SECTION D
PUERTO RICO HIGHWAYS

As explained in the main Alliance Report, the specific highways determined to comprise the LATTS Strategic Highway System were identified using a series of criteria to help identify a network of highways which had the greatest significance regarding trade with Latin America. The 22,859-mile mainline LATTS Strategic Highway System shown in Exhibit D-1 is the result of this process.

Just under two percent of the mainline LATTS Strategic Highway System (419 miles) is located in Puerto Rico (Exhibit D-2). The Puerto Rico components[1] include the following:

- All of Puerto Rico's 250 miles of interstate highways
- All of Puerto Rico's 125 miles of non-interstate National Highway System (NHS) facilities
- 44 miles of non-NHS facilities
- LATTS connectors linking a LATTS Strategic Highway with a LATTS airport or waterport were included in the Strategic Highway System. However, because of database differences, it was not possible to analyze LATTS connectors in the same manner and to the same level of detail as for mainline highways. LATTS connectors are discussed at the conclusion of Section D.

Exhibit D-3 displays the composition of Puerto Rico's portion of the LATTS highways by system.

[1] Mileage, number of lanes, pavement condition and other data reported herein were taken from the HPMS Database, as discussed subsequently, and may differ from information in other databases.

Exhibit D-1
LATTS STRATEGIC HIGHWAY SYSTEM

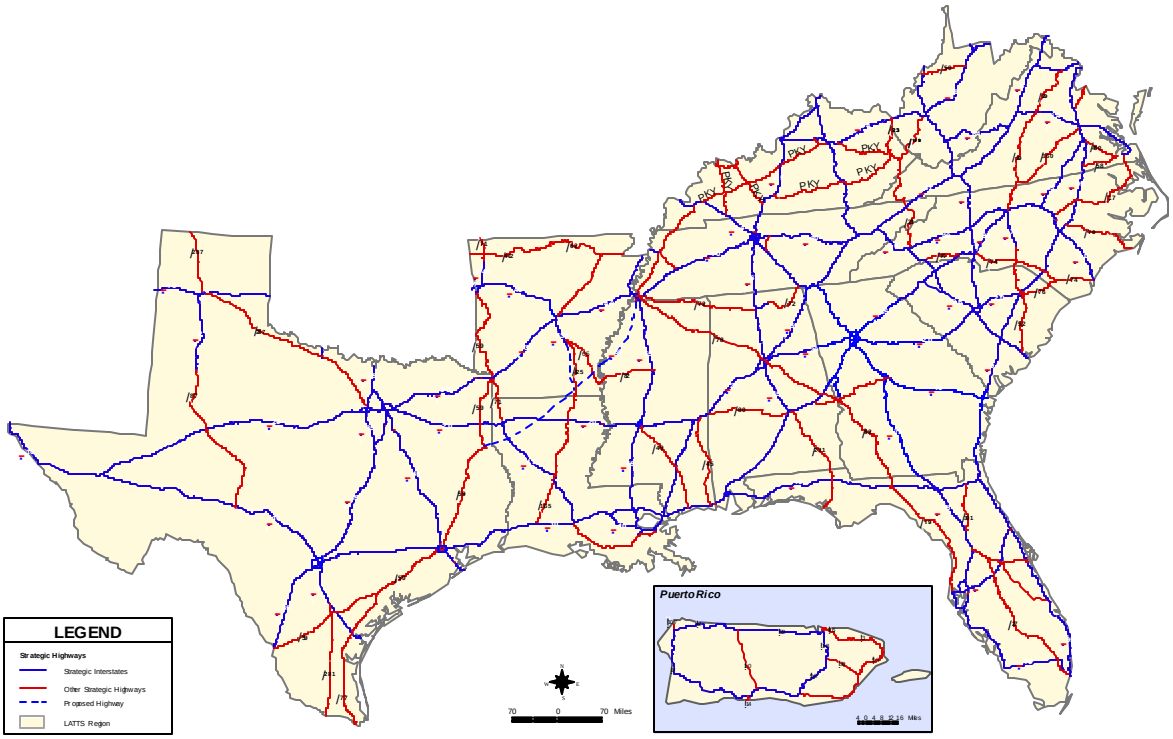


Exhibit D-2
PUERTO RICO LATTS HIGHWAY SYSTEM

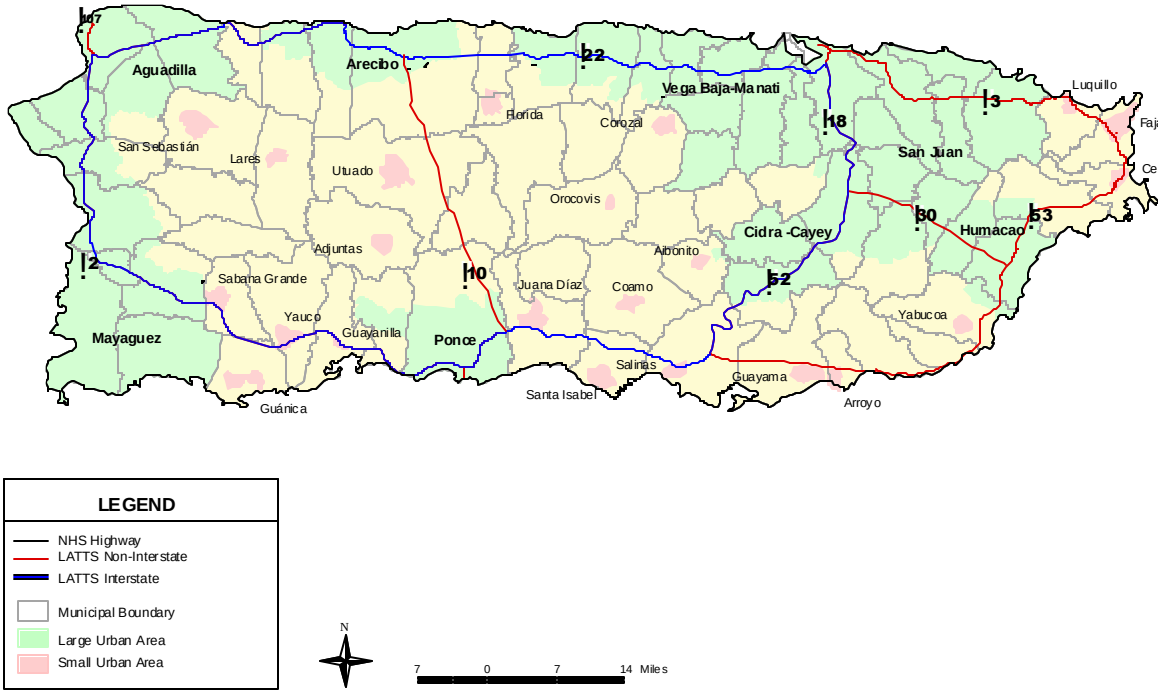
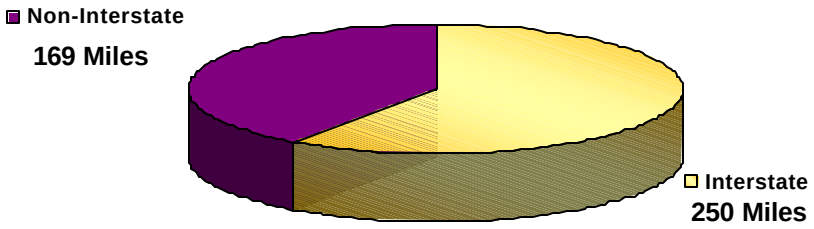


Exhibit D-3
LATTS MAINLINE STRATEGIC HIGHWAY SYSTEM – PUERTO RICO PORTION



419 Miles Total

Excludes LATTS Connectors

LATTS HIGHWAYS VS. LATTS TRADE CORRIDORS

The 22,859 miles of "mainline" LATTS Strategic Highways were grouped into 25 LATTS Trade Corridors (Exhibit D-4). The Trade Corridors were established using logical origins/destinations and assigning each highway to only one corridor. Each corridor was assigned a number (1-25) and was referred to by the primary highway within the corridor (i.e.,
I-40).

In recognition of the unique nature of Puerto Rico and the regional scale of LATTS, all of the 419 miles of LATTS highways were designated as LATTS Trade Corridor No. 25 for purposes of this study.

