Technical Report

Professional Services
Delaware Valley Regional Planning Commission
New Jersey Traffic Signal Retiming Initiative

Haddonfield Road, Camden County Route 644,
From Town Center Drive to Wyndam Road

In Cherry Hill and Pennsauken Townships, Camden County, NJ

Prepared For:

June 28, 2021

Prepared By:

I. Summary

A. *Project Overview*

Under contract with Delaware Valley Regional Planning Commission (DVPRC) and in cooperation with the New Jersey Department of Transportation, Camden County, Pennsauken Township, and Cherry Hill Township, the Taylor Wiseman & Taylor consultant project team has completed traffic signal retiming work at twelve (12) signalized intersections along Haddonfield Road (Camden County Route 644) in northwest Camden County. This work started in May 2019, following the completion of the Phase 1 project meeting which established a priority list with the county. In accordance with the process established by DVRPC, updated timing plans, including adjustments to cycle lengths, splits, and offsets, as well as the introduction of additional time-of-day coordination patterns, was completed by November 1, 2020.

Photo 1: Looking NB on CR 644 at Colwick Drive/ North Mall Plaza

Between the project meeting and implementation, field data collection activities were conducted, including peak hour turning movement counts, automatic traffic recorder counts, intersection operational assessments and 'before' travel time runs. The collected data was analyzed using traffic engineering software including Synchro™ and Tru-Traffic™. New timing plans were developed for the corridor which were implemented by the consultant team in October 2020. Implementation of the timing plans was impacted by the COVID-19 pandemic, which has dramatically changed travel patterns in March 2020 to the present day. Field observations were conducted throughout implementation, resulting in minor timing changes to those initially implemented. Follow-up field verifications were done in November 2020 after public schools reopened in Cherry Hill Township. This brief report summarizes the activities, observations, and results of this project.

B. *Project Description*

Haddonfield Road, Camden County Route 644 (CR 644), is a north to south oriented urban principal arterial. The corridor study limits extend 3.4 miles, from Wyndam Road (MP 5.53) on the northern limit in Pennsauken Township to Town Center Drive (MP 2.12) on the southern limit in Cherry Hill Township. NJ Route 70 intersects Haddonfield Road at a signalized intersection, south of the southern project limit. The intersection of NJ Route 70 and Haddonfield Road (MP 1.75) and the intersection of Haddonfield Road and Wynwood Avenue (MP 1.84) were not included as part of this project as these signalized intersections are maintained by NJDOT. NJ Route 38 has access to CR 644 via on/off ramps at the interchange, located at MP 3.07. NJ Route 90 (MP 5.74), Pennsauken Highway (MP 5.88), NJ Route 73 (MP 6.21) and US Route 130 (MP 6.48) intersect Haddonfield Road north of the northern project limits.

Land use at the southern end of CR 644 is primarily "big box" retail in the "Market Place at Garden State Park" and the "Town Place at Garden State Park", that include Wegmans, Home Depot, Costco, Dicks Sporting Goods, Nordstrom, Best Buy and Bed Bath & Beyond. The central part of the corridor includes the Cherry Hill Mall, home of over 1.2 million square feet of retail shopping. A variety of casual and fine dining restaurants line the southern end of the Haddonfield Road corridor. Access driveways to a variety of commercial and smaller retail land uses line Haddonfield Road. The Pennsauken Country Club is just north of the Cherry Hill Mall. Land use along the northern end of the corridor transitions to smaller commercial buildings and residential housing.

Photo 2: Development remains robust on Cherry Hill's "Golden Mile". New developments include a COSTCO with gasoline fueling positions, Shake Shack, Home Goods, TJ Maxx, Trader Joe's, and others.

Within these limits, twelve (12) signalized intersections were included as part of the retiming project:

1. Haddonfield Road (CR 644) & Wyndam Road
2. Haddonfield Road (CR 644) & Park Avenue (CR 621)
3. Haddonfield Road (CR 644) & New York Avenue
4. Haddonfield Road (CR 644) & Maple Avenue (CR 537)
5. Haddonfield Road (CR 644) & Colwick Drive/North Mall Plaza
6. Haddonfield Road (CR 644) & Church Road (CR 616)
7. Haddonfield Road (CR 644) & Dudley Avenue
8. Haddonfield Road (CR 644) & Cherry Hill Mall Drive
9. Haddonfield Road (CR 644) & Movie Theater Entrance
10. Haddonfield Road (CR 644) & Chapel Avenue (CR 626)
11. Haddonfield Road (CR 644) & Garden Park Boulevard
12. Haddonfield Road (CR 644) & Town Center Drive

The project location is shown in **Figure 1**.

C. Project Impact of COVID-19 Pandemic

COVID-19, a highly contagious respiratory illness caused by a virus, impacted the Haddonfield Road Signal Retiming Effort as both the State of New Jersey and the Federal Government imposed restrictions which influenced travel behavior in 2020 and 2021. Important milestones in the COVID-19 fight included:

- New Jersey Governor Murphy Executive Order 104, March 16, 2020: Closed Movie Theaters, Casinos, Gyms. Restricted Restaurants and Bars to take out and delivery services. Closed all public and private schools (including pre-kindergarten, colleges, and universities).
- New Jersey Governor Murphy Executive Order 107, March 21, 2020: Directs all New Jersey residents to effectively "stay at home" until further notice. This order resulted in non-essential businesses closing or telecommuting from home.
- New Jersey Governor Murphy Executive Order 150, June 3, 2020: Provided for outdoor dining protocols for New Jersey restaurants.
- New Jersey Governor Murphy Executive Order 157, June 26, 2020: Provided guidance for non-essential retail operations and individualized instruction at gyms and fitness centers.
- New Jersey Governor Murphy Executive Order 175, August 13, 2020: Provided guidance for schools to reopen subject to critical health and safety protocols.
- New Jersey Governor Murphy Executive Order 183, September 1, 2020: Allowed for reopening of indoor dining (25% capacity) on September 4, 2020.

From a traffic engineering perspective, traffic volumes decreased significantly as New Jersey residents complied with stay-at-home directives. Business operations changed significantly to comply with social distancing and other public health protocols. The consultant team delayed implementation of new timings waiting for traffic volumes to stabilize and increase from the height of the restrictive period in March-May 2020.

Photo 3: Looking SB on Haddonfield Road from Garden Park Boulevard to Town Center Drive.

In October 2020 the consultant team, working with Cherry Hill Township, Pennsauken Township and the Delaware Valley Regional Planning Commission, moved forward with implementation of the new signal timings on the Haddonfield Road corridor.

