TRAFFIC OPERATIONS ANALYSIS

SR 676 (CAUSEWAY BOULEVARD)
FROM SR 45 (US 41) TO SR 43 (US 301)
HILLSBOROUGH COUNTY, FLORIDA

Financial Project ID: 255599-1-32-02

Prepared For

FLORIDA DEPARTMENT OF TRANSPORTATION
DISTRICT SEVEN
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EXECUTIVE SUMMARY

Construction plans are being prepared for the widening of Causeway Boulevard between SR 45 (US 41) and SR 43 (US 301) from a two-lane undivided to a four-lane divided roadway. Prior to the completion of the construction plans, a traffic operations analysis was prepared for the corridor to identify specific geometric improvements required at three signalized intersections (US 41, 78th Street and US 301). In addition, the study would evaluate several alternatives for the future grade-separation at the intersection of Causeway Boulevard and US 41. This information would be used in preparing a Bridge Alternatives Study, which is being conducted by another consultant.

The first step in preparing the traffic operations analysis was to collect existing traffic data along the corridor as well as in the vicinity of the project. To determine the traffic characteristics (peak hour volumes to daily traffic ratios, directional distribution, percentage of trucks, etc.) of the study corridor, seven-day machine counts were taken along Causeway Boulevard between US 41 and 78th Street and between 78th Street and US 301. To establish traffic characteristics along the side streets and for other roadways in the vicinity of the project, 24-hour bi-directional machine counts were taken at twelve locations. Manual turning movement counts were obtained for eight hours at five intersections to document the peak hour turning movements at critical intersections within the study area.

Based on the seven-day classification counts along Causeway Boulevard, approximately 16,000 vehicles per day (two-way) travel along the section of roadway between US 41 and 78th Street during a typical weekday (Tuesday through Thursday). Approximately 13 percent of the vehicles are trucks or heavy vehicles. For the section between 78th Street and US 301, approximately 21,500 vehicles per day (11 percent trucks) travel along Causeway Boulevard.

According to the Florida Department of Transportation's *Quality/Level of Service Manual*, 2002, Causeway Boulevard between US 41 and US 301 can accommodate 16,400 vehicles on a daily basis. The section of roadway between US 41 and 78th Street is currently operating at level of service (LOS) D conditions, which is acceptable since the level of service standard for the study

corridor is LOS D. However, for the section between 78th Street and US 301, LOS F conditions prevail because the traffic demand (volume) exceeds the maximum service volume (i.e. 21,500 vpd > 16,400 vpd).

Capacity analyses conducted for the three signalized intersections along the corridor revealed that two of the three currently function at unacceptable levels of service during the peak hours of operation. Causeway Boulevard at US 41 experiences long delays (over 400 seconds per vehicle) for the northbound left turn during the morning peak hour, while the return volume in the afternoon (i.e. eastbound right turn) suffers the same consequences (approximately 285 seconds of delay per vehicle). To compound the problem at this location, the northbound and southbound through volumes along US 41 are considerably higher than those along Causeway Boulevard; thus, requiring a longer green time to service the demand.

Due to the close proximity of two railroad crossings (one approximately 1,300 feet east of US 41 and the other 1,400 feet south of Causeway Boulevard), additional vehicular delay can be experienced at the intersection when a train is crossing. During those time periods when a train crosses, vehicles queue through the intersection, thus creating gridlock. It was observed that when a train crosses the east leg of the intersection, vehicles heading east along Causeway Boulevard that turned from US 41 started to backup into the intersection.

At Causeway Boulevard and 78th Street, traffic appears to be adequately served by the traffic signal during the peak travel periods. Based on the three time periods analyzed, acceptable levels of service for the entire intersection were achieved. The only movement currently experiencing poor operational conditions is the westbound left turn during the PM peak hour.

Poor levels of service are currently experienced at Causeway Boulevard and US 301 during the morning and evening peak hours, due to the high northbound and southbound through volumes. To decrease some of the delay, additional northbound and southbound through lanes are required, as well as the addition of some exclusive right-turn lanes.

The roadway corridor and three signalized intersections were evaluated under projected traffic conditions to determine the improvements required to achieve LOS D operating conditions. The annual average daily traffic (AADT) volumes for 2025 were determined using the Tampa Bay Regional Transportation Analysis model. According to the results of the model, projected AADT west and east of 78th Street along Causeway Boulevard are 40,000 and 39,000, respectively. Based on the FDOT *Quality/Level of Service Manual*, 2002, a four-lane divided roadway in an urban area can accommodate 35,700 vehicles per day. Since the projected traffic demand exceeds capacity, LOS F conditions could prevail for 2025 unless additional eastbound and westbound through lanes were considered.

The three signalized intersections were analyzed under projected 2025 traffic conditions using the procedures outlined in the Federal Highway Administration's *"Highway Capacity Manual"*, 2000. Even with additional exclusive turn lanes added, all three intersections will experience LOS F operating conditions during the peak hour of travel. To resolve the capacity issues, additional through lanes along Causeway Boulevard (i.e., six-lanes instead of four-lanes) plus additional northbound and southbound through lanes along both US 41 and US 301 would be required. It should be noted, however, that Causeway Boulevard is a constrained facility limited to a four-lane divided roadway. This is according to the Hillsborough County Metropolitan Planning Organization's (MPO) 2025 Long Range Transportation Plan.

In an effort to evaluate several alternatives for grade-separation at the intersection of US 41 and Causeway Boulevard, including the railroad crossings east and south of the intersection, the entire three-mile corridor was modeled using the Corridor Simulation (CORSIM) software. According to the results of the four alternatives analyzed, CORSIM revealed that no alternative would totally resolve the capacity issues at the US 41 and Causeway Boulevard intersection. The capacity problem stems from the fact that Causeway Boulevard is constrained to a four-lane divided facility; however, 2025 projected traffic demands dictate the need for a six-lane divided roadway. Furthermore, the traffic demand along US 41 will be substantially higher than those volumes projected for Causeway Boulevard and US 41 is already a six-lane divided facility.

Of the alternatives analyzed, The best solution for resolving most of the capacity issues at US 41 and Causeway Boulevard is to provide grade-separation for US 41, since this road is projected to accommodate the majority of the traffic. By providing a grade-separation over Causeway Boulevard for the north-south through movements along US 41, additional green time could be allocated to the east-west movements along Causeway Boulevard. However, this alternative would require additional right-of-way, which in turn would increase the cost of the project.

Even with an urban interchange provided at US 41 and Causeway Boulevard, capacity problems would still exist for specific movements according to the results of the CORSIM evaluation. Furthermore, some design issues may arise with the construction of the bridges due to the close proximity of the two railroad crossings.

In order to better accommodate the northbound left turns during the morning peak hour, a two-lane fly-over for the northbound to westbound movement should be considered. As for the return volumes (or eastbound right turns) during the evening peak period, channelization should be considered in providing continual free-flow movements. Therefore, it is recommended that the intersection remain at-grade with the proposed grade-separated fly-over. As for the two railroad crossings in the vicinity of the intersection, it is recommended that grade-separation be provided for both crossings in order to prevent the potential queue (spill-back) of vehicles through the intersection during a train crossing.

Additional alternatives for grade-separation should be considered for the intersection of US 41 and Causeway Boulevard. As identified in the scope of services, only grade-separation was evaluated for Causeway Boulevard (not US 41). In order to provide better levels of service at this intersection, grade-separation should be considered for US 41. At the completion of this study, the FDOT has requested the evaluation of other grade-separated alternatives. This additional study will be completed under a separate cover.

At the intersection of 78th Street and Causeway Boulevard, the addition of auxiliary lanes is not enough to resolve the capacity issues. Causeway Boulevard requires a six-lane divided roadway to accommodate the eastbound and westbound projected demand for 2025. Without the addition

east-west through lane capacity, the intersection should operate at LOS E conditions, which is unacceptable. Furthermore, no additional improvements were made along 78th Street that required additional right-of-way because this roadway is under County jurisdiction.

To resolve the capacity problems at US 301 and Causeway Boulevard, an interchange should be reviewed. With US 301 grade-separated, the heavy northbound and southbound demands, which are the critical movements during the peak periods of travel, should be accommodated. For this analysis, only those improvements within the existing right-of-way along US 301 were considered. Based on the results, LOS F conditions would still prevail for 2025 traffic volumes.

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1.0 INTRODUCTION

The Florida Department of Transportation (FDOT) proposes to re-construct SR 676 (Causeway Boulevard) from a two-lane undivided to a four-lane divided roadway between SR 45 (US 41) and SR 43 (US 301) in eastern Hillsborough County. Figure 1 illustrates the general vicinity of the project.

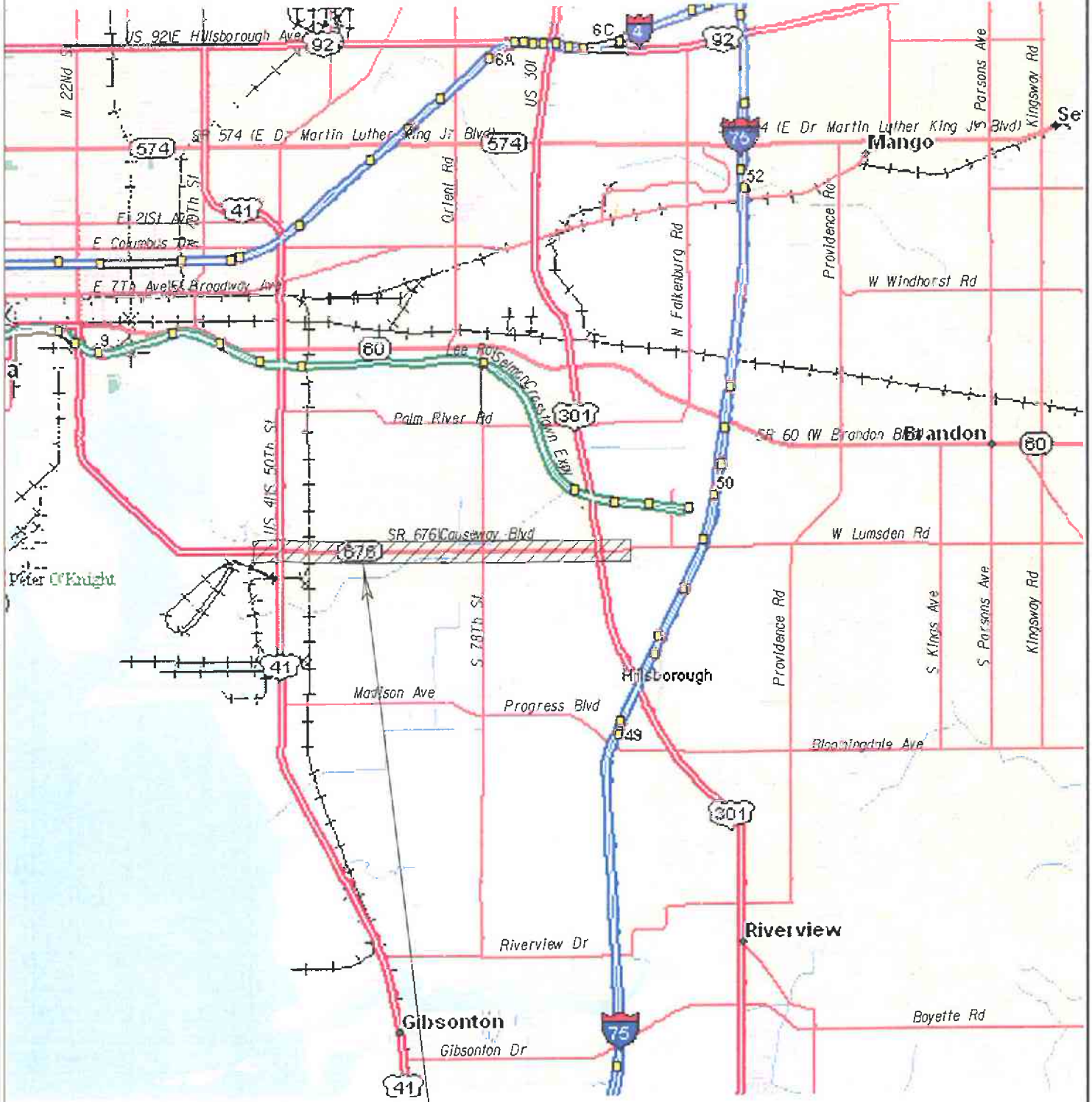
Prior to developing construction plans, a traffic study was prepared to document the existing and future traffic conditions along the approximate three-mile corridor. A thorough examination of existing traffic conditions was conducted to define existing travel related patterns and problems. This analysis was followed by an examination of projected traffic conditions anticipated for the corridor. Specifically, this involved determining the geometric improvements required to accommodate design year 2025 forecasted traffic volumes at three intersections along Causeway Boulevard within the study area (i.e., US 41, 78th Street and US 301).

At the intersection of US 41 and Causeway Boulevard, the FDOT is considering a grade separation to improve intersection capacity and eliminate the vehicular delays incurred by the railroad crossings located approximately 1,300 feet east of US 41 and approximately 1,400 south of Causeway Boulevard. Several alternatives will be evaluated for the grade separation.

2.0 STUDY METHODOLOGY

In general, the following steps were accomplished in preparing the traffic operations analysis:

- Data Collection – Twenty-four hour and seven-day bi-directional machine counts that classify vehicular types were conducted at specific locations. In addition, eight-hour manual turning movement counts were obtained at several intersections. Those traffic count locations are as follows:



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Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 1: Location Map

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24-hour Machine Counts

- US 41 north of Causeway Boulevard
- US 41 south of Causeway Boulevard
- Causeway Boulevard west of US 41
- Causeway Boulevard east of US 301
- 78th Street north of Causeway Boulevard
- 78th Street south of Causeway Boulevard
- US 301 north of Causeway Boulevard
- US 301 south of Causeway Boulevard
- Maydell Drive north of Causeway Boulevard
- 70th Street south of Causeway Boulevard
- Hartford Street between US 41 and 78th Street
- 16th Avenue between US 41 and Maydell Drive

7-day Machine Counts

- Causeway Boulevard between US 41 and 78th Street
- Causeway Boulevard between 78th Street and US 301

8-hour Manual Counts

- US 41 at Causeway Boulevard
- 78th Street at Causeway Boulevard
- US 301 at Causeway Boulevard
- US 41 at Palm River Road
- US 41 at Hartford Street

- Coordination Meetings – Meetings with the CSX Railroad and Port of Tampa were conducted to determine their future plans and how those plans impact the study area.

- Qualitative Assessment – Observations were made during the AM peak, off-peak and PM peak hours to determine any unique travel characteristics along the study corridor.

- Crash Analysis – Collision data for the latest three years has been obtained from the FDOT's system and analyzed to determine any trends.

- Traffic Projections – Using both historical trends along Causeway Boulevard as well as the Regional Transportation Model for Tampa Bay, forecasted traffic volumes were determined for design year 2025.

- Evaluation of Grade Separated Alternatives - Utilizing traffic simulation models, several alternatives for a grade separation at US 41 and Causeway Boulevard were analyzed.

- Roadway and Intersection Capacity Analyses – Existing and future capacity analyses were conducted for the peak hours to determine the operation of the corridor and specific intersections.

- Storage Lane Lengths – Appropriate calculations were made to determine the length of exclusive turn lanes based on the recommended geometry for the three intersections analyzed.

3.0 EXISTING CONDITIONS

3.1 Qualitative Assessment

Causeway Boulevard (SR 676) is an east/west roadway that extends from McKay Bay on the west to US 301 on the east. Continuing east from US 301, Causeway Boulevard becomes Lumsden Road through the Brandon area and terminates at Mulrennan Road in eastern Hillsborough County. According to Hillsborough County's *Roadway Level of Service Report* (December 2001), Causeway Boulevard from Maritime Boulevard to US 41 is classified as a four-lane divided principle arterial. This section of roadway has a posted speed limit of 50 miles per hour (mph). East of US 41 to US 301, Causeway Boulevard is a two-lane undivided minor arterial roadway with a posted speed limit of 45 mph. East of US 301, Causeway Boulevard is a four-lane divided principle arterial with a 50 mph posted speed limit.

The posted speed limits for US 41, 78th Street and US 301 north and south of Causeway Boulevard are 50 mph, 45 mph and 50 mph, respectively. It should be noted that the posted speed limit along 78th Street changes to 50 mph south of Causeway Boulevard.

Causeway Boulevard parallels SR 60 (Adamo Drive) and the Crosstown Expressway. Since Causeway Boulevard and Lumsden Road extend from the east side of downtown Tampa to Brandon, many motorists use this facility to travel to work, instead of taking SR 60, the Crosstown Expressway or I-4. Thus, the section of roadway under study primarily serves to divert or relieve trips from other parallel roadways. With other principle arterials in the area (US 41, US 301 and I-75) that traverse north/south, Causeway Boulevard acts as a collector roadway that disperses trips to either downtown Tampa, the Port of Tampa and many large industrial facilities as well as smaller commercial businesses in the area. In addition, there are many local roads both north and south of Causeway Boulevard within the study corridor that provide access to residential communities.

Field observations were conducted during the morning, mid-day and evening peak periods of travel to determine what the travel patterns were like, especially when a train crosses both US 41 and Causeway Boulevard. During the morning peak period between the hours of 7:00 a.m. and 9:00 a.m. on Monday, June 17, 2002, the heaviest amount of traffic was observed heading west towards downtown Tampa and the Port of Tampa. It was also observed that a large number of vehicles were trucks that traveled in both directions. When reviewing the three subject intersections (i.e., US 41, 78th Street and US 301), some traffic congestion was observed at both US 41 and US 301.

US 41 at Causeway Boulevard is a signalized intersection. Currently, protected left turns are provided for the northbound and southbound movements. Protected/permissive left turns are provided for the eastbound and westbound movements. This particular intersection does not provide exclusive right-turn lanes; however, this movement is channelized at the intersection. As for the number of through lanes in each direction, the northbound/southbound approaches have three, while the eastbound and westbound approaches have two. During the AM peak hour, the northbound left-turn movement at US 41 appeared to be overcapacity. With only one lane

serving the high demand, vehicles queued or spilled-back into the adjacent through lane, thus preventing the adjacent northbound through movements to proceed until the left turn demand was satisfied. During the lunch hour, a train crossed both US 41 (approximately 1,400 feet south of Causeway Boulevard) and Causeway Boulevard (approximately 1,300 feet east of US 41), and appeared to stop. The train created large backups and long delays at US 41 and Causeway Boulevard. Within fifteen minutes, the train began to move again, and traffic started to disperse. It took approximately four cycles to clear the long queues created by the train. During the evening peak hour, a significant number of eastbound right turns were observed. Since this movement is not provided an exclusive turn lane, additional delay was incurred by the eastbound through movements.

78th Street, which is approximately two miles east of US 41, is a signalized intersection with three approach lanes in each direction. Exclusive left, through and right-turn lanes are provided for each approach to the intersection. Permissive movements are only permitted for the eastbound and westbound movements. Protected/permissive left turns were provided for the north- and southbound left turns. No apparent capacity problems were observed at any time for this intersection.

At the intersection of US 301 and Causeway Boulevard, a traffic signal is used to control the flow of traffic. This intersection is provided with exclusive left-turn lanes for each approach. The southbound left turn has dual lanes. The westbound and southbound right turns are provided an exclusive turn lane, while the remaining right turn movements are shared with the adjacent through lane. There are three northbound and two southbound through lanes. As for the eastbound and westbound approaches, two through lanes are provided. During the morning peak hour, traffic congestion was observed for the northbound to westbound left turn as well as the northbound through movements. Traffic during the off-peak period appeared to flow without any excessive delays. As for the PM peak hour, the southbound through movements were very heavy, creating long queues and excessive delays.

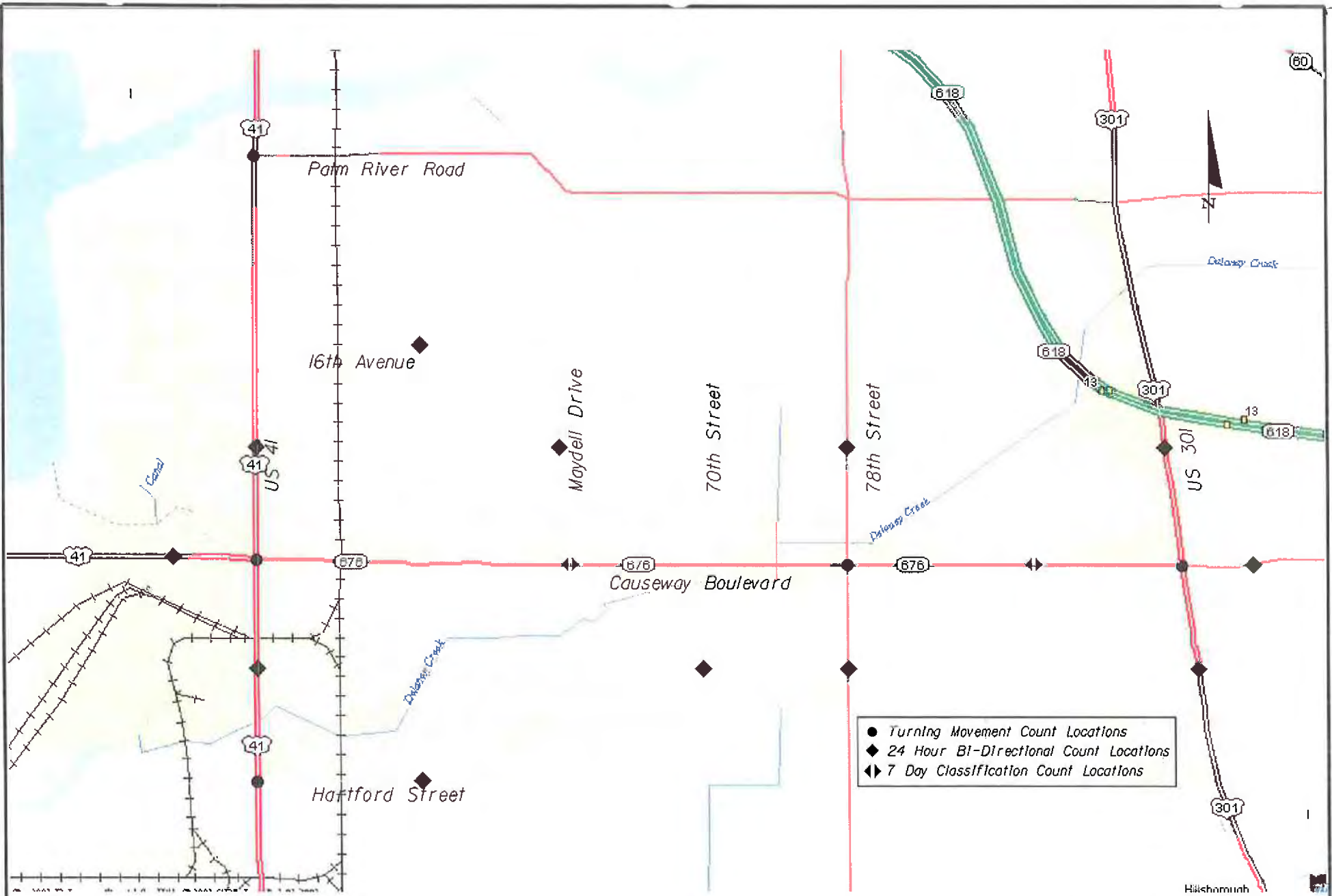
3.2 Traffic Volumes

A comprehensive examination of existing travel conditions within the study corridor was undertaken for the purpose of identifying all corridor related traffic movements for both daily and peak period conditions. Figure 2 identifies the type and location of all traffic counts obtained for this study.

In order to obtain the variation in traffic traveling the corridor during a typical week, seven-day bi-directional classification counts were obtained along SR 676 (Causeway Boulevard) between US 41 and 78th Street, and between 78th Street and US 301. Automatic traffic data recorders (machines) were used to gather the seven-day classification count information from Tuesday, April 30, 2002 to May 6, 2002. The output was summarized by the hour. Table 1 provides a daily overview by direction of the seven-day traffic counts obtained along Causeway Boulevard. In addition, the percent of heavy vehicles (trucks) is also identified. Tables 2, 3, and 4 present the eastbound, westbound and total unadjusted traffic counts, respectively, on an hourly basis for the roadway segment between US 41 and 78th Street. Figures 3, 4, and 5 illustrate the hourly volumes by direction obtained from the seven-day count.

Tables 5, 6, and 7 present the eastbound, westbound and total volumes for the seven-day count conducted along Causeway Boulevard between 78th Street and US 301. Figures 6, 7 and 8 illustrate the hourly variations in traffic for this segment of roadway. Again, the eastbound, westbound and total volumes are illustrated, respectively. From review of the figures above, it is apparent that during the morning peak hours, traffic is highest for the westbound direction. Conversely, during the evening rush hours, the eastbound direction is the highest.