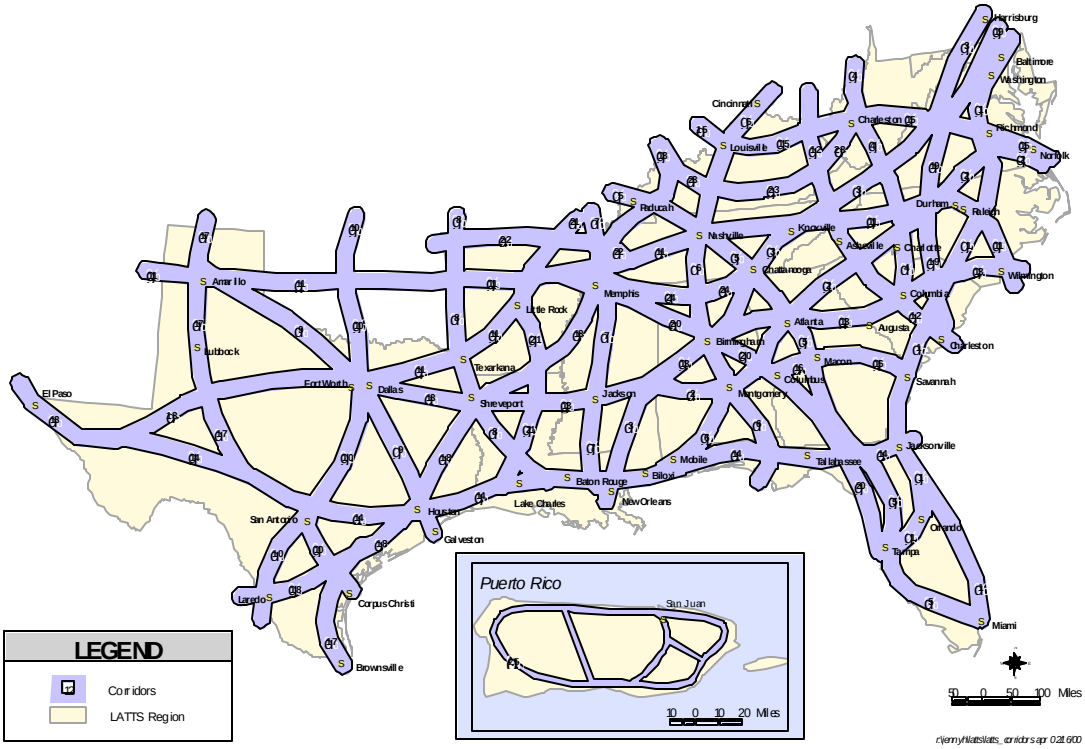
HIGHWAY DATABASES

Two main sources of data were used for the analysis of highway investment. The first one, the Highway Performance Monitoring System (HPMS), includes information about the characteristics and conditions of public highways. The second source of data was the LATTS estimates of current and forecasts of future Latin America trade flows.

HPMS Database

The HPMS database was selected for the LATTS analyses of highway system investment needs because (1) it covered the entire Alliance Region, (2) it employs a consistent format and data definitions and (3) no additional primary data collection was necessary. Nevertheless, it was recognized that (1) the data is time sensitive (i.e., since the latest available information at the time of these analyses was for 1997, it is expected that improvements and additions will have occurred subsequently) (2) the HPMS database may have minor differences relative to other databases that individual Alliance members might use for their own planning and system management purposes and (3) information is not always available for every segment of the LATTS Strategic Highway System.

Exhibit D-4
LATTS TRADE CORRIDORS



For this study, only that portion of the HPMS database corresponding to the selected LATTS Strategic Highway Network was utilized. For Puerto Rico, the LATTS HPMS database consisted of 276 records describing the 419 miles of highway on the LATTS Strategic Highway Network.

Trade Flows

As explained in the main Alliance report, 1996 and expected 2020 trade volumes with Latin America were estimated and the portion of this trade that would be using highway facilities was translated into truck flows. The truck flows were then assigned to specific highway facilities using GIS generated shortest time paths. The LATTS truck traffic assignment was then merged with the LATTS HPMS database for further analysis.

The LATTS procedure for assigning truck flows is appropriate for a macro-scale study such as LATTS. However, the island nature of Puerto Rico and the scale of the LATTS Strategic Highway System were such that they did not accommodate this truck assignment process. Accordingly, Puerto Rico was treated as a single "zone" (i.e., origin and destination) for purposes of the LATTS trade flow analyses. Given the macro-scale nature of the trade flow analyses, no determination was made regarding where in Puerto Rico particular trade flows originated or terminated. For purposes of this regional study, an assignment of LATTS truck flows to specific roadway facilities in Puerto Rico was not undertaken, i.e., they were simply assigned to "Corridor 25."

