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BATH 18-008

Master Long-Range Transportation Improvements Plan:

Alternatives Analysis

Borough of Bath
Northampton County, Pennsylvania

November 13, 2019

Prepared For:

Borough of Bath
121 S. Walnut St.
Bath, PA 18014

Prepared By:

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I. Introduction and Background

As part of an ongoing effort by the Borough of Bath to be proactive in developing solutions to address significant existing and projected traffic congestion issues, the Borough has retained Keystone Consulting Engineers, Inc. to review traffic control alternatives and develop a Master Long-Range Transportation Improvements Plan (MLRTIP) specific to the Borough. This Plan will identify needed improvements to the roadway network that will provide the most benefit towards reducing traffic congestion while minimizing anticipated project costs, acquisition of property, and disruption to local residents and businesses. This Plan will also serve as a long-range planning tool and necessary pre-requisite for project grant applications.

Since the MLRTIP will require a substantial commitment of resources to complete, a phased approach is recommended which will provide the opportunity to prioritize and try less costly/disruptive measures first while still maintaining the ability to employ more substantial measures in the future should the currently experienced traffic congestion issues persist or intensify.

PennDOT Coordination and Required Approvals

Since the vast majority of the roadway network located within the Borough is State-owned, KCE and Borough Staff have met on several occasions with PennDOT personnel to discuss the most appropriate scope of improvements for the MLRTIP. Ultimately, it is understood that PennDOT must endorse and ultimately approve any modifications to the roadway network that are proposed as part of the MLRTIP or any of its sub-phases. In light of this, and specifically in light of the Borough's last meeting with the Department on May, 2, 2019, where the Department requested that the Borough prepare a High-Level Alternatives Analysis that comprehensively considers a wide range of mitigation strategies, the following step-by-step process has been followed to arrive at the proposed scope of improvements identified as part of the MLRTIP:

- Step 1 - Identify the traffic congestion problems currently experienced by the Borough's traveling public.

- Step 2 - Identify the probable causes of the existing traffic congestion.

- Step 3 - Identify potential mitigation strategies that consider a broad-spectrum of alternatives, then qualitatively evaluate alternatives based on how each option proposes to address the items identified in Step 2. Identify which options are recommended for further consideration.

- Step 4 –Define a Master Long-Range Transportation Improvements Plan for the Borough of Bath that incorporates the recommended mitigation strategies identified in Step 3. This plan depicts the ultimate traffic improvements that are needed to alleviate traffic congestion in the Borough for the next 20-years.

- Step 5 – Using the master plan developed in Step 4, identify project phases. Phased implementation will provide the opportunity to prioritize and try less costly/disruptive measures first while still maintaining the ability to employ more substantial measures in the future should the currently experienced traffic congestion issues continue to persist or intensify.

II. Step 2 – Identify Probable Causes of Existing Traffic Congestion

The following measures were taken to identify the probable causes of the traffic congestion experienced in the Borough:

- Collection of Traffic Count Data

    - Twelve (12 Hours) of turning movement counts and video were collected at the twelve (12) major intersections within the Borough.
    - Inbound/outbound volume counts were collected on the seven (7) major State Highways that provide access to/from the Borough.
    - Volume capture data to verify pass-through traffic and to confirm origin-destination patterns was obtained using Wifi recording devices.
    - Queue counts to determine maximum queue lengths and unmet traffic demand (number of cars still in-queue when the light turns red) were performed.

- Field Visits

    - Field-verification of existing traffic signal operations was performed by KCE staff. This included measuring observed field timings and comparing them to the values depicted on the respective Condition Diagram for each signalized intersection.

    - Various flow-friction factors were determined by general observation of traffic conditions. This included items like queue spillback, single lane intersection blocking, vehicle "run-around" using de-facto lanes, truck turning maneuvers, mid-block turning, etc.

- Consideration of Borough Staff Testimonials

- Data collection results and observations were reviewed with Borough Staff to compare with their day to day experiences.

Causes of Traffic Congestion

Based on the information obtained from the above measures, the following is a discussion of the factors that are believed to be significant contributors to the traffic congestion experienced in the Borough:

A. Heavy Traffic Volumes - A review of the traffic volumes and movement capacities in the Borough indicate that volumes for certain movements are either nearing capacity or are high enough to consume the majority of the capacity for a given movement (i.e. northbound thru/right movement at Walnut and Northampton Street and the northbound/thru right movement at Walnut and Main Street have v/c ratios of 0.89 and 0.65, respectively, during the 2024 PM Peak Hour projected conditions analysis). While an independently conducted HCM analysis suggests that the traffic volumes alone are not significant enough to cause the observed congestion issues (movement levels-of-service are reported as LOS C or better), the above noted v/c ratios indicate that the traffic volumes are significant enough to produce a greater instability in traffic conditions when considering the cumulative effect of other contributing factors. An example is that of a tractor-trailer turning slowly through a narrow intersection. The slow-moving tractor-trailer causes delay to the upstream traffic that would not otherwise be caused by smaller vehicles. During very light traffic conditions, both the slow-moving tractor trailer and the remainder of the traffic demand behind the tractor-trailer may have time to clear the intersection within the green time allocated for that particular signal phase. However, during heavier traffic conditions (such as those present in Bath) the additional delay caused by the slow-moving tractor trailer may be enough to cause the demand traffic volume to exceed capacity. This would result in some vehicles arriving on red that would otherwise have cleared the signal, thereby increasing vehicle delay and congestion.

B. Close Intersection Spacing / Traffic Flow Patterns - The primary traffic flow patterns in the Borough and the intersection spacing/configuration have been observed to contribute to congested traffic conditions in the Borough, as further described below:

- There are two main traffic flow paths via Race/Chestnut Streets and SR 512 (Walnut Street) that flow from south to north through the Borough that both convey approximately 500 veh/hour of traffic during the PM peak hour (see Figure 1).

- In general, during PM peak conditions, the heavy south to north traffic on Chestnut Street acts as a "barrier" that impedes the flow of westbound traffic on Northampton and Main Streets between Chestnut and Walnut streets (The vehicle storage capacity on the roadway segments between Chestnut and Walnut Streets is only 250-feet and 165-feet for Main and Northampton Streets, respectively – this is in part due to the location of the stop bars which have been pulled back to help convey tractor trailers through the confined Borough intersections). This causes congestion and spillback on Northbound Walnut Street, and westbound Main and Northampton Streets.