Twenty-four hour bi-directional machine counts were conducted on SR 676 (Causeway Boulevard) east of US 301, US 301 north and south of SR 676, 78th Street north and south of SR 676, 70th Street south of SR 676, Maydell Drive north of SR 676, US 41 north and south of SR 676, and Causeway Boulevard (BUS 41) west of US 41. These 24-hour counts were obtained during the end of April 2002 and the first week of May 2002. The counts were summarized by



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Project Title	Causeway Boulevard Corridor Analysis
Drawing Title	Figure 2: Count Location Map

TABLE 1: SEVEN-DAY CLASSIFICATION COUNTS FOR CAUSEWAY BOULEVARD BETWEEN US 41 AND 78TH STREET				
Date	**Day of Week**	**Eastbound Volume**	**Number of Heavy Vehicles**	**% Heavy Vehicles**
4/30/02	Tuesday	8108	1161	14.32
5/1/02	Wednesday	7962	1044	13.11
5/2/02	Thursday	7913	1015	12.83
5/3/02	Friday	8450	1076	12.73
5/4/02	Saturday	6254	525	8.40
5/5/02	Sunday	5041	361	7.16
5/6/02	Monday	7926	1005	12.68
Date	**Day of Week**	**Westbound Volume**	**Number of Heavy Vehicles**	**% Heavy Vehicles**
4/30/02	Tuesday	8260	1040	12.59
5/1/02	Wednesday	8264	1048	12.68
5/2/02	Thursday	8246	950	11.52
5/3/02	Friday	8253	938	11.37
5/4/02	Saturday	5741	357	6.22
5/5/02	Sunday	4787	292	6.10
5/6/02	Monday	8223	962	11.70
BETWEEN 78TH STREET AND US 301				
Date	**Day of Week**	**Eastbound Volume**	**Number of Heavy Vehicles**	**% Heavy Vehicles**
4/30/02	Tuesday	10939	1328	12.14
5/1/02	Wednesday	11069	1360	12.29
5/2/02	Thursday	11026	1322	11.99
5/3/02	Friday	11895	1319	11.09
5/4/02	Saturday	9091	619	6.81
5/5/02	Sunday	7000	409	5.84
5/6/02	Monday	10625	1191	11.21
Date	**Day of Week**	**Westbound Volume**	**Number of Heavy Vehicles**	**% Heavy Vehicles**
4/30/02	Tuesday	10819	1001	9.25
5/1/02	Wednesday	10916	1083	9.92
5/2/02	Thursday	10978	983	8.95
5/3/02	Friday	11750	996	8.48
5/4/02	Saturday	8998	482	5.36
5/5/02	Sunday	7284	290	3.98
5/6/02	Monday	10502	938	8.93

Source: Adams Traffic

TABLE 2: SEVEN-DAY COUNT
CAUSEWAY BOULEVARD BETWEEN 78TH ST. & US 41 - EASTBOUND

	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
1	83	87	103	101	144	129	82
2	66	62	50	58	110	127	55
3	61	41	63	68	102	118	53
4	39	64	42	70	83	83	35
5	59	81	69	73	50	58	63
6	110	112	123	119	74	70	102
7	257	237	229	240	130	73	219
8	334	333	348	308	173	123	316
9	313	366	343	334	237	141	319
10	387	361	350	332	321	195	388
11	399	394	388	440	376	269	399
12	479	473	451	497	400	313	480
13	482	483	473	527	479	361	516
14	469	459	471	520	484	354	460
15	535	399	457	593	411	358	513
16	672	536	615	692	403	342	676
17	789	781	760	796	422	334	740
18	830	872	859	714	332	326	845
19	525	560	520	527	347	298	507
20	353	359	356	408	271	248	357
21	287	294	291	320	248	246	276
22	246	269	216	263	246	229	213
23	190	196	185	228	218	144	168
24	143	143	151	222	193	102	144
TOTAL	8108	7962	7913	8450	6254	5041	7926

Source: Adams Traffic

TABLE 3: SEVEN -DAY COUNT
CAUSEWAY BOULEVARD BETWEEN 78TH ST. & US 41 - WESTBOUND

	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
1	53	54	65	68	114	135	64
2	33	40	45	44	81	98	38
3	31	45	26	29	58	54	32
4	54	58	44	66	41	51	40
5	108	91	112	90	51	45	92
6	298	308	294	284	112	74	272
7	727	679	700	673	173	117	707
8	983	970	994	964	220	145	1023
9	723	722	665	688	259	180	688
10	433	424	440	444	307	298	431
11	425	438	402	414	298	296	429
12	430	392	436	443	365	306	429
13	478	487	462	493	450	321	465
14	466	491	456	515	401	346	511
15	488	488	485	556	376	352	501
16	472	461	468	495	372	278	463
17	439	417	422	342	320	276	447
18	393	397	398	311	323	284	367
19	333	342	348	287	322	282	335
20	273	313	316	270	269	213	268
21	197	234	221	246	248	233	225
22	187	190	186	197	230	175	178
23	149	129	174	197	200	141	130
24	87	94	87	137	151	87	88
TOTAL	8260	8264	8246	8253	5741	4787	8223

Source: Adams Traffic

TABLE 4: SEVEN -DAY COUNT
CAUSEWAY BOULEVARD BETWEEN 78TH ST. & US 41 - TOTAL

	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
1	136	141	168	169	258	264	146
2	99	102	95	102	191	225	93
3	92	86	89	97	160	172	85
4	93	122	86	136	124	134	75
5	167	172	181	163	101	103	155
6	408	420	417	403	186	144	374
7	984	916	929	913	303	190	926
8	1317	1303	1342	1272	393	268	1339
9	1036	1088	1008	1022	496	321	1007
10	820	785	790	776	628	493	819
11	824	832	790	854	674	565	828
12	909	865	887	940	765	619	909
13	960	970	935	1020	929	682	981
14	935	950	927	1035	885	700	971
15	1023	887	942	1149	787	710	1014
16	1144	997	1083	1187	775	620	1139
17	1228	1198	1182	1138	742	610	1187
18	1223	1269	1257	1025	655	610	1212
19	858	902	868	814	669	580	842
20	626	672	672	678	540	461	625
21	484	528	512	566	496	479	501
22	433	459	402	460	476	404	391
23	339	325	359	425	418	285	298
24	230	237	238	359	344	189	232
TOTAL	16368	16226	16159	16703	11995	9828	16149

Source: Adams Traffic

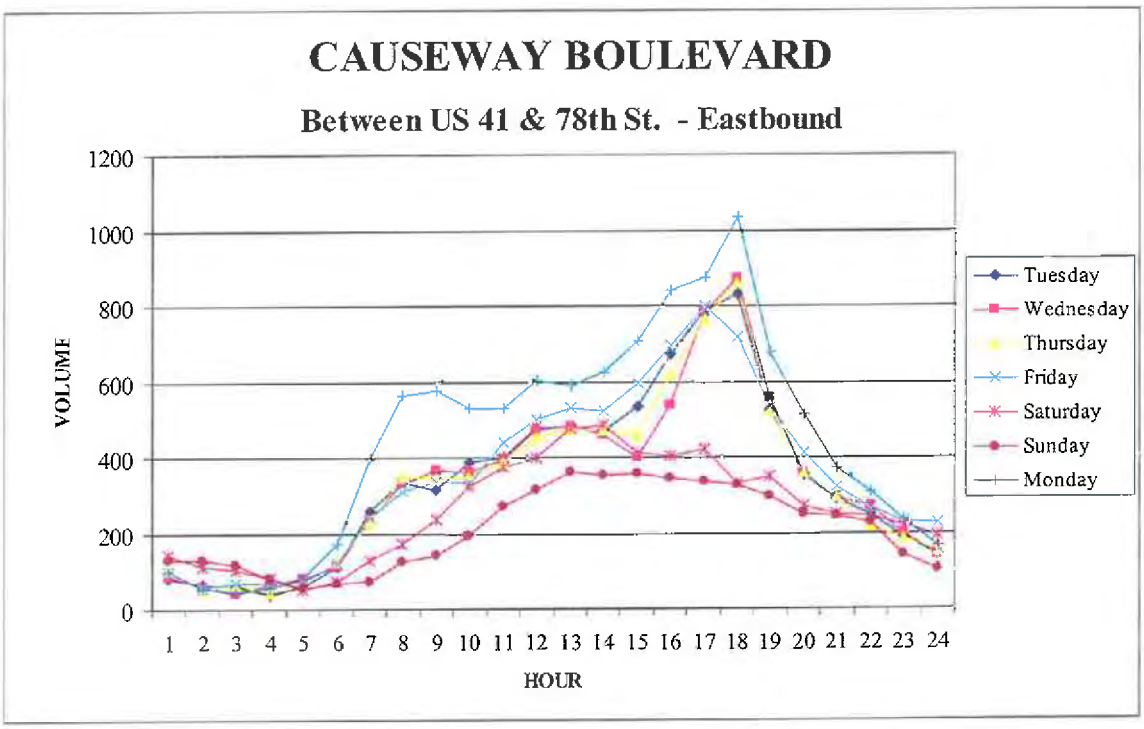


FIGURE 3: SEVEN-DAY COUNTS BETWEEN US 41 & 78TH ST – EASTBOUND

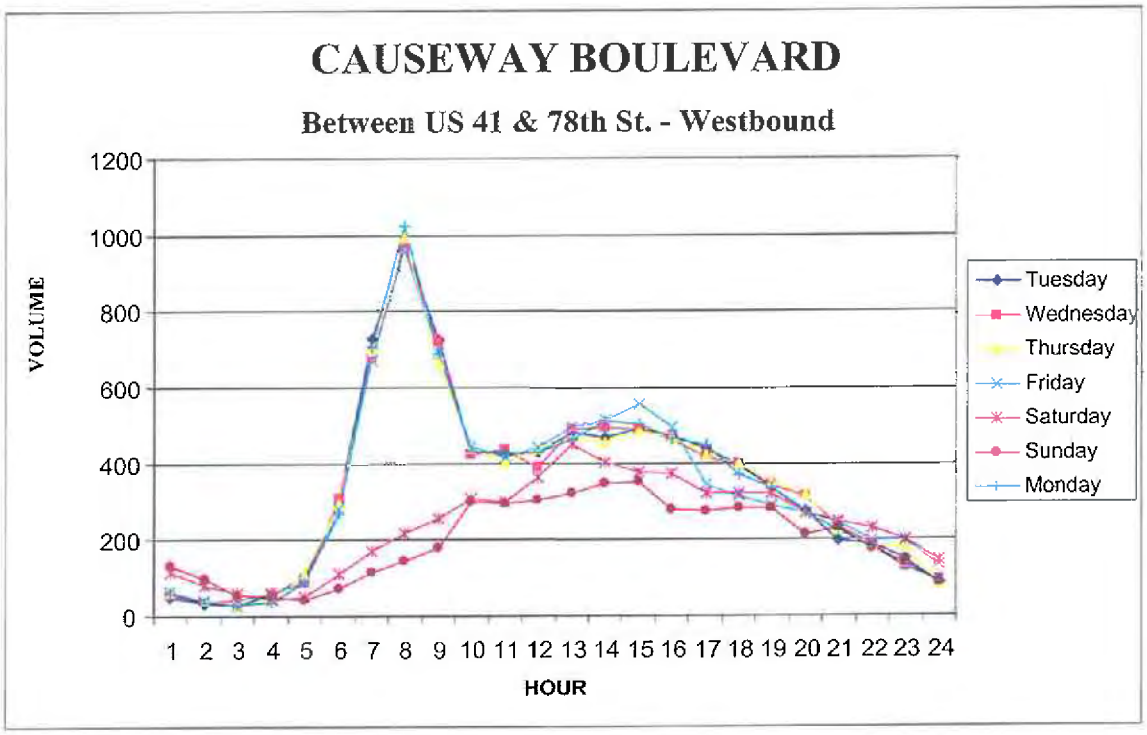


FIGURE 4: SEVEN-DAY COUNTS BETWEEN US 41 & 78TH ST – WESTBOUND

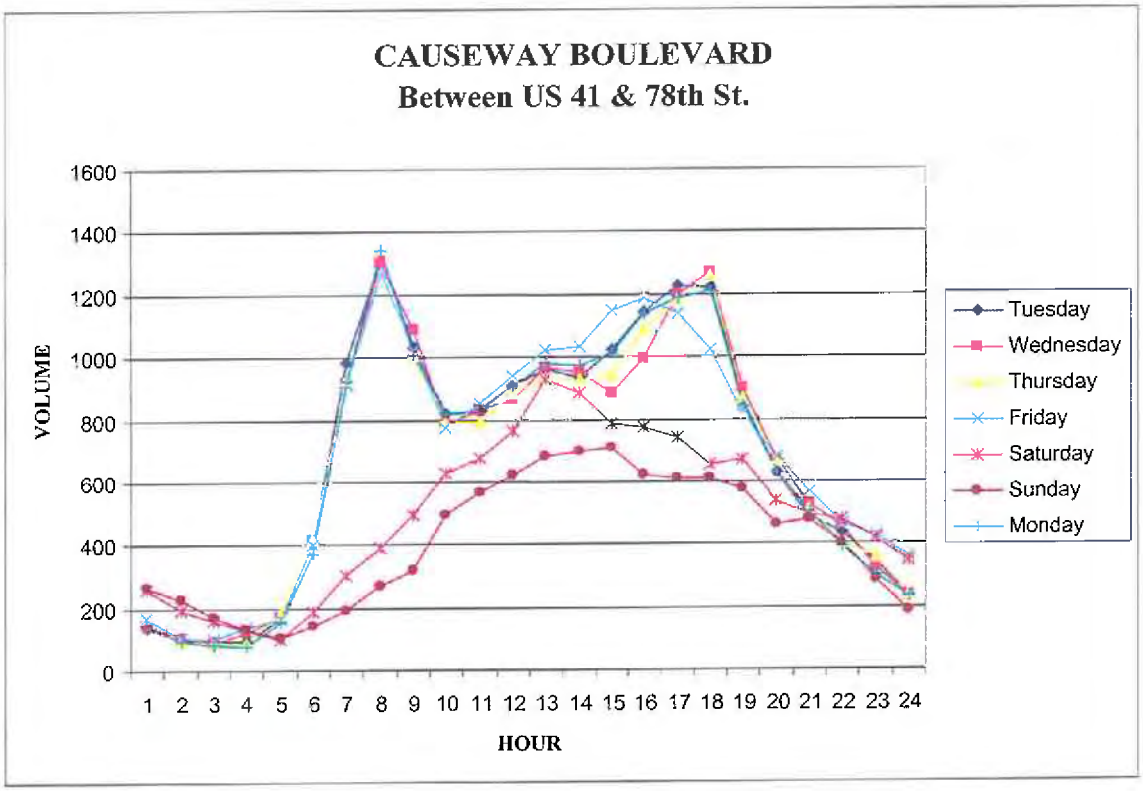


FIGURE 5: SEVEN-DAY COUNTS BETWEEN US 41 & 78TH ST – TOTAL

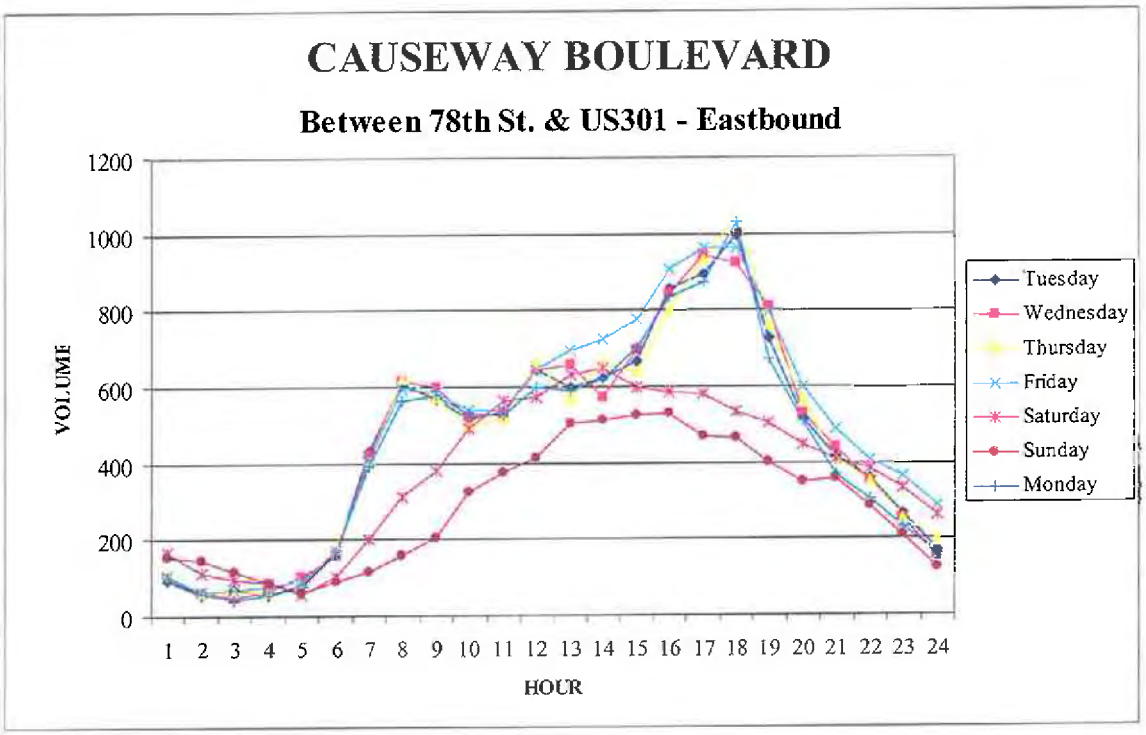


FIGURE 6: SEVEN-DAY COUNTS BETWEEN 78TH ST & US 301 – EASTBOUND

TABLE 5: SEVEN-DAY COUNT
CAUSEWAY BOULEVARD BETWEEN 78TH ST. & US 301 - EASTBOUND

	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
1	93	103	110	107	166	154	101
2	54	62	58	63	112	144	58
3	68	47	65	70	95	116	43
4	54	63	58	78	87	86	57
5	79	103	78	92	55	59	81
6	169	158	180	172	102	90	173
7	434	423	402	411	200	115	395
8	609	619	623	595	312	159	564
9	568	598	574	589	382	205	577
10	520	525	498	540	492	324	531
11	535	531	519	538	567	376	527
12	648	646	665	649	576	414	601
13	602	659	571	700	636	505	591
14	627	574	664	730	653	516	623
15	670	697	639	781	601	528	705
16	858	845	803	907	588	533	837
17	894	949	933	963	582	471	874
18	999	925	1045	965	537	466	1034
19	728	809	763	797	506	404	674
20	519	533	561	598	450	353	511
21	414	443	413	488	411	361	368
22	361	351	351	407	386	287	304
23	264	251	254	366	334	211	233
24	172	155	199	289	261	123	163
TOTAL	10939	11069	11026	11895	9091	7000	10625

Source: Adams Traffic

TABLE 6: SEVEN-DAY COUNT
CAUSEWAY BOULEVARD BETWEEN 78TH ST. & US 301 - WESTBOUND

	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
1	82	88	87	93	171	177	94
2	45	46	48	55	99	119	56
3	35	49	41	46	79	65	27
4	52	57	37	58	47	46	47
5	100	83	109	83	55	58	80
6	301	295	289	272	125	65	287
7	744	717	721	698	194	116	721
8	1109	1049	1073	1074	308	162	1073
9	659	720	692	729	380	209	683
10	512	527	518	503	521	347	500
11	544	506	499	558	505	547	503
12	541	544	541	594	590	608	542
13	637	673	664	689	646	526	639
14	652	661	632	732	621	468	674
15	657	637	676	705	558	512	583
16	662	697	711	716	584	465	659
17	665	674	643	727	554	469	677
18	672	622	600	671	568	452	609
19	518	579	599	625	480	438	526
20	477	505	527	539	458	369	443
21	398	425	446	507	423	380	399
22	327	371	393	430	425	308	309
23	277	232	267	368	352	218	232
24	153	159	165	278	255	160	139
TOTAL	10819	10916	10978	11750	8998	7284	10502

Source: Adams Traffic

TABLE 7: SEVEN-DAY COUNT
CAUSEWAY BOULEVARD BETWEEN 78TH ST. & US 301 - TOTAL

	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
1	175	191	197	200	337	331	195
2	99	108	106	118	211	263	114
3	103	96	106	116	174	181	70
4	106	120	95	136	134	132	104
5	179	186	187	175	110	117	161
6	470	453	469	444	227	155	460
7	1178	1140	1123	1109	394	231	1116
8	1718	1668	1696	1669	620	321	1637
9	1227	1318	1266	1318	762	414	1260
10	1032	1052	1016	1043	1013	671	1031
11	1079	1037	1018	1096	1072	923	1030
12	1189	1190	1206	1243	1166	1022	1143
13	1239	1332	1235	1389	1282	1031	1230
14	1279	1235	1296	1462	1274	984	1297
15	1327	1334	1315	1486	1159	1040	1288
16	1520	1542	1514	1623	1172	998	1496
17	1559	1623	1576	1690	1136	940	1551
18	1671	1547	1645	1636	1105	918	1643
19	1246	1388	1362	1422	986	842	1200
20	996	1038	1088	1137	908	722	954
21	812	868	859	995	834	741	767
22	688	722	744	837	811	595	613
23	541	483	521	734	686	429	465
24	325	314	364	567	516	283	302
TOTAL	21758	21985	22004	23645	18089	14284	21127

Source: Adams Traffic

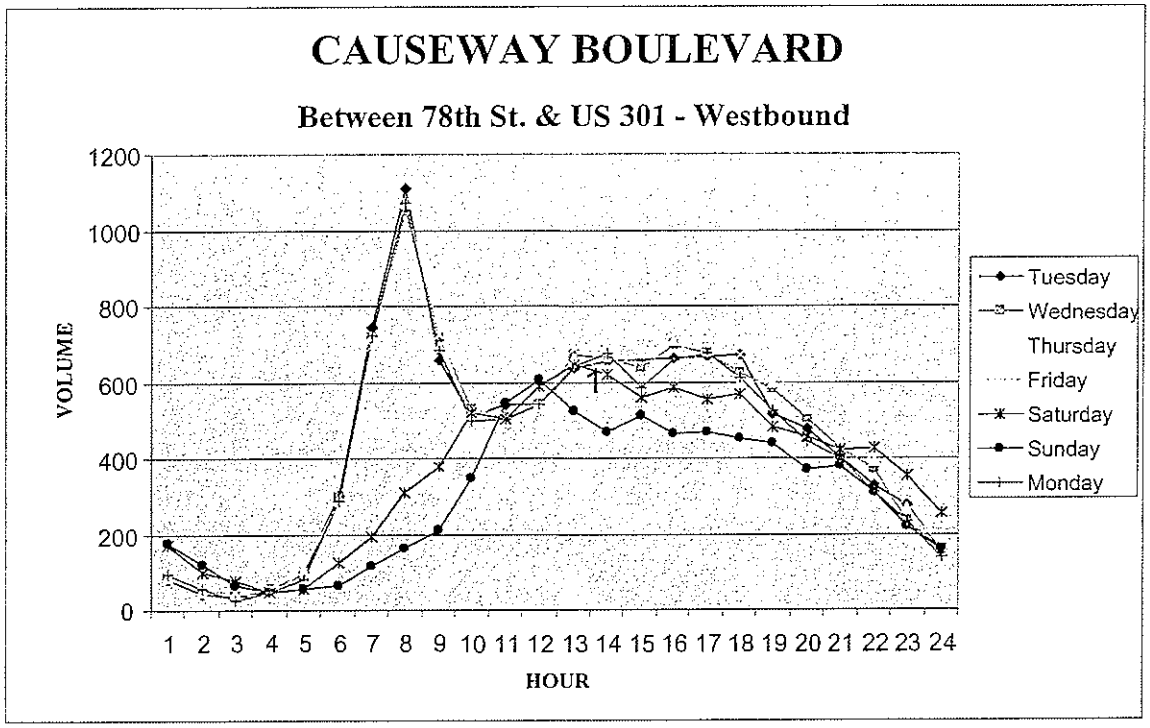


FIGURE 7: SEVEN-DAY COUNTS BETWEEN 78TH ST & US 301 – WESTBOUND

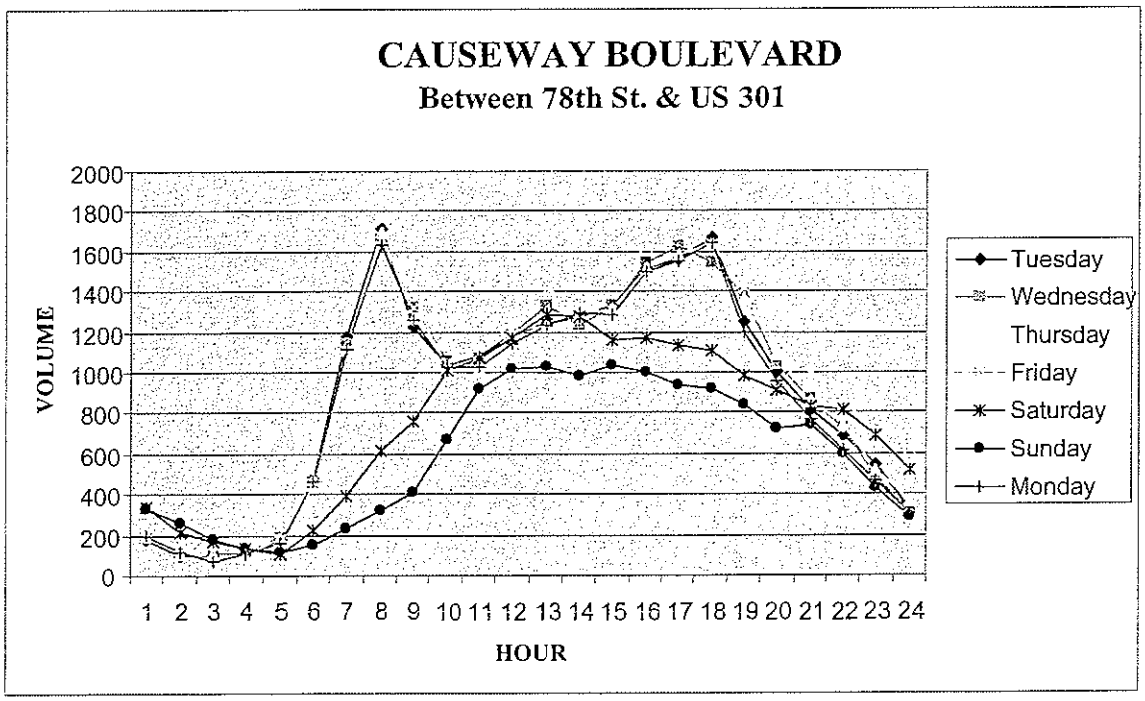


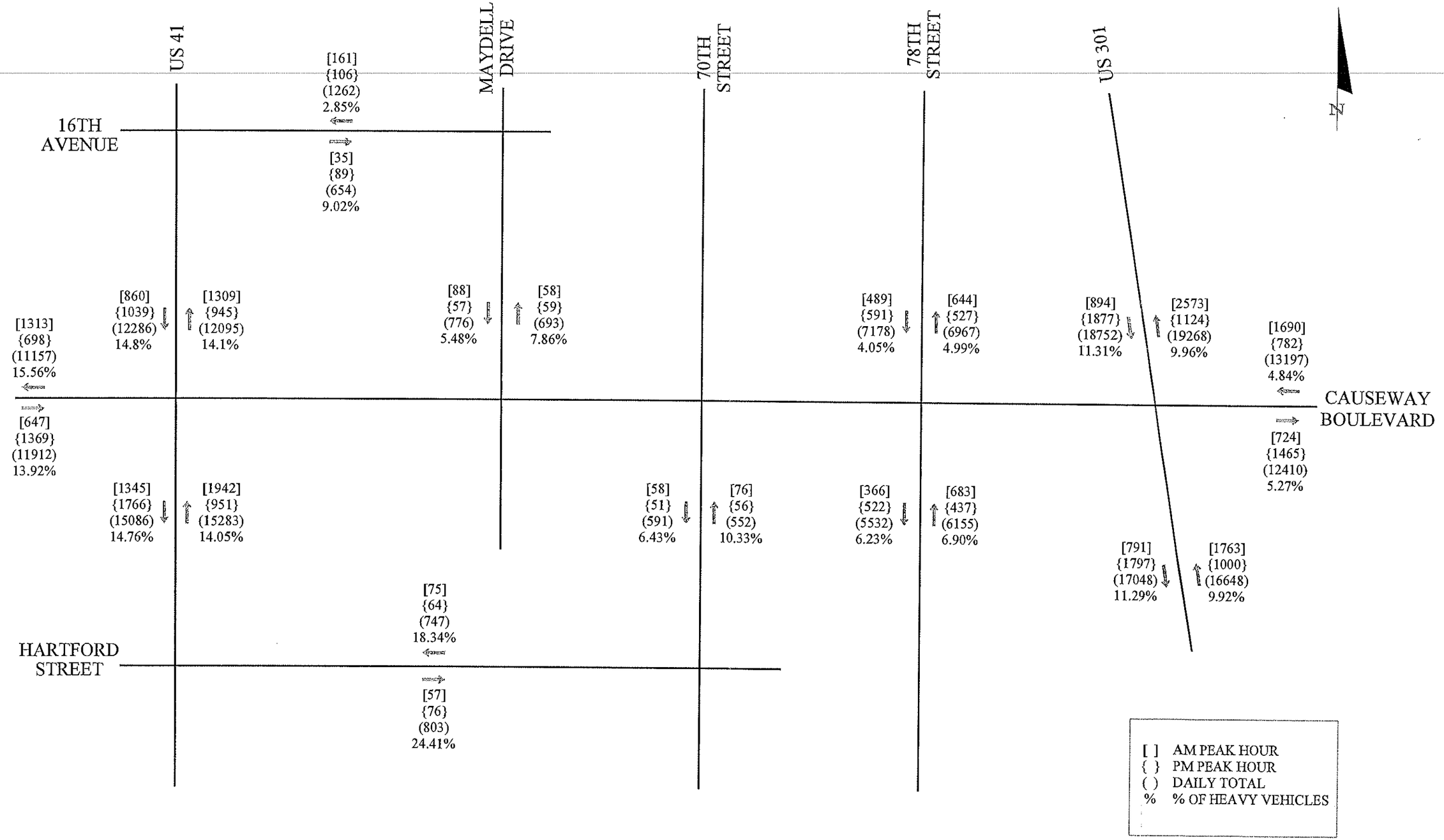
FIGURE 8: SEVEN-DAY COUNTS BETWEEN 78TH ST & US 301 – TOTAL

15-minute intervals in order to calculate the duration of the peak hour conditions, peak hour factors within each peak hour and the percentage of daily traffic occurring during the periods. The counts also classified the types of vehicles crossing the counters. Figure 9 summarizes the 24-hour data collected.

To supplement the machine counts, peak hour manual turning movements counts were conducted for eight hours at the following intersections: SR 676/US 41, SR 676/78th Street, SR 676/US 301, US 41/Palm River Road, and US 41/Hartford Street intersections. These peak period turning movement counts, which were obtained during the second week in May 2002, provided specific information from which detailed capacity analyses could be conducted to determine LOS and potential operational problems. During the manual counts, truck (heavy vehicles) movements through the intersection were tabulated. Figure 10 presents the AM, off-peak, and PM peak hour traffic volumes for each intersection.

Prior to performing any roadway or intersection capacity analyses, the raw traffic counts were adjusted to obtain average annual traffic conditions using FDOT's Seasonal Adjustment Factors (Year 2001) for Hillsborough County. These FDOT adjustment factors express counts made during a given week of the year as a percentage of the annual average daily traffic (AADT) volumes.

To determine the existing AADT of SR 676 (Causeway Boulevard), average daily traffic (ADT) counts for Tuesday, Wednesday and Thursday, obtained from the seven-day classification count, were averaged. Then, the seasonal adjustment factors were applied to obtain the AADT. The axle correction factors calculated by the FDOT were not applied, since the machine counts already account for the number of axles crossing the road tubes. To determine the AADT for US 41, US 301, Maydell Drive and 78th Street, 24-hour directional counts were adjusted by applying the seasonal adjustment factors. The resulting AADTs are shown in Table 8.



