, Km. 0.8, Tortugo ward, San Juan, Puerto Rico, for Best Properties

OCTOBER 2004
Evaluation of the Traffic Impact Study (written report and comparison to public hearings) submitted by the proponents of the Expansion of the Actual Facilities of SER de Puerto Rico, located at 500 Báez street, Pérez Morris Housing Development, Universidad ward, San Juan, Puerto Rico, for Asociación de Residentes y Propietarios de la Urbanización Pérez Morris, Inc.

MAY 2003 TO OCTOBER 2004
Maintenance of Traffic Plan for the Reconstruction of Intersection number 5 (Junction of the State Highways PR-1, PR-25, PR-26 and PR-35), Santurce ward, San Juan, Puerto Rico for Orval E. Sifontes, A.I.A.

OCTOBER 2 AND 10, 2004
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

AUGUST 2004
Evaluation of the impact in the traffic of the adjacent area of Caribbean Medical Testing Center, located at 300 Clemson street, University Gardens Housing Development, Hato Rey Sur ward, San Juan, Puerto Rico, for Farmacias El Amal

AUGUST 2004
Evaluation of the impact in the traffic of the adjacent area of Terrazas del Turabo Housing Development, to be located at Reina de las Flores road, Rincón ward, Gurabo, Puerto Rico, for Terrazas del Turabo

MAY 2004
Traffic Count to determine the Average Daily Traffic at McKinley and Méndez Vigo streets, immediately at west of State Highway PR-2, Marina Meridional ward, Mayagüez, Puerto Rico, for Mr. Eduardo Ruiz Valentín

MAY 2004
Traffic Count to determine the Average Daily Traffic at the intersection of State Highway PR-2 and Carlos Chardón street, Río ward, Mayagüez, Puerto Rico, for Mr. Eduardo Ruiz Valentín

MAY 2004
Consultant hired by the opposite part in the procedures for a Necessity and Convenience Certificate for a Walgreens Drug Store proposed at Boulevard street, Pueblo ward, Bayamón, Puerto Rico, for Farmacias El Amal

MAY 2004
Traffic Study to analyze the impact of Laurel Sur Housing Development in the adjacent area, to be located at the State Highway PR-506, Km. 1.7, Coto Laurel ward, Ponce, Puerto Rico, for D.I.S., Inc.

MARCH 2004
Feasibility Study to Evaluate the Public Transportation System of the Municipality of Dorado, Puerto Rico - Project FTA - P.R. 80-X011 - Task 22-01, for the Municipality of Dorado

MARCH 6 AND 20, 2004
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

DECEMBER 2003
Traffic Study to analyze the impact of Plaza La Cumbre project in the adjacent area, to be located at the State Highway PR-199, Km. 4.0, Cupey ward, San Juan, Puerto Rico, for Álvarez-Díaz Group, P.S.C.

OCTOBER 2003
Report with the results of an evaluation of the future street network of Multeado Estrella urban development, Playa ward, Ponce, Puerto Rico, for Administración de Terrenos

SEPTEMBER 2003
Expert witness report of an accident occurred on September 27, 1997 in 435 Street, Villa Carolina Housing Development, Carolina, Puerto Rico, for Mrs. Sonia Carballo Fernandez

SEPTEMBER 13 AND 27, 2003
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

MARCH 29 AND APRIL 5, 2003
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

MARCH 2003
Expert witness report analyzing the Maintenance of Traffic Plan approved for the projects AC-014206 and AC-14207 (State Highway PR-142 Quebrada Arenas ward, Toa Alta, Puerto Rico), for American International Insurance Company

OCTOBER 5 AND 19, 2002
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

SEPTEMBER 2002
Composed Pavement Design for a frontage road of the State Highway PR-199, Río Piedras, Puerto Rico, for A.S. Consulting Engineers

SEPTEMBER 2002
Traffic Study to analyze the impact of the operation of Antonio S. Paoli Fine Arts Center in the adjacent area, to be located at Los Caobos Avenue, Bucaná Ward, Ponce, Puerto Rico, for Urban Venture Group, P.S.C.