Restrictions impacting the corridor during implementation included:

- Cherry Hill Township public schools were closed in October 2020. They would reopen briefly in November 2020 and the consultant team did observe the corridor under school traffic conditions. Pennsauken Township schools stayed open during the October implementation period.
- Retail occupancy was restricted to 50% of building capacity, including employees.
- Restaurants and bars operated outdoor dining sites, also allowing 25% of indoor capacity with appropriate social distancing.
- Businesses implemented telecommuting and remote work policies to protect health of employees.
- Ridership on public transit had reduced due to potential exposure to COVID-19.

- Many businesses closed in New Jersey directly attributed to COVID-19 protocols and restrictions.

The consultant team did conduct a single automatic traffic recorder count to attempt to quantify the impact of the pandemic on average daily traffic. The results, presented later in this report, are inconclusive. Comparisons on a typical weekday (Thursday) showed a 19% reduction in traffic, although weekend volumes were 4% higher on Saturday and 14% higher on Sunday. The volume increases during weekend traffic could be attributed to new land development on the corridor and an extended holiday shopping season due to the pandemic. It is reasonable to state that on a typical weekday, Haddonfield Road traffic volumes remain lower than counted in 2019. It is harder to establish the impact of the COVID-19 health emergency on weekend traffic due to the robust development occurring in the southern area pf the corridor.

D. Existing Signal Documentation/Operation:

Typically, signalized intersections in New Jersey may have signal timing directives, electrical plans and layout plans. The consultant team reviewed record archives in Camden County, Cherry Hill Township and Pennsauken Township with a focus on signal timing documentation. Table 1 presents the results of the consultant team's record search:

Table 1
Haddonfield Road (Camden County Route 644)
Record Archive Results

Intersection Cross Street	Record
Town Center Drive	Layout Plan, Electrical Plan, Timing Directive (on plan sheets)
Garden Park Boulevard	Layout Plan & Timing Directive; Photograph of Timing Directive in Controller Cabinet;
Chapel Avenue	Layout Plan & Timing Directive
Movie Theatre Driveway	Layout Plan & Timing Directive
South Mall Driveway	Layout Plan & Timing Directive
Dudley Avenue	Layout Plan, with Timing Directive on plan
Church Road	Layout Plan & Timing Directive
North Mall Plaza/Colwick Drive	Layout Plan & Timing Directive
Maple Avenue	Layout Plan with Timing Directive on plan
New York Avenue	Timing Directive & hand sketch Layout Plan within Pennsauken Township email
Park Avenue	Layout Plan
Wyndam Road	Layout Plan & Timing Page within NJDOT letter to Pennsauken Township

The historical signal timing records are found in **Appendix A**.

A review of the existing traffic signal documentation revealed "free" operation at the majority of the Haddonfield Road signals. The Maple Avenue traffic signal, located on the boundary between Pennsauken and Cherry Hill Townships, was programmed to technically operate coordinated but utilized a simple 90 second program throughout the day and was not coordinated with the adjacent signals on Haddonfield Road. A second time-based coordination system was designed to operate between Town Center Drive and the Movie Theater entrance on the southern end of the corridor. This system operated with a common

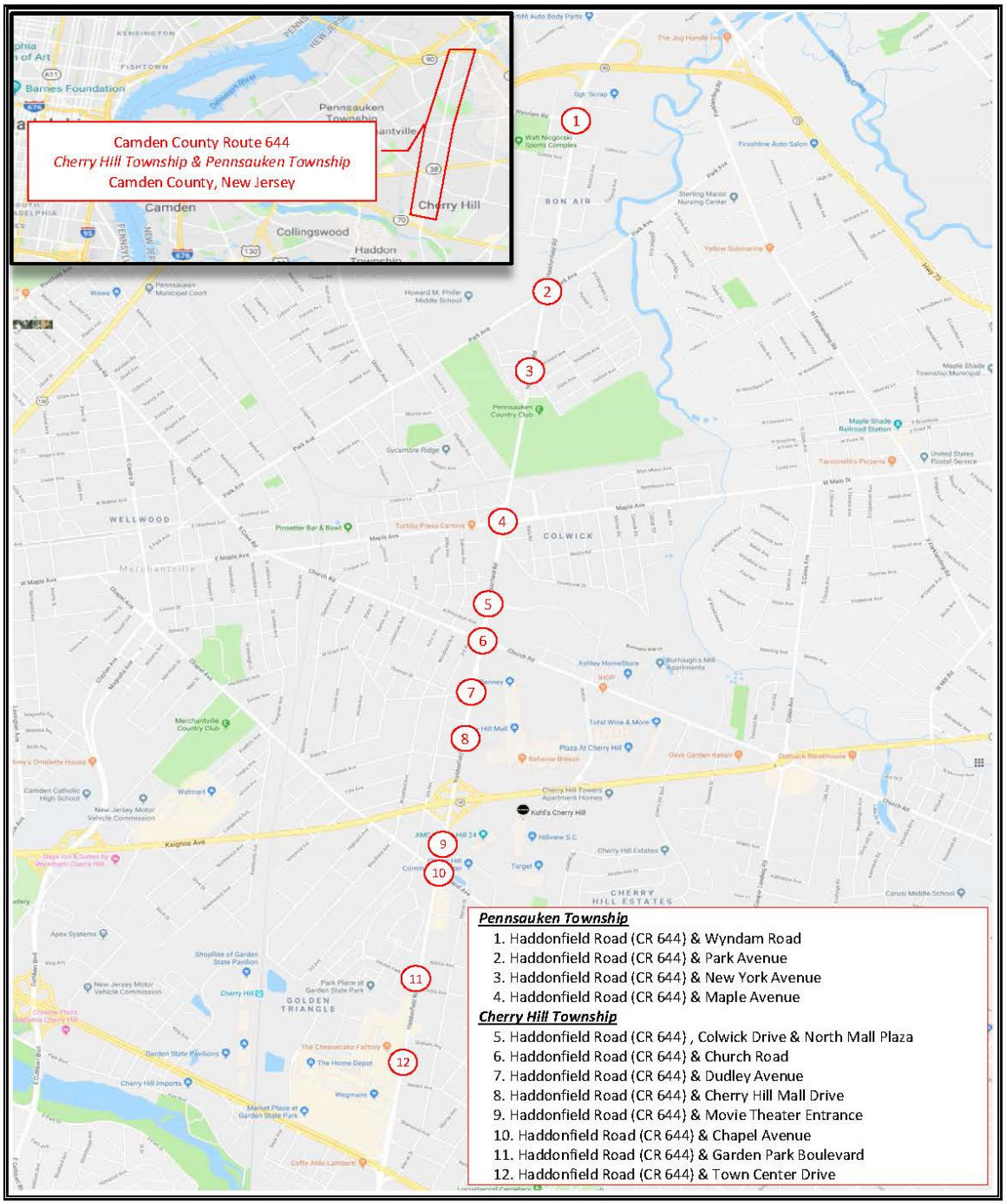
120-second cycle length and the only intersection which changed phase/movement times was the Movie Theater entrance.