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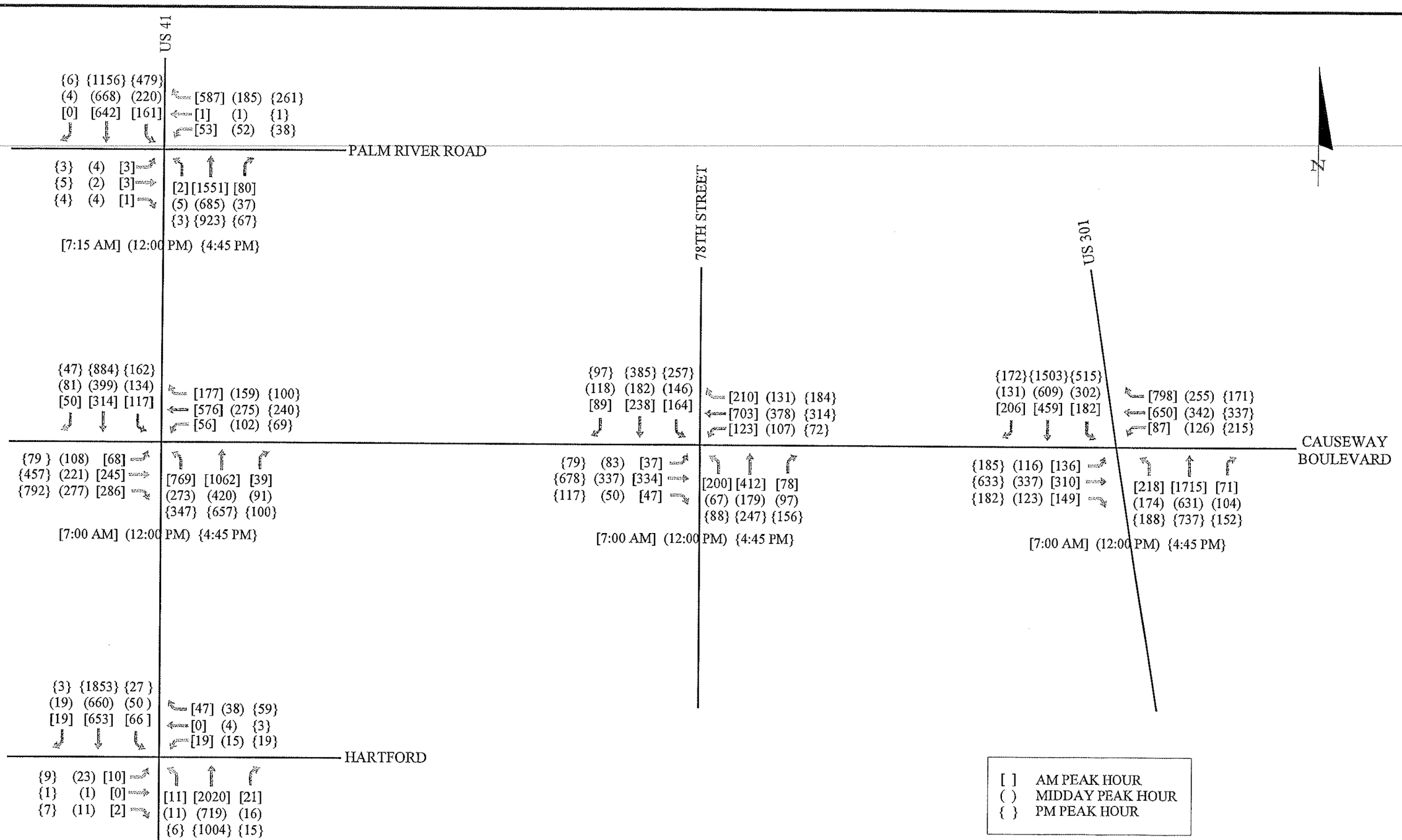
Project Title	Causeway Boulevard Corridor Analysis
Drawing Title	Figure 9: 24-Hour Bi-Directional Machine Counts (2002)

Title: GC42 s:\202...\24HrDCAgn
Name: PHD
Date: 11/21/2003



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Project Title	Causeway Boulevard Corridor Analysis
Drawing Title	Figure 10: Manual Turning Movement Count (2002)

Title: GCA2 sh2020...IAC2.dgn
Name: PHD Time: 04:45:31 PM
Date: 11/21/2003

TABLE 8: AADT (YEAR 2002)	
Roadway Segment	**AADT**
Causeway Boulevard between US 41 and 78th Street	16,000
Causeway Boulevard between 78th Street and US 301	21,500
US 41 N of Causeway Boulevard	24,000
US 41 S of Causeway Boulevard	29,500
US 301 N of Causeway Boulevard	37,000
US 301 S of Causeway Boulevard	33,000
78th Street N of Causeway Boulevard	14,000
78th Street S of Causeway Boulevard	11,000
US 41 (BUS) W of US 41	22,500

Appendix A contains the output from the machine counts as well as manual turning movement counts obtained in the field. In addition, the FDOT's Seasonal Adjustment Factors are also provided.

3.3 Traffic Characteristics

The percentage of daily traffic occurring during the peak hour defines the peak to daily ratio (P/D ratio). The directional distribution, or D-factor, represents the percentage of total, two-way peak hour traffic which occurs in the peak direction. The daily truck factor, T24-factor, represents the percentage of truck traffic that occurs in a 24-hour period. To obtain the weekly variation of the P/D ratio, D-factor and T-factor, the seven-day counts collected along the two sections of Causeway Boulevard were analyzed. Again, the two sections were between US 41 and 78th Street, and 78th Street and US 301. For the first section (between US 41 and 78th Street), the P/D ratios ranged from 7.26 percent to 11.55 percent for the week, with an average of 11.29 percent for a typical weekday (Tuesday through Thursday). The D-factors ranged from 50.57 percent to 76.40 percent for the week with an average of 74.38 percent for a typical weekday. The daily T-factors ranged from 6.63 percent to 13.46 percent for the week, with an average of 12.85 percent for a typical weekday.

For the second section (between 78th Street and US 301), the P/D ratios ranged from 7.18 percent to 9.98 percent for the week, with an average of 9.47 percent for a typical weekday. The D-factors ranged from 51.02 percent to 65.55 percent for the week with an average of 63.66 percent for a typical weekday. The T24-factors ranged from 4.91 percent to 11.10 percent for

the week, with an average of 10.75 percent for a typical weekday. The results from the two sections are shown in Tables 9 and 10.

TABLE 9: TRAFFIC CHARACTERISTICS CAUSEWAY BOULEVARD BETWEEN US 41 AND 78TH STREET			
Day Of Week	**P/D (%)**	**D (%)**	**T_{24} (%)**
Tuesday	11.07	74.64	13.46
Wednesday	11.34	74.44	12.90
Thursday	11.46	74.07	12.18
Friday	10.55	75.79	12.05
Saturday	7.79	54.69	7.31
Sunday	7.26	50.57	6.63
Monday	11.55	76.40	12.19

TABLE 10: TRAFFIC CHARACTERISTICS CAUSEWAY BOULEVARD BETWEEN 78TH STREET AND US 301			
Day Of Week	**P/D (%)**	**D (%)**	**T_{24} (%)**
Tuesday	9.69	64.55	10.70
Wednesday	9.09	62.89	11.10
Thursday	9.62	63.53	10.47
Friday	8.62	64.35	9.78
Saturday	7.18	51.26	6.08
Sunday	7.98	51.02	4.91
Monday	9.98	65.55	10.07

The P/D ratio does not represent the K_{30}-factor. In order to determine the K_{30}-factor, which is a factor applied to the AADT to arrive at the thirtieth highest hourly volume for design use, continuous traffic counting for 365 days is required. The D_{30}-factor is the percentage of traffic traveling in the peak direction during the peak hour of the thirtieth highest hour in a year. Since Causeway Boulevard (SR 676) is a state maintained roadway, the factors were obtained from the FDOT Statistics Office for 2001. According to the FDOT statistics, the K_{30}- and D_{30}-factors for 2001 are 9.21 percent and 53.52 percent, respectively. These factors were applied to all the roads analyzed within this study area (i.e., US 41, 78th Street and US 301).

The daily T-factor (T_{24}-factor) is the percentage of trucks or heavy vehicles in relation to the total traffic volume during a 24-hour period. According to the FDOT Statistics Office, the following daily T-factors were obtained:

1. US 41 north of Causeway Boulevard – 9.44 percent
2. US 41 south of Causeway Boulevard – 11.76 percent
3. Causeway Boulevard west of US 301 – 10.68 percent
4. Causeway Boulevard west of US 41 – 13.92 percent
5. US 301 south of Causeway Boulevard – 9.51 percent
6. US 301 south of Crosstown Expressway – 7.31 percent

For the design hour, the T-factor is assumed to be one-half the value of the daily T-factor; therefore, the following design hour T-factors are:

1. US 41 north of Causeway Boulevard – 4.72 percent
2. US 41 south of Causeway Boulevard – 5.88 percent
3. Causeway Boulevard west of US 301 – 5.34 percent
4. Causeway Boulevard west of US 41 – 6.96 percent
5. US 301 south of Causeway Boulevard – 4.76 percent
6. US 301 south of Crosstown Expressway – 3.66 percent

Table 11 provides a comparison between the average values obtained from the seven-day count for each section of Causeway Boulevard and the FDOT's statistics for those roadways in the study area. After comparing the traffic characteristics, it was determined that the values provided by the FDOT fall within the acceptable ranges for K_{30}- and D_{30}-factors as outlined in the FDOT's *Design Traffic Handbook*, January 1996.

TABLE 11: COMPARISON OF TRAFFIC CHARACTERISTICS

Roadway Segment along Causeway Boulevard	Average Values		
	Peak-to-Daily Ratio vs. K-Factor	D-Factor	T_{24}-Factor
US 41 to 78th Street	11.19%	75.07%	12.56%
78th Street to US 301	9.40%	64.17%	10.42%
Avg. for Corridor	**10.30%**	**69.62%**	**11.49%**
FDOT Statistics	**9.21%**	**53.52%**	**10.68%**

Appendix B contains the statistical information provided by the FDOT for the traffic characteristics as well as the acceptable values obtained from the FDOT's *Design Traffic Handbook*, latest edition.

The directional design hour volume (DDHV) was determined by applying the K_{30} and D_{30} factors to the calculated AADT. Table 12 presents the results for the various roadway segments analyzed.

TABLE 12: AADT AND DDHV (2002)

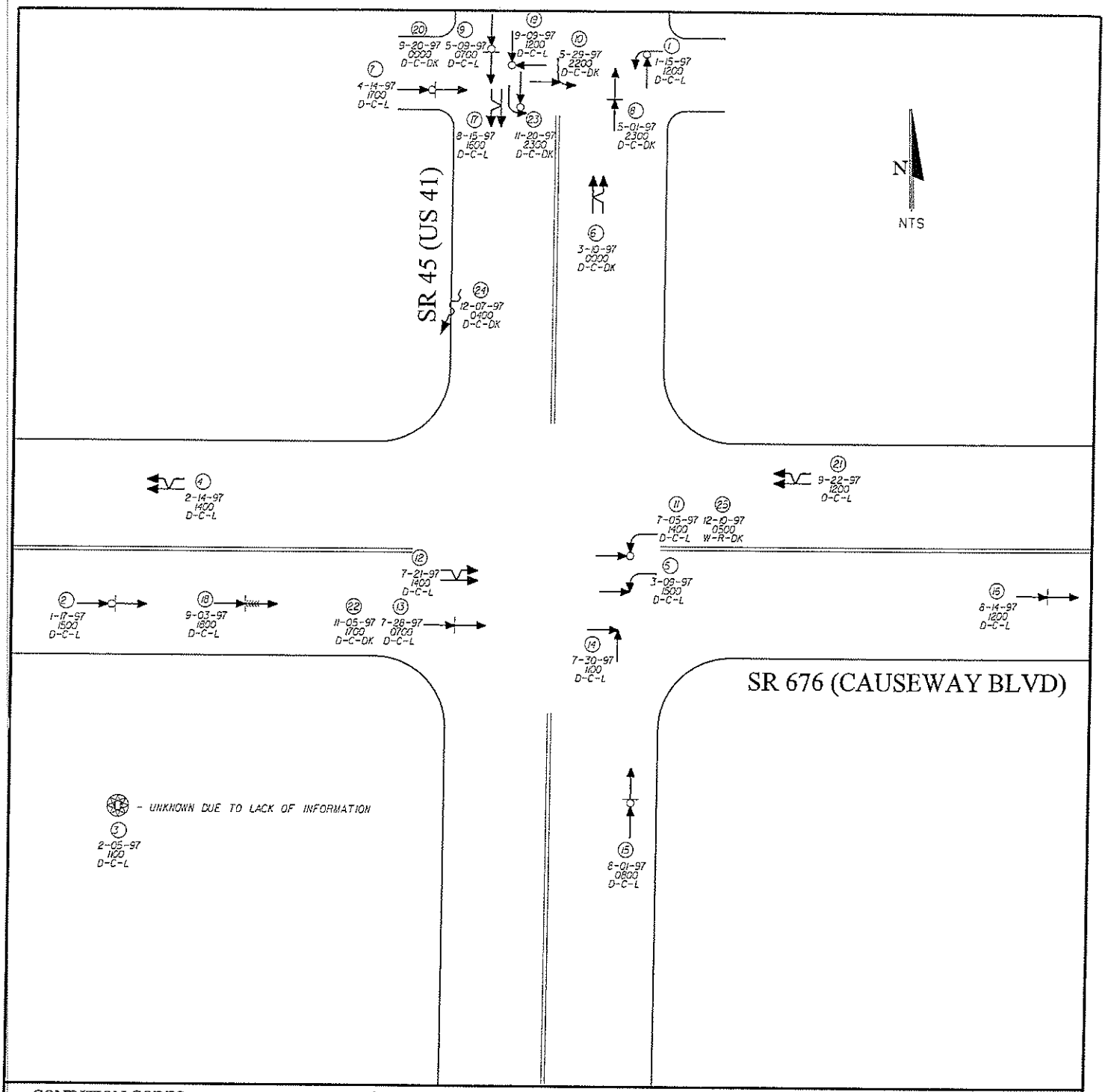
Roadway Segment	AADT (VPD)	DDHV (VPH)
Causeway Boulevard between US 41 and 78th Street	16,000	789
Causeway Boulevard between 78th Street and US 301	21,500	1,060
US 41 N of Causeway Boulevard	24,000	1,183
US 41 S of Causeway Boulevard	29,500	1,454
US 301 N of Causeway Boulevard	37,000	1,824
US 301 S of Causeway Boulevard	33,000	1,627
78th Street N of Causeway Boulevard	14,000	690
78th Street S of Causeway Boulevard	11,000	542
US 41 (BUS) W of US 41	22,500	1,109

3.4 Crash Analysis

The crash analysis consists of analyzing the traffic accident history at five locations with crash data obtained from 1997, 1998 and 1999. Of the five selected locations, four are along Causeway Boulevard (US 41, the railroad crossing east of US 41, 78th Street South and US 301). US 41 at the railroad crossing south of Causeway Boulevard was also analyzed for possible safety problems due to the train crossing. The collision summary tables for each of these locations are included in Appendix C.

Causeway Boulevard (SR 676) at US 41 (SR 45)

Crash data for this intersection revealed that there were a total of 68 crashes during the three-year study period. The location and type of each crash is shown in Figures 11, 12 and 13. There were 25 crashes in 1997, 23 crashes in 1998 and 20 crashes in 1999. Out of the 68 crashes, there were 30 rear-end, 8 left turn, 9 angle and 15 sideswipe crashes. The remaining six accidents involved other types of collisions. Thirty of these crashes resulted in injury due to the high speed as vehicles approached the intersection.



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	9	8	0	17
NIGHTTIME	4	4	0	8
TOTAL	13	12	0	25

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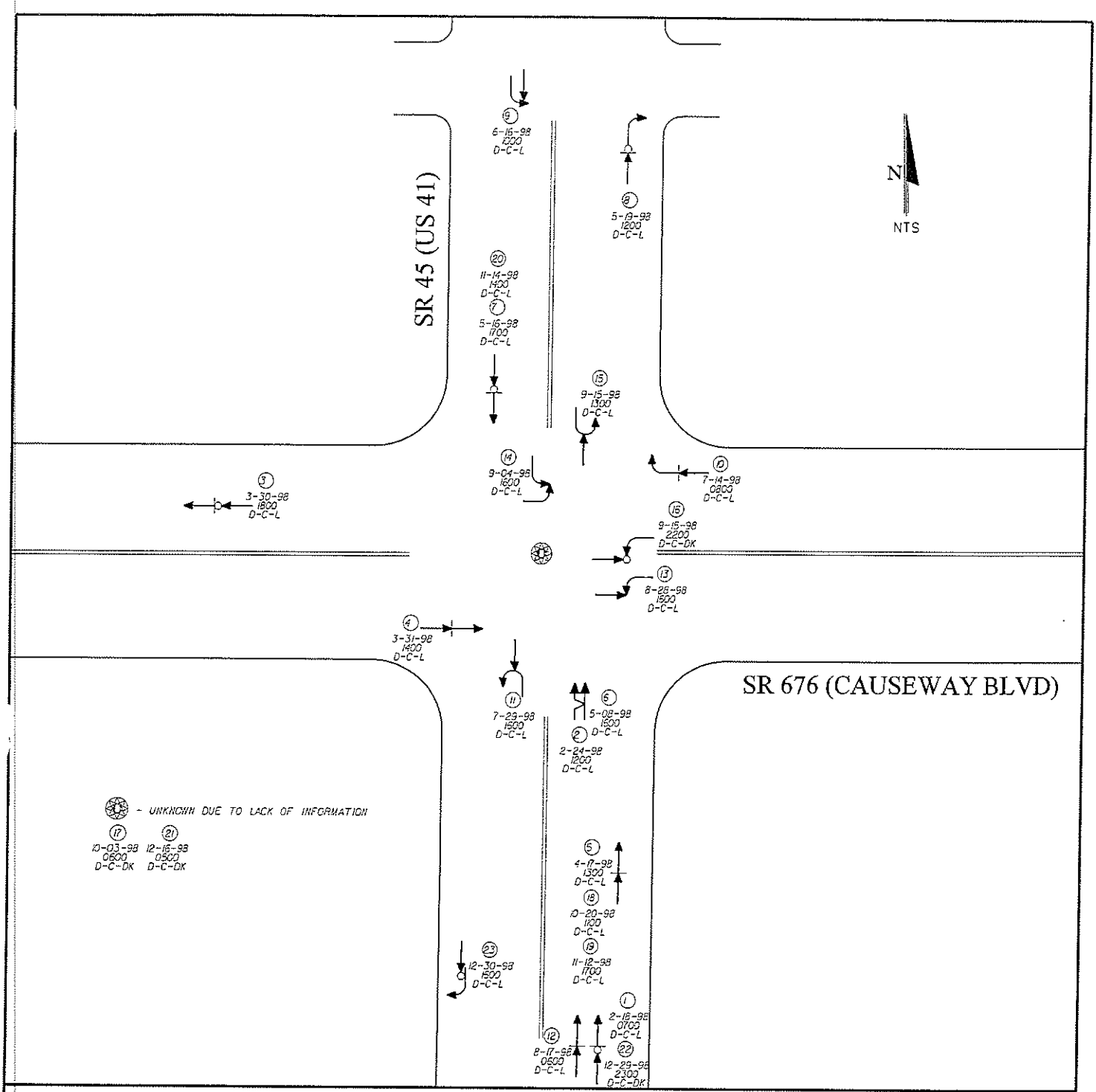
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 11: 1997 Collision Diagram for SR 676 (Causeway Blvd)/SR 45 (US 41)
Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	13	6	0	19
NIGHTTIME	1	3	0	4
TOTAL	14	9	0	23

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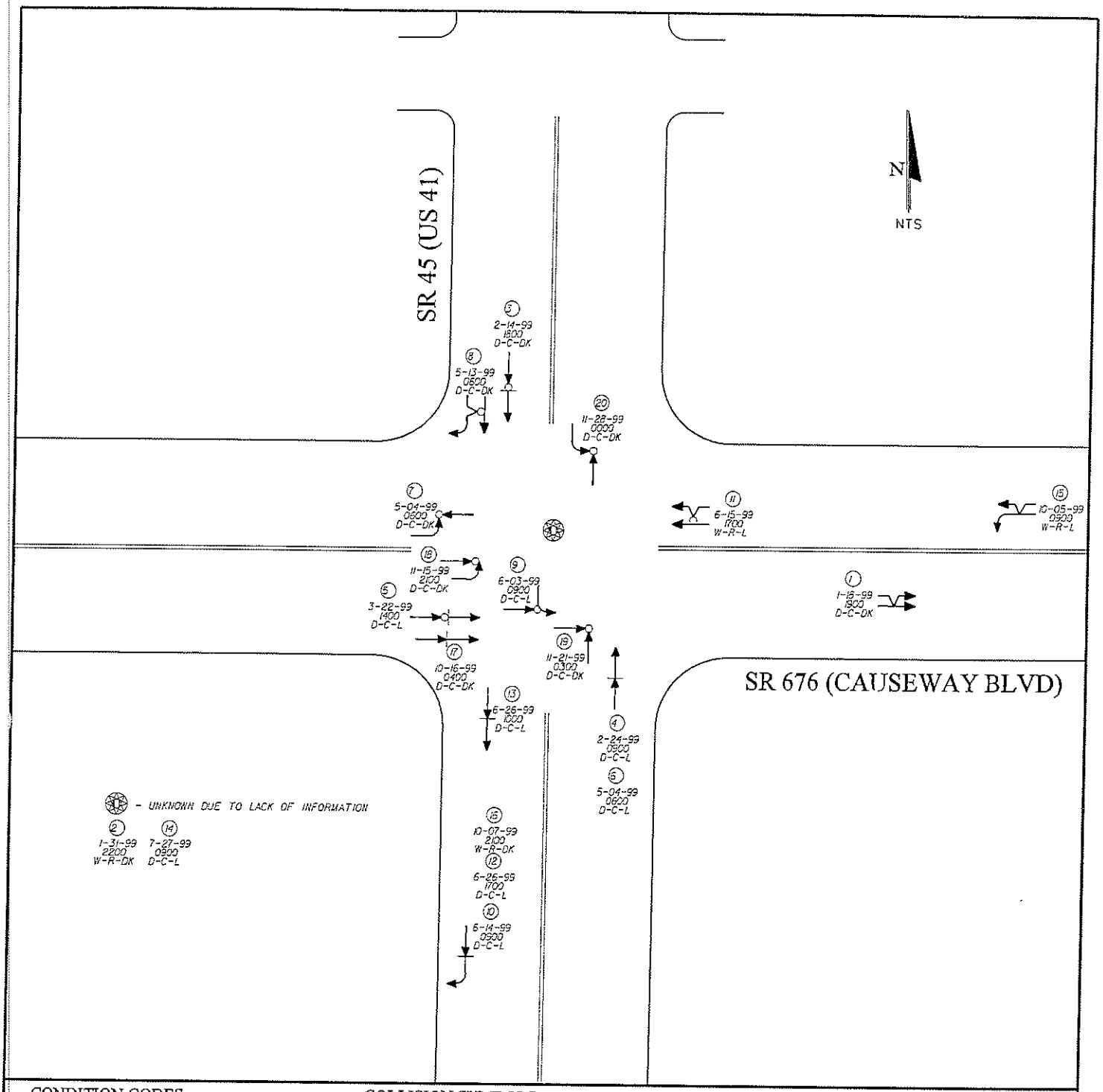
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 12: 1998 Collision Diagram for SR 676 (Causeway Blvd)/SR 45 (US 41)
Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	7	3	0	10
NIGHTTIME	4	6	0	10
TOTAL	11	9	0	20

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Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 13: 1999 Collision Diagram for SR 676 (Causeway Blvd)/SR 45 (US 41)
Drawn by	PHD
Project No.	2021101
Date	6/26/02

Thirty-two percent of the crashes occurred at night and more than half (55 percent) of these night crashes resulted in injury.

Causeway Boulevard (SR 676) at Railroad Crossing East of US 41

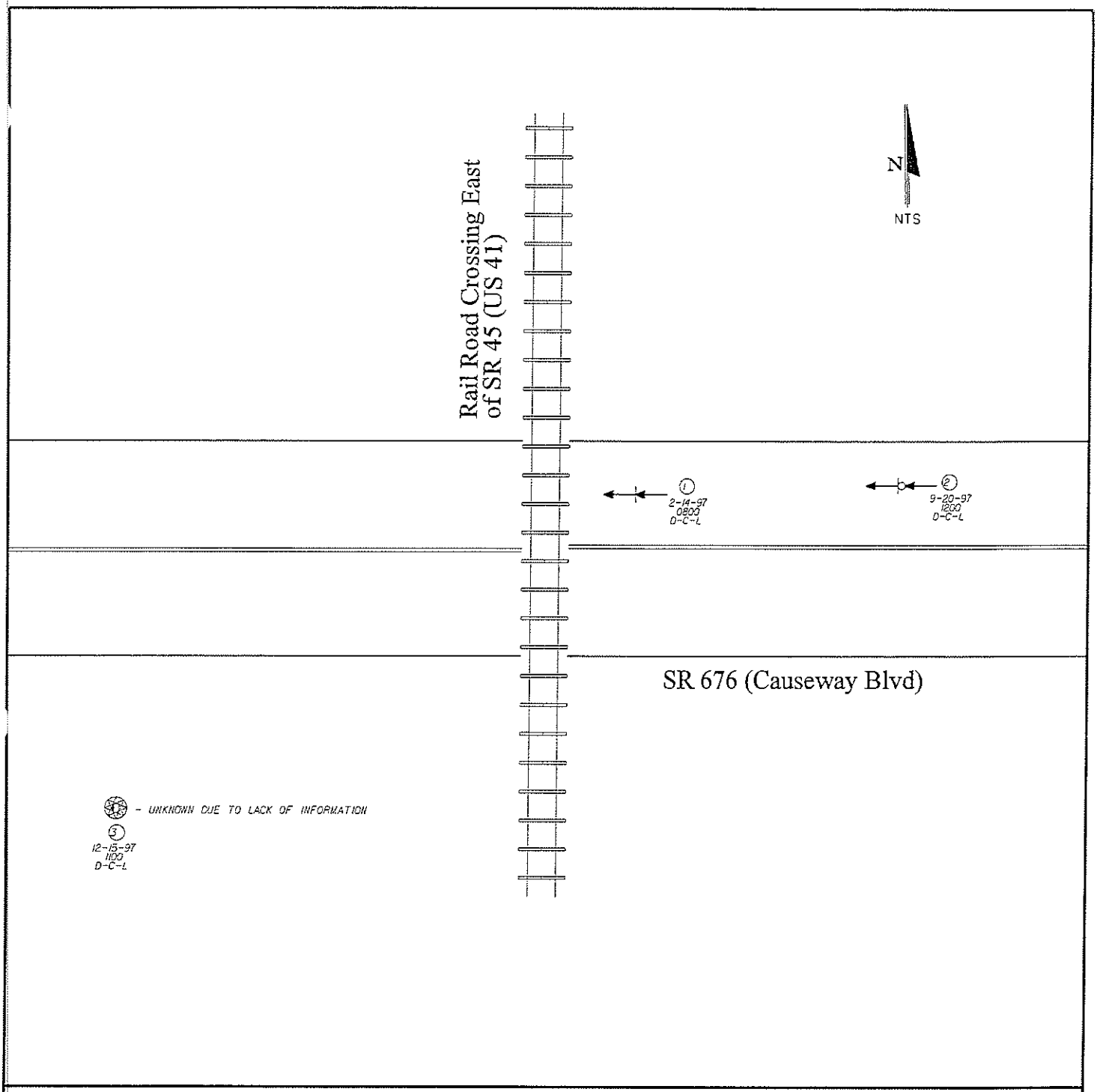
The crash data shows that there were 12 crashes at this location for the three-year study period. The collision diagrams for this location are illustrated in Figures 14, 15 and 16. During the three-year study period, there were three crashes in 1997, six crashes in 1998 and three crashes in 1999. Out of these 12 crashes, seven were rear-end, one angle, one sideswipe and the rest were unknown due to lack of information. Five of the 12 crashes involved injury, seven involved property damage and there were no reported fatality crashes.

Causeway Boulevard (SR 676) at 78th Street South

During the three-year study period at this intersection, there were a total of 35 crashes, with 17 of these crashes resulting in one or more injuries. The collision diagrams for this intersection are shown in Figures 17, 18, and 19. Ten crashes were recorded in 1997, 15 crashes in 1998 and 10 crashes in 1999. Out of the 35 total crashes, there were 11 rear-end, 10 left turn, 11 angle, 1 right turn and 2 unknown crashes due to lack of information. The crash analysis also shows a high number of angle collisions at this signalized intersection.

Causeway Boulevard (SR 676) at US 301 (SR 43)

The crash data for this intersection shows that there were 142 crashes from 1997 through 1999. The collision diagrams for this intersection are shown in Figures 20, 21 and 22. The crash distribution for each year shows that there were 42 crashes in 1997, 40 crashes in 1998 and 60 crashes in 1999. Out of the total 142 crashes, there were 60 rear-end, 26 left-turn, 21 angle, 16 sideswipe and 13 other types of crashes. The crash data for 1999 reveals that there were 11 left-turn crashes at this intersection. The left-turn crashes are due to the permissive left turn phases on eastbound and westbound. The number of crashes resulting in injury was also high. There were 62 crashes with injury. Rear-end accidents were also a problem at this location, more than half of the crashes were rear-end crashes.