Accordingly, the analyses which are reported herein were based primarily on the information contained in the HPMS database. This approach was useful in identifying the conditions existing on Puerto Rico's portion of the LATTS Strategic Highway System and the needs associated with these highways.

LATTS TRUCK TRAFFIC IN PUERTO RICO

The HPMS database was used to quantify total truck traffic in terms of annual Vehicle Miles of Travel (VMT). Results of this analysis by functional classification for 1997 and 2020 are illustrated in Exhibit D-5. More detailed information is presented in Exhibit D-6.

Exhibit D-5
LATTS ANNUAL TRUCK VMT IN PUERTO RICO

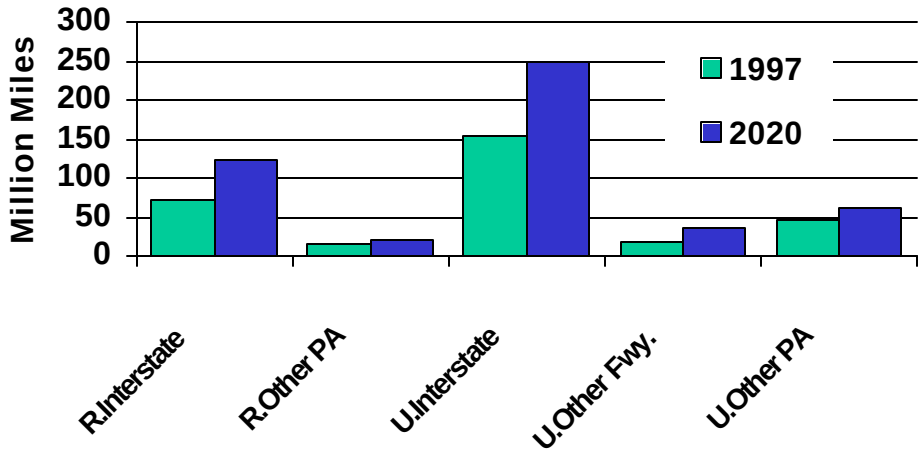


Exhibit D-6
PUERTO RICO LATTS TRUCK TRAFFIC

Corridor/ Functional Class	Length (Miles)	Annual Truck VMT (Million Miles)	
		All Trucks 1997	All Trucks 2020
25	**PR-2, PR-3**		
R.Interstate	102.10	73.30	125.34
R.Other PA	74.85	16.32	19.60
U.Interstate	147.66	155.96	249.45
U.Other Fwy.	21.84	19.10	35.86
U.Other PA	72.86	47.88	62.33
TOTAL	419.31	312.56	492.57

One-half of the total truck traffic occurs on urban interstate facilities and another 23 percent is on the rural interstate system. Truck traffic on Puerto Rico's portion of the LATTS Strategic Highway System is forecast to grow from 312 million truck miles in 1997 to 493 million truck miles in 2020, a 58 percent increase.

IMPACT MEASURES

The purpose of the highway analysis portion of this study was to quantify the LATTS Strategic Network total investment needs and the incremental investment needs that could be attributed to LATTS truck traffic specifically. Because of the macro-scale nature of this study, the investment needs analysis focused on capacity and pavement resurfacing needs.

Minimum tolerable conditions (MTCs) for both congestion (capacity) and pavement conditions were applied uniformly to all segments of the LATTS Strategic Highway System. These MTCs are described in more detail in the main Alliance report and are summarized below.

- Capacity needs were based on Level of Service (LOS) not exceeding:
  - LOS C for rural highways
  - LOS D for urban highways

- Pavement resurfacing needs were based on the following minimum pavement condition rating:
  - Interstate type facilities: PSR 3.0
  - Other facilities: PSR 2.5

The LATTS minimum tolerable conditions are in no way intended to replicate or replace values that individual members of the Alliance might consider to be more appropriate for their circumstances. The LATTS MTCs were established for this study so as to be consistent for all the Alliance members.

To price the identified capacity or pavement needs, the same unit costs were used consistently throughout the Alliance Region. These unit costs were provided by the FHWA and correspond to 1997 national averages. To maintain consistency throughout the Region, no attempt was made to tailor these unit costs to each state beyond the stratification provided by the FHWA.