- *Westbound approach to Main St. / Chestnut Street intersection* - The signing configuration along Main Street at Race and Chestnut Streets provides for free-flow movement of vehicles from Race Street to Chestnut Street. During times of heavy traffic congestion, westbound vehicles are not able to find gaps in the oncoming traffic since the opposing traffic stream is free-flowing.

- *Westbound approach to Northampton Street / Chestnut Street intersection* – In addition to limited green time allocated to the east/westbound signal phase, the westbound approach is further hindered by westbound left turning traffic that must wait for gaps in the eastbound through traffic stream before completing the left turn maneuver. Since the geometry of this intersection does not allow for westbound through and right turning traffic to "run-around" a stopped vehicle, the queue can quickly grow to spill-back into the adjacent Walnut/Northampton Street intersection and affect upstream traffic conditions. This is further exacerbated if one of the queued vehicles is a tractor-trailer.

C. Confined Intersection Geometry - The Borough of Bath was initially established in 1728, and as such contains many historic structures that line the Borough's road network in a traditional style with shallow front yard setbacks and small radii at intersection corners. As a result, certain types of truck traffic have been observed to experience difficulty in negotiating Borough roads, which lead to problems ranging from slowed turning maneuvers to complete blockages at times. These types of occurrences are expected to worsen as the amount of truck traffic continues to increase in the Lehigh Valley and surrounding regions.

D. Left Turns from Single Approach Lanes - Due to the geometric constraints described above, all Borough intersections consist of single-lane approaches from which all turning maneuvers are performed. This results in the potential for a single left-turning vehicle to block or significantly impede the flow of traffic while waiting for a gap in opposing traffic flow to complete a permitted turning

maneuver. Most Borough intersections are wide enough to support the "run-around" of thru-traffic, however, additional delay is still incurred as vehicles must move slower to safely navigate around the waiting left turn vehicle. As previously mentioned, the westbound approach to the Chestnut Street & Northampton Street intersection becomes completely blocked by a waiting left turn vehicle since the intersection geometry does not allow for the run-around of through traffic.

E. Friction from On-Street Parking Maneuvering - Off-street parking is limited in the Borough due to space constraints. On-street parking is permitted on one or both sides of Borough roadways to accommodate the excess parking demand. The excess maneuvering associated with parallel on-street parking, as well as the potential for double-parked vehicles can serve to further impede the flow of traffic and contribute to traffic congestion in the Borough.

F. Driver Confusion/Frustration Due to Unorthodox Existing Sign Configuration - The Main Street intersections with Race and Chestnut Streets are unsignalized and are signed to allow for the free-flow movement of northbound and southbound traffic between Race and Chestnut Streets. Further, limited sight distance is available on northbound Race and Southbound Chestnut Streets which further require that traffic be stopped along Main Street to allow for the safe conveyance of traffic. This area appears to be a source of driver confusion and frustration as evidenced by audible vehicle horns which have been witnessed and reported on several occasions. While this factor may not be a significant contributor to congestion, it does contribute to the overall negative experience of driving in the Borough.

G. Variable traffic patterns - Recently conducted traffic counts have confirmed that traffic demand varies significantly from one 15-minute interval to the next over the course of an average weekday. Since three of the four existing traffic signals in the Borough are pre-timed with fixed cycle lengths, splits, and offsets, the system lacks the functionality to change to adapt to dynamic traffic conditions.

H. Static Signal Timings - Based on a field-measurements obtained on July 30, 2019, the offset values between the signalized intersections were observed to have drifted approximately 3 to 4 seconds from those indicated on the approved Condition Diagrams. Further, the existing signals are programed as pre-timed and three of the signals have no vehicle detection. This allows for no opportunity for the traffic to respond to vehicle inputs and results in all intersection approaches receiving the same amount of green time, regardless of traffic demand.

III. Step 3 – Identify and Evaluate Potential Mitigation Strategies

In an effort to consider a broad spectrum of alternatives, several potential mitigation strategies have been identified below (see Summary Table):

A. Truck Traffic Diversion/Turn Restrictions – In targeting ***congestion cause II.A, II.B, II.C, and II.D***,, per above (Traffic Volumes, Flow Paths/Intersection Spacing, Geometry, and Left Turns, respectively), traffic diversion has been considered as a potential mitigation strategy. Specifically, two types of potential traffic diversion have been identified: 1.) *External* diversion of traffic to alternate roadways *outside* of the Borough, and 2.) *Internal* diversion of traffic to alternate roadways *within* the Borough that are better able to accommodate it.

1. External Diversion – It is our understanding that a "Bath Bypass" consisting of a circular roadway around the Borough has been discussed with local planners for several decades. We also understand that an alternate route for truck traffic between SR 987 (Race Street) and SR 512 in the vicinity of the SR 512/Silvercrest Road intersection has been contemplated and added to the Long-Range Transportation Plan. While implementation of these and other similar projects would completely or partially eliminate the Borough's traffic congestion problems, we also understand that the PennDOT is not in support of this project due to magnitude of anticipated project cost and the unlikelihood of obtaining the necessary funding.

   Recommendation: In light of the above, we believe that external diversion is not a suitable mitigation strategy and should not be relied upon to provide congestion relief for the foreseeable future.

2. Internal Diversion – The Lehigh Valley Planning Commission / Lehigh Valley Transportation Study recently completed the *Bath Multimodal Safety + Parking Analysis*. One of the recommendations of this study was to convert Mill Street into a designated truck route, pending certain improvements to Mill Street as detailed in the study (see attached study excerpts). We concur with the study findings that utilization of Mill Street as a truck route would significantly improve traffic operations in the Borough since it would divert trucks away from key downtown intersections via an alternate route to a location where trucks could be more easily accommodated. While this strategy appears feasible for truck traffic traveling from west to east on Mill Street, our independent evaluation of tractor trailer maneuverability has revealed that the

southbound right turn from SR 512 onto Mill Street westbound is not sufficient to accommodate tractor trailer traffic without the acquisition of property. In light of this, internal diversion via Mill Street would require acquisition of property or would require that the route be restricted to eastbound traffic only.