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	2	1	0	3
NIGHTTIME	0	0	0	0
TOTAL	2	1	0	3

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Drawing Title:	Figure 14: 1997 Collision Diagram for SR 676 (Causeway Blvd)/Railroad Crossing East of US 41
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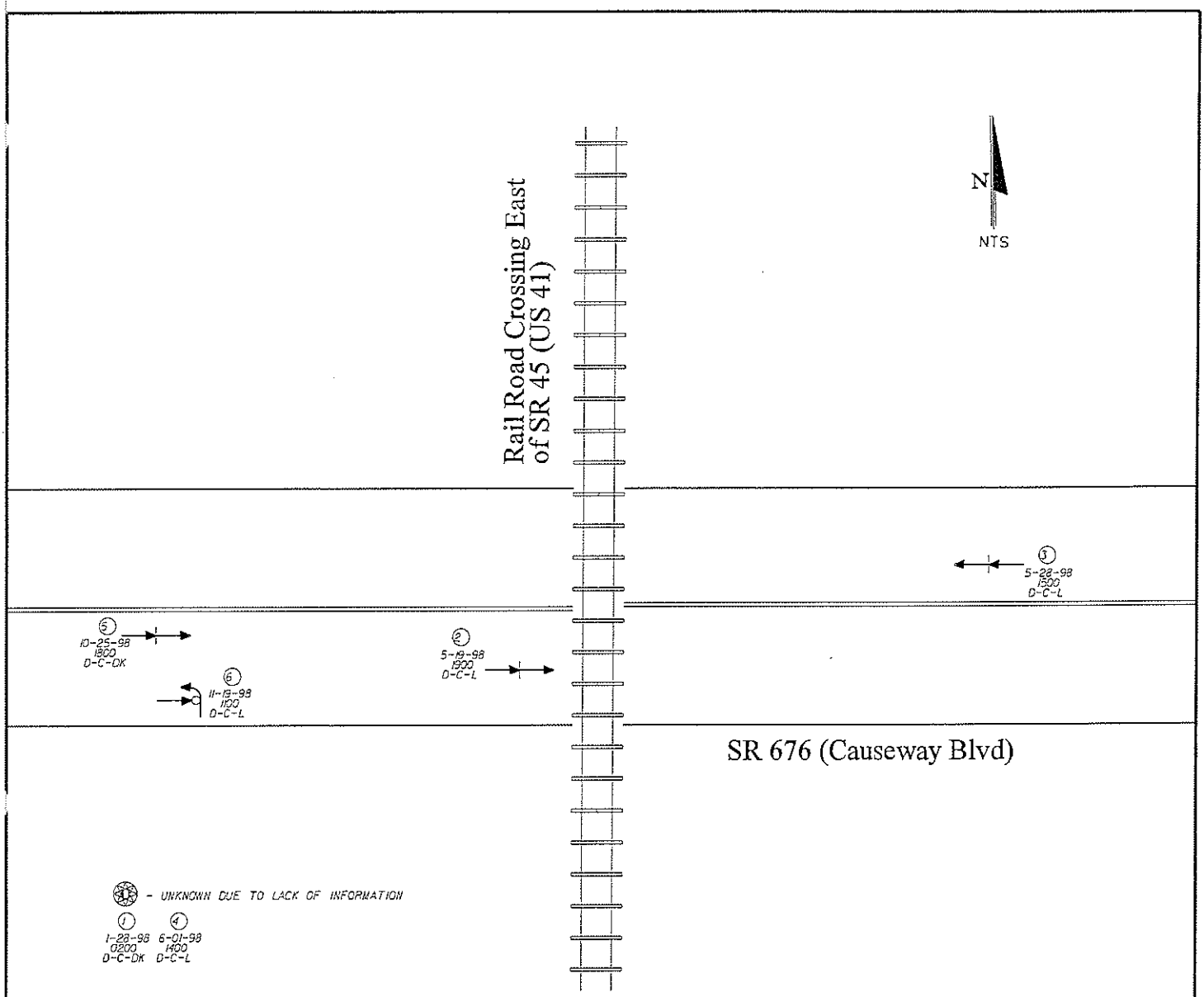
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	3	1	0	4
NIGHTTIME	1	1	0	2
TOTAL	4	2	0	6

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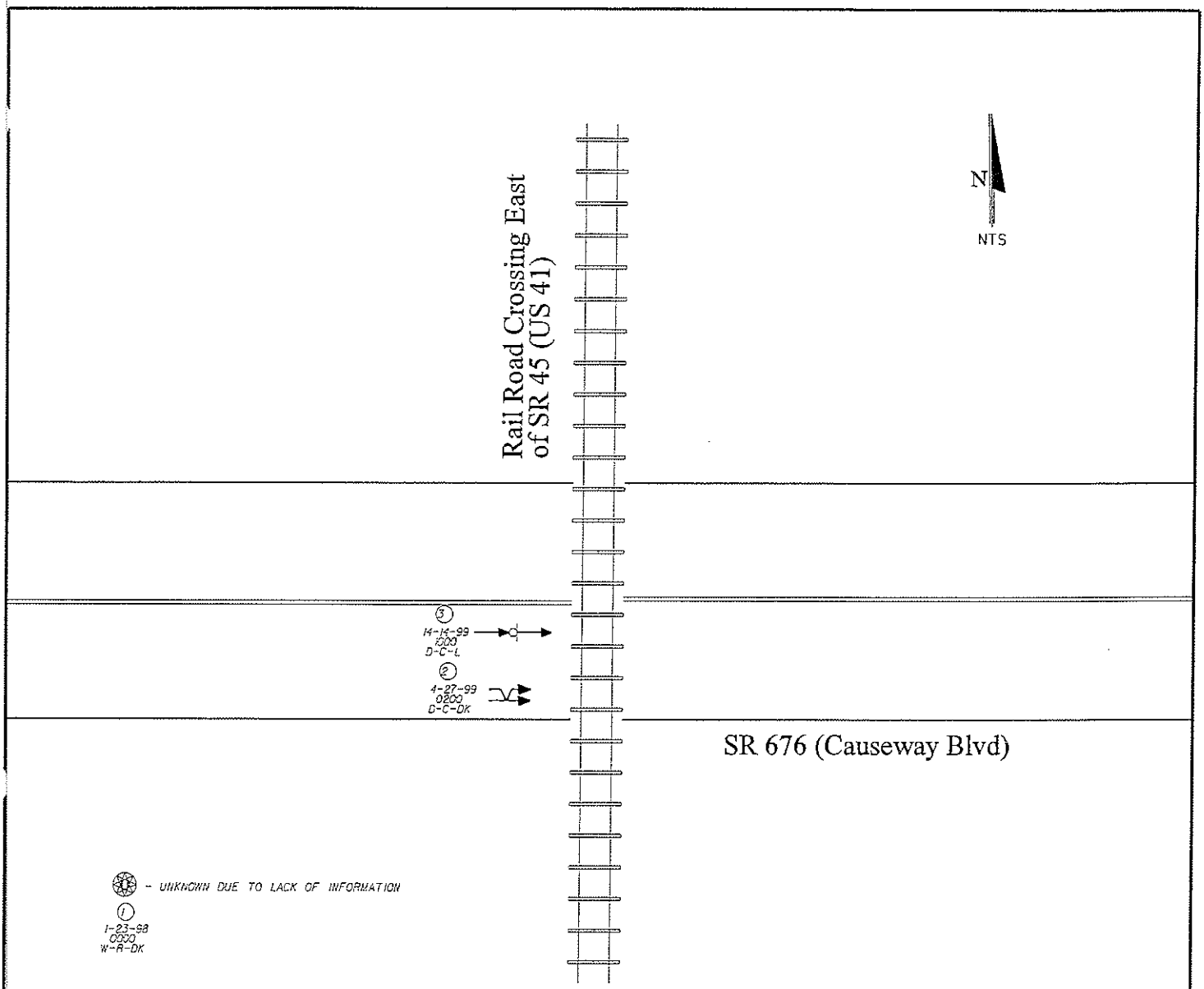
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 15: 1998 Collision Diagram for SR 676 (Causeway Blvd)/Railroad Crossing East of US 41
Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	0	1	0	1
NIGHTTIME	1	1	0	2
TOTAL	1	2	0	3

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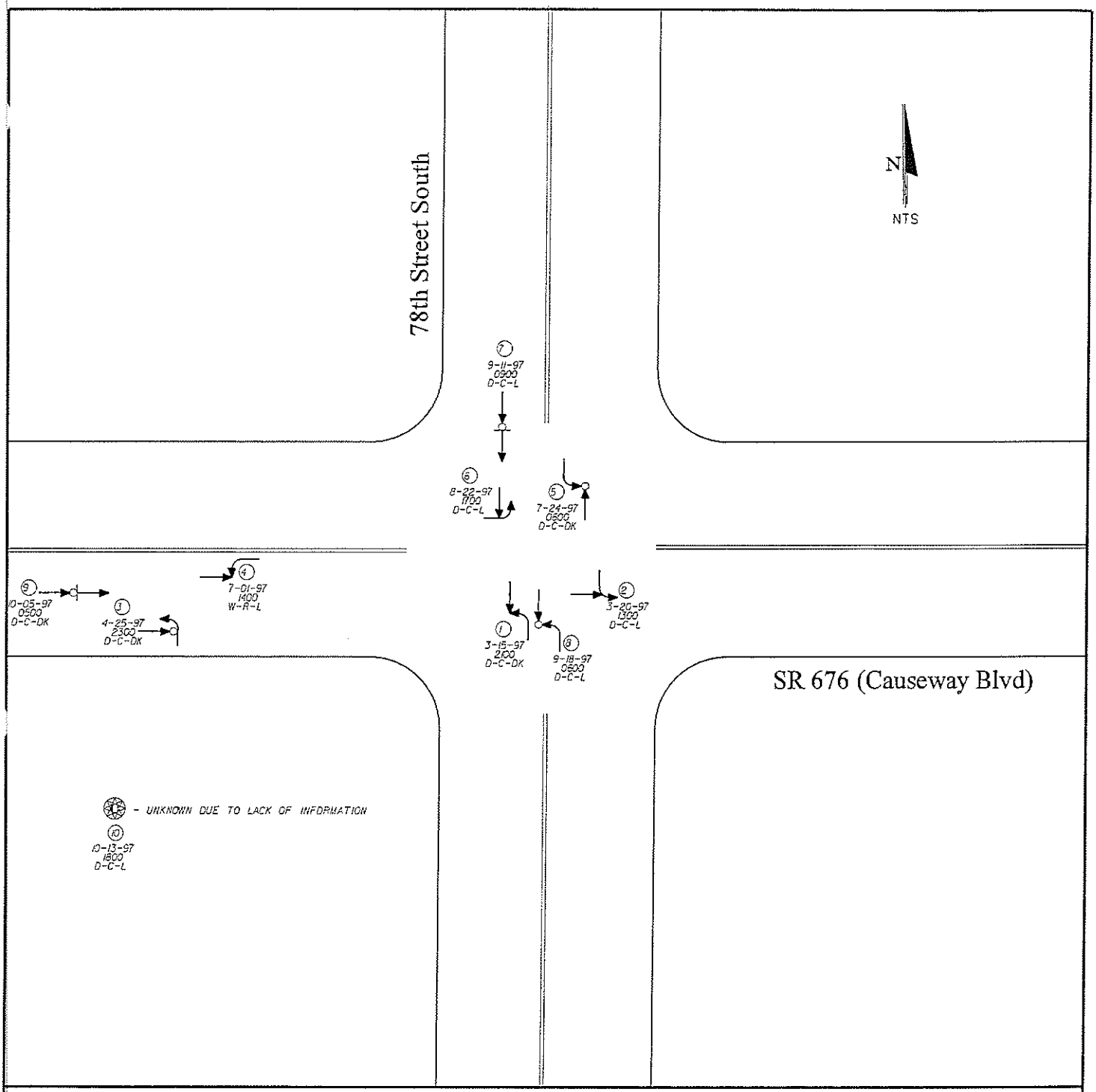
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 16: 1999 Collision Diagram for SR 676 (Causeway Blvd)/Railroad Crossing East of US 41
Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	3	3	0	6
NIGHTTIME	2	2	0	4
TOTAL	5	5	0	10

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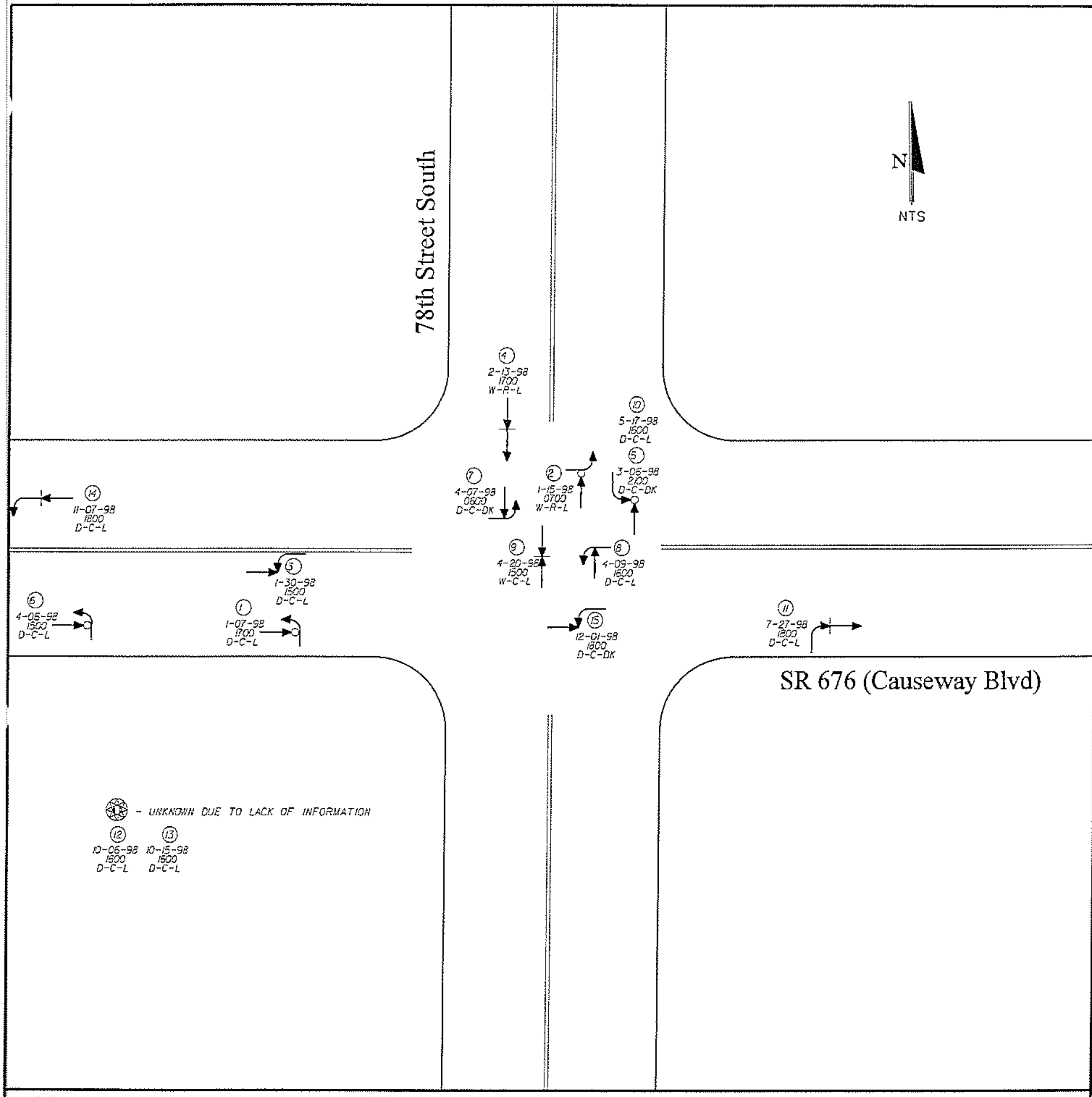
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 17: 1997 Collision Diagram for SR 676 (Causeway Blvd)/78th St

Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET

WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG

LIGHT CONDITION
L-DAYLIGHT DK-DARK

TIME OF DAY
MILITARY

COLLISION SYMBOLS

- VEHICLE DIRECTION
- BACKING VEHICLE
- PEDESTRIAN
- FIXED OBJECT
- PARKED VEHICLE
- INJURY
- FATALITY
- REAR-END COLLISION
- HEAD-ON COLLISION
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED VEHICLE
- LEFT TURN COLLISION
- RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	7	5	0	12
NIGHTTIME	2	1	0	3
TOTAL	9	6	0	15

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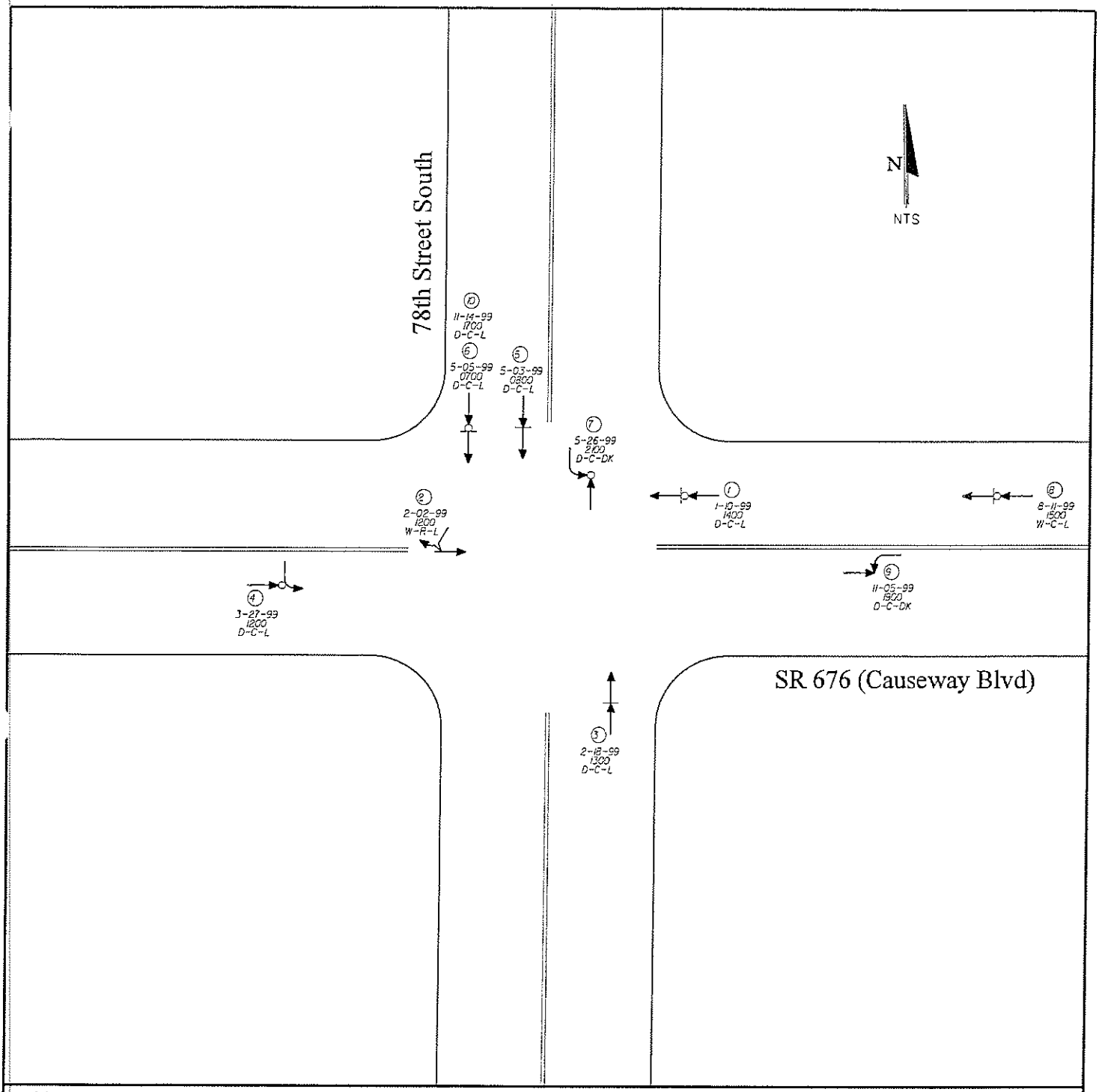
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 18: 1998 Collision Diagram for SR 676 (Causeway Blvd)/78th St
Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	3	5	0	8
NIGHTTIME	1	1	0	2
TOTAL	4	6	0	10

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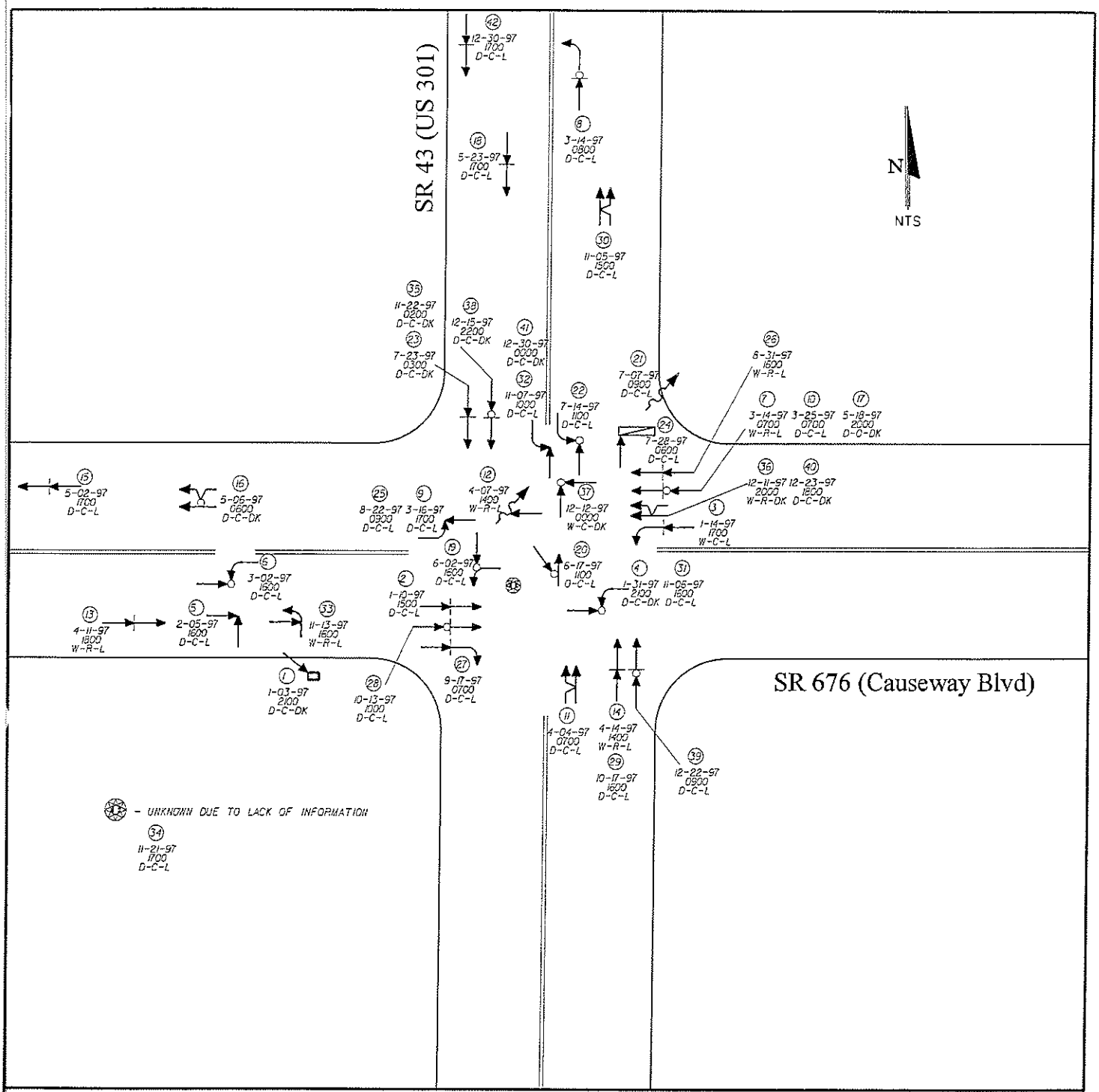
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 19: 1999 Collision Diagram for SR 676 (Causeway Blvd)/78th St
Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

- VEHICLE DIRECTION
- BACKING VEHICLE
- PEDESTRIAN
- FIXED OBJECT
- PARKED VEHICLE
- INJURY
- FATALITY
- REAR-END COLLISION
- HEAD-ON COLLISION
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED VEHICLE
- LEFT TURN COLLISION
- RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	21	10	0	31
NIGHTTIME	6	5	0	11
TOTAL	26	15	0	42

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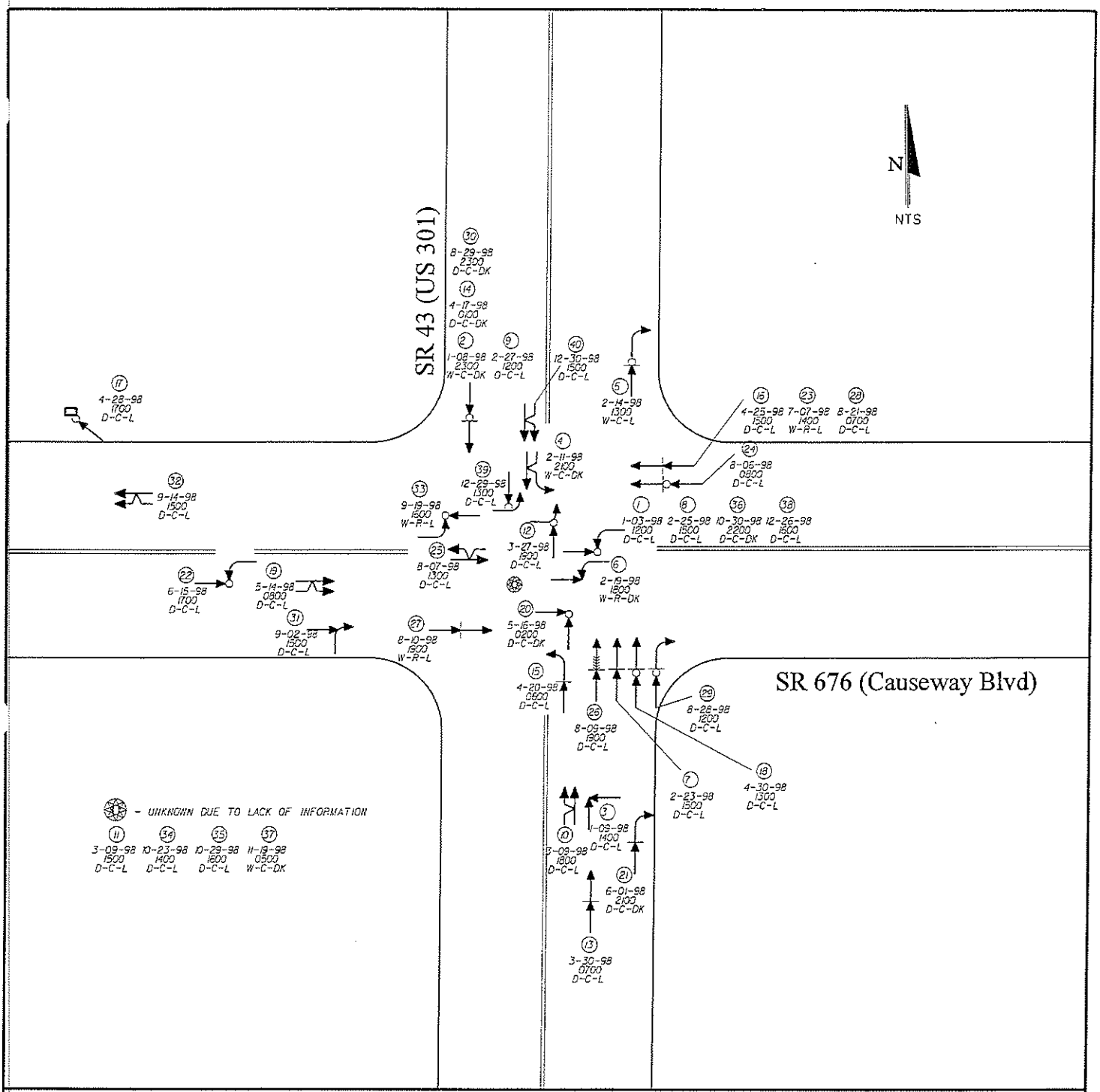
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 20: 1997 Collision Diagram for SR 676 (Causeway Blvd)/SR 43 (US 301)
Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

- VEHICLE DIRECTION
- BACKING VEHICLE
- PEDESTRIAN
- FIXED OBJECT
- PARKED VEHICLE
- INJURY
- FATALITY
- REAR-END COLLISION
- HEAD-ON COLLISION
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED VEHICLE
- LEFT TURN COLLISION
- RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	15	14	0	29
NIGHTTIME	5	6	0	11
TOTAL	20	20	0	40