E. Results

With implementation of the 1) updated timing plans, 2) modifications to the corridor's time-of-day schedule, and, 3.) potential decreases in corridor volume attributed to the COVID-19 health emergency, the project consultant team has documented significant reductions in corridor travel times and delay. Northbound weekday morning, mid-day, evening, and weekend mid-day peak travel times have been reduced by 20.8%, 30.5%, 19.3%, and 8.4%, respectively. Southbound weekday morning, mid-day, evening, and weekend mid-day peak travel times have been reduced by 34.1%, 29.3%, 26.1%, and 22.5%, respectively. Cumulative (combined northbound and southbound) travel time on Haddonfield Road has been reduced 27.7%, 29.9%, 22.5% and 15.8% during the weekday morning, mid-day, evening, and weekend mid-day time periods. Cumulative stops have decreased 79.1% in the weekday morning, 53.8 % in the weekday mid-day, 54.2% in the weekday evening and 45.5% in the weekend mid-day peak period.

"Cumulative stops have decreased 79.1% in the weekday morning, 53.8 % in the weekday mid-day, 54.2% in the weekday evening and 45.5% in the weekend mid-day peak period. "

FIGURE 1--PROJECT LOCATION MAP
DVRPC NEW JERSEY SIGNAL TIMING INITIATIVE
CR 644 - HADDONFIELD ROAD
CHERRY HILL TOWNSHIP & PENNSAUKEN TOWNSHIP
CAMDEN COUNTY



II. Data Collection

A. Turning Movement Counts

Peak hour intersection counts were conducted at the above intersections during the weekday morning (7:15 am to 9:15 am), weekday mid-day (12:00 pm to 2:30 pm) and evening (3:45 pm to 7:45 pm) peak hour periods. Saturday counts were taken between 9:00 am to 11:00 am, 12:00 pm and 4:00 pm. The manual turning movement counts were taken on Tuesday, May 14, 2019 and Saturday, May 11, 2019 by Imperial Traffic & Data Collection. The TMCs are available on the project website, http://dvrpc.taylorwiseman.com.

B. Automatic Traffic Recorder (ATR) Counts

In May 2019, automatic traffic recorder counts were taken as follows:

Table 1
2019 Average Daily Traffic (ADT)
Haddonfield Road--Camden County Route 644

Location	Average Daily Traffic
311: Haddonfield Road, North of Pennsauken Highway – NB Traffic	8,383 vehicles
Haddonfield Road, North of Pennsauken Highway – SB Traffic	7,447 vehicles
Total ADT	15,830 vehicles
312: Haddonfield Road, Between Maple Avenue and New York Avenue – NB Traffic	10,456 vehicles
Haddonfield Road, Between Maple Avenue and New York Avenue – SB Traffic	10,496 vehicles
Total ADT	20,952 vehicles
313: Haddonfield Road, Between Cherry Hill Mall and Dudley Avenue – NB Traffic	12,393 vehicles
Haddonfield Road, Between Cherry Hill Mall and Dudley Avenue – SB Traffic	12,134 vehicles
Total ADT	24,527 vehicles
314: Haddonfield Road, Between Garden Park and Town Center – NB Traffic	12,990 vehicles
Haddonfield Road, Between Garden Park and Town Center – SB Traffic	13,010 vehicles
Total ADT	26,000 vehicles

The twenty-four hour counts clearly shows higher volumes at the south end of CR 644 in the vicinity of the Cherry Hill Mall and Garden State Park Market Place near State Route 70.

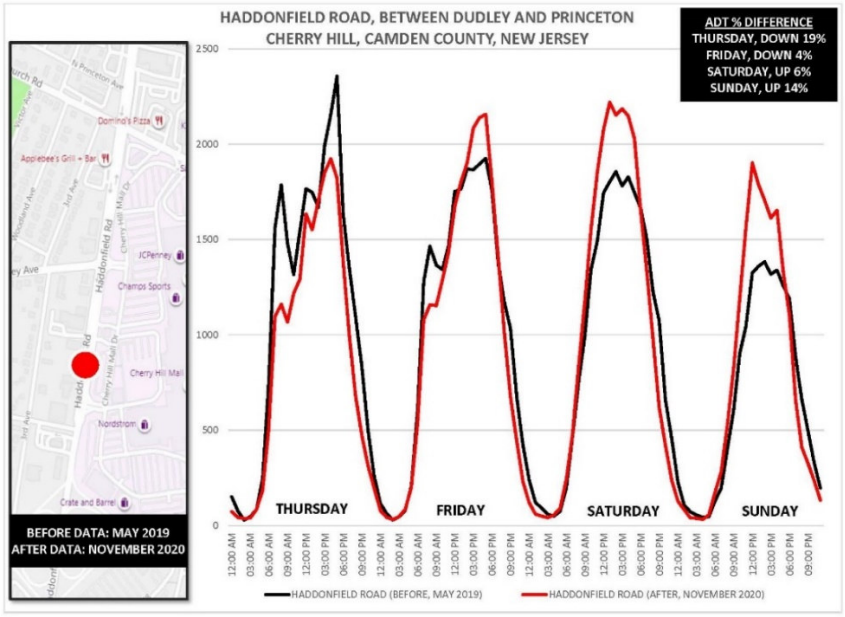
C. Impact of COVID-19 Pandemic on Haddonfield Road

To document traffic variances associated with the COVID-19 pandemic in Cherry Hill, New Jersey, check counts were taken at one location 313: Haddonfield Road, between Cherry Hill Mall and Dudley Avenue in November (11th-14th) 2020. Table 2 illustrates the observed volume, as well as a comparison to the May 2019 counts at the same location. The automatic traffic recorder counts are available on the project website: http://www.dvrpc.taylorwiseman.com.