Recommendation: In light of the above, we recommend that Mill Street be improved per the recommendations in the above noted LVPC/LVTS study and used as a truck route in the eastbound direction. We further recommend that the use of Mill Street as a truck route in the westbound direction be evaluated in light of the cost of acquiring the property at the northwest corner of SR 512 and Mill Street to accommodate tractor trailers. If property acquisition costs outweigh the benefits received, an alternate truck route should be evaluated for trucks destined to SR 248 (Race Street).

B. Adaptive Traffic Control Technologies – In targeting ***congestion cause II.G and II.H. (Variable traffic patterns and Signal Timings)***, implementation of adaptive traffic controllers has been identified as a mitigation strategy. Adaptive controllers will allow traffic signals to change responsively to actual traffic demand rather than rely on the existing fixed time-of-day plans that have no ability to change with variable traffic conditions.

Recommendation: While we understand that adaptive controllers are not effective during oversaturated conditions, we believe that adaptive operation will shorten the *duration* of oversaturation and also improve the quality of traffic flow during undersaturated conditions. In that regard, the Borough of Bath has submitted a TE-153 application for approval to implement adaptive controllers in the Borough. However, as suggested by the Department and an interim step prior to implementing full adaptive traffic control, the intersections should be upgraded to include detection capabilities, new ATC type controllers, and broad-band radio communications. While these interim measures don't directly account for the observed variability in traffic demand, they will provide a level of dynamic functionality that the existing pre-timed signals are not capable of. Following implementation of the interim signal measures, the high-resolution data provided by the new ATC controllers can be used to further evaluate the need for full adaptive traffic control.

C. Provision of Left-Turn Lanes - In targeting ***congestion cause II.B. and II.D. (close intersection spacing, and left turns from single approach lanes, respectively)***, provision of center turn lanes has been identified as a potential mitigation strategy. Since the volume of left turning vehicles typically averages between

only 1 to 2 vehicles per approach per cycle, the installation of even minimum length left-turn lanes is expected to provide a significant benefit to traffic flow as left-turning vehicles would be able to wait for a gap in opposing traffic without impeding the flow of traffic in the adjacent through lane. However, a drawback to this strategy would be the required relocation of on-street parking to off-street locations since the entire curb-to-curb pavement width would be needed to accommodate the necessary pavement markings. Also, the provision of left turn lanes would negatively impact the ability of tractor-trailers to negotiate turning movements at Borough intersections.

Recommendation: While the provision of left turn lanes would provide a measurable benefit to traffic flow and should be pursued, these benefits should be carefully weighed against the above noted drawbacks (which are significant) during the improvement options development process. Potential workarounds to be explored include property acquisition to improve intersection geometry and the repurposing/reconfiguration of nearby paved areas to accommodate off-street parking demand.

D. Implementation of One-Way Traffic Patterns - In targeting ***congestion causes II.A, II.B, II.D, II.F, II.H (Traffic Volumes, Flow Paths/Intersection Spacing, Geometry, Left Turns, Existing Sign Configurations, and Signal Timings, respectively)***, provision one-way traffic patterns has been considered as a potential mitigation strategy.

Potential benefits to one-way traffic patterns in the Borough of Bath would include the following:

1. Left turn conflicts eliminated – this results in greater capacity/efficiency as well as reduced crash potential.
2. Better progression due to one-way signal coordination
3. Would allow existing parking spaces to be preserved
4. Heavy vehicle turns onto a two-lane, one-way street would be easier to accommodate.

Potential disadvantages to one-way traffic patterns would include the following:

1. Increased Vehicle-Miles traveled due to more circuitous travel routes
2. Increased potential for driver confusion, especially for drivers unfamiliar with the area.
3. Perceived negative benefit to local businesses
4. Left turns from two-lane, one-way roadways would become more difficult to negotiate for truck traffic.

Recommendation: We believe that one-way streets would provide many advantages to Borough traffic that would be otherwise unattainable without significant property acquisition and construction efforts. However, due to the above noted disadvantages, we further recommend that one-way streets be implemented only if the results of a forthcoming quantified traffic analysis indicate a *significant* travel-time reduction as compared to two-way traffic flow.

E. Provision of Roundabouts - In targeting ***congestion cause II.A, II.B, II.D, II.F, II.G, and II.H (Traffic Volumes, Flow Paths/Intersection Spacing, Left Turns, Existing Sign Configurations, Variable Traffic Patterns, and Signal Timings, respectively)***, provision of roundabouts has been identified as a potential mitigation strategy, however, has not been seriously considered since provision of roundabouts would require extensive property acquisition to be able to provide roundabouts capable of supporting tractor-trailer traffic.

Recommendation: In General, roundabouts should not be considered as a mitigation strategy in the Borough of Bath due to the constraints of limited right-of-way and the presence of tractor trailer traffic.

F. Implementation of Travel Demand Management (TDM) Strategies – In targeting ***congestion causes II.A, (Traffic Volumes)***, travel demand management has been considered as a potential mitigation strategy. In general, TDM is the application of strategies and policies to reduce travel demand, or to redistribute this demand in space or in time. Examples of TDM would include staggering shift times, providing carpooling incentives, enhancements in public transportation, etc.

Recommendation: Since data collection efforts suggest that over 90% of the Borough's traffic originates from or is destined to locations outside of the Borough and is therefore beyond the Borough's control, TDM is not recommended as a mitigation strategy for the Borough of Bath.

G. Provision of Intersection Geometry Improvements – In targeting ***congestion cause II.C, (Intersection Geometry)***, corner radii improvements have been considered as a potential mitigation strategy. While improving every intersection corner radius to improve truck traffic flow appears to be impractical since it would require extensive property acquisition and building demolition, improving certain key radii in conjunction with truck route diversions would seem to result in a reasonable compromise between the quality of traffic flow and the preservation of existing structures.

Recommendation: In light of the above, corner radii improvements should be considered where deemed necessary based on designated truck routes within the Borough.