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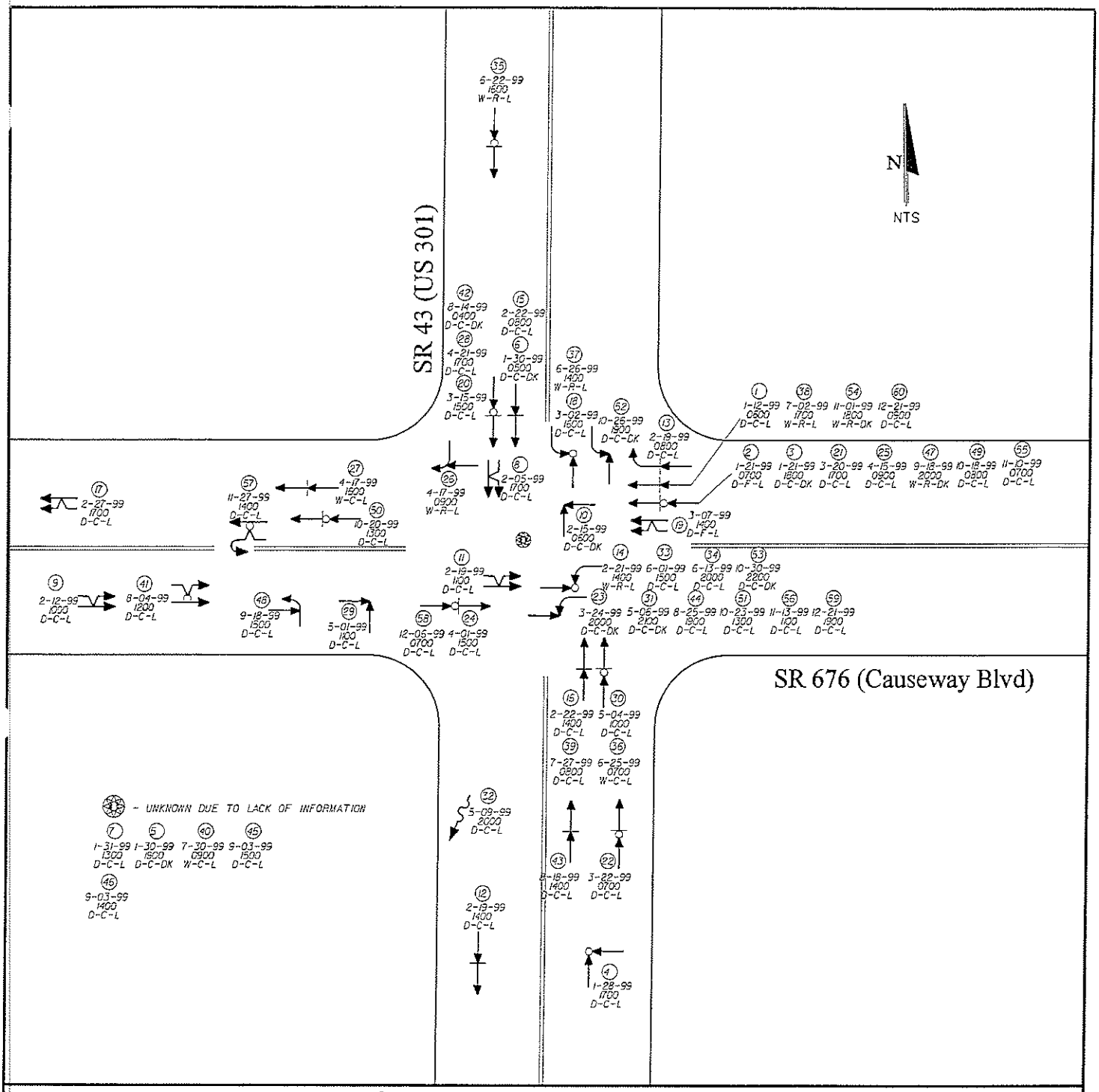
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 21: 1998 Collision Diagram for SR 676 (Causeway Blvd)/SR 43 (US 301)
Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET

WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG

LIGHT CONDITION
L-DAYLIGHT DK-DARK

TIME OF DAY
MILITARY

COLLISION SYMBOLS

- VEHICLE DIRECTION
- BACKING VEHICLE
- PEDESTRIAN
- FIXED OBJECT
- PARKED VEHICLE
- INJURY
- FATALITY
- REAR-END COLLISION
- HEAD-ON COLLISION
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED VEHICLE
- LEFT TURN COLLISION
- RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	25	24	0	49
NIGHTTIME	7	4	0	11
TOTAL	32	28	0	60

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Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 22: 1999 Collision Diagram for SR 676 (Causeway Blvd)/SR 43 (US 301)
Drawn by	PHD
Project No.	2021101
Date	6/26/02

US 41 (SR 45) at Railroad Crossing South of Causeway Boulevard (SR 676)

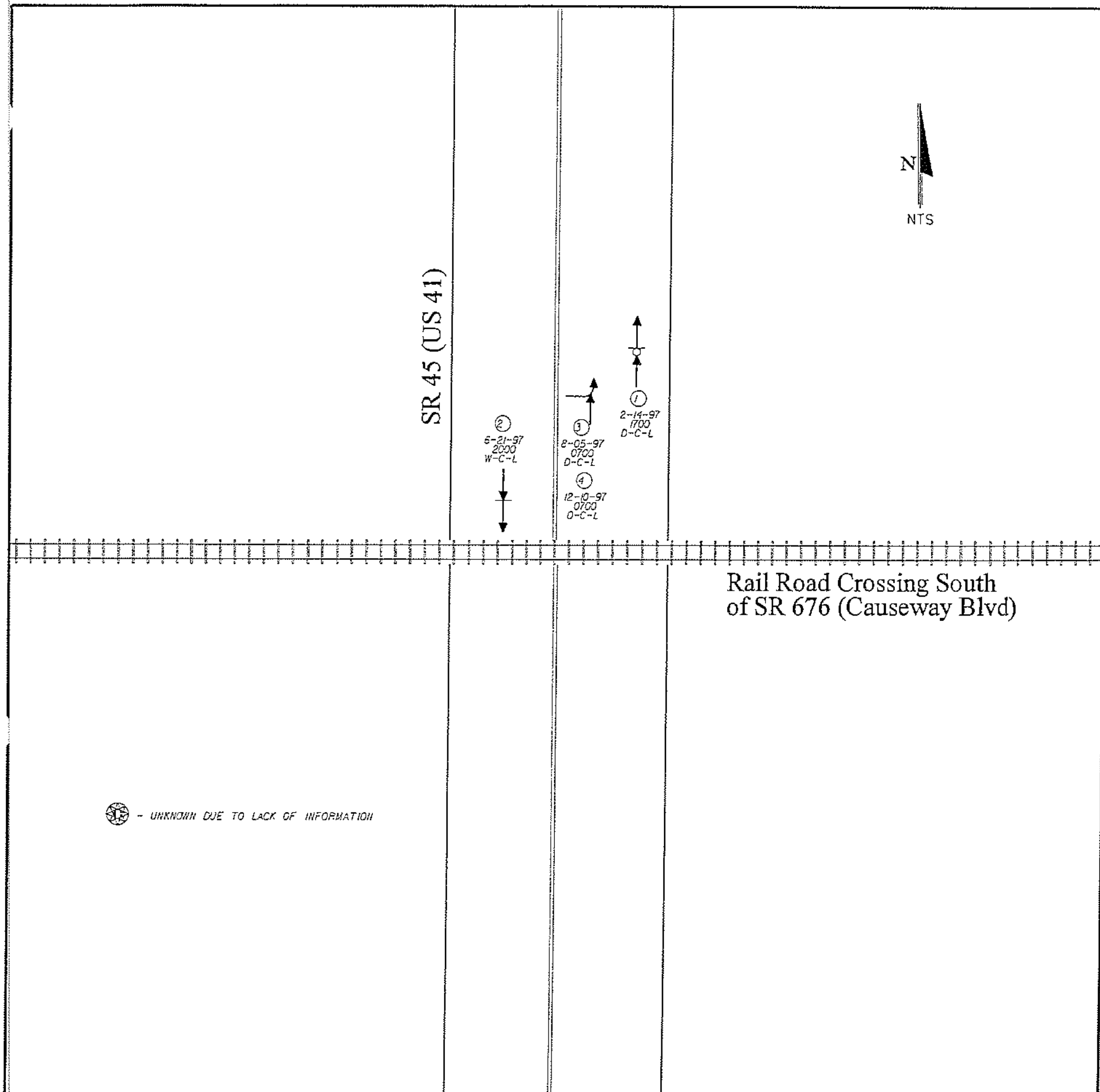
The crash data from 1997 thru 1999 revealed that there were a total of 24 crashes that occurred at this location. There were four crashes in 1997, twelve in 1998 and eight in 1999. The collision diagrams for this location are shown in Figures 23, 24 and 25. The crash distribution shows that 65 percent of the crashes were either rear-end or sideswipe crashes and 35 percent of the crashes are composed of other types of crashes, which occurred at a driveway or median opening. Out of the 24 crashes, there were 12 crashes with one or more injuries, including one fatality that occurred in 1998. Most of these crashes occurred due to the high speed limits along US 41 in which vehicles fail to decelerate and stop appropriately during a train crossing.

In summary, there were 281 crashes with 127 resulting in one or more injuries. The majority of the crashes (142 crashes) occurred at the intersection of Causeway Boulevard (SR 676) and US 301 (SR 43). The high number of crashes could mainly be contributed to the high speed limits (45 and 50 mph) on both Causeway Boulevard (SR 676) and US 301 (SR 43), where vehicles fail to decelerate as they approach the intersection. The crash analysis for the three-year study period shows that 127 accidents are rear-end collisions (42 percent). Rear-end crashes may be reduced by adding turn lanes and lowering the speed limit on both Causeway Boulevard and US 301.

3.5 Roadway Capacity Analysis

The LOS for the study corridor (i.e., Causeway Boulevard from US 41 to US 301) were determined based on two different methods. First, the annual average daily traffic (AADT) and peak hour directional volumes were compared to the generalized capacities presented in the FDOT *2002 Quality/Level of Service Manual.* The second method utilized the procedures outlined in the Transportation Research Board *2000 Highway Capacity Manual* for analyzing an urban arterial roadway.

The FDOT *2002 Quality/Level of Service Manual* provides capacity tables for various types of roadways (two-lane undivided, four-lane divided, etc.) within a variety of surroundings, such as urban or suburban areas. According to the Hillsborough County *Roadway Level of Service Report*, December 2001, Causeway Boulevard between US 41 and US 301 is classified as a two-lane undivided, urban interrupted flow arterial. The LOS standard (or acceptable LOS)



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	3	1	0	4
NIGHTTIME	0	0	0	0
TOTAL	3	1	0	4

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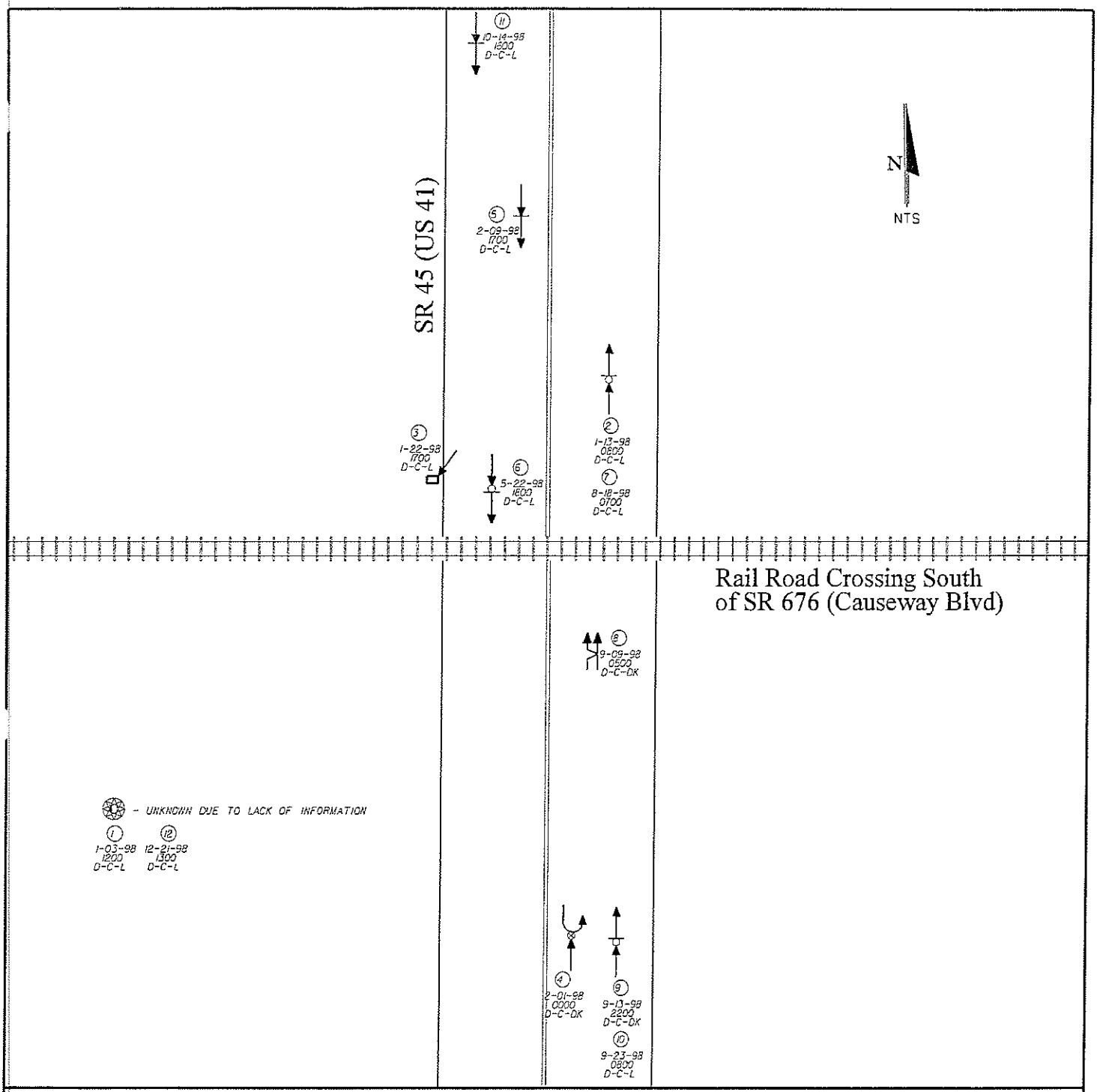
Project Title:	Causeway Boulevard Corridor Analysis	Drawn by	PHD
Drawing Title:	Figure 23: 1997 Collision Diagram for SR 45 (US 41)/Rail Road Crossing South of Causeway Blvd	Project No.	2021101
		Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

- VEHICLE DIRECTION
- BACKING VEHICLE
- PEDESTRIAN
- FIXED OBJECT
- PARKED VEHICLE
- INJURY
- FATALITY
- REAR-END COLLISION
- HEAD-ON COLLISION
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED VEHICLE
- LEFT TURN COLLISION
- RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	4	5	0	9
NIGHTTIME	1	1	1	3
TOTAL	5	6	1	12

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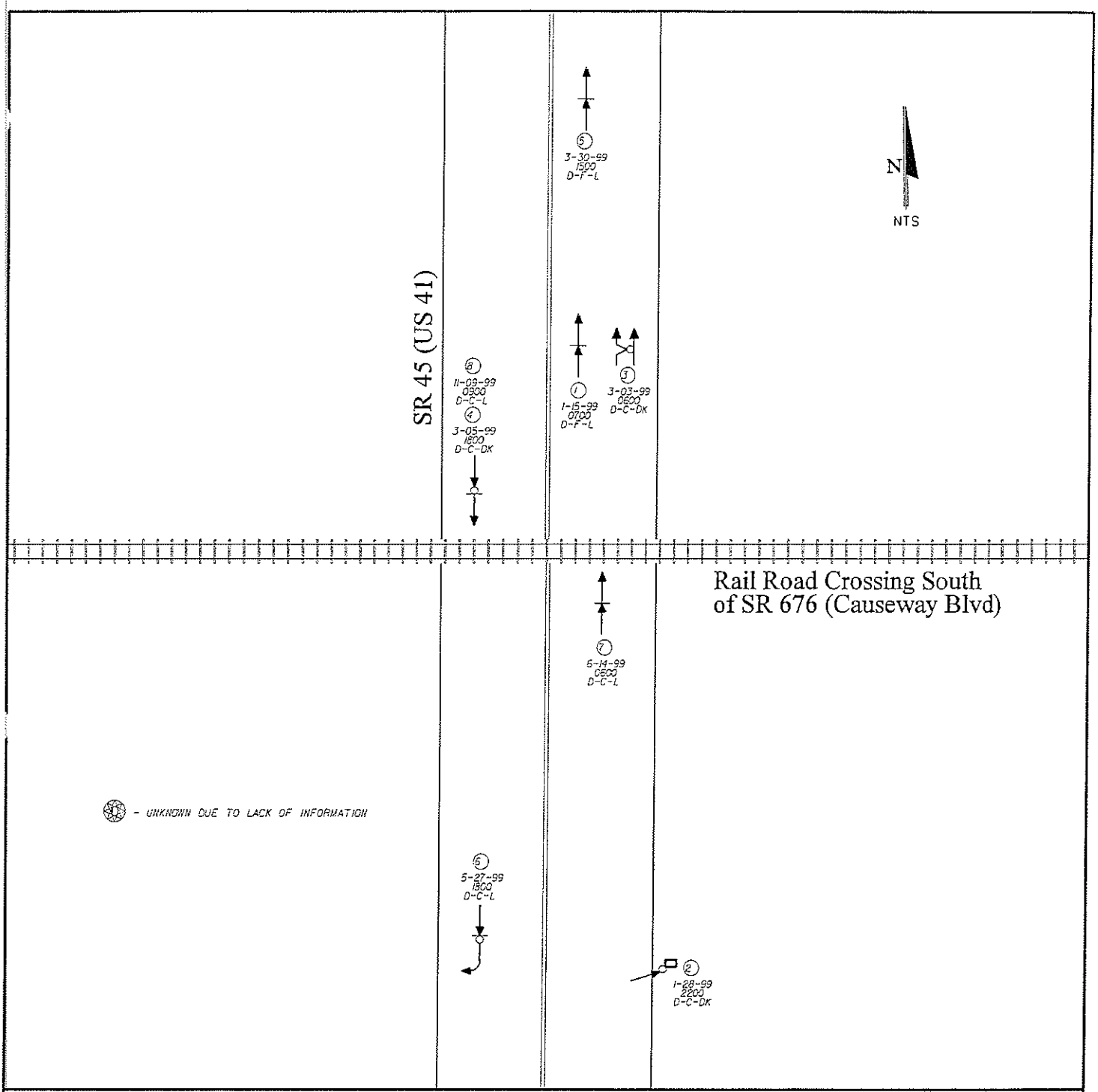
Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 24: 1998 Collision Diagram for SR 45 (US 41)/Rail Road Crossing South of Causeway Blvd
Drawn by	PHD
Project No.	2021101
Date	6/26/02



CONDITION CODES

PAVEMENT CONDITION
D-DRY W-WET
WEATHER CONDITION
C-CLEAR R-RAIN
F-FOG
LIGHT CONDITION
L-DAYLIGHT DK-DARK
TIME OF DAY
MILITARY

COLLISION SYMBOLS

VEHICLE DIRECTION
BACKING VEHICLE
PEDESTRIAN
FIXED OBJECT
PARKED VEHICLE
INJURY
FATALITY
REAR-END COLLISION
HEAD-ON COLLISION
SIDE SWIPE
OUT OF CONTROL
OVERTURNED VEHICLE
LEFT TURN COLLISION
RIGHT ANGLE COLLISION

ACCIDENT SUMMARY

	PRO. DAMAGE	INJURY	FATAL	TOTAL
DAYTIME	3	2	0	5
NIGHTTIME	0	3	0	3
TOTAL	3	5	0	8

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Project Title:	Causeway Boulevard Corridor Analysis
Drawing Title:	Figure 25: 1999 Collision Diagram for SR 45 (US 41)/Rail Road Crossing South of Causeway Blvd
Drawn by	PHD
Project No.	2021101
Date	6/26/02

Title: GCA2 stds
Name: JHL
Date: 11/21/2003
I:\Diagrams\US 41a RRX S Causeway.dgn 4:54:42 PM

for this roadway is LOS D. This information, along with the AADT and peak hour directional volumes, was applied to the generalized tables and the results are documented in Table 13.

TABLE 13: EXISTING ROADWAY LEVEL OF SERVICE

Roadway Segment	AADT			DDHV		
	Volume (vpd)	Capacity [1]	LOS	Volume (vpd)	Capacity [2]	LOS
Causeway Blvd. (US 41 to 78th St.)	16,000	16,400	D	789	860	D
Causeway Blvd. (78th St. to US 301)	21,500	16,400	F	1,060	860	F

1 – Table 4.1 from the FDOT's 2002 Quality / Level of Service Manual.
2 – Table 4.7 from the FDOT's 2002 Quality / Level of Service Manual.

According to the results presented in Table 13, the section of roadway between US 41 and 78th Street currently functions at acceptable levels of service for both daily and peak hour directional volumes. However, this section is approaching LOS D capacity as evident by the volume to capacity ratios (v/c) approaching 1.0. The volume to capacity ratios for the section on a daily and peak hour basis are 0.98 and 0.92, respectively. The second segment of roadway (78th Street to US 301) currently experiences capacity problems. The volume to capacity ratios are 1.31 and 1.23, respectively, indicating LOS F conditions.

The second method involved using the urban street module from the Highway Capacity Software (HCS), release 4.1b, to analyze the corridor. This module of the HCS replicates the procedures from Chapter 15 of the 2000 Highway Capacity Manual, and will determine the LOS based on travel speed. The entire Causeway Boulevard corridor from US 41 to US 301 was analyzed by direction of travel. Table 14 presents the results of the arterial analysis.

TABLE 14: EXISTING ARTERIAL ANALYSIS

Direction of Travel	AM Peak Hour		Off Peak Hour		PM Peak Hour	
	Speed (mph)	LOS	Speed (mph)	LOS	Speed (mph)	LOS
Eastbound	20.4	D	31.0	B	12.8	F
Westbound	31.5	B	33.5	B	32.7	B

According to the results presented in Table 14, the eastbound traffic traveling along Causeway Boulevard from US 41 to US 301 experiences LOS F conditions during the evening rush hour. No other problems exist for either direction of travel during any other time period.

Appendix D provides the following: the FDOT Generalized Capacity Tables (Tables 4-1 and 4-7), information from the Highway Capacity Manual related to urban streets and the HCS output for the arterial analysis.

3.6 Intersection Capacity Analysis

Utilizing the signalized and unsignalized intersection modules of the HCS, release 4.1b, which replicate Chapters 16 and 17, respectively, of the Transportation Research Board *2000 Highway Capacity Manual*, a determination of existing capacity was made for the following intersections: Causeway Boulevard at US 41, Causeway Boulevard at 78th Street, Causeway Boulevard at US 301, US 41 at Palm River Road, and US 41 at Hartford Street. Tables 15 and 16 present the results for the intersection capacity analyses for the various times of day (i.e., morning, mid-day and evening peak periods). Appendix E contains the HCS worksheets for the signalized and unsignalized intersections.

The level of service standard for the intersections reviewed is LOS D. According to the results from Table 15, three of the four signalized intersections currently experience excessive delays that yield unacceptable levels of service (i.e., LOS E or F). At the intersection of Causeway Boulevard and US 41, the northbound left-turn movement fails due to the large amount of traffic making this maneuver. Currently, 831 vehicles are turning during the AM peak hour and only one northbound left-turn lane is provided. With such a high demand, dual northbound left-turn lanes are required. According to the FDOT's planning and design procedures, dual turn lanes should be considered when the turning movement volume approaches or exceeds 300 vehicles per hour. During the mid-day or off-peak period, this intersection functions at acceptable levels of service. During the PM peak hour, the eastbound shared through/right-turn lane experiences LOS F conditions. This failure is mainly due to the high volume of traffic turning right (309 vehicles). Therefore, an exclusive eastbound to southbound right-turn lane should be provided.

TABLE 15: EXISTING SIGNALIZED INTERSECTION CAPACITY ANALYSIS							
Causeway Boulevard (SR 676) at US 41							
Direction of Travel	Turning Movement	AM Peak Hour		Off- Peak Hour		PM Peak Hour	
		Control Delay (sec/veh)	LOS	Control Delay (sec/veh)	LOS	Control Delay (sec/veh)	LOS
Eastbound	Left	22.0	C	23.8	C	19.4	B
	Thru/Right	30.3	C	48.4	D	283.6	F
Westbound	Left	18.3	B	33.2	C	28.7	C
	Thru/Right	48.9	D	36.9	D	26.5	C
Northbound	Left	416.4	F	47.0	D	288.2	F
	Thru/Right	46.2	D	34.1	C	35.8	D
Southbound	Left	51.9	D	30.1	C	46.5	D
	Thru/Right	50.8	D	31.6	C	41.1	D
Intersection		116.4	F	37.6	D	130.6	F
Causeway Boulevard (SR 676) at 78th Street							
Eastbound	Left	29.7	C	18.2	B	16.2	B
	Thru	18.0	B	21.5	C	53.0	D
	Right	5.3	A	8.5	A	8.5	A
Westbound	Left	18.5	B	19.3	B	199.8	F
	Thru	48.2	D	21.6	C	18.1	B
	Right	9.3	A	9.1	A	8.8	A
Northbound	Left	24.5	C	14.8	B	24.6	C
	Thru	50.4	D	25.4	C	27.8	C
	Right	24.2	C	24.2	C	27.3	C
Southbound	Left	51.7	D	17.1	B	51.5	D
	Thru	51.6	D	24.9	C	52.3	D
	Right	29.2	C	24.1	C	25.0	C
Intersection		36.5	D	20.4	C	41.0	D
Causeway Boulevard (SR 676) at US 301							
Eastbound	Left	62.8	E	34.9	C	28.6	C
	Thru/Right	260.4	F	47.3	D	334.7	F
Westbound	Left	20.4	C	40.8	D	97.8	F
	Thru	60.9	E	33.3	C	170.5	F
	Right	229.8	F	11.1	B	18.3	B
Northbound	Left	49.4	D	52.5	D	83.4	F
	Thru/Right	141.6	F	51.6	D	41.9	D
Southbound	Left	50.8	D	26.0	C	36.3	D
	Thru	33.9	C	30.1	C	221.9	F
	Right	23.5	C	17.2	B	11.1	B
Intersection		128.0	F	37.3	D	148.9	F
US 41 at Palm River Road							
Eastbound	Left/Thru/Right	25.5	C	25.4	C	25.5	C
Westbound	Left/Thru/Right	500.0	F	507.3	F	71.5	E
Northbound	Left	31.3	C	29.8	C	16.9	B
	Thru/Right	54.3	D	21.6	C	48.4	D
Southbound	Left	42.6	D	47.9	D	49.6	D
	Thru/Right	19.6	B	21.3	C	16.1	B
Intersection		141.5	F	167.4	F	38.9	D

TABLE 16: EXISTING UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS							
US 41 at Hartford Street							
Direction of Travel	Turning Movement	AM Peak Hour		Off- Peak Hour		PM Peak Hour	
		Control Delay (sec/veh)	LOS	Control Delay (sec/veh)	LOS	Control Delay (sec/veh)	LOS
Northbound	Left	10.0	A	9.4	A	24.2	C
Southbound	Left	78.9	F	11.1	B	12.9	B
Westbound	Left/Right	783.0	F	20.1	C	87.7	F
Eastbound	Left/Right	19.6	C	26.2	D	116.8	F

At the intersection of Causeway Boulevard and 78th Street, the westbound left-turn is the only movement that experiences capacity problems. This poor level of service occurs during the PM peak hour. Revising the signal timings and/or phasing of the cycle may achieve additional capacity that improves the westbound left-turn flow.

During the AM and PM peak hours, the intersection of US 301 at Causeway Boulevard fails. The poor levels of service can be attributed to the high traffic demands along US 301, which require a significant amount of green time. This additional green time reduces the amount allocated for Causeway Boulevard, thus producing LOS E and F conditions for the eastbound and westbound movements. In order to resolve some of the capacity issues, additional northbound and southbound through lanes should be considered, as well as exclusive eastbound and northbound right-turn lanes.

Palm River Road at US 41 fails during the morning and mid-day peak periods. The biggest problem at this location is the westbound approach lane. Currently, only one approach lane is provided and the westbound to northbound right-turn demand is extremely high (over 630 vehicles per hour). In order to resolve the capacity problem at this intersection, an exclusive westbound right-turn lane should be considered.

Table 16 reveals poor levels of service during both the AM and PM peak hours for the unsignalized intersection of Hartford Street at US 41. Level of service F conditions are experienced for the southbound left-turns and the westbound approach. During this time period, the majority of the traffic is heading north, thus creating few gaps for the southbound lefts and westbound lefts. During the PM peak hour, the side-street approaches fail due to the lack of

available gaps in the northbound and southbound through stream of traffic. This particular intersection will continue to experience long delays for the side-street movements unless signalization is considered. With the low eastbound and westbound approach volumes that currently exist, a traffic signal would not be warranted.