Table 2
Haddonfield Road, between Cherry Hill Mall and Dudley Avenue
Impacts of COVID-19 Pandemic on Traffic Volume
ADT Comparisons, May 2019 to November 2020

2019-Date & Day	Volume, Vehicles	2020-Date & Day	Volume, Vehicles	Percent Variance
May 9, 2019, Thursday	26,434	November 12, 2020, Thursday	21,335	-19.29%
May 10, 2019, Friday	25,581	November 13, 2020, Friday	24,472	-4.34%
May 11, 2019, Saturday	23,222	November 14, 2020, Saturday	24,609	+5.97%
May 12, 2019, Sunday	15,577	November 15, 2020, Sunday	17,806	+14.31%

This data is further illustrated by **Figure 1.**



In reviewing the automatic traffic recorder data, one should realize that the 2020 data was taken in the extended holiday shopping season (two weeks before Thanksgiving) in an area which has experienced aggressive retail development. The Thursday weekday comparison showed a significant drop in traffic (19.29%) which may be explained by various COVID-19 restrictions and protocols. Given the time periods involved and the limited data available in 2020, it is hard to reach any broad conclusions regarding the current impact of COVID-19 on Haddonfield Road in Cherry Hill, New Jersey.

D. Travel Time Runs

Travel time runs were collected within the project area both before and after initial timing plan implementation. Using a GPS enabled laptop with the software Tru-Traffic™ Version 10.0, floating car studies were completed in both the northbound and southbound directions on Haddonfield Road between Town Center Drive and Wyndam Road. Studies were completed during the weekday AM, mid-day, and PM peak hours, as well as the weekend mid-day peak hours. The travel time runs are presented in **Appendix D** of this report.

E. Traffic Signal Timing and Phasing Data

Existing traffic signal timing and phasing data were obtained from existing signal timing directives. All operational data was verified by direct controller download in October 2019. The existing timing directives are presented in **Appendix A** of this report. The existing timing directives and controller downloads are presented on the project website: http://www.dvrpc.taylorwiseman.com.

F. Field Review of Existing Operations

Field notes were collected at the intersection on various intersection, signal, and traffic characteristics to assist in model development and signal optimization. Information gathered included lane geometry, storage lengths, number and types of signal heads, cabinet and pedestrian push button locations, and signal phasing.

Posted speed limits, left turn types (protected, protected/permitted, or permitted), turn restrictions, and the presence of roadway lighting and signal back plates were noted. Pedestrian push buttons were tested for proper operation during the field review. Any other unique characteristics were also recorded.

As noted in the project summary, the consultant team found a simple coordinated signal system operating between Town Center Drive and the Movie Theater entrance (4 intersections). The system operated via time based coordination and at three out of four intersections, maintained a single set of phase times and a 120-second cycle throughout the day. The northern most signal in the system, the Movie Theater Entrance did modify phase times as three specific coordination programs were identified, each running a 120-second cycle. The intersection of Maple Avenue operated with a single 90-second cycle coordinated program, but was not coordinated with any other signal on Haddonfield Road.

During the initial field review of project controller assemblies on the project corridor the consultant team found a mixture of Econolite ASC/2, Econolite ASC/3, Econolite COBALT, TCT LMD8000 and Peek 3000 controllers. The cabinets were all configured in a NEMA TS1-1989 configuration. Optical-based emergency preemption was found at the Town Center, Garden Park Boulevard and Cherry Hill Mall intersections. Some intersections were equipped with battery backup systems, In October 2019 there was no consistent controller assembly standard on the corridor irrespective of municipality. In general, maintenance on the corridor appeared to be response-only. The cabinets were generally in fair condition, however numerous detection failures as well as other maintenance items were observed on the corridor.

As there is no communication between the project intersections (Town Center Drive to Wyndam Road), the consultant team compared displayed clock time to the time.gov internet standard. The results of the October 2019 field inspection are presented in Table 3.

Table 3
Existing Controller Time Variance
Haddonfield Road: Town Center Drive to Wyndham Road
October 2019

Intersection Cross Street	Variance (compared to time.gov)	Comments
Town Center Drive	13 seconds slow	
Garden Park Boulevard	47 seconds fast	
Chapel Avenue	3 seconds slow	
Movie Theater Driveway	57 seconds fast	
South Mall Driveway	45 seconds slow	
Dudley Avenue	120 seconds slow (2 minutes)	
Church Road	3 seconds fast	
North Mall Plaza/Colwick Drive	1 hour, 28 seconds slow	
Maple Avenue	22 seconds slow	
New York Avenue	3 seconds fast	
Park Avenue	11 hours fast	Date read May 4, 1985
Wyndham Road	9 hours fast	Date read March 12, 1974

The internal clocks in modern traffic signal controllers are typically accurate and theoretically capable of maintaining a common time standard allowing for coordinated operation. The time clocks are dependent on the power company supplied frequency to keep time accurately. The variances found in the initial Haddonfield Road field inspection could be attributed to several things:

- Power outages.
- Irregularities in the power company supplied frequency. This could be mitigated by backup power supply/power smoothing units which were found in some Haddonfield Road cabinets.
- Controllers/clocks at the end of their useful life.

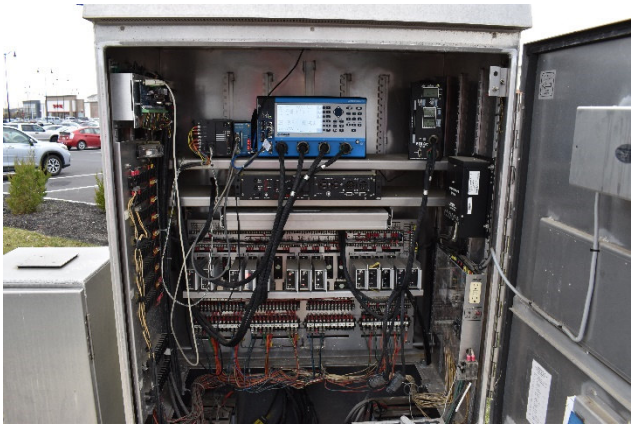


Photo 4: Garden Park Boulevard Controller Assembly (NEMA TS1-1989)--November 2020

- Errors in time/date setting during installation/maintenance of timing patterns. The availability of smartphones with atomic time, time.gov, and Naval Observatory time has made the synchronization of time on traffic signal clocks much easier.
- Lack of synchronization devices such as GPS pucks or communication systems.
- Lack of routine preventive maintenance in the controller assemblies.