IV. Step 4 – Define a Master Long-Range Transportation Improvements Plan for the Borough of Bath

The above recommended mitigation strategies have been considered and combined into a single, specific Long-Range Master Transportation Improvements Plan in a manner that addresses the causes of congestion indicated in Step 2 and that allows for phasing of improvements. The specific plan elements and anticipated benefits are described below and are illustrated on the attached concept plan:

A. Truck Traffic Routes and Restrictions

1. Mill Street between Race Street and SR 512 should be reconstructed to accommodate truck traffic. This will include the widening of the existing bridge to accommodate truck loading.

2. Signage should be implemented to prohibit trucks over a certain length (length restriction to-be-determined) from traveling northbound on Race Street between Mill Road and Main Street. Trucks would be redirected to points north and east via Mill Road and SR 512. This will require that the Department prepare an engineering study to justify the proposed truck restriction and install appropriate signage.

3. Proposed truck routes through the Borough have been determined based on the following criteria and have been graphically illustrated in the attached Truck Route figures:

    i. Existing truck origins and destinations based on daily truck volumes (see Daily Truck Volume Map)
    ii. Ability of roadways and intersections to adequately convey tractor-trailer traffic (i.e. roadway width, size of radii, etc.).
    iii. Ability to acquire the needed property to construct improvements to facilitate truck traffic (i.e. Mill Street diversion, corner radii improvements).
    iv. The presence of a suitable alternate truck route (if restrictions are proposed).

B. Adaptive Traffic Control Technologies

1. Adaptive Traffic Control Technologies should be implemented at the four signalized intersections in the Borough. This will allow for the efficient and dynamic allocation of green time to serve the highly variable traffic demand observed in the manual traffic counts.

C. Provision of Left Turn Lanes

1. Left Turn lanes should be provided at the following locations to alleviate traffic congestion caused by single left-turning vehicles blocking or impeding flow of adjacent through traffic:

    i. Walnut and Main Streets (all approaches)
    ii. Walnut and Northampton Streets (northbound, westbound, and southbound approaches)
    iii. Northampton Street and Chestnut Street (eastbound and westbound approach only)

2. Provision of the above noted left turn lanes will result in the loss of approximately 81 on-street parking spaces. The proposed parking areas depicted on the plan provide 91 new off-street spaces for a net gain of about 10 spaces.

3. Provision of off-street parking spaces will require coordination and possible acquisition with the affected property owners

D. Implementation of One-Way Traffic Patterns

A counter-clockwise one-way traffic pattern is recommended along the following roadways:

1. Main Street between Northampton Street and Chestnut Street
2. Chestnut Street between Main Street and Northampton Street
3. Northampton Street between Chestnut Street and Main Street

In addition to the applicable general benefits listed in Section III.D., the following specific benefits are anticipated by the implementation of the above one-way traffic pattern:

1. The westbound spillback on Main and Northampton Streets between Walnut and Chestnut streets will be minimized or eliminated as follows:

    i. The westbound movement on Main Street will be able to make a free-flowing right turn onto the easternmost travel lane on Chestnut Street (2-

lanes northbound). Similarly, the eastbound movement on Main Street will be able to make a free-flowing left turn into the westernmost travel lane on Chestnut Street. The provision of free-flowing movement at this intersection will eliminate the potential for eastbound spillback on Main Street during normal peak traffic conditions.

ii. Due to the confined geometry at the Main Street / Chestnut Street intersection, the above mentioned free flowing right turn would not support tractor-trailer movements. In light of this, truck traffic would be restricted and redirected to access locations west of the Borough via northbound Walnut Street and westbound Northampton Street.

iii. Since left turns would no-longer be permitted from Northampton Street onto Chestnut Street, the delay and queueing associated with the existing permissive left turn movement would be eliminated. Further, since Northampton Street west of Chestnut Street would be one-way (2-lanes westbound), two westbound through lanes could be provided at the Northampton / Chestnut Street intersection to increase capacity and further reduce vehicle queues.

2. On-street parking in the vicinity of one-way streets is largely un-affected.

3. The proposed one-way pattern on westbound Northampton Street allows for additional roadway width to accommodate southbound left turning vehicles from Chestnut Street onto westbound Northampton Street (note: consideration was given to relocating all southbound truck traffic to southbound SR 512, and then providing access to Race Street via Mill Street, however, this would require the razing of the historic property at the northeast corner of the Walnut Street / Mill Street intersection – The proposed one-way pattern provides an alternate truck route that preserves existing architecture).

4. The proposed one-way pattern eliminates the confusing and frustrating signage configuration at the Main Street intersections with Race and Chestnut Streets. Right-turns into the one-way pattern from Race Street are accommodated by a simple yield right turn similar to that of a roundabout.

5. The PennDOT programmed improvements to the Main Street and Northampton Street Intersection are complimentary to transitioning to a one-way pattern. With some minor island and striping adjustments, the two-way western approach of Main Street splits into one-way operation in a manner similar to that of a roundabout.

Implementation of the above described one-way pattern will result in the following required improvements:

1. Acquisition of the entire property at the southwest corner of Main/Race Street intersection, and associated radius improvements to accommodate southbound trucks destined to Race Street.

2. Radius improvements at the southeast corner of the Main/Race Street intersection. Some minor property acquisition will be required, however, the existing structure will remain.

3. Radius improvements at the northeast corner of the Walnut/Main Street intersection. This improvement will require property acquisition, utility relocation, and reconfiguration of the retail parking area, however the existing businesses will remain.

4. Reconfiguration of the internal island and striping at the intersection of Main/Northampton Streets.

5. Radius improvements at the northwest corner of the Northampton/Chestnut Street intersection. Some minor property acquisition may be required however the existing structure will remain.

6. General striping and signage modifications.

E. Additional Intersection Radius Improvements (not associated with the proposed one-way traffic pattern)

In an effort to maintain and/or improve truck mobility through the Borough, the following Intersection radius improvements are proposed (Note: the determination of where radius improvements are required is based in part on the volume of daily truck traffic and the presence of adequate routes to access the nearby interstate highway system and surrounding properties/businesses – see Daily Truck Volumes figure located in the appendix):

1. Acquisition of the entire property at the southeast corner of the Walnut/Northampton Street intersection, and associated radius improvements to accommodate trucks with destinations to the east on Northampton Street (SR 248).