JUNE 2002
Traffic Study to analyze the impact of a proposed housing development in the State Highway PR-4466, Km. 0.8, Bajura Ward, Isabela, Puerto Rico, for Mr. Hauger Martín Hau

APRIL 2002
Traffic Study to analyze the impact of the expansion of the Panamerican Terminal in the adjacent area, located at Lindbergh Street interior, Isla Grande sector, Santurce Ward, San Juan, Puerto Rico, for Royal Caribbean and RAY Architects Engineers

APRIL 6 AND 13, 2002
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

MARCH 2002
Traffic Study to determine the Average Daily Traffic at the State Highway PR-54, Km. 3.0, Guayama, Puerto Rico, for Mr. Oscar Rodríguez Crespo, R.I.P.

JANUARY 2002
Traffic Study to analyze the impact of the expansion of the Winnie's Active Learning Kids School in the adjacent area (including depositions at public audiences), located in the State Highway PR-104, Km. 1.9, Algarrobos Ward, Mayagüez, Puerto Rico, for WALKS

NOVEMBER 2001
Traffic Study to analyze the impact of Apartamentos Marazul housing and commercial development in the State Highway PR-187, Km. 9.7, Medianía Baja Ward, Loíza, Puerto Rico, for Ossam Construction

NOVEMBER 2001
Traffic Study to analyze the impact of Paraíso de Mayagüez housing development in the adjacent roads, Sábalos ward, Mayagüez, Puerto Rico, for Pulte Homes Caribbean

SEPTEMBER 29 AND OCTOBER 6, 2001
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

FEBRUARY 2001 TO JULY 2001
Inspector of the Project "Widening of the Bridge over Maricao River", located at the State Highway PR-120, Km. 11.30, Maricao, Puerto Rico, for Ingeniar Engineering Solutions, P.S.C.

JULY 2001
Traffic Study to analyze the impact of Garden State Commercial Center project in the State Highway PR-100, Kms. 3.3 to 4.6, Guanajibo and Miradero wards, Cabo Rojo, Puerto Rico, for Mr. Guisseppe Marino Damiani

JUNE 2001
Traffic Study to determine the Average Daily Traffic at the State Highway PR-980, Km. 1.1, Florida ward, San Lorenzo, Puerto Rico, for Mr. Rafael Martínez Santana

MARCH 28 AND APRIL 2, 2001
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

FEBRUARY 3, 2001
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Interamerican University of Puerto Rico at Arecibo

JANUARY 2001
Traffic Study to determine the Average Daily Traffic at the junction of the State Highways PR-3 and PR-901, Juan Martín ward, Yabucoa, Puerto Rico, for Farmacias El Amal

DECEMBER 2000
Traffic Study to determine the Average Daily Traffic at the junction of the State Highways PR-14 and PR-721 (including depositions at public audiences), Pueblo Norte and Pueblo Sur wards, Aibonito, Puerto Rico, for Farmacias El Amal

OCTOBER 2000
Traffic Study to determine the Average Daily Traffic at the State Highway PR-1, Km. 88.1, Lapa ward, Salinas, Puerto Rico, for Mr. Bernardo Olmeda Morales

SEPTEMBER 30, 2000
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

SEPTEMBER 2000
Traffic Study to analyze the impact of Haciendas El Monte project in the State Highway PR-2, Kms. 173.2 to 174.7, Cain Alto ward, San Germán, Puerto Rico, for Paseos de San Antonio Development Corporation

AUGUST 2000
Expert witness report with the results of a traffic study to analyze the impact of Percon Industrial park at the junctions of the State Highway PR-14 with the future Caribe Principal Street, State Highway PR-52, Puerto Viejo road and the future Contreras Avenue, Playa ward, Ponce, Puerto Rico, for Percon Development Corporation

MAY 2000
Traffic Count to determine the Average Daily Traffic at Ave. Del Pescador, La Parguera ward, Lajas, Puerto Rico, for Carlyle Benavent, M.D.