To the credit of Pennsauken and Cherry Hill Townships, equipment was upgraded on this corridor where recommended during this project prior to implementation of coordinated operation. Although cabinet assemblies were not upgraded, the intersection timer units were upgraded where recommended to new Econolite COBALT controllers. Where Econolite ASC/3 controllers existed, those controllers remained. In addition, GPS pucks were installed at all intersections. This investment will ensure that all project intersections will maintain a common time-standard, effectively eliminating time base coordinator drift. The new controllers/GPS pucks will ensure that coordinated operation will operate at maximum efficiency for the foreseeable future. Table 2 illustrates controller equipment observed on the Haddonfield Road corridor.

Table 2
Haddonfield Road-Camden County Route 644
Controller Inventory, October 2019-October 2020

ID	Cross Street	Municipality	Controller 10/2019	GPS 10/2019	Controller 10/2020	GPS 10/2020	Emergency Premption 10/2020
1	Wyndam Road	Pennsauken	Econolite ASC/3	NO	Econolite ASC/3	YES	
2	Park Avenue (CR 621)	Pennsauken	TCT LMD 8000	NO	Econolite COBALT	YES	
3	New York Avenue	Pennsauken	Econolite COBALT	NO	Econolite COBALT	YES	
4	Maple Avenue (CR537)	Cherry Hill	Econolite ASC/2	NO	Econolite COBALT	YES	
5	Colwick Drive/North Mall Plaza	Cherry Hill	Peek 3000	NO	Econolite COBALT	YES	
6	Church Road (CR 616)	Cherry Hill	Econolite ASC/2	NO	Econolite COBALT	YES	
7	Dudley Avenue	Cherry Hill	Econolite ASC/3	NO	Econolite ASC/3	YES	
8	Cherry Hill Mall Drive	Cherry Hill	Econolite ASC/2	NO	Econolite COBALT	YES	Optical
9	Movie Theater Entrance	Cherry Hill	Peek 3000	NO	Econolite COBALT	YES	
10	Chapel Avenue (CR 626)	Cherry Hill	Econolite ASC/2	NO	Econolite COBALT	YES	
11	Garden Park Boulevard	Cherry Hill	Econolite ASC/2	NO	Econolite COBALT	YES	Optical
12	Town Center Drive	Cherry Hill	Econolite ASC/3	NO	Econolite ASC/3	YES	Optical

Field observations on the corridor revealed the following maintenance concerns:

Haddonfield Road and Garden Park Boulevard, Cherry Hill Township: The video detection for the NBLT (Phase 1) and NB (Phase 6) movements are showing a constant call, resulting in these phases receiving maximum time irrespective of vehicular demand. Video detection zone and operation needs to be reviewed.

Haddonfield Road and Chapel Avenue, Cherry Hill Township: All eastbound and westbound pedestrian buttons call both phase 4 and 8. Operations would be significantly improved if the pedestrian phases would only call the adjacent pedestrian phase. The eastbound buttons would call only pedestrian phase 4 and westbound phases would call only pedestrian phase 8. This would limit the impact of pedestrian actuations on the coordinated operations. The southbound left turn three section head indication is tilted slightly, so not straight (vertical).

Haddonfield Road and Movie Theatre Entrance, Cherry Hill Township: The Walk signal on the northwest corner is partially out. The Walk signal for the northbound pedestrian movement on the northeast corner signal head is out. Northeast corner red indication is out for the westbound right turn overlap five section signal head.

Haddonfield Road and Cherry Hill Mall Drive, Cherry Hill Township: The eastbound (Phase 4) video detector was observed to be unreliable, often missing vehicles on the approach. The video detection zone should be reviewed to ensure that vehicles are picked up. Vehicles in the center of the approach appear to be a problem for the current zone. The southbound pedestrian signal head on the southwest corner is tilted 45 degrees away from the crosswalk so indications cannot be seen from the crosswalk. Pedestrian buttons on the northwest and southwest corners are inoperable. The controller is currently in pedestrian recall, impacting the efficiency of the timing plans.

Haddonfield Road and Dudley Avenue, Cherry Hill Township: Both the eastbound and westbound video detectors have constant calls. The video detection system needs to be adjusted and/or replaced.

Haddonfield Road and Church Road, Cherry Hill Township: The existing cabinet configuration has this signal as a four-phase intersection where the northbound left turn and southbound left turn are both tied to Phase 1. The southbound left turn volumes are significantly higher than the northbound left turn, so separating these phases and assigning a lower split time to the northbound left turn would significantly improve the operation of this signal. All eastbound and westbound pedestrian buttons call Phase 4, due to the existing configuration of this signal. Being able to separate these pedestrian buttons to individual phases would improve operations.

Haddonfield Road and Colwick Rd./ N. Mall Plaza, Cherry Hill Township: Phase 1 (northbound left turn) has no detection, so services each cycle regardless of demand.

Haddonfield Road and Maple Avenue, Cherry Hill Township: Vehicle detection at this intersection needs to be replaced. The intersection is currently running on maximum recall, which impacts the efficiency of the signal operation. Pedestrian indications on the northeast (Phase 2-NB) and northwest (Phase 6-SB) corners are not working.

Haddonfield Road and New York Avenue, Pennsauken Township: Detection needs to be replaced at this intersection. Northbound three-section head has a failed amber indication. Pedestrian indications on the northwest and southeast corners are in need of maintenance.

Haddonfield Road and Park Avenue, Pennsauken Township: Side street detection is in fault mode and needs to be replaced. The pedestrian button for the westbound pedestrian movement on the northwest corner needs to be replaced. Due to this, the pedestrian movement must be covered in the splits and the pedestrian recall is enabled. Red indication for the westbound pedestrian movement signal head needs maintenance.

Haddonfield Road and Wyndam Road: Side street detection at this intersection needs to be replaced. Intersection is running pre-timed.

III. Analysis and Implementation

A. Modeling

The Project Team developed a set of base Synchro™ Version 10 models for management of the new traffic data, initial analysis of the intersection with and without various timing and a screening level review of each intersection's overall potential for capacity-level improvements using the Intersection Capacity Utilization (ICU) Methodology. Microscopic simulation using SimTraffic™ was used to assess the impact of unmet demand, turn pocket overflow, metering and spillback, and the effects of origin-destination pairs. TruTraffic™ was used to assist in offset determination in order to assess early release issues created when minor phases gap out and unused cycle time is typically sent back to the coordinated phases.