2. Acquisition of the entire property at the southwest corner of the Walnut/Main Street intersection, and associated radius improvements to accommodate trucks with destinations to the south on Walnut Street (SR 512).

3. Radius improvements at the northeast corner of the Walnut/Northampton Street intersection. Some minor property acquisition may be required however the existing structure will remain.

V. Step 5 – Identify Project Phases

The above identified MLRTIP has been divided into phases that consecutively build on each other towards the completion of the entire Plan. Depending on the availability of project funding and the general consensus of the Department and the Borough regarding the timeliness of the need to implement various portions of the MLRTIP, the project phases could be broken up differently or the project could be constructed as a single project without phasing.

The proposed phases have been delineated in the attached Concept Plans.

VI. Conclusion

In light of the above analysis and supporting documentation contained in this report, we believe that above described MLRTIP should be further pursued. In that regard, we recommend that proposed MLRTIP be studied in further detail as part of a Traffic Impact Study prior to final acceptance by the Borough and PennDOT. Specifically, the study should include the following:

- Existing, No- Build, and Build Analyses (5 and 20-year projections) for the MLRTIP
- Macro-analysis using HCM 2010 methodologies and Synchro v. 10 (LOS and 95th Percentile Back of Queue)
- Micro-simulation analysis using SimTraffic (travel time comparison)
- Geometric Review of Proposed intersection Improvements (identifying property acquisitions required).

In addition to preparation of the above Traffic and Preliminary design study, we also recommend further coordination and consideration with the *Bath Multimodal Safety + Parking Analysis* prepared by the Lehigh Valley Planning Commission.

The Borough and KCE look forward to further dialogue with PennDOT, and the LVPC as we collectively work towards improving mobility in the Borough of Bath.

Data Collection

10 Intersections, 12-Hours of Traffic Data including the following:

- Turning Movement Counts
- Upstream Demand Volume Count
- Queue Recording
- Travel Time Measurement
- O-D Patterns Confirmed from Captured Vehicles
- Intersection Video

Traffic volumes were observed to be highly variable

DESIGNED BY:		REVISIONS		**TRAFFIC VOLUMES - 2019 PM PEAK HOUR**	KEYSTONE CONSULTING ENGINEERS, INC.
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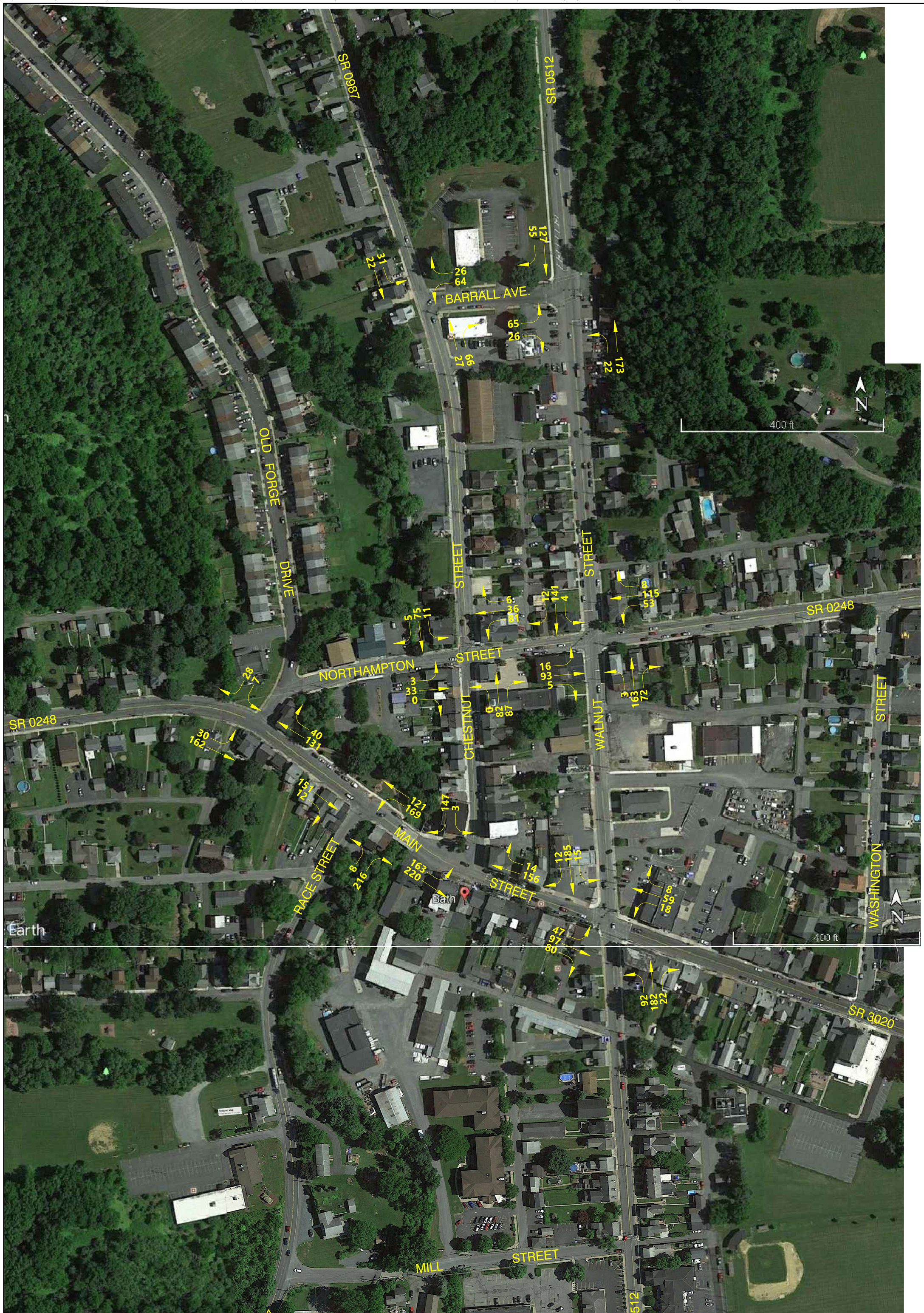