CAPACITY NEEDS

A needs analysis model was developed to analyze capacity needs for 1997 and 2020. The model was applied to every one of the HPMS records comprising the Puerto Rico LATTS highway database and the results were summarized. This model applied the same methodology, outlined in the main Alliance report, and found in the HPMS Analytical Package, to calculate capacity needs. The results reflect the information contained in the HPMS Database and do not consider any improvements that may have occurred subsequently or any planned improvements.

Detailed results for Puerto Rico are presented in Exhibit D-7. The total number of Puerto Rico LATTS Strategic Highway Network road miles with capacity deficiencies in 1997 and 2020 are shown.

These analyses indicate 87 of the LATTS roadway miles in Puerto Rico, or 21 percent of the Puerto Rico portion of the Strategic Network, have existing capacity problems. The analyses also show that the majority of the capacity deficiencies will occur in the next 20 years. Unless capacity is added, 222 roadway miles or 53 percent of the LATTS facilities in Puerto Rico, will experience congestion in 2020.

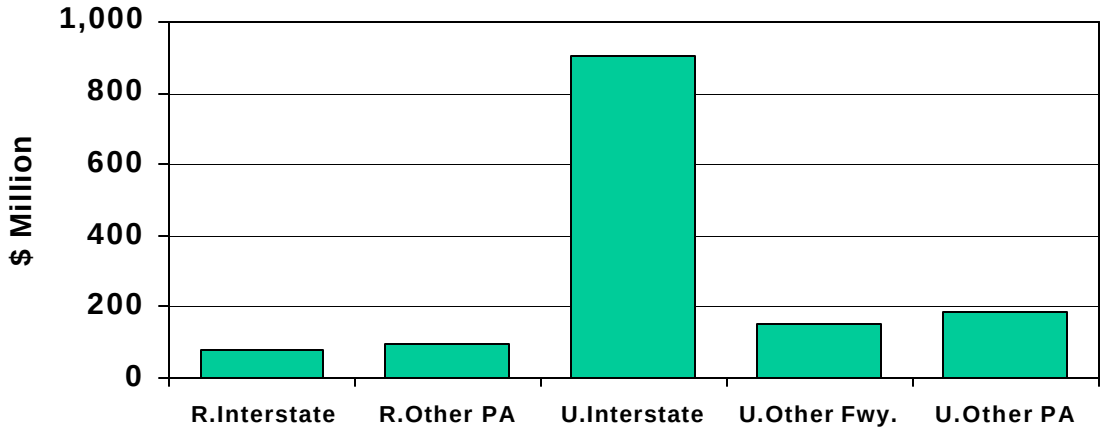
Exhibit D-7
PUERTO RICO CAPACITY INVESTMENT NEEDS

Corridor/ Functional Class	Length (Miles)	Existing Lane Miles	Capacity Analysis			
			Deficient Mileage		Needed	Cost
			1997	2020	Lane Miles 2020	in $Million 2020
25	**PR-2, PR-3**		**Puerto Rico**			
R.Interstate	102.10	410.96	1.99	37.04	74.08	83
R.Other PA	74.85	227.87	29.12	36.07	82.72	93
U.Interstate	147.66	709.52	30.15	88.14	261.20	907
U.Other Fwy.	21.84	87.36	0.55	16.78	43.77	152
U.Other PA	72.86	287.24	25.70	44.01	95.61	186
TOTAL	419.31	1,722.95	87.51	222.05	557.38	1,421

LATTS truck traffic will be affected by all the capacity deficiencies regardless of the traffic source. As congestion increases, LATTS trucks like other traffic will experience lower operating speeds, frequent speed changes, lower reliability, and increased operating costs.

The cost of addressing these capacity needs through 2020 is illustrated in Exhibit D-8. Based on the HPMS expected growth in traffic, nearly $ 1.4 billion will be required in the next 20 years to address congestion problems on Puerto Rico's portion of the LATTS Strategic Network. The majority of these capacity needs (64 percent) are for the urban interstate system.

Exhibit D-8
PUERTO RICO STRATEGIC HIGHWAY NETWORK
Total 2020 Capacity Needs by Functional Class



PAVEMENT NEEDS

For purposes of this study, average annual pavement needs in 2020 were estimated. The number of years it would take for the pavement to deteriorate from new in 2020 to a deficient PSR rating (as defined by the minimum tolerable conditions presented earlier) was calculated for each highway segment. As an indicator of the existing condition of the network, pavement deficiencies were identified for 1997.