It is important to note that the delay minimization focus of the optimization routine in Synchro™ is helpful to a point in deriving improved cycle lengths and splits; however, this method does not necessarily favor corridor progression and bandwidth requirements. After development of the base models and supplemental evaluations in SimTraffic™, the UTDF file transfer feature with various spreadsheets were used to create base TruTraffic™ models for more in-depth optimization.

B. Initial Results--Modeling

Using the data collected to date and the modeled (i.e. theoretical) timing plans, several network-wide measures of effectiveness were presented for the then pre-existing conditions without retiming (Existing), and with the proposed signal retiming (Proposed). The results showed significant time savings, reductions in delays and reductions in fuel consumption throughout the Project area. Weekday total delays decrease by approximately 21.9% during the AM peak hour, 18.2% during the Mid-Day peak hour, 15.1% during the weekday PM peak hour, 16.9% during the weekday PM off-peak hour, 20.5% during the weekend am peak, 19.7% during the weekend mid-day and 20.5% during the weekend PM peak hour. Table 3 illustrates the results of the Synchro modeling effort. For additional information, Table 3 includes the "observed" results obtained from field studies using Tru-Traffic™ 10 on the corridor. The differences are to be expected, especially given the dynamic conditions experienced in New Jersey due to COVID-19 restrictions and population behavior.

Table 3
Synchro™ 10.0 Network Performance Measures
(Weekday and Weekend - Modeled)

AM Weekday Peak	Existing	Implemented	Difference	Observed Difference
Total Delay (hr)	128	100	-21.9%	-69.4%
Total Stops	14,455	10,820	-25.1%	-79.1%
Total Travel Time (hr)	322	294	-8.7%	--27.7%
Fuel Consumed (gal)	526	460	-12.5%	NA
Weekday Mid-day Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	159	130	-18.2%	-62.4%
Total Stops	16,192	14,651	-9.5%	-53.8%
Total Travel Time (hr)	366	337	-7.9%	-29.9%
Fuel Consumed (gal)	584	544	-6.8%	NA
Weekday PM Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	258	219	-15.1%	-44.1%
Total Stops	23,664	19,812	-16.3%	-54.2%
Total Travel Time (hr)	533	493	-7.5%	-22.5%
Fuel Consumed (gal)	829	753	-9.2%	
Weekday PM Off-Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	118	98	-16.9%	NA
Total Stops	12,565	11,406	-9.2%	NA
Total Travel Time (hr)	292	272	-6.8%	NA
Fuel Consumed (gal)	466	436	-6.4%	NA
Weekend AM Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	151	120	-20.5%	NA
Total Stops	15,026	13,069	-13.0%	NA
Total Travel Time (hr)	352	321	-8.8%	NA
Fuel Consumed (gal)	556	508	-8.6%	NA
Weekend Mid-Day Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	319	256	-19.7%	-33.5%
Total Stops	24,753	22,228	-10.2%	-45.5%
Total Travel Time (hr)	606	543	-10.4%	-15.8%
Fuel Consumed (gal)	908	831	-8.5%	NA
Weekend PM Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	151	120	-20.5%	NA
Total Stops	15,026	13,168	-12.4%	NA

Total Travel Time (hr)	352	321	-8.8%	NA
Fuel Consumed (gal)	556	509	-8.5%	NA

It should be noted that Synchro™ 10.0 includes a simulation module, SimTraffic™. Additional modeling was performed to obtain measures of effectiveness generated by SimTraffic™ 10.0. Table 4 illustrates the measures of effectiveness generated by SimTraffic™.

Table 4
SimTraffic™ 10.0 Network Performance Measures
(Weekday and Weekend - Modeled)

AM Weekday Peak	Existing	Implemented	Difference	Observed Difference
Total Delay (hr)	134	107	-20.5%	-69.4%
Total Stops	11,763	8,513	-27.6%	-79.1%
Total Travel Time (hr)	387	357	-7.7%	--27.7%
Fuel Consumed (gal)	335	316	-5.9%	NA
Weekday Mid-day Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	176	132	-24.8%	-62.4%
Total Stops	13,958	11,673	-16.4%	-53.8%
Total Travel Time (hr)	445	400	-10.1%	-29.9%
Fuel Consumed (gal)	368	353	-4.1%	NA
Weekday PM Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	386	256	-33.8%	-44.1%
Total Stops	21,422	16,285	-24.0%	-54.2%
Total Travel Time (hr)	741	614	-17,2%	-22.5%
Fuel Consumed (gal)	517	482	-6.7%	NA
Weekday PM Off-Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	116	99	-15.0%	NA
Total Stops	10,469	9,290	-11.3%	NA
Total Travel Time (hr)	342	327	-4.4%	NA
Fuel Consumed (gal)	299	294	-1.5%	NA
Weekend AM Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	190	122	-35.9%	NA
Total Stops	12,954	10,480	-19.1%	NA
Total Travel Time (hr)	450	381	-15.3%	NA
Fuel Consumed (gal)	357	335	-6.1%	NA
Weekend Mid-Day Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	441	305	-30.8%	-33.5%

Total Stops	24,434	18,713	-23.4%	-45.5%
Total Travel Time (hr)	822	682	-17.0%	-15.8%
Fuel Consumed (gal)	552	518	-6.1%	NA
Weekend PM Peak	**Existing**	**Implemented**	**Difference**	**Observed Difference**
Total Delay (hr)	190	129	-32.4%	NA
Total Stops	12,954	10,619	-18.0%	NA
Total Travel Time (hr)	450	388	-13.7%	NA
Fuel Consumed (gal)	357	338	-5.5%	NA

C. Implementation

During the week of October 20, 2020, the consultant team implemented the optimized timing plans into each of the project intersection controllers via direct link and manual keystroke. The consultant team verified that each controller maintained a common time standard via the newly installed GPS pucks, utilizing time.gov as a reliable standard.

In developing timing plans, the collected 24-volume counts were studied during both the weekday (Monday-Friday) and weekend (Saturday-Sunday) time periods. A time-of-day plan was developed with custom cycle lengths and phase times for each observed traffic condition. The time periods varied by intersection slightly. Timing plans were developed for the following time periods:

- Weekday AM peak hour
- Weekday Mid-Day peak hour
- Weekday PM peak hour
- Weekday PM off-peak hour (early evening/overnight)
- Weekend AM peak hour
- Weekend Mid-Day peak hour
- Weekend PM peak hour
- Free Program

Photo 5: Left to Right: Brian Jatzke, Iteris; Colleen Richwall, Corridor Project Manager, TWT; and Dan Miller, TWT install new timings at Town Center Drive.