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DAILY TRUCK VOLUMES

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

GRAPHIC SCALE
80' 0 40' 80' 160'
SCALE: 1" = 80'

SLANTED TEXT INDICATES EXISTING FEATURES
STRAIGHT TEXT INDICATES PROPOSED FEATURES

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Borough of Bath - Long-Range Transportation Improvement Plan

Summary of Potential Mitigation Strategies[1]

Probable Causes of Existing Traffic Congestion (See Section II)		Potential Mitigation Strategies Considered (See Section III)						
		III.A.	III.B.	III.C.	III.D.	III.E.	III.F.	III.G.
		Truck Traffic Diversion/Turn Restrictions	Adaptive Traffic Control Technologies	Provision of Left-Turn Lanes	Implementation of One-Way Traffic Patterns	Provision of Roundabouts	Impelmentation of TDM Strategies	Provision of Intersection Geometry Improvements
II.A.	Heavy Traffic Volumes	Recommended		Recommended	Recommended	Not Recommended	Not Recommended	
II.B.	Close Intersection Spacing / Traffic Flow Patterns	Recommended		Recommended	Recommended	Not Recommended		
II.C.	Confined Intersection Geometry	Recommended						Recommended
II.D.	Left Turns from Single Lane Approaches	Recommended		Recommended	Recommended	Not Recommended		
II.E.	Friction from On-Street Parking Manuevers							
II.F.	Driver Confusion/Frustration Due to Existing Sign Configuration				Recommended	Not Recommended		
II.G.	Variable Traffic Patterns		Recommended			Not Recommended		
II.H.	Static Signal Timings		Recommended		Recommended	Not Recommended		

Notes:

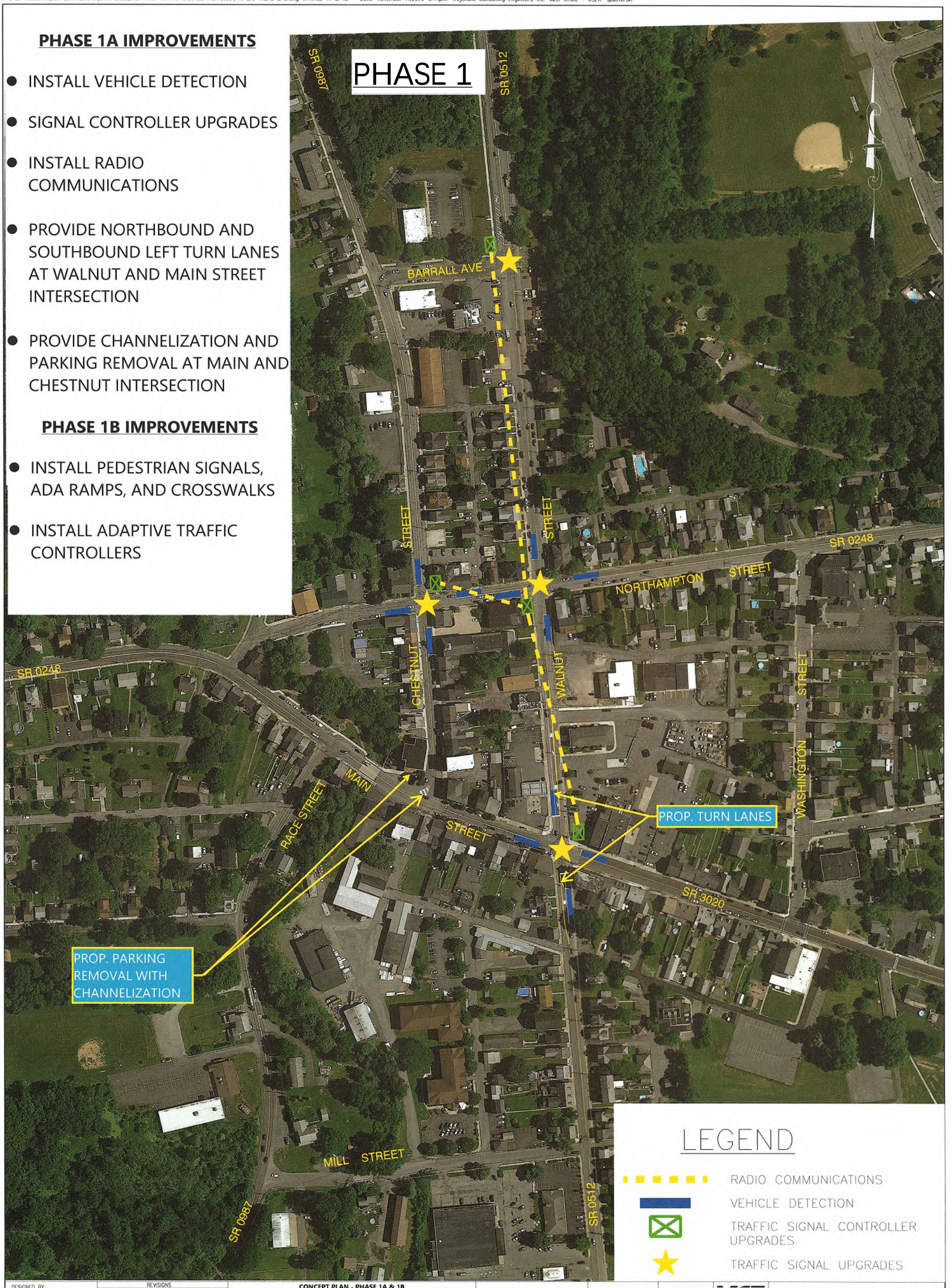
1. **"Recommended"** indicates that a potential mitigation strategy is both effective and recommended for use in the Borough of Bath; **"Not Recommended"** indicates that a potential mitigation strategy would be effective, but is not recommended for implementation due to reasons discussed in Section III of this report; Shaded cells indicate that a potential mitigation strategy is not expected to be effective and has therefore not been considered.