3.7 CSX Railroad

On June 21, 2002, a meeting was held with a representative (Mike Duke) from CSX Railroad to discuss the current and future operations of the rail system that affects the Causeway Boulevard project. As previously stated, CSX rail lines cross Causeway Boulevard east of US 41 (approximately 1,300 feet), and US 41 south of Causeway Boulevard (approximately 1,400 feet). According to Mr. Duke, many trains serve the Rockport area, which is southwest of the project, and the Port of Tampa. Due to the close proximity of Rockport, many trains cross Causeway Boulevard and US 41 throughout the course of a day. Based on the latest information from CSX, approximately 32 trains travel in the area of the project each day. The time at which these trains move varies from day to day, but basically one train will move in each hour of the day. Each train consists of 100 to 150 boxcars, and a boxcar is approximately 55 feet long. Therefore, a train could reach a length between 5,500 feet and 8,250 feet (or greater than 1.0 mile). With such a long distance and close proximity to the train yard at Rockport, delays along Causeway Boulevard and US 41 are not uncommon. The cause for a train to stop across the roadways is typically due to the "Y" switch southeast of the US 41 and Causeway Boulevard intersection. This switch leads to and from the Rockport yard, and can send trains in both the north and south direction. Trains must slow down and brake when entering the "Y" switch, thus creating delays along the roadways.

According to the CSX representative, it would be difficult to estimate the future number of trains likely to cross the subject roadways because it is driven by the business at the Port of Tampa as well as other businesses in the area, such as phosphate mining and agriculture. Therefore, the traffic operations analysis should consider existing conditions to remain relatively stable for the near future.

3.8 Port of Tampa

A meeting was held with a representative (Ram Kancharla) of the Tampa Port Authority to discuss the future expansion of the Port on May 16, 2002. Mr. Kancharla provided a document which summarizes the findings of a traffic study that includes the projected growth of the Port. According to the Executive Summary of the "Tampa Port Authority Intermodal Transportation Plan", July 2000, it was estimated that car, truck and rail traffic at the Port will increase by as much as 36 percent, 52 percent and 21 percent per year, respectively, over the next 10 years. The report also showed that the 20th Street/Causeway Boulevard route was heavily used by both Port work trips as well as heavy trucks transporting cargoes to and from the Port facilities.

The study identified the immediate need to improve the intersection operations at US 41 and Causeway Boulevard by constructing an additional northbound left-turn lane and adding an exclusive eastbound right-turn lane. Furthermore, the study concluded that a grade-separation was required at the Causeway Boulevard railroad crossing to prevent any further delays and accidents incurred by motorists. Also, Causeway Boulevard from US 41 to US 301 should be widened from a two-lane undivided to a four-lane divided roadway in order to accommodate the anticipated increase in traffic along the corridor.

4.0 FUTURE CONDITIONS

4.1 Projected Traffic Volumes

In determining the projected traffic volumes for 2025 along the Causeway Boulevard study corridor, Tampa Bay's Regional Transportation Model was utilized. The latest model prepared for the Hillsborough County Metropolitan Planning Organization (MPO) is for 2025. This model incorporates both the planned roadway improvements based on the County's 2025 Long Range Transportation Plan and social-economic data (ZDATA) forecasted for that horizon year based on zoning requirements for the area. The ZDATA for the traffic analysis zones (TAZ) in the area of the study corridor were not modified to account for any variations in traffic growth due to the potential expansion of the Port of Tampa. After careful consideration, it was determined that this analysis will use the 2025 model without any changes because the model already takes into account some growth within the various land uses in the area. Furthermore,

the potential growth at the Port of Tampa as documented in Section 3.8 of that this report is subjective and thus, could skew the projected traffic volumes obtained from the model considerably.

The raw (unadjusted) output from the regional transportation model for 2025 is presented in Appendix F.

To obtain the directional design hour volumes (DDHV) for 2025, the model volumes, which represent peak season weekday average daily traffic (PSWADT) projections, were adjusted using the model output conversion factor (MOCF) for 2001 to obtain an AADT volume. The MOCF value for Hillsborough County, which was obtained from FDOT Planning Statistics Office, is 0.95. Then, the K_{30} and D_{30} factors for 2001, which were documented earlier in this report and are considered constant for the future years, were applied to the calculated AADT to obtain the DDHV. The calculated AADTs and DDHVs for 2025 are shown in Table 17.

TABLE 17: AADT AND DDHV (YEAR 2025)

	AADT	DDHV
Causeway Boulevard W of 78th Street	40,000	1,972
Causeway Boulevard E of 78th Street	39,000	1,922
Causeway Boulevard between US 41 and Maydell Street	38,000	1,873
US 41 N of Causeway Boulevard	26,000	1,282
US 41 S of Causeway Boulevard	49,000	2,415
US 301 N of Causeway Boulevard	66,500	3,278
US 301 S of Causeway Boulevard	62,500	3,081
78th Street N of Causeway Boulevard	20,500	1,010
78th Street S of Causeway Boulevard	26,000	1,282
US 41 (BUS) W of US 41	48,500	2,391
Causeway Boulevard W of US 301	49,000	2,415
Causeway Boulevard E of US 301	45,500	2,243

The future intersection volumes were determined by applying the existing turning movement percentages (or splits) for each approach during the PM peak hour from the three subject intersections (Causeway Boulevard at US 41, 78th Street and US 301) to the 2025 DDHVs. The PM peak hour was chosen for the percent distribution of the turning movement volumes because that hour represented the heaviest volume of traffic throughout the study area based on a 24-hour period. Table 18 presents the estimated turning movement volumes during the peak hour for

each intersection. Appendix G provides the calculations for determining the 2025 intersection volumes.

TABLE 18: FUTURE INTERSECTION TURNING MOVEMENT VOLUMES				
Approach	**Turning Movement**	**Causeway Boulevard at US 41 (vph)**	**Causeway Boulevard at 78th St. (vph)**	**Causeway Boulevard at US 301 (vph)**
Southbound	Left	190	351	771
	Through	1037	526	2250
	Right	55	133	257
	Total	**1282**	**1010**	**3278**
Eastbound	Left	142	178	447
	Through	823	1530	1529
	Right	1426	264	440
	Total	**2391**	**1972**	**2415**
Northbound	Left	759	230	538
	Through	1437	645	2108
	Right	219	407	435
	Total	**2415**	**1282**	**3081**
Westbound	Left	316	243	667
	Through	1099	1059	1045
	Right	458	620	530
	Total	**1873**	**1922**	**2243**

4.2 Future Roadway Capacity Analysis

To determine if a four-lane divided roadway can accommodate the projected traffic volumes for 2025 along the Causeway Boulevard study corridor, the projected volumes were compared to the generalized capacity tables prepared by the FDOT (see Appendix D). Again, the level of service standard (or acceptable LOS) for this roadway is LOS D. Table 19 presents the results of the comparison.

TABLE 19: FUTURE ROADWAY LEVEL OF SERVICE						
Roadway Segment	**AADT**			**DDHV**		
	Volume (vpd)	**Capacity [1]**	**LOS**	**Volume (vpd)**	**Capacity [2]**	**LOS**
Causeway Blvd. (US 41 to 78th St.)	40,000	35,700	F	1,972	1,860	F
Causeway Blvd. (78th St. to US 301)	39,000	35,700	F	1,922	1,860	F

1 – Table 4.1 from the FDOT 2002 Quality / Level of Service Manual.
2 – Table 4.7 from the FDOT 2002 Quality / Level of Service Manual.

According to the results presented in Table 19, both sections of roadway would operate at LOS F conditions for daily traffic volumes, as well as during the peak hour/peak direction.

Table 20 presents the results of the HCS arterial analysis using the future roadway conditions and traffic volumes for 2025. Appendix H provides the HCS output.

TABLE 20: FUTURE ARTERIAL ANALYSIS		
Direction of Travel	Peak Hour	
	Speed (mph)	LOS
Eastbound	15.1	E
Westbound	18.1	D

According to the results presented in Table 20, the eastbound traffic traveling along Causeway Boulevard from US 41 to US 301 would experience LOS E conditions during the future peak hour (2025), which exceeds the level of service standard (LOS D). For the reverse direction, acceptable levels of service could be achieved.

4.3 Future Intersection Capacity Analysis

This section of the report presents the future capacity analysis at the three major intersections along the Causeway Boulevard study corridor. The HCS 2000 and CORSIM were used to analyze the future capacity at the three selected intersections. The analysis was based on 2025 projected traffic volumes, and the results of the HCS runs are presented in Table 21. The intersection capacity analysis outputs from HCS 2000 are contained in Appendix I.

The intersection at Causeway Boulevard and US 41 is the major focus of this project. The 2025 traffic volume reveals that the northbound left- turns and eastbound right-turns are the two critical movements, with very high turning volumes during the peak hour. The future capacity analysis also shows that northbound and southbound approaches are the two major movements with much heavier through traffic volumes than the eastbound and westbound approaches. As a result, an overpass design alternative of US 41 over Causeway Boulevard was considered in this study. The six-lane overpass matching the existing lane configuration along US 41 would remove the northbound and southbound through traffic and thus, improve the overall intersection level of service at Causeway Boulevard. The overpass would also eliminate the blockage caused

Table 21: Future Signalized Intersection Capacity Analysis

Causeway Boulevard (SR 676) at US 41

Design Alternative	Delay	EB			WB			NB			SB		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Existing Geometry w/ Future Traffic	Control delay	170.5	955.5		471.1	539.5		769.6	436.6		329.8	577.6	
	Apprch. delay	897.1			526.7			538.4			539.6		
	Approach LOS	F			F			F			F		
	Intersec. delay	633.7			Intersection LOS						F		
At-grade Alternative (Geometric Improvement on both Causeway Blvd and US 41)	Control delay	86.6	49.5	54.8	134.5	219.3	178.9	179.6	111.2	50.0	225.6	140.9	50.3
	Apprch. delay	55.5			194.0			125.1			149.6		
	Approach LOS	E			F			F			F		
	Intersec. delay	128.3			Intersection LOS						F		
At-Grade - Geometric Improvement only on Causeway Blvd	Control delay	101.2	101.9	40.2	37.3	299.8	249.6	316.1	86.6		195.5	239.0	
	Apprch. delay	64.5			239.0			156.8			232.3		
	Approach LOS	E			F			F			F		
	Intersec. delay	165.4			Intersection LOS						F		
Overpass Alternative A-C (Overpass on Causeway Blvd)	Control delay		49.0	90.4	80.7	632.1		133.7	77.9	44.7	183.3	100.2	47.8
	Apprch. delay	85.8			388.0			91.1			110.4		
	Approach LOS	F			F			F			F		
	Intersec. delay	138.2			Intersection LOS						F		
Overpass on Causeway with no improvement on US 41	Control delay		156.6	83.3	87.9	639.1		214.6	47.9		127.1	148.7	
	Apprch. delay	91.3			395.1			98.9			145.4		
	Approach LOS	F			F			F			F		
	Intersec. delay	150.9			Intersection LOS						F		
Overpass Alternative D (US 41 Overpass Causeway Blvd with EBR Free Flow)	Control delay	167.1	44.9	0.3	319.2	68.1	59.0	91.5	68.1		86.0	76.4	
	Apprch. delay	27.0			112.8			85.1			83.7		
	Approach LOS	C			F			F			F		
	Intersec. delay	72.9			Intersection LOS						E		
Overpass Alternative E (Overpass on Causeway Blvd with NB Clover-Leaf on US 41)	Control delay		156.6	83.3	87.9	639.1		214.6	47.9		127.1	148.7	
	Apprch. delay	12.8			259.7			98.8			42.7		
	Approach LOS	B			F			F			D		
	Intersec. delay	90.2			Intersection LOS						F		
Northbound Fly-over Alternative (At-Grade with EBR Free Flow and NB Rightside Fly-Over)	Control delay	143.4	54.8		58.8	142.7	40.5		84.1	18.9	107.4	30.5	
	Apprch. delay	71.5			103.0			73.3			42.3		
	Approach LOS	E			F			E			D		
	Intersec. delay	77.3			Intersection LOS						E		

Causeway Boulevard (SR 676) at 78th Street

Design Alternative	Delay	EB			WB			NB			SB		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Existing Geometry w/ Future Traffic	Control delay		289.1	15.5		119.9	0.2	334.9	256.2	107.7	78.1	138.4	73.8
	Apprch. delay	355.9			331.5			223.2			108.0		
	Approach LOS	F			F			F			F		
	Intersec. delay	280.3			Intersection LOS						F		
Proposed Geometry w/ Future Traffic	Control delay	24.3	115.2	29.9	31.3	43.9	69.8	146.3	231.2	94.5	40.5	120.4	66.2
	Apprch. delay	95.6			50.7			172.5			91.0		
	Approach LOS	F			D			F			F		
	Intersec. delay	96.8			Intersection LOS						F		
Future Traffic w/ Geometric Improvement on Both Causeway Blvd and 78th St	Control delay	23.4	108.8	30.0	30.7	43.2	66.4	67.1	51.4	96.1	34.7	47.2	43.2
	Apprch. delay	90.6			49.1			68.4			42.3		
	Approach LOS	F			D			E			D		
	Intersec. delay	65.2			Intersection LOS						E		

Causeway Boulevard (SR 676) at US 301

Design Alternative	Delay	EB			WB			NB			SB		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Existing Geometry w/ Future Traffic	Control delay	509.9	704.5		602.6	109.0	176.1	665.8	284.4		574.8	545.8	44.5
	Apprch. delay	668.5			271.7			351.0			513.4		
	Approach LOS	F			F			F			F		
	Intersec. delay	452.8			Intersection LOS						F		
Proposed Geometry w/ Future Traffic	Control delay	241.6	364.9	160.4	482.8	147.9	222.1	305.3	145.7	48.9	230.4	410.0	36.8
	Apprch. delay	304.9			265.0			159.9			338.5		
	Approach LOS	F			F			F			F		
	Intersec. delay	266.2			Intersection LOS						F		

by the queue generated by the railroad crossing to the south of the intersection. However, due to the railroad crossing approximately 1,300 feet east of the intersection, an overpass along Causeway Boulevard over US 41 was also considered. The frequent train crossings caused traffic to backup, frequently blocking other traffic movements at the intersection. An overpass along Causeway Boulevard allows traffic to travel through this section of the roadway without experiencing any delays caused by the signalized intersection or train crossing to the east. With an overpass, eastbound and westbound through volumes are removed from the intersections and therefore, improves the overall performance of the roadway segment. Based on the projected traffic volumes for 2025, the required lane configuration for the northbound approach along US 41 is as follows: two left-turn lanes, three through lanes and a right-turn lane. The southbound approach would have three through lanes, one left-turn lane and a right-turn lane. Due to the heavy eastbound to southbound right-turn traffic, the eastbound approach requires at least two free-flow right-turn lanes, two through lanes and one left-turn lane. The westbound approach has a fairly significant number of left- and right-turn traffic volumes; therefore, the lane configuration would require two left-turn lanes, two through lanes and a right-turn lane.

At the intersection of Causeway Boulevard and 78th Street South, the intersection capacity analysis for 2025 traffic depicted the necessary lane configuration for both eastbound and westbound as follows: two left-turn lanes, three through lanes and a right-turn lane. The southbound and northbound lane configurations require two left-turn lanes, two through lanes and a right-turn lane. Due to the right-of-way constraints along Causeway Boulevard and along 78th Street South, the proposed lane configuration for the eastbound approach is two left-turn lanes, two through lanes and a right-turn lane. The westbound approach should have two left-turn lanes, two through lanes and a right-turn lane. The lane configuration for both the northbound and southbound approaches is very similar to the existing lane configuration. However, existing right-of-way south of the intersection along the west side of 78th Street South will allow an additional southbound receiving lane, thus accommodating the dual westbound left-turn lanes. With the proposed improvements, the HCS 2000 capacity analysis depicted an intersection delay of 96.8 seconds per vehicle (i.e., LOS F conditions). If additional improvements were permitted along 78th Street South, the overall intersection level of service could improve to LOS E, with a delay of 65.2 seconds per vehicle.

At the intersection of Causeway Boulevard and US 301, the roadway improvements for both northbound and southbound approaches are limited due to the right-of-way constraints. Therefore, additional through lanes cannot be added to improve the operation of the intersection. According to the results of the intersection capacity analysis, both northbound and southbound approaches are over-capacity. Some minor improvements were considered to help reduce the overcapacity problem at this intersection. The southbound approach was changed from an existing dual left-turn to a triple left-turn allowing more storage space to accommodate the heavy southbound left-turn traffic volume. For the northbound approach, an additional left-turn lane is added to improve the northbound level of service. Due to the possible right-of-way limitations for the northbound approach south of the intersection, an exclusive northbound right-turn lane may not be included. If right-of-way is available, the appropriate storage lane length has been calculated. The HCS 2000 capacity analysis indicated that both eastbound and westbound approaches required at least three through lanes and an exclusive right-turn lane. The future left-turn traffic volume requires that both eastbound and westbound approaches have two left-turn lanes. With the proposed improvements, the intersection would still function at LOS F with an intersection delay of 266.2 seconds per vehicle. The poor operating conditions at this intersection are mainly attributed to the over-capacity of both northbound and southbound approaches. To adequately accommodate the high projected traffic volume of both northbound and southbound approaches, it is recommended that an overpass be constructed along US 301 to remove the heavy through traffic from the intersection.

4.4 Description of Alternatives

Causeway Boulevard from US 41 to US 301 will be widened from a two-lane undivided to a four-lane divided roadway. At the intersection of Causeway Boulevard and US 41, an overpass has been considered in the analysis to provide additional capacity at the subject intersection, as well as to prevent undue delays created by the train crossing east of US 41. The bridge overpass is considered along Causeway Boulevard and US 41. This section of the report provides a description for each of the seven design alternatives at the intersection of Causeway Boulevard and US 41. All seven of these alternatives focused on the geometric design at the intersection of US 41 and Causeway Boulevard and how the overpass should be designed (i.e., a grade-separation for Causeway Boulevard or US 41). These seven alternatives are: No Overpass (at-

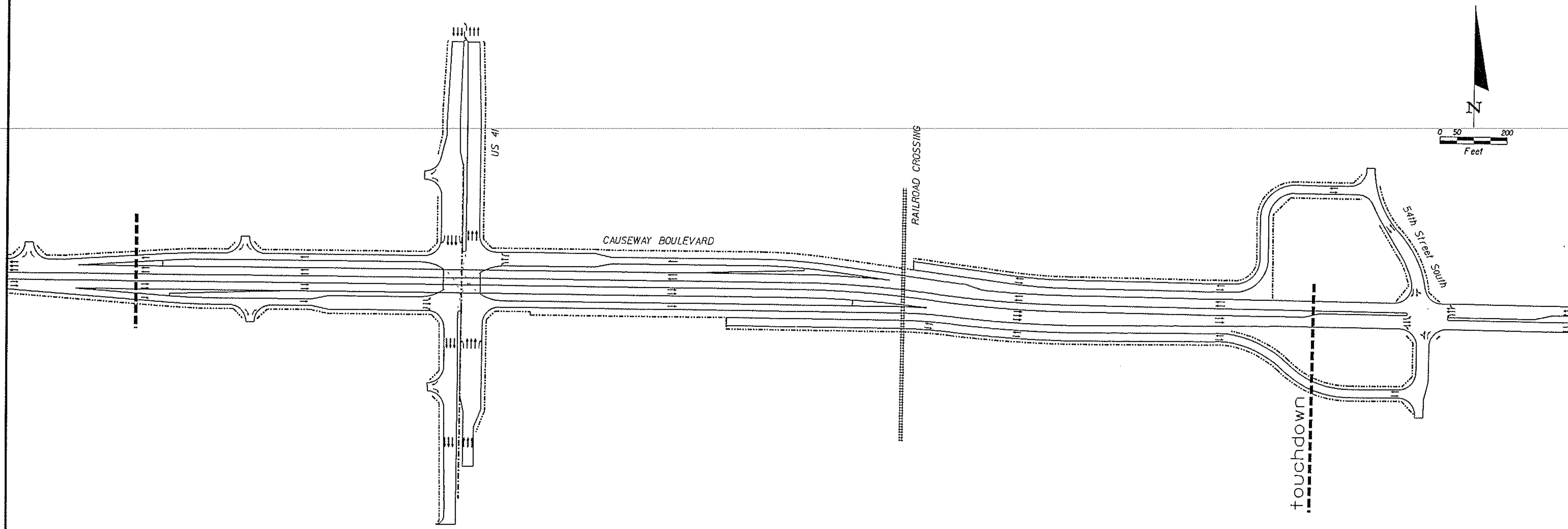
grade), Overpass Alternative A, Overpass Alternative B, Overpass Alternative C, Overpass Alternative D, Overpass Alternative E and Northbound Fly-over. Figures 26, 27 and 28 illustrate the three original conceptual designs of the bridge overpass for Causeway Boulevard (Alternatives A through C).

No Overpass (At-grade)

For this alternative, the intersection at Causeway Boulevard and US 41 is considered at-grade with no overpass along Causeway Boulevard. The intersection geometry considered for analysis is as follows: northbound (three through lanes, two left-turn lanes and a right-turn lane), southbound (three through lanes, a left-turn lane and a right-turn lane), westbound (two through lanes, two left-turn lanes and a right-turn lane), and eastbound (two through lanes, a left-turn lane and two right-turn lanes).

Overpass Alternative A

For this alternative, a four-lane divided overpass is considered along Causeway Boulevard to bridge over US 41 creating an urban interchange with entrance and exit ramps from US 41 onto Causeway Boulevard. The overpass starts about 1000 feet west of US 41 and touches down about 2500 feet east of US 41. Along the west side of the interchange, the eastbound off-ramp at the gore has two exiting lanes. At the intersection with US 41, the ramp widens out to three eastbound lanes with the following configuration (one shared left/through lane and dual right-turn lanes). The westbound on-ramp at the intersection has two lanes, which merge to a single lane entering Causeway Boulevard westbound. Along the east side of the interchange, the westbound off-ramp at the gore has a one-lane exit ramp that widens to three lanes at the intersection with US 41. The following lane configuration was provided: a left-turn lane, a shared left/through lane and an exclusive right-turn lane. The eastbound on-ramp at the intersection has been provided with a single lane that eventually merges with Causeway Boulevard heading eastbound. At the intersection, US 41 is a six-lane divided roadway with dual left-turn lanes northbound, a single left-turn lane southbound and an exclusive right-turn lane for both approaches. The northbound dual left-turn lanes require two receiving lanes along the on-ramp.



OVERPASS ALTERNATIVE A

FOUR LANE DIVIDED OVERPASS ALONG CAUSEWAY BOULEVARD OVER US 41 AND RAILROAD CROSSING 1400 FEET EAST OF INTERSECTION

LEGEND

- EXISTING RIGHT-OF-WAY
- PROPOSED RIGHT-OF-WAY
- EDGE OF PAVEMENT
- STRUCTURE OR RETAINING WALL
- NUMBER OF LANE PER APPROACH

Drawn by	PHD
Project No.	2021101
Date	7/26/02

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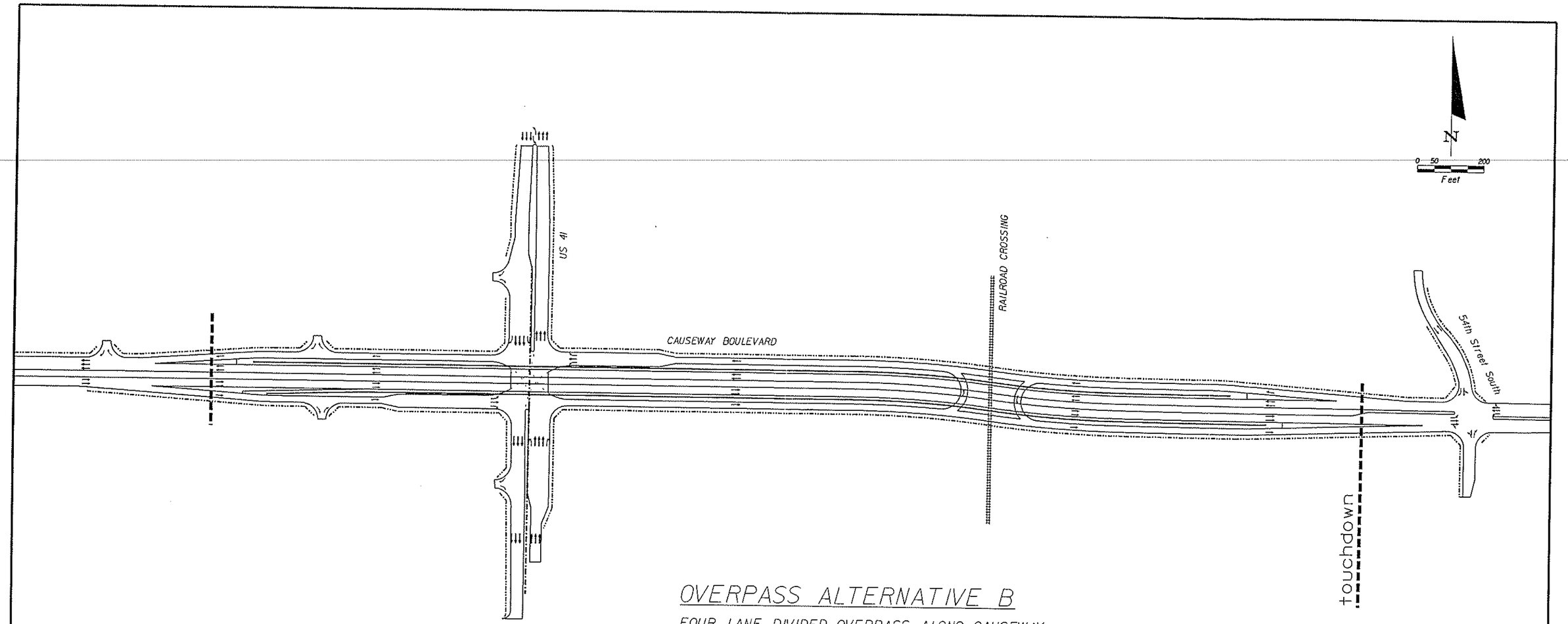
Project Title	Causeway Boulevard Corridor Analysis
Drawing Title	Figure 26: Causeway Boulevard at US 41 (Alternative A)



OVERPASS ALTERNATIVE B

FOUR LANE DIVIDED OVERPASS ALONG CAUSEWAY BOULEVARD OVER US 41 WITH ENTRANCE AND EXIT RAMPS FORMING A PAIR OF LOCAL STREETS. U-TURN LANES EXIST AT RAILROAD CROSSING.

LEGEND

- EXISTING RIGHT-OF-WAY
- PROPOSED RIGHT-OF-WAY
- EDGE OF PAVEMENT
- STRUCTURE OR RETAINING WALL
- NUMBER OF LANE PER APPROACH

Title: GCA2 sh20i All A thru C.dgn
Name: PHD Times 04:26:36 PM
Date: 11/21/2003

Drawn by	PHD
Project No.	2021101
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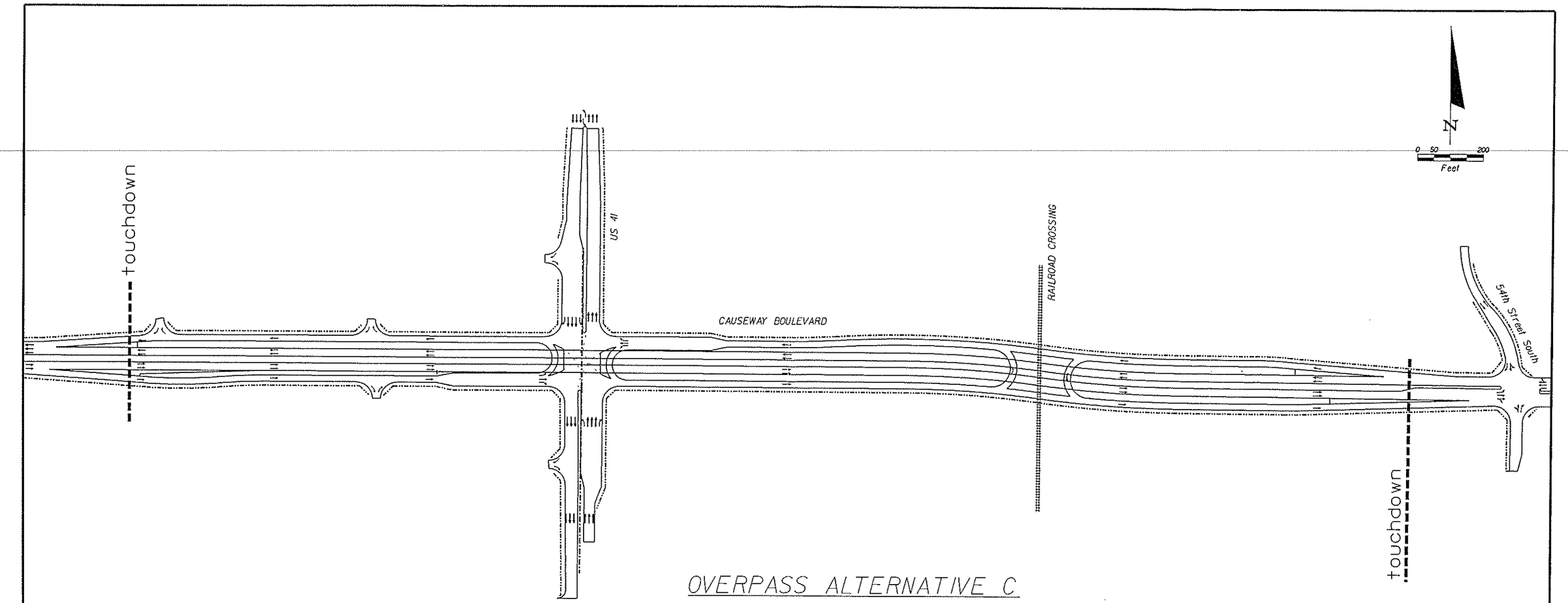
Project Title	Causeway Boulevard Corridor Analysis
Drawing Title	Figure 27: Causeway Boulevard at US 41 (Alternative B)



OVERPASS ALTERNATIVE C

FOUR LANE DIVIDED OVERPASS ALONG CAUSEWAY BOULEVARD OVER US 41 WITH ENTRANCE AND EXIT RAMPS FORMING A PAIR OF LOCAL STREETS. U-TURN LANES EXIST AT RAILROAD CROSSING AND AT INTERSECTION.