The system was broken into two zones which coincidentally mirrored municipal boundary lines. Higher volume/demand was seen between Town Center Drive and Maple Avenue (Cherry Hill Township) so typically these signals were programmed with longer cycle lengths. The cycle length experienced by motorists on the southern end during the early morning and late evening hours was dropped from 120 to 100 seconds, which should significantly reduce delay experienced by motorists entering the system. The Pennsauken system, New York Avenue to Wyndham Road, was programmed with

lower cycle lengths and fewer overall programs, due to the lower vehicular demand and lack of vehicular detection. The 24-hour count analyses, as well as graphic representation of day plans installed are presented in **Appendix B**.

D. Fine-Tuning of Signal Timings

The project team observed each new timing plan at every intersection during its respective program period to ensure each phase split was appropriate for the traffic conditions present. If a movement or intersection is over capacity, split adjustments were made to manage queue spillback and blockage. In addition to fine-tuning splits, offset adjustments often have a larger effect on the performance of the network. Offsets were adjusted at the coordinated intersections by conducting travel time runs along the corridor. Travel time runs were conducted using Tru-Traffic™ in conjunction with a direct connect GPS unit which tracks the location of the test vehicle within the traffic signal system. This provides the user dynamic information about the performance of the traffic signal system such as travel time and delay and approximate position in a dynamic time/space diagram. Results of the travel time runs under existing timings (the "before" runs) and implemented signal timings (the "after" runs) are discussed in the next section of this report.

The revised signal timings are available from the project website, http://dvrpc.taylorwiseman.com. Updated signal timing directives were developed by the consultant team, with electronic and paper copies delivered to Camden County and laminated copies placed in each controller. Copies of the final signal timing directives are presented in **Appendix C**.

IV. Results

A. Before and After Data

Travel time data along the corridor was collected before and after implementation of the initial timing plans during the weekday morning, mid-day, evening and the weekend mid-day peak hour periods. Refer to Table 4 and Table 5 that includes the cumulative measures of effectiveness for the before and after conditions, as well as the percent differences between the two scenarios, per peak period based on actual field data, as opposed to the theoretical values highlighted in the previous section.

With implementation of the new timing plans and maintenance of a uniform time clock via the GPS pucks between controllers, progression along Haddonfield Road (CR 644) improved significantly, in both directions. For all four peak hour periods, the implemented retiming is producing positive results and significant savings in travel time, delay, the number of stops, and travel speed in both directions. Refer to **Appendix D** for the travel time plots for the time periods.

Table 4
Peak Hour Travel Time and Delay Improvements
Tru-Traffic™ 10 Floating Car Studies

		AM Peak		Mid-day Peak		PM Peak		Weekend Mid-day Peak	
		Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)
Northbound	Existing	433	161	511	239	550	278	477	205
	Implemented	343	71	355	83	444	172	437	166
	Difference	-90		-156		-106		-40	
	% Difference	**-20.8%**	**-55.9%**	**-30.5%**	**-65.3%**	**-19.3%**	**-38.1%**	**-8.4%**	**-19.5%**
Southbound	Existing	469	197	535	263	555	283	550	278
	Implemented	309	37	378	106	410	138	426	155
	Difference	-160		-157		-145		-124	
	% Difference	**-34.1%**	**-81.2%**	**-29.3%**	**-59.7%**	**-26.1%**	**-51.2%**	**-22.5%**	**-44.6%**
Cummulative	Existing	451	180	522	250	552	281	513	242
	Implemented	326	54	366	95	428	156	432	160
	Difference	-125		-156		-124		-81	
	% Difference	**-27.7%**	**-69.4%**	**-29.9%**	**-62.4%**	**-22.5%**	**-44.1%**	**-15.8%**	**-33.5%**

Northbound: Town Center Drive to Wyndam Road
Southbound: Wyndam Road to Town Center Drive

Table 5
Peak Hour Stop and Fuel Consumption Improvements
Tru-Traffic™ 10.0 Floating Car Studies

		AM Peak		Mid-day Peak		PM Peak		Weekend Mid-day Peak	
		Stops	Fuel Cons (gal/hr)	Stops	Fuel Cons (gal/hr)	Stops	Fuel Cons (gal/hr)	Stops	Fuel Cons (gal/hr)
Northbound	Existing	3.9	134	4.8	162.6	5.9	249.7	4.7	228.5
	Implemented	1.3	88.2	2.4	111.2	3.2	181	3.3	189.7
	Difference	-2.6	-45.8	-2.4	-51.4	-2.7	-68.7	-1.4	-38.8
	% Difference	**-66.7%**	**-34.2%**	**-50.0%**	**-31.6%**	**-45.8%**	**-27.5%**	**-29.8%**	**-17.0%**
Southb	Existing	4.7	180.5	5.7	202.1	5.9	253.4	6.2	285.7
	Implemented	0.6	97.4	2.4	136.3	2.1	155.7	2.8	192.5

	Difference	-4.1	-83.1	-3.3	-65.8	-3.8	-97.7	-3.4	-93.2
	% Difference	**-87.2%**	**-46.0%**	**-57.9%**	**-32.6%**	**-64.4%**	**-38.6%**	**-54.8%**	**-32.6%**
Cummulative	Existing	4.3	158	5.2	181.3	5.9	251.6	5.5	257.1
	Implemented	0.9	92.8	2.4	123.7	2.7	168.9	3	191
	Difference	-3.4	-65.2	-2.8	-57.6	-3.2	-82.7	-2.5	-66.1
	% Difference	**-79.1%**	**-41.3%**	**-53.8%**	**-31.8%**	**-54.2%**	**-32.9%**	**-45.5%**	**-25.7%**

Northbound: Town Center Drive to Wyndam Road
Southbound: Wyndam Road to Town Center Drive

B. Opportunities for Improvement

Haddonfield Road, Camden County Route 644, is a heavily utilized route in Camden County, New Jersey. This route provides access to three major state routes, New Jersey Route 73 north of the northern project limit, New Jersey Route 38 at its midpoint and New Jersey Route 70 south of the southern project limit for this corridor. This corridor provides access to one of the heaviest developed roadway segments in Southern New Jersey, Cherry Hill Township's "Golden Mile". The corridor provides access to numerous retail, office, restaurant and institutional land uses.

This report has documented significant improvements in traffic flow associated with this project. Average delay, travel time and vehicle stops have all improved with new signal timing. The significant investment by Cherry Hill and Pennsauken Townships, namely 10 new controller units and GPS pucks throughout, should sustain the coordination settings for the foreseeable future.