Pavements typically are designed to last for a fairly long time. However, as they age and are subjected to traffic loads, they deteriorate. The pavement life measure used in these analyses is dependent on the amount of traffic using the highway and, more specifically, truck traffic (car traffic is a factor in the pavement deterioration rate but it has far less impact). The type of pavement (for example high flexible versus high rigid) is also an important factor affecting pavement deterioration rates. The pavement type on each highway segment, as indicated by the 1997 HPMS database, was used in the estimation of the deterioration rates. The number of lanes indicated for 1997 was used in the calculation of pavement deterioration rate and resurfacing costs. No attempt was made to measure the impact on pavement needs of adding lanes to address the congestion problems identified earlier. Finally, the HPMS-AP methodology for deteriorating pavement was applied in this study. It is based on the concept of 18Kip Equivalent Single Axle Loads. Weather condition or type of subsoil can also influence pavement deterioration rates but, for this study, no other factors beyond traffic and pavement type were used to differentiate pavement deterioration rates between sections.

Puerto Rico's pavement needs for the LATTS Strategic Highway Network are presented in Exhibit D-9. Based on the HPMS data, only 10 percent or 43 miles of the Puerto Rico overall LATTS Strategic Highway Network had existing (1997) pavement deficiencies. More than 10 percent of the rural interstate system and only 5 percent of the urban interstate system had existing pavement deficiencies.

Exhibit D-9
PUERTO RICO STRATEGIC HIGHWAY NETWORK
Resurfacing Needs

Corridor/ Functional Class	Length (Miles)	Existing Lane Miles	Pavement Analysis		
			1997 Deficient Mileage	Pavement Life (Years) 2020	Average Annual Cost ($1,000) 2020
25	**PR-2, PR-3**		**Puerto Rico**		
R.Interstate	102.10	410.96	10.81	11.3	4,020
R.Other PA	74.85	227.87	9.69	12.7	1,439
U.Interstate	147.66	709.52	7.21	7.6	22,336
U.Other Fwy.	21.84	87.36	4.93	7.2	2,925
U.Other PA	72.86	287.24	10.25	12.3	3,527
TOTAL	419.31	1,722.95	42.90	9.9	34,248

Pavement life for the Puerto Rico portion of the LATTS Strategic Highway Network life will average 9.9 years in 2020. The annual resurfacing costs for the Puerto Rico portion of the Strategic Highway Network will exceed $34 million per year by 2020.

OPERATING SPEEDS

Truck operating speed was chosen as a key study performance measure for the LATTS Strategic Highway Network. Truck operating speeds were estimated for each LATTS roadway segment based on the conditions of the roadway, including roadway geometry and alignment, pavement condition, speed limit and traffic volumes. The operating speed calculation for each sample segment or link was based on the methodology of the HPMS Analytical Package used by FHWA to estimate highway needs.

Two types of operating speeds were calculated. One was the average daily operating speed and the other was the peak hour operating speed as defined by the peak hour factor or "K" factor for each road segment. Truck operating speeds were calculated for each LATTS roadway section.

Truck operating speeds on the Puerto Rico portion of the LATTS Strategic Highway Network are presented on Exhibit D-10. In this exhibit, Puerto Rico truck operating speeds estimates are presented by functional class. The total lengths of all the segments used in the analysis are listed first. This is followed by items describing the characteristics of the segments, including average number of lanes, speed limit, and AADT. The purpose of listing these items is to facilitate better understanding of the calculated operating speeds. For example, two/three-lane highways have lower operating speeds than equivalent four-lane highways because of passing difficulties.

Similarly, low speed limits will result in low operating speeds on facilities no matter what the road conditions are.