APRIL 1st, 2000
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

MARCH 2000
Expert witness report based on the results of an evaluation about the possible access for the project Percon Industrial Park, Playa ward, Ponce, Puerto Rico, for Percon Development Corporation

FEBRUARY 2000
Traffic Study to determine the Average Daily Traffic at the State Highway PR-348, Km. 8.8, Rosario Bajo ward, San Germán, Puerto Rico, for Félix J. Rodríguez Arroyo

DECEMBER 1999
Traffic Study to determine the impact of an extension of the PRTC facilities at the junctions of the State Highway PR-5 with the access of the Puerto Nuevo Distribution Center and the 11th street of Las Vegas Housing Development, Palmas ward, Cataño, Puerto Rico, for Puerto Rico Telephone Company

NOVEMBER 1999
Traffic Study to determine the Average Daily Traffic at the junction of the State Highways PR-921 and PR-9922, Collores ward, Las Piedras, Puerto Rico, for Mr. Carlos Beltrán Rodríguez

OCTOBER 16, 1999
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

OCTOBER 1999
Traffic Study to determine the Average Daily Traffic at the junction of the State Highways PR-189, PR-9919 and Hormazábal street, Pueblo Norte ward, Juncos, Puerto Rico, for Mr. Carlos L. Beltrán Rodríguez

JULY 1997 TO JULY 1999
Maintenance of Traffic Plan for the Bayamón Alignment Section Contract-Tren Urbano (project AC-500007), for ICA-Miramar Metro San Juan, Corp.

MAY 1999
Expert witness report of an accident occurred on June 21, 1998 in the junction of the State Highway PR-823 and the access to the construction project of the future PR-142, Quebrada Arenas ward, Toa Alta, Puerto Rico, for Mr. Ismael Díaz Santos

MAY 1999
Expert witness report of an accident occurred on May 27, 1996 in the State Highways PR-335, Km. 11.0, Indios ward, Guayanilla, Puerto Rico, for Mr. Frank A. Quiñones Martínez

MAY 1999
Pavement design for projects AC-000136, AC-100202 and AC-100203 (Mejoras a la PR-1 desde PR-735 a PR-170), Cayey, Puerto Rico, for A.S. Consulting Engineers

MARCH 13, 1999
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

FEBRUARY 1999
Traffic Count to determine the Average Daily Traffic at the State Highway PR-111, Km. 0.4 at Aguadilla, Puerto Rico, for Fidel De Frías, M.D.

NOVEMBER 1998
Expert witness report of an accident occurred on June 19, 1994 in the junction of the state highways PR-2 and PR-114, Sábalos ward, Mayagüez, Puerto Rico, for Eng. Pablo Crespo Pérez

OCTOBER 1998
Expert witness report of an accident occurred on December 6, 1997 in state highway PR-307, Km. 8.9, Boquerón ward, Cabo Rojo, Puerto Rico, for Mrs. Anabelle Rodríguez Sepúlveda

OCTOBER 1998
Report with the results of an evaluation about the proposed alternatives for the project AC-030108 (Conector PR-100 Intersección PR-101 a PR-301), Boquerón ward, Cabo Rojo, Puerto Rico, for Dr. Ricardo Ramírez Ramírez

OCTOBER 17, 1998
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

MAY 1998
Traffic Study to analize the impact of Isla Azul housing development, proposed at the State Highway PR-472, km. 2.7, Bejucos ward, Isabela, Puerto Rico, for Mr. Luis A. Pérez Villanueva

MAY 1998
Traffic Impact Study and preliminar design of access for the Parque de Diversiones de Luquillo (including depositions at public audiences), proposed at the State Highway PR-3, kms. 33.0 to 35.0, Mata de Plátano ward, Luquillo, Puerto Rico, for Fernando L. Rodríguez, P.E. & Associates

MARCH 1998
Evaluation of the Haul Route used by Betteroads Asphalt Corp. when operates the extraction area at Cercado and Cidra wards, Añasco, Puerto Rico, for Betteroads Asphalt Corp.