LEGEND

- EXISTING RIGHT-OF-WAY
- PROPOSED RIGHT-OF-WAY
- EDGE OF PAVEMENT
- STRUCTURE OR RETAINING WALL
- NUMBER OF LANE PER APPROACH

Title: GC42 s\2021\u...
Name: PHD
Date: 11/21/2003
1 A thru Cdgn
Time: 04:26:46 PM

Drawn by	PHD
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Project Title	Causeway Boulevard Corridor Analysis
Drawing Title	Figure 28: Causeway Boulevard at US 41 (Alternative C)

Overpass Alternative B

For this alternative, the lane configurations at the intersection and the interchange geometry west of the intersection are identical to those described for Overpass Alternative A. The bridge overpass for this alternative would also be constructed with the same starting point on the west side of US 41 and has the same touchdown point on the east side. The only difference between Alternative A and B is that U-turn lanes are provided before and after the railroad crossing along the east leg.

Overpass Alternative C

The interchange geometry and lane configurations at the intersection are similar to that of Overpass Alternative B. The bridge overpass along Causeway Boulevard starts approximately 1,400 feet west of the intersection with the touchdown point approximately 2,500 feet east of US 41. The entrance and exit ramp configurations on the east side of the interchange are identical to those described for Overpass Alternative A and B. On the west side of the interchange, both entrance and exit ramps are located 1,400 feet from the intersection (400 feet longer than the other two alternatives). The lane configuration and geometry for these ramps are also similar to the other two alternatives. The only other difference between this alternative and Alternative B is that U-turn lanes are provided at the intersection of US 41.

Overpass Alternative D

This alternative involves the design of an overpass along US 41 over Causeway Boulevard. The initial geometric design for this alternative has not been created by the subconsultant preparing the Bridge Alternatives Study due to the fact that this is a new alternative that was not part of the original analysis. The overpass considered contains three through lanes northbound and southbound with on- and off-ramps intersecting Causeway Boulevard forming an urban interchange. It should be noted that the six-lane overpass should be extended beyond Causeway Boulevard to also include the railroad crossing south of the intersection. Both northbound and southbound exit ramps are one-lane roadways with auxiliary lanes intersecting Causeway Boulevard. At the intersecting point with Causeway Boulevard, both northbound and southbound approaches have two left-turn lanes and a shared through/right-turn lane. The northbound on-ramp is a one-lane roadway with an acceleration lane for traffic to merge onto US

41 heading northbound. The southbound entrance ramp is a two-lane roadway that adequately accommodates the heavy eastbound to southbound right-turn traffic. These two southbound on-ramp lanes merge into one lane with an acceleration lane provided for traffic to merge onto US 41. As for the eastbound and westbound approaches along Causeway Boulevard at US 41, the following lane geometry is provided: a left-turn lane, two through lanes and a free-flow right-turn lane.

Overpass Alternative E

This alternative is another new design that was not included in the original study; therefore, the initial geometric design was not created and no scaled drawings exist. The overpass design concept for this alternative is similar to that of Alternative A, with Causeway Boulevard being grade-separated over US 41. The eastbound entrance and exit ramp lane configurations remain the same as Alternative A. The westbound on-ramp, located in the northeast quadrant of the intersection, is a dual-lane clover-leaf design with acceleration lanes for traffic to merge onto Causeway Boulevard heading westbound. The westbound off-ramp east of US 41 is a one-lane roadway that widens to three approach lanes at the intersection. The lane configuration for the westbound approach to US 41 is two left-turn lanes and a right-turn lane. At the intersection of US 41 and the off-ramps, the southbound lane configuration has one left-turn lane and three through lanes. The northbound approach has four through lanes south of the intersection. Just north of the intersection, the northbound lane configuration changes from four through lanes to two through lanes, a shared through/right lane and a right-turn only lane heading onto the clover-leaf ramp.

Northbound Fly-over

The initial geometric design for this alternative also does not exist because it is a new alternative. For this alternative, Causeway Boulevard and US 41 intersect at grade level. The lane configurations for eastbound, westbound and southbound are the same as those approaches in the at-grade alternative. The eastbound approach has two through lanes, a left-turn lane and two free-flow right-turn lanes to accommodate the heavy eastbound right-turn traffic. The westbound approach has two through lanes, two left-turn lanes and a right-turn lane. Because of the right-of-way limitations along US 41 and the low right-turn traffic volumes, an exclusive

southbound right-turn lane was not considered in this alternative. As a result, the southbound approach has a left-turn lane, two through lanes and a shared through/right lane. The northbound approach lane configuration consists of a two-lane fly-over to accommodate the heavy northbound left-turn traffic, three through lanes and a right-turn lane.

4.5 Evaluation of Alternatives

This section of the report provides a summary of the results from the NETSIM model runs and the HCS 2000 capacity analyses for the Causeway Boulevard corridor from US 41 to US 301. NETSIM and FRESIM are two microscopic simulation software programs that makeup the CORSIM package. The prefix NET and FRE stand for a surface street network and a freeway network, respectively, and the suffix SIM means microscopic simulation. The combination of NETSIM and FRESIM is named CORSIM, which stands for corridor-microscopic simulation. These NETSIM analyses consider the various bridge overpass alternatives previously described for the intersection at US 41. In addition, the analyses also considered the effects of a train crossing Causeway Boulevard east of US 41. The NETSIM outputs from these various alternatives are contained on a CD, which is appended to this report.

The NETSIM analysis of the At-grade Alternative at the intersection of Causeway Boulevard and US 41 identifies that the northbound through and left turn, and the eastbound right turns as the three critical movements. The NETSIM model for this alternative is illustrated on Figure 29. The capacity analysis at this intersection depicts a LOS F condition, with an intersection delay of 128.3 seconds per vehicle. The high traffic volumes for both the northbound left-turns and eastbound right-turns are accommodated with dual turn lanes. However, dual turn lanes only provide LOS E conditions for those movements. In order to achieve an acceptable level of service (i.e., LOS D or better), triple turn lanes are required for both the northbound left turns and eastbound right-turns. In this alternative, delays caused by the train crossing the east leg of the intersection create capacity problems. The eastbound and westbound movements experience an average of 15 minutes of delay each time a train crosses Causeway Boulevard. During each train crossing, the eastbound traffic along Causeway Boulevard backs up quickly, causing an almost complete shut down of the intersection. Throughout the one-hour simulation period, long queues were noted for both the eastbound right-turn and northbound left-turn movements. It was

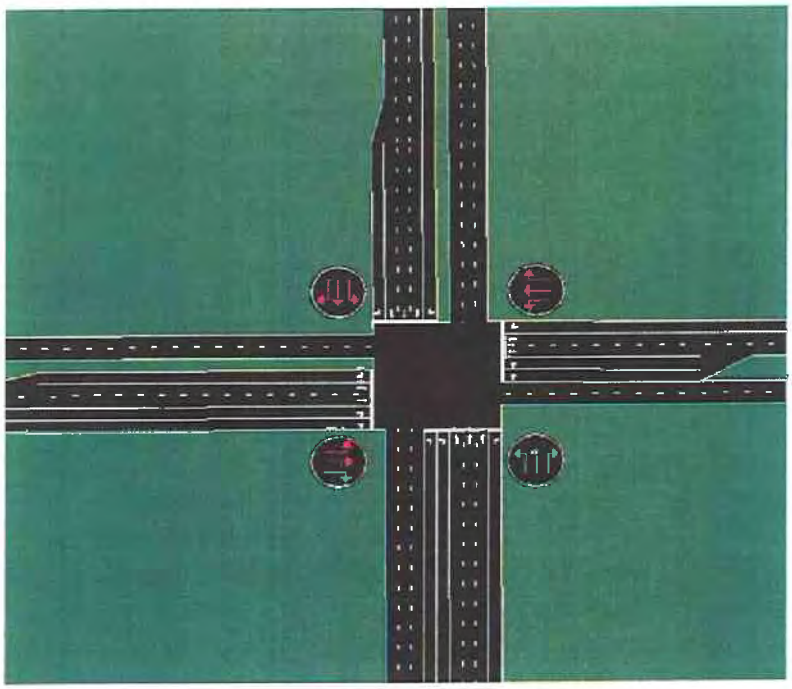


FIGURE 29: NETSIM MODEL FOR CAUSEWAY BOULEVARD AT US 41 (AT-GRADE ALTERNATIVE)

also noted that the eastbound and westbound through volumes were not accommodated by the two through lanes for each approach. For the corridor, the NETSIM simulation revealed that traffic flows smoothly throughout the entire length with each queue (or back up) of traffic clearing during the appropriate phase of the signal.

The NETSIM analysis of Alternative A at the intersection of Causeway Boulevard and US 41 shows that northbound left-turns and eastbound right-turns are the two critical movements that have the most influence on the intersection level of service. The NETSIM model for this intersection is shown in Figure 30. The simulation revealed that long traffic queues existed for both eastbound right-turns and northbound left-turns. Even with the overpass removing the less problematic eastbound and westbound through movements, the HCS capacity analysis for this alternative reveals LOS F conditions overall, with an intersection delay of approximately 138.2 seconds per vehicle. However, this alternative provides the permanent solution for eliminating the train crossing delay by over-passing the railroad crossing east of the intersection. In order to improve the level of service at this intersection, triple right-turn lanes or channelized dual free flow right-turn lanes are required for the eastbound off-ramp. As a result, this alternative did not

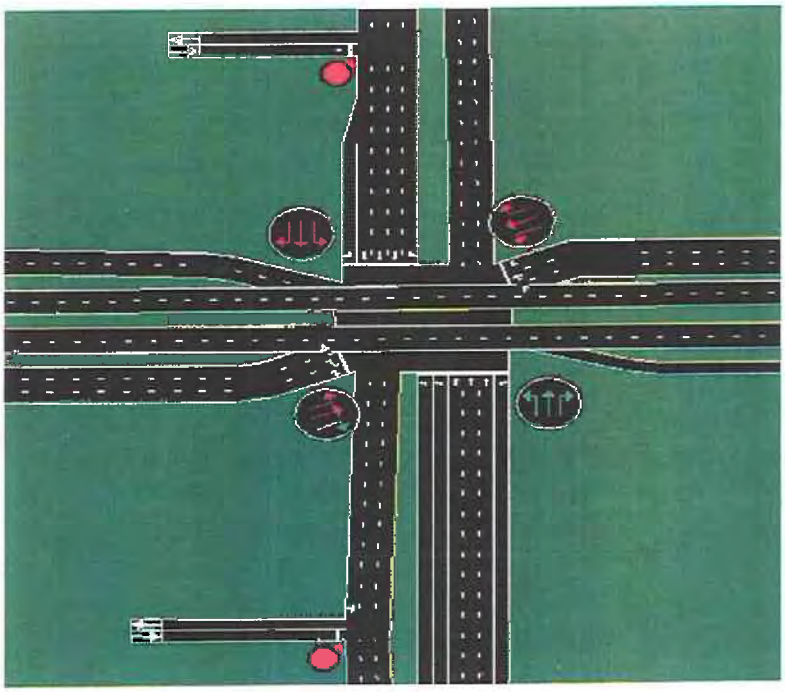


FIGURE 30: NETSIM MODEL FOR CAUSEWAY BOULEVARD AT US 41 (ALTERNATIVE A)

provide any improvements to the intersection level of service because the delay caused by the heavy eastbound right-turns and northbound left-turns still exist.

The evaluation of Alternative B yields similar results to the previous two alternatives. The HCS analysis for this alternative shows an intersection delay of 138.2 seconds per vehicle (i.e., LOS F conditions). In this alternative, both the eastbound and westbound through movements are removed from the intersection and the railroad crossing along Causeway Boulevard. However, the eastbound and westbound through volumes are adequately accommodated with the designed two through lanes with or without the overpass, which means that they have little effect on the intersection. Capacity problems still exist for both the eastbound right- and northbound left-turns. The delay caused by a train crossing also exists for the eastbound on-ramp traffic. During each train crossing, the southbound left-turn and northbound right-turn movements from US 41 would back up causing blockage at the intersection. The NETSIM model for this alternative during a train crossing is shown in Figure 31. As a result, this alternative provides no improvement to the intersection level of service or delay. In comparison with the at-grade alternative, the intersection delay increased by approximately 10 seconds per vehicle. Again,

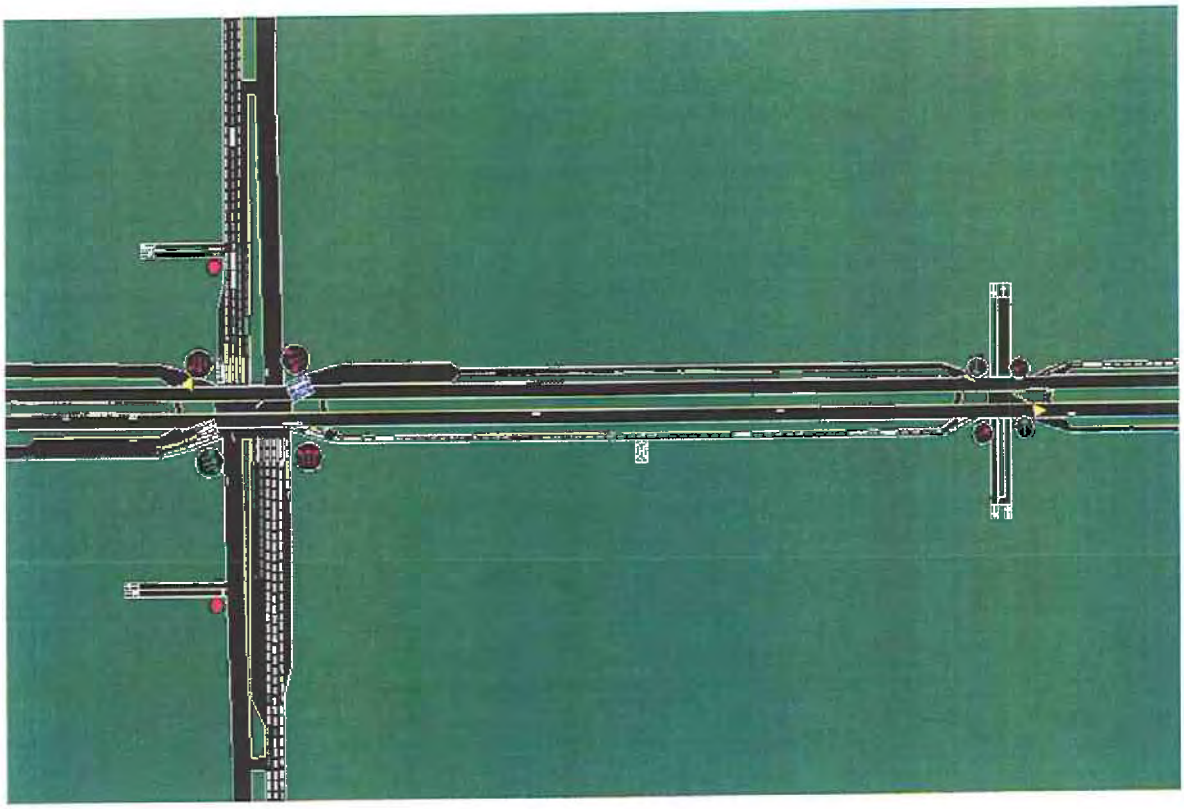


FIGURE 31: NETSIM MODEL FOR CAUSEWAY BOULEVARD AT US 41 (ALTERNATIVE B)

however, the delay caused by a train crossing is eliminated for the eastbound and westbound through movements.

Alternative C and Alternative B are almost identical in both geometric designs and in vehicular movement characteristics. The lane configurations for both alternatives are the same, except for the additional U-turn lanes at the intersection for eastbound and westbound approaches. Since the volumes for these U-turn lanes are predicted to be very low, they would have little influence on the intersection level of service or delay. The HCS analysis for this alternative shows LOS F conditions would prevail, with an intersection delay of 138.2 seconds per vehicle. This is the same as Alternatives A and B. In this alternative, the delay caused by a train crossing also resulted in blockage at the intersection. During each train crossing, the eastbound on-ramp is calculated to store approximately 48 vehicles before traffic would start to spill back into the intersection. Figure 32 illustrates the NETSIM model for this alternative, which shows the traffic delay caused by the train crossing to the east of the intersection. In summary, this alternative provides the same results as those of Alternatives A and B. It does not offer any

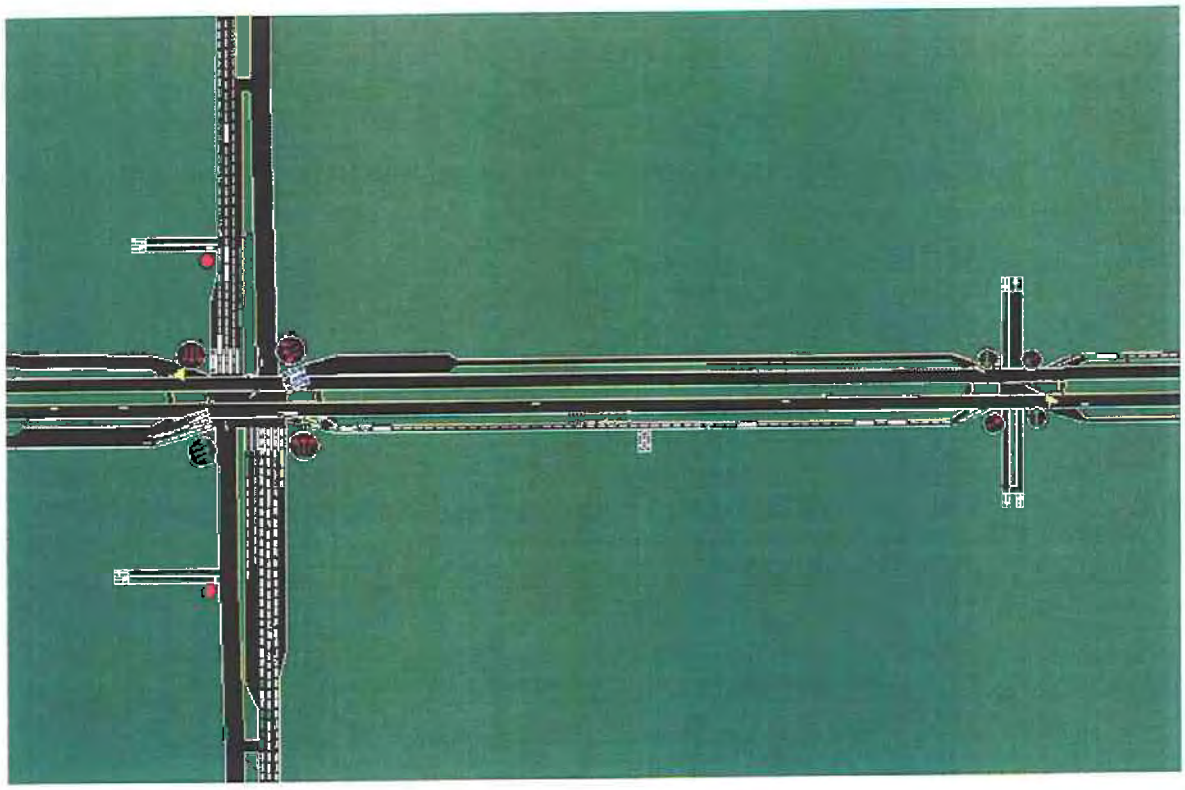


FIGURE 32: NETSIM MODEL FOR CAUSEWAY BOULEVARD AT US 41 (ALTERNATIVE C)

improvement to the intersection level of service or delay. However, the additional U-turn lanes at the intersection and before the railroad crossing provide convenience for traffic to make a U-turn when needed.

The NETSIM simulation for Alternative D shows similar results in traffic behavior as compared to Alternative A. Throughout the one-hour simulation, traffic on all approaches queued up and cleared out smoothly. The NETSIM model for this alternative is shown in Figure 33. The six-lane overpass for US 41 in this alternative seemed to function more efficiently than those of Alternatives A through C. In this alternative, the overpass and the channelized right-turn removed the heavy through traffic along US 41 northbound and southbound, as well as the eastbound right-turn traffic along Causeway Boulevard. Therefore, the intersection level of service increased to LOS E, with an overall delay of 72.9 seconds per vehicle. That is an improvement of approximately 65 seconds per vehicle when compared to the results for Alternative A through C. However, when considering the delay caused by the railroad crossing to the east of the intersection, this alternative provides little improvement in eliminating the

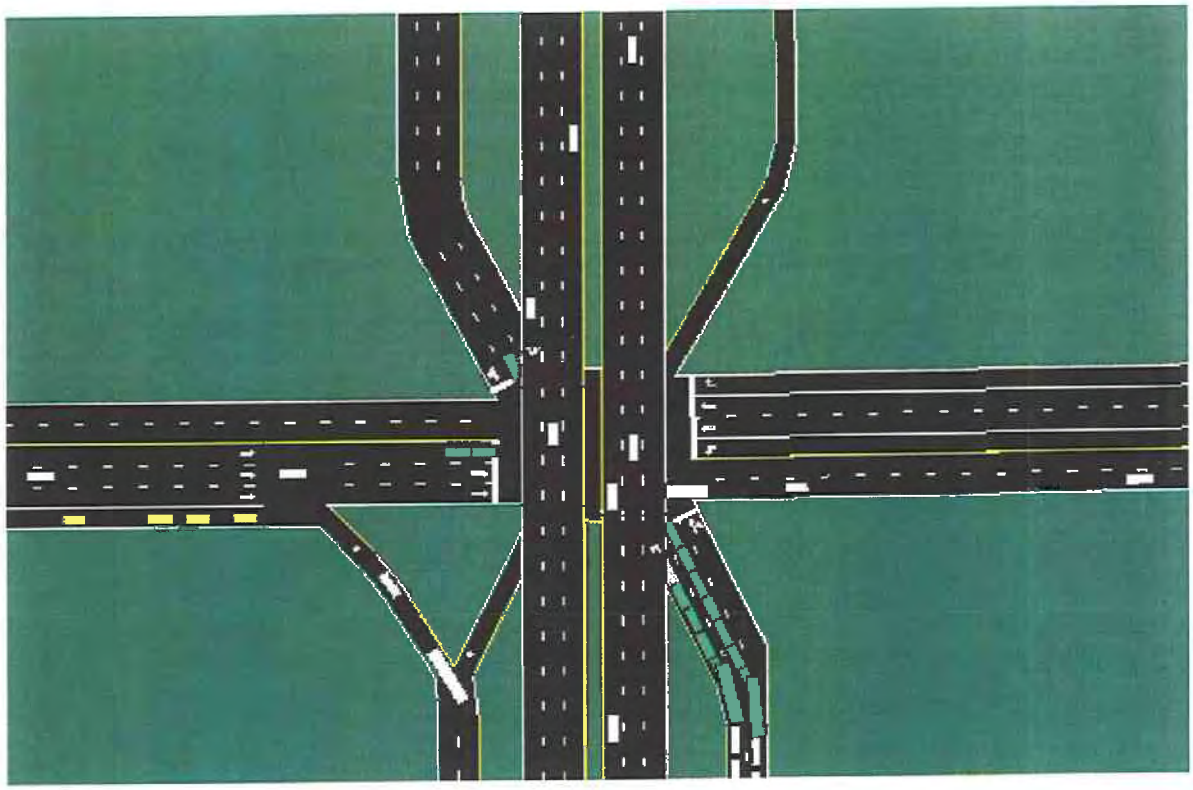


FIGURE 33: NETSIM MODEL FOR CAUSEWAY BOULEVARD AT US 41 (ALTERNATIVE D)

queue blockage at the intersection. The two eastbound through lanes would provide more storage space compared to the single lane entrance ramp in Alternative B and C.

Alternative E is a product of Alternative A, where the overall design geometry is similar except for the westbound entrance ramp. As previously stated, the three critical movements at this intersection are the northbound throughs, northbound left-turns and eastbound right-turns. The westbound entrance ramp is a two lane clover-leaf design, with the intention of converting the heavy northbound left-turn traffic into through traffic at the intersection. The NETSIM model for this alternative is shown on Figure 34. The NETSIM simulation run for this model shows no major traffic problems. The increase in the northbound through traffic occasionally backed up, but cleared out within a few signal timing cycles. The HCS analysis for this alternative shows a LOS F, with an intersection delay of 90.2 seconds per vehicle. This alternative reduces the amount of overall delay by approximately 48 seconds per vehicle when compared to the results of Alternative A through C. This alternative, however, is not feasible when compared to the

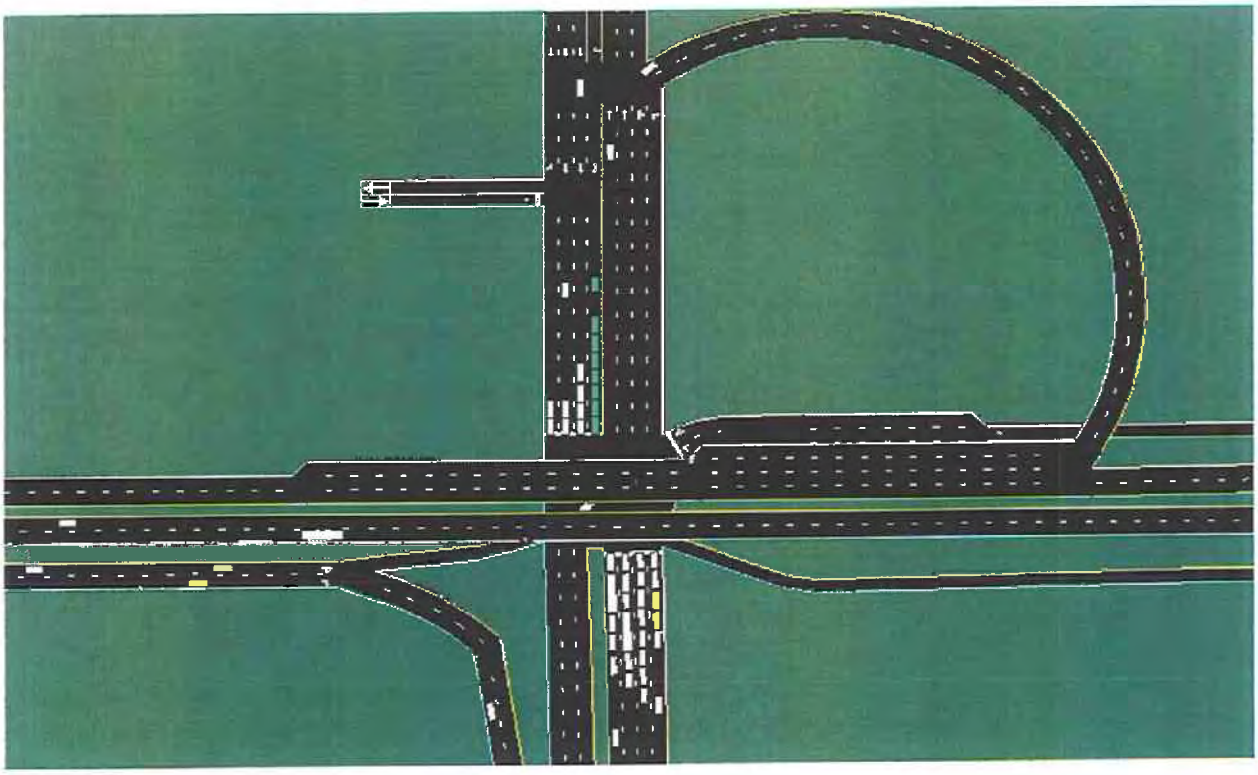


FIGURE 34: NETSIM MODEL FOR CAUSEWAY BOULEVARD AT US 41 (ALTERNATIVE E)

right-of-way needs of the previous alternatives due to excessive amount of right-of-way required to construct the clover-leaf.