Exhibit D-10
PUERTO RICO TRUCK OPERATING SPEEDS

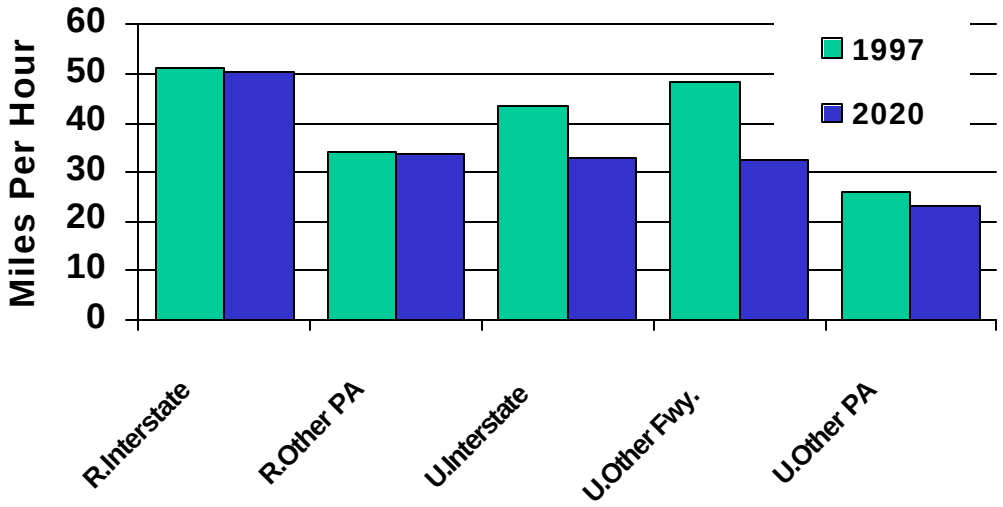
Corridor/ Functional Class	Length (Miles)	Average No. Lane	Speed Limit (MPH)	Average 1997 AADT	1997 Truck Speed (MPH)		2020 Truck Speed (MPH)	
					Daily Average	Peak Hour	Daily Average	Peak Hour
25	**PR-2, PR-3**		**Puerto Rico**					
R.Interstate	102.10	4.0	54.0	32,116	51.3	50.4	50.1	37.9
R.Other PA	74.80	3.0	42.2	12,492	34.3	32.7	33.6	29.6
U.Interstate	147.70	4.8	51.8	62,673	43.6	25.1	33.1	17.6
U.Other Fwy.	21.80	4.0	54.3	50,756	48.2	30.6	32.3	18.2
U.Other PA	72.90	3.9	42.2	34,659	25.9	18.3	23.3	15.2
TOTAL	**419.30**	**4.1**	**48.5**	**40,787**	**38.8**	**28.2**	**33.4**	**21.4**
Time (HR)					**10.8**	**14.9**	**12.5**	**19.6**

Average daily and peak period speeds/travel times for trucks also are presented for the base year (1997). Further, truck operating speeds are listed for year 2020. Overall results are then listed, as well as the overall time required to travel all roadway segments. By comparing these speed and travel time values (based on present conditions), it is possible to determine which facilities are most efficient today and which facilities are going to experience deteriorating conditions due to traffic growth.

Average daily truck operating speeds on Puerto Rico LATTS strategic highway network are summarized in Exhibit D-11.

The projected growth in traffic between 1997 and 2020 will affect this measure of performance significantly. Unless additional capacity is provided, the average daily speed on Puerto Rico portion of the LATTS Strategic Highway Network will be reduced by 5 MPH or more. Both urban interstates and other freeways will experience deterioration in average daily travel speeds exceeding 10 MPH reduction, unless new capacity enhancement measures are undertaken.

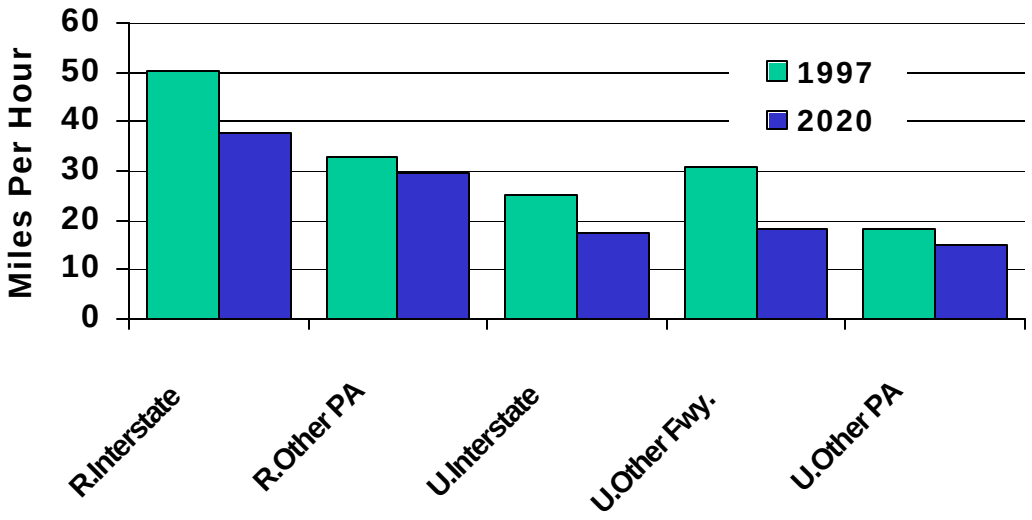
Exhibit D-11
PUERTO RICO STRATEGIC HIGHWAY NETWORK
Average Daily Truck Operating Speed



The expected traffic growth on Puerto Rico LATTS strategic highway network will also affect "peak hour" speeds significantly, from an average of 28 MPH in 1997 to an average of 21 MPH in 2020 as illustrated in Exhibit D-12.