PHASE 1A IMPROVEMENTS

- INSTALL VEHICLE DETECTION
- SIGNAL CONTROLLER UPGRADES
- INSTALL RADIO COMMUNICATIONS
- PROVIDE NORTHBOUND AND SOUTHBOUND LEFT TURN LANES AT WALNUT AND MAIN STREET INTERSECTION
- PROVIDE CHANNELIZATION AND PARKING REMOVAL AT MAIN AND CHESTNUT INTERSECTION

PHASE 1B IMPROVEMENTS

- INSTALL PEDESTRIAN SIGNALS, ADA RAMPS, AND CROSSWALKS
- INSTALL ADAPTIVE TRAFFIC CONTROLLERS



DESIGNED BY:	REVISIONS	CONCEPT PLAN - PHASE 1A & 1B	KEYSTONE CONSULTING ENGINEERS, INC.
DRAWN BY: GJG	NO. DATE DESCRIPTION	2019 ENGINEERING AND TRAFFIC SURVEY	Engineering firm of choice since 1972
CHECKED BY:		BOROUGH OF BATH, NORTHAMPTON COUNTY, PENNSYLVANIA	6235 Hamilton Blvd., Wescosville, PA 18106 - 610-395-0971
DATE: 11/05/19		GRAPHIC SCALE 80' 0 40' 80' 160' SCALE: 1" = 80'	East Office: Bethlehem, West Office: Wescosville, North Office: Kresgeville
SCALE: 1"=80'		SLANTED TEXT INDICATES EXISTING FEATURES STRAIGHT TEXT INDICATES PROPOSED FEATURES	www.KCEinc.com
JOB NUMBER: BATH-18-008			KCE KEYSTONE CONSULTING ENGINEERS
SHEET: 1 OF 1			

F:\KCE Accounts\Bath\BATH_2018\BATH18008_ADAPTIVE TRAFFIC SIGNALIZATION\GJG\PHASES 1A_1B & 2.dwg->PHASE 2 Date: November 12,2019-9:59am Keystone Consulting Engineers, Inc. West Office - USER: sposterski

PHASE 2

SR 0987

SR 0512

PROP. RADIUS IMPROVEMENT

BARRALL AVE.

PROP. TURN LANE IMPROVEMENTS

PROP. OFF-STREET PARKING (NET GAIN OF ABOUT 10 SPACES)

PROP. TURN LANE IMPROVEMENTS

OLD FORGE DRIVE

STREET

STREET

SR 0248

NORTHAMPTON STREET

PROP. RADIUS IMPROVEMENT & PROP. ACQUISITION W/ OFF-STREET PARKING (8 SPACES)

SR 0248

CHESTNUT

WALNUT

STREET

INTERSECTION AND BRIDGE IMPROVEMENTS (BY OTHERS)

MAIN

RACE STREET

STREET

WASHINGTON

PROP. RADIUS IMPROVEMENT AND PROPERTY ACQUISITION

PROP. OFF-STREET PARKING (NET GAIN OF ABOUT 80 SPACES)

SR 3020

PROP. TURN LANE IMPROVEMENTS

POTENTIAL RADIUS IMPROVEMENTS (REQUIRES ACQUISITION)

PROP. RADIUS IMPROVEMENTS (REQUIRES PARKING RECONFIGURATION FOR BATH DRUG)

PROP. TRUCK DIVERSION ROUTE

MILL STREET

SR 0987

SR 0512

BRIDGE WIDENING (BY OTHERS)

NOTES:

1. PHASE 1 IMPROVEMENTS REMAIN IN EFFECT IN PHASE 2 UNLESS OTHERWISE SPECIFIED.

2. PROP. TURN LANE AREAS REQUIRE REQUIRE ELIMINATION OF 81 ON-STREET PARKING SPACES TOTAL (98 NEW OFF-STREET SPACES PROVIDED FOR A NET GAIN OF 17 SPACES).

LEGEND

- PROPOSED PAVEMENT WIDENING
- PROPOSED CONCRETE/SIDEWALK
- PROPERTY ACQUISITION
- TRAFFIC SIGNAL INSTALLATION

DESIGNED BY:	
DRAWN BY:	GJG
CHECKED BY:	
DATE:	11/08/19
SCALE:	1"=80'
JOB NUMBER:	BATH-18-008
SHEET:	1 OF 1

REVISIONS

NO.	DATE	DESCRIPTION

CONCEPT PLAN - PHASE 2

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

GRAPHIC SCALE
80' 0 40' 80' 160'
SCALE: 1" = 80'

SLANTED TEXT INDICATES EXISTING FEATURES
STRAIGHT TEXT INDICATES PROPOSED FEATURES

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PHASE 3 (FINAL)

SR 0987

SR 0512

BARRALL AVE.

PROP. ISLAND AND STRIPING RECONFIGURATION TO ACCOMMODATE ONE-WAY PATTERN

PROVIDE TWO (2) WESTBOUND THROUGH LANES TO MINIMIZE QUEUING

PROPOSED ONE-WAY COUNTER-CLOCK WISE TRAFFIC PATTERN

FREE-FLOW INTERSECTION WITH CHANNELIZING ISLAND (MONUMENT OPPORTUNITY)

PROP. RADIUS IMPROVEMENT (REQUIRES PARKING RECONFIGURATIO)

OLD FORGE DRIVE

STREET

NORTHAMPTON STREET

SR 0248

CHESTNUT

WALNUT

WASHINGTON STREET

RACE STREET

MAIN STREET

SR 3020

MILL STREET

NOTE: PHASE 2 IMPROVEMENTS REMAIN IN EFFECT IN PHASE 3 UNLESS OTHERWISE SPECIFIED.