The design consideration for the Northbound Fly-over Alternative is to eliminate the delay caused by the heavy eastbound right-turn and northbound left-turn volume. The NETSIM simulation run for this alternative (as shown on Figure 35) reveals that the northbound through movement remained the critical factor. The heavy northbound through traffic has the most influence on the level of service and the delay at the intersection. The results of the HCS analysis yield LOS E operation, with an overall delay of 77.3 seconds per vehicle. Based on the capacity analysis, this alternative produced the second-best result in both level of service and overall delay. However, the delay caused by the railroad crossing to the east of the intersection would still remain a problem.

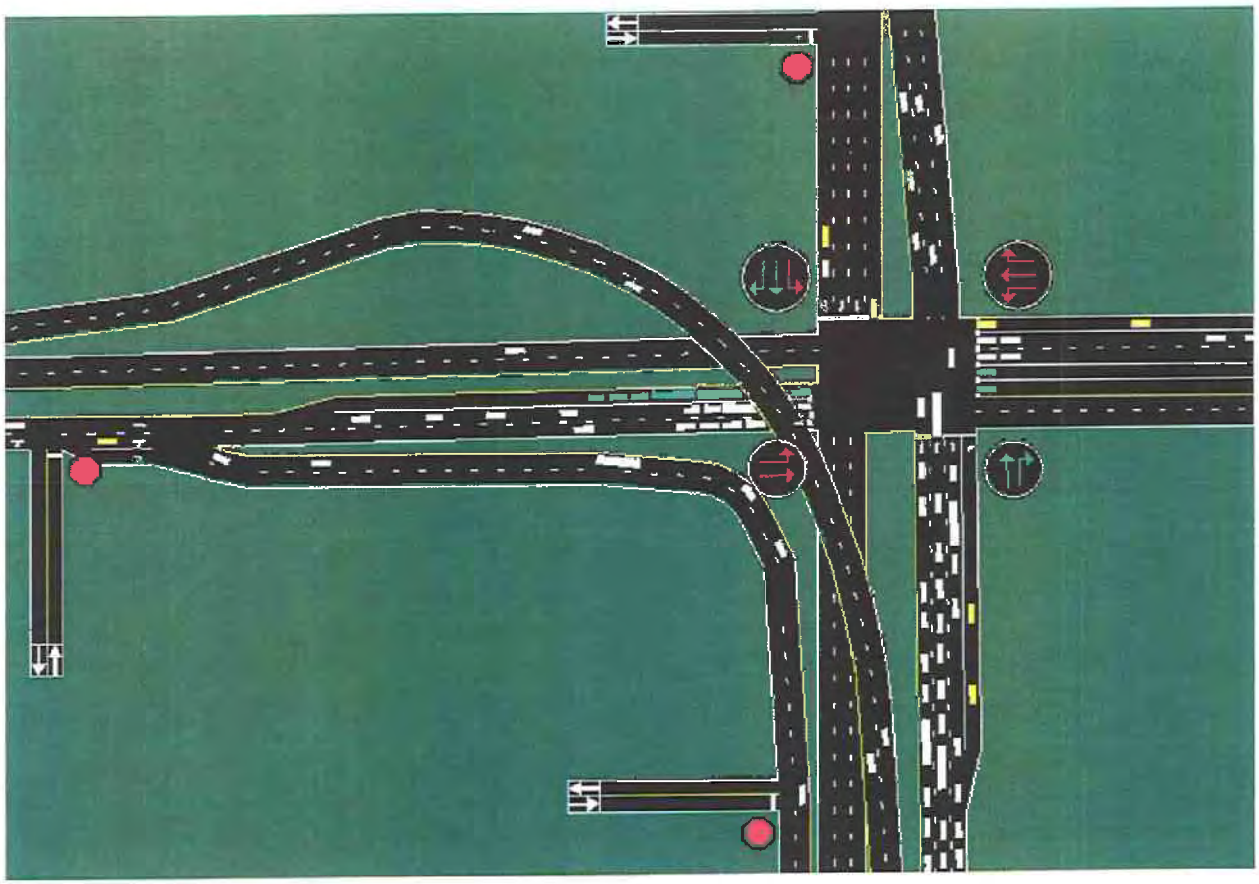


FIGURE 35: NETSIM MODEL FOR CAUSEWAY BOULEVARD AT US 41 (NORTHBOUND FLY-OVER ALTERNATIVE)

In conclusion, the HCS and NETSIM analysis have identified the four critical traffic factors that have the most influence on both the level of service and the overall intersection delay. These critical factors include the heavy eastbound right-turn traffic, northbound left-turn traffic, northbound through traffic and a train crossing. The seven grade-separated design alternatives above have individually satisfied some of these critical factors; however, none adequately accommodate all of the factors. Therefore, the level of service and the intersection delay varies based on the number of factors considered in each alternative.

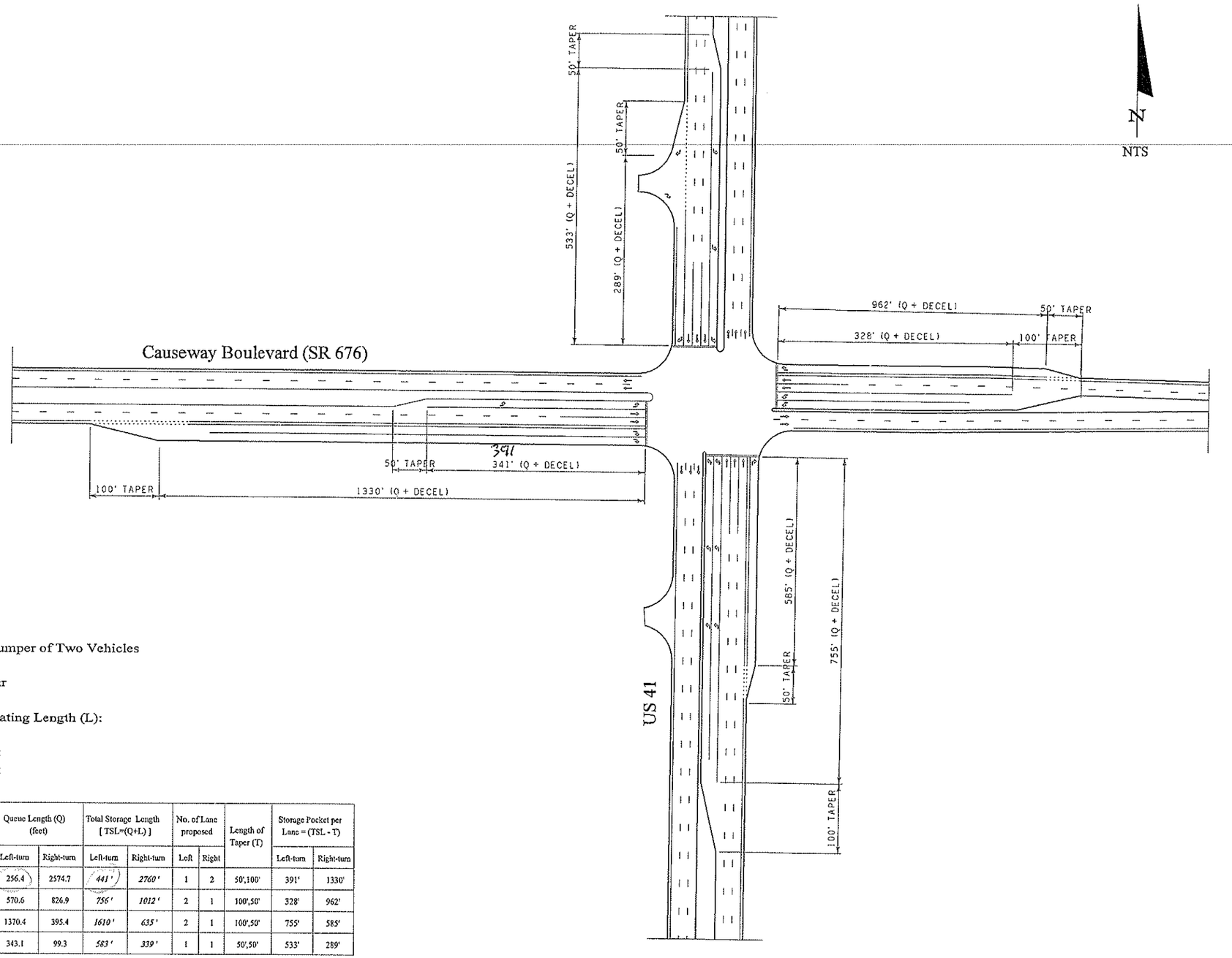
4.6 Storage Lane Lengths

Results from the three future at-grade intersection capacity analyses revealed that some geometric improvements are required to accommodate the 2025 traffic conditions. In order to

provide the most efficient intersection operation, the exclusive turn lanes should be sized accordingly to prevent any further degradation in roadway or intersection capacity. For those intersections studied (Causeway Boulevard at US 41, 78th Street and US 301), a storage lane length calculation was made. The required storage length for each exclusive turn lane at the three intersections was determined by summing the queue length plus the total deceleration length. The queue length was determined from the queue length formula found in the FDOT *Plans Preparation Manual.* The total deceleration length was obtained from the FDOT *Roadway and Traffic Design Standards*, latest edition.

According to FDOT's Standard Index No. 301 for design speeds of 45 and 50 mph, the total deceleration length is 185 and 240 feet, respectively. The design speed for Causeway Boulevard is 45 mph and the existing speed limit for US 301 is 50 mph. Dual turn lanes were recommended when the turning movement volume exceeded 300 vehicles per hour. Table 22 presents the results of the storage length calculation based on the FDOT formula for the 2025 traffic volumes. Appendix J provides the calculations. Figures 36, 37 and 38 illustrate the intersection geometry analyzed with appropriate storage lanes depicted.

The storage length values produced by the FDOT formula are conservative in many cases, as illustrated in Table 22. For this reason, an alternative method of obtaining the storage lengths was developed using the maximum queue per lane that resulted from the NETSIM simulation runs.



FDOT Queue Length Formula:

$$Q = [2(25)(q)]/N$$

Where:

Q = Queue Length
2 = 90th Percentile Factor
25 = Length Between Front Bumper of Two Vehicles
q = Arrival Rate (vph)
N = Number of Cycle Per Hour

FDOT Standard Index No. 301 for Total Decelerating Length (L):

Speed = 45 mph ; L = 185 feet
Speed = 50 mph ; L = 240 feet

Causeway Blvd @	Approach	Design Speed (mph)	Deceleration Length (L) Index No. 301	Arrival Rate (q) (vph)		Cycle Length (sec)	Number of Cycle per Hour (N)	Queue Length (Q) (feet)		Total Storage Length [TSL=(Q+L)]		No. of Lane proposed		Length of Taper (T)	Storage Pocket per Lane = (TSL - T)	
				Left-turn	Right-turn			Left-turn	Right-turn	Left-turn	Right-turn	Left	Right		Left-turn	Right-turn
US 41	EB	45	185'	142	1426	130	27.7	256.4	2574.7	441'	2760'	1	2	50',100'	391'	1330'
	WB	45	185'	316	458	130	27.7	570.6	826.9	756'	1012'	2	1	100',50'	328'	962'
	NB	50	240'	759	219	130	27.7	1370.4	395.4	1610'	635'	2	1	100',50'	755'	585'
	SB	50	240'	190	55	130	27.7	343.1	99.3	583'	339'	1	1	50',50'	533'	289'

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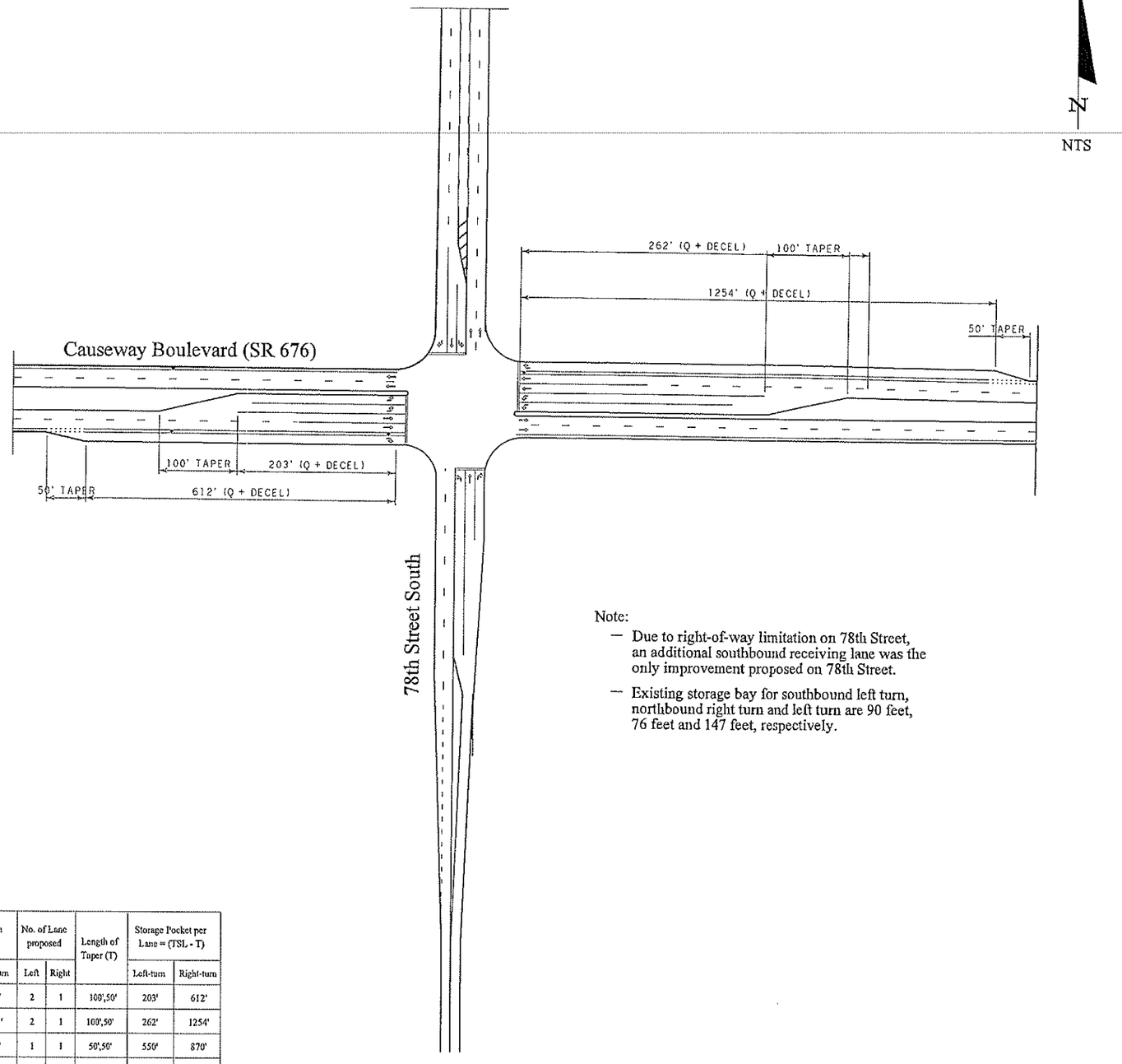
Project Title	Causeway Boulevard Corridor Analysis
Drawing Title	Figure 36: Proposed Lane Configurations for Causeway Blvd at US 41



FDOT Queue Length Formula:

$$Q = [2(25)(q)]/N$$

Where:

Q = Queue Length
2 = 90th Percentile Factor
25 = Length Between Front Bumper of Two Vehicles
q = Arrival Rate (vph)
N = Number of Cycle Per Hour

FDOT Standard Index No. 301 for Total Decelerating Length (L):

Speed = 45 mph ; L = 185 feet
Speed = 50 mph ; L = 240 feet

Causeway Blvd @	Approach	Design Speed (mph)	Deceleration Length (L) Index No. 301	Arrival Rate (q) (vph)		Cycle Length (sec)	Number of Cycle per Hour (N)	Queue Length (Q) (feet)		Total Storage Length [TSL=(Q+L)]		No. of Lane proposed		Length of Taper (T)	Storage Pocket per Lane = (TSL - T)	
				Left-turn	Right-turn			Left-turn	Right-turn	Left-turn	Right-turn	Left	Right		Left-turn	Right-turn
78th Street North	EB	45	185'	178	264	130	27.7	321.4	476.7	*506'*	*662'*	2	1	100',50'	203'	612'
	WB	45	185'	243	620	130	27.7	438.8	1119.4	*624'*	*1304'*	2	1	100',50'	262'	1254'
	NB	45	185'	230	407	130	27.7	415.3	734.9	*600'*	*920'*	1	1	50',50'	550'	870'
	SB	45	185'	351	133	130	27.7	633.8	240.1	*819'*	*425'*	2	1	100',50'	359.5'	375'

Note:

- Due to right-of-way limitation on 78th Street, an additional southbound receiving lane was the only improvement proposed on 78th Street.
- Existing storage bay for southbound left turn, northbound right turn and left turn are 90 feet, 76 feet and 147 feet, respectively.

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Project Title	Causeway Boulevard Corridor Analysis
Drawing Title	Figure 37: Proposed Lane Configurations for Causeway Blvd at 78th Street South

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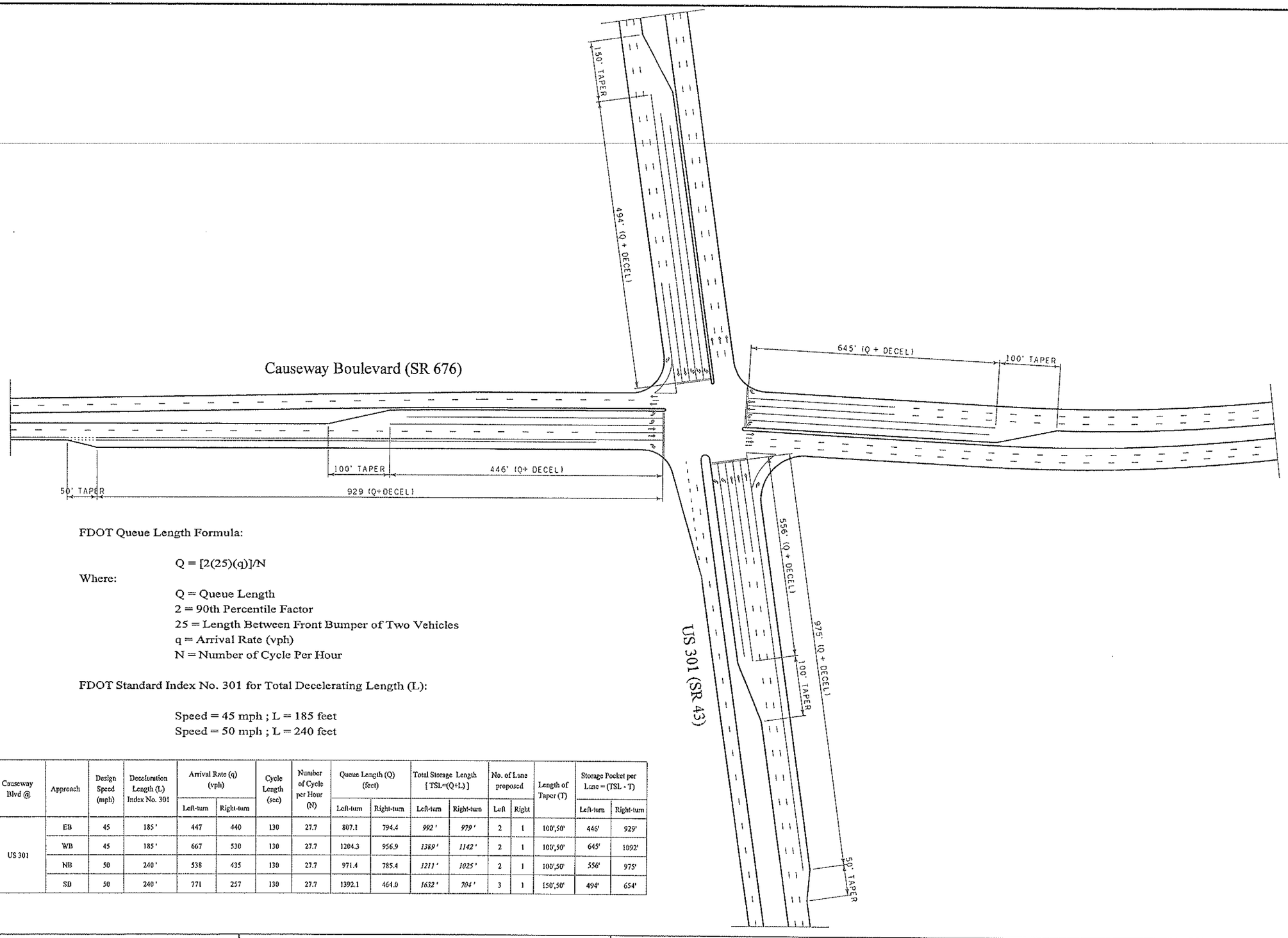

FDOT Queue Length Formula:

$$Q = [2(25)(q)]/N$$

Where:

Q = Queue Length
2 = 90th Percentile Factor
25 = Length Between Front Bumper of Two Vehicles
q = Arrival Rate (vph)
N = Number of Cycle Per Hour

FDOT Standard Index No. 301 for Total Decelerating Length (L):

Speed = 45 mph ; L = 185 feet
Speed = 50 mph ; L = 240 feet

Causeway Blvd @	Approach	Design Speed (mph)	Deceleration Length (L) Index No. 301	Arrival Rate (q) (vph)		Cycle Length (sec)	Number of Cycle per Hour (N)	Queue Length (Q) (feet)		Total Storage Length [TSL=(Q+L)]		No. of Lane proposed		Length of Taper (T)	Storage Pocket per Lane = (TSL - T)	
				Left-turn	Right-turn			Left-turn	Right-turn	Left-turn	Right-turn	Left	Right		Left-turn	Right-turn
US 301	EB	45	185 '	447	440	130	27.7	807.1	794.4	*992 '*	*979 '*	2	1	100',50'	446'	929'
	WB	45	185 '	667	530	130	27.7	1204.3	956.9	*1389 '*	*1142 '*	2	1	100',50'	645'	1092'
	NB	50	240 '	538	435	130	27.7	971.4	785.4	*1211 '*	*1025 '*	2	1	100',50'	556'	975'
	SB	50	240 '	771	257	130	27.7	1392.1	464.0	*1632 '*	*704 '*	3	1	150',50'	494'	654'

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Project Title	Causeway Boulevard Corridor Analysis
Drawing Title	Figure 38: Proposed Lane Configurations for Causeway Blvd at US 301

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TABLE 22: STORAGE LANE LENGTHS BASED ON FDOT FORMULA			
Intersection	**Direction**	**Left Turn Lane***	**Right Turn Lane***
Causeway Blvd at US 41	SB	583 ft.	339 ft.
	EB	441 ft.	2760 ft. Consider dual rights at 1430 ft.
	NB	1610 ft. Consider dual lefts at 855 ft.	635 ft.
	WB	756 ft. Consider dual lefts at 428 ft.	1012 ft.
Causeway Blvd at 78th Street	SB	819 ft. Consider dual lefts at 460 ft.	425 ft.
	EB	506 ft.	662 ft.
	NB	600 ft.	920 ft.
	WB	624 ft. Consider dual lefts at 362 ft.	1304 ft.
Causeway Blvd at US 301	SB	1632 ft. Consider triple lefts at 644 ft.	704 ft.
	EB	992 ft. Consider dual left 546 ft.	979 ft.
	NB	1211 ft. Consider dual lefts at 656 ft.	1025 ft.
	WB	1389 ft. Consider dual lefts at 745 ft.	1142 ft.

* - *includes taper length*

Table 23 reflects the results of the storage length calculations based on the NETSIM maximum queue length. The calculations based on this method would only work if the approaches do not experience capacity problems, such that continuous queues would build up and the signal phase would not satisfy the demand (i.e. clear the queue). The Causeway Boulevard and US 301 intersection is over capacity; therefore, the NETSIM method of calculating storage length would not apply.

TABLE 23: STORAGE LANE LENGTHS BASED ON NETSIM SIMULATION			
Intersection	**Direction**	**Left Turn Lane***	**Right Turn Lane***
Causeway Blvd at US 41 (Based on Northbound Fly-over and At-grade Alternatives)	SB	515 ft.	365 ft.
	EB	335 ft.	585 ft.
	NB	690 ft. Consider dual lefts at 1380 ft.	365 ft.
	WB	460 ft.	435 ft.
Causeway Blvd at 78th Street (Based on Proposed Geometry)	SB	90 ft Existing to remain	Continuous Existing to remain
	EB	310 ft.	360 ft.
	NB	147 ft Existing to remain	76 ft. Existing to remain
	WB	460 ft.	535 ft.

* - *includes taper length*

5.0 SUMMARY AND RECOMMENDATIONS

Based on the results of the HCS and the NETSIM analyses, the evaluation of the seven design alternatives at the intersection at Causeway Boulevard and US 41 reveals that the addition of an overpass will not offer much improvement in capacity or decrease vehicular delay. However, when considering the delay caused by the railroad crossing east of US 41, Alternative A is the best alternative in that it eliminates the train crossing delays by bridging over the railroad crossing. The projected future traffic volumes show that four of the seven alternatives shared the same capacity problems with the eastbound right-turns and northbound left-turns. The last three alternatives, Alternatives D, E and the Northbound Fly-over, were modeled with the intention of eliminating some, if not all, of the four critical traffic factors that exist at the intersection of US 41 and Causeway Boulevard. The NETSIM simulation shows that all seven alternatives operate normally when the delay caused by the train crossing did not exist. Throughout the one-hour NETSIM simulation run for each alternative, traffic volumes for all approaches were effectively moving in and out of the intersection. Overall, the HCS analysis for Alternative D yielded the best results for both the intersection level of service (LOS E) and delay (72.9 seconds per vehicle). However, Alternative D may not be feasible when considering the cost of constructing a six-lane overpass along US 41 due to the additional right-of-way costs required. The Northbound Fly-over Alternative seemed to be the most feasible option out of the seven alternatives analyzed because this alternative eliminated the critical northbound left-turn movement at the intersection with a northbound-to-westbound fly-over. It also resolved the heavy eastbound right-turn by channelizing the right-turn movement for free-flow. With these two improvements, the Northbound Fly-over Alternative yielded the second-best results (i.e., LOS E, with an overall delay of 77.3 seconds per vehicle).

The HCS analysis for the intersection at Causeway Boulevard and 78th Street South reveals that the Causeway Boulevard corridor needs to be a six-lane divided roadway. Due to right-of-way limitations along Causeway Boulevard and 78th Street South, the proposed intersection lane configuration is two left-turn lanes, two through lanes and a right-turn lane for the eastbound and westbound approaches. Along 78th Street South, the northbound and southbound approaches will remain unchanged; however, along the south leg of the intersection, an additional departing

(receiving) lane could be constructed. As a result, the proposed geometry yielded LOS F operating conditions, with the overall delay of 96.8 seconds per vehicle.

Based on the HCS analysis at the intersection of Causeway Boulevard and US 301, capacity problems exist along all four approaches, mainly due to the high traffic demand along US 301. Both HCS and NETSIM simulations reveal that this intersection will not work with the current proposed geometry. It is recommended that further analysis be performed with the consideration of installing an overpass along US 301. Installing an overpass would remove the two major through movements (i.e. northbound and southbound) along US 301; thereby improving the intersection level of service. The overpass should be constructed as an urban interchange with entrance and exit ramps for both northbound and southbound traffic. An additional through lane for southbound movements would make the six-lane overpass sufficient enough to accommodate 2025 traffic demands.

Although this report has identified several concerns about whether or not a four-lane divided roadway can accommodate the projected traffic demands for year 2025, one thing that has not been mentioned is the fact that Causeway Boulevard is a parallel facility to both the Crosstown Expressway and SR 60 (Adamo Drive). As capacity improvements are made to both of these roadways, especially the Crosstown Expressway, trips along Causeway Boulevard between Tampa and Brandon could be expected to decrease over time. Many motorists tend to use this corridor as means of completing a long trip between the two cities. However, this may change with the additional lanes added to the Crosstown Expressway. It is anticipated that the widening of the Crosstown Expressway to include elevated reversible express lanes will be completed by the middle of 2005. Considering the area of influence, including US 41 and US 301, and understanding the nature of the trips using the corridor (mostly industrial and business traffic), most of the trips would be short in length. Therefore, the projected traffic volumes for 2025 may require further review.

The grade-separated alternatives defined in the scope of service have depicted Causeway Boulevard passing over US 41. However, the traffic analyses at this intersection have shown that the amount of vehicular traffic on US 41 is significantly higher than that of Causeway

Boulevard. Therefore, US 41 passing over Causeway Boulevard is more logical because it provides additional capacity by removing the two heaviest traffic movements away from the intersection (i.e., the northbound and southbound through movements). Due to the need for further analysis of other grade-separated alternatives beyond the original scope of services, the Florida Department of Transportation (FDOT) has requested an additional study to analyze the feasibility of constructing an urban interchange involving US 41 over Causeway Boulevard. The additional study would include the analyses of different grade-separated bridge alternatives involving the railroad crossing to the east and south of the intersection in conjunction with interchange at US 41 and Causeway Boulevard. All local streets and driveways within the area affected by the new interchange will also be analyzed so that they may be accommodated or diverted.