However, there are numerous opportunities for improvement on this corridor, including the following general and specific recommendations:

General Recommendations:

1. The overall level of maintenance of the corridor traffic signals is well-below average. Sixty-seven percent (67%) of the intersections have observed detection failures, which dramatically impacts the efficiency of these signals. There is no evidence of preventive maintenance on the corridor. Camden County may wish to evaluate its policy of delegating maintenance of traffic signals on County roadways to municipalities. There are numerous examples of faulty pedestrian and vehicular indications on the corridor which impact the safety of both pedestrian and vehicular traffic on the corridor.
2. The corridor would benefit from standardized specifications for traffic signal installations. Optically based emergency preemption was observed at three of the twelve corridor signals (25%). The benefit associated with preemption would be better realized if all signals within the municipality or county were similarly equipped. Non-invasive detection, utilizing video and/or radar should be considered.
3. The municipalities involved have invested in GPS pucks to synchronize time clocks on the corridor, which will be vital to the sustainability of the coordination settings. However, given the regional importance of this corridor and the intense demand associated with the retail/restaurant component as well as the proximity of three major state routes, this corridor is a good candidate for total modernization. In this modernization the following issues could be addressed:
    a. The appropriate use of battery back-up systems should be considered.

b. LED signals should be the norm. 12" indications should be considered for all vehicular indications.
c. The use of computer control, or adaptive control should be considered.
d. Detection issues were identified on the corridor. New non-invasive detection systems based on state-of-the-art video and radar should be considered.
e. Phasing, both pedestrian and vehicular, should be upgraded.
f. Emergency preemption should be installed the entire length of the corridor if being used by County municipalities.
g. Pedestrian facilities should include countdown timer signals, ADA compliant ramps and MUTCD compliant pedestrian detectors.
h. Street name signing should be included at all signals.

4. Land development access should be scrutinized for impact on the corridor. The Chick-fil-A, for example, north of Route 38 on the corridor, effectively blocks a northbound lane during meal rushes, secondarily causing notable queues on northbound Haddonfield Road where both through traffic and that associated with Route 38 are trying merge.

Specific Recommendations:

1. Haddonfield Road and Garden Park Boulevard, Cherry Hill Township:
   a. Phase 1—northbound left turn video detection zone is showing constant call. Video detection zone/detection system needs to be revised or replaced.
   b. Northbound through video detection zone is also showing constant call. Video detection zone/detection system needs to be revised or replaced.
2. Haddonfield Road and Chapel Avenue, Cherry Hill Township:
   a. All eastbound/westbound pedestrian pushbuttons call both phases 4 and 8. Operations would be significantly improved if the pedestrian phases would call the adjacent pedestrian phase (EB buttons call phase 4, WB buttons call phase 8).
   b. The southbound facing left-turn three section head is tilted slightly and should be aligned to be vertical.
3. Haddonfield Road and Movie Theater Entrance, Cherry Hill Township:
   a. Walk indication on the northwest corner needs maintenance.
   b. Walk indication for the northbound pedestrian movement on the northeast corner needs maintenance.
   c. Westbound right-turn overlap five-section signal head on northeast corner has red indication not working.
4. Haddonfield Road and Cherry Hill Mall Drive, Cherry Hill Township:
   a. Video detection for the eastbound approach is not working reliably.
   b. The southbound pedestrian indication on the southwest corner is tilted from the crosswalk so indications cannot be seen.
   c. Pedestrian pushbuttons on the northwest and southwest corners do not place calls in the controller.
5. Haddonfield Road and Dudley Avenue, Cherry Hill Township:
   a. Side street video detection (both directions, eastbound and westbound) is not working reliably. Detection system should be revised or replaced.
6. Haddonfield Road and Church Road, Cherry Hill Township:

a. The existing cabinet configuration at this intersection provides for four phases. Accordingly, the northbound and southbound left-turn phases are linked together. Since southbound left-turn volumes are notably higher, reconfiguration of these phases and reducing northbound left-turn phase time will significantly improve signal operations.
b. Both eastbound and westbound pedestrian pushbuttons call Phase 4. Separating these actuations to Phases 4 and 8 respectfully will improve operations.

Photo 6: Photo depicts high demand for southbound left-turn at Church Road during fine tuning. Problem could be mitigated somewhat if CR 644 left-turn phases were separated.

7. Haddonfield Road, Colwick Drive and North Mall Plaza, Cherry Hill Township:
   a. Northbound left turn phase (Phase 1) should be actuated.
8. Haddonfield Road and Maple Avenue, Cherry Hill Township:
   a. All vehicle detection at this intersection has failed. Detection should be reestablished at this location.
   b. Pedestrian indication for northbound pedestrian movement (Phase 2) on northeast corner does not illuminate.
   c. Pedestrian indication for southbound pedestrian movement (Phase 6) on northwest corner does not illuminate.
9. Haddonfield Road and New York Avenue, Pennsauken Township:
   a. Vehicle detection needs to be reestablished.
   b. Three-section signal head for the northbound inside approach has a failed amber indication.
   c. Pedestrian indication on southeast corner for northbound (Phase 2) movement needs maintenance.
   d. Pedestrian indication on northwest corner for southbound movement (Phase 6) needs maintenance.
10. Haddonfield Road and Park Avenue, Pennsauken Township:
    a. Existing eastbound/westbound vehicular detection is faulting and needs repair or replacement.
    b. Pedestrian pushbutton on northwest corner for westbound pedestrian movement does not place calls.
    c. Pedestrian signal head (3-section) for westbound pedestrian movement needs repair to red indication.
11. Haddonfield Road and Wyndham Road, Pennsauken Township:
    a. Vehicular detection at this intersection should be repaired. Intersection is currently operating in maximum recall (pre-timed operation).

C. Additional Resources/Project Data

Additional information, including project data, analysis files, and other detailed reports will be available on the project website at: http://dvrpc.taylorwiseman.com. Additional information about traffic signal retiming projects in the Philadelphia/Southern New Jersey region is available from the Delaware Valley Regional Planning Commission, Transportation Systems Management and Operations (TSM&O) office, https://www.dvrpc.org/transportation/tsmo.

Appendix A—Existing Timing Directives

Appendix B—24 Count Analyses/Implemented Day Plans

Appendix C—Final Signal Timing Directives

Appendix D—Travel Time Runs

Appendix E—October 2019 Cabinet Photos