FEBRUARY 28, 1998
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

JANUARY 1998
Traffic Study to determine the impact of Garden State Commercial Center at the junction of the State Highways PR-100 and PR-311, Miradero and Guanajibo wards, Cabo Rojo, Puerto Rico, for Mr. Guisseppe Marino Damiani

DECEMBER 1997
Traffic Study to determine the impact of an extension of S.E.S.O. school at the junction of their access and the Cuba road, Miradero ward, Mayagüez, Puerto Rico, for Southwestern Educational Society

NOVEMBER 1997
Rigid Pavement Design for Project AC-006608 (State Highway PR-66, Carolina - Canóvanas, Puerto Rico), for Behar-Ybarra Associates

OCTOBER 4, 1997
Instructor - Review for the Professional Civil Engineer Exam, sponsored by the Institute of Engineers and Surveyors of Puerto Rico

AUGUST 1997
Traffic Count to determine the Average Daily Traffic at the State Highway PR-128, Km. 2.0, Yauco, Puerto Rico, for PCO Associates

APRIL 1997
Traffic Study to determine the Average Daily Traffic at the junction of the State Highways PR-102 and PR-308, La Garita Sector, Miradero ward, Cabo Rojo, Puerto Rico, for Chaibén J. Fas Alzamora, Esq.

AUGUST 1996
Quality tests of the asphalt concrete used on the parking of the Municipal Drop-Off Center, for the Municipality of Las Marías

JULY 1996
Traffic Study (written report and comparison to public hearings) to determine the Average Daily Traffic at the State Highway PR-3, Km. 16.3, Canóvanas, Puerto Rico, for Moravarcy Engineering Group.

JULY 1996
Traffic Study to determine the Average Daily Traffic at the State Highway PR-128, Km. 2.0, Yauco, Puerto Rico, for Moravarcy Engineering Group

MAY 1996
Pavement Design for the project AC-053603, Rehabilitation of State Highway PR-536, Santa Isabel, Puerto Rico, for A.S. Consulting Engineers

MARCH 1996
Origin and Destiny Study for the preliminary design of the future interchange of the State Highways PR-148 and PR-828, Bayamón and Toa Alta, Puerto Rico, for CSA Architects and Engineers

FEBRUARY 1996
Traffic Study to determine the Average Daily Traffic at the State Highway PR-110, Km. 9.7, Moca, Puerto Rico, for Moravarcy Engineering Group

NOVEMBER 1995
Traffic Study to determine the Average Daily Traffic at the junction of the State Highways PR-2 and PR-402, Añasco, Puerto Rico, for Moravarcy Engineering Group

AUGUST 1995
Pavement Design for preliminary design of State Highway PR-66 (Río Piedras-Loiza), for Lebrón Associates

JULY 1995
Pavement design for project AC-001732 (Mejoras inmediatas a carretera PR-17), Jesús T. Piñero Avenue, Hato Rey, Puerto Rico, for Lebrón Associates

JULY 1995
Pavement design for Piers N 1/2 & O. San Juan, San Juan, Puerto Rico, for EBP Design Group Consulting Engineers

MARCH 1995
Traffic Study to determine the Average Daily Traffic at the State Highway PR-111, Km. 4.0, Moca, Puerto Rico, for Moravar Engineering Group

MARCH 1995
Traffic Study to determine the Average Daily Traffic at the State Highway PR-420, Km. 5.2, Moca, Puerto Rico, for Moravar Engineering Group

FEBRUARY 1995
Traffic Study to determine the Average Daily Traffic at the State Highway PR-115, Km. 26.6, Aguada, Puerto Rico, for Moravar Engineering Group

SEPTEMBER 1994
Structural evaluation of the streets of Montesol Housing Development for the Municipal Legislature of Cabo Rojo