As mentioned earlier, these travel speeds were estimated assuming no change in capacity on any section of the LATTS highway network and traffic peaking patterns the same as they are today. This is unlikely given the severity of the estimated resulting congestion on some highways.

Exhibit D-12
PUERTO RICO STRATEGIC HIGHWAY NETWORK
"Peak-Hour" Truck Operating Speeds



CONCLUSIONS FOR LATTS MAINLINE HIGHWAYS

(1) About 53 percent of the LATTS Strategic Highway Network in Puerto Rico will require additional capacity by 2020 at a cost of $ 1.4 billion. Nearly 70 percent of these capacity needs are for the interstate system (64 percent for the urban interstate system alone).

(2) If these investment needs are not met, the Puerto Rico portion of the LATTS Strategic Highway Network will experience significant deterioration in operating speeds, especially during "peak hour."

(3) Annual pavement needs will reach $34 millions by 2020. More than 65 percent of these needs will be for the urban interstate system which carries half of the Strategic Highway Network traffic in terms of VMT.

WATERPORT AND AIRPORT INTERMODAL CONNECTORS

The focus of the highway analysis was, appropriately, on the mainline portion of the LATTS Strategic Highway System. This is the portion of the highway network carrying the vast majority of truck travel (vehicle miles) and has "needs" that could be quantified using existing databases. Additionally, the portion of the highway system connecting the LATTS mainline system with the LATTS waterports and airports also were assessed. While these highway intermodal connectors sometimes are overlooked, their deficiencies can significantly impact the efficient movement of vehicles, especially large trucks.

LATTS intermodal connectors are the highways that link the mainline LATTS Strategic System with LATTS intermodal facilities (waterports and airports). To avoid costly new data collection activities, a recently compiled database was used to conduct the connectors analysis. This database, the *NHS Connectors*, was populated by the state DOTs and compiled by the Federal Highway Administration. It includes a high quality sample of the LATTS intermodal connectors. However, it does not contain information for every LATTS intermodal connector. These analyses utilized information for those LATTS intermodal connectors for which information was available in the NHS connectors database at the time the analyzes were performed.

As noted in Exhibit D-13, Puerto Rico had four connectors for which information was available in the NHS Connectors Inventory Database.

Exhibit D-13
LATTS INTERMODAL CONNECTORS

FACILTY ID	FACILITY NAME	LINK MILES	RURAL/URBAN DESIGNATION	OWNERSHIP	AGENCY
PR1A	Rafael Hernandez Airport, Aguadilla	2.9	Urbanized (50k to 200k)	State Highway	Puerto Rico
PR1A	Rafael Hernandez Airport, Aguadilla	5.8	Urbanized (50k to 200k)	State Highway	Puerto Rico
PR3P	Ponce Port, Ponce	1.1	Urbanized (50k to 200k)	State Highway	Puerto Rico
PR7P	San Juan Port, San Juan (North)	1.9	Urbanized (>200k)	State Highway	Puerto Rico

Information for the Luis Munoz Marin Intl. Airport, PR5A, connector was not contained in the inventory database at the time of this review.

Pavement Problems

Puerto Rico reported having no pavement deficiencies on the four connectors.

Geometric/Physical Problems

Deficiencies with connector shoulders were reported for all connectors. Additionally, San Juan Port, PR7P, reported problems with turning movements.

Traffic Operations and Safety Problems

San Juan Port, PR7P, was the only connector that reported significant deficiencies in this category. PR7P has problems with congestion, difficult turns, frequent accidents, and on-street parking.

Commonwealth Summary

With the exception of San Juan Port, PR7P, Puerto Rico's connectors were reported to be in good overall condition based upon the available information. PR7P reported a high number of problems with geometric/physical issues and operations and safety issues.