LEGEND

- PROPOSED PAVEMENT WIDENING
- POTENTIAL PAVEMENT WIDENING
- PROPOSED CONCRETE

DESIGNED BY:	
DRAWN BY:	GJC
CHECKED BY:	
DATE:	11/05/19
SCALE:	1"=80'
JOB NUMBER:	BATH-18-008
SHEET:	1 OF 1

REVISIONS

NO.	DATE	DESCRIPTION

MASTER LONG-RANGE TRANSPORTATION IMPROVEMENTS PLAN (PHASE 3)

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

GRAPHIC SCALE
80' 0 40' 80' 160'
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TRUCK ROUTES - FROM RACE STREET

SR 0987

SR 0512

SR 0248

OLD FORGE DRIVE

STREET

CHESTNUT STREET

WALNUT STREET

NORTHAMPTON STREET

WASHINGTON STREET

RACE STREET

MAIN STREET

SR 3020

MILL STREET

LEGEND

- PROPOSED PAVEMENT WIDENING
- POTENTIAL PAVEMENT WIDENING
- PROPOSED CONCRETE

DESIGNED BY:		
DRAWN BY:	GJG	
CHECKED BY:		
DATE:	11/05/19	
SCALE:	1"=80'	
JOB NUMBER:	BATH-18-008	
SHEET	1 OF 1	

REVISIONS		
NO.	DATE	DESCRIPTION

MASTER LONG-RANGE TRANSPORTATION IMPROVEMENTS PLAN (PHASE 3)

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

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TRUCK ROUTES - FROM WALNUT STREET (SOUTH)

SR 0987
SR 0512
SR 0248
SR 0245
SR 3020
OLD FORGE DRIVE
CHESTNUT STREET
WALNUT STREET
WASHINGTON STREET
NORTHAMPTON STREET
RACE STREET
MAIN STREET
MILL STREET

LEGEND

- PROPOSED PAVEMENT WIDENING
- POTENTIAL PAVEMENT WIDENING
- PROPOSED CONCRETE

DESIGNED BY	
DRAWN BY:	GJG
CHECKED BY:	
DATE:	11/05/19
SCALE:	1"=80'
JOB NUMBER	BATH-18-008
SHEET:	1 OF 1

REVISIONS

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MASTER LONG-RANGE TRANSPORTATION IMPROVEMENTS PLAN (PHASE 3)

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

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TRUCK ROUTES - FROM MAIN STREET (EAST)

SR 0987

SR 0512

BARRA CAVE

OLD FORGE DRIVE

STREET

STREET

SR 0248

NORTHAMPTON STREET

SR 0248

CHESTNUT

WALNUT

WASHINGTON STREET

RACE STREET

MAIN STREET

SR 3020

MILL STREET

SR 0987

SR 0512

LEGEND

PROPOSED PAVEMENT WIDENING

POTENTIAL PAVEMENT WIDENING

PROPOSED CONCRETE

DESIGNED BY:
DRAWN BY: GJG
CHECKED BY:
DATE: 11/05/19
SCALE: 1"=80'
JOB NUMBER: BATH-18-008
SHEET: 1 OF 1

REVISIONS

NO.	DATE	DESCRIPTION

MASTER LONG-RANGE TRANSPORTATION IMPROVEMENTS PLAN (PHASE 3)

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

GRAPHIC SCALE
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F:\KCE Accounts\Bath\BATH_2018\BATH18008_ADAPTIVE TRAFFIC SIGNALIZATION\GJG\PHASE 3.dwg->PHASE 3 Date: November 12,2019-10:56am Keystone Consulting Engineers, Inc. West Office - USER: spasterski

TRUCK ROUTES - FROM NORTHAMPTON STREET (EAST)

SR 0987
SR 0512
OLD FORGE DRIVE
STREET
NORTHAMPTON STREET
SR 0248
CHESTNUT STREET
WALNUT STREET
WASHINGTON STREET
RACE STREET
MAIN STREET
SR 3020
MILL STREET

LEGEND

- PROPOSED PAVEMENT WIDENING
- POTENTIAL PAVEMENT WIDENING
- PROPOSED CONCRETE

DESIGNED BY:	
DRAWN BY:	GJG
CHECKED BY:	
DATE:	11/05/19
SCALE:	1"=80'
JOB NUMBER:	BATH-18-008
SHEET:	1 OF 1

REVISIONS

NO.	DATE	DESCRIPTION

MASTER LONG-RANGE TRANSPORTATION IMPROVEMENTS PLAN (PHASE 3)

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

GRAPHIC SCALE
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TRUCK ROUTES - FROM WALNUT STREET (NORTH)

SR 0987

SR 0512

OLD FORGE DRIVE

CHESTNUT STREET

WALNUT STREET

NORTHAMPTON STREET

SR 0248

WASHINGTON STREET

RACE STREET

MAIN STREET

SR 3020

MILL STREET

LEGEND

- PROPOSED PAVEMENT WIDENING
- POTENTIAL PAVEMENT WIDENING
- PROPOSED CONCRETE

DESIGNED BY:	
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DATE:	11/05/19
SCALE:	1"=80'
JOB NUMBER:	BATH-18-008
SHEET:	1 OF 1

REVISIONS

NO.	DATE	DESCRIPTION

MASTER LONG-RANGE TRANSPORTATION IMPROVEMENTS PLAN (PHASE 3)

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

GRAPHIC SCALE
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TRUCK ROUTES - FROM CHESTNUT STREET

SR 1087
SR 0512
OLD FORGE DRIVE
CHESTNUT STREET
WALNUT STREET
NORTHAMPTON STREET
SR 0248
WASHINGTON STREET
MAIN STREET
MILL STREET
SR 3020

LEGEND

- PROPOSED PAVEMENT WIDENING
- POTENTIAL PAVEMENT WIDENING
- PROPOSED CONCRETE

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JOB NUMBER:	BATH-18-008
SHEET:	1 OF 1

REVISIONS

NO.	DATE	DESCRIPTION

MASTER LONG-RANGE TRANSPORTATION IMPROVEMENTS PLAN (PHASE 3)

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

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TRUCK ROUTES - FROM MAIN STREET (WEST)

SR 0987

SR 0512

BARRACK AVE.

OLD FORGE DRIVE

STREET

NORTHAMPTON STREET

SR 0248

CHESTNUT STREET

WASHINGTON STREET

RACE STREET

MAIN STREET

SR 3020

MILL STREET

SR 0987

SR 0512

LEGEND

- PROPOSED PAVEMENT WIDENING
- POTENTIAL PAVEMENT WIDENING
- PROPOSED CONCRETE

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MASTER LONG-RANGE TRANSPORTATION IMPROVEMENTS PLAN (PHASE 3)

2019 ENGINEERING AND TRAFFIC SURVEY

BOROUGH OF BATH
NORTHAMPTON COUNTY, PENNSYLVANIA

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